WAKE COUNTY
NORTH CAROLINA

Wake County, North Carolina

Multi-Jurisdictional Hazard Mitigation Plan

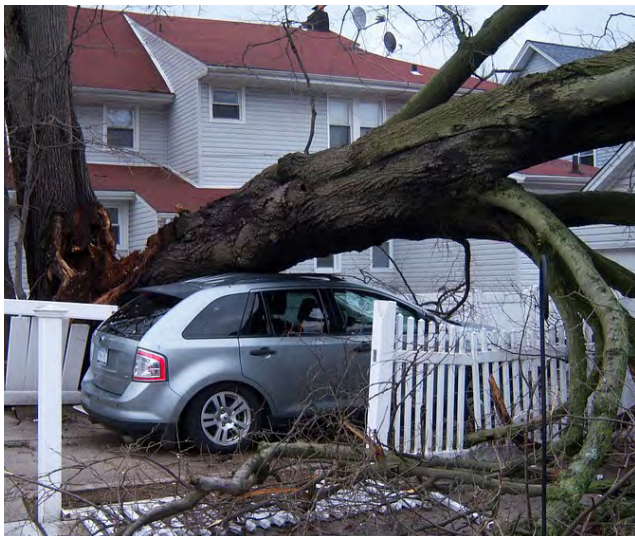

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TABLE OF CONTENTS

1 Introduction 1
1.1 Background 1
1.2 Purpose and Authority 2
1.3 Scope 2
1.4 References 3
1.5 Plan Organization 3
2 Planning Process 4
2.1 Purpose and Vision 4
2.2 What's Changed in the Plan 5
2.3 Preparing the Plan 6
2.3.1 Phase I – Planning Process 7
2.3.2 Phase II – Risk Assessment 8
2.3.3 Phase III – Mitigation Strategy 8
2.3.4 Phase IV – Plan Maintenance 9
2.4 Hazard Mitigation Planning Committee 9
2.5 Meetings and Workshops 11
2.6 Involving the Public 12
2.7 Outreach Efforts 13
2.8 Involving the Stakeholders 14
2.9 Documentation of Plan Progress 14
3 Planning Area Profile 24
3.1 Geography and Environment 24
3.2 Population and Demographics 30
3.3 Parcels and Buildings 34
3.4 Historic Properties 34
3.5 Housing 40
3.6 Infrastructure 41
3.6.1 Transportation 41
3.6.2 Utilities 41
3.7 Current and Future Land Use 42
3.8 Employment and Industry 44
3.8.1 Wages and Employment 44
4 Risk Assessment 46
4.1 Overview 46

4.2 Hazard Identification 47
4.3 Risk Assessment Methodology and Assumptions 51
4.4 Asset Inventory 55
4.5 Hazard Profiles, Analysis, and Vulnerability 61
4.5.1 Dam Failure 61
4.5.2 Drought 72
4.5.3 Earthquake 79
4.5.4 Extreme Heat 92
4.5.5 Flood 98
4.5.6 Landslide 115
4.5.7 Hurricane and Tropical Storm 121
4.5.8 Severe Weather (Thunderstorm Winds, Lightning & Hail) 135
4.5.9 Severe Winter Storm 153
4.5.10 Tornado 159
4.5.11 Wildfire 172
4.5.12 Hazardous Materials Incident 186
4.5.13 Radiological Incident 194
4.5.14 Terrorism 202
4.6 Conclusions on Hazard Risk 208
5 Capability Assessment 210
5.1 Overview 210
5.2 Methodology 210
5.3 Capability Assessment Findings 211
5.3.1 Planning and Regulatory Capability 211
5.3.2 Administrative and Technical Capability 218
5.3.3 Fiscal Capability 220
5.3.4 Education and Outreach Capability 221
5.3.5 Mitigation Capability 222
5.3.6 Political Capability 222
5.3.7 Local Self-Assessment Rating 223
5.4 Conclusions on Local Capability 225
6 Mitigation Strategy 226
6.1 Goals and Objectives 226
6.1.1 Coordination with Other Planning Efforts 226
6.1.2 Goal Setting 226
6.1.3 Resulting Goals and Objectives 227
6.2 Identification and Analysis of Mitigation Activities 229

6.2.1 Prioritization Process 229
7 Mitigation Action Plans 231
8 Plan Maintenance 256
8.1 Implementation 256
8.2 Monitoring, Evaluation, and Enhancement 258
8.2.1 Role of HMPC in Implementation, Monitoring and Maintenance 258
8.2.2 Maintenance Schedule 258
8.2.3 Maintenance Evaluation Process 258
8.3 Continued Public Involvement 260
9 Plan Adoption 261
Annex A Wake County Unincorporated Areas 262
A.1 Planning Process 262
A.2 Community Profile 262
A.3 Risk Assessment 267
A.3.1 Dam Failure 267
A.3.2 Flood 270
A.3.3 Wildfire 273
A.4 Capability Assessment 277
A.4.1 Overall Capability 277
A.4.2 Floodplain Management 277
A.5 Mitigation Strategy 279
Annex B City of Raleigh 280
B.1 Planning Process 280
B.2 Community Profile 280
B.3 Risk Assessment 288
B.3.1 Flood 288
B.3.2 Wildfire 293
B.4 Capability Assessment 297
B.4.1 Overall Capability 297
B.4.2 Floodplain Management 297
B.5 Mitigation Strategy 299
Annex C Town of Apex 302
C.1 Planning Process 302
C.2 Community Profile 302
C.3 Risk Assessment 308
C.3.1 Flood 308

C.3.2 Wildfire 312
C.4 Capability Assessment 316
C.4.1 Overall Capability 316
C.4.2 Floodplain Management 316
C.5 Mitigation Strategy 318
Annex D Town of Cary 320
D.1 Planning Process 320
D.2 Community Profile 320
D.3 Risk Assessment 325
D.3.1 Flood 325
D.3.2 Wildfire 329
D.4 Capability Assessment 333
D.4.1 Overall Capability 333
D.4.2 Floodplain Management 333
D.5 Mitigation Strategy 335
Annex E Town of Fuquay-Varina 337
E.1 Planning Process 337
E.2 Community Profile 337
E.3 Risk Assessment 342
E.3.1 Flood 342
E.3.2 Wildfire 346
E.4 Capability Assessment 350
E.4.1 Overall Capability 350
E.4.2 Floodplain Management 350
E.5 Mitigation Strategy 352
Annex F Town of Garner 354
F.1 Planning Process 354
F.2 Community Profile 354
F.3 Risk Assessment 359
F.3.1 Flood 359
F.3.2 Wildfire 363
F.4 Capability Assessment 367
F.4.1 Overall Capability 367
F.4.2 Floodplain Management 367
F.5 Mitigation Strategy 369
Annex G Town of Holly Springs 371

G.1 Planning Process 371
G.2 Community Profile 371
G.3 Risk Assessment 376
G.3.1 Flood 376
G.3.2 Wildfire 380
G.4 Capability Assessment 384
G.4.1 Overall Capability 384
G.4.2 Floodplain Management 384
G.5 Mitigation Strategy 386
Annex H Town of Knightdale 389
H.1 Planning Process 389
H.2 Community Profile 389
H.3 Risk Assessment 394
H.3.1 Flood 394
H.3.2 Wildfire 398
H.4 Capability Assessment 402
H.4.1 Overall Capability 402
H.4.2 Floodplain Management 402
H.5 Mitigation Strategy 404
Annex I Town of Morrisville 405
I.1 Planning Process 405
I.2 Community Profile 405
I.3 Risk Assessment 410
I.3.1 Flood 410
I.3.2 Wildfire 414
I.4 Capability Assessment 418
I.4.1 Overall Capability 418
I.4.2 Floodplain Management 418
I.5 Mitigation Strategy 420
Annex J Town of Rolesville 422
J.1 Planning Process 422
J.2 Community Profile 422
J.3 Risk Assessment 427
J.3.1 Flood 427
J.3.2 Wildfire 431
J.4 Capability Assessment 435

J.4.1 Overall Capability 435
J.4.2 Floodplain Management 435
J.5 Mitigation Strategy 437
Annex K Town of Wake Forest 438
K.1 Planning Process 438
K.2 Community Profile 438
K.3 Risk Assessment 443
K.3.1 Flood 443
K.3.2 Wildfire 447
K.4 Capability Assessment 451
K.4.1 Overall Capability 451
K.4.2 Floodplain Management 451
K.5 Mitigation Strategy 453
Annex L Town of Wendell 455
L.1 Planning Process 455
L.2 Community Profile 455
L.3 Risk Assessment 460
L.3.1 Flood 460
L.3.2 Wildfire 464
L.4 Capability Assessment 468
L.4.1 Overall Capability 468
L.4.2 Floodplain Management 468
L.5 Mitigation Strategy 470
Annex M Town of Zebulon 472
M.1 Planning Process 472
M.2 Community Profile 472
M.3 Risk Assessment 477
M.3.1 Flood 477
M.3.2 Wildfire 481
M.4 Capability Assessment 485
M.4.1 Overall Capability 485
M.4.2 Floodplain Management 485
M.5 Mitigation Strategy 487
Appendix A Plan Review Tool A.1
Appendix B Planning Process Documentation B.1
Appendix C Mitigation Alternatives C.1

C.1 Categories of Mitigation Measures Considered C.1
C.2 Alternative Mitigation Measures per Category C.1
C.2.1 Preventative and Regulatory Measures C.1
C.2.2 Property Protection Measures C.6
C.2.3 Natural Resource Protection C.10
C.2.4 Emergency Services Measures C.13
C.2.5 Structural Projects C.17
C.2.6 Public Information C.19
Appendix D References D.1

1 Introduction

Section 1 provides a general introduction to hazard mitigation and an introduction to the Wake County Multi-Jurisdictional Hazard Mitigation Plan. This section contains the following subsections:

- 1.1 Background
- 1.2 Purpose and Authority
- 1.3 Scope
- 1.4 References
- 1.5 Plan Organization

1.1 BACKGROUND

This document comprises a Hazard Mitigation Plan for Wake County, North Carolina and its incorporated municipalities.

Each year in the United States, natural and human-caused hazards take the lives of hundreds of people and injure thousands more. Nationwide, taxpayers pay billions of dollars annually to help communities, organizations, businesses, and individuals recover from disasters. These monies only partially reflect the true cost of disasters because additional expenses incurred by insurance companies and non-governmental organizations are not reimbursed by tax dollars. Many natural hazards are predictable, and much of the damage caused by hazard events can be reduced or even eliminated.

Hazards are a natural part of the environment that will inevitably continue to occur, but there is much we can do to minimize their impacts on our communities and prevent them from resulting in disasters. Every community faces different hazards, has different resources to draw upon in combating problems, and has different interests that influence the solutions to those problems. Because there are many ways to deal with hazards and many agencies that can help, there is no one solution for managing or mitigating their effects. Planning is one of the best ways to develop a customized program that will mitigate the impacts of hazards while accounting for the unique character of a community.

A well-prepared hazard mitigation plan will ensure that all possible activities are reviewed and implemented so that the problem is addressed by the most appropriate and efficient solutions. It can also ensure that activities are coordinated with each other and with other goals and activities, preventing conflicts and reducing the costs of implementing each individual activity. This plan provides a framework for all interested parties to work together toward mitigation. It establishes the vision and guiding principles for reducing hazard risk and proposes specific mitigation actions to eliminate or reduce identified vulnerabilities.

In an effort to reduce the nation's mounting natural disaster losses, the U.S. Congress passed the Disaster Mitigation Act of 2000 (DMA 2000) to invoke new and revitalized approaches to mitigation planning. Section 322 of DMA 2000 emphasizes the need for state and local government entities to closely coordinate on mitigation planning activities and makes the development of a hazard mitigation plan a specific eligibility requirement for any local government applying for federal mitigation grant funds. These funds include the Hazard Mitigation Grant Program (HMGP), the Pre-Disaster Mitigation (PDM) program, and the Flood Mitigation Assistance (FMA) Program, all of which are administered by the Federal Emergency Management Agency (FEMA) under the Department of Homeland Security. Communities with an adopted and federally approved hazard mitigation plan thereby become pre-positioned and more apt to receive available mitigation funds before and after the next disaster strikes.

This plan was prepared in coordination with FEMA Region IV and the North Carolina Division of Emergency Management (NCEM) to ensure that it meets all applicable federal and state planning requirements. A Local Mitigation Plan Review Tool, found in Appendix A, provides a summary of FEMA's current minimum standards of acceptability and notes the location within this plan where each planning requirement is met.

1.2 PURPOSE AND AUTHORITY

This plan was developed in a joint and cooperative manner by members of a Hazard Mitigation Planning Committee (HMPC) which included representatives of County, City, and Town departments, federal and state agencies, citizens, and other stakeholders. This plan will ensure Wake County and its incorporated municipalities remain eligible for federal disaster assistance including the Federal Emergency Management Agency (FEMA) Hazard Mitigation Grant Program (HMGP), Pre-Disaster Mitigation Program (PDM), and the Flood Mitigation Assistance Program (FMA).

This Plan has been prepared in compliance with Section 322 of the Robert T. Stafford Disaster Relief and Emergency Assistance Act (Stafford Act or the Act), 42 U.S.C. 5165, enacted under Section 104 of the Disaster Mitigation Act of 2000, (DMA 2000) Public Law 106-390 of October 30, 2000, as implemented at CFR 201.6 and 201.7 dated October 2007.

This plan will be adopted by each participating jurisdiction in accordance with standard local procedures. Copies of adoption resolutions are provided in Section 9 Plan Adoption.

1.3 SCOPE

This document comprises a Multi-Jurisdictional Hazard Mitigation Plan for Wake County. The planning areas includes all of Wake County's incorporated municipalities and unincorporated areas. All participating jurisdictions are listed in Table 1.1.

Table 1.1 – Participating Jurisdictions in the Wake County Multi-Jurisdictional Hazard Mitigation Plan

Wake County	
Apex	Morrisville
Cary	Raleigh
Fuquay-Varina	Rolesville
Garner	Wake Forest
Holly Springs	Wendell
Knightdale	Zebulon

The focus of this plan is on those hazards deemed "high" or "moderate" priority hazards for the planning area, as determined through the risk and vulnerability assessments. Lower priority hazards will continue to be evaluated but will not necessarily be prioritized for mitigation in the action plan.

Wake County followed the planning process prescribed by the Federal Emergency Management Agency (FEMA), and this plan was developed under the guidance of a Hazard Mitigation Planning Committee (HMPC) comprised of representatives of County, City, and Town departments; citizens; and other stakeholders. The HMPC conducted a risk assessment that identified and profiled hazards that pose a risk to the planning area, assessed the planning area's vulnerability to these hazards, and examined each participating jurisdiction's capabilities in place to mitigate them. The hazards profiled in this plan include:

- Dam Failure
- Drought
- Earthquake
- Extreme Heat
- Flood

- Hurricane and Tropical Storm
- Landslide
- Severe Weather (Thunderstorm Winds, Hail, and Lightning)
- Severe Winter Storm
- Tornado
- Wildfire
- Hazardous Materials Incident
- Radiological Incident
- Terrorism

1.4 REFERENCES

The following FEMA guides and reference documents were used to prepare this document:

- FEMA 386-1: Getting Started. September 2002.
- FEMA 386-2: Understanding Your Risks: Identifying Hazards and Estimating Losses. August 2001.
- FEMA 386-3: Developing the Mitigation Plan. April 2003.
- FEMA 386-4: Bringing the Plan to Life. August 2003.
- FEMA 386-5: Using Benefit-Cost Review in Mitigation Planning. May 2007.
- FEMA 386-6: Integrating Historic Property and Cultural Resource Considerations into Hazard Mitigation Planning. May 2005.
- FEMA 386-7: Integrating Manmade Hazards into Mitigation Planning. September 2003.
- FEMA 386-8: Multijurisdictional Mitigation Planning. August 2006.
- FEMA 386-9: Using the Hazard Mitigation Plan to Prepare Successful Mitigation Projects. August 2008.
- FEMA. Local Mitigation Planning Handbook. March 2013.
- FEMA. Local Mitigation Plan Review Guide. October 1, 2011.
- FEMA National Fire Incident Reporting System 5.0: Complete Reference Guide. January, 2008.
- FEMA Hazard Mitigation Assistance Unified Guidance. June 1, 2010.
- FEMA. Integrating Hazard Mitigation into Local Planning: Case Studies and Tools for Community Officials. March 1, 2013.
- FEMA. Mitigation Ideas. A Resource for Reducing Risk to Natural Hazards. January 2013.

Additional sources used in the development of this plan, including data compiled for the Hazard Identification and Risk Assessment, are listed in Appendix D.

1.5 PLAN ORGANIZATION

The Wake County Multi-Jurisdictional Hazard Mitigation Plan is organized into the following sections:

- Section 2: Planning Process
- Section 3: Planning Area Profile
- Section 4: Hazard Identification & Risk Assessment
- Section 5: Capability Assessment
- Section 6: Mitigation Strategy
- Section 7: Mitigation Action Plans
- Section 8: Plan Adoption
- Section 9: Plan Implementation and Maintenance
- Appendix A: Local Plan Review Tool
- Appendix B: Planning Process Documentation
- Appendix C: Mitigation Alternatives
- Appendix D: References

2 Planning Process

Requirement §201.6(b): An open public involvement process is essential to the development of an effective plan. To develop a more comprehensive approach to reducing the effects of natural disasters, the planning process shall include:
1) An opportunity for the public to comment on the plan during the drafting stage and prior to plan approval;
2) An opportunity for neighboring communities, local and regional agencies involved in hazard mitigation activities, and agencies that have the authority to regulate development, as well as businesses, academia, and other private and nonprofit interests to be involved in the planning process; and
3) Review and incorporation, if appropriate, of existing plans, studies, reports, and technical information.
Requirement §201.6(c)(1): The plan shall include the following:
1) Documentation of the planning process used to develop the plan, including how it was prepared, who was involved in the process, and how the public was involved.

This section provides a review of the planning process followed for the development of the Wake County Multi-Jurisdictional Hazard Mitigation Plan. It consists of the following sub-sections:

- 2.1 Purpose and Vision
- 2.2 History of Hazard Mitigation Planning
- 2.3 Preparing the Plan
- 2.4 Hazard Mitigation Planning Committee
- 2.5 Meetings and Workshops
- 2.6 Involving the Public
- 2.7 Outreach Efforts
- 2.8 Involving the Stakeholders
- 2.9 Documentation of Plan Progress

2.1 PURPOSE AND VISION

As defined by FEMA, "hazard mitigation" means any sustained action taken to reduce or eliminate the long-term risk to life and property from a hazard event. Hazard mitigation planning is the process through which hazards are identified, likely impacts determined, mitigation goals set, and appropriate mitigation strategies determined, prioritized, and implemented.

The purpose of the Wake County Multi-Jurisdictional Hazard Mitigation Plan is to identify, assess, and mitigate hazard risk to better protect the people and property within Wake County from the effects of natural and human-caused hazards. This plan documents progress on existing hazard mitigation planning efforts, updates the previous plan to reflect current conditions in the County including relevant hazards and vulnerabilities, increases public education and awareness about the plan and planning process, maintains grant eligibility for participating jurisdictions, maintains compliance with state and federal requirements for local hazard mitigation plans, and identifies and outlines strategies the County and participating jurisdictions will use to decrease vulnerability and increase resiliency.

The Wake County Hazard Mitigation Planning Committee (HMPC) met in working groups on January 7th and January 9th, 2019; during these meetings, the HMPC discussed their vision for Wake County in terms of hazard mitigation planning. The committee was asked to consider what the successful implementation of the plan would achieve, what outcomes the plan would generate, and what Wake County will look like in five years as a way to brainstorm a vision statement for the plan. The HMPC developed and discussed a list of ideas that were consolidated into the following statement and set of key principles that they agreed should define and guide the planning process and the County's approach to hazard mitigation.

Wake County will build upon the success of its past efforts to become more resilient and adaptable to hazards, embrace the need to manage growth with sustainable practices, and make intentional, coordinated decisions that maximize long-term and shared benefits for all.

The following key principles underpin this vision and describe how the HMPC hopes to characterize the future of Wake County. In many cases, the County and its incorporated jurisdictions already operate with these principles in mind.

Resilient & Adaptable: Wake County will be able to quickly react to and recover from hazard events and will use both the development and post-disaster redevelopment processes to reduce existing vulnerabilities and future potential risk, including through identification and planning for vulnerable populations.

Sustainable: From an environmental mindset, Wake County will protect key ecological resources, and from a resource and efficiency perspective, the county will use administrative and financial resources in ways that maximize and share benefits.

Intentional: Wake County will address growth and development decisions by considering long-term outcomes, seeking opportunities for mitigation, minimizing risk and vulnerability, and implementing mitigation projects that can be scaled up or shared with other jurisdictions, if successful.

Coordinated: Wake County will integrate planning efforts across departments and across incorporated jurisdictions to ensure that goals and decisions reinforce each other. Additionally, jurisdictions will work together to address issues on larger scales, such as a watershed or ecosystem level.

2.2 WHAT'S CHANGED IN THE PLAN

This plan is an update to the 2015 Wake County Multi-jurisdictional Hazard Mitigation Plan, which included participation from all jurisdictions involved in this plan update. The previous plan was approved by FEMA on January 28, 2015.

This hazard mitigation plan update involved a comprehensive review and update of each section of the existing plan and an assessment of the success of the County and participating municipalities in evaluating, monitoring and implementing the mitigation strategy outlined in their existing plans. Only the information and data still valid from the existing plans was carried forward as applicable into this update. The following requirements were addressed during the development of this regional plan:

- Consider changes in vulnerability due to action implementation;
- Document success stories where mitigation efforts have proven effective;
- Document areas where mitigation actions were not effective;
- Document any new hazards that may arise or were previously overlooked;
- Incorporate new data or studies on hazards and risks;
- Incorporate new capabilities or changes in capabilities;
- Incorporate growth and development-related changes to inventories; and
- Incorporate new action recommendations or changes in action prioritization.

Section 4.2 provides a comparison of the hazards addressed in the 2018 State of North Carolina HMP and the existing Wake County plan and provides the final decision made by the HMPC as to which hazards should be included in the updated 2020 Wake County Multi-Jurisdictional Plan.

In addition to the specific changes in hazard analyses identified in Section 4.2, the following items were also addressed in this 2020 plan update:

- GIS was used, to the extent data allowed, to analyze the priority hazards as part of the vulnerability assessment.
- Assets at risk to identified hazards were identified by property type and values of properties based on North Carolina Emergency Management's IRISK Database.
- A discussion on climate change and its projected effect on specific hazards was included in each hazard profile in the risk assessment.
- The discussion on growth and development trends was enhanced utilizing 2017 American Community Survey data.
- Enhanced public outreach and agency coordination efforts were conducted throughout the plan update process in order to meet the more rigorous requirements of the 2017 CRS Coordinator's Manual, in addition to DMA requirements.

2.3 PREPARING THE PLAN

The planning process for preparing the Wake County Multi-jurisdictional Hazard Mitigation Plan was based on DMA planning requirements and FEMA's associated guidance. This guidance is structured around a four-phase process:

1) Planning Process;
2) Risk Assessment;
3) Mitigation Strategy; and
4) Plan Maintenance.

Into this process, the planning consultant integrated a more detailed 10-step planning process used for FEMA's Community Rating System (CRS) and Flood Mitigation Assistance programs. Thus, the modified 10-step process used for this plan meets the requirements of six major programs: FEMA's Hazard Mitigation Grant Program; Pre-Disaster Mitigation Program; Community Rating System; Flood Mitigation Assistance Program; Severe Repetitive Loss Program; and new flood control projects authorized by the U.S. Army Corps of Engineers.

Table 2.1 shows how the 10-step CRS planning process aligns with the four phases of hazard mitigation planning pursuant to the Disaster Mitigation Act of 2000.

Table 2.1 – Mitigation Planning and CRS 10-Step Process Reference Table

DMA Process	CRS Process
Phase I – Planning Process	
§201.6(c)(1)	Step 1. Organize to Prepare the Plan
§201.6(b)(1)	Step 2. Involve the Public
§201.6(b)(2) & (3)	Step 3. Coordinate
Phase II – Risk Assessment	
§201.6(c)(2)(i)	Step 4. Assess the Hazard
§201.6(c)(2)(ii) & (iii)	Step 5. Assess the Problem
Phase III – Mitigation Strategy	
§201.6(c)(3)(i)	Step 6. Set Goals
§201.6(c)(3)(ii)	Step 7. Review Possible Activities
§201.6(c)(3)(iii)	Step 8. Draft an Action Plan
Phase IV – Plan Maintenance	
§201.6(c)(5)	Step 9. Adopt the Plan
§201.6(c)(4)	Step 10. Implement, Evaluate and Revise the Plan

In addition to meeting DMA and CRS requirements, this plan also meets the recommended steps for developing a Community Wildfire Protection Plan (CWPP). Table 2.2 below outlines the recommended CWPP process and the CRS step and sections of this plan that meet each step.

Table 2.2 – Community Wildfire Protection Plan Process Reference

CWPP Process	CRS Step	Fulfilling Plan Section
Convene decision makers	Step 1	Section 2 – HMPC
Involve Federal agencies	Step 3	Section 2 – Involving Stakeholders
Engage interested parties (such as community representatives)	Step 1, 2, and 3	Section 2 – HMPC, Involving the Public, Involving Stakeholders
Establish a community base map		Section 4 – Wildfire
Develop a community risk assessment, including fuel hazards, risk of wildfire occurrence, homes, business and essential infrastructure at risk, other community values at risk, local preparedness, and firefighting capability	Step 4 and 5	Section 4 – Wildfire Section 5 – Capability
Establish community hazard reduction priorities and recommendations to reduce structural ignitability	Step 6, 7, and 8	Section 6 – Mitigation Strategy Section 7 – Mitigation Action Plans
Develop an action plan and assessment strategy	Step 8 and 10	Section 7 – Mitigation Action Plans Section 8 – Plan Maintenance
Finalize the CWPP	Step 9	Section 9 – Plan Adoption

The process followed for the preparation of this plan, as outlined in Table 2.1 above, is as follows:

2.3.1 Phase I – Planning Process

Planning Step 1: Organize to Prepare the Plan

With the County's commitment to participate in the DMA planning process, community officials worked to establish the framework and organization for development of the plan. An initial meeting was held with key community representatives to discuss the organizational aspects of the plan development process. The Wake County Emergency Management Deputy Director led the County's effort to reorganize and coordinate for the plan update. Consultants from Wood Environment and Infrastructure Solutions, Inc. assisted by leading the County through the planning process and preparing the plan document.

Planning Step 2: Involve the Public

Public involvement in the development of the plan was sought using various methods, as detailed in Section 2.6.

Planning Step 3: Coordinate

The HMPC formed for development of the 2015 Plan was reconvened for this plan update. More details on the HMPC are provided in Section 1.4. Stakeholder coordination was incorporated into the formation of the HMPC and was sought through additional outreach methods. These efforts are detailed in Section 1.8.

Coordination with Other Community Planning Efforts and Hazard Mitigation Activities

In addition to stakeholder involvement, coordination with other community planning efforts was also seen as paramount to the success of this plan. Mitigation planning involves identifying existing policies, tools, and actions that will reduce a community's risk and vulnerability to hazards. Wake County and its participating jurisdictions use a variety of planning mechanisms, such as Comprehensive Plans, subdivision regulations, building codes, and ordinances to guide growth and development. Integrating existing planning efforts, mitigation policies, and action strategies into this plan establishes a credible and

comprehensive plan that ties into and supports other community programs. As detailed in Table 2.3, the development of this plan incorporated information from existing plans, studies, reports, and initiatives as well as other relevant data from neighboring communities and other jurisdictions.

These and other documents were reviewed and considered, as appropriate, during the collection of data to support the planning process and plan development, including the hazard identification, vulnerability assessment, and capability assessment. Data from these sources was incorporated into the risk assessment and hazard vulnerability sections of the plan as appropriate. The data was also used in determining the capability of each jurisdiction to implement certain mitigation strategies. The Capability Assessment can be found in Section 5.

Table 2.3 – Summary of Existing Studies and Plans Reviewed

Resource Referenced	Use in this Plan
Local Comprehensive Plans (Wake County Comprehensive Plan, City of Raleigh 2030 Comprehensive Plan, etc.)	The Wake County Plan and City of Raleigh Plan were referenced in the Planning Area Profile in Section 3. Other local comprehensive plans were incorporated into Mitigation Action Plans where applicable in Section 7 and referenced in the Capability Assessment in Section 6.
Local Ordinances (Flood Damage Prevention Ordinances, Subdivision Ordinances, Zoning Ordinances, etc)	Local ordinances were referenced in the Capability Assessment in Section 6 and where applicable for updates or enforcement in Mitigation Action Plans in Section 7.
Triangle Regional Resilience Partnership Resilience Assessment	The Technical Report was used in the preparation of the HIRA and referenced in hazard profiles in Section 4.
Wake County and Incorporated Areas Flood Insurance Study (FIS), Revised 11/17/2017	The FIS was referenced in the preparation of flood hazard profile in Section 4.
Wake County Multi-Jurisdictional Hazard Mitigation Plan, 2015	The previous plan was referenced in compiling the Hazard Identification and Risk Assessment in Section 4 and in reporting on implementation status and developing the Mitigation Action Plans in Section 2 and Section 7, respectively.

2.3.2 Phase II – Risk Assessment

Planning Steps 4 and 5: Identify/Assess the Hazard and Assess the Problem

The HMPC completed a comprehensive effort to identify, document, and profile all hazards that have, or could have, an impact on the planning area. Geographic information systems (GIS) were used to display, analyze, and quantify hazards and vulnerabilities. A draft of the risk and vulnerability assessment was made available on the plan website for the HMPC, stakeholders, and the public to review and comment.

The HMPC also conducted a capability assessment to review and document the planning area's current capabilities to mitigate risk from and vulnerability to hazards. By collecting information about existing government programs, policies, regulations, ordinances, and emergency plans, the HMPC could assess those activities and measures already in place that contribute to mitigating some of the risks and vulnerabilities identified. A more detailed description of the risk assessment process and the results are included in Section 4 Risk Assessment.

2.3.3 Phase III – Mitigation Strategy

Planning Steps 6 and 7: Set Goals and Review Possible Activities

Wood facilitated brainstorming and discussion sessions with the HMPC that described the purpose and process of developing a vision for the planning process and setting planning goals and objectives, a

comprehensive range of mitigation alternatives, and a method of selecting and defending recommended mitigation actions using a series of selection criteria. This information is included in Section 6 Mitigation.

Planning Step 8: Draft an Action Plan

A complete first draft of the plan was prepared based on input from the HMPC regarding the draft risk assessment and the goals and activities identified in Planning Steps 6 and 7. This draft was shared for HMPC, stakeholder, and public review and comment via the plan website. HMPC, public, and stakeholder comments were integrated into the final draft for the North Carolina Division of Emergency Management (NCEM) and FEMA Region IV to review and approve, contingent upon final adoption by the County and its participating jurisdictions.

2.3.4 Phase IV – Plan Maintenance

Planning Step 9: Adopt the Plan

To secure buy-in and officially implement the plan, the plan will be reviewed and adopted by all participating jurisdictions. Resolutions will be provided in Section 9.

Planning Step 10: Implement, Evaluate and Revise the Plan

Implementation and maintenance of the plan is critical to the overall success of hazard mitigation planning. Up to this point in the planning process, the HMPC's efforts have been directed at researching data, coordinating input from participating entities, and developing appropriate mitigation actions. Section 8 Plan Maintenance provides an overview of the overall strategy for plan implementation and maintenance and outlines the method and schedule for monitoring, updating, and evaluating the plan. The Section also discusses incorporating the plan into existing planning mechanisms and how to address continued public involvement.

2.4 HAZARD MITIGATION PLANNING COMMITTEE

As with the previous plan, this Hazard Mitigation Plan was developed under the guidance of a Hazard Mitigation Planning Committee (HMPC). The Committee's representatives included representatives of Town departments, federal and state agencies, citizens and other stakeholders.

To reconvene the planning committee, a letter was sent via email to all County, City, and Town Hazard Mitigation Planning Committee (HMPC) contacts from the previous planning effort. Each community was asked to designate a primary and secondary contact for the HMPC. Communities were also asked to identify local stakeholder representatives to participate on the HMPC alongside the County, City, and Town officials in order to improve the integration of stakeholder input into the plan.

For the sake of simplifying the planning process and facilitating easier coordination across all the participating jurisdictions, the HMPC was split into two regional working groups. The East Wake Working Group included Knightdale, Rolesville, Wake Forest, Wendell, and Zebulon. The West Wake Working Group included Apex, Cary, Fuquay-Varina, Garner, Holly Springs, and Morrisville. Representatives from Wake County, Raleigh, and RDU were included in both working groups. Table 2.4 details the HMPC members and the agencies and jurisdictions they represented.

The formal HMPC meetings followed the 10 CRS Planning Steps. Agendas, minutes, and sign-in sheets for the HMPC meetings are included in Appendix B. The meeting dates and topics discussed are summarized in Section 2.5 Meetings and Workshops. All HMPC meetings were open to the public.

The DMA planning regulations and guidance stress that to satisfy multi-jurisdictional participation requirements, each local government seeking FEMA approval of their mitigation plan must participate in the planning effort in the following ways:

- Participate in the process as part of the HMPC;
- Detail where within the planning area the risk differs from that facing the entire area;
- Identify potential mitigation actions; and
- Formally adopt the plan.

For the Wake County HMPC, "participation" meant the following:

- Providing facilities for meetings;
- Attending and participating in the HMPC meetings;
- Collecting and providing requested data (as available);
- Completing the Local Capability Self-Assessment;
- Providing an update on previously adopted mitigation actions;
- Managing administrative details;
- Making decisions on plan process and content;
- Identifying mitigation actions for the plan;
- Reviewing and providing comments on plan drafts;
- Informing the public, local officials, and other interested parties about the planning process and providing opportunity for them to comment on the plan;
- Coordinating and participating in the public input process; and
- Coordinating the formal adoption of the plan by local governing bodies.

Detailed summaries of HMPC meetings are provided under Meetings and Workshops, including meeting dates, locations, and topics discussed. During the planning process, the HMPC members communicated through face-to-face meetings, email, and telephone conversations. This continued communication ensured that coordination was ongoing throughout the entire planning process despite the fact that not all HMPC members could be present at every meeting. Additionally, draft documents were distributed via the plan website so that the HMPC members could easily access and review them and provide comments.

Table 2.4 – HMPC Members

Jurisdiction	Agency	Representative	Position or Title
City of Raleigh	Emergency Management and Special Events	Kelly Lindsey*	Emergency Management Coordinator
City of Raleigh	Emergency Management and Special Events	Whitney Schoenfeld	Special Events Planner
City of Raleigh	Engineering Services – Stormwater Management	Ben Brown	Stormwater Administrator
City of Raleigh	Office of Sustainability	Megan Anderson	Sustainability Manager
City of Raleigh	Office of Sustainability	Nicole Goddard	Sustainability Analyst
Town of Apex	Planning Department	Shelly Mayo	Planner
Town of Apex	Planning Department	Dianne Khin	Planning Director
Town of Apex	N/A	Jim Scarborough	Citizen Stakeholder
Town of Cary	Town Manager's Office	Emily Barrett	Sustainability Manager
Town of Cary	Water Resources Department	Eric Kulz	Environmental Specialist
Town of Cary	N/A	Tom Hegele	Citizen Stakeholder
Town of Fuquay-Varina	Planning Department	Samantha Smith	Planning Director
Town of Fuquay-Varina	Planning Department	Allyssa Stafford	Planner
Town of Fuquay-Varina	N/A	Ed Ridpath	Citizen Stakeholder
Town of Garner	Planning Department	David Bamford	Planning Services Manager
Town of Garner	Planning Department	Jeff Triezenberg	Planning Director

Jurisdiction	Agency	Representative	Position or Title
Town of Holly Springs	Town of Holly Springs	Kimberly Keyes	Project and Construction Manager
Town of Holly Springs	Engineering Department	Daniel Colavito	Environmental Specialist
Town of Holly Springs	N/A	John Sutherland	Citizen Stakeholder
Town of Knightdale	Development Services Department	Jason Brown	Senior Planner – Long Range
Town of Knightdale	Development Services Department	Chris Hills	Development Services Director
Town of Knightdale	N/A	Ben McDonald	Citizen Stakeholder
Town of Morrisville	Planning Department	Brad West	Planner
Town of Morrisville	Planning Department	Dylan Bruchhaus	Planner
Town of Morrisville	N/A	Steve Botha	Citizen Stakeholder
Town of Rolesville	Planning Department	Danny Johnson	Planning Director
Town of Rolesville	Town of Rolesville	Kelly Arnold	Town Manager
Town of Wake Forest	Town of Wake Forest	Patrick Reidy	Senior Planner – Development Services
Town of Wake Forest	N/A	Grif Bond	Citizen Stakeholder
Town of Wendell	Planning Department	David Bergmark	Planning Director
Town of Wendell	Planning Department	Mackenzie Day	Planner
Town of Wendell	N/A	Jon Olson	Citizen Stakeholder
Town of Zebulon	Public Works Department	Chris Ray	Public Works Director
Town of Zebulon	Town of Zebulon	Joe Moore	Town Manager
Town of Zebulon	Planning Department	Teresa Piner	Interim Planning Director
Town of Zebulon	Planning Department	Meade Bradshaw	Assistant Planning Director
Wake County	Wake County Planning	Sharon Peterson	Long Range Planner
Wake County	Wake County Planning	Bryan Coates	Long Range Planner
Wake County	Wake Soil and Water Conservation District	Teresa Furr	Natural Resource Conservationist
Wake County	N/A	Emma D'Allaird	Citizen Stakeholder
Wake County	RDU	Jason Alvero	Director of Emergency Operations

*Note: Vacated position midway through the planning process. Replaced by Whitney Schoenfeld.

2.5 MEETINGS AND WORKSHOPS

The preparation of this Plan required a series of meetings and workshops for facilitating discussion, gaining consensus, and initiating data collection efforts with local government staff, community officials, and other identified stakeholders. More importantly, the meetings and workshops prompted continuous input and feedback from relevant participants throughout the drafting stages of the Plan.

Table 2.5 summarizes the key meetings and workshops held by the HMPC during the development of the plan. In many cases, routine discussions and additional meetings were held by local staff to accomplish planning tasks specific to their department or agency. For example, completing the Local Capability Self-Assessment or seeking approval of specific mitigation actions for their department or agency to undertake and include in their Mitigation Action Plan. These meetings were informal and are not documented here.

Public meetings are summarized in subsection 2.6.

Table 2.5 – Summary of HMPC Meetings

Meeting Title	Meeting Topic	Meeting Date	Meeting Location
HMPC Mtg. #1 – Project Kick-Off	1) Introduction to DMA, CRS, and FMA requirements and the planning process 2) Review of HMPC responsibilities and the project schedule.	November 14, 2018	Wake County Commons Bldg. 4011 Carya Drive, Raleigh
HMPC Mtg. #2 – East Working Group	1) Review and update plan goals 2) Brainstorm a vision statement 3) Report on status of actions from the 2015 plan 4) Complete the capability self-assessment	January 07, 2019	Wake County Eastern Regional Center 1002 Dogwood Drive, Room 157, Zebulon
HMPC Mtg. #2 – West Working Group		January 09, 2019	Page Walker Arts & History Center, 3rd fl., 119 Ambassador Loop, Cary
HMPC Mtg. #3 – East Working Group	1) Review Draft Hazard Identification & Risk Assessment (HIRA) 2) Draft objectives and Mitigation Action Plans	March 04, 2019	Knightdale Fire Dept. Training Rm 979 Steeple Square Ct, Knightdale, NC 27545
HMPC Mtg. #3 – West Working Group		March 08, 2019	Holly Springs Cultural Center, 300 West Ballentine Street, Holly Springs, NC 27540
HMPC Mtg. #4	1) Review the Draft Hazard Mitigation Plan 2) Solicit comments and feedback	April 22, 2019	Wake County Commons Bldg. 4011 Carya Drive, Raleigh

2.6 INVOLVING THE PUBLIC

An important component of any mitigation planning process is public participation. Individual citizen and community-based input provides the entire planning team with a greater understanding of local concerns and increases the likelihood of successfully implementing mitigation actions by developing community "buy-in" from those directly affected by the decisions of public officials. As citizens become more involved in decisions that affect their safety, they are more likely to gain a greater appreciation of the hazards present in their community and take the steps necessary to reduce their impact. Public awareness is a key component of any community's overall mitigation strategy aimed at making a home, neighborhood, school, business, or entire planning area safer from the potential effects of hazards.

Public involvement in the development of the plan was sought using various methods including open public meetings, an interactive plan website, a public participation survey, and by making copies of draft plan documents available for public review online and at government offices. Additionally, all HMPC meetings were made open to the public.

All public meetings were advertised on the plan website, which was shared on local community websites, and on local community websites, where possible. Copies of meeting announcements are provided in Appendix B. The public meetings held during the planning process are summarized in Table 2.6.

Table 2.6 – Summary of Public Meetings

Meeting Title	Meeting Topic	Meeting Date	Meeting Location
Public Meeting #1	1) Introduction to DMA, CRS, and FMA requirements and the planning process 2) Review of HMPC responsibilities and the project schedule.	November 14, 2018	Wake County Commons Bldg. 4011 Carya Drive, Raleigh
Public Meeting #2	1) Review "Draft" Hazard Mitigation Plan 2) Solicit comments and feedback	April 22, 2019	Wake County Commons Bldg. 4011 Carya Drive, Raleigh

2.7 OUTREACH EFFORTS

The HMPC agreed to employ a variety of public outreach methods including established public information mechanisms and resources within the community. The table below details public outreach efforts employed during the preparation of this plan.

Table 2.7 – Public Outreach Efforts

Location	Date	Event/Message
Plan website	Ongoing	Meeting announcements, meeting materials, and description of hazards; contact information provided to request additional information and/or provide comments
Local community websites	11/13/2018	Public Meeting #1 announcements posted
Local community websites	Ongoing	Link to the plan website shared to expand reach
Public survey	Ongoing	Survey hosted online and made available via shareable link
Plan website - HIRA draft	3/4/2019	Draft HIRA made available for review and comment online
Plan website - Draft Plan	4/26/2019	Full draft plan made available for review and comment online

Public involvement activities for this plan update included press releases, creation of a website for the plan, a public survey, and the collection of public and stakeholder comments on the draft plan.

A public outreach survey was made available on November 14, 2018 and remained open for response until February 22, 2019. The public survey requested public input into the Hazard Mitigation Plan planning process and the identification of mitigation activities to lessen the risk and impact of future hazard events. The survey is shown in Appendix B. The survey was available in hard copy at the first public meeting and online on the plan website. In total, 110 survey responses were received, with 66 responses received via direct response on the website and 44 received via the shared web link.

The following is a list of high-level summary results and analysis derived from survey responses:

- 12.7% of respondents say they feel not at all prepared for a hazard event; 69.1% feel somewhat prepared.
- 65.1% of respondents do not know where evacuation centers or storm shelters are located; however, 96.3% of respondents say they are able to evacuate or take shelter if necessary, which indicates that most people manage evacuating or taking shelter through their own resources. It is possible that these results skew toward those with more awareness of hazard risk and resources to respond.
- Over 40% of respondents do not know where to get more information on hazard risk and preparedness.

- Hurricane was rated the most significant hazard, followed by tornado, severe winter storm, and severe weather. Landslide was rated the least significant hazard, followed by dam failure and earthquake.
- Many respondents who reported having taken steps to mitigate risk at home reported preparedness actions such as emergency kits and supplies and evacuation plans. Few respondents noted prevention or property protection actions; therefore, these may be important ideas to promote in outreach.
- Respondents largely favored emergency services projects and structural projects for mitigation.

Detailed survey results are provided in Appendix B.

2.8 INVOLVING THE STAKEHOLDERS

In addition to representatives of each participating jurisdiction, the Hazard Mitigation Planning Committee included a variety of stakeholders. Stakeholders on the HMPC included representatives from Cary CERT and Wake County EMS. Representatives from North Carolina Emergency Management also attended HMPC meetings. Input from additional stakeholders, including neighboring communities, was solicited through invitations to the open public meetings and distribution of the public survey. However, if any additional stakeholders representing other agencies and organizations participated through the public survey, that information is unknown due to the anonymous nature of the survey.

2.9 DOCUMENTATION OF PLAN PROGRESS

Progress on the mitigation strategy developed in the previous plan is documented in this plan update. Table 2.8 below details the status of mitigation actions from the previous plan. More detail on actions being carried forward is provided in Section 7: Mitigation Action Plans.

Table 2.8 – Status of Previous Mitigation Actions

Jurisdiction	Completed	Deleted	Carried Forward
Wake County	2	0	3
City of Raleigh	0	0	12
Town of Apex	4	6	12
Town of Cary	3	4	4
Town of Fuquay-Varina	13	1	25
Town of Garner	5	6	13
Town of Holly Springs	8	1	21
Town of Knightdale	3	7	9
Town of Morrisville	6	0	3
Town of Rolesville	1	1	3
Town of Wake Forest	2	0	9
Town of Wendell	7	0	1
Town of Zebulon	6	0	6
Total	**60**	**26**	**121**

Table 2.9 on the following pages details all completed and deleted actions from the 2015 plan.

Community capability continues to improve with the implementation of new plans, policies, and programs that help to promote hazard mitigation at the local level. The current state of local capabilities for the participating jurisdictions is captured in Section 5: Capability Assessment. The participating jurisdictions continue to demonstrate their commitment to hazard mitigation and have proven this by reconvening the

HMPC to update this multi-jurisdictional plan and by continuing to involve the public in the hazard mitigation planning process.

Moving forward, information in this plan will be used to help guide and coordinate mitigation activities and decisions for local plans and policies in the future. Proactive mitigation planning will help reduce the cost of disaster response and recovery to communities and their residents by protecting critical community facilities, reducing liability exposure, and minimizing overall community impacts and disruptions. This plan identifies activities that can be undertaken by both the public and the private sectors to reduce safety hazards, health hazards, and property damage.

Table 2.9 – Completed and Deleted Actions from the 2015 Wake County Hazard Mitigation Plan

2015 Action #	Description	2019 Status	Status Comments/Explanation
Wake County			
ES-3	Oversee completion of planned equipment replacements/upgrades for 800 MGHZ emergency communications systems, EMS facilities, and fire/rescue facilities per the approved capital improvement program.	Completed	
PEA-5	Maintain Environmental Network Call Center. Citizens may report flooding problems, pollution issues, erosion problems, infrastructure damage, littering, etc.	Completed	
Raleigh			
n/a	*n/a*	*n/a*	*n/a*
Apex			
P-33	Form a citizen plan implementation steering committee to monitor progress on local mitigation actions. Include a mix of representatives from neighborhoods, local businesses, and local government.	Delete	Updated neighborhood mtg report standards to increase neighbor input on projects before they're approved.
P-35	Encourage the use of porous pavement, vegetative buffers, and islands in large parking areas.	Delete	Considered part of p-34
P-36	Encourage the use of permeable driveways and surfaces to reduce runoff and promote groundwater recharge.	Delete	Considered part of p-34
P-39	Obtain local data including tax parcels, critical facility locations, and other information for use in risk analysis.	Delete	continually being updated - moved to PP-2 & reworded
NRP-10	Adopt erosion and sedimentation control regulations for construction.	Completed	
NRP-11	Use stream restoration to ensure adequate drainage and diversion of stormwater.	Delete	doesn't seem to address the hazard
ES-13	Construct Fire Stations #5 and #6.	Completed	Construction of Fire Station #5 completed. Fire Station #6 targeted under a new action.
PEA-1	Town website - public access, emergency information and contact numbers, link to hurricane and Harris nuclear evacuation route maps and safety information. Revise the Emergency Information Page. Add Ready Wake link.	Completed	
PEA-4	Public Library – Maintain and update hazard information accessible to the public.	Delete	
PEA-8	Include FEMA flood map link on the Town Website on the Engineering page.	Completed	technically under the Planning page….
Cary			
P-4	Land Use Plan An existing tool which guides future development based on available services and existing site features/resources to ensure that future development is meeting the overall vision of the Town while ensuring the safety of the citizens.	Delete	Cary's comprehensive plan, called alternately the Cary Community Plan and the Imagine Cary Plan was finalized on January 24, 2017. Implementation in-process.

2015 Action #	Description	2019 Status	Status Comments/Explanation
P-7	Open Space Preservation – Existing Open Space Plan identifies and evaluates various land and open space resources throughout the ETJ and Urban Services Areas. The plan is used by Town staff to identify properties to be protected from development.	Delete	Comprehensive Plan was completed and implementation is In-Progress. Adaptive stormwater aproach to openspace and green stormwater infrastucuture opportunities.
P-15	If grant application is approved by FEMA, the Town will conduct a detailed study to determine the risk level of each residential structure in the identified floodplain areas and take actions to reduce the risk to those properties.	Delete	Town has spent the last year on a new Adaptive Stormater approach which includes a review and revisions to stormwater ordinances, a pilot dynamic floodplain model in the Walnut Creek Basin that will be expanded to include partners such as the City of Raleigh as well as modoleing of other basins, a proactive approach to maintenance of the Town stormwater infrastructure, using GIS for Condition Assessment and most importantly understanding that our most effective tool for floodplain management is Open Space and exploring ways to continue the development of that very important tool.
SP-2	Replace culverts on Willow Street.	Completed	
SP-3	Replace culverts on Woodland Drive.	Completed	
SP-5	Replace culverts on Kilarney Drive	Completed	
SP-6	Replace culverts on Yubinaranda Circle	Delete	Suspended
Fuquay-Varina			
P-1	Update the Land Use Plan (LUP) update including identification of environmentally sensitive areas for evaluation and protection during development review process.	Completed	New LUP adopted in 2017. Regular updates made to LUP based on zoning map changes and functionality requirements
P-3	Update the Community Transportation Plan including evaluation of stream-crossings to reduce impacts on streams, flood plains and wetlands.	Completed	New CTP adopted 2017
P-4	Update land Development Ordinance (LDO) to incentivize and encourage floodplains, wetlands, riparian buffers to be maintained as open space.	Completed	New LDO adopted 2016. Regular updates made for clarification and functionality
P-5	Add standards to LDO to reduce impervious surface areas as part of landscaping requirements to reduce storm water volume and concentration in nonresidential development.	Completed	Landscaping and stormwater standards were updated as part of new LDO 2016
P-6	Develop Stormwater Management Plan based on NPDES Phase II Stormwater Requirements.	Completed	
P-8	Enforce Wake County Flood Hazard Soils Policy, following and utilizing flood study standards.	Completed	Adopted our own in 2016 w/ LDO update
P-10	Adopt a Land Development Ordinance that will improve the review process, standards and results to reduce the impact of development on the natural environment.	Completed	

2015 Action #	Description	2019 Status	Status Comments/Explanation
P-11	Implement standard for each buildable lot to have a minimum percentage of buildable area outside floodplains, wetlands, riparian buffers as part of the plan review and recording process.	Completed	Adopted standards for max environmental features on lots outside of development standards
P-12	Map storm water drainage system as part of Phase II Stormwater Management Plan.	Completed	regular updates
P-13	Provide for public dissemination building inspections brochures regarding high winds, water damage prevention, and tie downs for accessory structures.	Completed	Same action as 2014
NRP-5	Incorporate regulations for illicit discharge control in Phase II Stormwater Management Plan.	Completed	We now have an illicit discharge ordinance
ES-2	Examine need to evaluate weather radio distribution program (daycares/nursing homes) initiated by Wake County Emergency Management 1999	Delete	County abandoned program
ES-4	Update and implement a Basic Emergency Operations Plan and a Disaster Operations Plan for the Town.	Completed	Regularly updated
ES-11	Examine the feasibility and need to contract/purchase a reverse 911 system to alert citizens of impending danger.	Completed	Reverse 911 program in place
Garner			
P-6	Partner with Wake County and other interested parties to jointly identify and acquire open space lands.	Delete	
P-12	Provide backup power for all critical public facilities (Police, Public Works, and other critical public buildings).	Completed	Completed in 2017
P-28	The Town will seek opportunities to use Federal grant resources to assist private property owners in elevating existing structures located within flood hazard zones.	Delete	we do not have enough properties to have an action item
PP-3	Building Retrofit - The Town is willing to develop a plan to utilize Federal grant resources to assist private property owners in renovating and retrofitting existing structures.	Delete	
PP-6	When feasible, Town of Garner will alleviate flooding into habitable space due to storm water, as consistent with Town Drainage Policy.	Completed	
NRP-4	Continue to work with the U.S. Army Corps of Engineers on wetland protection.	Delete	
NRP-5	Use Open Space Ordinance to protect wildlife habitat.	Delete	Our open space ordinance is geared towards protecting water quality
SP-2	Incorporate on-site retention/detention requirements for Phase II Stormwater Management Plan.	Completed	

2015 Action #	Description	2019 Status	Status Comments/Explanation
ES-3	Emergency Operations Command Post Center – established when natural hazard imminent. Center coordinates evacuations, sheltering, staging areas for equipment, manpower, and needed supplies. Equipment includes internet access, telephone, wireless communications, radio and backup supplied by emergency batteries and/or generators.	Completed	Completed in 2015
ES-8	Mobile Command Post - Available 24 hours a day and equipped to communicate with all agencies in the Triangle including Emergency Management, State agencies, fire departments, etc. The Town will be upgrading this service.	Delete	We partner with Wake County to use theirs.
PEA-2	Town website will be updated to answer citizen questions about flood hazards, flood safety, availability of flood insurance, stormwater regulations, and other information.	Completed	
Holly Springs			
P-12	Unified Development Ordinance (UDO) - The Town has an existing UDO which regulates development to ensure safety from fire, panic and other dangers. The UDO provides for orderly growth and development within the Town and ETJ by determining appropriate land use and development standards.	Completed	Updated in 2018
P-14	Stormwater Management - The Town maintains numerous basin HEC-HMS and HEC-RAZ models to determine the water surface elevation where nuisance flooding is a known problem. To ensure that water surface elevations and velocities in the streams do not get worse, the Town has adopted a policy to require new development, to run the model with the proposed development and to add stormwater BMPs or other measures to make sure that there is not a negative impact downstream.	Completed	
ES-8	Urban Search and Rescue – The Town currently has US&R services provided through the NC US&R team region 4, with backup assistance provided by region 8. Internally, we provide urban search and rescue services consisting of structural collapse and similar emergencies.	Completed	We now have enhanced capabilities with the purchase of a drone. The is funded through the State with a mutual aid agreement.
ES-9	Warning Systems - The Town currently uses Wake County's warning systems. The Town is looking into options for warning systems for the Town of Holly Springs.	Completed	The town currently utilizes Wake County's warning systems in conjunction with mobile applications that are subscription based for citizens and employees alike. In addition, the town has public access channels and access via media outlets through the PIO to disseminate information concerning emergency warnings and other incidents.
ES-10	Warning Barricades - The Town uses visual warning barricades for vehicular and pedestrian traffic to block properties, roadways, etc. for the safety of the general public.	Completed	The town has a collection of cones, traffic barriers, and other mechanisms to block off, re-route, or set detours for vehicular and pedestrian traffic. In the event that these resources are depleted, WCEM will loan resources to the town for the duration of an incident under the current structures of the MOU.

2015 Action #	Description	2019 Status	Status Comments/Explanation
ES-11	Trailer Transportation - Deploy step van and tandem axel trailers for transportation of emergency barricades and other equipment on a large scale.	Completed	The police department and the public works department have access to trailers and trucks to deploy resources as needed throughout town.
ES-16	Emergency Response Plans for the Police Station – Develop plans that address immediate action to be undertaken for all personnel assigned to the district in the event of any large scale emergency. A critique will be completed after each critical incident to document need for improvements.	Completed	Completed and constantly reevaluated. We currently have plans of action in place at the Law Enforcement Center that are implemented in the case of large scale emergency situations and disaster responses. Command and control protocols are in place that outline the framework of our responses to planned and unplanned events which detail which command implements will be mobilized within the Emergency Operations Center. All of our command and supervisory staff undergo FEMA NIMS and ICS training, and our planned actions follow in accordance with the best practices recommended by the Department of Homeland Security. In addition, any of our personnel wishing to promote into supervisory positions are tested through table top scenario exercises intended to ensure their knowledge and capabilities in managing a large-scale event. Partnerships have been established through mutual aid agreements, memorandums of understanding, and other such agreements with the various public sector and private sector stakeholders that would be involved in the mitigation, response to, and recovery from large-scale emergencies and other disasters.
ES-19	Mobile Command Post-Available 24 hours a day and equipped to communicate with all agencies in the Triangle including Emergency Management, State agencies, fire departments, etc.	Delete	Not Completed, but attainable through mutual aid with WCEM. The police department does not have a specifically dedicated mobile command center. However, in circumstances where one would be required, our mutual aid agreement with Wake County Emergency Management authorizes that one be requested for loan and brought to the scene of an incident command situation. In most cases, the initial command field response to a large scale situation would be managed from a command post location operated out of a commander's vehicle. Prolonged incidents may see that command operations remain at the original command post that was established in the field or those operations could be moved back to the Law Enforcement Center's Emergency Operations Center as circumstances dictate.

2015 Action #	Description	2019 Status	Status Comments/Explanation
ES-21	Emergency Response Plans - Emergency response plans are all designed for officers to be assigned for security purposes until owners can take over the responsibility of securing premises.	Completed	Completed and constantly reevaluated. Under our current general orders manual and other established directives, Holly Springs Police Officers would set priority in the event of emergency responses to that of preserving life and mitigating hazards to safety. Once these hazards have been stabilized or mitigated, attention would shift to protecting real and personal properties. Areas of response in order of highest importance to lowest importance have been delineated according to the risk that would occur in allowing the area to be compromised. Town facilities and other critical infrastructure key to response and recovery efforts would take immediate priority. Major business and banking areas likely to be seen as opportunistic targets for persons attempting to exploit situations of mass power outages or civil unrest would be the next priority. Lastly, residential areas (though patrolled throughout a major event) would receive more focused resources to prevent property crime.
Knightdale			
P-1	Adopt Hazard Mitigation Plan & Updates.	Delete	On-Going Task
P-2	Prepare Plan Maintenance Report.	Delete	On-Going Task
P-3	Prepare updates to Plan.	Delete	On-Going Task
P-4	Revise Hazard Mitigation Plan.	Delete	Standard item that must be completed regardless.
P-8	Update Emergency Response Plan.	Completed	The most recent version of the Knightdale EOP was adopted on January 16, 2018.
PEA-1	Distribute “Ready Wake” brochures in libraries, Town Hall, public places and on the Town Web Site.	Delete	On-Going Task
PEA-4	Present Plan at public meeting.	Delete	On-Going Task
PEA-10	Utilize electronic newsletter to keep citizens informed.	Completed	The Town of Knightdale has established an electronic newsletter to distribute information to citizens on a regular basis.
PEA-14	Improve drought monitoring and communication of data to the public by relying less on state and regional data and establishing a local source.	Delete	With new technology available to citizens this project seems unneccessary
PEA-19	Update current approved plant list to add emphasis on drought tolerant species.	Completed	The plant list was updated in 2016 and includes drought tolerant species.
Morrisville			
P-1	Improve road visibility and safety by evaluating existing road conditions and paving and/or placing new reflector tape or paint along road edges and in the divided line on all major Town roads.	Completed	
P-2	Evaluate and update the Town of Morrisville Multi-Hazard Emergency Response Plan on an annual basis.	Completed	

2015 Action #	Description	2019 Status	Status Comments/Explanation
P-4	Maintain all tax parcel information, floodplain locations and frequent flooding areas in Geographic Information Systems (GIS).	Completed	
PEA-1	Disperse via the Morrisville Connection newsletter a posting which provides information regarding natural hazard emergency response and preparedness actions the public can take.	Completed	
PEA-2	Notify citizens of the public hearing on the Hazard Mitigation Plan annual progress report.	Completed	
PEA-3	Continue providing website link to Federal and State Declared Emergencies affecting the Town.	Completed	
Rolesville			
PEA-3	Develop planned park to include nature trails and environmental education center.	Delete	Nature trail constructed, no plans for the environmental education center.
PEA-4	Town Hall – Maintain and update hazard information accessible to the public.	Completed	Copy of most recent hazard mitigation plan is available for public viewing.
Wake Forest			
P-17	Review and revise the existing response plan and call list, as needed	Completed	
ES-6	Coordinate with suppliers and develop a resource list for fuel and power generation.	Completed	This list has been created and is continously updated with suppliers
Wendell			
P-17	Include flood map data on GIS system.	Completed	This data is continually updated by Wake County and we download updated information regularly.
NRP-1	Maintain and expand greenway system, stream buffers.	Completed	Clean Water Management Trust Fund Grant awarded. Park expanded to south (Pin 1783383759) with conservation easements in place to protect stream buffers and floodplain.
ES-5	Review Inclement Weather Policy.	Completed	In Q4 2018, the Town Board passed a Street Clearing Policy as a supplemental document to the Inclement Weather Policy. No further amendments are planned at this time.
PEA-2	Inform public of construction requirements in hazard areas.	Completed	Website updated to reflect information on construction requirements, such as flood elevation certificates.
PEA-4	Make FEMA manuals available to residents.	Completed	Link to FEMA site providing the most recent FEMA manuals added to Wendell Website.
PEA-8	Provide links to flood warnings, hurricane tracks, tornado and severe thunderstorm warnings, winter storm warnings, and drought/heat wave information on website.	Completed	During the hurricane, tropical storm and winter weather, the Alert Box on the Town's website was activated with a link to the National Weather Service – Raleigh Office. Social media was updated also. In addition, the Town shared updates from NCDOT, Wake County, the Attorney General's office, City of Raleigh, and Duke Energy during the hurricane. The winter weather included updates from NCDOT, Wake County and Duke Energy. What is posted depends upon the event.

2015 Action #	Description	2019 Status	Status Comments/Explanation
PEA-12	Inform public about flood mitigation techniques (i.e., remove debris from storm drains prior to large storm event).	Completed	Material has been added to the Public Works webpage to communicate this material to citizens.
Zebulon			
P-21	Prepare and implement debris removal and disposal plan.	Completed	Debris removal plan adopted.
P-23	Include flood map data on GIS system.	Completed	Flood map data is now available on GIS system.
P-24	Tie law enforcement to Statewide 800 megahertz system.	Completed	Public Safety communications has all been moved to Wake County 800 Mhz system.
PEA-1	Provide links to hazard notices on Town website.	Completed	Town provides hazard notices via social media platforms, including preparatory actions.
PEA-4	Public outreach projects.	Completed	Town provides seasonal preparatory actions on social media platforms.
PEA-9	Provide links to flood warnings, hurricane tracking information, tornado and severe thunderstorm warnings, winter storm warnings, wildfire warnings, and any other available hazard warning information on website.	Completed	Town has the ability to alert visitors of the website to provides hazard notices via social media platforms, including preparatory actions.

3 Planning Area Profile

This section provides a general overview of the current conditions in Wake County and its participating municipalities. It consists of the following sub-sections:

- 3.1 Geography and Climate
- 3.2 Population and Demographics
- 3.3 Parcels and Buildings
- 3.4 Historic Properties
- 3.5 Housing
- 3.6 Infrastructure
- 3.7 Current and Future Land Use
- 3.8 Employment and Industry

3.1 GEOGRAPHY AND ENVIRONMENT

Wake County is located in the eastern portion of the Piedmont of North Carolina. It is part of the Raleigh, NC Metropolitan Statistical Area, which falls within the larger Raleigh-Durham-Chapel Hill, NC Combined Statistical Area. The Planning Area includes Wake County unincorporated areas, Town of Apex, Town of Cary, Town of Fuquay-Varina, Town of Garner, Town of Holly Springs, Town of Knightdale, Town of Morrisville, City of Raleigh, Town of Rolesville, Town of Wake Forest, Town of Wendell, and Town of Zebulon. A location map is provided in Figure 3.1.

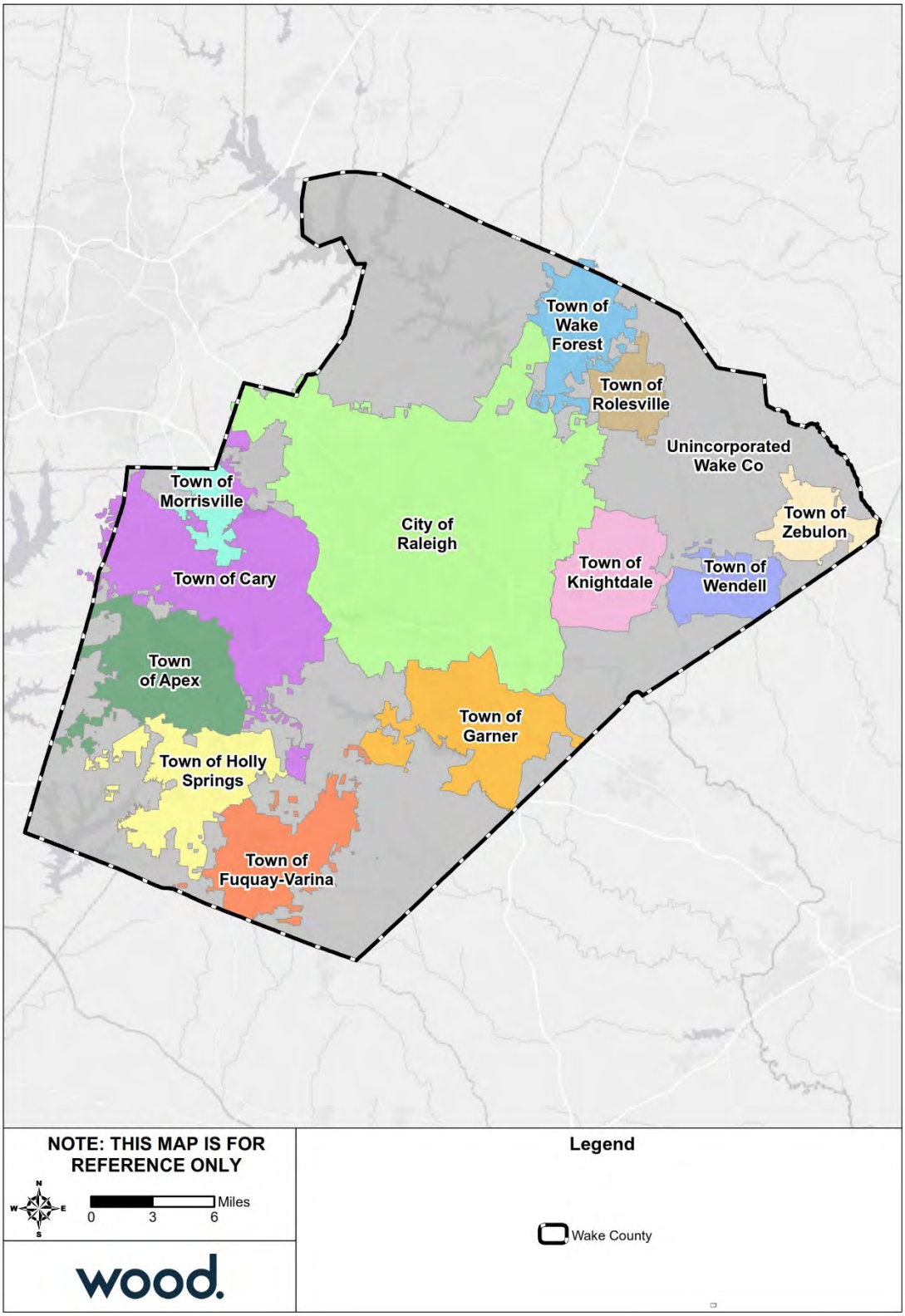
Wake County comprises a total land area of 834 square miles. The total land area of each participating jurisdiction is listed in Table 3.1.

Table 3.1 – Total Land Area of Participating Jurisdictions

Jurisdiction	Total Land Area
Wake County	**827.22 square miles**
Unincorporated areas	537.93 square miles
Apex	23.37 square miles
Cary	54.34 square miles
Fuquay-Varina	12.09 square miles
Garner	14.75 square miles
Holly Springs	15.01 square miles
Knightdale	6.21 square miles
Morrisville	8.26 square miles
Raleigh	142.90 square miles
Rolesville	3.93 square miles
Wake Forest	15.10 square miles
Wendell	5.20 square miles
Zebulon	4.13 square miles

Source: US Census Bureau

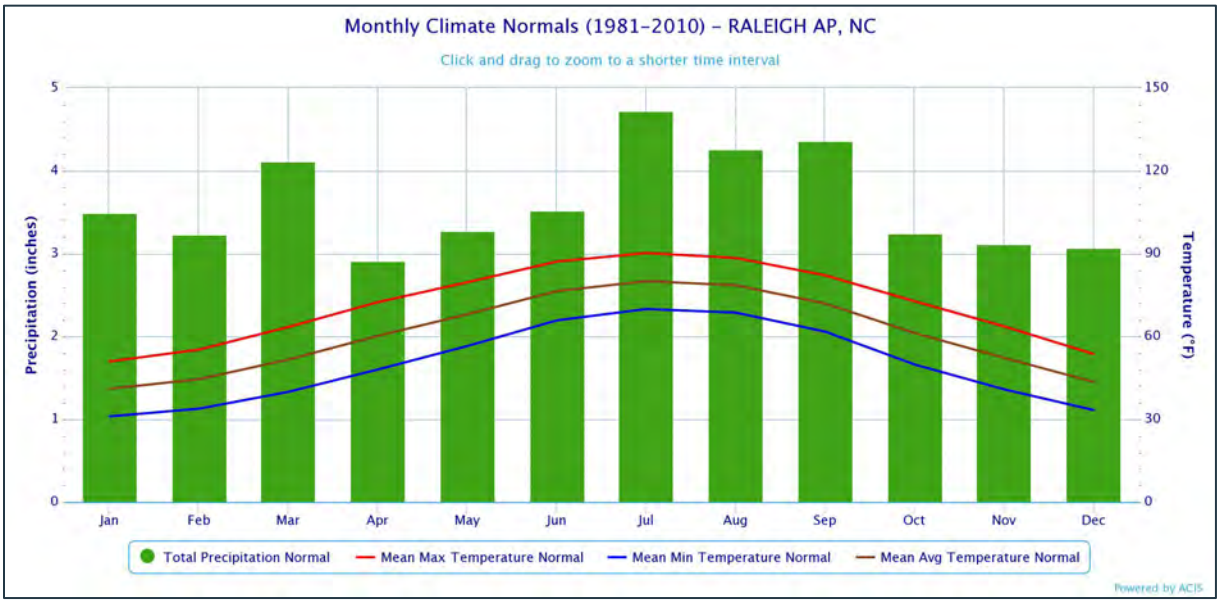
Figure 3.1 – Wake County and Participating Jurisdictions Location Map



Source: Wake County GIS Open Data

According to the Köppen climate classification system, Wake County has a humid subtropical climate characterized by mild winters and hot humid summers with significant precipitation even during the driest month. The county experiences an average annual high temperature of 71.6°F and an average annual low of 49.9°F. Average annual rainfall is approximately 43.3 inches and average annual snowfall is 4.8 inches. Figure 3.2 shows the average monthly precipitation for the Raleigh Airport weather station, which approximates temperature and precipitation of the County.

Figure 3.2 – Average Monthly Precipitation



Source: Northeast RCC CLIMOD 2.

As shown in the map of HUC-8 watersheds in Figure 3.3, most of Wake County falls within the Upper Neuse River watershed. Portions of the east and south of the county are in the Haw River watershed and the Upper Cape Fear River watershed, respectively; an area in the northeast of the county falls in the Contentnea Creek watershed. The Neuse River runs through the county from the northwest border to the southeast central border.

Wetlands

According to data from the U.S. Fish and Wildlife Service's National Wetlands Inventory, there are approximately 49,944 acres of wetlands in the County. Wetlands areas are shown by type in Figure 3.4.

Natural and Beneficial Wetland Functions: The benefits of wetlands are hard to overestimate. They provide critical habitat for many plant and animal species that could not survive in other habitats. They are also critical for water management as they absorb and store vast quantities of storm water, helping reduce floods and recharge aquifers. Not only do wetlands store water like sponges, they also filter and clean water as well, absorbing toxins and other pollutants.

Parks, Preserve, and Conservation

Wake County is home to three state parks: Falls Lake State Recreation Area, William B. Umstead State Park, and Jordan Lake State Recreation Area. There are also a number of county and municipal parks located throughout the jurisdictions, as well as several greenways that traverse the county and connect to surrounding regions.

Threatened and Endangered Species

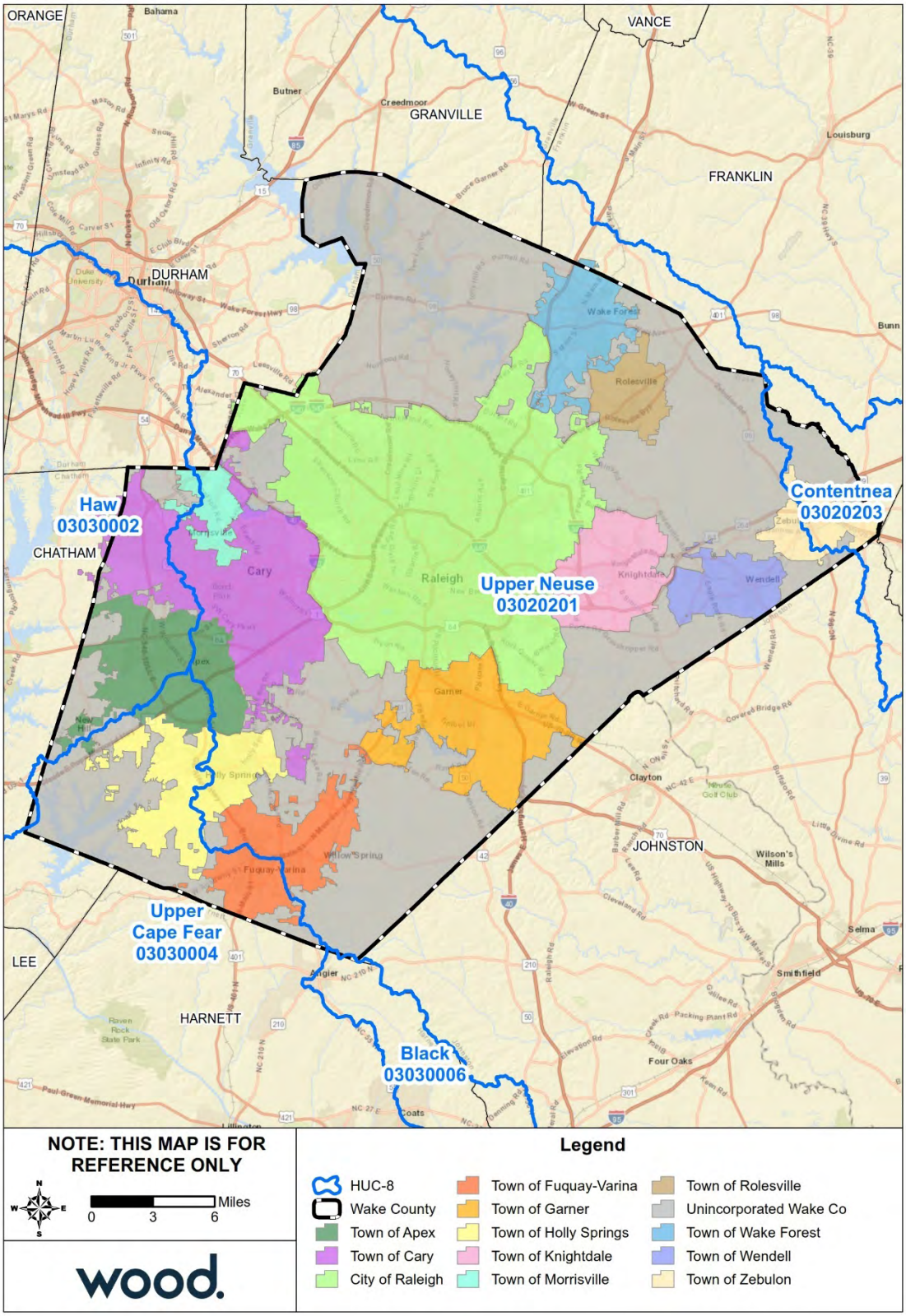
The U.S. Fish and Wildlife Service maintains a regular listing of threatened species, endangered species, species of concern, and candidate species for counties across the United States. Wake County has nine species that are listed with the U.S. Fish and Wildlife Services. Table 3.2 below lists the species identified as threatened, endangered, or other classification.

Table 3.2 – Threatened and Endangered Species

Group	Common Name	Scientific Name	Federal Status
Amphibians	Neuse River waterdog	Necturus lewisi	Under Review
Birds	Red-cockaded woodpecker	Picoides borealis	Endangered
Clams	Tar River spinymussel	Elliptio steinstansana	Endangered
Clams	Dwarf wedgemussel	Alasmidonta heterodon	Endangered
Clams	Yellow lance	Elliptio lanceolata	Threatened
Clams	Atlantic pigtoe	Fusconaia masoni	Proposed Threatened
Fishes	Cape Fear shiner	Notropis mekistocholas	Endangered
Fishes	Carolina madtom	Noturus furiosus	Under Review
Flowering Plants	Michaux's sumac	Rhus michauxii	Endangered

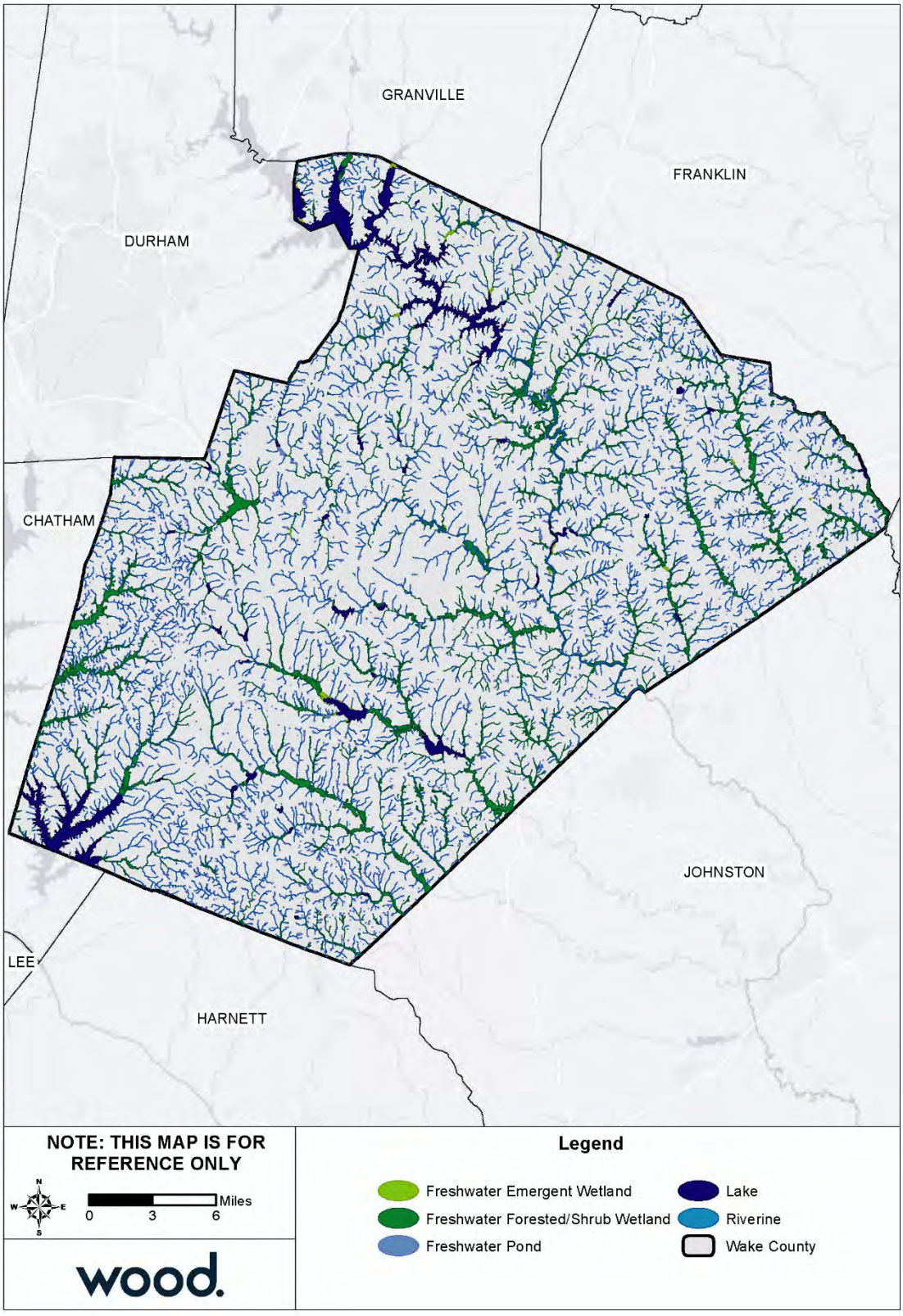
Source: U.S. Fish & Wildlife Service (https://ecos.fws.gov/ecp0/reports/species-by-current-range-county?fips=37183)

Figure 3.3 – HUC-8 Drainage Basins



Source: USDA Natural Resources Conservation Service

Figure 3.4 – Wetlands by Type in Wake County



Source: U.S. Fish & Wildlife Service, National Wetlands Inventory - Version 2

3.2 POPULATION AND DEMOGRAPHICS

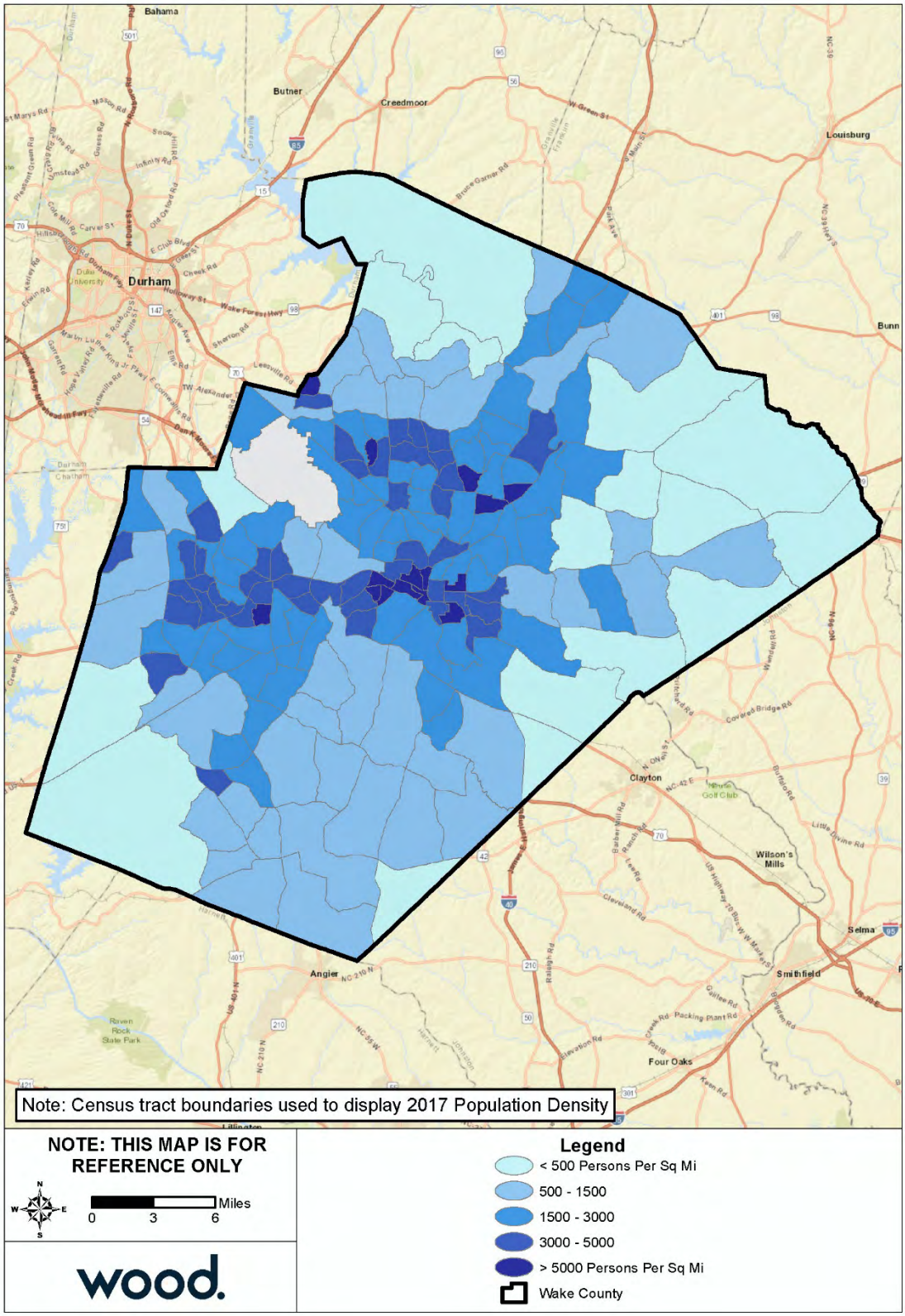
Wake County and its municipalities have experienced significant population growth over the last several decades. From 2000 to 2017, Wake County's population grew by 63 percent, which equates to an average annual growth rate of nearly 3 percent. Overall population density in the County increased from 1,078.8 persons per square mile in 2010 to 1,225.8 persons per square mile in 2017. Trends suggest that this number is likely to continue growing. All jurisdictions experienced growth between 2010 and 2017, with an average population increase across the County of 13.6 percent. The Towns of Fuquay-Varina and Rolesville both grew by more than 30 percent over this period. Table 3.3 provides population counts from 2000, 2010, and 2017 for each of the participating jurisdictions. Figure 3.5 on the following page shows 2017 population density by census tract in persons per square mile.

Table 3.3 – Wake County Population Counts

Jurisdiction	2000 Census Population	2010 Census Population	2017 ACS Population Estimate	Total Change 2010-2017	% Change 2010-2017
Wake County	**627,846**	**900,993**	**1,023,811**	**122,818**	**13.6%**
Unincorporated areas	169,386	181,890	189,996	8,106	4.5%
Apex	20,212	37,476	45,899	8,423	22.5%
Cary	94,536	135,234	159,715	24,481	15.1%
Fuquay-Varina	7,898	17,937	24,373	6,436	35.9%
Garner	17,575	25,745	28,048	2,303	8.9%
Holly Springs	9,192	24,661	31,827	7,166	29.1%
Knightdale	5,958	11,401	14,363	2,962	26.0%
Morrisville	5,208	18,576	23,873	5,297	28.5%
Raleigh	276,093	403,892	449,477	45,585	11.3%
Rolesville	907	3,786	6,308	2,522	40.0%
Wake Forest	12,588	30,117	38,473	8,356	27.7%
Wendell	4,247	5,845	6,516	671	11.5%
Zebulon	4,046	4,433	4,943	510	11.5%

Source: US Census Bureau Decennial Census 2000, Decennial Census 2010; American Community Survey 2017 Annual Estimates
Note: The total population of Cary, Raleigh, and Wake Forest includes population residing in adjacent counties.

Figure 3.5 – Population Density, 2016



Source: U.S. Census Bureau, American Community Survey 2013-2017 5-Year Estimates

According to 2017 American Community Survey 5-Year Estimates, the median age in Wake County was 35.8. Of the population aged 25 years and over, 92.5 percent have a high school degree or higher and 51.0 percent have a bachelor's degree or higher. Approximately 16.8 percent of Wake County residents speak a language other than English at home; of those, 65.1 percent also speak English "very well". The racial characteristics of the participating jurisdictions are presented in Table 3.4. Generally, white persons make up the majority of the population in the county, accounting for over 66 percent of the population in Wake County overall. However, several jurisdictions have much higher minority populations than others including Garner, Knightdale, Morrisville, Raleigh, and Zebulon.

Table 3.4 – Racial Demographics of Wake County Jurisdictions, 2016

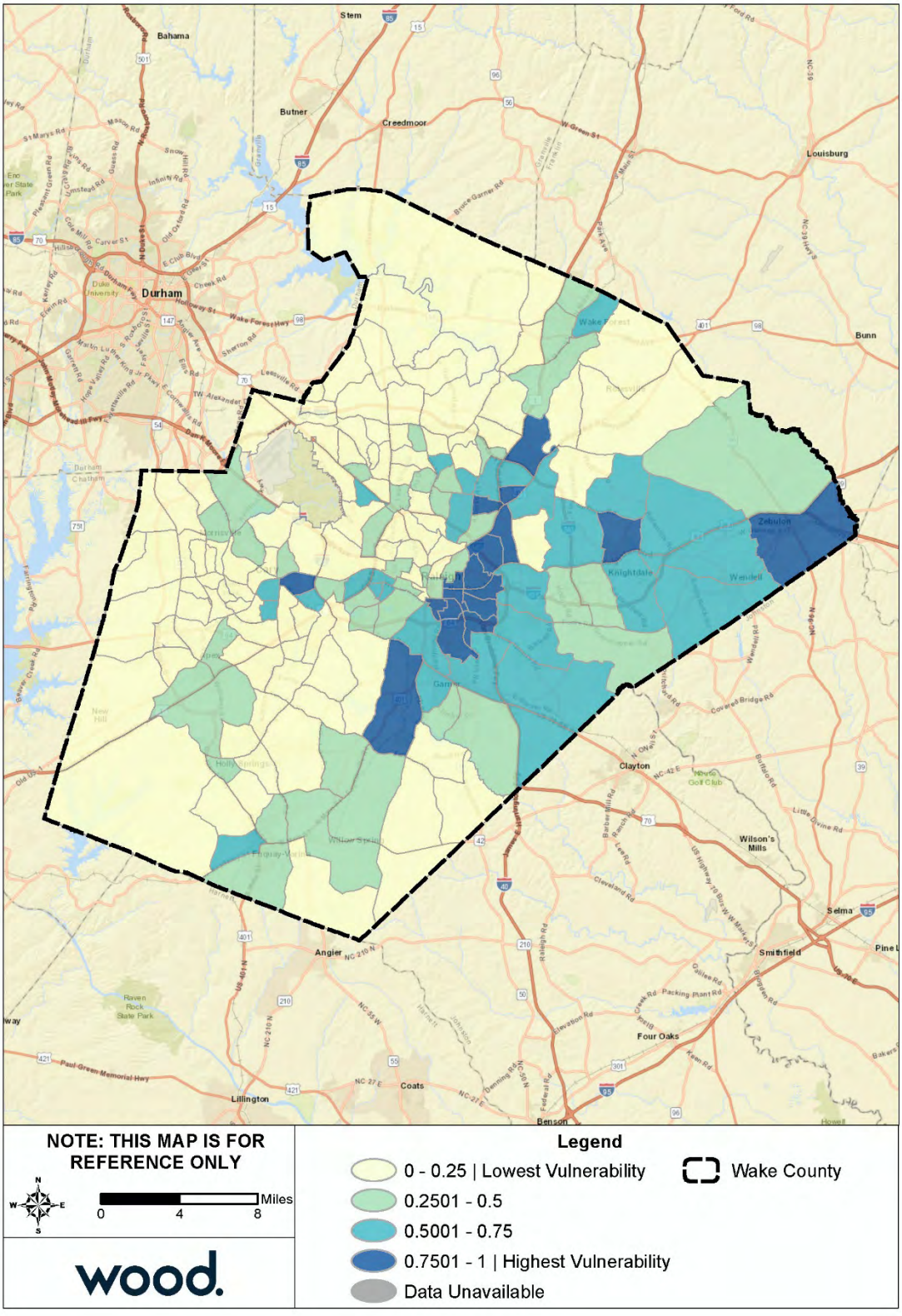
Jurisdiction	White, %	Black, %	Asian, %	Other Race, %	Two or More Races, %	Persons of Hispanic or Latino Origin*, %
Wake County	**66.5%**	**20.4%**	**6.5%**	**3.6%**	**2.7%**	**10.0%**
Apex	79.3%	8.6%	7.4%	1.5%	2.9%	7.3%
Cary	69.9%	7.9%	16.8%	2.2%	2.8%	8.1%
Fuquay-Varina	77.5%	15.4%	1.6%	2.8%	2.7%	9.4%
Garner	61.9%	32.5%	1.9%	1.4%	2.2%	10.8%
Holly Springs	79.6%	11.9%	2.5%	1.8%	3.8%	6.5%
Knightdale	49.8%	35.9%	4.1%	6.0%	4.1%	15.4%
Morrisville	44.3%	12.1%	37.0%	1.2%	4.8%	4.5%
Raleigh	59.0%	28.9%	4.6%	4.6%	2.6%	11.0%
Rolesville	66.2%	27.1%	3.2%	1.2%	2.4%	3.0%
Wake Forest	78.9%	14.5%	1.5%	0.9%	4.1%	4.8%
Wendell	67.8%	19.4%	1.0%	3.6%	4.3%	12.9%
Zebulon	50.0%	42.1%	1.2%	1.6%	5.1%	13.1%

Source: US Census Bureau

*Persons of Hispanic origin may be of any race, so also are included in applicable race categories

Figure 3.6 displays social vulnerability information for Wake County by census tract according to 2016 data and analysis by the Centers for Disease Control and Prevention (CDC). The CDC's Social Vulnerability Index (SVI) indicates the relative vulnerability within census tracts based on 15 social factors: poverty, unemployment, income, education, age, disability, household composition, minority status, language, housing type, and transportation access. Higher social vulnerability is an indicator that a community may be limited in its ability to respond to and recover from hazard events. Therefore, using this SVI information can help the County and jurisdictions to prioritize pre-disaster aid, allocate emergency preparedness and response resources, and plan for the provision of recovery support.

Figure 3.6 – Social Vulnerability Index by Census Tract, 2016



Source: Centers for Disease Control and Prevention (CDC) / Agency for Toxic Substances and Disease Registry (ATSDR) / Geospatial Research, Analysis, and Services Program (GRASP).

3.3 PARCELS AND BUILDINGS

Table 3.5 provides a count of the undeveloped and developed parcels in Wake County by jurisdiction.

Table 3.5 – Parcel Count by Jurisdiction

Jurisdiction	Developed Parcels	Undeveloped Parcels
City of Raleigh	125,227	12,331
Town of Apex	18,060	5,273
Town of Cary	49,067	5,730
Town of Fuquay-Varina	13,194	2,193
Town of Garner	11,977	2,437
Town of Holly Springs	12,695	2,860
Town of Knightdale	7,570	1,207
Town of Morrisville	6,481	1,018
Town of Rolesville	3,186	933
Town of Wake Forest	3,777	1,308
Town of Wendell	13,572	2,676
Town of Zebulon	2,631	905
Wake County	49,760	11,039
Total	**317,197**	**49,910**

Source: Wake County GIS Open Data; April 2019

3.4 HISTORIC PROPERTIES

As of October 17, 2018, Wake County had 224 listings on the National Register of Historic Places, detailed in Table 3.6. This list includes 64 Historic Districts. Listing on the National Register signifies that these structures and districts have been determined to be worthy of preservation for their historical or cultural values. In addition to these properties, there are four National Historic Landmarks in Wake County; all four are located in the City of Raleigh.

Table 3.6 – National Register of Historic Places Listings in Wake County

Ref#	Property Name	Status Date	Category	City
85003077	Apex City Hall	12/5/1985	Building	Apex
88002697	Apex Union Depot	12/1/1988	Building	Apex
94000185	Apex Historic District	3/17/1994	District	Apex
95000210	Apex Historic District (Boundary Increase)	3/10/1995	District	Apex
02000016	Apex Historic District (Boundary Increase)	2/14/2002	District	Apex
07001502	Apex Historic District (Boundary Increase II)	1/31/2008	District	Apex
08000937	Lawrence, Calvin Wray, House	9/23/2008	Building	Apex
03000967	Poole, Wayland E., House	9/25/2003	Building	Auburn
79003339	Page-Walker Hotel	5/29/1979	Building	Cary
84002540	Jones, Nancy, House	3/1/1984	Building	Cary
00000549	Carpenter Historic District	5/26/2000	District	Cary
01000340	Green Level Historic District	4/5/2001	District	Cary
01000425	Cary Historic District	4/25/2001	District	Cary
02000498	Utley--Council House	5/16/2002	Building	Cary
08000414	Ivey--Ellington House	5/15/2008	Building	Cary

Ref#	Property Name	Status Date	Category	City
01000424	Cannady--Brogden Farm	4/25/2001	Building	Creedmoor
74001379	Mangum, James, House	11/18/1974	Building	Creedmoor
99000509	Hood--Anderson Farm	4/29/1999	District	Eagle Rock
83001921	Falls of the Neuse Manufacturing Company	9/19/1983	Building	Falls
84000118	Forestville Baptist Church	10/25/1984	Building	Forestville
14000230	Fuquay Springs Historic District (Boundary Increase)	5/19/2014	District	Fuquay Varina
14001023	Stevens, Wayland H. and Mamie Burt, House	12/10/2014	Building	Fuquay Varina
86003457	Fuquay Mineral Spring	12/4/1986	Site	Fuquay-Varina
89002352	Jones--Johnson--Ballentine Historic District	1/26/1990	District	Fuquay-Varina
89002351	Varina Commercial Historic District	1/31/1990	District	Fuquay-Varina
91001375	Johnson, J. Beale, House	9/5/1991	Building	Fuquay-Varina
97000195	Ben--Wiley Hotel	2/27/1997	Building	Fuquay-Varina
02000495	Fuquay Springs High School	5/16/2002	Building	Fuquay-Varina
07000352	Fuquay-Varina Woman's Club Clubhouse	4/24/2007	Building	Fuquay-Varina
96001398	Fuquay Springs Historic District	11/29/1996	District	Fuquay-Varina
05001028	Johnson, Kemp B., House	9/15/2005	Building	Fuquay-Varina
05001448	Fuquay Springs Teacherage	12/23/2005	Building	Fuquay-Varina
89002157	Downtown Garner Historic District	12/21/1989	District	Garner
93000544	Edenwood	7/2/1993	Building	Garner
09001106	Meadowbrook Country Club	12/16/2009	District	Garner
97000218	Leslie--Alford--Mims House	3/8/1997	Building	Holly Springs
10000164	Holly Springs Masonic Lodge	4/7/2010	Building	Holly Springs
86001631	Walnut Hill Cotton Gin	8/14/1986	Building	Knightdale
86003529	Beaver Dam	1/6/1987	Building	Knightdale
87002234	Knight, Henry H. and Bettie S., Farm	1/12/1988	District	Knightdale
00001183	Walnut Hill Historic District	10/6/2000	District	Knightdale
07000543	Midway Plantation House and Outbuildings	6/15/2007	Building	Knightdale
12000218	Page, Williamson, House	4/16/2012	Building	Morrisville
12000913	Morrisville Christian Church	11/6/2012	Building	Morrisville
14000334	Pugh House	6/19/2014	Building	Morrisville
01000426	New Hill Historic District	4/25/2001	District	New Hill
07001503	Holleman, Samuel Bartley, House	1/30/2008	Building	New Hill
70000475	North Carolina Executive Mansion	2/26/1970	Building	Raleigh
70000476	North Carolina State Capitol	2/26/1970	Building	Raleigh
70000479	Yates Mill	2/26/1970	Building	Raleigh
70000474	Mordecai House	7/1/1970	Building	Raleigh
70000478	State Bank of North Carolina	7/1/1970	Building	Raleigh
70000469	Christ Church	7/28/1970	Building	Raleigh
70000470	Haywood Hall	7/28/1970	Building	Raleigh
70000471	Haywood, Richard B., House	7/28/1970	Building	Raleigh

Ref#	Property Name	Status Date	Category	City
70000472	Lane, Joel, House	7/28/1970	Building	Raleigh
70000477	St. Mary's Chapel	11/20/1970	Building	Raleigh
71000627	White-Holman House	4/16/1971	Building	Raleigh
71000624	Federal Building	5/6/1971	Building	Raleigh
71000626	Seaboard Coast Line Railroad Company Office Building	5/6/1971	Building	Raleigh
71000623	Dodd-Hinsdale House	11/12/1971	Building	Raleigh
71000625	Raleigh Water Tower	12/16/1971	Building	Raleigh
72000998	Andrews-Duncan House	1/20/1972	Building	Raleigh
72001000	Heck-Andrews House	1/20/1972	Building	Raleigh
72000999	Hawkins-Hartness House	2/1/1972	Building	Raleigh
72001001	Lewis-Smith House	12/11/1972	Building	Raleigh
73001375	J. S. Dorton Arena	4/11/1973	Building	Raleigh
73001374	Heck-Lee, Heck-Wynne, and Heck-Pool Houses	4/13/1973	Building	Raleigh
73001373	Estey Hall	5/25/1973	Building	Raleigh
73001376	Jones Jr., Nathaniel, House	6/4/1973	Building	Raleigh
73001377	Peace College Main Building	6/19/1973	Building	Raleigh
73001372	Briggs Hardware Building	10/25/1973	Building	Raleigh
74001380	Oakwood Historic District	6/25/1974	District	Raleigh
75001293	Capehart House	1/17/1975	Building	Raleigh
75001297	Tucker Carriage House	2/13/1975	Building	Raleigh
75001295	Jones, Alpheus, House	7/7/1975	Building	Raleigh
75001294	Elmwood	10/29/1975	Building	Raleigh
76001341	Agriculture Building	6/16/1976	Building	Raleigh
76001343	North Carolina School for the Blind and Deaf Dormitory	8/11/1976	Building	Raleigh
76001344	Pullen Park Carousel	9/8/1976	Structure	Raleigh
76001342	Daniels, Josephus, House	12/8/1976	Building	Raleigh
77001012	Polk, Leonidas L., House	4/13/1977	Building	Raleigh
78001979	Montford Hall	3/8/1978	Building	Raleigh
78001978	Capitol Area Historic District	4/15/1978	District	Raleigh
78001980	Raleigh, Sir Walter, Hotel	8/11/1978	Building	Raleigh
78001981	St. Mary's College	12/19/1978	District	Raleigh
79001759	Rogers-Bagley-Daniels-Pegues House	3/21/1979	Building	Raleigh
79003341	Masonic Temple Building	9/17/1979	Building	Raleigh
80002902	Norburn Terrace	2/1/1980	Building	Raleigh
80002903	St. Augustine's College Campus	3/28/1980	District	Raleigh
77001011	Lane-Bennett House	6/30/1983	Building	Raleigh
83001924	Moore Square Historic District	8/3/1983	District	Raleigh
83001923	Lumsden-Boone Building	9/8/1983	Building	Raleigh
83001925	Professional Building	9/8/1983	Building	Raleigh

Ref#	Property Name	Status Date	Category	City
83004003	Spring Hill	12/29/1983	Building	Raleigh
84002533	Masonic Temple Building	5/3/1984	Building	Raleigh
85001671	Boylan Heights	7/29/1985	District	Raleigh
85001672	Glenwood	7/29/1985	District	Raleigh
85001673	Cameron Park	7/29/1985	District	Raleigh
85003076	Capital Club Building	12/5/1985	Building	Raleigh
86000403	Marshall--Harris--Richardson House	3/5/1986	Building	Raleigh
87000855	North Carolina State Fair Commercial & Education Buildings	6/5/1987	Building	Raleigh
87001787	Oakwood Historic District (Boundary Increase)	10/21/1987	District	Raleigh
80004607	St. Paul A.M.E. Church	11/5/1987	Building	Raleigh
87002597	Christ Episcopal Church	12/23/1987	Building	Raleigh
87002235	Oakwood Historic District (Boundary Increase II)	1/6/1988	District	Raleigh
88003044	Oakwood Historic District (Boundary Increase III)	1/9/1989	District	Raleigh
89000441	Pilot Mill	6/5/1989	District	Raleigh
89001049	Henderson, Isabelle Bowen, House and Gardens	8/7/1989	District	Raleigh
90001030	Wyatt, Leonidas R., House	7/5/1990	Building	Raleigh
90001527	East Raleigh--South Park Historic District	10/11/1990	District	Raleigh
90001638	Dix Hill	11/7/1990	District	Raleigh
91000359	Oak View	4/3/1991	District	Raleigh
92001602	Grosvenor Gardens Apartments	11/12/1992	Building	Raleigh
93000440	Fadum House	6/10/1993	Building	Raleigh
93000543	Raleigh Banking and Trust Company Building	6/17/1993	Building	Raleigh
94001085	Small, G. Milton, and Associates, Office Building	9/21/1994	Building	Raleigh
94001086	Small House	9/21/1994	Building	Raleigh
94001087	Ritcher House	9/21/1994	Building	Raleigh
94001088	Paschal House	9/21/1994	Building	Raleigh
94001089	Matsumoto House	9/21/1994	Building	Raleigh
95000783	Crabtree Creek Recreational Demonstration Area	6/30/1995	District	Raleigh
95001440	Haywood, Dr. Hubert Benbury, House	12/13/1995	Building	Raleigh
96000197	Kamphoefner, Henry L., House	3/12/1996	Building	Raleigh
97000022	Raleigh National Cemetery	1/31/1997	Site	Raleigh
97001304	Carolina Power and Light Company Car Barn and Automobile Garage	10/30/1997	Building	Raleigh
97001305	Raleigh Electric Company Power House	10/30/1997	Building	Raleigh
97001498	Odd Fellows Building	12/1/1997	Building	Raleigh
97001499	Pine Street Creamery, (Former)	12/1/1997	Building	Raleigh
97001593	Royal Baking Company	12/30/1997	Building	Raleigh
97001668	Mordecai Place Historic District	2/4/1998	District	Raleigh
99001392	Pope, Dr. M.T., House	11/22/1999	Building	Raleigh

Ref#	Property Name	Status Date	Category	City
99001452	Raleigh Water Works and E.B. Bain Water Treatment Plant	11/22/1999	Building	Raleigh
00000457	Mahler and Carolina Trust Buildings	11/29/2000	Building	Raleigh
00001570	Mordecai Place Historic District (Boundary Increase)	12/28/2000	Building	Raleigh
01000416	St. Matthews School	4/25/2001	Building	Raleigh
01000421	Panther Branch School	5/8/2001	Building	Raleigh
01000557	Caraleigh Mills	5/25/2001	Building	Raleigh
01001112	North Carolina Agricultural Experiment Station Cottage	10/15/2001	Building	Raleigh
02000058	Glenwood--Brooklyn Historic District (Boundary Increase and Decrease)	2/20/2002	District	Raleigh
02000165	Penny, Jesse, House and Outbuildings	3/13/2002	Building	Raleigh
02000499	Turner, John T. and Mary, House	5/16/2002	Building	Raleigh
02000500	Graves, Willis M., House	5/16/2002	Building	Raleigh
02000501	Hall, Rev. Plummer T., House	5/16/2002	Building	Raleigh
02000502	Latta, Rev. M.L., House	5/16/2002	Building	Raleigh
02000496	Hayes Barton Historic District	5/16/2002	District	Raleigh
02000497	Bloomsbury Historic District	5/16/2002	District	Raleigh
02000946	Depot Historic District	9/6/2002	District	Raleigh
03000389	Roanoke Park Historic District	5/9/2003	District	Raleigh
03000391	Vanguard Park Historic District	5/9/2003	District	Raleigh
03000929	Occidental Life Insurance Company Building	9/11/2003	Building	Raleigh
03000930	Green, Herman, House	9/11/2003	Building	Raleigh
03001300	West Raleigh Historic District	12/18/2003	District	Raleigh
04001584	Washington Graded and High School	2/2/2005	Building	Raleigh
05000321	Rothstein, Mae and Philip, House	4/15/2005	Building	Raleigh
05000320	Lawrence, Dr. Elmo N., House	4/20/2005	Building	Raleigh
05001449	Blalock, Dr. Nathan M., House	12/23/2005	Building	Raleigh
06000223	Ivey, Rufus J., House	4/5/2006	Building	Raleigh
06000338	Maiden Lane Historic District	5/3/2006	District	Raleigh
06000790	Raleigh Bonded Warehouse	8/24/2006	Building	Raleigh
06000789	Pine Hall	9/6/2006	Building	Raleigh
06001109	Adams--Edwards House	12/6/2006	Building	Raleigh
07000902	Boylan Apartments	9/5/2007	Building	Raleigh
07001412	Fayetteville Street Historic District	2/27/2008	District	Raleigh
08000888	Free Church of the Good Shepherd	9/10/2008	Building	Raleigh
08000889	City Cemetery	9/12/2008	District	Raleigh
08000939	Curtis, William A., House	9/24/2008	Building	Raleigh
08001292	Mount Hope Cemetery	1/8/2009	District	Raleigh
08001388	Welles, Paul and Ellen, House	1/29/2009	Building	Raleigh
08001415	Mary Elizabeth Hospital	2/5/2009	Building	Raleigh

Ref#	Property Name	Status Date	Category	City
09000661	Carolina Coach Garage and Shop	8/27/2009	Building	Raleigh
10000632	Madonna Acres Historic District	9/1/2010	District	Raleigh
10001098	Harris, Harwell Hamilton and Jean Bangs, House and Office	12/28/2010	Building	Raleigh
10001111	Battery Heights Historic District	1/3/2011	District	Raleigh
10001112	Capitol Heights Historic District	1/3/2011	District	Raleigh
10001113	Longview Gardens Historic District	1/3/2011	District	Raleigh
11000484	Hi-Mount Historic District	7/29/2011	District	Raleigh
11000892	Arndt, G. Dewey and Elma, House	12/7/2011	Building	Raleigh
11000893	Rochester Heights Historic District	12/7/2011	District	Raleigh
11000956	Cameron Village Historic District	12/22/2011	District	Raleigh
14000523	Merrimon--Wynne House	8/25/2014	Building	Raleigh
14001024	Tucker, Garland Scott and Toler Moore, House	12/10/2014	Building	Raleigh
14001025	Wachovia Building Company Contemporary Ranch House	12/10/2014	Building	Raleigh
16000188	Chavis, John, Memorial Park	4/19/2016	District	Raleigh
100000941	O'Kelly, Berry, Historic District	5/11/2017	District	Raleigh
100001634	Depot Historic District (Boundary Increase)	9/21/2017	District	Raleigh
100002930	Oak Grove Cemetery	9/14/2018	Site	Raleigh
100002931	Oberlin Cemetery	9/14/2018	Site	Raleigh
94001025	Perry Farm	8/26/1994	Building	Riley Hill
89002158	Green--Hartsfield House	12/21/1989	Building	Rolesville
02001728	Heartsfield--Perry Farm	1/23/2003	Building	Rolesville
03000966	Young, Dr. Lawrence Branch, House	9/25/2003	Building	Rolesville
93001021	Oaky Grove	9/30/1993	Building	Shotwell
85002418	Rogers--Whitaker--Haywood House	9/19/1985	Building	Wake Crossroads
74001381	Powell House	10/15/1974	Building	Wake Forest
74001378	Wakefields	10/16/1974	Building	Wake Forest
75001298	Lea Laboratory	5/29/1975	Building	Wake Forest
88000238	Purefoy--Dunn Plantation	3/24/1988	District	Wake Forest
91001504	Royall Cotton Mill Commissary	10/16/1991	Building	Wake Forest
93000998	DuBois, W. E. B., School	10/5/1993	Building	Wake Forest
97000788	Purefoy--Dunn Plantation (Boundary Decrease)	7/25/1997	District	Wake Forest
98000689	Oakforest	6/11/1998	Building	Wake Forest
99001046	Glen Royall Mill Village Historic District	8/27/1999	District	Wake Forest
02000059	Downtown Wake Forest Historic District	2/20/2002	District	Wake Forest
02001719	Wakefield Dairy Complex	1/15/2003	Building	Wake Forest
03001301	Wake Forest Historic District	12/18/2003	District	Wake Forest
05001030	Thompson House	9/15/2005	Building	Wake Forest
07000879	Rock Cliff Farm	8/29/2007	District	Wake Forest

Ref#	Property Name	Status Date	Category	City
08001016	Purefoy-Chappell House and Outbuildings	10/22/2008	Building	Wake Forest
10001097	Bailey--Estes House	12/28/2010	Building	Wake Forest
14000265	South Brick House	5/27/2014	Building	Wake Forest
16000880	Jones, Dr. Calvin, House	12/22/2016	Building	Wake Forest
98000947	Wendell Commercial Historic District	7/31/1998	District	Wendell
01000415	Riley Hill School	4/25/2001	Building	Wendell
01001113	Sunnyside	10/15/2001	Building	Wendell
03000928	Avera, Dr. Thomas H., House	9/11/2003	Building	Wendell
07001504	Harmony Plantation	1/29/2008	Building	Wendell
09000382	Wendell Boulevard Historic District	6/3/2009	District	Wendell
06000788	Davis--Adcock Store	9/6/2006	Building	Wilbon
03000931	Smith, Frank and Mary, House	9/11/2003	Building	Willow Spring
05000549	Smith, Turner and Amelia, House	6/10/2005	Building	Willow Spring
76001345	Wakelon School	5/13/1976	Building	Zebulon
86000157	Bunn, Bennett, Plantation	2/4/1986	Building	Zebulon
07000881	Barbee, George and Neva, House	8/28/2007	Building	Zebulon

Source: National Parks Service, National Register of Historic Places, October 2018

3.5 HOUSING

According to the 2012-2016 ACS 5-Year Estimates, there are 411,632 housing units in Wake County, of which 92.8 percent are occupied. Approximately 35.9% of occupied units are renter-occupied. A high percentage of renters is an indicator of higher pre- and post-disaster vulnerability because, according to Cutter, et al. (2003), renters often do not have the financial resources of homeowners, are more transient, are less likely to have information about or access to recovery aid following a disaster, and are more likely to require temporary shelter following a disaster. Higher rates of home ownership in some jurisdictions, including Fuquay-Varina, Holly Springs, Rolesville, and Wake Forest may indicate that more residents in these areas are able to implement certain types of mitigation in their homes.

Median home value in Wake County is $250,700. Of the County's owner-occupied housing units, 77.2 percent have a mortgage. More than 49 percent of householders moved into their current homes since the year 2010, and another 31 percent moved in between 2000 and 2009, which is indicative of the extreme growth the area has been experiencing and could indicate that many residents may be new to the area they live in. Householders of 4.1 percent of occupied housing units have no vehicle available to them; these residents may have difficulty in the event of an evacuation.

Over 60 percent of housing units in Wake County are detached single family homes, and another 10.4 percent are attached single family homes. Approximately 3.4 percent of units are mobile homes, which can be more vulnerable to certain hazards, such as tornadoes and wind storms, especially if they aren't secured with tie downs.

The County's housing stock is relatively new, with over 36 percent of all units built since 2000. Age can indicate the potential vulnerability of a structure to certain hazards. For example, Wake County first entered the National Flood Insurance Program in 1978. Therefore, based on housing age estimates at least 23 percent of housing in the County was built before any floodplain development restrictions were

required. Several jurisdictions did not enter the NFIP until years later; therefore, the actual percent of housing built without floodplain development restrictions may be higher.

Table 3.7 – Housing Characteristics

Jurisdiction	Housing Units (2010)	Housing Units (2017)	Housing Units Percent Change (2010-2017)	Owner-Occupied, Percent (2017)	Vacant Units, Percent (2017)	Median Home Value (2017)
Wake County	**371,836**	**411,632**	**10.7%**	**59.5%**	**7.2%**	**$250,700**
Apex	13,922	16,883	21.3%	68.9%	4.2%	$289,300
Cary	55,303	63,008	13.9%	66.0%	4.4%	$323,000
Fuquay-Varina	7,325	8,626	17.8%	69.8%	4.1%	$221,000
Garner	10,993	11,633	6.4%	60.5%	7.5%	$167,700
Holly Springs	8,658	10,425	20.4%	82.2%	3.0%	$264,500
Knightdale	4,723	5,559	17.7%	64.6%	4.4%	$176,600
Morrisville	8,357	9,365	12.1%	45.8%	6.0%	$304,400
Raleigh	176,124	194,768	10.6%	47.2%	9.2%	$225,000
Rolesville	1,341	2,355	75.6%	73.1%	12.6%	$273,900
Wake Forest	11,370	13,888	22.1%	67.2%	4.7%	$278,600
Wendell	2,430	2,691	10.7%	64.8%	8.8%	$145,900
Zebulon	1,862	1,790	-3.9%	52.1%	6.8%	$145,000

Source: U.S. Census Bureau 2010 Decennial Census, American Community Survey 2012-2017 5-Year Estimates
Note: Owner-Occupied and vacant-unit measures are reported as a percent of the total number of housing units.

3.6 INFRASTRUCTURE

3.6.1 Transportation

There are several major roadways that cross Wake County. The most prominent is Interstate 40 which runs through the county on an east-west track. It has two spurs that more or less encompass the city of Raleigh and provide access to many of the outlying municipalities. In conjunction with I-40, I-440 makes up the "Beltline" that encircles most of central Raleigh. Additionally, I-540/NC-540 is a partly completed loop that is outside the beltline that currently connects many of the northern and western municipalities. In addition to the Interstate, there are many major highways that traverse the county. Federal highways of note are US-1, US-64, US-264, US-70, and US-401, while state highways in the county include NC-39, NC-42, NC-50, NC-54, NC-55, NC-96, NC-98, and NC-231.

Raleigh-Durham International Airport (RDU) is the primarily commercial airport in the region. It is one of the largest airports in the state and serves more than 35 international and domestic locations and over 9 million passengers a year.

There are two Amtrak railway facilities in Wake County, located in Raleigh and Cary.

The Triangle Transit authority operates a bus system that connects Raleigh, Durham, and Chapel-Hill and there are also several intra-county bus lines that provide service between Wake County municipalities.

3.6.2 Utilities

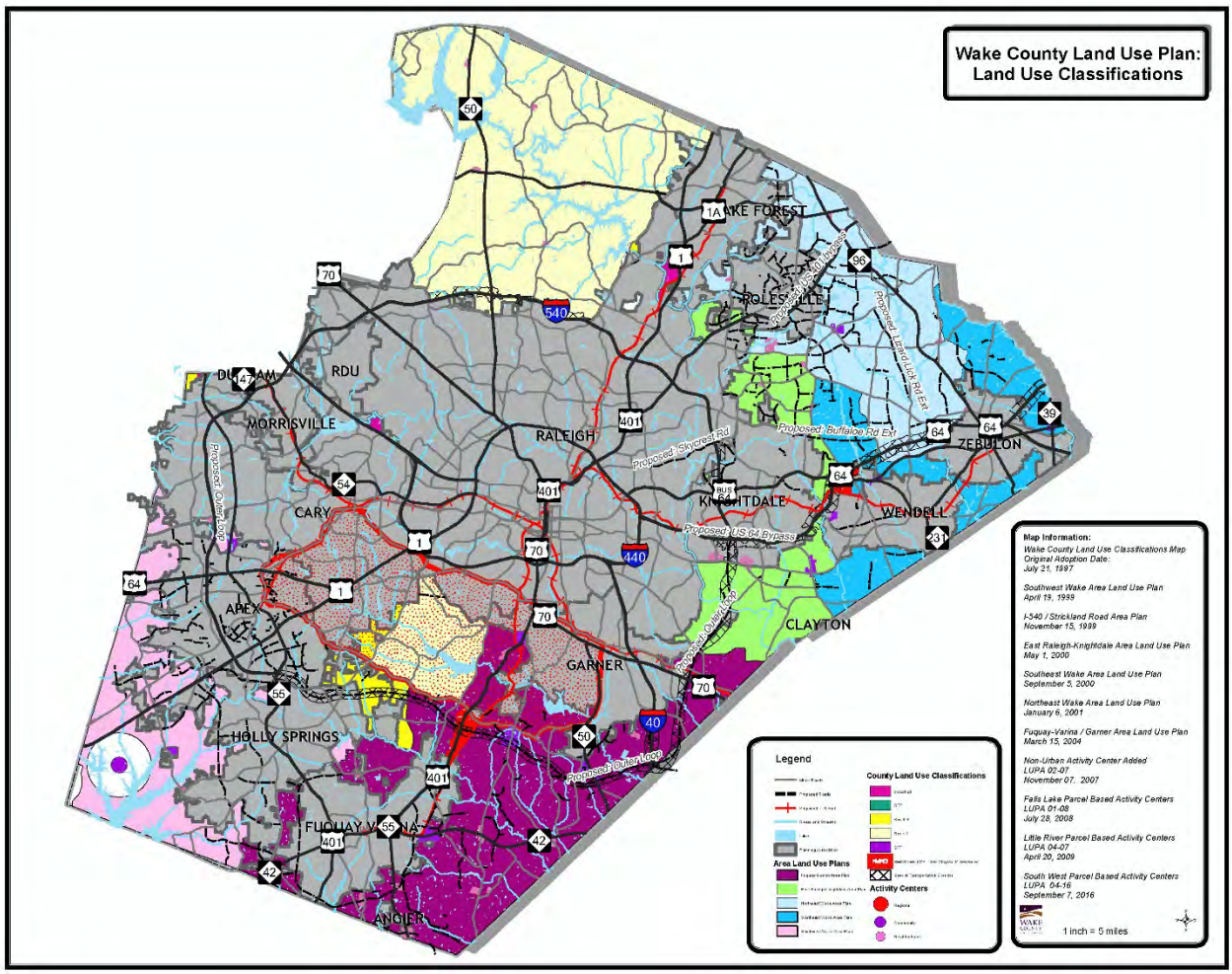
Electric power for the county is provided by Duke Energy and Wake Electric Membership Corporation, with Duke Energy providing service to a majority of the county. Water and sewer service is provided by the City of Raleigh Public Utilities and Western Wake Partners. Natural gas is provided by PSNC Energy.

3.7 CURRENT AND FUTURE LAND USE

Current and future land use in Wake County are predominantly regulated at the jurisdictional level. The Wake County Planning department provides public planning services to the unincorporated areas of Wake County. They plan for general land use classifications, water supply watersheds, and create small area land use plans. Figure 3.7 below shows these general classifications along with the areas planned for in more detail. Further information on land use planning in Wake County is available on the County's website.

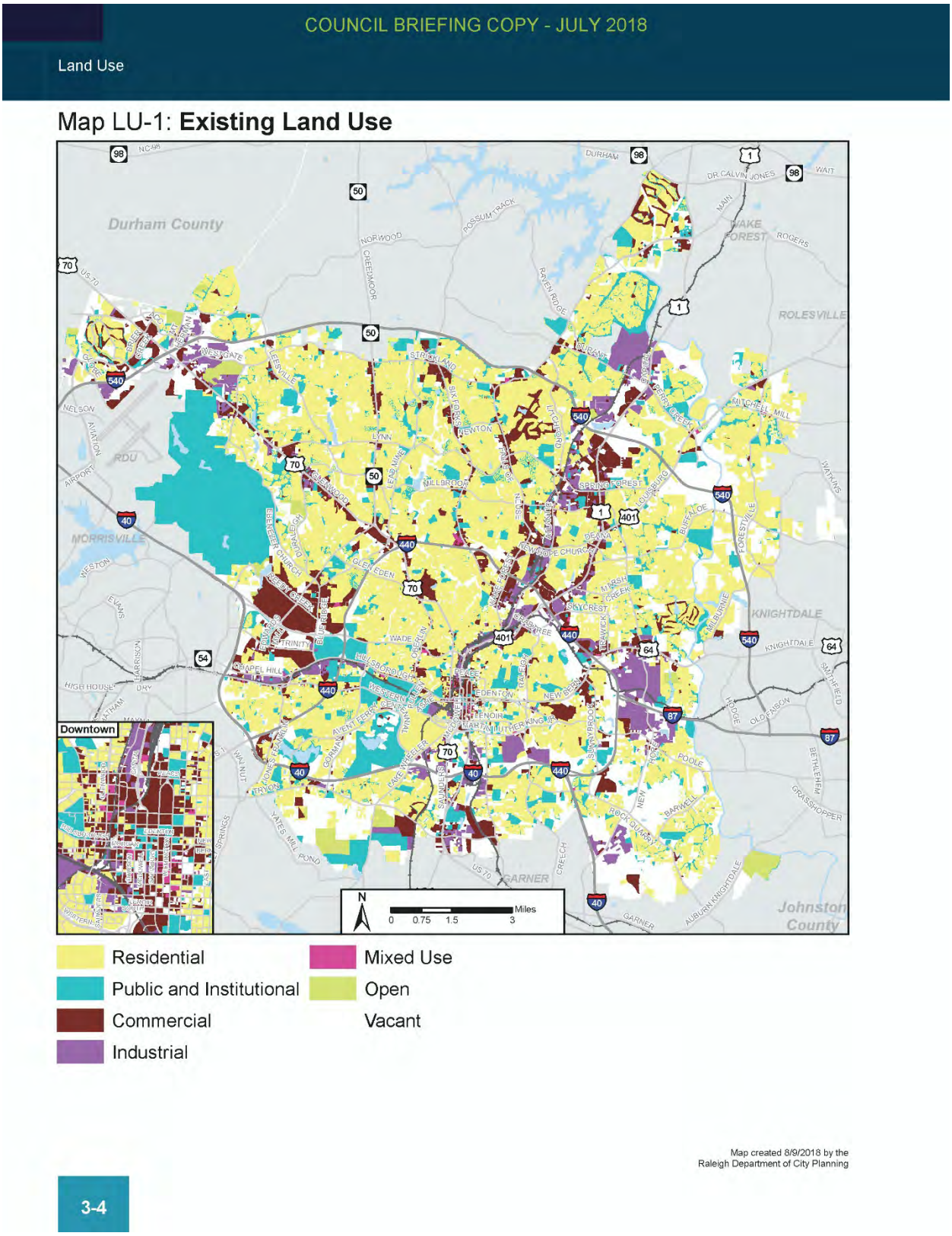
The City of Raleigh is Wake County's largest municipality and can be accessed by multiple major interstates and federal highways. 34.4% of the City's acreage, or 34,409 acres, was developed as residential single-family use as of 2016. Most existing retail and office space is located along major transportation corridors, and makes up just over 6 percent of the City's total acreage. Figure 3.8, from the 2030 Comprehensive Plan, shows the existing land use in the City of Raleigh. The most updated plan for 2030 proposes 19 different future land-use categories, including five different mixed-use categories, many of which propose increased density and walkability. Section 5 of the City of Raleigh 2030 Comprehensive Plan lays out the City's programs and initiatives that protect and enhance natural resources. These include policies for flood reduction and preparedness as well as open space preservation.

Figure 3.7 – Wake County Land Use



Source: Wake County Planning, Land Use & Zoning

Figure 3.8 – City of Raleigh Land Use



Source: City of Raleigh 2030 Comprehensive Plan

3.8 EMPLOYMENT AND INDUSTRY

Wake County is best known as being home of the capital of North Carolina, Raleigh, and is home to many government agencies and functions. Many state agencies are located in Wake County as are many federal agencies.

Wake County is one of three counties that comprise the Research Triangle metropolitan region, named for the Research Triangle Park (RTP) which encompasses the three major metropolitan areas of Chapel-Hill, Durham, and Raleigh. Each of these metropolitan areas is home to a major research university (UNC-Chapel Hill, Duke, and NC State University, respectively) and RTP draws on these universities for its workforce. The Research Triangle Park is a hub of high-tech and biotech research and is a defining feature of the economy in Wake County.

The early modern economy Wake County was built around agriculture and government, as the state capital of Raleigh was established in 1793. Since that time, much of the growth and economic well-being of the county has been linked to the county's status as a hub of government. While the county's position as home to the state capital remains important, in recent decades, the county's economic focus has shifted towards the fields of information technology and health care. The Research Triangle Park, located between Raleigh and Durham, is home to more than 250 companies that employ more than 50,000 people.

3.8.1 Wages and Employment

Per the 2012-2016 American Community Survey 5-Year Estimates, the median household income for the Wake County was $73,577, which is over 46 percent higher than the state's median household income ($50,320). However, approximately 10.1% of the population is considered to be living below the poverty level. Moreover, 13.4 percent of people under 18 years of age are living below the poverty level.

Table 3.7 shows employment statistics for all participating jurisdictions. Table 3.8 shows occupation statistics for all participating jurisdictions.

Table 3.8 – Employment Statistics for Wake County

Jurisdiction	Population in Labor Force	Percent Employed* (%)	Percent Unemployed* (%)	Percent Not in Labor Force* (%)	Unemployment Rate (%)
Wake County	**564,096**	**67.2**	**3.5**	**29.2**	**4.9**
Apex	25,403	72.5	3.0	24.5	3.9
Cary	88,040	68.8	2.7	28.5	3.8
Fuquay-Varina	12,407	65.9	3.9	29.9	5.6
Garner	15,338	64.6	4.1	31.2	6.0
Holly Springs	16,121	69.4	2.6	27.7	3.6
Knightdale	8,274	70.8	3.4	25.7	4.5
Morrisville	13,403	73.9	3.0	23.0	3.9
Raleigh	257,228	67.5	3.6	28.8	5.0
Rolesville	3,334	67.3	8.0	24.7	10.6
Wake Forest	19,229	65.6	3.8	30.5	5.4
Wendell	2,939	60.5	1.7	37.9	2.7
Zebulon	2,169	57.2	3.8	39.0	6.2

Source: U.S. Census Bureau, 2012-2016 American Community Survey 5-Year Estimates

Note: This table reports only the civilian labor force. The labor force in armed services accounted for 0.3% or less of the population 16 and over in all jurisdictions. *Population employed, population unemployed, and Population not in labor force are reported as a percent of the total population aged 16 years and older.

Table 3.9 – Percent of Employed Population by Occupation for Wake County

Occupation	Management, business, science and arts (%)	Service (%)	Sales and Office (%)	Natural Resources, Construction, and Maintenance (%)	Production, transportation, and material moving (%)
Wake County	**50.1**	**13.8**	**23.4**	**6.0**	**6.7**
Apex	57.2	11.4	22.6	4.8	4.0
Cary	61.8	10.4	19.7	3.9	4.3
Fuquay-Varina	47.3	16.7	22.4	5.3	8.3
Garner	42.2	15.8	24.9	8.3	8.8
Holly Springs	54.8	9.3	24.3	3.7	7.9
Knightdale	49.6	15.6	22.4	6.7	5.8
Morrisville	65.5	8.1	17.6	3.0	5.8
Raleigh	46.2	15.7	24.6	6.0	7.4
Rolesville	54.0	15.8	22.8	1.6	5.8
Wake Forest	53.4	13.2	25.0	4.0	4..4
Wendell	39.5	10.7	35.0	4.6	10.3
Zebulon	35.0	22.9	20.9	8.4	12.7

Source: U.S. Census Bureau, 2012-2016 American Community Survey 5-Year Estimates

Across the County as a whole, major industry sectors include educational services, and health care and social assistance (21.0 percent of employment in 2017); professional, scientific, and management, and administrative and waste management services (18.4 percent of employment in 2017); and retail trade (10.1 percent of employment in 2017).

Wake County accounts for the majority of its own employment, as approximately 82.3 percent of workers worked in their county of residence as of 2016. Much of the employment outside the County is likely accounted for by the other cities of the Research Triangle, Durham in Durham County and Chapel Hill in Orange County.

Table 3.9 summarizes the major employers with 5,000 employees or more in Wake County according to Wake County Economic Development.

Table 3.10 – Major Employers in Wake County

Employer	Estimated Employees
Duke University and Health System	38,591
State of North Carolina	24,083
Wake County Public School System	19,845
Wal-Mart	16,135
IBM Corporation	10,000
WakeMed Health & Hospitals	9,105
North Carolina State University	9,069
Target	8,000
UNC Rex Healthcare	7,400
SAS Institute, Inc.	5,632
Cisco Systems, Inc.	5,000
Harris Teeter	5,000

Source: Wake County Economic Development

4 Risk Assessment

Requirement §201.6(c)(2): [The plan shall include] A risk assessment that provides the factual basis for activities proposed in the strategy to reduce losses from identified hazards. Local risk assessments must provide sufficient information to enable the jurisdiction to identify and prioritize appropriate mitigation actions to reduce losses from identified hazards.
Requirement §201.6(c)(2)(i): [The risk assessment shall include a] description of the type…of all natural hazards that can affect the jurisdiction.

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

44 CFR Subsection D §201.6(c)(2)(ii): [The risk assessment shall include a] description of the jurisdiction's vulnerability to the hazards described in paragraph (c)(2)(i) of this section. This description shall include an overall summary of each hazard and its impact on the community. Plans approved after October 1, 2008 must also address NFIP insured structures that have been repetitively damaged by floods. The plan should describe vulnerability in terms of:
A) The types and numbers of existing and future buildings, infrastructure, and critical facilities located in the identified hazard areas;

(B): An estimate of the potential dollar losses to vulnerable structures identified in paragraph (c)(2)(ii)(A) of this section and a description of the methodology used to prepare the estimate; and

(C): Providing a general description of land uses and development trends within the community so that mitigation options can be considered in future land use decisions.

4.1 OVERVIEW

This section describes the Hazard Identification and Risk Assessment process for the development of the Wake County Multi-Jurisdictional Hazard Mitigation Plan. It describes how the County met the following requirements from the 10-step planning process:

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

As defined by FEMA, risk is a combination of hazard, vulnerability, and exposure. "It is the impact that a hazard would have on people, services, facilities, and structures in a community and refers to the likelihood of a hazard event resulting in an adverse condition that causes injury or damage."

This hazard risk assessment covers all of Wake County, including the unincorporated County and all incorporated jurisdictions participating in this plan. It should be noted that the City of Durham, the Town of Clayton, and the Town of Angier each have a small area of land that crosses into Wake County; however, risk was not assessed for these communities as they are not participants of this plan. Population and building counts presented in this risk assessment do not include these communities. Instead, these communities are addressed in full in their own respective hazard mitigation plans.

The risk assessment process identifies and profiles relevant hazards and assesses the exposure of lives, property, and infrastructure to these hazards. The process allows for a better understanding of the potential risk to natural hazards in the county and provides a framework for developing and prioritizing mitigation actions to reduce risk from future hazard events. This risk assessment followed the

methodology described in the FEMA publication Understanding Your Risks—Identifying Hazards and Estimating Losses (FEMA 386-2, 2002), which breaks the assessment down to a four-step process:

Data collected through this process has been incorporated into the following sections of this plan:

- **Section 4.2**: **Hazard Identification** identifies the natural and human-caused hazards that threaten the planning area.
- **Section 4.3: Risk Assessment Methodology and Assumptions**
- **Section 4.4: Asset Inventory** details the population, buildings, and critical facilities at risk within the planning area.
- **Section 4.5**: **Hazard Profiles, Analysis, and Vulnerability** discusses the threat to the planning area, describes previous occurrences of hazard events and the likelihood of future occurrences, and assesses the planning area's exposure to each hazard profiled; considering assets at risk, critical facilities, and future development trends.
- **Section 4.6: Conclusions on Hazard Risk** summarizes the results of the Priority Risk Index and defines each hazard as a Low, Medium, or High Risk hazard.

4.2 HAZARD IDENTIFICATION

To identify hazards relevant to the planning area, the HMPC began with a review of the list of hazards identified in the 2018 State Hazard Mitigation Plan and the 2015 Wake County Multi-Jurisdictional Hazard Mitigation Plan as summarized in Table 4.1. The HMPC used these lists to identify a full range of hazards for potential inclusion in this plan update and to ensure consistency across these planning efforts. All hazards on the below list were evaluated for inclusion in this plan update.

Table 4.1 – Full Range of Hazards Evaluated

Hazard	Included in 2018 State HMP?	Included in 2015 Wake County HMP?
Flooding	Yes	Yes
Hurricanes and Coastal Hazards	Yes	Yes
Severe Winter Weather (Freezing Rain, Snowstorms, Blizzards, Wind Chill, Extreme Cold)	Yes	Yes
Extreme Heat	Yes	Yes
Earthquake	Yes	Yes
Wildfire	Yes	Yes
Dam Failure	Yes	Yes
Levee Failure	No	Yes
Drought	Yes	Yes
Severe Thunderstorm (Tornado, Hailstorm, Torrential Rain, High Wind, Thunderstorm Wind, Lightning)	Yes	Yes (Hailstorm and Lightning evaluated as separate hazards)
Landslide	Yes	Yes
Sinkholes	Yes	No
Erosion	Yes	Yes
Hazardous Materials Incident	Yes	Yes

Hazard	Included in 2018 State HMP?	Included in 2015 Wake County HMP?
Radiological Emergency	Yes	Yes
Terrorism	Yes	Yes
Infectious Disease	Yes	No
Cyber Threat	Yes	No
Electromagnetic Pulse	Yes	No

The HMPC evaluated the above list of hazards using existing hazard data, past disaster declarations, local knowledge, and information from the 2018 State Plan and the 2015 Wake County Plan to determine the significance of these hazards to the planning area. Significance was measured in general terms and focused on key criteria such as frequency and resulting damage, which includes deaths and injuries, as well as property and economic damage.

One significant resource in this effort was the National Oceanic and Atmospheric Administration's National Center for Environmental Information (NCEI), which has been tracking various types of severe weather since 1950. Their Storm Events Database contains an archive by county of destructive storm or weather data and information which includes local, intense and damaging events. NCEI receives storm data from the National Weather Service (NWS). The NWS receives their information from a variety of sources, which include but are not limited to: county, state and federal emergency management officials, local law enforcement officials, SkyWarn spotters, NWS damage surveys, newspaper clipping services, the insurance industry and the general public, among others. The NCEI database contains 783 records of severe weather events that occurred in Wake County in the 20-year period from 1998 through 2017. Table 4.2 summarizes these events.

Table 4.2 – NCEI Severe Weather Reports for Wake County, 1998 – 2017

Type	# of Events	Property Damage	Crop Damage	Deaths	Injuries
Cold/Wind Chill	0	$0	$0	0	0
Drought	0	$0	$0	0	0
Extreme Cold/Wind Chill	0	$0	$0	0	0
Excessive Heat	0	$0	$0	0	0
Flash Flood	117	$68,651,000	$0	0	0
Flood	7	$60,000	$0	0	0
Hail	209	$10,000,000	$0	0	0
Heat	2	$0	$0	0	1
Heavy Rain	5	$0	$0	0	0
Heavy Snow	2	$0	$0	0	0
High Wind	5	$135,000	$0	0	0
Hurricane	6	$910,000	$0	0	0
Ice Storm	1	$0	$0	0	0
Lightning	33	$2,417,000	$0	3	0
Strong Wind	12	$958,000	$5,000	1	0
Thunderstorm Wind	324	$2,956,250	$4,000	1	12
Tornado	12	$116,028,000	$25,000	4	70
Tropical Storm	2	$20,000	$0	0	0
Wildfire	1	$1,000,000	$0	0	0
Winter Storm	25	$1,000,000	$0	0	0
Winter Weather	19	$40,000	$0	0	0
Total:	**782**	**$204,175,250**	**$34,000**	**9**	**83**

Source: National Center for Environmental Information Events Database, June 2018
Note: Losses reflect totals for all impacted areas for each event.

The HMPC also researched past events that resulted in a federal and/or state emergency or disaster declaration for Wake County in order to identify significant hazards. Federal and/or state disaster declarations may be granted when the Governor certifies that the combined local, county and state resources are insufficient and that the situation is beyond their recovery capabilities. When the local government's capacity has been surpassed, a state disaster declaration may be issued, allowing for the provision of state assistance. If the disaster is so severe that both the local and state government capacities are exceeded, a federal emergency or disaster declaration may be issued allowing for the provision of federal assistance.

Records of designated counties for FEMA major disaster declarations start in 1964. Since then, Wake County has been designated in 11 major disaster declarations, as detailed in Table 4.3.

Table 4.3 – FEMA Major Disaster Declarations, Wake County

Disaster #	Dec. Date	Incident Type	Event Title
4285	10/10/2016	Hurricane	Hurricane Matthew
1969	4/19/2011	Severe Storm(s)	Severe Storms, Tornadoes, And Flooding
1490	9/18/2003	Hurricane	Hurricane Isabel
1448	12/12/2002	Severe Ice Storm	Severe Ice Storm
1312	1/31/2000	Severe Storm(s)	Severe Winter Storm
1292	9/16/1999	Hurricane	Hurricane Floyd Major Disaster Declarations
1211	3/22/1998	Severe Storm(s)	Severe Storms Tornadoes, And Flooding
1134	9/6/1996	Hurricane	Hurricane Fran
1087	1/13/1996	Snow	Blizzard Of 96
818	12/2/1988	Tornado	Severe Storms & Tornadoes
234	2/10/1968	Severe Ice Storm	Severe Ice Storm

Source: FEMA Disaster Declarations Summary, October 16, 2018

Using the above information and additional discussion, the HMPC evaluated each hazard's significance to the planning area in order to decide which hazards to include in this plan update. Some hazard titles have been updated either to better encompass the full scope of a hazard or to assess closely related hazards together. Table 4.4 summaries the determination made for each hazard.

Table 4.4 – Hazard Evaluation Results

Hazard	Included in this plan update?	Explanation for Decision
Natural Hazards		
Dam Failure	Yes	The 2015 Wake County plan addressed this hazard.
Drought	Yes	The 2015 Wake County plan addressed this hazard. The State Hazard Mitigation Plan lists drought as a hazard for the Piedmont region which includes Wake County.
Earthquake*	Yes	The 2015 Wake County plan and the State HMP addressed this hazard. Wake County could be impacted by the New Madrid fault and the Charleston fault.
Extreme Heat	Yes	The 2015 Wake County plan addressed this hazard. NCEI reports 2 heat events for Wake County. The State HMP includes Excessive Heat as a moderate hazard.
Flood	Yes	The 2015 Wake County plan addressed this hazard. Multiple disaster declarations for the County are related to flooding. NCEI reports 130 flood-related events.

Hazard	Included in this plan update?	Explanation for Decision
Hurricane & Tropical Storm	Yes	Wake County is not exposed to coastal hazards; therefore storm surge, coastal flooding, and coastal erosion will not be assessed. However, past disaster declarations and NCEI storm reports indicate hurricane wind and rain are still a significant hazard for the County. The State HMP lists hurricane as a top hazard in the Piedmont region which includes Wake County. The 2015 Wake County plan addressed this hazard.
Landslide*	Yes	The 2015 Wake County plan and 2018 State HMP addressed this hazard.
Severe Winter Weather (Freezing Rain, Snowstorms, Blizzards, Wind Chill, Extreme Cold)	Yes	The 2015 Wake County plan and 2018 State plan addressed this hazard. Several past disaster and emergency declarations relate to this hazard.
Severe Weather (Thunderstorm Wind, Lightning, Hail)	Yes	The 2015 Wake County plan addressed these hazard. NCEI reports 341 wind events, 33 lightning events, and 209 hail events in the past 20 years. Given this frequency, analysis is warranted.
Tornado	Yes	The 2015 Wake County plan addressed this hazard. NCEI reports 12 previous tornado events. Per the State HMP, vulnerability to tornado is high. Wake County has previously received a major disaster declaration for tornado.
Wildfire	Yes	The 2015 Wake County plan addressed this hazard. There are areas of the County with high burn probability and moderate potential fire intensity.
Erosion	No	The 2015 Wake County plan addressed this hazard but did not find any historical occurrences and assigned a low probability of future occurrence. Erosion will be discussed as a subset of wind and flood hazards.
Levee Failure	No	The 2015 Wake County plan addressed this hazard in conjunction with dam failure but did not list any levees or historical levee failures in the County. The USACE's National Levee Database does not identify any USACE or non-USACE levees in Wake County.
Sinkholes	No	The 2015 Wake County plan did not address this hazard. Per the State HMP, vulnerability to sinkhole is low in the Piedmont region.
Technological Hazards & Threats		
Hazardous Materials Incident	Yes	The 2015 Wake County plan addressed this hazard and found it to be a moderate priority hazard to the planning area.
Radiological Emergency	Yes	The 2015 Wake County plan addressed this hazard and found it to be a moderate priority hazard to the planning area.
Terrorism	Yes	The 2015 Wake County plan addressed this hazard and found it to be a moderate priority hazard to the planning area.
Cyber Threat	No	The 2015 Wake County plan did not address this threat. The County considers this threat more appropriately addressed at the State level.
Electromagnetic Pulse	No	The 2015 Wake County plan did not address this threat. The County considers this threat more appropriately addressed at the State level.
Infectious Disease	No	The 2015 Wake County plan did not address this hazard. The State HMP reports the entire State is equally at risk, but vulnerability is low across all but one impact category.

*These hazards were found to be low-risk hazards through the risk assessment process; therefore, they are not prioritized for mitigation actions.

4.3 RISK ASSESSMENT METHODOLOGY AND ASSUMPTIONS

The Disaster Mitigation Act of 2000 requires that the HMPC evaluate the risks associated with each of the hazards identified in the planning process. Each hazard was evaluated to determine its probability of future occurrence and potential impact. A vulnerability assessment was conducted for each hazard using either quantitative or qualitative methods depending on the available data, to determine its potential to cause significant human and/or monetary losses. A consequence analysis was also completed for each hazard.

Each hazard is profiled in the following format:

Hazard Description

This section provides a description of the hazard, including discussion of its speed of onset and duration, as well as any secondary effects followed by details specific to the Wake County planning area.

Location

This section includes information on the hazard's physical extent, with mapped boundaries where applicable.

Extent

This section includes information on the hazard extent in terms of magnitude, describe how the severity of the hazard can be measured. Where available, the most severe event on record used as a frame of reference.

Past Occurrences

This section contains information on historical events, including the location and consequences of all past events on record within or near the Wake County planning area.

Probability of Future Occurrence

This section gauges the likelihood of future occurrences based on past events and existing data. The frequency is determined by dividing the number of events observed by the number of years on record and multiplying by 100. This provides the percent chance of the event happening in any given year according to historical occurrence (e.g. 10 winter storm events over a 30-year period equates to a 33 percent chance of experiencing a severe winter storm in any given year). The likelihood of future occurrences is categorized into one of the classifications as follows:

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

Climate Change

Where applicable, this section discusses how climate change may or may not influence the risk posed by the hazard on the planning area in the future.

Vulnerability Assessment

This section quantifies, to the extent feasible using best available data, assets at risk to natural hazards and potential loss estimates. People, properties and critical facilities, and environmental assets that are vulnerable to the hazard are identified. Future development is also discussed in this section, including how exposure to the hazard may change in the future or how development may affect hazard risk.

The vulnerability assessments followed the methodology described in the FEMA publication Understanding Your Risks—Identifying Hazards and Estimating Losses (August 2001). The vulnerability assessment first describes the total vulnerability and values at risk and then discusses vulnerability by hazard. Data used to support this assessment included the following:

- Geographic Information System (GIS) datasets, including building footprints, topography, aerial photography, and transportation layers;
- Hazard layer GIS datasets from state and federal agencies;
- Written descriptions of inventory and risks provided by the State Hazard Mitigation Plan; and
- Written descriptions of inventory and risks provided by the previous Wake County Multi-Jurisdictional Hazard Mitigation Plan.
- Exposure and vulnerability estimates provided by the North Carolina Emergency Management IRISK database.
- Crop insurance claims by cause from USDA's Risk Management Agency

NCEM's IRISK database incorporates county building footprint and parcel data. Footprints with an area less than 500 square feet were excluded from the analysis. To determine if a building is in a hazard area, the building footprints were intersected with each of the mapped hazard areas. If a building intersects two or more hazard areas (such as the 1-percent-annual-chance flood zone and the 0.2-percent-annual-chance flood zone), it is counted as being in the hazard area of highest risk. The parcel data provided building value and year built. Building value was used to determine the value of buildings at risk. Year built was used to determine if the building was constructed prior to or after the community had joined the NFIP and had an effective FIRM and building codes enforced.

Census blocks and Summary File 1 from the 2010 Census were used to determine population at risk. This included the total population, as well as the vulnerable elderly and children age groups. To determine population at risk, the census blocks were intersected with the hazard area. To better determine the actual number of people at risk, the intersecting area of the census block was calculated and divided by the total area of the census block to determine a ratio of area at risk. This ratio was applied to the population of the census block. For example, a census block has a population of 400 people. Five percent of the census block intersects the 1-percent-annual-chance flood hazard area. The ratio estimates that 20 people are then at risk within the 1-percent-annual-chance flood hazard area (5% of the total population for that census block).

Two distinct risk assessment methodologies were used in the formation of the vulnerability assessment. The first consists of a ***quantitative*** analysis that relies upon best available data and technology, while the second approach consists of a ***qualitative*** analysis that relies on local knowledge and rational decision making. The quantitative analysis involved the use of NCEM's IRISK database, which provides modeled damage estimates for flood, wind, and wildfire hazards.

Vulnerability can be quantified in those instances where there is a known, identified hazard area, such as a mapped floodplain. In these instances, the numbers and types of buildings subject to the identified hazard can be counted and their values tabulated. Where hazard risk cannot be distinctly quantified and modeled, other information can be collected in regard to the hazard area, such as the location of critical

facilities, historic structures, and valued natural resources (e.g., an identified wetland or endangered species habitat). Together, this information conveys the vulnerability of that area to that hazard.

Certain assumptions are inherent in any risk assessment. For the Wake County Multi-Jurisdictional HMP, three primary assumptions were discussed by the HMPC from the beginning of the risk assessment process: (1) that the best readily available data would be used, (2) that the hazard data selected for use is reasonably accurate for mitigation planning purposes, and (3) that the risk assessment will be regional in nature with local, municipal-level data provided where appropriate and practical.

Key methodologies and assumptions for specific hazards analysis are described in their respective profiles.

Priority Risk Index

The conclusions drawn from the hazard profiling and vulnerability assessment process can be used to prioritize all potential hazards to the Wake County planning area. The Priority Risk Index (PRI) was applied for this purpose because it provides a standardized numerical value so that hazards can be compared against one another (the higher the PRI value, the greater the hazard risk). PRI values are obtained by assigning varying degrees of risk to five categories for each hazard (probability, impact, spatial extent, warning time, and duration). Each degree of risk was assigned a value (1 to 4) and a weighting factor as summarized in Table 4.5.

The results of the risk assessment and PRI scoring are provided in Section 4.6 Conclusions on Hazard Risk.

Table 4.5 – Priority Risk Index

RISK ASSESSMENT CATEGORY	LEVEL	DEGREE OF RISK CRITERIA	INDEX	WEIGHT
PROBABILITY What is the likelihood of a hazard event occurring in a given year?	**UNLIKELY**	LESS THAN 1% ANNUAL PROBABILITY	**1**	**30%**
	POSSIBLE	BETWEEN 1 & 10% ANNUAL PROBABILITY	**2**	
	LIKELY	BETWEEN 10 &100% ANNUAL PROBABILITY	**3**	
	HIGHLY LIKELY	100% ANNUAL PROBABILTY	**4**	
IMPACT In terms of injuries, damage, or death, would you anticipate impacts to be minor, limited, critical, or catastrophic when a significant hazard event occurs?	**MINOR**	VERY FEW INJURIES, IF ANY. ONLY MINOR PROPERTY DAMAGE & MINIMAL DISRUPTION ON QUALITY OF LIFE. TEMPORARY SHUTDOWN OF CRITICAL FACILITIES.	**1**	**30%**
	LIMITED	MINOR INJURIES ONLY. MORE THAN 10% OF PROPERTY IN AFFECTED AREA DAMAGED OR DESTROYED. COMPLETE SHUTDOWN OF CRITICAL FACILITIES FOR > 1 DAY	**2**	
	CRITICAL	MULTIPLE DEATHS/INJURIES POSSIBLE. MORE THAN 25% OF PROPERTY IN AFFECTED AREA DAMAGED OR DESTROYED. COMPLETE SHUTDOWN OF CRITICAL FACILITIES FOR > 1 WEEK.	**3**	
	CATASTROPHIC	HIGH NUMBER OF DEATHS/INJURIES POSSIBLE. MORE THAN 50% OF PROPERTY IN AFFECTED AREA DAMAGED OR DESTROYED. COMPLETE SHUTDOWN OF CRITICAL FACILITIES > 30 DAYS.	**4**	
SPATIAL EXTENT How large of an area could be impacted by a hazard event? Are impacts localized or regional?	**NEGLIGIBLE**	LESS THAN 1% OF AREA AFFECTED	**1**	**20%**
	SMALL	BETWEEN 1 & 10% OF AREA AFFECTED	**2**	
	MODERATE	BETWEEN 10 & 50% OF AREA AFFECTED	**3**	
	LARGE	BETWEEN 50 & 100% OF AREA AFFECTED	**4**	
WARNING TIME Is there usually some lead time associated with the hazard event? Have warning measures been implemented?	**MORE THAN 24 HRS**	SELF DEFINED	**1**	**10%**
	12 TO 24 HRS	SELF DEFINED	**2**	
	6 TO 12 HRS	SELF DEFINED	**3**	
	LESS THAN 6 HRS	SELF DEFINED	**4**	
DURATION How long does the hazard event usually last?	**LESS THAN 6 HRS**	SELF DEFINED	**1**	**10%**
	LESS THAN 24 HRS	SELF DEFINED	**2**	
	LESS THAN 1 WEEK	SELF DEFINED	**3**	
	MORE THAN 1 WEEK	SELF DEFINED	**4**	

The sum of all five risk assessment categories equals the final PRI value, demonstrated in the equation below (the highest possible PRI value is 4.0).

PRI = [(PROBABILITY x .30) + (IMPACT x .30) + (SPATIAL EXTENT x .20) + (WARNING TIME x .10) + (DURATION x .10)]

The purpose of the PRI is to categorize and prioritize all potential hazards for the Wake County planning area as high, moderate, or low risk. The summary hazard classifications generated through the use of the PRI allows for the prioritization of those high and moderate hazard risks for mitigation planning purposes. Mitigation actions are not developed for hazards identified as low risk through this process.

4.4 ASSET INVENTORY

North Carolina Emergency Management's (NCEM) IRISK database provided the asset inventory used for this vulnerability assessment. Population data in IRISK is pulled from the 2010 Census and includes a breakdown of population into two subpopulations considered to be a greater risk than the general population, the elderly and children. Table 4.6 details the population counts by jurisdiction used for the vulnerability assessment.

Table 4.6 – Population Counts by Jurisdiction, 2010

Jurisdiction	2010 Census Population	Elderly (Age 65 and Over)	Children (Age 5 and Under)
Raleigh	419,053	35,611	30,469
Apex	41,724	3,546	3,034
Cary	136,260	11,579	9,907
Fuquay-Varina	25,023	2,126	1,819
Garner	30,981	2,633	2,253
Holly Springs	25,790	2,192	1,875
Knightdale	18,501	1,572	1,345
Morrisville	18,655	1,585	1,356
Rolesville	5,199	442	378
Wake Forest	30,382	2,582	2,209
Wendell	7,889	670	574
Zebulon	6,102	519	444
Unincorporated Wake County	135,124	11,483	9,825
Total	**900,683**	**76,540**	**65,488**

Source: NCEM IRISK Database; 2010 Decennial Census

Building counts were also provided by the IRISK database. These values were generated using locally-provided building footprint and parcel data. The methodology for generating the building asset inventory is described in greater detail in Section 4.3. Note that these building counts were provided in 2010, and Wake County has since experienced a substantial amount of growth and new development. Therefore, the exposure reflected in the following tables is an underestimate of actual present-day exposure. Section 3 Planning Area Profile describes the growth that has occurred since 2010 and provides a means of estimating the degree to which exposure and vulnerability may have increased.

Table 4.7 – Building Counts and Values by Jurisdiction, 2010

Jurisdiction	Building Count	Building Value
Raleigh	128,076	$36,932,753,604
Apex	14,554	$3,308,524,073
Cary	45,306	$14,607,342,852
Fuquay-Varina	10,244	$2,075,445,520
Garner	11,975	$2,243,212,305
Holly Springs	9,178	$2,304,103,554
Knightdale	7,144	$1,240,283,673
Morrisville	5,181	$2,166,113,564

Jurisdiction	Building Count	Building Value
Rolesville	2,103	$388,407,100
Wake Forest	10,547	$2,829,746,009
Wendell	3,728	$483,437,990
Zebulon	3,074	$580,245,547
Unincorporated Wake County	59,373	$13,446,080,728
Total	**310,483**	**$82,605,696,519**

Source: NCEM IRISK Database

Table 4.8 provides an estimate of the number of pre-FIRM buildings in each jurisdiction. This analysis was prepared using NCEM's IRISK database and comparing the year built for each structure to the corresponding community's initial Flood Insurance Rate Map (FIRM) date. The pre-FIRM building counts include all building constructed prior to the year of the initial FIRM.

Table 4.8 – Pre-FIRM Buildings by Jurisdiction

Jurisdiction	Pre-FIRM Building Count	Date of Initial FIRM
Wake County	11,483	11/15/1978
Raleigh	44,658	8/15/1978
Apex	3,769	3/3/1992
Cary	7,616	7/17/1978
Fuquay-Varina	2,181	11/1/1978
Garner	5,561	7/3/1978
Holly Springs	1,532	3/3/1992
Knightdale	1,698	8/1/1978
Morrisville	287	11/1/1978
Rolesville	817	3/3/1992
Wake Forest	1,469	7/3/1978
Wendell	1,597	6/1/1978
Zebulon	1,552	7/3/1978

Source: NCEM IRISK Database; GIS analysis performed by Wood
Note: These estimates do not account for any historical changes in jurisdictional boundaries. Buildings were classified based on the Initial FIRM date for the current jurisdictional boundaries.

The IRISK database also identifies Critical Infrastructure and Key Resources (CIKR) buildings as well as High Potential Loss Properties. These properties were also identified in 2010 and are likely an underestimate of the exposure of current CIKR and High Potential Loss Properties. These properties are detailed in Table 4.9 and Table 4.10, respectively.

Table 4.9 – Critical Infrastructure and Key Resources by Type and Jurisdiction

Jurisdiction	Food and Agriculture	Banking and Finance	Chemical & Hazardous	Commercial	Communications	Critical Manufacturing	EM	Healthcare	Government Facilities	Defense Industrial Base	National Monuments and Icons	Nuclear Reactors, Materials and Waste	Postal and Shipping	Transportation Systems	Energy	Emergency Services	Water	Total
Raleigh	166	164	1	3,653	8	1,678	2	1,643	457	0	0	2	0	739	13	40	12	**8,578**
Apex	75	14	0	302	0	225	1	91	27	0	0	0	0	59	0	2	0	**796**
Cary	91	55	0	1,259	5	270	1	334	98	0	0	1	0	203	4	12	27	**2,360**
Fuquay-Varina	136	17	0	275	0	150	1	69	27	0	0	0	0	37	0	3	5	**720**
Garner	67	19	0	297	0	309	0	110	23	0	0	0	0	27	1	3	4	**860**
Holly Springs	68	6	0	118	0	42	0	37	3	0	0	0	0	9	0	5	3	**291**
Knightdale	68	10	0	120	0	64	0	46	8	0	0	0	0	12	1	5	0	**334**
Morrisville	2	5	0	162	1	142	1	31	2	0	0	0	0	40	0	2	0	**388**
Rolesville	43	1	0	37	0	11	0	20	2	0	0	0	0	4	0	2	0	**120**
Wake Forest	8	12	0	315	0	199	0	93	23	0	0	0	0	36	0	4	3	**693**
Wendell	72	4	0	132	0	75	0	37	6	0	0	0	0	22	0	2	0	**350**
Zebulon	60	8	0	151	0	85	0	52	18	0	0	0	0	19	0	2	2	**397**
Unincorporated Wake County	1,902	0	0	574	0	621	0	198	27	0	0	0	0	186	28	14	43	**3,593**
Total	**2,758**	**315**	**1**	**7,395**	**14**	**3,871**	**6**	**2,761**	**721**	**0**	**0**	**3**	**0**	**1,393**	**47**	**96**	**99**	**19,480**

Source: NCEM Risk Management Tool

Table 4.10 – High Potential Loss Properties by Use and Jurisdiction

Jurisdiction	Residential	Commercial	Industrial	Government	Agricultural	Religious	Utilities	Total
Raleigh	1,284	1,359	338	505	1	170	13	**3,670**
Apex	71	76	50	19	0	16	0	**232**
Cary	437	519	65	87	0	48	26	**1,182**
Fuquay-Varina	19	52	16	15	1	17	5	**125**
Garner	69	84	59	23	0	17	2	**254**
Holly Springs	14	26	14	14	0	5	2	**75**
Knightdale	40	37	4	19	0	8	1	**109**
Morrisville	148	100	59	10	0	7	0	**324**
Rolesville	4	8	1	4	0	1	0	**18**
Wake Forest	44	70	21	21	0	15	3	**174**
Wendell	2	13	3	6	0	10	0	**34**

Jurisdiction	Residential	Commercial	Industrial	Government	Agricultural	Religious	Utilities	Total
Zebulon	3	21	15	16	0	5	2	**62**
Unincorporated Wake County	432	84	26	44	1	36	66	**689**
Total	**2,567**	**2,449**	**671**	**783**	**3**	**355**	**120**	**6,948**

Source: NCEM Risk Management Tool

In addition to examining CIKR overall, the following critical facilities and assets were examined against known hazard areas, where possible, in this risk assessment. These facilities are those that could severely disrupt emergency operations or response and recovery efforts should they be damaged by a hazard event. Note that these facilities are a subset of the CIKR inventory; critical facility exposure and risk is accounted for in the exposure and vulnerability of CIKR.

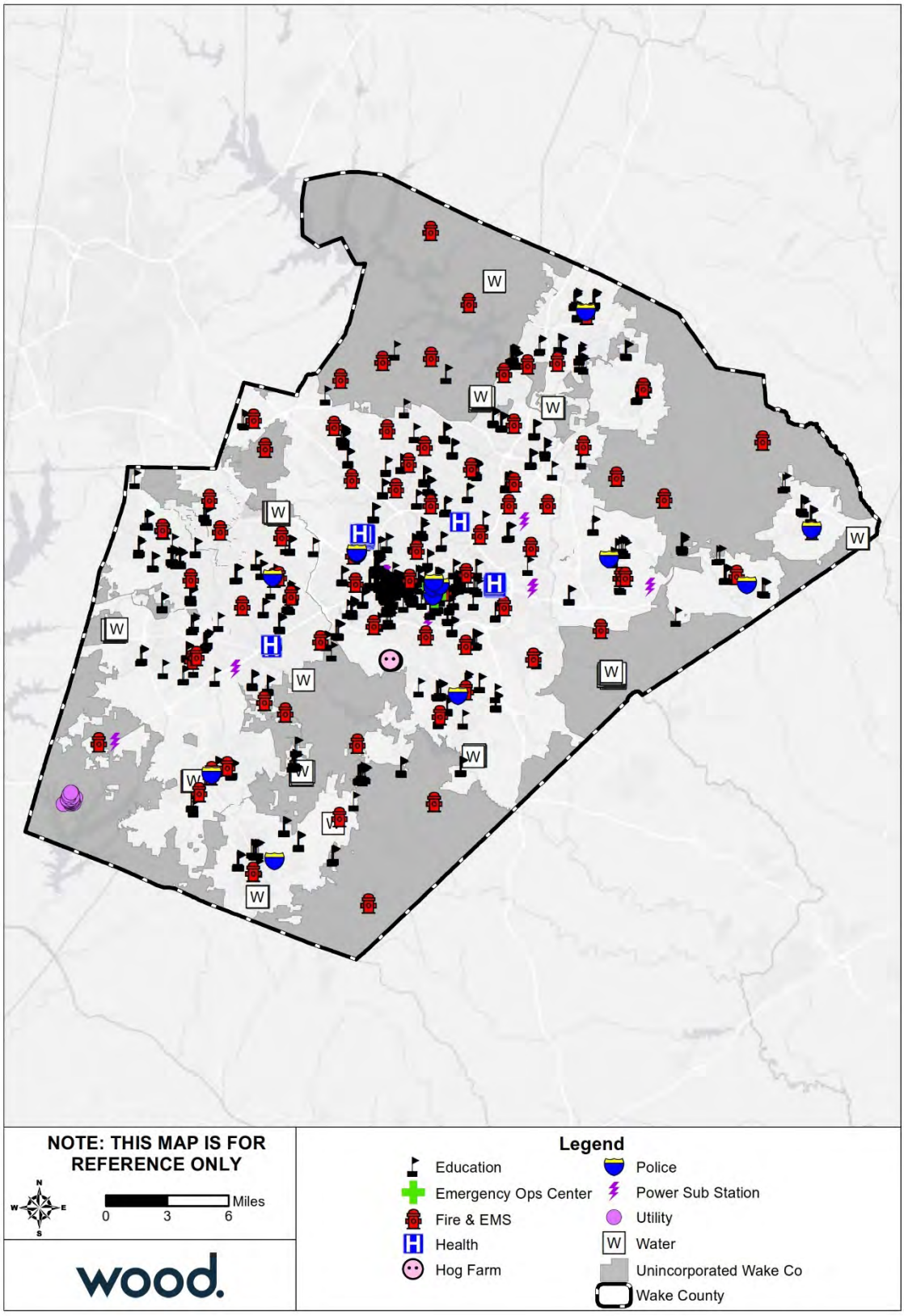
Critical facilities are summarized in Table 4.11 and shown in Figure 4.1.

Table 4.11 – Critical Facilities, Wake County

Sector	Asset	Count	Value
Emergency Management	EOC	2	$44,920,851
	Fire	79	$55,948,431
	Police	15	$212,372,157
Healthcare and Public Health	Hospital	23	$783,859,956
Government	School	79	$177,931,942
	School	1,067	$2,628,151,033
	University	257	$700,146,739
Energy	Utility	24	$499,999,999
	Substation	12	$90,898,660
Water	Treatment Plant	98	$1,413,119,006
Agriculture and Food Distribution	Hog Farm	6	$943,387

Source: NCEM IRISK Database; GIS analysis

Figure 4.1 – Wake County Critical Facilities



Source: NCEM IRISK Database, GIS Analysis

To supplement the asset inventory and provide a clearer picture of the current asset exposure in Wake County, current parcel data was evaluated to identify development since 2010. This information is not incorporated into the risk assessment, which was prepared using NCEM's IRISK database. However, this summary of development since 2010 provides some context to understand the degree to which the IRISK exposure and vulnerability numbers differ from current conditions. This information is presented by individual jurisdiction in each jurisdiction's respective annex of this plan.

Table 4.12 provides a summary by land class of parcel development from January 2011 to April 2019.

Table 4.12 – Parcels Developed 2011 or Later

Land Class	Number of Parcels	Sum of Building Value
Acres Greater Than 10 With House	77	$ 33,301,960
Agriculture	30	$ 10,187,595
Apartment	165	$ 2,555,109,339
Commercial	536	$ 2,225,302,523
Condo Complex	18	$ -
EXEMPT	225	$ 805,213,500
Forestry	8	$ 3,987,003
Golf Course	1	$ 76,222
HOA	56	$ 3,206,102
Horticulture	2	$ 757,361
Industrial	83	$ 224,883,337
Mobile Home Park	1	$ 137,073
Part Exempt	278	$ 526,385,636
Residential Less Than 10 Acres	42,488	$ 12,026,043,100
Retirement Home	9	$ 54,011,162
State Assessed	1	$ 4,890,225
Grand Total	**43,978**	**$ 18,473,492,138**

Source: Wake County Open Data; retrieved April 8, 2019

4.5 HAZARD PROFILES, ANALYSIS, AND VULNERABILITY

4.5.1 Dam Failure

Hazard Background

A dam is a barrier constructed across a watercourse that stores, controls, or diverts water. Dams are usually constructed of earth, rock, concrete, or mine tailings. The water impounded behind a dam is referred to as the reservoir and is measured in acre-feet. One acre-foot is the volume of water that covers one acre of land to a depth of one foot. Dams can benefit farm land, provide recreation areas, generate electrical power, and help control erosion and flooding issues. A dam failure is the collapse or breach of a dam that causes downstream flooding. Dam failures may be caused by natural events, manmade events, or a combination. Due to the lack of advance warning, failures resulting from natural events, such as earthquakes or landslides, may be particularly severe. Prolonged rainfall and subsequent flooding is the most common cause of dam failure.

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

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

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

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

Dam failure can occur with little warning. Intense storms may produce a flood in a few hours or even minutes for upstream locations. Flash floods occur within six hours of the beginning of heavy rainfall, and dam failure may occur within hours of the first signs of breaching. Other failures and breaches can take much longer to occur, from days to weeks, as a result of debris jams or the accumulation of melting snow.

Dam failures are of particular concern because the failure of a large dam has the potential to cause more death and destruction than the failure of any other manmade structure. This is because of the destructive power of the flood wave that would be released by the sudden collapse of a large dam. Dams are innately hazardous structures. Failure or poor operation can result in the release of the reservoir contents—this can include water, mine wastes, or agricultural refuse–causing negative impacts upstream or downstream or at locations far from the dam. Negative impacts of primary concern are loss of human life, property damage, lifeline disruption, and environmental damage.

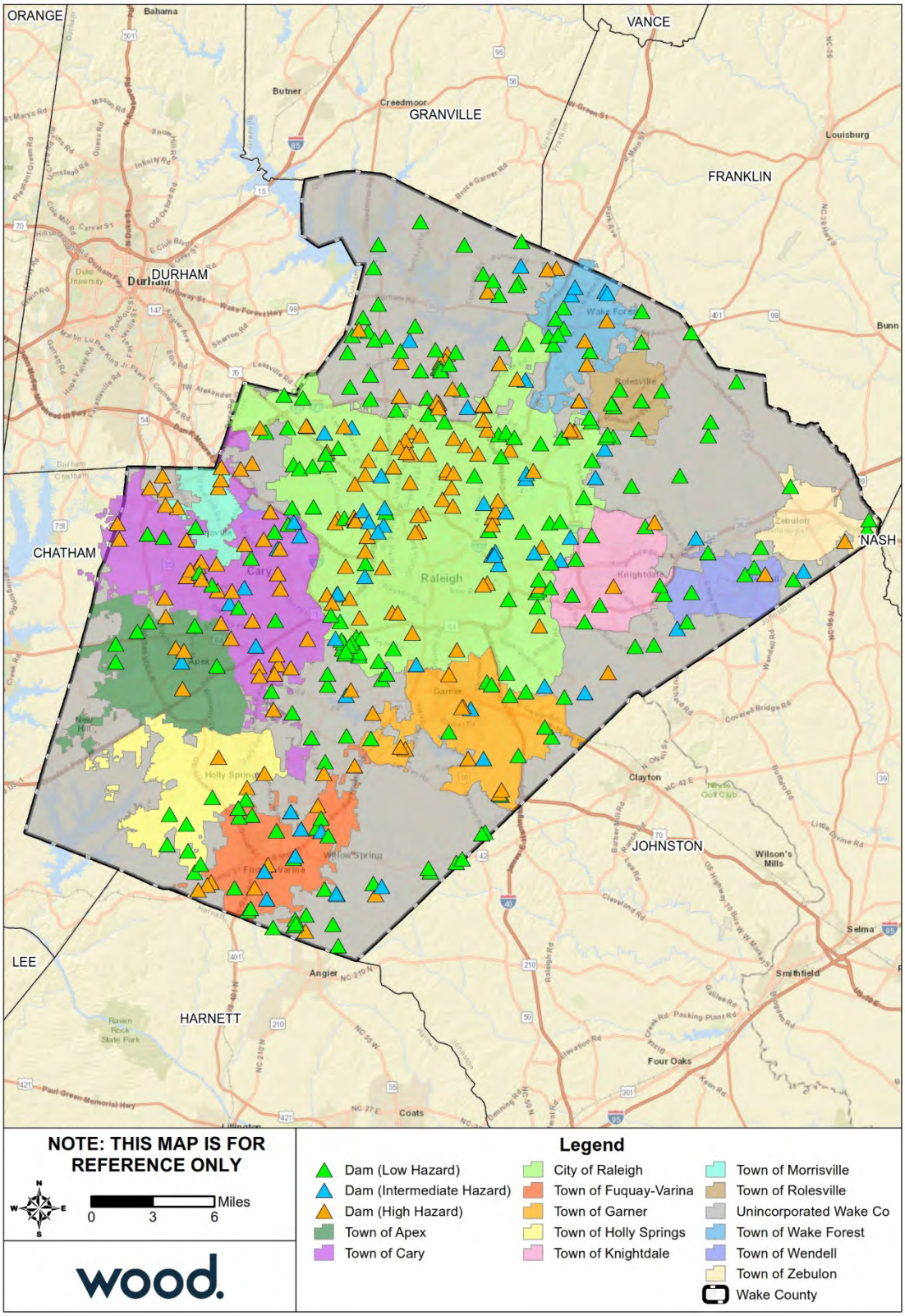
Warning Time: 4 – Less than 6 hours

Duration: 3 – Less than 1 week

Location

The North Carolina Dam Inventory, maintained by North Carolina Department of Environmental Quality, provides a detailed inventory of all dams in the state. As of July 2018, there are 422 dams in Wake County, of which 204 are rated low hazard, 59 are rated intermediate hazard, and 159 are rated high hazard. Figure 4.2 shows the location of all dams in Wake County. Table 4.13 lists all dams with high hazard potential in the county.

Figure 4.2 – Dam Locations in Wake County



Source: North Carolina Dam Inventory, July 2018

Table 4.13 – High Hazard Dams in Wake County

Dam Name	NID ID	Condition as of Last Inspection	Max Capacity (Ac-Ft)	Nearest Downstream Location
Wake County				
Johnson Pond Dam	NC00163	Satisfactory	95	Lillington
Crossgate Lake Dam #1	NC00850	Fair	207	Raleigh
Crossgate Dam #2	NC04437	Fair	40	Raleigh
Lake Benson Dam	NC00861	Satisfactory	7200	Smithfield (Benson Rd near Dam
Lake Wheeler Dam	NC00864	Satisfactory	10800	Smithfield (See Comments)
Mason Lake Dam	NC00865	Fair	52	Milburnie
Panther Lake Dam	NC00876	Fair	253	Smithfield
Rdu Wastewater Dam	NC04443		22.5	N/A
Rtp South Dam	NC04444	Satisfactory	708	Apex
Pendleton Lake	NC04450	Satisfactory	10	Swan Mill Crossing Rd
Crabtree Dam 20-A	NC04456	Satisfactory	2500	John Brantley Blvd
Johnson Pond Dam	NC00845	Poor	5	NC-39
Coachman Trail Lake Dam Lower	NC01461	Fair	93	Falls (CoachmanWay@Dam)
Falls Of The Neuse Dam	NC01713		1128100	Falls (OldFallOfNeuseRd-Dam)
Stonebridge Lake Dam	NC01664	Fair	45	Falls
Coachman Trail Lake Dam Upper	NC04531	Fair	180	Coachman's Way Rd
Byrd Dam	NC04532	Fair	10	Baird Drive
Crabtree Creek Dam 5-A	NC04536	Fair	3010	Raleigh (I-40 @ Dam)
Bailey Dam	NC04563	Fair	76	Six Forks Road
Marshall Pond #2	NC04576	Unsatisfactory	59	Forestville Road
Howell Dam	NC04621	Fair	36	
Manchester Dam	NC04964	Fair	88	Enderbury Drive
Rtp W-1	NC05193	Satisfactory	327	
Crossgate Dam #3	NC05068	Fair	12	White Chapel Way
Chateau Lapointe Dam H	NC05069	Satisfactory	90	White Chapel Way
Cozart Pond Dam	NC05065	Not Rated		
Underwood Pond Dam	NC05218	Fair	27	
Betts Pond Dam	NC05036	Fair	40	
Hasentree Golf Communtiy Dam	NC05685	Satisfactory	139	Hasentree Club Drive
Neuse River Waste Water Treatment Plant Equalization Basin	NC05686	Satisfactory	114	Mai Plantation Road
RTP W-5 Dam	NC05795	Satisfactory	700	Jordan Reservoir
Burnside Drive Dam	NC05802	Fair	12	Burnside Drive
Rosewood Subdivision Dam	NC05877	Satisfactory	6	MacTavish Way
McCullers Pond Dam	NC06160	Not Rated		
Raleigh				
Hedingham Dam #1	NC00794	Fair	152	Raleigh
Gresham Lake Dam	NC00795	Satisfactory	1755	Milburnie (at Dam US-1 and I-5

Dam Name	NID ID	Condition as of Last Inspection	Max Capacity (Ac-Ft)	Nearest Downstream Location
Shaw Lake Dam	NC00851	Fair	55	Raleigh
Dunnaway Lake Dam	NC00858	Satisfactory	290	Raleigh
Lake Johnson Dam	NC00862	Fair	3090	Raleigh (Lake Dam Rd at Dam)
Lake Raleigh Dam	NC00863	Fair	781	Raleigh (Main Camp. Dr @ Dam)
Baker Lake Dam	NC00885	Satisfactory	60	Raleigh
Turfgrass Lake Dam #3	NC00994	Satisfactory	85	Smithfield
Lakes Apartment Dam	NC00376	Satisfactory	21.6	Raleigh
Raintree Lake	NC00383			
Brentwood Today Lake Dam	NC01200	Not Rated	12	Raleigh
NCSU Centennial Campus Farm Pond Dam	NC01283	Fair	20	Raleigh
Em Johnson Alum Sludge Lagoon Dam	NC04460	Fair	108.3	Raleigh (FallsOfNeuseRd @ dam)
Alyson Pond	NC04462	Fair	40	Yucca Trail Dr.
Heathrow Dam	NC04466	Fair	26	Cub Trail Road
Shelley Lake	NC01452	Satisfactory	4269	Raleigh (W.MillbrookRd.@Dam)
Lake Lynn	NC01454	Satisfactory	2292	Raleigh (Lynn Rd near dam)
Lakemont Dam	NC01455		91	Raleigh
Cedar Hills Lake Dam	NC04482	Fair	20	E. Millbrook Rd
Eastgate Park Dam	NC04490	Satisfactory	27	Raleigh
Mallard Pond Dam	NC05154	Fair	8	Buck Jones Rd.
Northshore Lake Dam	NC01231	Satisfactory	63	Raleigh
Bullard And Patterson Dam	NC04504	Fair	2.5	Walnut Crk Trail Rd
White Oak Lake Dam	NC04516	Unsatisfactory	20	US-1 (Cliff Benson Beltline
Camp Pond Dam	NC04519	Poor	24	Raleigh
Wooten Pond Dam	NC04520	Unsatisfactory	40	Raleigh
Ammons Lake Dam Upper	NC04527	Poor	50	Raleigh
Ammons Lake Dam Lower	NC04528	Satisfactory	352	Raleigh
Longview Lake Dam Lower	NC01627	Not Rated	143	Raleigh
Longview Lake Upper Dam	NC04529	Fair	44	Raleigh
Springdale Estates Upper Dam	NC01665	Fair	75	Raleigh
North Ridge Lake Dam Upper	NC01711	Satisfactory	168	Raleigh
North Ridge Lake Dam Lower	NC01712	Satisfactory	161	Raleigh
Crabtree Creek W/S Structure #11a	NC01720	Satisfactory	3327	Raleigh-EbenezerChRd (.78 mi)
North Blvd Comm Center Dam	NC04533	Fair	20	Waterbury Road
Fuller Lake Dam	NC01719	Satisfactory	70	Sawmill Road
Hart-George Pond	NC04535	Fair	18	Raleigh
Williams-Johnson Pond Dam	NC04537	Poor	44	Raleigh
The Lakes Lower Dam	NC04538	Satisfactory	41	Shanda Drive
State Fair H & L Dam	NC04539	Fair	78	Raleigh
Summer Lake Dam	NC04545	Fair	18	West Millbrook Rd

Dam Name	NID ID	Condition as of Last Inspection	Max Capacity (Ac-Ft)	Nearest Downstream Location
Meredith College Dam	NC04546	Poor	34	Faircloth Street
Underwood Dam	NC04547	Poor	30	Seabrook Road
Ward Transformer Dike	NC04548	Satisfactory	13	Glenwood Ave (US-70)
Martin Marietta #1 Dam	NC04549	Satisfactory	59	Raleigh
Lakeside Dam	NC04955		23	Raleigh
Leadmine Lake Dam	NC05142	Fair	92	Raleigh
Delta Lake	NC04910	Fair	42	Raleigh
Olde Raleigh Dam #3	NC05176	Fair	24	Raleigh
Olde Raleigh Dam #1	NC05174	Fair	19.7	Raleigh
Olde Raleigh Dam #2	NC05175	Fair	25.1	Raleigh
Landmark Apts. Dam	NC04632	Satisfactory	18	Raleigh
Remington Park Dam	NC04979	Fair	84	I-540 (Northern Wake Expresswa
Carolina Country Club Dam	NC05053	Poor	32	Scotland Street
Newton Commons Dam	NC05170		8.6	Raleigh
E.M. Johnson Water Plant B	NC05078	Satisfactory	383	Raleigh (Raven Ridge Road)
Lake Plaza Dam	NC05133	Fair	18.4	Raleigh
E.M. Johnson Plant A Dam	NC05077	Satisfactory	110	Raleigh (FallsofNeuseRd@Dam)
Art Museum Dam	NC05026	Fair	10	Nancy Ann Drive
Brier Creek Village Center Dam	NC05737	Fair		
Carolina Pines Dam	NC05753	Satisfactory	53	Raleigh
Bedford at Falls River Dam #1	NC06066		4	
Pine Knoll Dam	NC06093	Poor		Raleigh
Chavis Dam	NC06107	Satisfactory	4	
Carolina Country Club Water Harvesting Pond Dam	NC06108	Satisfactory		Raleigh
Highland Creek SWF # 1	NC06148	Satisfactory		
Highland Creek SWF # 2	NC06149	Satisfactory		
Highland Creek SWF # 10	NC06150	Satisfactory		
Apex				
Lake Pine Dam	NC00933	Fair	163	Cary
Haddon Hall Dam	NC05102	Fair	42	
Haddon Hall Upper Dam	NC05779	Poor	0	
Seymour Farms Pond Dam	NC05870	Satisfactory	7	Apex
Cary				
Jack Rigsbee Dam	NC04438	Satisfactory	20	Cary
Preston Crossings Dam	NC00877	Satisfactory	18.8	Cary
Fred G Bond Dam	NC00926	Fair	666	Morrisville (SE CaryPkwy .48 m
Riggsbee Dam	NC04442	Satisfactory	24	Apex
Barbee Dam	NC04445	Satisfactory	12	Council Gap Ct. (homes before)
Blackhawk Dam	NC01451	Fair	26	Cary
Panther Creek Dam	NC05177	Satisfactory	202	

Dam Name	NID ID	Condition as of Last Inspection	Max Capacity (Ac-Ft)	Nearest Downstream Location
Herndon Pond Dam	NC05108	Not Rated	22	
Crabtree Crk. W/S Structure #2	NC01450	Satisfactory	409	Davis Drive
Adams Dam	NC04550		17	
Coronado Lake Dam	NC04616	Fair	26	Cary
Hobby Dam	NC05111	Satisfactory	16	
Regency Park Dam	NC04624	Satisfactory	350	Ederlee Drive
Lochmere Lake Dam #2	NC05146	Satisfactory	196	Lochmere Drive
Loch Highlands Dam	NC05145	Fair	59	Loch Highlands Drive
Kildaire Farms Dam	NC04949	Satisfactory	420	Cary
Lochmere Dam	NC04961	Fair	728	Lochmere Drive
Lake Crabtree	NC04952	Satisfactory	8950	Raleigh (OldReedyCrRd.is.15 mi
Audubon Parc Dam	NC05028	Satisfactory	8.1	Cary
Lake Amberly Dam	NC05644	Satisfactory	0	
Huggins Glen Dam	NC05658	Satisfactory	80	Castalia Drive
Searstone	NC05695	Satisfactory	9	Cary
Powell Tract Dam	NC05707	Satisfactory	9999	Millens Bay Court
Tryon Road Dam	NC05894	Fair		Tryon Rd (NC-1009)
Woolner Dam	NC06089	Fair	11	Cary
Kera Gardens Dam	NC06135	Fair		Raleigh
Silverton Dam	NC06171	Satisfactory		Cary
Fuquay-Varina				
Parker Lake Dam	NC00849	Satisfactory	75	
Crooked Creek	NC04446	Fair	40	Bushy Meadow Drive
Jones Pond Dam	NC04946	Poor	19	
Garner				
Weston #1	NC05235	Poor	10.8	Aversboro Road
Weston #2	NC05236	Poor	10	Aversboro and Lakeside Rd (int
Massengill Dam	NC04626	Fair	82	Walerville Street
Garner Ww Lagoon #1	NC04917	Satisfactory	394	I-40 (James E. Harrison Freewa
Garner Ww Lagoon #2	NC04918	Satisfactory	306	I-40 (James E. Harrison Freewa
Eagle Ridge Golf Course Dam	NC05626	Satisfactory	0	Smithfield
Holly Springs				
Sunset Lake Dam	NC00880	Fair	750	Holly Springs (Sunset Lake Rd)
Bass Lake Dam	NC00934	Fair	910	Holly Springs (BassLakeRd@dam)
Windcrest	NC05683	Fair	42	Amacord Way
Knightdale				
Robertson Pond Dam	NC04481	Fair	20	Smithfield
Myrick Lake Dam	NC01656	Poor	5	Knightdale
Morrisville				
Perimeter Park West Dam	NC05180	Satisfactory	10	Marcom Dr

Dam Name	NID ID	Condition as of Last Inspection	Max Capacity (Ac-Ft)	Nearest Downstream Location
Crabtree Creek W/S #1 (PL-566)	NC01449	Satisfactory	480	Raleigh
Crabtree Creek W/S Dam #18	NC01453	Satisfactory	661	Morrisville
Breckenridge Recreation Center Dam	NC05622	Satisfactory	38	Cary
Breckenridge Tract 9 & 10 Dam	NC05623	Satisfactory	83	Cary
Rolesville				
none				
Wake Forest				
Brown Lake Dam (AKA St. Andrews Plantation WAKE-268)	NC00859	Fair	52	Milburnie
Holding Lake Dam	NC00873	Satisfactory	145	Milburnie (S. Franklin St @ Dam
Lewis Dam	NC04439	Not Rated	80	Wake Forest
Wake Forest Water Supply Dam	NC00995	Satisfactory	945	Milburnie (WaitAve(NC-98)(.12)
St. Andrews Plantation Dam	NC04579	Fair	23	Coach Lantern Ave
Wendell				
Timberlake Dam	NC05843	Fair	9999	Cedarmere Drive
Zebulon				
none				

Source: North Carolina Dam Inventory, July 2018

Extent

Each state has definitions and methods to determine the hazard potential of a dam. In North Carolina, dams are regulated by the state if they are 25 feet or more in height and impound 50 acre-feet or more. Dams and impoundments smaller than that may fall under state regulation if it is determined that failure of the dam could result in loss of human life or significant damage to property. The height of a dam is from the highest point on the crest of the dam to the lowest point on the downstream toe, and the storage capacity is the volume impounded at the elevation of the highest point on the crest of the dam.

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

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

Table 4.14 – Dam Hazard Classifications

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

Source: NCDEQ

The most recent failure of a high hazard dam occurred in 1996 with the failure of the Lake Raleigh dam following Hurricane Fran.

Based on classification criteria, a high hazard dam failure could cause death and/or injury as well as severe property damage and economic impacts within the affected area. Therefore, though the affected area would be negligible in size relative to the entire planning area, the potential impact of a high hazard dam failure is critical.

Impact: 3 – Critical

Spatial Extent: 1 – Negligible

Historical Occurrences

The following table details the historical occurrences of dam failure reported in the 2015 Wake County Hazard Mitigation Plan. No additional failures are known to have occurred in the County since 2015.

Dam Name	Location	Class at Time of Failure	Year of Failure	Cause of Failure
Cedar Hills*	Wake County	Intermediate*	mid 1970s	Heavy rain
Coachman's Trail Lower	Wake County	High	late 1970s	Heavy rain
Beaman's Lake	Wake County	Intermediate	late 1980s	Heavy rain
Bass Lake*	Holly Springs	Low*	1996	Hurricane Fran
Lake Raleigh	Raleigh	High	1996	Hurricane Fran
Penny Hill Lake	Zebulon	Low	1996	Hurricane Fran
Silver Lake*	Raleigh	Intermediate*	1996	Hurricane Fran
Yates Mill Pond	Wake County	Intermediate	1996	Hurricane Fran

*These dams are now classified as high hazard due to downstream development and/or increased downstream traffic.
Source: 2015 Wake County Multi-Jurisdictional Hazard Mitigation Plan

Probability of Future Occurrence

Given the significant presence of high hazard dams in Wake County, failure of a dam is possible. Dam failure has not occurred in the county since 1996, however historical events alone do not provide an adequate estimate of potential future occurrence. With heavy rain events becoming more frequent and intense, conditions conducive to dam failure may occur more frequently as well.

Probability: 2 – Possible

Climate Change

Studies have been conducted to investigate the impact of climate change scenarios on dam safety. The safety of dams for the future climate can be based on an evaluation of changes in design floods and the freeboard available to accommodate an increase in flood levels. The results from the studies indicate that the design floods with the corresponding outflow floods and flood water levels will increase in the future, and this increase will affect the safety of the dams in the future. Studies concluded that the total hydrological failure probability of a dam will increase in the future climate and that the extent and depth of flood waters will increase by the future dam break scenario.

Vulnerability Assessment

Methodologies and Assumptions

Dam inundation areas were not available for the identified dams; therefore, a quantitative vulnerability assessment could not be completed. Vulnerability discussed below is based on anecdotal evidence and theoretical understanding of potential risks.

People

A person's immediate vulnerability to a dam failure is directly associated with the person's distance downstream of the dam as well as proximity to the stream carrying the floodwater from the failure. For dams that have an Emergency Action Plan (EAP), the vulnerability of loss of life for persons in their homes or on their property may be mitigated by following the EAP evacuation procedures; however, the displaced persons may still incur sheltering costs. For persons located on the river (e.g. for recreation) the vulnerability of loss of life is significant.

People are also vulnerable to the loss of the uses of the lake upstream of a dam following failure. Several uses are minor, such as aesthetics or recreational use. However, some lakes serve as drinking water supplies and their loss could disrupt the drinking water supply and present a public health problem.

Property

Vulnerability of the built environment includes damage to the dam itself and any man-made feature located within the inundation area caused by the dam failure. Downstream of the dam, vulnerability includes potential damage to homes, personal property, commercial buildings and property, and government owned buildings and property; destruction of bridge or culvert crossings; weakening of bridge supports through scour; and damage or destruction of public or private infrastructure that cross the stream such as water and sewer lines, gas lines and power lines. Water dependent structures on the lake upstream of the dam, such as docks/piers, floating structures or water intake structures, may be damaged by the rapid reduction in water level during the failure.

Environment

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

Consequence Analysis

Table 4.15 summarizes the potential negative consequences of dam failure.

Table 4.15 – Consequence Analysis – Dam Failure

Category	Consequences
Public	Localized impact expected to be severe for inundation area and moderate to light for other adversely affected areas.
Responders	Localized impact expected to limit damage to personnel in the inundation area at the time of the incident.
Continuity of Operations (including Continued Delivery of Services)	Damage to facilities/personnel in the area of the incident may require temporary relocation of some operations. Localized disruption of roads and/or utilities may postpone delivery of some services. Regulatory waivers may be needed locally. Fulfillment of some contracts may be difficult. Impact may reduce deliveries.
Property, Facilities and Infrastructure	Localized impact to facilities and infrastructure in the inundation area of the incident. Some severe damage possible.
Environment	Localized impact expected to be severe for inundation area and moderate to light for other adversely affected areas. Consequences include erosion, water quality degradation, wildlife displacement or destruction, and habitat destruction.
Economic Condition of the Jurisdiction	Local economy and finances adversely affected, possibly for an extended period of time, depending on damage and length of investigation.
Public Confidence in the Jurisdiction's Governance	Localized impact expected to primarily adversely affect only the dam owner and local entities.

Hazard Summary by Jurisdiction

The following table summarizes dam failure hazard risk by jurisdiction. Warning time and duration are inherent to the hazard and remain constant across jurisdictions. Spatial extent of any dam failure will be negligible relative to the planning area. Jurisdictions with high hazard dams within their boundaries were assigned a probability rating of possible and an impact score of critical. Jurisdictions with no high hazard dams were assigned a probability rating of unlikely and an impact rating of limited.

Jurisdiction	Probability	Impact	Spatial Extent	Warning Time	Duration	Score	Priority
Wake County	2	3	1	4	3	2.4	M
Apex	2	3	1	4	3	2.4	M
Cary	2	3	1	4	3	2.4	M
Fuquay-Varina	2	3	1	4	3	2.4	M
Garner	2	3	1	4	3	2.4	M
Holly Springs	2	3	1	4	3	2.4	M
Knightdale	2	3	1	4	3	2.4	M
Morrisville	2	3	1	4	3	2.4	M
Raleigh	2	3	1	4	3	2.4	M
Rolesville	1	2	1	4	3	1.8	L
Wake Forest	2	3	1	4	3	2.4	M
Wendell	2	3	1	4	3	2.4	M
Zebulon	1	2	1	4	3	1.8	L

4.5.2 Drought

Hazard Background

Drought is a deficiency in precipitation over an extended period. It is a normal, recurrent feature of climate that occurs in virtually all climate zones. The duration of a drought varies widely. There are cases when drought develops relatively quickly and lasts a very short period of time, exacerbated by extreme heat and/or wind, and there are other cases when drought spans multiple years, or even decades. Studying the paleoclimate record is often helpful in identifying when long-lasting droughts have occurred. Common types of drought are detailed below in Table 4.16.

Table 4.16 – Types of Drought

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

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

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

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

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

The State of North Carolina has a Drought Assessment and Response Plan as an Annex to its Emergency Operations Plan. This plan provides the framework to coordinate statewide response to a drought incident.

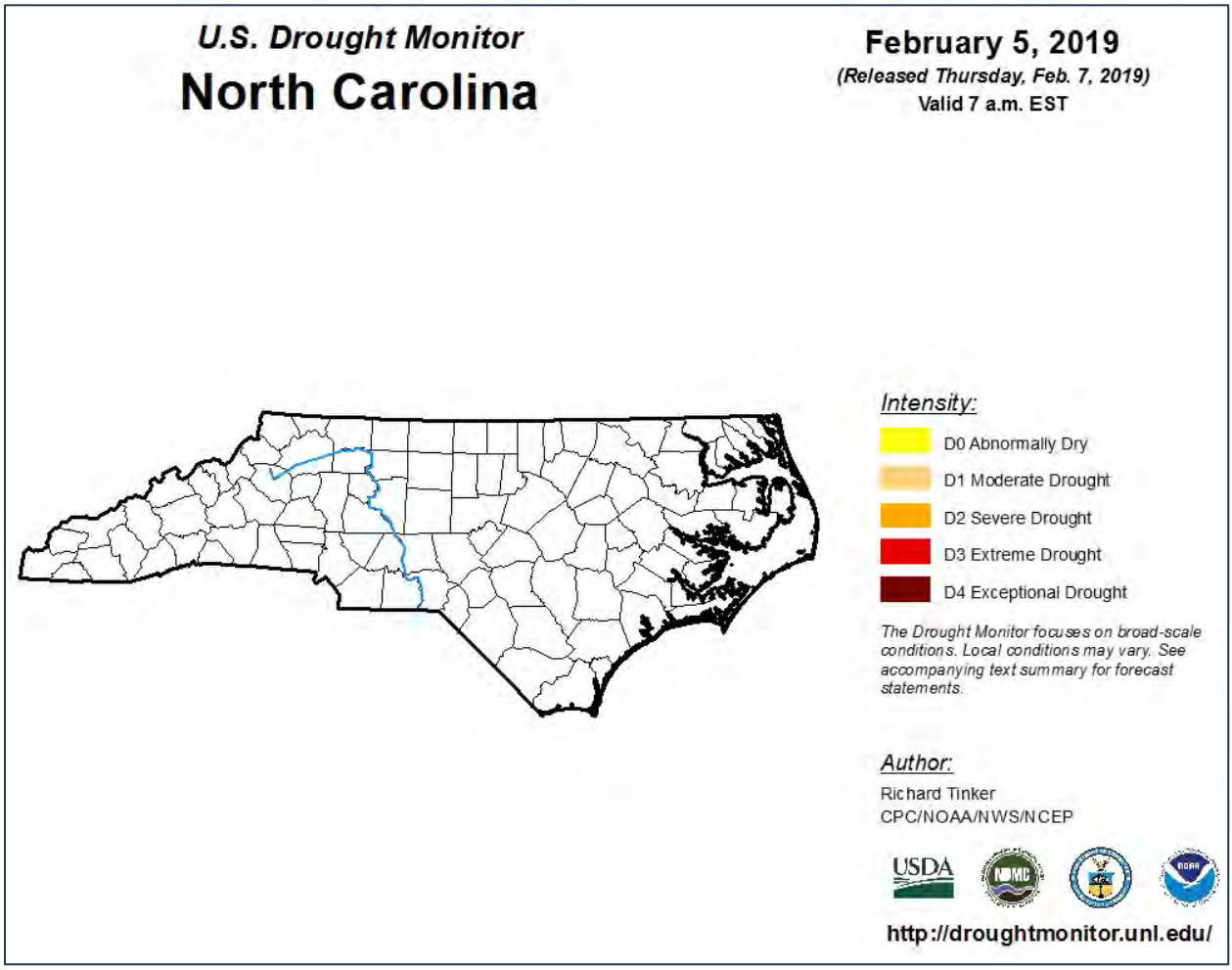
Warning Time: 1 – More than 24 hours

Duration: 4 – More than one week

Location

Drought is a regional hazard that can cover an entire the entire planning area, and in some cases the entire state. The figure below notes the U.S. Drought Monitor's drought ratings for North Carolina as of February 5, 2019; as of that date, Wake County was experiencing no impacts of drought.

Figure 4.3 – US Drought Monitor for Week of February 5, 2019



Source: U.S. Drought Monitor

Extent

Drought extent can be defined in terms of intensity, using the U.S. Drought Monitor scale. The Drought Monitor Scale measures drought episodes with input from the Palmer Drought Severity Index, the Standardized Precipitation Index, the Keetch-Byram Drought Index, soil moisture indicators, and other inputs as well as information on how drought is affecting people. Figure 4.4 details the classifications used by the U.S. Drought Monitor. A category of D2 (severe) or higher on the U.S. Drought Monitor Scale can typically result in crop or pasture losses, water shortages, and the need to institute water restrictions.

Figure 4.4 – US Drought Monitor Classifications

			Ranges				
Category	Description	Possible Impacts	Palmer Drought Severity Index (PDSI)	CPC Soil Moisture Model (Percentiles)	USGS Weekly Streamflow (Percentiles)	Standardized Precipitation Index (SPI)	Objective Drought Indicator Blends (Percentiles)
D0	Abnormally Dry	Going into drought: ▪ short-term dryness slowing planting, growth of crops or pastures Coming out of drought: ▪ some lingering water deficits ▪ pastures or crops not fully recovered	-1.0 to -1.9	21 to 30	21 to 30	-0.5 to -0.7	21 to 30
D1	Moderate Drought	▪ Some damage to crops, pastures ▪ Streams, reservoirs, or wells low, some water shortages developing or imminent ▪ Voluntary water-use restrictions requested	-2.0 to -2.9	11 to 20	11 to 20	-0.8 to -1.2	11 to 20
D2	Severe Drought	▪ Crop or pasture losses likely ▪ Water shortages common ▪ Water restrictions imposed	-3.0 to -3.9	6 to 10	6 to 10	-1.3 to -1.5	6 to 10
D3	Extreme Drought	▪ Major crop/pasture losses ▪ Widespread water shortages or restrictions	-4.0 to -4.9	3 to 5	3 to 5	-1.6 to -1.9	3 to 5
D4	Exceptional Drought	▪ Exceptional and widespread crop/pasture losses ▪ Shortages of water in reservoirs, streams, and wells creating water emergencies	-5.0 or less	0 to 2	0 to 2	-2.0 or less	0 to 2

Source: US Drought Monitor

The most severe drought to impact Wake County within the past 20 years occurred when the county spent 54 weeks in drought from May 2007 to May 2008. At the drought's peak from October 2, 2007 through March 4, 2008, the entirety of the county was considered in D4 (Exceptional) drought.

Impact: 1 – Minor

Spatial Extent: 4 – Large

Historical Occurrences

Table 4.17 summarizes the drought events reported by the U.S. Drought Monitor for Wake County from 1998 through 2018.

Table 4.17 – Recorded Instances of Drought in Wake County, 1998-2018

Start Date	End Date	Duration (Weeks)	Details
10/31/2000	11/11/2002	106	At the drought's peak from August 13 through August 19, 51.27% of Wake County was considered in a D4 drought (Exceptional)
4/6/2004	4/19/2004	2	At the drought's peak, 100% of the County was considered in a D0 drought (Abnormally Dry)
6/21/2005	6/27/2005	1	At the drought's peak, 100% of the County was considered in a D0 drought (Abnormally Dry)
9/6/2005	11/28/2005	12	At the drought's peak from November 1 through November 21, 28.99% of the County was considered in a D2 drought (Severe)
1/31/2006	6/19/2006	20	At the drought's peak from April 11 through May 1, 100% of the County was considered in a D2 drought (Severe)
8/22/2006	9/11/2006	3	At the drought's peak from August 29 through September 4, 64.94% of the County was considered in D1 drought (Moderate)
3/13/2007	4/16/2007	5	At the drought's peak from March 13 through April 16, 100% of the County was considered in D0 drought (Abnormally Dry)
5/8/2007	5/19/2008	54	At the drought's peak from October 2, 2007 through March 4, 2008, 100% of the County was considered in D4 drought (Exceptional)

Start Date	End Date	Duration (Weeks)	Details
6/10/2008	9/8/2008	13	At the drought's peak from July 1 to July 7, 99% of the County was considered in D2 drought (Severe)
2/10/2009	3/16/2009	5	At the drought's peak from February 10 to March 16, 100% of the County was considered in D0 drought (Abnormally Dry)
7/14/2009	11/16/2009	18	At the drought's peak from October 20 through October 26, 75% of the County was considered in D1 drought (Moderate)
5/4/2010	5/17/2010	2	At the drought's peak from May 4 through May 17, 100% of the County was considered in D0 drought (Abnormally Dry)
7/6/2010	8/2/2010	4	At the drought's peak from July 27 through August 2, 34% of the County was considered in D1 drought (Moderate)
9/14/2010	10/4/2010	3	At the drought's peak from September 21 through September 27, 0.5% of the County was considered in D2 drought (Severe)
11/16/2010	8/29/2011	41	At the drought's peak from February 1 through April 4, 100% of the County was considered in D2 drought (Severe)
10/11/2011	6/4/2012	34	At the drought's peak, 100% of the County was considered in D1 drought (Moderate)
6/26/2012	7/30/2012	5	At the drought's peak from July 17 through July 23, 99% of the County was considered in D1 drought (Moderate)
11/13/2012	5/6/2013	25	At the drought's peak from December 4 through February 25, 100% of the County was considered in D1 drought (Moderate)
11/19/2013	12/30/2013	6	At the drought's peak from November 19 through December 30, 100% of the County was considered in D1 drought (Moderate)
6/16/2015	6/29/2015	2	At the drought's peak from June 16 through June 29, 100% of the County was considered in D1 drought (Moderate)
8/4/2015	10/5/2015	9	At the drought's peak from September 15 through September 28, 100% of the County was considered in D1 drought (Moderate)
12/20/2016	1/2/2017	2	At the drought's peak from December 20 through January 2, 100% of the County was considered in D0 drought (Abnormally Dry)
2/14/2017	3/13/2017	4	At the drought's peak from February 14 through March 12, 100% of the County was considered in D0 drought (Abnormally Dry)
3/28/2017	4/3/2017	1	At the drought's peak from March 28 through April 3, 13% of the County was considered in D1 drought (Moderate)
8/1/2017	8/14/2017	2	At the drought's peak from August 1 through August 14, 100% of the County was considered in D0 drought (Abnormally Dry)
10/3/2017	12/31/2017	13	At the drought's peak from October 24 through October 30, 96% of the County was considered in D1 drought (Moderate)

Source: US Drought Monitor

The National Drought Mitigation Center (NDMC), located at the University of Nebraska in Lincoln, provides a clearinghouse for information on the effects of drought, based on reports from media, observers, impact records, and other sources.

According to the National Drought Mitigation Center's Drought Impact Reporter, during the 10-year period from January 2009 through December 2018, 289 drought impacts were noted for the State of North Carolina, of which 24 were reported to affect Wake County. Table 4.18 summarizes the number of impacts reported by category and the years impacts were reported for each category. Note that the Drought Impact Reporter assigns multiple categories to each impact.

Table 4.18 – Drought Impacts Reported for Wake County, January 2009 through December 2018

Category	Impacts	Years Reported
Agriculture	2	2016, 2012
Fire	2	2018, 2011
Plants & Wildlife	13	2018, 2017, 2010
Relief, Response & Restrictions	7	2017, 2016, 2012, 2011
Society & Public Health	1	2018
Water Supply & Quality	13	2018, 2017, 2012, 2011

Source: Drought Impact Reporter, http://droughtreporter.unl.edu

Probability of Future Occurrence

Probability: 3 – Likely

Over the 20-year (1,040 week) period from 1998 through 2017, Wake County experienced 392 weeks of drought conditions ranging from abnormally dry to exceptional drought. This equates to a 38 percent chance of drought in any given week. Of this time, approximately 114 weeks were categorized as a severe (D2) drought or greater; which equates to an 11 percent chance of severe drought in any given week.

Climate Change

The Fourth National Climate Assessment reports that average and extreme temperatures are increasing across the country and average annual precipitation is decreasing in the Southeast. Heavy precipitation events are becoming more frequent, meaning that there will likely be an increase in the average number of consecutive dry days. As temperature is projected to continue rising, evaporation rates are expected to increase, resulting in decreased surface soil moisture levels. Together, these factors suggest that drought will increase in intensity and duration in the Southeast.

Vulnerability Assessment

Methodologies and Assumptions

Vulnerability to drought in Wake County is based on historical occurrences of drought in the planning area and generalized concerns regarding potential drought consequences. Agricultural vulnerability was estimated using data from the 2012 Census of Agriculture and a review of past claims related to drought.

People

Drought can affect people's physical and mental health. For those economically dependent on a reliable water supply, drought may cause anxiety or depression about economic losses, reduced incomes, and other employment impacts. Conflicts may arise over water shortages. People may be forced to pay more for water, food, and utilities affected by increased water costs.

Drought may also cause health problems due to poorer water quality from lower water levels. If accompanied by extreme heat, drought can also result in higher incidents of heat stroke and even loss of human life.

Property

Drought is unlikely to cause damages to the built environment. However, in areas with shrinking and expansive soils, drought may lead to structural damages. Drought may cause severe property loss for the agricultural industry in terms of crop and livestock losses. The USDA's Risk Management Agency (RMA) maintains a database of all paid crop insurance claims. Between 2007-2017, the sum of claims paid for crop damage as a result of drought in Wake County was $7,083,164, or an average of $643,924 in losses

every year. Losses were greatest in 2007 when 12,460 acres of soybeans, flue cured tobacco, and corn were affected, resulting in $1,684,909 in crop losses. Table 4.19 summarizes the crop losses due to drought in reported in the RMA system.

Table 4.19 – Crop Losses Resulting from Drought, 2007-2017

Year	Determined Acres	Indemnity Amount
2007	12459.84	$1,684,909
2008	4727.20	$506,630
2009	2858.15	$282,486
2010	8186.53	$1,202,328
2011	3473.58	$656,081
2012	685.28	$91,120
2013	160.07	$8,811
2014	605.03	$123,391.1
2015	4375.86	$1,152,001.62
2016	968.63	$682,636
2017	1767.51	$692,770.7
Total	**40,267.67**	**$7,083,164.42**

Source: USDA Risk Management Agency

Environment

Drought can affect local wildlife by shrinking food supplies and damaging habitats. Sometimes this damage is only temporary, and other times it is irreversible. Wildlife may face increased disease rates due to limited access to food and water. Increased stress on endangered species could cause extinction.

Drought conditions can also provide a substantial increase in wildfire risk. As plants and trees die from a lack of precipitation, increased insect infestations, and diseases—all of which are associated with drought—they become fuel for wildfire. Long periods of drought can result in more intense wildfires, which bring additional consequences for the economy, the environment, and society. Drought may also increase likelihood of wind and water erosion of soils.

Consequence Analysis

Table 4.20 summarizes the potential negative consequences of drought.

Table 4.20 – Consequence Analysis - Drought

Category	Consequences
Public	Can cause anxiety or depression about economic losses, conflicts over water shortages, reduced incomes, fewer recreational activities, higher incidents of heat stroke, and fatality.
Responders	Impacts to responders are unlikely. Exceptional drought conditions may impact the amount of water immediately available to respond to wildfires.
Continuity of Operations (including Continued Delivery of Services)	Drought would have minimal impacts on continuity of operations due to the relatively long warning time that would allow for plans to be made to maintain continuity of operations.
Property, Facilities and Infrastructure	Drought has the potential to affect water supply for residential, commercial, institutional, industrial, and government-owned areas. Drought can reduce water supply in wells and reservoirs. Utilities may be forced to increase rates.
Environment	Environmental impacts include strain on local plant and wildlife; increased probability of erosion and wildfire.

Economic Condition of the Jurisdiction	Farmers may face crop losses or increased livestock costs. Businesses that depend on farming may experience secondary impacts. Extreme drought has the potential to impact local businesses in landscaping, recreation and tourism, and public utilities.
Public Confidence in the Jurisdiction's Governance	When drought conditions persist with no relief, local or State governments must often institute water restrictions, which may impact public confidence.

Hazard Summary by Jurisdiction

The following table summarizes drought hazard risk by jurisdiction. Drought risk is uniform across the planning area. Warning time, duration, and spatial extent are inherent to the hazard and remain constant across jurisdictions. The majority of damages that result from drought are to crops and other agriculture-related activities as well as water-dependent recreation industries. The magnitude of the impacts is typically greater in unincorporated areas, however Wake County is highly developed. In developed areas, the magnitude of drought is less severe, with lawns and local gardens affected and potential impacts on local water supplies during severe, prolonged drought.

Jurisdiction	Probability	Impact	Spatial Extent	Warning Time	Duration	Score	Priority
Wake County	3	1	4	1	4	2.5	H
Apex	3	1	4	1	4	2.5	H
Cary	3	1	4	1	4	2.5	H
Fuquay-Varina	3	1	4	1	4	2.5	H
Garner	3	1	4	1	4	2.5	H
Holly Springs	3	1	4	1	4	2.5	H
Knightdale	3	1	4	1	4	2.5	H
Morrisville	3	1	4	1	4	2.5	H
Raleigh	3	1	4	1	4	2.5	H
Rolesville	3	1	4	1	4	2.5	H
Wake Forest	3	1	4	1	4	2.5	H
Wendell	3	1	4	1	4	2.5	H
Zebulon	3	1	4	1	4	2.5	H

4.5.3 Earthquake

Hazard Background

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

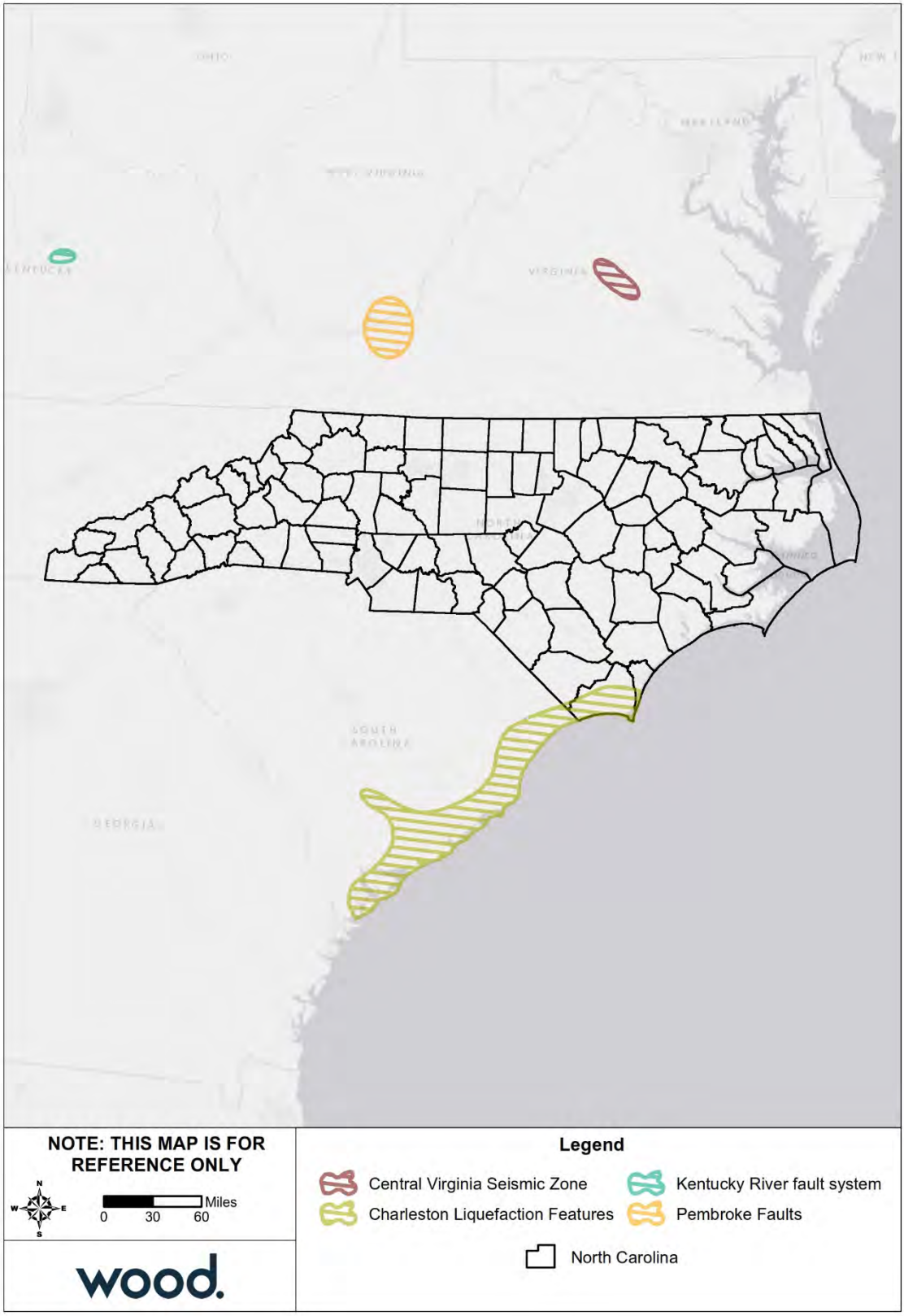
Warning Time: 4 – Less than 6 hours

Duration: 1 – Less than 6 hours

Location

Figure 4.5 reflects the Quaternary faults that present an earthquake hazard for the Wake County planning area based on data from the USGS Earthquake Hazards Program.

Figure 4.5 – US Quaternary Faults



Source: USGS Earthquake Hazards Program

All of North Carolina is subject to earthquakes, with the western and southern region most vulnerable to a damaging earthquake. The state is affected by both the Charleston Fault in South Carolina and New Madrid Fault in Tennessee. Both of these faults have generated earthquakes measuring greater than 8.0 on the Richter Scale during the last 200 years. In addition, there are several smaller fault lines in eastern Tennessee and throughout North Carolina that could produce less severe shaking.

Extent

Earthquakes are measured in terms of their magnitude and intensity. Magnitude is measured using the Richter Scale, an open-ended logarithmic scale that describes the energy release of an earthquake through a measure of shock wave amplitude. A detailed description of the Richter Scale is given in Table 4.21. Although the Richter scale is usually used by the news media when reporting the intensity of earthquakes and is the scale most familiar to the public, the scale currently used by the scientific community in the United States is called the Modified Mercalli Intensity (MMI) scale. The MMI scale is an arbitrary ranking based on observed effects. Table 4.22 shows descriptions for levels of earthquake intensity on the MMI scale compared to the Richter scale. Seismic shaking is typically the greatest cause of losses to structures during earthquakes.

Table 4.21 – Richter Scale

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

Source: FEMA

Table 4.22 – Comparison of Richter Scale and Modified Mercalli Intensity (MMI) Scale

MMI	Richter Scale	Felt Intensity
I	0 – 1.9	Not felt. Marginal and long period effects of large earthquakes.
II	2.0 – 2.9	Felt by persons at rest, on upper floors, or favorably placed.
III	3.0 – 3.9	Felt indoors. Hanging objects swing. Vibration like passing of light trucks. Duration estimated. May not be recognized as an earthquake.
IV	4.0 – 4.3	Hanging objects swing. Vibration like passing of heavy trucks. Standing motor cars rock. Windows, dishes, doors rattle. Glasses clink the upper range of IV, wooden walls and frame creak.
V	4.4 – 4.8	Felt outdoors; direction estimated. Sleepers wakened. Liquids disturbed, some spilled. Small unstable objects displaced or upset. Doors swing, close, open. Pendulum clocks stop, start.
VI	4.9 – 5.4	Felt by all. Many frightened and run outdoors. Persons walk unsteadily. Windows, dishes, glassware broken. Books, etc., fall off shelves. Pictures fall off walls. Furniture moved. Weak plaster and masonry D cracked. Small bells ring. Trees, bushes shaken.
VII	5.5 – 6.1	Difficult to stand. Noticed by drivers of motor cars. Hanging objects quiver. Furniture broken. Damage to masonry D, including cracks. Weak chimneys broken at roof line. Fall of plaster, loose bricks, stones, tiles, cornices. Some cracks in masonry C. Waves on ponds. Small slides and caving in along sand or gravel banks. Large bells ring. Concrete irrigation ditches damaged.
VII	6.2 – 6.5	Steering of motor cars is affected. Damage to masonry C; partial collapse. Some damage to masonry B. Fall of stucco and some masonry walls. Twisting, fall of chimneys, factory

MMI	Richter Scale	Felt Intensity
		stacks, monuments, towers, elevated tanks. Frame houses moved on foundations. Decayed piling broken off. Branches broken from trees. Changes in flow or temperature of springs and wells. Cracks in wet ground and on steep slopes.
IX	6.6 – 6.9	General panic. Masonry D destroyed; masonry C heavily damaged, sometimes with complete collapse; masonry B seriously damaged. (General damage to foundations.) Serious damage to reservoirs. Underground pipes broken. Conspicuous cracks in ground. In alluvial areas sand and mud ejected, earthquake fountains, sand craters.
X	7.0 – 7.3	Most masonry and frame structures destroyed with their foundations. Some well-built wooden structures and bridges destroyed. Serious damage to dams, dikes, embankments. Large landslides. Water thrown on banks of canals, rivers, lakes, etc. Sand and mud shifted horizontally on beaches and flat land. Rails bent slightly.
XI	7.4 – 8.1	Rails bent greatly. Underground pipelines completely out of service.
XII	> 8.1	Damage nearly total. Large rock masses displaced. Lines of sight and level distorted. Objects thrown in the air.

Masonry A: Good workmanship, mortar, and design; reinforced, especially laterally, and bound together by using steel, concrete, etc.; designed to resist lateral forces. Masonry B: Good workmanship and mortar; reinforced, but not designed in detail to resist lateral forces. Masonry C: Ordinary workmanship and mortar; no extreme weaknesses like failing to tie in at corners, but neither reinforced nor designed against horizontal forces. Masonry D: Weak materials, such as adobe; poor mortar; low standards of workmanship; weak horizontally.
Source: Oklahoma State Hazard Mitigation Plan.

The most severe earthquake to impact the Wake County area was the Charleston earthquake of 1886. It is estimated to have been felt as a 7 or 8 on the MMI Scale. Since then, six earthquakes have been felt in Wake County, and all were at an MMI Scale of 4 or lower.

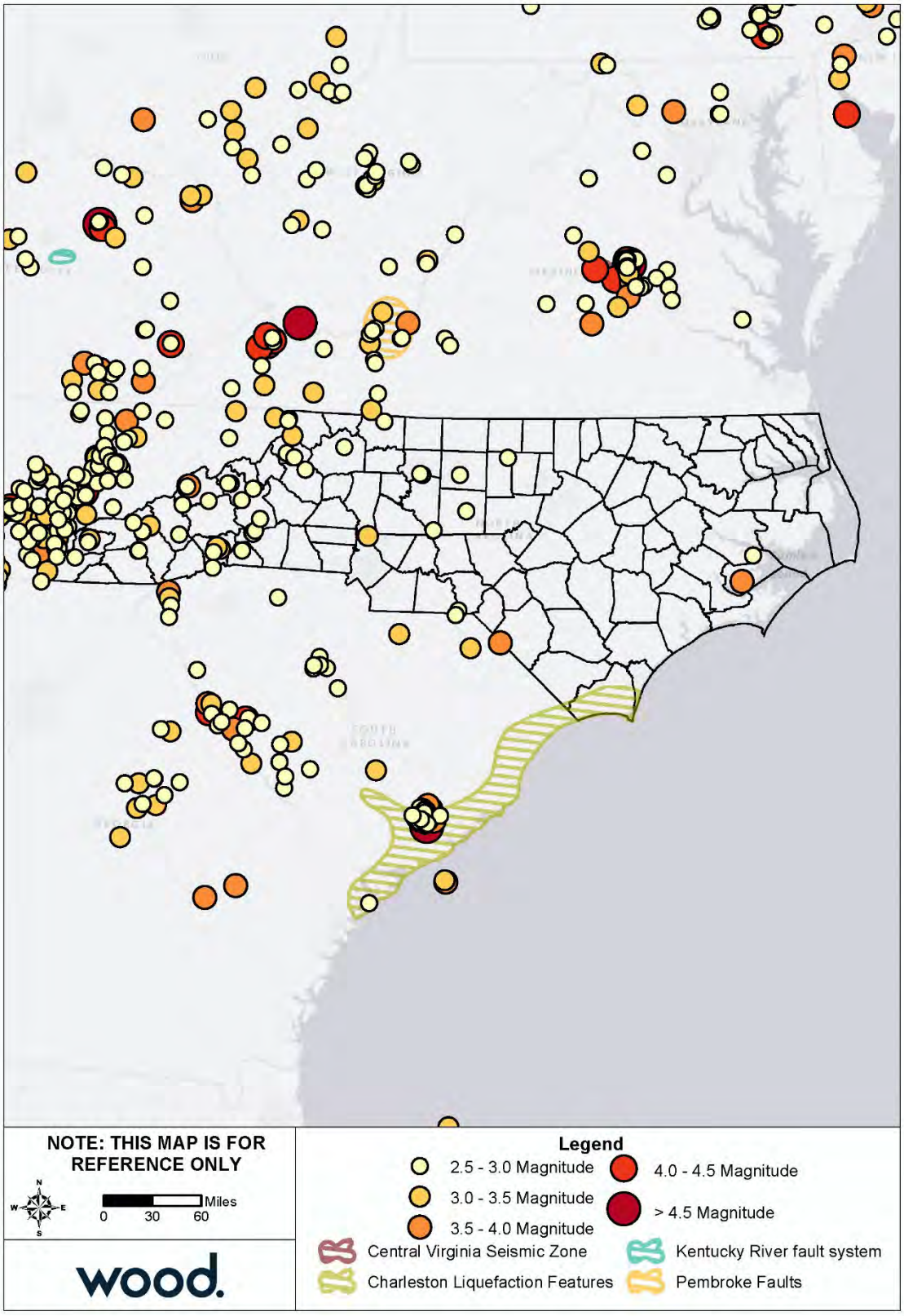
Impact: 1 – Minor

Spatial Extent: 4 – Large

Historical Occurrences

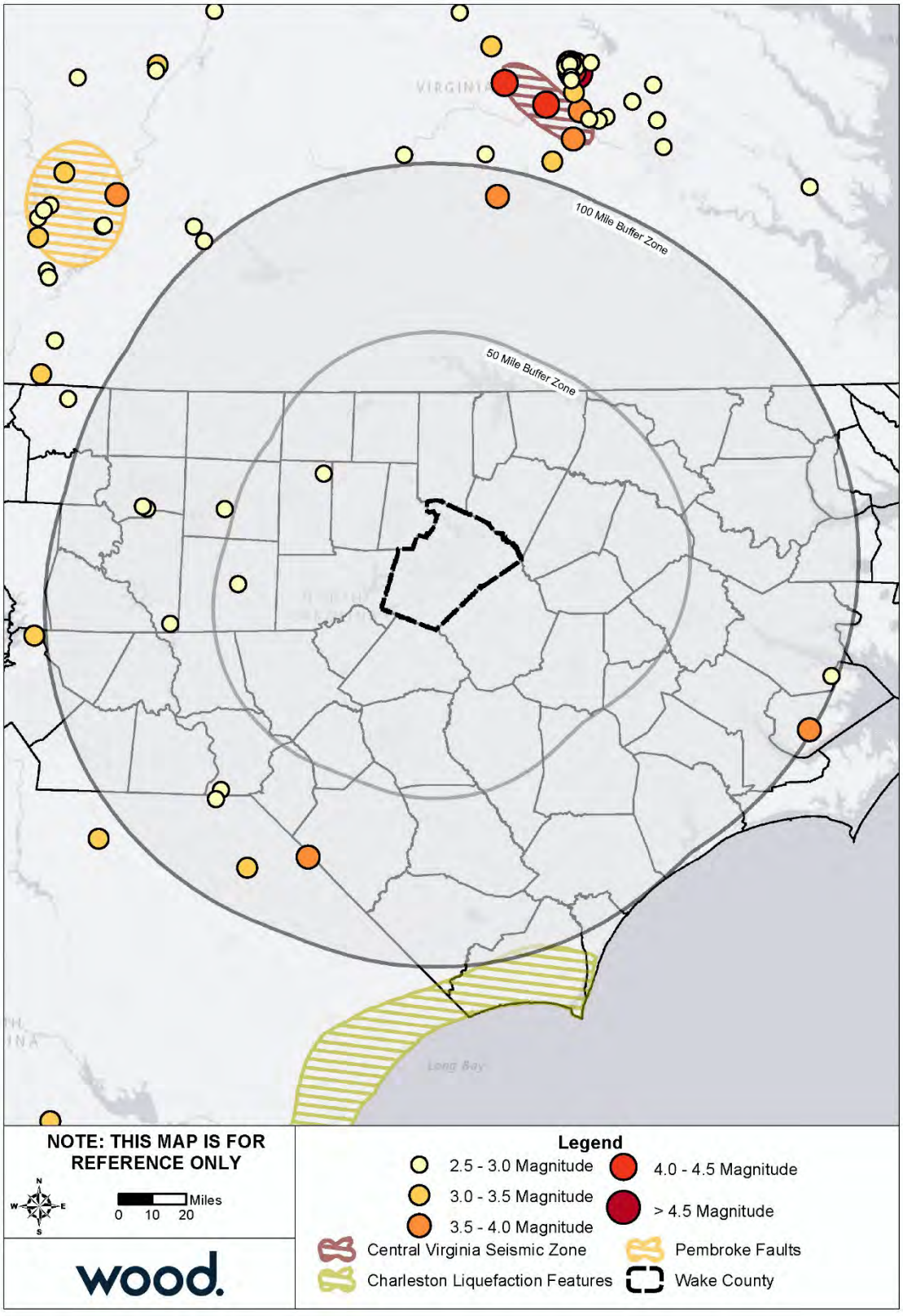
The USGS Earthquake Hazards Program maintains a database of all historical earthquakes of a magnitude 2.5 and greater. These events are illustrated in the following pages. Figure 4.6 shows historical earthquakes by magnitude in relation to North Carolina and the Quaternary Faults identified by USGS. This includes events from 1973 to 2019. Figure 4.7 provides a more detailed view of earthquakes that have occurred within 50 and 100 miles of Wake County.

Figure 4.6 – Historical Earthquakes by Magnitude, 1973-2019



Source: USGS Earthquakes Hazard Program

Figure 4.7 – Historical Earthquakes, Distance from Wake County, 1973-2019



Source: USGS Earthquakes Hazard Program

The above map documents all earthquakes that have occurred within North Carolina; however, given the long distances across which earthquake impacts can be felt, these events do not encompass all earthquakes that have affected North Carolina. The following data, detailed in Table 4.23, was compiled and presented in the 2015 Wake County Hazard Mitigation Plan and remains relevant to the planning area.

Table 4.23 – Historical Earthquakes Impacting North Carolina

Date	Location	Richter Scale (Magnitude)	MMI (Intensity)	MMI in North Carolina
12/16/1811 – 1	NE Arkansas	8.5	XI	VI
12/16/1811 – 2	NE Arkansas	8.0	X	VI
12/18/1811 – 3	NE Arkansas	8.0	X	VI
01/23/1812	New Madrid, MO	8.4	XI	VI
02/071812	New Madrid, MO	8.7	XII	VI
04/29/1852	Wytheville, VA	5.0	VI	VI
08/31/1861	Wilkesboro, NC	5.1	VII	VII
12/23/1875	Central Virginia	5.0	VII	VI
08/31/1886	Charleston, SC	7.3	X	VII
05/31/1897	Giles County, VA	5.8	VIII	VI
01/01/1913	Union County, SC	4.8	VII	VI
02/21/1916	Asheville, NC	5.5	VII	VII
07/08/1926	Mitchell County, NC	5.2	VII	VII
11/03/1928	Newport, TN	4.5	VI	VI
05/13/1957	McDowell County, NC	4.1	VI	VI
07/02/1957	Buncombe County, NC	3.7	VI	VI
11/24/1957	Jackson County, NC	4.0	VI	VI
10/27/1959 *	Chesterfield, SC	4.0	VI	VI
07/13/1971	Newry, SC	3.8	VI	VI
11/30/1973	Alcoa, TN	4.6	VI	VI
11/13/1976	Southwest Virginia	4.1	VI	VI
05/05/1981	Henderson County, NC	3.5	VI	VI

* Conflicting reports on this event, intensity in North Carolina could have been either V or VI

Source: 2015 Wake County Hazard Mitigation Plan (This information compiled by Dr. Kenneth B. Taylor and provided by Tiawana Ramsey of NCEM. Information was compiled from the National Earthquake Center, Earthquakes of the US by Carl von Hake (1983), and a compilation of newspaper reports in the Eastern Tennessee Seismic Zone compiled by Arch Johnston, CERI, Memphis State University (1983)).

Probability of Future Occurrence

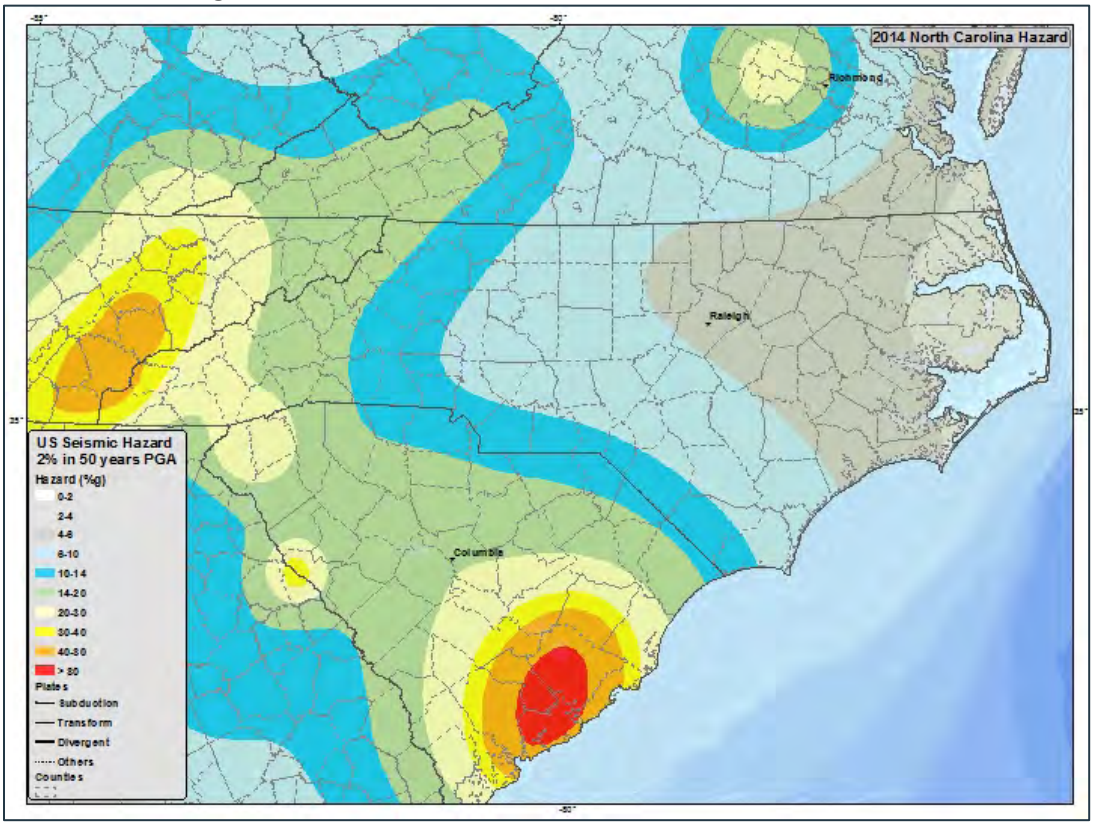
Ground motion is the movement of the earth's surface due to earthquakes or explosions. It is produced by waves generated by a sudden slip on a fault or sudden pressure at the explosive source and travels through the earth and along its surface. Ground motion is amplified when surface waves of unconsolidated materials bounce off of or are refracted by adjacent solid bedrock. The probability of ground motion is depicted in USGS earthquake hazard maps by showing, by contour values, the earthquake ground motions (of a particular frequency) that have a common given probability of being exceeded in 50 years.

Figure 4.8 reflects the seismic hazard for Wake County based on the national USGS map of peak acceleration with two percent probability of exceedance in 50 years. To produce these estimates, the ground motions being considered at a given location are those from all future possible earthquake magnitudes at all possible distances from that location. The ground motion coming from a particular magnitude and distance is assigned an annual probability equal to the annual probability of occurrence of the causative magnitude and distance. The method assumes a reasonable future catalog of earthquakes,

based upon historical earthquake locations and geological information on the recurrence rate of fault ruptures. When all the possible earthquakes and magnitudes have been considered, a ground motion value is determined such that the annual rate of its being exceeded has a certain value.

Therefore, for the given probability of exceedance, two percent, the locations shaken more frequently will have larger ground motions. Wake County is located within the light blue and dark gray zones representing a low peak acceleration of 0.04 to 0.1% g.

Figure 4.8 – Seismic Hazard Information for North Carolina



Source: USGS Earthquake Hazards Program

Based on this data, it can be reasonably assumed that an earthquake event affecting Wake County is unlikely.

Probability: 1 – Unlikely

Climate Change

Scientists are beginning to believe there may be a connection between climate change and earthquakes. Changing ice caps and sea-level redistribute weight over fault lines, which could potentially have an influence on earthquake occurrences. However, currently no studies quantify the relationship to a high level of detail, so recent earthquakes should not be linked with climate change. While not conclusive, early research suggest that more intense earthquakes and tsunamis may eventually be added to the adverse consequences that are caused by climate change.

Vulnerability Assessment

Methodologies and Assumptions

Population and property at risk to flooding was estimated using data from the North Carolina Emergency Management (NCEM) IRISK database, which was compiled in NCEM's Risk Management Tool.

People

Earthquake events in Wake County are unlikely to produce more than mild ground shaking; therefore, injury or death is unlikely. Objects falling from shelves generally pose the greatest threat to safety.

Table 4.24 and Table 4.25 detail the population estimated to be at risk from a 250-year earthquake and a 500-year earthquake, respectively, according to the NCEM IRISK database.

Table 4.24 – Estimated Population Impacted by 250-Year Earthquake

Jurisdiction	Total Population	Total Population at Risk		All Elderly Population	Elderly Population at Risk		All Children Population	Children at Risk	
		Number	Percent		Number	Percent		Number	Percent
Raleigh	419,053	48,654	11.60%	35,611	4,136	11.60%	30,469	3,538	11.60%
Apex	41,724	4,218	10.10%	3,546	358	10.10%	3,034	307	10.10%
Cary	136,260	12,025	8.80%	11,579	1,033	8.90%	9,907	873	8.80%
Fuquay-Varina	25,023	2,791	11.20%	2,126	237	11.10%	1,819	203	11.20%
Garner	30,981	4,534	14.60%	2,633	385	14.60%	2,253	330	14.60%
Holly Springs	25,790	2,211	8.60%	2,192	188	8.60%	1,875	161	8.60%
Knightdale	18,501	3,307	17.90%	1,572	281	17.90%	1,345	240	17.80%
Morrisville	18,655	4,676	25.10%	1,585	397	25%	1,356	340	25.10%
Rolesville	5,199	834	16%	442	71	16.10%	378	61	16.10%
Wake Forest	30,382	3,726	12.30%	2,582	321	12.40%	2,209	270	12.20%
Wendell	7,889	835	10.60%	670	71	10.60%	574	61	10.60%
Zebulon	6,102	781	12.80%	519	66	12.70%	444	57	12.80%
Unincorporated Wake County	135,124	22,391	16.60%	11,483	1,903	16.60%	9,825	1,628	16.60%
Total	**900,683**	**110,983**	**12.32%**	**76,540**	**9,447**	**12.34%**	**65,488**	**8,069**	**12.32%**

Source: NCEM Risk Management Tool

Table 4.25 – Estimated Population Impacted by 500-Year Earthquake

Jurisdiction	Total Population	Total Population at Risk		All Elderly Population	Elderly Population at Risk		All Children Population	Children at Risk	
		Number	Percent		Number	Percent		Number	Percent
Raleigh	419,053	420,104	100.30%	35,611	35,714	100.30%	30,469	30,547	100.30%
Apex	41,724	41,724	100%	3,546	3,546	100%	3,034	3,034	100%
Cary	136,260	137,544	100.90%	11,579	11,814	102%	9,907	9,986	100.80%
Fuquay-Varina	25,023	25,023	100%	2,126	2,126	100%	1,819	1,819	100%
Garner	30,981	30,981	100%	2,633	2,633	100%	2,253	2,253	100%

Jurisdiction	Total Population	Total Population at Risk		All Elderly Population	Elderly Population at Risk		All Children Population	Children at Risk	
		Number	Percent		Number	Percent		Number	Percent
Holly Springs	25,790	25,790	100%	2,192	2,192	100%	1,875	1,875	100%
Knightdale	18,501	18,501	100%	1,572	1,572	100%	1,345	1,345	100%
Morrisville	18,655	18,655	100%	1,585	1,585	100%	1,356	1,356	100%
Rolesville	5,199	5,199	100%	442	442	100%	378	378	100%
Wake Forest	30,382	31,175	102.60%	2,582	2,682	103.90%	2,209	2,261	102.40%
Wendell	7,889	7,889	100%	670	670	100%	574	574	100%
Zebulon	6,102	6,102	100%	519	519	100%	444	444	100%
Unincorporated Wake County	135,124	135,124	100%	11,483	11,483	100%	9,825	9,825	100%
Total	**900,683**	**903,811**	**100.35%**	**76,540**	**76,978**	**100.57%**	**65,488**	**65,697**	**100.32%**

Source: NCEM Risk Management Tool

Property

In a severe earthquake event, buildings can be damaged by the shaking itself or by the ground beneath them settling to a different level than it was before the earthquake (subsidence). Buildings can even sink into the ground if soil liquefaction occurs. If a structure (a building, road, etc.) is built across a fault, the ground displacement during an earthquake could seriously damage that structure.

Earthquakes can also cause damages to infrastructure, resulting in secondary hazards. Damages to dams or levees could cause failures and subsequent flooding. Fires can be started by broken gas lines and power lines. Fires can be a serious problem, especially if the water lines that feed the fire hydrants have been damaged as well.

Wake County has not been impacted by an earthquake with more than a moderate intensity, so damage to the built environment is unlikely.

Table 4.26 through Table 4.27 detail the estimated buildings impacted from varying magnitudes of earthquake events.

Table 4.26 – Estimated Buildings Impacted by 250-Year Earthquake Event

Jurisdiction	All Buildings	Residential Buildings at Risk			Commercial Buildings at Risk			Public Buildings at Risk			Total Buildings at Risk		
	Num	Num	% of Total	Estimated Damages	Num	% of Total	Estimated Damages	Num	% of Total	Estimated Damages	Num	% of Total	Estimated Damages
Raleigh	128,076	13,673	10.7%	$424,380	6,158	4.8%	$1,302,645	2,077	1.6%	$534,247	21,908	17.1%	$2,261,272
Apex	14,554	1,385	9.5%	$30,754	638	4.4%	$101,729	127	0.9%	$25,004	2,150	14.8%	$157,487
Cary	45,306	3,712	8.2%	$153,063	1,837	4.1%	$386,301	428	0.9%	$101,539	5,977	13.2%	$640,903
Fuquay-Varina	10,244	1,051	10.3%	$12,141	574	5.6%	$95,264	120	1.2%	$25,330	1,745	17%	$132,735
Garner	11,975	1,611	13.5%	$16,109	677	5.7%	$94,971	164	1.4%	$25,963	2,452	20.5%	$137,042
Holly Springs	9,178	762	8.3%	$8,411	222	2.4%	$47,943	53	0.6%	$20,173	1,037	11.3%	$76,527
Knightdale	7,144	1,217	17%	$12,152	255	3.6%	$26,315	59	0.8%	$13,951	1,531	21.4%	$52,417
Morrisville	5,181	1,198	23.1%	$32,527	334	6.4%	$106,722	42	0.8%	$7,218	1,574	30.4%	$146,467
Rolesville	2,103	318	15.1%	$751	88	4.2%	$5,204	29	1.4%	$2,999	435	20.7%	$8,954
Wake Forest	10,547	1,170	11.1%	$13,756	527	5%	$56,347	134	1.3%	$14,127	1,831	17.4%	$84,230
Wendell	3,728	356	9.5%	$1,344	263	7.1%	$17,247	58	1.6%	$6,949	677	18.2%	$25,540
Zebulon	3,074	339	11%	$2,146	296	9.6%	$41,797	65	2.1%	$5,605	700	22.8%	$49,548
Unincorporated Wake County	59,372	9,230	15.5%	$22,309	3,059	5.2%	$193,247	360	0.6%	$52,279	12,649	21.3%	$267,835
Total	**310,482**	**36,022**	**11.6%**	**$729,843**	**14,928**	**4.8%**	**$2,475,732**	**3,716**	**1.2%**	**$835,384**	**54,666**	**17.6%**	**$4,040,957**

Source: NCEM Risk Management Tool

Table 4.27 – Estimated Buildings Impacted by 500-Year Earthquake Event

Jurisdiction	All Buildings	Residential Buildings at Risk			Commercial Buildings at Risk			Public Buildings at Risk			Total Buildings at Risk		
	Num	Num	% of Total	Estimated Damages	Num	% of Total	Estimated Damages	Num	% of Total	Estimated Damages	Num	% of Total	Estimated Damages
Raleigh	128,076	119,439	93.3%	$9,406,402	6,345	5%	$12,656,615	2,272	1.8%	$5,415,760	128,056	100%	$27,478,777
Apex	14,554	13,758	94.5%	$1,006,370	648	4.5%	$942,887	148	1%	$286,564	14,554	100%	$2,235,820
Cary	45,306	42,944	94.8%	$3,946,800	1,872	4.1%	$4,179,591	462	1%	$1,027,396	45,278	99.9%	$9,153,787
Fuquay-Varina	10,244	9,524	93%	$548,907	585	5.7%	$874,308	130	1.3%	$258,931	10,239	100%	$1,682,145
Garner	11,975	11,103	92.7%	$563,146	687	5.7%	$910,771	181	1.5%	$257,289	11,971	100%	$1,731,206
Holly Springs	9,178	8,887	96.8%	$549,465	226	2.5%	$474,617	62	0.7%	$201,468	9,175	100%	$1,225,549
Knightdale	7,144	6,811	95.3%	$308,199	265	3.7%	$235,747	67	0.9%	$138,754	7,143	100%	$682,700
Morrisville	5,181	4,793	92.5%	$646,953	340	6.6%	$1,032,965	48	0.9%	$64,561	5,181	100%	$1,744,480
Rolesville	2,103	1,983	94.3%	$71,720	91	4.3%	$39,738	29	1.4%	$24,399	2,103	100%	$135,857
Wake Forest	10,547	9,852	93.4%	$542,005	541	5.1%	$495,629	151	1.4%	$169,170	10,544	100%	$1,206,803
Wendell	3,728	3,378	90.6%	$83,614	277	7.4%	$151,000	73	2%	$78,095	3,728	100%	$312,709
Zebulon	3,074	2,677	87.1%	$71,316	316	10.3%	$366,134	79	2.6%	$61,445	3,072	99.9%	$498,894
Unincorporated Wake County	59,372	55,779	93.9%	$2,448,636	3,122	5.3%	$1,980,577	402	0.7%	$533,421	59,303	99.9%	$4,962,634
Total	**310,482**	**290,928**	**93.7%**	**$20,193,533**	**15,315**	**4.9%**	**$24,340,579**	**4,104**	**1.3%**	**$8,517,253**	**310,347**	**100%**	**$53,051,361**

Source: NCEM Risk Management Tool

Environment

An earthquake is unlikely to cause substantial impacts to the natural environment in Wake County. Impacts to the built environment (e.g. ruptured gas line) could damage the surrounding environment. However, this type damage is unlikely based on historical occurrences.

Consequence Analysis

Table 4.28 summarizes the potential negative consequences of earthquake.

Table 4.28 – Consequence Analysis - Earthquake

Category	Consequences
Public	Impact expected to be severe for people who are unprotected or unable to take shelter; moderate to light impacts are expected for those who are protected.
Responders	Responders may be required to enter unstable structures or compromised infrastructure. Adverse impacts are expected to be severe for unprotected personnel and moderate to light for protected personnel.
Continuity of Operations (including Continued Delivery of Services)	Damage to facilities/personnel in the area of the incident may require relocation of operations and lines of succession execution. Disruption of lines of communication and destruction of facilities may extensively postpone delivery of services.
Property, Facilities and Infrastructure	Damage to facilities and infrastructure in the area of the incident may be extensive for facilities, people, infrastructure, and HazMat.
Environment	May cause extensive damage, creating denial or delays in the use of some areas. Remediation may be needed.
Economic Condition of the Jurisdiction	Local economy and finances expected to be adversely affected, possibly for an extended period of time.
Public Confidence in the Jurisdiction's Governance	Ability to respond and recover may be questioned and challenged if planning, response, and recovery are not timely and effective.

Hazard Summary by Jurisdiction

The following table summarizes earthquake hazard risk by jurisdiction. Earthquake risk is uniform across the planning area.

Jurisdiction	Probability	Impact	Spatial Extent	Warning Time	Duration	Score	Priority
Wake County	1	1	4	4	1	1.9	L
Apex	1	1	4	4	1	1.9	L
Cary	1	1	4	4	1	1.9	L
Fuquay-Varina	1	1	4	4	1	1.9	L
Garner	1	1	4	4	1	1.9	L
Holly Springs	1	1	4	4	1	1.9	L
Knightdale	1	1	4	4	1	1.9	L
Morrisville	1	1	4	4	1	1.9	L
Raleigh	1	1	4	4	1	1.9	L
Rolesville	1	1	4	4	1	1.9	L
Wake Forest	1	1	4	4	1	1.9	L
Wendell	1	1	4	4	1	1.9	L
Zebulon	1	1	4	4	1	1.9	L

4.5.4 Extreme Heat

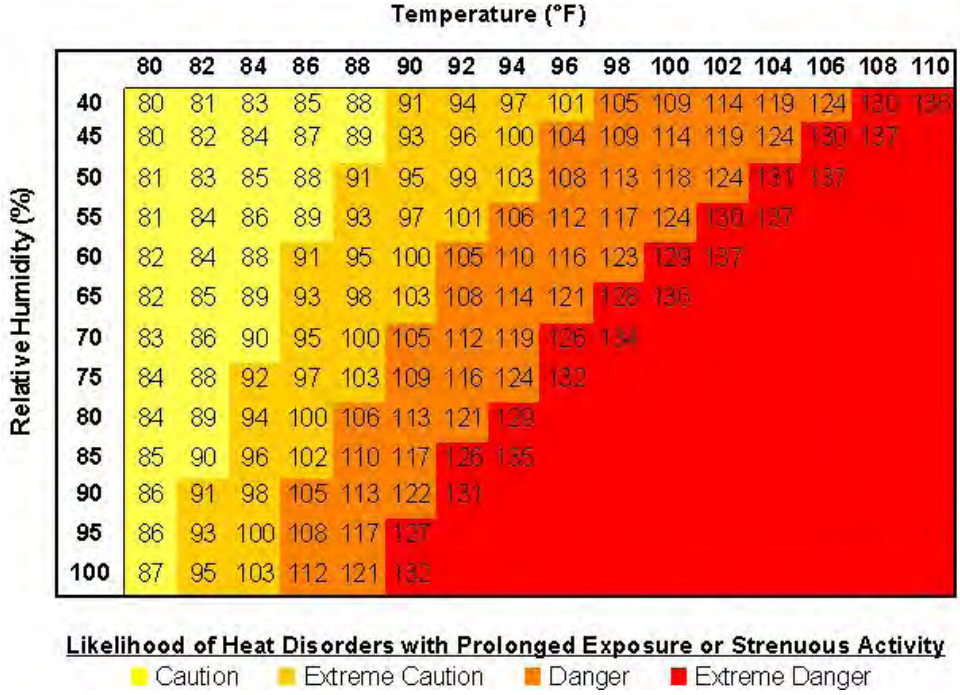
Hazard Background

Per information provided by FEMA, in most of the United States extreme heat is defined as a long period (2 to 3 days) of high heat and humidity with temperatures above 90 degrees. In extreme heat, evaporation is slowed and the body must work extra hard to maintain a normal temperature, which can lead to death by overwork of the body. Extreme heat often results in the highest annual number of deaths among all weather-related disasters. Per Ready.gov:

- Extreme heat can occur quickly and without warning
- Older adults, children, and sick or overweight individuals are at greater risk from extreme heat
- Humidity increases the feeling of heat as measured by heat index

Ambient air temperature is one component of heat conditions, with relative humidity being the other. The relationship of these factors creates what is known as the apparent temperature. The Heat Index Chart in Figure 4.9 uses both of these factors to produce a guide for the apparent temperature or relative intensity of heat conditions.

Figure 4.9 – Heat Index Chart



Source: National Weather Service (NWS) http://www.nws.noaa.gov/os/heat/heat_index.shtml
Note: Exposure to direct sun can increase Heat Index values by as much as 15°F. The shaded zone above 105°F corresponds to a heat index that may cause increasingly severe heat disorders with continued exposure and/or physical activity.

During these conditions, the human body has difficulties cooling through the normal method of the evaporation of perspiration. Health risks rise when a person is over exposed to heat.

The most dangerous place to be during an extreme heat incident is in a permanent home, with little or no air conditioning. Those at greatest risk for heat-related illness include people 65 years of age and older, young children, people with chronic health problems such as heart disease, people who are obese, people who are socially isolated, and people who are on certain medications, such as tranquilizers, antidepressants, sleeping pills, or drugs for Parkinson's disease. However, even young and healthy

individuals are susceptible if they participate in strenuous physical activities during hot weather or are not acclimated to hot weather. Table 4.29 lists typical symptoms and health impacts of exposure to extreme heat.

Table 4.29 – Typical Health Impacts of Extreme Heat

Heat Index (HI)	Disorder
80-90° F (HI)	Fatigue possible with prolonged exposure and/or physical activity
90-105° F (HI)	Sunstroke, heat cramps, and heat exhaustion possible with prolonged exposure and/or physical activity
105-130° F (HI)	Heatstroke/sunstroke highly likely with continued exposure

Source: National Weather Service Heat Index Program, www.weather.gov/os/heat/index.shtml

The National Weather Service has a system in place to initiate alert procedures (advisories or warnings) when the Heat Index is expected to have a significant impact on public safety. The expected severity of the heat determines whether advisories or warnings are issued. A common guideline for issuing excessive heat alerts is when the maximum daytime Heat Index is expected to equal or exceed 105 degrees Fahrenheit (°F) and the night time minimum Heat Index is 80°F or above for two or more consecutive days. A heat advisory is issued when temperatures reach 105 degrees and a warning is issued at 115 degrees.

Impacts of extreme heat are not only focused on human health, as prolonged heat exposure can have devastating impacts on infrastructure as well. Prolonged high heat exposure increases the risk of pavement deterioration, as well as railroad warping or buckling. High heat also puts a strain on energy systems and consumption, as air conditioners are run at a higher rate and for longer; extreme heat can also reduce transmission capacity over electric systems.

Warning Time: 1 – More than 24 hours warning time

Duration: 4 – More than one week

Location

The entire planning area is susceptible to high temperatures and incidents of extreme heat.

Extent

The extent of extreme heat can be defined by the maximum apparent temperature reached. Apparent temperature is a function of ambient air temperature and relative humidity and is reported as the heat index. The National Weather Service Forecast Office in Raleigh sets the following criteria for heat advisory and excessive heat warning:

- **Heat Advisory** – Heat Index of 105°F to 109°F for 3 hours or more. Can also be issued for lower values 100ºF to 104ºF for heat lasting several consecutive days
- **Excessive Heat Watch** – Potential for heat index values of 110°F or hotter within 24 to 48 hours. Also issued during prolonged heat waves when the heat index is near 110°F
- **Excessive Heat Warning** – Heat Index of 110°F or greater for any duration

Based on data from the "Raleigh State Univ" weather station from January 1892 through January 2019, the highest temperature recorded in Wake County was 107°F and occurred in July 2011.

Impact: 3 – Critical

Spatial Extent: 4 – Large

Historical Occurrences

According to the National Oceanic and Atmospheric Administration (NOAA), 2017 was North Carolina's hottest year on record; that record stretches back 123 years to 1895.

The following two heat-related incidents were reported by NCEI for Wake County; these incidents caused one injury and no fatalities, property damage, or crop damage:

July 22, 1998 – Excessive heat plagued central North Carolina during July 22 through July 23. Maximum temperatures reached the 98 to 103 degree range combined with dew points in the 78 to 80 degree range with little wind to give heat index values of around 110 degrees for several hours each afternoon. To make matters worse, the minimum temperatures did not fall below 80 at several locations and those that did achieved that feat for only an hour or two. Strong thunderstorms ended the 2 day excessive heat ordeal on the evening of the 23 when rain cooled the environment enough to send temperatures into the lower 70s at most locations.

August 22, 2007 – An athlete from Enloe High School running track collapsed from heat exhaustion and was sent to the hospital in critical condition. The student remained in the hospital in critical condition for several days.

Probability of Future Occurrence

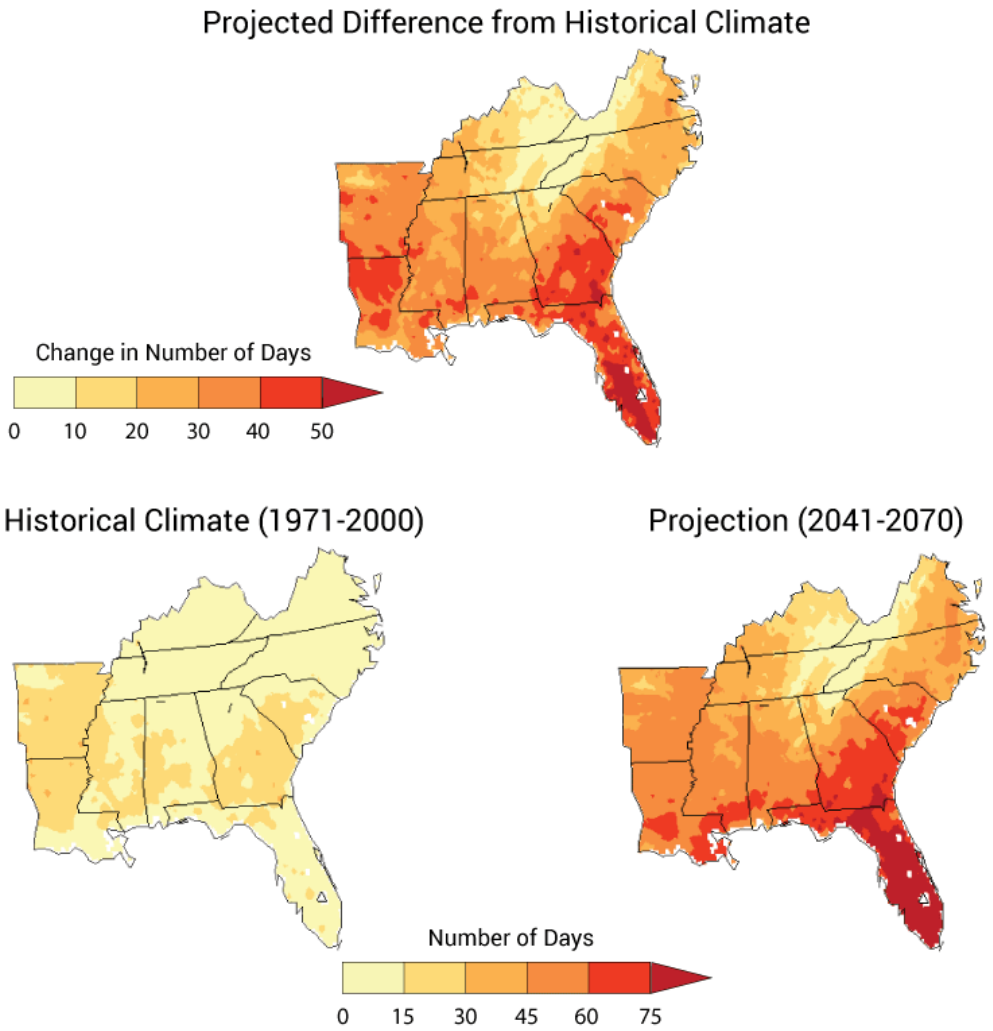
Data was gathered from the North Carolina State Climate Office's Climate Thresholds Tool using the Raleigh State University weather station as an approximation for Wake County. During the 20-year period from 1999 through 2018, Wake County experienced 33 days with a high temperature above 100°F, or an average of 1.65 days per year. In 2012, there were 10 days with recorded temperatures above this threshold.

Probability: 4 – Highly Likely

Climate Change

Research shows that average temperatures will continue to rise in the Southeast United States and globally, directly affecting the Wake County region in North Carolina. Per the Fourth National Climate Assessment, "extreme temperatures are projected to increase even more than average temperatures. Cold waves are projected to become less intense and heat waves more intense." The number of days over 95°F is expected to increase by between 20 and 30 days annually, as shown in Figure 4.10. The Triangle Regional Resilience Partnership Resilience Assessment notes that the number of days with extreme temperatures has been increasing in the Triangle; climbing from an average of 18 days over 92°F per year from 1948 to 2012 to a peak of 48 days over 92°F in 2010.

Figure 4.10 – Projected Change in Number of Days Over 95°F



Source: NOAA NCDC from 2014 National Climate Assessment

Vulnerability Assessment

Methodologies and Assumptions

No data is available to assess the vulnerability of people or property in the planning area to extreme heat.

People

Extreme heat can cause heat stroke and even loss of human life. The elderly and the very young are most at risk to the effects of heat. People who are isolated are also more vulnerable to extreme heat.

Property

Extreme heat is unlikely to cause significant damages to the built environment. However, road surfaces can be damaged as asphalt softens, and concrete sections may buckle under expansion caused by heat. Train rails may also distort or buckle under the stress of head induced expansion. Power transmission lines may sag from expansion and if contact is made with vegetation the line may short out causing power

outages. Additional power demand for cooling also increases power line temperature adding to heat impacts.

Extreme heat can also cause significant agricultural losses. Between 2007-2017, the sum of claims paid for crop damage due to heat in Wake County was $2,844,454, or an average of $258,587 in losses every year. Losses were greatest in 2016 when 512 acres of flue cured tobacco, soybeans, and corn were affected, resulting in $1,684,909 in crop losses. Table 4.19 summarizes the crop losses due to drought in reported in the RMA system.

Table 4.30 – Crop Losses Resulting from Heat, 2007-2017

Year	Determined Acres	Indemnity Amount
2008	16.40	$380.00
2010	1480.92	$338,250.00
2011	296.21	$104,999.00
2012	456.98	$114,504.00
2015	239.62	$280,358.30
2016	512.32	$494,026.75
2017	386.77	$179,418.00
Total	**6,391.67**	**$2,844,454.10**

Source: USDA Risk Management Agency

Environment

Wild animals are vulnerable to heat disorders similar to humans, including mortality. Vegetation growth will be stunted or plants may be killed if temperatures rise above their tolerance extremes.

Consequence Analysis

Table 4.31 summarizes the potential negative consequences of extreme heat.

Table 4.31 – Consequence Analysis – Extreme Heat

Category	Consequences
Public	Extreme heat may cause illness and/or death.
Responders	Consequences may be greater for responders if their work requires exertion and/or wearing heavy protective gear.
Continuity of Operations (including Continued Delivery of Services)	Continuity of operations is not expected to be impacted by extreme heat because warning time for these events is long.
Property, Facilities and Infrastructure	Minor impacts may occur, including possible damages to road surfaces and power lines.
Environment	Environmental impacts include strain on local plant and wildlife, including potential for illness or death.
Economic Condition of the Jurisdiction	Farmers may face crop losses or increased livestock costs.
Public Confidence in the Jurisdiction's Governance	Extreme heat is unlikely to impact public confidence.

Hazard Summary by Jurisdiction

The following table summarizes extreme heat hazard risk by jurisdiction. Extreme heat risk does not vary significantly by jurisdiction.

Jurisdiction	Probability	Impact	Spatial Extent	Warning Time	Duration	Score	Priority
Wake County	4	3	4	1	3	3.3	H
Apex	4	3	4	1	3	3.3	H
Cary	4	3	4	1	3	3.3	H
Fuquay-Varina	4	3	4	1	3	3.3	H
Garner	4	3	4	1	3	3.3	H
Holly Springs	4	3	4	1	3	3.3	H
Knightdale	4	3	4	1	3	3.3	H
Morrisville	4	3	4	1	3	3.3	H
Raleigh	4	3	4	1	3	3.3	H
Rolesville	4	3	4	1	3	3.3	H
Wake Forest	4	3	4	1	3	3.3	H
Wendell	4	3	4	1	3	3.3	H
Zebulon	4	3	4	1	3	3.3	H

4.5.5 Flood

Hazard Background

Flooding is defined by the rising and overflowing of water onto normally dry land. As defined by FEMA, a flood is a general and temporary condition of partial or complete inundation of two or more acres of normally dry land area or of two or more properties. Flooding can result from an overflow of inland waters or an unusual accumulation or runoff of surface waters from any source.

Flooding is the most frequent and costly of all natural hazards in the United States, and has caused more than 10,000 death(s) since 1900. Approximately 90 percent of presidentially declared disasters result from flood-related natural hazard events. Taken as a whole, more frequent, localized flooding problems that do not meet federal disaster declaration thresholds ultimately cause the majority of damages across the United States.

Sources and Types of Flooding

Flooding within Wake County can be attributed to two main sources as noted below.

Riverine Flooding: The primary riverine flooding sources in Wake County are the Black River, Contentnea River, Haw River, Cape Fear River, and Neuse River, according to the 2015 Preliminary Flood Insurance Study for Wake County. These rivers and their tributaries are susceptible to overflowing their banks during and following excessive precipitation events. Though less common, riverine flood events (such as the "100-year flood") will cause significantly more damage and economic disruption for the area than incidences of localized stormwater flooding.

Wake County has an Effective FIRM is dated May 2, 2006 and a Revised Flood Insurance Study (FIS) dated November 17, 2017. The FIS summarizes the principal flood problems in the county as follows:

> "Flooding problems in the unincorporated areas of Wake County have been mostly attributed to the inefficient removal of runoff from highly developed areas. The extent to which development in this area has affected flooding problems can be seen by comparing a flood in May 1957 with one in February 1973. The 1957 flood resulted from approximately 5.7 inches of rain and was considered to have an average frequency of once in 7 years. The 1973 flood reached higher levels in the floodplain but resulted from only 3.5 inches of rain, or a storm predicted to occur once in every 2 to 5 years. This increase in flood potential, caused partially by the intense development which has taken place in the area, has resulted in reduced crop yields and lowered land values and caused more frequent property damage."

Flash Flooding: A flash flood occurs when water levels rise at an extremely fast rate as a result of intense rainfall over a brief period, possibly from slow-moving intense thunderstorms and sometimes combined with rapid snowmelt, ice jam release, frozen ground, saturated soil, or impermeable surfaces. Ice jam flooding is a form of flash flooding that occurs when ice breaks up in moving waterways, and then stacks on itself where channels narrow. This creates a natural dam, often causing flooding within minutes of the dam formation. Flash flooding can happen in Special Flood Hazard Areas (SFHAs) as delineated by the National Flood Insurance Program (NFIP) and can also happen in areas not associated with floodplains. Flash flood hazards caused by surface water runoff are most common in urbanized areas, where greater population density generally equates to more impervious surface (e.g., pavement and buildings) which increases the amount of surface water generated.

Flash flooding is a dangerous form of flooding which can reach full peak in only a few minutes. Rapid onset allows little or no time for protective measures. Flash flood waters move at very fast speeds and

can move boulders, tear out trees, scour channels, destroy buildings, and obliterate bridges. Flash flooding can result in higher loss of life, both human and animal, than slower developing river and stream flooding.

In certain areas, aging storm sewer systems are not designed to carry the capacity currently needed to handle the increased storm runoff. Typically, the result is water backing into basements, which damages mechanical systems and can create serious public health and safety concerns.

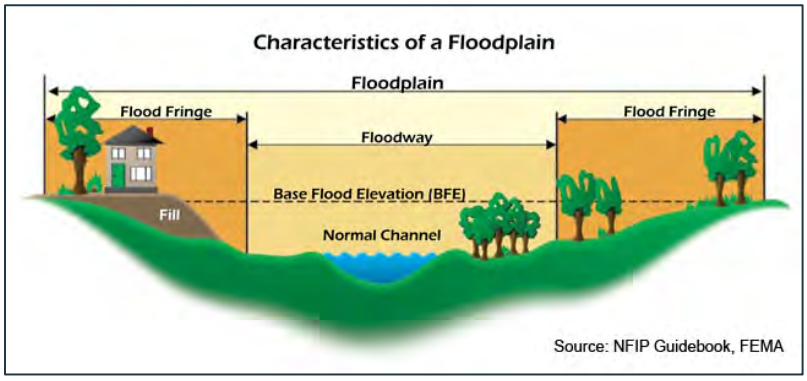
Localized flooding may be caused by the following issues:

- **Inadequate Capacity –** An undersized/under capacity pipe system can cause water to back-up behind a structure which can lead to areas of ponded water and/or overtopping of banks.
- **Clogged Inlets** – Debris covering the asphalt apron and the top of grate at catch basin inlets may contribute to an inadequate flow of stormwater into the system. Debris within the basin itself may also reduce the efficiency of the system by reducing the carrying capacity.
- **Blocked Drainage Outfalls** – Debris blockage or structural damage at drainage outfalls may prevent the system from discharging runoff, which may lead to a back-up of stormwater within the system.
- **Improper Grade** – Poorly graded asphalt around catch basin inlets may prevent stormwater from entering the catch basin as designed. Areas of settled asphalt may create low spots within the roadway that allow for areas of ponded water.

Flooding and Floodplains

In the case of riverine flooding, the area adjacent to a channel is the floodplain, as shown in Figure 4.11. A floodplain is flat or nearly flat land adjacent to a stream or river that experiences occasional or periodic flooding. It includes the floodway, which consists of the stream channel and adjacent areas that carry flood flows, and the flood fringe, which are areas covered by the flood, but which do not experience a strong current. Floodplains are made when floodwaters exceed the capacity of the main channel or escape the channel by eroding its banks. When this occurs, sediments (including rocks and debris) are deposited that gradually build up over time to create the floor of the floodplain. Floodplains generally contain unconsolidated sediments, often extending below the bed of the stream.

Figure 4.11 – Characteristics of a Floodplain



In its common usage, the floodplain most often refers to that area that is inundated by the "100-year flood," which is the flood that has a 1% chance in any given year of being equaled or exceeded. The 500-year flood is the flood that has a 0.2 percent chance of being equaled or exceeded in any given year. The potential for flooding can change and increase through various land use changes and changes to land

surface, which result in a change to the floodplain. A change in environment can create localized flooding problems inside and outside of natural floodplains by altering or confining natural drainage channels. These changes are most often created by human activity.

The 100-year flood, which is the minimum standard used by most federal and state agencies, is used by the National Flood Insurance Program (NFIP) as the standard for floodplain management and to determine the need for flood insurance. Participation in the NFIP requires adoption and enforcement of a local floodplain management ordinance which is intended to prevent unsafe development in the floodplain, thereby reducing future flood damages. Participation in the NFIP allows for the federal government to make flood insurance available within the community as a financial protection against flood losses. Since floods have an annual probability of occurrence, have a known magnitude, depth and velocity for each event, and in most cases, have a map indicating where they will likely occur, they are in many ways often the most predictable and manageable hazard.

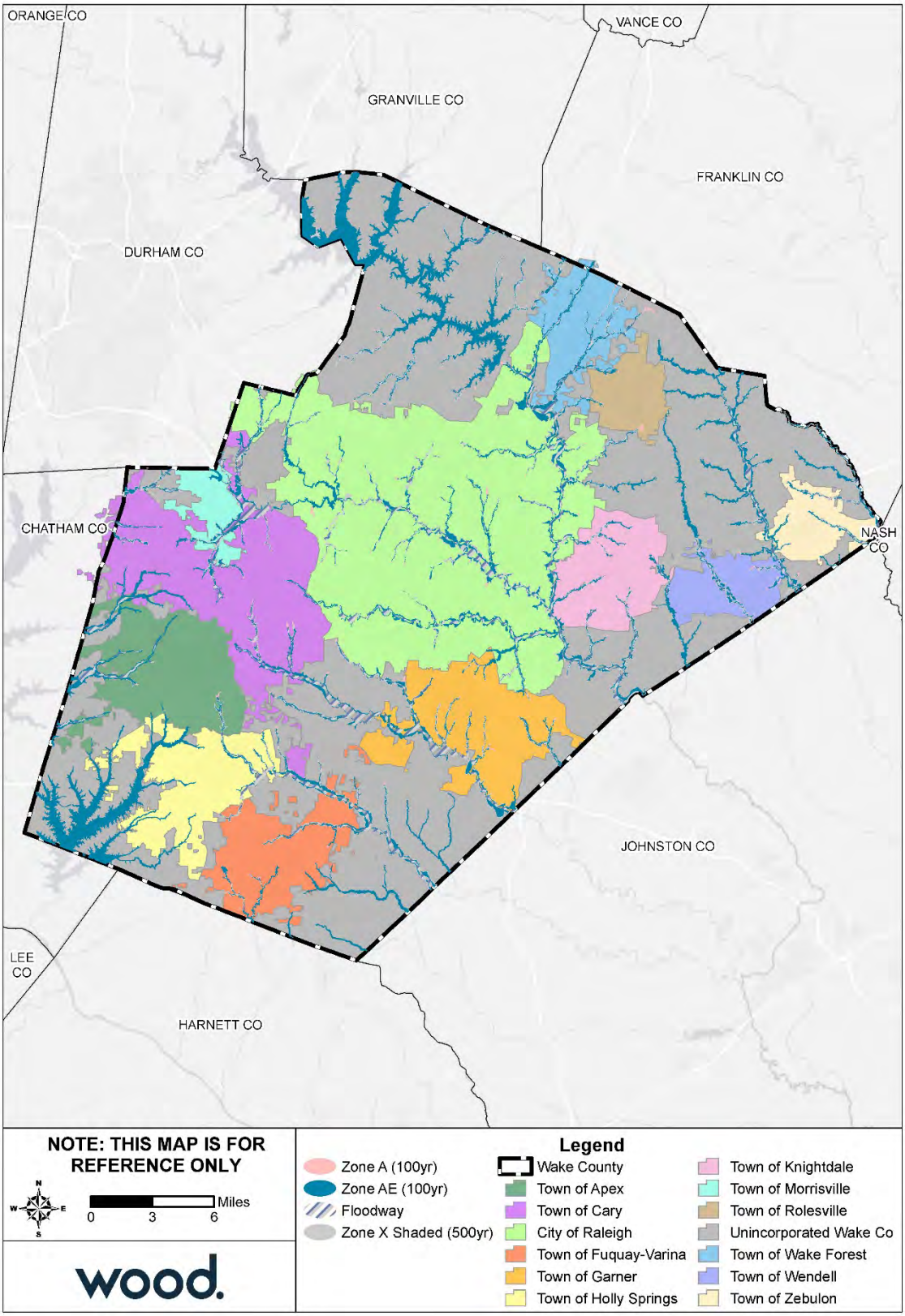
Warning Time: 3 – 6 to 12 hours

Duration: 3 – Less than 1 week

Location

Figure 4.12 reflects the effective mapped flood insurance zones for Wake County.

Figure 4.12 – FEMA Flood Hazard Areas in Wake County



Source: FEMA 2009 Effective DFIRM

Extent

Flood extent can be defined by the amount of land in the floodplain and the potential magnitude of flooding as measured by flood height and velocity.

Regulated floodplains are illustrated on inundation maps called Flood Insurance Rate Maps (FIRMs). It is the official map for a community on which FEMA has delineated both the Special Flood Hazard Areas (SFHAs) and the risk premium zones applicable to the community. SFHAs represent the areas subject to inundation by the 100-year flood event. Structures located within the SFHA have a 26-percent chance of flooding during the life of a standard 30-year mortgage. Flood prone areas were identified within Wake County using the Effective FIRMs, dated May 2, 2006. Table 4.32 summarizes the flood insurance zones identified by the Digital FIRM (DFIRM).

Table 4.32 – Mapped Flood Insurance Zones within Wake County

Zone	Description
AE	AE Zones, also within the 100-year flood limits, are defined with BFEs that reflect the combined influence of stillwater flood elevations and wave effects less than 3 feet. The AE Zone generally extends from the landward VE zone limit to the limits of the 100-year flood from coastal sources, or until it reaches the confluence with riverine flood sources. The AE Zones also depict the SFHA due to riverine flood sources, but instead of being subdivided into separate zones of differing BFEs with possible wave effects added, they represent the flood profile determined by hydrologic and hydraulic investigations and have no wave effects. The Coastal AE Zone is differentiated from the AE Zone by the Limit of Moderate Wave Action (LiMWA) and includes areas susceptible to wave action between 1.5 to 3 feet.
A	Areas with a 1% annual chance of flooding and a 26% chance of flooding over the life of a 30-year mortgage. Because detailed analyses are not performed for such areas, no depths or base flood elevations are shown within these zones.
0.2% Annual Chance (shaded Zone X)	Moderate risk areas within the 0.2-percent-annual-chance floodplain, areas of 1-percent-annual-chance flooding where average depths are less than 1 foot, areas of 1-percent-annual-chance flooding where the contributing drainage area is less than 1 square mile, and areas protected from the 1-percent-annual-chance flood by a levee. No BFEs or base flood depths are shown within these zones. (Zone X (shaded) is used on new and revised maps in place of Zone B.)
Zone X (unshaded)	Minimal risk areas outside the 1-percent and .2-percent-annual-chance floodplains. No BFEs or base flood depths are shown within these zones. Zone X (unshaded) is used on new and revised maps in place of Zone C.

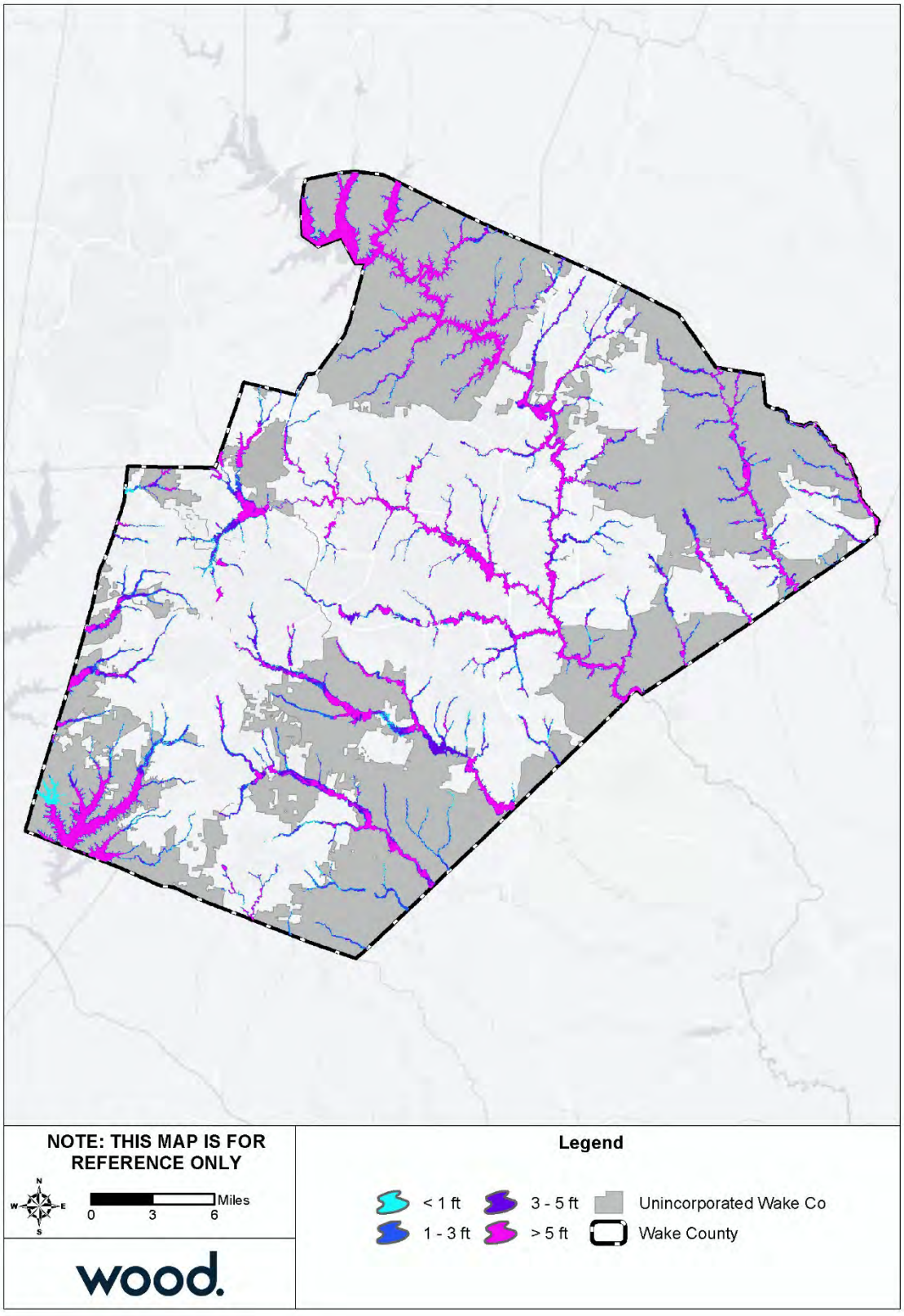
Approximately 9% of the County falls within the SFHA. Table 4.33 below summarizes acreage of the County's total area by flood zone on the effective DFIRM. Figure 4.13 shows the depth of flooding predicted from a 1% annual chance flood.

Table 4.33 – Flood Zone Acreage in Wake County

Flood Zone	Acreage	Percent of Total (%)
Zone A	415.97	0.08
Zone AE	49,341.95	9.00
Zone X (500-year)	3,548.68	0.65
Zone X Unshaded	495,237.24	90.28
Total	**548,543.84**	--

Source: FEMA Effective DFIRM; Wake County GIS

Figure 4.13 – Flood Depth, 100-Year Floodplain



Source: FEMA Effective DFIRM

The NFIP utilizes the 100-year flood as a basis for floodplain management. The Flood Insurance Study (FIS) defines the probability of flooding as flood events of a magnitude which are expected to be equaled or exceeded once on the average during any 100-year period (recurrence intervals). Or considered another way, properties within a 100-year flood zone have a one percent probability of being equaled or exceeded during any given year. Mortgage lenders require that owners of properties with federally-backed mortgages located within SFHAs purchase and maintain flood insurance policies on their properties. Consequently, newer and recently purchased properties in the community are typically insured against flooding.

Impact: 3 – Critical

Spatial Extent: 2 – Small

Historical Occurrences

Table 4.34 details the historical occurrences of flooding identified from 2007 through 2018 by NCEI Storm Events database. It should be noted that only those historical occurrences listed in the NCEI database are shown here and that other, unrecorded or unreported events may have occurred within the planning area during this timeframe.

Table 4.34 – NCEI Records of Flooding, 2007-2018

Location	Date	Type	Deaths/ Injuries	Reported Property Damage	Reported Property Damage (PV)	Reported Crop Damage	Reported Crop Damage (PV)
Raleigh	04/27/08	Flash Flood	0/0	$0	$0	$0	$0
Raleigh	04/27/08	Flash Flood	0/0	$0	$0	$0	$0
Raleigh	08/30/08	Flash Flood	0/0	$0	$0	$0	$0
Raleigh	09/06/08	Flash Flood	0/0	$100,000	$69,731	$0	$0
Raleigh	05/05/09	Flash Flood	0/0	$0	$0	$0	$0
Raleigh	05/05/09	Flash Flood	0/0	$0	$0	$0	$0
Raleigh	06/16/09	Flash Flood	0/0	$0	$0	$0	$0
Raleigh	06/16/09	Flash Flood	0/0	$0	$0	$0	$0
Raleigh	12/02/09	Flash Flood	0/0	$0	$0	$0	$0
Raleigh	12/02/09	Flash Flood	0/0	$0	$0	$0	$0
Raleigh	12/02/09	Flash Flood	0/0	$0	$0	$0	$0
Raleigh	01/25/10	Flash Flood	0/0	$0	$0	$0	$0
Raleigh	01/25/10	Flash Flood	0/0	$0	$0	$0	$0
Raleigh	08/05/10	Flash Flood	0/0	$0	$0	$0	$0
Raleigh	08/24/10	Flash Flood	0/0	$0	$0	$0	$0
Raleigh	09/30/10	Flash Flood	0/0	$0	$0	$0	$0
Raleigh	09/30/10	Flash Flood	0/0	$0	$0	$0	$0
Raleigh	08/06/11	Flash Flood	0/0	$0	$0	$0	$0
Raleigh	08/06/11	Flash Flood	0/0	$0	$0	$0	$0
Raleigh	09/21/11	Flash Flood	0/0	$5,000	$3,871	$0	$0
Raleigh	07/30/12	Flash Flood	0/0	$0	$0	$0	$0
Raleigh	09/06/12	Flash Flood	0/0	$0	$0	$0	$0
Raleigh	09/08/12	Flash Flood	0/0	$0	$0	$0	$0
Raleigh	09/08/12	Flash Flood	0/0	$0	$0	$0	$0
Raleigh	09/18/12	Flash Flood	0/0	$0	$0	$0	$0
Raleigh	06/07/13	Flash Flood	0/0	$0	$0	$0	$0

Location	Date	Type	Deaths/ Injuries	Reported Property Damage	Reported Property Damage (PV)	Reported Crop Damage	Reported Crop Damage (PV)
Raleigh	06/07/13	Flash Flood	0/0	$0	$0	$0	$0
Raleigh	06/07/13	Flash Flood	0/0	$0	$0	$0	$0
Raleigh	07/08/13	Flash Flood	0/0	$0	$0	$0	$0
Raleigh	09/01/13	Flash Flood	0/0	$10,000	$8,279	$0	$0
Raleigh	05/15/14	Flash Flood	0/0	$0	$0	$0	$0
Raleigh	05/15/14	Flash Flood	0/0	$0	$0	$0	$0
Raleigh	05/15/14	Flash Flood	0/0	$0	$0	$0	$0
Raleigh	07/10/14	Flash Flood	0/0	$10,000	$8,528	$0	$0
Raleigh	08/12/14	Flash Flood	0/0	$0	$0	$0	$0
Raleigh	08/12/14	Flash Flood	0/0	$2,500,000	$2,138,508	$0	$0
Raleigh	06/18/15	Flash Flood	0/0	$0	$0	$0	$0
Raleigh	06/18/15	Flash Flood	0/0	$0	$0	$0	$0
Raleigh	12/30/15	Flash Flood	0/0	$0	$0	$0	$0
Raleigh	07/17/16	Flood	0/0	$0	$0	$0	$0
Raleigh	04/25/17	Flash Flood	0/0	$150,000	$140,799	$0	$0
Raleigh	04/25/17	Flash Flood	0/0	$10,000	$9,387	$0	$0
Raleigh	05/21/18	Flash Flood	0/0	$600,000	$584,315	$0	$0
Raleigh	07/06/18	Flash Flood	0/0	$10,000	$9,782	$0	$0
Raleigh	07/06/18	Flash Flood	0/0	$0	$0	$0	$0
Raleigh	07/06/18	Flash Flood	0/0	$0	$0	$0	$0
Raleigh	07/07/18	Flash Flood	0/0	$10,000	$9,782	$0	$0
Raleigh	08/19/18	Flash Flood	0/0	$0	$0	$0	$0
Raleigh	08/19/18	Flash Flood	0/0	$0	$0	$0	$0
Raleigh	08/19/18	Flash Flood	0/0	$0	$0	$0	$0
Raleigh	08/20/18	Flash Flood	0/0	$80,000	$78,582	$0	$0
Raleigh	08/20/18	Flash Flood	0/0	$0	$0	$0	$0
Raleigh	08/20/18	Flash Flood	0/0	$0	$0	$0	$0
Raleigh	08/20/18	Flash Flood	0/0	$0	$0	$0	$0
Apex	07/27/10	Flash Flood	0/0	$0	$0	$0	$0
Apex	07/27/10	Flash Flood	0/0	$0	$0	$0	$0
Apex	05/15/14	Flash Flood	0/0	$0	$0	$0	$0
Apex	04/25/17	Flash Flood	0/0	$2,000	$1,877	$0	$0
Cary	07/17/07	Flash Flood	0/0	$0	$0	$0	$0
Cary	05/05/09	Flash Flood	0/0	$0	$0	$0	$0
Cary	05/05/09	Flood	0/0	$0	$0	$0	$0
Cary	06/01/10	Flash Flood	0/0	$0	$0	$0	$0
Cary	07/24/11	Flash Flood	0/0	$0	$0	$0	$0
Cary	08/06/11	Flash Flood	0/0	$0	$0	$0	$0
Cary	07/15/14	Flash Flood	0/0	$2,500	$2,133	$0	$0
Cary	08/12/14	Flash Flood	0/0	$10,000	$8,554	$0	$0
Cary	06/18/15	Flash Flood	0/0	$5,000	$4,404	$0	$0
Cary	07/16/16	Flash Flood	0/0	$250,000	$228,531	$0	$0
Cary	06/16/17	Flash Flood	0/0	$0	$0	$0	$0
Fuquay-Varina	08/28/08	Flash Flood	0/0	$0	$0	$0	$0
Fuquay-Varina	07/07/18	Flash Flood	0/0	$0	$0	$0	$0

Location	Date	Type	Deaths/ Injuries	Reported Property Damage	Reported Property Damage (PV)	Reported Crop Damage	Reported Crop Damage (PV)
Fuquay-Varina	09/14/18	Flash Flood	0/0	$0	$0	$0	$0
Holly Springs	09/22/09	Flash Flood	0/0	$0	$0	$0	$0
Holly Springs	05/27/11	Flash Flood	0/0	$0	$0	$0	$0
Holly Springs	06/07/13	Flash Flood	0/0	$0	$0	$0	$0
Holly Springs	04/09/15	Flash Flood	0/0	$20,000	$17,501	$0	$0
Morrisville	08/30/08	Flash Flood	0/0	$0	$0	$0	$0
Morrisville	07/21/14	Flash Flood	0/0	$0	$0	$0	$0
Morrisville	07/21/14	Flash Flood	0/0	$0	$0	$0	$0
Morrisville	07/05/18	Flash Flood	0/0	$0	$0	$0	$0
Wake Forest	12/02/09	Flash Flood	0/0	$0	$0	$0	$0
Wake Forest	06/07/13	Flash Flood	0/0	$0	$0	$0	$0
Wake Forest	09/01/17	Flash Flood	0/0	$0	$0	$0	$0
Zebulon	06/18/15	Flash Flood	0/0	$20,000	$17,616	$0	$0
Zebulon	10/11/18	Flash Flood	0/0	$50,000	$49,351	$0	$0
Unincorporated Wake County	09/30/10	Flash Flood	0/0	$0	$0	$0	$0
Unincorporated Wake County	08/12/14	Flash Flood	0/0	$0	$0	$0	$0
Unincorporated Wake County	04/09/15	Flash Flood	0/0	$5,000	$4,375	$0	$0
Unincorporated Wake County	10/08/16	Flash Flood	0/0	$65,500,000	$60,350,833	$0	$0
Unincorporated Wake County	10/09/16	Flood	4/0	$24,700,000	$22,758,253	$20,000,000	$18,427,735
Unincorporated Wake County	04/25/17	Flash Flood	0/0	$2,000	$1,877	$0	$0
Unincorporated Wake County	09/17/18	Flood	0/0	$1,310	$1,290	$30,000	$29,549
Unincorporated Wake County	09/17/18	Flood	0/0	$5,000,000	$4,924,887	$20,000,000	$19,699,547
Total		**93 Events**	**4/0**	**$99,052,810**	**$91,433,045**	**$40,030,000**	**$38,156,832**

Source: NCEI

According to NCEI, 93 recorded flood events affected the planning area from 2007 to 2018 causing an estimated $99,052,810 in property damage, $40,030,000 in crop damage, and 4 deaths.

Table 4.35 provides a summary of this historical information by participating jurisdiction. It is important to note that many of the events attributed to the county are countywide or cover large portions of the county. The individual counts by jurisdiction are for those events that are only attributed to that one jurisdiction.

Table 4.35 – Summary of Historical Flood Occurrences by Participating Jurisdiction, 2007-2018

Jurisdiction	Event Count	Deaths	Injuries	Property Damage	Property Damage (PV)	Crop Damage	Crop Damage (PV)
Raleigh	54	0	0	$3,485,000	$2,400,211	$0	$0
Apex	4	0	0	$2,000	$1,488	$0	$0

Jurisdiction	Event Count	Deaths	Injuries	Property Damage	Property Damage (PV)	Crop Damage	Crop Damage (PV)
Cary	11	0	0	$267,500	$179,356	$0	$0
Fuquay-Varina	3	0	0	$0	$0	$0	$0
Holly Springs	4	0	0	$20,000	$14,459	$0	$0
Morrisville	4	0	0	$0	$0	$0	$0
Wake Forest	3	0	0	$0	$0	$0	$0
Zebulon	2	0	0	$70,000	$61,655	$0	$0
Unincorporated Wake County	8	4	0	$95,208,310	$71,289,655	$40,030,000	$29,973,486
Total	**93**	**4**	**0**	**$99,052,810**	**$73,946,825**	**$40,030,000**	**$29,973,486**

Source: NCEI

The following historical flood elevations are reported in the 2017 Revised FIS for Wake County and illustrate the potential for flooding throughout the county:

July 4, 2001 – Middle Creek and Swift Creek overflowed their banks, causing extensive flooding in Holly Springs, Fuquay-Varina, and Garner. A mobile home park near Ten-Ten Road and Highway 401 was evacuated. Many roads and a few bridges were washed out, causing some people to abandon their cars.

April 27, 2008 – Over three inches of rain fell between 6:45 p.m. and 11:00 p.m. with nearly 2.5 inches falling in the first hour alone. The heavy rainfall caused Marsh Creek to overflow, flooding south bound lanes of Capital Boulevard near the intersection of Brentwood Road. The softball field and walking trail in Brentwood Park also experienced flooding, with 4 to 5 feet of flowing water through the park.

September 6, 2008 – During the early morning house Tropical Storm Hanna made landfall near Myrtle beach, SC and tracked north into central North Carolina along Interstate 95. Four to seven inches of rain which fell over the eastern piedmont resulted in flash flooding over large areas including the Triangle. Up to seven inches of rain caused flash flooding in many locations across Raleigh particularly along Crabtree Creek and other flood prone areas. A motorist was rescued from a vehicle after driving into a flooded underpass at Hillsborough Drive and Chapel Hill Drive in west Raleigh. Sullivan Drive between Dan Allen and Varsity Drive was closed due to flooding along with Avent Ferry Road at Trailwood Drive. Number creeks across the region flooded low lying areas as well as some vehicles.

Probability of Future Occurrence

By definition of the 100-year flood event, SFHAs are defined as those areas that will be inundated by the flood event having a 1-percent chance of being equaled or exceeded in any given year. Properties located in these areas have a 26 percent chance of flooding over the life of a 30-year mortgage.

The 500-year flood area is defined as those areas that will be inundated by the flood event having a 0.2-percent chance of being equaled or exceeded in any given year; it is not the flood that will occur once every 500 years.

While exposure to flood hazards vary across jurisdictions, all jurisdictions have at least some area of land in FEMA flood hazard areas, therefore the likelihood of flooding is considered possible (between 10% and 50% annual probability) for all jurisdictions.

Additional flood risk comes from localized stormwater flooding and flash floods. Historical records indicate that an average of 7.75 flood or flash flood events occur each year in the planning area.

Probability: 3 – Likely

Climate Change

Per the Fourth National Climate Assessment, frequency and intensity of heavy precipitation events is expected to increase across the country. Additionally, increases in precipitation totals are expected in the Southeast. Therefore, with more rainfall falling in more intense incidents, the region may experience more frequent flash flooding. Increased flooding may also result from more intense tropical cyclone; researchers have noted the occurrence of more intense storms bringing greater rainfall totals, a trend that is expected to continue as ocean and air temperatures rise.

Vulnerability Assessment

The following section provides an assessment of vulnerability to flooding by jurisdiction and flood return period.

Methodologies and Assumptions

Population and property at risk to flooding was estimated using data from the North Carolina Emergency Management (NCEM) IRISK database, which was compiled in NCEM's Risk Management Tool.

As a subset of the building vulnerability analysis, exposure of pre-FIRM structures was also estimated. Table 4.36 below provides the NFIP entry date for each participating jurisdiction, which was used to determine which buildings were constructed pre-FIRM. Pre-FIRM structures were built prior to the adoption of flood protection building standards and are therefore assumed to be at greater risk to the flood hazard.

Table 4.36 – NFIP Entry Dates

Jurisdiction	NFIP Entry Date
City of Raleigh	08/15/78
Town of Apex	03/03/92
Town of Cary	07/17/78
Town of Fuquay-Varina	11/01/78
Town of Garner	07/03/78
Town of Holly Springs	03/03/92
Town of Knightdale	08/01/78
Town of Morrisville	11/01/78
Town of Rolesville	03/03/92
Town of Wake Forest	07/03/78
Town of Wendell	06/01/78
Town of Zebulon	07/03/78
Unincorporated Wake County	11/15/78

Source: Federal Emergency Management Agency Community Status Book Report: Communities Participating in the National Flood Program, August 2013

If the NFIP entry date for a given community is between January and June, buildings constructed the same year as the entry date are considered to be post-FIRM (e.g., if the NFIP entry date is 02/01/1991, buildings constructed in 1990 and before are pre-FIRM. Buildings constructed from 1991 to the present are post-FIRM.). If the NFIP entry date is between July and December, then the following year applies for the year built cut-off (e.g., if the NFIP entry date is 12/18/2007, buildings constructed in the year 2007 and before are pre-FIRM, 2008 and newer are post-FIRM).

Effective FEMA DFIRM data was used for the flood hazard areas. Flood zones used in the analysis consist of Zone AE (1-percent-annual-chance flood), Zone AE Floodway, and the 0.2-percent-annual-chance flood hazard area.

People

Certain health hazards are common to flood events. While such problems are often not reported, three general types of health hazards accompany floods. The first comes from the water itself. Floodwaters carry anything that was on the ground that the upstream runoff picked up, including dirt, oil, animal waste, and lawn, farm and industrial chemicals. Pastures and areas where farm animals are kept or where their wastes are stored can contribute polluted waters to the receiving streams.

Debris also poses a risk both during and after a flood. During a flood, debris carried by floodwaters can cause physical injury from impact. During the recovery process, people may often need to clear debris out of their properties but may encounter dangers such as sharp materials or rusty nails that pose a risk of tetanus. People must be aware of these dangers prior to a flood so that they understand the risks and take necessary precautions before, during, and after a flood.

Floodwaters also saturate the ground, which leads to infiltration into sanitary sewer lines. When wastewater treatment plants are flooded, there is nowhere for the sewage to flow. Infiltration and lack of treatment can lead to overloaded sewer lines that can back up into low-lying areas and homes. Even when it is diluted by flood waters, raw sewage can be a breeding ground for bacteria such as e.coli and other disease causing agents.

The second type of health problem arises after most of the water has gone. Stagnant pools can become breeding grounds for mosquitoes, and wet areas of a building that have not been properly cleaned breed mold and mildew. A building that is not thoroughly cleaned becomes a health hazard, especially for small children and the elderly.

Another health hazard occurs when heating ducts in a forced air system are not properly cleaned after inundation. When the furnace or air conditioner is turned on, the sediments left in the ducts are circulated throughout the building and breathed in by the occupants. If the City water system loses pressure, a boil order may be issued to protect people and animals from contaminated water.

The third problem is the long-term psychological impact of having been through a flood and seeing one's home damaged and personal belongings destroyed. The cost and labor needed to repair a flood-damaged home puts a severe strain on people, especially the unprepared and uninsured. There is also a long-term problem for those who know that their homes can be flooded again. The resulting stress on floodplain residents takes its toll in the form of aggravated physical and mental health problems.

Floods can also result in fatalities. Individuals face particularly high risk when driving through flooded streets. According to NCEI records, there have been 4 deaths in Wake County caused by flood events.

Table 4.37 details the population at risk from the 1% annual chance flood event, according to data from the NCEM IRISK database. Note that development and population growth have occurred since the original analysis for the IRISK dataset was performed, therefore actual population at risk is likely higher.

Table 4.37 – Population Impacted by the 100 Year Flood Event

Jurisdiction	Total Population	Total Population at Risk		All Elderly Population	Elderly Population at Risk		All Children Population	Children at Risk	
		Number	Percent		Number	Percent		Number	Percent
Raleigh	419,053	1,624	0.4%	35,611	138	0.4%	30,469	118	0.4%
Apex	41,724	33	0.1%	3,546	3	0.1%	3,034	2	0.1%
Cary	136,260	624	0.5%	11,579	54	0.5%	9,907	45	0.5%
Fuquay-Varina	25,023	37	0.1%	2,126	3	0.1%	1,819	3	0.2%
Garner	30,981	148	0.5%	2,633	13	0.5%	2,253	11	0.5%
Holly Springs	25,790	9	0%	2,192	1	0%	1,875	1	0.1%
Knightdale	18,501	14	0.1%	1,572	1	0.1%	1,345	1	0.1%
Morrisville	18,655	23	0.1%	1,585	2	0.1%	1,356	2	0.1%
Rolesville	5,199	0	0%	442	0	0%	378	0	0%
Wake Forest	30,382	19	0.1%	2,582	2	0.1%	2,209	1	0%
Wendell	7,889	26	0.3%	670	2	0.3%	574	2	0.3%
Zebulon	6,102	30	0.5%	519	3	0.6%	444	2	0.5%
Unincorporated Wake County	135,124	140	0.1%	11,483	12	0.1%	9,825	10	0.1%
Total	**900,683**	**2,727**	**0.30%**	**76,540**	**234**	**0.31%**	**65,488**	**198**	**0.30%**

Source: NCEM Risk Management Tool

Property

Residential, commercial, and public buildings, as well as critical infrastructure such as transportation, water, energy, and communication systems may be damaged or destroyed by flood waters.

Table 4.38 details the property at risk from the 1% annual chance flood event, according to data from the NCEM IRISK database. As with population vulnerability data, actual property at risk is likely higher due to the amount of development that has occurred since the original analysis for the IRISK dataset was performed.

The damage estimates for the 1% annual chance flood event total $186,783,632, which equates to a loss ratio of less than 1 percent. The loss ratio is the damage estimate divided by the total potential exposure (i.e., total value of all buildings in the planning area), displayed as a percentage of value at risk. FEMA considers loss ratios greater than 10% to be significant and an indicator a community may have more difficulties recovering from an event.

Table 4.39 provides building counts and estimated damages for Critical Infrastructure and Key Resources (CIKR) buildings across all jurisdictions, by sector and flood event. Vulnerability of CIKR as well as High Potential Loss Properties, where applicable, can be found by jurisdiction in each community's annex to this plan.

Table 4.38 – Buildings Impacted by the 100-Year Flood Event

Jurisdiction	All Buildings	Number of Pre-FIRM Buildings at Risk		Residential Buildings at Risk			Commercial Buildings at Risk			Public Buildings at Risk			Total Buildings at Risk		
	Num	Num	% of Total	Num	% of Total	Estimated Damages	Num	% of Total	Estimated Damages	Num	% of Total	Estimated Damages	Num	% of Total	Estimated Damages
Raleigh	128,076	424	0.3%	458	0.4%	$21,967,204	169	0.1%	$160,840,826	7	0%	$356,363	634	0.5%	$183,164,393
Apex	14,554	3	0%	11	0.1%	$71,079	0	0%	$0	0	0%	$0	11	0.1%	$71,079
Cary	45,306	65	0.1%	195	0.4%	$927,583	10	0%	$1,064,743	0	0%	$0	205	0.5%	$1,992,327
Fuquay-Varina	10,244	8	0.1%	14	0.1%	$142,468	0	0%	$0	0	0%	$0	14	0.1%	$142,468
Garner	11,975	43	0.4%	53	0.4%	$258,970	1	0%	$1,279	0	0%	$0	54	0.5%	$260,249
Holly Springs	9,178	1	0%	3	0%	$9,209	0	0%	$0	0	0%	$0	3	0%	$9,209
Knightdale	7,144	0	0%	5	0.1%	$5,075	0	0%	$0	0	0%	$0	5	0.1%	$5,075
Morrisville	5,181	3	0.1%	6	0.1%	$223,964	1	0%	$199	0	0%	$0	7	0.1%	$224,162
Rolesville	2,103	0	0%	0	0%	$0	0	0%	$0	0	0%	$0	0	0%	$0
Wake Forest	10,547	1	0%	6	0.1%	$10,184	1	0%	$25,973	0	0%	$0	7	0.1%	$36,158
Wendell	3,728	7	0.2%	11	0.3%	$34,384	0	0%	$0	0	0%	$0	11	0.3%	$34,384
Zebulon	3,074	4	0.1%	13	0.4%	$65,703	0	0%	$0	0	0%	$0	13	0.4%	$65,703
Unincorporated Wake County	59,372	32	0.1%	58	0.1%	$192,357	21	0%	$500,068	2	0%	$86,000	81	0.1%	$778,425
Total	**310,482**	**591**	**0.2%**	**833**	**0.3%**	**$23,908,180**	**203**	**0.1%**	**$162,433,088**	**9**	**0%**	**$442,363**	**1,045**	**0.3%**	**$186,783,632**

Source: NCEM Risk Management Tool

Table 4.39 – Critical Infrastructure and Key Resources Buildings at Risk to Flood Events by Sector

Sector	Event	Number of Buildings at Risk	Estimated Damages
Banking and Finance	100 Year	4	$1,433,067
	Floodway	1	$48,447
Commercial Facilities	100 Year	184	$157,262,261
	Floodway	46	$7,942,338
Critical Manufacturing	100 Year	10	$1,514,411
	Floodway	4	$255,532
Government Facilities	100 Year	7	$345,852
	Floodway	1	$64,062
Healthcare and Public Health	100 Year	1	$74,308
Transportation Systems	100 Year	6	$2,245,553
	Floodway	1	$60,845
All Categories	**100 Year**	**212**	**$162,875,452**
	Floodway	**53**	**$8,371,224**

Source: NCEM Risk Management Tool

To supplement the IRISK assessment of property at risk from the 1% annual chance flood event and provide a clearer picture of the current property at risk in Wake County, current parcel data was evaluated to identify parcels developed since 2010. Using GIS analysis, parcels developed after 2010 were compared to the boundaries of the 1% annual chance floodplain to identify the exposure of newly developed property to the base flood. In most cases, a parcel was considered exposed to the floodplain if any portion of the parcel was located in the floodplain. However, for parcels where updated building footprints were available, the parcel was considered exposed only if the building intersected the floodplain boundary.

This assessment does not evaluate flood impacts or provide damage estimates. However, this summary of development in or near the floodplain since 2010 provides some context to understand the degree to which the IRISK exposure and vulnerability numbers differ from current conditions. This information is presented by individual jurisdiction in each jurisdiction's respective annex of this plan.

Table 4.40 provides a summary by land class of parcel development located in the 1% annual chance floodplain from January 2011 to April 2019.

Table 4.40 – Parcels Developed 2011 or Later and Located in 100-Year Floodplain

Land Class	Number of Parcels	Sum of Building Value
Acres Greater Than 10 With House	21	$9,443,180
Apartment	14	$309,325,723
Commercial	30	$437,590,714
EXEMPT	20	$192,726,683
Forestry	1	$777,207
Golf Course	1	$76,222
Industrial	13	$63,502,639
Part Exempt	1	$541,282
Residential Less Than 10 Acres	434	$145,027,953
Retirement Home	2	$16,116,150
Grand Total	**537**	**$1,175,128,053**

Source: Wake County Open Data; retrieved April 8, 2019; FEMA Effective DFIRM

Repetitive Loss Analysis

A repetitive loss property is a property for which two or more flood insurance claims of more than $1,000 have been paid by the NFIP within any 10-year period since 1978. An analysis of repetitive loss was completed to examine repetitive losses within the region.

According to August 2018 NFIP records, there are a total of 118 repetitive loss properties within Wake County, of which 49 are insured and 69 are uninsured. At the time of their first claim, 35 of these properties were non-residential and 83 were residential. There are 27 properties on the list classified as severe repetitive loss properties. A severe repetitive loss property is classified as such if it has four or more separate claim payments of more than $5,000 each (including building and contents payments) or two or more separate claim payments (building only) where the total of the payments exceeds the current value of the property.

Table 4.41 summarizes repetitive loss properties by jurisdiction as identified by FEMA through the NFIP.

Table 4.41 – Repetitive Loss Properties by Jurisdiction

Jurisdiction	Total Number of Properties	Total Number of Losses	Total Amount of Claims Payments
Raleigh	109	352	$14,342,725
Apex	0	0	$0
Cary	0	0	$0
Fuquay-Varina	0	0	$0
Garner	4	9	$82,019
Holly Springs	0	0	$0
Knightdale	0	0	$0
Morrisville	0	0	$0
Rolesville	0	0	$0
Wake Forest	0	0	$0
Wendell	0	0	$0
Zebulon	0	0	$0
Unincorporated Wake County	5	17	$283,104
Total	**118**	**378**	**$14,707,848**

Source: FEMA/ISO

Environment

During a flood event, chemicals and other hazardous substances may end up contaminating local water bodies. Flooding kills animals and in general disrupts the ecosystem. Snakes and insects may also make their way to the flooded areas.

Floods can also cause significant erosion, which can alter streambanks and deposit sediment, changing the flow of streams and rivers and potentially reducing the drainage capacity of those waterbodies.

Consequence Analysis

Table 4.42 summarizes the potential detrimental consequences of flood.

Table 4.42 – Consequence Analysis - Flood

Category	Consequences
Public	Localized impact expected to be severe for incident areas and moderate to light for other adversely affected areas.
Responders	First responders are at risk when attempting to rescue people from their homes. They are subject to the same health hazards as the public. Flood waters may prevent access to areas in need of response or the flood may prevent access to the critical facilities themselves which may prolong response time. Damage to personnel will generally be localized to those in the flood areas at the time of the incident and is expected to be limited.
Continuity of Operations (including Continued Delivery of Services)	Floods can severely disrupt normal operations, especially when there is a loss of power. Damage to facilities in the affected area may require temporary relocation of some operations. Localized disruption of roads, facilities, and/or utilities caused by incident may postpone delivery of some services.
Property, Facilities and Infrastructure	Buildings and infrastructure, including transportation and utility infrastructure, may be damaged or destroyed. Impacts are expected to be localized to the area of the incident. Severe damage is possible.
Environment	Chemicals and other hazardous substances may contaminate local water bodies. Wildlife and livestock deaths possible. The localized impact is expected to be severe for incident areas and moderate to light for other areas affected by the flood or HazMat spills.
Economic Condition of the Jurisdiction	Local economy and finances will be adversely affected, possibly for an extended period of time. During floods (especially flash floods), roads, bridges, farms, houses and automobiles are destroyed. Additionally, the local government must deploy firemen, police and other emergency response personnel and equipment to help the affected area. It may take years for the affected communities to be re-built and business to return to normal.
Public Confidence in the Jurisdiction's Governance	Ability to respond and recover may be questioned and challenged if planning, response, and recovery are not timely and effective.

Hazard Summary by Jurisdiction

The following table summarizes flood hazard risk by jurisdiction. To account for increased risk of flood due to stormwater and flash flooding, communities with between 2 and 12 flash flood events in the period from 2007-2018 were assigned a probability rating of 3, and communities with over 12 flash flood events during this period were assigned a probability rating of 4. Communities with 10% or more of their land area in the SFHA were assigned a spatial extent of 3. All other factors do not vary by jurisdiction.

Jurisdiction	Probability	Impact	Spatial Extent	Warning Time	Duration	Score	Priority
Wake County	3	3	3	3	3	3.0	H
Apex	3	3	2	3	3	2.8	H
Cary	3	3	2	3	3	2.8	H
Fuquay-Varina	3	3	2	3	3	2.8	H
Garner	2	3	2	3	3	2.5	H
Holly Springs	3	3	2	3	3	2.8	H
Knightdale	2	3	2	3	3	2.5	H
Morrisville	3	3	2	3	3	2.8	H
Raleigh	4	3	2	3	3	3.1	H
Rolesville	2	3	2	3	3	2.5	H
Wake Forest	3	3	2	3	3	2.8	H
Wendell	2	3	2	3	3	2.5	H
Zebulon	3	3	2	3	3	2.8	H

4.5.6 Landslide

Hazard Background

A landslide is the downhill movement of masses of soil and rock, driven by gravity. Landslides occur when susceptible rock, earth, or debris moves down a slope under the force of gravity and water. They can be triggered by natural changes, such as heavy rains, snow melt, fires, and earthquakes; and human-caused changes, such as slope or drainage modifications. Landslides may be very small or very large and can move at slow to very high speeds.

There are several types of landslides: rock falls, rock topple, slides, and flows. Rock falls are rapid movements of bedrock, which result in bouncing or rolling. A topple is a section or block of rock that rotates or tilts before falling to the slope below. Slides are movements of soil or rock along a distinct surface of rupture, which separates the slide material from the more stable underlying material. Mudflows, sometimes referred to as mudslides, mudflows, lahars or debris avalanches, are fast-moving rivers of rock, earth, and other debris saturated with water. They develop when water rapidly accumulates in the ground, such as heavy rainfall or rapid snowmelt, changing the soil into a flowing river of mud or "slurry." Slurry can flow rapidly down slopes or through channels and can strike with little or no warning at avalanche speeds. Slurry can travel several miles from its source, growing in size as it picks up trees, cars, and other materials along the way. As the flows reach flatter ground, the mudflow spreads over a broad area where it can accumulate in thick deposits.

Landslides are typically associated with periods of heavy rainfall or rapid snow melt and tend to worsen the effects of flooding that often accompanies these events. In areas burned by forest and brush fires, a lower threshold of precipitation may initiate landslides. Some landslides move slowly and cause damage gradually, whereas others move so rapidly that they can destroy property and take lives suddenly and unexpectedly.

Areas that are generally prone to landslide hazards include previous landslide areas, the bases of steep slopes, the bases of drainage channels, and developed hillsides where leach-field septic systems are used. Areas that are typically considered safe from landslides include areas that have not moved in the past, relatively flat-lying areas away from sudden changes in slope, and areas at the top or along ridges set back from the tops of slopes.

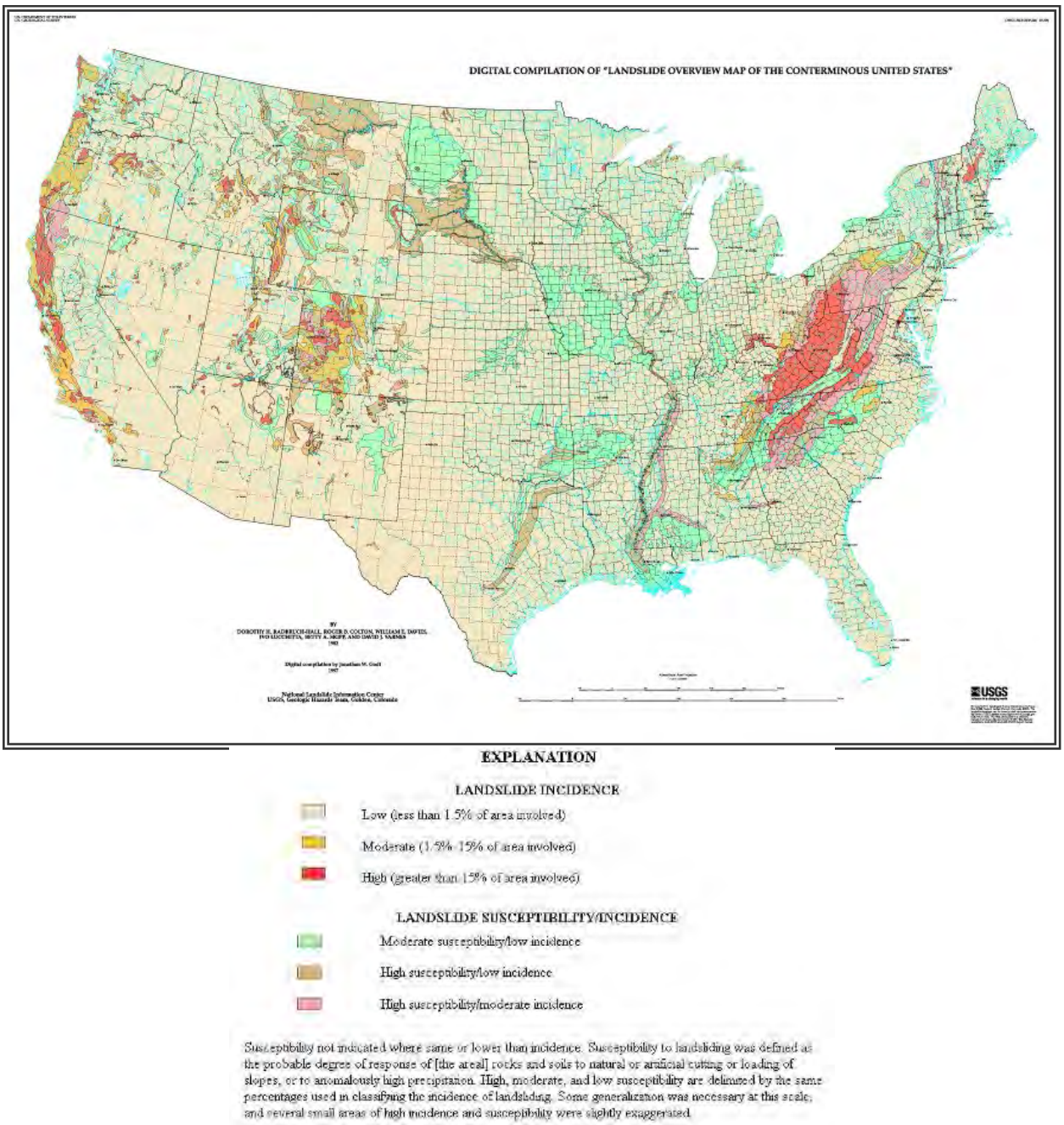
Warning Time: 3 – 6 to 12 hours

Duration: 1 – Less than 6 hours

Location

The U.S. Geological Survey (USGS) has produced landslide susceptibility and incidence mapping of the U.S., as shown in Figure 4.14. The USGS determines susceptibility based on the probable degree of response to cutting or loading of slopes or to anomalously high precipitation. Incidence is measured by the rate of past occurrences. According to the USGS definition and mapping, most of Wake County faces low susceptibility and incidence of landslide. However, areas along the western border of county, including portions of Apex, Cary, and Morrisville, face moderate susceptibility to and incidence of landslide.

Figure 4.14 – Landslide Incidence and Susceptibility



Source: USGS

Extent

Landslide extent can be defined by susceptibility and incidence, which are defined and depicted in Figure 4.14. Event magnitude is also dependent on topography; landslide risk is higher in areas with steeper slopes. Given the gentle topography of most of the county, the magnitude of any landslides in the planning area would be minor.

The event that occurred in Holly Springs in 2003 defines the potential extent of damages that may occur because of landslide in Wake County. This event caused damages to multiple nearby homes but did not result in any deaths or injuries.

Impact: 1 – Minor

Spatial Extent: 1 – Negligible

Historical Occurrences

According to the North Carolina Department of Environmental Quality (NC DEQ), two recent landslides have occurred in Wake County and caused significant property damage. These event narratives from NC DEQ are reported below:

- *Interstate I-540, Wake County (summer 2000)* — While landslides are more frequent in the mountainous part of North Carolina, landslides also occur in other parts of the state. One landslide example occurred in the summer of 2000 along Interstate I-540 in Raleigh in Wake County.
- *Holly Springs, Wake County (summer 2003)* — Piedmont earth movements have affected homes as well. In May 2003 a soil embankment failure in Holly Springs, Wake County, North Carolina, affected a number of homes.

Figure 4.15 shows the location of all past landslide occurrences recorded by NC DEQ since 1995. Past landslide events have all occurred on the western side of the county, which is consistence with the susceptibility and incidence mapping produced by USGS. There have been two events in Raleigh, one in Cary, five in Apex, one in Holly Springs, and two in the unincorporated county.

The following event details were recorded in the NC Geological Survey's movement history records:

Cary, 1995 – Movement occurred in winter and spring of 1995 in Cary that appears to be threatening an apartment complex.

Southeast Durham, 1996 – A slide caused road damage, blocked a drainage ditch, and damaged a cut slope. I-540 and US-70 were affected.

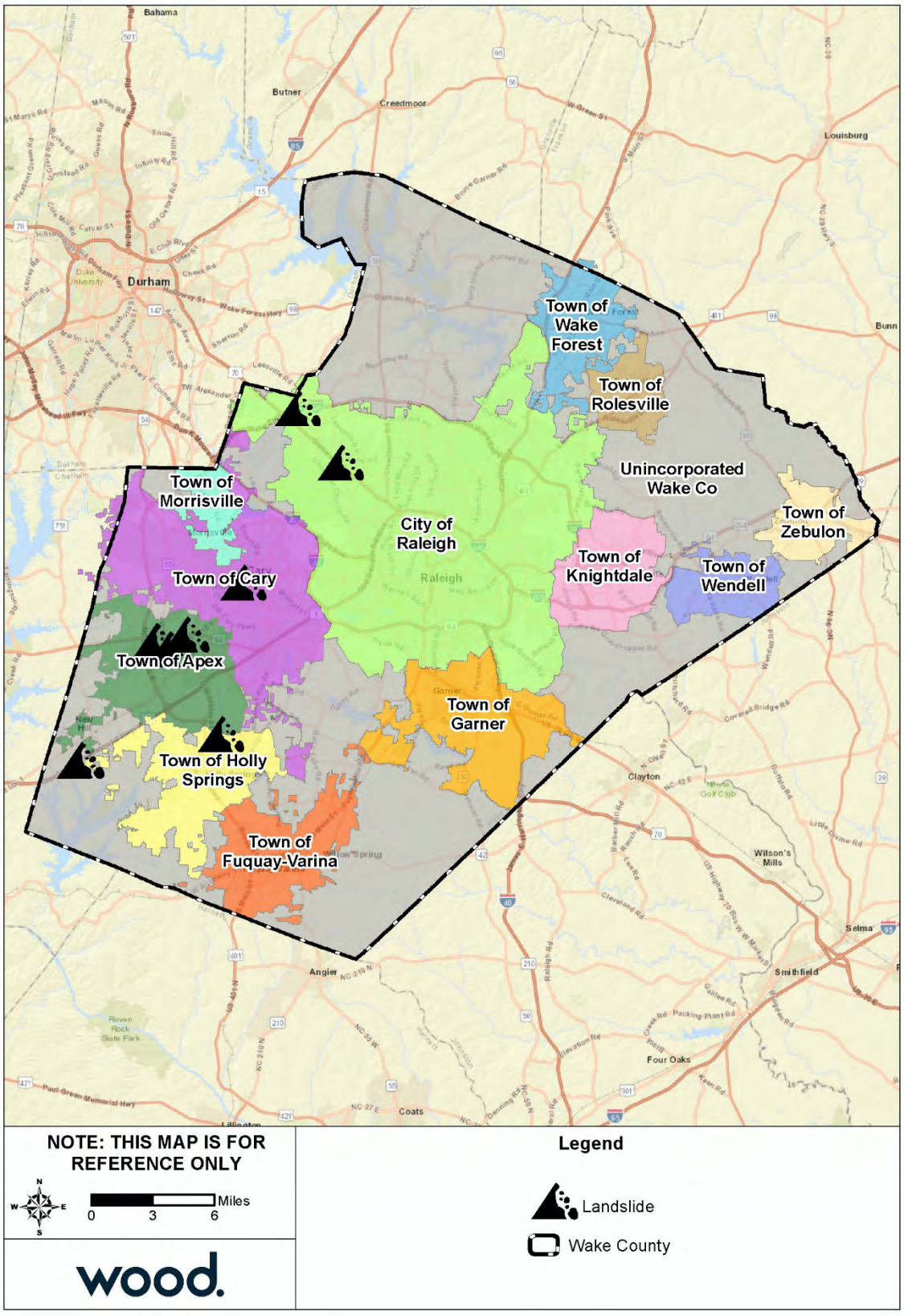
Apex, April 1998 – Evidence of failure seen on September 30, 1999. Failure was possibly associated with Hurricane Floyd.

West Raleigh, 1999 – Movement began in the winter of 1999 and caused road damage. Sediment covered Lynn Road. The slope was since stabilized with a gabion wall.

Holly Springs, 2003 – Damage caused to three homes in a subdivision. Scarp noted at the homes foundation.

Apex, 2006 – Movement occurred during Tropical Storm Alberto, however slow movement was noted by a neighbor approximately 4-6 weeks prior to failure. The damage threatened a retaining wall and a sewer line.

Figure 4.15 – Landslide Locations



Source: NC Geological Survey

Probability of Future Occurrence

From 1995 through 2018 there have been 11 landslide events in the planning area, which equates to an annual probability of 45.8 percent. This probability applies to Wake County and jurisdictions in western Wake County, but reflects only the probability of a minor event. Jurisdictions in eastern Wake County that do not have any historical occurrences or susceptibility are unlikely to experience any landslide events in the future. Across all areas of the county, the probability of a severe landslide event is unlikely.

Probability: 1 – Unlikely

Climate Change

Per the Fourth National Climate Assessment, frequency and intensity of heavy precipitation events is expected to increase across the country. Additionally, increases in precipitation totals are expected in the Southeast. Increased flooding may also result from more intense tropical cyclone; researchers have noted the occurrence of more intense storms bringing greater rainfall totals, a trend that is expected to continue as ocean and air temperatures rise. More rainfall falling in more intense incidents could contribute to an increase in landslide events.

Vulnerability Assessment

Methodologies and Assumptions

This assessment of vulnerability to landslide in Wake County was based solely on records of past events. Data on susceptibility is limited for the planning area and only available in an area-wide aggregate.

People

People are unlikely to sustain serious physical harm as a result of landslides in Wake County. Impacts would be relatively minor and highly localized. An individual using an impacted structure or infrastructure at the time of a landslide event may sustain minor injuries.

Property

Landslides are infrequent in Wake County and occur in small, highly localized instances relative to the general area of risk. Additionally, these events are generally small scale in terms of the magnitude of impacts. As a result, it is difficult to estimate the property at risk to landslide. On average, a landslide event in the planning area may cause minor to moderate property damage to one or more buildings or cause localized damage to infrastructure. A landslide event may also result in the need for debris removal.

Environment

Because landslides are essentially a mass movement of sediment, they may result in changes to terrain, damage to trees in the slide area, changes to drainage patterns, and increases in sediment loads in nearby waterways. Landslides in Wake County are unlikely to cause any more severe impacts.

Consequence Analysis

Table 4.43 summarizes the potential negative consequences of landslide.

Table 4.43 – Consequence Analysis - Landslide

Category	Consequences
Public	Any impacts to the public are expected to be minor. Individuals may sustain injuries if they are in an affected structure or using affected infrastructure when the event occurs.
Responders	Impacts to responders are unlikely. Personnel responsible for debris cleanup or roadway closures may face increased risk.

Category	Consequences
Continuity of Operations (including Continued Delivery of Services)	Landslide is unlikely to affect continuity of operations in Wake County.
Property, Facilities and Infrastructure	Buildings and infrastructure may incur minor damages as a result of landslide; however, vulnerability in Wake County is low.
Environment	Environmental impacts are expected to be minimal. Landslide may cause terrain and drainage changes and may temporarily increase sediment loads in nearby waterways.
Economic Condition of the Jurisdiction	Economic impacts are not expected.
Public Confidence in the Jurisdiction's Governance	Any landslide occurring in Wake County is unlikely to be severe and would not be expected to affect public confidence.

Hazard Summary by Jurisdiction

The following table summarizes landslide hazard risk by jurisdiction. Probability was determined to be slightly higher for jurisdictions in western Wake County where USGS mapping indicates there is moderate susceptibility and incidence. It should be noted that this probability rating reflects a low-consequence event and that the probability of a significant landslide is unlikely across the entire county. All other factors do not vary across jurisdictions.

Jurisdiction	Probability	Impact	Spatial Extent	Warning Time	Duration	Score	Priority
Wake County	2	1	1	3	1	1.5	L
Apex	2	1	1	3	1	1.5	L
Cary	2	1	1	3	1	1.5	L
Fuquay-Varina	1	1	1	3	1	1.2	L
Garner	1	1	1	3	1	1.2	L
Holly Springs	2	1	1	3	1	1.5	L
Knightdale	1	1	1	3	1	1.2	L
Morrisville	2	1	1	3	1	1.5	L
Raleigh	2	1	1	3	1	1.5	L
Rolesville	1	1	1	3	1	1.2	L
Wake Forest	1	1	1	3	1	1.2	L
Wendell	1	1	1	3	1	1.2	L
Zebulon	1	1	1	3	1	1.2	L

4.5.7 Hurricane and Tropical Storm

Hazard Background

Hurricanes and tropical storms are classified as cyclones and defined as any closed circulation developing around a low-pressure center in which the winds rotate counter-clockwise in the Northern Hemisphere (or clockwise in the Southern Hemisphere) and whose diameter averages 10 to 30 miles across. A tropical cyclone refers to any such circulation that develops over tropical waters. Tropical cyclones act as a "safety-valve," limiting the continued build-up of heat and energy in tropical regions by maintaining the atmospheric heat and moisture balance between the tropics and the pole-ward latitudes. The primary damaging forces associated with these storms are high-level sustained winds, heavy precipitation, and tornadoes.

The key energy source for a tropical cyclone is the release of latent heat from the condensation of warm water. Their formation requires a low-pressure disturbance, warm sea surface temperature, rotational force from the spinning of the earth, and the absence of wind shear in the lowest 50,000 feet of the atmosphere. The majority of hurricanes and tropical storms form in the Atlantic Ocean, Caribbean Sea, and Gulf of Mexico during the official Atlantic hurricane season, which encompasses the months of June through November. The peak of the Atlantic hurricane season is in early to mid-September and the average number of storms that reach hurricane intensity per year in the Atlantic basin is about six.

As an incipient hurricane develops, barometric pressure (measured in millibars or inches) at its center falls and winds increase. If the atmospheric and oceanic conditions are favorable, it can intensify into a tropical depression. When maximum sustained winds reach or exceed 39 miles per hour, the system is designated a tropical storm, given a name, and is closely monitored by the National Hurricane Center in Miami, Florida. When sustained winds reach or exceed 74 miles per hour the storm is deemed a hurricane.

Warning Time: 1 – More than 24 hours

Duration: 2 – Less than 24 hours

Location

Hurricanes and tropical storms can occur anywhere within the Wake County planning area. While coastal areas are most vulnerable to hurricanes, their wind and rain impacts can be felt hundreds of miles inland.

Extent

Hurricane intensity is classified by the Saffir-Simpson Scale (Table 4.44), which rates hurricane intensity on a scale of 1 to 5, with 5 being the most intense.

Table 4.44 – Saffir-Simpson Scale

Category	Maximum Sustained Wind Speed (MPH)	Types of Damage
1	74–95	Very dangerous winds will produce some damage; Well-constructed frame homes could have damage to roof, shingles, vinyl siding and gutters. Large branches of trees will snap and shallowly rooted trees may be toppled. Extensive damage to power lines and poles likely will result in power outages that could last a few to several days.
2	96–110	Extremely dangerous winds will cause extensive damage; Well-constructed frame homes could sustain major roof and siding damage. Many shallowly rooted trees will be snapped or uprooted and block numerous roads. Near-total power loss is expected with outages that could last from several days to weeks.
3	111–129	Devastating damage will occur; Well-built framed homes may incur major damage or removal of roof decking and gable ends. Many trees will be snapped or uprooted, blocking numerous roads. Electricity and water will be unavailable for several days to weeks after the storm passes.
4	130–156	Catastrophic damage will occur; Well-built framed homes can sustain severe damage with loss of most of the roof structure and/or some exterior walls. Most trees will be snapped or uprooted and power poles downed. Fallen trees and power poles will isolate residential areas. Power outages will last weeks to possibly months. Most of the area will be uninhabitable for weeks or months.
5	157 +	Catastrophic damage will occur; A high percentage of framed homes will be destroyed, with total roof failure and wall collapse. Fallen trees and power poles will isolate residential areas. Power outages will last for weeks to possibly months. Most of the area will be uninhabitable for weeks or months.

Source: National Hurricane Center

The Saffir-Simpson Scale categorizes hurricane intensity linearly based upon maximum sustained winds and barometric pressure, which are combined to estimate potential damage. Categories 3, 4, and 5 are classified as "major" hurricanes and, while hurricanes within this range comprise only 20 percent of total tropical cyclone landfalls, they account for over 70 percent of the damage in the United States. Table 4.45 describes the damage that could be expected for each category of hurricane. Damage during hurricanes may also result from spawned tornadoes, storm surge, and inland flooding associated with heavy rainfall that usually accompanies these storms.

Table 4.45 – Hurricane Damage Classifications

Storm Category	Damage Level	Description of Damages	Photo Example
1	MINIMAL	No real damage to building structures. Damage primarily to unanchored mobile homes, shrubbery, and trees. Also, some coastal flooding and minor pier damage.	
2	MODERATE	Some roofing material, door, and window damage. Considerable damage to vegetation, mobile homes, etc. Flooding damages piers and small craft in unprotected moorings may break their moorings.	
3	EXTENSIVE	Some structural damage to small residences and utility buildings, with a minor amount of curtainwall failures. Mobile homes are destroyed. Flooding near the coast destroys smaller structures, with larger structures damaged by floating debris. Terrain may be flooded well inland.	
4	EXTREME	More extensive curtainwall failures with some complete roof structure failure on small residences. Major erosion of beach areas. Terrain may be flooded well inland.	
5	CATASTROPHIC	Complete roof failure on many residences and industrial buildings. Some complete building failures with small utility buildings blown over or away. Flooding causes major damage to lower floors of all structures near the shoreline. Massive evacuation of residential areas may be required.	

Source: National Hurricane Center; Federal Emergency Management Agency

Hurricane Fran is illustrative of the potential impact of hurricanes on the Wake County planning area. In Wake County alone, Fran caused oved $900 million in residential and commercial property damage and at least one death. Additional losses included infrastructure damages and power outages.

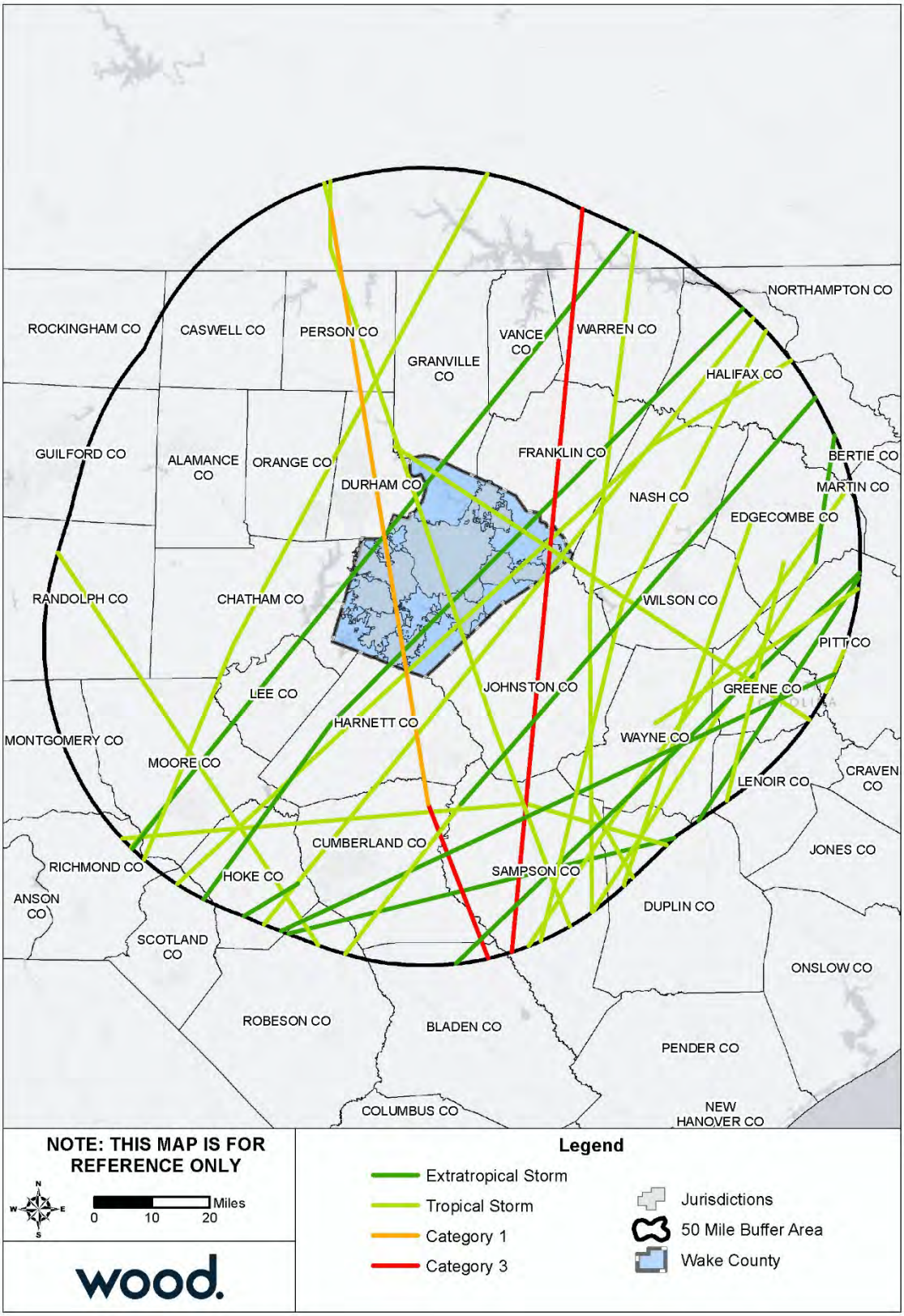
Impact: 3 – Critical

Spatial Extent: 4 – Large

Historical Occurrences

According to the Office of Coastal Management's Tropical Cyclone Storm Segments data, which is a subset of the International Best Track Archive for Climate Stewardship (IBTrACS) dataset, 28 hurricanes and tropical storms have passed within 50 miles of Wake County since 1900. These storms tracks are shown in Figure 4.16. The date, storm name, storm category, and maximum wind speed of each event are detailed in Table 4.46.

Figure 4.16 – Hurricane Tracks within 50 miles of Wake County since 1900



Source: NOAA Office of Coastal Management

Table 4.46 – Hurricane and Tropical Storm Tracks Passing within 50 Miles of Wake County, 1900-2016

Date	Storm Name	Max Storm Category*	Max Wind Speed (mph)
9/6/1916	Unnamed	Tropical Storm	52
9/23/1920	Unnamed	Tropical Storm	40
9/30/1924	Unnamed	Extratropical Storm	69
9/19/1928	Unnamed	Tropical Storm	81
10/2/1929	Unnamed	Extratropical Storm	58
9/6/1935	Unnamed	Tropical Storm	58
8/2/1944	Unnamed	Tropical Storm	69
10/20/1944	Unnamed	Extratropical Storm	58
9/18/1945	Unnamed	Tropical Storm	58
10/15/1954	Hazel	Category 4	132
8/17/1955	Diane	Tropical Storm	69
7/10/1959	Cindy	Tropical Storm	40
9/14/1961	Unnamed	Tropical Storm	40
6/16/1965	Unnamed	Extratropical Storm	40
10/1/1971	Ginger	Tropical Storm	52
9/6/1996	Fran	Category 3	115
9/4/1998	Earl	Extratropical Storm	58
9/5/1999	Dennis	Tropical Storm	58
9/23/2000	Helene	Tropical Storm	40
6/14/2006	Alberto	Extratropical Storm	40
9/1/2006	Ernesto	Tropical Storm	58
9/6/2008	Hanna	Tropical Storm	69
6/7/2013	Andrea	Tropical Storm	46

*Reports the most intense category that occurred within 50 miles of Wake County, not for the storm event overall.
Source: Office of Coastal Management, 2019. https://marinecadastre.gov/data/

The above list of storms is not an exhaustive list of hurricanes that have affected Wake County. Several storms, including Hurricane Floyd and Tropical Storm Hermine passed further than 50 miles away from Wake County yet had strong enough wind or rain impacts to affect the county. Storms with hurricane and tropical storm force winds that impacted Wake County from 1996 through 2017 are noted in Table 4.47, as identified by NCEI.

Table 4.47 – Recorded Winds in Wake County, 1996-2017

Date	Type	Storm	Fatalities	Injuries	Property Damage	Crop Damage
7/12/1996	Hurricane (Typhoon)	Hurricane Bertha	0	0	$0	$0
9/5/1996	Hurricane (Typhoon)	Hurricane Fran	3	0	$0	$0
8/27/1998	Hurricane (Typhoon)	Hurricane Bonnie	0	0	$0	$0
9/4/1999	Hurricane (Typhoon)	Hurricane Dennis	0	0	$0	$0
9/15/1999	Hurricane (Typhoon)	Hurricane Floyd	0	0	$0	$0
9/18/2003	Hurricane (Typhoon)	Hurricane Isabel	0	0	$890,000	$0
9/1/2006	Tropical Storm	Tropical Storm Ernesto	0	0	$0	$0
9/2/2016	Tropical Storm	Tropical Storm Hermine	0	0	$20,000	$0
		Total	**3**	**0**	**$910,000**	**$0**

Source: NCEI

Hurricane Fran (1996) – In the RAH county warning area along, the damage exceeded 2 billion dollars. Damage to crops, livestock, farm equipment/buildings was over 400 million. The agricultural damage was the greatest in Sampson, Johnston, and Wayne counties. Several hundred thousand trees were uprooted or broken. Tens of thousands of homes were damaged by falling trees. In the path of the storm's center, almost every neighborhood was affected. The copious rainfall produced many severe flash and river floods. Along the Crabtree Creek in Raleigh, which crested at its highest since 1973, hundreds of new cars from local dealerships floated in 6 feet of water. Scores of businesses reported heavy damage at the area's largest shopping center.

Hurricane Dennis (1999) – The remnants of Dennis finally moved inland across the central portion of the state. Its main impact was to end the drought in the eastern half of the state. The Triangle received from 6 to 8 inches of rain with Chapel Hill peaking out at 12 inches. The I-40 corridor of counties also got dumped on with totals in the 6- to 10-inch range. This water caused considerable urban and lowland flooding. Several main stem rivers also went into flood. The winds with the remnants of Dennis were generally not a significant problem. There were many old, larger trees uprooted and widespread limb damage was reported. However, the wind and rain combination caused considerable crop damage.

Hurricane Floyd (1999) – Hurricane Floyd produced more human misery and environmental impact in North Carolina than any disaster in memory. The 15-20 inches of rain that fell across the eastern half of the state caused every river and stream to flood. Many rivers set new flood records. Whole communities were underwater for days, even weeks in some areas. Thousands of homes were lost. Crop damage was extensive. The infrastructure of the eastern counties, mainly roads, bridges, water plants, etc., was heavily damaged. By the end of 1999, $1.5 billion had already been spent, with estimates that the cost would reach $3-4 billion. The counties within the Raleigh county warning area probably sustained more than half of the state total. Even worse, was the loss of life, mainly due to flooding. Many Carolinians did not heed the call to evacuate and many more drove into flooded streams and rivers. In the central part of the state, 21 people lost their lives. Also, the loss of livestock was significant, mainly swine and poultry.

Tropical Storm Ernesto (2006) – Tropical Storm Ernesto produced high winds county wide. There were numerous reports form emergency officials of downed trees and large tree limbs.

Tropical Storm Hermine (2016) – Tropical Storm Hermine produced heavy rain across portions of central North Carolina. However, due to dry antecedent conditions, no flooding occurred despite rainfall amounts of up to 3 to 5 inches across southeastern portions of central North Carolina. Given the rain and gusty winds associated with Hermine there were numerous reports of trees down and wind damage and resultant power outages. A large tree fell through the roof of a house near New Hill.

Probability of Future Occurrence

Probability: 3 – Likely

In the 22-year period from 1996 through 2017, 8 hurricanes and tropical storms have impacted the Wake County area, which equates to a 36 percent annual probability of hurricane winds impacting the county. This probability does not account for impacts from hurricane rains, which may also be severe. An additional 5 storms passed within 50 miles of Wake County during this period; these storms did not have significant wind impacts but may have brought heavy rains. Overall, the probability of a hurricane or tropical storm impacting Wake County is likely.

Climate Change

One of the primary factors contributing to the origin and growth of tropical storm and hurricanes systems is water temperature. Per the Fourth National Climate Assessment, “There is growing evidence that the tropics have expanded poleward by about 70 to 200 miles in each hemisphere since satellite

measurements began in 1979, with an accompanying shift of the subtropical dry zones, midlatitude jets, and both midlatitude and tropical cyclone tracks." It is unclear as of yet whether these changes can be attributed to climate change, but current climate science suggests cyclones would become more frequent and intense as water temperatures warm. In addition to occurring with greater frequency, intense hurricanes are also expected to produce greater amounts of rainfall. The 2017 hurricane season is considered an indicator of these potential changes.

Vulnerability Assessment

Methodologies and Assumptions

Property at risk to hurricanes was estimated using data from the North Carolina Emergency Management (NCEM) IRISK database, which was compiled in NCEM's Risk Management Tool. The vulnerability data displayed below is for wind-related damages. Hurricanes may also cause substantial damages from heavy rains and subsequent flooding, which is addressed in Section 4.5.5 Flood.

People

The very young, the elderly and the handicapped are especially vulnerable to harm from hurricanes. For those who are unable to evacuate for medical reasons, there should be provision to take care of special-needs patients and those in hospitals and nursing homes. Many of these patients are either oxygen-dependent, insulin-dependent, or in need of intensive medical care. There is a need to provide ongoing treatment for these vulnerable citizens, either on the coast or by air evacuation to upland hospitals. The stress from disasters such as a hurricane can result in immediate and long-term physical and emotional health problems among victims.

Property

Hurricanes can cause catastrophic damage to coastlines and several hundred miles inland. Hurricanes can produce winds exceeding 157 mph as well as tornadoes and microbursts. Additionally, hurricanes often bring intense rainfall that can result in flash flooding. Floods and flying debris from the excessive winds are often the deadly and most destructive results of hurricanes.

Hurricanes and tropical storms can also cause agricultural damages. For Wake County, USDA RMA reports losses of $736,364 from 2007-2017 due to cyclones, which equates to an average annual loss of $66,942. Table 4.48 summarizes the crop losses due to drought in reported in the RMA system.

Table 4.48 – Crop Losses Resulting from Severe Weather, 2007-2017

Year	Determined Acres	Indemnity Amount
2010	55.11	$42,928.00
2011	419.90	$262,951.00
2016	398.59	$430,484.80
Total	**873.60**	**$736,363.80**

Source: USDA Risk Management Agency

The damage estimates for the 100-year hurricane wind event total $398,511,328, which equates to a loss ratio of less than 1 percent. These damage estimates account for only wind impacts and actual damages would likely be higher due to flooding. Therefore, the Region would likely experience a higher overall loss ratio from the 100-year hurricane event and face difficulty recovering from such an event.

Table 4.49 through Table 4.53 detail the estimated building damages from varying magnitudes of hurricane events.

Table 4.49 – Estimated Buildings Impacted by 25-Year Hurricane Wind Event

Jurisdiction	All Buildings	Residential Buildings at Risk			Commercial Buildings at Risk			Public Buildings at Risk			Total Buildings at Risk		
	Num	Num	% of Total	Estimated Damages	Num	% of Total	Estimated Damages	Num	% of Total	Estimated Damages	Num	% of Total	Estimated Damages
Raleigh	128,076	119,050	93%	$13,488,953	6,345	5%	$2,566,523	2,272	1.8%	$1,960,364	127,667	99.7%	$18,015,840
Apex	14,554	13,717	94.2%	$1,370,251	648	4.5%	$96,898	148	1%	$30,743	14,513	99.7%	$1,497,891
Cary	45,306	42,705	94.3%	$5,413,382	1,872	4.1%	$843,439	462	1%	$185,816	45,039	99.4%	$6,442,637
Fuquay-Varina	10,244	9,363	91.4%	$759,309	585	5.7%	$95,115	130	1.3%	$34,730	10,078	98.4%	$889,153
Garner	11,975	11,012	92%	$679,897	687	5.7%	$105,640	181	1.5%	$30,352	11,880	99.2%	$815,890
Holly Springs	9,178	8,683	94.6%	$585,883	226	2.5%	$62,277	62	0.7%	$23,514	8,971	97.7%	$671,674
Knightdale	7,144	6,674	93.4%	$463,148	265	3.7%	$37,022	67	0.9%	$30,882	7,006	98.1%	$531,052
Morrisville	5,181	4,779	92.2%	$514,220	340	6.6%	$307,695	48	0.9%	$15,502	5,167	99.7%	$837,417
Rolesville	2,103	1,968	93.6%	$230,741	91	4.3%	$8,544	29	1.4%	$5,028	2,088	99.3%	$244,312
Wake Forest	10,547	9,772	92.7%	$911,444	541	5.1%	$133,986	151	1.4%	$44,521	10,464	99.2%	$1,089,951
Wendell	3,728	3,270	87.7%	$183,760	277	7.4%	$24,193	73	2%	$12,908	3,620	97.1%	$220,861
Zebulon	3,074	2,675	87%	$162,367	316	10.3%	$55,095	79	2.6%	$13,139	3,070	99.9%	$230,601
Unincorporated Wake County	59,372	55,162	92.9%	$5,066,679	3,122	5.3%	$536,300	402	0.7%	$98,562	58,686	98.8%	$5,701,541
Total	**310,482**	**288,830**	**93%**	**$29,830,034**	**15,315**	**4.9%**	**$4,872,727**	**4,104**	**1.3%**	**$2,486,061**	**308,249**	**99.3%**	**$37,188,820**

Source: NCEM Risk Management Tool

Table 4.50 – Estimated Buildings Impacted by 50-Year Hurricane Wind Event

Jurisdiction	All Buildings	Residential Buildings at Risk			Commercial Buildings at Risk			Public Buildings at Risk			Total Buildings at Risk		
	Num	Num	% of Total	Estimated Damages	Num	% of Total	Estimated Damages	Num	% of Total	Estimated Damages	Num	% of Total	Estimated Damages
Raleigh	128,076	119,439	93.3%	$49,910,371	6,345	5%	$9,753,440	2,272	1.8%	$8,826,046	128,056	100%	$68,489,856
Apex	14,554	13,758	94.5%	$5,146,914	648	4.5%	$344,580	148	1%	$123,314	14,554	100%	$5,614,808
Cary	45,306	42,944	94.8%	$20,437,014	1,872	4.1%	$3,555,396	462	1%	$751,377	45,278	99.9%	$24,743,787
Fuquay-Varina	10,244	9,524	93%	$3,022,976	585	5.7%	$386,422	130	1.3%	$135,271	10,239	100%	$3,544,669
Garner	11,975	11,103	92.7%	$2,916,521	687	5.7%	$388,516	181	1.5%	$110,169	11,971	100%	$3,415,206
Holly Springs	9,178	8,887	96.8%	$2,685,332	226	2.5%	$252,814	62	0.7%	$66,210	9,175	100%	$3,004,356
Knightdale	7,144	6,811	95.3%	$1,751,201	265	3.7%	$140,602	67	0.9%	$117,162	7,143	100%	$2,008,965
Morrisville	5,181	4,793	92.5%	$2,103,855	340	6.6%	$1,022,575	48	0.9%	$61,450	5,181	100%	$3,187,880
Rolesville	2,103	1,983	94.3%	$813,404	91	4.3%	$31,923	29	1.4%	$12,881	2,103	100%	$858,207
Wake Forest	10,547	9,852	93.4%	$3,977,196	541	5.1%	$549,214	151	1.4%	$160,595	10,544	100%	$4,687,005
Wendell	3,728	3,378	90.6%	$756,442	277	7.4%	$76,005	73	2%	$47,616	3,728	100%	$880,063
Zebulon	3,074	2,677	87.1%	$635,555	316	10.3%	$212,876	79	2.6%	$46,950	3,072	99.9%	$895,382
Unincorporated Wake County	59,372	55,779	93.9%	$20,496,296	3,122	5.3%	$2,522,217	402	0.7%	$360,569	59,303	99.9%	$23,379,082
Total	**310,482**	**290,928**	**93.7%**	**$114,653,077**	**15,315**	**4.9%**	**$19,236,580**	**4,104**	**1.3%**	**$10,819,610**	**310,347**	**100%**	**$144,709,266**

Source: NCEM Risk Management Tool

Table 4.51 – Estimated Buildings Impacted by 100-Year Hurricane Wind Event

Jurisdiction	All Buildings	Residential Buildings at Risk			Commercial Buildings at Risk			Public Buildings at Risk			Total Buildings at Risk		
	Num	Num	% of Total	Estimated Damages	Num	% of Total	Estimated Damages	Num	% of Total	Estimated Damages	Num	% of Total	Estimated Damages
Raleigh	128,076	119,439	93.3%	$128,715,805	6,345	5%	$33,214,120	2,272	1.8%	$30,447,640	128,056	100%	$192,377,565
Apex	14,554	13,758	94.5%	$13,173,617	648	4.5%	$1,193,921	148	1%	$480,982	14,554	100%	$14,848,520
Cary	45,306	42,944	94.8%	$51,345,150	1,872	4.1%	$12,594,032	462	1%	$2,727,029	45,278	99.9%	$66,666,211
Fuquay-Varina	10,244	9,524	93%	$7,596,640	585	5.7%	$1,479,181	130	1.3%	$499,228	10,239	100%	$9,575,049
Garner	11,975	11,103	92.7%	$7,781,221	687	5.7%	$1,425,997	181	1.5%	$412,885	11,971	100%	$9,620,103
Holly Springs	9,178	8,887	96.8%	$7,024,984	226	2.5%	$957,182	62	0.7%	$216,917	9,175	100%	$8,199,083
Knightdale	7,144	6,811	95.3%	$4,524,674	265	3.7%	$516,869	67	0.9%	$417,503	7,143	100%	$5,459,045
Morrisville	5,181	4,793	92.5%	$5,766,554	340	6.6%	$2,981,303	48	0.9%	$228,286	5,181	100%	$8,976,143
Rolesville	2,103	1,983	94.3%	$1,980,105	91	4.3%	$102,001	29	1.4%	$35,562	2,103	100%	$2,117,667
Wake Forest	10,547	9,852	93.4%	$10,566,637	541	5.1%	$1,802,458	151	1.4%	$530,608	10,544	100%	$12,899,702
Wendell	3,728	3,378	90.6%	$2,000,680	277	7.4%	$257,441	73	2%	$175,742	3,728	100%	$2,433,862
Zebulon	3,074	2,677	87.1%	$1,603,959	316	10.3%	$836,776	79	2.6%	$195,890	3,072	99.9%	$2,636,625
Unincorporated Wake County	59,372	55,779	93.9%	$52,237,409	3,122	5.3%	$9,197,403	402	0.7%	$1,266,942	59,303	99.9%	$62,701,753
Total	**310,482**	**290,928**	**93.7%**	**$294,317,435**	**15,315**	**4.9%**	**$66,558,684**	**4,104**	**1.3%**	**$37,635,214**	**310,347**	**100%**	**$398,511,328**

Source: NCEM Risk Management Tool

Table 4.52 – Estimated Buildings Impacted by 300-Year Hurricane Wind Event

Jurisdiction	All Buildings	Residential Buildings at Risk			Commercial Buildings at Risk			Public Buildings at Risk			Total Buildings at Risk		
	Num	Num	% of Total	Estimated Damages	Num	% of Total	Estimated Damages	Num	% of Total	Estimated Damages	Num	% of Total	Estimated Damages
Raleigh	128,076	119,439	93.3%	$525,488,756	6,345	5%	$151,196,161	2,272	1.8%	$136,567,702	128,056	100%	$813,252,620
Apex	14,554	13,758	94.5%	$40,034,120	648	4.5%	$4,033,293	148	1%	$1,621,622	14,554	100%	$45,689,036
Cary	45,306	42,944	94.8%	$196,048,226	1,872	4.1%	$36,098,632	462	1%	$10,263,618	45,278	99.9%	$242,410,477
Fuquay-Varina	10,244	9,524	93%	$60,085,421	585	5.7%	$15,693,569	130	1.3%	$5,402,472	10,239	100%	$81,181,462
Garner	11,975	11,103	92.7%	$53,264,329	687	5.7%	$12,113,648	181	1.5%	$4,034,805	11,971	100%	$69,412,782
Holly Springs	9,178	8,887	96.8%	$63,367,358	226	2.5%	$7,258,465	62	0.7%	$2,270,227	9,175	100%	$72,896,050
Knightdale	7,144	6,811	95.3%	$33,099,261	265	3.7%	$4,220,584	67	0.9%	$3,013,398	7,143	100%	$40,333,242
Morrisville	5,181	4,793	92.5%	$15,973,924	340	6.6%	$8,206,253	48	0.9%	$694,380	5,181	100%	$24,874,557
Rolesville	2,103	1,983	94.3%	$4,909,682	91	4.3%	$263,350	29	1.4%	$96,399	2,103	100%	$5,269,432
Wake Forest	10,547	9,852	93.4%	$25,792,988	541	5.1%	$4,674,382	151	1.4%	$1,555,115	10,544	100%	$32,022,485
Wendell	3,728	3,378	90.6%	$12,979,785	277	7.4%	$2,415,799	73	2%	$1,545,144	3,728	100%	$16,940,728
Zebulon	3,074	2,677	87.1%	$10,285,587	316	10.3%	$9,266,489	79	2.6%	$3,452,372	3,072	99.9%	$23,004,448
Unincorporated Wake County	59,372	55,779	93.9%	$259,574,432	3,122	5.3%	$28,290,555	402	0.7%	$10,439,543	59,303	99.9%	$298,304,530
Total	**310,482**	**290,928**	**93.7%**	**$1,300,903,869**	**15,315**	**4.9%**	**$283,731,180**	**4,104**	**1.3%**	**$180,956,797**	**310,347**	**100%**	**$1,765,591,849**

Source: NCEM Risk Management Tool

Table 4.53 – Estimated Buildings Impacted by 700-Year Hurricane Wind Event

Jurisdiction	All Buildings	Residential Buildings at Risk			Commercial Buildings at Risk			Public Buildings at Risk			Total Buildings at Risk		
	Num	Num	% of Total	Estimated Damages	Num	% of Total	Estimated Damages	Num	% of Total	Estimated Damages	Num	% of Total	Estimated Damages
Raleigh	128,076	119,439	93.3%	$1,263,887,853	6,345	5%	$302,507,103	2,272	1.8%	$184,538,126	128,056	100%	$1,750,933,082
Apex	14,554	13,758	94.5%	$131,328,593	648	4.5%	$9,412,786	148	1%	$4,606,351	14,554	100%	$145,347,729
Cary	45,306	42,944	94.8%	$529,858,025	1,872	4.1%	$81,374,716	462	1%	$24,422,300	45,278	99.9%	$635,655,041
Fuquay-Varina	10,244	9,524	93%	$169,833,216	585	5.7%	$43,225,463	130	1.3%	$15,085,781	10,239	100%	$228,144,460
Garner	11,975	11,103	92.7%	$152,591,639	687	5.7%	$30,688,285	181	1.5%	$11,073,419	11,971	100%	$194,353,344
Holly Springs	9,178	8,887	96.8%	$193,255,397	226	2.5%	$16,949,835	62	0.7%	$6,633,352	9,175	100%	$216,838,584
Knightdale	7,144	6,811	95.3%	$91,684,078	265	3.7%	$10,852,401	67	0.9%	$7,084,666	7,143	100%	$109,621,144
Morrisville	5,181	4,793	92.5%	$51,258,144	340	6.6%	$24,297,787	48	0.9%	$1,996,181	5,181	100%	$77,552,112
Rolesville	2,103	1,983	94.3%	$14,021,628	91	4.3%	$659,838	29	1.4%	$267,483	2,103	100%	$14,948,949
Wake Forest	10,547	9,852	93.4%	$76,829,477	541	5.1%	$12,352,008	151	1.4%	$4,748,661	10,544	100%	$93,930,146
Wendell	3,728	3,378	90.6%	$35,555,601	277	7.4%	$6,593,918	73	2%	$3,964,687	3,728	100%	$46,114,207
Zebulon	3,074	2,677	87.1%	$27,885,173	316	10.3%	$25,517,971	79	2.6%	$10,420,744	3,072	99.9%	$63,823,888
Unincorporated Wake County	59,372	55,779	93.9%	$704,602,902	3,122	5.3%	$64,696,088	402	0.7%	$26,367,559	59,303	99.9%	$795,666,549
Total	**310,482**	**290,928**	**93.7%**	**$3,442,591,726**	**15,315**	**4.9%**	**$629,128,199**	**4,104**	**1.3%**	**$301,209,310**	**310,347**	**100%**	**$4,372,929,235**

Source: NCEM Risk Management Tool

Environment

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

Consequence Analysis

Table 4.54 summarizes the potential negative consequences of hurricanes and tropical storms.

Table 4.54 – Consequence Analysis – Hurricane and Tropical Storm

Category	Consequences
Public	Impacts include injury or death, loss of property, outbreak of diseases, mental trauma and loss of livelihoods. Power outages and flooding are likely to displace people from their homes. Water can become polluted such that if consumed, diseases and infection can be easily spread. Residential, commercial, and public buildings, as well as critical infrastructure such as transportation, water, energy, and communication systems may be damaged or destroyed, resulting in cascading impacts on the public.
Responders	Localized impact expected to limit damage to personnel in the inundation area at the time of the incident.
Continuity of Operations (including Continued Delivery of Services)	Damage to facilities/personnel from flooding or wind may require temporary relocation of some operations. Operations may be interrupted by power outages. Disruption of roads and/or utilities may postpone delivery of some services. Regulatory waivers may be needed locally. Fulfillment of some contracts may be difficult. Impact may reduce deliveries.
Property, Facilities and Infrastructure	Structural damage to buildings may occur; loss of glass windows and doors by high winds and debris; loss of roof coverings, partial wall collapses, and other damages requiring significant repairs are possible in a major (category 3 to 5) hurricane.
Environment	Hurricanes can devastate wooded ecosystems and remove all the foliation from forest canopies, and they can change habitats so drastically that the indigenous animal populations suffer as a result. Specific foods can be taken away as high winds will often strip fruits, seeds and berries from bushes and trees. Secondary impacts may occur; for example, high winds and debris may result in damage to an above-ground fuel tank, resulting in a significant chemical spill.
Economic Condition of the Jurisdiction	Local economy and finances adversely affected, possibly for an extended period of time, depending on damages. Intangible impacts also likely, including business interruption and additional living expenses.
Public Confidence in the Jurisdiction's Governance	Likely to impact public confidence due to possibility of major event requiring substantial response and long-term recovery effort.

Hazard Summary by Jurisdiction

The following table summarizes hurricane and tropical storm hazard risk by jurisdiction. Most aspects of hurricane risk do not vary substantially by jurisdiction; however, impacts may be greater in more highly developed areas with greater amounts of impervious surface and higher exposure in terms of both property and population density. Additionally, mobile home units are more vulnerable to wind damage. While mobile home units do not comprise a significant proportion of any jurisdictions housing mix, Wake

County, Apex, Cary, and Raleigh each have over 250 mobile home units in their jurisdiction and therefore may face more severe impacts from wind.

Jurisdiction	Probability	Impact	Spatial Extent	Warning Time	Duration	Score	Priority
Wake County	3	4	4	1	2	3.2	H
Apex	3	4	4	1	2	3.2	H
Cary	3	4	4	1	2	3.2	H
Fuquay-Varina	3	3	4	1	2	2.9	H
Garner	3	3	4	1	2	2.9	H
Holly Springs	3	3	4	1	2	2.9	H
Knightdale	3	3	4	1	2	2.9	H
Morrisville	3	4	4	1	2	3.2	H
Raleigh	3	4	4	1	2	3.2	H
Rolesville	3	3	4	1	2	2.9	H
Wake Forest	3	3	4	1	2	2.9	H
Wendell	3	3	4	1	2	2.9	H
Zebulon	3	3	4	1	2	2.9	H

4.5.8 Severe Weather (Thunderstorm Winds, Lightning & Hail)

Hazard Background

Thunderstorm Winds

Thunderstorms result from the rapid upward movement of warm, moist air. They can occur inside warm, moist air masses and at fronts. As the warm, moist air moves upward, it cools, condenses, and forms cumulonimbus clouds that can reach heights of greater than 35,000 ft. As the rising air reaches its dew point, water droplets and ice form and begin falling the long distance through the clouds towards earth's surface. As the droplets fall, they collide with other droplets and become larger. The falling droplets create a downdraft of air that spreads out at earth's surface and causes strong winds associated with thunderstorms.

There are four ways in which thunderstorms can organize: single cell, multi-cell cluster, multi-cell lines (squall lines), and supercells. Even though supercell thunderstorms are most frequently associated with severe weather phenomena, thunderstorms most frequently organize into clusters or lines. Warm, humid conditions are favorable for the development of thunderstorms. The average single cell thunderstorm is approximately 15 miles in diameter and lasts less than 30 minutes at a single location. However, thunderstorms, especially when organized into clusters or lines, can travel intact for distances exceeding 600 miles.

Thunderstorms are responsible for the development and formation of many severe weather phenomena, posing great hazards to the population and landscape. Damage that results from thunderstorms is mainly inflicted by downburst winds, large hailstones, and flash flooding caused by heavy precipitation. Stronger thunderstorms are capable of producing tornadoes and waterspouts. While conditions for thunderstorm conditions may be anticipated within a few hours, severe conditions are difficult to predict. Regardless of severity, storms generally pass within a few hours.

Warning Time: 4 – Less than six hours

Duration: 1 – Less than six hours

Lightning

Lightning is a sudden electrical discharge released from the atmosphere that follows a course from cloud to ground, cloud to cloud, or cloud to surrounding air, with light illuminating its path. Lightning's unpredictable nature causes it to be one of the most feared weather elements.

All thunderstorms produce lightning, which often strikes outside of the area where it is raining and is known to fall more than 10 miles away from the rainfall area. When lightning strikes, electricity shoots through the air and causes vibrations creating the sound of thunder. A bolt of lightning can reach temperatures approaching 50,000 degrees Fahrenheit. Nationwide, lightning kills 75 to 100 people each year. Lightning strikes can also start building fires and wildland fires, and damage electrical systems and equipment.

The watch/warning time for a given storm is usually a few hours. There is no warning time for any given lightning strike. Lightning strikes are instantaneous. Storms that cause lightning usually pass within a few hours.

Warning Time: 4 – minimal or no warning time (less than 6 hours warning)

Duration: 1 – less than six hours

Hail

According to the National Oceanic and Atmospheric Administration (NOAA), hail is precipitation that is formed when updrafts in thunderstorms carry raindrops upward into extremely cold areas of the atmosphere causing them to freeze. The raindrops form into small frozen droplets and then continue to grow as they come into contact with super-cooled water which will freeze on contact with the frozen rain droplet. This frozen rain droplet can continue to grow and form hail. As long as the updraft forces can support or suspend the weight of the hailstone, hail can continue to grow.

At the time when the updraft can no longer support the hailstone, it will fall down to the earth. For example, a ¼" diameter or pea sized hail requires updrafts of 24 mph, while a 2 ¾" diameter or baseball sized hail requires an updraft of 81 mph. The largest hailstone recorded in the United States was found in Vivian, South Dakota on July 23, 2010; it measured eight inches in diameter, almost the size of a soccer ball. While soccer-ball-sized hail is the exception, but even small pea sized hail can do damage.

Hailstorms in North Carolina cause damage to property, crops, and the environment, and kill and injure livestock. In the United States, hail causes more than $1 billion in damage to property and crops each year. Much of the damage inflicted by hail is to crops. Even relatively small hail can shred plants to ribbons in a matter of minutes. Vehicles, roofs of buildings and homes, and landscaping are the other things most commonly damaged by hail. Hail has been known to cause injury to humans; occasionally, these injuries can be fatal.

The onset of thunderstorms with hail is generally rapid. However, advancements in meteorological forecasting allow for some warning. Storms usually pass in a few hours.

Warning Time: 4 – Less than 6 hours

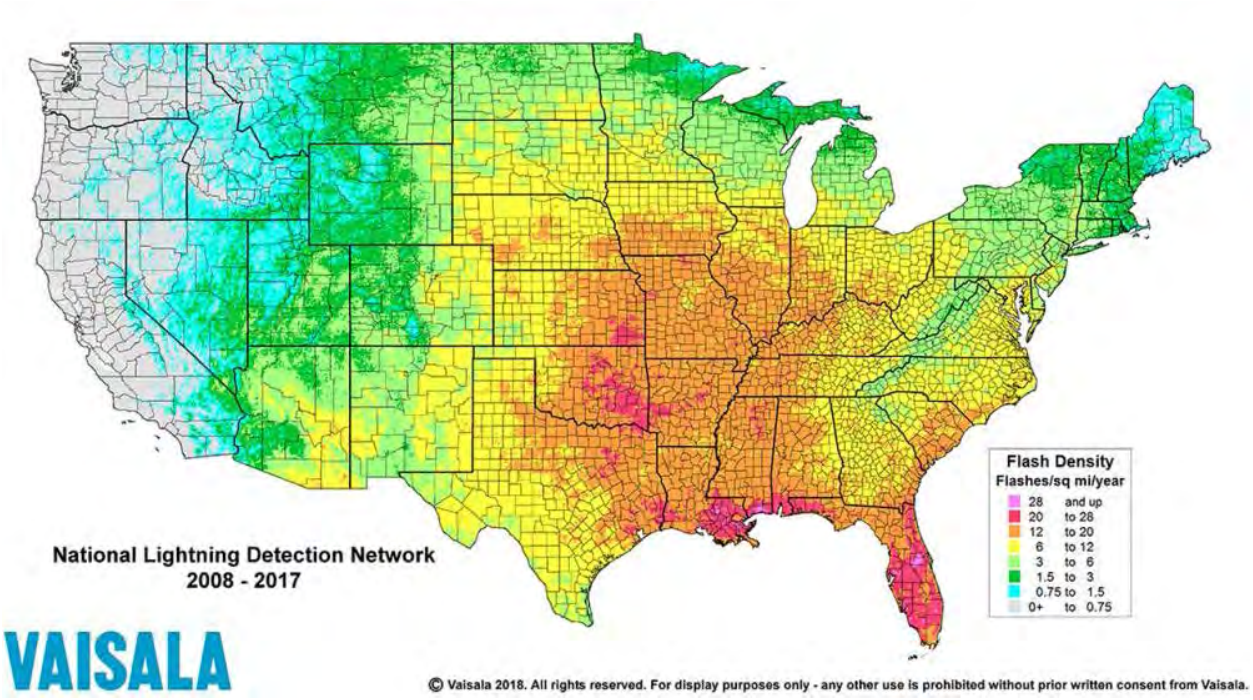
Duration: 1 – Less than 6 hours

Location

Thunderstorm wind, lightning, and hail events do not have a defined vulnerability zone. The scope of lightning and hail is generally defined to the footprint of its associated thunderstorm. The entirety of Wake County shares equal risk to the threat of severe weather.

According to the Vaisala flash density map, shown in Figure 4.17, the majority of Wake County is located in an area that experiences 6 to 12 lightning flashes per square mile per year. It should be noted that future lightning occurrences may exceed these figures.

Figure 4.17 – Lightning Flash Density (2008-2017)



Source: Vaisala

Extent

Thunderstorm Winds

The magnitude of a thunderstorm event can be defined by the storm's maximum wind speed and its impacts. NCEI divides wind events into several types including High Wind, Strong Wind, Thunderstorm Wind, Tornado and Hurricane. For this severe weather risk assessment, High Wind, Strong Wind and Thunderstorm Wind data was collected. Hurricane Wind and Tornadoes are addressed as individual hazards. The following definitions come from the NCEI Storm Data Preparation document.

- **High Wind** – Sustained non-convective winds of 40mph or greater lasting for one hour or longer or winds (sustained or gusts) of 58 mph for any duration on a widespread or localized basis.
- **Strong Wind** – Non-convective winds gusting less than 58 mph, or sustained winds less than 40 mph, resulting in a fatality, injury, or damage.
- **Thunderstorm Wind** – Winds, arising from convection (occurring within 30 minutes of lightning being observed or detected), with speeds of at least 58 mph, or winds of any speed (non-severe thunderstorm winds below 58 mph) producing a fatality, injury or damage.

The strongest recorded thunderstorm wind event in the county occurred on January 11, 2014 with a measured gust of 86 mph at Raleigh-Durham International Airport and estimated gusts of 75 mph elsewhere across the county. The event caused one fatality, four injuries, and an estimated $1.35 million in property damage.

Impact: 2 – Limited

Spatial Extent: 4 – Large

Lightning

Lightning is measured by the Lightning Activity Level (LAL) scale, created by the National Weather Service to define lightning activity into a specific categorical scale. The LAL is a common parameter that is part of fire weather forecasts nationwide.

Table 4.55 – Lightning Activity Level Scale

Lightning Activity Level Scale	
LAL 1	No thunderstorms
LAL 2	Isolated thunderstorms. Light rain will occasionally reach the ground. Lightning is very infrequent, 1 to 5 cloud to ground lightning strikes in a five minute period
LAL 3	Widely scattered thunderstorms. Light to moderate rain will reach the ground. Lightning is infrequent, 6 to 10 cloud to ground strikes in a five minute period
LAL 4	Scattered thunderstorms. Moderate rain is commonly produced. Lightning is frequent, 11 to 15 cloud to ground strikes in a five minute period
LAL 5	Numerous thunderstorms. Rainfall is moderate to heavy. Lightning is frequent and intense, greater than 15 cloud to ground strikes in a five minute period
LAL 6	Dry lightning (same as LAL 3 but without rain). This type of lightning has the potential for extreme fire activity and is normally highlighted in fire weather forecasts with a Red Flag warning

Source: National Weather Service

With the right conditions in place, the entire county is susceptible to each lightning activity level as defined by the LAL. Most lightning strikes cause limited damage to specific structures in a limited area, and cause very few injuries or fatalities, and minimal disruption on quality of life.

Impact: 1 – Minor

While the total area vulnerable to a lightning strike corresponds to the footprint of a given thunderstorm, a specific lightning strike is usually a localized event and occurs randomly. It should be noted that while lightning is most often affiliated with severe thunderstorms, it may also strike outside of heavy rain and might occur as far as 10 miles away from any rainfall. All of Wake County is uniformly exposed to the threat of lightning.

Spatial Extent: 1 – Negligible

Hail

The National Weather Service classifies hail by diameter size, and corresponding everyday objects to help relay scope and severity to the population. Table 4.56 indicates the hailstone measurements utilized by the National Weather Service.

Table 4.56 – Hailstone Measurement Comparison Chart

Average Diameter	Corresponding Household Object
.25 inch	Pea
.5 inch	Marble/Mothball
.75 inch	Dime/Penny
.875 inch	Nickel
1.0 inch	Quarter
1.5 inch	Ping-pong ball
1.75 inch	Golf ball
2.0 inch	Hen egg
2.5 inch	Tennis ball
2.75 inch	Baseball

Average Diameter	Corresponding Household Object
3.00 inch	Teacup
4.00 inch	Grapefruit
4.5 inch	Softball

Source: National Weather Service

The Tornado and Storm Research Organization (TORRO) has further described hail sizes by their typical damage impacts. Table 4.57 describes typical intensity and damage impacts of the various sizes of hail.

Table 4.57 – Tornado and Storm Research Organization Hailstorm Intensity Scale

Intensity Category	Diameter (mm)	Diameter (inches)	Size Description	Typical Damage Impacts
Hard Hail	5-9	0.2-0.4	Pea	No damage
Potentially Damaging	10-15	0.4-0.6	Mothball	Slight general damage to plants, crops
Significant	16-20	0.6-0.8	Marble, grape	Significant damage to fruit, crops, vegetation
Severe	21-30	0.8-1.2	Walnut	Severe damage to fruit and crops, damage to glass and plastic structures, paint and wood scored
Severe	31-40	1.2-1.6	Pigeon's egg > squash ball	Widespread glass damage, vehicle bodywork damage
Destructive	41-50	1.6-2.0	Golf ball > Pullet's egg	Wholesale destruction of glass, damage to tiled roofs, significant risk of injuries
Destructive	51-60	2.0-2.4	Hen's egg	Bodywork of grounded aircraft dented, brick walls pitted
Destructive	61-75	2.4-3.0	Tennis ball > cricket ball	Severe roof damage, risk of serious injuries
Destructive	76-90	3.0-3.5	Large orange > softball	Severe damage to aircraft bodywork
Super Hailstorms	91-100	3.6-3.9	Grapefruit	Extensive structural damage. Risk of severe or even fatal injuries to persons caught in the open
Super Hailstorms	>100	4.0+	Melon	Extensive structural damage. Risk of severe or even fatal injuries to persons caught in the open

Source: Tornado and Storm Research Organization (TORRO), Department of Geography, Oxford Brookes University
Notes: In addition to hail diameter, factors including number and density of hailstones, hail fall speed and surface wind speeds affect severity.

The average hailstone size recorded between 1998 and 2017 in Wake County was a little over 1" in diameter; the largest hailstone recorded was 2.75", recorded on September 1, 2017. This storm resulted in a recorded $10 million in property damage per NCEI. The largest hailstone ever recorded in the U.S. fell in Vivian, SD on June 23, 2010, with a diameter of 8 inches and a circumference of 18.62 inches.

Impact: 1 – Minor

Hailstorms frequently accompany thunderstorms, so their locations and spatial extents coincide. Wake County is uniformly exposed to severe thunderstorms; therefore, the entire planning area is equally exposed to hail which may be produced by such storms. However, large-scale hail tends to occur in a more localized area within the storm.

Spatial Extent: 2 – Small

Historical Occurrences

Thunderstorm Winds

Between January 1, 1998 and December 31, 2017, the NCEI recorded 324 separate incidents of thunderstorm winds, occurring on 172 separate days. These events caused $2,956,000 in recorded

property damage, 12 injuries and 1 fatality. The recorded gusts averaged 58.7 mph, with the highest gusts recorded at 86 mph. Gusts of 86 mph were recorded six times in the county, all during a storm on January 11, 2014. Of these events, 73 caused property damage. Wind gusts with property damage recorded averaged $40,500 in damage, with two gusts causing a reported $1,000,000 in damage each (in Wilbon on January 11, 2014 and in Morrisville on June 13, 2013). These incidents are recorded below:

Table 4.58 – Recorded Thunderstorm Winds with Property Damages in Wake County, 1998-2017

Location	Date	Time	Wind Speed (mph)	Fatalities	Injuries	Property Damage
Fuquay Spgs	4/19/1998	1835	58	0	0	$25,000
Bayleaf	8/15/2008	1512	58	0	0	$15,000
Wilders Grove	7/1/2009	2246	58	0	0	$2,000
Raleigh	7/1/2009	2246	58	0	0	$1,000
Holly Spgs	7/31/2009	1250	58	0	0	$100,000
Knightdale	6/13/2010	1640	58	0	0	$1,000
Millbrook	7/29/2010	2135	58	0	0	$1,000
Zebulon	11/17/2010	35	58	0	0	$7,000
Royal Mills	3/23/2011	1907	58	0	0	$20,000
Apex	4/5/2011	300	58	0	0	$30,000
Asbury	5/9/2012	1523	58	0	0	$2,000
Purnell	6/29/2012	2208	58	0	0	$5,000
Barham	7/1/2012	1410	58	0	0	$1,000
Millbrook	7/3/2012	1915	58	0	0	$2,000
Banks	7/3/2012	2007	58	0	0	$2,000
Raleigh	7/4/2012	1530	58	0	0	$1,000
College View	7/4/2012	1612	58	0	0	$5,000
Wilders Grove	7/5/2012	1440	58	0	0	$3,000
Macedonia	7/5/2012	1454	58	0	0	$2,000
Eagle Rock	7/5/2012	1506	58	0	0	$3,000
Apex	7/6/2012	1635	58	0	0	$2,000
Varina	7/9/2012	1351	58	0	0	$500
Holly Spgs	7/9/2012	1435	58	0	0	$3,000
Apex	7/24/2012	1433	58	0	0	$7,000
Raleigh	7/24/2012	1449	58	0	0	$10,000
Echo Hgts	7/24/2012	1449	58	0	0	$2,000
Auburn	7/24/2012	1451	58	0	0	$2,000
Method	7/24/2012	1455	58	0	0	$5,000
Bayleaf	8/8/2012	1759	58	0	0	$750
Green Level	4/19/2013	1735	58	0	0	$7,000
Morrisville	6/13/2013	1630	70	0	0	$1,000,000
Brentwood	7/24/2013	1640	58	0	0	$2,000
Macedonia	8/10/2013	1615	58	0	0	$5,000
Wilbon	1/11/2014	1352	86	0	0	$1,000,000
(Rdu)Raleigh-Durham	1/11/2014	1403	86	0	0	$350,000

Location	Date	Time	Wind Speed (mph)	Fatalities	Injuries	Property Damage
(Rdu)Raleigh-Durham	6/11/2014	1615	58	0	0	$5,000
Purnell	6/19/2014	1645	58	0	0	$500
Apex	7/15/2014	1610	58	0	0	$1,000
Apex	7/15/2014	1618	58	0	0	$500
Leesville	8/12/2014	1816	58	0	0	$2,000
Macedonia	8/18/2014	1850	58	0	0	$1,000
(Rdu)Raleigh-Durham	8/20/2014	1655	58	0	0	$25,000
Garner	8/20/2014	1757	58	0	0	$2,000
Garner	8/20/2014	1800	58	0	0	$10,000
Cary	6/17/2015	2123	58	0	0	$15,000
Pet Xrds	6/20/2015	1950	58	0	0	$20,000
Pet Xrds	6/20/2015	1950	58	0	0	$20,000
Williams Xrds	6/26/2015	1500	58	0	0	$1,000
Auburn	7/13/2015	629	58	0	0	$5,000
Mc Cullers	7/13/2015	630	58	0	0	$2,000
Morrisville	7/21/2015	1815	58	0	0	$1,000
College View	2/16/2016	604	58	0	0	$15,000
Starmount	2/24/2016	1746	58	0	0	$50,000
Fuquay Spgs	3/14/2016	1358	58	0	0	$5,000
Macedonia	4/28/2016	1638	58	0	0	$10,000
Lassiter	4/28/2016	1730	58	0	0	$1,000
Lassiter	5/2/2016	1605	58	0	0	$2,500
Caraleigh	6/4/2016	1840	58	0	0	$1,500
(Rdu)Raleigh-Durham	6/5/2016	1815	59	0	0	$2,500
Rockton	6/23/2016	0	58	0	0	$2,500
Bonsal	6/29/2016	1815	58	0	0	$2,000
Raleigh	6/29/2016	1909	58	0	0	$1,500
Knightdale	7/19/2016	2140	58	0	0	$2,500
Wilders Grove	9/30/2016	911	58	0	0	$5,000
Brookhaven	5/11/2017	2039	58	0	0	$75,000
Varina	6/16/2017	1820	58	0	0	$500
Raleigh	6/16/2017	1857	58	0	0	$10,000
Wendell Arpt	7/8/2017	1812	58	0	0	$2,000
Millbrook	7/13/2017	1830	58	0	0	$10,000
Fuquay Spgs	7/16/2017	1628	58	0	0	$500
Leesville	7/23/2017	1720	58	0	0	$8,000
Lassiter	8/23/2017	1453	58	0	0	$10,000
Brookhaven	9/1/2017	1721	58	0	0	$4,000
Total				**0**	**0**	**$2,956,250**

Source: NCEI

In addition to recorded thunderstorm wind events, NCEI reports 17 high wind and strong wind events during this same period that caused $1,093,000 in property damage. Of all 341 wind events during this period, there were 5 incidents that directly caused deaths or injuries. These incidents are recorded below:

Table 4.59 – Recorded Wind Events with Injuries and/or Fatalities, 1998-2017

Location	Event Type	Date	Wind Speed (mph)	Fatalities	Injuries	Property Damage
Raleigh	Thunderstorm Wind	8/21/2007	50	0	8	$0
Neuse	Thunderstorm Wind	1/11/2014	86	1	2	$0
Forestville	Thunderstorm Wind	1/11/2014	86	0	1	$0
Brookhaven	Thunderstorm Wind	1/11/2014	86	0	1	$0
Wake (Zone)	Strong Wind	10/8/2016	39	1	0	$500,000
			Total	**2**	**12**	**$500,000**

Source: NCEI

Lightning

According to NCEI data, there were 33 lightning strikes reported between 1998 and 2017. Of these, 26 recorded property damage totaling over $2.4 million and three directly caused fatalities. Event narratives indicate in some cases that property damage occurred but was not estimated; therefore, actual property damage amounts are higher. No injuries or crop damage was recorded by these strikes. It should be noted that lightning events recorded by the NCEI are only those that are reported; it is certain that additional lightning incidents have occurred in Wake County. Table 4.60 details NCEI-recorded lightning strikes from 1998 through 2017.

Table 4.60 – Recorded Lightning Strikes in Wake County, 1998-2017

Location	Date	Time	Fatalities	Injuries	Property Damage
Wake Forest	1/16/1998	1900	0	0	$35,000
Cary	5/3/1998	1650	0	0	$50,000
Falls	7/24/1999	1515	1	0	$0
Cary	9/3/2000	1820	0	0	$0
Fuquay Springs	6/22/2001	1614	0	0	$0
Wendell	8/22/2003	1405	0	0	$450,000
Cary	3/7/2005	1240	0	0	$20,000
Knightdale	7/13/2005	2342	1	0	$0
Raleigh	4/3/2006	900	0	0	$0
Raleigh	4/22/2006	1200	0	0	$0
Raleigh	8/15/2008	1500	0	0	$200,000
Forestville	7/1/2009	2215	0	0	$5,000
Holly Springs	6/2/2010	1420	0	0	$1,000,000
Willow	6/2/2010	1440	0	0	$25,000
Upchurch	6/15/2010	1810	0	0	$50,000
Upchurch	6/22/2010	1815	0	0	$125,000
Macedonia	7/16/2010	1944	0	0	$10,000
Knightdale	7/17/2010	1200	0	0	$10,000
Wilders Grove	7/17/2010	1308	0	0	$10,000

Location	Date	Time	Fatalities	Injuries	Property Damage
Leesville	7/20/2010	1757	0	0	$15,000
Falls	7/20/2010	1830	0	0	$10,000
Apex	7/27/2010	1146	0	0	$5,000
Six Forks	7/29/2010	2120	0	0	$2,000
Holly Springs	7/29/2010	2245	0	0	$300,000
Cary	2/28/2011	1910	0	0	$5,000
Cary	2/28/2011	1910	0	0	$5,000
Cary	7/24/2011	1425	0	0	$15,000
Wyatt	5/9/2012	1545	0	0	$5,000
Morrisville	7/6/2012	1600	0	0	$5,000
Upchurch	7/6/2012	1625	0	0	$5,000
Varina	2/19/2014	500	0	0	$30,000
Macedonia	4/9/2015	1915	1	0	$0
Auburn	7/13/2015	640	0	0	$25,000
		Total	**3**	**0**	**$2,417,000**

Source: NCEI

The following are a selection of narrative descriptions recorded in NCEI for lightning events that occurred in Wake County:

July 24, 1999 – A 24-year-old male was stepping from a boat to a dock when he was struck by lightning; he never regained consciousness and died the next day.

July 13, 2005 – A smoldering tree which had been struck by lightning a few hours earlier fell, killing a firefighter.

April 9, 2015 – A 28-year-old male was struck and killed by lightning in the parking lot of a shopping center.

Twenty of the 27 incidents recorded by the NCEI included property damage, which was mostly recorded as fire damage ignited by lightning. The highest rate of property damage recorded for a single incident was $1,000,000.

Hail

NCEI records 270 separate hail incidents across 140 days between January 1, 1998 and December 31, 2017 in Wake County. Of these, two events were reported to have caused property damage and none caused death, injury or crop damage. The largest diameter hail recorded in the County was in Raleigh on March 28, 2005; the average hail size in all storms was a little over one inch in diameter.

Table 4.61 – Summary of Hail Occurrences by Jurisdiction

Location	Number of Occurrences	Average Hail Diameter
Apex	10	1.038”
Cary	15	.92”
Fuquay-Varina	13	1.13”
Garner	13	1.14”
Holly Springs	8	.92”
Knightdale	7	.96”

Morrisville	6	.92”
Raleigh	42	1.1”
Rolesville	5	1.076”
Wake Forest	6	1.21”
Wendell	4	.75”
Zebulon	4	1.03”
Unincorporated Wake County	76	1.04”

The following narratives provide detail on select hailstorms from the above list of NCEI recorded events:

June 15, 1998 – Dime size hail fell in north Raleigh. This storm also produced very heavy rain and frequent lightning across much of northern Wake county from near the RDU Airport to Falls Lake and north Raleigh.

July 10, 2003 – Tobacco fields were damaged by large hail.

March 28, 2005 – 3.5 to 4 inch elongated hail reported at I-540 and Falls of Neuse Road. 3 inch hail reported at Strickland and Falls of Neuse Roads. 2 inch hail reported in Five Points. Golf ball sized hail reported at Cameron Village, Atlantic and New Hope Church Roads, North Raleigh Community Hospital, Green and Lee Spring Roads, and Durant and Falls of Neuse Roads. Ping pong ball sized hail reported on Wake Forest Road. Quarter to half dollar sized hail reported on Highwoods Road.

April 15, 2007 – Quarter size hail reported between Angier and Fuquay-Varina.

July 1, 2012 – A lee side surface trough interacted with a very unstable atmosphere and produced clusters of showers and thunderstorms. Some of these storms became severe and produce large hail and damaging winds across all of central North Carolina.

September 1, 2017 – The remnants of Harvey increased the southwesterly flow over Central North Carolina as it moved northeastward through Tennessee and Kentucky. In the wake of the northward moving warm front, a cold front moved into and stalled over Central North Carolina providing lift in the strongly sheared, moist environment. The resulting thunderstorms became severe, producing damaging wind gusts, large hail and flash flooding.

Probability of Future Occurrence

Based on historical occurrences recorded by NCEI for the 20-year period from 1998 through 2017, Wake County averages 16.2 thunderstorm wind events per year. Over this same period, 33 lightning events were reported as having caused death, injury, or property damage, which equates to an average of 1.65 damaging lightning strikes per year.

The average hail storm in Wake County occurs in late afternoon and has a hail stone with a diameter of an inch. Over the 20-year period from 1998 through 2017, Wake County experienced 207 reported hail incidents; this averages over ten reported incidents per year somewhere in the planning area, or a 100% chance that the County will experience a hail incident each year.

Based on these historical occurrences, there is a 100% chance that the County will experience severe weather each year. The probability of a damaging impacts is highly likely.

Probability: 4 – Highly Likely

Climate Change

According to the National Aeronautics and Space Administration (NASA), thunderstorm events in the future are likely to become more frequent in the southeast as a result of weather extremes. Thunderstorm

potential is measured by an index that NASA created called the Convective Available Potential Energy (CAPE) index. This measures how warm and moist the air is, which is a major contributing factor in thunderstorm/tornado formation. NASA projects that by the period of 2072-2099, the CAPE in the southeastern United States will increase dramatically. Parts of North Carolina are in an area that will likely experience the greatest increase in CAPE in the United States and all of the state is likely to experience at least some increase. This indicates that there will potentially be even more frequent thunderstorms in the state going forward.

Vulnerability Assessment

Methodologies and Assumptions

Population and property at risk to wind events was estimated using data from the North Carolina Emergency Management (NCEM) IRISK database, which was compiled in NCEM's Risk Management Tool.

People

People and populations exposed to the elements are most vulnerable to severe weather. A common hazard associated with wind events is falling trees and branches. Risk of being struck by lightning is greater in open areas, at higher elevations, and on the water.

Lightning can also cause cascading hazards, including power loss. Loss of power could critically impact those relying on energy to service, including those that need powered medical devices. Additionally, the ignition of fires is always a concern with lightning strikes.

The availability of sheltered locations such as basements, buildings constructed using hail-resistant materials and methods, and public storm shelters, all reduce the exposure of the population. Residents living in mobile homes are more vulnerable to hail events due to the lack of shelter locations and the vulnerability of the housing unit to damages. According to the 2017 American Community Survey (ACS) 5-Year Estimates, 12,321 occupied housing units (3.2 percent) in Wake County are classified as "mobile homes or other types of housing." Using the 2017 ACS persons per household estimate of 2.62, the population at risk due to their housing type was estimated at 32,281 residents. Individual who work outdoors may also face increased risk.

Since 1998, the NCEI records three fatalities and no injuries attributed to lightning in Wake County. NCEI records 2 fatalities and 12 injuries attributed to wind events in Wake County. There are no injuries or fatalities attributed to hail.

Property

Property damage caused by lightning usually occurs in one of two ways – either by direct damages through fires ignited by lightning, or by secondary impacts due to power loss. According to data collected on lightning strikes in Wake County, the vast majority of recorded property damage was due to structure fires.

NCEI records lightning impacts over 17 years (1998-2015), with $2,417,000 in property damage recorded (no incidents were recorded in 2016, 2017, or 2018). Historically, this has resulted in $142,176 in property impacts annually in Wake County. The average impact from lightning per incident in Wake County is $73,242.

General damages to property from hail are direct, including destroyed windows, dented cars, and building, roof and siding damage in areas exposed to hail. Hail can also cause enough damage to cars to cause them to be totaled. The level of damage is commensurate with both a material's ability to withstand hail impacts, and the size of the hailstones that are falling. Construction practices and building codes can help

maximize the resistance of the structures to damage. Large amounts of hail may need to be physically cleared from roadways and sidewalks, depending on accumulation. Hail can cause other cascading impacts, including power loss.

During a 20-year span between January 1, 1998 and December 31, 2017 in Wake County, NCEI reported $10 million in property damage as a direct result of hail. This averages to $50,000 per year in reported damages due to hail, though it should be noted that the $10 million in recorded damage was all due to one storm.

According to a National Insurance Crime Bureau (NICB) study of insurance claims from the Insurance Services Office (ISO) ClaimSearch database, between 2014 and 2016, North Carolina saw 45,274 separate hail damage claims.

It should be noted that property damage due to hail is usually insured loss, with damages covered under most major comprehensive insurance plans. Because of this, hail losses are notoriously underreported by the NCEI. It is difficult to find an accurate repository of hail damages in Wake County, thus the NCEI is still used to form a baseline.

When strong enough, wind events can cause significant direct damage to buildings and infrastructure. NCEM's IRISK database estimates damages from increasing magnitudes of wind events, detailed in Table 4.62 through Table 4.65.

Table 4.62 – Estimated Buildings Impacted by 50-Year Thunderstorm Winds

Jurisdiction	All Buildings	Residential Buildings at Risk			Commercial Buildings at Risk			Public Buildings at Risk			Total Buildings at Risk		
	Num	Num	% of Total	Estimated Damages	Num	% of Total	Estimated Damages	Num	% of Total	Estimated Damages	Num	% of Total	Estimated Damages
Raleigh	128,076	119,439	93.3%	$81,662,620	6,345	5%	$18,471,232	2,272	1.8%	$17,102,582	128,056	100%	$117,236,435
Apex	14,554	13,758	94.5%	$8,397,881	648	4.5%	$654,750	148	1%	$248,731	14,554	100%	$9,301,362
Cary	45,306	42,944	94.8%	$33,033,201	1,872	4.1%	$6,952,793	462	1%	$1,479,415	45,278	99.9%	$41,465,409
Fuquay-Varina	10,244	9,524	93%	$4,933,125	585	5.7%	$773,772	130	1.3%	$266,664	10,239	100%	$5,973,561
Garner	11,975	11,103	92.7%	$4,947,010	687	5.7%	$761,435	181	1.5%	$215,958	11,971	100%	$5,924,403
Holly Springs	9,178	8,887	96.8%	$4,510,097	226	2.5%	$507,636	62	0.7%	$116,899	9,175	100%	$5,134,633
Knightdale	7,144	6,811	95.3%	$2,898,039	265	3.7%	$275,811	67	0.9%	$228,035	7,143	100%	$3,401,885
Morrisville	5,181	4,793	92.5%	$3,567,760	340	6.6%	$1,774,735	48	0.9%	$122,300	5,181	100%	$5,464,795
Rolesville	2,103	1,983	94.3%	$1,299,072	91	4.3%	$58,848	29	1.4%	$21,500	2,103	100%	$1,379,420
Wake Forest	10,547	9,852	93.4%	$6,734,588	541	5.1%	$1,033,008	151	1.4%	$297,223	10,544	100%	$8,064,819
Wendell	3,728	3,378	90.6%	$1,276,274	277	7.4%	$140,810	73	2%	$93,416	3,728	100%	$1,510,499
Zebulon	3,074	2,677	87.1%	$1,044,247	316	10.3%	$431,206	79	2.6%	$95,549	3,072	99.9%	$1,571,002
Unincorporated Wake County	59,372	55,779	93.9%	$33,897,736	3,122	5.3%	$5,082,607	402	0.7%	$691,995	59,303	99.9%	$39,672,338
Total	**310,482**	**290,928**	**93.7%**	**$188,201,650**	**15,315**	**4.9%**	**$36,918,643**	**4,104**	**1.3%**	**$20,980,267**	**310,347**	**100%**	**$246,100,561**

Source: NCEM Risk Management Tool

Table 4.63 – Estimated Buildings Impacted by 100-Year Thunderstorm Winds

Jurisdiction	All Buildings	Residential Buildings at Risk			Commercial Buildings at Risk			Public Buildings at Risk			Total Buildings at Risk		
	Num	Num	% of Total	Estimated Damages	Num	% of Total	Estimated Damages	Num	% of Total	Estimated Damages	Num	% of Total	Estimated Damages
Raleigh	128,076	119,439	93.3%	$128,715,805	6,345	5%	$33,214,120	2,272	1.8%	$30,447,640	128,056	100%	$192,377,565
Apex	14,554	13,758	94.5%	$13,173,617	648	4.5%	$1,193,921	148	1%	$480,982	14,554	100%	$14,848,520
Cary	45,306	42,944	94.8%	$51,345,150	1,872	4.1%	$12,594,032	462	1%	$2,727,029	45,278	99.9%	$66,666,211
Fuquay-Varina	10,244	9,524	93%	$7,596,640	585	5.7%	$1,479,181	130	1.3%	$499,228	10,239	100%	$9,575,049
Garner	11,975	11,103	92.7%	$7,781,221	687	5.7%	$1,425,997	181	1.5%	$412,885	11,971	100%	$9,620,103
Holly Springs	9,178	8,887	96.8%	$7,024,984	226	2.5%	$957,182	62	0.7%	$216,917	9,175	100%	$8,199,083
Knightdale	7,144	6,811	95.3%	$4,524,674	265	3.7%	$516,869	67	0.9%	$417,503	7,143	100%	$5,459,045
Morrisville	5,181	4,793	92.5%	$5,766,554	340	6.6%	$2,981,303	48	0.9%	$228,286	5,181	100%	$8,976,143
Rolesville	2,103	1,983	94.3%	$1,980,105	91	4.3%	$102,001	29	1.4%	$35,562	2,103	100%	$2,117,667
Wake Forest	10,547	9,852	93.4%	$10,566,637	541	5.1%	$1,802,458	151	1.4%	$530,608	10,544	100%	$12,899,702
Wendell	3,728	3,378	90.6%	$2,000,680	277	7.4%	$257,441	73	2%	$175,742	3,728	100%	$2,433,862
Zebulon	3,074	2,677	87.1%	$1,603,959	316	10.3%	$836,776	79	2.6%	$195,890	3,072	99.9%	$2,636,625
Unincorporated Wake County	59,372	55,779	93.9%	$52,237,409	3,122	5.3%	$9,197,403	402	0.7%	$1,266,942	59,303	99.9%	$62,701,753
Total	**310,482**	**290,928**	**93.7%**	**$294,317,435**	**15,315**	**4.9%**	**$66,558,684**	**4,104**	**1.3%**	**$37,635,214**	**310,347**	**100%**	**$398,511,328**

Source: NCEM Risk Management Tool

Table 4.64 – Estimated Buildings Impacted by 300-Year Thunderstorm Winds

Jurisdiction	All Buildings	Residential Buildings at Risk			Commercial Buildings at Risk			Public Buildings at Risk			Total Buildings at Risk		
	Num	Num	% of Total	Estimated Damages	Num	% of Total	Estimated Damages	Num	% of Total	Estimated Damages	Num	% of Total	Estimated Damages
Raleigh	128,076	119,439	93.3%	$346,924,189	6,345	5%	$94,447,260	2,272	1.8%	$75,592,846	128,056	100%	$516,964,295
Apex	14,554	13,758	94.5%	$36,282,343	648	4.5%	$3,450,031	148	1%	$1,557,827	14,554	100%	$41,290,201
Cary	45,306	42,944	94.8%	$142,533,175	1,872	4.1%	$33,341,124	462	1%	$7,796,364	45,278	99.9%	$183,670,662
Fuquay-Varina	10,244	9,524	93%	$19,284,407	585	5.7%	$4,869,455	130	1.3%	$1,634,768	10,239	100%	$25,788,631
Garner	11,975	11,103	92.7%	$18,621,802	687	5.7%	$4,345,869	181	1.5%	$1,339,071	11,971	100%	$24,306,742
Holly Springs	9,178	8,887	96.8%	$18,467,636	226	2.5%	$2,819,105	62	0.7%	$708,325	9,175	100%	$21,995,066
Knightdale	7,144	6,811	95.3%	$11,151,915	265	3.7%	$1,533,206	67	0.9%	$1,160,829	7,143	100%	$13,845,949
Morrisville	5,181	4,793	92.5%	$15,973,924	340	6.6%	$8,206,253	48	0.9%	$694,380	5,181	100%	$24,874,557
Rolesville	2,103	1,983	94.3%	$4,809,445	91	4.3%	$263,350	29	1.4%	$96,399	2,103	100%	$5,169,195
Wake Forest	10,547	9,852	93.4%	$25,792,988	541	5.1%	$4,674,382	151	1.4%	$1,555,115	10,544	100%	$32,022,485
Wendell	3,728	3,378	90.6%	$4,722,639	277	7.4%	$797,232	73	2%	$545,523	3,728	100%	$6,065,394
Zebulon	3,074	2,677	87.1%	$3,720,938	316	10.3%	$2,848,522	79	2.6%	$846,926	3,072	99.9%	$7,416,386
Unincorporated Wake County	59,372	55,779	93.9%	$124,251,902	3,122	5.3%	$23,876,333	402	0.7%	$3,957,886	59,303	99.9%	$152,086,121
Total	**310,482**	**290,928**	**93.7%**	**$772,537,303**	**15,315**	**4.9%**	**$185,472,122**	**4,104**	**1.3%**	**$97,486,259**	**310,347**	**100%**	**$1,055,495,684**

Source: NCEM Risk Management Tool

Table 4.65 – Estimated Buildings Impacted by 700-Year Thunderstorm Winds

Jurisdiction	All Buildings	Residential Buildings at Risk			Commercial Buildings at Risk			Public Buildings at Risk			Total Buildings at Risk		
	Num	Num	% of Total	Estimated Damages	Num	% of Total	Estimated Damages	Num	% of Total	Estimated Damages	Num	% of Total	Estimated Damages
Raleigh	128,076	119,439	93.3%	$628,593,150	6,345	5%	$162,518,703	2,272	1.8%	$115,848,893	128,056	100%	$906,960,746
Apex	14,554	13,758	94.5%	$67,919,681	648	4.5%	$5,845,456	148	1%	$2,724,688	14,554	100%	$76,489,825
Cary	45,306	42,944	94.8%	$269,656,415	1,872	4.1%	$53,121,526	462	1%	$13,082,531	45,278	99.9%	$335,860,473
Fuquay-Varina	10,244	9,524	93%	$34,498,819	585	5.7%	$9,119,164	130	1.3%	$3,109,866	10,239	100%	$46,727,849
Garner	11,975	11,103	92.7%	$31,569,913	687	5.7%	$7,498,064	181	1.5%	$2,414,103	11,971	100%	$41,482,080
Holly Springs	9,178	8,887	96.8%	$34,668,791	226	2.5%	$4,684,483	62	0.7%	$1,326,494	9,175	100%	$40,679,769
Knightdale	7,144	6,811	95.3%	$19,359,471	265	3.7%	$2,615,372	67	0.9%	$1,921,880	7,143	100%	$23,896,724
Morrisville	5,181	4,793	92.5%	$29,152,922	340	6.6%	$14,472,769	48	0.9%	$1,217,612	5,181	100%	$44,843,303
Rolesville	2,103	1,983	94.3%	$8,295,647	91	4.3%	$423,875	29	1.4%	$165,725	2,103	100%	$8,885,247
Wake Forest	10,547	9,852	93.4%	$44,789,310	541	5.1%	$7,746,348	151	1.4%	$2,790,105	10,544	100%	$55,325,762
Wendell	3,728	3,378	90.6%	$7,860,005	277	7.4%	$1,444,310	73	2%	$953,122	3,728	100%	$10,257,437
Zebulon	3,074	2,677	87.1%	$6,204,673	316	10.3%	$5,372,684	79	2.6%	$1,833,694	3,072	99.9%	$13,411,050
Unincorporated Wake County	59,372	55,779	93.9%	$213,585,085	3,122	5.3%	$37,431,787	402	0.7%	$7,200,950	59,303	99.9%	$258,217,822
Total	**310,482**	**290,928**	**93.7%**	**$1,396,153,882**	**15,315**	**4.9%**	**$312,294,541**	**4,104**	**1.3%**	**$154,589,663**	**310,347**	**100%**	**$1,863,038,087**

Source: NCEM Risk Management Tool

Severe weather can also cause significant agricultural losses. Between 2007-2017, the sum of claims paid for crop damage due to hail and wind damages in Wake County was $1,285,682, or an average of $116,880 in losses every year. Table 4.68 summarizes the crop losses due to drought in reported in the RMA system.

Table 4.66 – Crop Losses Resulting from Severe Weather, 2007-2017

Year	Cause Description	Determined Acres	Indemnity Amount
2007	Hail	137.10	$263,755.00
2008	Hail	25.80	$61,333.00
2009	Hail	91.78	$133,582.00
2012	Hail	16.56	$11,728.00
2015	Hail	33.10	$34,456.00
2016	Hail	382.98	$132,304.30
2017	Hail	202.71	$198,752.00
	Hail Subtotal	**890.03**	**$835,910.30**
2012	Wind/Excess Wind	16.50	$13,756.00
2014	Wind/Excess Wind	7.92	$12,110.40
2015	Wind/Excess Wind	9.62	$21,951.00
2016	Wind/Excess Wind	174.55	$401,954.45
	Wind Subtotal	**208.59**	**$449,771.85**
	TOTAL	**1,098.62**	**$1,285,682.15**

Source: USDA Risk Management Agency

Environment

The main environmental impact from wind is damage to trees or crops. Wind events can also bring down power lines, which could cause a fire and result in even greater environmental impacts. Lightning may also result in the ignition of wildfires. This is part of a natural process, however, and the environment will return to its original state in time.

Hail can cause extensive damage to the natural environment, pelting animals, trees and vegetation with hailstones. Melting hail can also increase both river and flash flood risk.

Consequence Analysis

Table 4.67 summarizes the potential negative consequences of severe weather.

Table 4.67 – Consequence Analysis – Severe Weather (Thunderstorm Winds, Lightning, and Hail)

Category	Consequences
Public	Injuries; fatalities
Responders	Injuries; fatalities; potential impacts to response capabilities due to storm impacts
Continuity of Operations (including Continued Delivery of Services)	Potential impacts to continuity of operations due to storm impacts; delays in providing services
Property, Facilities and Infrastructure	Possibility of structure fire ignition; potential for disruptions in power and communications infrastructure; destruction and/or damage to any exposed property, especially windows, cars and siding; mobile homes see increased risk
Environment	Potential fire ignition from lightning; hail damage to wildlife and foliage
Economic Condition of the Jurisdiction	Lightning damage contingent on target; can severely impact/destroy critical infrastructure and other economic drivers

Category	Consequences
Public Confidence in the Jurisdiction's Governance	Public confidence is not generally affected by severe weather events.

Hazard Summary by Jurisdiction

The following table summarizes severe weather hazard risk by jurisdiction. Most aspects of severe weather risk do not vary substantially by jurisdiction; however, wind and hail impacts may be greater in more highly developed areas with higher exposure in terms of both property and population density. Additionally, mobile home units are more vulnerable to wind damage. While mobile home units do not comprise a significant proportion of any jurisdictions housing mix, Wake County, Apex, Cary, and Raleigh each have over 250 mobile home units in their jurisdiction and therefore may face more severe impacts from wind. Where priority ratings vary between thunderstorm wind, lightning, and hail for impact and spatial extent, these scores represent an average rating with greater weight given to thunderstorm wind because it occurs much more frequently.

Jurisdiction	Probability	Impact	Spatial Extent	Warning Time	Duration	Score	Priority
Wake County	4	2	3	4	1	2.9	H
Apex	4	1	3	4	1	2.6	H
Cary	4	2	3	4	1	2.9	H
Fuquay-Varina	4	1	3	4	1	2.6	H
Garner	4	1	3	4	1	2.6	H
Holly Springs	4	1	3	4	1	2.6	H
Knightdale	4	1	3	4	1	2.6	H
Morrisville	4	2	3	4	1	2.9	H
Raleigh	4	2	3	4	1	2.9	H
Rolesville	4	1	3	4	1	2.6	H
Wake Forest	4	1	3	4	1	2.6	H
Wendell	4	1	3	4	1	2.6	H
Zebulon	4	1	3	4	1	2.6	H

4.5.9 Severe Winter Storm

Hazard Background

A winter storm can range from a moderate snow over a period of a few hours to blizzard conditions with blinding wind-driven snow that lasts for several days. Events may include snow, sleet, freezing rain, or a mix of these wintry forms of precipitation. Some winter storms might be large enough to affect several states, while others might affect only localized areas. Occasionally, heavy snow might also cause significant property damages, such as roof collapses on older buildings.

All winter storm events have the potential to present dangerous conditions to the affected area. Larger snowfalls pose a greater risk, reducing visibility due to blowing snow and making driving conditions treacherous. A heavy snow event is defined by the National Weather Service as an accumulation of 4 of more inches in 12 hours or less. A blizzard is the most severe form of winter storm. It combines low temperatures, heavy snow, and winds of 35 miles per hour or more, which reduces visibility to a quarter mile or less for at least 3 hours. Winter storms are often accompanied by sleet, freezing rain, or an ice storm. Such freeze events are particularly hazardous as they create treacherous surfaces.

Ice storms are defined as storms with significant amounts of freezing rain and are a result of cold air damming (CAD). CAD is a shallow, surface-based layer of relatively cold, stably-stratified air entrenched against the eastern slopes of the Appalachian Mountains. With warmer air above, falling precipitation in the form of snow melts, then becomes either super-cooled (liquid below the melting point of water) or re-freezes. In the former case, super-cooled droplets can freeze on impact (freezing rain), while in the latter case, the re-frozen water particles are ice pellets (or sleet). Sleet is defined as partially frozen raindrops or refrozen snowflakes that form into small ice pellets before reaching the ground. They typically bounce when they hit the ground and do not stick to the surface. However, it does accumulate like snow, posing similar problems and has the potential to accumulate into a layer of ice on surfaces. Freezing rain, conversely, usually sticks to the ground, creating a sheet of ice on the roadways and other surfaces. All of the winter storm elements – snow, low temperatures, sleet, ice, etcetera – have the potential to cause significant hazard to a community. Even small accumulations can down power lines and trees limbs and create hazardous driving conditions and disrupt communication and power for days.

Advancements in meteorology and forecasting usually allow for mostly accurate forecasting a few days in advance of an impending storm. Most storms have a duration of a few hours; however, impacts can last a few days after the initial incident until cleanup is completed.

Warning Time: 1 – More than 24 hours

Duration: 3 – Less than 1 week

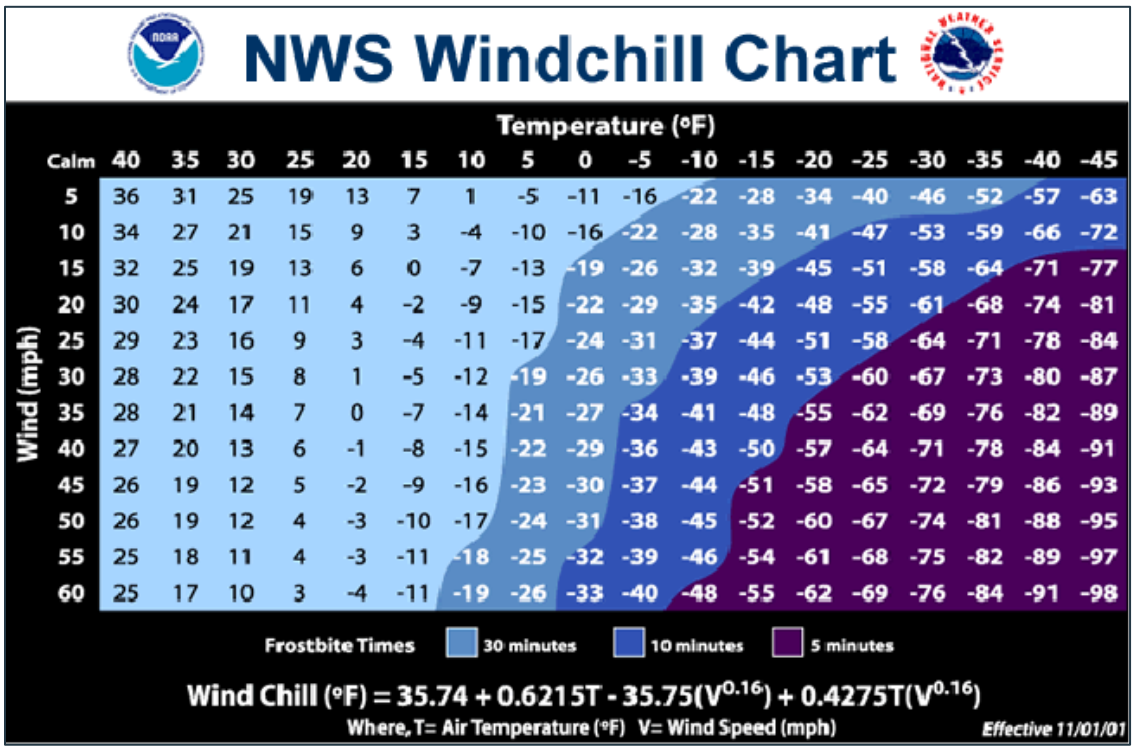
Location

Severe winter storms are usually a countywide or regional hazard, impacting the entire county at the same time. The risk of a severe winter storm occurring is uniform across the County.

Extent

Severe winter storms often involve a mix of hazardous weather conditions. The magnitude of an event can be defined based on the severity of each of the involved factors, including precipitation type, precipitation accumulation amounts, temperature, and wind. The NWS Wind Chill Temperature Index, shown in Figure 4.18, provides a formula for calculating the dangers of winter winds and freezing temperatures.

Figure 4.18 – NWS Wind Chill Temperature Index



Source: http://www.nws.noaa.gov/om/winter/windchill.shtml

The greatest snowfall amount recorded in the Wake County planning area was 17.8 inches, recorded on March 2, 1927 at the Raleigh weather station.

Impact: 2 – Limited

Spatial Extent: 4 – Large

The entirety of North Carolina is susceptible to winter storm and freeze events. Some ice and winter storms may be large enough to affect several states, while others might affect limited, localized areas. The degree of exposure typically depends on the normal expected severity of local winter weather. Wake County is accustomed to smaller scale severe winter weather conditions and often receives winter weather during the winter months. Given the atmospheric nature of the hazard, the entire County has uniform exposure to a winter storm.

Historical Occurrences

To get a full picture of the range of impacts of a severe winter storm, data for the following weather types as defined by the National Weather Service (NWS) Raleigh Forecast Office and tracked by NCEI were collected:

- **Blizzard** – A winter storm which produces the following conditions for 3 consecutive hours or longer: (1) sustained winds or frequent gusts 30 knots (35 mph) or greater, and (2) falling and/or blowing snow reducing visibility frequently to less than 1/4 mile.
- **Cold/Wind Chill** – Period of low temperatures or wind chill temperatures reaching or exceeding locally/regionally defined advisory conditions of 0°F to -14°F with wind speeds 10 mph (9 kt) or greater.

- **Extreme Cold/Wind Chill** – A period of extremely low temperatures or wind chill temperatures reaching or exceeding locally/regionally defined warning criteria, defined as wind chill -15°F or lower with wind speeds 10 mph (9 kt) or greater.
- **Frost/Freeze** – A surface air temperature of 32°F or lower, or the formation of ice crystals on the ground or other surfaces, for a period of time long enough to cause human or economic impact, during the locally defined growing season.
- **Heavy Snow** – Snow accumulation meeting or exceeding 12 and/or 24 hour warning criteria of 3 and 4 inches, respectively.
- **Ice Storm** – Ice accretion meeting or exceeding locally/regionally defined warning criteria of ¼ inch or greater resulting in significant, widespread power outages, tree damage and dangerous travel. Issued only in those rare instances where just heavy freezing rain is expected and there will be no "mixed bag" precipitation meaning no snow, sleet or rain.
- **Sleet** – Sleet accumulations meeting or exceeding locally/regionally defined warning criteria of ½ inch or more.
- **Winter Storm** – A winter weather event that has more than one significant hazard and meets or exceeds locally/regionally defined 12 and/or 24 hour warning criteria for at least one of the precipitation elements. Defined by NWS Raleigh Forecast Office as snow accumulations 3 inches or greater in 12 hours (4 inches or more in 24 hours); Freezing rain accumulations ¼ inch (6 mm) or greater; Sleet accumulations ½ inch (13 mm) or more. Issued when there is at least a 60% forecast confidence of any one of the three criteria being met.
- **Winter Weather** – A winter precipitation event that causes a death, injury, or a significant impact to commerce or transportation, but does not meet locally/regionally defined warning criteria.

Summarized impacts from data collected for 1998 through 2017 are included in Table 4.68. Cumulatively, severe winter storms caused over $1 million in property damage. In this timeframe, the county experienced no fatalities, injuries or crop damage from severe winter storm, though these types of impacts are possible in future events. No blizzard, cold/wind chill, extreme cold/wind chill, frost/freeze, or sleet events were recorded. Impacts in Wake County by incident are recorded in Table 4.69.

Table 4.68 – Total Severe Winter Storm Impacts in Wake County, 1998-2017

Event Type	Number of Recorded Incidents	Total Fatalities	Total Injuries	Total Property Damage	Total Crop Damage
Winter Storm	25	0	0	$1,000,000	$0
Winter Weather	19	0	0	$40,000	$0
Ice Storm	1	0	0	0	$0
Heavy Snow	1	0	0	0	$0
Total	**46**	**0**	**0**	**$1,040,000**	**$0**

Source: NCEI

Table 4.69 – Recorded Severe Winter Storm Impacts in Wake County, 1998-2017

Date	Event Type	Fatalities	Injuries	Property Damage	Crop Damage
1/19/1998	Heavy Snow	0	0	0	0
12/23/1998	Ice Storm	0	0	0	0
1/18/2000	Winter Storm	0	0	0	0
1/20/2000	Winter Storm	0	0	0	0
1/22/2000	Winter Storm	0	0	0	0
1/24/2000	Winter Storm	0	0	0	0
1/28/2000	Winter Storm	0	0	0	0

Date	Event Type	Fatalities	Injuries	Property Damage	Crop Damage
11/19/2000	Heavy Snow	0	0	0	0
1/3/2002	Winter Storm	0	0	0	0
12/4/2002	Winter Storm	0	0	0	0
2/16/2003	Winter Storm	0	0	0	0
2/27/2003	Winter Storm	0	0	0	0
1/26/2004	Winter Storm	0	0	0	0
2/15/2004	Winter Storm	0	0	0	0
2/26/2004	Winter Storm	0	0	0	0
12/26/2004	Winter Storm	0	0	0	0
1/18/2007	Winter Weather	0	0	0	0
2/1/2007	Winter Weather	0	0	0	0
12/7/2007	Winter Weather	0	0	30,000	0
1/17/2008	Winter Weather	0	0	0	0
1/20/2009	Winter Storm	0	0	0	0
3/2/2009	Winter Storm	0	0	0	0
12/18/2009	Winter Weather	0	0	0	0
1/29/2010	Winter Storm	0	0	0	0
2/12/2010	Winter Storm	0	0	0	0
3/2/2010	Winter Storm	0	0	0	0
12/4/2010	Winter Weather	0	0	0	0
12/16/2010	Winter Weather	0	0	0	0
12/25/2010	Winter Storm	0	0	0	0
1/10/2011	Winter Weather	0	0	0	0
12/26/2013	Winter Weather	0	0	0	0
1/21/2014	Winter Weather	0	0	0	0
1/28/2014	Winter Storm	0	0	0	0
2/11/2014	Winter Weather	0	0	0	0
2/12/2014	Winter Storm	0	0	0	0
3/3/2014	Winter Weather	0	0	0	0
3/17/2014	Winter Weather	0	0	0	0
1/13/2015	Winter Weather	0	0	0	0
2/16/2015	Winter Storm	0	0	0	0
2/24/2015	Winter Weather	0	0	0	0
2/25/2015	Winter Storm	0	0	$1,000,000	0
3/1/2015	Winter Weather	0	0	0	0
1/22/2016	Winter Storm	0	0	0	0
2/7/2016	Winter Weather	0	0	$10,000	0
2/15/2016	Winter Weather	0	0	0	0
1/7/2017	Winter Storm	0	0	0	0
12/8/2017	Winter Weather	0	0	0	0
	Total	**0**	**0**	**$1,010,000**	**0**

Source: NCEI

Several storm impacts from NCEI are summarized below:

December 7, 2007 – A brief period of light freezing rain fell across central North Carolina. Most of the freezing rain accumulation occurred from southern Wake County, east to Smithfield and north to Wilson, Rock Mount and Roanoke Rapids. Portions of Interstate 40 and Highway 70 in Johnston County were

closed due to numerous accidents. Over 150 automobile accidents were reported across central North Carolina due to icy bridges. The storm caused $415,000 in damage across the region; Wake County itself suffered $30,000 in recorded damage.

February 25-26, 2015 – As a low pressure system tracked along the southeast coast, wintry precipitation spread into central North Carolina. Much of the impacted area received 2-4 inches of snow and sleet, with norther counties receiving up to 7-9 inches. In addition to the snow, some areas also saw ice accumulations. The heavy, wet snow caused extensive power outages, with some outages extending beyond 24 hours. In Wake County, snowfall/sleet amounts of 2 to 6 inches fell across the county. The heavy wet snow caused widespread power outages from falling trees and power lines. At the peak of the storm, over 92,000 customers were without power in the county.

February 7, 2016 – A deepening low pressure system tracking along the southeast coast spread precipitation into the eastern portions of North Carolina. A trace to a couple tenths of an inch of snow and sleet fell across Wake County. This brief burst of wintry weather caused numerous traffic accidents.

Wake County received six emergency declarations and presidential disaster declarations since 1968 for incidents related to severe winter storms. As a state, North Carolina received eight disaster declarations related to severe winter storms during this timeframe.

Table 4.70 – Emergency & Disaster Declarations in Wake County due to Severe Winter Storms

Disaster Number	Date	Disaster Type	Incident Start	Incident End
234	1968	Severe Ice Storm	2/10/1968	2/10/1968
3033	1977	Snow	3/2/1977	3/2/1977
3110	1993	Severe Snow and Winter Storm	3/13/1993	3/17/1993
1087	1996	Blizzard	1/6/1996	1/12/1996
1312	2000	Severe Winter Storm	1/24/2000	2/1/2000
1448	2003	Severe Ice Storm	12/4/2002	12/6/2002

Source: FEMA, December 20, 2018

Probability of Future Occurrence

NCEI records 46 severe winter storm related events during the 20-year period from 1998 through 2017, which is an average of 2.3 events per year or more than 100 percent probability in any given year.

Probability: 4 – Highly Likely

Climate Change

Per the 2018 North Carolina Hazard Mitigation Plan, there is uncertainty associated with climate change impacts on future severe winter storms. Global temperature rise could cause shorter and warmer winters in many areas; however, the likelihood of dangerously low temperatures may increase due to continuing trends of temperature extremes. Warmer winters, however, mean that precipitation that would normally fall as snow may begin to fall as rain or freezing rain instead.

Vulnerability Assessment

People

Winter storms are considered deceptive killers because most deaths are indirectly related to the storm event. The leading cause of death during winter storms is from automobile or other transportation accidents due to poor visibility and/or slippery roads. Additionally, exhaustion and heart attacks caused by overexertion may result from winter storms.

Power outages during very cold winter storm conditions can also create potentially dangerous situations. Elderly people account for the largest percentage of hypothermia victims. In addition, if the power is out for an extended period, residents are forced to find alternative means to heat their homes. The danger arises from carbon monoxide released from improperly ventilated heating sources such as space or kerosene heaters, furnaces, and blocked chimneys. House fires also occur more frequently in the winter due to lack of proper safety precautions when using an alternative heating source.

Property

According to reported data of storm impacts recorded by the NCEI, between 1998 and 2017 Wake County experienced $1.04 million in property damage related to the impacts of severe winter storm. Based on this data, Wake County experiences average annual losses of $52,000 due to severe winter storm events.

Environment

Winter storm events may include ice or snow accumulation on trees which can cause large limbs, or even whole trees, to snap and potentially fall on buildings, cars, or power lines. This potential for winter debris creates a dangerous environment to be outside in; significant injury or fatality may occur if a large limb snaps while a local resident is out driving or walking underneath it.

Consequence Analysis

Table 4.68 summarizes the potential negative consequences of severe winter storm.

Table 4.71 – Consequence Analysis – Severe Winter Storm

Category	Consequences
Public	Localized impact expected to be severe for affected areas and moderate to light for other less affected areas.
Responders	Adverse impact expected to be severe for unprotected personnel and moderate to light for trained, equipped, and protected personnel.
Continuity of Operations (including Continued Delivery of Services)	Localized disruption of roads and/or utilities caused by incident may postpone delivery of some services.
Property, Facilities and Infrastructure	Localized impact to facilities and infrastructure in the areas of the incident. Power lines and roads most adversely affected.
Environment	Environmental damage to trees, bushes, etc.
Economic Condition of the Jurisdiction	Local economy and finances may be adversely affected, depending on damage.
Public Confidence in the Jurisdiction's Governance	Ability to respond and recover may be questioned and challenged if planning, response, and recovery not timely and effective.

Hazard Summary by Jurisdiction

The following table summarizes severe winter storm hazard risk by jurisdiction. Severe winter storm risk does not vary substantially by jurisdiction because these events are typically regional in nature.

Jurisdiction	Probability	Impact	Spatial Extent	Warning Time	Duration	Score	Priority
Wake County	4	2	4	1	3	3.0	H
Apex	4	2	4	1	3	3.0	H
Cary	4	2	4	1	3	3.0	H
Fuquay-Varina	4	2	4	1	3	3.0	H
Garner	4	2	4	1	3	3.0	H
Holly Springs	4	2	4	1	3	3.0	H

Jurisdiction	Probability	Impact	Spatial Extent	Warning Time	Duration	Score	Priority
Knightdale	4	2	4	1	3	3.0	H
Morrisville	4	2	4	1	3	3.0	H
Raleigh	4	2	4	1	3	3.0	H
Rolesville	4	2	4	1	3	3.0	H
Wake Forest	4	2	4	1	3	3.0	H
Wendell	4	2	4	1	3	3.0	H
Zebulon	4	2	4	1	3	3.0	H

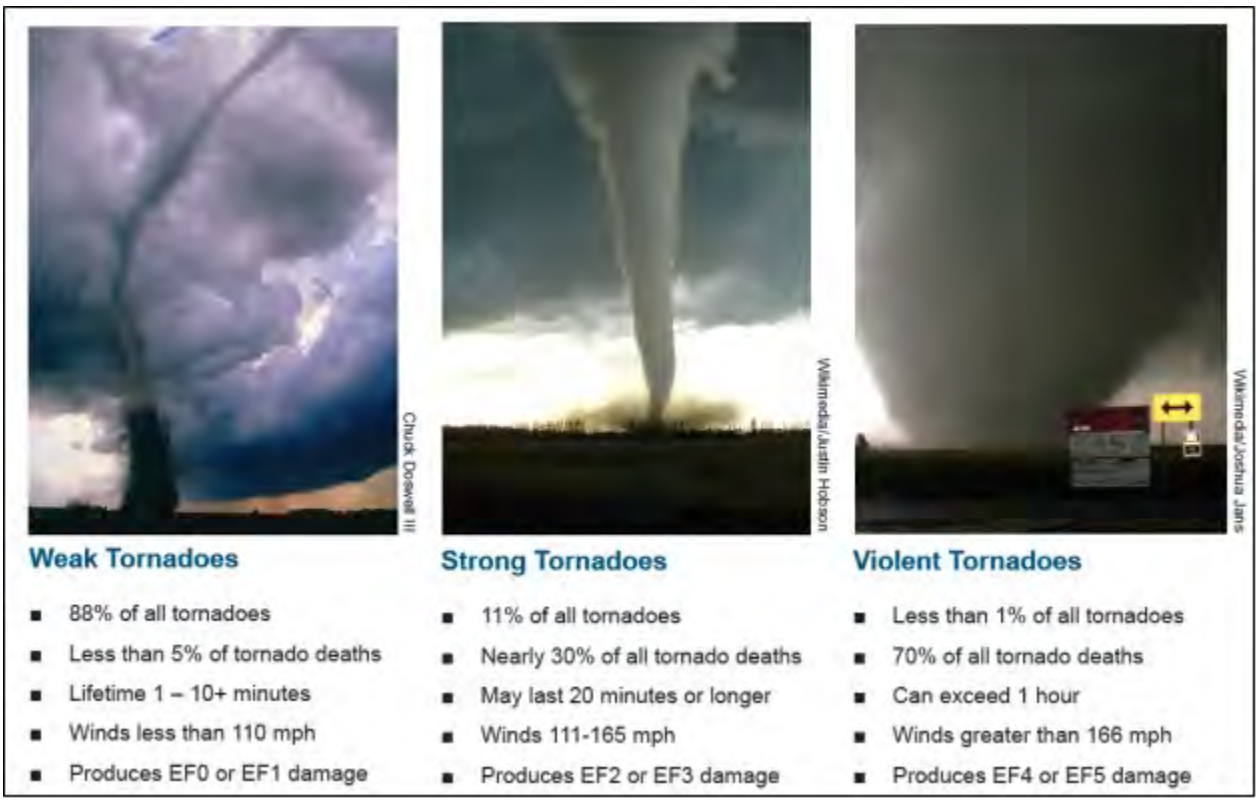
4.5.10 Tornado

Hazard Background

According to the Glossary of Meteorology (AMS 2000), a tornado is "a violently rotating column of air, pendant from a cumuliform cloud or underneath a cumuliform cloud, and often (but not always) visible as a funnel cloud." Tornadoes can appear from any direction. Most move from southwest to northeast, or west to east. Some tornadoes have changed direction amid path, or even backtracked.

Tornadoes are commonly produced by land falling tropical cyclones. Those making landfall along the Gulf coast traditionally produce more tornadoes than those making landfall along the Atlantic coast. Tornadoes that form within hurricanes are more common in the right front quadrant with respect to the forward direction but can occur in other areas as well. According to the NHC, about 10% of the tropical cyclone-related fatalities are caused by tornadoes. Tornadoes are more likely to be spawned within 24 hours of landfall and are usually within 30 miles of the tropical cyclone's center.

Tornadoes have the potential to produce winds in excess of 200 mph (EF5 on the Enhanced Fujita Scale) and can be very expansive – some in the Great Plains have exceeded two miles in width. Tornadoes associated with tropical cyclones, however, tend to be of lower intensity (EF0 to EF2) and much smaller in size than ones that form in the Great Plains.



Source: NOAA National Weather Service

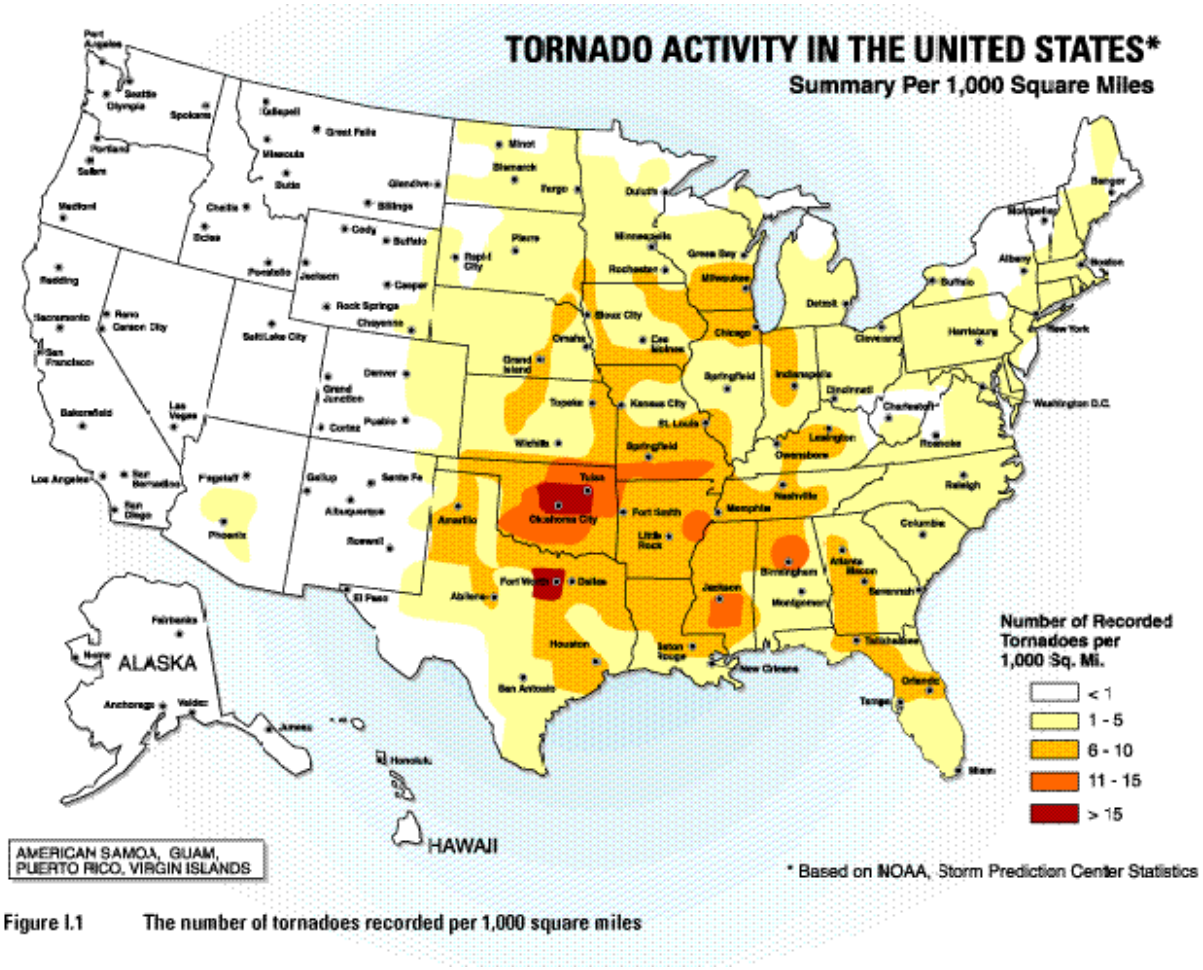
Warning Time: 4 – Less than 6 hours

Duration: 1 – Less than 6 hours

According to the NOAA Storm Prediction Center (SPC), the highest concentration of tornadoes in the United States has been in Oklahoma, Texas, Kansas and Florida respectively. Although the Great Plains region of the Central United States does favor the development of the largest and most dangerous

tornadoes (earning the designation of "tornado alley"), Florida experiences the greatest number of tornadoes per square mile of all U.S. states (SPC, 2002). The below figure shows tornado activity in the United States based on the number of recorded tornadoes per 1,000 square miles.

Figure 4.19 – Tornado Activity in the U.S.

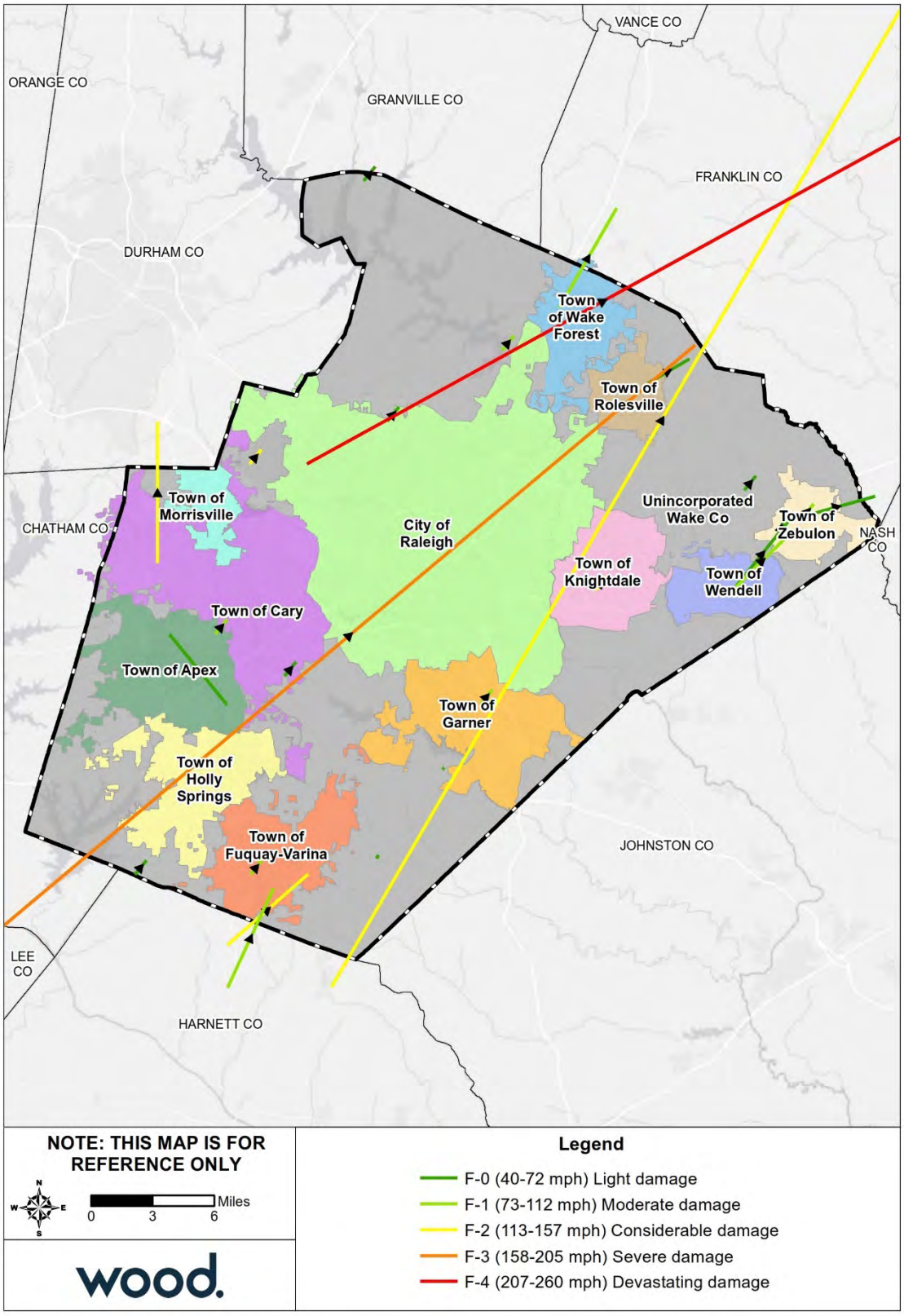


Source: American Society of Civil Engineers

Location

Figure 4.20 reflects the tracks of past tornados that passed through Wake County from 1950 through 2017 according to data from the NOAA/National Weather Service Storm Prediction Center.

Figure 4.20 – Tornado Paths Through Wake County, 1950-2017



Source: NOAA/NWS Storm Prediction Center

Tornados can occur anywhere in the County. Tornadoes typically impact a small area, but damage may be extensive. Tornado locations are completely random, meaning risk to tornado isn't increased in one area of the county versus another. All of Wake County is uniformly exposed to this hazard.

Extent

Prior to February 1, 2007, tornado intensity was measured by the Fujita (F) scale. This scale was revised and is now the Enhanced Fujita (EF) scale. Both scales are sets of wind estimates (not measurements) based on damage. The new scale provides more damage indicators (28) and associated degrees of damage, allowing for more detailed analysis, better correlation between damage and wind speed. It is also more precise because it takes into account the materials affected and the construction of structures damaged by a tornado. Table 4.5 shows the wind speeds associated with the enhanced Fujita scale ratings and the damage that could result at different levels of intensity.

Table 4.72 – Enhanced Fujita Scale

EF Number	3 Second Gust (mph)	Damage
0	65-85	**Light damage.** Peels surface off some roofs; some damage to gutters or siding; branches broken off trees; shallow-rooted trees pushed over.
1	96-110	**Moderate damage.** Roofs severely stripped; mobile homes overturned or badly damaged; loss of exterior doors; windows and other glass broken.
2	111-135	**Considerable damage.** Roofs torn off well-constructed houses; foundations of frame homes shifted; mobile homes completely destroyed; large trees snapped or uprooted; light-object missiles generated; cars lifted off ground.
3	136-165	**Severe damage.** Entire stories of well-constructed houses destroyed; severe damage to large buildings such as shopping malls; trains overturned; trees debarked; heavy cars lifted off the ground and thrown; structures with weak foundations blown away some distance.
4	166-200	**Devastating damage.** Well-constructed houses and whole frame houses completely leveled; cars thrown and small missiles generated.
5	Over 200	**Incredible damage.** Strong frame houses leveled off foundations and swept away; automobile-sized missiles fly through the air in excess of 100 m; high-rise buildings have significant structural deformation; incredible phenomena will occur.

The most intense tornado to pass through Wake County was an F4 in 1988; this tornado also had the longest path (83 miles) and resulted in the most injuries (154 people). An F2 tornado in 1981 had the widest observed path in the county at 800 yards. An F3 tornado in 2011 resulted in the most fatalities, killing six people. An EF3 tornado in 2011 caused $115 million in recordable property damage.

Impact: 3 – Critical

Spatial Extent: 2 – Small

Historical Occurrences

NCEI storm reports were reviewed from 1988 through 2017 to assess whether recent trends varied from the longer historical record. According to NCEI, Wake County experienced 19 tornado incidents between 1988 and 2017, causing 6 fatalities, 201 injuries, $369 million in property damage and $25,000 in crop damage. Table 4.72 shows historical tornadoes in Wake County during this time period.

Table 4.73 – Recorded Tornadoes in Wake County, 1988-2017

Location	Date	Time	Magnitude	Deaths	Injuries	Property Damage	Crop Damage
Wake Co.	3/26/1988	1955	F0	0	0	$0	$0
Wake Co.	11/28/1988	0	F4	2	105	$250,000,000	$0
Wake Co.	10/23/1990	218	F1	0	0	$0	$0
Raleigh	3/27/1993	1605	F0	0	0	$0	$0
Wendell	4/15/1996	1708	F0	0	0	$10,000	$0
Wendell	4/15/1996	1725	F1	0	26	$3,000,000	$0
Cary	7/12/1996	1325	F0	0	0	$50,000	$0
Holly Springs	3/20/1998	1815	F0	0	0	$0	$0
Garner	3/20/1998	1840	F2	0	2	$650,000	$0
Raleigh	3/20/1998	1845	F0	0	0	$15,000	$0
Cary	6/1/2001	1300	F0	0	0	$0	$0
Apex	9/27/2004	1830	F0	0	0	$0	$0
Garner	9/14/2007	1825	EF0	0	0	$0	$0
Rockton	4/25/2010	1859	EF0	0	0	$250,000	$25,000
Rolesville	3/6/2011	1710	EF0	0	1	$100,000	$0
Burt	4/16/2011	1427	EF3	4	67	$115,000,000	$0
Zebulon	9/18/2012	1438	EF0	0	0	$0	$0
South Raleigh Airport	3/29/2014	1957	EF0	0	0	$8,000	$0
Williams Crossroads	3/29/2014	2008	EF0	0	0	$5,000	$0
Total				**6**	**201**	**$369,088,000**	**$25,000**

Source: NCEI

Specific incidents with some level of impact include:

March 20, 1998 – a cell of tornadoes broke out during the 6 pm hour, with a tornado each in Holly Springs, Garner and Raleigh. In Garner, several trees fell on homes and outbuildings. The tornado touched down of Highway 70 near a church; the roof of one section was taken off and the steeple was blown off the chapel. The debris from the church took out windows at a car lot across the street. A block away, the wind removed several large siding sheets from a business. The storm caused two direct injuries and $650,000 in damages. The storm produced another tornado six miles to the northeast on the east side of Raleigh. Damage began just off US64 at Wake Medical Center and the Tower Shopping Center. Cars were overturned, trees were damaged and a steal-beamed billboard was twisted. The tornado then crossed the highway where it lifted the roof off the business office of a tree nursery, damaged two sheds and destroyed five greenhouses. Insulation and debris was strewn up in the trees well away from the tornado's path.

April 25, 2010 – a storm produced a weak EF0 tornado near Zebulon in eastern Wake County. The tornado damaged buildings on its way east, where it caused minor damage to several businesses and vehicles in the Triangle East Center. The storm was responsible for $250,000 in property damage and $25,000 in crop damage.

March 6, 2011 – a weak EF-0 tornado touched down just northeast of downtown Rolesville along NC Highway 401 (Main Street). The tornado tracked to the northeast for two miles, causing damage to trees, homes and other infrastructure, resulting in $100,000 in property damage. An elderly man was injured from the tornado due to a house fire.

April 16, 2011 – A strong storm system produced nine tornadoes in the Raleigh CWA, including two EF3s and four EF2s. The tornadoes left eight dead with approximately 275 injuries. In Burt, an EF0 tornado entered southwest Wake County and tracked northeast, causing tree, roof and infrastructure damage. In total, 2,270 homes were damaged, including 67 homes that were destroyed and 184 homes that suffered major damage; additionally, 34 businesses were damaged. NCEI recorded four fatalities in a trailer park, 67 injuries and $115 million in property damage.

November 28, 1988 – A powerful tornado touched down in Umstead State Park in the northwest part of Raleigh, three miles southeast of the center of Raleigh-Durham Airport. The tornado tracked across one of the most densely populated parts of the City of Raleigh, destroying hundreds of homes and damaging thousands of others. Two people were killed in Raleigh. The strongest damage, mostly F3 with some very weak F4, occurred along a 4 mile long portion of the path extending northeast from where it crossed U.S. Highway 70, four miles east of Raleigh Airport. Numerous businesses along U.S. Highway 70 were destroyed, including a K-mart.

The tornado destroyed a total of 426 residences and 78 businesses. It damaged 2,057 residences, leaving 978 people homeless. Four people were killed and 154 were injured; total damage was near $77.2 million. The track of the tornado was almost continuous for 83 miles.

Outside of the above time period, NCEI also records an F2 tornado on November 2, 1966 that caused nine injuries and $250,000 in damage.

November 2, 1966 – In the area east and south of Raleigh, two homes and five house trailers were destroyed, three trailers and six homes severely damaged, and minor damage to approximately twenty other homes and business buildings, with trees twisted off and power poles broken.

Probability of Future Occurrence

Probability of future occurrence was calculated based on past occurrences and was assumed to be uniform across the county.

In a thirty-year span between 1988 and 2017, Wake County experienced 19 separate tornado incidents over 15 separate days. This correlates to a 63 percent annual probability that the county will experience a tornado somewhere in its boundaries. Only three of these past tornado events was a magnitude EF2 or greater; therefore, the annual probability of a significant tornado event is approximately 10 percent.

Probability: 3 – Likely

Climate Change

There presently is not enough data or research to quantify the magnitude of change that climate change may have related to tornado frequency and intensity. NASA's Earth Observatory has conducted studies which aim to understand the interaction between climate change and tornadoes. Based on these studies meteorologists are unsure why some thunderstorms generate tornadoes and others don't, beyond knowing that they require a certain type of wind shear. Tornadoes spawn from approximately one percent of thunderstorms, usually supercell thunderstorms that are in a wind shear environment that promotes rotation. Some studies show a potential for a decrease in wind shear in mid-latitude areas. Because of uncertainty with the influence of climate change on tornadoes, future updates to the mitigation plan

should include the latest research on how the tornado hazard frequency and severity could change. The level of significance of this hazard should be revisited over time.

Vulnerability Assessment

People

People and populations exposed to the elements are most vulnerable to tornados. The availability of sheltered locations such as basements, buildings constructed using tornado-resistant materials and methods, and public storm shelters, all reduce the exposure of the population. According to the 2017 American Community Survey (ACS), 12,321 occupied housing units (3.2%) in Wake County are classified as "mobile homes or other types of housing." Based on an estimated average of 2.62 persons per household from the 2017 ACS, there are approximately 32,281 people in Wake County living in mobile homes.

Since 1950, the NCEI records seven fatalities and 213 injuries attributed to tornadoes in Wake County; these fatalities and injuries were the result of tornadoes rated as low as EF0, illustrating the destructive power of tornadoes and the dangers they pose to exposed populations without proper shelter.

Property

General damages to property are both direct (what the tornado physically destroys) and indirect, which focuses on additional costs, damages and losses attributed to secondary hazards spawned by the tornado, or due to the damages caused by the tornado. Depending on the size of the tornado and its path, a tornado is capable of damaging and eventually destroying almost anything. Construction practices and building codes can help maximize the resistance of the structures to damage.

Secondary impacts of tornado damage often result from damage to infrastructure. Downed power and communications transmission lines, coupled with disruptions to transportation, create difficulties in reporting and responding to emergencies. These indirect impacts of a tornado put tremendous strain on a community. In the immediate aftermath, the focus is on emergency services.

Since 1950, damaging tornadoes in the County are directly responsible for $370 million worth of damage to property, and no reported damage to crops, according to NCEI data.

Table 4.74 through Table 4.78 detail the estimated buildings impacted from tornado events of magnitudes ranging from EF0 to EF4. Note that these tables provide an estimate of building damages should all exposed property be impacted by an event of the stated magnitude. Actual damages resulting from a tornado event of each magnitude would be lower because the event would impact only a fraction of the county.

Table 4.74 – Estimated Buildings Impacted by EF0 Tornado

Jurisdiction	All Buildings	Residential Buildings at Risk			Commercial Buildings at Risk			Public Buildings at Risk			Total Buildings at Risk		
	Num	Num	% of Total	Estimated Damages	Num	% of Total	Estimated Damages	Num	% of Total	Estimated Damages	Num	% of Total	Estimated Damages
Raleigh	128,076	119,439	93.3%	$1,462,925,632	6,345	5%	$667,919,732	2,272	1.8%	$214,085,079	128,056	100%	$2,344,930,443
Apex	14,554	13,758	94.5%	$167,077,777	648	4.5%	$38,257,406	148	1%	$11,421,669	14,554	100%	$216,756,852
Cary	45,306	42,944	94.8%	$657,611,160	1,872	4.1%	$203,740,695	462	1%	$47,457,113	45,278	99.9%	$908,808,968
Fuquay-Varina	10,244	9,524	93%	$97,488,272	585	5.7%	$34,843,445	130	1.3%	$8,400,807	10,239	100%	$140,732,524
Garner	11,975	11,103	92.7%	$103,663,128	687	5.7%	$47,520,768	181	1.5%	$11,042,172	11,971	100%	$162,226,068
Holly Springs	9,178	8,887	96.8%	$110,820,398	226	2.5%	$21,378,787	62	0.7%	$9,299,019	9,175	100%	$141,498,204
Knightdale	7,144	6,811	95.3%	$61,152,204	265	3.7%	$14,122,395	67	0.9%	$7,528,413	7,143	100%	$82,803,012
Morrisville	5,181	4,793	92.5%	$78,337,848	340	6.6%	$53,973,286	48	0.9%	$3,355,118	5,181	100%	$135,666,253
Rolesville	2,103	1,983	94.3%	$23,246,517	91	4.3%	$2,529,057	29	1.4%	$1,599,689	2,103	100%	$27,375,263
Wake Forest	10,547	9,852	93.4%	$131,630,797	541	5.1%	$31,561,165	151	1.4%	$13,282,846	10,544	100%	$176,474,808
Wendell	3,728	3,378	90.6%	$24,235,870	277	7.4%	$9,493,528	73	2%	$4,099,871	3,728	100%	$37,829,269
Zebulon	3,074	2,677	87.1%	$18,281,713	316	10.3%	$23,491,799	79	2.6%	$4,733,857	3,072	99.9%	$46,507,369
Unincorporated Wake County	59,372	55,779	93.9%	$697,627,719	3,122	5.3%	$113,926,950	402	0.7%	$21,225,286	59,303	99.9%	$832,779,955
Total	**310,482**	**290,928**	**93.7%**	**$3,634,099,035**	**15,315**	**4.9%**	**$1,262,759,013**	**4,104**	**1.3%**	**$357,530,939**	**310,347**	**100%**	**$5,254,388,988**

Source: NCEM Risk Management Tool

Table 4.75 – Estimated Buildings Impacted by EF1 Tornado

Jurisdiction	All Buildings	Residential Buildings at Risk			Commercial Buildings at Risk			Public Buildings at Risk			Total Buildings at Risk		
	Num	Num	% of Total	Estimated Damages	Num	% of Total	Estimated Damages	Num	% of Total	Estimated Damages	Num	% of Total	Estimated Damages
Raleigh	128,076	119,439	93.3%	$10,416,918,277	6,345	5%	$4,342,524,798	2,272	1.8%	$1,294,088,485	128,056	100%	$16,053,531,561
Apex	14,554	13,758	94.5%	$1,212,459,960	648	4.5%	$247,461,915	148	1%	$57,987,422	14,554	100%	$1,517,909,297
Cary	45,306	42,944	94.8%	$4,768,157,932	1,872	4.1%	$1,241,329,992	462	1%	$233,753,318	45,278	99.9%	$6,243,241,243
Fuquay-Varina	10,244	9,524	93%	$712,500,120	585	5.7%	$236,976,212	130	1.3%	$44,272,459	10,239	100%	$993,748,792
Garner	11,975	11,103	92.7%	$745,557,084	687	5.7%	$303,719,474	181	1.5%	$56,578,357	11,971	100%	$1,105,854,914
Holly Springs	9,178	8,887	96.8%	$813,713,743	226	2.5%	$148,789,896	62	0.7%	$41,802,214	9,175	100%	$1,004,305,852
Knightdale	7,144	6,811	95.3%	$438,850,279	265	3.7%	$85,966,313	67	0.9%	$36,373,280	7,143	100%	$561,189,872
Morrisville	5,181	4,793	92.5%	$552,947,796	340	6.6%	$361,606,818	48	0.9%	$17,676,783	5,181	100%	$932,231,397
Rolesville	2,103	1,983	94.3%	$168,823,830	91	4.3%	$17,561,438	29	1.4%	$7,800,376	2,103	100%	$194,185,643
Wake Forest	10,547	9,852	93.4%	$955,729,364	541	5.1%	$204,624,734	151	1.4%	$63,651,869	10,544	100%	$1,224,005,967
Wendell	3,728	3,378	90.6%	$176,238,985	277	7.4%	$66,293,935	73	2%	$21,394,247	3,728	100%	$263,927,166
Zebulon	3,074	2,677	87.1%	$131,872,300	316	10.3%	$164,254,888	79	2.6%	$23,118,401	3,072	99.9%	$319,245,589
Unincorporated Wake County	59,372	55,779	93.9%	$5,114,080,529	3,122	5.3%	$733,546,995	402	0.7%	$120,924,291	59,303	99.9%	$5,968,551,815
Total	**310,482**	**290,928**	**93.7%**	**$26,207,850,199**	**15,315**	**4.9%**	**$8,154,657,408**	**4,104**	**1.3%**	**$2,019,421,502**	**310,347**	**100%**	**$36,381,929,108**

Source: NCEM Risk Management Tool

Table 4.76 – Estimated Buildings Impacted by EF2 Tornado

Jurisdiction	All Buildings	Residential Buildings at Risk			Commercial Buildings at Risk			Public Buildings at Risk			Total Buildings at Risk		
	Num	Num	% of Total	Estimated Damages	Num	% of Total	Estimated Damages	Num	% of Total	Estimated Damages	Num	% of Total	Estimated Damages
Raleigh	128,076	119,439	93.3%	$21,223,313,072	6,345	5%	$10,355,437,329	2,272	1.8%	$4,239,533,660	128,056	100%	$35,818,284,061
Apex	14,554	13,758	94.5%	$2,353,454,802	648	4.5%	$591,211,502	148	1%	$174,678,795	14,554	100%	$3,119,345,099
Cary	45,306	42,944	94.8%	$9,381,294,545	1,872	4.1%	$2,893,508,918	462	1%	$692,355,748	45,278	99.9%	$12,967,159,211
Fuquay-Varina	10,244	9,524	93%	$1,357,961,297	585	5.7%	$557,139,075	130	1.3%	$136,026,227	10,239	100%	$2,051,126,598
Garner	11,975	11,103	92.7%	$1,457,940,926	687	5.7%	$711,512,671	181	1.5%	$171,283,720	11,971	100%	$2,340,737,317
Holly Springs	9,178	8,887	96.8%	$1,547,349,959	226	2.5%	$341,843,391	62	0.7%	$117,046,571	9,175	100%	$2,006,239,921
Knightdale	7,144	6,811	95.3%	$851,176,294	265	3.7%	$217,744,762	67	0.9%	$106,535,991	7,143	100%	$1,175,457,047
Morrisville	5,181	4,793	92.5%	$1,146,781,961	340	6.6%	$813,377,540	48	0.9%	$54,304,009	5,181	100%	$2,014,463,510
Rolesville	2,103	1,983	94.3%	$308,264,199	91	4.3%	$39,097,268	29	1.4%	$22,970,375	2,103	100%	$370,331,842
Wake Forest	10,547	9,852	93.4%	$1,870,172,080	541	5.1%	$488,179,917	151	1.4%	$185,530,682	10,544	100%	$2,543,882,679
Wendell	3,728	3,378	90.6%	$335,995,281	277	7.4%	$150,755,331	73	2%	$65,397,923	3,728	100%	$552,148,535
Zebulon	3,074	2,677	87.1%	$252,784,640	316	10.3%	$375,997,487	79	2.6%	$68,138,793	3,072	99.9%	$696,920,920
Unincorporated Wake County	59,372	55,779	93.9%	$9,548,933,764	3,122	5.3%	$1,588,978,607	402	0.7%	$385,872,314	59,303	99.9%	$11,523,784,685
Total	**310,482**	**290,928**	**93.7%**	**$51,635,422,820**	**15,315**	**4.9%**	**$19,124,783,798**	**4,104**	**1.3%**	**$6,419,674,808**	**310,347**	**100%**	**$77,179,881,425**

Source: NCEM Risk Management Tool

Table 4.77 – Estimated Buildings Impacted by EF3 Tornado

Jurisdiction	All Buildings	Residential Buildings at Risk			Commercial Buildings at Risk			Public Buildings at Risk			Total Buildings at Risk		
	Num	Num	% of Total	Estimated Damages	Num	% of Total	Estimated Damages	Num	% of Total	Estimated Damages	Num	% of Total	Estimated Damages
Raleigh	128,076	119,439	93.3%	$28,576,604,430	6,345	5%	$13,504,553,706	2,272	1.8%	$6,642,125,388	128,056	100%	$48,723,283,524
Apex	14,554	13,758	94.5%	$2,923,595,780	648	4.5%	$724,986,285	148	1%	$269,979,885	14,554	100%	$3,918,561,950
Cary	45,306	42,944	94.8%	$11,829,754,049	1,872	4.1%	$3,864,515,984	462	1%	$1,066,920,830	45,278	99.9%	$16,761,190,862
Fuquay-Varina	10,244	9,524	93%	$1,631,307,520	585	5.7%	$659,165,839	130	1.3%	$210,954,786	10,239	100%	$2,501,428,145
Garner	11,975	11,103	92.7%	$1,857,319,426	687	5.7%	$853,420,096	181	1.5%	$264,960,887	11,971	100%	$2,975,700,409
Holly Springs	9,178	8,887	96.8%	$1,835,972,479	226	2.5%	$387,175,562	62	0.7%	$178,518,663	9,175	100%	$2,401,666,703
Knightdale	7,144	6,811	95.3%	$1,080,680,577	265	3.7%	$277,956,147	67	0.9%	$163,844,433	7,143	100%	$1,522,481,156
Morrisville	5,181	4,793	92.5%	$1,591,480,162	340	6.6%	$999,330,152	48	0.9%	$84,214,790	5,181	100%	$2,675,025,104
Rolesville	2,103	1,983	94.3%	$358,315,781	91	4.3%	$46,907,622	29	1.4%	$35,360,834	2,103	100%	$440,584,236
Wake Forest	10,547	9,852	93.4%	$2,339,356,223	541	5.1%	$607,802,624	151	1.4%	$285,082,674	10,544	100%	$3,232,241,521
Wendell	3,728	3,378	90.6%	$408,087,164	277	7.4%	$174,844,420	73	2%	$101,333,244	3,728	100%	$684,264,828
Zebulon	3,074	2,677	87.1%	$313,983,232	316	10.3%	$426,760,361	79	2.6%	$104,910,127	3,072	99.9%	$845,653,721
Unincorporated Wake County	59,372	55,779	93.9%	$11,143,245,954	3,122	5.3%	$2,045,383,452	402	0.7%	$602,203,730	59,303	99.9%	$13,790,833,135
Total	**310,482**	**290,928**	**93.7%**	**$65,889,702,777**	**15,315**	**4.9%**	**$24,572,802,250**	**4,104**	**1.3%**	**$10,010,410,271**	**310,347**	**100%**	**$100,472,915,294**

Source: NCEM Risk Management Tool

Table 4.78 – Estimated Buildings Impacted by EF4 Tornado

Jurisdiction	All Buildings	Residential Buildings at Risk			Commercial Buildings at Risk			Public Buildings at Risk			Total Buildings at Risk		
	Num	Num	% of Total	Estimated Damages	Num	% of Total	Estimated Damages	Num	% of Total	Estimated Damages	Num	% of Total	Estimated Damages
Raleigh	128,076	119,439	93.3%	$29,468,067,648	6,345	5%	$14,005,762,959	2,272	1.8%	$7,061,665,278	128,056	100%	$50,535,495,885
Apex	14,554	13,758	94.5%	$2,965,533,313	648	4.5%	$750,339,784	148	1%	$294,007,286	14,554	100%	$4,009,880,383
Cary	45,306	42,944	94.8%	$12,033,926,207	1,872	4.1%	$4,040,134,449	462	1%	$1,167,820,191	45,278	99.9%	$17,241,880,847
Fuquay-Varina	10,244	9,524	93%	$1,642,621,151	585	5.7%	$674,061,968	130	1.3%	$228,386,862	10,239	100%	$2,545,069,981
Garner	11,975	11,103	92.7%	$1,894,788,588	687	5.7%	$880,357,811	181	1.5%	$288,113,216	11,971	100%	$3,063,259,615
Holly Springs	9,178	8,887	96.8%	$1,843,041,904	226	2.5%	$393,774,934	62	0.7%	$198,882,516	9,175	100%	$2,435,699,353
Knightdale	7,144	6,811	95.3%	$1,102,127,131	265	3.7%	$291,500,076	67	0.9%	$179,955,706	7,143	100%	$1,573,582,913
Morrisville	5,181	4,793	92.5%	$1,650,698,135	340	6.6%	$1,025,653,699	48	0.9%	$91,177,528	5,181	100%	$2,767,529,362
Rolesville	2,103	1,983	94.3%	$358,765,272	91	4.3%	$48,227,632	29	1.4%	$38,773,663	2,103	100%	$445,766,568
Wake Forest	10,547	9,852	93.4%	$2,375,799,550	541	5.1%	$631,897,853	151	1.4%	$313,586,439	10,544	100%	$3,321,283,842
Wendell	3,728	3,378	90.6%	$412,070,013	277	7.4%	$178,076,927	73	2%	$109,872,126	3,728	100%	$700,019,067
Zebulon	3,074	2,677	87.1%	$318,729,205	316	10.3%	$432,971,166	79	2.6%	$115,004,270	3,072	99.9%	$866,704,641
Unincorporated Wake County	59,372	55,779	93.9%	$11,151,176,373	3,122	5.3%	$2,101,325,727	402	0.7%	$644,903,139	59,303	99.9%	$13,897,405,239
Total	**310,482**	**290,928**	**93.7%**	**$67,217,344,490**	**15,315**	**4.9%**	**$25,454,084,985**	**4,104**	**1.3%**	**$10,732,148,220**	**310,347**	**100%**	**$103,403,577,696**

Source: NCEM Risk Management Tool

Environment

Tornadoes can cause massive damage to the natural environment, uprooting trees and other debris within the tornado's path. This is part of a natural process, however, and the environment will return to its original state in time.

Consequence Analysis

Table 4.79 summarizes the potential negative consequences of tornado.

Table 4.79 – Consequence Analysis - Tornado

Category	Consequences
Public	Injuries; fatalities
Responders	Injuries; fatalities; potential impacts to response capabilities due to storm impacts
Continuity of Operations (including Continued Delivery of Services)	Potential impacts to continuity of operations due to storm impacts; delays in providing services
Property, Facilities and Infrastructure	The weakest tornadoes, EF0, can cause minor roof damage, while strong tornadoes can destroy frame buildings and even badly damage steel reinforced concrete structures. Buildings are vulnerable to direct impact from tornadoes and also from wind borne debris. Mobile homes are particularly susceptible to damage during tornadoes.
Environment	Potential devastating impacts in storm's path
Economic Condition of the Jurisdiction	Contingent on tornado's path; can severely impact/destroy critical infrastructure and other economic drivers
Public Confidence in the Jurisdiction's Governance	Public confidence in the jurisdiction's governance may be influenced by severe tornado events if response and recovery are not timely and effective.

Hazard Summary by Jurisdiction

The following table summarizes tornado hazard risk by jurisdiction. Tornado hazard risk does not vary substantially by jurisdiction.

Jurisdiction	Probability	Impact	Spatial Extent	Warning Time	Duration	Score	Priority
Wake County	3	3	2	4	1	2.7	H
Apex	3	3	2	4	1	2.7	H
Cary	3	3	2	4	1	2.7	H
Fuquay-Varina	3	3	2	4	1	2.7	H
Garner	3	3	2	4	1	2.7	H
Holly Springs	3	3	2	4	1	2.7	H
Knightdale	3	3	2	4	1	2.7	H
Morrisville	3	3	2	4	1	2.7	H
Raleigh	3	3	2	4	1	2.7	H
Rolesville	3	3	2	4	1	2.7	H
Wake Forest	3	3	2	4	1	2.7	H
Wendell	3	3	2	4	1	2.7	H
Zebulon	3	3	2	4	1	2.7	H

4.5.11 Wildfire

Hazard Background

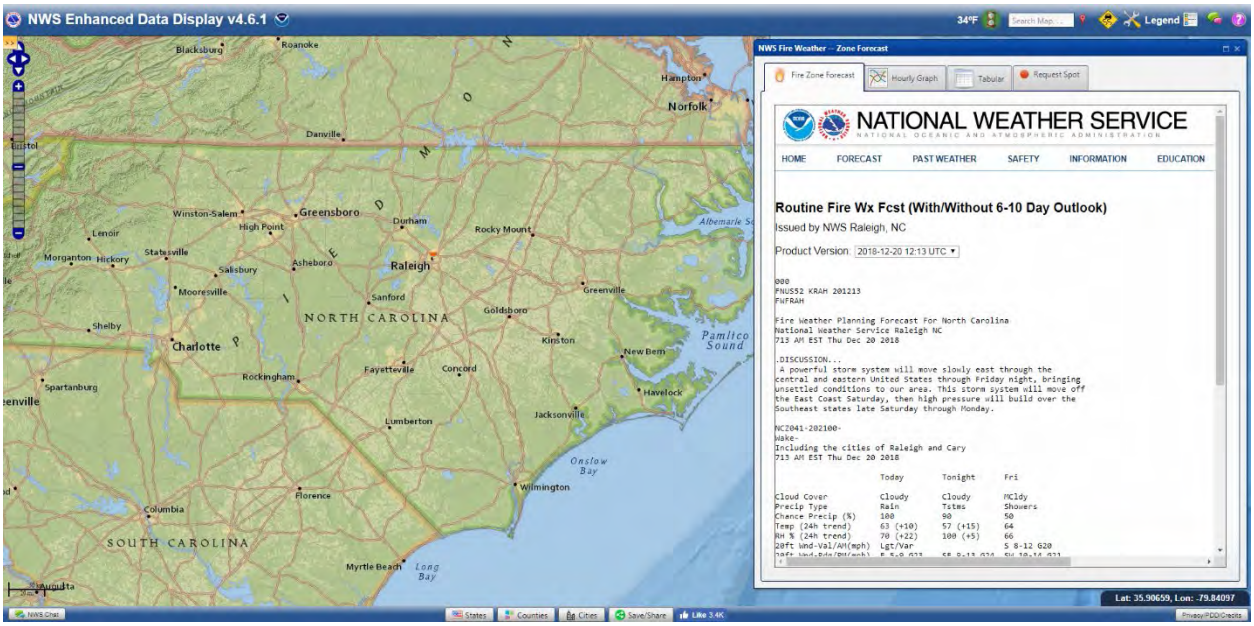
A wildfire is an uncontained fire that spreads through the environment. Wildfires have the ability to consume large areas, including infrastructure, property, and resources. When massive fires, or conflagrations, develop near populated areas, evacuations possibly ensue. Not only do the flames impact the environment, but the massive volumes of smoke spread by certain atmospheric conditions also impact the health of nearby populations. There are three general types of fire spread that are recognized.

- **Ground fires** – burn organic matter in the soil beneath surface litter and are sustained by glowing combustion.
- **Surface fires** – spread with a flaming front and burn leaf litter, fallen branches and other fuels located at ground level.
- **Crown fires** – burn through the top layer of foliage on a tree, known as the canopy or crown fires. Crown fires, the most intense type of fire and often the most difficult to contain, need strong winds, steep slopes and a heavy fuel load to continue burning.

Generally, wildfires are started by humans, either through arson or carelessness. Fire intensity is controlled by both short-term weather conditions and longer-term vegetation conditions. During intense fires, understory vegetation, such as leaves, small branches, and other organic materials that accumulate on the ground, can become additional fuel for the fire. The most explosive conditions occur when dry, gusty winds blow across dry vegetation.

Weather plays a major role in the birth, growth and death of a wildfire. In support of forecasting for fire weather, the National Weather Service Fire Weather Program emerged in response to a need for weather support to large and dangerous wildfires. This service is provided to federal and state land management agencies for the prevention, suppression, and management of forest and rangeland fires. As shown in Figure 4.21, the National Weather Service Raleigh Forecast Office provides year-round fire weather forecasts for Wake County.

Figure 4.21 – Fire Weather Forecast, Wake County



Source: National Weather Service

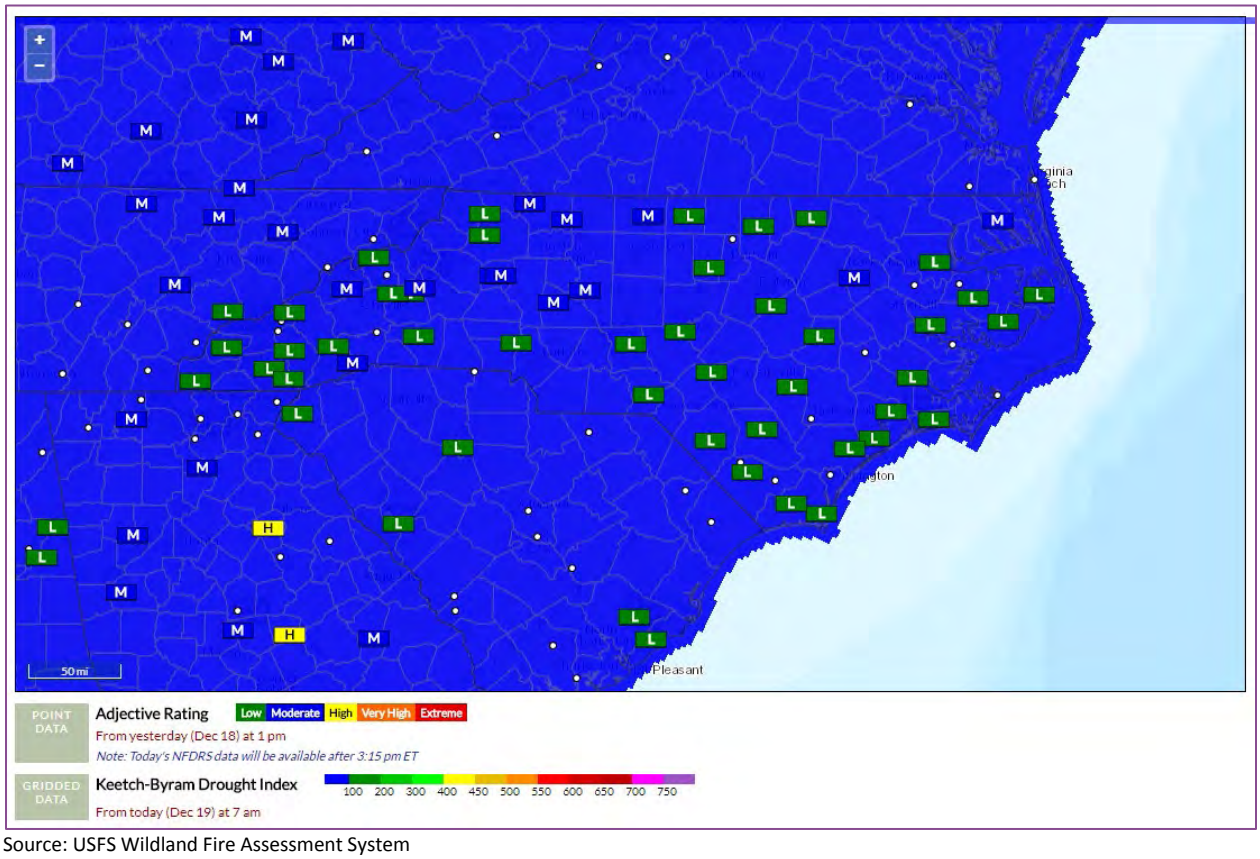
Weather conditions favorable to wildfire include drought, which increases flammability of surface fuels, and winds, which aid a wildfire's progress. The combination of wind, temperature, and humidity affects how fast wildland fires can spread. Rapid response can contain wildfires and limit their threat to property.

Wake County experiences a variety of wildfire conditions found in the Keetch-Byram Drought Index, which is described in Table 4.80. The Keetch-Byram Drought Index (KBDI) for December 19, 2018 is shown in Figure 4.22 along with a Daily Fire Danger Estimate Adjective Rating for certain points across the state. The KBDI for Wake County at this time was below 100, and the Fire Danger Estimate for the nearby area was "Low."

Table 4.80 – Keetch-Byram Drought Index Fire Danger Rating System

KBDI	Description
0-200	Soil and fuel moisture are high. Most fuels will not readily ignite or burn. However, with sufficient sunlight and wind, cured grasses and some light surface fuels will burn in sports and patches.
200-400	Fires more readily burn and will carry across an area with no gaps. Heavier fuels will still not readily ignite and burn. Also, expect smoldering and the resulting smoke to carry into and possibly through the night.
400-600	Fire intensity begins to significantly increase. Fires will readily burn in all directions exposing mineral soils in some locations. Larger fuels may burn or smolder for several days creating possible smoke and control problems.
600-800	Fires will burn to mineral soil. Stumps will burn to the end of underground roots and spotting will be a major problem. Fires will burn through the night and heavier fuels will actively burn and contribute to fire intensity.

Figure 4.22 – Keetch-Byram Drought Index, December 2018



Source: USFS Wildland Fire Assessment System

Warning Time: 4 – Less than 6 hours

Duration: 3 – Less than 1 week

Location

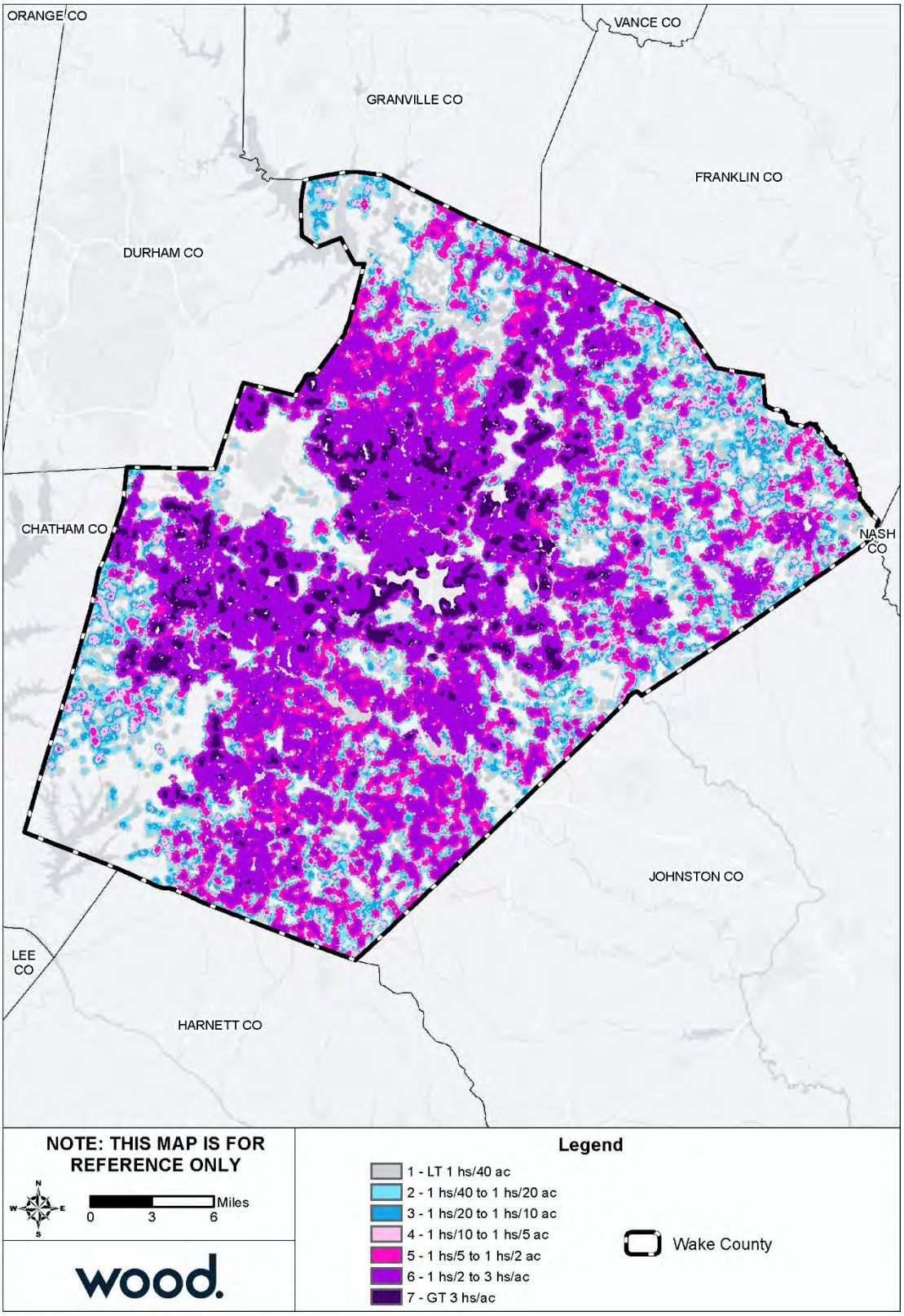
The location of wildfire risk can be defined by the acreage of Wildland Urban Interface (WUI). The WUI is described as the area where structures and other human improvements meet and intermingle with undeveloped wildland or vegetative fuels, and thus demarcates the spatial extent of wildfire risk. The WUI is essentially all the land in the county that is not heavily urbanized. The Southern Wildfire Risk Assessment (SWRA) estimates that 96 percent of the Wake County population lives within the WUI. The expansion of residential development from urban centers out into rural landscapes increases the potential for wildland fire threat to public safety and the potential for damage to forest resources and dependent industries. Population growth within the WUI substantially increases the risk of wildfire. Table 4.81 details the extent of the WUI in Wake County, and Figure 4.23 maps the WUI.

Table 4.81 – Wildland Urban Interface, Population and Acres

	Housing Density	WUI Population	Percent of WUI Population	WUI Acres	Percent of WUI Acres
	LT 1hs/40ac	943	0.1 %	42,258	9.7 %
	1hs/40ac to 1hs/20ac	1,975	0.2 %	33,961	7.8 %
	1hs/20ac to 1hs/10ac	5,417	0.6 %	44,188	10.1 %
	1hs/10ac to 1hs/5ac	13,722	1.6 %	52,621	12.1 %
	1hs/5ac to 1hs/2ac	49,907	5.8 %	76,831	17.6 %
	1hs/2ac to 3hs/1ac	511,813	59.1 %	161,007	36.9 %
	GT 3hs/1ac	281,706	32.5 %	24,986	5.7 %
	Total	**865,483**	**100.0 %**	**435,852**	**100.0 %**

Source: Southern Wildfire Risk Assessment

Figure 4.23 – Wildland Urban Interface, Wake County



Source: Southern Wildfire Risk Assessment

Extent

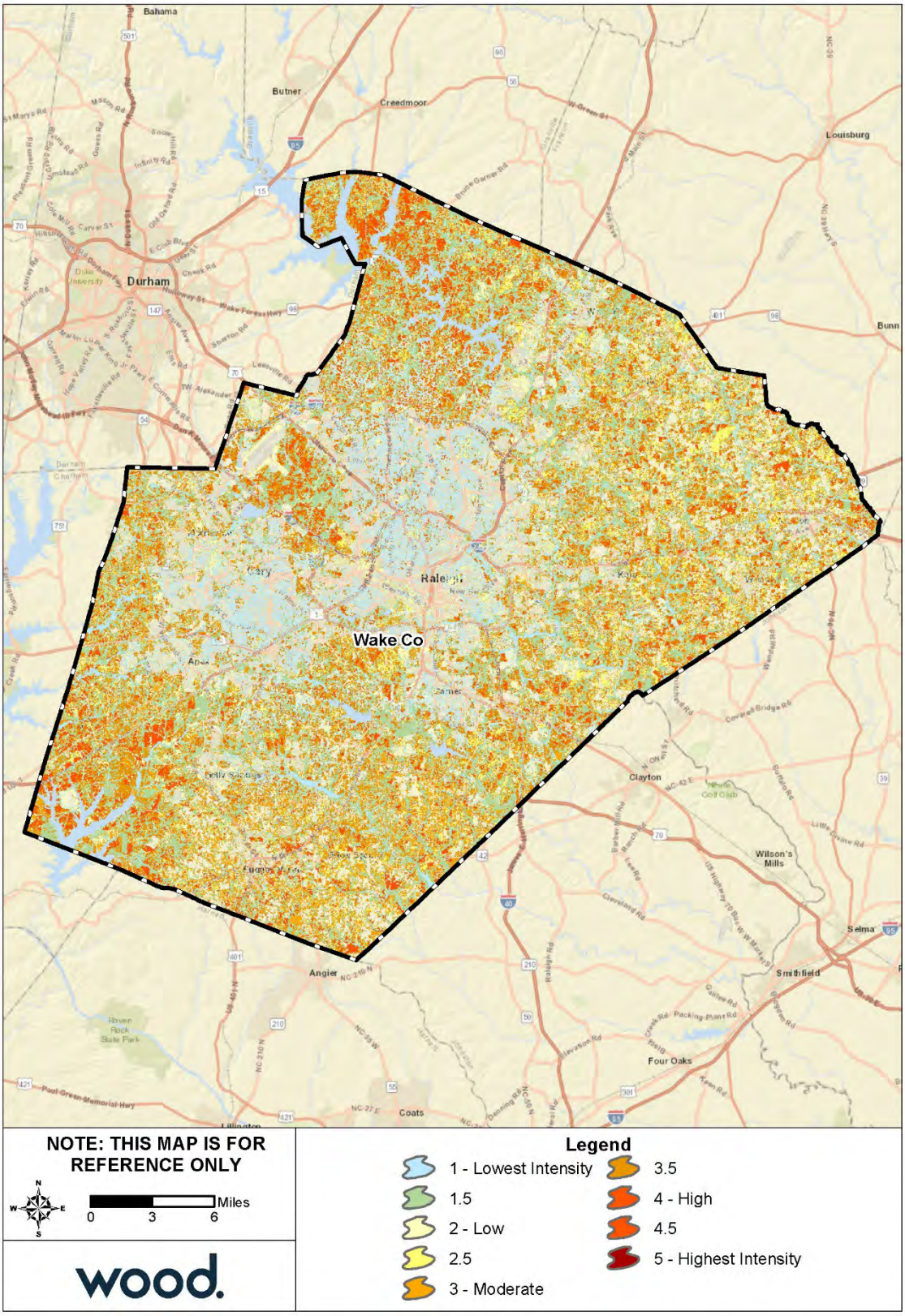
Wildfire extent can be defined by the fire's intensity and measured by the Characteristic Fire Intensity Scale, which identifies areas where significant fuel hazards which could produce dangerous fires exist. Fire Intensity ratings identify where significant fuel hazards and dangerous fire behavior potential exist based on fuels, topography, and a weighted average of four percentile weather categories. The Fire Intensity Scale consists of five classes, as defined by Southern Wildfire Risk Assessment. Figure 4.24 shows the potential fire intensity within the WUI across Wake County.

Table 4.82 – Fire Intensity Scale

Class	Description
1, Very Low	Very small, discontinuous flames, usually less than 1 foot in length; very low rate of spread; no spotting. Fires are typically easy to suppress by firefighters with basic training and non-specialized equipment.
2, Low	Small flames, usually less than two feet long; small amount of very short range spotting possible. Fires are easy to suppress by trained firefighters with protective equipment and specialized tools.
3, Moderate	Flames up to 8 feet in length; short-range spotting is possible. Trained firefighters will find these fires difficult to suppress without support from aircraft or engines, but dozer and plows are generally effective. Increasing potential for harm or damage to life and property.
4, High	Large Flames, up to 30 feet in length; short-range spotting common; medium range spotting possible. Direct attack by trained firefighters, engines, and dozers is generally ineffective, indirect attack may be effective. Significant potential for harm or damage to life and property.
5, Very High	Very large flames up to 150 feet in length; profuse short-range spotting, frequent long-range spotting; strong fire-induced winds. Indirect attack marginally effective at the head of the fire. Great potential for harm or damage to life and property.

Source: Southern Wildfire Risk Assessment

Figure 4.24 – Characteristic Fire Intensity, Wake County



Source: Southern Wildfire Risk Assessment

A small portion, approximately 7 percent, of Wake County may experience up to a Class 4 Fire Intensity, which poses significant harm or damage to life and property. Over 22 percent of Wake County may experience Class 3 Fire Intensity, which has potential for harm to life and property but is easier to suppress with dozer and plows. The remainder of the county is either non-burnable (26.4%) or would face a Class 1 or Class 2 Fire Intensity, which are easily suppressed.

Impact: 2 – Limited

Spatial Extent: 3 – Moderate

Historical Occurrences

The North Carolina Forest Service (NCFS) began keeping records of fire occurrence on private and state-owned lands in 1928. Since this time, there has been an average of approximately 4,000 fires burning more than 115,000 acres annually. Recently, within the last 10 years, the State has averaged closer to 3,200 fires per year and 15,000 acres burned annually.

Table 5.17 lists past occurrences of wildfire in Wake County since 2009 as provided by the North Carolina Forest Service (NCFS) in January 2019. This data only accounts for occurrences within unincorporated Wake County, which fall under the NCFS jurisdiction, as well as larger events in incorporated areas where local fire departments requested NCFS support for fire suppression. Actual number of fires and acreage burned are higher than what can be reported here.

Table 4.83 – Records for Wildfire in Wake County, 2009-2018

Year	Number of Fires	Acreage Burned
2009	2	17.3
2010	21	130.2
2011	17	225.0
2012	13	101.0
2013	1	2.5
2014	3	5.1
2015	3	32.1
2016	23	75.4
2017	27	148.3
2018	11	40.2
Total	**101**	**777.1**

Source: NC Forest Service

Wake County experienced prolonged periods of severe drought in 2010 and 2011, as well as moderate drought in 2009, 2012, 2013, 2015, and 2017. These periods of drought may explain some of the annual variation in fires and acreage burned.

On average, Wake County experiences 10.1 fires and 77.7 acres burned annually from fires that require the North Carolina Forest Service to respond. Actual number of fires and acreage burned is likely higher because smaller fires within jurisdictional boundaries are managed by local fire departments.

Probability of Future Occurrence

The Southern Wildfire Risk Assessment provides a Burn Probability analysis which predicts the probability of an area burning based on landscape conditions, weather, historical ignition patterns, and historical fire prevention and suppression efforts. Burn Probability data is generated by simulating fires under different weather, fire intensity, and other conditions. Values in the Burn Probability (BP) data layer indicate, for

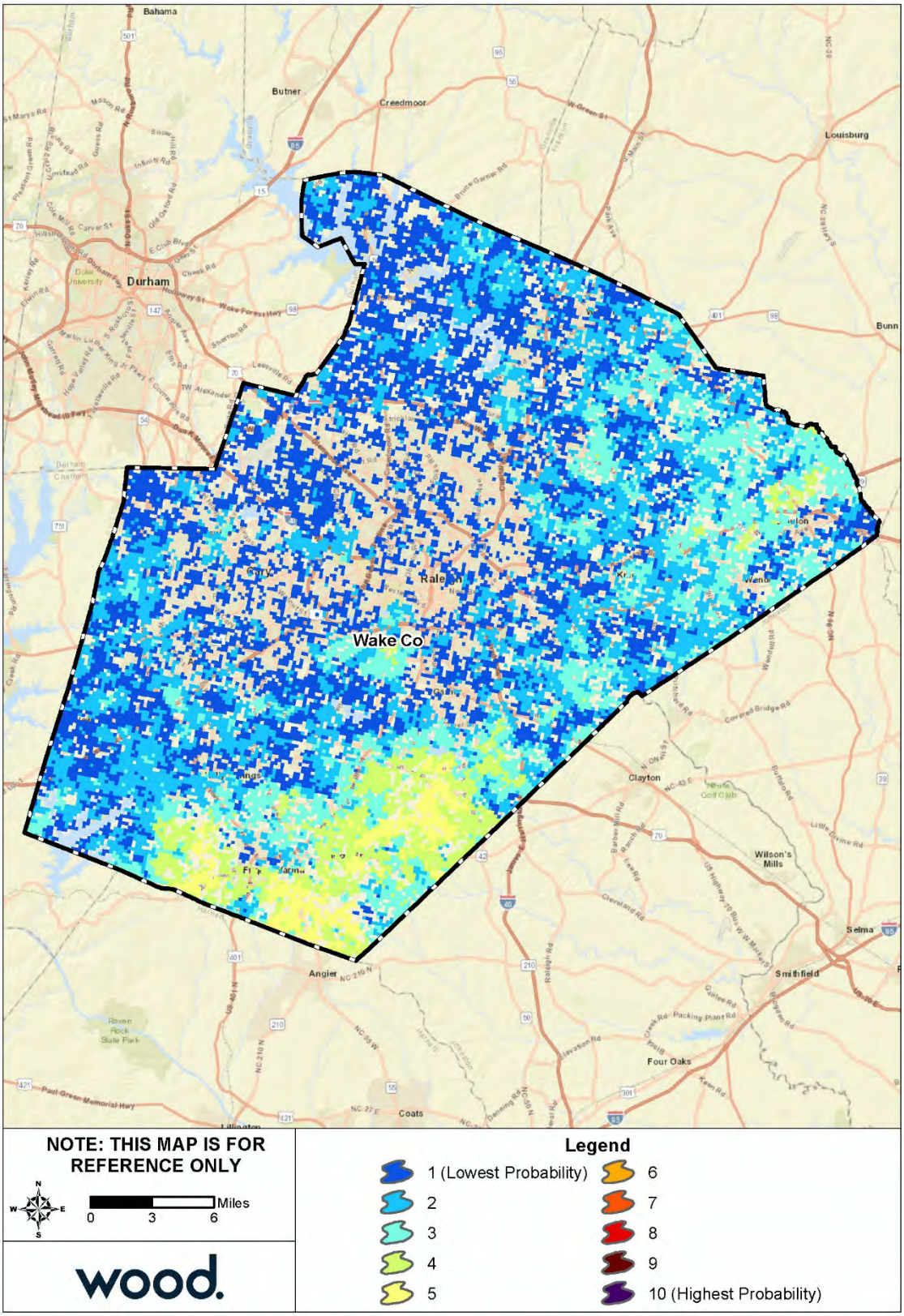
each pixel, the number of times that cell was burned by a modeled fire, divided by the total number of annual weather scenarios simulated. The simulations are calibrated to historical fire size distributions. The Burn Probability for Wake County is presented in Table 4.84 and illustrated in Fig.

Table 4.84 – Burn Probability, Wake County

Class	Acres	Percent
1	146,796	39.8 %
2	125,323	34.0 %
3	59,446	16.1 %
4	25,400	6.9 %
5	11,763	3.2 %
6	0	0.0 %
7	0	0.0 %
8	0	0.0 %
9	0	0.0 %
10	0	0.0 %
Total	**368,728**	**100.0 %**

Source: Southern Wildfire Risk Assessment

Figure 4.25 – Burn Probability, Wake County



Source: Southern Wildfire Risk Assessment

All of Wake County has a relatively low burn probability, with the highest probabilities reaching a rating of 5 or less. The areas of moderate burn probability are located primarily in the southeast of the county in Fuquay-Varina, Garner, and the unincorporated county, with an additional small cluster in the northeast in and around Zebulon. The probability of wildfire across the county is considered possible, defined as between a 1% and 10% annual chance of occurrence. While all jurisdictions fall within this threshold, the communities containing moderate burn probability, noted above, have a comparatively higher probability of occurrence.

Probability: 2 – Possible

Climate Change

Wildfires are usually prevalent with a combination of high temperatures and dry conditions, combustible fuels and an ignition source. Climate change has been linked to longer, warmer and drier conditions in the Southeast, exacerbating key potential conditions for a wildfire to spread.

Vulnerability Assessment

Methodologies and Assumptions

Population and property at risk to wildfire was estimated using data from the North Carolina Emergency Management (NCEM) IRISK database, which was compiled in NCEM's Risk Management Tool.

Within IRISK, wildfire hazard areas were determined using the Wildland Fire Susceptibility Index (WFSI). The following parameters were applied:

- Areas with a WFSI value of 0.01 – 0.05 were considered to be at moderate risk.
- Areas with a WFSI value greater than 0.05 were considered to be at high risk.
- Areas with a WFSI value less than 0.01 were considered to not be at risk.

The WFSI integrates the probability of an acre igniting and the expected final fire size based on the rate of spread in four weather percentile categories into a single measure of wildland fire susceptibility. Due to some necessary assumptions, mainly fuel homogeneity, it is not the true probability. But since all areas of the state have this value determined consistently, it allows for comparison and ordination of areas of the state as to the likelihood of an acre burning.

People

Wildfire can cause fatalities and human health hazards. Ensuring procedures are in place for rapid warning and evacuation are essential to reducing vulnerability. Table 4.85 details the population estimated to be at risk to wildfire according to the NCEM IRISK database.

Table 4.85 – Estimated Population Impacted by Wildfire

Jurisdiction	Total Population	Total Population at Risk		All Elderly Population	Elderly Population at Risk		All Children Population	Children at Risk	
		Number	Percent		Number	Percent		Number	Percent
Raleigh	419,053	14	0%	35,611	1	0%	30,469	1	0%
Apex	41,724	0	0%	3,546	0	0%	3,034	0	0%
Cary	136,260	0	0%	11,579	0	0%	9,907	0	0%
Fuquay-Varina	25,023	527	2.10%	2,126	45	2.10%	1,819	38	2.10%
Garner	30,981	0	0%	2,633	0	0%	2,253	0	0%

Jurisdiction	Total Population	Total Population at Risk		All Elderly Population	Elderly Population at Risk		All Children Population	Children at Risk	
		Number	Percent		Number	Percent		Number	Percent
Holly Springs	25,790	0	0%	2,192	0	0%	1,875	0	0%
Knightdale	18,501	92	0.50%	1,572	8	0.50%	1,345	7	0.50%
Morrisville	18,655	0	0%	1,585	0	0%	1,356	0	0%
Rolesville	5,199	0	0%	442	0	0%	378	0	0%
Wake Forest	30,382	0	0%	2,582	0	0%	2,209	0	0%
Wendell	7,889	89	1.10%	670	8	1.20%	574	6	1%
Zebulon	6,102	71	1.20%	519	6	1.20%	444	5	1.10%
Unincorporated Wake County	135,124	470	0.30%	11,483	40	0.30%	9,825	34	0.30%
Total	**900,683**	**1,263**	**0.14%**	**76,540**	**108**	**0.14%**	**65,488**	**91**	**0.14%**

Source: NCEM Risk Management Tool

Property

Wildfire can cause direct property losses, including damage to buildings, vehicles, landscaped areas, agricultural lands, and livestock. Construction practices and building codes can increase fire resistance and fire safety of structures. Techniques for reducing vulnerability to wildfire include using street design to ensure accessibility to fire trucks, incorporating fire resistant materials in building construction, and using landscaping practices to reduce flammability and the ability for fire to spread.

Table 4.87 provides building counts and estimated damages for Critical Infrastructure and Key Resources (CIKR) buildings across all jurisdictions, by sector. The sectors facing the greatest risk to wildfire in Wake County are critical manufacturing, commercial facilities, food and agriculture, and transportation systems.

Table 4.86 details the buildings at risk to wildfire in Wake County.

Table 4.86 – Estimated Buildings Impacted by Wildfire

Jurisdiction	All Buildings	Residential Buildings at Risk			Commercial Buildings at Risk			Public Buildings at Risk			Total Buildings at Risk		
	Num	Num	% of Total	Estimated Damages	Num	% of Total	Estimated Damages	Num	% of Total	Estimated Damages	Num	% of Total	Estimated Damages
Raleigh	128,076	4	0%	$472,031	2	0%	$381,965	0	0%	$0	6	0%	$853,996
Apex	14,554	0	0%	$0	0	0%	$0	0	0%	$0	0	0%	$0
Cary	45,306	0	0%	$0	0	0%	$0	0	0%	$0	0	0%	$0
Fuquay-Varina	10,244	201	2%	$42,797,092	3	0%	$7,290,895	0	0%	$0	204	2%	$50,087,987
Garner	11,975	0	0%	$0	1	0%	$19,571,810	0	0%	$0	1	0%	$19,571,810
Holly Springs	9,178	0	0%	$0	0	0%	$0	0	0%	$0	0	0%	$0
Knightdale	7,144	34	0.5%	$3,182,975	3	0%	$157,144	0	0%	$0	37	0.5%	$3,340,119
Morrisville	5,181	0	0%	$0	0	0%	$0	0	0%	$0	0	0%	$0
Rolesville	2,103	0	0%	$0	0	0%	$0	0	0%	$0	0	0%	$0
Wake Forest	10,547	0	0%	$0	0	0%	$0	0	0%	$0	0	0%	$0
Wendell	3,728	38	1%	$4,977,285	0	0%	$0	0	0%	$0	38	1%	$4,977,285
Zebulon	3,074	31	1%	$1,978,442	1	0%	$71,156	0	0%	$0	32	1%	$2,049,598
Unincorporated Wake County	59,372	194	0.3%	$36,581,396	60	0.1%	$7,760,387	3	0%	$3,453,114	257	0.4%	$47,794,897
Total	**310,482**	**502**	**0.2%**	**$89,989,221**	**70**	**0%**	**$35,233,357**	**3**	**0%**	**$3,453,114**	**575**	**0.2%**	**$128,675,692**

Source: NCEM Risk Management Tool

Table 4.87 – Critical Infrastructure and Key Resources Buildings at Risk to Wildfire by Sector

Sector	Number of Buildings at Risk	Estimated Damages
Commercial Facilities	7	$11,385,851
Critical manufacturing	7	$24,434,636
Food and Agriculture	57	$2,484,018
Transportation Systems	2	$381,965
All Categories	**73**	**$38,686,470**

Source: NCEM Risk Management Tool

Environment

Wildfires have the potential to destroy forest and forage resources and damage natural habitats. Wildfire can also damage agricultural crops on private land. Wildfire is part of a natural process, however, and the environment will return to its original state in time.

Consequence Analysis

Table 4.88 summarizes the potential detrimental consequences of wildfire.

Table 4.88 – Consequence Analysis - Wildfire

Category	Consequences
Public	In addition to the potential for fatalities, wildfire and the resulting diminished air quality pose health risks. Exposure to wildfire smoke can cause serious health problems within a community, including asthma attacks and pneumonia, and can worsen chronic heart and lung diseases. Vulnerable populations include children, the elderly, people with respiratory problems or with heart disease. Even healthy citizens may experience minor symptoms, such as sore throats and itchy eyes.
Responders	Public and firefighter safety is the first priority in all wildland fire management activities. Wildfires are a real threat to the health and safety of the emergency services. Most fire-fighters in rural areas are 'retained'. This means that they are part-time and can be called away from their normal work to attend to fires.
Continuity of Operations (including Continued Delivery of Services)	Wildfire events can result in a loss of power which may impact operations. Downed trees, power lines and damaged road conditions may prevent access to critical facilities and/or emergency equipment.
Property, Facilities and Infrastructure	Wildfires frequently damage community infrastructure, including roadways, communication networks and facilities, power lines, and water distribution systems. Restoring basic services is critical and a top priority. Efforts to restore roadways include the costs of maintenance and damage assessment teams, field data collection, and replacement or repair costs. Direct impacts to municipal water supply may occur through contamination of ash and debris during the fire, destruction of aboveground distribution lines, and soil erosion or debris deposits into waterways after the fire. Utilities and communications repairs are also necessary for equipment damaged by a fire. This includes power lines, transformers, cell phone towers, and phone lines.
Environment	Wildfires cause damage to the natural environment, killing vegetation and animals. The risk of floods and debris flows increases after wildfires due to the exposure of bare ground and the loss of vegetation. In addition, the secondary effects of wildfires, including erosion, landslides, introduction of invasive species, and changes in water quality, are often more disastrous than the fire itself.
Economic Condition of the Jurisdiction	Wildfires can have significant short-term and long-term effects on the local economy. Wildfires, and extreme fire danger, may reduce recreation and tourism in and near the fires. If aesthetics are impaired, local property values can decline. Extensive fire

	damage to trees can significantly alter the timber supply, both through a short-term surplus from timber salvage and a longer-term decline while the trees regrow. Water supplies can be degraded by post-fire erosion and stream sedimentation. Wildfires can also have positive effects on local economies. Positive effects come from economic activity generated in the community during fire suppression and post-fire rebuilding. These may include forestry support work, such as building fire lines and performing other defenses, or providing firefighting teams with food, ice, and amenities such as temporary shelters and washing machines.
Public Confidence in the Jurisdiction's Governance	Wildfire events may cause issues with public confidence because they have very visible impacts on the community. Public confidence in the jurisdiction's governance may be influenced by: • The jurisdiction's actions taken pre-disaster to mitigate and prepare for impacts, including the amount of public education provided • The jurisdiction's efforts to provide warning to residents • The jurisdiction's actions taken to respond to the event • The jurisdiction's actions taken to recover from the impacts and return impacted communities to the same or better state before the wildfire occurred

Hazard Summary by Jurisdiction

The following table summarizes wildfire hazard risk by jurisdiction. Wildfire warning time and duration do not vary by jurisdiction. Spatial extent ratings were based on the proportion of area within the WUI; all jurisdictions have at least 50% of their area in the WUI and were assigned a rating of 3. Impact ratings were based on fire intensity data from SWRA. Jurisdictions with significant clusters of moderate to high fire intensity were assigned a rating of 3; all other jurisdictions were assigned a rating of 2. Probability ratings were determined based on burn probability data from SWRA. Jurisdictions with clusters of moderate burn probability were assigned a rating of 3; all other jurisdictions were assigned a probability of 2.

Jurisdiction	Probability	Impact	Spatial Extent	Warning Time	Duration	Score	Priority
Wake County	3	3	3	4	3	3.1	H
Apex	2	2	3	4	3	2.5	H
Cary	2	2	3	4	3	2.5	H
Fuquay-Varina	3	2	3	4	3	2.8	H
Garner	3	2	3	4	3	2.8	H
Holly Springs	3	2	3	4	3	2.8	H
Knightdale	2	3	3	4	3	2.8	H
Morrisville	2	2	3	4	3	2.5	H
Raleigh	2	2	3	4	3	2.5	H
Rolesville	2	3	3	4	3	2.8	H
Wake Forest	2	2	3	4	3	2.5	H
Wendell	2	2	3	4	3	2.5	H
Zebulon	3	2	3	4	3	2.8	H

4.5.12 Hazardous Materials Incident

Hazard Background

A hazardous substance is any substance that may cause harm to persons, property, or the environment when released to soil, water, or air. Chemicals are manufactured and used in increasing types and quantities. Each year over 1,000 new synthetic chemicals are introduced and as many as 500,000 products pose physical or health hazards and can be defined as "hazardous chemicals". Hazardous substances are categorized as toxic, corrosive, flammable, irritant, or explosive. Hazardous material incidents generally affect a localized area.

Fixed Hazardous Materials Incident

A fixed hazardous materials incident is the accidental release of chemical substances or mixtures during production or handling at a fixed facility.

Transportation Hazardous Materials Incident

A transportation hazardous materials incident is the accidental release of chemical substances or mixtures during transport. Transportation Hazardous Materials Incidents in Wake County can occur during highway or air transport. Highway accidents involving hazardous materials pose a great potential for public exposures. Both nearby populations and motorists can be impacted and become exposed by accidents and releases. If airplanes carrying hazardous cargo crash, or otherwise leak contaminated cargo, populations and the environment in the impacted area can become exposed.

Pipeline Incident

A pipeline transportation incident occurs when a break in a pipeline creates the potential for an explosion or leak of a dangerous substance (oil, gas, etc.) possibly requiring evacuation. An underground pipeline incident can be caused by environmental disruption, accidental damage, or sabotage. Incidents can range from a small, slow leak to a large rupture where an explosion is possible. Inspection and maintenance of the pipeline system along with marked gas line locations and an early warning and response procedure can lessen the risk to those near the pipelines.

Warning Time Score: 4 – Less than six hours

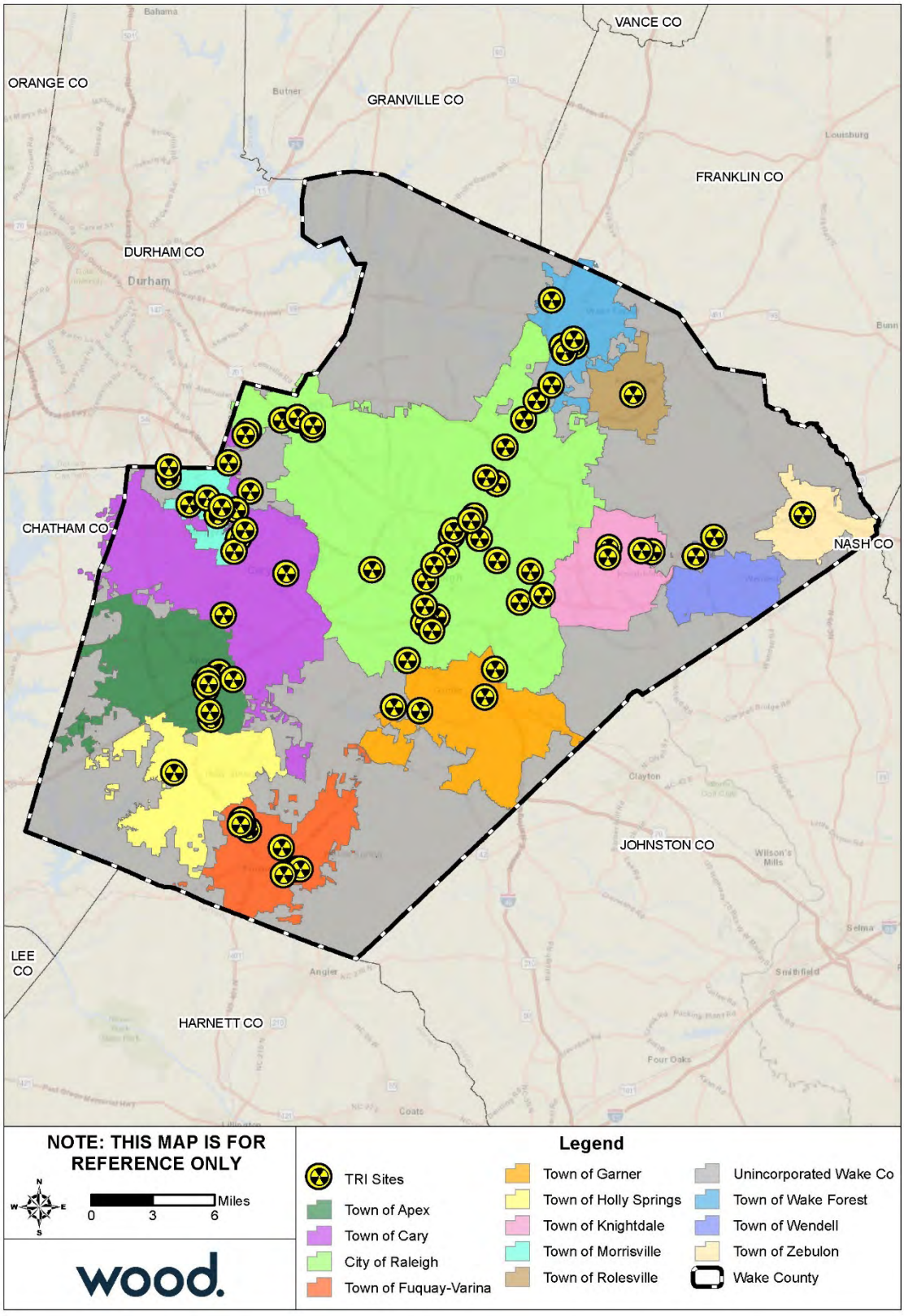
Duration Score: 2 – Less than 24 hours

Location

The Toxics Release Inventory (TRI) Program run by the U.S. Environmental Protection Agency (EPA) maintains a database of industrial facilities across the country and the type and quantity of toxic chemicals they release. The program also tracks pollution prevention activities and which facilities are reducing toxic releases. The Toxic Release Inventory reports 35 sites with hazardous materials in Wake County. These sites are shown in Figure 4.26.

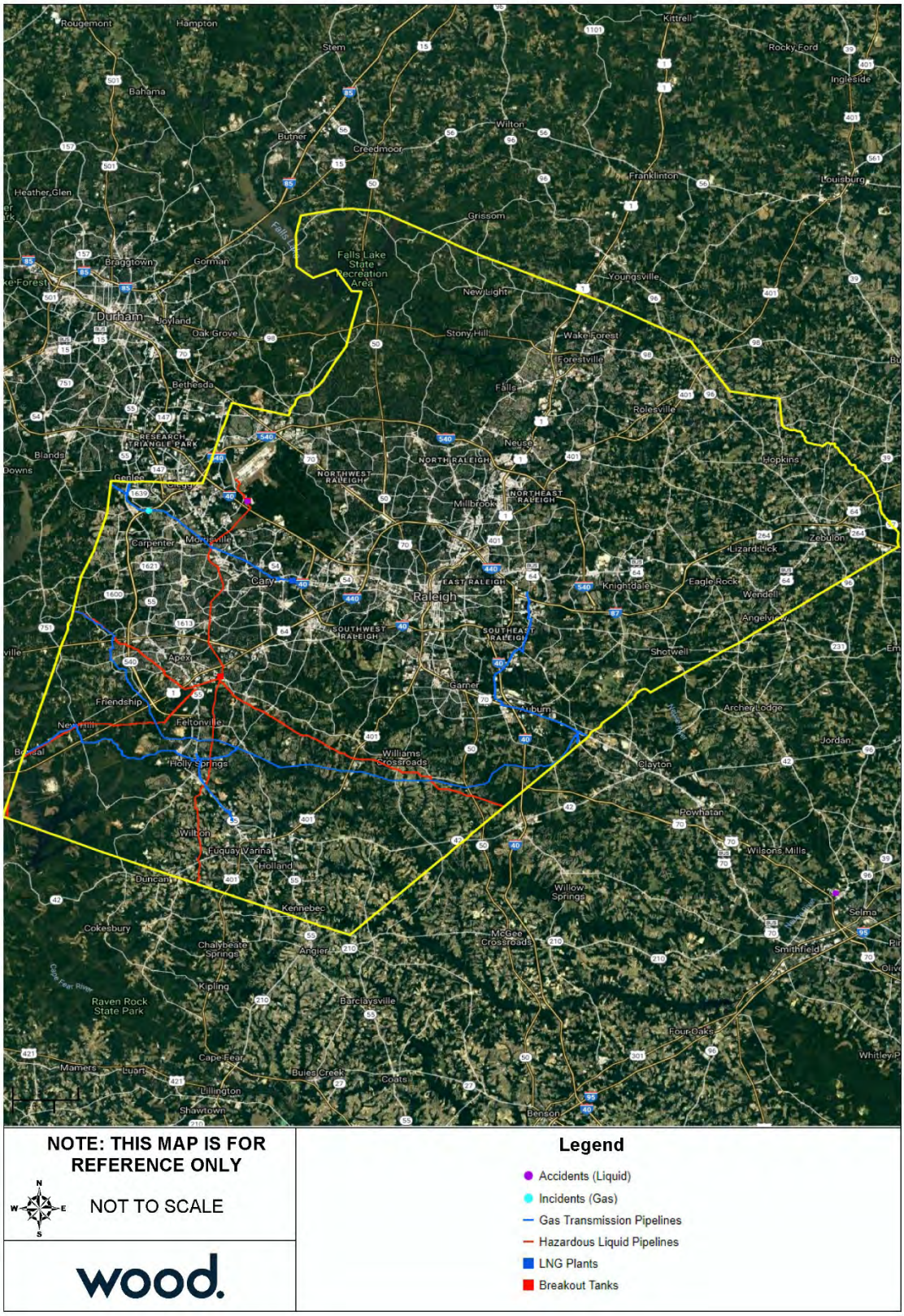
The U.S. Department of Transportation (USDOT) Pipeline and Hazardous Materials Safety Administration (PHMSA) maintains an inventory of the location of all gas transmission and hazardous liquid pipelines as well as liquid natural gas plants and hazardous liquid breakout tanks. The location of pipelines and pipeline infrastructure in Wake County are shown in Figure 4.27, as reported in the public viewer of the National Pipeline Mapping System.

Figure 4.26 – Toxic Release Inventory Sites in Wake County



Source: EPA Toxic Release Inventory

Figure 4.27 – Pipelines and Pipeline Infrastructure in Wake County



Source: US Department of Transportation, Pipeline and Hazardous Materials Safety Administration, National Pipeline Mapping System

Extent

The magnitude of a hazardous materials incident can be defined by the material type, the amount released, and the location of the release. The U.S. Department of Transportation Pipeline and Hazardous Materials Safety Administration (PHMSA), which records hazardous material incidents across the country, defines a "serious incident" as a hazardous materials incident that involves:

- a fatality or major injury caused by the release of a hazardous material,
- the evacuation of 25 or more persons as a result of release of a hazardous material or exposure to fire,
- a release or exposure to fire which results in the closure of a major transportation artery,
- the alteration of an aircraft flight plan or operation,
- the release of radioactive materials from Type B packaging,
- the release of over 11.9 galls or 88.2 pounds of a severe marine pollutant, or
- the release of a bulk quantity (over 199 gallons or 882 pounds) of a hazardous material.

Impact: 1 – Minor

Spatial Extent: 1 – Negligible

Historical Occurrences

The USDOT PHMSA's National Pipeline Mapping System records two events within Wake County:

April 6, 2005 – Excavation damage recorded on a PSNC Energy pipeline. No fatalities or injuries occurred.

September 16, 2009 – Damage occurred on to a Colonial Pipeline Co. pipeline causing 0.90 barrels of aviation kerosene to be released. The cause of the accident was reported as "Material/Weld/Equipment Failure".

PHMSA also maintains a database of other reported hazardous materials incidents, which are summarized in Table 4.89 by hazard class and mode of transport. According to PHMSA records, there were 589 recorded releases in Wake County from 1999 through 2018. Fifteen events were considered serious incidents, of which 13 were serious bulk releases; 6 events were flagged for serious evacuation.

Table 4.89 – Hazardous Materials Releases in Wake County, 1999 – 2018

	Mode of Release	Hazard Class	Incident Count
Wake County			**2**
	Highway	Miscellaneous Hazardous Material	1
	Highway	Flammable - Combustible Liquid	1
Raleigh-Durham Airport			**2**
	Air	Flammable - Combustible Liquid	1
	Air	Miscellaneous Hazardous Material	1
Apex			**1**
	Highway	Corrosive Material	1
Cary			**4**
	Highway	Corrosive Material	2
	Highway	Flammable - Combustible Liquid	2
Fuquay Varina			**2**
	Highway	Corrosive Material	1
	Highway	Oxidizer	1
Garner			**7**
	Highway	Corrosive Material	**5**
	Highway	Flammable - Combustible Liquid	2

	Mode of Release	Hazard Class	Incident Count
Holly Springs			**1**
	Highway	Flammable - Combustible Liquid	1
Knightdale			**1**
	Highway	Flammable - Combustible Liquid	1
Morrisville			**183**
	Air	Corrosive Material	2
	Air	Flammable - Combustible Liquid	7
	Air	Flammable Gas	2
	Air	Infectious Substance (Etiologic)	1
	Air	Miscellaneous Hazardous Material	2
	Air	Nonflammable Compressed Gas	1
	Air	(Not Defined)	3
Air Subtotal			*18*
	Highway	Combustible Liquid	2
	Highway	Corrosive Material	70
	Highway	Flammable - Combustible Liquid	63
	Highway	Flammable Gas	1
	Highway	Flammable Solid	1
	Highway	Nonflammable Compressed Gas	7
	Highway	Organic Peroxide	3
	Highway	Oxidizer	3
	Highway	Poisonous Gas	2
	Highway	Poisonous Materials	13
Highway Subtotal			*165*
Raleigh			**370**
	Air	Corrosive Material	11
	Air	Flammable - Combustible Liquid	8
	Air	Flammable Gas	1
	Air	Miscellaneous Hazardous Material	5
	Air	Nonflammable Compressed Gas	1
	Air	Organic Peroxide	1
	Air	Poisonous Materials	4
	Air	(Not Defined)	1
Air Subtotal			*32*
	Highway	Combustible Liquid	3
	Highway	Corrosive Material	121
	Highway	Flammable - Combustible Liquid	148
	Highway	Flammable Gas	3
	Highway	Flammable Solid	1
	Highway	Miscellaneous Hazardous Material	7
	Highway	Nonflammable Compressed Gas	13
	Highway	Organic Peroxide	5
	Highway	Oxidizer	17
	Highway	Poisonous Materials	6
	Highway	Spontaneously Combustible	1
	Highway	(Not Defined)	1
Highway Subtotal			*326*
	Rail	Corrosive Material	3
	Rail	Flammable - Combustible Liquid	5

	Mode of Release	Hazard Class	Incident Count
	Rail	Miscellaneous Hazardous Material	2
	Rail	Nonflammable Compressed Gas	1
	Rail	Oxidizer	1
Rail Subtotal			*12*
Rolesville			**3**
	Highway	Combustible Liquid	2
	Highway	Flammable - Combustible Liquid	1
Wake Forest			**4**
	Highway	Corrosive Material	1
	Highway	Flammable - Combustible Liquid	3
Wendell			**2**
	Highway	Corrosive Material	1
	Highway	Very Insensitive Explosive	1
Zebulon			**7**
	Highway	Corrosive Material	2
	Highway	Flammable - Combustible Liquid	2
	Highway	Flammable Gas	2
	Highway	Poisonous Materials	1
Grand Total			**589**

Source: PHMSA Incident Reports, Office of Hazardous Materials Safety, Incident Reports Database Search, data as of Feb 19, 2019.

The following narratives, recorded in the PHMSA database, are for a selection of past releases deemed serious incidents, and illustrate the types of spills and damages that may occur:

Zebulon, March 24, 2003 – A transport truck was involved in a single vehicle accident which caused the load to shift and the bulk tank to rollover. The tank ruptured, which caused the loss of approx. 3000 gallons of gasoline. The spill was contained by Wendell Fire Department Hazmat Unit. Reclamation and renovation of the site was performed by eastern environmental. The driver was the only injury. He was hospitalized but recovered fully.

Zebulon, July 14, 2004 – delivery driver had finished his delivery to this customer. Driver was doing his normal vehicle walk around check, he heard a noise, looked under the unit and noticed a leak out of the belly valve area. He tried the emergency shut-off but the leak was past this area. Driver was able to manually shut this leak down. Driver had noted that after his delivery unit was @ 35% after he shut off the leak it was at 30% this is how we determined the gallon of release. Driver called the local fire department and hazmat team they evacuated approximately 10 people from about 300 yds away. They had a small two-lane road closed for about 3 hours. No property damages. No injuries.

Cary, July 10, 2013 – While entering parking lot at Ace Hardware in Cary North Carolina it appears the freight shifted and punctured one 300-gallon tote of caustic soda 50% being shipped as sodium hydroxide solution. Approximately 250 gallons of free product released to the trailer floor and asphalt parking lot. Cary Fire Department responded to assess the site and proceeded to wash the parking lot with excessive amounts of water. As a result, free product and water affected the asphalt parking lot entrance around to back of store and impacted outside pallets and debris being held outside the hardware store. Environmental Restoration and Hepaco were dispatched to perform the cleanup. Upon arrival on site absorbent material was applied to the affected area in an effort to contain. Due to the large area of impact as a result of the fire department water placement a vacuum truck was dispatched to recover free liquids from the lot. Environmental Restoration and Hepaco personnel proceeded to recover free product and wash waters from the parking lot while neutralizing the caustic material. Once the parking lot was secure Hepaco Inc. proceeded to offload trailer clean impacted trailer floor and surrounding areas and

containerize remaining free product. Freight was loaded onto a recovery trailer provided by Wilson Trucking Corporation to be sent on to its destination. Following a rain event in the area Hepaco returned to the site collected residual product and site was deemed for closure. Disposal was coordinated in accordance with local state and federal regulations. There were no injuries or exposures reported.

Probability of Future Occurrence

Based on historical occurrences recorded by PHMSA, there have been 15 serious incidents of hazardous materials release in the 20-year period from 1999 through 2018. Using historical occurrences as an indication of future probability, there is a 75 percent annual probability of a serious incident occurring.

Probability: 3 – Likely

Vulnerability Assessment

People

People near facilities storing or transporting hazardous materials are at higher risk of exposure to a release incident. Additionally, any individuals working with or transporting hazardous materials are also at heightened risk. Depending on the materials, they may pose certain health hazards. If hazardous materials contaminate soils or water supply, people may be at risk of exposure through food or water.

Property

A radiological incident could cause severe damage to the power station itself but would not cause direct property damage outside the station. However, property values could drop substantially if a radiological incident resulted in contamination of nearby areas.

Environment

A radiological incident could result in the spread of radioactive material into the environment, which could contaminate water and food sources and harm animal and plant life.

Consequence Analysis

Table 4.91 summarizes the potential detrimental consequences of hazardous materials incident.

Table 4.90 – Consequence Analysis – Hazardous Materials Incident

Category	Consequences
Public	Contact with hazardous materials could cause serious illness or death. Those living and working closest to hazardous materials sites face the greatest risk of exposure. Exposure may also occur through contamination of food or water supplies.
Responders	Responders face similar risks as the general public but a heightened potential for exposure to hazardous materials.
Continuity of Operations (including Continued Delivery of Services)	A hazardous materials incident may cause temporary road closures or other localized impacts but is unlikely to affect continuity of operations.
Property, Facilities and Infrastructure	Some hazardous materials are flammable, explosive, and/or corrosive, which could result in structural damages to property. Impacts would be highly localized.
Environment	Consequences depend on the type of material released. Possible ecological impacts include loss of wildlife, loss of habitat, and degradation of air and/or water quality.
Economic Condition of the Jurisdiction	Clean up, remediation, and/or litigation costs may apply. Long-term economic damage is unlikely.
Public Confidence in the Jurisdiction's Governance	A hazardous materials incident may affect public confidence if the environmental or health impacts are enduring.

4.5.13 Radiological Incident

Hazard Background

A radiological incident is an occurrence resulting in the release of radiological material at a fixed facility (such as power plants, hospitals, laboratories, etc.) or in transit.

Radiological incidents related to transportation are described as an incident resulting in a release of radioactive material during transportation. Transportation of radioactive materials through North Carolina over the interstate highway system is considered a radiological hazard. The transportation of radioactive material by any means of transport is licensed and regulated by the federal government. As a rule, there are two categories of radioactive materials that are shipped over the interstate highways:

- Low level waste consists of primarily of materials that have been contaminated by low level radioactive substances but pose no serious threat except through long-term exposure. These materials are shipped in sealed drums within placarded trailers. The danger to the public is no more than a wide array of other hazardous materials.
- High level waste, usually in the form of spent fuel from nuclear power plants, is transported in specially constructed casks that are built to withstand a direct hit from a locomotive.

Radiological emergencies at nuclear power plants are divided into classifications. **Table 4.91** shows these classifications, as well as descriptions of each.

Table 4.91 – Radiological Emergency Classifications

Emergency Classification	Description
Notification of Unusual Event (NOUE)	Events are in progress or have occurred which indicate a potential degradation of the level of safety of the plant or indicate a security threat to facility protection has been initiated. No releases of radioactive material requiring offsite response or monitoring are expected unless further degradation of safety systems occurs.
Alert	Events are in progress or have occurred which involve an actual or potential substantial degradation of the level of safety of the plant or a security event that involves probable life-threatening risk to site personnel or damage to site equipment because of HOSTILE ACTION. Any releases are expected to be limited to small fractions of the Environmental Protection Agency (EPA) Protective Action Guides (PAGs)
Site Area Emergency (SAE)	Events are in progress or have occurred which involve actual or likely major failures of plant functions needed for protection of the public or hostile action that results in intentional damage or malicious acts; 1) toward site personnel or equipment that could lead to the likely failure of or; 2) that prevent effective access to, equipment needed for the protection of the public. Any releases are not expected to result in exposure levels which exceed EPA PAG exposure levels beyond the site boundary.
General Emergency	Events are in progress or have occurred which involve actual or imminent substantial core degradation or melting with potential for loss of containment integrity or hostile action that results in an actual loss of physical control of the facility. Releases can be reasonably expected to exceed EPA PAG exposure levels offsite for more than the immediate site area.

Warning Time: 4 – Less than 6 hours

Duration: 4 – More than one week

Location

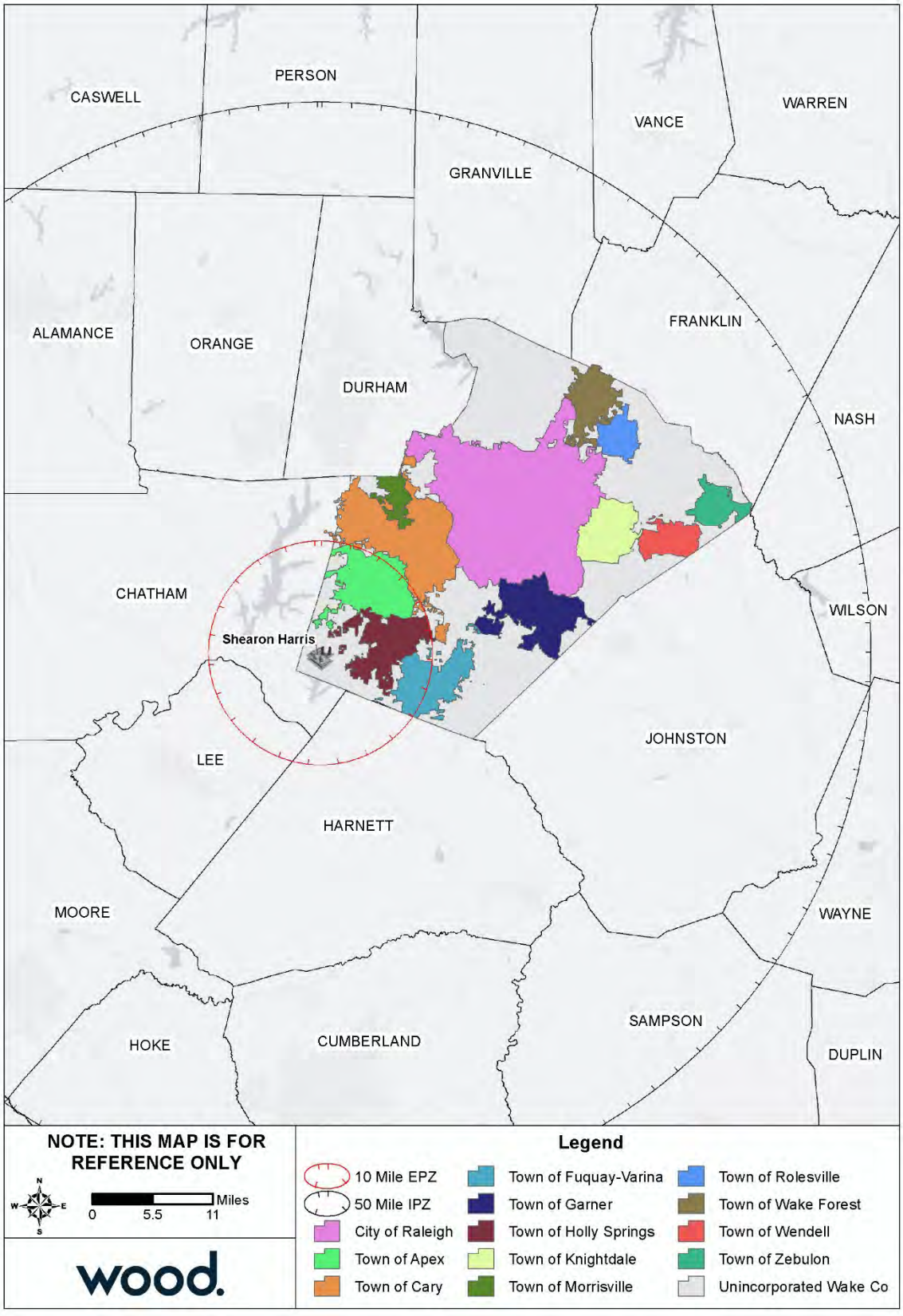
Harris Nuclear Plant, which is located in southwest Wake County, is a single-unit 928-megawatt power plant. The plant began commercial operation in 1987 and now employs approximately 800 people. Its reactor is a pressurized water reactor and the plant operates with a very high level of security. This is the location from which the most catastrophic nuclear accident might occur in Wake County and will be the focal point of the nuclear analysis in this plan. However, it should also be noted that there is a 1-megawatt PULSTAR research reactor located on North Carolina State University's campus in downtown Raleigh. Although its impacts would potentially be less far-reaching than Harris Nuclear Plant's in the event of an accident, it should still be noted that the effects could be extremely detrimental, especially to citizens and property within Raleigh.

The Nuclear Regulatory Commission defines two emergency planning zones around nuclear plants:

- **Emergency Planning Zone (EPZ)** – The EPZ is a 10-mile radius around nuclear facilities. It is also known as the Plume Exposure Pathway. Areas located within this zone are considered to be at highest risk of exposure to radioactive materials. Within this zone, the primary concern is exposure to and inhalation of radioactive contamination. Predetermined action plans within the EPZ are designed to avoid or reduce dose from such exposure. Residents within this zone would be expected to evacuate in the event of an emergency. Other actions such as sheltering, evacuation, and the use of potassium-iodide must be taken to avoid or reduce exposure in the event of a nuclear incident.
- **Ingestion Pathway Zone (IPZ)** – The IPZ is delineated by a 50-mile radius around nuclear facilities as defined by the federal government. Also known as the Ingestion Exposure Pathway, the IPZ has been designated to mitigate contamination in the human food change resulting from a radiological accident at a nuclear power facility. Contamination to fresh produce, water supplies, and other food produce may occur when radionuclides are deposited on surfaces.

Figure 4.28 shows the location of Harris Nuclear Plant and the approximate 10-mile Emergency Planning Zone (EPZ) buffer and 50-mile Ingestion Pathway Zone (IPZ) around the plant. Nearly all of Apex and Holly Springs, and much of western Fuquay-Varina fall within the EPZ for Harris Nuclear Plant. All of Wake County falls within the IPZ for Harris Nuclear Plant.

Figure 4.28 – Harris Nuclear Plant Location

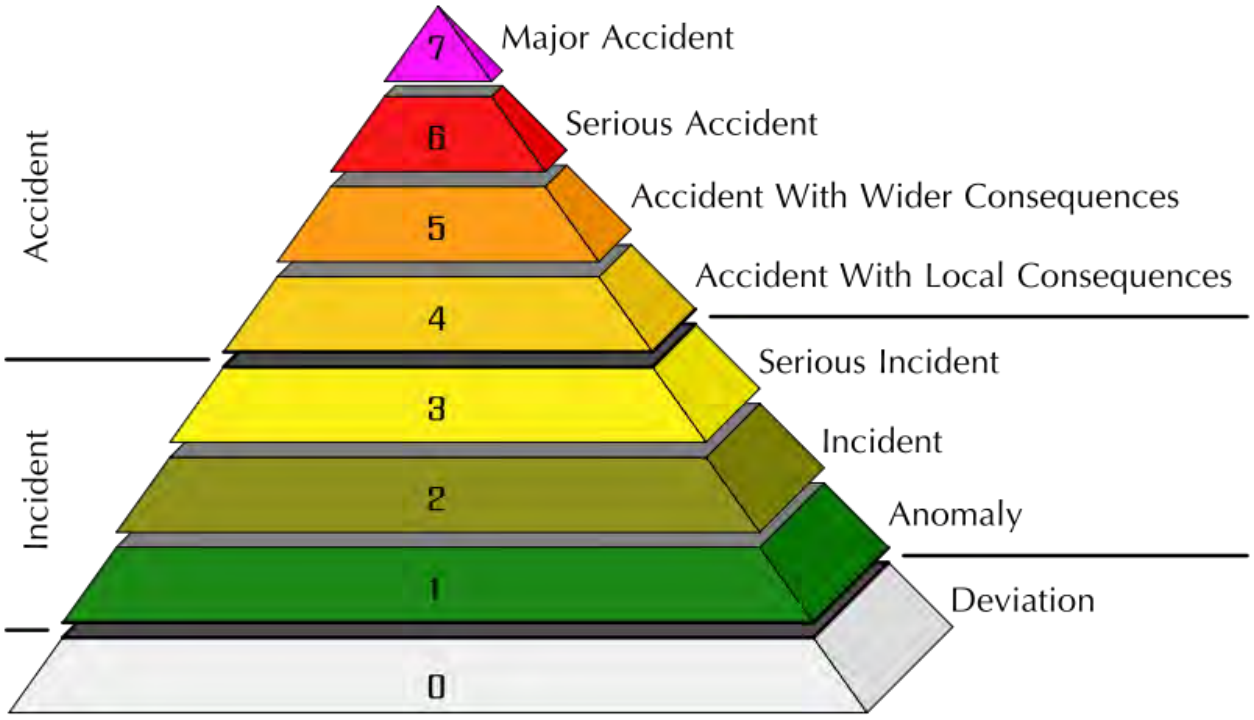


The entire county is at risk to a nuclear incident. However, areas in the southwest part of the region are more susceptible due to their proximity to the Harris Nuclear Plant and its 10-mile EPZ.

The Nuclear Regulatory Commission defines two emergency planning zones around nuclear plants. Areas located within 10 miles of the station are considered to be within the zone of highest risk to a nuclear incident and this radius is the designated evacuation radius recommended by the Nuclear Regulatory Commission. Within the 10-mile zone, the primary concern is exposure to and inhalation of radioactive contamination. The most concerning effects in the secondary 50-mile zone are related to ingestion of food and liquids that may have been contaminated. All areas of the county that are not located within the 10-mile radius are located within this 50-mile radius that is still considered to be at risk from a nuclear incident.

Extent

The International Atomic Energy Association (IAEA) developed the International Nuclear and Radiological Event Scale to quantify the magnitude of radiological events. This scale is logarithmic, meaning each increasing level represents a 10-fold increase in severity compared to the previous level.



Source: International Atomic Energy Association

Impact: 4 – Catastrophic

Spatial Extent: 2 – Small

Historical Occurrences

As reported in the 2018 State Hazard Mitigation Plan, Harris Nuclear Plant is one of only three plants in the country to have had no Nuclear Regulatory Commission findings as of September 2017. Therefore, there are no recent historical occurrences of any serious incidents at the Harris Plant. However, there have been events that warranted emergency declarations at both the Harris Nuclear Plant and the

PULSTAR research reactor at North Carolina State University. Table 4.92 lists emergency declarations reported in the 2015 Wake County Multi-Jurisdictional Hazard Mitigation Plan.

Table 4.92 – Emergency Declarations at Harris Nuclear Plant, 1986 – 2015

Emergency Declaration	Date	Description
Alert	08/12/1988	Loss of greater than 50% of main control board (MCB) alarms due to electrical problems; normal power supply to annunciator panel failed and did not transfer to its backup inverter.
Alert	10/09/1988	Fire on "B" Main Electrical Transformer; release of flammable gas in the Protected Area.
Unusual Event	11/28/1986	Loss of ERFIS computer system to display Safety Parameter Display System (SPDS) (55 lapsed minutes).
Unusual Event	11/29/1986	Loss of ERFIS computer system to display SPDS (58 lapsed minutes).
Unusual Event	11/30/1986	Loss of ERFIS computer system to display SPDS (48 lapsed minutes).
Unusual Event	12/03/1986	Loss of ERFIS computer system to display SPDS (27 lapsed minutes).
Unusual Event	12/11/1986	Safety Injection (an Emergency Core Cooling System) actuated while testing electronic circuitry.
Unusual Event	01/27/1987	Loss of ERFIS computer system to display SPDS (23 lapsed minutes).
Unusual Event	07/11/1987	Loss of ERFIS computer system to display SPDS (22 lapsed minutes).
Unusual Event	07/24/1987	Loss of ERFIS computer system to display SPDS (32 lapsed minutes).
Unusual Event	07/25/1987	Loss of ERFIS computer system to display SPDS (28 lapsed minute).
Unusual Event	02/04/1988	Fire within the Protected Area greater than 10 minutes; smoke observed coming from the motor for the reactor auxiliary building supply fan.
Unusual Event	10/06/1988	RCS leakage in excess of Tech Specs (unidentified leakage > 1.0 gpm).
Unusual Event	10/20/1988	RCS leakage in excess of Tech Specs; pressure operated relief valve opened and admitted RCS inventory to the pressurized relief tank (PRT).
Unusual Event	11/17/1988	Loss of ERFIS computer system to display SPDS for > 60 minutes.
Unusual Event	12/01/1988	Reactor coolant system (RCS) leakage in excess of Tech Specs (unidentified leakage > 1.0 gpm).
Unusual Event	12/16/1988	High level alarm on radiological effluent release monitor the (Treated Laundry and Hot Shower high level alarm was set just above background).
Unusual Event	03/13/1989	Loss of ERFIS computer system to display SPDS for > 60 minutes.
Unusual Event	01/24/1991	Plant shutdown required by Technical Specifications. Excessive leakage of a containment penetration; leakage discovered during surveillance testing.
Unusual Event	02/15/1991	Loss of ERFIS computer system to display SPDS for > 4 hours.
Unusual Event	03/05/1991	Plant shutdown required by Technical Specifications (testing of "A" Reactor Coolant Pump (RCP) electrical protection function).
Unusual Event	04/14/1992	Loss of ERFIS computer system to display SPDS for > 4 hours.
Unusual Event	02/06/1993	Loss of ERFIS computer system to display SPDS for > 4 hours.
Unusual Event	02/17/1994	Loss of ERFIS computer system to display SPDS for > 4 hours.
Unusual Event	07/22/1994	Loss of both emergency diesel generators - "B" diesel generator was being worked on; in accordance with test procedures, "A" diesel generator is required to be tested within 24 hours following having redundant diesel out-of-service; did not pass test.
Unusual Event	11/05/1995	Unplanned emergency core cooling system (ECCS) discharge to the reactor vessel; reactor trip and safety injection (SI) occurred during the performance of testing.
Unusual Event	12/14/1995	Train derailment on site - while removing empty cask car from the Protected Area, the rail cars were moved onto the Engine Spur to allow passage of the CSX engine on adjacent Plant Spur; cask car shifted; 4 wheels of the car left the rails.

Emergency Declaration	Date	Description
Unusual Event	01/22/1997	Security Event - while working Work Request and Authorization (WR&A), I&C Tech investigation found cut wire in a Turbine Building radiation monitor. Later determined to not be vandalism (i.e., not a security threat).
Unusual Event	04/02/2000	Loss of Emergency Response Facility Information System (ERFIS) computer system to display Safety Parameter Display System (SPDS) for more than 4 hours.
Unusual Event	08/23/2011	Seismic activity at the site due to a magnitude 5.8 earthquake near Mineral, VA.

Source: 2015 Wake County Multi-Jurisdictional Hazard Mitigation Plan

Table 4.93 – Emergency Declarations at the PULSTAR Research Reactor, 1986 – 2015

Emergency Declaration	Date	Description
None	12/13/2010	A radiography technician walked in front of a 30 REM per hour beam of radiation for 60 seconds due to a shutter being left open. This incident was reported to the Nuclear Regulatory Commission (NRC), but no assistance was required from the City of Raleigh or Wake County.
None	07/02/2011	PULSTAR shut down due to a 10 gallon per hour leak. No emergency was declared (less than 350 gallons per hour reporting threshold), and no action was required from the City of Raleigh or Wake County.
Unusual Event	08/23/2011	Seismic activity at the site due to a magnitude 5.8 earthquake near Mineral, VA.

Source: 2015 Wake County Multi-Jurisdictional Hazard Mitigation Plan

Probability of Future Occurrence

Radiological hazards are highly unpredictable. Nuclear reactors present the possibility of catastrophic damages, yet the industry is highly regulated and historical precedence suggests an incident is unlikely.

Probability: 1 – Unlikely

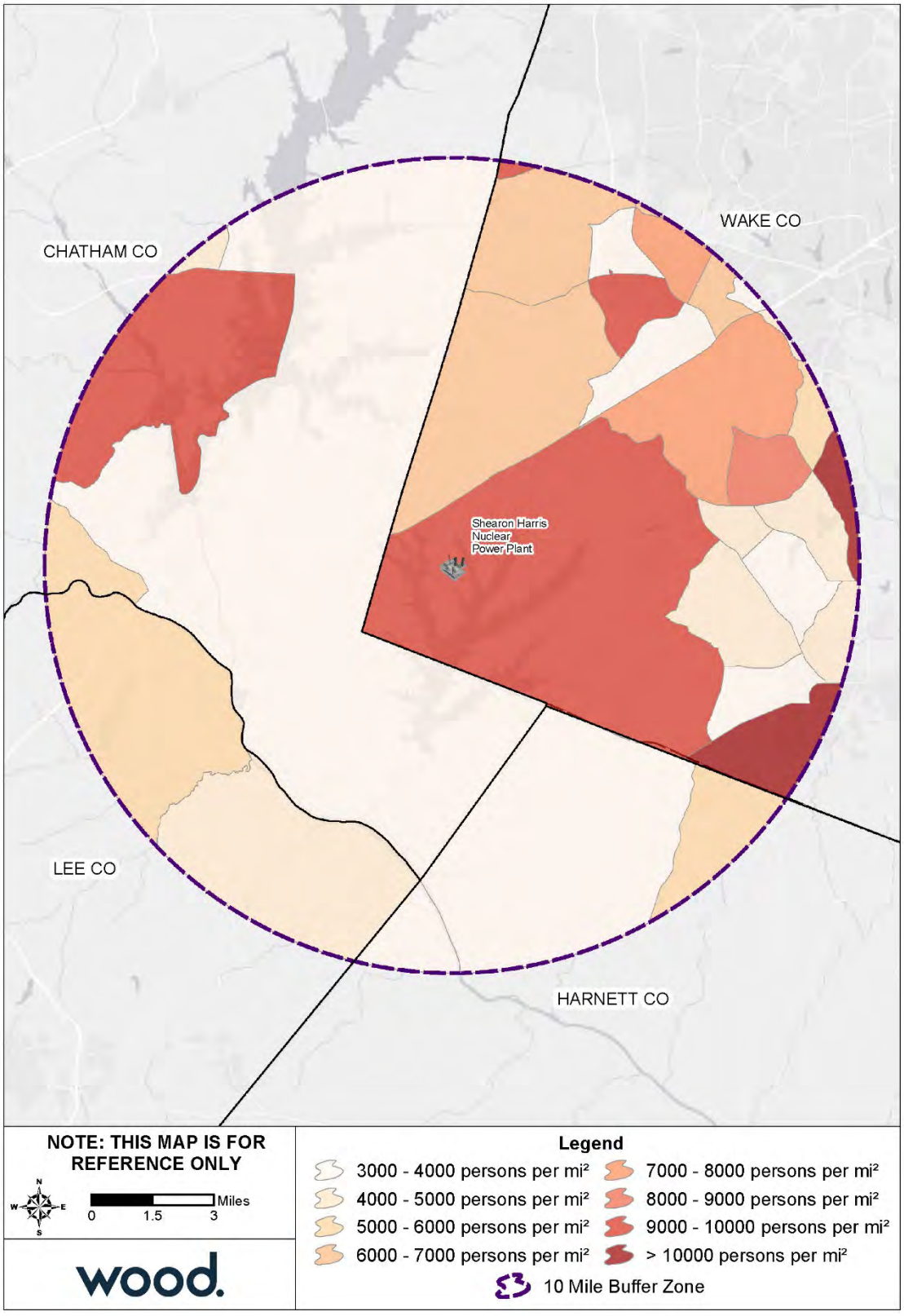
Vulnerability Assessment

People

People within the 10-mile EPZ are at risk of direct exposure to radioactive material. People within the 50-mile EPZ are at risk of exposure through ingestion of contaminated food and water. Low levels of radiation are not considered harmful, but a high exposure to radiation can cause serious illness or death.

Figure 4.29 reflects the population density of census block groups within the 10-mile EPZ of Harris Nuclear Plant and indicates the potential vulnerability of people to a radiological incident.

Figure 4.29 – Population Density by Census Block Group within the Harris Nuclear Plant 10-Mile EPZ



Source: U.S. Census Bureau, GIS Analysis

Property

A radiological incident could cause severe damage to the power station itself but would not cause direct property damage outside the station. However, property values could drop substantially if a radiological incident resulted in contamination of nearby areas.

A GIS analysis was completed to determine the vulnerability of critical facilities to radiological incident by overlaying the Emergency Planning Zone area with the critical facilities inventory. The resulting vulnerability of critical facilities is summarized in Table 4.11.

Table 4.94 – Critical Facilities Vulnerable to Radiological Incident, Wake County

Sector	Asset	Count
Emergency Management	Fire	8
	Police	1
Government	School	84
Energy	Utility	24
	Substation	1
Water	Treatment Plant	15

Source: NCEM IRISK Database; GIS analysis

Environment

A radiological incident could result in the spread of radioactive material into the environment, which could contaminate water and food sources and harm animal and plant life.

Consequence Analysis

Table 4.95 summarizes the potential detrimental consequences of radiological incident.

Table 4.95 – Consequence Analysis – Radiological Incident

Category	Consequences
Public	High levels of radiation could cause serious illness or death. Those living and working closest to the nuclear plant would face the greatest risk of exposure.
Responders	Responders face potential for heightened exposure to radiation, which could cause severe chronic illness and death.
Continuity of Operations (including Continued Delivery of Services)	An incident at the nuclear plant could interrupt power generation and cause power shortages. Regular operations would likely be affected by the response effort an event would require.
Property, Facilities and Infrastructure	The plant itself could be damaged by a radiological incident. Nearby property and facilities could be affected by contamination.
Environment	Water supplies, food crops, and livestock within 50 miles of the nuclear plant could be contaminated by radioactive material in the event of a major incident.
Economic Condition of the Jurisdiction	The local economy could be affected if a radiological incident caused contamination of nearby areas. Property values and economic activity could decline as a result.
Public Confidence in the Jurisdiction's Governance	A radiological incident would likely cause severe loss of public confidence given that the hazard is human-caused and highly regulated. Public confidence can also be affected by false alarms.

4.5.14 Terrorism

Hazard Background

There is no universal globally agreed-upon definition of terrorism. In a broad sense, terrorism is the use of violence and threats to intimidate or coerce, especially against civilians, in the pursuit of political aims. Terrorism is defined in the United States by the Code of Federal Regulations as "the unlawful use of force or violence against persons or property to intimidate or coerce a government, civilian population, or any segment thereof, in furtherance of political or social objectives."

For this analysis, this hazard encompasses the following sub-hazards: enemy attack, biological terrorism, chemical terrorism, conventional terrorism, cyber-attack, radiological terrorism, and public disorder. These hazards can occur anywhere and demonstrate unlawful force, violence, and/or threat against persons or property causing intentional harm for purposes of intimidation, coercion or ransom in violation of the criminal laws of the United States. These actions may cause massive destruction and/or extensive casualties. The threat of terrorism, both international and domestic, is ever present, and an attack can occur when least expected.

Enemy attack is an incident that could cause massive destruction and extensive casualties throughout the world. Some areas could experience direct weapons' effects: blast and heat; others could experience indirect weapons' effect. International political and military activities of other nations are closely monitored by the federal government and the State of North Carolina would be notified of any escalating military threats.

The use of biological agents against persons or property in violation of the criminal laws of the United States for purposes of intimidation, coercion or ransom can be described as biological terrorism. Liquid or solid contaminants can be dispersed using sprayers/aerosol generators or by point of line sources such as munitions, covert deposits and moving sprayers. Biological agents vary in the amount of time they pose a threat. They can be a threat for hours to years depending upon the agent and the conditions in which it exists.

Chemical terrorism involves the use or threat of chemical agents against persons or property in violation of the criminal laws of the United States for purposes of intimidation, coercion or ransom. Effects of chemical contaminants are similar to biological agents.

Use of conventional weapons and explosives against persons or property in violation of the criminal laws of the United States for purposes of intimidations, coercion, or ransom is conventional terrorism. Hazard effects are instantaneous; additional secondary devices may be used, lengthening the time duration of the hazard until the attack site is determined to be clear. The extent of damage is determined by the type and quantity of explosive. Effects are generally static other than cascading consequences and incremental structural failures. Conventional terrorism can also include tactical assault or sniping from remote locations.

Electronic attack using one computer system against another in order to intimidate people or disrupt other systems is a cyber-attack. All governments, businesses and citizens that conduct business utilizing computers face these threats. Cyber-security and critical infrastructure protection are among the most important national security issues facing our country today. The North Carolina State Bureau of investigation' Computer Crime Unit helps law enforcement across North Carolina solve sophisticated crimes involving digital evidence.

Radiological terrorism is the use of radiological materials against persons or property in violation of the criminal laws of the United States for purposes of intimidation, coercion or ransom. Radioactive contaminants can be dispersed using sprayers/aerosol generators, or by point of line sources such as

munitions, covert deposits and moving sprayers or by the detonation of a nuclear device underground, at the surface, in the air or at high altitude.

Mass demonstrations, or direct conflict by large groups of citizens, as in riots and non-peaceful strikes, are examples of public disorder. These are assembling of people together in a manner to substantially interfere with public peace to constitute a threat, and with use of unlawful force or violence against another person, or causing property damage or attempting to interfere with, disrupting, or destroying the government, political subdivision, or group of people. Labor strikes and work stoppages are not considered in this hazard unless they escalate into a threat to the community. Vandalism is usually initiated by a small number of individuals and limited to a small target or institution. Most events are within the capacity of local law enforcement.

The Southern Poverty Law Center reports 32 active hate groups in North Carolina. Table 4.96 shows active hate groups in North Carolina, according to the Southern Poverty Law Center (SPLC). The SPLC defines a hate group as any group with "beliefs or practices that attack or malign an entire class of people – particularly when the characteristics being maligned are immutable." It is important to note that inclusion on the SPLC list is not meant to imply that a group advocates or engages in violence or other criminal activity.

Table 4.96 – Hate Groups Active in North Carolina

Group	Type	Location
Nation of Islam	Black Nationalist, Nation of Islam	Greensboro
ACTBAC NC	Neo-confederate	Snow Camp
Israelite Church of God in Jesus Christ	Black Nationalist	Greensboro
American Guard	General Hate	Statewide
Traditionalist Worker Party	Neo-Nazi; Traditionalist Worker Party	Statewide
Vinlanders Social Club	Racist Skinhead; Vinlanders Social Club	Statewide
Vanguard America	Neo-Nazi	Statewide
Israelite School of Universal Practical Knowledge	Black Nationalist	Statewide
Crew 38	Racist Skinhead	Statewide
Soldiers of Odin	Anti-Muslim	Statewide
Blood and Honour Social Club	Racist Skinhead; Blood and Honour	Statewide
The Daily Stormer	Neo-Nazi	Statewide
Confederate Hammerskins	Racist Skinhead	Statewide
Blood and Honour U.S.A.	Racist Skinhead; Blood and Honour	Statewide
East Coast Nights of the True Invisible Empire	Ku Klux Klan	Statewide
Israel United in Christ	Black Nationalist	Concord
Nation of Islam	Black Nationalist; Nation of Islam	Durham
Nation of Islam	Black Nationalist; Nation of Islam	Charlotte
Great Millstone	Black Nationalist	Charlotte
Loyal White Knights of the Ku Klux Klan	Ku Klux Klan	Pelham
Americans for Legal Immigration (ALIPAC)	Anti-Immigrant	Raleigh
Identity Dixie	Neo-Confederate	Statewide
Loyal White Knights of the Ku Klux Klan	Ku Klux Klan	Pelham
ACT for America	Anti-Muslim; Act for America	Fayetteville
Nation of Islam	Black Nationalist; Nation of Islam	Raleigh
Cumberland Conservatives	Anti-Muslim	North Carolina
North Carolinians for Immigration Reform and Enforcement	Anti-Immigrant	Wade

Group	Type	Location
Confederate White Knights of the Ku Klux Klan	Ku Klux Klan	Vale
North Carolina Pastors Network	Anti-Muslim	Morgantown
Identity Evropa	White Nationalist; Identity Evropa	Boone
Revolutionary Black Panther Party	Black Nationalist	Wilmington
Nation of Islam	Black Nationalist; Nation of Islam	Wilmington

Source: Southern Poverty Law Center, https://www.splcenter.org/hate-map

Two hate groups identified by the SPLC have a footprint in Wake County – the Nation of Islam (Raleigh/Durham) and Americans for Legal Immigration (Raleigh).

Warning Time: 4 – Less than 6 hours

Duration: 4 – More than one week

Generally, no warning is given for specific acts of terrorism. Duration is dependent on the vehicle used during the terrorist attack. This score takes into account a prolonged scenario with continuous impacts.

Location

A terror threat could occur at any location in the County, but are more likely to target highly populated areas, critical infrastructure, or symbolic locations.

In terms of cyber-attack, our society is highly networked and interconnected. An attack could be launched from anywhere on earth and could range in impacts from small and localized to a far-reaching global scale. Depending on the attack vector and parameters, a cyber-attack could impact all of Wake County and its associated municipal jurisdictions.

Extent

The extent of a terrorist incident is tied to many factors, including the attack vector, location, time of day, and other circumstances; for this reason, it is difficult to put assess a single definition or conclusion of the extent of "terrorism." As a general rule, terrorism incidents are targeted to where they can do the most damage and have the maximum impact possible, though this impact is tempered by the weapon used in the attack itself.

Impact: 4 – Catastrophic

Spatial Extent: 1 – Negligible

Historical Occurrences

As noted in the 2018 North Carolina Hazard Mitigation Plan, there has never been a major terror attack in North Carolina, but several terror related incidents have been prevented through the arrest of terrorism suspects, the disruption of terrorism planning and training activities, and the response to lone suspect attacks. North Carolina has for decades dealt with homegrown extremists with a propensity for terror and violence. Examples of these extremists include militia groups, white supremacy groups, sovereign citizens, and left wing/right wing extremist groups.

The 2015 Wake County Multi-Jurisdictional Hazard Mitigation Plan noted that in 2009, seven longtime residents were arrested in the rural Wake County subdivision of Shadow Oaks on suspicion of plotting terrorism and for providing money, training, transportation, and men to help terrorists. All seven conspirators were found guilty and sentenced for terrorist activities documented between 2006 and 2009.

Probability of Future Occurrence

While difficult to estimate when a deliberate act like terrorism may occur, it can be inferred that the probability of a terrorism attack in any one area in the County is very low at any given time. When identified, credible threats may increase the probability of an incident; these threats are generally tracked by law enforcement.

Probability: 1 – Unlikely

Vulnerability Assessment

Methodologies and Assumptions

Vulnerability to terrorism was assessed through hypothetical scenarios. These scenarios were modeled using the Electronic Mass Casualty Assessment and Planning Scenarios (EMCAPS) tool developed by the Johns Hopkins Office of Critical Event Preparedness and Response, Johns Hopkins Applied Physics Laboratory, the U.S. Department of Homeland Security, and the National Center for the Study of Preparedness and Catastrophic Event Response.

People

People can suffer death or illness as a result of a terrorist attack. Symptoms of illness from a biological or chemical attack may go undetected for days or even weeks. Local healthcare workers may observe a pattern of unusual illness or early warning monitoring systems may detect airborne pathogens. People will face increased risk if a biological or chemical agent is released indoors, as this may result in exposure to a higher concentration of pathogens, whereas agents that are released outdoors would disperse in the direction of the wind. Physical harm from a weapons attack or explosive device is not dependent on location, but risk is greater in areas where higher numbers of people may gather. People could also be affected by an attack on food and water supply. In addition to impacts on physical health, any terrorist attack could cause significant stress and anxiety.

The following hypothetical scenarios illustrate the potential impacts of a chlorine gas release and an improvised explosive device (IED) attack on a location in the City of Raleigh, chosen due to its relatively high population density as well as the presence of multiple government buildings, culturally significant sites, and critical facilities and infrastructure. These scenarios were modeled using the Electronic Mass Casualty Assessment and Planning Scenarios (EMCAPS) tool developed by the Johns Hopkins Office of Critical Event Preparedness and Response, Johns Hopkins Applied Physics Laboratory, the U.S. Department of Homeland Security, and the National Center for the Study of Preparedness and Catastrophic Event Response.

Scenario #1 – Chemical Attack: Toxic Gas – Chlorine Release

Scenario Overview: A bomb is attached to a tractor trailer tanker carrying compressed chlorine. The entire contents of the tank escape to the atmosphere and the plume spreads to the surrounding area. The plume spreading and the effect on the population are calculated according to the following input variables: outdoor temperature is 60°F, wind speed is 9 mph, the setting is urban, and the population density is 2,800 persons per square mile. The following assumptions apply:

- 4,850-gallon tank, all contents released through 3-ft hole
- Partly cloudy, no precipitation
- 50% of people in plume area are indoors
- Effects of chlorine on population determined through evaluation of chlorine gas concentration zones, which were determined using ALOHA plume modeling software (see References)
- First effects on humans at concentration = 10 ppm

- Minimum lethal dose = 430 ppm for 30 min
- Median lethal dose (short-term exposure) = 1,000 ppm

Table 4.97 outlines the expected losses based on the above parameters.

Table 4.97 – Estimated Casualties from Chlorine Attack

Injury Description	Population affected
Fatality	59 persons
Eye pain & swelling, headache, restricted airflow – difficulty breathing, coughing, chest pain, lung inflammation and edema, bloody sputum, vomiting, skin irritation, possible chemical burns	89 persons
Eye pain & swelling, headache, throat irritation, rapid breathing, coughing, chest pain, lung inflammation and edema, bloody sputum, vomiting, skin irritation	203 persons
Eye pain & swelling, headache, throat irritation, rapid breathing, coughing, chest pain, skin irritation	422 persons
Eye irritation, headache, throat irritation, coughing, skin irritation	516 persons
Eye irritation, headache, coughing, skin irritation	476 persons
Total impacted population	1,765 persons
"Worried Well" Cases (assumed to be 9x affected population)	15,885 persons
Cost of Decontamination @ $12/person (assumes all persons with skin injuries will require decontamination and approximately 1/10 of the worried well will demand to be decontaminated). Total persons treated = 3,354	$40,248

Source: EMCAPS tool

Scenario #2 – IED: Truck Bomb

Scenario Overview: An Improvised Explosive Device (IED) utilizing an ammonium nitrate/fuel oil (ANFO) mixture is carried in a cargo truck to a populated area and detonated. The bomb size is assumed to be 1000 lbs ANFO and the population density is 1 person per 50 square feet, equivalent to a moderately crowded pedestrian area as might be found in an average large city or outside a stadium. It is assumed that the explosion takes place in a relatively open area (e.g. stadium parking lot, park, etc). The following assumptions apply:

- ANFO - TNT equivalence = 0.82
- Blast pressure damage impact taken from National Fire Protection Association (NFPA) 921 Guide for Fire and Explosion Investigations - 2001 Edition, Table 18.13.3.1[b]
- Buildings and other physical structures are not considered in these calculations

Table 4.98 outlines the expected losses based on the above parameters.

Table 4.98 – Estimated Casualties from IED Attack

Injury Description	Population affected
Total Dead	275 persons
Total Traumatic Injuries	483 persons
Total Urgent Care Injuries	2,367 persons
Injuries not Requiring Hospitalization	886 persons

Source: EMCAPS tool

Expected symptoms and injuries would include impact injuries (pulmonary blast), pulmonary contusion, barotrauma, fractures (internal, compound, spinal), smoke inhalation, GI blast injury (edema, hemorrhage, rupture), auditory blast injury (partial or total loss of hearing), lacerations, shrapnel, debris penetrations (glass, metal, etc.) and burns. Transportation would be limited or inaccessible near the blast, and services and utilities could be unavailable.

Property

The potential for damage to property is highly dependent on the type of attack. Buildings and infrastructure may be damaged by an explosive device or by contamination from a biological or chemical attack. Impacts are generally highly localized to the target of the attack.

Environment

Environmental impacts are also dependent on the type of attack. Impacts could be negligible or could require major clean-up and remediation.

Consequence Analysis

Table 4.99 summarizes the potential detrimental consequences of a terror threat.

Table 4.99 – Consequence Analysis – Terrorism

Category	Consequences
Public	Illness, injury, or fatality are possible; these impacts would be highly localized to the attack. Widespread stress and psychological suffering may occur.
Responders	Responders face increased risks during an effort to stop an attack or rescue others while an attack is underway.
Continuity of Operations (including Continued Delivery of Services)	Critical infrastructure may be targeted by an attack; therefore, continuity of operations may be affected. Long-term issues may arise if transportation or utility infrastructure is severely damaged.
Property, Facilities and Infrastructure	Impacts depend of the type of attack. Buildings and infrastructure could be unaffected or completely destroyed.
Environment	Water and food supply could be contaminated by a biological or chemical attack. Remediation could be required.
Economic Condition of the Jurisdiction	The local economy could be disrupted, depending on the location and scale of an attack.
Public Confidence in the Jurisdiction's Governance	Loss of public confidence likely should an attack be carried out; additional loss of confidence and trust may result if response and recovery are not swift and effective

4.6 CONCLUSIONS ON HAZARD RISK

Priority Risk Index

As discussed in Section 4.3 Risk Assessment Methodology and Assumptions, the Priority Risk Index was used to rate each hazard on a set of risk criteria and determine an overall standardized score for each hazard. The conclusions drawn from this process are summarized below.

Table 4.100 summarizes the degree of risk assigned to each identified hazard using the PRI method.

Table 4.100 – Summary of PRI Results

Hazard	Probability	Impact	Spatial Extent	Warning Time	Duration	PRI Score
Dam Failure	Possible	Critical	Negligible	Less than 6 hrs	Less than 1 week	2.4
Drought	Likely	Minor	Large	More than 24 hrs	More than 1 week	2.5
Earthquake	Unlikely	Minor	Large	Less than 6 hrs	Less than 6 hrs	1.9
Extreme Heat	Highly Likely	Critical	Large	More than 24 hrs	Less than 1 week	3.3
Flood	Likely	Critical	Small	6 to 12 hrs	Less than 1 week	2.8
Hurricane & Tropical Storm	Likely	Critical	Large	More than 24 hrs	Less than 24 hrs	2.9
Landslide	Unlikely	Minor	Negligible	6 to 12 hours	Less than 6 hrs	1.2
Severe Weather: Hail[1]	Highly Likely	Minor	Small	6 to 12 hrs	Less than 6 hours	2.3
Severe Weather: Lightning[1]	Highly Likely	Minor	Negligible	6 to 12 hrs	Less than 6 hours	2.1
Severe Weather: Thunderstorm Winds[1]	Highly Likely	Limited	Large	6 to 12 hrs	Less than 6 hours	3.0
Severe Winter Storm	Highly Likely	Limited	Large	More than 24 hrs	More than 1 week	3.0
Tornado	Likely	Critical	Small	Less than 6 hrs	Less than 6 hours	2.7
Wildfire	Possible	Limited	Moderate	Less than 6 hrs	Less than 1 week	2.5
Hazardous Materials Incident	Highly Likely	Minor	Negligible	Less than 6 hrs	Less than 24 hrs	2.3
Radiological Emergency	Unlikely	Catastrophic	Small	Less than 6 hrs	More than 1 week	2.7
Terrorism	Unlikely	Catastrophic	Negligible	Less than 6 hrs	Less than 6 hrs	2.2

[1]Note: Severe Weather hazards average to a score of 2.5 and are therefore considered together as a high risk hazard.

The results from the PRI have been classified into three categories based on the assigned risk value which are summarized in Table 4.101:

- **High Risk** – Widespread potential impact. This ranking carries a high threat to the general population and/or built environment. The potential for damage is widespread.
- **Medium Risk** – Moderate potential impact. This ranking carries a moderate threat level to the general population and/or built environment. Here the potential damage is more isolated and less costly than a more widespread disaster.
- **Low Risk** – Minimal potential impact. The occurrence and potential cost of damage to life and property is negligible or nonexistent. This is not a priority hazard for mitigation projects.

Table 4.101 – Summary of Hazard Risk Classification

High Risk (> 2.4)	Extreme Heat Severe Weather Severe Winter Storm Hurricane & Tropical Storm Flood Tornado Radiological Emergency Drought Wildfire
Moderate Risk (2.0 – 2.4)	Dam Failure Hazardous Materials Incident Terrorism
Low Risk (< 2.0)	Earthquake Landslide

Note: Low risk hazards are not prioritized for mitigation.

5 Capability Assessment

This section discusses the capability of the Wake County planning area to implement hazard mitigation activities. It consists of the following four subsections:

5.1 Overview
5.2 Methodology
5.3 Capability Assessment Findings
5.4 Conclusions on Local Capability

5.1 OVERVIEW

The purpose of conducting a capability assessment is to determine the ability of a local jurisdiction to implement a comprehensive mitigation strategy, and to identify potential opportunities for establishing or enhancing specific mitigation policies, programs, or projects. As in any planning process, it is important to try to establish which goals, objectives, and actions are feasible, based on an understanding of the organizational capacity of those agencies or departments tasked with their implementation. A capability assessment helps to determine which mitigation actions are practical and likely to be implemented over time given a local government's planning and regulatory framework, level of administrative and technical support, amount of fiscal resources, and current political climate.

A capability assessment has two primary components: 1) an inventory of a local jurisdiction's relevant plans, ordinances, and programs already in place; and 2) an analysis of its capacity to carry them out. Careful examination of local capabilities will detect any existing gaps, shortfalls, or weaknesses with ongoing government activities that could hinder proposed mitigation activities and possibly exacerbate community hazard vulnerability. The capability assessment also highlights the positive mitigation measures already in place or being implemented at the local government level, which should continue to be supported and enhanced through future mitigation efforts.

The capability assessment completed for the Wake County planning area serves as a critical planning step toward developing an effective mitigation strategy. Coupled with the risk assessment, the capability assessment helps identify and target effective goals, objectives, and mitigation actions that are realistically achievable under given local conditions.

5.2 METHODOLOGY

To facilitate the inventory and analysis of local government capabilities within the planning area, a detailed Local Capability Self-Assessment worksheet was distributed to members of the HMPC after the first planning committee meeting. The survey questionnaire requested information on a variety of "capability indicators" such as existing local plans, policies, programs, or ordinances that contribute to and/or hinder the region's ability to implement hazard mitigation actions. Other indicators included information related to the region's fiscal, administrative, and technical capabilities, such as access to local budgetary and personnel resources for mitigation purposes, and existing education and outreach programs that can be used to promote mitigation. Communities were also asked to comment on the current political climate with respect to hazard mitigation, an important consideration for any local planning or decision-making process.

At a minimum, the survey results provide an extensive and consolidated inventory of existing local plans, ordinances, programs, and resources in place or under development. With this information, inferences can be made about the overall effect on hazard loss reduction in each community. In completing the

survey, local officials were also asked to rate their jurisdiction's specific capabilities. The survey instrument thereby not only helps accurately assess the degree of local capability, but it also serves as a good source of introspection for counties and local jurisdictions that want to improve their capabilities. Identified gaps, weaknesses, or conflicts can be recast as opportunities for specific actions to be proposed as part of the mitigation strategy.

The information provided in response to the survey questionnaire was incorporated into a database for further analysis. A general scoring methodology was then applied to quantify each jurisdiction's overall capability. According to the scoring system, each capability indicator was assigned a point value based on its relevance to hazard mitigation. Additional points were added based on the jurisdiction's self-assessment of their own planning and regulatory capability, administrative and technical capability, fiscal capability, education and outreach capability, and political capability.

Using this scoring methodology, a total score and an overall capability rating of "High," "Moderate," or "Limited" could be determined according to the total number of points received. These classifications are designed to provide nothing more than a general assessment of local government capability. In combination with the narrative responses provided by local officials, the results of this capability assessment provide critical information for developing an effective and meaningful mitigation strategy.

5.3 CAPABILITY ASSESSMENT FINDINGS

The findings of the capability assessment are summarized in this plan to provide insight into the relevant capacity of the Wake County Planning Area to implement hazard mitigation activities. All information is based upon the input provided by local government officials through the Local Capability Self-Assessment.

5.3.1 Planning and Regulatory Capability

Planning and regulatory capability is based on the implementation of plans, ordinances, and programs that demonstrate a local jurisdiction's commitment to guiding and managing growth, development, and redevelopment in a responsible manner, while maintaining the general welfare of the community. It includes emergency response and mitigation planning, comprehensive land use planning, and transportation planning. Regulatory capability also includes the enforcement of zoning or subdivision ordinances and building codes that regulate how land is developed and structures are built, as well as protecting environmental, historic, and cultural resources in the community. Although some conflicts can arise, these planning initiatives generally present significant opportunities to integrate hazard mitigation principles and practices into the local decision-making process.

This assessment is designed to provide a general overview of the key planning and regulatory tools or programs in place or under development for the Wake County planning area, along with their potential effect on loss reduction. This information will help identify opportunities to address gaps, weaknesses, or conflicts with other initiatives and integrate the implementation of this plan with existing planning mechanisms where appropriate.

Table 5.1 provides a summary of the relevant local plans, ordinances, and programs already in place or under development for the Wake County planning area. A checkmark (v) indicates that the given item is currently in place and being implemented. An asterisk (*) indicates that the given item is currently being developed for future implementation. A plus sign (+) indicates that a jurisdiction is covered for that item under a county-implemented version. Each of these local plans, ordinances, and programs should be considered available mechanisms for incorporating the requirements of the Hazard Mitigation Plan.

Table 5.1 – Relevant Plans, Ordinances, and Programs

Jurisdiction	Hazard Mitigation Plan	Comprehensive Land Use Plan	Floodplain Management Plan	Open Space Management Plan	Stormwater Management Plan	Emergency Operations Plan	SARA Title III Plan	Radiological Emergency Plan	Continuity of Operations Plan	Evacuation Plan	Disaster Recovery Plan	Capital Improvements Plan	Economic Development Plan	Historic Preservation Plan	Transportation Plan	Flood Damage Prevention Ordinance	Zoning Ordinance	Subdivision Ordinance	Site Plan Review Requirements	Unified Development Ordinance	Post-Disaster Redevelopment Ordinance	Building Code	Fire Code	Community Wildfire Protection Plan	National Flood Insurance Program	Community Rating System
Wake County	✓	✓	✓	✓	✓	✓	✓	✓	*	✓		✓	✓	✓	✓	✓	✓	✓	✓	✓		✓	✓		✓	
Town of Apex	✓	✓	✓	✓	✓	✓	+	+	✓	+		✓	*	+	✓	✓	✓	✓	✓	✓		✓	✓		✓	
Town of Cary	✓	✓		✓	✓	✓	+	+	✓		✓	✓	✓	✓	✓	✓	✓	✓	✓	✓		✓	✓	✓	✓	
Town of Fuquay-Varina	✓	✓	✓	✓	✓	✓	+	+	✓	+		✓	✓	+	✓	✓	✓	✓	✓	✓		✓	✓		✓	
Town of Garner	✓	✓	✓	✓	✓	✓	+	+	✓	+		✓		✓	✓	✓	✓	✓	✓	✓		✓	✓		✓	
Town of Holly Springs	✓	✓	✓	✓	✓	✓	+	+	✓	✓		✓	✓	+	✓	✓	✓	✓	✓	✓	√	✓	✓		✓	
Town of Knightdale	✓	✓	✓	✓	*	✓	+	+				*		+	✓	✓	✓	✓	✓	✓		+	✓		✓	
Town of Morrisville	✓	✓	✓	✓	✓	✓	+	+	✓			✓			✓	✓	✓	✓	✓	✓	√	✓	✓		✓	
City of Raleigh	✓	✓			✓	✓	+	+	*		✓	✓	✓		✓	✓	✓	✓	✓	✓		✓	✓		✓	
Town of Rolesville	✓	✓	✓	✓	✓	✓	+	+	✓			✓	✓	+	✓	✓	✓	✓	✓	✓		✓	✓		✓	
Town of Wake Forest	✓		✓	✓	✓	*	+	+	*		*	✓	✓	✓	✓	✓	✓	✓	✓	✓		✓	✓		✓	
Town of Wendell	✓	✓	✓	✓	✓	+	+	+				*	*	+	✓	✓	✓	✓	✓	✓		+	+		✓	
Town of Zebulon	✓	✓	✓	✓	✓	✓	+	+				✓		+	✓	✓	✓	✓	✓	*		✓	✓		✓	

A more detailed discussion on the region's planning and regulatory capability follows, along with the incorporation of additional information based on the narrative comments provided by local officials in response to the survey questionnaire.

5.3.1.1 Emergency Management

Hazard mitigation is widely recognized as one of the four primary phases of emergency management, as is shown in Figure 5.1. In reality, mitigation is interconnected with all other phases and is an essential component of effective preparedness, response, and recovery. Opportunities to reduce potential losses through mitigation practices are most often implemented before a disaster event, such as through the elevation of flood-prone structures or by regular enforcement of policies that regulate development. However, mitigation opportunities can also be identified during immediate preparedness or response activities, such as installing storm shutters in advance of a hurricane. Furthermore, incorporating mitigation during the long-term recovery and redevelopment process following a disaster event is what enables a community to become more resilient.

Figure 5.1 – The Four Phases of Emergency Management

Planning for each phase is a critical part of a comprehensive emergency management program and a key to the successful implementation of hazard mitigation actions. As such, the Local Capability Self-Assessment asked several questions across a range of emergency management plans to assess the region's willingness to plan and their level of technical planning proficiency.

Hazard Mitigation Plan

A hazard mitigation plan is a community's blueprint for how it intends to reduce the impact of natural, and in some cases human-caused, hazards on people and the built environment. The essential elements of a hazard mitigation plan include a risk assessment, capability assessment, and mitigation strategy.

- 13 of the 13 participating jurisdictions in this regional planning effort have previously been covered by the Wake County Multi-Jurisdictional Hazard Mitigation Plan.

Disaster Recovery Plan

A disaster recovery plan serves to guide the physical, social, environmental, and economic recovery and reconstruction process following a disaster event. In many instances, hazard mitigation principles and practices are incorporated into local disaster recovery plans with the intent of capitalizing on

opportunities to break the cycle of repetitive disaster losses. Disaster recovery plans can also lead to the preparation of disaster redevelopment policies and ordinances to be enacted following a hazard event.

- 3 of the 13 participating jurisdictions have a disaster recovery plan either in place or under development. (2 jurisdictions have one in place; 1 has one under development)

Emergency Operations Plan

An emergency operations plan outlines responsibilities and how resources will be deployed during and following an emergency or disaster.

- 13 of the 13 participating jurisdictions have an emergency operations plan either in place or are covered under a county plan. (11 jurisdictions have one in place; 1 has one under development; 1 covered under a county plan)

Continuity of Operations Plan

A continuity of operations plan establishes a chain of command, line of succession, and plans for backup or alternate emergency facilities in case of an extreme emergency or disaster event.

- 10 of the 13 participating jurisdictions have a continuity of operations plan in place.

5.3.1.2 General Planning

The implementation of hazard mitigation activities often involves agencies and individuals beyond the emergency management profession. Stakeholders may include local planners, public works officials, economic development specialists, and others. In many instances, concurrent local planning efforts will help to achieve or complement hazard mitigation goals, even though they may not be designed as such. The Local Capability Self-Assessment asked questions regarding general planning capabilities and the degree to which hazard mitigation is integrated into other ongoing planning efforts in the region.

Comprehensive/General Plan

A comprehensive land use plan, or general plan, establishes the overall vision for what a community wants to be and serves as a guide for future governmental decision making. Typically a comprehensive plan contains sections on demographic conditions, land use, transportation elements, and community facilities. Given the broad nature of the plan and its regulatory standing in many communities, the integration of hazard mitigation measures into the comprehensive plan can enhance the likelihood of achieving risk reduction goals, objectives, and actions.

- 12 of the 13 participating jurisdictions have a comprehensive land use plan in place.

Capital Improvements Plan

A capital improvements plan guides the scheduling of spending on public improvements. A capital improvements plan can serve as an important mechanism for guiding future development away from identified hazard areas. Limiting public spending in hazardous areas is one of the most effective long-term mitigation actions available to local governments.

- 13 of the 13 participating jurisdictions have a capital improvements plan in place or under development (11 jurisdictions have one in place; 2 have one under development).

Historic Preservation Plan

A historic preservation plan is intended to preserve historic structures or districts within a community. An often-overlooked aspect of the historic preservation plan is the assessment of buildings and sites located in areas subject to natural hazards, and the identification of ways to reduce future damages. This may

involve retrofitting or relocation techniques that account for the need to protect buildings that do not meet current building standards or are within a historic district that cannot easily be relocated out of harm's way.

- 11 of the 13 participating jurisdictions have an historic preservation plan in place or are covered by a county plan.

Zoning Ordinance

Zoning represents the primary means by which land use is controlled by local governments. As part of a community's police power, zoning is used to protect the public health, safety, and welfare of those in a given jurisdiction that maintains zoning authority. A zoning ordinance is the mechanism through which zoning is typically implemented. Since zoning regulations enable municipal governments to limit the type and density of development, a zoning ordinance can serve as a powerful tool when applied in identified hazard areas.

- 13 of the 13 participating jurisdictions have a zoning ordinance in place.

Subdivision Ordinance

A subdivision ordinance is intended to regulate the development of residential, commercial, industrial, or other uses, including associated public infrastructure, as land is subdivided into buildable lots for sale or future development. Subdivision design that accounts for natural hazards can dramatically reduce the exposure of future development.

- 13 of the 13 participating jurisdictions have a subdivision ordinance in place.

Building Codes, Permitting, and Inspections

Building codes regulate construction standards. In many communities, permits and inspections are required for new construction. Decisions regarding the adoption of building codes (that account for hazard risk), the type of permitting process required both before and after a disaster, and the enforcement of inspection protocols all affect the level of hazard risk faced by a community.

- 13 of the 13 participating jurisdictions have building codes in place.

The adoption and enforcement of building codes by local jurisdictions is routinely assessed through the Building Code Effectiveness Grading Schedule (BCEGS) program, developed by the Insurance Services Office, Inc. (ISO). In North Carolina, the North Carolina Department of Insurance assesses the building codes in effect in a particular community and how the community enforces its building codes, with special emphasis on mitigation of losses from natural hazards. The results of BCEGS assessments are routinely provided to ISO's member private insurance companies, which in turn may offer ratings credits for new buildings constructed in communities with strong BCEGS classifications. The expectation is that communities with well-enforced, up-to-date codes should experience fewer disaster-related losses, and as a result should have lower insurance rates.

In conducting the assessment, ISO collects information related to personnel qualification and continuing education, as well as number of inspections performed per day. This type of information combined with local building codes is used to determine a grade for that jurisdiction. The grades range from 1 to 10, with a BCEGS grade of 1 representing exemplary commitment to building code enforcement, and a grade of 10 indicating less than minimum recognized protection.

5.3.1.3 Floodplain Management

Flooding represents the greatest natural hazard facing the nation, yet the tools available to reduce the impacts associated with flooding are among the most developed when compared to other hazard-specific mitigation techniques. In addition to approaches that cut across hazards such as education, outreach, and the training of local officials, the National Flood Insurance Program (NFIP) contains specific regulatory measures that enable government officials to determine where and how growth occurs relative to flood hazards. Participation in the NFIP is voluntary for local governments; however, program participation is strongly encouraged by FEMA as a first step for implementing and sustaining an effective hazard mitigation program. It is therefore used as part of this *Capability Assessment* as a key indicator for measuring local capability.

In order for a county or municipality to participate in the NFIP, they must adopt a local flood damage prevention ordinance that requires jurisdictions to follow established minimum building standards in the floodplain. These standards require that all new buildings and substantial improvements to existing buildings be protected from damage by a 100-year flood event, and that new development in the floodplain not exacerbate existing flood problems or increase damage to other properties.

A key service provided by the NFIP is the mapping of identified flood hazard areas. Once completed, the Flood Insurance Rate Maps (FIRMs) are used to assess flood hazard risk, regulate construction practices, and set flood insurance rates. FIRMs are an important source of information to educate residents, government officials, and the private sector about the likelihood of flooding in their community.

Table 5.2 provides NFIP policy and claim information for each participating jurisdiction in the Wake County planning area.

All jurisdictions in the region participate in the NFIP and will continue to comply with all required provisions of the program. Floodplain management is managed through zoning ordinances, building code restrictions, and the county building inspection program. The jurisdictions will coordinate with NCEM and FEMA to develop maps and regulations related to Special Flood Hazard Areas within their jurisdictional boundaries and, through a consistent monitoring process, will design and improve their floodplain management program in a way that reduces the risk of flooding to people and property.

Community Rating System

An additional indicator of floodplain management capability is active participation in the Community Rating System (CRS). The CRS is an incentive-based program that encourages communities to undertake defined flood mitigation activities that go beyond the minimum requirements of the NFIP. Each of the CRS mitigation activities is assigned a point value. As a community earns points and reaches identified thresholds, they can apply for an improved CRS class. Class ratings, which range from 10 to 1 and increase on 500-point increments, are tied to flood insurance premium reductions. Every class improvement earns an additional 5 percent discount for NFIP policyholders, with a starting discount of 5 percent for Class 9 communities and a maximum possible discount of 45 percent for Class 1 communities.

Community participation in the CRS is voluntary. Any community that is in full compliance with the rules and regulations of the NFIP may apply to FEMA for a CRS classification better than class 10. The CRS application process has been greatly simplified over the past several years, based on community comments intended to make the CRS more user friendly, and extensive technical assistance available for communities who request it.

- The City of Raleigh and the Town of Cary were previously CRS participants but have since been rescinded and are now Class 10 communities.

Table 5.2 – NFIP Policy and Claim Information

Jurisdiction	Date Joined NFIP	Current Effective Map Date	NFIP Policies in Force	Insurance in Force	Written Premium in Force	Closed Losses	Total Payments
City of Raleigh	06/28/74	04/16/13	1,774	$494,165,600	$1,821,219	840	$23,269,081
Town of Apex	03/03/92	04/16/13	96	$28,479,400	$43,304	1	$1,299
Town of Cary	06/28/74	04/16/13	695	$205,652,100	$376,232	137	$2,424,510
Town of Fuquay-Varina	04/11/75	04/16/13	88	$23,759,100	$42,592	3	$107,051
Town of Garner	07/19/74	04/16/13	116	$29,600,400	$81,284	21	$167,744
Town of Holly Springs	03/03/92	04/16/13	70	$21,438,300	$31,255	11	$186,744
Town of Knightdale	04/12/74	04/16/13	35	$10,167,000	$17,907	3	$31,363
Town of Morrisville	10/29/78	04/16/13	78	$23,604,000	$35,687	4	$92,752
Town of Rolesville	03/03/92	04/16/13	11	$3,227,000	$4,009	0	$0
Town of Wake Forest	03/15/74	04/16/13	120	$35,040,700	$48,537	0	$0
Town of Wendell	03/08/74	04/16/13	19	$4,928,000	$8,754	8	$144,907
Town of Zebulon	03/08/74	04/16/13	21	$3,668,000	$9,158	10	$187,065
Wake County (Unincorporated Area)	11/15/78	04/16/13	370	$100,313,300	$143,940	70	$996,074
TOTAL PLAN	-	-	**3,493**	**$984,042,900**	**$2,663,878**	**1,108**	**$27,608,590**

Source: FEMA NFIP Policy Statistics, NCEM Risk Management Tool

Floodplain Management Plan

A floodplain management plan (or a flood mitigation plan) provides a framework for action regarding corrective and preventative measures to reduce flood-related impacts.

- 11 of the 13 participating jurisdictions have a floodplain management plan in place.

Open Space Management Plan

An open space management plan is designed to preserve, protect, and restore largely undeveloped lands in their natural state, and to expand or connect areas in the public domain such as parks, greenways, and other outdoor recreation areas. In many instances open space management practices are consistent with the goals of reducing hazard losses, such as the preservation of wetlands or other flood-prone areas in their natural state in perpetuity.

- 12 of the 13 participating jurisdictions have an open space management plan in place or under development.

Stormwater Management Plan

A stormwater management plan is designed to address flooding associated with stormwater runoff. The stormwater management plan is typically focused on design and construction measures that are intended to reduce the impact of more frequently occurring minor urban flooding.

- 13 of the 13 participating jurisdictions have a stormwater management plan in place.

5.3.2 Administrative and Technical Capability

The ability of a local government to develop and implement mitigation projects, policies, and programs is directly tied to its ability to direct staff time and resources for that purpose. Administrative capability can be evaluated by determining how mitigation-related activities are assigned to local departments and if there are adequate personnel resources to complete these activities. The degree of intergovernmental coordination among departments will also affect administrative capability for the implementation and success of proposed mitigation activities.

Technical capability can generally be evaluated by assessing the level of knowledge and technical expertise of local government employees, such as personnel skilled in using geographic information systems (GIS) to analyze and assess community hazard vulnerability. The Local Capability Self-Assessment was used to capture information on administrative and technical capability through the identification of available staff and personnel resources.

Table 5.3 provides a summary of the Local Capability Self-Assessment results for the region with regard to relevant staff and personnel resources. A checkmark indicates the presence of a staff member(s) in that jurisdiction with the specified knowledge or skill.

Table 5.3 – Relevant Staff/Personnel Resources

Jurisdiction	Planners with knowledge of land development and land management practices	Engineers or professionals trained in construction practices related to buildings and/or infrastructure	Planners or engineers with an understanding of natural and/or human-caused hazards	Building Official	Emergency manager	Floodplain manager	Land surveyors	Scientist familiar with the hazards of the community	Staff with education or expertise to assess the community vulnerability to hazards	Personnel skilled in Geographic Information Systems (GIS) and/or HAZUS	Resource development staff or grant writers	Maintenance programs to reduce risk	Warning systems/services	Mutual Aid Agreements
Wake County	✓	✓		✓	✓	✓		✓	✓	✓			✓	✓
Town of Apex	✓	✓	✓	✓	✓	✓	✓		✓	✓			✓	✓
Town of Cary	✓	✓	✓	✓	✓	✓	✓	✓	✓	✓	✓	✓	✓	
Town of Fuquay-Varina	✓	✓	✓	✓	✓	✓		✓	✓	✓	✓	✓	✓	✓
Town of Garner	✓	✓	✓	✓	✓	✓			✓	✓	✓			✓
Town of Holly Springs	✓	✓	✓	✓	✓	✓			✓	✓	✓	✓	✓	✓
Town of Knightdale	✓	✓	✓	✓	✓	✓				✓				✓
Town of Morrisville	✓	✓	✓	✓	✓	✓	✓	✓	✓	✓		✓	✓	✓
City of Raleigh	✓	✓	✓	✓	✓	✓	✓		✓	✓	✓	✓	✓	✓
Town of Rolesville	✓	✓	✓	✓		✓			✓	✓	✓	✓	✓	✓
Town of Wake Forest	✓	✓	✓	✓	✓	✓			✓	✓	✓	✓	✓	✓
Town of Wendell	✓	✓	✓	✓		✓			✓	✓			✓	✓
Town of Zebulon	✓	✓	✓	✓	✓	✓	✓	✓	✓	✓				✓

Source: Local Capability Assessment Survey

5.3.3 Fiscal Capability

The ability of a local government to implement mitigation actions is often dependent on the amount of money available. This may take the form of outside grant funding awards or locally based revenue and financing. The costs associated with mitigation policy and project implementation vary widely. In some cases, policies are tied primarily to staff time or administrative costs associated with the creation and monitoring of a given program. In other cases, direct expenses are linked to an actual project such as the acquisition of flood-prone houses, which can require a substantial commitment from local, state, and federal funding sources.

The Local Capability Self-Assessment was used to capture information on the region's fiscal capability through the identification of locally available financial resources.

Table 5.4 provides a summary of the results for the region with regard to relevant fiscal resources. A checkmark indicates that the given fiscal resource is locally available for hazard mitigation purposes (including match funds for state and federal mitigation grant funds).

Table 5.4 – Relevant Fiscal Resources

Jurisdiction	Capital Improvement Programming	Community Development Block Grants (CDBG)	Special Purpose Taxes	Gas/Electric Utility Fees	Water/Sewer Fees	Stormwater Utility Fees	Development Impact Fees	General Obligation Bonds	Revenue Bonds	Special Tax Bonds	Other
Wake County	✓	✓	✓					✓	✓	✓	
Town of Apex	✓	✓		✓	✓		✓	✓	✓		✓
Town of Cary	✓	✓			✓		✓	✓	✓		
Town of Fuquay-Varina	✓	✓	✓		✓			✓	✓		
Town of Garner	✓	✓			✓	✓	✓				
Town of Holly Springs	✓				✓	✓		✓	✓		
Town of Knightdale	✓	✓		✓	✓	✓	✓	✓			
Town of Morrisville	✓	✓	✓	✓		✓		✓	✓	✓	✓
City of Raleigh	✓	✓			✓	✓	✓	✓	✓	✓	
Town of Rolesville	✓	✓					✓	✓			
Town of Wake Forest	✓		✓	✓			✓	✓	✓		✓
Town of Wendell		✓			✓						
Town of Zebulon	✓	✓	✓			✓	✓				

Source: Local Capability Assessment Survey

5.3.4 Education and Outreach Capability

This type of local capability refers to education and outreach programs and methods already in place that could be used to implement mitigation activities and communicate hazard-related information. Examples include natural disaster or safety related school programs; participation in community programs such as Firewise or StormReady; and activities conducted as part of hazard awareness campaigns such as a Tornado Awareness Month.

Table 5.5 provides a summary of the results for the region with regard to relevant education and outreach resources. A checkmark indicates that the given resource is locally available for hazard mitigation purposes.

Table 5.5 – Education and Outreach Resources

Jurisdiction	Local citizen groups or non-profit organizations focused on environmental protection, emergency preparedness, access and functional needs populations, etc.	Ongoing public education or information program (e.g., responsible water use, fire safety, household preparedness, environmental education)	Natural disaster or safety related school programs	StormReady certification	Firewise Communities certification	Public-private partnership initiatives addressing disaster-related issues	Other
Wake County	✓	✓	✓	✓		✓	
Town of Apex	✓	✓	✓				
Town of Cary	✓	✓					
Town of Fuquay-Varina	✓	✓	✓				
Town of Garner		✓				✓	
Town of Holly Springs	✓	✓	✓				
Town of Knightdale	✓	✓	✓				
Town of Morrisville	✓	✓	✓				
City of Raleigh	✓	✓	✓			✓	
Town of Rolesville		✓					
Town of Wake Forest		✓	✓			✓	
Town of Wendell		✓					
Town of Zebulon							

Source: Local Capability Assessment Survey

5.3.5 Mitigation Capability

This type of local capability refers to the mitigation strategies and actions that are developed by the communities in this plan.

Table 5.6 provides a summary of the results for the planning area with regard to relevant mitigation resources. A checkmark (√) indicates that the given resource is locally available for hazard mitigation purposes.

Table 5.6 – Mitigation Resources

Jurisdiction	Do you apply for mitigation grant funding?	Do you perform reconstruction projects?	Do you perform building elevations?	Do you perform acquisitions?
Wake County				
Town of Apex		✓		✓
Town of Cary	✓			✓
Town of Fuquay-Varina	✓	✓		
Town of Garner			✓	
Town of Holly Springs		✓		
Town of Knightdale			✓	
Town of Morrisville				
City of Raleigh	✓	✓	✓	✓
Town of Rolesville				
Town of Wake Forest	✓			✓
Town of Wendell				
Town of Zebulon	✓			

5.3.6 Political Capability

One of the most difficult capabilities to evaluate involves the political will of a jurisdiction to enact meaningful policies and projects designed to reduce the impact of future hazard events. Hazard mitigation may not be a local priority, or it may conflict with or be seen as an impediment to other goals of the community, such as growth and economic development. Therefore, the local political climate must be considered in designing mitigation strategies, as it could be the most difficult hurdle to overcome in accomplishing their adoption and implementation.

The Local Capability Self-Assessment was used to capture information on political capability of the region. Survey respondents were asked to rate political support as they perceive it and identify general examples of local political capability, such as guiding development away from identified hazard areas, restricting public investments or capital improvements within hazard areas, or enforcing local development

standards that go beyond minimum state or federal requirements (e.g., building codes, floodplain management, etc.).

Most participating jurisdictions indicated that political leaders are willing to implement mitigation measures. However, fiscal limitations were noted as a limitation for garnering political support. Additionally, some jurisdictions noted that although their local leaders are willing to implement mitigation measures, current state legislation is not supportive of that effort, particularly in terms of environmental regulations.

Several jurisdictions have local standards in support of hazard mitigation that exceed state requirements. For example, in Garner and Wendell, not development is allowed in the 100-year floodplain. In Wake Forest, no development is allowed within the 500-year floodplain. Both Wake Forest and Morrisville have higher freeboard requirements for construction in the floodplain. Additionally, Morrisville requires stormwater detention for the 1-, 2-, and 10-year storm events despite the state only requiring detention for the 1-year event. These regulations are indicative of local political capability to implement mitigation measures.

Four jurisdictions responded in the Local Capability Self-Assessment that they do not have local standards for mitigation exceeding state requirements, which may suggest increased barriers to implementation of mitigation regulations in this jurisdictions.

5.3.7 Local Self-Assessment Rating

In addition to the inventory and analysis of specific local capabilities, the Local Capability Self-Assessment asked counties and local jurisdictions within the Wake County planning area to assign a rating of their perceived capability across each of the capability categories and overall as either “limited,” “moderate,” or “high.”

Table 5.7 summarizes the results of the self-assessment ratings for each community in the Wake County planning area.

Table 5.7 – Self-Assessment of Capability

Jurisdiction	Plans, Ordinances, Codes and Programs	Administrative and Technical Capability	Fiscal Capability	Education and Outreach Capability	Mitigation Capability	Political Capability	OVERALL CAPABILITY
Wake County	High	Moderate	Moderate	Limited	Unrated	Unrated	Moderate
Town of Apex	Moderate	High	High	Limited	High	High	High
Town of Cary	High	High	High	High	High	High	High
Town of Fuquay-Varina	High	High	High	High	High	High	High
Town of Garner	Moderate	Moderate	High	Moderate	Moderate	Moderate	Moderate
Town of Holly Springs	High	High	High	Moderate	Moderate	High	High
Town of Knightdale	High	Moderate	Limited	Limited	Limited	Moderate	Moderate

Jurisdiction	Plans, Ordinances, Codes and Programs	Administrative and Technical Capability	Fiscal Capability	Education and Outreach Capability	Mitigation Capability	Political Capability	OVERALL CAPABILITY
Town of Morrisville	Moderate	Moderate	Moderate	Moderate	Moderate	Moderate	Moderate
City of Raleigh	High	High	High	High	High	High	High
Town of Rolesville	High	High	Moderate	Moderate	Moderate	Moderate	Moderate
Town of Wake Forest	High	High	High	Moderate	Limited	High	High
Town of Wendell	High	Moderate	Limited	Limited	Limited	Limited	Limited
Town of Zebulon	Moderate	Moderate	Moderate	Moderate	Limited	Moderate	Moderate

Source: Local Capability Assessment Survey

5.4 CONCLUSIONS ON LOCAL CAPABILITY

In order to form meaningful conclusions on the assessment of local capability, a quantitative scoring methodology was designed and applied to results of the Local Capability Self-Assessment. This methodology attempts to assess the overall level of capability of the Wake County planning area to implement hazard mitigation actions.

Table 5.8 shows the results of the capability assessment using the designed scoring methodology. The capability score is based solely on the information provided by local officials in response to the Local Capability Self-Assessment. According to the assessment, the average local capability score for all responding jurisdictions is 95, which falls into the Moderate capability ranking.

Table 5.8 – Capability Assessment Results

Jurisdiction	Overall Capability Score	Overall Capability Rating
Wake County	98	Moderate
Town of Apex	102	High
Town of Cary	108	High
Town of Fuquay-Varina	107	High
Town of Garner	93	Moderate
Town of Holly Springs	106	High
Town of Knightdale	80	Moderate
Town of Morrisville	97	Moderate
City of Raleigh	106	High
Town of Rolesville	92	Moderate
Town of Wake Forest	97	Moderate
Town of Wendell	72	Moderate
Town of Zebulon	82	Moderate

Source: Local Capability Assessment Survey, NCEM Risk Management Tool

As previously discussed, one of the reasons for conducting a capability assessment is to examine local capabilities to detect any existing gaps or weaknesses within ongoing government activities that could hinder proposed mitigation activities and possibly exacerbate community hazard vulnerability. These gaps or weaknesses have been identified, for each jurisdiction, in the tables found throughout this section. The participating jurisdictions used the capability assessment as part of the basis for the mitigation actions that are identified in Section 7; therefore, each jurisdiction addresses their ability to expand on and improve their existing capabilities through the identification of their mitigation actions.

6 Mitigation Strategy

Requirement §201.6(c)(3): [The plan shall include] a mitigation strategy that provides the jurisdiction's blueprint for reducing the potential losses identified in the risk assessment, based on existing authorities, policies, programs and resources, and its ability to expand on and improve these existing tools.

This section describes the process for developing the mitigation strategy for the Wake County Multi-Jurisdictional Hazard Mitigation Plan. It describes how the County met the requirements for Planning Step 6 (Set Goals), Planning Step 7 (Review Possible Activities), and Planning Step 8 (Draft an Action Plan). This section includes the following sub-sections:

- 6.1 Goals and Objectives
- 6.2 Identification & Analysis of Mitigation Activities

6.1 GOALS AND OBJECTIVES

Requirement §201.6(c)(3)(i): [The mitigation strategy section shall include a] description of mitigation goals to reduce or avoid long-term vulnerabilities to the identified hazards.

Goal setting builds upon the findings of Section 4, which documents the hazards and associated risks that threaten the Wake County planning area, and Section 5, which evaluates the capacity of the County to reduce the impact of those hazards. The intent of Goal Setting is to identify areas where improvements to existing capabilities can be made so that community vulnerability is reduced. Goals are also necessary to guide the review of possible mitigation measures. This plan needs to make sure that recommended actions are consistent with what is appropriate for the County and its incorporated municipalities. Mitigation goals need to reflect community priorities and should be consistent with other local plans.

- **Goals** are general guidelines that explain what is to be achieved. They are usually broad-based policy type statements, long term and represent global visions. Goals help define the benefits that the plan is trying to achieve.
- **Objectives** are short term aims that, when combined, form a strategy or course of action to meet a goal. Unlike goals, objectives are specific and measurable.

6.1.1 Coordination with Other Planning Efforts

The goals of this plan need to be consistent with and complement the goals of other local planning efforts. The primary planning documents that the goals of this plan should complement and be consistent with are the county and participating jurisdictions' comprehensive plans. Comprehensive plans are important because they are developed and designed to guide future growth within their communities. Keeping the Hazard Mitigation Plan and Comprehensive Plans consistent ensures that land development is done with awareness and understanding of hazard risk and that mitigation projects complement rather than contradict community development objectives.

6.1.2 Goal Setting

At the second planning meetings, held on January 7, 2019 and January 9, 2019, the HMPC reviewed and discussed the goals from the 2015 Plan. The previous goals were as follows:

#1	Protect public health, life, safety, and welfare by increasing public awareness and education of hazards and by encouraging collective and individual responsibility for mitigating hazard risks.

#2	Improve technical capability to respond to hazards and to improve the effectiveness of hazard mitigation actions.
#3	Enhance existing or create new policies and ordinances that will help reduce the damaging effects of natural hazards.
#4	Minimize threats to life and property by protecting the most vulnerable populations, buildings, and critical facilities through the implementation of cost-effective and technically feasible mitigation actions.
#5	Generally reduce the impact of all natural hazards.
#6	Ensure that hazard mitigation is considered when redevelopment occurs after a natural disaster.
#7	Ensure that disaster response and recovery personnel have the necessary equipment and supplies available in order to serve the public in the event of a disaster.

The following changes were proposed to the HMPC:

- Re-word Goal #2 to emphasize implementing hazard mitigation in addition to hazard response.
- Delete Goal #3 and incorporate it as an objective under the existing Goal #6.
- Delete Goal #5.
- Modify Goal #6 to include new development in addition to post-disaster redevelopment. Emphasize recovery development and the need for resilience.
- Delete Goal #7 and incorporate it as an objective under the existing Goal #2.

There were three comments on the goal revisions. For Goal #2, the scope of technical capability was questioned and the group decided it should include administrative resources as well as tools, data, and equipment. For Goal #4, it was recommended that adaptation be included in addition to resiliency, to emphasize the need to consider future conditions during the development and redevelopment processes. For Goal #6, it was recommended that the action specifically include recovery because a current capability gap for the County and jurisdictions is the lack of a recovery plan. With the inclusion of these comments, the HMPC approved of the recommended goal revisions.

During the third planning meetings, held on March 4, 2019 and March 8, 2019, the HMPC discussed objectives within each goal in order to better facilitate the development of clearly defined mitigation actions.

The revised goals and the newly identified objectives of this plan update are detailed below in Section 6.1.3.

6.1.3 Resulting Goals and Objectives

The HMPC agreed upon four general goals for this planning effort and included specific objectives in support of each goal. The refined goals and objectives are as follows:

Goal 1 – Protect public health, life, safety, and welfare by increasing public awareness and education of hazards and by encouraging collective and individual responsibility for mitigating hazard risks.

Objective 1.1: Develop outreach materials and expand outreach platforms to identify hazard areas and explain risks.

Objective 1.2: Seek opportunities to improve warning and notification of hazard events.

Goal 2 – Improve technical capability (including administrative resources, tools, data, and equipment) to implement hazard mitigation and respond to hazard events.

Objective 2.1: Ensure that disaster response and recovery personnel have the necessary equipment and supplies available in order to serve the public in the event of a disaster.

Objective 2.2: Seek to fill gaps in local capabilities that will enable improved implementation of mitigation projects.

Goal 3 – Minimize threats to life and property by protecting the most vulnerable populations, buildings, and critical facilities through the implementation of cost-effective and technically feasible mitigation actions.

Objective 3.1: Retrofit, harden, or otherwise protect critical facilities and infrastructure to protect against damages and ensure continuity of operations during hazard events.

Objective 3.2: Implement policies and projects that reduce vulnerabilities of key populations and property at risk.

Goal 4 – Incorporate resiliency into future growth by ensuring that hazard mitigation is considered for both new development and post-disaster redevelopment and recovery.

Objective 4.1: Enhance existing or create new policies and ordinances that will help reduce the damaging effects of natural hazards.

Objective 4.2: Integrate hazard mitigation into existing and new planning efforts.

6.2 IDENTIFICATION AND ANALYSIS OF MITIGATION ACTIVITIES

Requirement §201.6(c)(3)(ii): [The mitigation strategy section shall include a] section that identifies and analyzes a comprehensive range of specific mitigation actions and projects being considered to reduce the effects of each hazard, with particular emphasis on new and existing buildings and infrastructure. All plans approved by FEMA after October 1, 2008, must also address the jurisdiction's participation in the NFIP, and continued compliance with NFIP requirements, as appropriate.

To identify and select mitigation projects that support the mitigation goals, each hazard identified in Section 4 Hazard Identification was evaluated. The following were determined based on the Priority Risk Index scores to be high and medium priority hazards:

- Extreme Heat
- Severe Weather
- Severe Winter Storm
- Hurricane & Tropical Storm
- Tornado
- Radiological Emergency
- Flood
- Drought
- Wildfire
- Hazardous Materials Incident
- Terrorism
- Dam Failure

Note: actions were also identified for Landslide despite it being a low priority hazard.

Once it was determined which hazards warranted the development of specific mitigation actions, the HMPC analyzed viable mitigation options that supported the identified goals and objectives. The HMPC was provided with the following list of mitigation categories which are utilized as part of the CRS planning process but are also applicable to multi-hazard mitigation.

- Prevention
- Property Protection
- Natural Resource Protection
- Emergency Services
- Structural Projects
- Public Information and Outreach

The HMPC was also provided with examples of potential mitigation actions for each of the above categories. The HMPC was instructed to consider both future and existing buildings in evaluating possible mitigation actions. Facilitated discussions took place to examine and analyze the options. The HMPC also considered which actions from the previous plan that were not already completed should be continued in this action plan.

6.2.1 Prioritization Process

In the process of identifying continuing and new mitigation actions, the HMPC was provided with a set of prioritization criteria to assist in deciding why one recommended action might be more important, more effective, or more likely to be implemented than another. HMPC members were asked to rate each action on a set of criteria, which were grouped into three categories: Suitability, Risk Reduction, and Cost. The criteria for the prioritization process included the following:

- **Suitability**
  - Appropriateness of Action
  - Community Acceptance
  - Technical and Administrative Feasibility
  - Environmental Impact
  - Legal Conformance
  - Consistency with Existing Plans and Other Community Goals
- **Risk Reduction**
  - Scope of Benefits
  - Potential to Save Lives
  - Importance of Benefits
  - Level of Inconvenience or Unintended Consequence
  - Losses Avoided
  - Number of People to Benefit
- **Cost**
  - Estimate of Upfront Cost
  - Estimate of Ongoing Cost
  - Benefit to Cost Ratio
  - Financing Availability
  - Affordability
  - Elimination of Repetitive Damages

In accordance with the DMA requirements, an emphasis was placed on the importance of a benefit-cost analysis in determining action priority, as reflected in the prioritization criteria above. For each action, the HMPC considered the benefit-cost analysis in terms of:

- Ability of the action to address the problem
- Contribution of the action to save life or property
- Available technical and administrative resources for implementation
- Availability of funding and perceived cost-effectiveness

The consideration of these criteria helped to prioritize and refine mitigation actions but did not constitute a full benefit-cost analysis. The cost-effectiveness of any mitigation alternative will be considered in greater detail through performing benefit-cost project analyses when seeking FEMA mitigation grant funding for eligible actions associated with this plan.

Using these prioritization criteria, the HMPC's ratings for each action were input into the North Carolina Emergency Management's Risk Management Tool (RMT), which provided a ranking of High, Medium, or Low priority. The prioritization ranking for each mitigation action considered by the HMPC is provided in Section 7 Mitigation Action Plans.

7 Mitigation Action Plans

Requirement §201.6(c)(3)(iii): [The mitigation strategy section shall include an] action plan describing how the actions identified in section (c)(3)(ii) will be prioritized, implemented, and administered by the local jurisdiction. Prioritization shall include a special emphasis on the extent to which benefits are maximized according to a cost benefit review of the proposed projects and their associated costs.

This section provides the mitigation action plans for each participating jurisdiction. The plans are organized as follows:

- Wake County (Unincorporated Area)
- City of Raleigh
- Town of Apex
- Town of Cary
- Town of Fuquay-Varina
- Town of Garner
- Town of Holly Springs
- Town of Knightdale
- Town of Morrisville
- Town of Rolesville
- Town of Wake Forest
- Town of Wendell
- Town of Zebulon

Additional details on each mitigation action are provided by jurisdiction in their respective annex of this plan.

Table 7.1 – Mitigation Action Plan, Wake County (Unincorporated Area)

Wake County											
Action #	**Description**	**Goal**	**Objective**	**Hazard(s) Addressed**	**Relative Priority**	**Lead Agency/ Department**	**Estimated Cost**	**Potential Funding Sources**	**Implementation Schedule**	**2019 Status**	**Status Comments/Explanation**
Prevention											
P-1	Conduct a groundwater assessment using a network of wells and leading to a groundwater model that can enhance the understanding of groundwater capacity, threats and vulnerabilities in response to growth and weather.	1	1	Drought	High	Wake Environmental Services, Wake Water Partnership, USGS	$1,565,000	Non-departmental operating expense and USGS	3-5 years	In-Progress – Carry Forward	Program scope established and project is underway. Wake County is partnering with USGS to conduct this study.
P-2	Oversee completion of planned reclaimed water projects per the County's approved Community Improvement Program (CIP).	4	2	Drought	Moderate	Raleigh, Wake County	$16,000,000	Annual budget process	2-3 years	In-Progress – Carry Forward	Completed several reclaimed water projects in RTP and others directly related to County facilities. Project has three phases; phases 1 and 2 are complete.
Property Protection											
PP-1	Identify road network segments no longer maintained by NCDOT and provide funding and planning resources for mitigation and recovery efforts to communities to ensure infrastructure and transportation resiliency. Assist in reinstating water and sewer services post disaster.	3	1	All	Moderate	Wake County Community Services	$100,000,000	Annual budget ordinance	Ongoing - Next 5 years	New	N/A
Natural Resource Protection											
NRP-1	Partner with other governmental units and other interested parties to jointly identify and acquire 30,000 acres of open space lands.	3	2	Flood, Drought, Landslide, Extreme Heat	High	Wake County Community Services	$335,000,000	Open Space Bonds	3-5 years	In-Progress – Carry Forward	The County has purchased approximately 7,634 acres since the program's inception. It will take several decades as indicated to complete. In 2018 voters approved $120m Parks, Greenways, Recreation and Open Space Bond. $26m available for 2019.
Structural Projects											
SP-1	Replace emergency generators located at facilities that serve as emergency shelter locations based on their scheduled end of life cycle.	3	1	All	Moderate	Wake County Facilities Design & Construction	$1,400,000	Local and Federal Grant	More than 5 years	New	N/A
SP-2	Construction of a new Emergency Operations Center adequate for the size and complexity of the jurisdiction	2	1	All	Moderate	Wake County Emergency Management	$6,500,000	Local	3-5 years	New	N/A
Emergency Services											
ES-1	Recovery Plan. Develop a comprehensive disaster recovery plan for Wake County consistent with the vision and goals described in PPD-8 and the National Disaster Recovery Framework.	4	2	All	Moderate	Wake County Emergency Management	$150,000	Local	3-5 years	New	N/A
ES-2	Upload dam failure inundation maps to Everbridge system for notification and evacuation.	1	2	Dam Failure	High	Wake County Emergency Management	Staff time	Local	1 year	New	N/A
Public Education and Awareness											
PEA-1	Emergency Planning and Community Right-to-Know Act (EPCRA) High Hazard Chemicals Awareness. Identify chem facilities, potential impact zones, and potentially affected communities. Inform public and provide resources and education.	1	1	Hazardous Material	Moderate	Wake County Local Emergency Planning Committee	$15,000	Local funding, donations	2-3 years	New	N/A
PEA-2	Increase public awareness and participation in the Ready Wake program and resources.	1	1	All	Moderate	Wake County Fire Services, Emergency Management	$10,000	Federal Grants and Local	2-3 years	New	N/A

Table 7.2 – Mitigation Action Plan, City of Raleigh

City of Raleigh											
Action #	**Description**	**Goal**	**Objective**	**Hazard(s) Addressed**	**Relative Priority**	**Lead Agency/ Department**	**Estimated Cost**	**Potential Funding Sources**	**Implementation Schedule**	**2019 Status**	**Status Comments/Explanation**
Prevention											
P-1	Establish a Lake Preservation Policy that encourages private property owners to preserve existing lakes and ponds, and in certain circumstances provides for public assistance.	4	1	Flood	Moderate	Raleigh Engineering Services	$100,000 - $1m	Local	1 year	In-Progress – Carry Forward	City Stormwater has also worked with the Stormwater Management Advisory Commission to develop recommendations to further enhance the lake preservation program. It is anticipated that the revised program will be considered by City Council during calendar year 2019. Enhancements would include the continued ability to restore and upgrade dams and spillways associated with safety improvements as well as removal of dams to protect safety and restore natural conditions
P-2	Develop ongoing multi-year program of detailed basin studies for each watershed in City's jurisdiction. Fifteen basin studies are complete with 10 additional studies budgeted in the capital program. (CRS 410).	2	2	Flood	Moderate	Raleigh Engineering Services	$100,000 - $1m	Local	1 year	In-Progress – Carry Forward	City Stormwater is currently working on an Integrated Stormwater Management Master Plan. Basin studies will be reviewed and updated as needed with further improvement needs and opportunities identified and prioritized. Reduction of flooding hazards remains a key priority for improvement projects.
P-3	Planning Commission to consider program to develop future conditions floodplain mapping for all FEMA mapped areas (this is already done for non-FEMA mapped areas). The program would consist of a multi-year capital program for mapping for all FEMA streams in the ETJ and consideration of changes to development regulations in these areas. Future conditions would be based on expected development per the Comprehensive Plan and zoning maps.	4	2	Flood	Moderate	Raleigh Engineering Services	$100,000 - $1m	Local	3-5 years	In-Progress – Carry Forward	The preliminary maps that have all FEMA floodplain in the city studied for future conditions. Our ordinance is already set up to enforce these areas. Once the maps are effective this effort will be complete.
P-4	Reallocation of Falls Lake water conservation pool; increased available storage for water supply by 4.1B gallons	2	1	Drought	High	Public Utilities Department	No cost	N/A	Ongoing - Next 5 years	New	N/A
P-5	Implementation of a regional mutual aid contract between local water utilities which would describe how the utilities would provide assistance if a partner utility experienced a water shortage	2	2	Drought	High	Public Utilities Department	Variable - depends on volume of water transferred between systems	Public Utilities Dept	Ongoing - Next 5 years	New	N/A
P-6	Develop a written Resiliency Plan for City of Raleigh operations and services, including infrastructure resilience, community resilience, ecosystem resilience and governance resilience.	4	1	All	High	Office of Sustainability	Less than $100,000	Unknown	2-3 years	New	N/A
P-7	Water Shortage Response Plan which uses a hydrologic model (OASIS) to establish risk based drought triggers that are designed to reduce water demand before severe drought conditions and also when to exit drought triggers when conditions improve.	2	2	Drought	Moderate	Public Utilities Department	No cost	N/A	Ongoing - Next 5 years	New	N/A
P-8	Update and maintain GIS data of building footprints, parcels, and critical facilities, and use it to regularly identify buildings in need of mitigation.	2	2	All	Moderate	Raleigh Information Technology, GIS staff	Staff time	Local	Ongoing - Next 5 years	New	Updated data will be used in future plan updates and risk assessments and to identify properties that should be prioritized for mitigation.
Property Protection											
PP-1	Develop ongoing program designed to utilize Federal grant resources to assist private property owners in relocating existing structures out of flood hazard zones. (CRS 500/510/520)	3	2	Flood	Moderate	Raleigh Engineering Services	$100,000 - $1m	Local, Federal	3-5 years	In-Progress – Carry Forward	The city is cataloging potential candidates for relocation based on our current repetitive loss list. Staff has developed a scoring system based on cost benefit for relocation.

City of Raleigh											
Action #	**Description**	**Goal**	**Objective**	**Hazard(s) Addressed**	**Relative Priority**	**Lead Agency/ Department**	**Estimated Cost**	**Potential Funding Sources**	**Implementation Schedule**	**2019 Status**	**Status Comments/Explanation**
PP-2	Develop an ongoing program designed to utilize Federal grant resources to assist private property owners in elevating existing structures located within flood hazard zones. (CRS 510/530)	3	2	Flood	Moderate	Raleigh Engineering Services	$100,000 - $1m	Local, Federal	3-5 years	In-Progress – Carry Forward	To further this initiative, the city is cataloging potential candidates for elevation based on our current repetitive loss list. Staff has developed a scoring system based on cost benefit for elevation that would compare the projects to relocation and retrofits.
PP-3	Develop an ongoing program designed to utilize Federal grant resources to assist private property owners in renovating and retrofitting existing structures in flood hazard zones to reduce vulnerability to flooding damage.	3	2	Flood	Moderate	Raleigh Engineering Services	$100,000 - $1m	Local, Federal	Ongoing – next 5 years	In-Progress – Carry Forward	City staff evaluates potential candidates and approaches property owners for mitigation help.
PP-4	Program to install emergency electrical generators at all public utility facilities. Current focus on redundant generators at critical facilities, second fuel truck and completion of 100% generator coverage in Garner area.	3	1	All	High	Raleigh Public Utilities	$100,000 - $1m	Local	2-3 years	In-Progress – Carry Forward	We now have emergency backup power generators at all our critical facilities except for our South Raleigh Operations Facility. However, we can relocate supplies, material and teams to any of our other facilities per our emergency operational planning. Also, per our Hurricane Florence AAR we are conducting emergency fuel capacity studies for our generators at our largest wastewater treatment plant and both our water treatment plants. A fuel truck is not in the works but we have emergency fuel contracts with Red Star and also exploring dual use of natural gas to power some of our energy resiliency to give us an added layer.
Structural Projects											
SP-1	Install cameras in flood prone areas throughout the City of Raleigh to allow us to view these locations and make informed decisions as it relates to flooding	2	2	Flood, Hurricane	Moderate	City of Raleigh Transportation	$100,000 to $1m	Unknown	3-5 years	New	N/A
Emergency Services											
ES-1	Provide and enhance technical rescue capabilities more equitably throughout the City.	2	1	Dam Failure, Flood, Hurricane, Severe Weather, Severe Winter Storm, Tornado, Wildfire	High	Raleigh Fire	$100,000 - $1m	Local	2-3 years	In-Progress – Carry Forward	We continually look at our technical rescue capabilities and adjust as needed. The initiative to add 1 Heavy Rescue and 2 Squads has been completed. Additionally, we've added 1 company (12 personnel) to the team, upgraded water rescue equipment, increased water rescue certified personnel from 20 to 60, required 100% of members be Technical Rescuer and Vehicle Extrication certified and are working toward 100% certification for all members in all the other technical rescue disciplines.
ES-2	Provide after-action report of emergency response to severe weather events in order to improve planning for future disasters.	2	2	Hurricane, Severe Weather, Severe Winter Storm, Tornado	High	Raleigh Fire and Emergency Management	$100,000 - $1m	Local	Ongoing- Post Event	In-Progress – Carry Forward	After-action report made for Hurricane Florence and will continue to be made for all subsequent weather events.
ES-3	Maintain a standard operating guideline to direct operational planning prior to anticipated weather emergencies.	2	1	All	High	Raleigh Fire and Emergency Management	$100,000 - $1m	Local	Ongoing – next 5 years	In-Progress – Carry Forward	The City's Emergency Operation Plan outlines our standard operating guidelines and has been adopted as an official document used prior to and during weather emergencies.
ES-4	Design GIS programming capable of providing real-time data to emergency managers and historic data for future emergency response planning.	2	2	All	High	Raleigh City Manager and Information Technology	$100,000 - $1m	Local	3-5 year	In-Progress – Carry Forward	The IT Department led a citywide effort to develop a Situational Analysis Smart Dashboard for the Emergency Operations Center and refined it in real time as new types of data, such as current wind speed, were identified as critical to the safety of the public and city workers during an emergency. The Smart Dashboard was first deployed for Hurricane Florence. The dashboard is cross-departmental, with real-time progress tracking, covering a range of emergency management issues from debris in streets and closures, malfunctioning traffic signals, flood monitoring and 911 call data.

City of Raleigh											
Action #	**Description**	**Goal**	**Objective**	**Hazard(s) Addressed**	**Relative Priority**	**Lead Agency/ Department**	**Estimated Cost**	**Potential Funding Sources**	**Implementation Schedule**	**2019 Status**	**Status Comments/Explanation**
ES-5	Continue to conduct disaster tabletop exercise program.	2	1	All	Low	Raleigh Public Utilities, Fire, Police, City Manager, Emergency Management, and Engineering Services	$100,000 - $1m	Local	Ongoing – next 5 years	In-Progress – Carry Forward	Tabletop disaster exercises continue to occur with all EOC partners prior to the anticipated peak of hurricane season. These trainings take place each year to ensure staff are comfortable in their EOC roles and to handle staff turnover.
ES-6	Establish cross-functional team to develop Debris Management Plan. Team should work to identify and prepare additional debris management sites.	2	1	Flood, Tornado, Earthquake, Severe Winter Storm, Severe Weather, Hurricane	Moderate	City of Raleigh Transportation	$100,000	FEMA, City of Raleigh general fund support	1 year	New	N/A
Public Education and Awareness											
PEA-1	Utilize existing Everbridge advisory software to issue Heat Advisory Alerts targeted to vulnerable neighborhoods	1	2	Extreme Heat	High	Communications/ Sustainability	Less than $100,000	COR Operating Funds	2-3 years	New	N/A

Table 7.3 – Mitigation Action Plan, Town of Apex

Town of Apex											
Action #	**Description**	**Goal**	**Objective**	**Hazard(s) Addressed**	**Relative Priority**	**Lead Agency/ Department**	**Estimated Cost**	**Potential Funding Sources**	**Implementation Schedule**	**2019 Status**	**Status Comments/Explanation**
Prevention											
P-1	Revise and update the regulatory floodplain boundary, including flood studies.	2	2	Flood	Moderate	Public Works & Transportation (Floodplain Administrator)	Staff Time	Town Funds	Ongoing - Next 5 years	In-Progress – Carry Forward	Action revised.
P-2	Develop an environmental committee that meets regularly to discuss issues and recommend projects.	2	2	All Hazards	Moderate	Water Resources (Stormwater and Utility Engineering Manager)	Staff Time	Town Funds	Ongoing - Next 5 years	In-Progress – Carry Forward	The Town Council's Environmental committee has been established and meets approximately every 2 months
P-3	Encourage the use of Low Impact Development techniques.	4	2	Flood, Landslide, Drought, Hurricane, Extreme Heat	Low	Water Resources (Stormwater and Utility Engineering Manager)	Staff Time	Town Funds	Ongoing - Next 5 years	In-Progress – Carry Forward	Ongoing activity that has seen more results in last 5 years and will continue to be prioritized.
P-4	Use system development fees to help fund public projects	3	2	Flood, Wildfire, Tornado, Severe Winter Storm, Severe Weather, Drought, Hurricane	Moderate	Water Resources (Stormwater and Utility Engineering Manager)	Unknown	Local Development Fees	3-5 years	In-Progress – Carry Forward	Action revised.
P-5	Update the UDO & Design and Development Manual to incorporate proper species selection and practices for planting and maintenance into the landscape ordinance.	4	1	Flood, Severe Winter Storm, Severe Weather, Drought, Hurricane	Moderate	Planning Dept.	Staff Time	Local	2-3 years	In-Progress – Carry Forward	Action revised.
P-6	Incorporate GIS data and risk analysis into the development review process.	4	2	All	Moderate	Fire Dept. & Planning Dept.	Staff Time	Local	Ongoing - Next 5 years	In-Progress – Carry Forward	Action revised.
P-7	Create a Stormwater Utility to fund the Town's Stormwater Program.	2	2	Flood	Moderate	Water Resources (Stormwater and Utility Engineering Manager)	$100,000	Local	2-3 years	New	Implement: 2021
P-8	Continue to use "Neighbors Helping Neighbors" program to help low income Apex Utility customers pay their utility bills.	3	2	Extreme Heat, Severe Winter Storm	Moderate	Finance Dept/Western Wake Crisis Ministry	None	Local	Ongoing - Next 5 years	New	Has been in use for years but is just now being recognized as contributing towards mitigating impacts of high heat and cold weather.
P-9	Salt local roads before Severe Winter Storm & plow after snow and ice fall.	3	2	Severe Winter Storm	Moderate	Public Works & Transportation		Local	Ongoing - Next 5 years	New	On-going activity that is just now being added as mitigation for Severe Winter Storms.
Property Protection											
PP-1	Adopt and enforce the Fire Prevention Code.	4	1	Wildfire, Hazardous Materials Incident	Moderate	Fire Department	Staff Time	Local	Ongoing - Next 5 years	New	N/A
PP-2	Annually update the comprehensive occupancy pre-plan program with local data for use in risk analysis.	4	2	Flood, Wildfire, Hazardous Materials Incident, Radiological Emergency	Moderate	Fire Department	Staff Time	Local	Ongoing - Next 5 years	In-Progress – Carry Forward	Action revised.
PP-3	Restore streams to slow the speed of water and reduce erosion to prevent both private property loss and public infrastructure damage.	3	2	Flood	Moderate	Water Resources (Stormwater and Utility Engineering Manager)	Over $500,000	Local & Federal	Ongoing - Next 5 years	New	N/A
Natural Resource Protection											
NRP-1	Middle Creek Greenway (Miramonte to Holly Springs).	3	2	All	Moderate	Apex Parks and Recreation	$2,870,000	Local	3-5 years	In-Progress – Carry Forward	under construction
NRP-2	White Oak Creek Greenway.	3	2	Flood	Moderate	Apex Parks and Recreation	$284,000	Local	3-5 years	In-Progress – Carry Forward	under construction
NRP-3	During development review, ensure new development complies with floodplain development restrictions listed in UDO Section 6.2 Flood Damage Prevention Overlay District.	4	2	Flood	Moderate	Public Works and Transportation (Floodplain Administrator)	Staff Time	Local	Ongoing - Next 5 years	New	N/A

Town of Apex											
Action #	**Description**	**Goal**	**Objective**	**Hazard(s) Addressed**	**Relative Priority**	**Lead Agency/ Department**	**Estimated Cost**	**Potential Funding Sources**	**Implementation Schedule**	**2019 Status**	**Status Comments/Explanation**
NRP-4	During development review, ensure new development complies with UDO stream buffer standards.	4	2	Flood	Moderate	Water Resources (Stormwater and Utility Engineering Manager)	Staff Time	Local	Ongoing - Next 5 years	New	N/A
NRP-5	During development review, ensure SCMs are designed in accordance with State criteria to safely pass 100-year storm.	4	2	Flood	Moderate	Water Resources (Stormwater and Utility Engineering Manager)	Staff Time	Local	Ongoing - Next 5 years	New	N/A
Structural Projects											
SP-1	Improve communications abilities for emergency response by building new fiber optic internet infrastructure and replacing current radio systems.	2	1	All	Moderate	Police Dept	$915,000	Local	3-5 years	New	N/A
SP-2	Build Jessie Drive to connect TenTen Rd and NC-55. This will provide greater connectivity and make evacuation faster & safer.	3	2	All	Moderate	Public Works and Transportation	$6,000,000	Local	3-5 years	New	N/A
SP-3	Relocate Beaver Creek Sewer Line out of the creek.	3	2	Flood, Wildfire, Severe Winter Storm, Hurricane	Moderate	Water Resources (Stormwater and Utility Engineering Manager)	$1,500,000	Local	3-5 years	New	N/A
SP-4	Finish the Peakway loop road. Will provide greater connectivity, faster emergency response times, and make evacuation faster & safer.	3	2	All	High	Public Works and Transportation	$20,000,000	Local	More than 5 years	New	Design work is in progress
Emergency Services											
ES-1	Construct Fire Station #6	3	2	All Hazards	Moderate	Apex Fire	$4,175,000	Local	3-5 years	New	N/A
ES-2	Construct Fire Station #7	3	2	All Hazards	Moderate	Apex Fire	$4,000,000	Local	More than 5 years	New	N/A
ES-3	Relocate Fire Station #3 from its existing location because of the impacts of widening NC-55.	3	1	All Hazards	Moderate	Apex Fire	$4,000,000	Local	More than 5 years	New	N/A
ES-4	Keep Town website updated with information about Shearon Harris Siren Testing.	1	2	Radiological Incident	Moderate	Apex Public Information Officer	Staff Time	Local	Ongoing - Next 5 years	New	Ongoing activity that's just now being recognized for its mitigation potential
Public Education and Awareness											
PEA-1	Town website and utility billing announcing National Preparedness Month (September) reminding citizens to have a plan and be prepared.	1	1	All	Moderate	Administration (Communications Officer)	Less than $100,000	Local	Ongoing - Next 5 years	In-Progress – Carry Forward	On-going activity to be implemented annually
PEA-2	Include Environment Education Station and classroom at Nature Park.	1	1	All	Moderate	Apex Parks and Recreation	$1,000,000	Local	3-5 years	Not Started – Carry Forward	New target completion date is 2022
PEA-3	Post warning signage at local parks for lightning.	1	1	Severe Weather	Moderate	Apex Parks and Recreation	$100,000	Local	3-5 years	Not Started – Carry Forward	New implementation schedule is 3-5 years
PEA-4	Hand out hazard educational materials at Apex festivals.	1	1	All	Moderate	Planning Dept. & Water Resources	Less than $1,500	Local	Ongoing - Next 5 years	New	N/A
PEA-5	Use Social Media to inform residents about local hazards.	1	1	All	Moderate	Apex Public Information Officer & Planning Dept.	Staff Time	Local	Ongoing - Next 5 years	New	N/A

Table 7.4 – Mitigation Action Plan, Town of Cary

Town of Cary											
Action #	**Description**	**Goal**	**Objective**	**Hazard(s) Addressed**	**Relative Priority**	**Lead Agency/ Department**	**Estimated Cost**	**Potential Funding Sources**	**Implementation Schedule**	**2019 Status**	**Status Comments/Explanation**
Prevention											
P-1	Town's Comprehensive Plan- The Town has an existing comprehensive plan which includes land use, parks and recreation, open space, transportation, utilities, and environment.	4	2	All	High	Cary Planning	$1M for plan development; implementation ongoing	General Fund	2-3 years	In-Progress – Carry Forward	Cary's comprehensive plan, called alternately the Cary Community Plan and the Imagine Cary Plan was finalized on January 24, 2017. Implementation in-process.
P-2	Adaptive Approach to Stormwater	4	1	Flood	High	Cary Stormwater	$900,000	General Fund and $300K Grant	Ongoing	New	Multi-pronged approach including 5 key components: 1) Working Group of residents and local experts to learn and advise 2) Maintenance, including Condition Assessment (a separately listed "action") 3) Open Space, examining how open space and tree canopy provide stormwater benefits 4) Model, hiring a firm to build a hynamic rainfall-runoff model to establish a baseline and test solutions and scenarios 5) Ordinance, looking at the stormwater ordinance as a way to achieve our risk mitigation goals
P-3	Stormwater Condition Assessment Program	4	2	Flood	High	Cary Stormwater	$750,000	General Fund	2-3 years	New	In phase 4, (1-GIS Assessment Tool, 2-GIS Mapping Data and assessment, 3-Modeling, 4-Maintenance) Assessment Tool completed. GIS Mapping 99% completed.
P-4	Develop flood model for upper Swift Creek watershed	2	2	Flood, Hurricane	High	Cary Stormwater	Unknown	Town Funds	1 year	New	N/A
P-5	Develop flood model for Symphony Lake	2	2	Flood, Hurricane	High	Cary Stormwater	Unknown	Town Funds	2-3 years	New	N/A
P-6	Engineering evaluation of Tryon Road dam	2	2	Dam Failure	Moderate	Cary Stormwater	Unknown	Town Funds	3-5 years	New	N/A
P-7	Conduct study and develop improvement plan for Twin Lakes dam	2	2	Dam Failure	High	Cary Stormwater	Unknown	Town Funds	3-5 years	New	N/A
P-8	Conduct flood study on Town-owned lake/dam, including breach analysis	2	2	River Flooding, Dam Failure	High	Cary Stormwater	Unknown	Town Funds	2-3 years	New	N/A
P-9	Triangle Regional Resiliency Partnership	4	1	River Flooding, Wildfire, Drought, Extreme Heat	Moderate	Town of Cary	Variable (depending on outside consultants)	General Funds	Ongoing	New	On-going partnership among Triangle area jurisdictions intended to do joint resilience planning and action. The group's first deliverable of a Triangle Regional Resilience Assessment was finalized late 2018. The group is continuing to meet and consider how it may implement recommendations of the assessment together.
Property Protection											
PP-1	Culvert Replacement - Arbor Brook	3	2	Flood	High	Cary Stormwater	$400,000	General Fund	1 year	New	Replace existing culverts with larger culverts
PP-2	Culvert Replacement - Two Creeks	3	2	Flood	High	Cary Stormwater	$800,000	General Fund	1 year	New	Replace existing culverts with larger culverts
Natural Resource Protection											
NRP-1	Downtown Park	3	2	Flood	High	Cary Stormwater and Facilities	$750,000	General Fund	2-3 years	New	In planning phase. Implementing SW management above and beyond state requirements. Detention of 2, 5 and 10-year storm reduces scour on receiving stream.
NRP-2	Buffer and UTB Protection	3	2	Flood	High	Cary Stormwater and Cary Planning	Over $10,000,000	Private (Developer) Funds	Ongoing - Next 5 Years	New	Extra 50-foot buffer (UTB) on USGS streams; no buffers platted in lots.
Structural Projects											
SP-1	Infrastructure improvements on Summer Lakes Dr.	3	2	Flood	High	Cary Stormwater	$900,000	General Fund	1 year	New	Replace existing undersized culverts
SP-2	Infrastructure improvements on Vincrest Ct	3	2	Flood	High	Cary Stormwater	$400,000	General Fund	2-3 years	New	Replace existing undersized culverts
SP-3	Update Water Shortage Response Plan	2	4	Drought	High	Town of Cary	Staff Time	N/A	1 year	New	N/A

Town of Cary											
Action #	**Description**	**Goal**	**Objective**	**Hazard(s) Addressed**	**Relative Priority**	**Lead Agency/ Department**	**Estimated Cost**	**Potential Funding Sources**	**Implementation Schedule**	**2019 Status**	**Status Comments/Explanation**
SP-4	Water System Risk Analysis	3	1	All	High	Town of Cary	$89,000	General Fund	Ongoing - 1 Year	New	The Water System Risk Analysis is a comprehensive look at the risks to our water system. It is being done to comply with the American Water Infrastructure Act of 2018. It will result in a new emergency response plan for our water system.
Emergency Services											
ES-1	Provide and enhance technical rescue capabilities throughout the Town.	2	1	All	High	Cary Fire	Unknown	Local	Ongoing - Next 5 Years	In-Progress – Carry Forward	Cary's Fire Department has a technical rescue training program that we coordinate with Morrisville and Apex, NC. We train on all disciplines of technical rescue.
ES-2	Provide after-action report of emergency response to severe weather events in order to improve planning for future disasters.	2	2	All	High	Cary Fire, Water Resources, and Facilities Design & Transportation Services	Unknown	General Fund	Ongoing - Next 5 Years	In-Progress – Carry Forward	Cary's key emergency response departments have formal after-action meetings to learn from what went well and seek opportunities to improve. This occurs after each event, so is ongoing in nature.
ES-3	Establish a relationship/partnership with the Renaissance Computing Institute (RENCI) to create a web-based tool capable of providing real-time flood data to emergency managers and historic data for future emergency response planning.	2	2	All	Low	Cary Fire and Technology Services	Unknown	General Fund	Ongoing – Next 5 Years	In-Progress – Carry Forward	Still in the early stages of developing this partnership.
ES-4	Partnership with FBI Terrorism Task Force	2	2	Terrorism	Moderate	Town of Cary, Town of Cary Police	$100,000	General Fund	Ongoing	New	Since 2011 the Town of Cary Police have an officer assigned full time to the FBI Terrorism Task Force to maintain a relationship with the FBI. FBI Terrorism Task Force located in the FBI Raleigh Office located in the Town of Cary off Cary Parkway near US 1. Wake County Emergency Management has a plan for large scale events that impact Wake County. Those plans include guidance for law enforcement as part of a multi-agency response to all sorts of issues that could include the unlikely event of a terrorist attack.
ES-5	Inclement Weather Response Plan	2	1	Severe Winter Storm, Thunderstorm, Hurricane	Moderate	Town of Cary, Town of Cary Public Works	$100,000 - $1 Million (depending on number and type)	General Fund	Ongoing	New	The town commits significant Town-wide resource allocation and operational commitment to ensuring all aspects of winter weather events are planned, executed, and reviewed to maximize positive recovery outcomes for its citizens. The Town has similar structure and programs for thunderstorm or wind events.
Public Education and Awareness											
PEA-1	Environmental Education "green infrastructure" signage on Dry Avenue Properties that were bought out due to flooding. Signs to be installed early 2019	1	1	Flood	Low	Cary Stormwater and Sustainability	$11,000	Local	Ongoing - Next 5 Years	New	N/A
PEA-2	Citizen volunteers make up the Community Emergency Response Team (CERT). CERT training is a Citizens Corps program designed to enable citizens to care for themselves and their neighbors during the first three days following a disaster event. Participants are educated about disaster preparedness, CERT organization, light search and rescue, medical care, fire extinguisher use and disaster psychology.	1	2	All	Moderate	Cary Police Department and Fire Department	$1,000/year	Donations	Ongoing - Next 5 Years	New	N/A

Table 7.5 – Mitigation Action Plan, Town of Fuquay-Varina

Town of Fuquay-Varina											
Action #	**Description**	**Goal**	**Objective**	**Hazard(s) Addressed**	**Relative Priority**	**Lead Agency/ Department**	**Estimated Cost**	**Potential Funding Sources**	**Implementation Schedule**	**2019 Status**	**Status Comments/Explanation**
Prevention											
P-1	Require pre and post construction certification for residential lot development within 10 feet of Wake County Flood Hazard Soils.	4	1	Flood	Moderate	Fuquay-Varina Planning	Budgeted Staff Time	Annual Budget	Ongoing - Next 5 Years	In-Progress – Carry Forward	Part of permit review process
P-2	Annually calculate acreage of flood prone property preserved as open space.	2	2	Flood, Hurricane	Moderate	Fuquay-Varina Planning	Budgeted Staff Time	Annual Budget	Ongoing - Next 5 Years	In-Progress – Carry Forward	Part of an annual report
P-3	Map storm water drainage system as part of Phase II Stormwater Management Plan.	2	2	Flood	High	Fuquay-Varina Engineering	Budgeted Staff Time	Annual Budget	Ongoing - Next 5 Years	In-Progress – Carry Forward	Part of infrastructure acceptance / ongoing project to work on historical data inclusion
P-4	Provide for public dissemination building inspections brochures regarding high winds, water damage prevention, and tie downs for accessory structures.	1	1	Flood, Tornado, Hurricane, Severe Weather	Moderate	Fuquay-Varina Inspections	Budgeted Staff Time	Annual Budget	Ongoing - Next 5 Years	In-Progress – Carry Forward	Brochures continuously made available to public at Town Hall
P-5	Review and update of drought policy for water conservation	2	2	Drought	High	Fuquay-Varina Planning	Budgeted Staff Time	Annual Budget	3-5 years	New	N/A
P-6	Review and update requirements for mast arms to be installed over strain poles	3	2	Severe Weather, Severe Winter Storm, Hurricane, Tornado	Moderate	Fuquay-Varina Planning	Budgeted Staff Time	Annual Budget	3-5 years	New	N/A
P-7	Review and update the 2014 Comprehensive Systemwide Parks, Recreation & Cultural Resources Master Plan for inclusion of hazard safety information at facilities	4	2	Flood, Earthquake, Extreme Heat, Severe Weather, Tornado	High	Fuquay-Varina Planning and Parks, Recreation, & Cultural Resources	Budgeted Staff Time	Annual Budget	3-5 years	New	N/A
Property Protection											
PP-1	Continue to enforce the Flood Damage Prevention Ordinance for all new construction or substantial building rehabilitations.	4	1	Flood, Hurricane	High	Fuquay-Varina Planning	Budgeted Staff Time	Annual Budget	Ongoing - Next 5 Years	In-Progress – Carry Forward	Part of development and permit review process
PP-2	Require minimum finished floor elevation in known FEMA flood hazard zones be minimum 2’ above base flood elevation.	4	1	Flood, Hurricane	High	Fuquay-Varina Planning and Inspections	Budgeted Staff Time	Annual Budget	Ongoing - Next 5 Years	In-Progress – Carry Forward	Part of development and permit review process
PP-3	Identify and inventory buildings that are located in FEMA flood zones to determine which structures may be prone to flooding (possible relocation and/or elevation).	3	1	Flood, Hurricane	High	Fuquay-Varina Planning and Engineering	Budgeted Staff Time	Annual Budget	Ongoing - Next 5 Years	In-Progress – Carry Forward	We reference the Dept of Public Safety's report
Natural Resource Protection											
NRP-1	Work with the U.S. Army Corps of Engineers on wetland protection.	4	1	Flood, Hurricane	Moderate	Fuquay-Varina Planning	Budgeted Staff Time	Annual Budget	Ongoing - Next 5 Years	In-Progress – Carry Forward	Part of development and permit review process
NRP-2	Use Open Space Ordinance to protect wildlife habitat.	4	1	All	Moderate	Fuquay-Varina Planning	Budgeted Staff Time	Annual Budget	Ongoing - Next 5 Years	In-Progress – Carry Forward	Part of development and permit review process
NRP-3	Notify Wake County of any illegal stream dumping instances	3	1	Flood, Dam Failure, Hurricane	Moderate	Fuquay-Varina Planning and Public Utilities	Budgeted Staff Time	Annual Budget	Ongoing - Next 5 Years	In-Progress – Carry Forward	Continued function of normal operation
NRP-4	Enforce standards for tree protection and control of clear cutting (Town has received legislative authority to enact tree protection and control of clearcutting standards.)	4	1	Flood, Wildfire, Landslide	High	Fuquay-Varina Planning	Budgeted Staff Time	Annual Budget	Ongoing - Next 5 Years	In-Progress – Carry Forward	Part of development and permit review process
NRP-5	Install low flow/high efficiency toilets at new town hall	3	1	Drought	Low	All Departments	To Be Determined	Annual Budget	1 year	New	N/A
Structural Projects											
S-1	Install a generator at the new town hall	3	1	All	High	All Departments	To Be Determined	Annual Budget	1 year	New	N/A
S-2	Install security cameras on new town hall	3	1	Terrorism	High	All Departments	To Be Determined	Annual Budget	1 year	New	N/A
Emergency Services											
ES-1	Maintain current warning system with local sirens on elevated platforms and use of the Emergency Broadcast System.	1	2	All	High	Fuquay-Varina Planning, Fire and Police	Budgeted Staff Time	Annual Budget	Ongoing - Next 5 Years	In-Progress – Carry Forward	Continued function of normal operation
ES-2	Coordinate an incident command course for all Town employees, related to Emergency Operations Plan and Disaster Operations Plan for the Town.	2	1	All	Moderate	Fuquay-Varina Fire and Police	Budgeted Staff Time	Annual Budget	Ongoing - Next 5 Years	In-Progress – Carry Forward	Lack of staffing has prevented implementation

Town of Fuquay-Varina											
Action #	**Description**	**Goal**	**Objective**	**Hazard(s) Addressed**	**Relative Priority**	**Lead Agency/ Department**	**Estimated Cost**	**Potential Funding Sources**	**Implementation Schedule**	**2019 Status**	**Status Comments/Explanation**
ES-3	Conduct a scenario-based training exercise, related to Emergency Operations Plan and Disaster Operations Plan for the Town.	2	1	All	Moderate	Fuquay-Varina Fire and Police	Budgeted Staff Time	Annual Budget	Ongoing - Next 5 Years	In-Progress – Carry Forward	Lack of staffing has prevented implementation
ES-4	Assist Wake County Emergency Management with updating list of local hazardous materials sites.	2	1	Hazardous Materials Incident, Radiological Emergency	Moderate	Fuquay-Varina Fire and Wake County Emergency Management	Budgeted Staff Time	Annual Budget	Ongoing - Next 5 Years	In-Progress – Carry Forward	Continued function of normal operation
ES-5	Continue Pre-Fire Incident Plan program for all commercial facilities within the Town limits.	3	2	All	High	Fuquay-Varina Fire	Budgeted Staff Time	Annual Budget	Ongoing - Next 5 Years	In-Progress – Carry Forward	Continued function of normal operation
ES-6	Address securing and cleaning up affected hazardous areas when revising Disaster Operations Plan.	4	2	All	High	Fuquay-Varina Planning, Fire and Police	Budgeted Staff Time	Annual Budget	Ongoing - Next 5 Years	In-Progress – Carry Forward	Continued function of normal operation
ES-7	Continue to evaluate and improve response and recovery methods following each hazard event.	2	2	All	High	Fuquay-Varina Fire and Police	Budgeted Staff Time	Annual Budget	Ongoing - Next 5 Years	In-Progress – Carry Forward	Continued function of normal operation
ES-8	Finalize implementation of new/updated radio communication equipment.	2	1	All	Moderate	Fuquay-Varina Fire and Police	$55,000	Annual Budget	Ongoing - Next 5 Years	In-Progress – Carry Forward	Police Department's portion completed. Fire Department anticipated completion, June 2019
Public Education and Awareness											
PEA-1	Maintain floodplain maps for public use and produce other maps as needed.	1	1	Flood, Hurricane	Moderate	Fuquay-Varina Planning and Engineering	Budgeted Staff Time	Annual Budget	Ongoing - Next 5 Years	In-Progress – Carry Forward	Continued function of normal operation
PEA-2	Develop and maintain a hazard mitigation section on the Town website that is updated every 5 years as the plan is updated.	1	1	All	High	Fuquay-Varina Public Information and Information Technology	Budgeted Staff Time	Annual Budget	Ongoing - Next 5 Years	In-Progress – Carry Forward	Continued function of normal operation
PEA-3	Collect educational materials on disaster preparedness and display at public library and local government offices.	1	1	All	High	Fuquay-Varina Planning, Inspections, Police, and Fire	Budgeted Staff Time	Annual Budget	Ongoing - Next 5 Years	In-Progress – Carry Forward	Lack of staffing has prevented implementation
PEA-4	Educate public on importance of channel maintenance as part of Phase II Stormwater Management Plan.	1	1	Flood, Dam Failure, Hurricane	Moderate	Fuquay-Varina Engineering	Budgeted Staff Time	Annual Budget	Ongoing - Next 5 Years	In-Progress – Carry Forward	Continued function of normal operation
PEA-5	Work with local real estate agents to ensure that potential buyers are aware of properties that are exposed to potential flood damage.	1	1	Flood, Dam Failure, Hurricane	Moderate	Fuquay-Varina Planning	Budgeted Staff Time	Annual Budget	Ongoing - Next 5 Years	In-Progress – Carry Forward	Continued function of normal operation
PEA-6	Require delineation of Wake County Flood Hazard Soils, FEMA flood zones, and wetlands on final plats.	3	2	Flood, Dam Failure, Hurricane	Moderate	Fuquay-Varina Planning	Budgeted Staff Time	Annual Budget	Ongoing - Next 5 Years	In-Progress – Carry Forward	Part of development and permit review process
PEA-7	Annual participation in Severe Weather Preparedness Week (March 3-9) via Weather Channel (social media campaign, newsletter, published materials)	1	1	All	High	Fuquay Varina Planning and Public Information	Budgeted Staff Time	Annual Budget	Ongoing - Next 5 Years	New	N/A
PEA-8	Annual participation in National Preparedness Month (September) Ready.gov (social media campaign, newsletter, published materials)	1	1	All	High	Fuquay Varina Planning and Public Information	Budgeted Staff Time	Annual Budget	Ongoing - Next 5 Years	New	N/A
PEA-9	Annual participation in Hurricane Prep Week (May 13-19) ReadyNC.gov (social media campaign, newsletter, published materials)	1	1	Flood, Landslide, Hurricane	High	Fuquay Varina Planning and Public Information	Budgeted Staff Time	Annual Budget	Ongoing - Next 5 Years	New	N/A
PEA-10	Annual participation in Earthquake Awareness Month and National Earthquake Drill (February & October) Ready.gov (social media campaign, newsletter, published materials)	1	1	Earthquake	High	Fuquay Varina Planning and Public Information	Budgeted Staff Time	Annual Budget	Ongoing - Next 5 Years	New	N/A
PEA-11	Annual participation in National Dam Safety Awareness Day (May 31) Ready.gov (social media campaign, newsletter, published materials)	1	1	Dam Failure	High	Fuquay Varina Planning and Public Information	Budgeted Staff Time	Annual Budget	Ongoing - Next 5 Years	New	N/A
PEA-12	Structured public education through social media, brochures, and flyers in critical facilities	1	1	All	High	Fuquay Varina Planning, Fire & Police, and Public Information	Budgeted Staff Time	Annual Budget	Ongoing - Next 5 Years	New	N/A

Table 7.6 – Mitigation Action Plan, Town of Garner

Town of Garner											
Action #	**Description**	**Goal**	**Objective**	**Hazard(s) Addressed**	**Relative Priority**	**Lead Agency/ Department**	**Estimated Cost**	**Potential Funding Sources**	**Implementation Schedule**	**2019 Status**	**Status Comments/Explanation**
Prevention											
P-1	Evaluate the need for regulations to encourage use of low impact development site planning principles to help control stormwater volume impacts.	4	1	Flood, Dam Failure, Hurricane	Moderate	Garner Engineering and Planning	Staff time	Local	2-3 years (2021)	Not Started – Carry Forward	Will be considered during our development code (UDO) update over the next 2 years
P-2	UDO: Continue to provide stream and creek buffers, and floodplain and wetland protection.	3	2	Flood, Dam Failure, Hurricane	High	Garner Planning	Staff time	Local	2-3 years (2021)	In-Progress – Carry Forward	Will be considered during our development code (UDO) update over the next 2 years
P-3	Provide adequate water supply through storage and interconnection with other public water systems.	3	2	Drought	Moderate	City of Raleigh and Garner Engineering	TBD	Local	2-3 years (2020)	In-Progress – Carry Forward	Support City of Raleigh's effort with the reservoir project at NC 50 and New Bethel Church Road
P-4	Garner Transportation Plan – Continue to address disaster preparedness (evacuation) through road interconnectivity, paved roads, and widening of roads.	4	2	Flood, Dam Failure, Earthquake, Hurricane, Severe Weather, Severe Winter Weather, Tornado, Hazardous Materials Incident, Radiological Emergency, Terrorism	Moderate	Garner Planning and Public Works	Improvement costs TBD on case-by-case basis	Local, State, Federal	Ongoing - Next 5 Years	In-Progress – Carry Forward	The Town's emergency preparedness plan follows the Wake County for routes. The Town's 2018 Transportation Plan does encourage and promote interconnectivity.
P-5	Develop for public dissemination building inspections brochures regarding high winds, water damage prevention, and tie downs for accessory structures.	1	1	Flood, Dam Failure, Earthquake, Hurricane, Severe Weather, Severe Winter Weather, Tornado	Moderate	Garner Inspections	Staff time and materials	Local	Ongoing - Next 5 Years	In-Progress – Carry Forward	We do this annually - seasonal brochures based on weather threats
P-6	The Town will inventory all its structures located within or immediately adjacent to known flood hazard areas.	2	2	Flood	Moderate	Garner Planning and Engineering	Staff time	Local	Ongoing - Next 5 Years	In-Progress – Carry Forward	Town reviews when data is available (Flood Plain mapping, new LIDAR data)
P-7	In the upcoming zoning and development ordinance update / re-write (UDO), look for ways discourage and steer high density residential and other at-risk populations (daycares, schools, and retirement facilities as examples)	4	1	Hazardous Materials	Moderate	Garner Planning and Fire / Building Inspections	Staff time	Local	2-3 years	New	The Town will update the UDO (Zoning & Development code) soon
Property Protection											
PP-1	The Town has a service to respond to requests and questions from citizens regarding actions they may take to improve drainage, halt erosion, and to relocate, renovate or retrofit structures being flooded.	1	1	Flood	Moderate	Garner Engineering	Staff time	Local, Private	Ongoing - Next 5 Years	In-Progress – Carry Forward	Normal operations; ongoing activity.
Natural Resource Protection											
NRP-1	Develop and adopt a conservation subdivision ordinance to help preserve significant natural features.	4	1	Flood, Hurricane, Severe Weather, Tornado, Winter Storm	Moderate	Garner Planning	Staff time	Local	2-3 Years (2021)	Not Started – Carry Forward	Will be considered during our development code (UDO) update over the next 2 years
Structural Projects											
SP-1	Pursue stream restoration projects	3	2	Flood	High	Garner Engineering	TBD	Local, Regional, State, Federal	2-3 Years (2021)	Not Started – Carry Forward	Consideration as a capital project under the "stormwater" category as problem areas are identified.
Emergency Services											
ES-1	Develop a Business Continuity Plan that is the primary document housing all disaster related plans and procedures including Hazard Mitigation Plan, Debris Management Plan, Multi-Hazard Plan as well as disaster response plans for all Town departments.	2	2	All Hazards	High	Garner Police, Public Works, and Administration	$25,000-$50,000	Local	2-3 Years	In-Progress – Carry Forward	Target 2021
Public Education and Awareness											

Town of Garner											
Action #	**Description**	**Goal**	**Objective**	**Hazard(s) Addressed**	**Relative Priority**	**Lead Agency/ Department**	**Estimated Cost**	**Potential Funding Sources**	**Implementation Schedule**	**2019 Status**	**Status Comments/Explanation**
PEA-1	Town website will be updated with public access to information pertaining to evacuation routes, emergency contact numbers, and detailed weather reports in case of emergency.	1	2	Flood, Hurricane, Earthquake, Severe Weather, Tornado, Severe Winter Storm, Wildfire, Hazardous Materials Incident, Radiological Emergency	Moderate	Police & Fire Departments, Garner Communications	Staff time	Local	Ongoing - Next 5 Years	In-Progress – Carry Forward	Target 2021
PEA-2	Develop and maintain a hazard mitigation section on the Town website.	1	1	All Hazards	Moderate	Garner Communications, and Garner IT	Staff time	Local	2-3 Years	Not Started – Carry Forward	Target 2021
PEA-3	Website - The Town maintains its own website which is able to provide up to date information for the public. Town continuously updates the site with additional resources.	1	1	All Hazards	High	Garner Police & Fire, Communications, and Garner IT	Staff time	Local	Ongoing - Next 5 Years	In-Progress – Carry Forward	Completed the initial effort; it is in place and on-going

Table 7.7 – Mitigation Action Plan, Town of Holly Springs

Town of Holly Springs											
Action #	**Description**	**Goal**	**Objective**	**Hazard(s) Addressed**	**Relative Priority**	**Lead Agency/ Department**	**Estimated Cost**	**Potential Funding Sources**	**Implementation Schedule**	**2019 Status**	**Status Comments/Explanation**
Prevention											
P-1	Vision Holly Springs Comprehensive Plan - The Town has an existing Comprehensive Plan which includes Land Use, Parks and Recreation, Public Safety, Economic Development, Transportation, Public Utilities and Environment. This plan includes past and current conditions and sets goals for future needs of the Town. The Hazard Mitigation Plan will be incorporated as an additional component of the CGP at plan update.	4	2	All	Moderate	Holly Springs Planning & Zoning	To be determined	Local	1 year	In-Progress – Carry Forward	To be updated in 2019
P-2	Update Floodplain Development Regulations - The Town has an ordinance developed to minimize public and private losses due to flood conditions. The latest update of the Flood Damage Prevention Ordinance was May 2, 2006. (00-23).	4	1	Flood	High	Holly Springs Engineering	No cost	Local	3-5 Years	In-Progress – Carry Forward	Ordinance will be updated once the preliminary maps under review by FEMA/NCDEM are adopted
P-3	Implement Floodplain Development Regulations related to participating in the National Flood Insurance Program	4	1	Flood	High	Holly Springs Engineering	Staff time	Local	2-3 years	Not Started – Carry Forward	The Town restricts or prohibits uses which are dangerous to health, safety and property due to water or erosion hazards or which result in damaging increases in erosion or in flood heights or velocities. (00-23)
P-4	Floodplain Development Regulations - The Town has been a participating member of the National Flood Insurance Program since 1992, The Town evaluated the Town's potential participation in the Community Rating System (CRS) and determined that the amount of insured properties in the Town did not warrant participation in the CRS. However, staff will reevaluate this determination in the future through the implementation of the Floodplain Management Program.	4	1	Flood	High	Holly Springs Engineering	To be determined	Local	Ongoing - Next 5 Years	In-Progress – Carry Forward	Re-evaluate potential for CRS participation
P-5	Water Emergency Response Plan - Develop Water Emergency Response Plan in accordance with EPA mandate with wastewater emergency plan developed voluntarily.	3	2	All	High	Holly Springs Public Utilities, Engineering	To be determined	Local	3-5 years	In-Progress – Carry Forward	Plan review and update will ensure secondary water sources available during an emergency
Property Protection											
PP-1	Building Acquisition and Clearance - The Town is willing to develop a plan designed to utilize Federal grant resources to assist private property owners in purchasing properties located in flood hazard zones.	3	2	Flood	Low	Holly Springs Code Enforcement	Staff time; acquisition costs TBD on case by case basis	Local, State, Federal	2-3 years	Not Started – Carry Forward	Target for development of plan to enable this activity is now 2019-2021
PP-2	Building Relocation - The Town is willing to develop a plan designed to utilize Federal grant resources to assist private property owners in relocating existing structures out of flood hazard zones.	3	2	Flood	Low	Holly Springs Code Enforcement	Staff time; relocation costs TBD on case by case basis	Local, State, Federal	2-3 years	Not Started – Carry Forward	Target for development of plan to enable this activity is now 2019-2021
PP-3	Building Retrofit - The Town is willing to develop a plan to utilize Federal grant resources to assist private property owners in renovating and retrofitting existing structures in flood hazard zones to reduce vulnerability to flooding damage.	3	2	Flood	Low	Holly Springs Code Enforcement	Staff time; retrofitting costs TBD on case by case basis	Local, State, Federal	2-3 years	Not Started – Carry Forward	Target for development of plan to enable this activity is now 2020-2021
PP-4	Purchase of Open Space, Parks and Greenways - The Parks and Recreation Department is asking for $500,000 for Capital Improvement Projects to purchase open space. The Town also works with Wake County and other agencies to find other funding for open space acquisition. Once funds are obtained the Town will acquire land consistent with Land Use and Master Open Space Plans.	4	2	Flood	Moderate	Holly Springs Parks and Recreation	Land Cost	County & State Agencies	More than 5 years	In-Progress – Carry Forward	Continually seeks new investments
PP-5	Backup Power to Fire and Police Stations – The Town provides backup power to all fire and police stations. Fire Station 1 – backup power provided by a grant; backup power to Fire Station 2 and Fire Station 3 and Police Station provided by local funds.	3	1	All	High	Holly Springs Public Safety	Requires new facility. Cost unknown at this time.	Local, Federal	3-5 Years	In-Progress – Carry Forward	Plans to be developed to establish backup power for Fire Station #3.

Town of Holly Springs											
Action #	**Description**	**Goal**	**Objective**	**Hazard(s) Addressed**	**Relative Priority**	**Lead Agency/ Department**	**Estimated Cost**	**Potential Funding Sources**	**Implementation Schedule**	**2019 Status**	**Status Comments/Explanation**
PP-6	Emergency Generator for Public Works Building	3	1	All	Moderate	Holly Springs Public Works	To be determined	Local	3-5 Years	In-Progress – Carry Forward	The Town currently has an emergency generator to provide power to the Front Office of the Public Works Building during emergencies. Future goal is to provide 100% generator power to the building.
PP-7	Install additional Generators	3	1	All	High	Holly Springs Public Utilities	To be determined	Local	1 year	In-Progress – Carry Forward	The wastewater treatment plant and sewer lift stations built after 1994 have generators. In emergency situations, the Town also has mobile generators to be used at lift stations built between 1985 – 1994 that are without permanent generators on site. Over the next ten years, the Town would like to purchase generators for lift stations that do not currently have generators.
Natural Resource Protection											
NRP-1	As part of the next phases(s) of the Town's Watershed Masterplan, a map of impervious cover will be created. This information may be used overlain to show which structures are in hazardous locations.	2	2	Flood, Dam Failure, Earthquake, Hurricane, Severe Weather, Tornado, Wildfire	High	Holly Springs Engineering	Staff time	Local	3-5 years	New	N/A
Structural Projects											
S-1	The Town is in the process of pursuing options to improve the existing spillway or create a secondary spillway. Per an agreement with NC Dam Safety, this will be completed within the next 5 years.	3	2	Flood, Dam Failure	High	Holly Springs Engineering, Parks & Recreation	Over $100,000	Local	3-5 years	New	N/A
S-2	Reservoirs/Retention/Detention Basins - The Town does not currently maintain any retention or detention basins. The Town does maintain Bass Lake Dam. The Town regularly provides maintenance of vegetation and minor erosion while providing visual inspections of the dam. If larger repairs are required the Town will find appropriate means to resolve the problem. The Town also has a few small ponds located on existing parks. The Town maintains these ponds consistent with measures taken to maintain the Bass Lake Dam.	3	1	Flood	Moderate	Holly Springs Parks & Recreation	Staff time	Local	Ongoing - Next 5 Years	In-Progress – Carry Forward	Consistently and correctly maintains all ponds and dams
Emergency Services											
ES-1	Technical Rescue Capabilities - Provide and enhance technical rescue capabilities more equitably throughout the Town.	2	2	All	High	Holly Springs Public Safety	No cost	Local, Federal	3-5 Years	In-Progress – Carry Forward	All crews have basic training. Currently looking into specialty training.
ES-2	GIS Programming - Design GIS programming capable of providing real-time data to emergency managers and historic data for future emergency response planning.	2	2	All	Low	Holly Springs Public Safety	No cost	Local	3-5 Years	In-Progress – Carry Forward	Currently in the implementation phase. The new Wake County CAD will be issued on May 2019. This is a no cost to the Town.
ES-3	ECC Notifications by NOAA for possible severe weather (tornados, ice, etc.). ECC is notified by both agencies when weather alerts are issued. Information is then broadcast over police radios. This information is generated by the State and Wake County and is obtained through the use of DC message, radio, fax and Nextel.	2	1	Severe Weather, Severe Winter Storm, Tornado, Hurricane	High	Holly Springs Public Safety	No cost	Local	3-5 years	In-Progress – Carry Forward	Partially implemented. Currently use WEB EOC and the dispatch center.
ES-4	Purchase ACU 1000 Communications Unit – System should allow all agencies on ACU 1000 to communicate using own radios and frequencies.	2	1	All	High	Holly Springs Public Safety	To be determined	Local	3-5 years	In-Progress – Carry Forward	In process of purchasing, but not yet completed.
ES-5	Tabletop Exercise Program - Continue to conduct disaster tabletop exercise program with Wake County	2	2	All	High	Holly Springs Public Safety	Staff time	Local	Ongoing - Next 5 Years	In-Progress – Carry Forward	Tabletop exercises are held through public safety periodically and will continue to be done.

Town of Holly Springs											
Action #	**Description**	**Goal**	**Objective**	**Hazard(s) Addressed**	**Relative Priority**	**Lead Agency/ Department**	**Estimated Cost**	**Potential Funding Sources**	**Implementation Schedule**	**2019 Status**	**Status Comments/Explanation**
ES-6	Counseling – Police psychologist and Critical Incident Stress Debriefing Team training to provide debriefing sessions for personnel.	2	1	All	High	Holly Springs Police Department	Staff time	Local	5 years	In-Progress – Carry Forward	Partially implemented, under construction. Currently, we have incorporated the services of a chaplaincy program and conduct critical incident debriefs with our personnel for both internal and external incidents. In addition, we are looking at a proposal to expand our program to include peer teams, peer counselors, and incorporation of the NC Law Enforcement Assistance Program (http://www.nc-leap.org/page6.aspx) in partnership with Teia Pullen of the Cary Police Department. Our goal is to network with southern Wake County law enforcement and public safety agencies, clinicians, and other mental health professionals to provide a broad base of support services to our public safety professionals.
Public Education and Awareness											
PEA-1	Environmental Education	1	1	Flood, Drought	High	Holly Springs Engineering	Staff time and O&M costs	Local	Ongoing - Next 5 Years	In-Progress – Carry Forward	The Town currently has a program which includes environmental education for the public through Town festivals (Holly Fest), public meetings, brochures and preconstruction meetings. The Town operates the Bass Lake Retreat Center which will allow for space to hold additional environmental education activities. The Town will also expand its current education activities to meet NPDES Phase II requirements. The Town's Environmental Education focuses on flooding, drainage, the National Flood Insurance Program, NPDES Phase II, Erosion & Sedimentation Control, Habitat Preservation, etc.
PEA-2	Website - The Town maintains its own website, which is able to provide up to date information for the public. The Town is continuously updating the site with additional resources.	1	1	All	High	Holly Springs Governing Body	Staff time	Local	2017	In-Progress – Carry Forward	The Communications Department provides the community with news and information via the Town's website, the Town's government access television channel HSTV-11, news releases, The Source newsletter, email and text message subscriptions, and social media on a daily basis.

Table 7.8 – Mitigation Action Plan, Town of Knightdale

Town of Knightdale											
Action #	**Description**	**Goal**	**Objective**	**Hazard(s) Addressed**	**Relative Priority**	**Lead Agency/ Department**	**Estimated Cost**	**Potential Funding Sources**	**Implementation Schedule**	**2019 Status**	**Status Comments/Explanation**
Prevention											
P-1	Pursue Grants to Acquire, Elevate and or Relocate Flood Prone Structures and Property.	3	1	Flood, Dam Failure, Hurricane & Tropical Storm	High	Knightdale Planning	Over $1m	Internal	Ongoing - Next 5 Years	Not Started – Carry Forward	This has not been necessary since there have been no affected structures and/or property. The Town will evaluate opportunities to purchase property for future events.
P-2	Establish post-disaster clean-up procedures.	2	1	All	High	Knightdale Public Works	$250,000	Internal	Ongoing - Next 5 Years	In-Progress – Carry Forward	The Town will continuously evaluate post-disaster clean-up procedures.
P-3	Prepare debris removal and disposal plan.	2	1	Dam Failure, Earthquake, Hurricane & Tropical Storm, Landslide, Severe Weather, Severe Winter Storm, Tornado	Moderate	Knightdale Public Works	Over $1m	Internal, FEMA, NCEM	Ongoing - Next 5 Years	In-Progress – Carry Forward	The Town will continuously evaluate debris removal and disposal plan
P-4	Protect and Obtain Land for the Little River Reservoir.	3	1	Drought	Moderate	City of Raleigh Public Utilities	Over $1m	Internal, City of Raleigh	Ongoing - Next 5 Years	In-Progress – Carry Forward	City of Raleigh is responsible for implementation
Structural Projects											
SP-1	Dredging, new riser and plunge pool for pond restoration at Environmental Park	3	2	Flood, Hurricane	Moderate	Knightdale Administration, Knightdale Public Works	$500,000	Grants, bonds, Knightdale Administration, Knightdale Fire	3-5 years	New	N/A
Public Education and Awareness											
PEA-1	Develop a policy for the installation of warning signs concerning lightning, hail and thunderstorms at outdoor public facilities and begin retro-fitting existing spaces.	1	2	Severe Weather, Tornado	Moderate	Knightdale Parks & Recreation	Over $1m	Internal	2-3 years	Not Started – Carry Forward	Due to staff turnover and lack of funding this project has not been completed. This project is still a valuable tool that will be studied for future implementation
PEA-2	Expand the Town's existing fire/smoke alarm program for retro-fitting older structures to include CO alarms.	1	2	Earthquake, Severe Weather, Tornado, Hazardous Materials Incident	Low	Knightdale Fire	about $200,000	Internal, Grants	2-3 years	In-Progress – Carry Forward	The Knightdale Fire Department routinely visits residents to ensure smoke detectors are working property.
PEA-3	Have a Town staff member that is a Certified Floodplain Manager.	2	1	Flood, Dam Failure, Hurricane & Tropical Storm	Moderate	Knightdale Engineering/Public Works	$40,000	Internal	2-3 years	In-Progress – Carry Forward	Due to recent turnover the Town lost its only Certified Floodplain Manager
PEA-4	Issue an annual local proclamation for Severe Weather Awareness Week and conduct associated promotional activities.	1	1	All	Moderate	Knightdale Fire	$200,000	Internal	Ongoing - Next 5 years	Not Started – Carry Forward	Due to staff turnover this item has not been started.
PEA-5	Incentivize the use of cool roofing products through the Town's Water Allocation Policy point system.	4	1	Extreme Heat	Low	Knightdale Planning	less than $100,000	Internal	3-5 years	Not Started – Carry Forward	Due to changes in development patterns other updates to the Town's Water Allocation Policy were deemed more timely. This will be evaluated for future inclusion.

Table 7.9 – Mitigation Action Plan, Town of Morrisville

Town of Morrisville											
Action #	**Description**	**Goal**	**Objective**	**Hazard(s) Addressed**	**Relative Priority**	**Lead Agency/ Department**	**Estimated Cost**	**Potential Funding Sources**	**Implementation Schedule**	**2019 Status**	**Status Comments/Explanation**
Prevention											
P-1	Reduce vulnerability of cyber attack by transitioning Town staff to encrypted laptops.	3	1	Terrorism	Moderate	Town of Morrisville	$9,000 annually	Town of Morrisville	Ongoing - Next 5 years	New	N/A
P-2	Establish a Municipal Service District (MSD) in order to convert private roads in Carpenter Park neighborhood to public roads with a higher design, safety, and maintenance standard.	3	2	All	Moderate	Town of Morrisville	$460,000	Town of Morrisville	1 year	New	N/A
P-3	Coordinate with Duke Power to draft Electric Utility Master Plan, which seeks to identify areas feasible for utility line burial.	4	1	Tornado, Severe Winter Storm, Severe Weather, Hurricane	High	Town of Morrisville	$20,000	Town of Morrisville	2-3 years	New	N/A
P-4	Update Land Use Plan to ensure protection of natural resources, strengthen existing development to resist hazards, and guide future development away from hazard prone areas.	4	2	Flood, Wildfire, Landslide, Dam Failure, Hurricane, Hazardous Materials Incident, Radiological Emergency	Moderate	Town of Morrisville	$275,000	Town of Morrisville	2-3 years	New	N/A
P-5	Obtain frequently updated, high-resolution aerial photography to assist with land use decisions, emergency response planning, and code enforcement.	2	2	Flood, Landslide, Severe Winter Storm, Severe Weather, Dam Failure, Hurricane, Hazards Materials Incident, Radiological Emergency, Terrorism	Moderate	Town of Morrisville	$7,000 annually	Town of Morrisville	Ongoing - Next 5 years	New	N/A
P-6	Working through the Triangle Water Supply Partnership, update the Water Resources Plan to ensure water supply is sufficient for Town's future needs.	4	2	Drought, Dam Failure, Extreme Heat	High	Triangle Water Supply Partnership	$250,000	Triangle Water Supply Partnership, Town of Morrisville	3-5 years	New	N/A
P-7	Working through the Triangle Water Supply Partnership, draft a Drought Management Plan to ensure water resources are properly managed during drought conditions.	4	1	Drought, Extreme Heat	High	Triangle Water Supply Partnership	$150,000	Triangle Water Supply Partnership, Town of Morrisville	3-5 years	New	N/A
P-8	Working through the Triangle Water Supply Partnership, draft an Emergency Spill Response and Mitigation Plan to protect watersheds and other water resources from hazardous spills.	3	2	Flood, Drought, Dam Failure, Extreme Heat, Hazardous Materials Incident, Radiological Emergency	High	Triangle Water Supply Partnership	$150,000	Triangle Water Supply Partnership, Town of Morrisville	3-5 years	New	N/A
P-9	Transition Wake County's sedimentation and erosion control permitting and monitoring to Town of Morrisville for better increased processing efficiency and faster incident response.	2	2	Flood, Landslide, Dam Failure, Hurricane, Hazardous Materials Incident	Moderate	Town of Morrisville	Unknown	Town of Morrisville	2-3 years	New	N/A
P-10	Conduct a complete review and update to the Town's stormwater management program, which helps mitigate effects of stormwater runoff and flooding.	4	1	Flood, Landslide, Dam Failure, Hurricane, Hazardous Materials Incident	High	Town of Morrisville	$100,000	Town of Morrisville	2-3 years	New	N/A
Property Protection											
PP-1	Reduce vulnerability of important data by transitioning IT Department's routine data backup to cloud storage.	3	1	Tornado, Earthquake, Severe Winter Storm, Severe Weather, Hurricane, Terrorism	High	Town of Morrisville	$42,000 annually	Town of Morrisville	Ongoing - Next 5 years	New	N/A
PP-2	Seek Federal, State, and County funding opportunities to purchase property located completely or partially in FEMA designated floodplains in order to mitigate potential property damage and protect natural resources.	3	2	Flood, Hurricane, Dam Failure	Low	Morrisville Director of Community Services, Director of Development Services	$5,000,000	Flood Mitigation Assistance Grant Program	More than 5 years	Not Started – Carry Forward	Town has purchased flood-prone properties using Town funds. Town has not sought any outside funding for floodplain property purchase.
Structural Projects											
SP-1	Construct Green Drive and Fairview Road Flood Reduction Drainage Project to mitigate potential flood hazards.	3	2	Flood, Dam Failure, Hurricane	High	Town of Morrisville	$450,000	Town of Morrisville	2-3 years	New	N/A
SP-2	Construct new public works facility, which will increase Town's capacity to respond to hazards and other safety concerns.	2	1	All	Moderate	Town of Morrisville	$8,500,000	Town of Morrisville	3-5 years	New	N/A

Town of Morrisville											
Action #	**Description**	**Goal**	**Objective**	**Hazard(s) Addressed**	**Relative Priority**	**Lead Agency/ Department**	**Estimated Cost**	**Potential Funding Sources**	**Implementation Schedule**	**2019 Status**	**Status Comments/Explanation**
Emergency Services											
ES-1	Monitor the status of backup generators, communications and vehicles for all Morrisville owned critical public facilities.	2	1	All	Low	Town of Morrisville	$5,500 annually	Town of Morrisville	Ongoing - Next 5 years	In-Progress – Carry Forward	The Town has a contract with a private vendor to monitor the status and condition of critical emergency response equipment such as backup generators, communications, and vehicles.
ES-2	Install new generators for Town Hall and Police Station to ensure continuity of critical operations during a power outage.	3	1	All	High	Town of Morrisville	$150,000	Town of Morrisville	1 year	New	N/A
ES-3	Construct new fire station in Morrisville in order to improve fire protection coverage and emergency response times.	2	1	All	Moderate	Town of Morrisville	$4,500,000	Town of Morrisville	3-5 years	New	N/A
ES-4	Update Town's Emergency Operations Plan to ensure best processes and procedures for the most likely and applicable emergency scenarios.	2	2	All	Moderate	Town of Morrisville	$150,000	Town of Morrisville	3-5 years	New	N/A
Public Education and Awareness											
PEA-1	Implement Wake County's Everbridge text alert system to notify citizens and Town staff of potential safety hazards or concerns.	1	1	All	High	Wake County	$0	Wake County	1 year	New	N/A
PEA-2	Purchase and implement new online civic engagement platform to be used in part to inform citizens on disaster preparation, emergency response training opportunities, and evacuation information.	1	1	All	Moderate	Town of Morrisville	$10,000	Town of Morrisville	1 year	New	N/A
PEA-3	Utilize volunteer citizen committees, such as CERT or Public Safety Committee, to educate residents in preparing for natural hazards.	1	1	All	Low	Town of Morrisville	$2,000/year	Town of Morrisville	Ongoing - Next 5 Years	In-Progress – Carry Forward	The Community Emergency Response Team is a group of dedicated volunteers that meet monthly for emergency response training.

Table 7.10 – Mitigation Action Plan, Town of Rolesville

Town of Rolesville											
Action #	**Description**	**Goal**	**Objective**	**Hazard(s) Addressed**	**Relative Priority**	**Lead Agency/ Department**	**Estimated Cost**	**Potential Funding Sources**	**Implementation Schedule**	**2019 Status**	**Status Comments/Explanation**
Prevention											
P-1	Provide backup power for all critical public facilities (wastewater treatment plant, sewer pump stations, Public Works and Utilities building, etc.) to ensure continued utility service during power loss.	3	1	All	Moderate	City of Raleigh	Cost varies by facility	Local	1 year	In-Progress – Carry Forward	City of Raleigh has updated sewer pump stations with backup power, no upgrade of Town buildings but intended for future budgets.
P-2	Transportation Plan – Continue to address disaster preparedness (evacuation) through road interconnectivity, paved roads, and widening of roads.	3	2	All	Moderate	Rolesville Planning	Staff Time	Local	1 year	In-Progress – Carry Forward	Town has policy for new development connectivity and is implemented with each new development. New Transportation Plan targeted in mid-year 2019.
P-3	Update Rolesville Stormwater Management Plan for operation/implementation and program effectiveness and study the possible changes	4	1	Flood	Moderate	Rolesville Administration	Staff Time	Local	2-3 years	New	N/A
Structural Projects											
SP-1	Install emergency power backup generator for Town Hall and Police Station to ensure continued operation of government during power loss.	3	2	All	High	Rolesville Administration	Over $100,000	Local	2 years	New	N/A
Emergency Services											
ES-1	Implement Wake County Everbridge text alert system to notify citizens in real time of an event of local interest with instructions.	1	2	All	High	Rolesville Administration	Staff Time	Local	1 year	New	N/A
Public Education and Awareness											
PEA-1	Town website - develop hazard mitigation section covering such items as public access, evacuation routes, emergency contact numbers, and detailed weather reports in case of emergency,	1	1	All	Moderate	Rolesville Administration	Staff Time	Local	1 year	In-Progress – Carry Forward	Town is in the process of new Town's Website development and development of a hazard mitigation section will be included by Spring of 2019.

Table 7.11 – Mitigation Action Plan, Town of Wake Forest

Town of Wake Forest											
Action #	**Description**	**Goal**	**Objective**	**Hazard(s) Addressed**	**Relative Priority**	**Lead Agency/ Department**	**Estimated Cost**	**Potential Funding Sources**	**Implementation Schedule**	**2019 Status**	**Status Comments/Explanation**
Prevention											
P-1	Prepare a Storm Drainage Master Plan to include all storm drainage, infrastructure, and capacity analysis.	2	2	Flood	High	Wake Forest Engineering	$400,000	General Fund	2019	In-Progress – Carry Forward	75% complete, completion scheduled June 2019
P-2	Put electric distribution lines underground.	3	1	Hurricane, Severe Weather, Severe Winter Storm, Tornado, Wildfire	Low	Wake Forest Power	$10,000,000	Electric Fund, General Fund, and Bonds	2024	In-Progress – Carry Forward	Where feasible, electric lines have been put underground. However, there are still some lines that could be buried and the town will look into carrying that out going forward.
P-3	Become a CRS community	2	2	Flood	Low	Wake Forest Public Works	$100,000	General Fund	2022	New	Work towards becoming a CRS community
P-4	Explore the use of Stormwater Utility Fees	3	1	Flood	Moderate	Wake Forest Administration	$100,000	General Fund that would become a User Fee if implemented	2020	New	As subdivisions age, their covenants could expire after 20 years leaving the town with maintaining additional stormwater control measures. These fees could help offset necessary maintenance.
P-5	Maintain a GIS database of building footprints and use it to regularly update a map of critical facilities and vulnerable buildings.	2	2	All	Moderate	Wake Forest GIS	Staff time	General Fund	Ongoing Annually	New	Updated data will be used to identify properties that should be prioritized for mitigation.
Property Protection											
PP-1	Document each historic structure in Wake Forest town limits and ETJ	3	1	Hurricane, Severe Weather, Severe Winter Storm, Tornado, Wildfire, Flood	Moderate	Wake Forest Planning	$75,000	General Fund	2020	New	Photographs and taken every other year in the local historic district. A baseline photographic inventory of all historic structures in the town limits and ETJ will be taken and repeated every 5 years. If damage occurred due to a natural disaster, it would be easier to secure funding to replace/repair back to its historical integrity.
PP-2	Provide for primary or mobile generators to shelter sites.	3	1	All	Moderate	Wake County Emergency Management	$500,000	General Fund	2024	In-Progress – Carry Forward	Heritage High School has generators. Town is constructing Joyner Park with intention to be used as a shelter site. Generator is being included with the building.
PP-3	Assess facilities for the need for emergency generation, giving consideration to alternate facility sites.	3	1	All	High	Wake Forest Power	$250,000	General Fund	2023	In-Progress – Carry Forward	The town has assessed facilities for the need for emergency generation and many facilities have been fitted with generators. However, additional facilities with emergency generation would be useful.
Natural Resource Protection											
NRP-1	Manage the Wake Forest Reservoir for hazard mitigation	2	1	Drought, Flood, Dam Failure	Moderate	Wake Forest Public Works	$300,000	General Fund	2021	New	The City of Raleigh is in the process of transferring the Wake Forest Reservoir to the town. Staff is investigating all details associated with the reservoir ownership from a hazard mitigation standpoint, such as flooding/breaching potential.
NRP-2	Expansion of our greenway trail network	3	2	Flood, Hurricane, Extreme Heat	Moderate	Wake Forest Planning	$16,100,000	General Fund and Bonds	2024	New	The Town has multiple greenway extensions and new routes planned. By installing greenways along our waterways, it gives the Town a better opportunity to remove fallen debris and trash that helps alleviate possible flooding.
Structural Projects											
SP-1	Conduct stream mitigation projects on Old Mill Stream, Richland Creek, and others subject to flooding or erosion.	3	2	Flood	Moderate	Wake Forest Engineering	$2,350,000	General Fund, Clean Water Management Trust Fund, Ecosystem Enhancement Program	2024	In-Progress – Carry Forward	Some mitigation projects have been conducted on these water bodies, but there is significant effort that is still needed to reduce potential erosion. Current projects include: Old Mill Stream and Richland Creek - construction plans @ 90%. Ailey Young Dam - completion June 2019; Smith Creek - quote has been requested for work to be done. Stream erosion throughout town continues to be an ongoing process as needed

Town of Wake Forest											
Action #	**Description**	**Goal**	**Objective**	**Hazard(s) Addressed**	**Relative Priority**	**Lead Agency/ Department**	**Estimated Cost**	**Potential Funding Sources**	**Implementation Schedule**	**2019 Status**	**Status Comments/Explanation**
Emergency Services											
ES-1	Investigate methods of encouraging gas stations to acquire backup generators.	1	1	All	High	Wake Forest Public Works and Inspections	$50,000	General Fund	2022	In-Progress – Carry Forward	Grocery stores and gas stations are encouraged to have back up generators. Wal-Mart added a generator with the help of the town. Wegmans which will be constructed in the next two years will have a generator on site. These sites will help provide necessary food and supplies to residents.
ES-2	See that all nursing homes and assisted living facilities have backup generators.	1	1	All	High	Property owners	$150,000	Property owners	2023	In-Progress – Carry Forward	New facilities are being encouraged to include generators. Existing facilities without generators are financially constrained and have little ability to add generators.
ES-3	Require, in the contract, that fuel suppliers have backup generators.	3	1	All	High	Wake Forest Administration, Finance, and Public Works	$25,000	General Fund	2024	In-Progress – Carry Forward	This is the Town's current policy and we continue to monitor new contracts for compliance.
ES-4	Adopt and Implement an Emergency Operations Plan	3	2	All	High	Wake Forest Administration	$100,000	General Fund	2021	New	A draft EOP has been created; adoption expected in 2019
ES-5	Adopt a SARA Title III Plan	4	2	All	Moderate	Wake Forest Fire Department	$150,000	General Fund	2023	New	Investigate the ability to create a SARA Title III Plan to have clearer knowledge and how to better handle chemical releases from facilities that could impact the town.
Public Education and Awareness											
PEA-1	Develop a policy and advise the public that all outside above ground LP or propane gas tanks be cut off during a major event.	1	1	All	Moderate	Wake Forest Communications	$10,000	General Fund	2020	In-Progress – Carry Forward	Past communications have included information advising the public of turning off propane tanks during a storm, but better outreach is needed to ensure this occurs. A policy should be put in place to ensure it is regularly communicated. Perhaps it can be included as part of the EOP.

Table 7.12 – Mitigation Action Plan, Town of Wendell

Town of Wendell											
Action #	**Description**	**Goal**	**Objective**	**Hazard(s) Addressed**	**Relative Priority**	**Lead Agency/ Department**	**Estimated Cost**	**Potential Funding Sources**	**Implementation Schedule**	**2019 Status**	**Status Comments/Explanation**
Prevention											
P-1	Install generators as needed at lift stations.	3	2	All	High	City of Raleigh Public Utilities	To be determined	Internal	3-5 years	Not Started – Carry Forward	No funds were budgeted by CORPUD for this since 2014, but a new pump station is planned south of Hollybrook Rd, which would require a generator.
P-2	Amend the Town's Water Allocation Policy to add a new point category for voluntarily increasing undisturbed riparian buffer protections from 50 to 100 feet around Neuse perennial streams	4	1	Flood, Dam Failure, Hurricane	High	Wendell Planning	$0	N/A	1 year	New	N/A
P-3	Add environmentally sensitive and hazard areas to the Future Land Use Map and adopt updated Comprehensive Plan, which will allow environmental conditions and hazard areas to guide zoning and density decisions.	4	2	Flood, Dam Failure, Hazardous Materials Incident, Radiological Incident, Terrorism	High	Wendell Planning	$120,000	Town of Wendell	2-3 years	New	N/A
P-4	Consider amendments to the UDO to establish minimum ingress/egress standards for new residential development based on density/# of lots	4	1	Earthquake, Flood, Dam Failure, Hurricane, Wildfire, Tornado, Severe Winter Storm, Hazardous Materials Incident, Radiological Incident, Terrorism	High	Wendell Planning	$0	N/A	1 year	New	N/A
P-5	Encourage the use of low-impact development techniques through amendments to the Town's Water Allocation Policy	4	1	Flood, Dam Failure, Hurricane	High	Wendell Planning	$0	N/A	1 year	New	N/A
P-6	Consider regulations to regulate clear-cutting to help control erosion from construction sites	4	1	Flood, Drought	Moderate	Wendell Planning	$0	Town of Wendell	2-3 years	New	N/A
P-7	Evaluate potential changes to the Town's Arterial and Collector Street Plan to minimize adverse impacts to environmentally sensitive areas due to new roadway construction or widening	4	2	Flood	Moderate	Wendell Planning	$500	Town of Wendell	2-3 years	New	N/A
Natural Resource Protection											
NRP-1	Perform environmental asset mapping in order to identify areas most key for preservation and potential acquisition due to an array of environmental factors	2	2	Flood, Drought	Moderate	Wendell Planning	$10,000	Town of Wendell	2-3 years	New	N/A
NRP-2	Evaluate policy regarding greenway dedication requirements in order to expand greenway network and further protect riparian corridors	4	2	Flood	High	Wendell Planning	$0	Town of Wendell	2-3 years	New	N/A
Structural Projects											
SP-1	Perform improvements to existing open drainage device near intersection of 1st St & Pine St. to increase total water volume & flow	3	1	Flood	Moderate	Wendell Public Works	$5,000	Town of Wendell	3-5 years	New	N/A
Emergency Services											
ES-1	Make electrical improvements in the downtown in order to help ensure continuity of service during extreme weather	3	1	Severe Weather, Severe Winter Storm, Hurricane	High	Wendell Public Works	$5,000	Town of Wendell	2-3 years	New	N/A
ES-2	Develop Adverse Weather Plan Map for Public Works crew	2	1	Severe Weather, Severe Winter Storm, Hurricane	High	Wendell Planning	$0	N/A	1 year	New	N/A
ES-3	Evaluate potential locations for a future Public Works debris site, to accommodate debris associated with natural hazards	2	2	All	Moderate	Wendell Public Works	$0	Town of Wendell	3-5 years	New	N/A
ES-4	Provide written after-action report of response to severe weather and hazard events to include recommendations for process improvements and improve planning for future disasters	2	2	All	Moderate	Wendell Police Dept.	$0	Town of Wendell	2-3 years	New	N/A
ES-5	Secure and utilize visual warning barricades for vehicular and pedestrian traffic to block properties, roadways, etc. for public safety during or following hazard events	2	1	All	Moderate	Wendell Public Works	$2,000	Town of Wendell	3-5 years	New	N/A

Town of Wendell											
Action #	**Description**	**Goal**	**Objective**	**Hazard(s) Addressed**	**Relative Priority**	**Lead Agency/ Department**	**Estimated Cost**	**Potential Funding Sources**	**Implementation Schedule**	**2019 Status**	**Status Comments/Explanation**
ES-6	Conduct periodic training exercises, related to higher-risk hazard threats identified by the Hazard Mitigation Plan	2	2	All	Moderate	Wendell Police Dept.	$500	Town of Wendell	2-3 years	New	N/A
ES-7	Work with Wake County and the City of Raleigh to operate and update the County's Master Address Repository program, which will support emergency response following hazards.	2	2	All	High	Wendell Planning	$0	Town of Wendell	2-3 years	New	N/A
Public Education and Awareness											
PEA-1	Modify the Town's "Tell Wendell" webpage application to allow citizens to report flood issues and create a tracking mechanism for the Town	1	2	Flood	High	Wendell Planning	$0	Town of Wendell	2-3 years	New	N/A
PEA-2	Incorporate Hazard Awareness class into the Track-Out Camp run by the Wendell Parks & Recreation Dept.	1	1	Flood, Earthquake, Extreme Heat, Drought, Hurricane, Severe Weather, Severe Winter Storm, Tornado	Moderate	Wendell Parks and Recreation	$0	Town of Wendell	2-3 years	New	N/A
PEA-3	Post warning signage at local parks for lightning	1	2	Severe Weather	High	Wendell Parks and Recreation	$500	Town of Wendell	2-3 years	New	N/A
PEA-4	Facilitate community outreach and distribution of educational materials regarding hazard awareness to the community, to include participation at community events such as Public Safety Day.	1	1	All	Moderate	Wendell Public Works	$500	Town of Wendell	2-3 years	New	N/A
PEA-5	Perform Continuing Education Training for select Public Works personnel as it relates to state storm water regulations	2	2	Flood	High	Wendell Public Works	$1,200	Town of Wendell	2-3 years	New	N/A

Table 7.13 – Mitigation Action Plan, Town of Zebulon

Town of Zebulon											
Action #	**Description**	**Goal**	**Objective**	**Hazard(s) Addressed**	**Relative Priority**	**Lead Agency/ Department**	**Estimated Cost**	**Potential Funding Sources**	**Implementation Schedule**	**2019 Status**	**Status Comments/Explanation**
Prevention											
P-1	Prepare Plan maintenance report.	2	2	All	High	Zebulon Planning Department	Staff time	Town of Zebulon	2019, Annually	Not Started – Carry Forward	Plan maintenance meetings have been held annually and will continue to be held going forward.
P-2	Enforce subdivision standards for development in flood hazard areas.	3	2	Flood	High	Zebulon Planning & Inspections	Staff time	Town of Zebulon, Wake County	2019	In-Progress – Carry Forward	UDO Revision is in final stages.
P-3	Further restrict development in floodplain by prohibiting development or requiring 2 feet of freeboard.	3	2	Flood	High	Zebulon Planning	Staff time	Town of Zebulon	2019	In-Progress – Carry Forward	UDO Revision is in final stages.
P-4	Revise floodplain ordinance.	4	1	Flood	High	Zebulon Planning	Staff time	Town of Zebulon	2019	In-Progress – Carry Forward	UDO Revision is in final stages.
P-5	Require burial of power lines for new developments.	3	1	Hurricane, Tornadoes, Winter Storms/ Freezes	Moderate	Zebulon Planning	Unknown	Town of Zebulon	2019	In-Progress – Carry Forward	UDO Revision is in final stages.
Structural Projects											
SP-1	Resolve localized flooding issue that occurs in/around West Sycamore Streets, Gannon Avenue, and North Arendell Avenue during heavy rainfall events.	3	2	Flood	Moderate	Zebulon Administration, Zebulon Public Works	$900,000	Town of Zebulon	2020	New	The town has completed design and permitting of project improvements and is currently acquiring easements.
Emergency Services											
ES-1	Develop an Emergency Operations Plan	2	2	All	Moderate	Zebulon Fire Department	TBD	Town of Zebulon	2019	New	The Town has been in the process of developing an Emergency Operations Plan and hopes to adopt the plan within the year.
Public Education and Awareness											
PEA-1	Require disclosure of flood hazard in real estate transactions.	1	1	Flood	Moderate	Zebulon Planning Department	Little to no cost	Town of Zebulon	2019	In-Progress – Carry Forward	N/A
PEA-2	Develop a public education program to provide hazard risk and preparedness education via social media	1	1	All	High	Zebulon Fire Department	Staff time	Town of Zebulon	2019	New	The Town is currently using social media for some public education but will formalize a program for hazards awareness.

8 Plan Maintenance

Requirement §201.6(c)(4): [The plan maintenance process shall include a] section describing the method and schedule of monitoring, evaluating, and updating the mitigation plan within a five-year cycle.

Implementation and maintenance of the plan is critical to the overall success of hazard mitigation planning. This section discusses how the Mitigation Action Plans will be implemented by participating jurisdictions and outlines the method and schedule for monitoring, updating, and evaluating the plan. This section also discusses incorporating the plan into existing planning mechanisms and how the public will continue to be involved in the planning process. It consists of the following three subsections:

8.1 Implementation
8.2 Monitoring, Evaluation, and Enhancement
8.3 Continued Public Involvement

8.1 IMPLEMENTATION

Each jurisdiction participating in this plan update is responsible for implementing specific mitigation actions as prescribed in their Mitigation Action Plan (found in Section 7). In each Mitigation Action Plan, every proposed action is assigned to a specific local department or agency to ensure responsibility and accountability and increase the likelihood of subsequent implementation. This approach enables individual jurisdictions to update their own unique mitigation action list as needed without altering the broader focus of the regional plan.

In addition to the assignment of a local lead department or agency, an implementation timeline or a specific implementation date or window has been assigned to each mitigation action to help assess whether reasonable progress is being made toward implementation. The participating jurisdictions will seek outside funding sources to implement mitigation projects in both the pre-disaster and post-disaster environments. When applicable, potential funding sources have been identified for proposed actions listed in the Mitigation Action Plan.

An important implementation mechanism that is highly effective and low-cost is incorporation of the Hazard Mitigation Plan recommendations and their underlying principles into other plans and mechanisms. Where possible, plan participants will use existing plans and/or programs to implement the Mitigation Action Plan. It will be the responsibility of the HMPC representatives from each participating jurisdiction to determine and pursue opportunities for integrating the requirements of this plan with other local planning documents and ensure that the goals and strategies of new and updated local planning documents for their jurisdictions or agencies are consistent with the goals and actions of the Hazard Mitigation Plan and will not contribute to increased hazard vulnerability in the Plan Area. Methods for integration may include:

- Monitoring other planning/program agendas;
- Attending other planning/program meetings;
- Participating in other planning processes; and
- Monitoring community budget meetings for other community program opportunities.

Table 8.1 details each jurisdiction's integration of the 2015 Wake County Multi-Jurisdictional Hazard Mitigation Plan into other local planning efforts as well as any identified opportunities for integration of this plan update.

Table 8.1 – Integration Efforts

Jurisdiction	Integration of 2015 plan	Intended integration of this plan update
Wake County	No integration occurred	Integration will be pursued as opportunities arise.
City of Raleigh	Raleigh has used the 2015 plan to identify frequent flood prone areas during disasters, including Hurricane Florence most recently. The plan aids as a notification strategy for vulnerable populations living in these locations	Plan update will continue to be used prominently during disasters.
Town of Apex	No integration occurred	Apex will have the opportunity to integrate the plan update with updates to the Transportation Plan and Bike & Pedestrian Plan
Town of Cary	Plan was generally integrated with the Comprehensive Plan	Integration will be pursued as opportunities arise.
Town of Fuquay-Varina	No integration occurred	Integration will be pursued as opportunities arise.
Town of Garner	Plan was integrated with the Unified Development Ordinance, Long-Range Land Use and Transportation Plans, and the Wake County Emergency Operations Plan.	Garner will continue to pursue implementation with these plans and ordinances.
Town of Holly Springs	No integration occurred	Integration will be pursued as opportunities arise.
Town of Knightdale	Plan was integrated with the Comprehensive Plan	Knightdale will have the opportunity to integrate this plan with the update of the Unified Development Ordinance and development of a Comprehensive Transportation Plan in future years.
Town of Morrisville	No integration occurred	Integration will be pursued as opportunities arise.
Town of Rolesville	No integration occurred	Integration will be pursued as opportunities arise.
Town of Wake Forest	No integration occurred	Integration will be pursued as opportunities arise.
Town of Wendell	No integration occurred	Wendell will seek to integrate this plan update with updates to the Comprehensive Plan, Greenway Plan, and Transportation Plan.
Town of Zebulon	No integration occurred	Zebulon will seek to integrate this plan update with upcoming updates to the Transportation Plan, Parks and Recreation Master Plan, Comprehensive Plan, and Emergency Operations Plan.

Opportunities to integrate the requirements of this Plan into other local planning mechanisms shall continue to be identified through future meetings of the HMPC and through the five-year review process described herein. Although it is recognized that there are many possible benefits to integrating components of this plan into other local planning mechanisms, the development and maintenance of this stand-alone Hazard Mitigation Plan is deemed by the HMPC to be the most effective and appropriate method to implement local hazard mitigation actions at this time.

8.2 MONITORING, EVALUATION, AND ENHANCEMENT

8.2.1 Role of HMPC in Implementation, Monitoring and Maintenance

With adoption of this plan, each jurisdiction will be responsible for the implementation and maintenance of their mitigation actions. Wake County will take the lead in all plan monitoring and update procedures. As such, the County, led by the Director of Emergency Management, agrees to continue its relationship with the HMPC and:

- Act as a forum for hazard mitigation issues;
- Disseminate hazard mitigation ideas and activities to all participants;
- Pursue the implementation of high-priority, low/no-cost recommended actions;
- Ensure hazard mitigation remains a consideration for community decision makers;
- Maintain a vigilant monitoring of multi-objective cost-share opportunities to help the community implement the plan's recommended actions for which no current funding exists;
- Monitor and assist in implementation and update of this plan;
- Report on plan progress and recommended revisions to the County Board of Commissioners; and
- Inform and solicit input from the public.

The HMPC's primary duty moving forward is to see the plan successfully carried out and report to the County Board of Commissioners, Town and City Councils, NCEM, FEMA, and the public on the status of plan implementation and mitigation opportunities. Other duties include reviewing and promoting mitigation proposals, considering stakeholder concerns about flood mitigation, passing concerns on to appropriate entities, and provide relevant information for posting on the County and local community websites (and others as appropriate).

Simultaneous to these efforts, it will be important to maintain a constant monitoring of funding opportunities that can be leveraged to implement some of the costlier recommended actions. This will include creating and maintaining a bank of ideas on how to meet local match or participation requirements. When funding does become available, the County and participating jurisdictions will be positioned to capitalize on the opportunity. Funding opportunities to be monitored include special pre- and post-disaster funds, state and federal earmarked funds, benefit assessments, and other grant programs, including those that can serve or support multi-objective applications.

8.2.2 Maintenance Schedule

Plan maintenance implies an ongoing effort to monitor and evaluate plan implementation and to update the plan as progress, roadblocks, or changing circumstances are recognized. The Wake County Emergency Manager will be responsible for convening the HMPC and initiating regular reviews. Regular maintenance will take place through quarterly conference calls and an annual meeting of the HMPC. The HMPC will also convene to review the plan after significant hazard events. If determined appropriate or as requested, an annual report on the plan will be developed and presented to local governing bodies of participating jurisdictions to report on implementation progress and recommended changes.

The five-year written update to this plan will be submitted to the NCEM and FEMA Region IV, unless disaster or other circumstances (e.g., changing regulations) require a change to this schedule. With this plan update anticipated to be adopted and fully approved by 2020, the next plan update for Wake County will be completed by 2025.

8.2.3 Maintenance Evaluation Process

Evaluation of progress can be achieved by monitoring changes in vulnerabilities identified in the plan. Changes in vulnerability can be identified by noting:

- Decreased vulnerability as a result of implementing recommended actions;
- Increased vulnerability as a result of failed or ineffective mitigation actions; and/or
- Increased vulnerability as a result of new development (and/or annexation).

Updates to this plan will:

- Consider changes in vulnerability due to project implementation;
- Document success stories where mitigation efforts have proven effective;
- Document areas where mitigation actions were not effective;
- Document any new hazards that may arise or were previously overlooked;
- Incorporate new data or studies on hazards and risks;
- Incorporate new capabilities or changes in capabilities;
- Incorporate growth and development-related changes to County inventories; and
- Incorporate new project recommendations or changes in project prioritization.

In order to best evaluate any changes in vulnerability as a result of plan implementation, the HMPC will follow the following process:

- The HMPC representatives from each jurisdiction will be responsible for tracking and reporting on their mitigation actions. Jurisdictional representatives should provide input on whether the action as implemented met the defined objectives and/or is likely to be successful in reducing vulnerabilities.
- If the action does not meet identified objectives, the jurisdictional representatives will determine what additional measures may be implemented and will make any required modifications to the plan.
- All monitoring and implementation information will be reported to the full HMPC, led by the Wake County Emergency Manager, during quarterly meetings. An annual plan maintenance report may be drafted as deemed necessary.

Changes will be made to the plan as needed to accommodate for actions that have failed or are not considered feasible after a review of their consistency with established criteria, time frame, community priorities, and/or funding resources. Actions that were not ranked high but were identified as potential mitigation activities will be reviewed during the monitoring and update of this plan to determine feasibility of future implementation. Updating of the mitigation action plans will be by written changes and submissions, as is appropriate and necessary, and as approved by the appropriate jurisdiction's local governing body.

Following a disaster declaration, the plan will be revised as necessary to reflect lessons learned, or to address specific issues and circumstances arising from the event. It will be the responsibility of Wake County Emergency Management to reconvene the HMPC and ensure the appropriate stakeholders are invited to participate in the plan revision and update process following declared disaster events.

Criteria for Quarterly Reviews in Preparation for 5-Year Update

The criteria recommended in 44 CFR 201 and 206 will be utilized in reviewing and updating the plan. More specifically, quarterly reviews will monitor changes to the following information:

- Community growth or change in the past quarter.
- The number of substantially damaged or substantially improved structures by flood zone.
- The renovations to public infrastructure including water, sewer, drainage, roads, bridges, gas lines, and buildings.
- Natural hazard occurrences that required activation of the Emergency Operations Center (EOC) and whether the event resulted in a presidential disaster declaration.

- Natural hazard occurrences that were not of a magnitude to warrant activation of the EOC or a federal disaster declaration but were severe enough to cause damage in the community or closure of businesses, schools, or public services.
- The dates of hazard events descriptions.
- Documented damages due to the event.
- Closures of places of employment or schools and the number of days closed.
- Road or bridge closures due to the hazard and the length of time closed.
- Assessment of the number of private and public buildings damaged and whether the damage was minor, substantial, major, or if buildings were destroyed. The assessment will include residences, mobile homes, commercial structures, industrial structures, and public buildings, such as schools and public safety buildings.
- Review of any changes in federal, state, and local policies to determine the impact of these policies on the community and how and if the policy changes can or should be incorporated into the Hazard Mitigation Plan. Review of the status of implementation of projects (mitigation strategies) including projects completed will be noted. Projects behind schedule will include a reason for delay of implementation.

8.3 CONTINUED PUBLIC INVOLVEMENT

Continued public involvement is imperative to the overall success of the plan's implementation. The quarterly review process will provide an opportunity to solicit participation from new and existing stakeholders and to publicize success stories from the plan implementation and seek additional public comment. Efforts to involve the public in the maintenance, evaluation and revision process may include:

- Advertising HMPC meetings in the local newspaper, public bulletin boards and/or City and County office buildings;
- Designating willing citizens and private sector representatives as official members of the HMPC;
- Utilizing local media to update the public of any maintenance and/or review activities;
- Utilizing City and County websites to advertise any maintenance and/or review activities;
- Maintaining copies of the plan in public libraries or other appropriate venues;
- Posting annual progress reports on the Plan to City, County and Town websites;
- Heavy publicity of the plan and potential ways for the public to be involved after significant hazard events, tailored to the event that has just happened;
- Keeping websites, social media outlets, etc. updated;
- Drafting articles for the local community newspapers/newsletters;
- Utilizing social media accounts (e.g. Twitter, Facebook).

Public Involvement for Five-year Update

When the HMPC reconvenes for the five-year update, they will coordinate with all stakeholders participating in the planning process—including those that joined the committee since the planning process began—to update and revise the plan. In reconvening, the HMPC will be responsible for coordinating the activities necessary to involve the greater public, including disseminating information through a variety of media channels detailing the plan update process. As part of this effort, public meetings will be held and public comments will be solicited on the plan update draft.

9 Plan Adoption

Requirement §201.6(c)(5): [The plan shall include] documentation that the plan has been formally approved by the governing body of the jurisdiction requesting approval of the plan (e.g., City Council, County Commissioner, Tribal Council).

The purpose of formally adopting this plan is to secure buy-in, raise awareness of the plan, and formalize the plan's implementation. The adoption of this plan completes Planning Step 9 (Adopt the Plan) of the 10-step planning process, in accordance with the requirements of DMA 2000. FEMA Approval Letters and community adoption resolutions are provided below.

Annex A Wake County Unincorporated Areas

A.1 PLANNING PROCESS

The table below lists the HMPC members who represented Wake County unincorporated areas.

Table A.1 – HMPC Members

Agency	Representative	Position or Title
Wake County Planning	Sharon Peterson	Long Range Planner
Wake County Planning	Bryan Coates	Long Range Planner
Wake Soil and Water Conservation District	Teresa Furr	Natural Resource Conservationist
N/A	Emma D'Allaird	Citizen Stakeholder
RDU	Jason Alvero	Director of Emergency Operations

A.2 COMMUNITY PROFILE

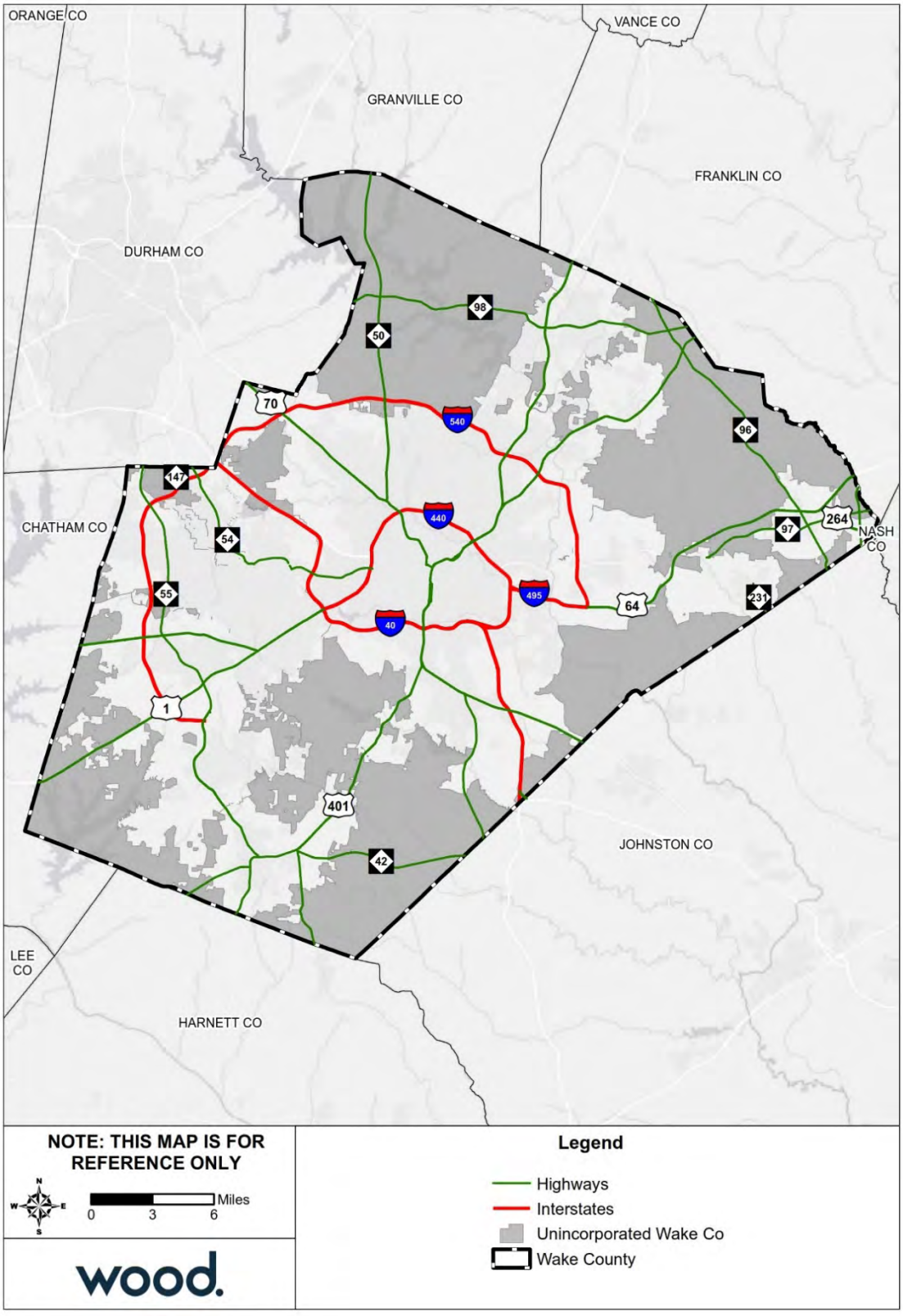
Geography

Wake County is located in the eastern portion of the Piedmont of North Carolina. It is part of the Raleigh, NC Metropolitan Statistical Area, which falls within the larger Raleigh-Durham-Chapel Hill, NC Combined Statistical Area. The County comprises a total land area of 834 square miles.

According to data from the U.S. Fish and Wildlife Service's National Wetlands Inventory, there are approximately 18,332 acres of wetlands in the unincorporated areas of the County.

Figure A.1 shows a base map of major transportation routes in the unincorporated areas of the County.

Figure A.1 – Major Transportation Routes, Wake County



Source: Wake County GIS Open Data

Population and Demographics

Table A.2 provides population counts and growth estimates for the County's unincorporated areas as compared to the County overall. Table A.3 provides demographic information for the unincorporated areas as compared to the whole County.

Table A.2 – Population Counts, Unincorporated Wake County, 2010-2017

Jurisdiction	2000 Census Population	2010 Census Population	2017 ACS Population Estimate	Total Change 2010-2017	% Change 2010-2017
Wake County total	**627,846**	**900,993**	**1,023,811**	**122,818**	**13.6%**
Unincorporated areas	169,386	181,890	189,996	8,106	4.5%

Source: US Census Bureau Decennial Census 2000, Decennial Census 2010; American Community Survey 2013-2017 5-Year Estimates
Note: Unincorporated areas statistics calculated by subtracting jurisdiction counts from the county total. The total population of Cary, Raleigh, and Wake Forest includes population residing in adjacent counties.

Table A.3 – Racial Demographics, Unincorporated Wake County, 2017

Jurisdiction	White, %	Black, %	Asian, %	Other Race, %	Two or More Races, %	Persons of Hispanic or Latino Origin*, %
Wake County total	**66.5%**	**20.4%**	**6.5%**	**3.6%**	**2.7%**	**10.0%**
Unincorporated areas	77.1%	14.2%	1.8%	4.3%	2.1%	12.0%

Source: US Census Bureau, American Community Survey 2013-2017 5-Year Estimates
*Persons of Hispanic origin may be of any race, so also are included in applicable race categories

Asset Inventory

The following tables summarize the asset inventory for Wake County unincorporated areas in order to estimate the total physical exposure to hazards in this area. The locations of critical facilities are shown in Figure A.2 on the following page. Critical facilities are a subset of identified assets from the Critical Infrastructure & Key Resources dataset. Note that the counts are by building; where a critical facility comprises a cluster of buildings, each building is counted and displayed.

Table A.4 – Critical Infrastructure & Key Resources by Type

Jurisdiction	Food & Agriculture	Banking & Finance	Chemical	Commercial Facilities	Communications	Manufacturing	Defense	Government	Healthcare	IT	National Monuments	Nuclear	Postal & Shipping	Transportation	Energy	Emergency Services	Water	Other	Total
Unincorporated Wake County	1,902	0	0	574	0	621	0	198	27	0	0	0	0	186	28	14	43	0	**3,593**

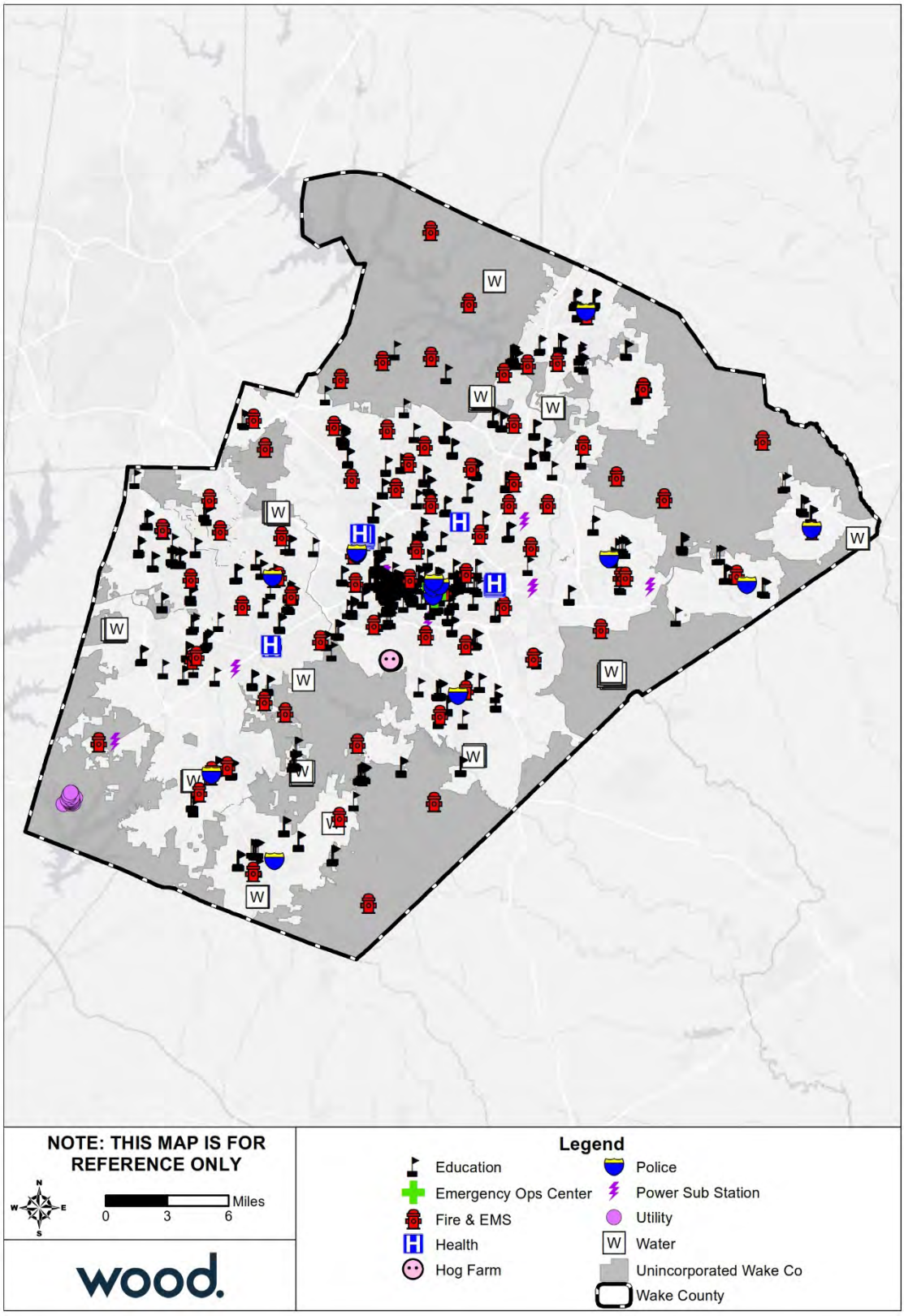
Source: NCEM Risk Management Tool

Table A.5 – High Potential Loss Facilities by Use

Jurisdiction	Residential	Commercial	Industrial	Government	Agricultural	Religious	Utilities	Other	Total
Wake County unincorporated areas	432	84	26	44	1	36	66	0	**689**

Source: NCEM Risk Management Tool

Figure A.2 – Critical Facilities, Unincorporated Wake County



Source: NCEM IRISK Database, GIS Analysis

To supplement the asset inventory and provide a clearer picture of the current asset exposure in Unincorporated Wake County, current parcel data was evaluated to identify development since 2010. This information is not incorporated into the risk assessment, which was prepared using NCEM's IRISK database. However, this summary of development since 2010 provides some context to understand the degree to which the IRISK exposure and vulnerability numbers differ from current conditions.

Table A.6 provides a summary by land class of parcel development from January 2011 to April 2019.

Table A.6 – Parcels Developed 2011 or Later, Unincorporated Wake County

Land Class	Number of Parcels	Sum of Building Value
Acres Greater Than 10 With House	56	$25,563,035
Agriculture	21	$8,023,782
Commercial	7	$14,603,090
EXEMPT	4	$4,843,752
Forestry	6	$3,289,430
HOA	3	-
Horticulture	2	$757,361
Industrial	3	$56,884,017
Part Exempt	30	$10,452,989
Residential Less Than 10 Acres	4,381	$1,566,297,546
Grand Total	**4,513**	**$1,690,715,002**

Source: Wake County Open Data; retrieved April 8, 2019

There are 13 listings on the National Register of Historic Places for Wake County unincorporated areas, including two historic districts. These sites are listed in the table below.

Table A.7 – Historic Properties

Ref#	Property Name	Status Date	Category	City
01000424	Cannady--Brogden Farm	4/25/2001	Building	Creedmoor
74001379	Mangum, James, House	11/18/1974	Building	Creedmoor
99000509	Hood--Anderson Farm	4/29/1999	District	Eagle Rock
83001921	Falls of the Neuse Manufacturing Company	9/19/1983	Building	Falls
84000118	Forestville Baptist Church	10/25/1984	Building	Forestville
01000426	New Hill Historic District	4/25/2001	District	New Hill
07001503	Holleman, Samuel Bartley, House	1/30/2008	Building	New Hill
94001025	Perry Farm	8/26/1994	Building	Riley Hill
93001021	Oaky Grove	9/30/1993	Building	Shotwell
85002418	Rogers--Whitaker--Haywood House	9/19/1985	Building	Wake Crossroads
06000788	Davis--Adcock Store	9/6/2006	Building	Wilbon
03000931	Smith, Frank and Mary, House	9/11/2003	Building	Willow Spring
05000549	Smith, Turner and Amelia, House	6/10/2005	Building	Willow Spring

Source: National Parks Service, National Register of Historic Places, October 2018

Housing

The table below details key housing statistics for Wake County unincorporated areas as compared to the County overall. Growth in housing units was much more limited in the unincorporated areas as compared to the County overall.

Table A.8 – Housing Statistics, Unincorporated Wake County, 2010-2017

Jurisdiction	Housing Units (2010)	Housing Units (2017)	Housing Units Percent Change (2010-2017)	Owner-Occupied, % (2017)	Vacant Units, % (2017)	Median Home Value (2017)
Wake County total	**371,836**	**411,632**	**10.7%**	**59.5%**	**7.2%**	**$250,700**
Unincorporated areas	69,428	70,641	1.7%	80.0%	6.6%	n/a

Source: U.S. Census Bureau 2010 Decennial Census, American Community Survey 2013-2017 5-Year Estimates
Note: Owner-Occupied and vacant-unit measures are reported as a percent of the total number of housing units.

Economy

The following tables present key economic statistics for Wake County unincorporated areas as compared to the County overall.

Table A.9 – Employment Statistics, Unincorporated Wake County, 2017

Jurisdiction	Population in Labor Force	Percent Employed* (%)	Percent Unemployed* (%)	Percent Not in Labor Force* (%)	Unemployment Rate (%)
Wake County	**564,096**	**67.2**	**3.5**	**29.2**	**4.9**
Unincorporated areas	100,211	63.8	3.9	32.2	5.7

Source: U.S. Census Bureau, American Community Survey 2013-2017 5-Year Estimates
Note: This table reports only the civilian labor force. The labor force in armed services accounted for 0.3% or less of the population 16 and over in all jurisdictions. *Population employed, population unemployed, and Population not in labor force are reported as a percent of the total population aged 16 years and older.

Table A.10 – Percent of Employed Population by Occupation, Unincorporated Wake County, 2017

Occupation	Management, business, science and arts (%)	Service (%)	Sales and Office (%)	Natural Resources, Construction, and Maintenance (%)	Production, transportation, and material moving (%)
Wake County	**50.1**	**13.8**	**23.4**	**6.0**	**6.7**
Unincorporated areas	46.3	13.2	23.7	9.3	7.4

Source: U.S. Census Bureau, American Community Survey 2013-2017 5-Year Estimates

A.3 RISK ASSESSMENT

This section contains a hazard profile and vulnerability assessment for those hazards that were rated with a higher priority for the unincorporated areas than for Wake County as a whole. Risk and vulnerability findings are also presented here for those hazards that are spatially defined and have variations in risk that could be evaluated quantitatively on a jurisdictional level. The hazards included in this section are: Dam Failure, Flood and Wildfire.

A.3.1 Dam Failure

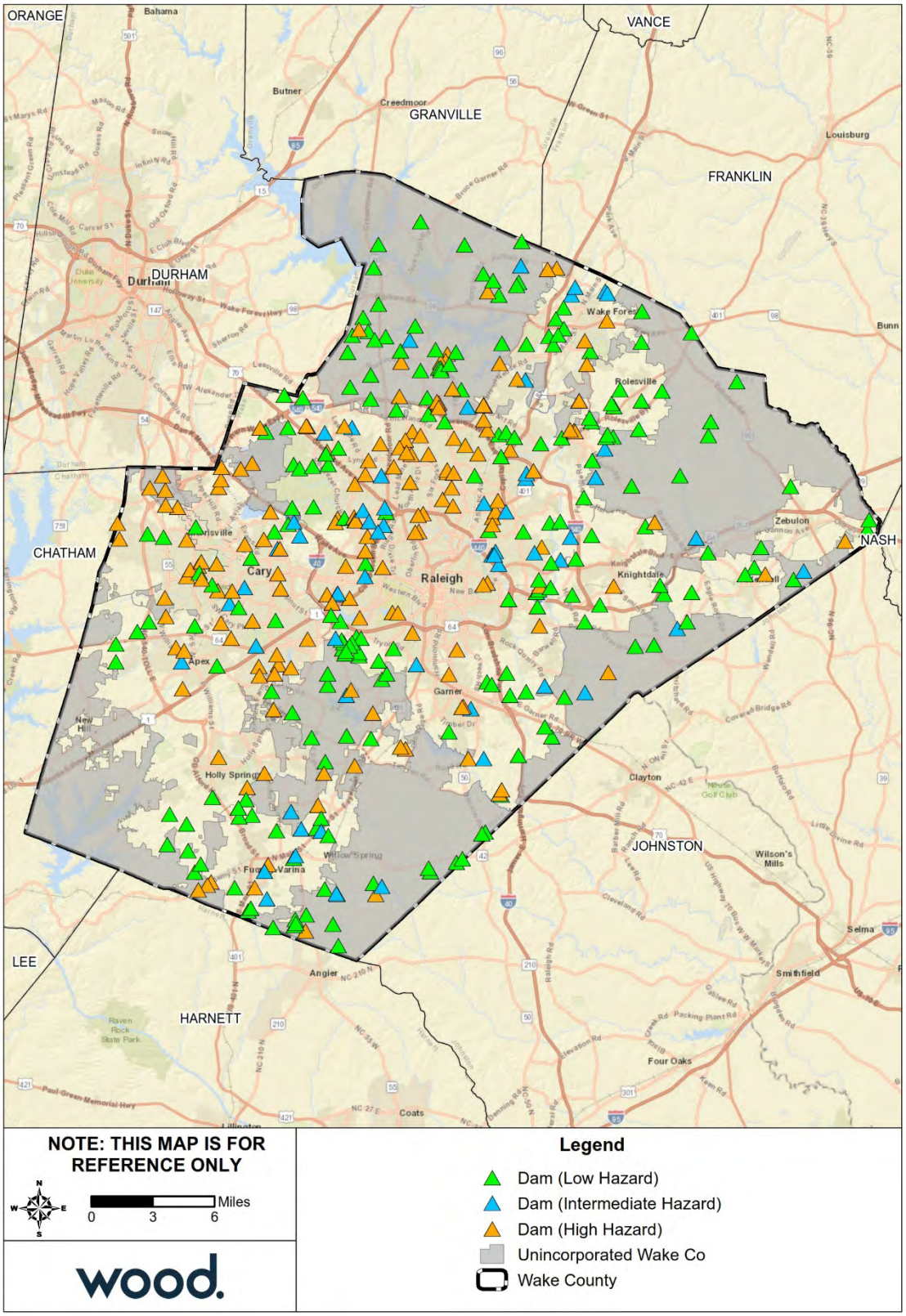
Table A.11 lists all high hazard dams identified by the North Carolina Dam Inventory as of July 2018. Dam locations in relation to unincorporated Wake County are shown in Figure A.3.

Table A.11 – High Hazard Dams in Unincorporated Wake County

Dam Name	NID ID	Condition as of Last Inspection	Max Capacity (Ac-Ft)	Nearest Downstream Location
Wake County				
Johnson Pond Dam	NC00163	Satisfactory	95	Lillington
Crossgate Lake Dam #1	NC00850	Fair	207	Raleigh
Crossgate Dam #2	NC04437	Fair	40	Raleigh
Lake Benson Dam	NC00861	Satisfactory	7200	Smithfield (Benson Rd near Dam
Lake Wheeler Dam	NC00864	Satisfactory	10800	Smithfield (See Comments)
Mason Lake Dam	NC00865	Fair	52	Milburnie
Panther Lake Dam	NC00876	Fair	253	Smithfield
Rdu Wastewater Dam	NC04443		22.5	N/A
Rtp South Dam	NC04444	Satisfactory	708	Apex
Pendleton Lake	NC04450	Satisfactory	10	Swan Mill Crossing Rd
Crabtree Dam 20-A	NC04456	Satisfactory	2500	John Brantley Blvd
Johnson Pond Dam	NC00845	Poor	5	NC-39
Coachman Trail Lake Dam Lower	NC01461	Fair	93	Falls (CoachmanWay@Dam)
Falls Of The Neuse Dam	NC01713		1128100	Falls (OldFallOfNeuseRd-Dam)
Stonebridge Lake Dam	NC01664	Fair	45	Falls
Coachman Trail Lake Dam Upper	NC04531	Fair	180	Coachman's Way Rd
Byrd Dam	NC04532	Fair	10	Baird Drive
Crabtree Creek Dam 5-A	NC04536	Fair	3010	Raleigh (I-40 @ Dam)
Bailey Dam	NC04563	Fair	76	Six Forks Road
Marshall Pond #2	NC04576	Unsatisfactory	59	Forestville Road
Howell Dam	NC04621	Fair	36	
Manchester Dam	NC04964	Fair	88	Enderbury Drive
Rtp W-1	NC05193	Satisfactory	327	
Crossgate Dam #3	NC05068	Fair	12	White Chapel Way
Chateau Lapointe Dam H	NC05069	Satisfactory	90	White Chapel Way
Cozart Pond Dam	NC05065	Not Rated		
Underwood Pond Dam	NC05218	Fair	27	
Betts Pond Dam	NC05036	Fair	40	
Hasentree Golf Communtiy Dam	NC05685	Satisfactory	139	Hasentree Club Drive
Neuse River Waste Water Treatment Plant Equalization Basin	NC05686	Satisfactory	114	Mai Plantation Road
RTP W-5 Dam	NC05795	Satisfactory	700	Jordan Reservoir
Burnside Drive Dam	NC05802	Fair	12	Burnside Drive
Rosewood Subdivision Dam	NC05877	Satisfactory	6	MacTavish Way
McCullers Pond Dam	NC06160	Not Rated		

Source: NC Dam Inventory, July 2018

Figure A.3 – Dam Locations, Unincorporated Wake County



Source: NC Dam Inventory, July 2018

A.3.2 Flood

Table A.12 details the acreage of unincorporated Wake County's total area by flood zone on the effective DFIRM. Per this assessment, over 10 percent of the unincorporated area in the County falls within the mapped 1%-annual-chance floodplains.

Table A.12 – Flood Zone Acreage in Unincorporated Wake County

Flood Zone	Acreage	Percent of Total (%)
Zone A	244.34	0.07
Zone AE	34,276.21	10.13
Zone X (500-year)	1,923.22	0.57
Zone X Unshaded	302,007.04	89.23
Total	**338,450.81**	--

Source: FEMA Effective DFIRM; Wake County GIS

Figure A.4 reflects the effective mapped flood hazard zones for Wake County, and Figure A.5 displays the depth of flooding estimated to occur in these areas during the 1%-annual-chance flood.

To supplement the IRISK assessment of property at risk from the 1% annual chance flood event in Section 4 and provide a clearer picture of the current property at risk in Unincorporated Wake County, current parcel data was evaluated to identify parcels developed since 2010. Using GIS analysis, parcels developed after 2010 were compared to the boundaries of the 1% annual chance floodplain to identify the exposure of newly developed property to the base flood. In most cases, a parcel was considered exposed to the floodplain if any portion of the parcel was located in the floodplain. This assessment does not evaluate flood impacts or provide damage estimates. However, this summary of development in or near the floodplain since 2010 provides some context to understand the degree to which the IRISK exposure and vulnerability numbers differ from current conditions. Table A.13 provides a summary by land class of parcel development located in the 1% annual chance floodplain from January 2011 to April 2019.

Table A.13 – Parcels Developed 2011 or Later and Located in 1% Annual Chance Floodplain

Land Class	Number of Parcels	Sum of Building Value
Acres Greater Than 10 With House	20	$9,213,446
Forestry	1	$777,207
Industrial	1	$48,366,843
Residential Less Than 10 Acres	118	$46,029,733
Grand Total	**140**	**$104,387,229**

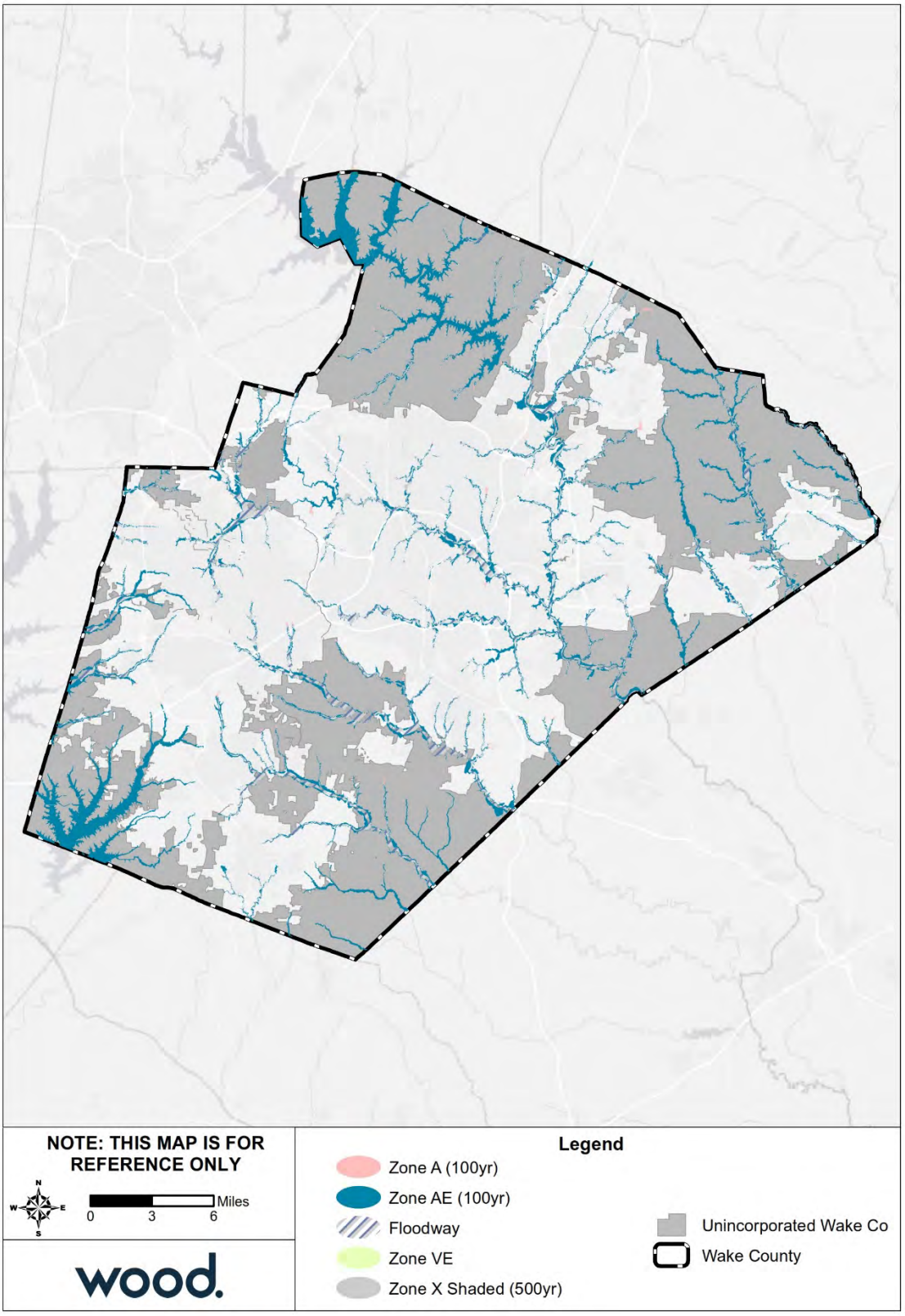
Source: Wake County Open Data; retrieved April 8, 2019; FEMA Effective DFIRM

Table A.14 provides building counts and estimated damages for Critical Infrastructure and Key Resources (CIKR) buildings by sector and flood event in the City of Raleigh.

Table A.14 – Critical Facilities Exposed to Flooding, Unincorporated Wake County

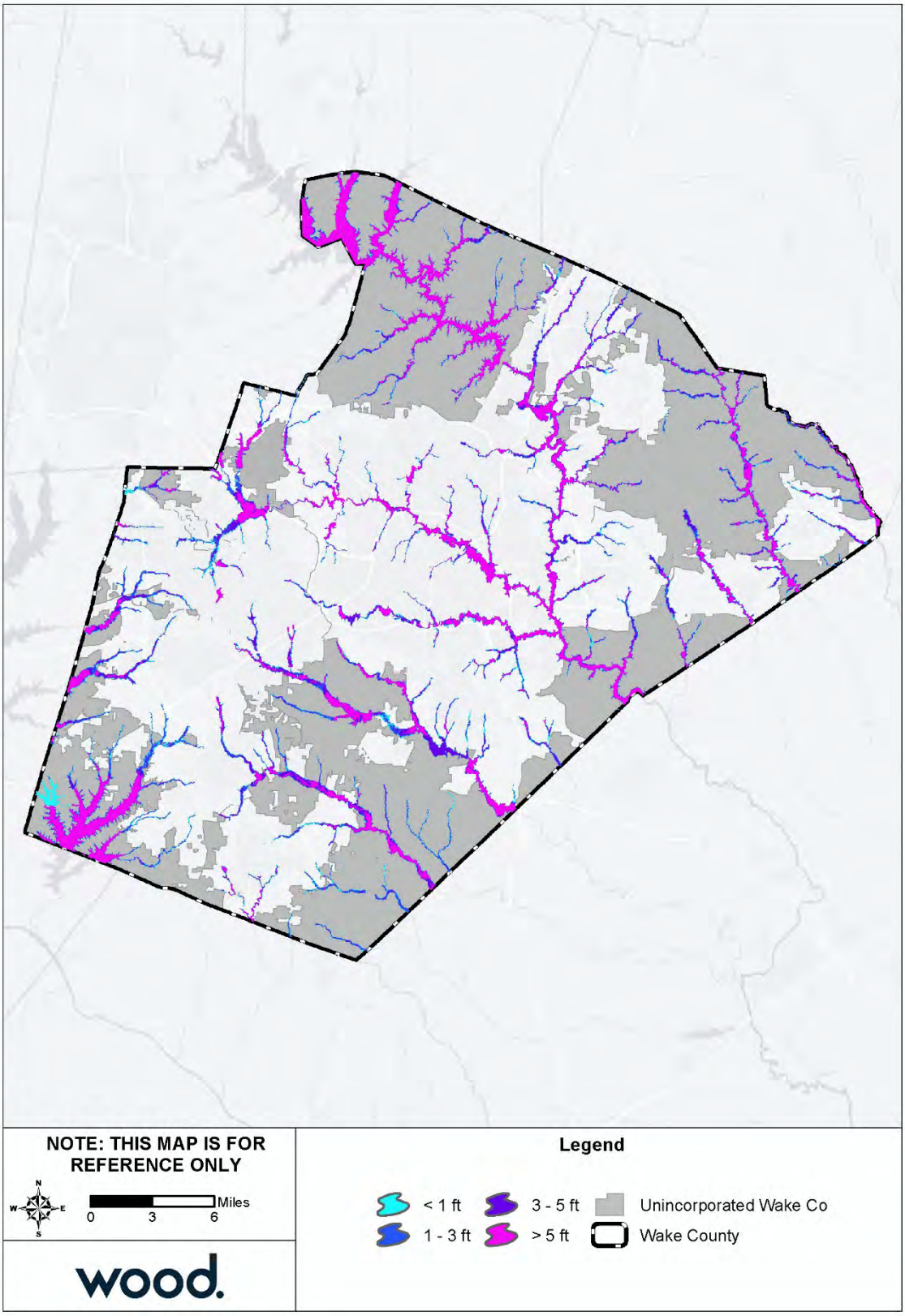
Sector	Event	Number of Buildings at Risk	Estimated Damages
Commercial Facilities	100 Year	20	$439,223
	Floodway	1	$23,765
Government Facilities	100 Year	2	$86,000
Transportation Systems	100 Year	1	$60,845
	Floodway	1	$60,845
All Categories	**100 Year**	**23**	**$586,068**
	Floodway	**2**	**$84,610**

Figure A.4 – FEMA Flood Hazard Areas, Unincorporated Wake County



Source: FEMA Effective DFIRM

Figure A.5 – Flood Depth, 1%-Annual-Chance Floodplain, Unincorporated Wake County



Source: FEMA Effective DFIRM

A.3.3 Wildfire

Table A.15 summarizes the acreage in unincorporated Wake County that falls within the Wildland Urban Interface (WUI), categorized by housing density. Areas in the WUI are those where development may intermix with flammable vegetation. Over 25 percent of unincorporated Wake County is not included in the WUI.

Table A.15 – Wildland Urban Interface Acreage, Unincorporated Wake County

	Housing Density	Total Acreage	Percent of Total Acreage
	Not in WUI	*61,268.0*	*25.5%*
	LT 1hs/40ac	21,805.8	9.1%
	1hs/40ac to 1hs/20ac	18,817.7	7.8%
	1hs/20ac to 1hs/10ac	25,599.6	10.7%
	1hs/10ac to 1hs/5ac	30,158.9	12.6%
	1hs/5ac to 1hs/2ac	42,523.2	17.7%
	1hs/2ac to 3hs/1ac	39,565.4	16.5%
	GT 3hs/1ac	180.7	0.1%
	Total	239,919.4	

Source: Southern Wildfire Risk Assessment

Figure A.6 depicts the WUI for unincorporated Wake County. The WUI is the area where housing development is built near or among areas of vegetation that may be prone to wildfire. Figure A.7 depicts the Fire Intensity Scale, which indicates the potential severity of fire based on fuel loads, topography, and other factors. Figure A.8 depicts Burn Probability based on landscape conditions, percentile weather, historical ignition patterns, and historical prevention and suppression efforts.

Potential fire intensity is highest in northwest and southwest Wake County; however, these areas have lower burn probability and/or are largely outside of the WUI, meaning little to no development is at risk. The area of greatest risk in the County is in the southeast where WUI overlays with moderate burn probability and moderate fire intensity levels.

Table A.16 provides building counts and estimated damages for Critical Infrastructure and Key Resources (CIKR) buildings by sector at risk to wildfire hazard. Table A.17provides counts and estimated damages for High Potential Loss Properties in the Town of Fuquay-Varina.

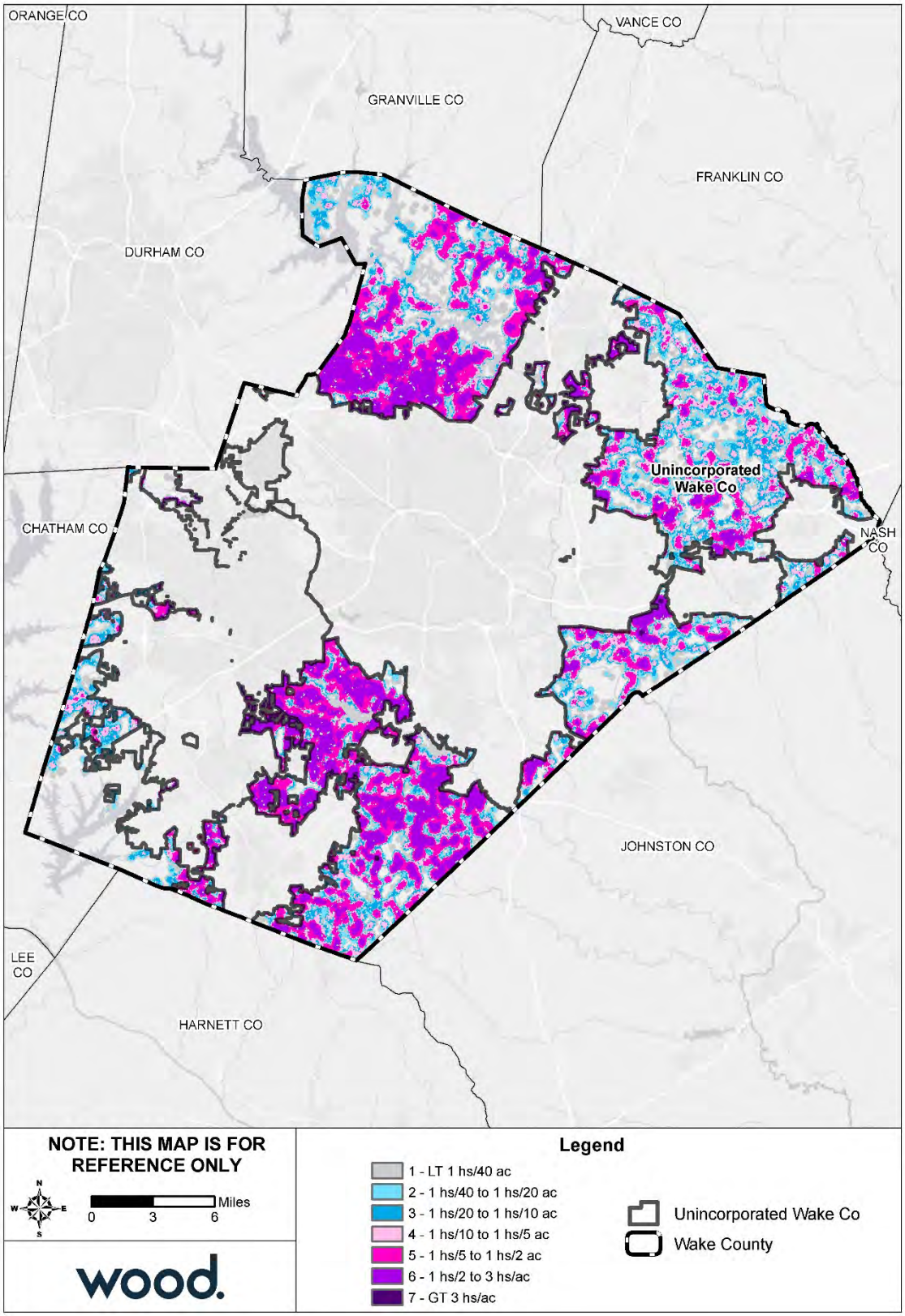
Table A.16 – Critical Facilities Exposed to Wildfire, Unincorporated Wake County

Sector	Event	Number of Buildings at Risk	Estimated Damages
Commercial Facilities	Wildfire Hazard	5	$7,400,764
Critical Manufacturing	Wildfire Hazard	4	$1,485,862
Food and Agriculture	Wildfire Hazard	54	$2,326,874
All Categories	**Wildfire Hazard**	**63**	**$11,213,500**

Table A.17 – High Potential Loss Properties Exposed to Wildfire, Unincorporated Wake County

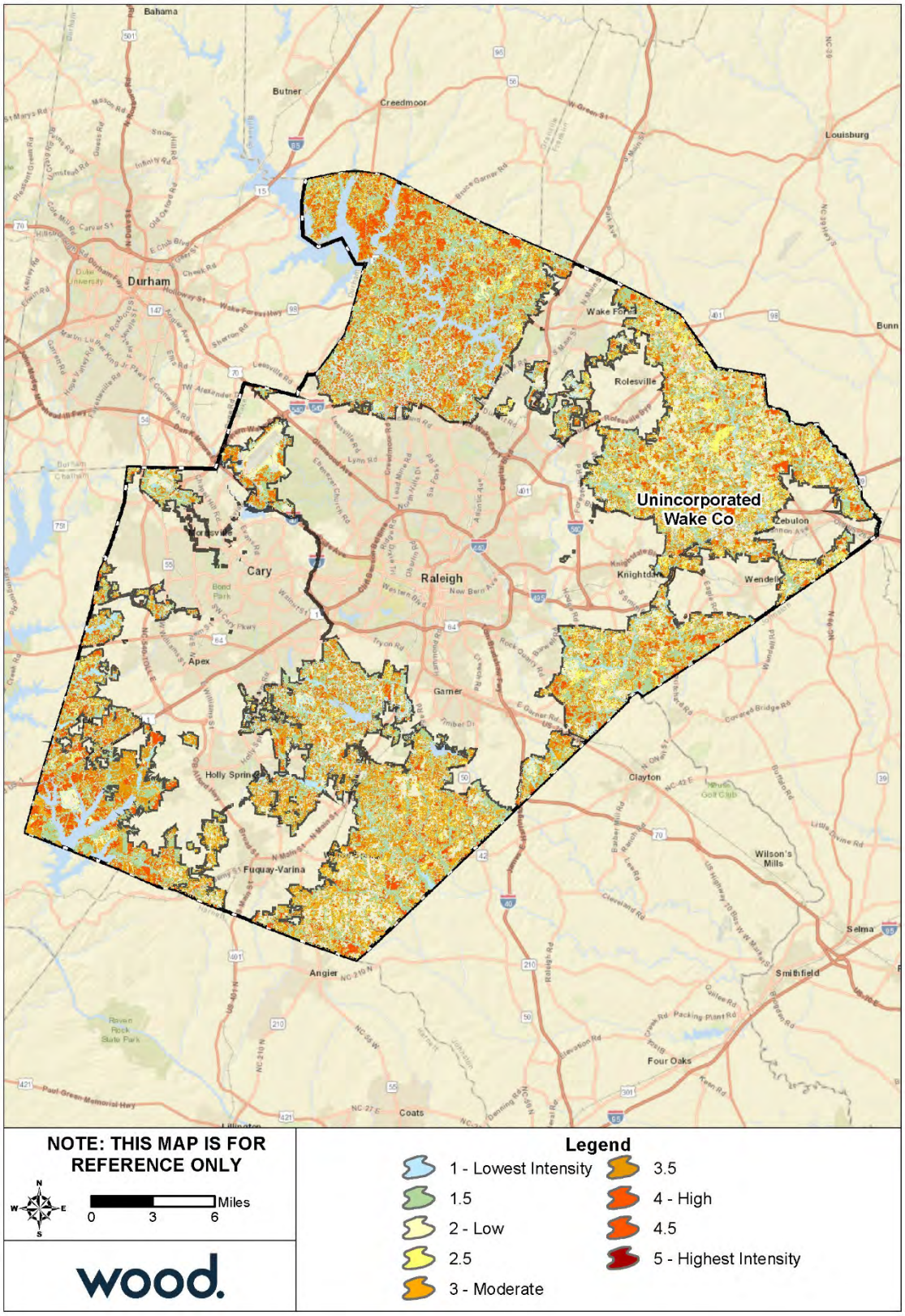
Category	Event	Number of Buildings at Risk	Estimated Damages
Commercial	Wildfire Hazard	1	$2,740,704
Religious	Wildfire Hazard	1	$1,658,293
All Categories	**Wildfire Hazard**	**2**	**$4,398,997**

Figure A.6 – Wildland Urban Interface, Unincorporated Wake County



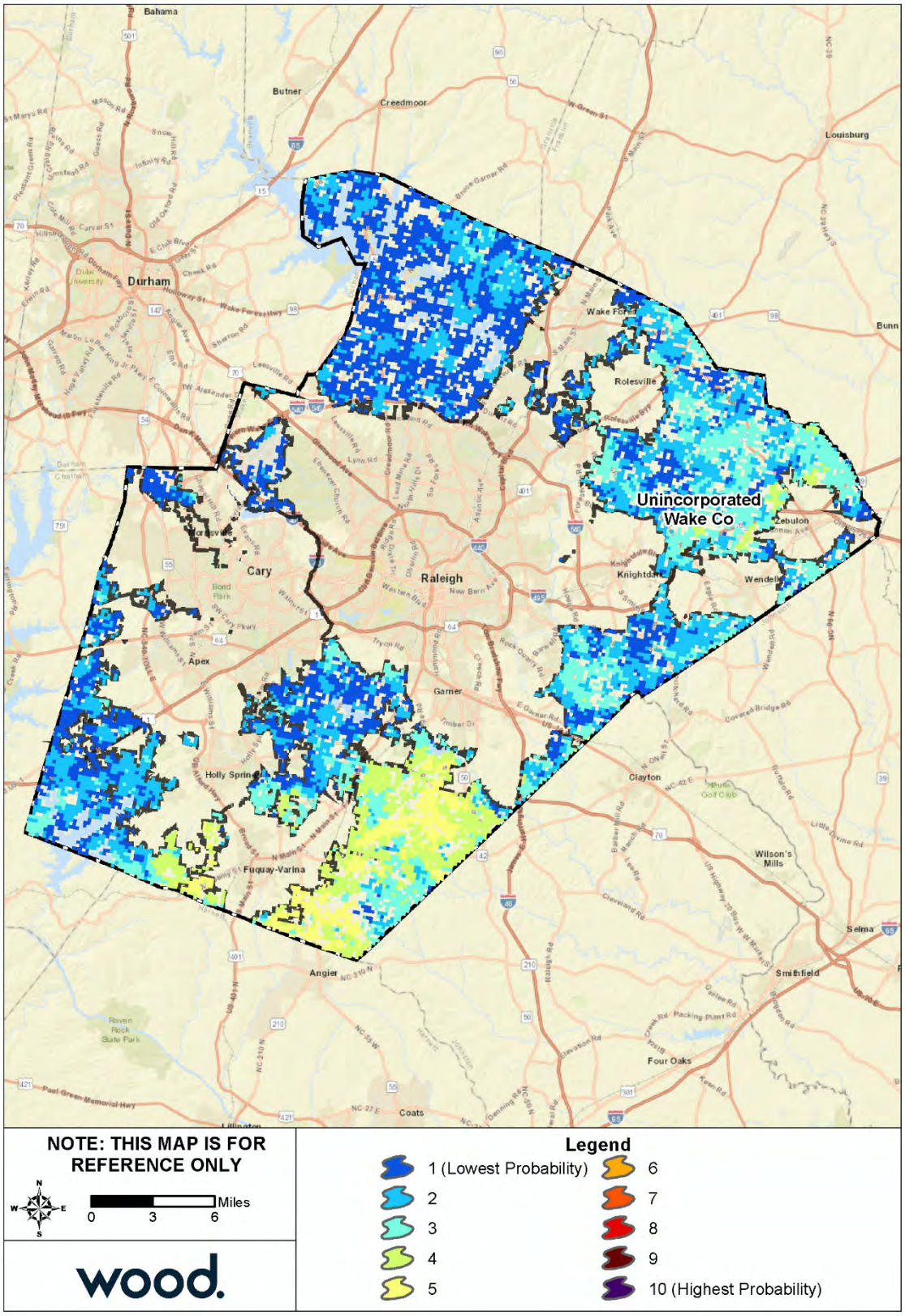
Source: Southern Wildfire Risk Assessment

Figure A.7 – Fire Intensity Scale, Unincorporated Wake County



Source: Southern Wildfire Risk Assessment

Figure A.8 – Burn Probability, Unincorporated Wake County



Source: Southern Wildfire Risk Assessment

A.4 CAPABILITY ASSESSMENT

A.4.1 Overall Capability

Details on the tools and resources in place and available to Wake County were provided by the County's HMPC representatives and are summarized in Section 5 Capability Assessment. Based on that information and using the scoring methodology detailed in that section, Wake County has an overall capability rating of Moderate. The County's Self-Assessment of key capability areas is summarized in Table A.18 below.

Table A.18 – Capability Self-Assessment, Unincorporated Wake County

Capability Area	Rating
Plans, Ordinances, Codes and Programs	High
Administrative and Technical Capability	Moderate
Fiscal Capability	Moderate
Education and Outreach Capability	Limited
Mitigation Capability	Unrated
Political Capability	Unrated
Overall Capability	Moderate

A.4.2 Floodplain Management

Wake County joined the NFIP emergency program in 1975 and has been a regular participant in the NFIP since November 1978. The following tables reflect NFIP policy and claims data for the County categorized by structure type, flood zone, Pre-FIRM and Post-FIRM.

Table A.19 – NFIP Policy and Claims Data by Structure Type

Structure Type	Number of Policies in Force	Total Premium	Insurance in Force	Number of Closed Paid Losses	Total of Closed Paid Losses
Single Family	382	$158,156	$111,781,800	51	$628,493.34
2-4 Family	1	$373	$350,000	1	$10,458.76
All Other Residential	51	$7,938	$7,640,800	0	$0.00
Non-Residential	4	$2,190	$180,500	18	$357,122.41
Total	438	$168,657	$119,953,100	70	$996,074.51

Source: FEMA Community Information System, accessed November 2018

Table A.20 – NFIP Policy and Claims Data by Flood Zone

Flood Zone	Number of Policies in Force	Total Premium	Insurance in Force	Number of Closed Paid Losses	Total of Closed Paid Losses
A01-30 & AE Zones	68	$26,968	$12,851,700	36	$646,919.29
A Zones	1	$677	$350,000	2	$3,575.95
AO Zones	0	$0	$0	0	$0.00
AH Zones	0	$0	$0	0	$0.00
AR Zones	0	$0	$0	0	$0.00
A99 Zones	0	$0	$0	0	$0.00
V01-30 & VE Zones	0	$0	$0	0	$0.00
V Zones	0	$0	$0	0	$0.00
D Zones	0	$0	$0	0	$0.00

Flood Zone	Number of Policies in Force	Total Premium	Insurance in Force	Number of Closed Paid Losses	Total of Closed Paid Losses
B, C & X Zone					
Standard	27	$16,200	$4,452,400	3	$103,973.20
Preferred	342	$124,812	$102,299,000	25	$220,469.76
Total	438	$168,657	$119,953,100	66	$974,938.20

Source: FEMA Community Information System, accessed November 2018

Table A.21 – NFIP Policy and Claims Data Pre-FIRM

Flood Zone	Number of Policies in Force	Total Premium	Insurance in Force	Number of Closed Paid Losses	Total of Closed Paid Losses
A01-30 & AE Zones	40	$10,332	$6,059,100	22	$306,182.74
A Zones	0	$0	$0	1	$2,692.23
AO Zones	0	$0	$0	0	$0.00
AH Zones	0	$0	$0	0	$0.00
AR Zones	0	$0	$0	0	$0.00
A99 Zones	0	$0	$0	0	$0.00
V01-30 & VE Zones	0	$0	$0	0	$0.00
V Zones	0	$0	$0	0	$0.00
D Zones	0	$0	$0	0	$0.00
B, C & X Zone	30	$12,465	$8,073,300	7	$56,998.08
Standard	2	$2,878	$379,300	0	$0.00
Preferred	28	$9,587	$7,694,000	7	$56,998.08
Total	70	$22,797	$14,132,400	30	$365,873.05

Source: FEMA Community Information System, accessed November 2018

Table A.22 – NFIP Policy and Claims Data Post-FIRM

Flood Zone	Number of Policies in Force	Total Premium	Insurance in Force	Number of Closed Paid Losses	Total of Closed Paid Losses
A01-30 & AE Zones	28	$16,636	$6,792,600	14	$340,736.55
A Zones	1	$677	$350,000	1	$883.72
AO Zones	0	$0	$0	0	$0.00
AH Zones	0	$0	$0	0	$0.00
AR Zones	0	$0	$0	0	$0.00
A99 Zones	0	$0	$0	0	$0.00
V01-30 & VE Zones	0	$0	$0	0	$0.00
V Zones	0	$0	$0	0	$0.00
D Zones	0	$0	$0	0	$0.00
B, C & X Zone	339	$128,547	$98,678,100	21	$267,444.88
Standard	25	$13,322	$4,073,100	3	$103,973.20
Preferred	314	$115,225	$94,605,000	18	$163,471.68
Total	368	$145,860	$105,820,700	36	$609,065.15

Source: FEMA Community Information System, accessed November 2018

A.5 MITIGATION STRATEGY

Wake County											
Action #	**Description**	**Goal**	**Objective**	**Hazard(s) Addressed**	**Relative Priority**	**Lead Agency/ Department**	**Estimated Cost**	**Potential Funding Sources**	**Implementation Schedule**	**2019 Status**	**Status Comments/Explanation**
Prevention											
P-1	Conduct a groundwater assessment using a network of wells and leading to a groundwater model that can enhance the understanding of groundwater capacity, threats and vulnerabilities in response to growth and weather.	1	1	Drought	High	Wake Environmental Services, Wake Water Partnership, USGS	$1,565,000	Non-departmental operating expense and USGS	3-5 years	In-Progress – Carry Forward	Program scope established and project is underway. Wake County is partnering with USGS to conduct this study.
P-2	Oversee completion of planned reclaimed water projects per the County's approved Community Improvement Program (CIP).	4	2	Drought	Moderate	Raleigh, Wake County	$16,000,000	Annual budget process	2-3 years	In-Progress – Carry Forward	Completed several reclaimed water projects in RTP and others directly related to County facilities. Project has three phases; phases 1 and 2 are complete.
Property Protection											
PP-1	Identify road network segments no longer maintained by NCDOT and provide funding and planning resources for mitigation and recovery efforts to communities to ensure infrastructure and transportation resiliency. Assist in reinstating water and sewer services post disaster.	3	1	All	Moderate	Wake County Community Services	$100,000,000	Annual budget ordinance	Ongoing - Next 5 years	New	N/A
Natural Resource Protection											
NRP-1	Partner with other governmental units and other interested parties to jointly identify and acquire 30,000 acres of open space lands.	3	2	Flood, Drought, Landslide, Extreme Heat	High	Wake County Community Services	$335,000,000	Open Space Bonds	3-5 years	In-Progress – Carry Forward	The County has purchased approximately 7,634 acres since the program's inception. It will take several decades as indicated to complete. In 2018 voters approved $120m Parks, Greenways, Recreation and Open Space Bond. $26m available for 2019.
Structural Projects											
SP-1	Replace emergency generators located at facilities that serve as emergency shelter locations based on their scheduled end of life cycle.	3	1	All	Moderate	Wake County Facilities Design & Construction	$1,400,000	Local and Federal Grant	More than 5 years	New	N/A
SP-2	Construction of a new Emergency Operations Center adequate for the size and complexity of the jurisdiction	2	1	All	Moderate	Wake County Emergency Management	$6,500,000	Local	3-5 years	New	N/A
Emergency Services											
ES-1	Recovery Plan. Develop a comprehensive disaster recovery plan for Wake County consistent with the vision and goals described in PPD-8 and the National Disaster Recovery Framework.	4	2	All	Moderate	Wake County Emergency Management	$150,000	Local	3-5 years	New	N/A
ES-2	Upload dam failure inundation maps to Everbridge system for notification and evacuation.	1	2	Dam Failure	High	Wake County Emergency Management	Staff time	Local	1 year	New	N/A
Public Education and Awareness											
PEA-1	Emergency Planning and Community Right-to-Know Act (EPCRA) High Hazard Chemicals Awareness. Identify chem facilities, potential impact zones, and potentially affected communities. Inform public and provide resources and education.	1	1	Hazardous Material	Moderate	Wake County Local Emergency Planning Committee	$15,000	Local funding, donations	2-3 years	New	N/A
PEA-2	Increase public awareness and participation in the Ready Wake program and resources.	1	1	All	Moderate	Wake County Fire Services, Emergency Management	$10,000	Federal Grants and Local	2-3 years	New	N/A

Annex B City of Raleigh

B.1 PLANNING PROCESS

The table below lists the HMPC members who represented the City of Raleigh.

Table B.1 – HMPC Members

Agency	Representative	Position or Title
Emergency Management and Special Events	Kelly Lindsey*	Emergency Management Coordinator
Emergency Management and Special Events	Whitney Schoenfeld	Special Events Planner
Engineering Services – Stormwater Management	Ben Brown	Stormwater Administrator
Office of Sustainability	Megan Anderson	Sustainability Manager
Office of Sustainability	Nicole Goddard	Sustainability Analyst

*Note: Vacated position midway through the planning process.

B.2 COMMUNITY PROFILE

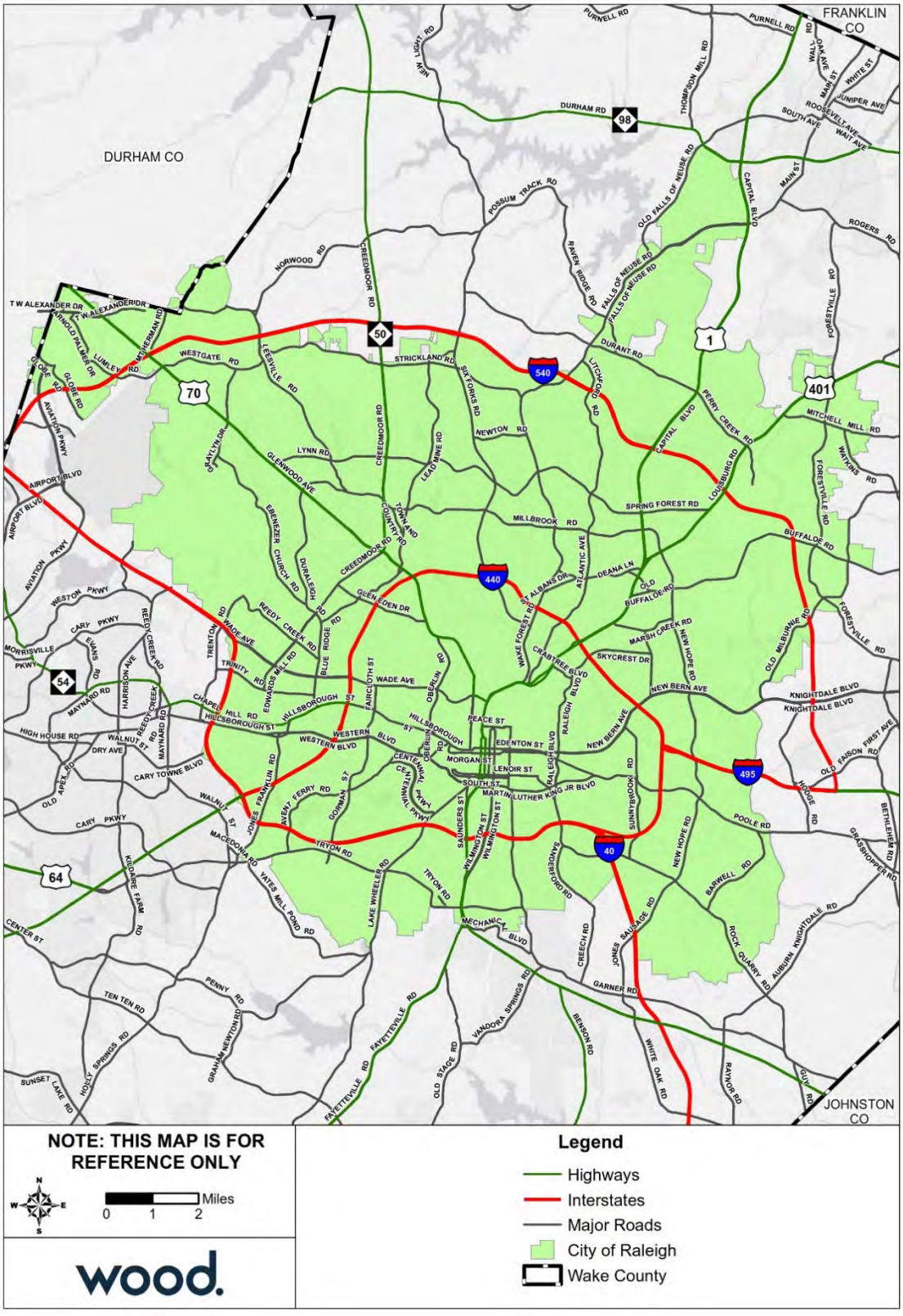
Geography

The City of Raleigh is located in central Wake County. A very small portion of the city extends west into Durham County, however all data presented here is representative of the entire city. The City is part of the Raleigh, NC Metropolitan Statistical Area, which falls within the larger Raleigh-Durham-Chapel Hill, NC Combined Statistical Area. Raleigh comprises a total land area of 142.9 square miles.

According to data from the U.S. Fish and Wildlife Service's National Wetlands Inventory, there are approximately 10,298 acres of wetlands in Raleigh.

Figure B.1 shows a base map of major transportation routes in the City of Raleigh.

Figure B.1 – Major Transportation Routes, City of Raleigh



Source: Wake County GIS Open Data

Population and Demographics

Table B.2 provides population counts and growth estimates for the City of Raleigh as compared to the County overall. Table B.3 provides demographic information for Raleigh as compared to the whole County.

Table B.2 – Population Counts, Raleigh, 2010-2017

Jurisdiction	2000 Census Population	2010 Census Population	2017 ACS Population Estimate	Total Change 2010-2017	% Change 2010-2017
Wake County total	**627,846**	**900,993**	**1,023,811**	**122,818**	**13.6%**
City of Raleigh	276,093	403,892	449,477	45,585	11.3%

Source: US Census Bureau Decennial Census 2000, Decennial Census 2010 American Community Survey 2013-2017 5-Year Estimates
Note: The total population of Raleigh includes population residing in adjacent county.

Table B.3 – Racial Demographics, Raleigh, 2017

Jurisdiction	White, %	Black, %	Asian, %	Other Race, %	Two or More Races, %	Persons of Hispanic or Latino Origin*, %
Wake County total	**66.5%**	**20.4%**	**6.5%**	**3.6%**	**2.7%**	**10.0%**
City of Raleigh	59.0%	28.9%	4.6%	4.6%	2.6%	11.0%

Source: US Census Bureau, American Community Survey 2013-2017 5-Year Estimates
*Persons of Hispanic origin may be of any race, so also are included in applicable race categories

Asset Inventory

The following tables summarize the asset inventory for Raleigh in order to estimate the total physical exposure to hazards in this area. The locations of critical facilities are shown in Figure B.2 on the following page. Critical facilities are a subset of identified assets from the Critical Infrastructure & Key Resources dataset. Note that the counts are by building; where a critical facility comprises a cluster of buildings, each building is counted and displayed.

Table B.4 – Critical Infrastructure & Key Resources by Type

Jurisdiction	Food & Agriculture	Banking & Finance	Chemical	Commercial Facilities	Communications	Manufacturing	Defense	Government	Healthcare	IT	National Monuments	Nuclear	Postal & Shipping	Transportation	Energy	Emergency Services	Water	Other	Total
City of Raleigh	166	164	1	3,653	8	1,678	2	1,643	457	0	0	2	0	739	13	40	12	0	**8,578**

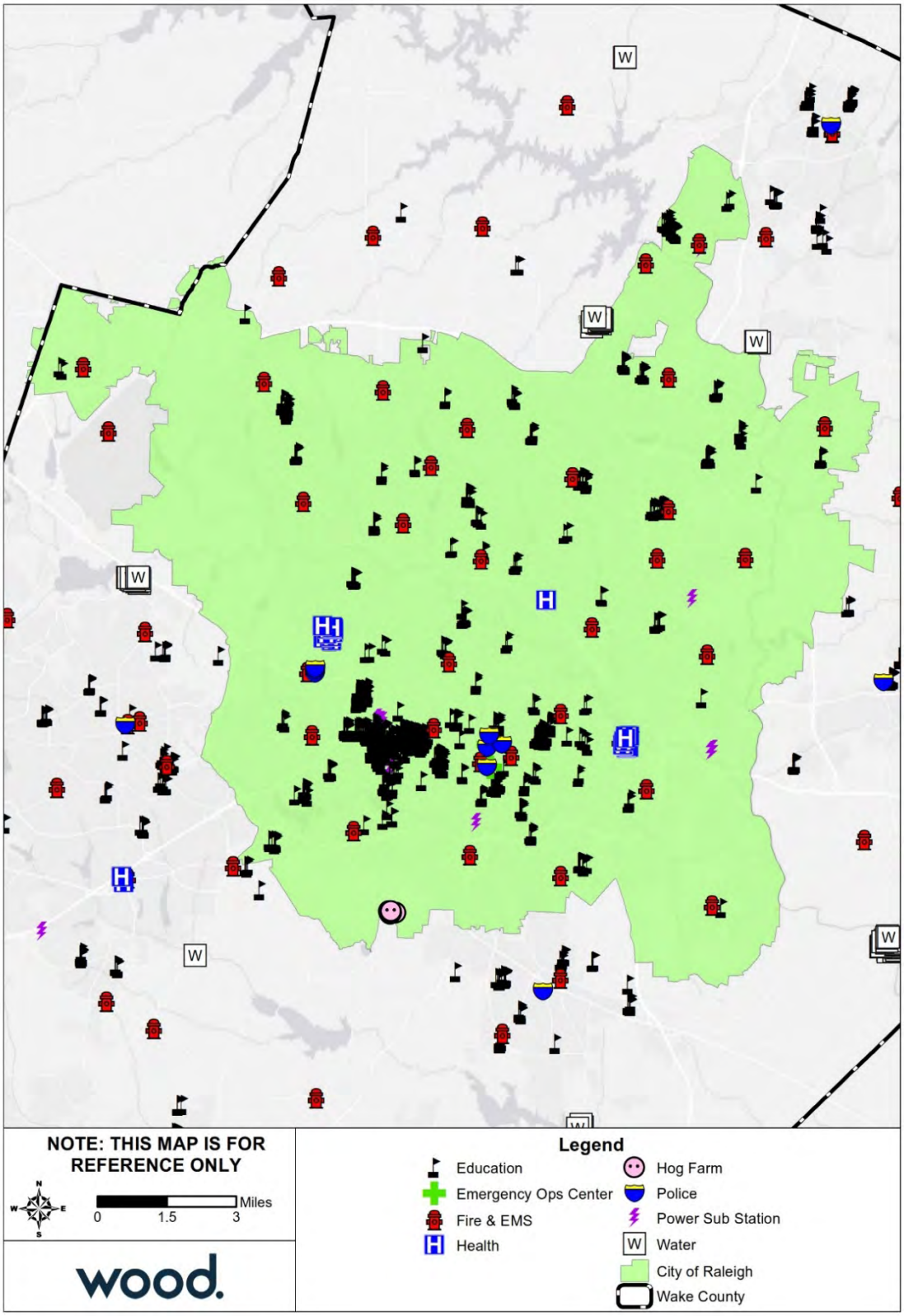
Source: NCEM Risk Management Tool

Table B.5 – High Potential Loss Facilities by Use

Jurisdiction	Residential	Commercial	Industrial	Government	Agricultural	Religious	Utilities	Other	Total
City of Raleigh	1,284	1,359	338	505	1	170	13	0	**3,670**

Source: NCEM Risk Management Tool

Figure B.2 – Critical Facilities, City of Raleigh



Source: NCEM IRISK Database, GIS Analysis

To supplement the asset inventory and provide a clearer picture of the current asset exposure in the City of Raleigh, current parcel data was evaluated to identify development since 2010. This information is not incorporated into the risk assessment, which was prepared using NCEM's IRISK database. However, this summary of development since 2010 provides some context to understand the degree to which the IRISK exposure and vulnerability numbers differ from current conditions.

TABLE provides a summary by land class of parcel development from January 2011 to April 2019.

Table B.6 – Parcels Developed 2011 or Later, City of Raleigh

Land Class	Number of Parcels	Sum of Building Value
Acres Greater Than 10 With House	2	$407,892
Agriculture	3	$639,681
Apartment	113	$1,607,194,130
Commercial	189	$956,181,909
Condo Complex	7	-
EXEMPT	148	$256,148,638
HOA	12	$1,635,560
Industrial	30	$43,151,006
Part Exempt	117	$405,564,987
Residential Less Than 10 Acres	9,226	$2,507,781,302
Retirement Home	3	$15,067,239
State Assessed	1	$4,890,225
Grand Total	**9,851**	**$5,798,662,569**

Source: Wake County Open Data; retrieved April 8, 2019

There are 141 listings on the National Register of Historic Places for the City of Raleigh, including 39 historic districts. These sites are listed in the table below. Four of these sites are also designated as National Historic Landmarks.

Table B.7 – Historic Properties

Ref#	Property Name	Status Date	Category	City
70000475	North Carolina Executive Mansion	2/26/1970	Building	Raleigh
70000476	North Carolina State Capitol	2/26/1970	Building	Raleigh
70000479	Yates Mill	2/26/1970	Building	Raleigh
70000474	Mordecai House	7/1/1970	Building	Raleigh
70000478	State Bank of North Carolina	7/1/1970	Building	Raleigh
70000469	Christ Church	7/28/1970	Building	Raleigh
70000470	Haywood Hall	7/28/1970	Building	Raleigh
70000471	Haywood, Richard B., House	7/28/1970	Building	Raleigh
70000472	Lane, Joel, House	7/28/1970	Building	Raleigh
70000477	St. Mary's Chapel	11/20/1970	Building	Raleigh
71000627	White-Holman House	4/16/1971	Building	Raleigh
71000624	Federal Building	5/6/1971	Building	Raleigh
71000626	Seaboard Coast Line Railroad Company Office Building	5/6/1971	Building	Raleigh
71000623	Dodd-Hinsdale House	11/12/1971	Building	Raleigh
71000625	Raleigh Water Tower	12/16/1971	Building	Raleigh

Ref#	Property Name	Status Date	Category	City
72000998	Andrews-Duncan House	1/20/1972	Building	Raleigh
72001000	Heck-Andrews House	1/20/1972	Building	Raleigh
72000999	Hawkins-Hartness House	2/1/1972	Building	Raleigh
72001001	Lewis-Smith House	12/11/1972	Building	Raleigh
73001375	J. S. Dorton Arena	4/11/1973	Building	Raleigh
73001374	Heck-Lee, Heck-Wynne, and Heck-Pool Houses	4/13/1973	Building	Raleigh
73001373	Estey Hall	5/25/1973	Building	Raleigh
73001376	Jones Jr., Nathaniel, House	6/4/1973	Building	Raleigh
73001377	Peace College Main Building	6/19/1973	Building	Raleigh
73001372	Briggs Hardware Building	10/25/1973	Building	Raleigh
74001380	Oakwood Historic District	6/25/1974	District	Raleigh
75001293	Capehart House	1/17/1975	Building	Raleigh
75001297	Tucker Carriage House	2/13/1975	Building	Raleigh
75001295	Jones, Alpheus, House	7/7/1975	Building	Raleigh
75001294	Elmwood	10/29/1975	Building	Raleigh
76001341	Agriculture Building	6/16/1976	Building	Raleigh
76001343	North Carolina School for the Blind and Deaf Dormitory	8/11/1976	Building	Raleigh
76001344	Pullen Park Carousel	9/8/1976	Structure	Raleigh
76001342	Daniels, Josephus, House	12/8/1976	Building	Raleigh
77001012	Polk, Leonidas L., House	4/13/1977	Building	Raleigh
78001979	Montford Hall	3/8/1978	Building	Raleigh
78001978	Capitol Area Historic District	4/15/1978	District	Raleigh
78001980	Raleigh, Sir Walter, Hotel	8/11/1978	Building	Raleigh
78001981	St. Mary's College	12/19/1978	District	Raleigh
79001759	Rogers-Bagley-Daniels-Pegues House	3/21/1979	Building	Raleigh
79003341	Masonic Temple Building	9/17/1979	Building	Raleigh
80002902	Norburn Terrace	2/1/1980	Building	Raleigh
80002903	St. Augustine's College Campus	3/28/1980	District	Raleigh
77001011	Lane-Bennett House	6/30/1983	Building	Raleigh
83001924	Moore Square Historic District	8/3/1983	District	Raleigh
83001923	Lumsden-Boone Building	9/8/1983	Building	Raleigh
83001925	Professional Building	9/8/1983	Building	Raleigh
83004003	Spring Hill	12/29/1983	Building	Raleigh
84002533	Masonic Temple Building	5/3/1984	Building	Raleigh
85001671	Boylan Heights	7/29/1985	District	Raleigh
85001672	Glenwood	7/29/1985	District	Raleigh
85001673	Cameron Park	7/29/1985	District	Raleigh
85003076	Capital Club Building	12/5/1985	Building	Raleigh
86000403	Marshall--Harris--Richardson House	3/5/1986	Building	Raleigh
87000855	North Carolina State Fair Commercial & Education Buildings	6/5/1987	Building	Raleigh
87001787	Oakwood Historic District (Boundary Increase)	10/21/1987	District	Raleigh
80004607	St. Paul A.M.E. Church	11/5/1987	Building	Raleigh
87002597	Christ Episcopal Church	12/23/1987	Building	Raleigh
87002235	Oakwood Historic District (Boundary Increase II)	1/6/1988	District	Raleigh
88003044	Oakwood Historic District (Boundary Increase III)	1/9/1989	District	Raleigh

Ref#	Property Name	Status Date	Category	City
89000441	Pilot Mill	6/5/1989	District	Raleigh
89001049	Henderson, Isabelle Bowen, House and Gardens	8/7/1989	District	Raleigh
90001030	Wyatt, Leonidas R., House	7/5/1990	Building	Raleigh
90001527	East Raleigh--South Park Historic District	10/11/1990	District	Raleigh
90001638	Dix Hill	11/7/1990	District	Raleigh
91000359	Oak View	4/3/1991	District	Raleigh
92001602	Grosvenor Gardens Apartments	11/12/1992	Building	Raleigh
93000440	Fadum House	6/10/1993	Building	Raleigh
93000543	Raleigh Banking and Trust Company Building	6/17/1993	Building	Raleigh
94001085	Small, G. Milton, and Associates, Office Building	9/21/1994	Building	Raleigh
94001086	Small House	9/21/1994	Building	Raleigh
94001087	Ritcher House	9/21/1994	Building	Raleigh
94001088	Paschal House	9/21/1994	Building	Raleigh
94001089	Matsumoto House	9/21/1994	Building	Raleigh
95000783	Crabtree Creek Recreational Demonstration Area	6/30/1995	District	Raleigh
95001440	Haywood, Dr. Hubert Benbury, House	12/13/1995	Building	Raleigh
96000197	Kamphoefner, Henry L., House	3/12/1996	Building	Raleigh
97000022	Raleigh National Cemetery	1/31/1997	Site	Raleigh
97001304	Carolina Power and Light Company Car Barn and Automobile Garage	10/30/1997	Building	Raleigh
97001305	Raleigh Electric Company Power House	10/30/1997	Building	Raleigh
97001498	Odd Fellows Building	12/1/1997	Building	Raleigh
97001499	Pine Street Creamery, (Former)	12/1/1997	Building	Raleigh
97001593	Royal Baking Company	12/30/1997	Building	Raleigh
97001668	Mordecai Place Historic District	2/4/1998	District	Raleigh
99001392	Pope, Dr. M.T., House	11/22/1999	Building	Raleigh
99001452	Raleigh Water Works and E.B. Bain Water Treatment Plant	11/22/1999	Building	Raleigh
00000457	Mahler and Carolina Trust Buildings	11/29/2000	Building	Raleigh
00001570	Mordecai Place Historic District (Boundary Increase)	12/28/2000	Building	Raleigh
01000416	St. Matthews School	4/25/2001	Building	Raleigh
01000421	Panther Branch School	5/8/2001	Building	Raleigh
01000557	Caraleigh Mills	5/25/2001	Building	Raleigh
01001112	North Carolina Agricultural Experiment Station Cottage	10/15/2001	Building	Raleigh
02000058	Glenwood--Brooklyn Historic District (Boundary Increase and Decrease)	2/20/2002	District	Raleigh
02000165	Penny, Jesse, House and Outbuildings	3/13/2002	Building	Raleigh
02000499	Turner, John T. and Mary, House	5/16/2002	Building	Raleigh
02000500	Graves, Willis M., House	5/16/2002	Building	Raleigh
02000501	Hall, Rev. Plummer T., House	5/16/2002	Building	Raleigh
02000502	Latta, Rev. M.L., House	5/16/2002	Building	Raleigh
02000496	Hayes Barton Historic District	5/16/2002	District	Raleigh
02000497	Bloomsbury Historic District	5/16/2002	District	Raleigh
02000946	Depot Historic District	9/6/2002	District	Raleigh
03000389	Roanoke Park Historic District	5/9/2003	District	Raleigh
03000391	Vanguard Park Historic District	5/9/2003	District	Raleigh

Ref#	Property Name	Status Date	Category	City
03000929	Occidental Life Insurance Company Building	9/11/2003	Building	Raleigh
03000930	Green, Herman, House	9/11/2003	Building	Raleigh
03001300	West Raleigh Historic District	12/18/2003	District	Raleigh
04001584	Washington Graded and High School	2/2/2005	Building	Raleigh
05000321	Rothstein, Mae and Philip, House	4/15/2005	Building	Raleigh
05000320	Lawrence, Dr. Elmo N., House	4/20/2005	Building	Raleigh
05001449	Blalock, Dr. Nathan M., House	12/23/2005	Building	Raleigh
06000223	Ivey, Rufus J., House	4/5/2006	Building	Raleigh
06000338	Maiden Lane Historic District	5/3/2006	District	Raleigh
06000790	Raleigh Bonded Warehouse	8/24/2006	Building	Raleigh
06000789	Pine Hall	9/6/2006	Building	Raleigh
06001109	Adams--Edwards House	12/6/2006	Building	Raleigh
07000902	Boylan Apartments	9/5/2007	Building	Raleigh
07001412	Fayetteville Street Historic District	2/27/2008	District	Raleigh
08000888	Free Church of the Good Shepherd	9/10/2008	Building	Raleigh
08000889	City Cemetery	9/12/2008	District	Raleigh
08000939	Curtis, William A., House	9/24/2008	Building	Raleigh
08001292	Mount Hope Cemetery	1/8/2009	District	Raleigh
08001388	Welles, Paul and Ellen, House	1/29/2009	Building	Raleigh
08001415	Mary Elizabeth Hospital	2/5/2009	Building	Raleigh
09000661	Carolina Coach Garage and Shop	8/27/2009	Building	Raleigh
10000632	Madonna Acres Historic District	9/1/2010	District	Raleigh
10001098	Harris, Harwell Hamilton and Jean Bangs, House and Office	12/28/2010	Building	Raleigh
10001111	Battery Heights Historic District	1/3/2011	District	Raleigh
10001112	Capitol Heights Historic District	1/3/2011	District	Raleigh
10001113	Longview Gardens Historic District	1/3/2011	District	Raleigh
11000484	Hi-Mount Historic District	7/29/2011	District	Raleigh
11000892	Arndt, G. Dewey and Elma, House	12/7/2011	Building	Raleigh
11000893	Rochester Heights Historic District	12/7/2011	District	Raleigh
11000956	Cameron Village Historic District	12/22/2011	District	Raleigh
14000523	Merrimon--Wynne House	8/25/2014	Building	Raleigh
14001024	Tucker, Garland Scott and Toler Moore, House	12/10/2014	Building	Raleigh
14001025	Wachovia Building Company Contemporary Ranch House	12/10/2014	Building	Raleigh
16000188	Chavis, John, Memorial Park	4/19/2016	District	Raleigh
100000941	O'Kelly, Berry, Historic District	5/11/2017	District	Raleigh
100001634	Depot Historic District (Boundary Increase)	9/21/2017	District	Raleigh
100002930	Oak Grove Cemetery	9/14/2018	Site	Raleigh
100002931	Oberlin Cemetery	9/14/2018	Site	Raleigh

Source: National Parks Service, National Register of Historic Places, October 2018

Housing

The table below details key housing statistics for Raleigh as compared to the County overall.

Table B.8 – Housing Statistics, Raleigh, 2010-2017

Jurisdiction	Housing Units (2010)	Housing Units (2017)	Housing Units Percent Change (2010-2017)	Owner-Occupied, % (2017)	Vacant Units, % (2017)	Median Home Value (2017)
Wake County total	**371,836**	**411,632**	**10.7%**	**59.5%**	**7.2%**	**$250,700**
City of Raleigh	176,124	194,768	10.6%	47.2%	9.2%	$225,000

Source: U.S. Census Bureau 2010 Decennial Census, American Community Survey 2013-2017 5-Year Estimates
Note: Owner-Occupied and vacant-unit measures are reported as a percent of the total number of housing units.

Economy

The following tables present key economic statistics for Raleigh as compared to the County overall.

Table B.9 – Employment Statistics, Raleigh, 2017

Jurisdiction	Population in Labor Force	Percent Employed* (%)	Percent Unemployed* (%)	Percent Not in Labor Force* (%)	Unemployment Rate (%)
Wake County	**564,096**	**67.2**	**3.5**	**29.2**	**4.9**
City of Raleigh	257,228	67.5	3.6	28.8	5.0

Source: U.S. Census Bureau, American Community Survey 2013-2017 5-Year Estimates
Note: This table reports only the civilian labor force. The labor force in armed services accounted for 0.3% or less of the population 16 and over in all jurisdictions. *Population employed, population unemployed, and Population not in labor force are reported as a percent of the total population aged 16 years and older.

Table B.10 – Percent of Employed Population by Occupation, Raleigh, 2017

Occupation	Management, business, science and arts (%)	Service (%)	Sales and Office (%)	Natural Resources, Construction, and Maintenance (%)	Production, transportation, and material moving (%)
Wake County	**50.1**	**13.8**	**23.4**	**6.0**	**6.7**
City of Raleigh	46.2	15.7	24.6	6.0	7.4

Source: U.S. Census Bureau, American Community Survey 2013-2017 5-Year Estimates

B.3 RISK ASSESSMENT

This section contains a hazard profile and vulnerability assessment for those hazards that were rated with a higher priority for the City of Raleigh than for Wake County as a whole. Risk and vulnerability findings are also presented here for those hazards that are spatially defined and have variations in risk that could be evaluated quantitatively on a jurisdictional level. The hazards included in in this section are: Flood and Wildfire.

B.3.1 Flood

Table B.11 details the acreage of the City of Raleigh's total area by flood zone on the effective DFIRM. Per this assessment, about 8 percent of the unincorporated area in the County falls within the mapped 1%-annual-chance floodplains.

Table B.11 – Flood Zone Acreage in the City of Raleigh

Flood Zone	Acreage	Percent of Total (%)
Zone A	101.08	0.09
Zone AE	9265.33	8.03
Zone X (500-year)	1085.68	0.94
Zone X Unshaded	104886.22	90.94
Total	**115338.32**	--

Source: FEMA Effective DFIRM; Wake County GIS

Figure B.3 reflects the effective mapped flood hazard zones for the City of Raleigh, and Figure B.4 displays the depth of flooding estimated to occur in these areas during the 1%-annual-chance flood.

To supplement the IRISK assessment of property at risk from the 1% annual chance flood event in Section 4 and provide a clearer picture of the current property at risk in the City of Raleigh, current parcel data was evaluated to identify parcels developed since 2010. Using GIS analysis, parcels developed after 2010 were compared to the boundaries of the 1% annual chance floodplain to identify the exposure of newly developed property to the base flood. For parcels where updated building footprints were available, the parcel was considered exposed only if the building intersected the floodplain boundary, otherwise, a parcel was considered exposed to the floodplain if any portion of the parcel was located in the floodplain

This assessment does not evaluate flood impacts or provide damage estimates. However, this summary of development in or near the floodplain since 2010 provides some context to understand the degree to which the IRISK exposure and vulnerability numbers differ from current conditions.

Table B.12 provides a summary by land class of parcel development located in the 1% annual chance floodplain from January 2011 to April 2019.

Table B.12 – Parcels Developed 2011 or Later and Located in 100-Year Floodplain, City of Raleigh

Land Class	Number of Parcels	Sum of Building Value
Apartment	9	$197,174,867
Commercial	12	$97,896,588
EXEMPT	12	$58,671,973
Industrial	5	$5,461,158
Part Exempt	1	$541,282
Residential Less Than 10 Acres	86	$31,032,549
Grand Total	**125**	**$390,778,417**

Source: Wake County Open Data; retrieved April 8, 2019; FEMA Effective DFIRM

Table B.13 provides building counts and estimated damages for Critical Infrastructure and Key Resources (CIKR) buildings by sector and flood event in the City of Raleigh. Table B.14 provides counts and estimated damages for High Potential Loss Properties in the City of Raleigh.

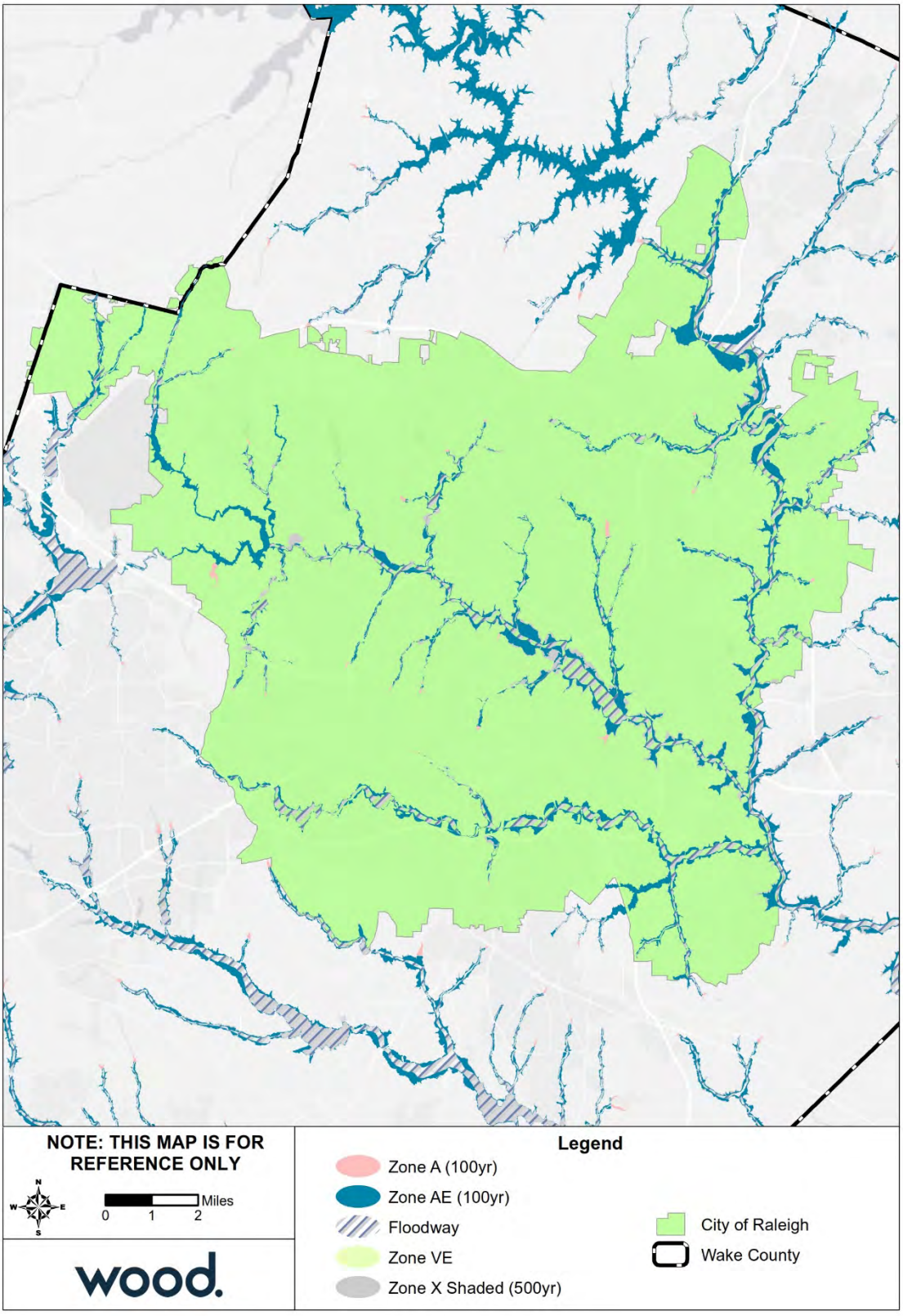
Table B.13 – Critical Facilities Exposed to Flooding, City of Raleigh

Sector	Event	Number of Buildings at Risk	Estimated Damages
Banking and Finance	100 Year	4	$1,433,067
	Floodway	1	$48,447
Commercial Facilities	100 Year	156	$156,539,970
	Floodway	45	$7,918,573
Critical Manufacturing	100 Year	8	$960,696
	Floodway	3	$255,246
Government Facilities	100 Year	5	$259,852
	Floodway	1	$64,062
Transportation Systems	100 Year	3	$2,003,605
All Categories	**100 Year**	**176**	**$161,197,190**
	Floodway	**50**	**$8,286,328**

Table B.14 – High Potential Loss Properties Exposed to Flooding, City of Raleigh

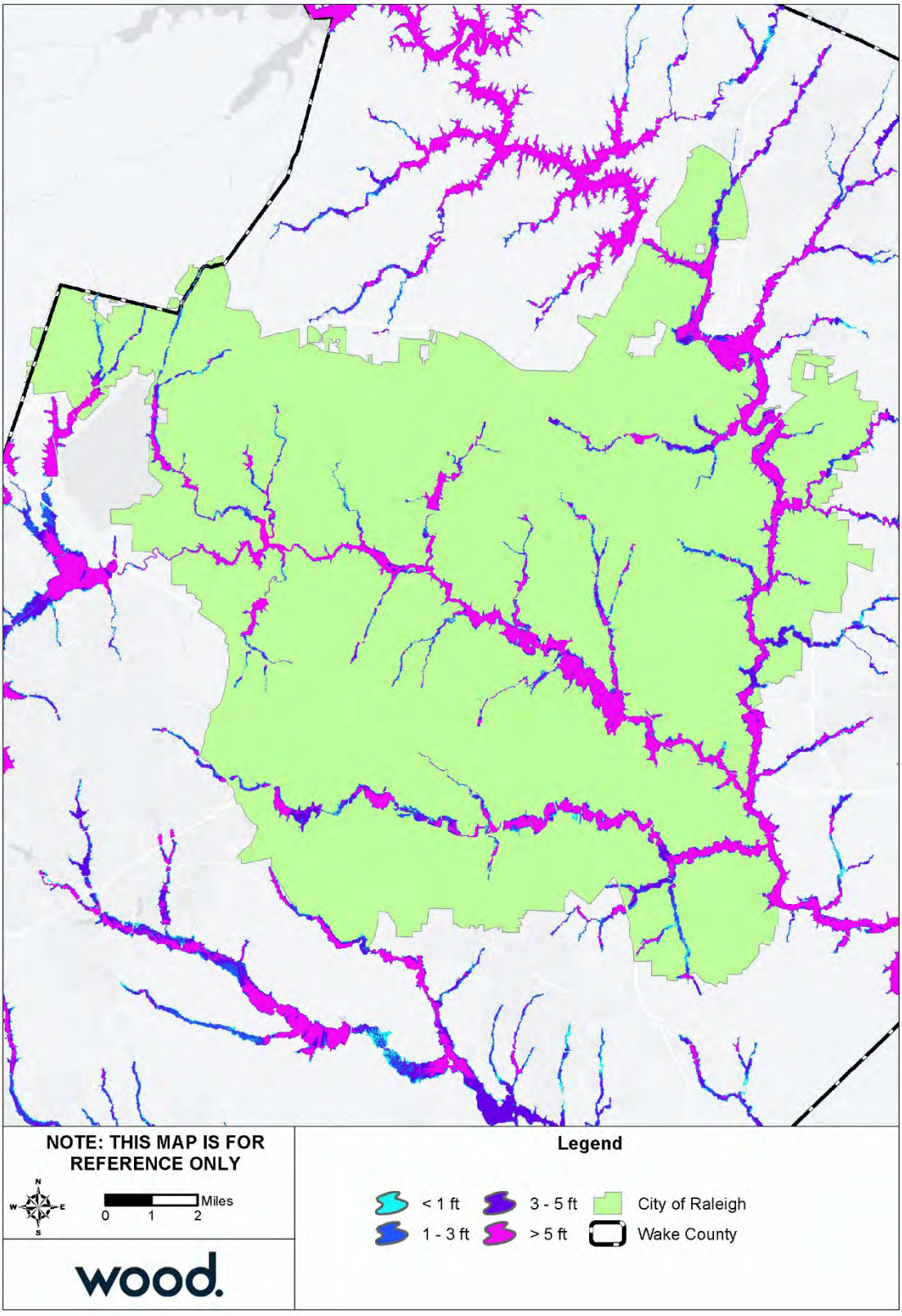
Category	Event	Number of Buildings at Risk	Estimated Damages
Commercial	100 Year	25	$148,719,520
	Floodway	5	$2,652,525
Residential	100 Year	11	$3,331,354
	Floodway	2	$1,349,353
All Categories	**100 Year**	**36**	**$152,050,874**
	Floodway	**7**	**$4,001,878**

Figure B.3 – FEMA Flood Hazard Areas, City of Raleigh



Source: FEMA Effective DFIRM

Figure B.4 – Flood Depth, 1%-Annual Chance Floodplain, City of Raleigh



Source: FEMA Effective DFIRM

B.3.2 Wildfire

Table B.15 summarizes the acreage in the City of Raleigh that falls within the Wildland Urban Interface (WUI), categorized by housing density. Areas in the WUI are those where development may intermix with flammable vegetation. 18 percent of the City of Raleigh is not included in the WUI.

Table B.15 – Wildland Urban Interface Acreage, City of Raleigh

	Housing Density	Total Acreage	Percent of Total Acreage
	Not in WUI	*20,688.0*	*18.0%*
	LT 1hs/40ac	4,359.1	3.8%
	1hs/40ac to 1hs/20ac	2,579.8	2.2%
	1hs/20ac to 1hs/10ac	3,549.9	3.1%
	1hs/10ac to 1hs/5ac	4,720.0	4.1%
	1hs/5ac to 1hs/2ac	8,663.3	7.5%
	1hs/2ac to 3hs/1ac	54,281.6	47.2%
	GT 3hs/1ac	16,195.1	14.1%
	Total	115,066.8	

Source: Southern Wildfire Risk Assessment

Figure B.5 depicts the WUI for the City of Raleigh. The WUI is the area where housing development is built near or among areas of vegetation that may be prone to wildfire. Figure B.6 depicts the Fire Intensity Scale, which indicates the potential severity of fire based on fuel loads, topography, and other factors. Figure B.7 depicts Burn Probability based on landscape conditions, percentile weather, historical ignition patterns, and historical prevention and suppression efforts.

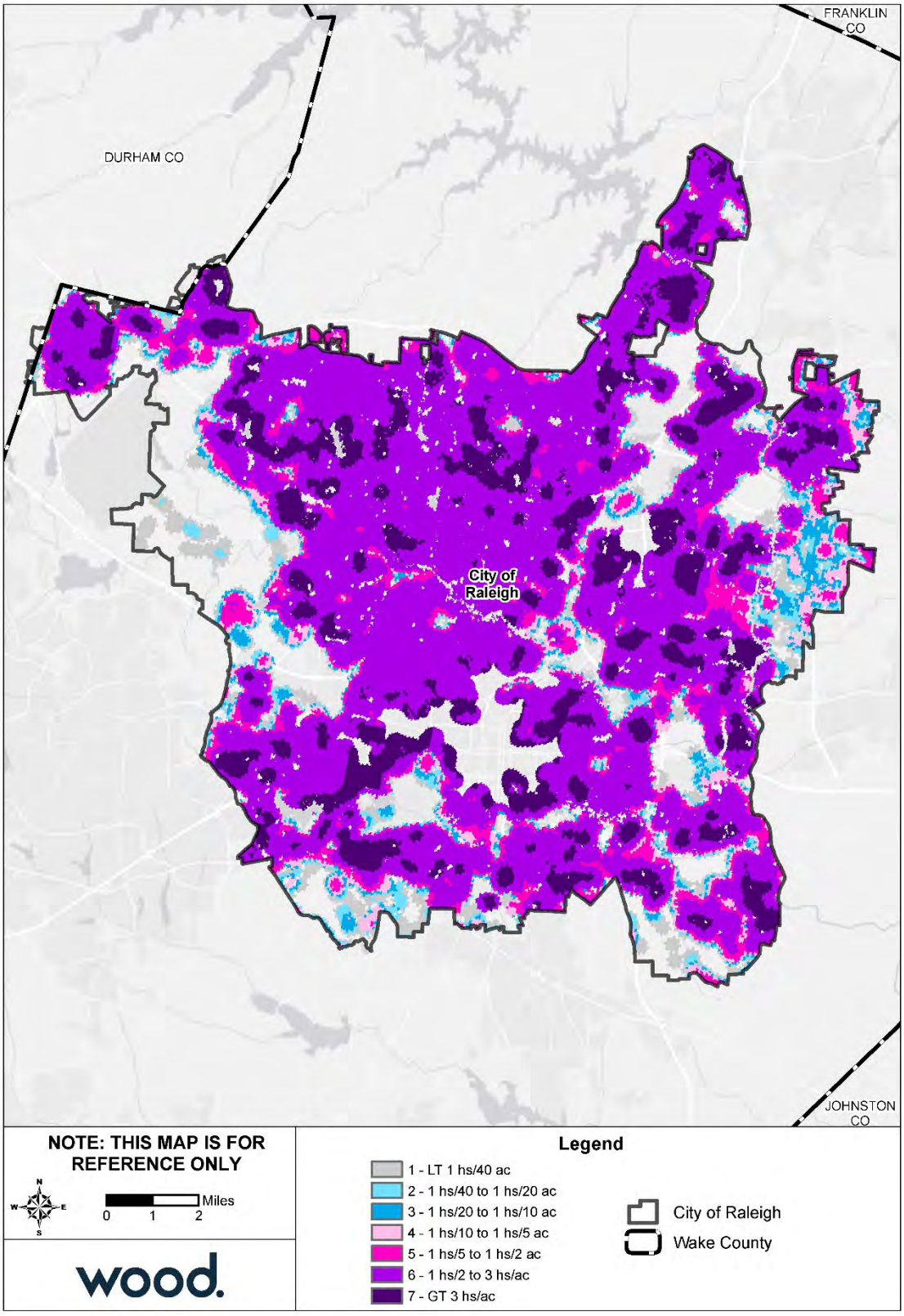
Potential fire intensity is highest on the western border of the City of Raleigh; however, this area has lower burn probability and is largely outside of the WUI, meaning little to no development is at risk. The City of Raleigh overall has relatively low burn probability – the highest being in the southwest, although much of this area is outside of the WUI.

Table B.16 provides building counts and estimated damages for Critical Infrastructure and Key Resources (CIKR) buildings by sector at risk to wildfire hazard.

Table B.16 – Critical Facilities Exposed to Wildfire, City of Raleigh

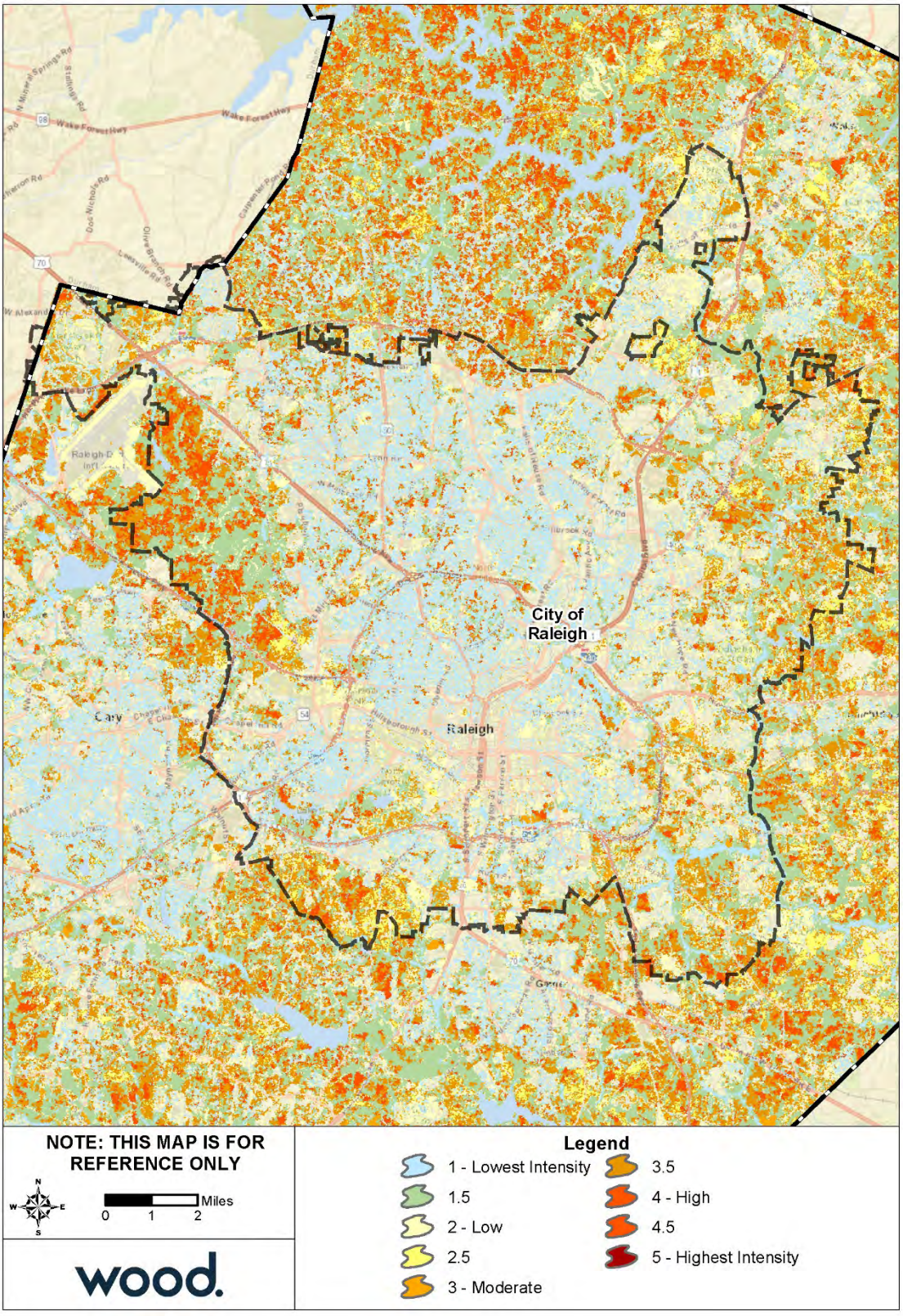
Sector	Event	Number of Buildings at Risk	Estimated Damages
Transportation Systems	Wildfire Hazard	2	$381,965
All Categories	**Wildfire Hazard**	**2**	**$381,965**

Figure B.5 – Wildland Urban Interface, City of Raleigh



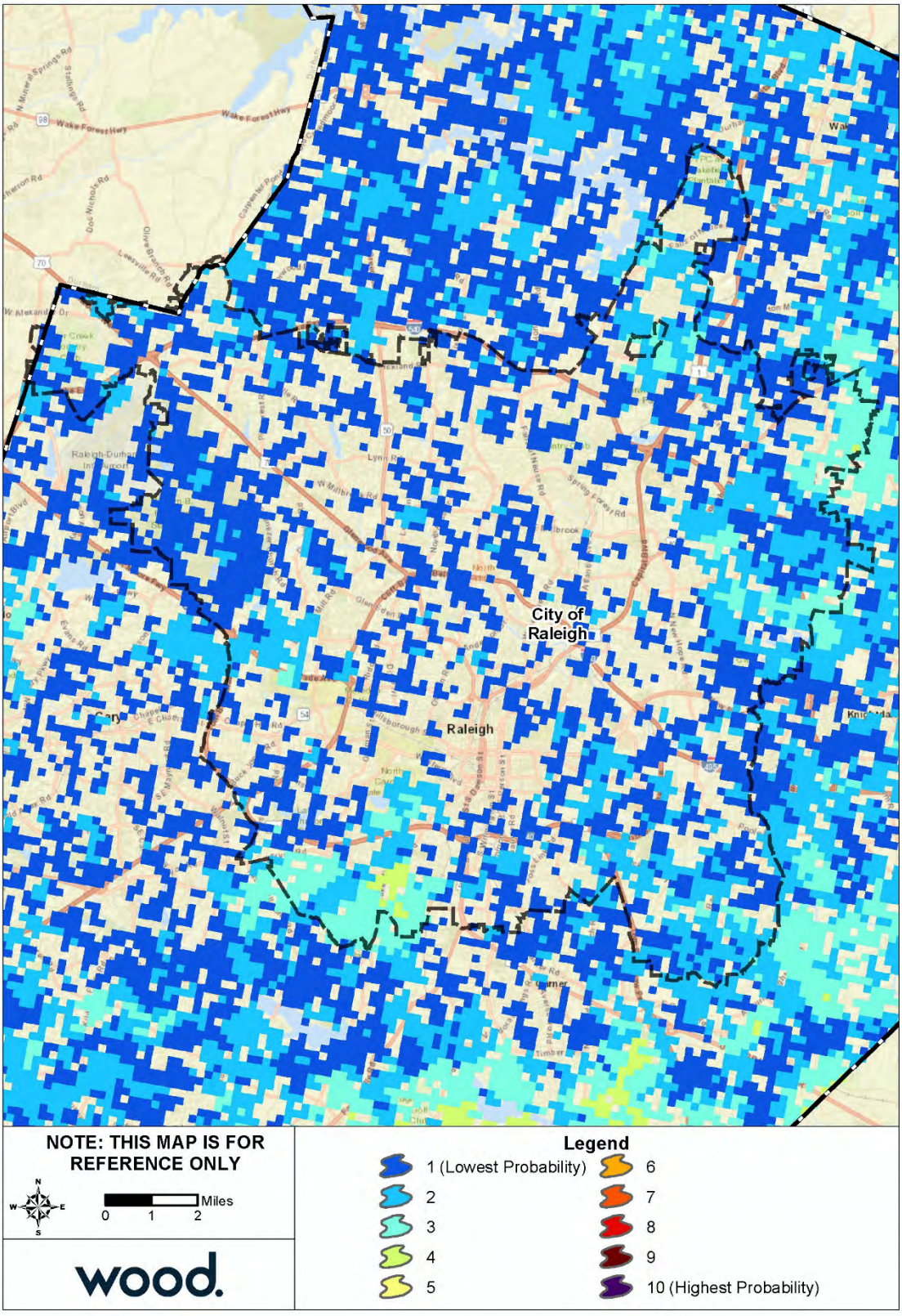
Source: Southern Wildfire Risk Assessment

Figure B.6 – Fire Intensity Scale, City of Raleigh



Source: Southern Wildfire Risk Assessment

Figure B.7 – Burn Probability, City of Raleigh



Source: Southern Wildfire Risk Assessment

B.4 CAPABILITY ASSESSMENT

B.4.1 Overall Capability

Details on the tools and resources in place and available to the City of Raleigh were provided by the City's HMPC representatives and are summarized in Section 5 Capability Assessment. Based on that information and using the scoring methodology detailed in that section, Raleigh has an overall capability rating of High. The City's Self-Assessment of key capability areas is summarized in Table B.17 below.

Table B.17 – Capability Self-Assessment, Raleigh

Capability Area	Rating
Plans, Ordinances, Codes and Programs	High
Administrative and Technical Capability	High
Fiscal Capability	High
Education and Outreach Capability	High
Mitigation Capability	High
Political Capability	High
Overall Capability	High

B.4.2 Floodplain Management

The City of Raleigh joined the NFIP emergency program in 1973 and has been a regular participant in the NFIP since August 1978. The following tables reflect NFIP policy and claims data for the City categorized by structure type, flood zone, Pre-FIRM and Post-FIRM.

Table B.18 – NFIP Policy and Claims Data by Structure Type

Structure Type	Number of Policies in Force	Total Premium	Insurance in Force	Number of Closed Paid Losses	Total of Closed Paid Losses
Single Family	1,452	$778,623	$398,477,500	443	$5,223,294.75
2-4 Family	78	$54,834	$12,871,300	69	$2,068,949.87
All Other Residential	246	$336,722	$68,078,200	97	$3,804,074.58
Non-Residential	169	$665,212	$72,437,400	245	$12,440,828.93
Total	1,945	$1,835,391	$551,864,400	854	$23,537,148.13

Source: FEMA Community Information System, accessed November 2018

Table B.19 – NFIP Policy and Claims Data by Flood Zone

Flood Zone	Number of Policies in Force	Total Premium	Insurance in Force	Number of Closed Paid Losses	Total of Closed Paid Losses
A01-30 & AE Zones	762	$1,317,146	$215,609,800	552	$17,138,041.13
A Zones	14	$13,926	$2,421,900	19	$902,450.88
AO Zones	0	$0	$0	0	$0.00
AH Zones	0	$0	$0	0	$0.00
AR Zones	0	$0	$0	0	$0.00
A99 Zones	0	$0	$0	0	$0.00
V01-30 & VE Zones	0	$0	$0	0	$0.00
V Zones	0	$0	$0	0	$0.00
D Zones	0	$0	$0	0	$0.00

Flood Zone	Number of Policies in Force	Total Premium	Insurance in Force	Number of Closed Paid Losses	Total of Closed Paid Losses
B, C & X Zone					
Standard	79	$97,728	$17,072,700	110	$3,994,871.47
Preferred	1,090	$406,591	$316,760,000	130	$1,347,167.04
Total	1,945	$1,835,391	$551,864,400	811	$23,382,530.52

Source: FEMA Community Information System, accessed November 2018

Table B.20 – NFIP Policy and Claims Data Pre-FIRM

Flood Zone	Number of Policies in Force	Total Premium	Insurance in Force	Number of Closed Paid Losses	Total of Closed Paid Losses
A01-30 & AE Zones	259	$911,803	$70,492,500	452	$15,857,154.78
A Zones	1	$1,497	$250,000	14	$655,980.79
AO Zones	0	$0	$0	0	$0.00
AH Zones	0	$0	$0	0	$0.00
AR Zones	0	$0	$0	0	$0.00
A99 Zones	0	$0	$0	0	$0.00
V01-30 & VE Zones	0	$0	$0	0	$0.00
V Zones	0	$0	$0	0	$0.00
D Zones	0	$0	$0	0	$0.00
B, C & X Zone	342	$157,915	$96,763,900	150	$2,964,790.14
Standard	24	$34,624	$4,763,900	62	$1,964,515.02
Preferred	318	$123,291	$92,000,000	88	$1,000,275.12
Total	602	$1,071,215	$167,506,400	616	$19,477,925.71

Source: FEMA Community Information System, accessed November 2018

Table B.21 – NFIP Policy and Claims Data Post-FIRM

Flood Zone	Number of Policies in Force	Total Premium	Insurance in Force	Number of Closed Paid Losses	Total of Closed Paid Losses
A01-30 & AE Zones	503	$405,343	$145,117,300	98	$1,270,586.35
A Zones	13	$12,429	$2,171,900	5	$246,470.09
AO Zones	0	$0	$0	0	$0.00
AH Zones	0	$0	$0	0	$0.00
AR Zones	0	$0	$0	0	$0.00
A99 Zones	0	$0	$0	0	$0.00
V01-30 & VE Zones	0	$0	$0	0	$0.00
V Zones	0	$0	$0	0	$0.00
D Zones	0	$0	$0	0	$0.00
B, C & X Zone	827	$346,404	$237,068,800	90	$2,377,248.37
Standard	55	$63,104	$12,308,800	48	$2,030,356.45
Preferred	772	$283,300	$224,760,000	42	$346,891.92
Total	1,343	$764,176	$384,358,000	193	$3,894,304.81

Source: FEMA Community Information System, accessed November 2018

B.5 MITIGATION STRATEGY

City of Raleigh											
Action #	**Description**	**Goal**	**Objective**	**Hazard(s) Addressed**	**Relative Priority**	**Lead Agency/ Department**	**Estimated Cost**	**Potential Funding Sources**	**Implementation Schedule**	**2019 Status**	**Status Comments/Explanation**
Prevention											
P-1	Establish a Lake Preservation Policy that encourages private property owners to preserve existing lakes and ponds, and in certain circumstances provides for public assistance.	4	1	Flood	Moderate	Raleigh Engineering Services	$100,000 - $1m	Local	1 year	In-Progress – Carry Forward	City Stormwater has also worked with the Stormwater Management Advisory Commission to develop recommendations to further enhance the lake preservation program. It is anticipated that the revised program will be considered by City Council during calendar year 2019. Enhancements would include the continued ability to restore and upgrade dams and spillways associated with safety improvements as well as removal of dams to protect safety and restore natural conditions
P-2	Develop ongoing multi-year program of detailed basin studies for each watershed in City's jurisdiction. Fifteen basin studies are complete with 10 additional studies budgeted in the capital program. (CRS 410).	2	2	Flood	Moderate	Raleigh Engineering Services	$100,000 - $1m	Local	1 year	In-Progress – Carry Forward	City Stormwater is currently working on an Integrated Stormwater Management Master Plan. Basin studies will be reviewed and updated as needed with further improvement needs and opportunities identified and prioritized. Reduction of flooding hazards remains a key priority for improvement projects.
P-3	Planning Commission to consider program to develop future conditions floodplain mapping for all FEMA mapped areas (this is already done for non-FEMA mapped areas). The program would consist of a multi-year capital program for mapping for all FEMA streams in the ETJ and consideration of changes to development regulations in these areas. Future conditions would be based on expected development per the Comprehensive Plan and zoning maps.	4	2	Flood	Moderate	Raleigh Engineering Services	$100,000 - $1m	Local	3-5 years	In-Progress – Carry Forward	The preliminary maps that have all FEMA floodplain in the city studied for future conditions. Our ordinance is already set up to enforce these areas. Once the maps are effective this effort will be complete.
P-4	Reallocation of Falls Lake water conservation pool; increased available storage for water supply by 4.1B gallons	2	1	Drought	High	Public Utilities Department	No cost	N/A	Ongoing - Next 5 years	New	N/A
P-5	Implementation of a regional mutual aid contract between local water utilities which would describe how the utilities would provide assistance if a partner utility experienced a water shortage	2	2	Drought	High	Public Utilities Department	Variable - depends on volume of water transferred between systems	Public Utilities Dept	Ongoing - Next 5 years	New	N/A
P-6	Develop a written Resiliency Plan for City of Raleigh operations and services, including infrastructure resilience, community resilience, ecosystem resilience and governance resilience.	4	1	All	High	Office of Sustainability	Less than $100,000	Unknown	2-3 years	New	N/A
P-7	Water Shortage Response Plan which uses a hydrologic model (OASIS) to establish risk based drought triggers that are designed to reduce water demand before severe drought conditions and also when to exit drought triggers when conditions improve.	2	2	Drought	Moderate	Public Utilities Department	No cost	N/A	Ongoing - Next 5 years	New	N/A
P-8	Update and maintain GIS data of building footprints, parcels, and critical facilities, and use it to regularly identify buildings in need of mitigation.	2	2	All	Moderate	Raleigh Information Technology, GIS staff	Staff time	Local	Ongoing - Next 5 years	New	Updated data will be used in future plan updates and risk assessments and to identify properties that should be prioritized for mitigation.
Property Protection											
PP-1	Develop ongoing program designed to utilize Federal grant resources to assist private property owners in relocating existing structures out of flood hazard zones. (CRS 500/510/520)	3	2	Flood	Moderate	Raleigh Engineering Services	$100,000 - $1m	Local, Federal	3-5 years	In-Progress – Carry Forward	The city is cataloging potential candidates for relocation based on our current repetitive loss list. Staff has developed a scoring system based on cost benefit for relocation.

City of Raleigh											
Action #	**Description**	**Goal**	**Objective**	**Hazard(s) Addressed**	**Relative Priority**	**Lead Agency/ Department**	**Estimated Cost**	**Potential Funding Sources**	**Implementation Schedule**	**2019 Status**	**Status Comments/Explanation**
PP-2	Develop an ongoing program designed to utilize Federal grant resources to assist private property owners in elevating existing structures located within flood hazard zones. (CRS 510/530)	3	2	Flood	Moderate	Raleigh Engineering Services	$100,000 - $1m	Local, Federal	3-5 years	In-Progress – Carry Forward	To further this initiative, the city is cataloging potential candidates for relocation based on our current repetitive loss list. Staff has developed a scoring system based on cost benefit for relocation that would compare the projects to relocation and retrofits.
PP-3	Develop an ongoing program designed to utilize Federal grant resources to assist private property owners in renovating and retrofitting existing structures in flood hazard zones to reduce vulnerability to flooding damage.	3	2	Flood	Moderate	Raleigh Engineering Services	$100,000 - $1m	Local, Federal	Ongoing – next 5 years	In-Progress – Carry Forward	City staff evaluates potential candidates and approaches property owners for mitigation help.
PP-4	Program to install emergency electrical generators at all public utility facilities. Current focus on redundant generators at critical facilities, second fuel truck and completion of 100% generator coverage in Garner area.	3	1	All	High	Raleigh Public Utilities	$100,000 - $1m	Local	2-3 years	In-Progress – Carry Forward	We now have emergency backup power generators at all our critical facilities except for our South Raleigh Operations Facility. However, we can relocate supplies, material and teams to any of our other facilities per our emergency operational planning. Also, per our Hurricane Florence AAR we are conducting emergency fuel capacity studies for our generators at our largest wastewater treatment plant and both our water treatment plants. A fuel truck is not in the works but we have emergency fuel contracts with Red Star and also exploring dual use of natural gas to power some of our energy resiliency to give us an added layer.
Structural Projects											
SP-1	Install cameras in flood prone areas throughout the City of Raleigh to allow us to view these locations and make informed decisions as it relates to flooding	2	2	Flood, Hurricane	Moderate	City of Raleigh Transportation	$100,000 to $1m	Unknown	3-5 years	New	N/A
Emergency Services											
ES-1	Provide and enhance technical rescue capabilities more equitably throughout the City.	2	1	Dam Failure, Flood, Hurricane, Severe Weather, Severe Winter Storm, Tornado, Wildfire	High	Raleigh Fire	$100,000 - $1m	Local	2-3 years	In-Progress – Carry Forward	We continually look at our technical rescue capabilities and adjust as needed. The initiative to add 1 Heavy Rescue and 2 Squads has been completed. Additionally, we've added 1 company (12 personnel) to the team, upgraded water rescue equipment, increased water rescue certified personnel from 20 to 60, required 100% of members be Technical Rescuer and Vehicle Extrication certified and are working toward 100% certification for all members in all the other technical rescue disciplines.
ES-2	Provide after-action report of emergency response to severe weather events in order to improve planning for future disasters.	2	2	Hurricane, Severe Weather, Severe Winter Storm, Tornado	High	Raleigh Fire and Emergency Management	$100,000 - $1m	Local	Ongoing- Post Event	In-Progress – Carry Forward	After-action report made for Hurricane Florence and will continue to be made for all subsequent weather events.
ES-3	Maintain a standard operating guideline to direct operational planning prior to anticipated weather emergencies.	2	1	All	High	Raleigh Fire and Emergency Management	$100,000 - $1m	Local	Ongoing – next 5 years	In-Progress – Carry Forward	The City's Emergency Operation Plan outlines our standard operating guidelines and has been adopted as an official document used prior to and during weather emergencies.
ES-4	Design GIS programming capable of providing real-time data to emergency managers and historic data for future emergency response planning.	2	2	All	High	Raleigh City Manager and Information Technology	$100,000 - $1m	Local	3-5 year	In-Progress – Carry Forward	The IT Department led a citywide effort to develop a Situational Analysis Smart Dashboard for the Emergency Operations Center and refined it in real time as new types of data, such as current wind speed, were identified as critical to the safety of the public and city workers during an emergency. The Smart Dashboard was first deployed for Hurricane Florence. The dashboard is cross-departmental, with real-time progress tracking, covering a range of emergency management issues from debris in streets and closures, malfunctioning traffic signals, flood monitoring and 911 call data.

City of Raleigh											
Action #	**Description**	**Goal**	**Objective**	**Hazard(s) Addressed**	**Relative Priority**	**Lead Agency/ Department**	**Estimated Cost**	**Potential Funding Sources**	**Implementation Schedule**	**2019 Status**	**Status Comments/Explanation**
ES-5	Continue to conduct disaster tabletop exercise program.	2	1	All	Low	Raleigh Public Utilities, Fire, Police, City Manager, Emergency Management, and Engineering Services	$100,000 - $1m	Local	Ongoing – next 5 years	In-Progress – Carry Forward	Tabletop disaster exercises continue to occur with all EOC partners prior to the anticipated peak of hurricane season. These trainings take place each year to ensure staff are comfortable in their EOC roles and to handle staff turnover.
ES-6	Establish cross-functional team to develop Debris Management Plan. Team should work to identify and prepare additional debris management sites.	2	1	Flood, Tornado, Earthquake, Severe Winter Storm, Severe Weather, Hurricane	Moderate	City of Raleigh Transportation	$100,000	FEMA, City of Raleigh general fund support	1 year	New	N/A
Public Education and Awareness											
PEA-1	Utilize existing Everbridge advisory software to issue Heat Advisory Alerts targeted to vulnerable neighborhoods	1	2	Extreme Heat	High	Communications/ Sustainability	Less than $100,000	COR Operating Funds	2-3 years	New	N/A

Annex C Town of Apex

C.1 PLANNING PROCESS

The table below lists the HMPC members who represented the Town of Apex.

Table C.1 – HMPC Members

Agency	Representative	Position or Title
Planning Department	Shelly Mayo	Planner
Planning Department	Dianne Khin	Planning Director
N/A	Jim Scarborough	Citizen Stakeholder

C.2 COMMUNITY PROFILE

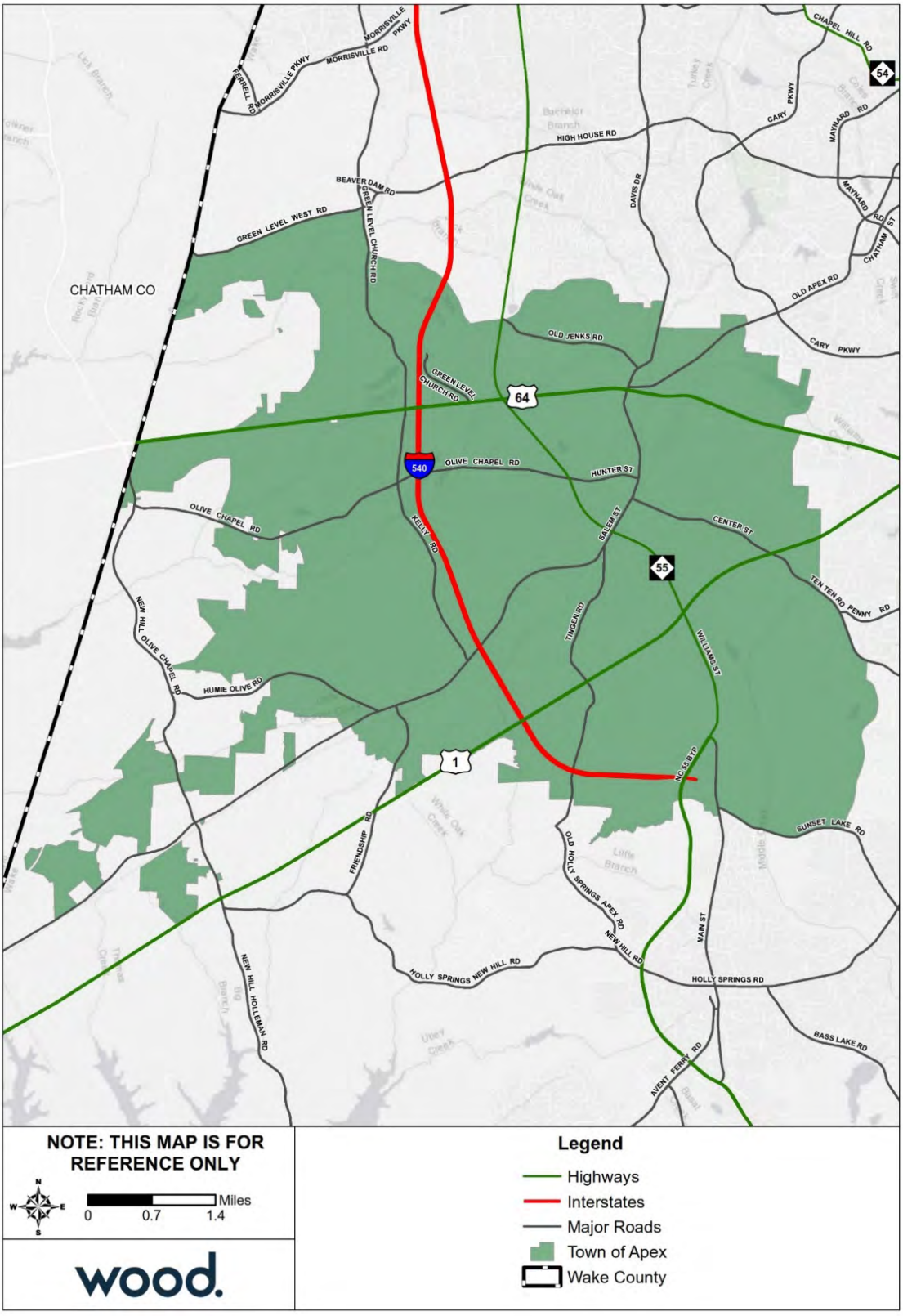
Geography

The Town of Apex is located in southwestern Wake County. It is neighbored by Cary to the north and northeast and Holly springs to the south. The Town is part of the Raleigh, NC Metropolitan Statistical Area, which falls within the larger Raleigh-Durham-Chapel Hill, NC Combined Statistical Area. Apex comprises a total land area of 23.4 square miles.

According to data from the U.S. Fish and Wildlife Service's National Wetlands Inventory, there are approximately 2,695 acres of wetlands in Apex.

Figure C.1 shows a base map of the major transportation routes in the Town of Apex.

Figure C.1 – Major Transportation Routes, Town of Apex



Source: Wake County GIS Open Data

Population and Demographics

Table C.2 provides population counts and growth estimates for the Town of Apex as compared to the County overall. Table C.3 provides demographic information for Raleigh as compared to the whole County.

Table C.2 – Population Counts, Apex, 2010-2017

Jurisdiction	2000 Census Population	2010 Census Population	2017 ACS Population Estimate	Total Change 2010-2017	% Change 2010-2017
Wake County total	**627,846**	**900,993**	**1,023,811**	**122,818**	**13.6%**
Town of Apex	20,212	37,476	45,899	8,423	22.5%

Source: US Census Bureau Decennial Census 2000, Decennial Census 2010; American Community Survey 2013-2017 5-Year Estimates

Table C.3 – Racial Demographics, Apex, 2017

Jurisdiction	White, %	Black, %	Asian, %	Other Race, %	Two or More Races, %	Persons of Hispanic or Latino Origin*, %
Wake County total	**66.5%**	**20.4%**	**6.5%**	**3.6%**	**2.7%**	**10.0%**
Town of Apex	79.3%	8.6%	7.4%	1.5%	2.9%	7.3%

Source: US Census Bureau, American Community Survey 2013-2017 5-Year Estimates
*Persons of Hispanic origin may be of any race, so also are included in applicable race categories

Asset Inventory

The following tables summarize the asset inventory for Apex in order to estimate the total physical exposure to hazards in the jurisdiction. The locations of critical facilities are shown in Figure C.2 on the following page. Critical facilities are a subset of identified assets from the Critical Infrastructure & Key Resources dataset. Note that the counts are by building; where a critical facility comprises a cluster of buildings, each building is counted.

Table C.4 – Critical Infrastructure & Key Resources by Type

Jurisdiction	Food & Agriculture	Banking & Finance	Chemical	Commercial Facilities	Communications	Manufacturing	Defense	Government	Healthcare	IT	National Monuments	Nuclear	Postal & Shipping	Transportation	Energy	Emergency Services	Water	Other	Total
Town of Apex	75	14	0	302	0	225	1	91	27	0	0	0	0	59	0	2	0	0	**796**

Source: NCEM Risk Management Tool

Table C.5 – High Potential Loss Facilities by Use

Jurisdiction	Residential	Commercial	Industrial	Government	Agricultural	Religious	Utilities	Other	Total
Town of Apex	71	76	50	19	0	16	0	0	**232**

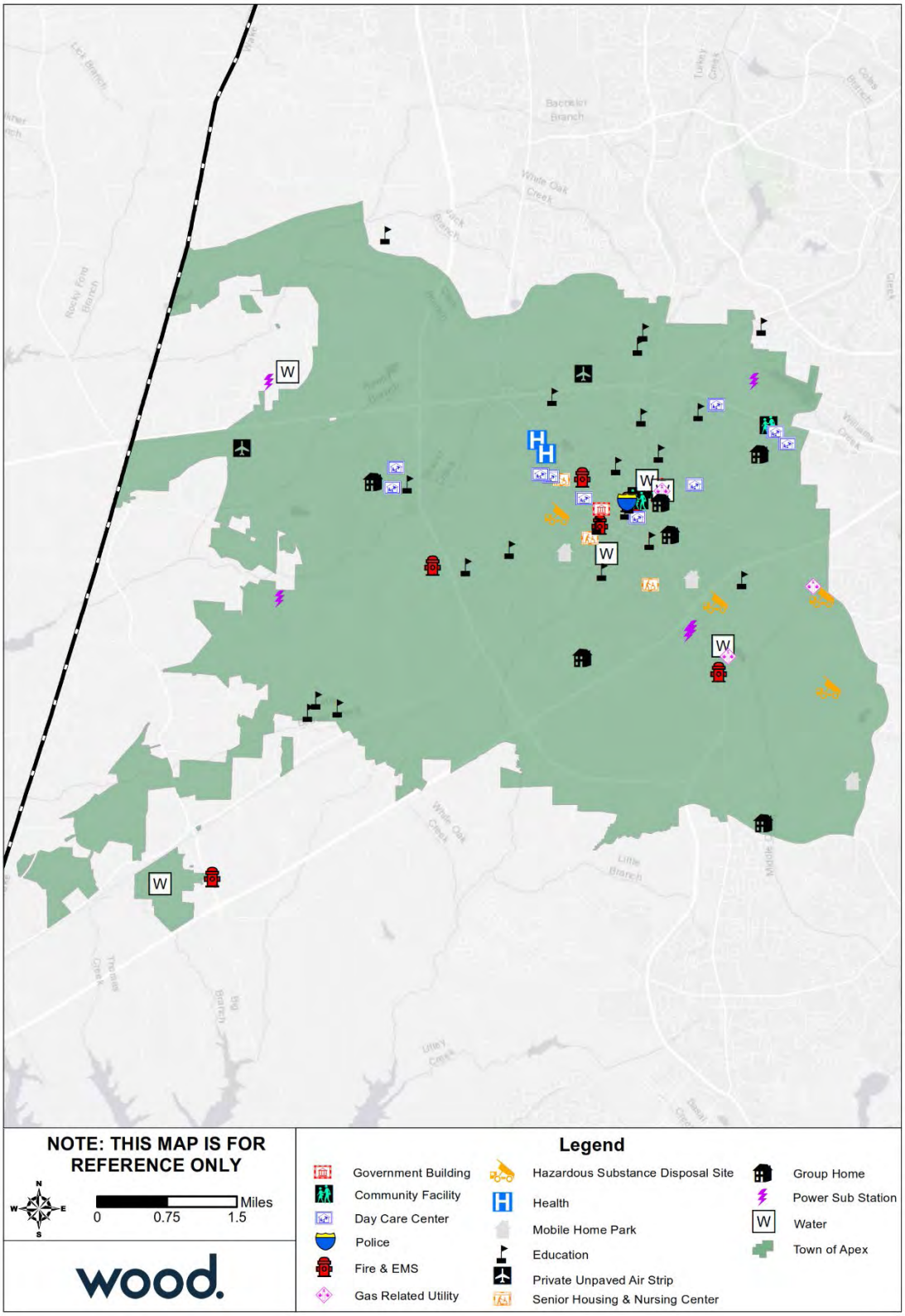
Source: NCEM Risk Management Tool

To supplement the NCEM IRISK database information on critical facilities and account for significant new development, the Town of Apex provided GIS datasets on critical facilities, schools, and other key assets. The additional facilities not already accounted for in Table C.4 are listed below. These facilities are displayed in Figure C.2 along with those identified in IRISK.

Table C.6 – Supplemental Critical Facilities List

Facility Type	Count
Community Facility	4
Day Care Center	10
Electrical Substation	5
Fire/Police/EMS	6
Gas Pressure Station	1
Gas Terminal	2
Government Building	1
Group Home	6
Hazardous Substance Disposal Site	4
Health Facility	1
Hospital	1
Mobile Home Park	3
Preschool	3
Private Unpaved Air Strip	2
School	10
Senior Housing/Nursing Center	3
Water Facility	6
Grand Total	**68**

Figure C.2 – Critical Facilities, Town of Apex



Source: NCEM IRISK Database, GIS Analysis

To supplement the asset inventory and provide a clearer picture of the current asset exposure in the Town of Apex, current parcel data was evaluated to identify development since 2010. This information is not incorporated into the risk assessment, which was prepared using NCEM's IRISK database. However, this summary of development since 2010 provides some context to understand the degree to which the IRISK exposure and vulnerability numbers differ from current conditions.

Table C.6 provides a summary by land class of parcel development from January 2011 to April 2019.

Table C.7 – Parcels Developed 2011 or Later, Town of Apex

Land Class	Number of Parcels	Sum of Building Value
Acres Greater Than 10 With House	5	$2,500,898
Agriculture	1	$196,703
Apartment	7	$93,911,496
Commercial	34	$76,087,487
Condo Complex	7	-
EXEMPT	14	$112,104,783
HOA	10	-
Industrial	16	$19,628,010
Part Exempt	36	$9,941,184
Residential Less Than 10 Acres	4,885	$1,391,100,016
Vacant	2	-
Grand Total	**5,011**	**$1,705,470,577**

Source: Wake County Open Data; retrieved April 8, 2019

There are seven listings on the National Register of Historic Places for the Town of Apex, including three historic districts. These sites are listed in the table below.

Table C.8 – Historic Properties

Ref#	Property Name	Status Date	Category	City
85003077	The Halle Building (f.k.a Historic Apex Town Hall)	12/5/1985	Building	Apex
88002697	Apex Union Depot	12/1/1988	Building	Apex
94000185	Apex Historic District	3/17/1994	District	Apex
95000210	Apex Historic District (Boundary Increase)	3/10/1995	District	Apex
02000016	Apex Historic District (Boundary Increase)	2/14/2002	District	Apex
07001502	Apex Historic District (Boundary Increase II)	1/31/2008	District	Apex
08000937	Lawrence, Calvin Wray, House	9/23/2008	Building	Apex

Source: National Parks Service, National Register of Historic Places, October 2018

Housing

The table below details key housing statistics for Apex as compared to the County overall.

Table C.9 – Housing Statistics, Apex, 2010-2017

Jurisdiction	Housing Units (2010)	Housing Units (2017)	Housing Units Percent Change (2010-2017)	Owner-Occupied, % (2017)	Vacant Units, % (2017)	Median Home Value (2017)
Wake County total	**371,836**	**411,632**	**10.7%**	**59.5%**	**7.2%**	**$250,700**
Town of Apex	13,922	16,883	21.3%	68.9%	4.2%	$289,300

Source: U.S. Census Bureau 2010 Decennial Census, American Community Survey 2013-2017 5-Year Estimates
Note: Owner-Occupied and vacant-unit measures are reported as a percent of the total number of housing units.

Economy

The following tables present key economic statistics for Apex as compared to the County overall.

Table C.10 – Employment Statistics, Apex, 2017

Jurisdiction	Population in Labor Force	Percent Employed* (%)	Percent Unemployed* (%)	Percent Not in Labor Force* (%)	Unemployment Rate (%)
Wake County	**564,096**	**67.2**	**3.5**	**29.2**	**4.9**
Town of Apex	25,403	72.5	3.0	24.5	3.9

Source: U.S. Census Bureau, American Community Survey 2013-2017 5-Year Estimates
Note: This table reports only the civilian labor force. The labor force in armed services accounted for 0.3% or less of the population 16 and over in all jurisdictions. *Population employed, population unemployed, and Population not in labor force are reported as a percent of the total population aged 16 years and older.

Table C.11 – Percent of Employed Population by Occupation, Apex, 2017

Occupation	Management, business, science and arts (%)	Service (%)	Sales and Office (%)	Natural Resources, Construction, and Maintenance (%)	Production, transportation, and material moving (%)
Wake County	**50.1**	**13.8**	**23.4**	**6.0**	**6.7**
Town of Apex	57.2	11.4	22.6	4.8	4.0

Source: U.S. Census Bureau, American Community Survey 2013-2017 5-Year Estimates

C.3 RISK ASSESSMENT

This section contains a hazard profile and vulnerability assessment for those hazards that were rated with a higher priority for the Town of Apex than for Wake County as a whole. Risk and vulnerability findings are also presented here for those hazards that are spatially defined and have variations in risk that could be evaluated quantitatively on a jurisdictional level. The hazards included in this section are: Flood and Wildfire.

C.3.1 Flood

Table C.11 details the acreage of the Town of Apex total area by flood zone on the effective DFIRM. Per this assessment, over 4 percent of the Town of Apex falls within the mapped 1%-annual-chance floodplains.

Table C.12– Flood Zone Acreage in the Town of Apex

Flood Zone	Acreage	Percent of Total (%)
Zone A	15.59	0.07
Zone AE	995.67	4.22
Zone X (500-year)	27.7	0.12
Zone X Unshaded	22,556.33	95.60
Total	**23,595.29**	**--**

Source: FEMA Effective DFIRM; Wake County GIS

Figure C.3 reflects the effective mapped flood hazard zones for the Town of Apex, and Figure C.4 displays the depth of flooding estimated to occur in these areas during the 1%-annual-chance flood.

To supplement the IRISK assessment of property at risk from the 1% annual chance flood event in Section 4 and provide a clearer picture of the current property at risk in the Town of Apex, current parcel data was evaluated to identify parcels developed since 2010. Using GIS analysis, parcels developed after 2010 were compared to the boundaries of the 1% annual chance floodplain to identify the exposure of newly

developed property to the base flood. In most cases, a parcel was considered exposed to the floodplain if any portion of the parcel was located in the floodplain.

This assessment does not evaluate flood impacts or provide damage estimates. However, this summary of development in or near the floodplain since 2010 provides some context to understand the degree to which the IRISK exposure and vulnerability numbers differ from current conditions.

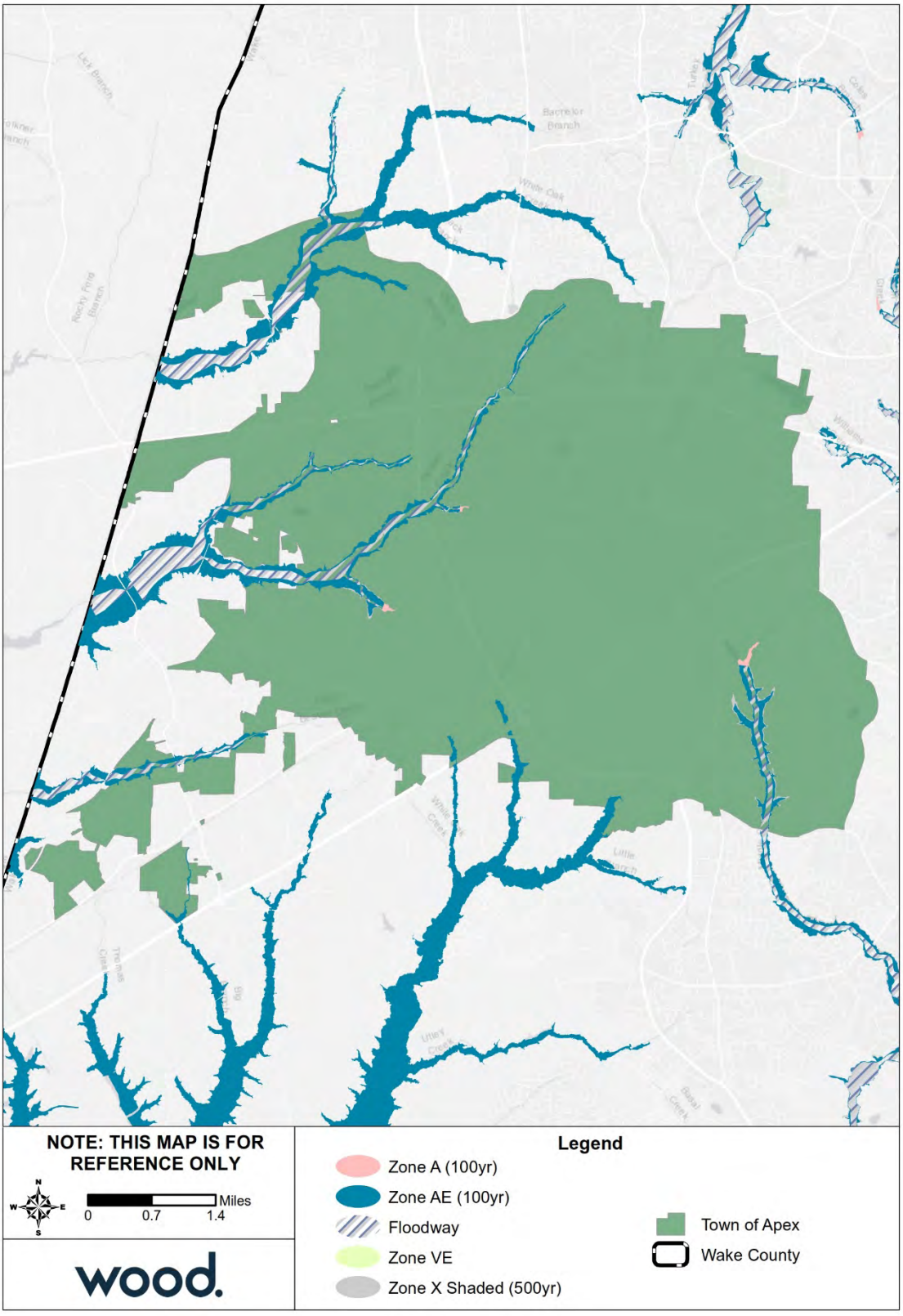
Table C.12 provides a summary by land class of parcel development located in the 1% annual chance floodplain from January 2011 to April 2019.

Table C.13 – Parcels Developed 2011 or Later and Located in 100-Year Floodplain, Town of Apex

Land Class	Number of Parcels	Sum of Building Value
Commercial	1	$10,465,559
EXEMPT	3	$3,428,276
Residential Less Than 10 Acres	12	$4,645,437
Grand Total	**16**	**$18,539,272**

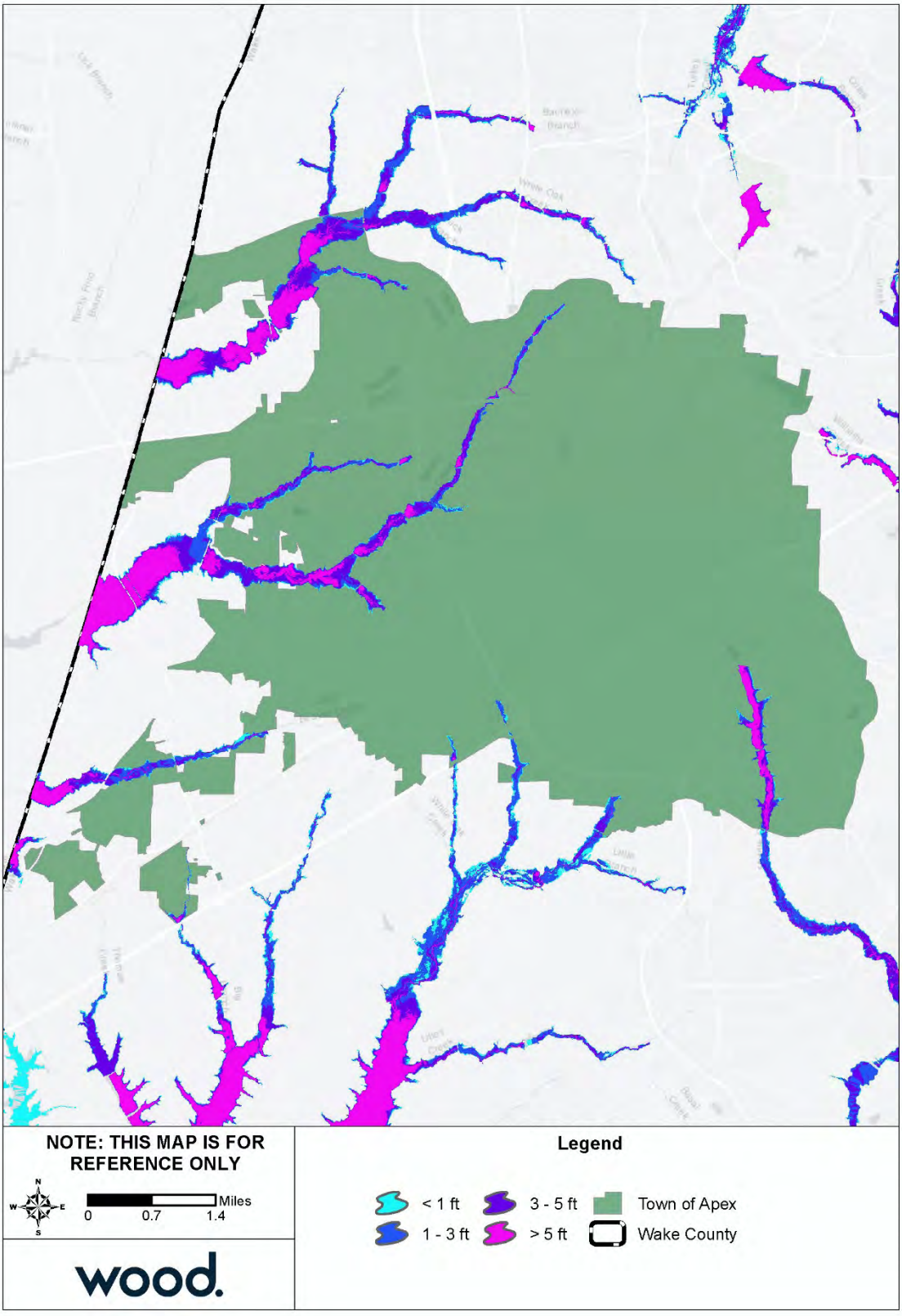
Source: Wake County Open Data; retrieved April 8, 2019; FEMA Effective DFIRM

Figure C.3 – FEMA Flood Hazard Areas, Town of Apex



Source: FEMA Effective DFIRM

Figure C.4 – Flood Depth, 1%-Annual-Chance Floodplain, Town of Apex



Source: FEMA Effective DFIRM

C.3.2 Wildfire

Table C.13 summarizes the acreage in the Town of Apex that falls within the Wildland Urban Interface (WUI), categorized by housing density. Areas in the WUI are those where development may intermix with flammable vegetation. Over 17 percent of the Town of Apex is not included in the WUI.

Table C.14 – Wildland Urban Interface Acreage, Town of Apex

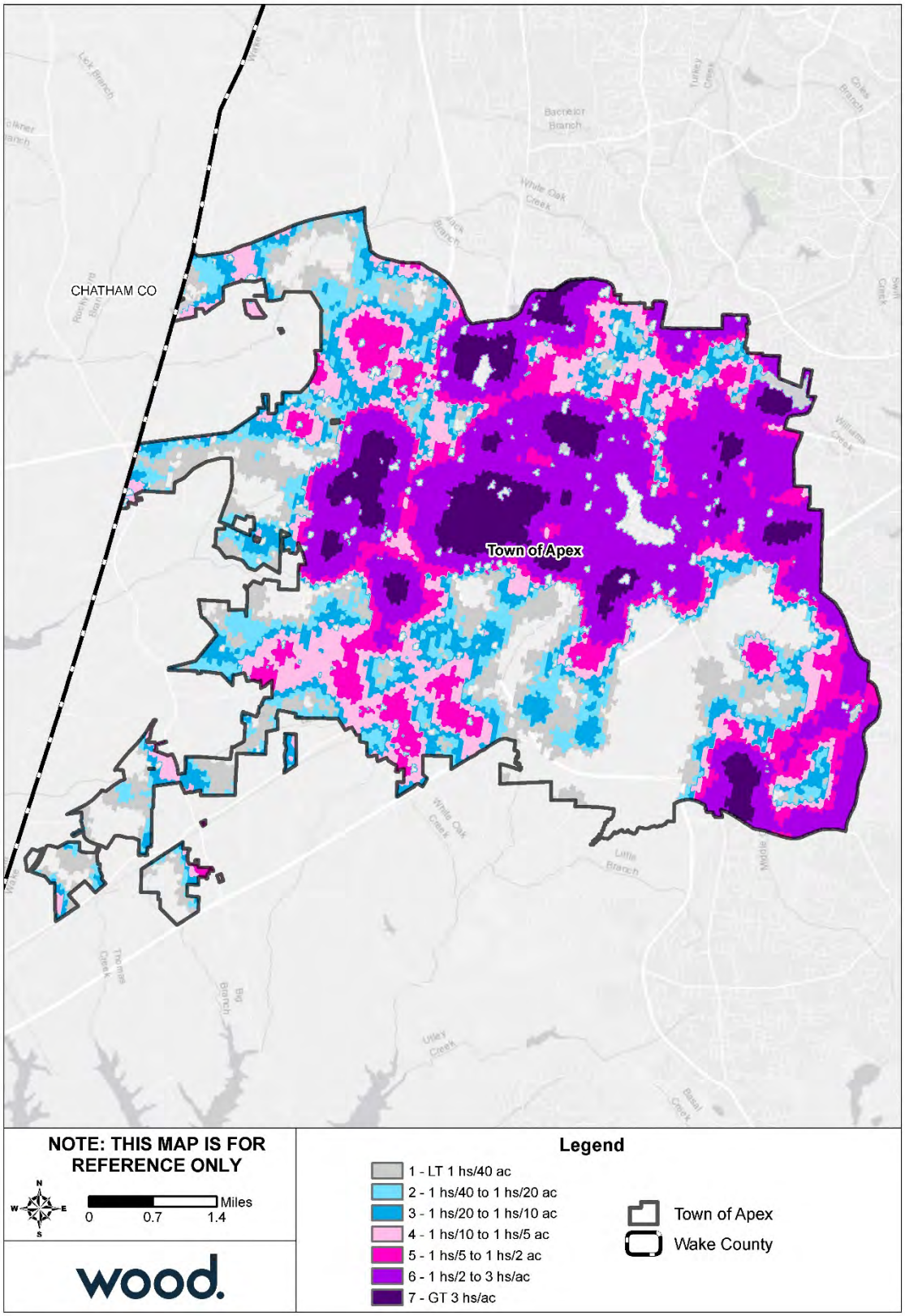
	Housing Density	Total Acreage	Percent of Total Acreage
	Not in WUI	*4,230.0*	*17.9%*
	LT 1hs/40ac	2,393.3	10.1%
	1hs/40ac to 1hs/20ac	1,859.2	7.9%
	1hs/20ac to 1hs/10ac	2,299.7	9.7%
	1hs/10ac to 1hs/5ac	2,589.9	11%
	1hs/5ac to 1hs/2ac	2,664.6	11.3%
	1hs/2ac to 3hs/1ac	5,829.0	24.7%
	GT 3hs/1ac	1,721.8	7.3%
	Total	23,587.5	

Source: Southern Wildfire Risk Assessment

Table C.5 depicts the WUI for unincorporated Wake County. The WUI is the area where housing development is built near or among areas of vegetation that may be prone to wildfire. Figure A.7 depicts the Fire Intensity Scale, which indicates the potential severity of fire based on fuel loads, topography, and other factors. Figure C.7 depicts Burn Probability based on landscape conditions, percentile weather, historical ignition patterns, and historical prevention and suppression efforts.

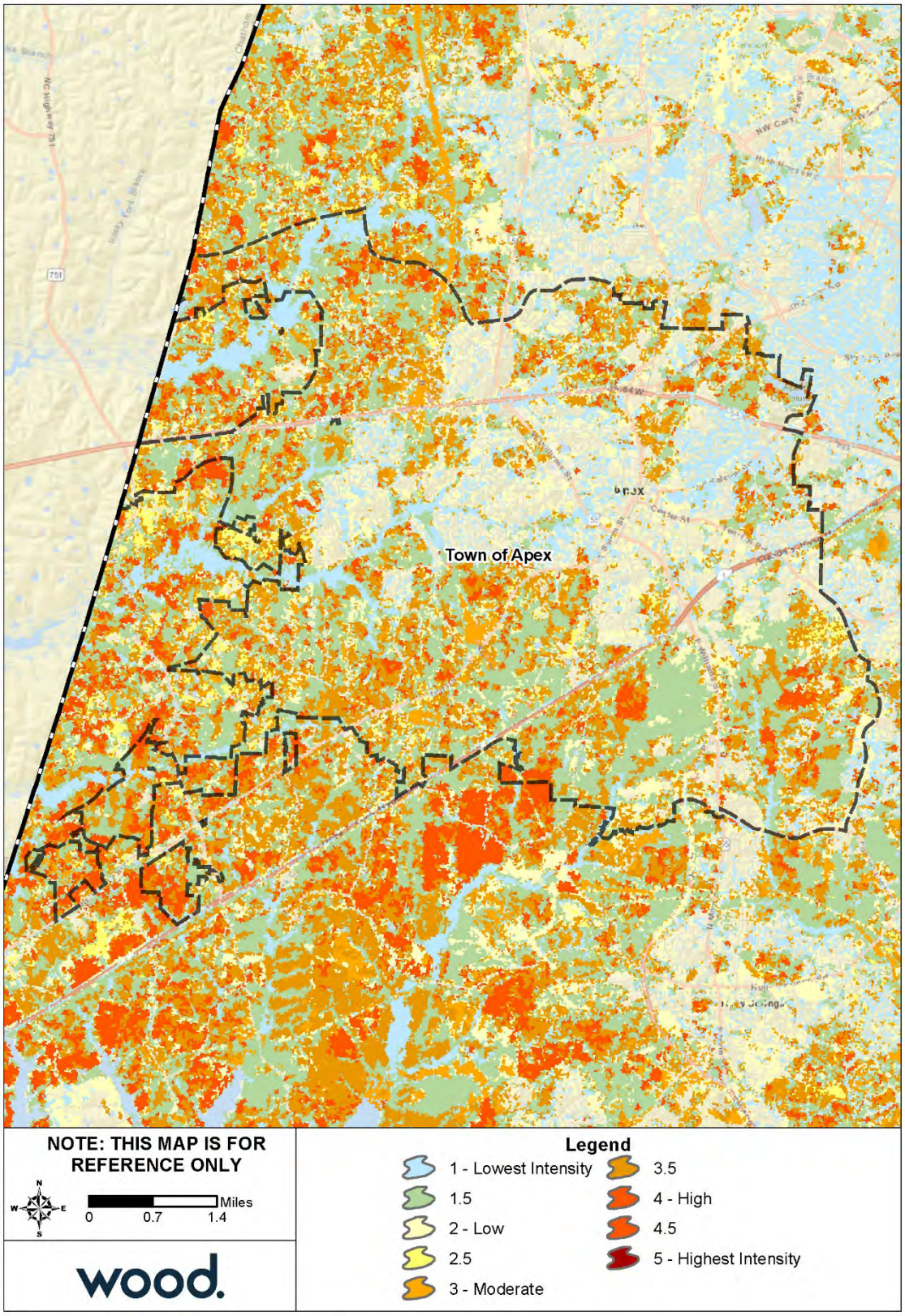
Potential fire intensity is highest in southeast part of the Town of Apex; however, these areas, as with much of the town, have lower burn. Much of the most densely developed area in the WUI have low to moderate fire intensity.

Figure C.5 – Wildland Urban Interface, Town of Apex



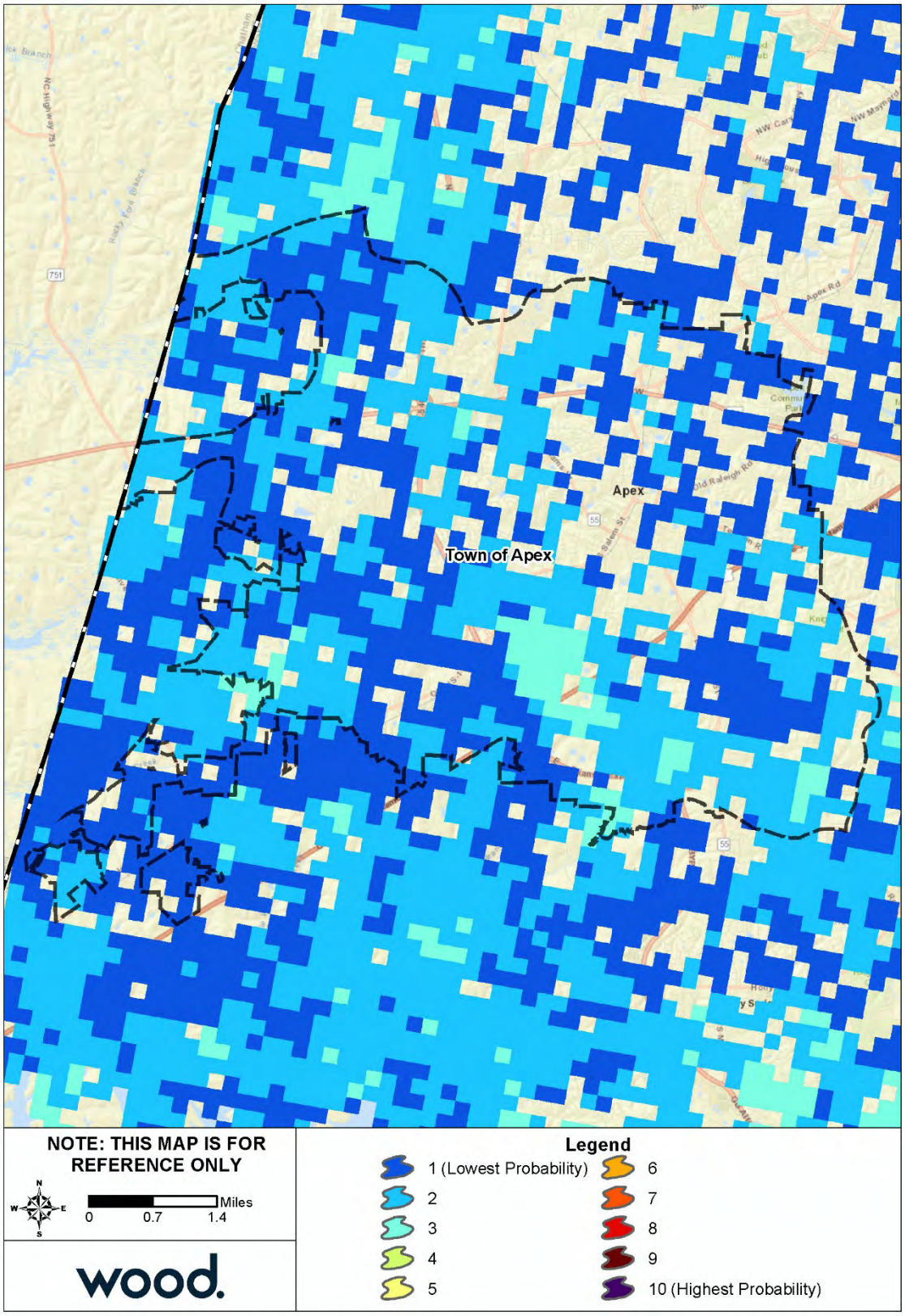
Source: Southern Wildfire Risk Assessment

Figure C.6 – Fire Intensity Scale, Town of Apex



Source: Southern Wildfire Risk Assessment

Figure C.7 – Burn Probability, Town of Apex



Source: Southern Wildfire Risk Assessment

C.4 CAPABILITY ASSESSMENT

C.4.1 Overall Capability

Details on the tools and resources in place and available to the Town of Apex were provided by the Town's HMPC representatives and are summarized in Section 5 Capability Assessment. Based on that information and using the scoring methodology detailed in that section, Apex has an overall capability rating of High. The Town's Self-Assessment of key capability areas is summarized in Table C.14 below.

Table C.15 – Capability Self-Assessment, Apex

Capability Area	Rating
Plans, Ordinances, Codes and Programs	Moderate
Administrative and Technical Capability	High
Fiscal Capability	High
Education and Outreach Capability	Limited
Mitigation Capability	High
Political Capability	High
Overall Capability	High

C.4.2 Floodplain Management

The Town of Apex joined the NFIP as a regular participant in March 1992. The following tables reflect NFIP policy and claims data for the Town categorized by structure type, flood zone, Pre-FIRM and Post-FIRM.

Table C.16 – NFIP Policy and Claims Data by Structure Type

Structure Type	Number of Policies in Force	Total Premium	Insurance in Force	Number of Closed Paid Losses	Total of Closed Paid Losses
Single Family	106	$42,257	$30,943,000	1	$1,299.97
2-4 Family	2	$555	$400,000	0	$0.00
All Other Residential	0	$0	$0	0	$0.00
Non-Residential	3	$5,991	$1,600,000	0	$0.00
Total	111	$48,803	$32,943,000	1	$1,299.97

Source: FEMA Community Information System, accessed November 2018

Table C.17 – NFIP Policy and Claims Data by Flood Zone

Flood Zone	Number of Policies in Force	Total Premium	Insurance in Force	Number of Closed Paid Losses	Total of Closed Paid Losses
A01-30 & AE Zones	15	$8,790	$4,269,000	0	$0.00
A Zones	0	$0	$0	0	$0.00
AO Zones	0	$0	$0	0	$0.00
AH Zones	0	$0	$0	0	$0.00
AR Zones	0	$0	$0	0	$0.00
A99 Zones	0	$0	$0	0	$0.00
V01-30 & VE Zones	0	$0	$0	0	$0.00
V Zones	0	$0	$0	0	$0.00
D Zones	0	$0	$0	0	$0.00
B, C & X Zone					

Flood Zone	Number of Policies in Force	Total Premium	Insurance in Force	Number of Closed Paid Losses	Total of Closed Paid Losses
Standard	2	$4,031	$750,000	0	$0.00
Preferred	94	$35,982	$27,924,000	1	$1,299.97
Total	111	$48,803	$32,943,000	1	$1,299.97

Source: FEMA Community Information System, accessed November 2018

Table C.18 – NFIP Policy and Claims Data Pre-FIRM

Flood Zone	Number of Policies in Force	Total Premium	Insurance in Force	Number of Closed Paid Losses	Total of Closed Paid Losses
A01-30 & AE Zones	0	$0	$0	0	$0.00
A Zones	0	$0	$0	0	$0.00
AO Zones	0	$0	$0	0	$0.00
AH Zones	0	$0	$0	0	$0.00
AR Zones	0	$0	$0	0	$0.00
A99 Zones	0	$0	$0	0	$0.00
V01-30 & VE Zones	0	$0	$0	0	$0.00
V Zones	0	$0	$0	0	$0.00
D Zones	0	$0	$0	0	$0.00
B, C & X Zone	9	$2,607	$1,665,000	0	$0.00
Standard	0	$0	$0	0	$0.00
Preferred	9	$2,607	$1,665,000	0	$0.00
Total	9	$2,607	$1,665,000	0	$0.00

Source: FEMA Community Information System, accessed November 2018

Table C.19 – NFIP Policy and Claims Data Post-FIRM

Flood Zone	Number of Policies in Force	Total Premium	Insurance in Force	Number of Closed Paid Losses	Total of Closed Paid Losses
A01-30 & AE Zones	15	$8,790	$4,269,000	0	$0.00
A Zones	0	$0	$0	0	$0.00
AO Zones	0	$0	$0	0	$0.00
AH Zones	0	$0	$0	0	$0.00
AR Zones	0	$0	$0	0	$0.00
A99 Zones	0	$0	$0	0	$0.00
V01-30 & VE Zones	0	$0	$0	0	$0.00
V Zones	0	$0	$0	0	$0.00
D Zones	0	$0	$0	0	$0.00
B, C & X Zone	87	$37,406	$27,009,000	1	$1,299.97
Standard	2	$4,031	$750,000	0	$0.00
Preferred	85	$33,375	$26,259,000	1	$1,299.97
Total	102	$46,196	$31,278,000	1	$1,299.97

Source: FEMA Community Information System, accessed November 2018

C.5 MITIGATION STRATEGY

Town of Apex											
Action #	**Description**	**Goal**	**Objective**	**Hazard(s) Addressed**	**Relative Priority**	**Lead Agency/ Department**	**Estimated Cost**	**Potential Funding Sources**	**Implementation Schedule**	**2019 Status**	**Status Comments/Explanation**
Prevention											
P-1	Revise and update the regulatory floodplain boundary, including flood studies.	2	2	Flood	Moderate	Public Works & Transportation (Floodplain Administrator)	Staff Time	Town Funds	Ongoing - Next 5 years	In-Progress – Carry Forward	Action revised.
P-2	Develop an environmental committee that meets regularly to discuss issues and recommend projects.	2	2	All Hazards	Moderate	Water Resources (Stormwater and Utility Engineering Manager)	Staff Time	Town Funds	Ongoing - Next 5 years	In-Progress – Carry Forward	The Town Council's Environmental committee has been established and meets approximately every 2 months
P-3	Encourage the use of Low Impact Development techniques.	4	2	Flood, Landslide, Drought, Hurricane, Extreme Heat	Low	Water Resources (Stormwater and Utility Engineering Manager)	Staff Time	Town Funds	Ongoing - Next 5 years	In-Progress – Carry Forward	Ongoing activity that has seen more results in last 5 years and will continue to be prioritized.
P-4	Use system development fees to help fund public projects	3	2	Flood, Wildfire, Tornado, Severe Winter Storm, Severe Weather, Drought, Hurricane	Moderate	Water Resources (Stormwater and Utility Engineering Manager)	Unknown	Local Development Fees	3-5 years	In-Progress – Carry Forward	Action revised.
P-5	Update the UDO & Design and Development Manual to incorporate proper species selection and practices for planting and maintenance into the landscape ordinance.	4	1	Flood, Severe Winter Storm, Severe Weather, Drought, Hurricane	Moderate	Planning Dept.	Staff Time	Local	2-3 years	In-Progress – Carry Forward	Action revised.
P-6	Incorporate GIS data and risk analysis into the development review process.	4	2	All	Moderate	Fire Dept. & Planning Dept.	Staff Time	Local	Ongoing - Next 5 years	In-Progress – Carry Forward	Action revised.
P-7	Create a Stormwater Utility to fund the Town's Stormwater Program.	2	2	Flood	Moderate	Water Resources (Stormwater and Utility Engineering Manager)	$100,000	Local	2-3 years	New	Implement: 2021
P-8	Continue to use "Neighbors Helping Neighbors" program to help low income Apex Utility customers pay their utility bills.	3	2	Extreme Heat, Severe Winter Storm	Moderate	Finance Dept/Western Wake Crisis Ministry	None	Local	Ongoing - Next 5 years	New	Has been in use for years but is just now being recognized as contributing towards mitigating impacts of high heat and cold weather.
P-9	Salt local roads before Severe Winter Storm & plow after snow and ice fall.	3	2	Severe Winter Storm	Moderate	Public Works & Transportation		Local	Ongoing - Next 5 years	New	On-going activity that is just now being added as mitigation for Severe Winter Storms.
Property Protection											
PP-1	Adopt and enforce the Fire Prevention Code.	4	1	Wildfire, Hazardous Materials Incident	Moderate	Fire Department	Staff Time	Local	Ongoing - Next 5 years	New	N/A
PP-2	Annually update the comprehensive occupancy pre-plan program with local data for use in risk analysis.	4	2	Flood, Wildfire, Hazardous Materials Incident, Radiological Emergency	Moderate	Fire Department	Staff Time	Local	Ongoing - Next 5 years	In-Progress – Carry Forward	Action revised.
PP-3	Restore streams to slow the speed of water and reduce erosion to prevent both private property loss and public infrastructure damage.	3	2	Flood	Moderate	Water Resources (Stormwater and Utility Engineering Manager)	Over $500,000	Local & Federal	Ongoing - Next 5 years	New	N/A
Natural Resource Protection											
NRP-1	Middle Creek Greenway (Miramonte to Holly Springs).	3	2	All	Moderate	Apex Parks and Recreation	$2,870,000	Local	3-5 years	In-Progress – Carry Forward	under construction
NRP-2	White Oak Creek Greenway.	3	2	Flood	Moderate	Apex Parks and Recreation	$284,000	Local	3-5 years	In-Progress – Carry Forward	under construction
NRP-3	During development review, ensure new development complies with floodplain development restrictions listed in UDO Section 6.2 Flood Damage Prevention Overlay District.	4	2	Flood	Moderate	Public Works and Transportation (Floodplain Administrator)	Staff Time	Local	Ongoing - Next 5 years	New	N/A

Town of Apex											
Action #	**Description**	**Goal**	**Objective**	**Hazard(s) Addressed**	**Relative Priority**	**Lead Agency/ Department**	**Estimated Cost**	**Potential Funding Sources**	**Implementation Schedule**	**2019 Status**	**Status Comments/Explanation**
NRP-4	During development review, ensure new development complies with UDO stream buffer standards.	4	2	Flood	Moderate	Water Resources (Stormwater and Utility Engineering Manager)	Staff Time	Local	Ongoing - Next 5 years	New	N/A
NRP-5	During development review, ensure SCMs are designed in accordance with State criteria to safely pass 100-year storm.	4	2	Flood	Moderate	Water Resources (Stormwater and Utility Engineering Manager)	Staff Time	Local	Ongoing - Next 5 years	New	N/A
Structural Projects											
SP-1	Improve communications abilities for emergency response by building new fiber optic internet infrastructure and replacing current radio systems.	2	1	All	Moderate	Police Dept	$915,000	Local	3-5 years	New	N/A
SP-2	Build Jessie Drive to connect TenTen Rd and NC-55. This will provide greater connectivity and make evacuation faster & safer.	3	2	All	Moderate	Public Works and Transportation	$6,000,000	Local	3-5 years	New	N/A
SP-3	Relocate Beaver Creek Sewer Line out of the creek.	3	2	Flood, Wildfire, Severe Winter Storm, Hurricane	Moderate	Water Resources (Stormwater and Utility Engineering Manager)	$1,500,000	Local	3-5 years	New	N/A
SP-4	Finish the Peakway loop road. Will provide greater connectivity, faster emergency response times, and make evacuation faster & safer.	3	2	All	High	Public Works and Transportation	$20,000,000	Local	More than 5 years	New	Design work is in progress
Emergency Services											
ES-1	Construct Fire Station #6	3	2	All Hazards	Moderate	Apex Fire	$4,175,000	Local	3-5 years	New	N/A
ES-2	Construct Fire Station #7	3	2	All Hazards	Moderate	Apex Fire	$4,000,000	Local	More than 5 years	New	N/A
ES-3	Relocate Fire Station #3 from its existing location because of the impacts of widening NC-55.	3	1	All Hazards	Moderate	Apex Fire	$4,000,000	Local	More than 5 years	New	N/A
ES-4	Keep Town website updated with information about Shearon Harris Siren Testing.	1	2	Radiological Incident	Moderate	Apex Public Information Officer	Staff Time	Local	Ongoing - Next 5 years	New	Ongoing activity that's just now being recognized for its mitigation potential
Public Education and Awareness											
PEA-1	Town website and utility billing announcing National Preparedness Month (September) reminding citizens to have a plan and be prepared.	1	1	All	Moderate	Administration (Communications Officer)	Less than $100,000	Local	Ongoing - Next 5 years	In-Progress – Carry Forward	On-going activity to be implemented annually
PEA-2	Include Environment Education Station and classroom at Nature Park.	1	1	All	Moderate	Apex Parks and Recreation	$1,000,000	Local	3-5 years	Not Started – Carry Forward	New target completion date is 2022
PEA-3	Post warning signage at local parks for lightning.	1	1	Severe Weather	Moderate	Apex Parks and Recreation	$100,000	Local	3-5 years	Not Started – Carry Forward	New implementation schedule is 3-5 years
PEA-4	Hand out hazard educational materials at Apex festivals.	1	1	All	Moderate	Planning Dept. & Water Resources	Less than $1,500	Local	Ongoing - Next 5 years	New	N/A
PEA-5	Use Social Media to inform residents about local hazards.	1	1	All	Moderate	Apex Public Information Officer & Planning Dept.	Staff Time	Local	Ongoing - Next 5 years	New	N/A

Annex D Town of Cary

D.1 PLANNING PROCESS

The table below lists the HMPC members who represented the Town of Cary.

Table D.1 – HMPC Members

Agency	Representative	Position or Title
Town Manager's Office	Emily Barrett	Sustainability Manager
Water Resources Department	Eric Kulz	Environmental Specialist
N/A	Tom Hegele	Citizen Stakeholder

D.2 COMMUNITY PROFILE

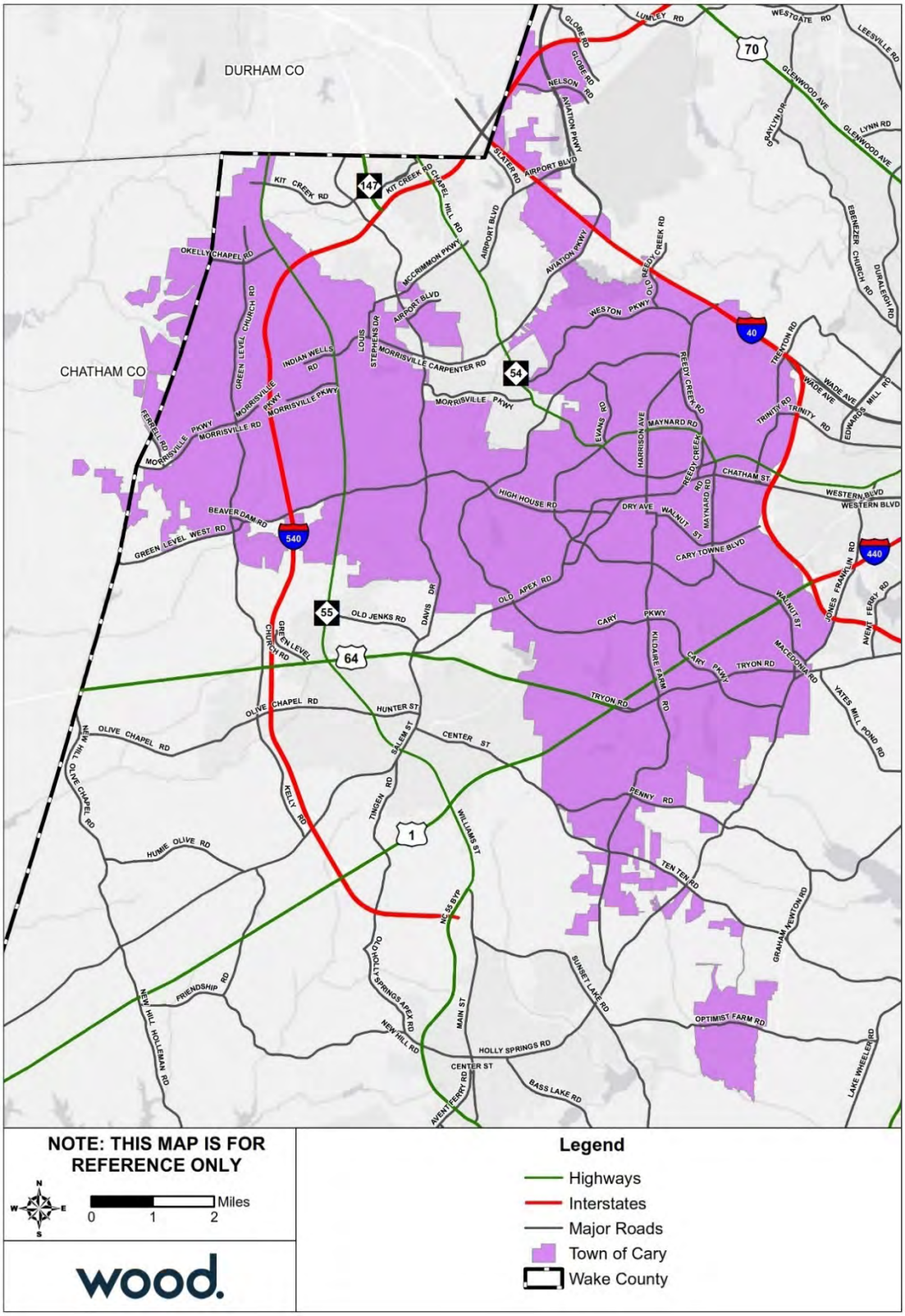
Geography

The Town of Cary is located in western Wake County. A small portion of the Town extends west into Chatham County. All statistics summarized in this section are for the entirety of the Town of Cary. It is neighbored by Apex and Holly Springs to the south, Raleigh to the north and east, Morrisville and RTP to the north and west, and Chatham County to the west. The Town is part of the Raleigh, NC Metropolitan Statistical Area, which falls within the larger Raleigh-Durham-Chapel Hill, NC Combined Statistical Area. Cary comprises a total land area of 54.3 square miles.

According to data from the U.S. Fish and Wildlife Service's National Wetlands Inventory, there are approximately 3,375 acres of wetlands in Cary.

Figure D.1 shows a base map of the major transportation routes in the Town of Cary

Figure D.1 – Major Transportation Routes – Town of Cary



Source: Wake County GIS Open Data

Population and Demographics

Table D.2 provides population counts and growth estimates for the Town of Cary as compared to the County overall. Table D.3 provides demographic information for Cary as compared to the whole County.

Table D.2 – Population Counts, Cary, 2010-2017

Jurisdiction	2000 Census Population	2010 Census Population	2017 ACS Population Estimate	Total Change 2010-2017	% Change 2010-2017
Wake County total	**627,846**	**900,993**	**1,023,811**	**122,818**	**13.6%**
Town of Cary	94,536	135,234	159,715	24,481	18.1%

Source: US Census Bureau Decennial Census 2000, Decennial Census 2010; American Community Survey 2013-2017 5-Year Estimates
Note: The total population of Cary includes population residing in adjacent county.

Table D.3 – Racial Demographics, Cary, 2017

Jurisdiction	White, %	Black, %	Asian, %	Other Race, %	Two or More Races, %	Persons of Hispanic or Latino Origin*, %
Wake County total	**66.5%**	**20.4%**	**6.5%**	**3.6%**	**2.7%**	**10.0%**
Town of Cary	69.9%	7.9%	16.8%	2.2%	2.8%	8.1%

Source: US Census Bureau, American Community Survey 2013-2017 5-Year Estimates
*Persons of Hispanic origin may be of any race, so also are included in applicable race categories

Asset Inventory

The following tables summarize the asset inventory for Cary in order to estimate the total physical exposure to hazards in this area. The locations of critical facilities are shown in Figure D.2 on the following page. Critical facilities are a subset of identified assets from the Critical Infrastructure & Key Resources dataset. Note that the counts are by building; where a critical facility comprises a cluster of buildings, each building is counted and displayed.

Table D.4 – Critical Infrastructure & Key Resources by Type

Jurisdiction	Food & Agriculture	Banking & Finance	Chemical	Commercial Facilities	Communications	Manufacturing	Defense	Government	Healthcare	IT	National Monuments	Nuclear	Postal & Shipping	Transportation	Energy	Emergency Services	Water	Other	Total
Town of Cary	91	55	0	1,259	5	270	1	334	98	0	0	1	0	203	4	12	27	0	**2,360**

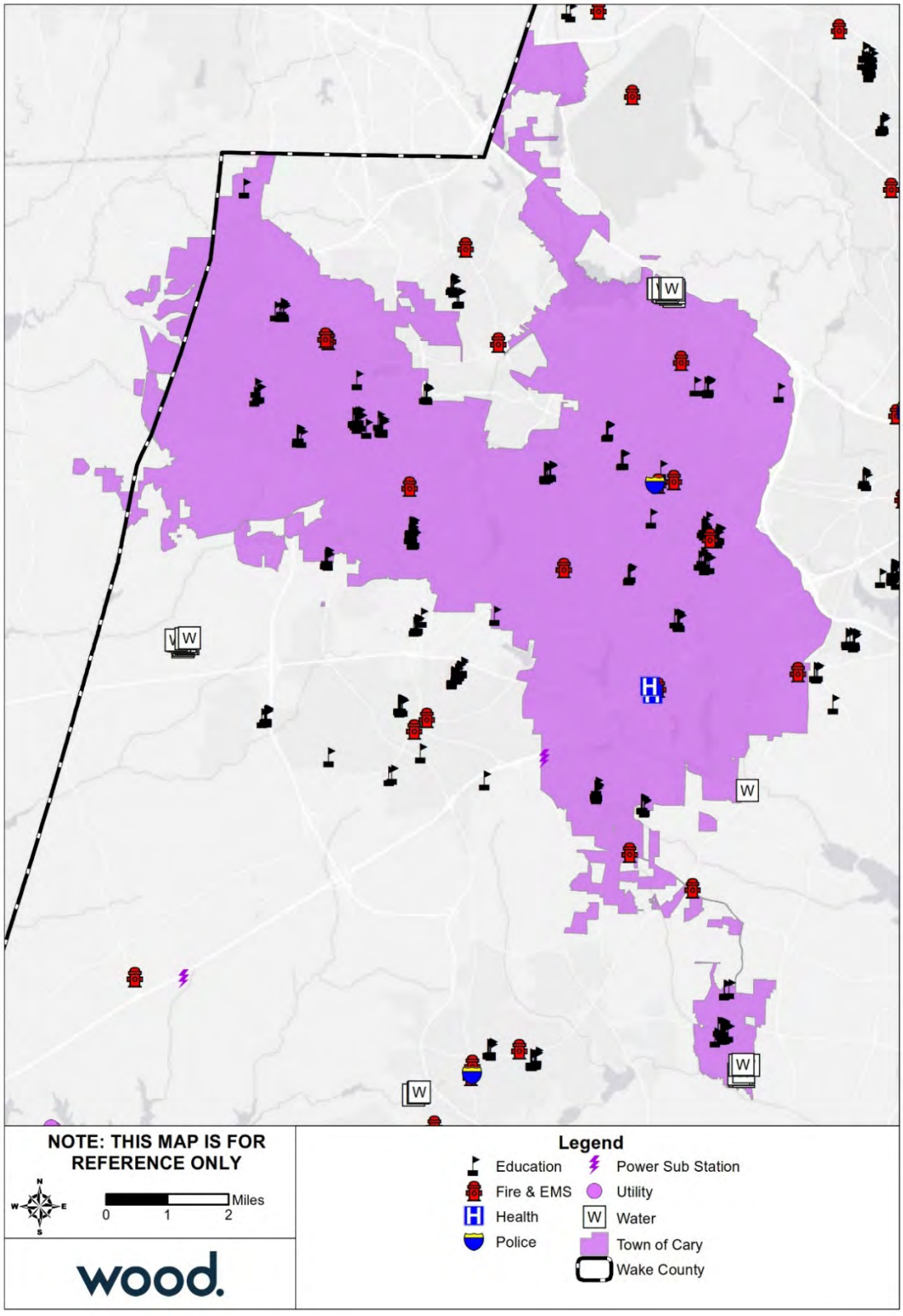
Source: NCEM Risk Management Tool

Table D.5 – High Potential Loss Facilities by Use

Jurisdiction	Residential	Commercial	Industrial	Government	Agricultural	Religious	Utilities	Other	Total
Town of Cary	437	519	65	87	0	48	26	0	**1,182**

Source: NCEM Risk Management Tool

Figure D.2 – Critical Facilities, Town of Cary



Source: NCEM IRISK Database, GIS Analysis

To supplement the asset inventory and provide a clearer picture of the current asset exposure in the Town of Cary, current parcel data was evaluated to identify development since 2010. This information is not incorporated into the risk assessment, which was prepared using NCEM's IRISK database. However, this summary of development since 2010 provides some context to understand the degree to which the IRISK exposure and vulnerability numbers differ from current conditions. Table D.6 provides a summary by land class of parcel development from January 2011 to April 2019.

Table D.6 – Parcels Developed 2011 or Later

Land Class	Number of Parcels	Sum of Building Value
Acres Greater Than 10 With House	1	$382,654
Apartment	16	$427,896,601
Commercial	99	$549,618,033
Condo Complex	3	-
EXEMPT	13	$126,925,448
Forestry	1	$441,673
HOA	9	$137,300
Industrial	2	$6,713,793
Part Exempt	44	$78,060,753
Residential Less Than 10 Acres	7,062	$2,313,360,158
Retirement Home	1	$5,268,142
Grand Total	**7,251**	**$3,508,804,555**

Source: Wake County Open Data; retrieved April 8, 2019

There are seven listings on the National Register of Historic Places for the Town of Cary, including three historic districts. These sites are listed in the table below.

Table D.7 – Historic Properties

Ref#	Property Name	Status Date	Category	City
79003339	Page-Walker Hotel	5/29/1979	Building	Cary
84002540	Jones, Nancy, House	3/1/1984	Building	Cary
00000549	Carpenter Historic District	5/26/2000	District	Cary
01000340	Green Level Historic District	4/5/2001	District	Cary
01000425	Cary Historic District	4/25/2001	District	Cary
02000498	Utley--Council House	5/16/2002	Building	Cary
08000414	Ivey--Ellington House	5/15/2008	Building	Cary

Source: National Parks Service, National Register of Historic Places, October 2018

Housing

The table below details key housing statistics for Cary as compared to the County overall.

Table D.8 – Housing Statistics, Cary, 2010-2017

Jurisdiction	Housing Units (2010)	Housing Units (2017)	Housing Units Percent Change (2010-2017)	Owner-Occupied, % (2017)	Vacant Units, % (2017)	Median Home Value (2017)
Wake County total	**371,836**	**411,632**	**10.7%**	**59.5%**	**7.2%**	**$250,700**
Town of Cary	55,303	63,008	13.9%	66.0%	4.4%	$323,000

Source: U.S. Census Bureau 2010 Decennial Census, American Community Survey 2013-2017 5-Year Estimates
Note: Owner-Occupied and vacant-unit measures are reported as a percent of the total number of housing units.

Economy

The following tables present key economic statistics for Cary as compared to the County overall.

Table D.9 – Employment Statistics, Cary, 2017

Jurisdiction	Population in Labor Force	Percent Employed* (%)	Percent Unemployed* (%)	Percent Not in Labor Force* (%)	Unemployment Rate (%)
Wake County	**564,096**	**67.2**	**3.5**	**29.2**	**4.9**
Town of Cary	88,040	68.8	2.7	28.5	3.8

Source: U.S. Census Bureau, American Community Survey 2013-2017 5-Year Estimates
Note: This table reports only the civilian labor force. The labor force in armed services accounted for 0.3% or less of the population 16 and over in all jurisdictions. *Population employed, population unemployed, and Population not in labor force are reported as a percent of the total population aged 16 years and older.

Table D.10 – Percent of Employed Population by Occupation, Cary, 2017

Occupation	Management, business, science and arts (%)	Service (%)	Sales and Office (%)	Natural Resources, Construction, and Maintenance (%)	Production, transportation, and material moving (%)
Wake County	**50.1**	**13.8**	**23.4**	**6.0**	**6.7**
Town of Cary	61.8	10.4	19.7	3.9	4.3

Source: U.S. Census Bureau, American Community Survey 2013-2017 5-Year Estimates

D.3 RISK ASSESSMENT

This section contains a hazard profile and vulnerability assessment for those hazards that were rated with a higher priority for the Town of Cary than for Wake County as a whole. Risk and vulnerability findings are also presented here for those hazards that are spatially defined and have variations in risk that could be evaluated quantitatively on a jurisdictional level. The hazards included in this section are: Flood and Wildfire.

D.3.1 Flood

Table D.11 details the acreage of the Town of Cary total area by flood zone on the effective DFIRM. Per this assessment, over 7 percent of the Town of Cary falls within the mapped 1%-annual-chance floodplains.

Table D.11 – Flood Zone Acreage in the Town of Cary

Flood Zone	Acreage	Percent of Total (%)
Zone A	29.54	0.07
Zone AE	3,336.894	7.70
Zone X (500-year)	216.56	0.50
Zone X Unshaded	39,753.18	91.73
Total	**43,336.174**	**--**

Source: FEMA Effective DFIRM; Wake County GIS

Figure D.3 reflects the effective mapped flood hazard zones for the Town of Cary, and Figure D.4 displays the depth of flooding estimated to occur in these areas during the 1%-annual-chance flood.

To supplement the IRISK assessment of property at risk from the 1% annual chance flood event in Section 4 and provide a clearer picture of the current property at risk in the Town of Cary, current parcel data was evaluated to identify parcels developed since 2010. Using GIS analysis, parcels developed after 2010 were compared to the boundaries of the 1% annual chance floodplain to identify the exposure of newly

developed property to the base flood. In most cases, a parcel was considered exposed to the floodplain if any portion of the parcel was located in the floodplain.

This assessment does not evaluate flood impacts or provide damage estimates. However, this summary of development in or near the floodplain since 2010 provides some context to understand the degree to which the IRISK exposure and vulnerability numbers differ from current conditions.

Table D.12 provides a summary by land class of parcel development located in the 1% annual chance floodplain from January 2011 to April 2019.

Table D.12 – Parcels Developed 2011 or Later and Located in 100-Year Floodplain, Town of Cary

Land Class	Number of Parcels	Sum of Building Value
Apartment	4	$92,009,343
Commercial	6	$132,211,547
EXEMPT	1	$54,874,633
Industrial	1	$4,945,183
Residential Less Than 10 Acres	38	$15,239,202
Grand Total	**50**	**$299,279,908**

Source: Wake County Open Data; retrieved April 8, 2019; FEMA Effective DFIRM

Error! Reference source not found. provides building counts and estimated damages for Critical Infrastructure and Key Resources (CIKR) buildings by sector and flood event in the Town of Cary. **Error! Reference source not found.** provides counts and estimated damages for High Potential Loss Properties in the Town of Cary.

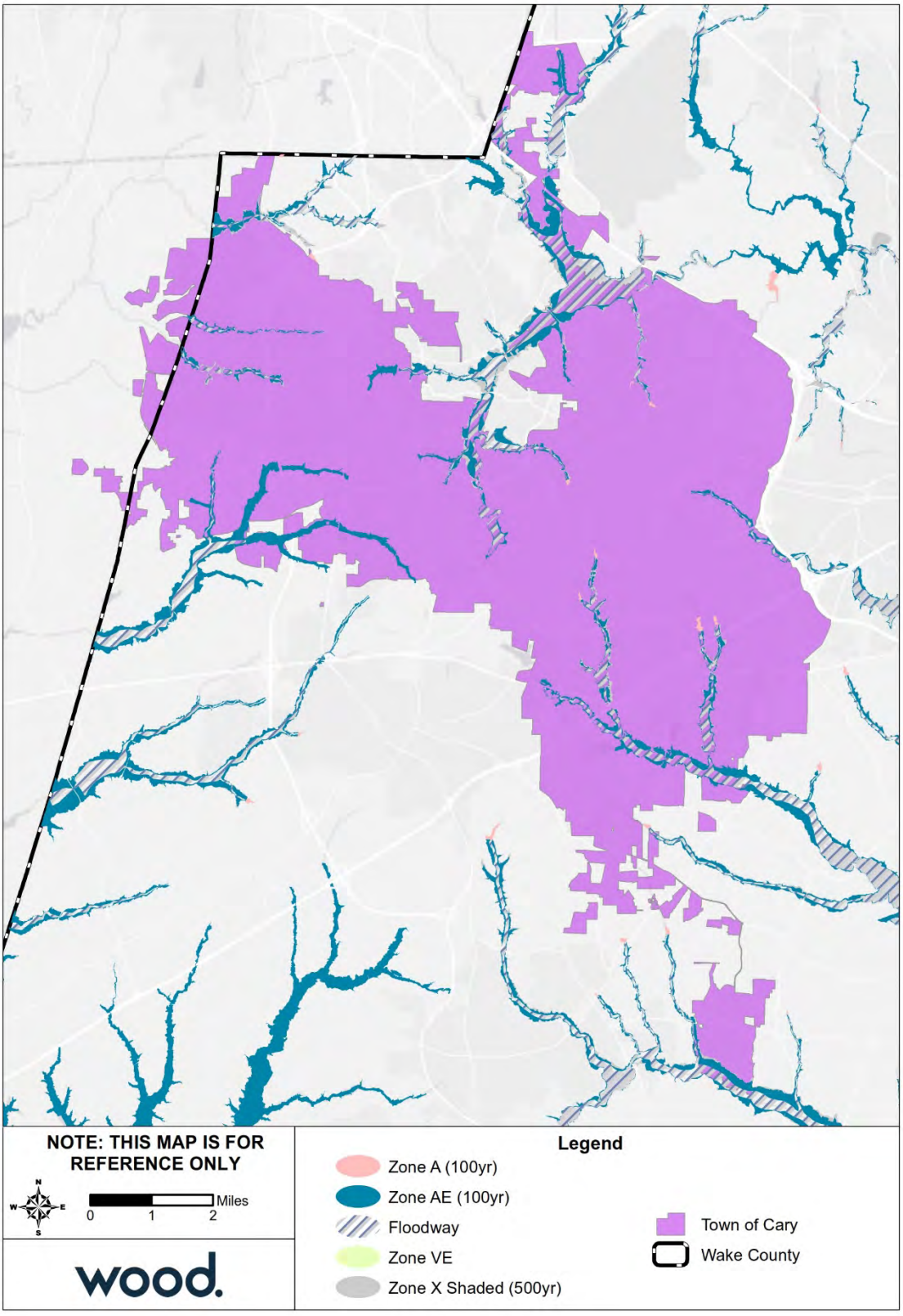
Table D.13 – Critical Facilities Exposed to Flooding, Town of Cary

Sector	Event	Number of Buildings at Risk	Estimated Damages
Commercial Facilities	100 Year	5	$255,617
Critical Manufacturing	100 Year	2	$553,715
	Floodway	1	$286
Healthcare and Public Health	100 Year	1	$74,308
Transportation Systems	100 Year	2	$181,103
All Categories	**100 Year**	**10**	**$1,064,743**
	Floodway	**1**	**$286**

Table D.14 – High Potential Loss Properties Exposed to Flooding, Town of Cary

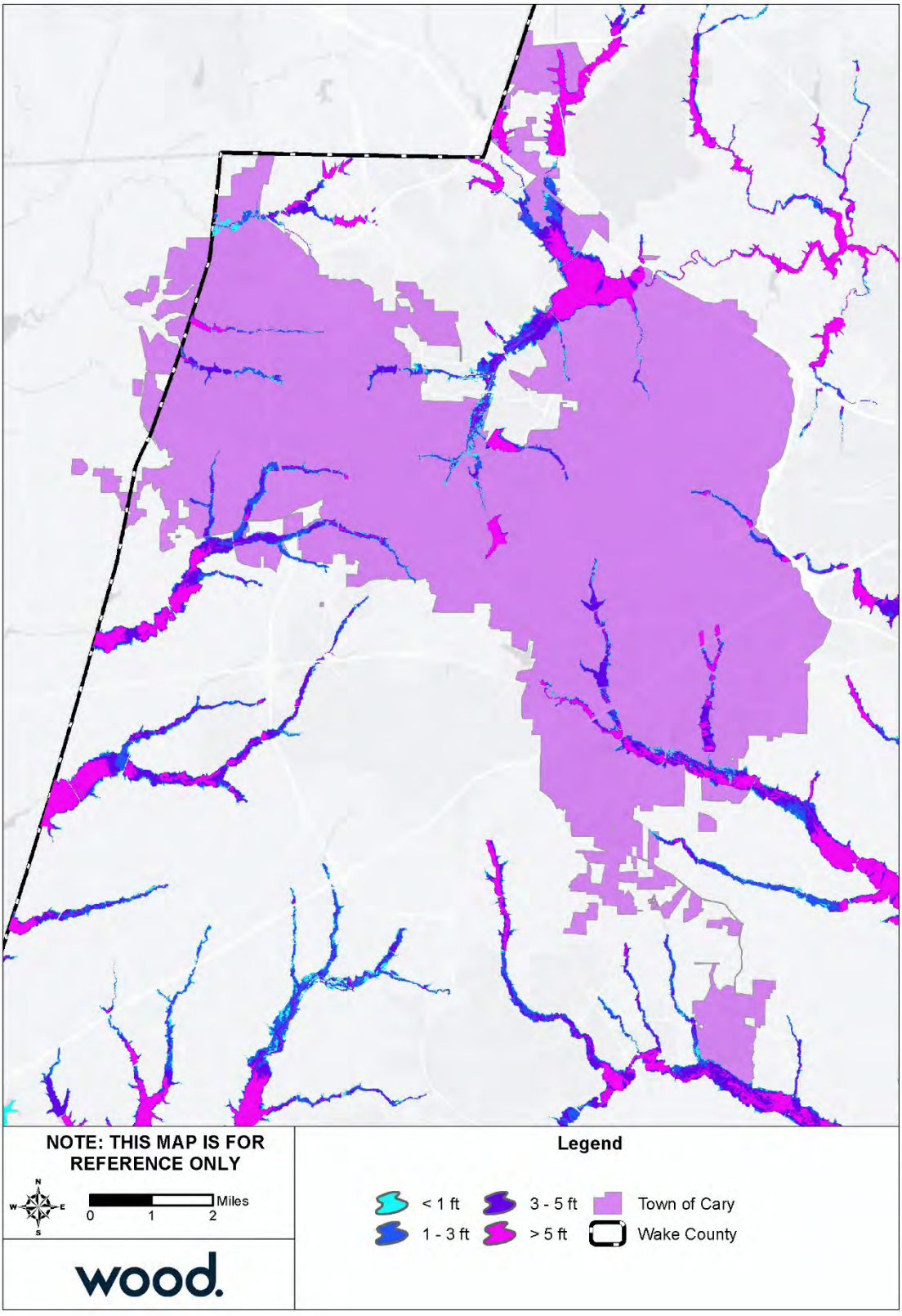
Category	Event	Number of Buildings at Risk	Estimated Damages
Commercial	100 Year	5	$965,335
All Categories	**100 Year**	**5**	**$965,335**

Figure D.3 – FEMA Flood Hazard Areas, Town of Cary



Source: FEMA Effective DFIRM

Figure D.4 – Flood Depth, 1%-Annual-Chance Floodplain, Town of Cary



Source: FEMA Effective DFIRM

D.3.2 Wildfire

Table D.15 summarizes the acreage in the Town of Cary that falls within the Wildland Urban Interface (WUI), categorized by housing density. Areas in the WUI are those where development may intermix with flammable vegetation. Over 13 percent the Town of Cary is not included in the WUI.

Table D.15 – Wildland Urban Interface Acreage, Town of Cary

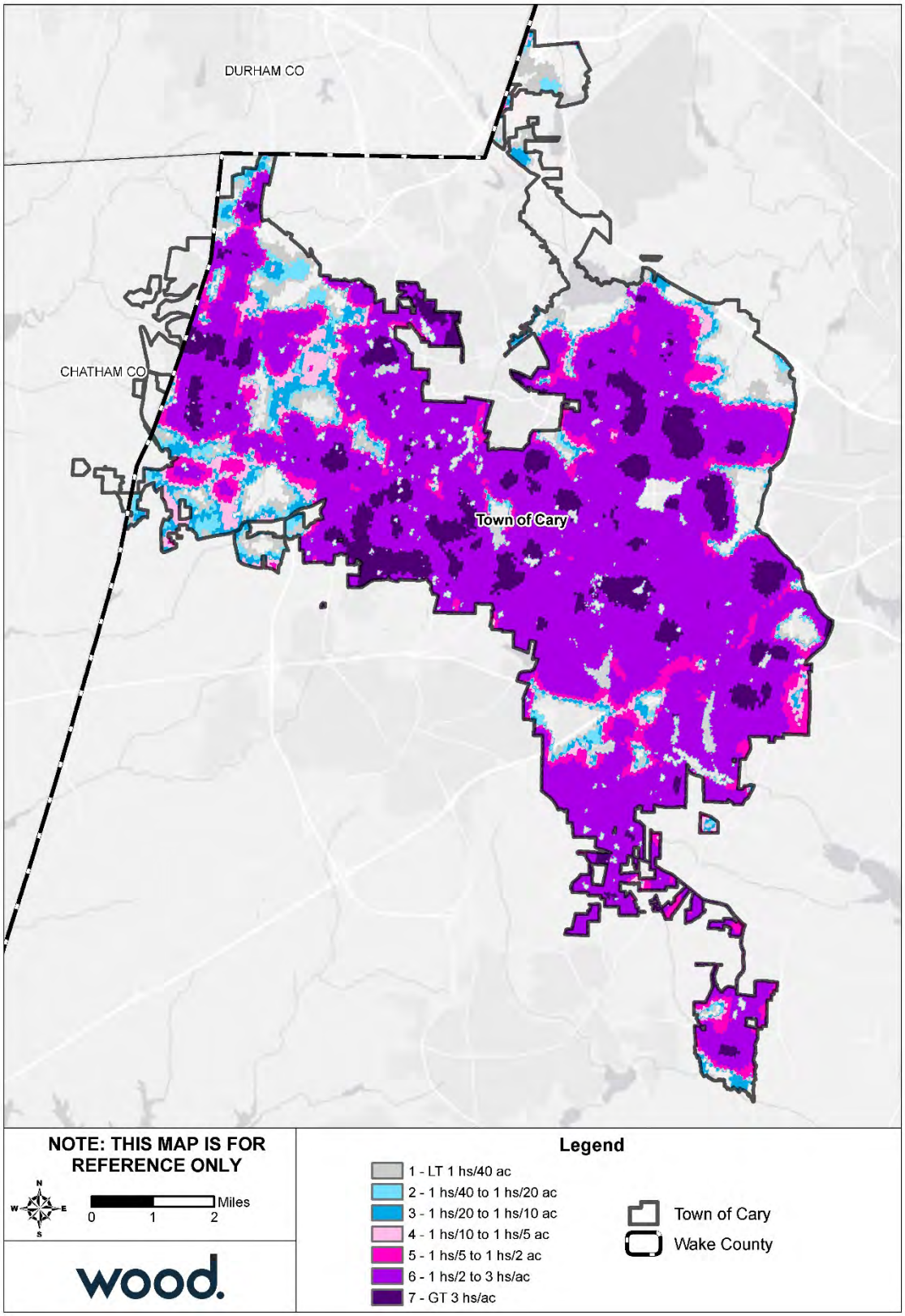
	Housing Density	Total Acreage	Percent of Total Acreage
	Not in WUI	*5,588.0*	*13.2%*
	LT 1hs/40ac	1,554.2	3.7%
	1hs/40ac to 1hs/20ac	1,177.9	2.8%
	1hs/20ac to 1hs/10ac	1,614.3	3.8%
	1hs/10ac to 1hs/5ac	1,790.8	4.2%
	1hs/5ac to 1hs/2ac	3,243.2	7.7%
	1hs/2ac to 3hs/1ac	23,228.5	54.9%
	GT 3hs/1ac	4,087.0	9.7%
	Total	42,283.9	

Source: Southern Wildfire Risk Assessment

Figure D.5 depicts the WUI for the Town of Cary. The WUI is the area where housing development is built near or among areas of vegetation that may be prone to wildfire. Figure D.6 depicts the Fire Intensity Scale, which indicates the potential severity of fire based on fuel loads, topography, and other factors. Figure D.7 depicts Burn Probability based on landscape conditions, percentile weather, historical ignition patterns, and historical prevention and suppression efforts.

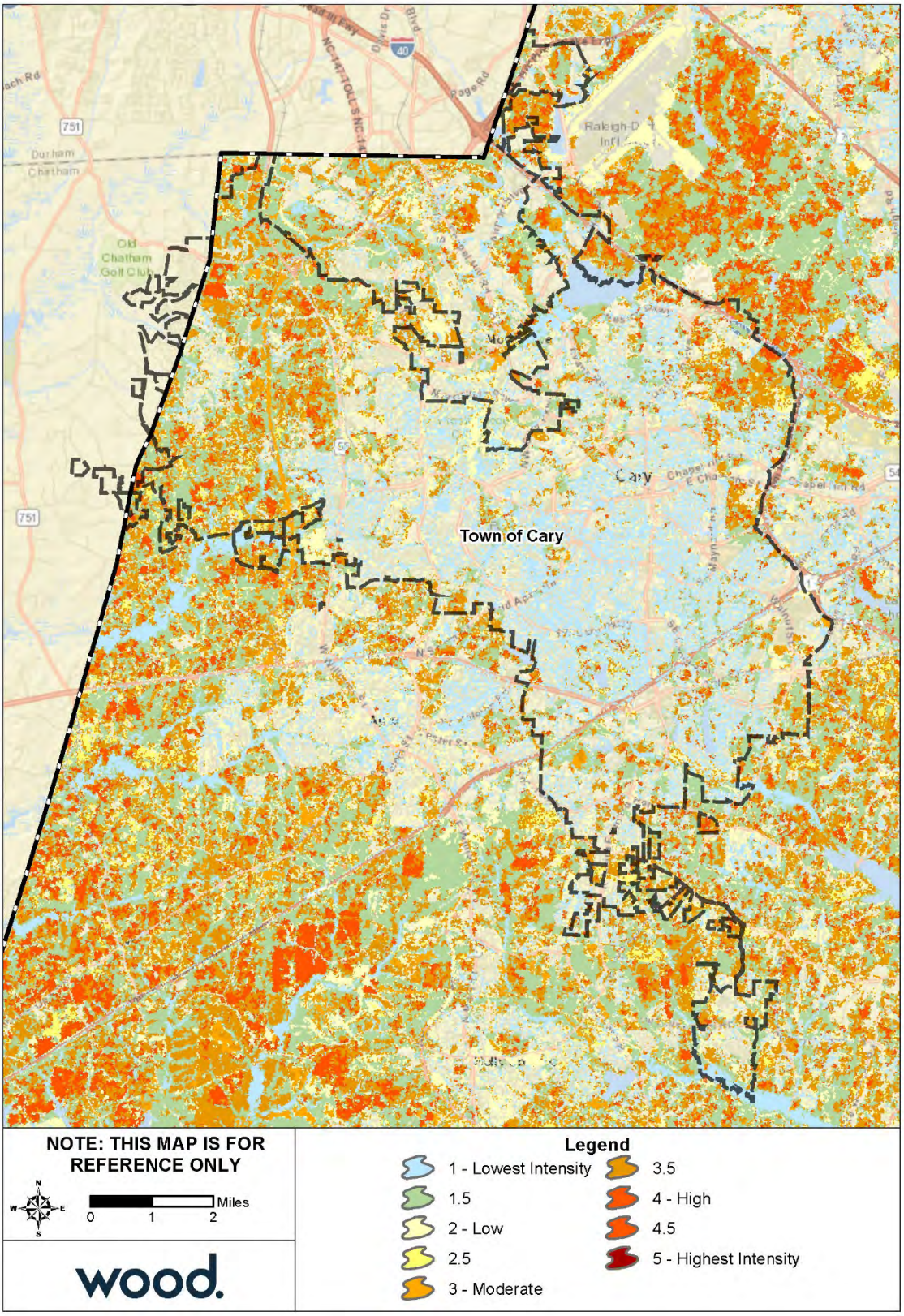
Potential fire intensity is highest in west and northeast Cary; while these areas are within the WUI, these areas have lower burn probability. Because these areas fall within the WUI, there is development potentially at risk to wildfire.

Figure D.5 – Wildland Urban Interface, Town of Cary



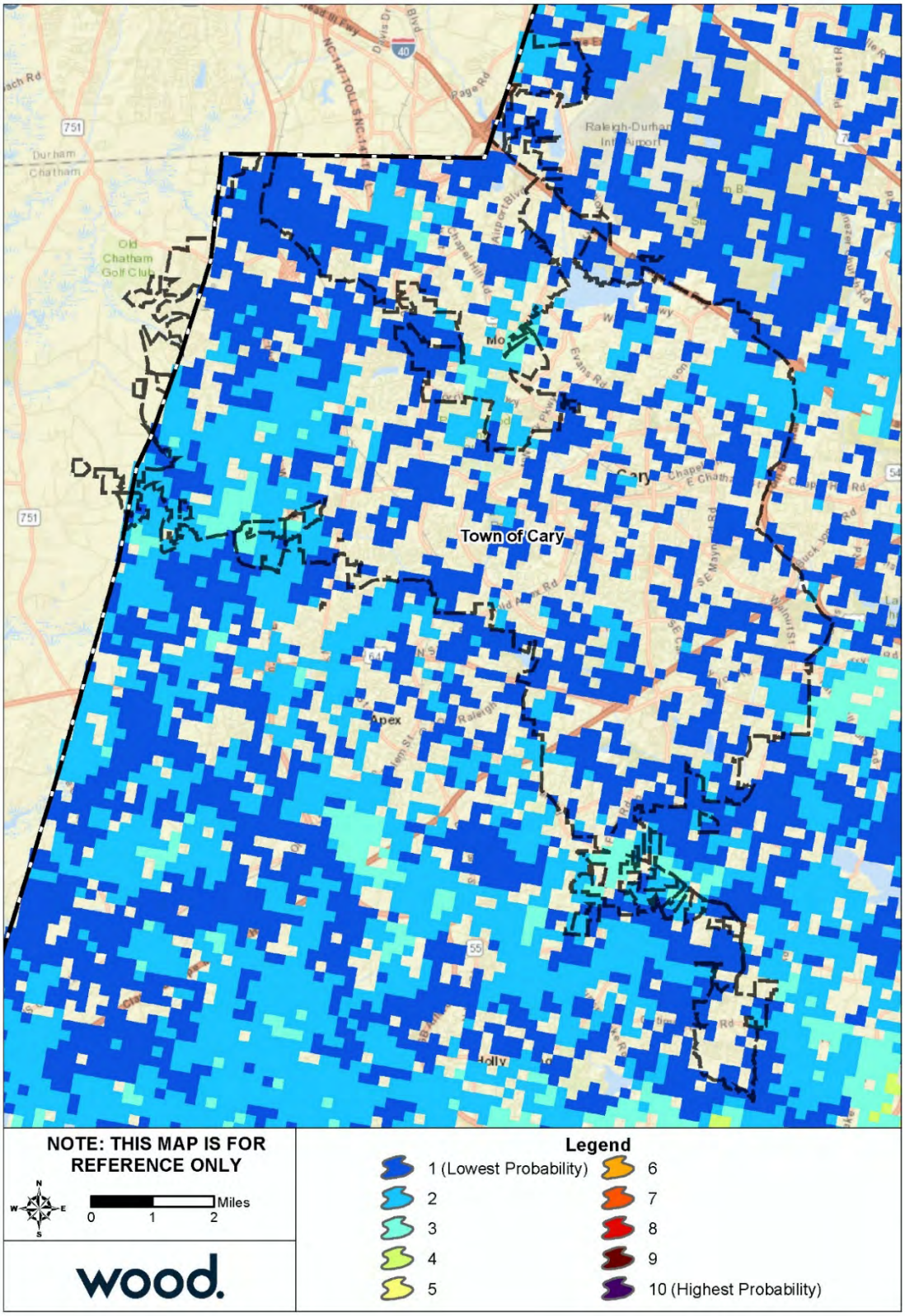
Source: Southern Wildfire Risk Assessment

Figure D.6 – Fire Intensity Scale, Town of Cary



Source: Southern Wildfire Risk Assessment

Figure D.7 – Burn Probability, Town of Cary



Source: Southern Wildfire Risk Assessment

D.4 CAPABILITY ASSESSMENT

D.4.1 Overall Capability

Details on the tools and resources in place and available to the Town of Cary were provided by the Town's HMPC representatives and are summarized in Section 5 Capability Assessment. Based on that information and using the scoring methodology detailed in that section, Cary has an overall capability rating of High. The Town's Self-Assessment of key capability areas is summarized in Table D.16 below.

Table D.16 – Capability Self-Assessment, Cary

Capability Area	Rating
Plans, Ordinances, Codes and Programs	High
Administrative and Technical Capability	High
Fiscal Capability	High
Education and Outreach Capability	High
Mitigation Capability	High
Political Capability	High
Overall Capability	High

D.4.2 Floodplain Management

The Town of Cary joined the NFIP through emergency entry in July 1975 and has been a regular participant since July 1978. The following tables reflect NFIP policy and claims data for the Town categorized by structure type, flood zone, Pre-FIRM and Post-FIRM.

Table D.17 – NFIP Policy and Claims Data by Structure Type

Structure Type	Number of Policies in Force	Total Premium	Insurance in Force	Number of Closed Paid Losses	Total of Closed Paid Losses
Single Family	738	$364,550	$220,419,800	137	$2,431,293.63
2-4 Family	9	$3,119	$2,068,500	0	$0.00
All Other Residential	20	$5,944	$3,006,500	0	$0.00
Non-Residential	28	$43,885	$12,181,000	1	$13,680.75
Total	795	$417,498	$237,675,800	138	$2,444,974.38

Source: FEMA Community Information System, accessed November 2018

Table D.18 – NFIP Policy and Claims Data by Flood Zone

Flood Zone	Number of Policies in Force	Total Premium	Insurance in Force	Number of Closed Paid Losses	Total of Closed Paid Losses
A01-30 & AE Zones	195	$151,960	$56,743,400	43	$879,969.16
A Zones	0	$0	$0	0	$0.00
AO Zones	0	$0	$0	0	$0.00
AH Zones	0	$0	$0	0	$0.00
AR Zones	0	$0	$0	0	$0.00
A99 Zones	0	$0	$0	0	$0.00
V01-30 & VE Zones	0	$0	$0	0	$0.00
V Zones	0	$0	$0	0	$0.00
D Zones	0	$0	$0	0	$0.00
B, C & X Zone					

Flood Zone	Number of Policies in Force	Total Premium	Insurance in Force	Number of Closed Paid Losses	Total of Closed Paid Losses
Standard	36	$53,141	$9,690,400	18	$320,961.62
Preferred	564	$212,397	$171,242,000	77	$1,244,043.60
Total	795	$417,498	$237,675,800	138	$2,444,974.38

Source: FEMA Community Information System, accessed November 2018

Table D.19 – NFIP Policy and Claims Data Pre-FIRM

Flood Zone	Number of Policies in Force	Total Premium	Insurance in Force	Number of Closed Paid Losses	Total of Closed Paid Losses
A01-30 & AE Zones	12	$20,853	$2,264,500	13	$493,539.53
A Zones	0	$0	$0	0	$0.00
AO Zones	0	$0	$0	0	$0.00
AH Zones	0	$0	$0	0	$0.00
AR Zones	0	$0	$0	0	$0.00
A99 Zones	0	$0	$0	0	$0.00
V01-30 & VE Zones	0	$0	$0	0	$0.00
V Zones	0	$0	$0	0	$0.00
D Zones	0	$0	$0	0	$0.00
B, C & X Zone	64	$28,712	$19,597,000	19	$361,025.79
Standard	4	$6,329	$1,200,000	1	$30,412.98
Preferred	60	$22,383	$18,397,000	18	$330,612.81
Total	76	$49,565	$21,861,500	32	$854,565.32

Source: FEMA Community Information System, accessed November 2018

Table D.20 – NFIP Policy and Claims Data Post-FIRM

Flood Zone	Number of Policies in Force	Total Premium	Insurance in Force	Number of Closed Paid Losses	Total of Closed Paid Losses
A01-30 & AE Zones	183	$131,107	$54,478,900	30	$386,429.63
A Zones	0	$0	$0	0	$0.00
AO Zones	0	$0	$0	0	$0.00
AH Zones	0	$0	$0	0	$0.00
AR Zones	0	$0	$0	0	$0.00
A99 Zones	0	$0	$0	0	$0.00
V01-30 & VE Zones	0	$0	$0	0	$0.00
V Zones	0	$0	$0	0	$0.00
D Zones	0	$0	$0	0	$0.00
B, C & X Zone	536	$236,826	$161,335,400	76	$1,203,979.43
Standard	32	$46,812	$8,490,400	17	$290,548.64
Preferred	504	$190,014	$152,845,000	59	$913,430.79
Total	719	$367,933	$215,814,300	106	$1,590,409.06

Source: FEMA Community Information System, accessed November 2018

D.5 MITIGATION STRATEGY

Town of Cary											
Action #	Description	Goal	Objective	Hazard(s) Addressed	Relative Priority	Lead Agency/ Department	Estimated Cost	Potential Funding Sources	Implementation Schedule	2019 Status	Status Comments/Explanation
Prevention											
P-1	Town's Comprehensive Plan- The Town has an existing comprehensive plan which includes land use, parks and recreation, open space, transportation, utilities, and environment.	4	2	All	High	Cary Planning	$1M for plan development; implementation ongoing	General Fund	2-3 years	In-Progress – Carry Forward	Cary's comprehensive plan, called alternately the Cary Community Plan and the Imagine Cary Plan was finalized on January 24, 2017. Implementation in-process.
P-2	Adaptive Approach to Stormwater	4	1	Flood	High	Cary Stormwater	$900,000	General Fund and $300K Grant	Ongoing	New	Multi-pronged approach including 5 key components: 1) Working Group of residents and local experts to learn and advise 2) Maintenance, including Condition Assessment (a separately listed "action") 3) Open Space, examining how open space and tree canopy provide stormwater benefits 4) Model, hiring a firm to build a hynamic rainfall-runoff model to establish a baseline and test solutions and scenarios 5) Ordinance, looking at the stormwater ordinance as a way to achieve our risk mitigation goals
P-3	Stormwater Condition Assessment Program	4	2	Flood	High	Cary Stormwater	$750,000	General Fund	2-3 years	New	In phase 4, (1-GIS Assessment Tool, 2-GIS Mapping Data and assessment, 3-Modeling, 4-Maintenance) Assessment Tool completed. GIS Mapping 99% completed.
P-4	Develop flood model for upper Swift Creek watershed	2	2	Flood, Hurricane	High	Cary Stormwater	Unknown	Town Funds	1 year	New	N/A
P-5	Develop flood model for Symphony Lake	2	2	Flood, Hurricane	High	Cary Stormwater	Unknown	Town Funds	2-3 years	New	N/A
P-6	Engineering evaluation of Tryon Road dam	2	2	Dam Failure	Moderate	Cary Stormwater	Unknown	Town Funds	3-5 years	New	N/A
P-7	Conduct study and develop improvement plan for Twin Lakes dam	2	2	Dam Failure	High	Cary Stormwater	Unknown	Town Funds	3-5 years	New	N/A
P-8	Conduct flood study on Town-owned lake/dam, including breach analysis	2	2	River Flooding, Dam Failure	High	Cary Stormwater	Unknown	Town Funds	2-3 years	New	N/A
P-9	Triangle Regional Resiliency Partnership	4	1	River Flooding, Wildfire, Drought, Extreme Heat	Moderate	Town of Cary	Variable (depending on outside consultants)	General Funds	Ongoing	New	On-going partnership among Triangle area jurisdictions intended to do joint resilience planning and action. The group's first deliverable of a Triangle Regional Resilience Assessment was finalized late 2018. The group is continuing to meet and consider how it may implement recommendations of the assessment together.
Property Protection											
PP-1	Culvert Replacement - Arbor Brook	3	2	Flood	High	Cary Stormwater	$400,000	General Fund	1 year	New	Replace existing culverts with larger culverts
PP-2	Culvert Replacement - Two Creeks	3	2	Flood	High	Cary Stormwater	$800,000	General Fund	1 year	New	Replace existing culverts with larger culverts
Natural Resource Protection											
NRP-1	Downtown Park	3	2	Flood	High	Cary Stormwater and Facilities	$750,000	General Fund	2-3 years	New	In planning phase. Implementing SW management above and beyond state requirements. Detention of 2, 5 and 10-year storm reduces scour on receiving stream.
NRP-2	Buffer and UTB Protection	3	2	Flood	High	Cary Stormwater and Cary Planning	Over $10,000,000	Private (Developer) Funds	Ongoing - Next 5 Years	New	Extra 50-foot buffer (UTB) on USGS streams; no buffers platted in lots.
Structural Projects											
SP-1	Infrastructure improvements on Summer Lakes Dr.	3	2	Flood	High	Cary Stormwater	$900,000	General Fund	1 year	New	Replace existing undersized culverts
SP-2	Infrastructure improvements on Vincrest Ct	3	2	Flood	High	Cary Stormwater	$400,000	General Fund	2-3 years	New	Replace existing undersized culverts
SP-3	Update Water Shortage Response Plan	2	4	Drought	High	Town of Cary	Staff Time	N/A	1 year	New	N/A

Town of Cary											
Action #	Description	Goal	Objective	Hazard(s) Addressed	Relative Priority	Lead Agency/ Department	Estimated Cost	Potential Funding Sources	Implementation Schedule	2019 Status	Status Comments/Explanation
SP-4	Water System Risk Analysis	3	1	All	High	Town of Cary	$89,000	General Fund	Ongoing - 1 Year	New	The Water System Risk Analysis is a comprehensive look at the risks to our water system. It is being done to comply with the American Water Infrastructure Act of 2018. It will result in a new emergency response plan for our water system.
Emergency Services											
ES-1	Provide and enhance technical rescue capabilities throughout the Town.	2	1	All	High	Cary Fire	Unknown	Local	Ongoing - Next 5 Years	In-Progress – Carry Forward	Cary's Fire Department has a technical rescue training program that we coordinate with Morrisville and Apex, NC. We train on all disciplines of technical rescue.
ES-2	Provide after-action report of emergency response to severe weather events in order to improve planning for future disasters.	2	2	All	High	Cary Fire, Water Resources, and Facilities Design & Transportation Services	Unknown	General Fund	Ongoing - Next 5 Years	In-Progress – Carry Forward	Cary's key emergency response departments have formal after-action meetings to learn from what went well and seek opportunities to improve. This occurs after each event, so is ongoing in nature.
ES-3	Establish a relationship/partnership with the Renaissance Computing Institute (RENCI) to create a web-based tool capable of providing real-time flood data to emergency managers and historic data for future emergency response planning.	2	2	All	Low	Cary Fire and Technology Services	Unknown	General Fund	Ongoing – Next 5 Years	In-Progress – Carry Forward	Still in the early stages of developing this partnership.
ES-4	Partnership with FBI Terrorism Task Force	2	2	Terrorism	Moderate	Town of Cary, Town of Cary Police	$100,000	General Fund	Ongoing	New	Since 2011 the Town of Cary Police have an officer assigned full time to the FBI Terrorism Task Force to maintain a relationship with the FBI. FBI Terrorism Task Force located in the FBI Raleigh Office located in the Town of Cary off Cary Parkway near US 1. Wake County Emergency Management has a plan for large scale events that impact Wake County. Those plans include guidance for law enforcement as part of a multi-agency response to all sorts of issues that could include the unlikely event of a terrorist attack.
ES-5	Inclement Weather Response Plan	2	1	Severe Winter Storm, Thunderstorm, Hurricane	Moderate	Town of Cary, Town of Cary Public Works	$100,000 - $1 Million (depending on number and type)	General Fund	Ongoing	New	The town commits significant Town-wide resource allocation and operational commitment to ensuring all aspects of winter weather events are planned, executed, and reviewed to maximize positive recovery outcomes for its citizens. The Town has similar structure and programs for thunderstorm or wind events.
Public Education and Awareness											
PEA-1	Environmental Education "green infrastructure" signage on Dry Avenue Properties that were bought out due to flooding. Signs to be installed early 2019	1	1	Flood	Low	Cary Stormwater and Sustainability	$11,000	Local	Ongoing - Next 5 Years	New	N/A
PEA-2	Citizen volunteers make up the Community Emergency Response Team (CERT). CERT training is a Citizens Corps program designed to enable citizens to care for themselves and their neighbors during the first three days following a disaster event. Participants are educated about disaster preparedness, CERT organization, light search and rescue, medical care, fire extinguisher use and disaster psychology.	1	2	All	Moderate	Cary Police Department and Fire Department	$1,000/year	Donations	Ongoing - Next 5 Years	New	N/A

Annex E Town of Fuquay-Varina

E.1 PLANNING PROCESS

The table below lists the HMPC members who represented the Town of Fuquay-Varina.

Table E.1 – HMPC Members

Agency	Representative	Position or Title
Planning Department	Samantha Smith	Planning Director
Planning Department	Alyssa Stafford	Planner
N/A	Ed Ridpath	Citizen Stakeholder

E.2 COMMUNITY PROFILE

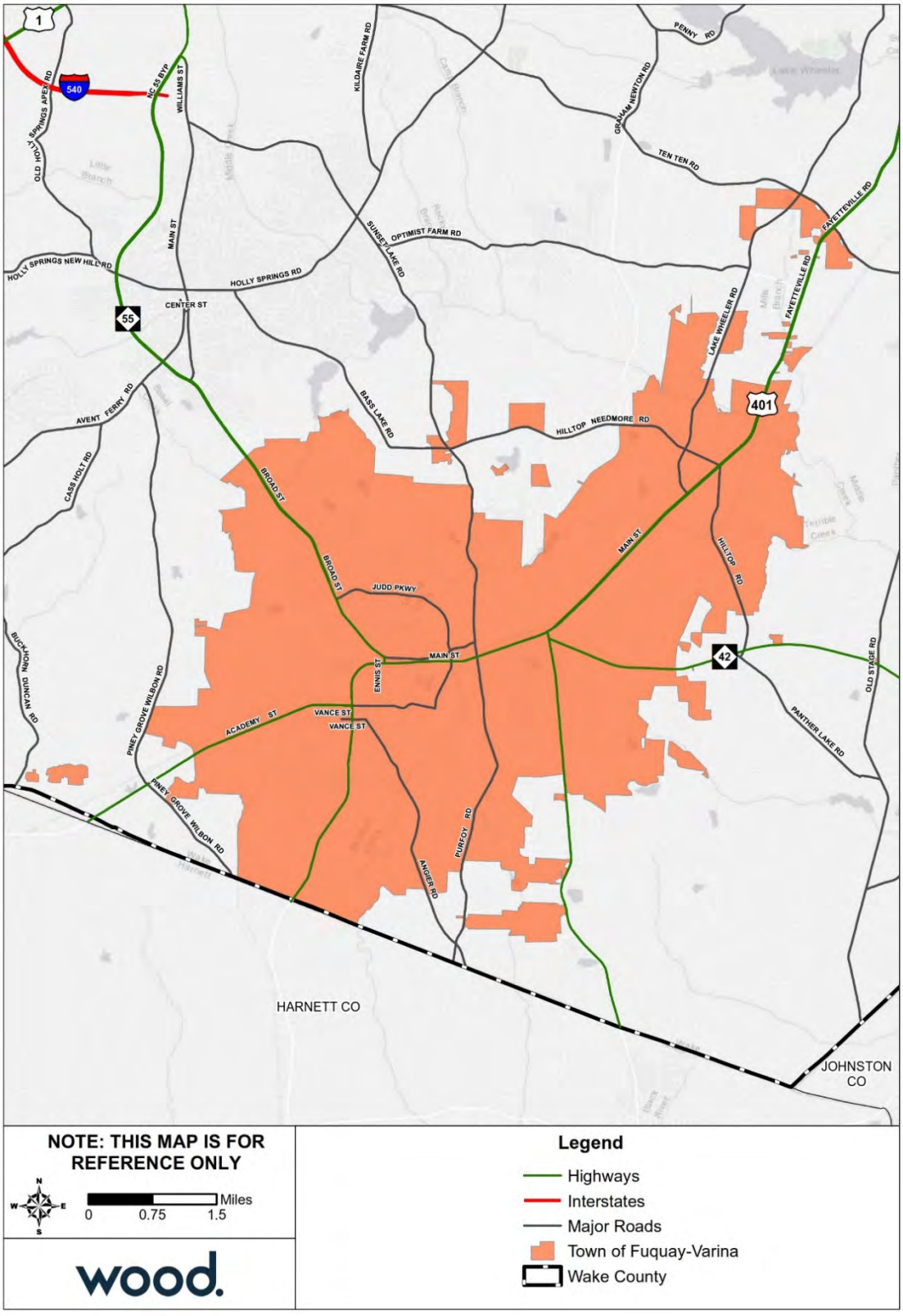
Geography

The Town of Fuquay-Varina is located in southern Wake County. It is neighbored by Holly Springs to the northwest, Angier to the southeast, and Harnett County to the southwest. The Town is part of the Raleigh, NC Metropolitan Statistical Area, which falls within the larger Raleigh-Durham-Chapel Hill, NC Combined Statistical Area. Fuquay-Varina comprises a total land area of 12.1 square miles.

Figure E.1 shows a base map of the major transportation routes in the Town of Fuquay-Varina.

According to data from the U.S. Fish and Wildlife Service's National Wetlands Inventory, there are approximately 1,450 acres of wetlands in Fuquay-Varina.

Figure E.1 – Major Transportation Routes – Town of Fuquay-Varina



Source: Wake County GIS Open Data

Population and Demographics

Table E.2 provides population counts and growth estimates for the Town of Fuquay-Varina as compared to the County overall. Table E.3 provides demographic information for Fuquay-Varina as compared to the whole County.

Table E.2 – Population Counts, Fuquay-Varina, 2010-2017

Jurisdiction	2000 Census Population	2010 Census Population	2017 ACS Population Estimate	Total Change 2010-2017	% Change 2010-2017
Wake County total	**627,846**	**900,993**	**1,023,811**	**122,818**	**13.6%**
Town of Fuquay-Varina	7,898	17,937	24,373	6,436	35.9%

Source: US Census Bureau Decennial Census 2000, Decennial Census 2010; American Community Survey 2013-2017 5-Year Estimates

Table E.3 – Racial Demographics, Fuquay-Varina, 2017

Jurisdiction	White, %	Black, %	Asian, %	Other Race, %	Two or More Races, %	Persons of Hispanic or Latino Origin*, %
Wake County total	**66.5%**	**20.4%**	**6.5%**	**3.6%**	**2.7%**	**10.0%**
Town of Fuquay-Varina	77.5%	15.4%	1.6%	2.8%	2.7%	9.4%

Source: US Census Bureau, American Community Survey 2013-2017 5-Year Estimates

*Persons of Hispanic origin may be of any race, so also are included in applicable race categories

Asset Inventory

The following tables summarize the asset inventory for Fuquay-Varina in order to estimate the total physical exposure to hazards in this area. The locations of critical facilities are shown in Figure E.2 on the following page. Critical facilities are a subset of identified assets from the Critical Infrastructure & Key Resources dataset. Note that the counts are by building; where a critical facility comprises a cluster of buildings, each building is counted and displayed.

Table E.4 – Critical Infrastructure & Key Resources by Type

Jurisdiction	Food & Agriculture	Banking & Finance	Chemical	Commercial Facilities	Communications	Manufacturing	Defense	Government	Healthcare	IT	National Monuments	Nuclear	Postal & Shipping	Transportation	Energy	Emergency Services	Water	Other	Total
Town of Fuquay-Varina	136	17	0	275	0	150	1	69	27	0	0	0	0	37	0	3	5	0	**720**

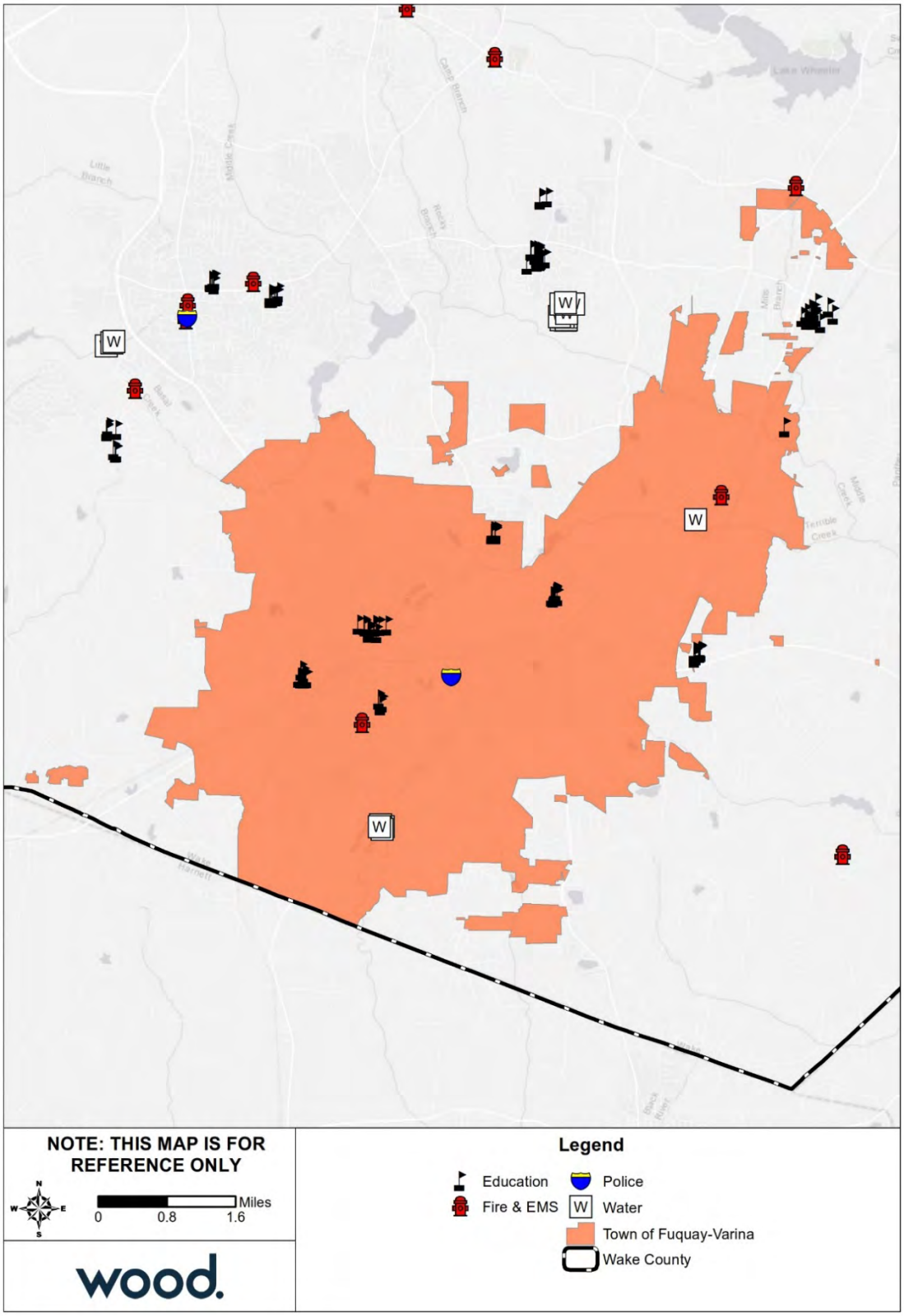
Source: NCEM Risk Management Tool

Table E.5 – High Potential Loss Facilities by Use

Jurisdiction	Residential	Commercial	Industrial	Government	Agricultural	Religious	Utilities	Other	Total
Town of Fuquay-Varina	19	52	16	15	1	17	5	0	**125**

Source: NCEM Risk Management Tool

Figure E.2 – Critical Facilities, Town of Fuquay-Varina



Source: NCEM IRISK Database, GIS Analysis

To supplement the asset inventory and provide a clearer picture of the current asset exposure in the Town of Fuquay-Varina, current parcel data was evaluated to identify development since 2010. This information is not incorporated into the risk assessment, which was prepared using NCEM's IRISK database. However, this summary of development since 2010 provides some context to understand the degree to which the IRISK exposure and vulnerability numbers differ from current conditions.

Table E.6 provides a summary by land class of parcel development from January 2011 to April 2019.

Table E.6 – Parcels Developed 2011 or Later, Town of Fuquay-Varina

Land Class	Number of Parcels	Sum of Building Value
Acres Greater Than 10 With House	2	$510,076
Apartment	5	$56,588,768
Commercial	35	$39,296,320
EXEMPT	4	$4,553,482
HOA	1	-
Industrial	5	$4,294,864
Part Exempt	4	$916,806
Residential Less than 10 Acres	3,809	$847,692,058
Retirement Home	1	$9,101,418
Vacant	2	-
Grand Total	**3,868**	**$962,953,892**

Source: Wake County Open Data; retrieved April 8, 2019

There are 12 listings on the National Register of Historic Places for the Town of Fuquay-Varina, including 4 historic districts. These sites are listed in the table below.

Table E.7 – Historic Properties

Ref#	Property Name	Status Date	Category	City
14000230	Fuquay Springs Historic District (Boundary Increase)	5/19/2014	District	Fuquay Varina
14001023	Stevens, Wayland H. and Mamie Burt, House	12/10/2014	Building	Fuquay Varina
86003457	Fuquay Mineral Spring	12/4/1986	Site	Fuquay-Varina
89002352	Jones--Johnson--Ballentine Historic District	1/26/1990	District	Fuquay-Varina
89002351	Varina Commercial Historic District	1/31/1990	District	Fuquay-Varina
91001375	Johnson, J. Beale, House	9/5/1991	Building	Fuquay-Varina
97000195	Ben--Wiley Hotel	2/27/1997	Building	Fuquay-Varina
02000495	Fuquay Springs High School	5/16/2002	Building	Fuquay-Varina
07000352	Fuquay-Varina Woman's Club Clubhouse	4/24/2007	Building	Fuquay-Varina
96001398	Fuquay Springs Historic District	11/29/1996	District	Fuquay-Varina
05001028	Johnson, Kemp B., House	9/15/2005	Building	Fuquay-Varina
05001448	Fuquay Springs Teacherage	12/23/2005	Building	Fuquay-Varina

Source: National Parks Service, National Register of Historic Places, October 2018

Housing

The table below details key housing statistics for Fuquay-Varina as compared to the County overall.

Table E.8 – Housing Statistics, Fuquay-Varina, 2010-2017

Jurisdiction	Housing Units (2010)	Housing Units (2017)	Housing Units Percent Change (2010-2017)	Owner-Occupied, % (2017)	Vacant Units, % (2017)	Median Home Value (2017)
Wake County total	**371,836**	**411,632**	**10.7%**	**59.5%**	**7.2%**	**$250,700**
Town of Fuquay-Varina	7,325	8,626	17.8%	69.8%	4.1%	$221,000

Source: U.S. Census Bureau 2010 Decennial Census, American Community Survey 2013-2017 5-Year Estimates
Note: Owner-Occupied and vacant-unit measures are reported as a percent of the total number of housing units.

Economy

The following tables present key economic statistics for Fuquay-Varina as compared to the County overall.

Table E.9 – Employment Statistics, Fuquay-Varina, 2017

Jurisdiction	Population in Labor Force	Percent Employed* (%)	Percent Unemployed* (%)	Percent Not in Labor Force* (%)	Unemployment Rate (%)
Wake County	**564,096**	**67.2**	**3.5**	**29.2**	**4.9**
Town of Fuquay-Varina	12,407	65.9	3.9	29.9	5.6

Source: U.S. Census Bureau, American Community Survey 2013-2017 5-Year Estimates
Note: This table reports only the civilian labor force. The labor force in armed services accounted for 0.3% or less of the population 16 and over in all jurisdictions. *Population employed, population unemployed, and Population not in labor force are reported as a percent of the total population aged 16 years and older.

Table E.10 – Percent of Employed Population by Occupation, Fuquay-Varina, 2017

Occupation	Management, business, science and arts (%)	Service (%)	Sales and Office (%)	Natural Resources, Construction, and Maintenance (%)	Production, transportation, and material moving (%)
Wake County	**50.1**	**13.8**	**23.4**	**6.0**	**6.7**
Town of Fuquay-Varina	47.3	16.7	22.4	5.3	8.3

Source: U.S. Census Bureau, American Community Survey 2013-2017 5-Year Estimates

E.3 RISK ASSESSMENT

This section contains a hazard profile and vulnerability assessment for those hazards that were rated with a higher priority for the Town of Fuquay-Varina than for Wake County as a whole. Risk and vulnerability findings are also presented here for those hazards that are spatially defined and have variations in risk that could be evaluated quantitatively on a jurisdictional level. The hazards included in this section are: Flood and Wildfire.

E.3.1 Flood

Table E.11 details the acreage of the Town of Fuquay-Varina by flood zone on the effective DFIRM. Per this assessment, over 5 percent of the Town of Fuquay-Varina falls within the mapped 1%-annual-chance floodplains.

Table E.11 – Flood Zone Acreage in the Town of Fuquay-Varina

Flood Zone	Acreage	Percent of Total (%)
Zone A	14.13	0.07
Zone AE	1,033.76	5.40
Zone X (500-year)	135.68	0.71
Zone X Unshaded	17,977.26	91.80
Total	**19,160.83**	--

Source: FEMA Effective DFIRM; Wake County GIS

Figure E.3 reflects the effective mapped flood hazard zones for the Town of Fuquay-Varina, and Figure E.4 displays the depth of flooding estimated to occur in these areas during the 1%-annual-chance flood.

To supplement the IRISK assessment of property at risk from the 1% annual chance flood event in Section 4 and provide a clearer picture of the current property at risk in Town of Fuquay-Varina, current parcel data was evaluated to identify parcels developed since 2010. Using GIS analysis, parcels developed after 2010 were compared to the boundaries of the 1% annual chance floodplain to identify the exposure of newly developed property to the base flood. For parcels where updated building footprints were available, the parcel was considered exposed only if the building intersected the floodplain boundary, otherwise, a parcel was considered exposed to the floodplain if any portion of the parcel was located in the floodplain. However

This assessment does not evaluate flood impacts or provide damage estimates. However, this summary of development in or near the floodplain since 2010 provides some context to understand the degree to which the IRISK exposure and vulnerability numbers differ from current conditions.

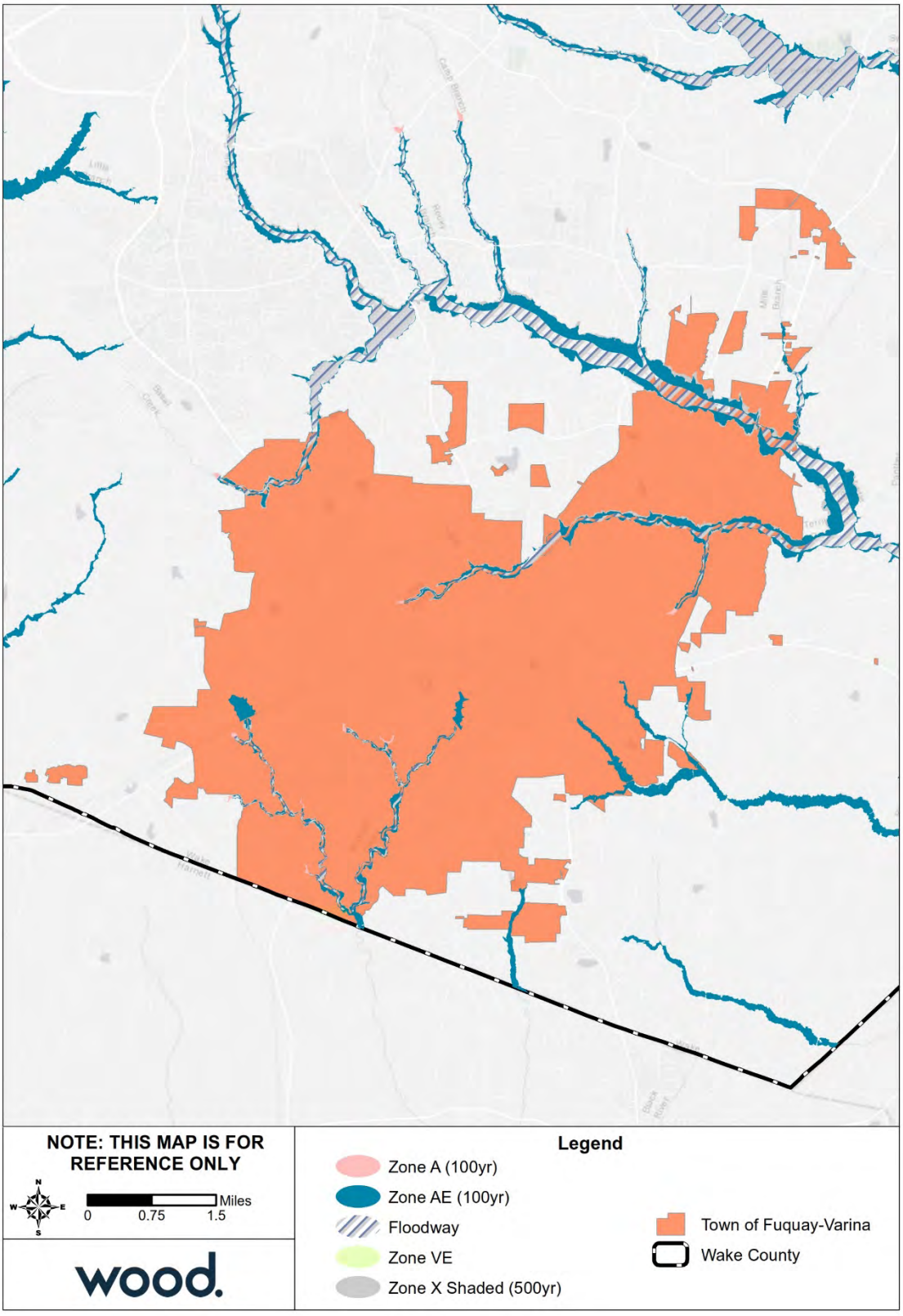
Table E.12 provides a summary by land class of parcel development located in the 1% annual chance floodplain from January 2011 to April 2019.

Table E.12 – Parcels Developed 2011 or Later and Located in 100-Year Floodplain, Town of Fuquay-Varina

Land Class	Number of Parcels	Sum of Building Value
Commercial	1	$5,138,598
Industrial	3	$955,917
Residential Less Than 10 Acres	58	$12,968,191
Grand Total	**62**	**$19,062,706**

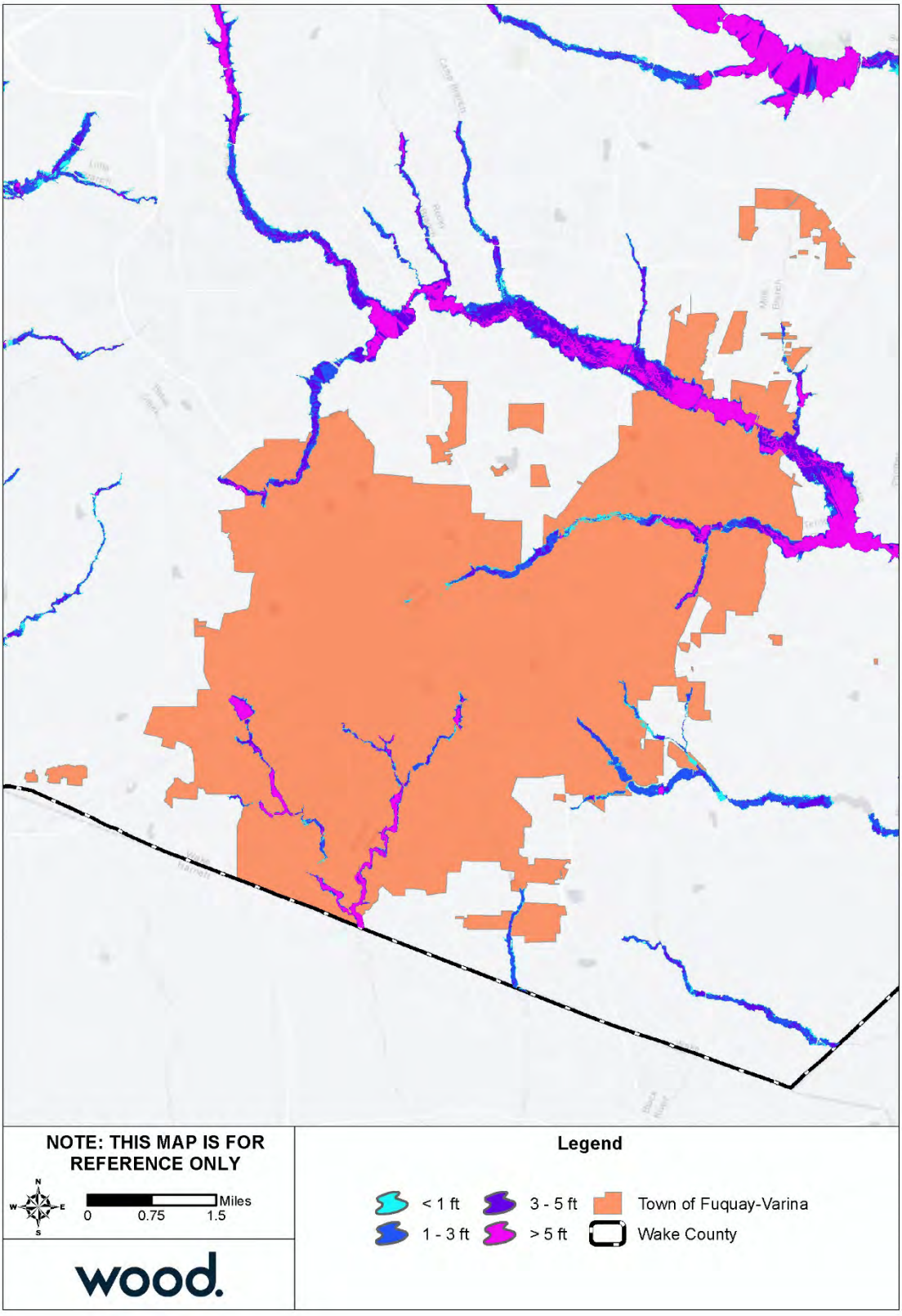
Source: Wake County Open Data; retrieved April 8, 2019; FEMA Effective DFIRM

Figure E.3 – FEMA Flood Hazard Areas, Town of Fuquay-Varina



Source: FEMA Effective DFIRM

Figure E.4 – Flood Depth, 1%-Annual-Chance Floodplain, Town of Fuquay-Varina



Source: FEMA Effective DFIRM

E.3.2 Wildfire

Table E.13 summarizes the acreage in the Town of Fuquay Varina that falls within the Wildland Urban Interface (WUI), categorized by housing density. Areas in the WUI are those where development may intermix with flammable vegetation. Over 8 percent of the Town of Fuquay Varina is not included in the WUI.

Table E.13 – Wildland Urban Interface Acreage, Town of Fuquay-Varina

	Housing Density	Total Acreage	Percent of Total Acreage
	Not in WUI	*1,653.7*	*8.6%*
	LT 1hs/40ac	1,157.2	6.0%
	1hs/40ac to 1hs/20ac	1,275.1	6.7%
	1hs/20ac to 1hs/10ac	1,676.9	8.8%
	1hs/10ac to 1hs/5ac	2,243.2	11.7%
	1hs/5ac to 1hs/2ac	4,180.1	21.8%
	1hs/2ac to 3hs/1ac	6,774.3	35.4%
	GT 3hs/1ac	200.1	1.0%
	Total	19,160.6	

Source: Southern Wildfire Risk Assessment

Figure E.5 depicts the WUI the Town of Fuquay-Varina. The WUI is the area where housing development is built near or among areas of vegetation that may be prone to wildfire. Figure E.6 depicts the Fire Intensity Scale, which indicates the potential severity of fire based on fuel loads, topography, and other factors. Figure E.7 depicts Burn Probability based on landscape conditions, percentile weather, historical ignition patterns, and historical prevention and suppression efforts.

Potential fire intensity is highest in central Fuquay-Varina as well as some areas in the southwest and northeast. These areas are generally within the WUI, but in the central area, there is a lower burn probability. The southern and eastern regions of the Town have moderate burn probabilities, and some areas within these regions have relatively high potential fire intensity and fall within the WUI, putting some development potentially at risk.

Table E.14 provides building counts and estimated damages for Critical Infrastructure and Key Resources (CIKR) buildings by sector at risk to wildfire hazard. Table E.15 provides counts and estimated damages for High Potential Loss Properties in the Town of Fuquay-Varina.

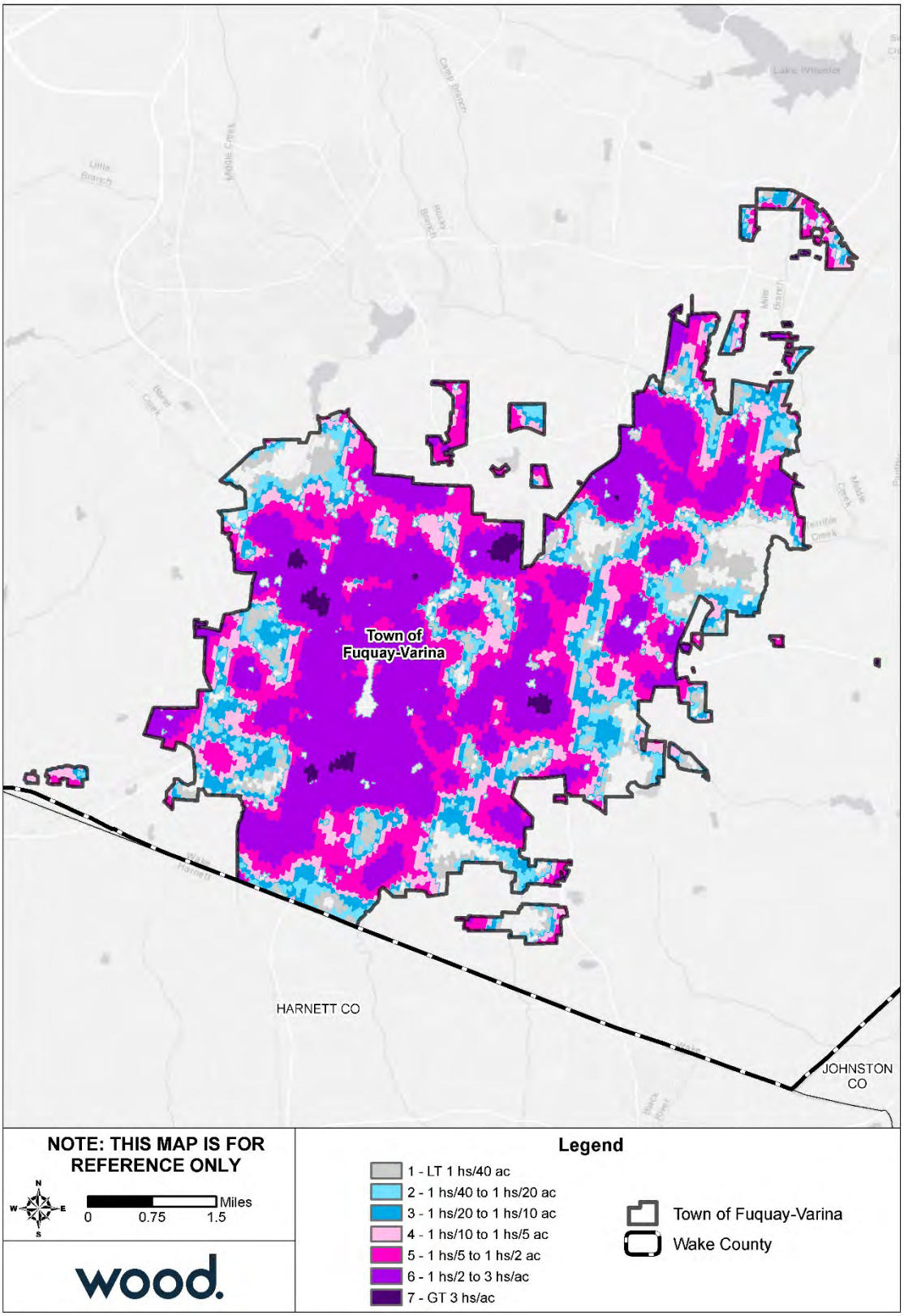
Table E.14 – Critical Facilities Exposed to Wildfire, Town of Fuquay-Varina

Sector	Event	Number of Buildings at Risk	Estimated Damages
Commercial Facilities	Wildfire Hazard	2	$3,985,087
Critical Manufacturing	Wildfire Hazard	1	$3,305,808
All Categories	**Wildfire Hazard**	**3**	**$7,290,895**

Table E.15 – High Potential Loss Properties Exposed to Wildfire, Town of Fuquay-Varina

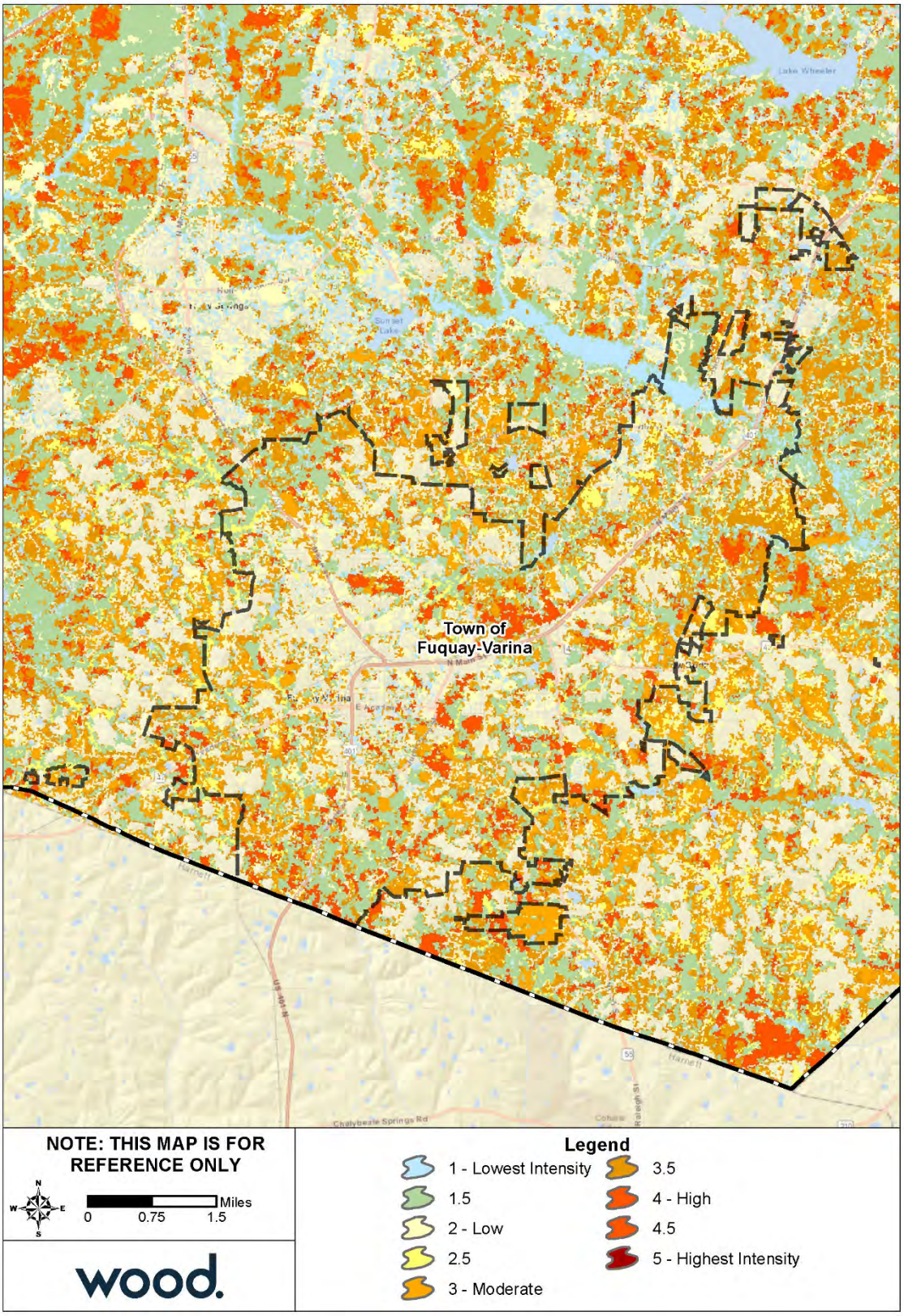
Category	Event	Number of Buildings at Risk	Estimated Damages
Commercial	Wildfire Hazard	1	$3,321,296
Residential	Wildfire Hazard	2	$3,915,097
All Categories	**Wildfire Hazard**	**3**	**$7,236,393**

Figure E.5 – Wildland Urban Interface, Fuquay-Varina



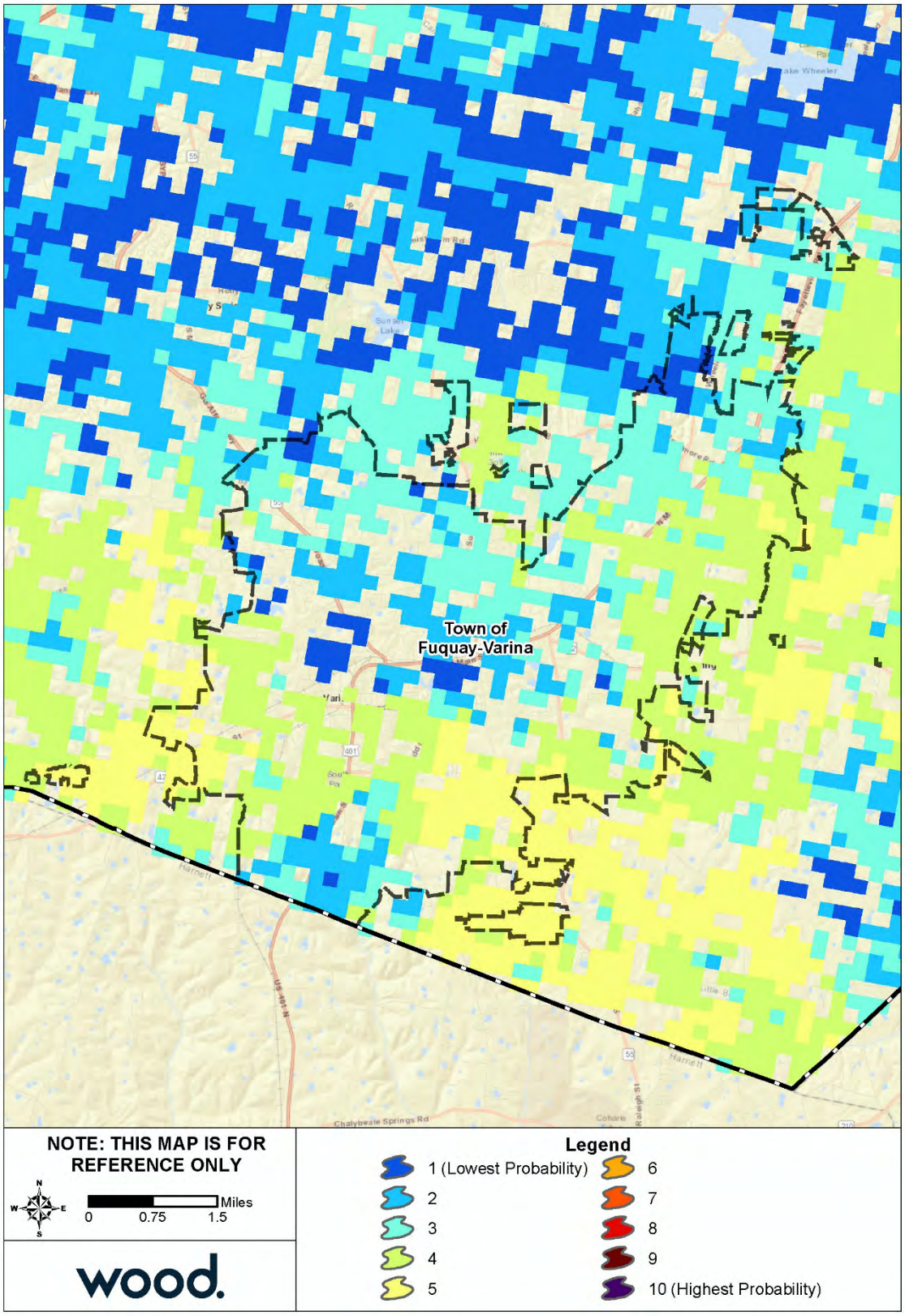
Source: Southern Wildfire Risk Assessment

Figure E.6 – Fire Intensity Scale, Fuquay Varina



Source: Southern Wildfire Risk Assessment

Figure E.7 – Burn Probability, Fuquay Varina



Source: Southern Wildfire Risk Assessment

E.4 CAPABILITY ASSESSMENT

E.4.1 Overall Capability

Details on the tools and resources in place and available to the Town of Fuquay-Varina were provided by the Town's HMPC representatives and are summarized in Section 5 Capability Assessment. Based on that information and using the scoring methodology detailed in that section, Fuquay-Varina has an overall capability rating of High. The Town's Self-Assessment of key capability areas is summarized in Table E.16 below.

Table E.16 – Capability Self-Assessment, Fuquay-Varina

Capability Area	Rating
Plans, Ordinances, Codes and Programs	High
Administrative and Technical Capability	High
Fiscal Capability	High
Education and Outreach Capability	High
Mitigation Capability	High
Political Capability	High
Overall Capability	High

E.4.2 Floodplain Management

The Town of Fuquay-Varina joined the NFIP through emergency entry in January 1975 and has been a regular participant since November 1978. The following tables reflect NFIP policy and claims data for the Town categorized by structure type, flood zone, Pre-FIRM and Post-FIRM.

Table E.17 – NFIP Policy and Claims Data by Structure Type

Structure Type	Number of Policies in Force	Total Premium	Insurance in Force	Number of Closed Paid Losses	Total of Closed Paid Losses
Single Family	126	$49,897	$34,163,900	3	$107,051.14
2-4 Family	0	$0	$0	0	$0.00
All Other Residential	0	$0	$0	0	$0.00
Non-Residential	1	$3,583	$750,000	0	$0.00
Total	127	$53,480	$34,913,900	3	$107,051.14

Source: FEMA Community Information System, accessed November 2018

Table E.18 – NFIP Policy and Claims Data by Flood Zone

Flood Zone	Number of Policies in Force	Total Premium	Insurance in Force	Number of Closed Paid Losses	Total of Closed Paid Losses
A01-30 & AE Zones	17	$12,397	$3,586,100	2	$101,268.39
A Zones	0	$0	$0	0	$0.00
AO Zones	0	$0	$0	0	$0.00
AH Zones	0	$0	$0	0	$0.00
AR Zones	0	$0	$0	0	$0.00
A99 Zones	0	$0	$0	0	$0.00
V01-30 & VE Zones	0	$0	$0	0	$0.00
V Zones	0	$0	$0	0	$0.00
D Zones	0	$0	$0	0	$0.00

Flood Zone	Number of Policies in Force	Total Premium	Insurance in Force	Number of Closed Paid Losses	Total of Closed Paid Losses
B, C & X Zone					
Standard	1	$127	$5,800	0	$0.00
Preferred	109	$40,956	$31,322,000	1	$5,782.75
Total	127	$53,480	$34,913,900	3	$107,051.14

Source: FEMA Community Information System, accessed November 2018

Table E.19 – NFIP Policy and Claims Data Pre-FIRM

Flood Zone	Number of Policies in Force	Total Premium	Insurance in Force	Number of Closed Paid Losses	Total of Closed Paid Losses
A01-30 & AE Zones	4	$5,225	$853,500	2	$101,268.39
A Zones	0	$0	$0	0	$0.00
AO Zones	0	$0	$0	0	$0.00
AH Zones	0	$0	$0	0	$0.00
AR Zones	0	$0	$0	0	$0.00
A99 Zones	0	$0	$0	0	$0.00
V01-30 & VE Zones	0	$0	$0	0	$0.00
V Zones	0	$0	$0	0	$0.00
D Zones	0	$0	$0	0	$0.00
B, C & X Zone	8	$2,894	$2,170,000	1	$5,782.75
Standard	0	$0	$0	0	$0.00
Preferred	8	$2,894	$2,170,000	1	$5,782.75
Total	12	$8,119	$3,023,500	3	$107,051.14

Source: FEMA Community Information System, accessed November 2018

Table E.20 – NFIP Policy and Claims Data Post-FIRM

Flood Zone	Number of Policies in Force	Total Premium	Insurance in Force	Number of Closed Paid Losses	Total of Closed Paid Losses
A01-30 & AE Zones	13	$7,172	$2,732,600	0	$0.00
A Zones	0	$0	$0	0	$0.00
AO Zones	0	$0	$0	0	$0.00
AH Zones	0	$0	$0	0	$0.00
AR Zones	0	$0	$0	0	$0.00
A99 Zones	0	$0	$0	0	$0.00
V01-30 & VE Zones	0	$0	$0	0	$0.00
V Zones	0	$0	$0	0	$0.00
D Zones	0	$0	$0	0	$0.00
B, C & X Zone	102	$38,189	$29,157,800	0	$0.00
Standard	1	$127	$5,800	0	$0.00
Preferred	101	$38,062	$29,152,000	0	$0.00
Total	115	$45,361	$31,890,400	0	$0.00

Source: FEMA Community Information System, accessed November 2018

E.5 MITIGATION STRATEGY

Town of Fuquay-Varina											
Action #	**Description**	**Goal**	**Objective**	**Hazard(s) Addressed**	**Relative Priority**	**Lead Agency/ Department**	**Estimated Cost**	**Potential Funding Sources**	**Implementation Schedule**	**2019 Status**	**Status Comments/Explanation**
Prevention											
P-1	Require pre and post construction certification for residential lot development within 10 feet of Wake County Flood Hazard Soils.	4	1	Flood	Moderate	Fuquay-Varina Planning	Budgeted Staff Time	Annual Budget	Ongoing - Next 5 Years	In-Progress – Carry Forward	Part of permit review process
P-2	Annually calculate acreage of flood prone property preserved as open space.	2	2	Flood, Hurricane	Moderate	Fuquay-Varina Planning	Budgeted Staff Time	Annual Budget	Ongoing - Next 5 Years	In-Progress – Carry Forward	Part of an annual report
P-3	Map storm water drainage system as part of Phase II Stormwater Management Plan.	2	2	Flood	High	Fuquay-Varina Engineering	Budgeted Staff Time	Annual Budget	Ongoing - Next 5 Years	In-Progress – Carry Forward	Part of infrastructure acceptance / ongoing project to work on historical data inclusion
P-4	Provide for public dissemination building inspections brochures regarding high winds, water damage prevention, and tie downs for accessory structures.	1	1	Flood, Tornado, Hurricane, Severe Weather	Moderate	Fuquay-Varina Inspections	Budgeted Staff Time	Annual Budget	Ongoing - Next 5 Years	In-Progress – Carry Forward	Brochures continuously made available to public at Town Hall
P-5	Review and update of drought policy for water conservation	2	2	Drought	High	Fuquay-Varina Planning	Budgeted Staff Time	Annual Budget	3-5 years	New	N/A
P-6	Review and update requirements for mast arms to be installed over strain poles	3	2	Severe Weather, Severe Winter Storm, Hurricane, Tornado	Moderate	Fuquay-Varina Planning	Budgeted Staff Time	Annual Budget	3-5 years	New	N/A
P-7	Review and update the 2014 Comprehensive Systemwide Parks, Recreation & Cultural Resources Master Plan for inclusion of hazard safety information at facilities	4	2	Flood, Earthquake, Extreme Heat, Severe Weather, Tornado	High	Fuquay-Varina Planning and Parks, Recreation, & Cultural Resources	Budgeted Staff Time	Annual Budget	3-5 years	New	N/A
Property Protection											
PP-1	Continue to enforce the Flood Damage Prevention Ordinance for all new construction or substantial building rehabilitations.	4	1	Flood, Hurricane	High	Fuquay-Varina Planning	Budgeted Staff Time	Annual Budget	Ongoing - Next 5 Years	In-Progress – Carry Forward	Part of development and permit review process
PP-2	Require minimum finished floor elevation in known FEMA flood hazard zones be minimum 2' above base flood elevation.	4	1	Flood, Hurricane	High	Fuquay-Varina Planning and Inspections	Budgeted Staff Time	Annual Budget	Ongoing - Next 5 Years	In-Progress – Carry Forward	Part of development and permit review process
PP-3	Identify and inventory buildings that are located in FEMA flood zones to determine which structures may be prone to flooding (possible relocation and/or elevation).	3	1	Flood, Hurricane	High	Fuquay-Varina Planning and Engineering	Budgeted Staff Time	Annual Budget	Ongoing - Next 5 Years	In-Progress – Carry Forward	We reference the Dept of Public Safety's report
Natural Resource Protection											
NRP-1	Work with the U.S. Army Corps of Engineers on wetland protection.	4	1	Flood, Hurricane	Moderate	Fuquay-Varina Planning	Budgeted Staff Time	Annual Budget	Ongoing - Next 5 Years	In-Progress – Carry Forward	Part of development and permit review process
NRP-2	Use Open Space Ordinance to protect wildlife habitat.	4	1	All	Moderate	Fuquay-Varina Planning	Budgeted Staff Time	Annual Budget	Ongoing - Next 5 Years	In-Progress – Carry Forward	Part of development and permit review process
NRP-3	Notify Wake County of any illegal stream dumping instances	3	1	Flood, Dam Failure, Hurricane	Moderate	Fuquay-Varina Planning and Public Utilities	Budgeted Staff Time	Annual Budget	Ongoing - Next 5 Years	In-Progress – Carry Forward	Continued function of normal operation
NRP-4	Enforce standards for tree protection and control of clear cutting (Town has received legislative authority to enact tree protection and control of clearcutting standards.)	4	1	Flood, Wildfire, Landslide	High	Fuquay-Varina Planning	Budgeted Staff Time	Annual Budget	Ongoing - Next 5 Years	In-Progress – Carry Forward	Part of development and permit review process
NRP-5	Install low flow/high efficiency toilets at new town hall	3	1	Drought	Low	All Departments	To Be Determined	Annual Budget	1 year	New	N/A
Structural Projects											
S-1	Install a generator at the new town hall	3	1	All	High	All Departments	To Be Determined	Annual Budget	1 year	New	N/A
S-2	Install security cameras on new town hall	3	1	Terrorism	High	All Departments	To Be Determined	Annual Budget	1 year	New	N/A
Emergency Services											
ES-1	Maintain current warning system with local sirens on elevated platforms and use of the Emergency Broadcast System.	1	2	All	High	Fuquay-Varina Planning, Fire and Police	Budgeted Staff Time	Annual Budget	Ongoing - Next 5 Years	In-Progress – Carry Forward	Continued function of normal operation

Town of Fuquay-Varina											
Action #	**Description**	**Goal**	**Objective**	**Hazard(s) Addressed**	**Relative Priority**	**Lead Agency/ Department**	**Estimated Cost**	**Potential Funding Sources**	**Implementation Schedule**	**2019 Status**	**Status Comments/Explanation**
ES-2	Coordinate an incident command course for all Town employees, related to Emergency Operations Plan and Disaster Operations Plan for the Town.	2	1	All	Moderate	Fuquay-Varina Fire and Police	Budgeted Staff Time	Annual Budget	Ongoing - Next 5 Years	In-Progress – Carry Forward	Lack of staffing has prevented implementation
ES-3	Conduct a scenario-based training exercise, related to Emergency Operations Plan and Disaster Operations Plan for the Town.	2	1	All	Moderate	Fuquay-Varina Fire and Police	Budgeted Staff Time	Annual Budget	Ongoing - Next 5 Years	In-Progress – Carry Forward	Lack of staffing has prevented implementation
ES-4	Assist Wake County Emergency Management with updating list of local hazardous materials sites.	2	1	Hazardous Materials Incident, Radiological Emergency	Moderate	Fuquay-Varina Fire and Wake County Emergency Management	Budgeted Staff Time	Annual Budget	Ongoing - Next 5 Years	In-Progress – Carry Forward	Continued function of normal operation
ES-5	Continue Pre-Fire Incident Plan program for all commercial facilities within the Town limits.	3	2	All	High	Fuquay-Varina Fire	Budgeted Staff Time	Annual Budget	Ongoing - Next 5 Years	In-Progress – Carry Forward	Continued function of normal operation
ES-6	Address securing and cleaning up affected hazardous areas when revising Disaster Operations Plan.	4	2	All	High	Fuquay-Varina Planning, Fire and Police	Budgeted Staff Time	Annual Budget	Ongoing - Next 5 Years	In-Progress – Carry Forward	Continued function of normal operation
ES-7	Continue to evaluate and improve response and recovery methods following each hazard event.	2	2	All	High	Fuquay-Varina Fire and Police	Budgeted Staff Time	Annual Budget	Ongoing - Next 5 Years	In-Progress – Carry Forward	Continued function of normal operation
ES-8	Finalize implementation of new/updated radio communication equipment.	2	1	All	Moderate	Fuquay-Varina Fire and Police	$55,000	Annual Budget	Ongoing - Next 5 Years	In-Progress – Carry Forward	Police Department's portion completed. Fire Department anticipated completion, June 2019
Public Education and Awareness											
PEA-1	Maintain floodplain maps for public use and produce other maps as needed.	1	1	Flood, Hurricane	Moderate	Fuquay-Varina Planning and Engineering	Budgeted Staff Time	Annual Budget	Ongoing - Next 5 Years	In-Progress – Carry Forward	Continued function of normal operation
PEA-2	Develop and maintain a hazard mitigation section on the Town website that is updated every 5 years as the plan is updated.	1	1	All	High	Fuquay-Varina Public Information and Information Technology	Budgeted Staff Time	Annual Budget	Ongoing - Next 5 Years	In-Progress – Carry Forward	Continued function of normal operation
PEA-3	Collect educational materials on disaster preparedness and display at public library and local government offices.	1	1	All	High	Fuquay-Varina Planning, Inspections, Police, and Fire	Budgeted Staff Time	Annual Budget	Ongoing - Next 5 Years	In-Progress – Carry Forward	Lack of staffing has prevented implementation
PEA-4	Educate public on importance of channel maintenance as part of Phase II Stormwater Management Plan.	1	1	Flood, Dam Failure, Hurricane	Moderate	Fuquay-Varina Engineering	Budgeted Staff Time	Annual Budget	Ongoing - Next 5 Years	In-Progress – Carry Forward	Continued function of normal operation
PEA-5	Work with local real estate agents to ensure that potential buyers are aware of properties that are exposed to potential flood damage.	1	1	Flood, Dam Failure, Hurricane	Moderate	Fuquay-Varina Planning	Budgeted Staff Time	Annual Budget	Ongoing - Next 5 Years	In-Progress – Carry Forward	Continued function of normal operation
PEA-6	Require delineation of Wake County Flood Hazard Soils, FEMA flood zones, and wetlands on final plats.	3	2	Flood, Dam Failure, Hurricane	Moderate	Fuquay-Varina Planning	Budgeted Staff Time	Annual Budget	Ongoing - Next 5 Years	In-Progress – Carry Forward	Part of development and permit review process
PEA-7	Annual participation in Severe Weather Preparedness Week (March 3-9) via Weather Channel (social media campaign, newsletter, published materials)	1	1	All	High	Fuquay Varina Planning and Public Information	Budgeted Staff Time	Annual Budget	Ongoing - Next 5 Years	New	N/A
PEA-8	Annual participation in National Preparedness Month (September) Ready.gov (social media campaign, newsletter, published materials)	1	1	All	High	Fuquay Varina Planning and Public Information	Budgeted Staff Time	Annual Budget	Ongoing - Next 5 Years	New	N/A
PEA-9	Annual participation in Hurricane Prep Week (May 13-19) ReadyNC.gov (social media campaign, newsletter, published materials)	1	1	Flood, Landslide, Hurricane	High	Fuquay Varina Planning and Public Information	Budgeted Staff Time	Annual Budget	Ongoing - Next 5 Years	New	N/A
PEA-10	Annual participation in Earthquake Awareness Month and National Earthquake Drill (February & October) Ready.gov (social media campaign, newsletter, published materials)	1	1	Earthquake	High	Fuquay Varina Planning and Public Information	Budgeted Staff Time	Annual Budget	Ongoing - Next 5 Years	New	N/A
PEA-11	Annual participation in National Dam Safety Awareness Day (May 31) Ready.gov (social media campaign, newsletter, published materials)	1	1	Dam Failure	High	Fuquay Varina Planning and Public Information	Budgeted Staff Time	Annual Budget	Ongoing - Next 5 Years	New	N/A
PEA-12	Structured public education through social media, brochures, and flyers in critical facilities	1	1	All	High	Fuquay Varina Planning, Fire & Police, and Public Information	Budgeted Staff Time	Annual Budget	Ongoing - Next 5 Years	New	N/A

Annex F Town of Garner

F.1 PLANNING PROCESS

The table below lists the HMPC members who represented the Town of Garner.

Table F.1 – HMPC Members

Agency	Representative	Position or Title
Planning Department	David Bamford	Planning Services Manager
Planning Department	Jeff Triezenberg	Planning Director

F.2 COMMUNITY PROFILE

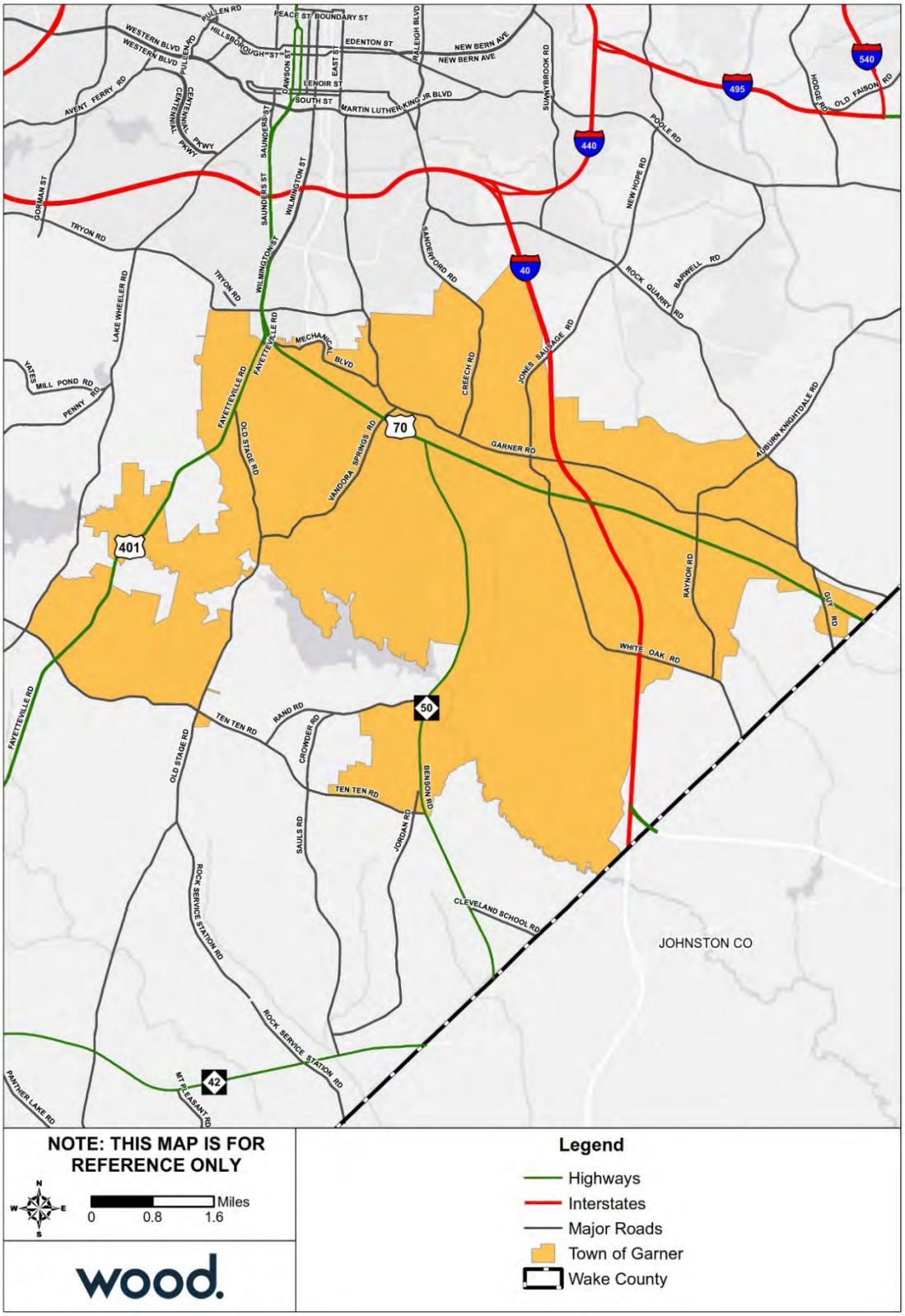
Geography

The Town of Garner is located in southeastern Wake County. It is neighbored by Raleigh to the northwest. Garner is part of the Raleigh, NC Metropolitan Statistical Area, which falls within the larger Raleigh-Durham-Chapel Hill, NC Combined Statistical Area. The Town comprises a total land area of 14.8 square miles.

According to data from the U.S. Fish and Wildlife Service's National Wetlands Inventory, there are approximately 3,961 acres of wetlands in Garner.

Figure F.1 shows a base map of major transportation routes in the Town of Garner.

Figure F.1 – Major Transportation Routes – Town of Garner



Source: Wake County GIS Open Data

Population and Demographics

Table F.2 provides population counts and growth estimates for the Town of Garner as compared to the County overall. Table F.3 provides demographic information for Garner as compared to the whole County.

Table F.2 – Population Counts, Garner, 2010-2017

Jurisdiction	2000 Census Population	2010 Census Population	2017 ACS Population Estimate	Total Change 2010-2017	% Change 2010-2017
Wake County total	**627,846**	**900,993**	**1,023,811**	**122,818**	**13.6%**
Town of Garner	17,575	25,745	28,048	2,303	8.9%

Source: US Census Bureau Decennial Census 2000, Decennial Census 2010; American Community Survey 2013-2017 5-Year Estimates

Table F.3 – Racial Demographics, Garner, 2017

Jurisdiction	White, %	Black, %	Asian, %	Other Race, %	Two or More Races, %	Persons of Hispanic or Latino Origin*, %
Wake County total	**66.5%**	**20.4%**	**6.5%**	**3.6%**	**2.7%**	**10.0%**
Town of Garner	61.9%	32.5%	1.9%	1.4%	2.2%	10.8%

Source: US Census Bureau, American Community Survey 2013-2017 5-Year Estimates
*Persons of Hispanic origin may be of any race, so also are included in applicable race categories

Asset Inventory

The following tables summarize the asset inventory for Garner in order to estimate the total physical exposure to hazards in this area. The locations of critical facilities are shown in Figure F.2 on the following page. Critical facilities are a subset of identified assets from the Critical Infrastructure & Key Resources dataset. Note that the counts are by building; where a critical facility comprises a cluster of buildings, each building is counted and displayed.

Table F.4 – Critical Infrastructure & Key Resources by Type

Jurisdiction	Food & Agriculture	Banking & Finance	Chemical	Commercial Facilities	Communications	Manufacturing	Defense	Government	Healthcare	IT	National Monuments	Nuclear	Postal & Shipping	Transportation	Energy	Emergency Services	Water	Other	Total
Town of Garner	67	19	0	297	0	309	0	110	23	0	0	0	0	27	1	3	4	0	**860**

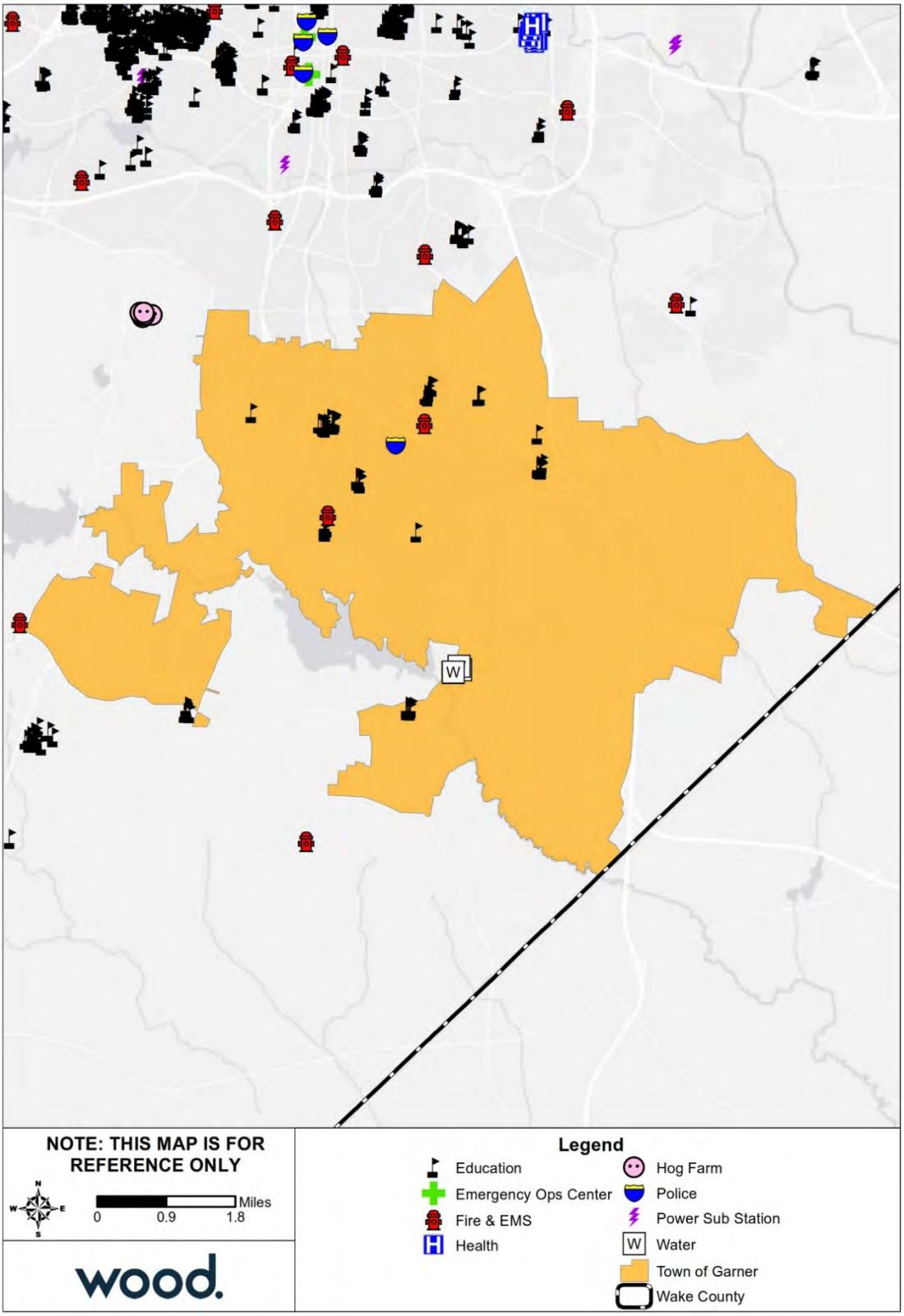
Source: NCEM Risk Management Tool

Table F.5 – High Potential Loss Facilities by Use

Jurisdiction	Residential	Commercial	Industrial	Government	Agricultural	Religious	Utilities	Other	Total
Town of Garner	69	84	59	23	0	17	2	0	**254**

Source: NCEM Risk Management Tool

Figure F.2 – Critical Facilities, Town of Garner



Source: NCEM IRISK Database, GIS Analysis

To supplement the asset inventory and provide a clearer picture of the current asset exposure in the Town of Garner, current parcel data was evaluated to identify development since 2010. This information is not incorporated into the risk assessment, which was prepared using NCEM's IRISK database. However, this summary of development since 2010 provides some context to understand the degree to which the IRISK exposure and vulnerability numbers differ from current conditions.

Table F.6 provides a summary by land class of parcel development from January 2011 to April 2019.

Table F.6 – Parcels Developed 2011 or Later, Town of Garner

Land Class	Number of Parcels	Sum of Building Value
Agriculture	1	$164,497
Apartment	6	$104,048,398
Commercial	34	$70,473,139
EXEMPT	8	$77,248,963
Forestry	1	$255,900
HOA	1	$230,967
Industrial	13	$21,498,216
Mobile Home Park	1	$137,073
Part Exempt	7	$10,751,847
Residential Less Than 10 Acres	628	$150,682,569
Retirement Home	3	$19,861,451
Vacant	1	-
Grand Total	**704**	**$455,353,020**

Source: Wake County Open Data; retrieved April 8, 2019

There are three listings on the National Register of Historic Places for the Town of Garner. These sites are listed in the table below.

Table F.7 – Historic Properties

Ref#	Property Name	Status Date	Category	City
89002157	Downtown Garner Historic District	12/21/1989	District	Garner
93000544	Edenwood	7/2/1993	Building	Garner
09001106	Meadowbrook Country Club	12/16/2009	District	Garner

Source: National Parks Service, National Register of Historic Places, October 2018

Housing

The table below details key housing statistics for Garner as compared to the County overall.

Table F.8 – Housing Statistics, Garner, 2010-2017

Jurisdiction	Housing Units (2010)	Housing Units (2017)	Housing Units Percent Change (2010-2017)	Owner-Occupied, % (2017)	Vacant Units, % (2017)	Median Home Value (2017)
Wake County total	**371,836**	**411,632**	**10.7%**	**59.5%**	**7.2%**	**$250,700**
Town of Garner	10,993	11,633	6.4%	60.5%	7.5%	$167,700

Source: U.S. Census Bureau 2010 Decennial Census, American Community Survey 2013-2017 5-Year Estimates
Note: Owner-Occupied and vacant-unit measures are reported as a percent of the total number of housing units.

Economy

The following tables present key economic statistics for Garner as compared to the County overall.

Table F.9 – Employment Statistics, Garner, 2017

Jurisdiction	Population in Labor Force	Percent Employed* (%)	Percent Unemployed* (%)	Percent Not in Labor Force* (%)	Unemployment Rate (%)
Wake County	**564,096**	**67.2**	**3.5**	**29.2**	**4.9**
Town of Garner	15,338	64.6	4.1	31.2	6.0

Source: U.S. Census Bureau, American Community Survey 2013-2017 5-Year Estimates
Note: This table reports only the civilian labor force. The labor force in armed services accounted for 0.3% or less of the population 16 and over in all jurisdictions. *Population employed, population unemployed, and Population not in labor force are reported as a percent of the total population aged 16 years and older.

Table F.10 – Percent of Employed Population by Occupation, Garner, 2017

Occupation	Management, business, science and arts (%)	Service (%)	Sales and Office (%)	Natural Resources, Construction, and Maintenance (%)	Production, transportation, and material moving (%)
Wake County	**50.1**	**13.8**	**23.4**	**6.0**	**6.7**
Town of Garner	42.2	15.8	24.9	8.3	8.8

Source: U.S. Census Bureau, American Community Survey 2013-2017 5-Year Estimates

F.3 RISK ASSESSMENT

This section contains a hazard profile and vulnerability assessment for those hazards that were rated with a higher priority for the Town of Garner than for Wake County as a whole. Risk and vulnerability findings are also presented here for those hazards that are spatially defined and have variations in risk that could be evaluated quantitatively on a jurisdictional level. The hazards included in this section are: Flood and Wildfire.

F.3.1 Flood

Table F.11 details the acreage of the Town of Garner by flood zone on the effective DFIRM. Per this assessment, over 7 percent of Garner falls within the mapped 1%-annual-chance floodplains.

Table F.11 – Flood Zone Acreage in the Town of Garner

Flood Zone	Acreage	Percent of Total (%)
Zone A	33.81	0.14
Zone AE	1,853.73	7.35
Zone X (500-year)	177.48	0.71
Zone X Unshaded	22,919.84	91.80
Total	**24,966.86**	--

Source: FEMA Effective DFIRM; Wake County GIS

Figure F.3 reflects the effective mapped flood hazard zones for the Town of Garner, and Figure F.4 displays the depth of flooding estimated to occur in these areas during the 1%-annual-chance flood.

To supplement the IRISK assessment of property at risk from the 1% annual chance flood event in Section 4 and provide a clearer picture of the current property at risk in the Town of Garner, current parcel data was evaluated to identify parcels developed since 2010. Using GIS analysis, parcels developed after 2010 were compared to the boundaries of the 1% annual chance floodplain to identify the exposure of newly developed property to the base flood. In most cases, a parcel was considered exposed to the floodplain if any portion of the parcel was located in the floodplain.

This assessment does not evaluate flood impacts or provide damage estimates. However, this summary of development in or near the floodplain since 2010 provides some context to understand the degree to which the IRISK exposure and vulnerability numbers differ from current conditions.

Table F.12 provides a summary by land class of parcel development located in the 1% annual chance floodplain from January 2011 to April 2019.

Table F.12 – Parcels Developed 2011 or Later and Located in 100-Year Floodplain, Town of Garner

Land Class	Number of Parcels	Sum of Building Value
Commercial	1	$627,557
EXEMPT	2	$19,510,405
Industrial	2	$2,617,038
Residential Less Than 10 Acres	4	$761,238
Retirement Home	2	$16,116,150
Grand Total	**11**	**$39,632,388**

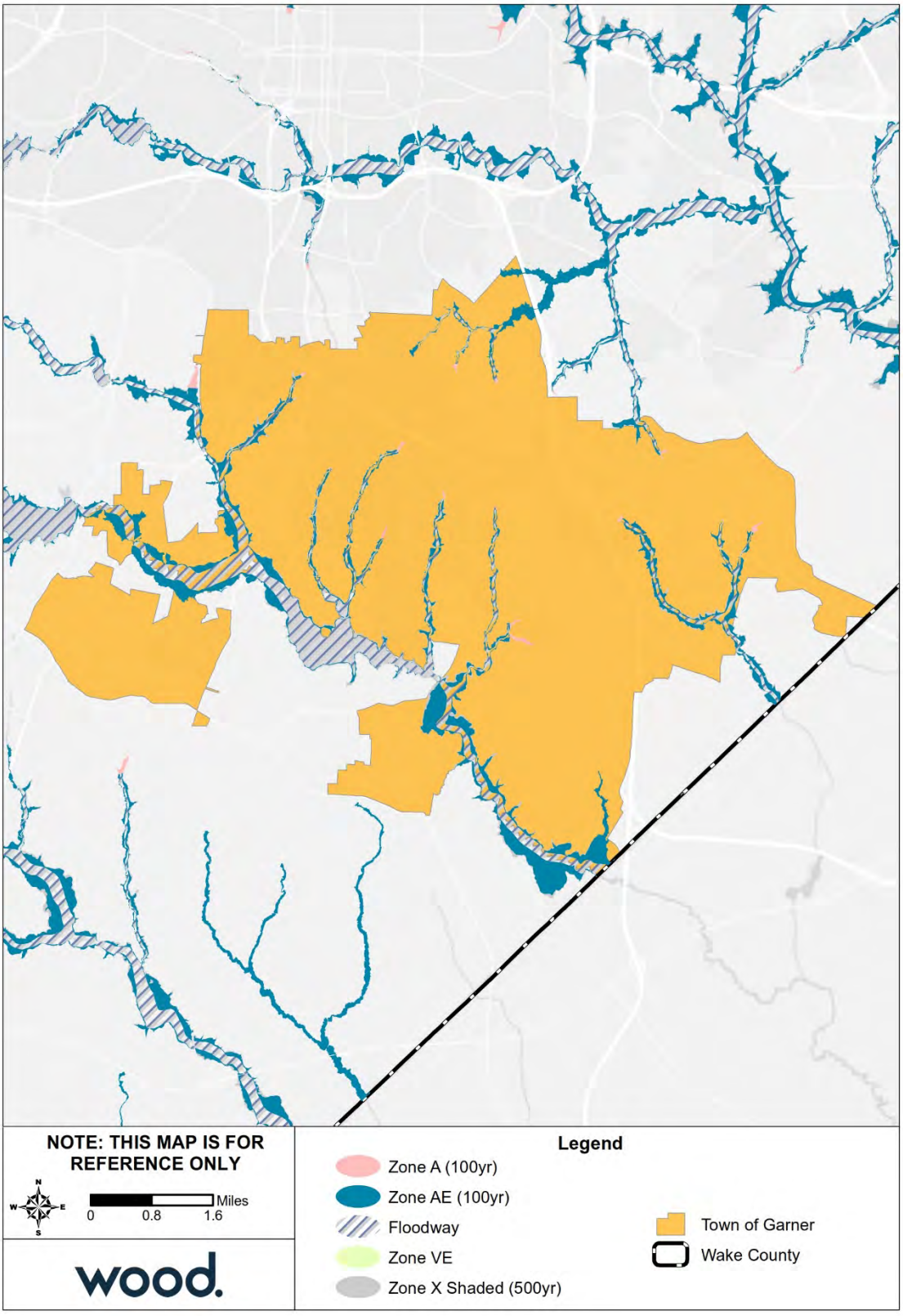
Source: Wake County Open Data; retrieved April 8, 2019; FEMA Effective DFIRM

Table F.13 provides building counts and estimated damages for Critical Infrastructure and Key Resources (CIKR) buildings by sector and flood event in the Town of Garner.

Table F.13 – Critical Facilities Exposed to Flooding, Town of Garner

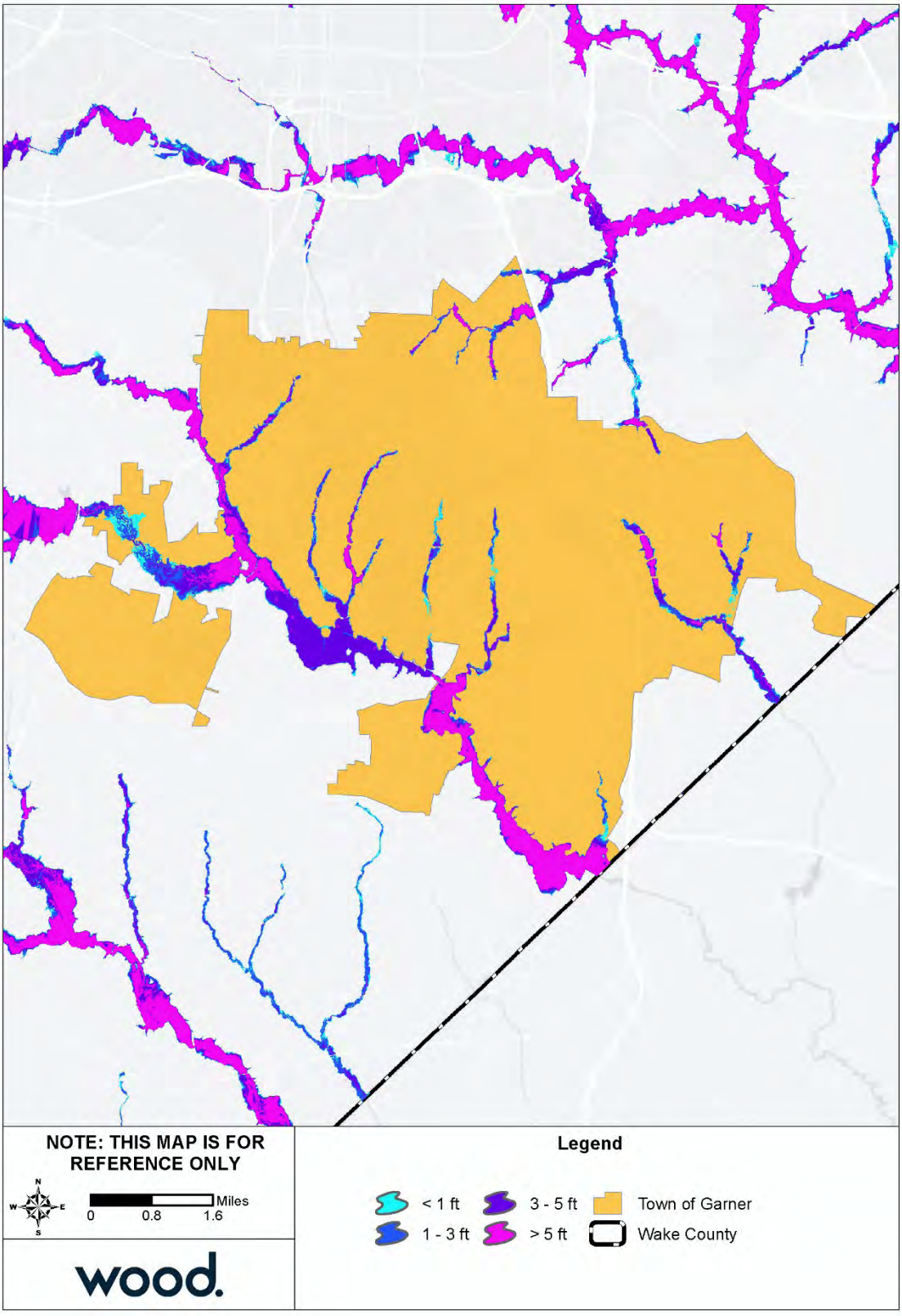
Sector	Event	Number of Buildings at Risk	Estimated Damages
Commercial Facilities	100 Year	1	$1,279
All Categories	**100 Year**	**1**	**$1,279**

Figure F.3 – FEMA Flood Hazard Areas, Town of Garner



Source: FEMA Effective DFIRM

Figure F.4 – Flood Depth, 1%-Annual-Chance Floodplain, Town of Garner



Source: FEMA Effective DFIRM

F.3.2 Wildfire

Table F.14 summarizes the acreage in the Town of Garner that falls within the Wildland Urban Interface (WUI), categorized by housing density. Areas in the WUI are those where development may intermix with flammable vegetation. Over 16 percent of the Town of Garner is not included in the WUI.

Table F.14 – Wildland Urban Interface Acreage, Town of Garner

	Housing Density	Total Acreage	Percent of Total Acreage
	Not in WUI	*4,028.2*	*16.1%*
	LT 1hs/40ac	2,057.0	8.2%
	1hs/40ac to 1hs/20ac	1,503.9	6.0%
	1hs/20ac to 1hs/10ac	1,864.0	7.5%
	1hs/10ac to 1hs/5ac	2,475.4	9.9%
	1hs/5ac to 1hs/2ac	4,206.6	16.8%
	1hs/2ac to 3hs/1ac	8,619.4	34.5%
	GT 3hs/1ac	212.4	0.9%
	Total	24,966.8	

Source: Southern Wildfire Risk Assessment

Figure F.5 depicts the WUI for the Town of Garner. The WUI is the area where housing development is built near or among areas of vegetation that may be prone to wildfire. Figure F.6 depicts the Fire Intensity Scale, which indicates the potential severity of fire based on fuel loads, topography, and other factors. Figure F.7 depicts Burn Probability based on landscape conditions, percentile weather, historical ignition patterns, and historical prevention and suppression efforts.

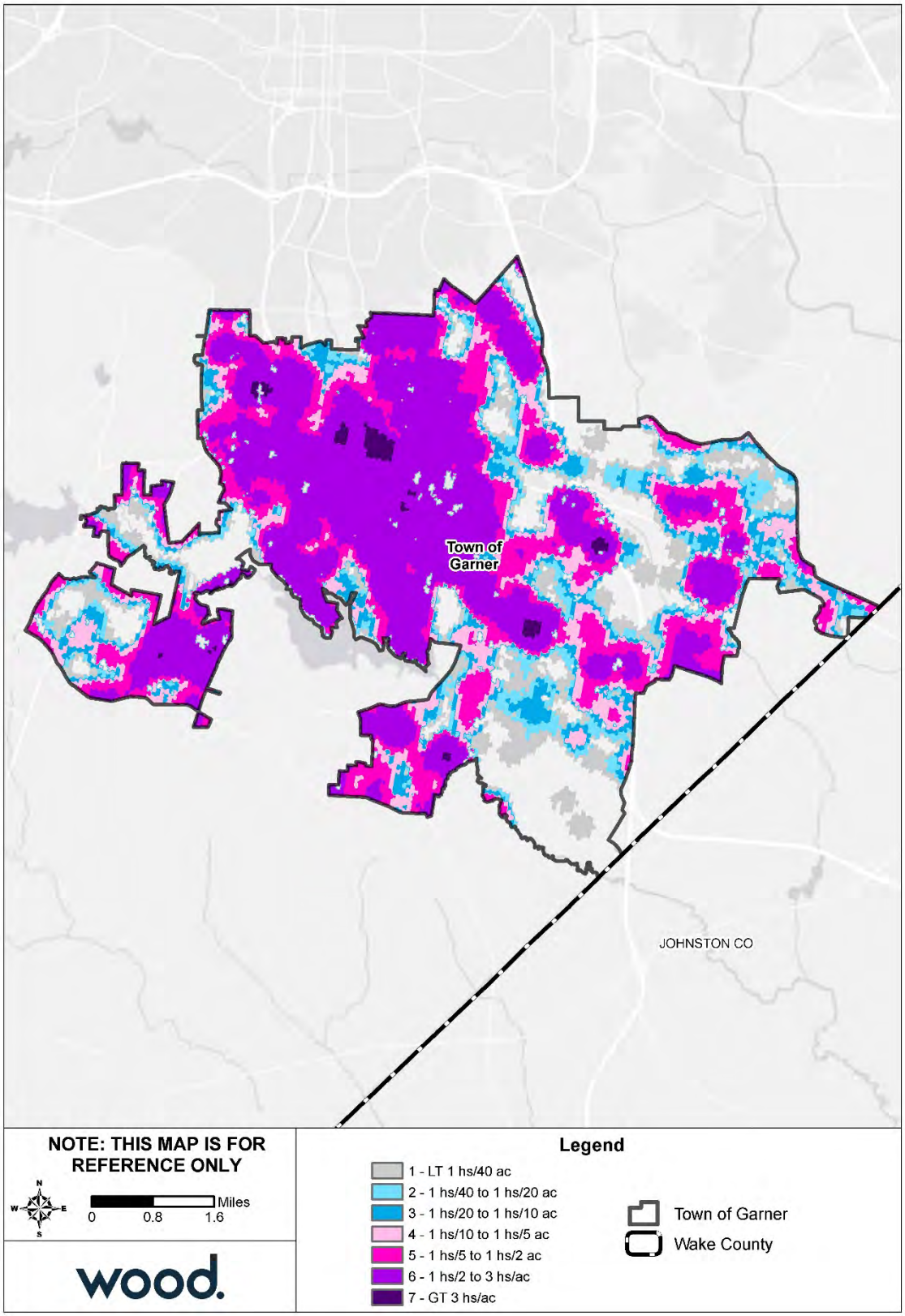
Potential fire intensity is highest in southwest and east Garner. Some of these areas do fall within the WUI but have a lower burn probability. The area of greatest risk in the Town of Garner are in the central-eastern region where WUI overlays with moderate burn probability and moderate to high potential fire intensity levels.

Table F.15 provides building counts and estimated damages for Critical Infrastructure and Key Resources (CIKR) buildings by sector at risk to wildfire hazard.

Table F.15 – Critical Facilities Exposed to Wildfire, Town of Garner

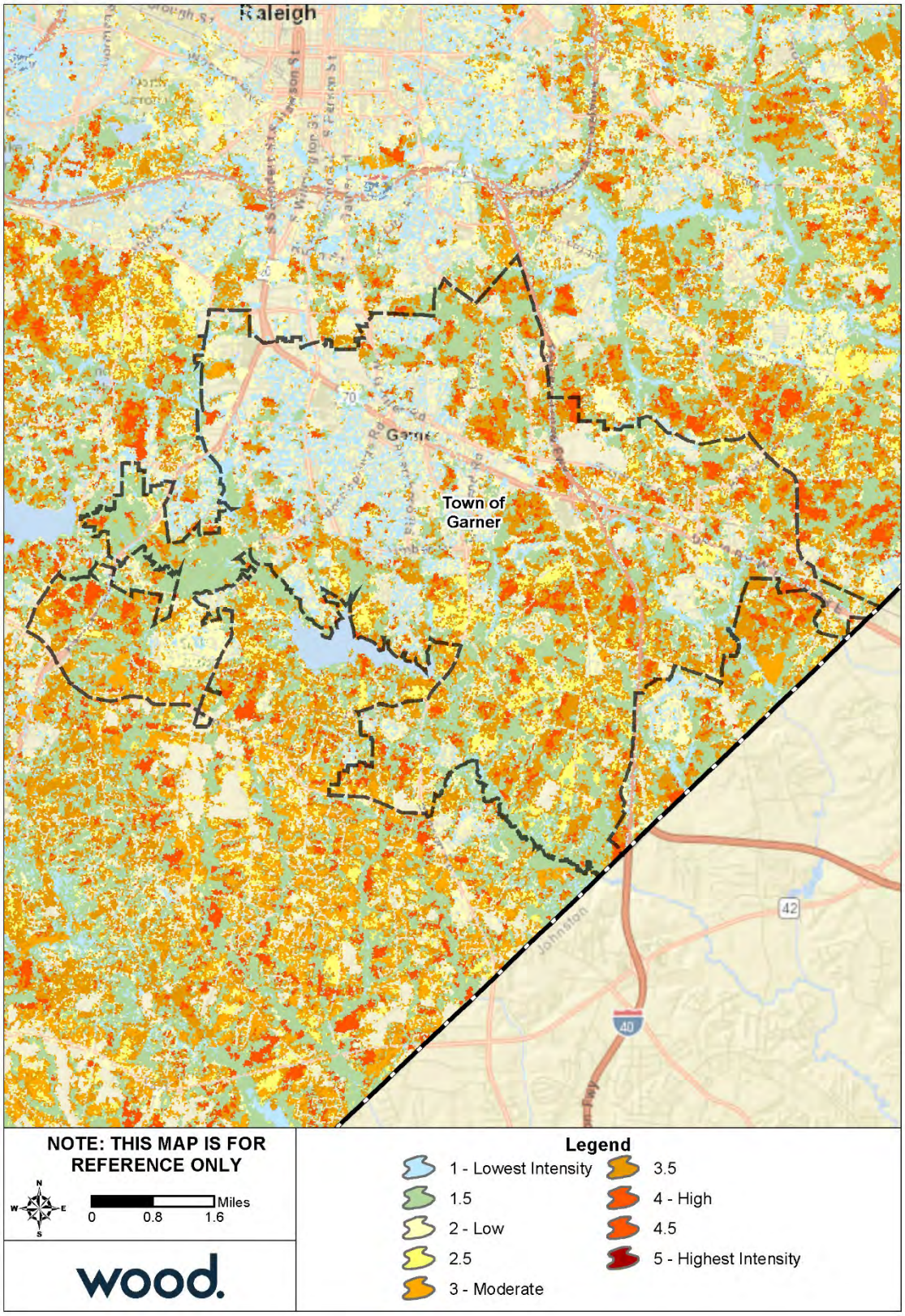
Sector	Event	Number of Buildings at Risk	Estimated Damages
Critical Manufacturing	Wildfire Hazard	1	$19,571,810
All Categories	**Wildfire Hazard**	**1**	**$19,571,810**

Figure F.5 – Wildland Urban Interface, Town of Garner



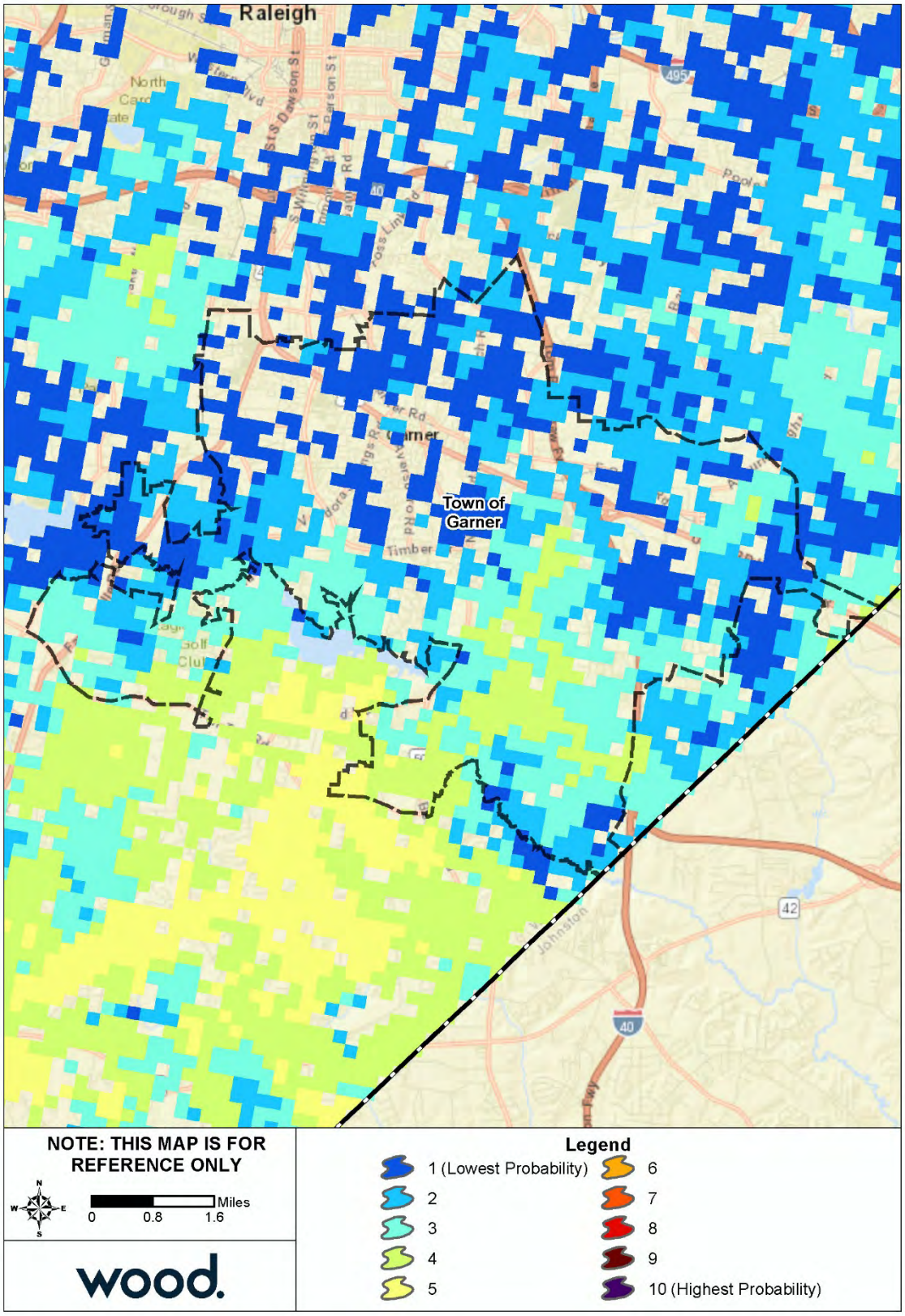
Source: Southern Wildfire Risk Assessment

Figure F.6 – Fire Intensity Scale, Town of Garner



Source: Southern Wildfire Risk Assessment

Figure F.7 – Burn Probability, Town of Garner



Source: Southern Wildfire Risk Assessment

F.4 CAPABILITY ASSESSMENT

F.4.1 Overall Capability

Details on the tools and resources in place and available to the Town of Garner were provided by the Town's HMPC representatives and are summarized in Section 5 Capability Assessment. Based on that information and using the scoring methodology detailed in that section, Garner has an overall capability rating of Moderate. The Town's Self-Assessment of key capability areas is summarized in Table F.16 below.

Table F.16 – Capability Self-Assessment, Garner

Capability Area	Rating
Plans, Ordinances, Codes and Programs	Moderate
Administrative and Technical Capability	Moderate
Fiscal Capability	High
Education and Outreach Capability	Moderate
Mitigation Capability	Moderate
Political Capability	Moderate
Overall Capability	Moderate

F.4.2 Floodplain Management

The Town of Garner joined the NFIP through emergency entry in November 1974 and has been a regular participant since July 1978. The following tables reflect NFIP policy and claims data for the Town categorized by structure type, flood zone, Pre-FIRM and Post-FIRM.

Table F.17 – NFIP Policy and Claims Data by Structure Type

Structure Type	Number of Policies in Force	Total Premium	Insurance in Force	Number of Closed Paid Losses	Total of Closed Paid Losses
Single Family	126	$81,260	$32,717,500	20	$145,059.32
2-4 Family	3	$6,314	$308,300	0	$0.00
All Other Residential	3	$2,304	$1,500,000	0	$0.00
Non-Residential	1	$1,204	$300,000	1	$22,684.95
Total	133	$91,082	$34,825,800	21	$167,744.27

Source: FEMA Community Information System, accessed November 2018

Table F.18 – NFIP Policy and Claims Data by Flood Zone

Flood Zone	Number of Policies in Force	Total Premium	Insurance in Force	Number of Closed Paid Losses	Total of Closed Paid Losses
A01-30 & AE Zones	46	$52,704	$10,132,200	17	$121,765.09
A Zones	2	$6,185	$288,300	1	$2,531.54
AO Zones	0	$0	$0	0	$0.00
AH Zones	0	$0	$0	0	$0.00
AR Zones	0	$0	$0	0	$0.00
A99 Zones	0	$0	$0	0	$0.00
V01-30 & VE Zones	0	$0	$0	0	$0.00
V Zones	0	$0	$0	0	$0.00
D Zones	0	$0	$0	0	$0.00
B, C & X Zone					

Flood Zone	Number of Policies in Force	Total Premium	Insurance in Force	Number of Closed Paid Losses	Total of Closed Paid Losses
Standard	2	$1,578	$318,300	0	$0.00
Preferred	83	$30,615	$24,087,000	3	$43,447.64
Total	133	$91,082	$34,825,800	21	$167,744.27

Source: FEMA Community Information System, accessed November 2018

Table F.19 – NFIP Policy and Claims Data Pre-FIRM

Flood Zone	Number of Policies in Force	Total Premium	Insurance in Force	Number of Closed Paid Losses	Total of Closed Paid Losses
A01-30 & AE Zones	35	$46,111	$7,427,900	15	$118,270.13
A Zones	0	$0	$0	0	$0.00
AO Zones	0	$0	$0	0	$0.00
AH Zones	0	$0	$0	0	$0.00
AR Zones	0	$0	$0	0	$0.00
A99 Zones	0	$0	$0	0	$0.00
V01-30 & VE Zones	0	$0	$0	0	$0.00
V Zones	0	$0	$0	0	$0.00
D Zones	0	$0	$0	0	$0.00
B, C & X Zone	27	$9,775	$6,966,200	2	$4,832.43
Standard	1	$662	$99,200	0	$0.00
Preferred	26	$9,113	$6,867,000	2	$4,832.43
Total	62	$55,886	$14,394,100	17	$123,102.56

Source: FEMA Community Information System, accessed November 2018

Table F.20 – NFIP Policy and Claims Data Post-FIRM

Flood Zone	Number of Policies in Force	Total Premium	Insurance in Force	Number of Closed Paid Losses	Total of Closed Paid Losses
A01-30 & AE Zones	11	$6,593	$2,704,300	2	$3,494.96
A Zones	2	$6,185	$288,300	1	$2,531.54
AO Zones	0	$0	$0	0	$0.00
AH Zones	0	$0	$0	0	$0.00
AR Zones	0	$0	$0	0	$0.00
A99 Zones	0	$0	$0	0	$0.00
V01-30 & VE Zones	0	$0	$0	0	$0.00
V Zones	0	$0	$0	0	$0.00
D Zones	0	$0	$0	0	$0.00
B, C & X Zone	58	$22,418	$17,439,100	1	$38,615.21
Standard	1	$916	$219,100	0	$0.00
Preferred	57	$21,502	$17,220,000	1	$38,615.21
Total	71	$35,196	$20,431,700	4	$44,641.71

Source: FEMA Community Information System, accessed November 2018

F.5 MITIGATION STRATEGY

Town of Garner											
Action #	**Description**	**Goal**	**Objective**	**Hazard(s) Addressed**	**Relative Priority**	**Lead Agency/ Department**	**Estimated Cost**	**Potential Funding Sources**	**Implementation Schedule**	**2019 Status**	**Status Comments/Explanation**
Prevention											
P-1	Evaluate the need for regulations to encourage use of low impact development site planning principles to help control stormwater volume impacts.	4	1	Flood, Dam Failure, Hurricane	Moderate	Garner Engineering and Planning	Staff time	Local	2-3 years (2021)	Not Started – Carry Forward	Will be considered during our development code (UDO) update over the next 2 years
P-2	UDO: Continue to provide stream and creek buffers, and floodplain and wetland protection.	3	2	Flood, Dam Failure, Hurricane	High	Garner Planning	Staff time	Local	2-3 years (2021)	In-Progress – Carry Forward	Will be considered during our development code (UDO) update over the next 2 years
P-3	Provide adequate water supply through storage and interconnection with other public water systems.	3	2	Drought	Moderate	City of Raleigh and Garner Engineering	TBD	Local	2-3 years (2020)	In-Progress – Carry Forward	Support City of Raleigh's effort with the reservoir project at NC 50 and New Bethel Church Road
P-4	Garner Transportation Plan – Continue to address disaster preparedness (evacuation) through road interconnectivity, paved roads, and widening of roads.	4	2	Flood, Dam Failure, Earthquake, Hurricane, Severe Weather, Severe Winter Weather, Tornado, Hazardous Materials Incident, Radiological Emergency, Terrorism	Moderate	Garner Planning and Public Works	Improvement costs TBD on case-by-case basis	Local, State, Federal	Ongoing - Next 5 Years	In-Progress – Carry Forward	The Town's emergency preparedness plan follows the Wake County for routes. The Town's 2018 Transportation Plan does encourage and promote interconnectivity.
P-5	Develop for public dissemination building inspections brochures regarding high winds, water damage prevention, and tie downs for accessory structures.	1	1	Flood, Dam Failure, Earthquake, Hurricane, Severe Weather, Severe Winter Weather, Tornado	Moderate	Garner Inspections	Staff time and materials	Local	Ongoing - Next 5 Years	In-Progress – Carry Forward	We do this annually - seasonal brochures based on weather threats
P-6	The Town will inventory all its structures located within or immediately adjacent to known flood hazard areas.	2	2	Flood	Moderate	Garner Planning and Engineering	Staff time	Local	Ongoing - Next 5 Years	In-Progress – Carry Forward	Town reviews when data is available (Flood Plain mapping, new LIDAR data)
P-7	In the upcoming zoning and development ordinance update / re-write (UDO), look for ways discourage and steer high density residential and other at-risk populations (daycares, schools, and retirement facilities as examples)	4	1	Hazardous Materials	Moderate	Garner Planning and Fire / Building Inspections	Staff time	Local	2-3 years	New	The Town will update the UDO (Zoning & Development code) soon
Property Protection											
PP-1	The Town has a service to respond to requests and questions from citizens regarding actions they may take to improve drainage, halt erosion, and to relocate, renovate or retrofit structures being flooded.	1	1	Flood	Moderate	Garner Engineering	Staff time	Local, Private	Ongoing - Next 5 Years	In-Progress – Carry Forward	Normal operations; ongoing activity.
Natural Resource Protection											
NRP-1	Develop and adopt a conservation subdivision ordinance to help preserve significant natural features.	4	1	Flood, Hurricane, Severe Weather, Tornado, Winter Storm	Moderate	Garner Planning	Staff time	Local	2-3 Years (2021)	Not Started – Carry Forward	Will be considered during our development code (UDO) update over the next 2 years
Structural Projects											
SP-1	Pursue stream restoration projects	3	2	Flood	High	Garner Engineering	TBD	Local, Regional, State, Federal	2-3 Years (2021)	Not Started – Carry Forward	Consideration as a capital project under the "stormwater" category as problem areas are identified.
Emergency Services											
ES-1	Develop a Business Continuity Plan that is the primary document housing all disaster related plans and procedures including Hazard Mitigation Plan, Debris Management Plan, Multi-Hazard Plan as well as disaster response plans for all Town departments.	2	2	All Hazards	High	Garner Police, Public Works, and Administration	$25,000-$50,000	Local	2-3 Years	In-Progress – Carry Forward	Target 2021
Public Education and Awareness											

Town of Garner											
Action #	**Description**	**Goal**	**Objective**	**Hazard(s) Addressed**	**Relative Priority**	**Lead Agency/ Department**	**Estimated Cost**	**Potential Funding Sources**	**Implementation Schedule**	**2019 Status**	**Status Comments/Explanation**
PEA-1	Town website will be updated with public access to information pertaining to evacuation routes, emergency contact numbers, and detailed weather reports in case of emergency.	1	2	Flood, Hurricane, Earthquake, Severe Weather, Tornado, Severe Winter Storm, Wildfire, Hazardous Materials Incident, Radiological Emergency	Moderate	Police & Fire Departments, Garner Communications	Staff time	Local	Ongoing - Next 5 Years	In-Progress – Carry Forward	Target 2021
PEA-2	Develop and maintain a hazard mitigation section on the Town website.	1	1	All Hazards	Moderate	Garner Communications, and Garner IT	Staff time	Local	2-3 Years	Not Started – Carry Forward	Target 2021
PEA-3	Website - The Town maintains its own website which is able to provide up to date information for the public. Town continuously updates the site with additional resources.	1	1	All Hazards	High	Garner Police & Fire, Communications, and Garner IT	Staff time	Local	Ongoing - Next 5 Years	In-Progress – Carry Forward	Completed the initial effort; it is in place and on-going

Annex G Town of Holly Springs

G.1 PLANNING PROCESS

The table below lists the HMPC members who represented the Town of Holly Springs.

Table G.1 – HMPC Members

Agency	Representative	Position or Title
Town of Holly Springs	Kimberly Keyes	Project and Construction Manager
Engineering Department	Daniel Colavito	Environmental Specialist
N/A	John Sutherland	Citizen Stakeholder

G.2 COMMUNITY PROFILE

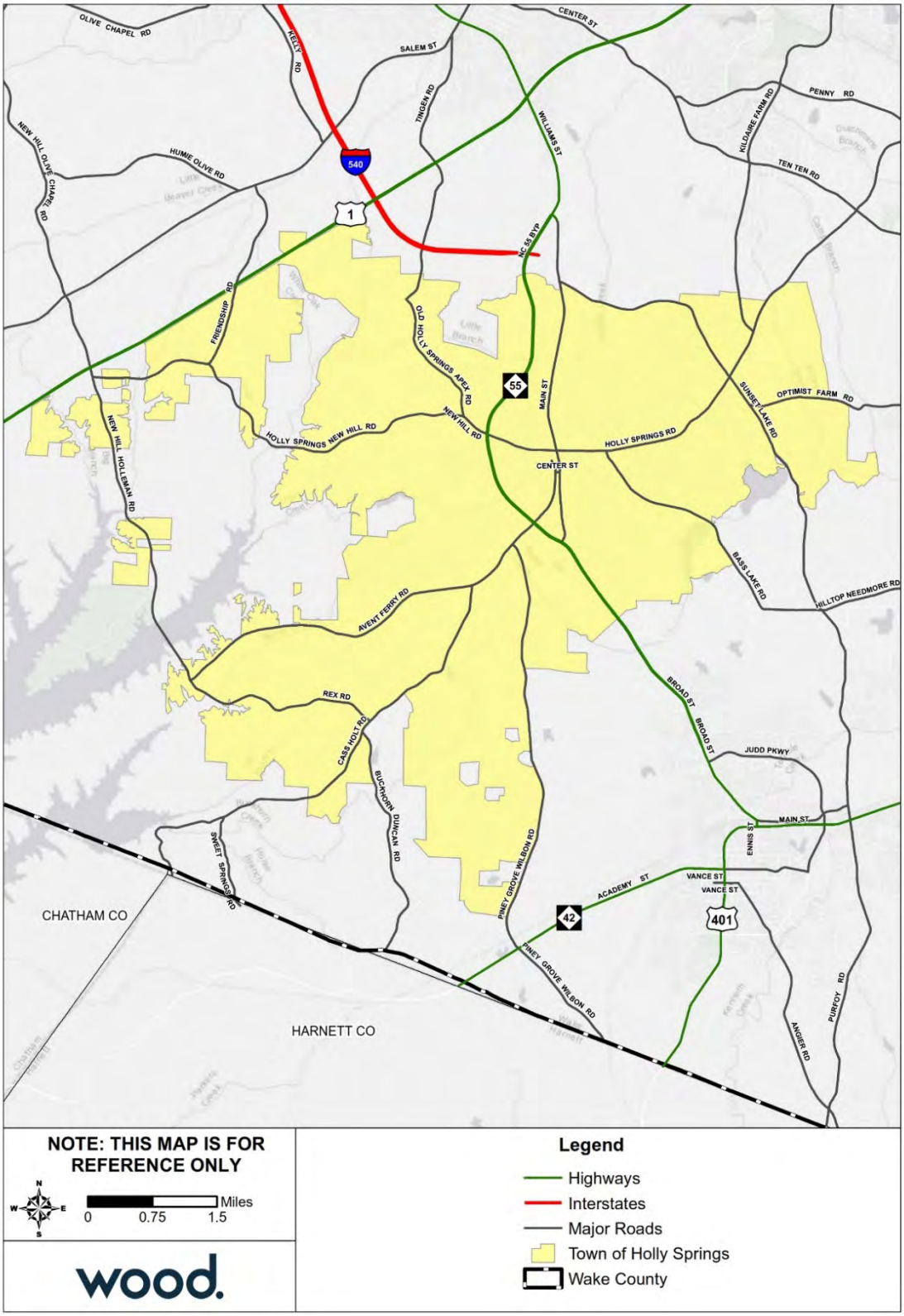
Geography

The Town of Holly Springs is located in southwestern Wake County. It is neighbored by Apex to the north and northwest, Cary to the north and northeast, and Fuquay-Varina to the southeast. The Town is part of the Raleigh, NC Metropolitan Statistical Area, which falls within the larger Raleigh-Durham-Chapel Hill, NC Combined Statistical Area. Holly Springs comprises a total land area of 15.0 square miles.

According to data from the U.S. Fish and Wildlife Service's National Wetlands Inventory, there are approximately 1,617 acres of wetlands in Holly Springs.

Figure G.1 shows a base map of major transportation routes in the Town of Holly Springs.

Figure G.1 – Major Transportation Routes – Town of Holly Springs



Source: Wake County GIS Open Data

Population and Demographics

Table G.2 provides population counts and growth estimates for the Town of Holly Springs as compared to the County overall. Table G.3 provides demographic information for Holly Springs as compared to the whole County.

Table G.2 – Population Counts, Holly Springs, 2010-2017

Jurisdiction	2000 Census Population	2010 Census Population	2017 ACS Population Estimate	Total Change 2010-2017	% Change 2010-2017
Wake County total	**627,846**	**900,993**	**1,023,811**	**122,818**	**13.6%**
Town of Holly Springs	9,192	24,661	31,827	7,166	29.1%

Source: US Census Bureau Decennial Census 2000, Decennial Census 2010; American Community Survey 2013-2017 5-Year Estimates

Table G.3 – Racial Demographics, Holly Springs, 2017

Jurisdiction	White, %	Black, %	Asian, %	Other Race, %	Two or More Races, %	Persons of Hispanic or Latino Origin*, %
Wake County total	**66.5%**	**20.4%**	**6.5%**	**3.6%**	**2.7%**	**10.0%**
Town of Holly Springs	79.6%	11.9%	2.5%	1.8%	3.8%	6.5%

Source: US Census Bureau, American Community Survey 2013-2017 5-Year Estimates

*Persons of Hispanic origin may be of any race, so also are included in applicable race categories

Asset Inventory

The following tables summarize the asset inventory for Holly Springs in order to estimate the total physical exposure to hazards in this area. The locations of critical facilities are shown in Figure G.2 on the following page. Critical facilities are a subset of identified assets from the Critical Infrastructure & Key Resources dataset. Note that the counts are by building; where a critical facility comprises a cluster of buildings, each building is counted and displayed.

Table G.4 – Critical Infrastructure & Key Resources by Type

Jurisdiction	Food & Agriculture	Banking & Finance	Chemical	Commercial Facilities	Communications	Manufacturing	Defense	Government	Healthcare	IT	National Monuments	Nuclear	Postal & Shipping	Transportation	Energy	Emergency Services	Water	Other	Total
Town of Holly Springs	68	6	0	118	0	42	0	37	3	0	0	0	0	9	0	5	3	0	**291**

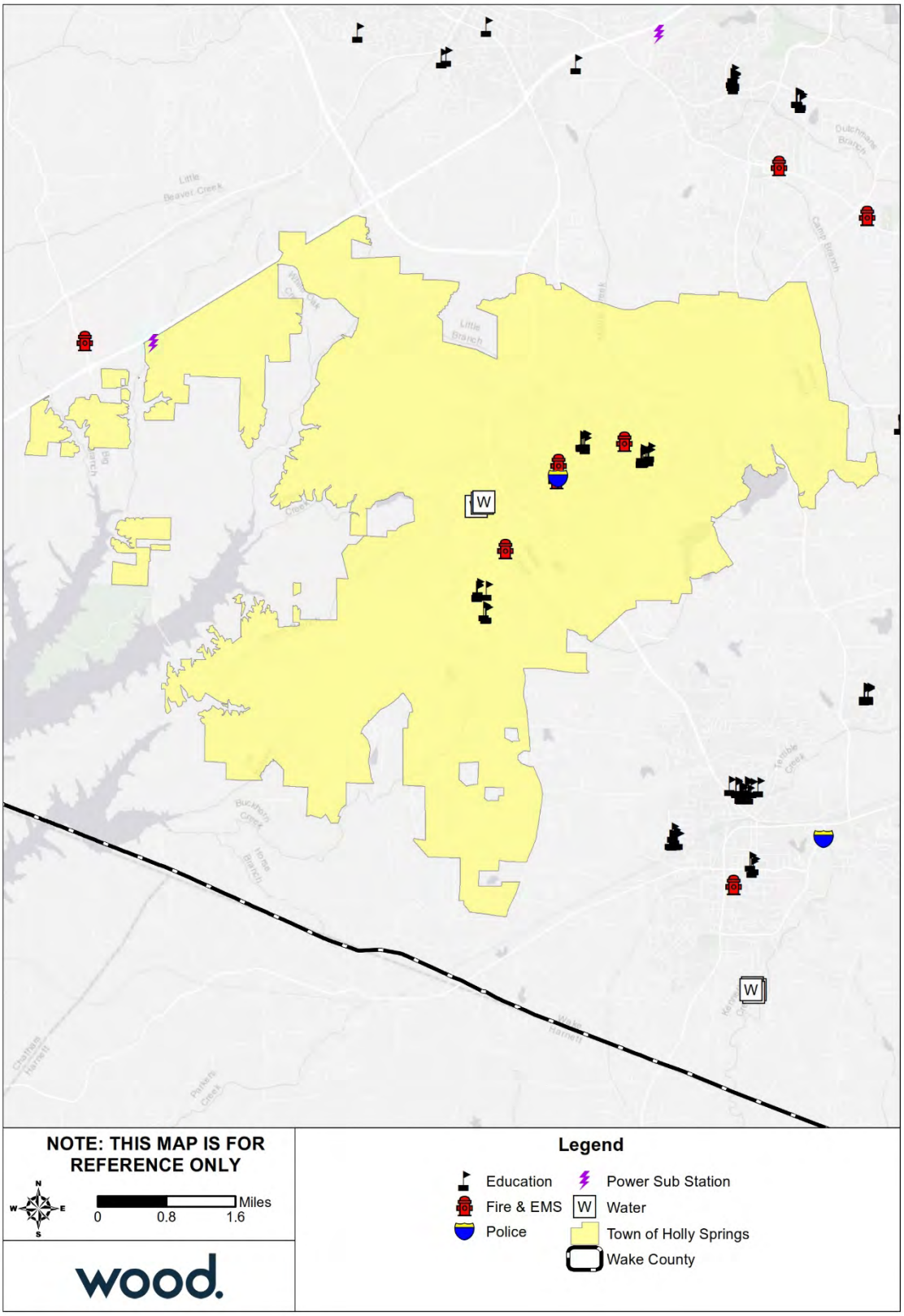
Source: NCEM Risk Management Tool

Table G.5 – High Potential Loss Facilities by Use

Jurisdiction	Residential	Commercial	Industrial	Government	Agricultural	Religious	Utilities	Other	Total
Town of Holly Springs	14	26	14	14	0	5	2	0	**75**

Source: NCEM Risk Management Tool

Figure G.2 – Critical Facilities, Town of Holly Springs



Source: NCEM IRISK Database, GIS Analysis

To supplement the asset inventory and provide a clearer picture of the current asset exposure in the Town of Holly Springs, current parcel data was evaluated to identify development since 2010. This information is not incorporated into the risk assessment, which was prepared using NCEM's IRISK database. However, this summary of development since 2010 provides some context to understand the degree to which the IRISK exposure and vulnerability numbers differ from current conditions.

Table G.6 provides a summary by land class of parcel development from January 2011 to April 2019.

Table G.6 – Parcels Developed 2011 or Later, Town of Holly Springs

Land Class	Number of Parcels	Sum of Building Value
Acres Greater Than 10 With House	6	$2,361,258
Agriculture	2	$981,809
Apartment	4	$50,897,618
Commercial	37	$101,721,338
EXEMPT	8	$36,391,243
Golf Course	1	$76,222
HOA	8	$352,756
Industrial	3	$5,962,559
Part Exempt	10	$2,763,591
Residential Less Than 10 Acres	3,525	$1,060,818,168
Vacant	2	-
Grand Total	**3,606**	**$1,262,326,562**

Source: Wake County Open Data; retrieved April 8, 2019

There are two listings on the National Register of Historic Places for the Town of Holly Springs. These sites are listed in the table below.

Table G.7 – Historic Properties

Ref#	Property Name	Status Date	Category	City
97000218	Leslie--Alford--Mims House	3/8/1997	Building	Holly Springs
10000164	Holly Springs Masonic Lodge	4/7/2010	Building	Holly Springs

Source: National Parks Service, National Register of Historic Places, October 2018

Housing

The following table details key housing statistics for Holly Springs as compared to the County overall.

Table G.8 – Housing Statistics, Holly Springs, 2010-2017

Jurisdiction	Housing Units (2010)	Housing Units (2016)	Housing Units Percent Change (2010-2017)	Owner-Occupied, % (2017)	Vacant Units, % (2017)	Median Home Value (2017)
Wake County total	**371,836**	**411,632**	**10.7%**	**59.5%**	**7.2%**	**$250,700**
Town of Holly Springs	8,658	10,425	20.4%	82.2%	3.0%	$264,500

Source: U.S. Census Bureau 2010 Decennial Census, American Community Survey 2013-2017 5-Year Estimates
Note: Owner-Occupied and vacant-unit measures are reported as a percent of the total number of housing units.

Economy

The following tables present key economic statistics for Holly Springs as compared to the County overall.

Table G.9 – Employment Statistics, Holly Springs, 2017

Jurisdiction	Population in Labor Force	Percent Employed* (%)	Percent Unemployed* (%)	Percent Not in Labor Force* (%)	Unemployment Rate (%)
Wake County	**564,096**	**67.2**	**3.5**	**29.2**	**4.9**
Town of Holly Springs	16,121	69.4	2.6	27.7	3.6

Source: U.S. Census Bureau, American Community Survey 2013-2017 5-Year Estimates
Note: This table reports only the civilian labor force. The labor force in armed services accounted for 0.3% or less of the population 16 and over in all jurisdictions. *Population employed, population unemployed, and Population not in labor force are reported as a percent of the total population aged 16 years and older.

Table G.10 – Percent of Employed Population by Occupation, Holly Springs, 2017

Occupation	Management, business, science and arts (%)	Service (%)	Sales and Office (%)	Natural Resources, Construction, and Maintenance (%)	Production, transportation, and material moving (%)
Wake County	**50.1**	**13.8**	**23.4**	**6.0**	**6.7**
Town of Holly Springs	54.8	9.3	24.3	3.7	7.9

Source: U.S. Census Bureau, American Community Survey 2013-2017 5-Year Estimates

G.3 RISK ASSESSMENT

This section contains a hazard profile and vulnerability assessment for those hazards that were rated with a higher priority for the Town of Holly Springs than for Wake County as a whole. Risk and vulnerability findings are also presented here for those hazards that are spatially defined and have variations in risk that could be evaluated quantitatively on a jurisdictional level. The hazards included in this section are: Flood and Wildfire.

G.3.1 Flood

Table G.11 details the acreage of the Town of Holly Springs by flood zone on the effective DFIRM. Per this assessment, over 7 percent of Holly Springs falls within the mapped 1%-annual-chance floodplains.

Table G.11 – Flood Zone Acreage in the Town of Holly Springs

Flood Zone	Acreage	Percent of Total (%)
Zone A	2.51	0.01
Zone AE	1,063.67	7.35
Zone X (500-year)	59.35	0.29
Zone X Unshaded	19,253.06	94.48
Total	**20,378.59**	**--**

Source: FEMA Effective DFIRM; Wake County GIS

Figure G.3 reflects the effective mapped flood hazard zones for the Town of Holly Springs, and Figure G.4 displays the depth of flooding estimated to occur in these areas during the 1%-annual-chance flood.

To supplement the IRISK assessment of property at risk from the 1% annual chance flood event in Section 4 and provide a clearer picture of the current property at risk in Town of Holly Springs, current parcel data was evaluated to identify parcels developed since 2010. Using GIS analysis, parcels developed after 2010 were compared to the boundaries of the 1% annual chance floodplain to identify the exposure of newly developed property to the base flood. In most cases, a parcel was considered exposed to the floodplain if any portion of the parcel was located in the floodplain.

This assessment does not evaluate flood impacts or provide damage estimates. However, this summary of development in or near the floodplain since 2010 provides some context to understand the degree to which the IRISK exposure and vulnerability numbers differ from current conditions.

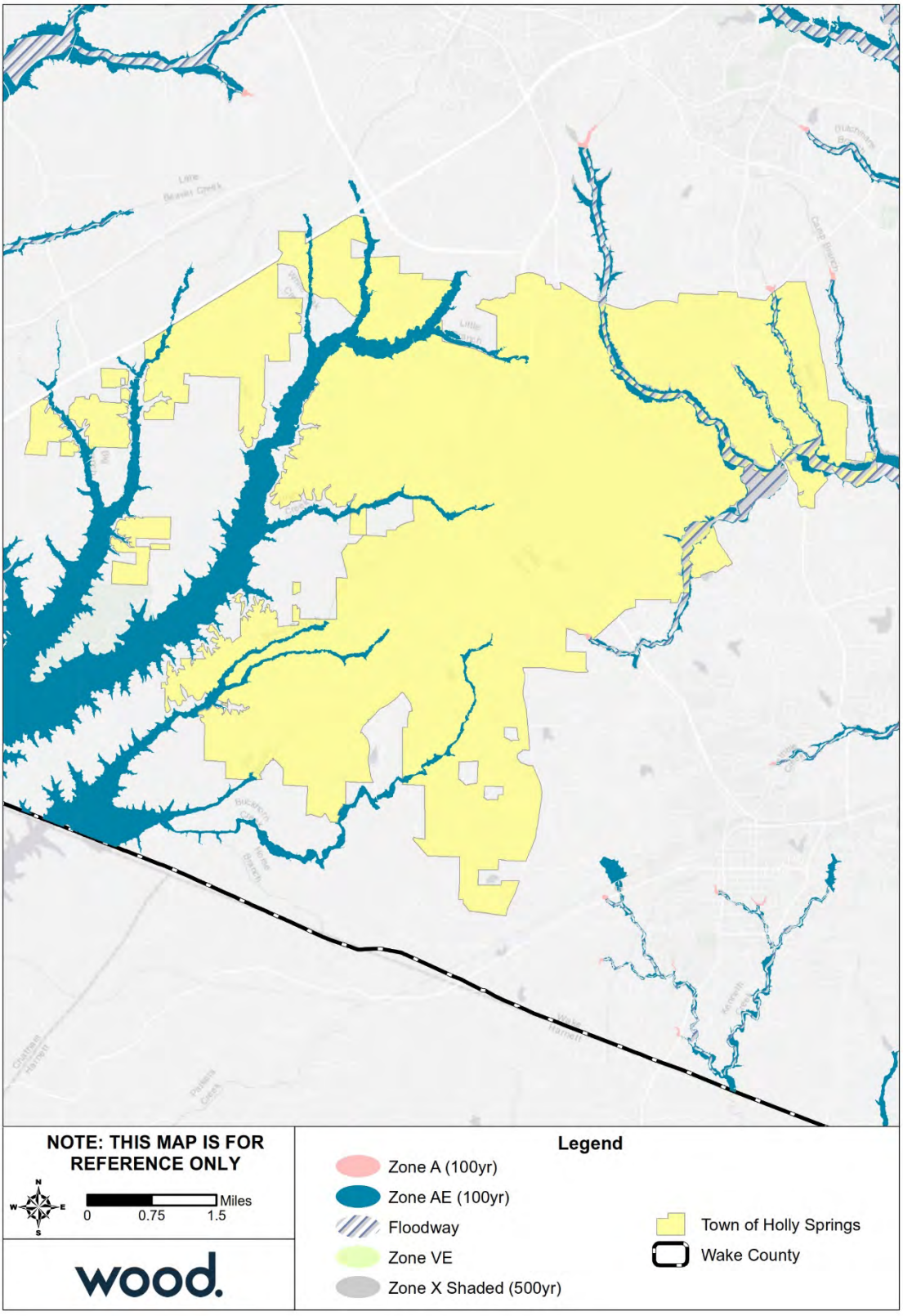
Table G.12 provides a summary by land class of parcel development located in the 1% annual chance floodplain from January 2011 to April 2019.

Table G.12 – Parcels Developed 2011 or Later and Located in 100-Year Floodplain, Town of Holly Springs

Land Class	Number of Parcels	Sum of Building Value
Golf Course	1	$76,222
Residential Less Than 10 Acres	34	$12,917,905
Grand Total	**35**	**$12,994,127**

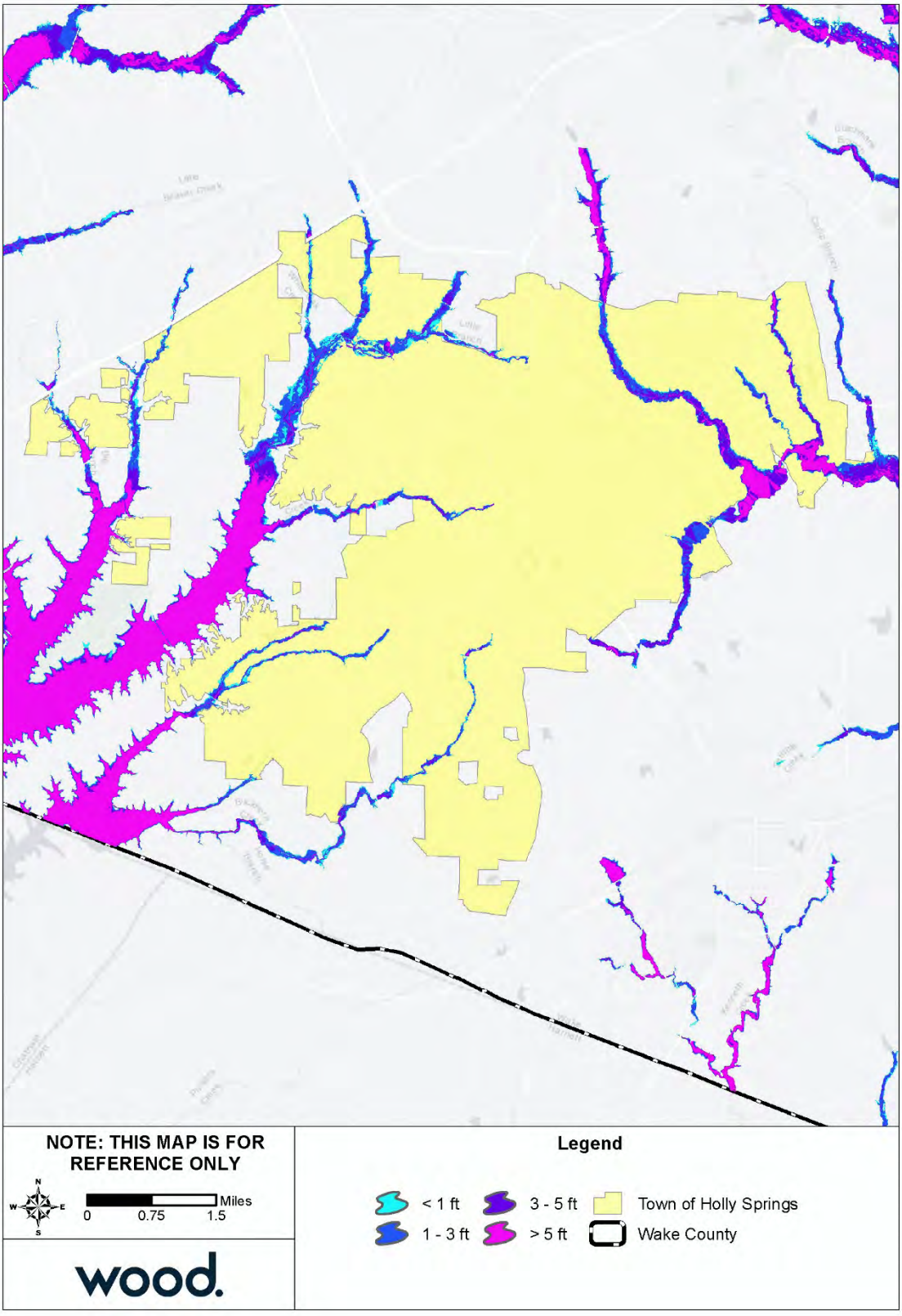
Source: Wake County Open Data; retrieved April 8, 2019; FEMA Effective DFIRM

Figure G.3 – FEMA Flood Hazard Areas, Town of Holly Springs



Source: FEMA Effective DFIRM

Figure G.4 – Flood Depth, 1%-Annual-Chance Floodplain, Town of Holly Springs



Source: FEMA Effective DFIRM

G.3.2 Wildfire

Table G.13 summarizes the acreage in the Town of Holly Springs that falls within the Wildland Urban Interface (WUI), categorized by housing density. Areas in the WUI are those where development may intermix with flammable vegetation. Over 24 percent of the Town of Holly Springs is not included in the WUI.

Table G.13 – Wildland Urban Interface Acreage, Town of Holly Springs

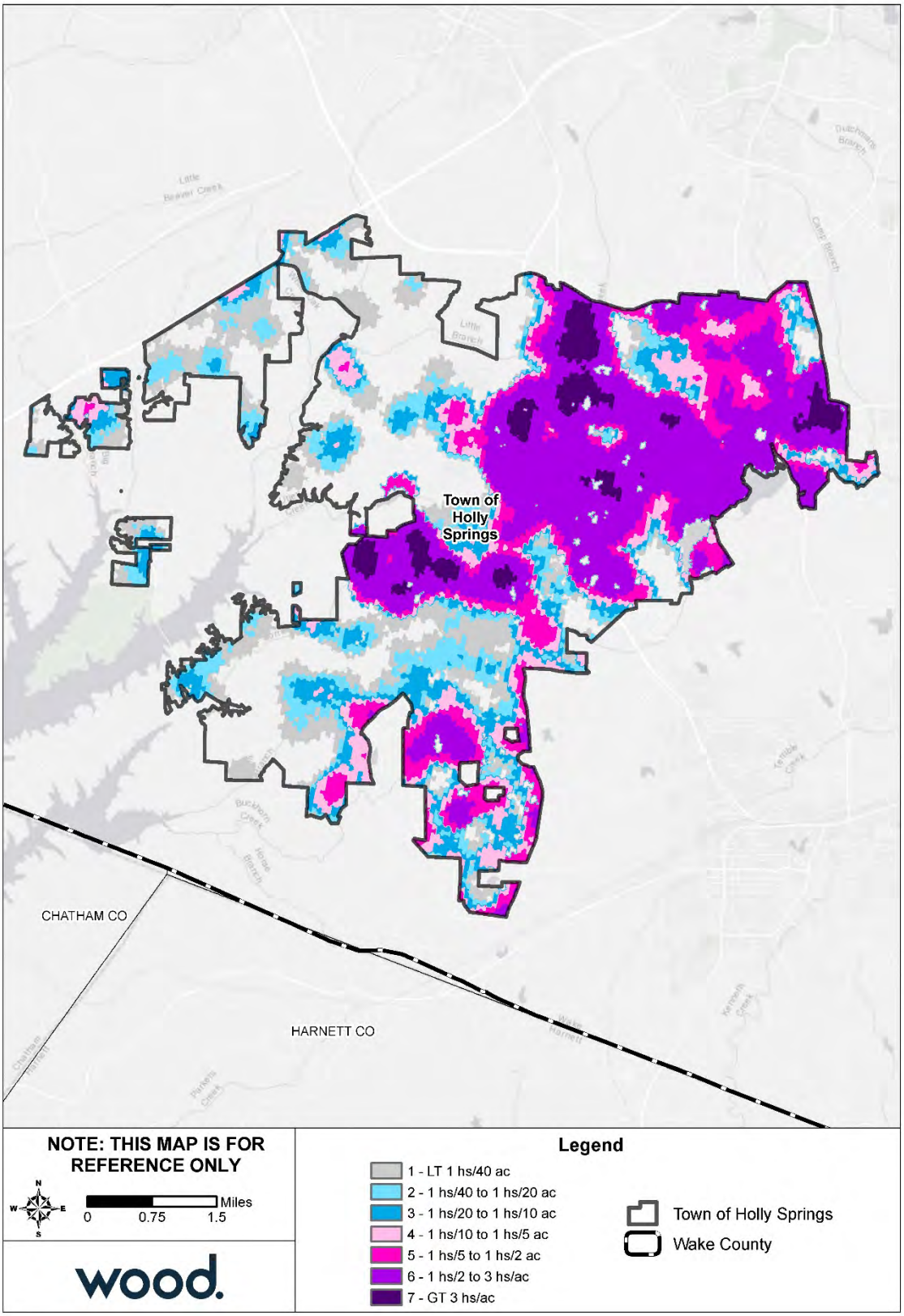
	Housing Density	Total Acreage	Percent of Total Acreage
	Not in WUI	*4,967.0*	*24.3%*
	LT 1hs/40ac	2,520.9	12.3%
	1hs/40ac to 1hs/20ac	1,814.0	8.9%
	1hs/20ac to 1hs/10ac	1,783.3	8.7%
	1hs/10ac to 1hs/5ac	1,588.4	7.8%
	1hs/5ac to 1hs/2ac	2,045.1	10.0%
	1hs/2ac to 3hs/1ac	4,961.7	24.3%
	GT 3hs/1ac	757.2	3.7%
	Total	20,437.5	

Source: Southern Wildfire Risk Assessment

Figure G.5 depicts the WUI for the Town of Holly Springs. The WUI is the area where housing development is built near or among areas of vegetation that may be prone to wildfire. Figure G.6 depicts the Fire Intensity Scale, which indicates the potential severity of fire based on fuel loads, topography, and other factors. Figure G.7 depicts Burn Probability based on landscape conditions, percentile weather, historical ignition patterns, and historical prevention and suppression efforts.

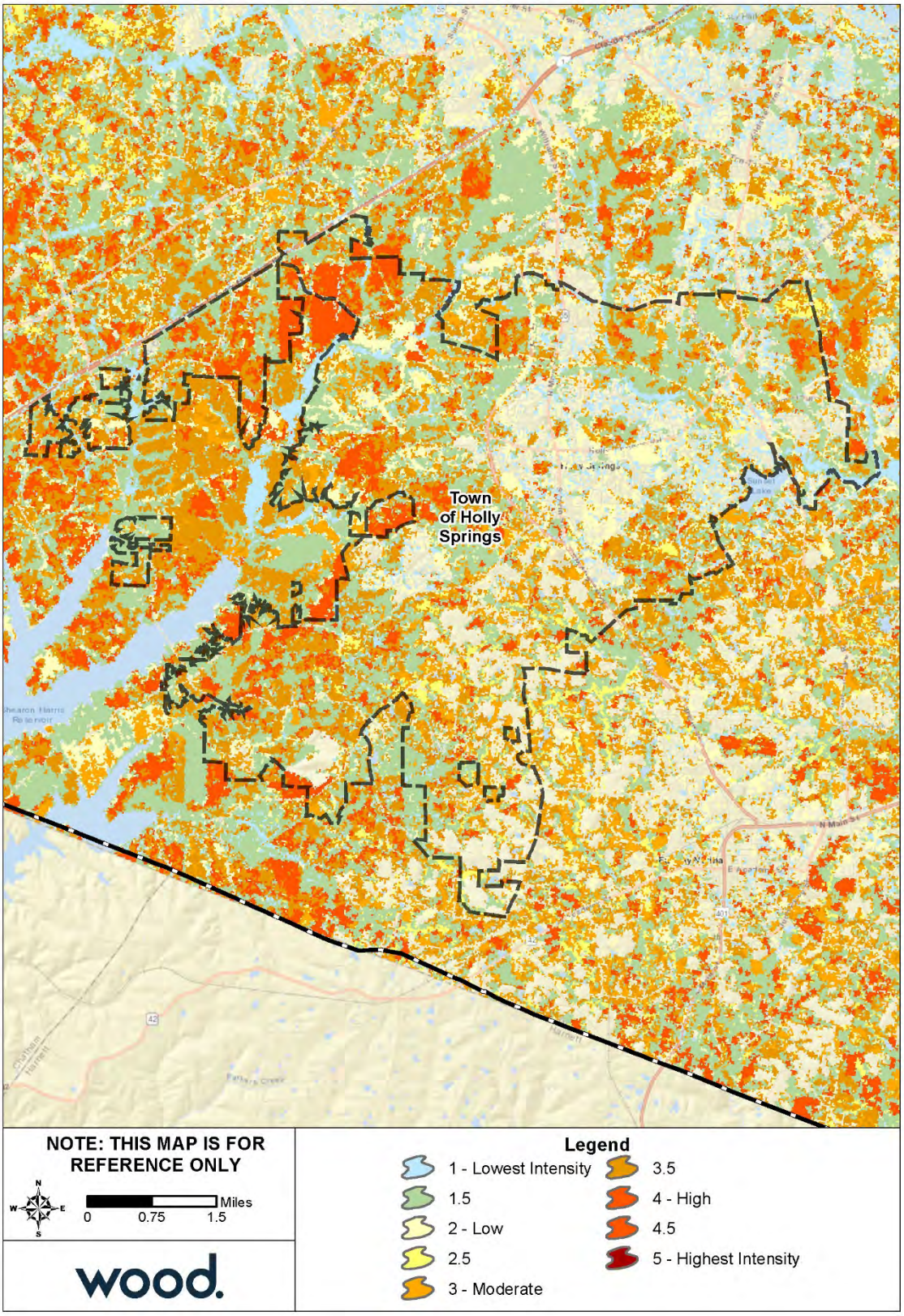
Potential fire intensity is highest in northwest and west Holly Springs. These areas are largely outside of the WUI and have low burn probability. Southeast Holly Springs has a moderate burn probability, however potential fire intensity is relatively low in most of the area.

Figure G.5 – Wildland Urban Interface, Town of Holly Spring



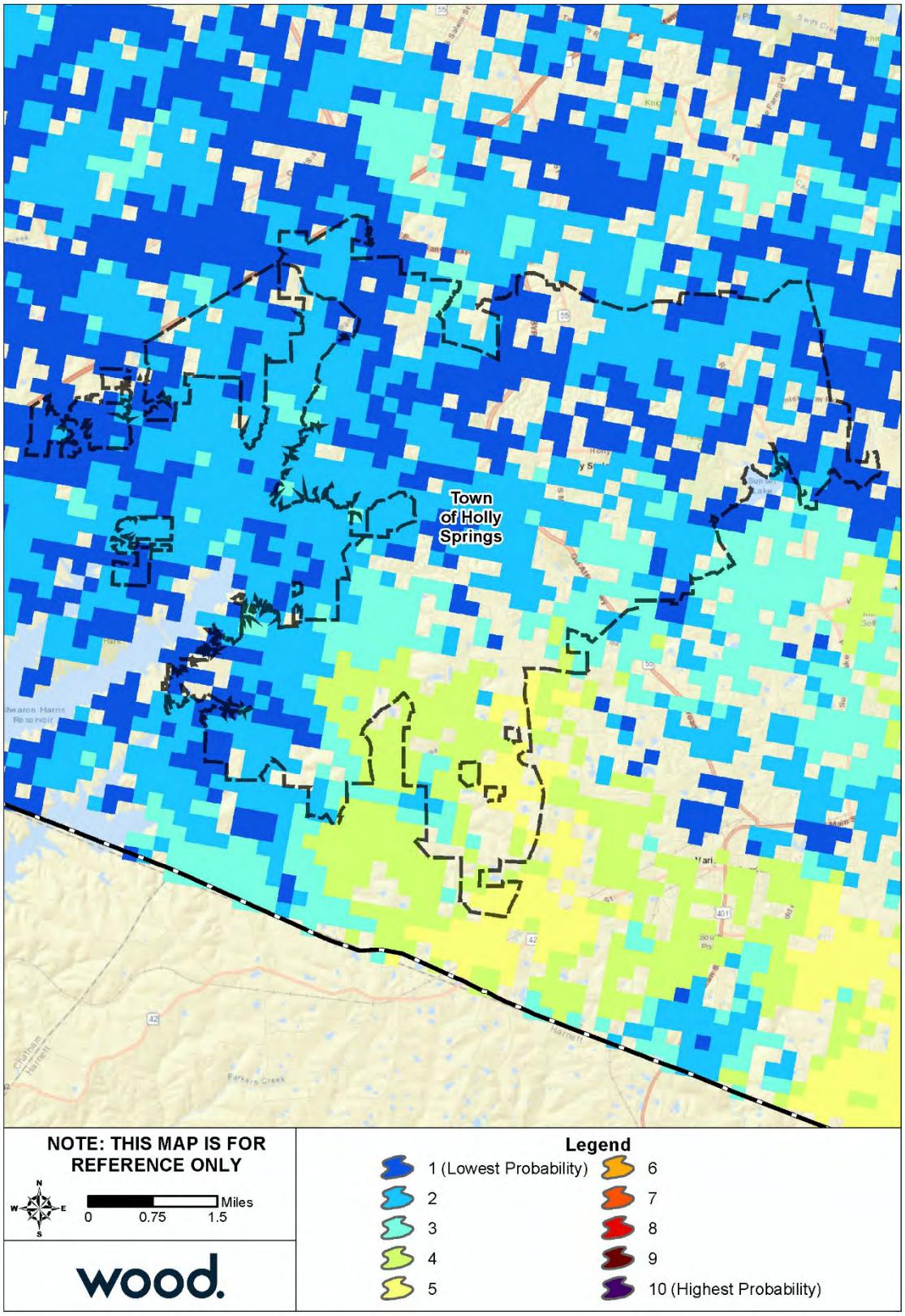
Source: Southern Wildfire Risk Assessment

Figure G.6 – Fire Intensity Scale, Town of Holly Springs



Source: Southern Wildfire Risk Assessment

Figure G.7 – Burn Probability, Town of Holly Springs



Source: Southern Wildfire Risk Assessment

G.4 CAPABILITY ASSESSMENT

G.4.1 Overall Capability

Details on the tools and resources in place and available to the Town of Holly Springs were provided by the Town's HMPC representatives and are summarized in Section 5 Capability Assessment. Based on that information and using the scoring methodology detailed in that section, Holly Springs has an overall capability rating of High. The Town's Self-Assessment of key capability areas is summarized in Table G.14 below.

Table G.14 – Capability Self-Assessment, Holly Springs

Capability Area	Rating
Plans, Ordinances, Codes and Programs	High
Administrative and Technical Capability	High
Fiscal Capability	High
Education and Outreach Capability	Moderate
Mitigation Capability	Moderate
Political Capability	High
Overall Capability	High

G.4.2 Floodplain Management

The Town of Holly Springs joined the NFIP as a regular participant in December 1994. The following tables reflect NFIP policy and claims data for the Town categorized by structure type, flood zone, Pre-FIRM and Post-FIRM.

Table G.15 – NFIP Policy and Claims Data by Structure Type

Structure Type	Number of Policies in Force	Total Premium	Insurance in Force	Number of Closed Paid Losses	Total of Closed Paid Losses
Single Family	91	$35,225	$27,559,100	10	$178,624.43
2-4 Family	1	$351	$280,000	0	$0.00
All Other Residential	0	$0	$0	0	$0.00
Non-Residential	1	$1,660	$949,200	1	$8,969.79
Total	93	$37,236	$28,788,300	11	$187,594.22

Source: FEMA Community Information System, accessed November 2018

Table G.16 – NFIP Policy and Claims Data by Flood Zone

Flood Zone	Number of Policies in Force	Total Premium	Insurance in Force	Number of Closed Paid Losses	Total of Closed Paid Losses
A01-30 & AE Zones	9	$6,785	$3,679,300	8	$134,388.63
A Zones	0	$0	$0	0	$0.00
AO Zones	0	$0	$0	0	$0.00
AH Zones	0	$0	$0	0	$0.00
AR Zones	0	$0	$0	0	$0.00
A99 Zones	0	$0	$0	0	$0.00
V01-30 & VE Zones	0	$0	$0	0	$0.00
V Zones	0	$0	$0	0	$0.00
D Zones	0	$0	$0	0	$0.00

Flood Zone	Number of Policies in Force	Total Premium	Insurance in Force	Number of Closed Paid Losses	Total of Closed Paid Losses
B, C & X Zone					
Standard	0	$0	$0	1	$6,237.93
Preferred	84	$30,451	$25,109,000	2	$46,967.66
Total	93	$37,236	$28,788,300	11	$187,594.22

Source: FEMA Community Information System, accessed November 2018

Table G.17 – NFIP Policy and Claims Data Pre-FIRM

Flood Zone	Number of Policies in Force	Total Premium	Insurance in Force	Number of Closed Paid Losses	Total of Closed Paid Losses
A01-30 & AE Zones	0	$0	$0	0	$0.00
A Zones	0	$0	$0	0	$0.00
AO Zones	0	$0	$0	0	$0.00
AH Zones	0	$0	$0	0	$0.00
AR Zones	0	$0	$0	0	$0.00
A99 Zones	0	$0	$0	0	$0.00
V01-30 & VE Zones	0	$0	$0	0	$0.00
V Zones	0	$0	$0	0	$0.00
D Zones	0	$0	$0	0	$0.00
B, C & X Zone	1	$373	$350,000	0	$0.00
Standard	0	$0	$0	0	$0.00
Preferred	1	$373	$350,000	0	$0.00
Total	1	$373	$350,000	0	$0.00

Source: FEMA Community Information System, accessed November 2018

Table G.18 – NFIP Policy and Claims Data Post-FIRM

Flood Zone	Number of Policies in Force	Total Premium	Insurance in Force	Number of Closed Paid Losses	Total of Closed Paid Losses
A01-30 & AE Zones	9	$6,785	$3,679,300	8	$134,388.63
A Zones	0	$0	$0	0	$0.00
AO Zones	0	$0	$0	0	$0.00
AH Zones	0	$0	$0	0	$0.00
AR Zones	0	$0	$0	0	$0.00
A99 Zones	0	$0	$0	0	$0.00
V01-30 & VE Zones	0	$0	$0	0	$0.00
V Zones	0	$0	$0	0	$0.00
D Zones	0	$0	$0	0	$0.00
B, C & X Zone	83	$30,078	$24,759,000	3	$53,205.59
Standard	0	$0	$0	1	$6,237.93
Preferred	83	$30,078	$24,759,000	2	$46,967.66
Total	92	$36,863	$28,438,300	11	$187,594.22

Source: FEMA Community Information System, accessed November 2018

G.5 MITIGATION STRATEGY

Town of Holly Springs											
Action #	**Description**	**Goal**	**Objective**	**Hazard(s) Addressed**	**Relative Priority**	**Lead Agency/ Department**	**Estimated Cost**	**Potential Funding Sources**	**Implementation Schedule**	**2019 Status**	**Status Comments/Explanation**
Prevention											
P-1	Vision Holly Springs Comprehensive Plan - The Town has an existing Comprehensive Plan which includes Land Use, Parks and Recreation, Public Safety, Economic Development, Transportation, Public Utilities and Environment. This plan includes past and current conditions and sets goals for future needs of the Town. The Hazard Mitigation Plan will be incorporated as an additional component of the CGP at plan update.	4	2	All	Moderate	Holly Springs Planning & Zoning	To be determined	Local	1 year	In-Progress – Carry Forward	To be updated in 2019
P-2	Update Floodplain Development Regulations - The Town has an ordinance developed to minimize public and private losses due to flood conditions. The latest update of the Flood Damage Prevention Ordinance was May 2, 2006. (00-23).	4	1	Flood	High	Holly Springs Engineering	No cost	Local	3-5 Years	In-Progress – Carry Forward	Ordinance will be updated once the preliminary maps under review by FEMA/NCDEM are adopted
P-3	Implement Floodplain Development Regulations related to participating in the National Flood Insurance Program	4	1	Flood	High	Holly Springs Engineering	Staff time	Local	2-3 years	Not Started – Carry Forward	The Town restricts or prohibits uses which are dangerous to health, safety and property due to water or erosion hazards or which result in damaging increases in erosion or in flood heights or velocities. (00-23)
P-4	Floodplain Development Regulations - The Town has been a participating member of the National Flood Insurance Program since 1992, The Town evaluated the Town's potential participation in the Community Rating System (CRS) and determined that the amount of insured properties in the Town did not warrant participation in the CRS. However, staff will reevaluate this determination in the future through the implementation of the Floodplain Management Program.	4	1	Flood	High	Holly Springs Engineering	To be determined	Local	Ongoing - Next 5 Years	In-Progress – Carry Forward	Re-evaluate potential for CRS participation
P-5	Water Emergency Response Plan - Develop Water Emergency Response Plan in accordance with EPA mandate with wastewater emergency plan developed voluntarily.	3	2	All	High	Holly Springs Public Utilities, Engineering	To be determined	Local	3-5 years	In-Progress – Carry Forward	Plan review and update will ensure secondary water sources available during an emergency
Property Protection											
PP-1	Building Acquisition and Clearance - The Town is willing to develop a plan designed to utilize Federal grant resources to assist private property owners in purchasing properties located in flood hazard zones.	3	2	Flood	Low	Holly Springs Code Enforcement	Staff time; acquisition costs TBD on case by case basis	Local, State, Federal	2-3 years	Not Started – Carry Forward	Target for development of plan to enable this activity is now 2019-2021
PP-2	Building Relocation - The Town is willing to develop a plan designed to utilize Federal grant resources to assist private property owners in relocating existing structures out of flood hazard zones.	3	2	Flood	Low	Holly Springs Code Enforcement	Staff time; relocation costs TBD on case by case basis	Local, State, Federal	2-3 years	Not Started – Carry Forward	Target for development of plan to enable this activity is now 2019-2021
PP-3	Building Retrofit - The Town is willing to develop a plan to utilize Federal grant resources to assist private property owners in renovating and retrofitting existing structures in flood hazard zones to reduce vulnerability to flooding damage.	3	2	Flood	Low	Holly Springs Code Enforcement	Staff time; retrofitting costs TBD on case by case basis	Local, State, Federal	2-3 years	Not Started – Carry Forward	Target for development of plan to enable this activity is now 2020-2021
PP-4	Purchase of Open Space, Parks and Greenways - The Parks and Recreation Department is asking for $500,000 for Capital Improvement Projects to purchase open space. The Town also works with Wake County and other agencies to find other funding for open space acquisition. Once funds are obtained the Town will acquire land consistent with Land Use and Master Open Space Plans.	4	2	Flood	Moderate	Holly Springs Parks and Recreation	Land Cost	County & State Agencies	More than 5 years	In-Progress – Carry Forward	Continually seeks new investments
PP-5	Backup Power to Fire and Police Stations – The Town provides backup power to all fire and police stations. Fire Station 1 – backup power provided by a grant; backup power to Fire Station 2 and Fire Station 3 and Police Station provided by local funds.	3	1	All	High	Holly Springs Public Safety	Requires new facility. Cost unknown at this time.	Local, Federal	3-5 Years	In-Progress – Carry Forward	Plans to be developed to establish backup power for Fire Station #3.

Town of Holly Springs											
Action #	**Description**	**Goal**	**Objective**	**Hazard(s) Addressed**	**Relative Priority**	**Lead Agency/ Department**	**Estimated Cost**	**Potential Funding Sources**	**Implementation Schedule**	**2019 Status**	**Status Comments/Explanation**
PP-6	Emergency Generator for Public Works Building	3	1	All	Moderate	Holly Springs Public Works	To be determined	Local	3-5 Years	In-Progress – Carry Forward	The Town currently has an emergency generator to provide power to the Front Office of the Public Works Building during emergencies. Future goal is to provide 100% generator power to the building.
PP-7	Install additional Generators	3	1	All	High	Holly Springs Public Utilities	To be determined	Local	1 year	In-Progress – Carry Forward	The wastewater treatment plant and sewer lift stations built after 1994 have generators. In emergency situations, the Town also has mobile generators to be used at lift stations built between 1985 – 1994 that are without permanent generators on site. Over the next ten years, the Town would like to purchase generators for lift stations that do not currently have generators.
Natural Resource Protection											
NRP-1	As part of the next phases(s) of the Town's Watershed Masterplan, a map of impervious cover will be created. This information may be used overlain to show which structures are in hazardous locations.	2	2	Flood, Dam Failure, Earthquake, Hurricane, Severe Weather, Tornado, Wildfire	High	Holly Springs Engineering	Staff time	Local	3-5 years	New	N/A
Structural Projects											
S-1	The Town is in the process of pursuing options to improve the existing spillway or create a secondary spillway. Per an agreement with NC Dam Safety, this will be completed within the next 5 years.	3	2	Flood, Dam Failure	High	Holly Springs Engineering, Parks & Recreation	Over $100,000	Local	3-5 years	New	N/A
S-2	Reservoirs/Retention/Detention Basins - The Town does not currently maintain any retention or detention basins. The Town does maintain Bass Lake Dam. The Town regularly provides maintenance of vegetation and minor erosion while providing visual inspections of the dam. If larger repairs are required the Town will find appropriate means to resolve the problem. The Town also has a few small ponds located on existing parks. The Town maintains these ponds consistent with measures taken to maintain the Bass Lake Dam.	3	1	Flood	Moderate	Holly Springs Parks & Recreation	Staff time	Local	Ongoing - Next 5 Years	In-Progress – Carry Forward	Consistently and correctly maintains all ponds and dams
Emergency Services											
ES-1	Technical Rescue Capabilities - Provide and enhance technical rescue capabilities more equitably throughout the Town.	2	2	All	High	Holly Springs Public Safety	No cost	Local, Federal	3-5 Years	In-Progress – Carry Forward	All crews have basic training. Currently looking into specialty training.
ES-2	GIS Programming - Design GIS programming capable of providing real-time data to emergency managers and historic data for future emergency response planning.	2	2	All	Low	Holly Springs Public Safety	No cost	Local	3-5 Years	In-Progress – Carry Forward	Currently in the implementation phase. The new Wake County CAD will be issued on May 2019. This is a no cost to the Town.
ES-3	ECC Notifications by NOAA for possible severe weather (tornados, ice, etc.). ECC is notified by both agencies when weather alerts are issued. Information is then broadcast over police radios. This information is generated by the State and Wake County and is obtained through the use of DC message, radio, fax and Nextel.	2	1	Severe Weather, Severe Winter Storm, Tornado, Hurricane	High	Holly Springs Public Safety	No cost	Local	3-5 years	In-Progress – Carry Forward	Partially implemented. Currently use WEB EOC and the dispatch center.
ES-4	Purchase ACU 1000 Communications Unit – System should allow all agencies on ACU 1000 to communicate using own radios and frequencies.	2	1	All	High	Holly Springs Public Safety	To be determined	Local	3-5 years	In-Progress – Carry Forward	In process of purchasing, but not yet completed.
ES-5	Tabletop Exercise Program - Continue to conduct disaster tabletop exercise program with Wake County	2	2	All	High	Holly Springs Public Safety	Staff time	Local	Ongoing - Next 5 Years	In-Progress – Carry Forward	Tabletop exercises are held through public safety periodically and will continue to be done.

Town of Holly Springs											
Action #	Description	Goal	Objective	Hazard(s) Addressed	Relative Priority	Lead Agency/ Department	Estimated Cost	Potential Funding Sources	Implementation Schedule	2019 Status	Status Comments/Explanation
ES-6	Counseling – Police psychologist and Critical Incident Stress Debriefing Team training to provide debriefing sessions for personnel.	2	1	All	High	Holly Springs Police Department	Staff time	Local	5 years	In-Progress – Carry Forward	Partially implemented, under construction. Currently, we have incorporated the services of a chaplaincy program and conduct critical incident debriefs with our personnel for both internal and external incidents. In addition, we are looking at a proposal to expand our program to include peer teams, peer counselors, and incorporation of the NC Law Enforcement Assistance Program (http://www.nc-leap.org/page6.aspx) in partnership with Teia Pullen of the Cary Police Department. Our goal is to network with southern Wake County law enforcement and public safety agencies, clinicians, and other mental health professionals to provide a broad base of support services to our public safety professionals.
Public Education and Awareness											
PEA-1	Environmental Education	1	1	Flood, Drought	High	Holly Springs Engineering	Staff time and O&M costs	Local	Ongoing - Next 5 Years	In-Progress – Carry Forward	The Town currently has a program which includes environmental education for the public through Town festivals (Holly Fest), public meetings, brochures and preconstruction meetings. The Town operates the Bass Lake Retreat Center which will allow for space to hold additional environmental education activities. The Town will also expand its current education activities to meet NPDES Phase II requirements. The Town's Environmental Education focuses on flooding, drainage, the National Flood Insurance Program, NPDES Phase II, Erosion & Sedimentation Control, Habitat Preservation, etc.
PEA-2	Website - The Town maintains its own website, which is able to provide up to date information for the public. The Town is continuously updating the site with additional resources.	1	1	All	High	Holly Springs Governing Body	Staff time	Local	2017	In-Progress – Carry Forward	The Communications Department provides the community with news and information via the Town's website, the Town's government access television channel HSTV-11, news releases, The Source newsletter, email and text message subscriptions, and social media on a daily basis.

Annex H Town of Knightdale

H.1 PLANNING PROCESS

The table below lists the HMPC members who represented the Town of Knightdale.

Table H.1 – HMPC Members

Agency	Representative	Position or Title
Development Services Department	Jason Brown	Senior Planner – Long Range
Development Services Department	Chris Hills	Development Services Director
N/A	Ben McDonald	Citizen Stakeholder

H.2 COMMUNITY PROFILE

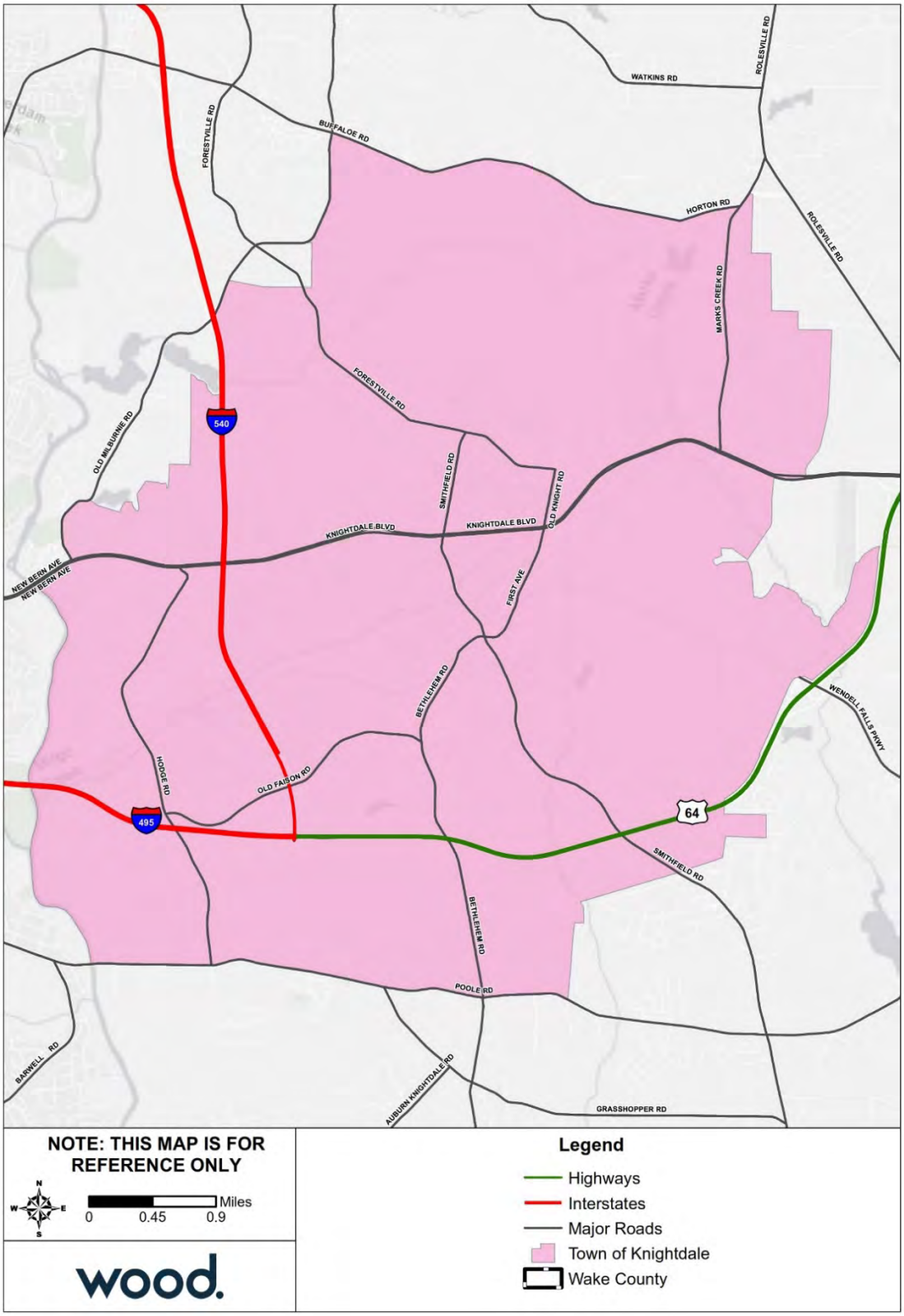
Geography

The Town of Knightdale is located in eastern Wake County. It is neighbored by Raleigh to the west and Wendell to the east. The Town is part of the Raleigh, NC Metropolitan Statistical Area, which falls within the larger Raleigh-Durham-Chapel Hill, NC Combined Statistical Area. Fuquay-Varina comprises a total land area of 6.2 square miles.

According to data from the U.S. Fish and Wildlife Service's National Wetlands Inventory, there are approximately 2,626 acres of wetlands in Knightdale.

Figure H.1 shows a base map of major transportation routes in the Town of Knightdale.

Figure H.1 – Major Transportation Routes – Town of Knightdale



Source: Wake County GIS Open Data

Population and Demographics

Table H.2 provides population counts and growth estimates for the Town of Knightdale as compared to the County overall. Table H.3 provides demographic information for Knightdale as compared to the whole County.

Table H.2 – Population Counts, Knightdale, 2010-2017

Jurisdiction	2000 Census Population	2010 Census Population	2017 ACS Population Estimate	Total Change 2010-2017	% Change 2010-2017
Wake County total	**627,846**	**900,993**	**1,023,811**	**122,818**	**13.6%**
Town of Knightdale	5,958	11,401	14,363	2,962	26.0%

Source: US Census Bureau Decennial Census 2000, Decennial Census 2010; American Community Survey 2013-2017 5-Year Estimates

Table H.3 – Racial Demographics, Knightdale, 2017

Jurisdiction	White, %	Black, %	Asian, %	Other Race, %	Two or More Races, %	Persons of Hispanic or Latino Origin*, %
Wake County total	**66.5%**	**20.4%**	**6.5%**	**3.6%**	**2.7%**	**10.0%**
Town of Knightdale	49.8%	35.9%	4.1%	6.0%	4.1%	15.4%

Source: US Census Bureau, American Community Survey 2013-2017 5-Year Estimates

*Persons of Hispanic origin may be of any race, so also are included in applicable race categories

Asset Inventory

The following tables summarize the asset inventory for Knightdale in order to estimate the total physical exposure to hazards in this area. The locations of critical facilities are shown in Figure H.2 on the following page. Critical facilities are a subset of identified assets from the Critical Infrastructure & Key Resources dataset. Note that the counts are by building; where a critical facility comprises a cluster of buildings, each building is counted and displayed.

Table H.4 – Critical Infrastructure & Key Resources by Type

Jurisdiction	Food & Agriculture	Banking & Finance	Chemical	Commercial Facilities	Communications	Manufacturing	Defense	Government	Healthcare	IT	National Monuments	Nuclear	Postal & Shipping	Transportation	Energy	Emergency Services	Water	Other	Total
Town of Knightdale	68	10	0	120	0	64	0	46	8	0	0	0	0	12	1	5	0	0	**334**

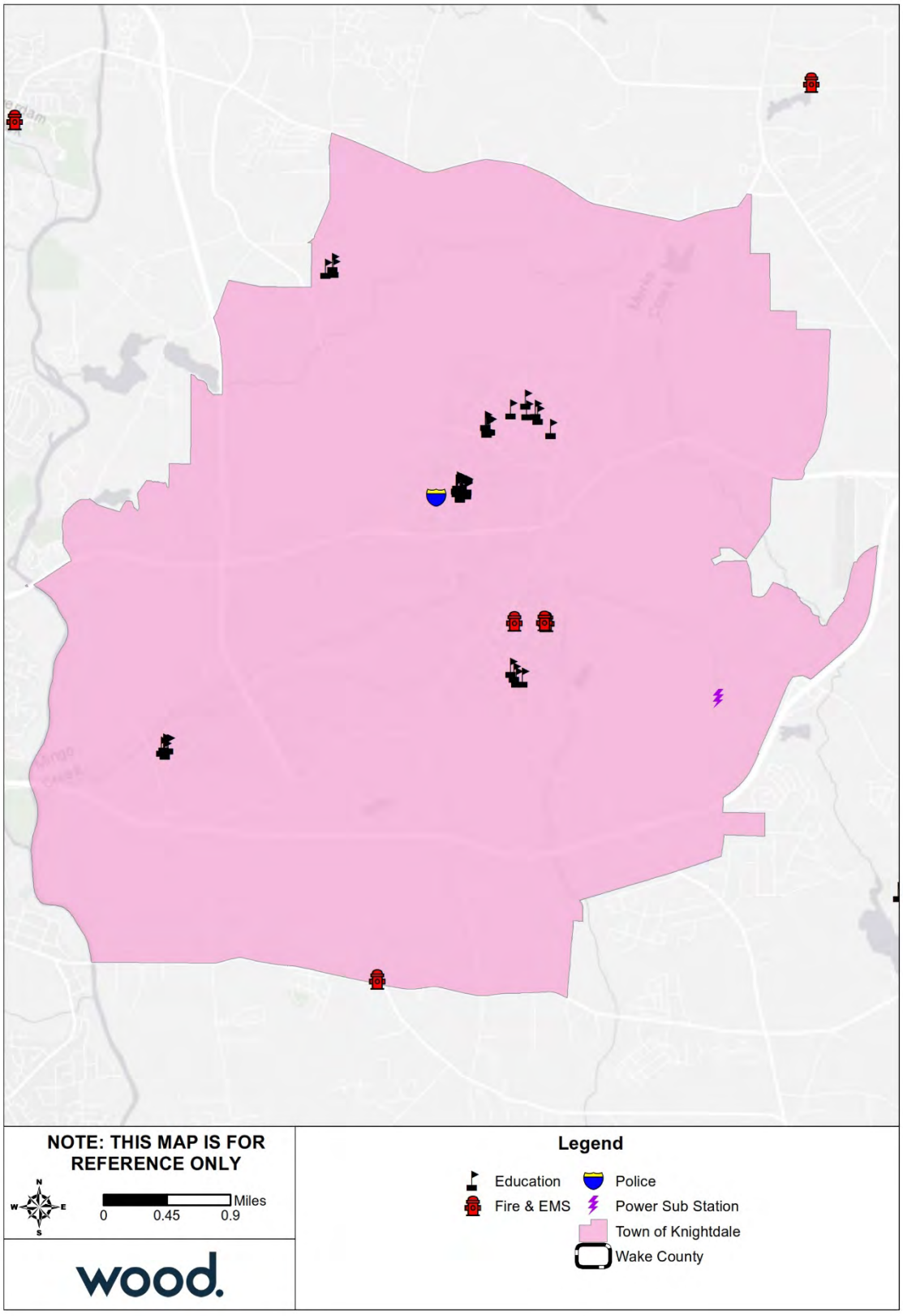
Source: NCEM Risk Management Tool

Table H.5 – High Potential Loss Facilities by Use

Jurisdiction	Residential	Commercial	Industrial	Government	Agricultural	Religious	Utilities	Other	Total
Town of Knightdale	40	37	4	19	0	8	1	0	**109**

Source: NCEM Risk Management Tool

Figure H.2 – Critical Facilities, Town of Knightdale



Source: NCEM IRISK Database, GIS Analysis

To supplement the asset inventory and provide a clearer picture of the current asset exposure in the Town of Knightdale, current parcel data was evaluated to identify development since 2010. This information is not incorporated into the risk assessment, which was prepared using NCEM's IRISK database. However, this summary of development since 2010 provides some context to understand the degree to which the IRISK exposure and vulnerability numbers differ from current conditions.

Table H.6 provides a summary by land class of parcel development from January 2011 to April 2019.

Table H.6 – Parcels Developed 2011 or Later, Town of Knightdale

Land Class	Number of Parcels	Sum of Building Value
Apartment	4	$30,753,734
Commercial	7	$14,434,438
EXEMPT	2	$21,156,065
HOA	3	-
Industrial	4	$19,237,886
Part Exempt	5	$359,864
Residential Less Than 10 Acres	1,473	$292,901,920
Vacant	1	-
Grand Total	**1,499**	**$378,843,907**

Source: Wake County Open Data; retrieved April 8, 2019

There are five listings on the National Register of Historic Places for the Town of Knightdale, including two historic districts. These sites are listed in the table below.

Table H.7 – Historic Properties

Ref#	Property Name	Status Date	Category	City
86001631	Walnut Hill Cotton Gin	8/14/1986	Building	Knightdale
86003529	Beaver Dam	1/6/1987	Building	Knightdale
87002234	Knight, Henry H. and Bettie S., Farm	1/12/1988	District	Knightdale
00001183	Walnut Hill Historic District	10/6/2000	District	Knightdale
07000543	Midway Plantation House and Outbuildings	6/15/2007	Building	Knightdale

Source: National Parks Service, National Register of Historic Places, October 2018

Housing

The table below details key housing statistics for Knightdale as compared to the County overall.

Table H.8 – Housing Statistics, Knightdale, 2010-2017

Jurisdiction	Housing Units (2010)	Housing Units (2017)	Housing Units Percent Change (2010-2017)	Owner-Occupied, % (2017)	Vacant Units, % (2017)	Median Home Value (2017)
Wake County total	**371,836**	**411,632**	**10.7%**	**59.5%**	**7.2%**	**$250,700**
Town of Knightdale	4,723	5,559	17.7%	64.6%	4.4%	$176,600

Source: U.S. Census Bureau 2010 Decennial Census, American Community Survey 2013-2017 5-Year Estimates
Note: Owner-Occupied and vacant-unit measures are reported as a percent of the total number of housing units.

Economy

The following tables present key economic statistics for Knightdale as compared to the County overall.

Table H.9 – Employment Statistics, Knightdale, 2017

Jurisdiction	Population in Labor Force	Percent Employed* (%)	Percent Unemployed* (%)	Percent Not in Labor Force* (%)	Unemployment Rate (%)
Wake County	**564,096**	**67.2**	**3.5**	**29.2**	**4.9**
Town of Knightdale	8,274	70.8	3.4	25.7	4.5

Source: U.S. Census Bureau, American Community Survey 2013-2017 5-Year Estimates
Note: This table reports only the civilian labor force. The labor force in armed services accounted for 0.3% or less of the population 16 and over in all jurisdictions. *Population employed, population unemployed, and Population not in labor force are reported as a percent of the total population aged 16 years and older.

Table H.10 – Percent of Employed Population by Occupation, Knightdale, 2017

Occupation	Management, business, science and arts (%)	Service (%)	Sales and Office (%)	Natural Resources, Construction, and Maintenance (%)	Production, transportation, and material moving (%)
Wake County	**50.1**	**13.8**	**23.4**	**6.0**	**6.7**
Town of Knightdale	49.6	15.6	22.4	6.7	5.8

Source: U.S. Census Bureau, American Community Survey 2013-2017 5-Year Estimates

H.3 RISK ASSESSMENT

This section contains a hazard profile and vulnerability assessment for those hazards that were rated with a higher priority for the Town of Knightdale than for Wake County as a whole. Risk and vulnerability findings are also presented here for those hazards that are spatially defined and have variations in risk that could be evaluated quantitatively on a jurisdictional level. The hazards included in this section are: Flood and Wildfire.

H.3.1 Flood

Table H.11 details the acreage of the Town of Knightdale by flood zone on the effective DFIRM. Per this assessment, over 5 percent of the Town of Knightdale falls within the mapped 1%-annual-chance floodplains.

Table H.11 – FEMA Flood Hazard Areas, Town of Knightdale

Flood Zone	Acreage	Percent of Total (%)
Zone A	12.96	0.08
Zone AE	840.1	5.21
Zone X (500-year)	108.12	0.67
Zone X Unshaded	15,160.18	94.04
Total	**16,121.36**	--

Source: FEMA Effective DFIRM; Wake County GIS

Figure H.3 reflects the effective mapped flood hazard zones for the Town of Knightdale, and Figure H.4 displays the depth of flooding estimated to occur in these areas during the 1%-annual-chance flood.

To supplement the IRISK assessment of property at risk from the 1% annual chance flood event in Section 4 and provide a clearer picture of the current property at risk in PLACE, current parcel data was evaluated to identify parcels developed since 2010. Using GIS analysis, parcels developed after 2010 were compared to the boundaries of the 1% annual chance floodplain to identify the exposure of newly developed

property to the base flood. In most cases, a parcel was considered exposed to the floodplain if any portion of the parcel was located in the floodplain.

This assessment does not evaluate flood impacts or provide damage estimates. However, this summary of development in or near the floodplain since 2010 provides some context to understand the degree to which the IRISK exposure and vulnerability numbers differ from current conditions.

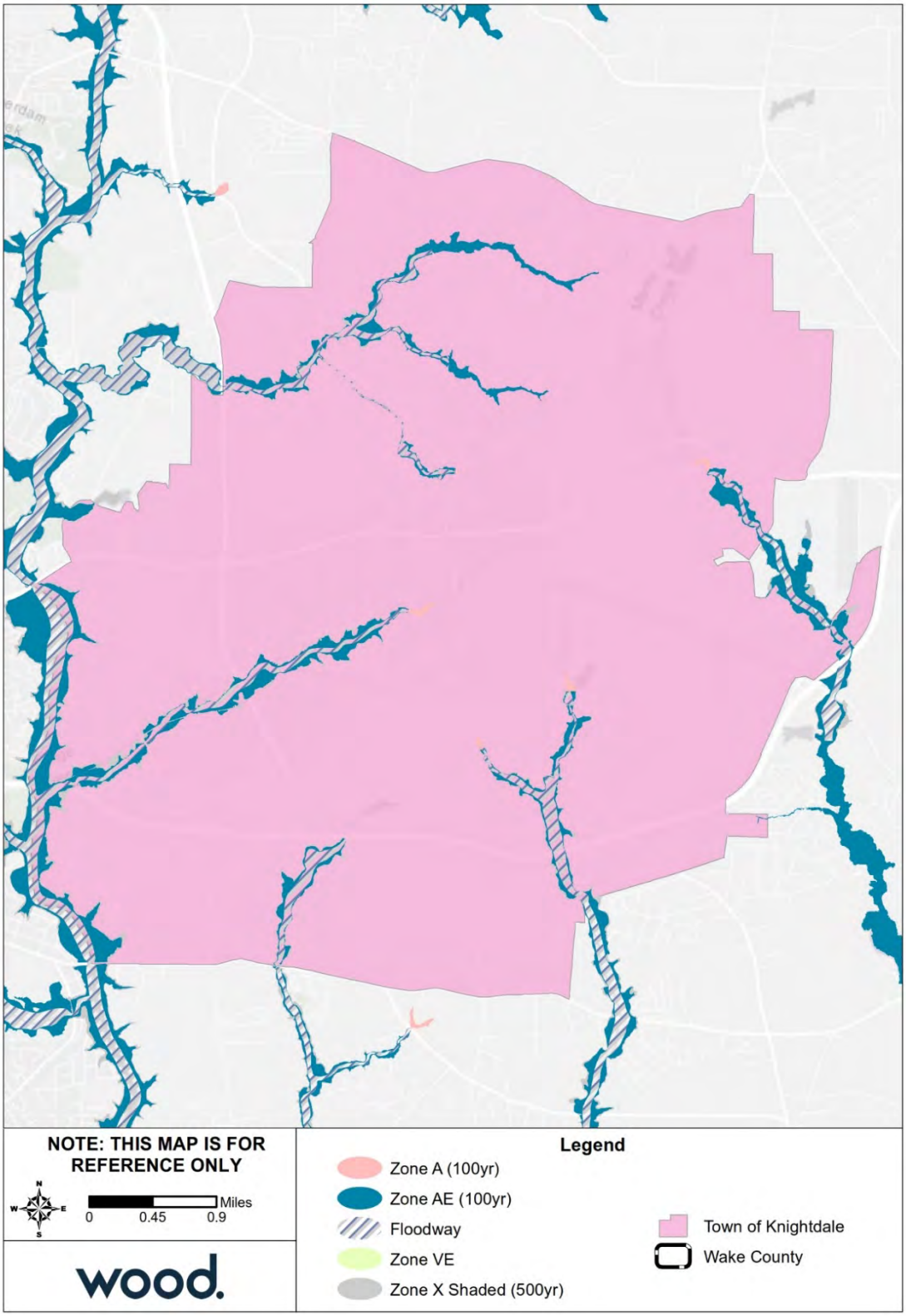
Table H.12 provides a summary by land class of parcel development located in the 1% annual chance floodplain from January 2011 to April 2019.

Table H.12 – Parcels Developed 2011 or Later and Located in 100-Year Floodplain, Town of Knightdale

Land Class	Number of Parcels	Sum of Building Value
Residential Less Than 10 Acres	18	$3,551,754
Grand Total	**18**	**$3,551,754**

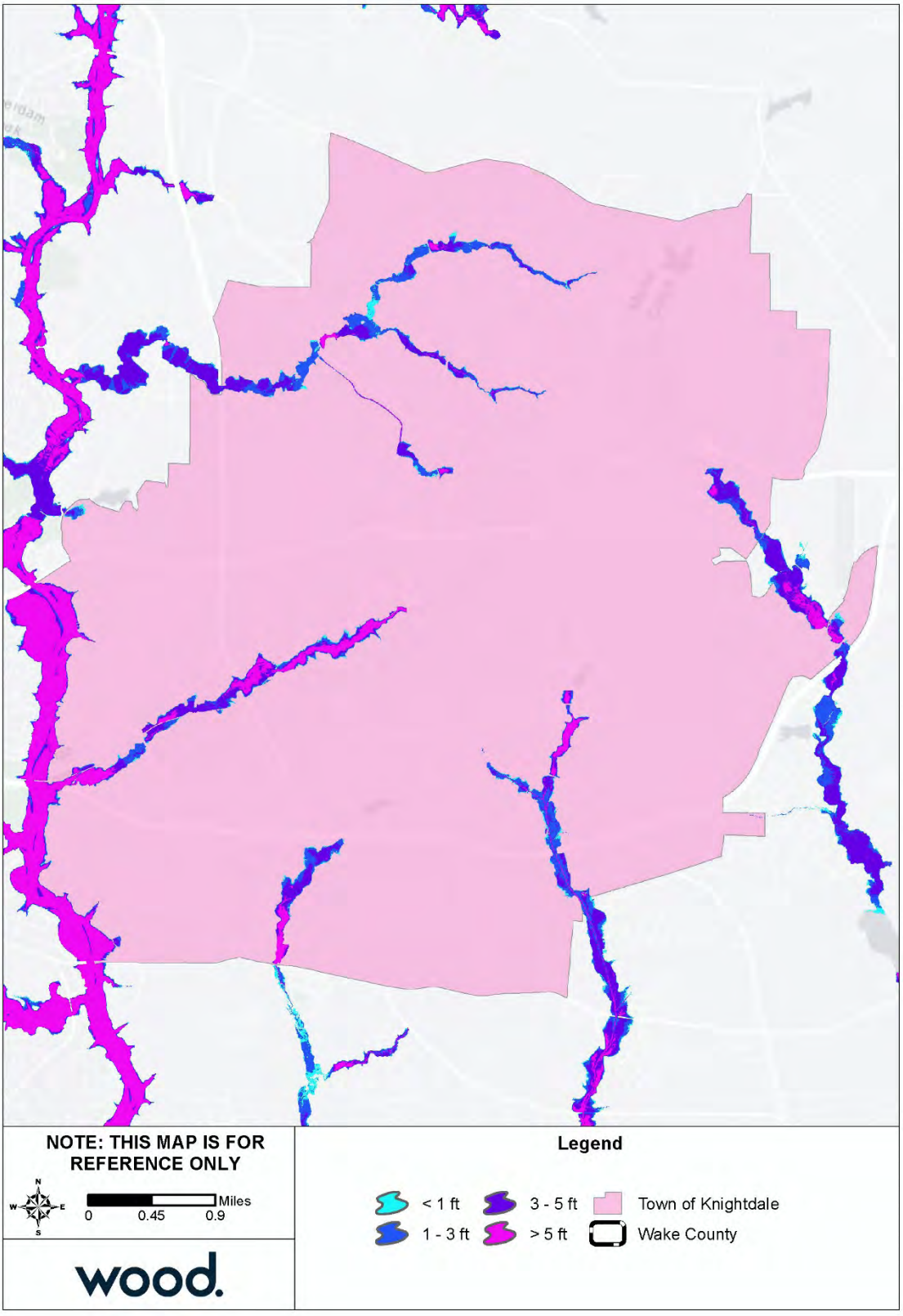
Source: Wake County Open Data; retrieved April 8, 2019; FEMA Effective DFIRM

Figure H.3 – FEMA Flood Hazard Areas, Town of Knightdale



Source: FEMA Effective DFIRM

Figure H.4 – Flood Depth, 1%-Annual-Chance Floodplain, Town of Knightdale



Source: FEMA Effective DFIRM

H.3.2 Wildfire

Table H.13 summarizes the acreage in the Town of Knightdale that falls within the Wildland Urban Interface (WUI), categorized by housing density. Areas in the WUI are those where development may intermix with flammable vegetation. Over 15 percent of the Town of Knightdale is not included in the WUI.

Table H.13 – Wildland Urban Interface Acreage, Town of Knightdale

	Housing Density	Total Acreage	Percent of Total Acreage
	Not in WUI	*2,530.8*	*15.7%*
	LT 1hs/40ac	1,571.2	9.7%
	1hs/40ac to 1hs/20ac	1,192.3	7.4%
	1hs/20ac to 1hs/10ac	1,632.5	10.1%
	1hs/10ac to 1hs/5ac	2,040.3	12.7%
	1hs/5ac to 1hs/2ac	2,872.7	17.8%
	1hs/2ac to 3hs/1ac	3,919.5	24.3%
	GT 3hs/1ac	362.1	2.2%
	Total	16,121.4	

Source: Southern Wildfire Risk Assessment

Figure H.5 depicts the WUI for the Town of Knightdale. The WUI is the area where housing development is built near or among areas of vegetation that may be prone to wildfire. Figure H.6 depicts the Fire Intensity Scale, which indicates the potential severity of fire based on fuel loads, topography, and other factors. Figure H.7 depicts Burn Probability based on landscape conditions, percentile weather, historical ignition patterns, and historical prevention and suppression efforts.

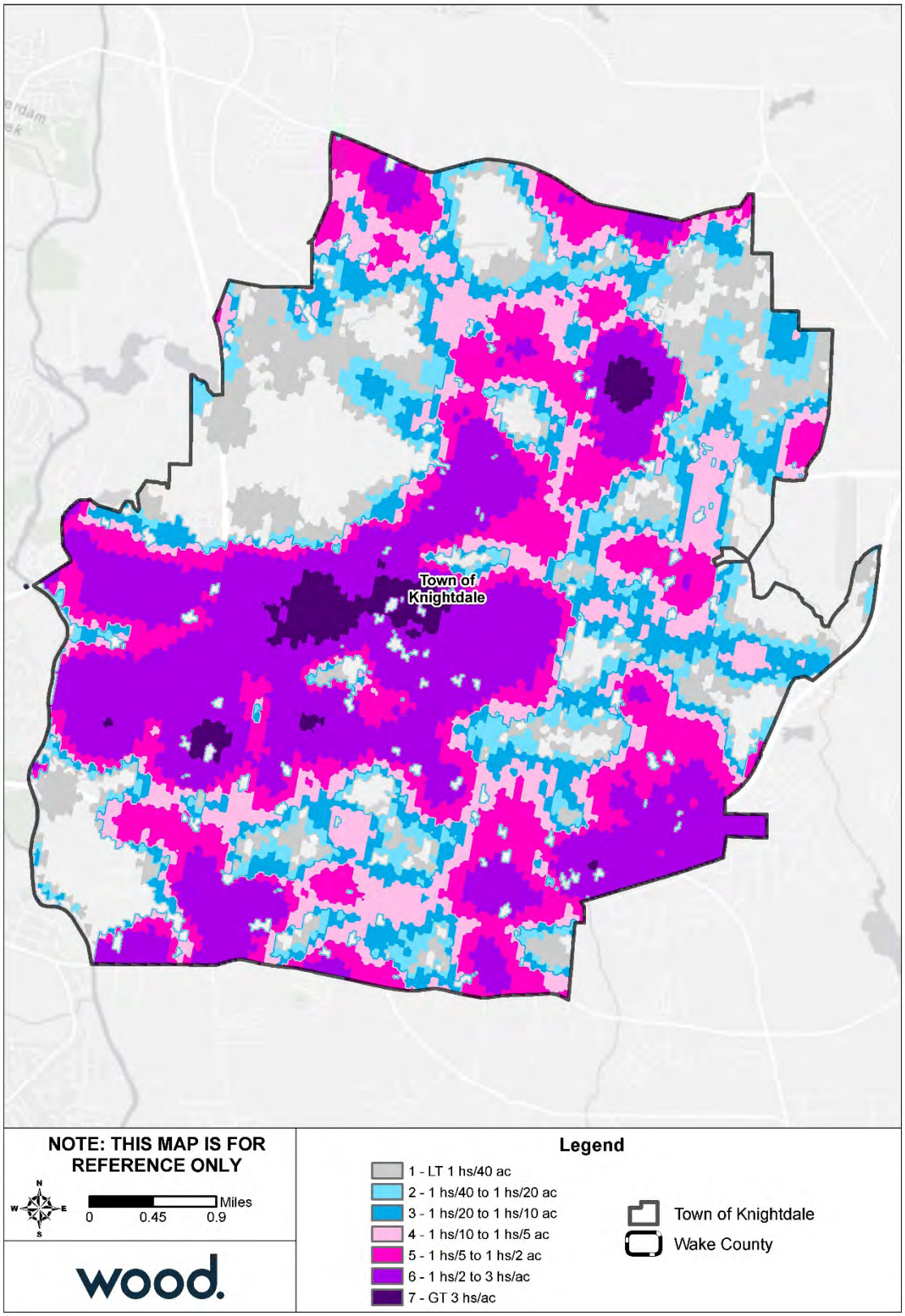
Areas of high potential fire intensity are scattered throughout Knightdale and overlap with areas of the WUI in the southern and northeaster portions of the town. However, burn probability is low throughout the town, meaning development in these areas is at low to no risk.

Table H.14 provides building counts and estimated damages for Critical Infrastructure and Key Resources (CIKR) buildings by sector at risk to wildfire hazard.

Table H.14 – Critical Facilities Exposed to Wildfire, Town of Knightdale

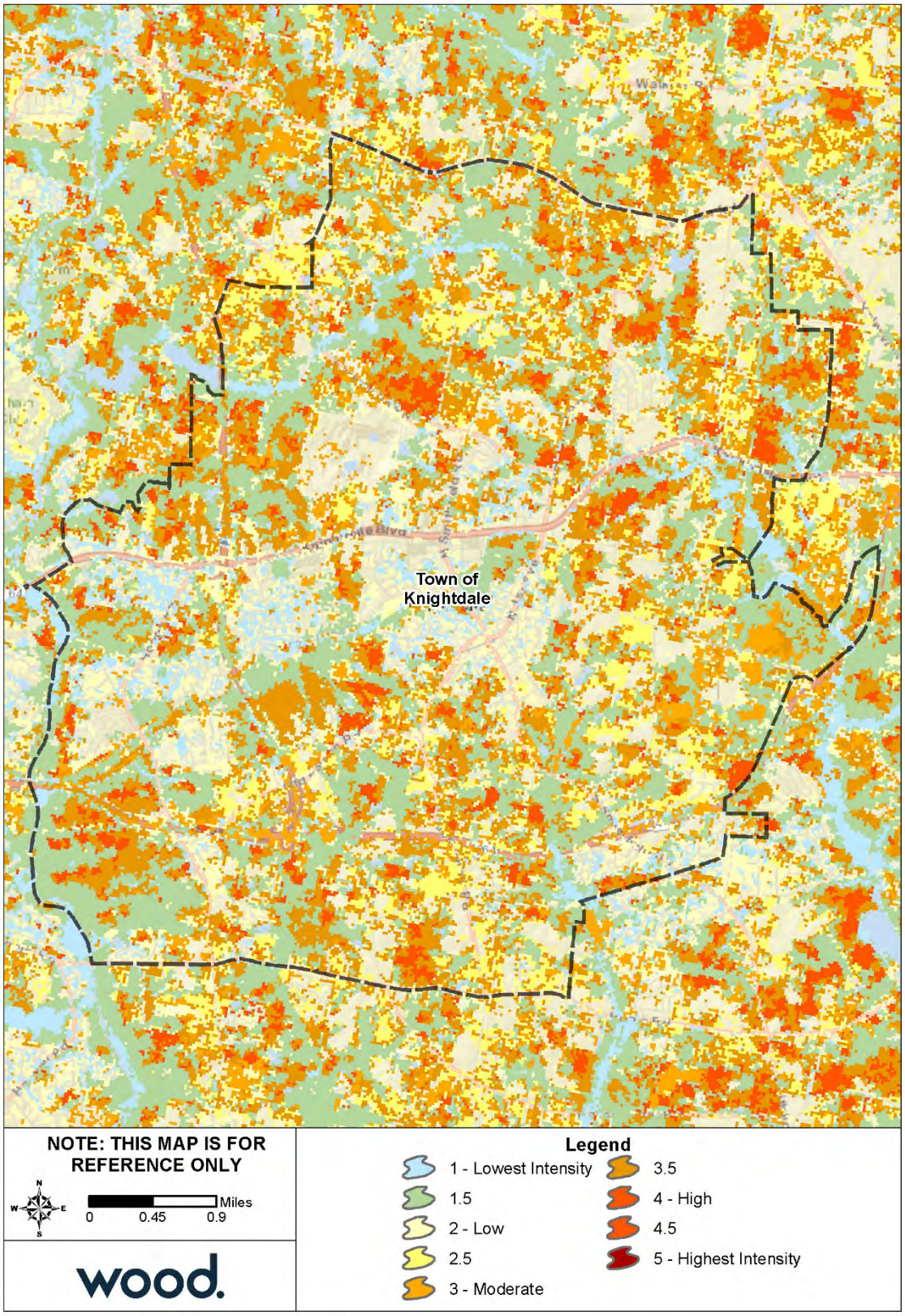
Sector	Event	Number of Buildings at Risk	Estimated Damages
Food and Agriculture	Wildfire Hazard	3	$157,144
All Categories	**Wildfire Hazard**	**3**	**$157,144**

Figure H.5 – Wildland Urban Interface, Town of Knightdale



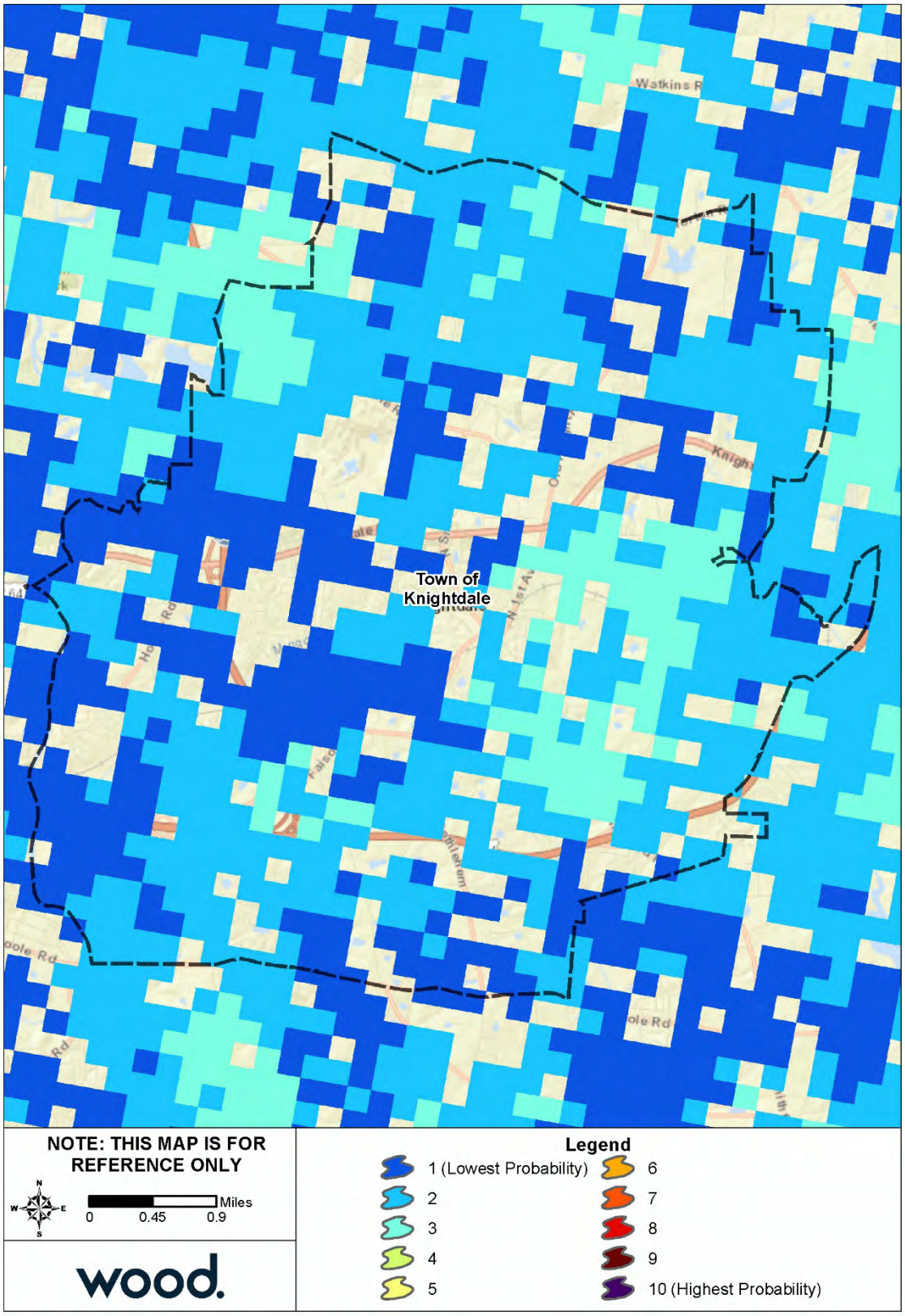
Source: Southern Wildfire Risk Assessment

Figure H.6 – Fire Intensity Scale, Town of Knightdale



Source: Southern Wildfire Risk Assessment

Figure H.7 – Burn Probability, Town of Knightdale



Source: Southern Wildfire Risk Assessment

H.4 CAPABILITY ASSESSMENT

H.4.1 Overall Capability

Details on the tools and resources in place and available to the Town of Knightdale were provided by the Town's HMPC representatives and are summarized in Section 5 Capability Assessment. Based on that information and using the scoring methodology detailed in that section, Knightdale has an overall capability rating of Moderate. The Town's Self-Assessment of key capability areas is summarized in Table H.15 below.

Table H.15 – Capability Self-Assessment, Knightdale

Capability Area	Rating
Plans, Ordinances, Codes and Programs	High
Administrative and Technical Capability	Moderate
Fiscal Capability	Limited
Education and Outreach Capability	Limited
Mitigation Capability	Limited
Political Capability	Moderate
Overall Capability	Moderate

H.4.2 Floodplain Management

The Town of Knightdale joined the NFIP through emergency entry in July 1975 and has been a regular participant since August 1978. The following tables reflect NFIP policy and claims data for the Town categorized by structure type, flood zone, Pre-FIRM and Post-FIRM.

Table H.16 – NFIP Policy and Claims Data by Structure Type

Structure Type	Number of Policies in Force	Total Premium	Insurance in Force	Number of Closed Paid Losses	Total of Closed Paid Losses
Single Family	43	$17,551	$11,787,800	3	$31,363.63
2-4 Family	0	$0	$0	0	$0.00
All Other Residential	0	$0	$0	0	$0.00
Non-Residential	2	$3,700	$1,100,000	0	$0.00
Total	45	$21,251	$12,887,800	3	$31,363.63

Source: FEMA Community Information System, accessed November 2018

Table H.17 – NFIP Policy and Claims Data by Flood Zone

Flood Zone	Number of Policies in Force	Total Premium	Insurance in Force	Number of Closed Paid Losses	Total of Closed Paid Losses
A01-30 & AE Zones	12	$6,874	$3,142,800	1	$14,002.27
A Zones	0	$0	$0	0	$0.00
AO Zones	0	$0	$0	0	$0.00
AH Zones	0	$0	$0	0	$0.00
AR Zones	0	$0	$0	0	$0.00
A99 Zones	0	$0	$0	0	$0.00
V01-30 & VE Zones	0	$0	$0	0	$0.00
V Zones	0	$0	$0	0	$0.00
D Zones	0	$0	$0	0	$0.00

Flood Zone	Number of Policies in Force	Total Premium	Insurance in Force	Number of Closed Paid Losses	Total of Closed Paid Losses
B, C & X Zone					
Standard	0	$0	$0	0	$0.00
Preferred	33	$14,377	$9,745,000	2	$17,361.36
Total	45	$21,251	$12,887,800	3	$31,363.63

Source: FEMA Community Information System, accessed November 2018

Table H.18 – NFIP Policy and Claims Data Pre-FIRM

Flood Zone	Number of Policies in Force	Total Premium	Insurance in Force	Number of Closed Paid Losses	Total of Closed Paid Losses
A01-30 & AE Zones	0	$0	$0	0	$0.00
A Zones	0	$0	$0	0	$0.00
AO Zones	0	$0	$0	0	$0.00
AH Zones	0	$0	$0	0	$0.00
AR Zones	0	$0	$0	0	$0.00
A99 Zones	0	$0	$0	0	$0.00
V01-30 & VE Zones	0	$0	$0	0	$0.00
V Zones	0	$0	$0	0	$0.00
D Zones	0	$0	$0	0	$0.00
B, C & X Zone	1	$351	$280,000	0	$0.00
Standard	0	$0	$0	0	$0.00
Preferred	1	$351	$280,000	0	$0.00
Total	1	$351	$280,000	0	$0.00

Source: FEMA Community Information System, accessed November 2018

Table H.19 – NFIP Policy and Claims Data Post-FIRM

Flood Zone	Number of Policies in Force	Total Premium	Insurance in Force	Number of Closed Paid Losses	Total of Closed Paid Losses
A01-30 & AE Zones	12	$6,874	$3,142,800	1	$14,002.27
A Zones	0	$0	$0	0	$0.00
AO Zones	0	$0	$0	0	$0.00
AH Zones	0	$0	$0	0	$0.00
AR Zones	0	$0	$0	0	$0.00
A99 Zones	0	$0	$0	0	$0.00
V01-30 & VE Zones	0	$0	$0	0	$0.00
V Zones	0	$0	$0	0	$0.00
D Zones	0	$0	$0	0	$0.00
B, C & X Zone	32	$14,026	$9,465,000	2	$17,361.36
Standard	0	$0	$0	0	$0.00
Preferred	32	$14,026	$9,465,000	2	$17,361.36
Total	44	$20,900	$12,607,800	3	$31,363.63

Source: FEMA Community Information System, accessed November 2018

H.5 MITIGATION STRATEGY

Town of Knightdale											
Action #	**Description**	**Goal**	**Objective**	**Hazard(s) Addressed**	**Relative Priority**	**Lead Agency/ Department**	**Estimated Cost**	**Potential Funding Sources**	**Implementation Schedule**	**2019 Status**	**Status Comments/Explanation**
Prevention											
P-1	Pursue Grants to Acquire, Elevate and or Relocate Flood Prone Structures and Property.	3	1	Flood, Dam Failure, Hurricane & Tropical Storm	High	Knightdale Planning	Over $1m	Internal	Ongoing - Next 5 Years	Not Started – Carry Forward	This has not been necessary since there have been no affected structures and/or property. The Town will evaluate opportunities to purchase property for future events.
P-2	Establish post-disaster clean-up procedures.	2	1	All	High	Knightdale Public Works	$250,000	Internal	Ongoing - Next 5 Years	In-Progress – Carry Forward	The Town will continuously evaluate post-disaster clean-up procedures.
P-3	Prepare debris removal and disposal plan.	2	1	Dam Failure, Earthquake, Hurricane & Tropical Storm, Landslide, Severe Weather, Severe Winter Storm, Tornado	Moderate	Knightdale Public Works	Over $1m	Internal, FEMA, NCEM	Ongoing - Next 5 Years	In-Progress – Carry Forward	The Town will continuously evaluate debris removal and disposal plan
P-4	Protect and Obtain Land for the Little River Reservoir.	3	1	Drought	Moderate	City of Raleigh Public Utilities	Over $1m	Internal, City of Raleigh	Ongoing - Next 5 Years	In-Progress – Carry Forward	City of Raleigh is responsible for implementation
Structural Projects											
SP-1	Dredging, new riser and plunge pool for pond restoration at Environmental Park	3	2	Flood, Hurricane	Moderate	Knightdale Administration, Knightdale Public Works	$500,000	Grants, bonds, Knightdale Administration, Knightdale Fire	3-5 years	New	N/A
Public Education and Awareness											
PEA-1	Develop a policy for the installation of warning signs concerning lightning, hail and thunderstorms at outdoor public facilities and begin retro-fitting existing spaces.	1	2	Severe Weather, Tornado	Moderate	Knightdale Parks & Recreation	Over $1m	Internal	2-3 years	Not Started – Carry Forward	Due to staff turnover and lack of funding this project has not been completed. This project is still a valuable tool that will be studied for future implementation
PEA-2	Expand the Town's existing fire/smoke alarm program for retro-fitting older structures to include CO alarms.	1	2	Earthquake, Severe Weather, Tornado, Hazardous Materials Incident	Low	Knightdale Fire	about $200,000	Internal, Grants	2-3 years	In-Progress – Carry Forward	The Knightdale Fire Department routinely visits residents to ensure smoke detectors are working property.
PEA-3	Have a Town staff member that is a Certified Floodplain Manager.	2	1	Flood, Dam Failure, Hurricane & Tropical Storm	Moderate	Knightdale Engineering/Public Works	$40,000	Internal	2-3 years	In-Progress – Carry Forward	Due to recent turnover the Town lost its only Certified Floodplain Manager
PEA-4	Issue an annual local proclamation for Severe Weather Awareness Week and conduct associated promotional activities.	1	1	All	Moderate	Knightdale Fire	$200,000	Internal	Ongoing - Next 5 years	Not Started – Carry Forward	Due to staff turnover this item has not been started.
PEA-5	Incentivize the use of cool roofing products through the Town's Water Allocation Policy point system.	4	1	Extreme Heat	Low	Knightdale Planning	less than $100,000	Internal	3-5 years	Not Started – Carry Forward	Due to changes in development patterns other updates to the Town's Water Allocation Policy were deemed more timely. This will be evaluated for future inclusion.

Annex I Town of Morrisville

I.1 PLANNING PROCESS

The table below lists the HMPC members who represented the Town of Morrisville.

Table I.1 – HMPC Members

Agency	Representative	Position or Title
Planning Department	Brad West	Planner
Planning Department	Dylan Bruchhaus	Planner
N/A	Steve Botha	Citizen Stakeholder

I.2 COMMUNITY PROFILE

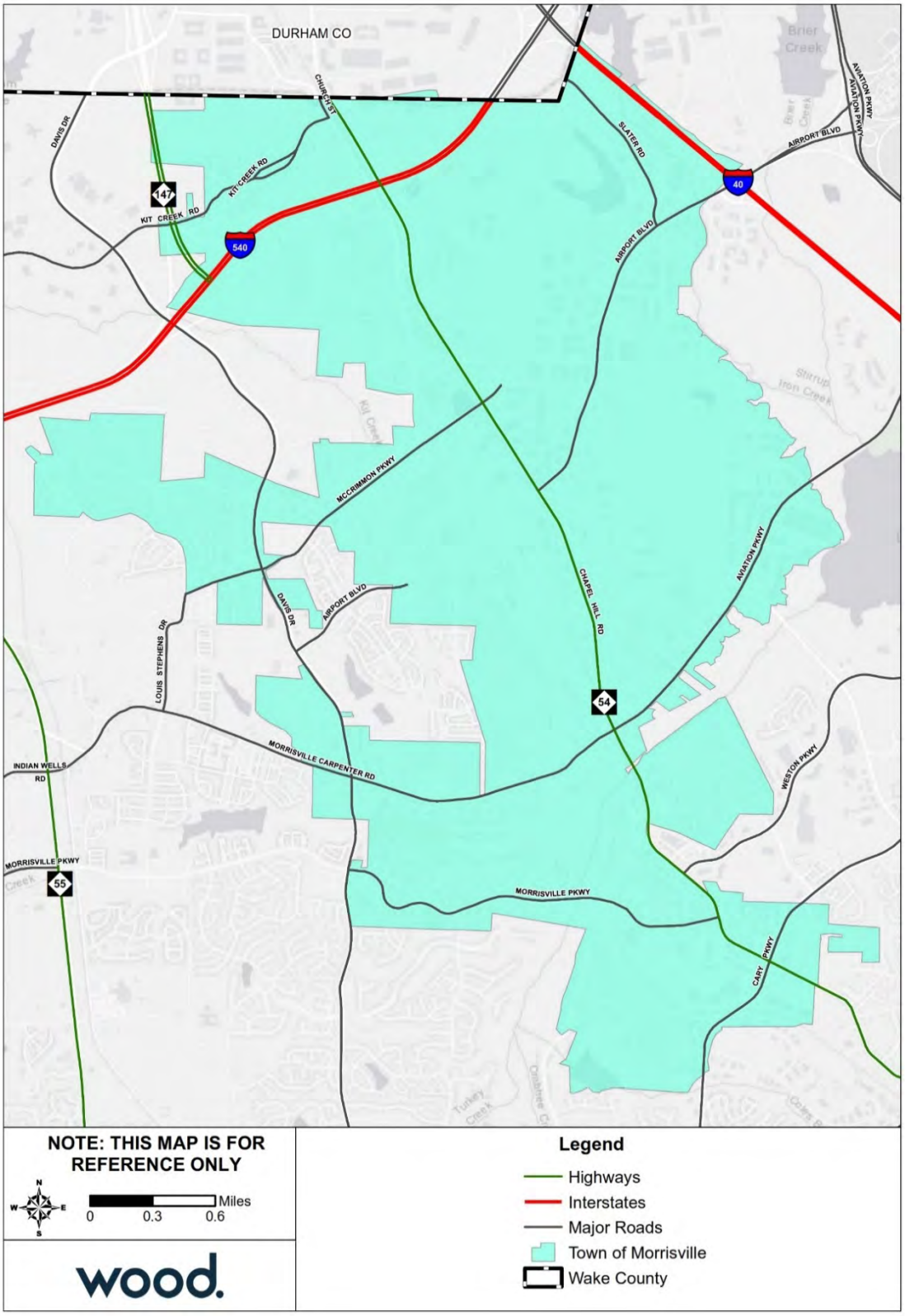
Geography

The Town of Morrisville is located in western Wake County. A small portion of the Town extends west into Durham County. All statistics summarized in this section are for the entirety of the Town of Morrisville. It is surrounded by Cary on its eastern, southern, and southwestern sides and by RTP to the northwest and Durham County to the north. The Town is part of the Raleigh, NC Metropolitan Statistical Area, which falls within the larger Raleigh-Durham-Chapel Hill, NC Combined Statistical Area. Morrisville comprises a total land area of 8.3 square miles.

According to data from the U.S. Fish and Wildlife Service's National Wetlands Inventory, there are approximately 1,002 acres of wetlands in Morrisville.

Figure I.1 shows a base map of major transportation routes in the Town of Morrisville.

Figure I.1 – Major Transportation Routes – Town of Morrisville



Source: Wake County GIS Open Data

Population and Demographics

Table I.2 provides population counts and growth estimates for Morrisville as compared to the County overall. Table I.3 provides demographic information for Morrisville as compared to the whole County.

Table I.2 – Population Counts, Morrisville, 2010-2017

Jurisdiction	2000 Census Population	2010 Census Population	2017 ACS Population Estimate	Total Change 2010-2017	% Change 2010-2017
Wake County total	**627,846**	**900,993**	**1,023,811**	**122,818**	**13.6%**
Town of Morrisville	5,208	18,576	23,873	5,297	28.5%

Source: US Census Bureau Decennial Census 2000, Decennial Census 2010; American Community Survey 2013-2017 5-Year Estimates

Table I.3 – Racial Demographics, Morrisville, 2017

Jurisdiction	White, %	Black, %	Asian, %	Other Race, %	Two or More Races, %	Persons of Hispanic or Latino Origin*, %
Wake County total	**66.5%**	**20.4%**	**6.5%**	**3.6%**	**2.7%**	**10.0%**
Town of Morrisville	44.3%	12.1%	37.0%	1.2%	4.8%	4.5%

Source: US Census Bureau, American Community Survey 2013-2017 5-Year Estimates
*Persons of Hispanic origin may be of any race, so also are included in applicable race categories

Asset Inventory

The following tables summarize the asset inventory for Morrisville in order to estimate the total physical exposure to hazards in this area. The locations of critical facilities are shown in Figure I.2 on the following page. Critical facilities are a subset of identified assets from the Critical Infrastructure & Key Resources dataset. Note that the counts are by building; where a critical facility comprises a cluster of buildings, each building is counted and displayed.

Table I.4 – Critical Infrastructure & Key Resources by Type

Jurisdiction	Food & Agriculture	Banking & Finance	Chemical	Commercial Facilities	Communications	Manufacturing	Defense	Government	Healthcare	IT	National Monuments	Nuclear	Postal & Shipping	Transportation	Energy	Emergency Services	Water	Other	Total
Town of Morrisville	2	5	0	162	1	142	1	31	2	0	0	0	0	40	0	2	0	0	**388**

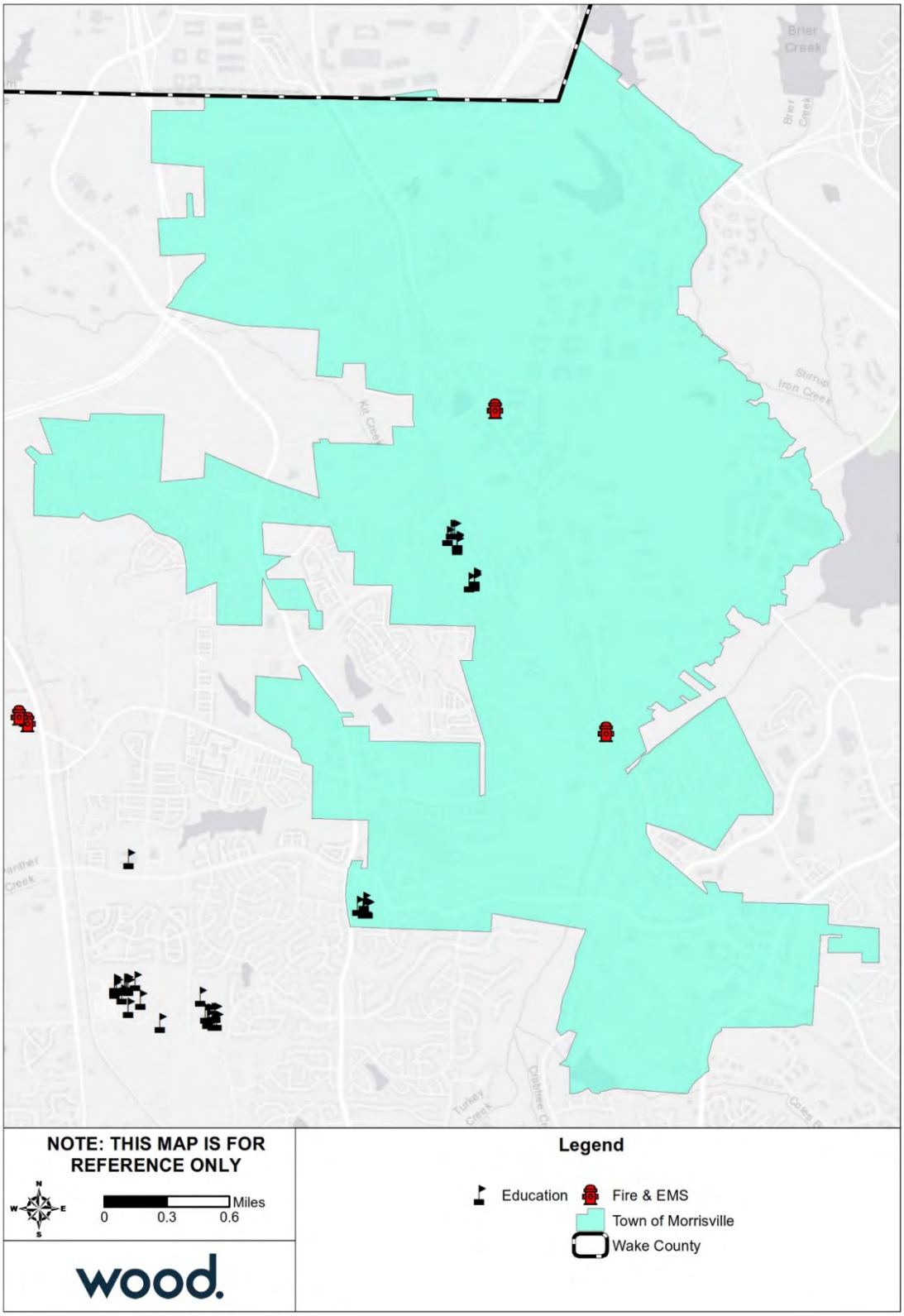
Source: NCEM Risk Management Tool

Table I.5 – High Potential Loss Facilities by Use

Jurisdiction	Residential	Commercial	Industrial	Government	Agricultural	Religious	Utilities	Other	Total
Town of Morrisville	148	100	59	10	0	7	0	0	**324**

Source: NCEM Risk Management Tool

Figure I.2 – Critical Facilities, Town of Morrisville



Source: NCEM IRISK Database, GIS Analysis

To supplement the asset inventory and provide a clearer picture of the current asset exposure in the Town of Morrisville, current parcel data was evaluated to identify development since 2010. This information is not incorporated into the risk assessment, which was prepared using NCEM's IRISK database. However, this summary of development since 2010 provides some context to understand the degree to which the IRISK exposure and vulnerability numbers differ from current conditions.

Table I.6 provides a summary by land class of parcel development from January 2011 to April 2019.

Table I.6 – Parcels Developed 2011 or Later, Town of Morrisville

Land Class	Number of Parcels	Sum of Building Value
Apartment	3	$68,721,018
Commercial	30	$289,612,514
Condo Complex	3	-
EXEMPT	6	$24,423,462
HOA	3	$522,814
Residential Less Than 10 Acres	1,640	$396,594,033
Grand Total	**1,685**	**$779,873,841**

Source: Wake County Open Data; retrieved April 8, 2019

There are three listings on the National Register of Historic Places for the Town of Morrisville. These sites are listed in the table below.

Table I.7 – Historic Properties

Ref#	Property Name	Status Date	Category	City
12000218	Page, Williamson, House	4/16/2012	Building	Morrisville
12000913	Morrisville Christian Church	11/6/2012	Building	Morrisville
14000334	Pugh House	6/19/2014	Building	Morrisville

Source: National Parks Service, National Register of Historic Places, October 2018

Housing

The following table details key housing statistics for Morrisville as compared to the County overall.

Table I.8 – Housing Statistics, Morrisville, 2010-2017

Jurisdiction	Housing Units (2010)	Housing Units (2017)	Housing Units Percent Change (2010-2017)	Owner-Occupied, % (2017)	Vacant Units, % (2017)	Median Home Value (2017)
Wake County total	**371,836**	**411,632**	**10.7%**	**59.5%**	**7.2%**	**$250,700**
Town of Morrisville	8,357	9,365	12.1%	45.8%	6.0%	$304,500

Source: U.S. Census Bureau 2010 Decennial Census, American Community Survey 2013-2017 5-Year Estimates
Note: Owner-Occupied and vacant-unit measures are reported as a percent of the total number of housing units.

Economy

The following tables present key economic statistics for Morrisville as compared to the County overall.

Table I.9 – Employment Statistics, Morrisville, 2017

Jurisdiction	Population in Labor Force	Percent Employed* (%)	Percent Unemployed* (%)	Percent Not in Labor Force* (%)	Unemployment Rate (%)
Wake County	**564,096**	**67.2**	**3.5**	**29.2**	**4.9**
Town of Morrisville	13,403	73.9	3.0	23.0	3.9

Source: U.S. Census Bureau, American Community Survey 2013-2017 5-Year Estimates
Note: This table reports only the civilian labor force. The labor force in armed services accounted for 0.3% or less of the population 16 and over in all jurisdictions. *Population employed, population unemployed, and Population not in labor force are reported as a percent of the total population aged 16 years and older.

Table I.10 – Percent of Employed Population by Occupation, Morrisville, 2017

Occupation	Management, business, science and arts (%)	Service (%)	Sales and Office (%)	Natural Resources, Construction, and Maintenance (%)	Production, transportation, and material moving (%)
Wake County	**50.1**	**13.8**	**23.4**	**6.0**	**6.7**
Town of Morrisville	65.5	8.1	17.6	3.0	5.8

Source: U.S. Census Bureau, American Community Survey 2013-2017 5-Year Estimates

I.3 RISK ASSESSMENT

This section contains a hazard profile and vulnerability assessment for those hazards that were rated with a higher priority for the Town of Morrisville than for Wake County as a whole. Risk and vulnerability findings are also presented here for those hazards that are spatially defined and have variations in risk that could be evaluated quantitatively on a jurisdictional level. The hazards included in this section are: Flood and Wildfire.

I.3.1 Flood

Table I.11 details the acreage of the Town of Morrisville by flood zone on the effective DFIRM. Per this assessment, over 6 percent of Morrisville falls within the mapped 1%-annual-chance floodplains.

Table I.11 – Flood Zone Acreage, Town of Morrisville

Flood Zone	Acreage	Percent of Total (%)
Zone A	72.83	0.13
Zone AE	3,629.18	6.43
Zone X (500-year)	402.17	0.71
Zone X Unshaded	52,339.67	92.73
Total	**56,443.85**	**--**

Source: FEMA Effective DFIRM; Wake County GIS

Figure I.3 reflects the effective mapped flood hazard zones for Town of Morrisville, and Figure I.4 displays the depth of flooding estimated to occur in these areas during the 1%-annual-chance flood.

To supplement the IRISK assessment of property at risk from the 1% annual chance flood event in Section 4 and provide a clearer picture of the current property at risk in the Town of Morrisville, current parcel data was evaluated to identify parcels developed since 2010. Using GIS analysis, parcels developed after 2010 were compared to the boundaries of the 1% annual chance floodplain to identify the exposure of newly developed property to the base flood. In most cases, a parcel was considered exposed to the floodplain if any portion of the parcel was located in the floodplain.

This assessment does not evaluate flood impacts or provide damage estimates. However, this summary of development in or near the floodplain since 2010 provides some context to understand the degree to which the IRISK exposure and vulnerability numbers differ from current conditions.

Table I.12 provides a summary by land class of parcel development located in the 1% annual chance floodplain from January 2011 to April 2019.

Table I.12 – Parcels Developed 2011 or Later and Located in 100-Year Floodplain, Town of Morrisville

Land Class	Number of Parcels	Sum of Building Value
Apartment	1	$20,141,513
Commercial	8	$184,625,269
Residential Less Than 10 Acres	3	$1,302,487
Grand Total	**12**	**$206,069,269**

Source: Wake County Open Data; retrieved April 8, 2019; FEMA Effective DFIRM

Table I.13 provides building counts and estimated damages for Critical Infrastructure and Key Resources (CIKR) buildings by sector and flood event in the Town of Morrisville. Table B.14 provides counts and estimated damages for High Potential Loss Properties in the Town of Morrisville.

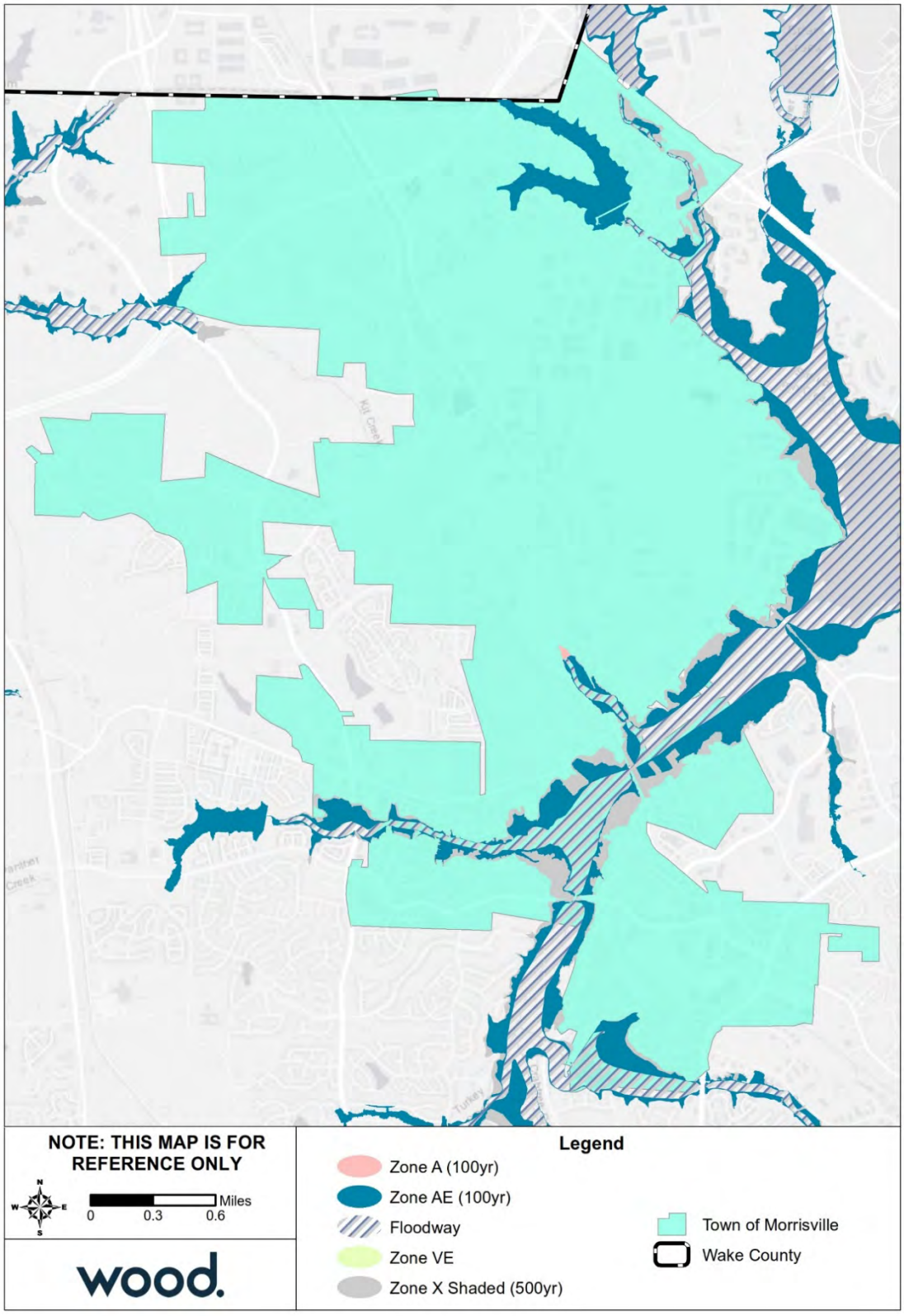
Table I.13 – Critical Facilities Exposed to Flooding, Town of Morrisville

Sector	Event	Number of Buildings at Risk	Estimated Damages
Commercial Facilities	100 Year	1	$199
All Categories	**100 Year**	**1**	**$199**

Table I.14 – High Potential Loss Properties Exposed to Flooding, Town of Morrisville

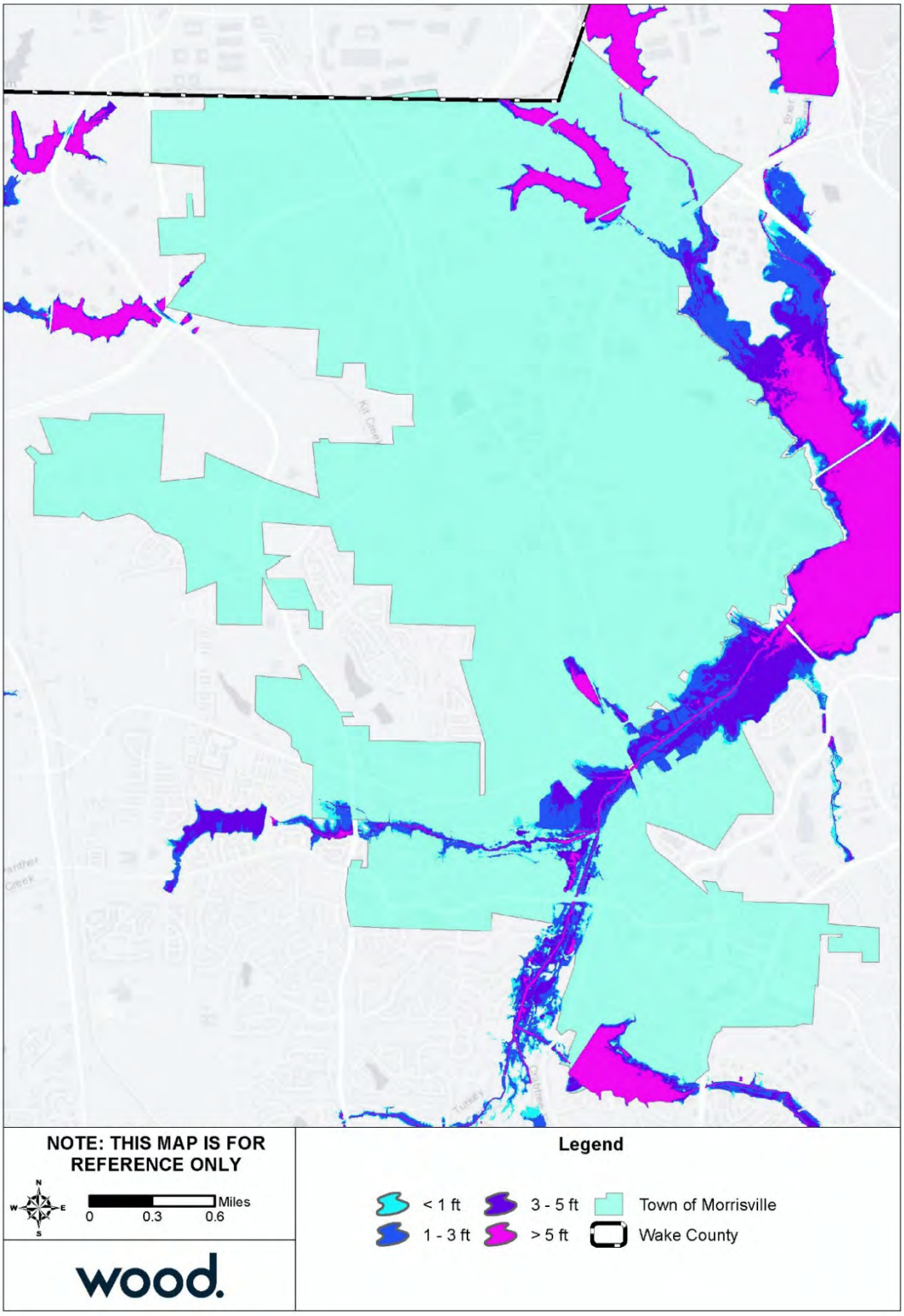
Category	Event	Number of Buildings at Risk	Estimated Damages
Residential	100 Year	1	$115,869
All Categories	**100 Year**	**1**	**$115,869**

Figure I.3 – FEMA Flood Hazard Areas, Town of Morrisville



Source: FEMA Effective DFIRM

Figure I.4 – Flood Depth, 1%-Annual-Chance Floodplain, Town of Morrisville



Source: FEMA Effective DFIRM

I.3.2 Wildfire

Table I.15 summarizes the acreage in the Town of Morrisville that falls within the Wildland Urban Interface (WUI), categorized by housing density. Areas in the WUI are those where development may intermix with flammable vegetation. Over 14% percent of the Town of Morrisville is not included in the WUI.

Table I.15 – Wildland Urban Interface Acreage, Town of Morrisville

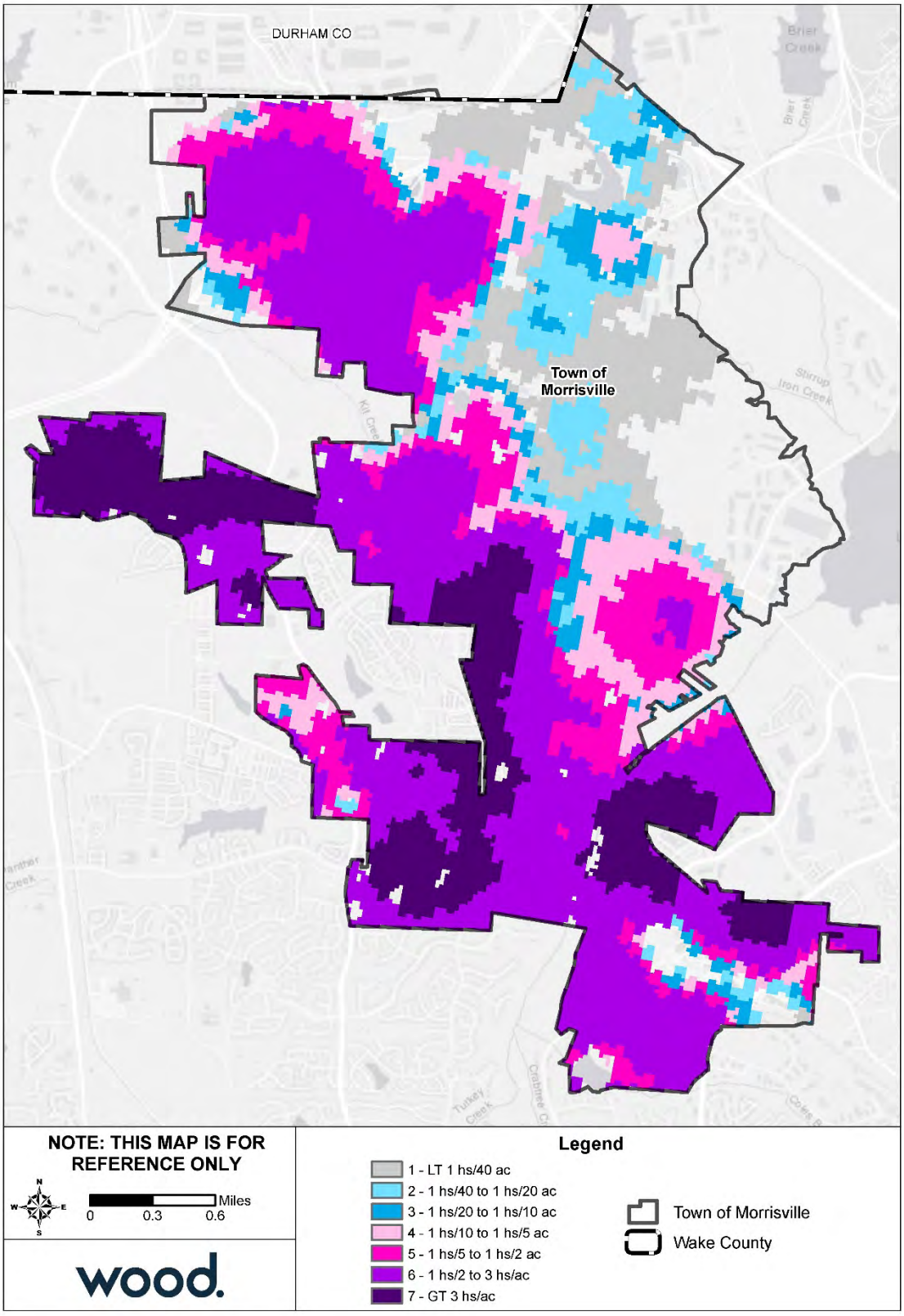
	Housing Density	Total Acreage	Percent of Total Acreage
	Not in WUI	*896.8*	*14.6%*
	LT 1hs/40ac	607.9	9.9%
	1hs/40ac to 1hs/20ac	359.4	5.8%
	1hs/20ac to 1hs/10ac	256.6	4.2%
	1hs/10ac to 1hs/5ac	450.7	7.3%
	1hs/5ac to 1hs/2ac	655.5	10.6%
	1hs/2ac to 3hs/1ac	2,104.9	34.2%
	GT 3hs/1ac	826.6	13.4%
	Total	6,158.4	

Source: Southern Wildfire Risk Assessment

Figure I.5 depicts the WUI for the Town of Morrisville. The WUI is the area where housing development is built near or among areas of vegetation that may be prone to wildfire. Figure I.6 depicts the Fire Intensity Scale, which indicates the potential severity of fire based on fuel loads, topography, and other factors. Figure I.7 depicts Burn Probability based on landscape conditions, percentile weather, historical ignition patterns, and historical prevention and suppression efforts.

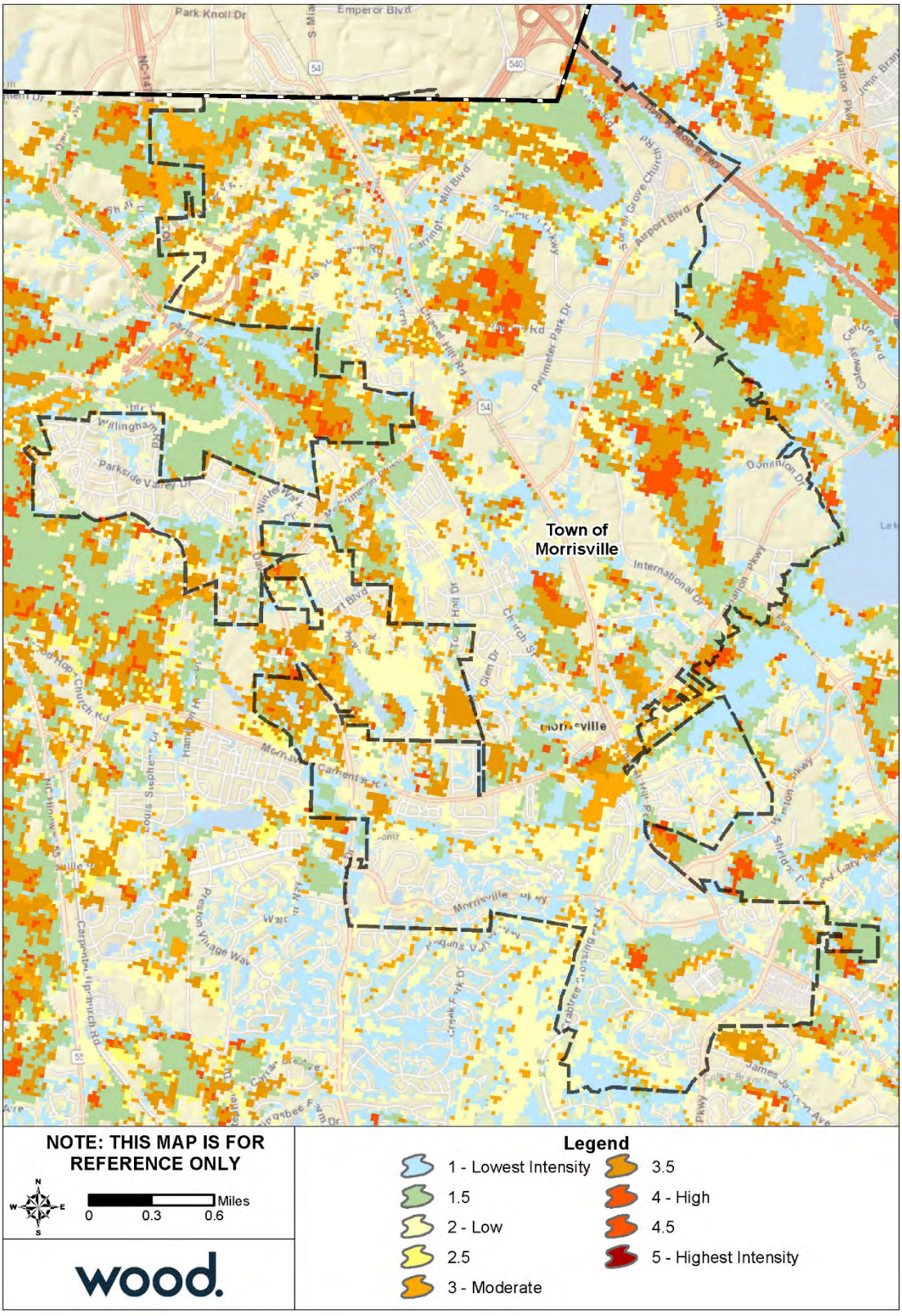
North and east Morrisville have the highest potential fire intensity in two concentrated pockets. These pockets, however, are largely outside of the WUI. The town has a relatively low burn probability, as well.

Figure I.5 – Wildland Urban Interface, Town of Morrisville



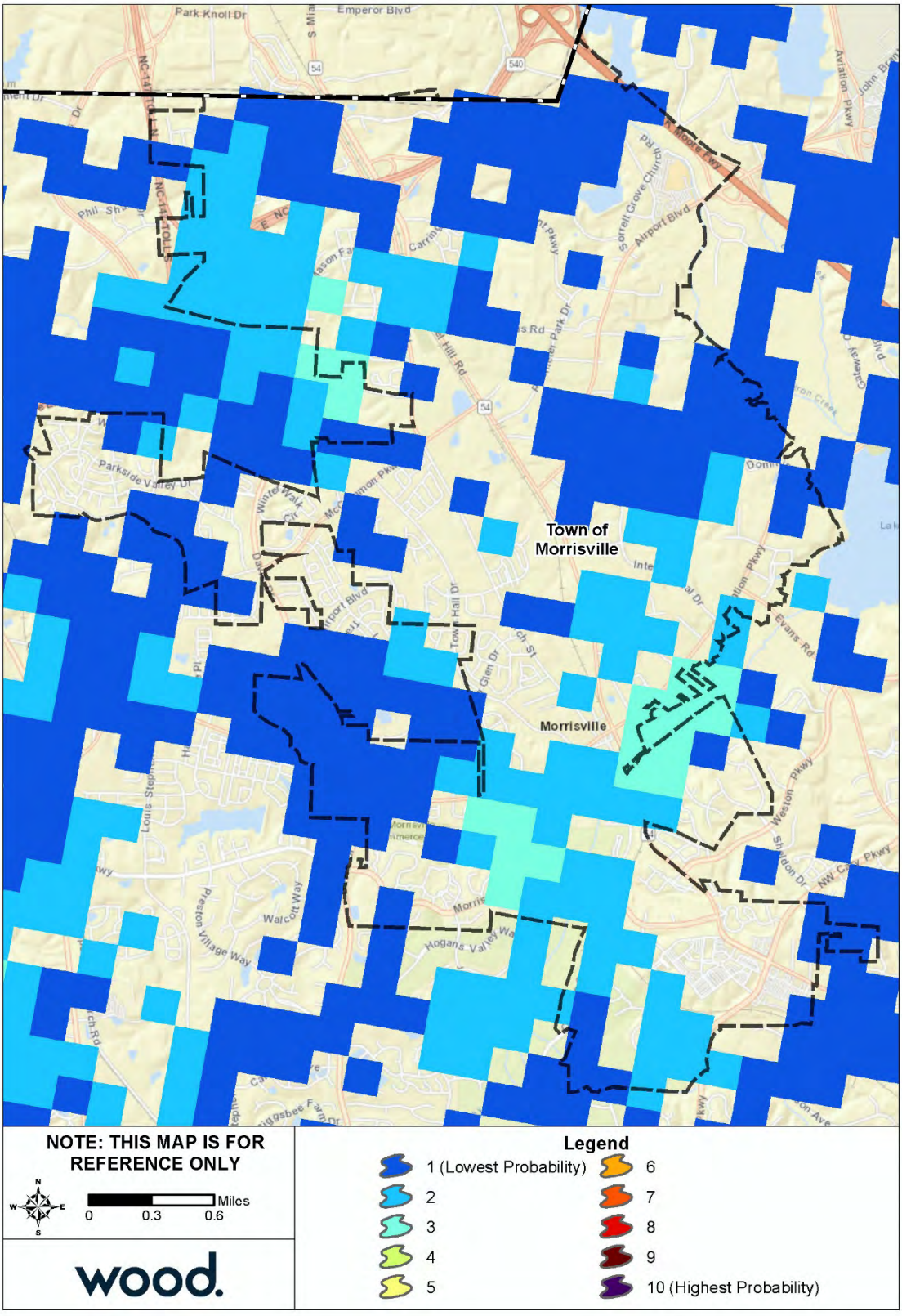
Source: Southern Wildfire Risk Assessment

Figure I.6 – Fire Intensity Scale, Town of Morrisville



Source: Southern Wildfire Risk Assessment

Figure I.7 – Burn Probability, Town of Morrisville



Source: Southern Wildfire Risk Assessment

I.4 CAPABILITY ASSESSMENT

I.4.1 Overall Capability

Details on the tools and resources in place and available to the Town of Morrisville were provided by the Town's HMPC representatives and are summarized in Section 5 Capability Assessment. Based on that information and using the scoring methodology detailed in that section, Morrisville has an overall capability rating of Moderate. The Town's Self-Assessment of key capability areas is summarized in Table I.17 below.

Table I.16 – Capability Self-Assessment, Morrisville

Capability Area	Rating
Plans, Ordinances, Codes and Programs	Moderate
Administrative and Technical Capability	Moderate
Fiscal Capability	Moderate
Education and Outreach Capability	Moderate
Mitigation Capability	Moderate
Political Capability	Moderate
Overall Capability	Moderate

I.4.2 Floodplain Management

The Town of Morrisville joined the NFIP through emergency entry in December 1977 and has been a regular participant since November 1978. The following tables reflect NFIP policy and claims data for the Town categorized by structure type, flood zone, Pre-FIRM and Post-FIRM.

Table I.17 – NFIP Policy and Claims Data by Structure Type

Structure Type	Number of Policies in Force	Total Premium	Insurance in Force	Number of Closed Paid Losses	Total of Closed Paid Losses
Single Family	50	$18,445	$14,422,300	4	$92,752.15
2-4 Family	1	$256	$77,000	0	$0.00
All Other Residential	29	$9,689	$8,185,300	0	$0.00
Non-Residential	8	$8,836	$4,341,300	0	$0.00
Total	88	$37,226	$27,025,900	4	$92,752.15

Source: FEMA Community Information System, accessed November 2018

Table I.18 – NFIP Policy and Claims Data by Flood Zone

Flood Zone	Number of Policies in Force	Total Premium	Insurance in Force	Number of Closed Paid Losses	Total of Closed Paid Losses
A01-30 & AE Zones	35	$15,077	$9,214,900	1	$52,860.61
A Zones	0	$0	$0	0	$0.00
AO Zones	0	$0	$0	0	$0.00
AH Zones	0	$0	$0	0	$0.00
AR Zones	0	$0	$0	0	$0.00
A99 Zones	0	$0	$0	0	$0.00
V01-30 & VE Zones	0	$0	$0	0	$0.00
V Zones	0	$0	$0	0	$0.00
D Zones	0	$0	$0	0	$0.00

Flood Zone	Number of Policies in Force	Total Premium	Insurance in Force	Number of Closed Paid Losses	Total of Closed Paid Losses
B, C & X Zone					
Standard	1	$2,410	$500,000	0	$0.00
Preferred	52	$19,739	$17,311,000	3	$39,891.54
Total	88	$37,226	$27,025,900	4	$92,752.15

Source: FEMA Community Information System, accessed November 2018

Table I.19 – NFIP Policy and Claims Data Pre-FIRM

Flood Zone	Number of Policies in Force	Total Premium	Insurance in Force	Number of Closed Paid Losses	Total of Closed Paid Losses
A01-30 & AE Zones	0	$0	$0	0	$0.00
A Zones	0	$0	$0	0	$0.00
AO Zones	0	$0	$0	0	$0.00
AH Zones	0	$0	$0	0	$0.00
AR Zones	0	$0	$0	0	$0.00
A99 Zones	0	$0	$0	0	$0.00
V01-30 & VE Zones	0	$0	$0	0	$0.00
V Zones	0	$0	$0	0	$0.00
D Zones	0	$0	$0	0	$0.00
B, C & X Zone	0	$0	$0	1	$695.95
Standard	0	$0	$0	0	$0.00
Preferred	0	$0	$0	1	$695.95
Total	0	$0	$0	1	$695.95

Source: FEMA Community Information System, accessed November 2018

Table I.20 – NFIP Policy and Claims Data Post-FIRM

Flood Zone	Number of Policies in Force	Total Premium	Insurance in Force	Number of Closed Paid Losses	Total of Closed Paid Losses
A01-30 & AE Zones	35	$15,077	$9,214,900	1	$52,860.61
A Zones	0	$0	$0	0	$0.00
AO Zones	0	$0	$0	0	$0.00
AH Zones	0	$0	$0	0	$0.00
AR Zones	0	$0	$0	0	$0.00
A99 Zones	0	$0	$0	0	$0.00
V01-30 & VE Zones	0	$0	$0	0	$0.00
V Zones	0	$0	$0	0	$0.00
D Zones	0	$0	$0	0	$0.00
B, C & X Zone	53	$22,149	$17,811,000	2	$39,195.59
Standard	1	$2,410	$500,000	0	$0.00
Preferred	52	$19,739	$17,311,000	2	$39,195.59
Total	88	$37,226	$27,025,900	3	$92,056.20

Source: FEMA Community Information System, accessed November 2018

I.5 MITIGATION STRATEGY

Town of Morrisville											
Action #	**Description**	**Goal**	**Objective**	**Hazard(s) Addressed**	**Relative Priority**	**Lead Agency/ Department**	**Estimated Cost**	**Potential Funding Sources**	**Implementation Schedule**	**2019 Status**	**Status Comments/Explanation**
Prevention											
P-1	Reduce vulnerability of cyber attack by transitioning Town staff to encrypted laptops.	3	1	Terrorism	Moderate	Town of Morrisville	$9,000 annually	Town of Morrisville	Ongoing - Next 5 years	New	N/A
P-2	Establish a Municipal Service District (MSD) in order to convert private roads in Carpenter Park neighborhood to public roads with a higher design, safety, and maintenance standard.	3	2	All	Moderate	Town of Morrisville	$460,000	Town of Morrisville	1 year	New	N/A
P-3	Coordinate with Duke Power to draft Electric Utility Master Plan, which seeks to identify areas feasible for utility line burial.	4	1	Tornado, Severe Winter Storm, Severe Weather, Hurricane	High	Town of Morrisville	$20,000	Town of Morrisville	2-3 years	New	N/A
P-4	Update Land Use Plan to ensure protection of natural resources, strengthen existing development to resist hazards, and guide future development away from hazard prone areas.	4	2	Flood, Wildfire, Landslide, Dam Failure, Hurricane, Hazardous Materials Incident, Radiological Emergency	Moderate	Town of Morrisville	$275,000	Town of Morrisville	2-3 years	New	N/A
P-5	Obtain frequently updated, high-resolution aerial photography to assist with land use decisions, emergency response planning, and code enforcement.	2	2	Flood, Landslide, Severe Winter Storm, Severe Weather, Dam Failure, Hurricane, Hazards Materials Incident, Radiological Emergency, Terrorism	Moderate	Town of Morrisville	$7,000 annually	Town of Morrisville	Ongoing - Next 5 years	New	N/A
P-6	Working through the Triangle Water Supply Partnership, update the Water Resources Plan to ensure water supply is sufficient for Town's future needs.	4	2	Drought, Dam Failure, Extreme Heat	High	Triangle Water Supply Partnership	$250,000	Triangle Water Supply Partnership, Town of Morrisville	3-5 years	New	N/A
P-7	Working through the Triangle Water Supply Partnership, draft a Drought Management Plan to ensure water resources are properly managed during drought conditions.	4	1	Drought, Extreme Heat	High	Triangle Water Supply Partnership	$150,000	Triangle Water Supply Partnership, Town of Morrisville	3-5 years	New	N/A
P-8	Working through the Triangle Water Supply Partnership, draft an Emergency Spill Response and Mitigation Plan to protect watersheds and other water resources from hazardous spills.	3	2	Flood, Drought, Dam Failure, Extreme Heat, Hazardous Materials Incident, Radiological Emergency	High	Triangle Water Supply Partnership	$150,000	Triangle Water Supply Partnership, Town of Morrisville	3-5 years	New	N/A
P-9	Transition Wake County's sedimentation and erosion control permitting and monitoring to Town of Morrisville for better increased processing efficiency and faster incident response.	2	2	Flood, Landslide, Dam Failure, Hurricane, Hazardous Materials Incident	Moderate	Town of Morrisville	Unknown	Town of Morrisville	2-3 years	New	N/A
P-10	Conduct a complete review and update to the Town's stormwater management program, which helps mitigate effects of stormwater runoff and flooding.	4	1	Flood, Landslide, Dam Failure, Hurricane, Hazardous Materials Incident	High	Town of Morrisville	$100,000	Town of Morrisville	2-3 years	New	N/A
Property Protection											
PP-1	Reduce vulnerability of important data by transitioning IT Department's routine data backup to cloud storage.	3	1	Tornado, Earthquake, Severe Winter Storm, Severe Weather, Hurricane, Terrorism	High	Town of Morrisville	$42,000 annually	Town of Morrisville	Ongoing - Next 5 years	New	N/A
PP-2	Seek Federal, State, and County funding opportunities to purchase property located completely or partially in FEMA designated floodplains in order to mitigate potential property damage and protect natural resources.	3	2	Flood, Hurricane, Dam Failure	Low	Morrisville Director of Community Services, Director of Development Services	$5,000,000	Flood Mitigation Assistance Grant Program	More than 5 years	Not Started – Carry Forward	Town has purchased flood-prone properties using Town funds. Town has not sought any outside funding for floodplain property purchase.
Structural Projects											
SP-1	Construct Green Drive and Fairview Road Flood Reduction Drainage Project to mitigate potential flood hazards.	3	2	Flood, Dam Failure, Hurricane	High	Town of Morrisville	$450,000	Town of Morrisville	2-3 years	New	N/A
SP-2	Construct new public works facility, which will increase Town's capacity to respond to hazards and other safety concerns.	2	1	All	Moderate	Town of Morrisville	$8,500,000	Town of Morrisville	3-5 years	New	N/A

Town of Morrisville											
Action #	**Description**	**Goal**	**Objective**	**Hazard(s) Addressed**	**Relative Priority**	**Lead Agency/ Department**	**Estimated Cost**	**Potential Funding Sources**	**Implementation Schedule**	**2019 Status**	**Status Comments/Explanation**
Emergency Services											
ES-1	Monitor the status of backup generators, communications and vehicles for all Morrisville owned critical public facilities.	2	1	All	Low	Town of Morrisville	$5,500 annually	Town of Morrisville	Ongoing - Next 5 years	In-Progress – Carry Forward	The Town has a contract with a private vendor to monitor the status and condition of critical emergency response equipment such as backup generators, communications, and vehicles.
ES-2	Install new generators for Town Hall and Police Station to ensure continuity of critical operations during a power outage.	3	1	All	High	Town of Morrisville	$150,000	Town of Morrisville	1 year	New	N/A
ES-3	Construct new fire station in Morrisville in order to improve fire protection coverage and emergency response times.	2	1	All	Moderate	Town of Morrisville	$4,500,000	Town of Morrisville	3-5 years	New	N/A
ES-4	Update Town's Emergency Operations Plan to ensure best processes and procedures for the most likely and applicable emergency scenarios.	2	2	All	Moderate	Town of Morrisville	$150,000	Town of Morrisville	3-5 years	New	N/A
Public Education and Awareness											
PEA-1	Implement Wake County's Everbridge text alert system to notify citizens and Town staff of potential safety hazards or concerns.	1	1	All	High	Wake County	$0	Wake County	1 year	New	N/A
PEA-2	Purchase and implement new online civic engagement platform to be used in part to inform citizens on disaster preparation, emergency response training opportunities, and evacuation information.	1	1	All	Moderate	Town of Morrisville	$10,000	Town of Morrisville	1 year	New	N/A
PEA-3	Utilize volunteer citizen committees, such as CERT or Public Safety Committee, to educate residents in preparing for natural hazards.	1	1	All	Low	Town of Morrisville	$2,000/year	Town of Morrisville	Ongoing - Next 5 Years	In-Progress – Carry Forward	The Community Emergency Response Team is a group of dedicated volunteers that meet monthly for emergency response training.

Annex J Town of Rolesville

J.1 PLANNING PROCESS

The table below lists the HMPC members who represented the Town of Rolesville.

Table J.1 – HMPC Members

Agency	Representative	Position or Title
Planning Department	Danny Johnson	Planning Director
Town of Rolesville	Kelly Arnold	Town Manager

J.2 COMMUNITY PROFILE

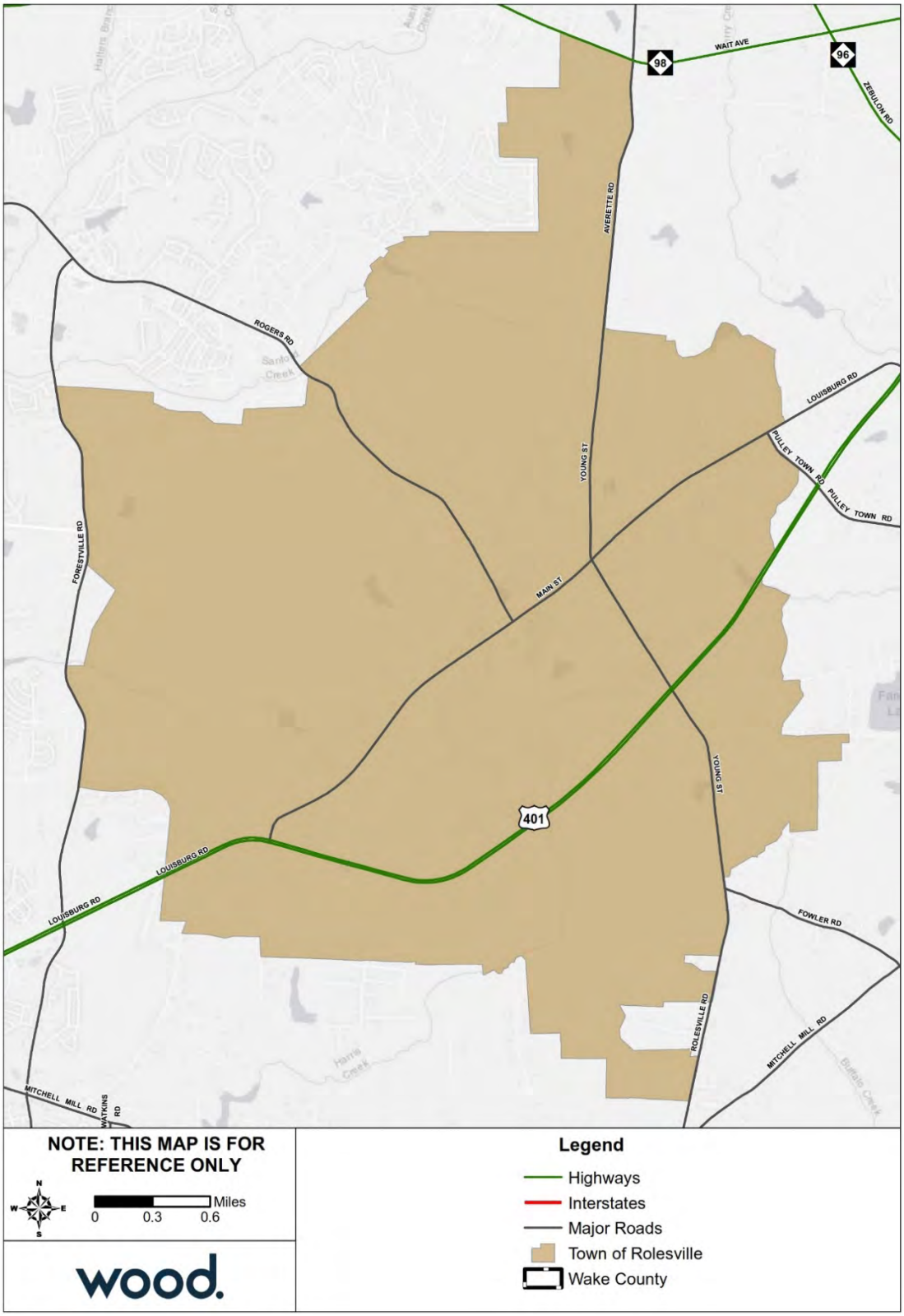
Geography

The Town of Rolesville is located in northeastern Wake County. It is neighbored by Wake Forest to the west and northwest, and Raleigh to the southwest. The Town is part of the Raleigh, NC Metropolitan Statistical Area, which falls within the larger Raleigh-Durham-Chapel Hill, NC Combined Statistical Area. Rolesville comprises a total land area of 3.9 square miles.

According to data from the U.S. Fish and Wildlife Service's National Wetlands Inventory, there are approximately 359.5 acres of wetlands in Rolesville.

Figure J.1 shows a base map of the major transportation routes in the Town of Rolesville.

Figure J.1 – Major Transportation Routes – Town of Rolesville



Source: Wake County GIS Open Data

Population and Demographics

Table J.2 provides population counts and growth estimates for the Town of Rolesville as compared to the County overall. Table J.3 provides demographic information for Rolesville as compared to the whole County.

Table J.2 – Population Counts, Rolesville, 2010-2017

Jurisdiction	2000 Census Population	2010 Census Population	2017 ACS Population Estimate	Total Change 2010-2017	% Change 2010-2017
Wake County total	**627,846**	**900,993**	**1,023,811**	**122,818**	**13.6%**
Town of Rolesville	907	3,786	6,308	2,522	40.0%

Source: US Census Bureau Decennial Census 2000, Decennial Census 2010; American Community Survey 2013-2017 5-Year Estimates

Table J.3 – Racial Demographics, Rolesville, 2017

Jurisdiction	White, %	Black, %	Asian, %	Other Race, %	Two or More Races, %	Persons of Hispanic or Latino Origin*, %
Wake County total	**66.5%**	**20.4%**	**6.5%**	**3.6%**	**2.7%**	**10.0%**
Town of Rolesville	66.2%	27.1%	3.2%	1.2%	2.4%	3.0%

Source: US Census Bureau, American Community Survey 2013-2017 5-Year Estimates

*Persons of Hispanic origin may be of any race, so also are included in applicable race categories

Asset Inventory

The following tables summarize the asset inventory for Rolesville in order to estimate the total physical exposure to hazards in this area. The locations of critical facilities are shown in Figure J.2 on the following page. Critical facilities are a subset of identified assets from the Critical Infrastructure & Key Resources dataset. Note that the counts are by building; where a critical facility comprises a cluster of buildings, each building is counted and displayed.

Table J.4 – Critical Infrastructure & Key Resources by Type

Jurisdiction	Food & Agriculture	Banking & Finance	Chemical	Commercial Facilities	Communications	Manufacturing	Defense	Government	Healthcare	IT	National Monuments	Nuclear	Postal & Shipping	Transportation	Energy	Emergency Services	Water	Other	Total
Town of Rolesville	43	1	0	37	0	11	0	20	2	0	0	0	0	4	0	2	0	0	**120**

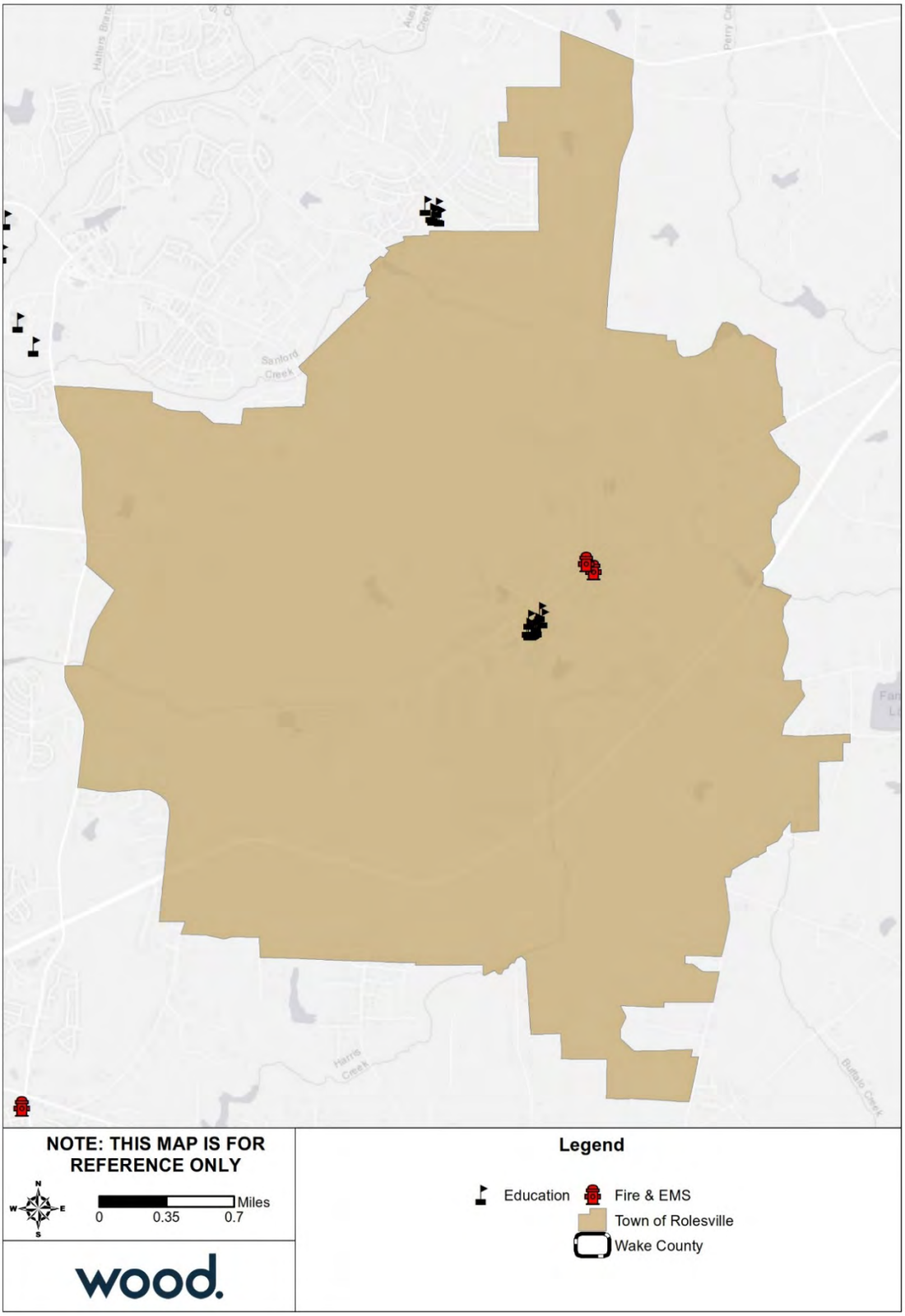
Source: NCEM Risk Management Tool

Table J.5 – High Potential Loss Facilities by Use

Jurisdiction	Residential	Commercial	Industrial	Government	Agricultural	Religious	Utilities	Other	Total
Town of Rolesville	4	8	1	4	0	1	0	0	**18**

Source: NCEM Risk Management Tool

Figure J.2 – Critical Facilities, Town of Rolesville



Source: NCEM IRISK Database, GIS Analysis

To supplement the asset inventory and provide a clearer picture of the current asset exposure in the Town of Rolesville, current parcel data was evaluated to identify development since 2010. This information is not incorporated into the risk assessment, which was prepared using NCEM's IRISK database. However, this summary of development since 2010 provides some context to understand the degree to which the IRISK exposure and vulnerability numbers differ from current conditions.

Table J.6 provides a summary by land class of parcel development from January 2011 to April 2019.

Table J.6 – Parcels Developed 2011 or Later, Town of Rolesville

Land Class	Number of Parcels	Sum of Building Value
Acres Greater Than 10 With House	1	$233,814
Apartment	2	$6,309,870
Commercial	3	$7,641,736
EXEMPT	4	$95,496,995
HOA	3	-
Part Exempt	2	$369,123
Residential Less Than 10 Acres	1,340	$393,252,705
Grand Total	**1,355**	**$503,304,243**

Source: Wake County Open Data; retrieved April 8, 2019

There are three listings on the National Register of Historic Places for the Town of Rolesville. These sites are listed in the table below.

Table J.7 – Historic Properties

Ref#	Property Name	Status Date	Category	City
89002158	Green--Hartsfield House	12/21/1989	Building	Rolesville
02001728	Heartsfield--Perry Farm	1/23/2003	Building	Rolesville
03000966	Young, Dr. Lawrence Branch, House	9/25/2003	Building	Rolesville

Source: National Parks Service, National Register of Historic Places, October 2018

Housing

The following table details key housing statistics for Rolesville as compared to the County overall.

Table J.8 – Housing Statistics, Rolesville, 2010-2017

Jurisdiction	Housing Units (2010)	Housing Units (2017)	Housing Units Percent Change (2010-2017)	Owner-Occupied, % (2017)	Vacant Units, % (2017)	Median Home Value (2017)
Wake County total	**371,836**	**411,632**	**10.7%**	**59.5%**	**7.2%**	**$250,700**
Town of Rolesville	1,341	2,355	75.6%	73.1%	12.6%	$273,900

Source: U.S. Census Bureau 2010 Decennial Census, American Community Survey 2013-2017 5-Year Estimates
Note: Owner-Occupied and vacant-unit measures are reported as a percent of the total number of housing units.

Economy

The following tables present key economic statistics for Rolesville as compared to the County overall.

Table J.9 – Employment Statistics, Rolesville, 2017

Jurisdiction	Population in Labor Force	Percent Employed* (%)	Percent Unemployed* (%)	Percent Not in Labor Force* (%)	Unemployment Rate (%)
Wake County	**564,096**	**67.2**	**3.5**	**29.2**	**4.9**
Town of Rolesville	3,334	67.3	8.0	24.7	10.6

Source: U.S. Census Bureau, American Community Survey 2013-2017 5-Year Estimates
Note: This table reports only the civilian labor force. The labor force in armed services accounted for 0.3% or less of the population 16 and over in all jurisdictions. *Population employed, population unemployed, and Population not in labor force are reported as a percent of the total population aged 16 years and older.

Table J.10 – Percent of Employed Population by Occupation, Rolesville, 2017

Occupation	Management, business, science and arts (%)	Service (%)	Sales and Office (%)	Natural Resources, Construction, and Maintenance (%)	Production, transportation, and material moving (%)
Wake County	**50.1**	**13.8**	**23.4**	**6.0**	**6.7**
Town of Rolesville	54.0	15.8	22.8	1.6	5.8

Source: U.S. Census Bureau, American Community Survey 2013-2017 5-Year Estimates

J.3 RISK ASSESSMENT

This section contains a hazard profile and vulnerability assessment for those hazards that were rated with a higher priority for the Town of Rolesville than for Wake County as a whole. Risk and vulnerability findings are also presented here for those hazards that are spatially defined and have variations in risk that could be evaluated quantitatively on a jurisdictional level. The hazards included in this section are: Flood and Wildfire.

J.3.1 Flood

Table J.11 details the acreage of the Town of Rolesville by flood zone on the effective DFIRM. Per this assessment, just over 1 percent of the Town of Rolesville falls within the mapped 1%-annual-chance floodplains.

Table J.11 – Flood Zone Acreage in the Town of Rolesville

Flood Zone	Acreage	Percent of Total (%)
Zone A	30.83	0.39
Zone AE	74.64	0.93
Zone X (500-year)	15.21	0.19
Zone X Unshaded	7,865.05	98.49
Total	**7,985.73**	--

Source: FEMA Effective DFIRM; Wake County GIS

Figure J.3 reflects the effective mapped flood hazard zones for the Town of Rolesville, and Figure J.4 displays the depth of flooding estimated to occur in these areas during the 1%-annual-chance flood.

To supplement the IRISK assessment of property at risk from the 1% annual chance flood event in Section 4 and provide a clearer picture of the current property at risk in PLACE, current parcel data was evaluated to identify parcels developed since 2010. Using GIS analysis, parcels developed after 2010 were compared to the boundaries of the 1% annual chance floodplain to identify the exposure of newly developed property to the base flood. In most cases, a parcel was considered exposed to the floodplain if any portion of the parcel was located in the floodplain.

This assessment does not evaluate flood impacts or provide damage estimates. However, this summary of development in or near the floodplain since 2010 provides some context to understand the degree to which the IRISK exposure and vulnerability numbers differ from current conditions.

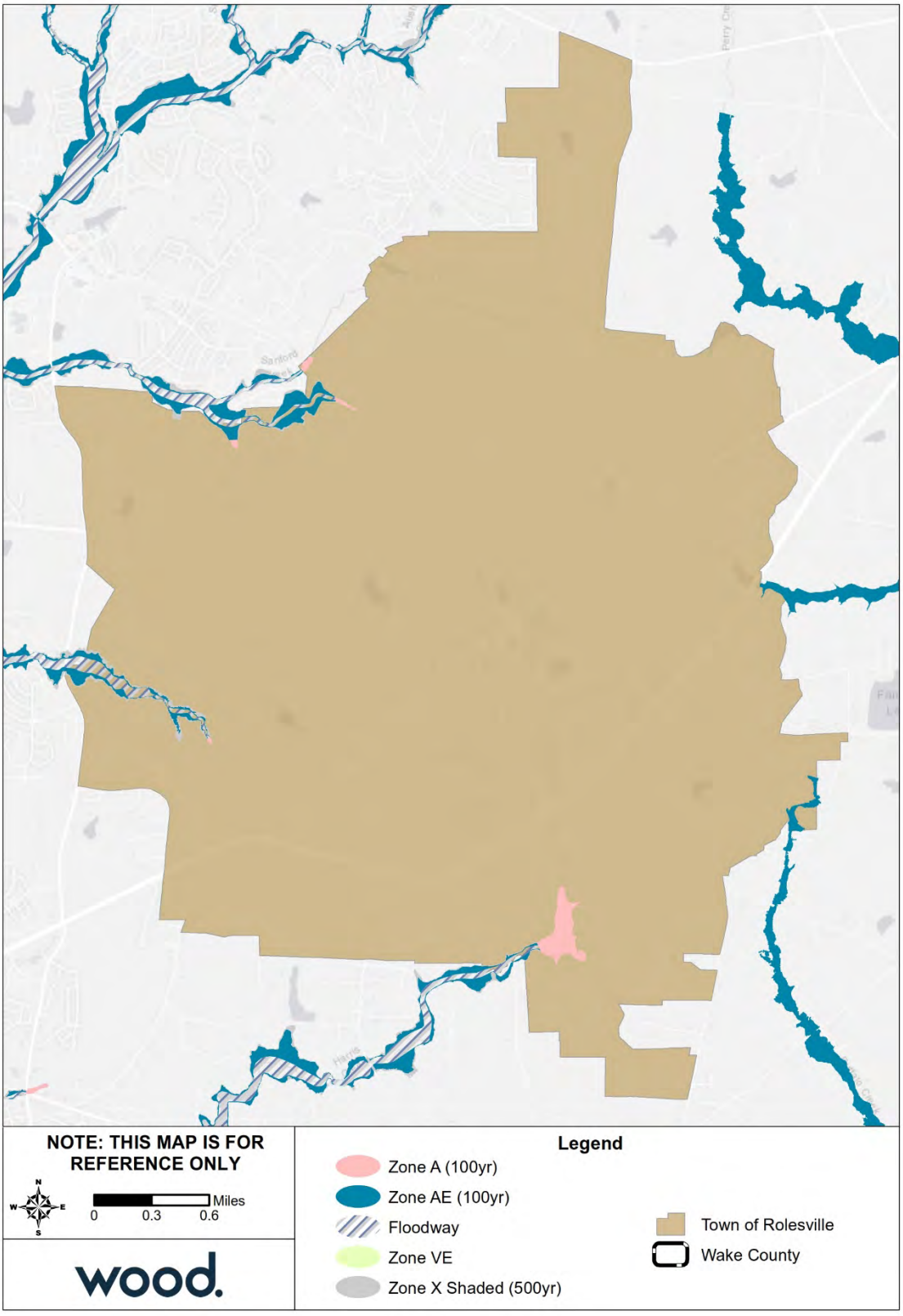
Table J.12 provides a summary by land class of parcel development located in the 1% annual chance floodplain from January 2011 to April 2019.

Table J.12 – Parcels Developed 2011 or Later and Located in 100-Year Floodplain, Town of Rolesville

Land Class	Number of Parcels	Sum of Building Value
EXEMPT	1	$56,241,696
Residential Less Than 10 Acres	11	$3,075,165
Grand Total	**12**	**$59,316,861**

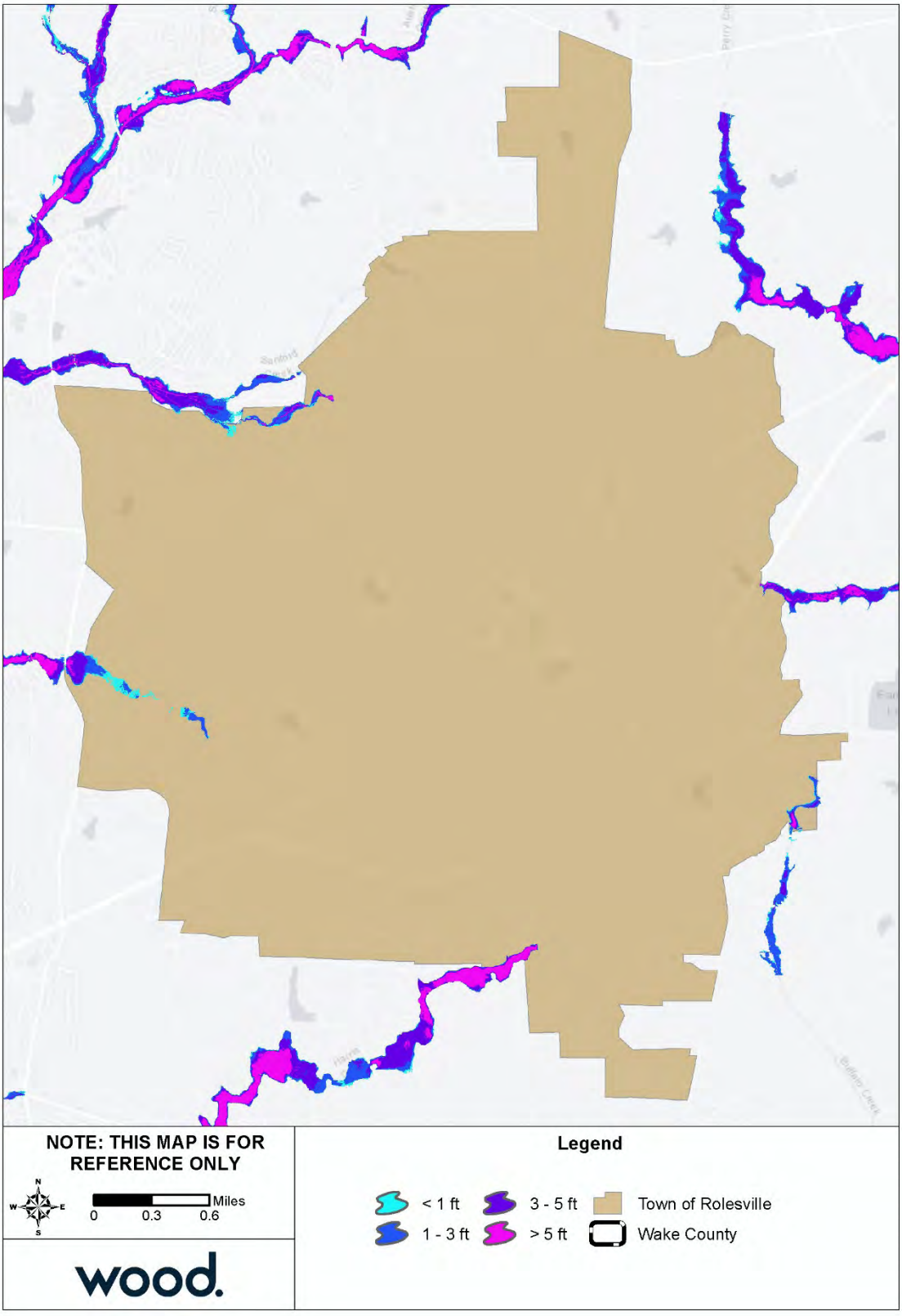
Source: Wake County Open Data; retrieved April 8, 2019; FEMA Effective DFIRM

Figure J.3 – Flood Zone Acreage in the Town of Rolesville



Source: FEMA Effective DFIRM

Figure J.4 – Flood Depth, 1%-Annual-Chance Floodplain, Town of Rolesville



Source: FEMA Effective DFIRM

J.3.2 Wildfire

Table J.13 summarizes the acreage in the Town of Rolesville that falls within the Wildland Urban Interface (WUI), categorized by housing density. Areas in the WUI are those where development may intermix with flammable vegetation. Over 15 percent of the Town of Rolesville is not included in the WUI.

Table J.13 – Wildland Urban Interface Acreage, Town of Rolesville

	Housing Density	Total Acreage	Percent of Total Acreage
	Not in WUI	*1,246.2*	*15.6%*
	LT 1hs/40ac	1,035.0	13.0%
	1hs/40ac to 1hs/20ac	964.4	12.1%
	1hs/20ac to 1hs/10ac	1,038.5	13.0%
	1hs/10ac to 1hs/5ac	1,072.0	13.4%
	1hs/5ac to 1hs/2ac	1,180.4	14.8%
	1hs/2ac to 3hs/1ac	1,445.6	18.1%
	GT 3hs/1ac	3.7	0.0%
	Total	7,985.7	

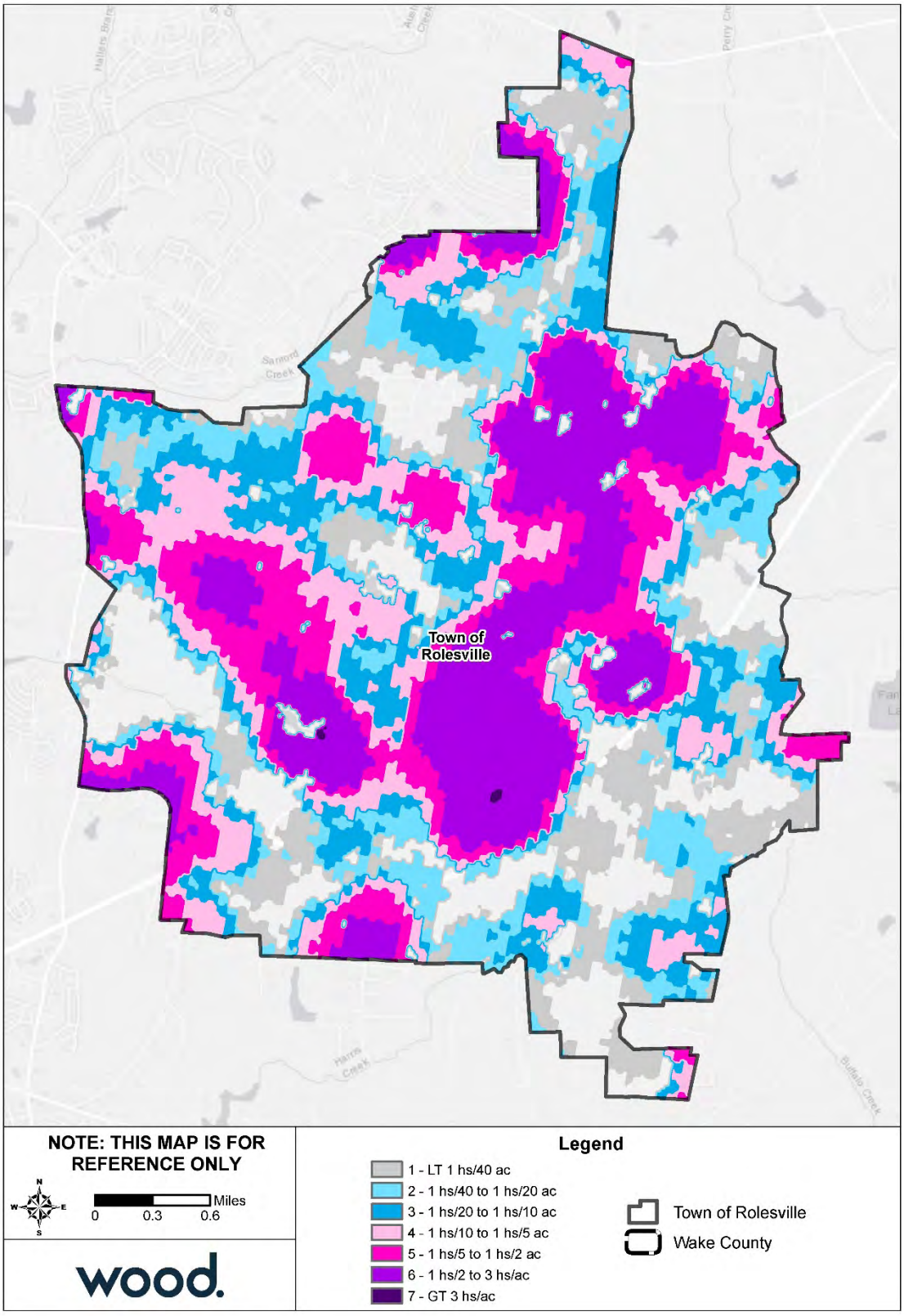
Source: Southern Wildfire Risk Assessment

Potential fire intensity is highest in west, south, and northwest Rolesville. These areas, however, are largely outside of the WUI. Additionally, the town has a whole has a low burn probability.

Figure J.5 depicts the WUI for the Town of Rolesville. The WUI is the area where housing development is built near or among areas of vegetation that may be prone to wildfire. Figure J.6 depicts the Fire Intensity Scale, which indicates the potential severity of fire based on fuel loads, topography, and other factors. Figure J.7 depicts Burn Probability based on landscape conditions, percentile weather, historical ignition patterns, and historical prevention and suppression efforts.

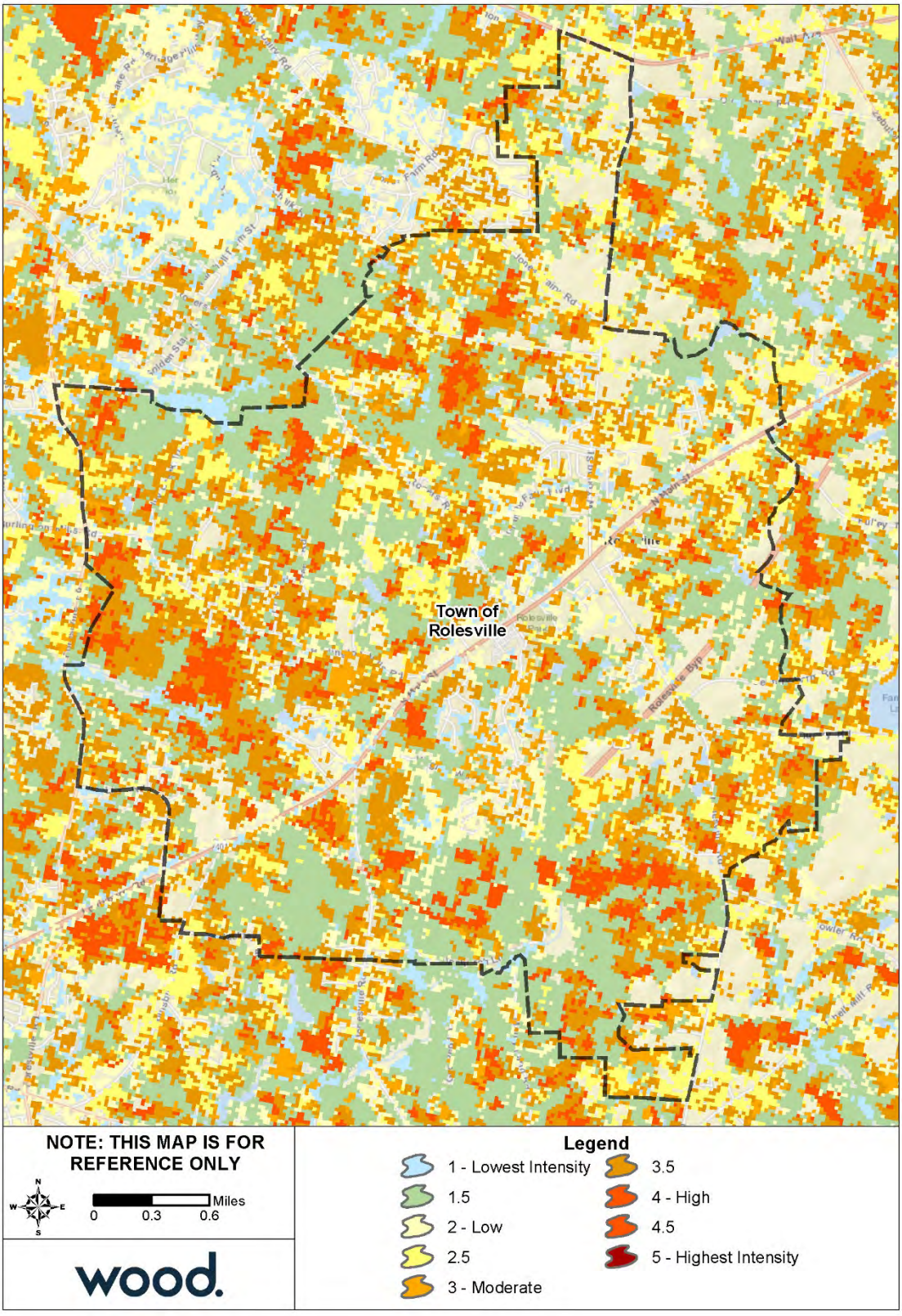
Potential fire intensity is highest in west, south, and northwest Rolesville. These areas, however, are largely outside of the WUI. Additionally, the town has a whole has a low burn probability.

Figure J.5 – Wildland Urban Interface, Town of Rolesville



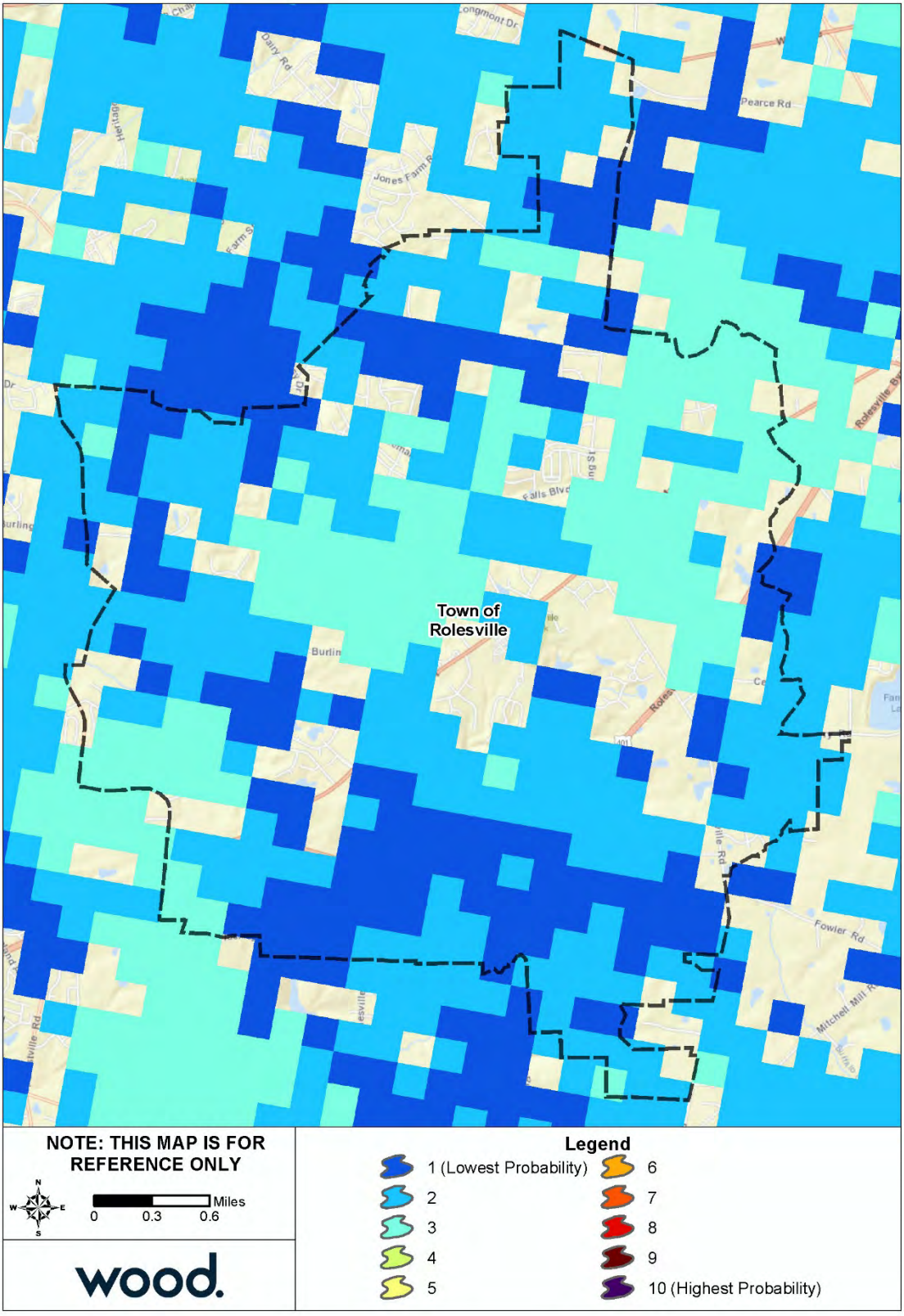
Source: Southern Wildfire Risk Assessment

Figure J.6 – Fire Intensity Scale, Town of Rolesville



Source: Southern Wildfire Risk Assessment

Figure J.7 – Burn Probability, Town of Rolesville



Source: Southern Wildfire Risk Assessment

J.4 CAPABILITY ASSESSMENT

J.4.1 Overall Capability

Details on the tools and resources in place and available to the Town of Rolesville were provided by the Town's HMPC representatives and are summarized in Section 5 Capability Assessment. Based on that information and using the scoring methodology detailed in that section, Rolesville has an overall capability rating of Moderate. The Town's Self-Assessment of key capability areas is summarized in Table J.14 below.

Table J.14 – Capability Self-Assessment, Rolesville

Capability Area	Rating
Plans, Ordinances, Codes and Programs	High
Administrative and Technical Capability	High
Fiscal Capability	Moderate
Education and Outreach Capability	Moderate
Mitigation Capability	Moderate
Political Capability	Moderate
Overall Capability	Moderate

J.4.2 Floodplain Management

The Town of Rolesville joined the NFIP as a regular participant in July 2001. The following tables reflect NFIP policy and claims data for the Town categorized by structure type, flood zone, Pre-FIRM and Post-FIRM.

Table J.15 – NFIP Policy and Claims Data by Structure Type

Structure Type	Number of Policies in Force	Total Premium	Insurance in Force	Number of Closed Paid Losses	Total of Closed Paid Losses
Single Family	15	$5,495	$4,417,000		
2-4 Family	0	$0	$0		
All Other Residential	0	$0	$0		
Non-Residential	0	$0	$0		
Total	15	$5,495	$4,417,000	0	$0.00

Source: FEMA Community Information System, accessed November 2018

Table J.16 – NFIP Policy and Claims Data by Flood Zone

Flood Zone	Number of Policies in Force	Total Premium	Insurance in Force	Number of Closed Paid Losses	Total of Closed Paid Losses
A01-30 & AE Zones	0	$0	$0		
A Zones	0	$0	$0		
AO Zones	0	$0	$0		
AH Zones	0	$0	$0		
AR Zones	0	$0	$0		
A99 Zones	0	$0	$0		
V01-30 & VE Zones	0	$0	$0		
V Zones	0	$0	$0		
D Zones	0	$0	$0		
B, C & X Zone					

Flood Zone	Number of Policies in Force	Total Premium	Insurance in Force	Number of Closed Paid Losses	Total of Closed Paid Losses
Standard	0	$0	$0		
Preferred	15	$5,495	$4,417,000		
Total	15	$5,495	$4,417,000	0	$0.00

Source: FEMA Community Information System, accessed November 2018

Table J.17 – NFIP Policy and Claims Data Pre-FIRM

Flood Zone	Number of Policies in Force	Total Premium	Insurance in Force	Number of Closed Paid Losses	Total of Closed Paid Losses
A01-30 & AE Zones	0	$0	$0		
A Zones	0	$0	$0		
AO Zones	0	$0	$0		
AH Zones	0	$0	$0		
AR Zones	0	$0	$0		
A99 Zones	0	$0	$0		
V01-30 & VE Zones	0	$0	$0		
V Zones	0	$0	$0		
D Zones	0	$0	$0		
B, C & X Zone	2	$724	$630,000		
Standard	0	$0	$0		
Preferred	2	$724	$630,000		
Total	2	$724	$630,000	0	$0.00

Source: FEMA Community Information System, accessed November 2018

Table J.18 – NFIP Policy and Claims Data Post-FIRM

Flood Zone	Number of Policies in Force	Total Premium	Insurance in Force	Number of Closed Paid Losses	Total of Closed Paid Losses
A01-30 & AE Zones	0	$0	$0		
A Zones	0	$0	$0		
AO Zones	0	$0	$0		
AH Zones	0	$0	$0		
AR Zones	0	$0	$0		
A99 Zones	0	$0	$0		
V01-30 & VE Zones	0	$0	$0		
V Zones	0	$0	$0		
D Zones	0	$0	$0		
B, C & X Zone	13	$4,771	$3,787,000		
Standard	0	$0	$0		
Preferred	13	$4,771	$3,787,000		
Total	13	$4,771	$3,787,000	0	$0.00

Source: FEMA Community Information System, accessed November 2018

J.5 MITIGATION STRATEGY

Town of Rolesville											
Action #	Description	Goal	Objective	Hazard(s) Addressed	Relative Priority	Lead Agency/ Department	Estimated Cost	Potential Funding Sources	Implementation Schedule	2019 Status	Status Comments/Explanation
Prevention											
P-1	Provide backup power for all critical public facilities (wastewater treatment plant, sewer pump stations, Public Works and Utilities building, etc.) to ensure continued utility service during power loss.	3	1	All	Moderate	City of Raleigh	Cost varies by facility	Local	1 year	In-Progress – Carry Forward	City of Raleigh has updated sewer pump stations with backup power, no upgrade of Town buildings but intended for future budgets.
P-2	Transportation Plan – Continue to address disaster preparedness (evacuation) through road interconnectivity, paved roads, and widening of roads.	3	2	All	Moderate	Rolesville Planning	Staff Time	Local	1 year	In-Progress – Carry Forward	Town has policy for new development connectivity and is implemented with each new development. New Transportation Plan targeted in mid-year 2019.
P-3	Update Rolesville Stormwater Management Plan for operation/implementation and program effectiveness and study the possible changes	4	1	Flood	Moderate	Rolesville Administration	Staff Time	Local	2-3 years	New	N/A
Structural Projects											
SP-1	Install emergency power backup generator for Town Hall and Police Station to ensure continued operation of government during power loss.	3	2	All	High	Rolesville Administration	Over $100,000	Local	2 years	New	N/A
Emergency Services											
ES-1	Implement Wake County Everbridge text alert system to notify citizens in real time of an event of local interest with instructions.	1	2	All	High	Rolesville Administration	Staff Time	Local	1 year	New	N/A
Public Education and Awareness											
PEA-1	Town website - develop hazard mitigation section covering such items as public access, evacuation routes, emergency contact numbers, and detailed weather reports in case of emergency,	1	1	All	Moderate	Rolesville Administration	Staff Time	Local	1 year	In-Progress – Carry Forward	Town is in the process of new Town's Website development and development of a hazard mitigation section will be included by Spring of 2019.

Annex K Town of Wake Forest

K.1 PLANNING PROCESS

The table below lists the HMPC members who represented the Town of Wake Forest.

Table K.1 – HMPC Members

Agency	Representative	Position or Title
Town of Wake Forest	Patrick Reidy	Senior Planner – Development Services
N/A	Grif Bond	Citizen Stakeholder

K.2 COMMUNITY PROFILE

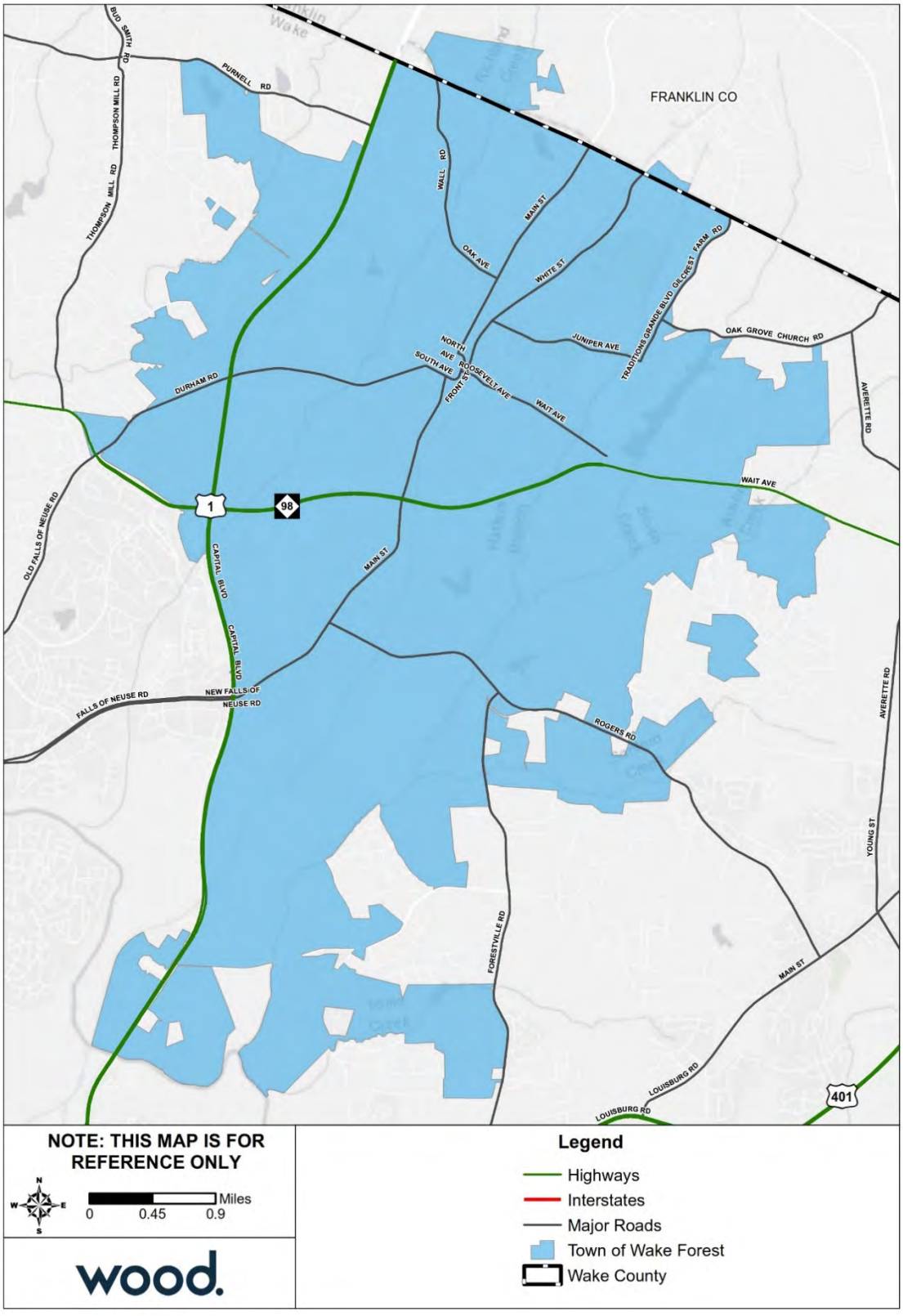
Geography

The Town of Wake Forest is located in northern Wake County. A small portion of the Town extends north into Franklin County. All statistics summarized in this section are for the entirety of the Town of Wake Forest. It is neighbored by Raleigh to the southwest and Rolesville to the southeast. The Town is part of the Raleigh, NC Metropolitan Statistical Area, which falls within the larger Raleigh-Durham-Chapel Hill, NC Combined Statistical Area. Wake Forest comprises a total land area of 15.1 square miles.

According to data from the U.S. Fish and Wildlife Service's National Wetlands Inventory, there are approximately 1,456 acres of wetlands in Wake Forest.

Figure K.1 shows a base map of the major transportation routes in the Town of Wake Forest.

Figure K.1 – Major Transportation Routes – Town of Wake Forest



Source: Wake County GIS Open Data

Population and Demographics

Table K.2 provides population counts and growth estimates for the Town of Wake Forest as compared to the County overall. Table K.3 provides demographic information for Wake Forest as compared to the whole County.

Table K.2 – Population Counts, Wake Forest, 2010-2017

Jurisdiction	2000 Census Population	2010 Census Population	2017 ACS Population Estimate	Total Change 2010-2017	% Change 2010-2017
Wake County total	**627,846**	**900,993**	**1,023,811**	**122,818**	**13.6%**
Town of Wake Forest	12,588	30,117	38,473	8,356	27.7%

Source: US Census Bureau Decennial Census 2000, Decennial Census 2010; American Community Survey 2013-2017 5-Year Estimates
Note: The total population of Wake Forest includes population residing in adjacent county.

Table K.3 – Racial Demographics, Wake Forest, 2017

Jurisdiction	White, %	Black, %	Asian, %	Other Race, %	Two or More Races, %	Persons of Hispanic or Latino Origin*, %
Wake County total	**66.5%**	**20.4%**	**6.5%**	**3.6%**	**2.7%**	**10.0%**
Town of Wake Forest	78.9%	14.5%	1.5%	0.9%	4.1%	4.8%

Source: US Census Bureau, American Community Survey 2013-2017 5-Year Estimates
*Persons of Hispanic origin may be of any race, so also are included in applicable race categories

Asset Inventory

The following tables summarize the asset inventory for Wake Forest in order to estimate the total physical exposure to hazards in this area. The locations of critical facilities are shown in Figure K.2 on the following page. Critical facilities are a subset of identified assets from the Critical Infrastructure & Key Resources dataset. Note that the counts are by building; where a critical facility comprises a cluster of buildings, each building is counted and displayed.

Table K.4 – Critical Infrastructure & Key Resources by Type

Jurisdiction	Food & Agriculture	Banking & Finance	Chemical	Commercial Facilities	Communications	Manufacturing	Defense	Government	Healthcare	IT	National Monuments	Nuclear	Postal & Shipping	Transportation	Energy	Emergency Services	Water	Other	Total
Town of Wake Forest	8	12	0	315	0	199	0	93	23	0	0	0	0	36	0	4	3	0	**693**

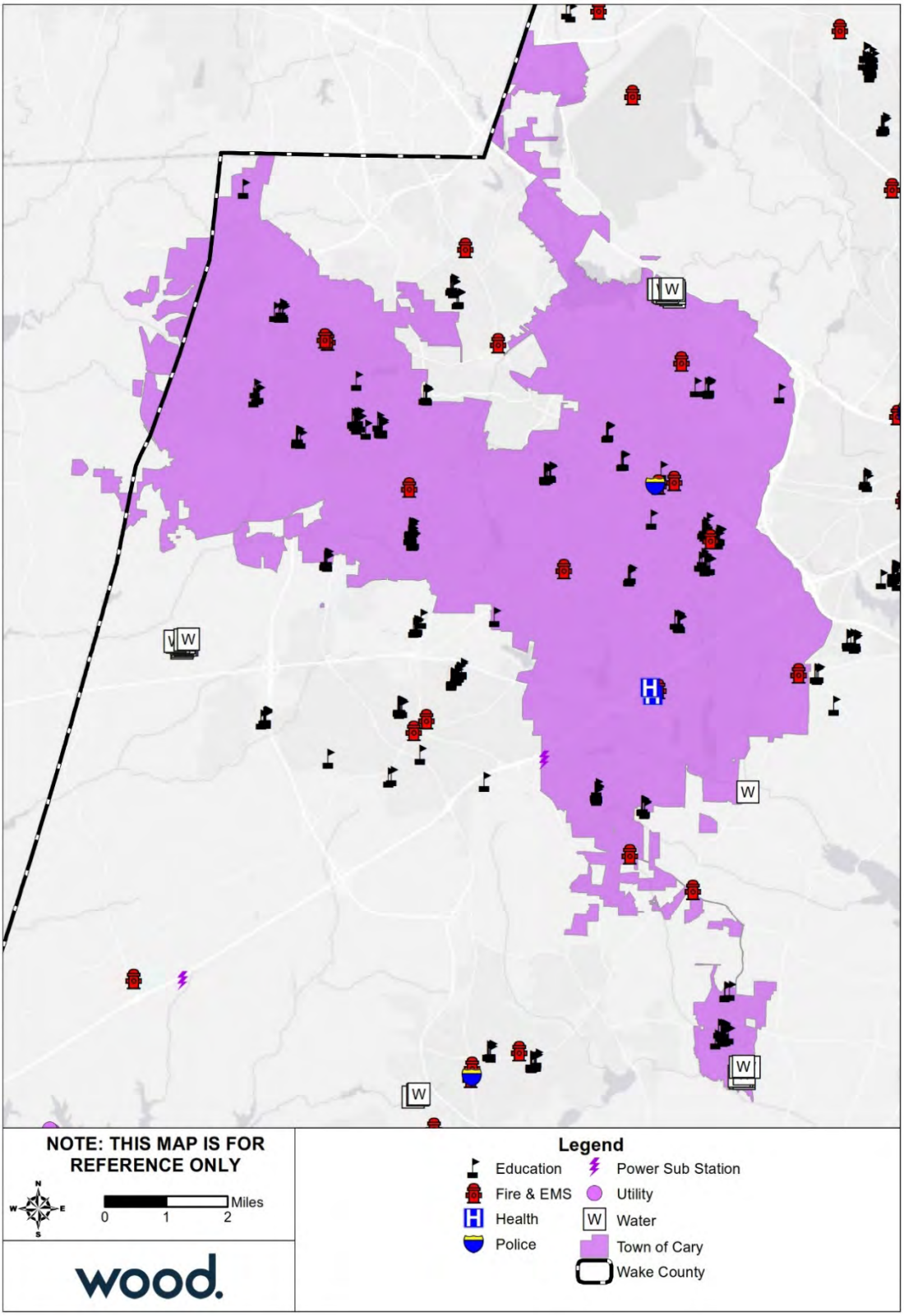
Source: NCEM Risk Management Tool

Table K.5 – High Potential Loss Facilities by Use

Jurisdiction	Residential	Commercial	Industrial	Government	Agricultural	Religious	Utilities	Other	Total
Town of Wake Forest	44	70	21	21	0	15	3	0	**174**

Source: NCEM Risk Management Tool

Figure K.2 – Critical Facilities, Town of Wake Forest



Source: NCEM IRISK Database, GIS Analysis

To supplement the asset inventory and provide a clearer picture of the current asset exposure in the Town of Wake Forest, current parcel data was evaluated to identify development since 2010. This information is not incorporated into the risk assessment, which was prepared using NCEM's IRISK database. However, this summary of development since 2010 provides some context to understand the degree to which the IRISK exposure and vulnerability numbers differ from current conditions.

Table K.6 provides a summary by land class of parcel development from January 2011 to April 2019.

Table K.6 – Parcels Developed 2011 or Later, Town of Wake Forest

Land Class	Number of Parcels	Sum of Building Value
Apartment	5	$108,787,706
Commercial	52	$96,539,284
Condo Complex	4	-
EXEMPT	9	$42,148,445
HOA	2	$326,705
Industrial	4	$2,815,251
Part Exempt	21	$6,572,261
Residential Less Than 10 Acres	3,409	$895,793,767
Retirement Home	1	$4,712,912
Grand Total	**3,507**	**$1,157,696,331**

Source: Wake County Open Data; retrieved April 8, 2019

There are 18 listings on the National Register of Historic Places for the Town of Wake, including 6 historic districts. These sites are listed in the table below.

Table K.7 – Historic Properties

Ref#	Property Name	Status Date	Category	City
74001381	Powell House	10/15/1974	Building	Wake Forest
74001378	Wakefields	10/16/1974	Building	Wake Forest
75001298	Lea Laboratory	5/29/1975	Building	Wake Forest
88000238	Purefoy--Dunn Plantation	3/24/1988	District	Wake Forest
91001504	Royall Cotton Mill Commissary	10/16/1991	Building	Wake Forest
93000998	DuBois, W. E. B., School	10/5/1993	Building	Wake Forest
97000788	Purefoy--Dunn Plantation (Boundary Decrease)	7/25/1997	District	Wake Forest
98000689	Oakforest	6/11/1998	Building	Wake Forest
99001046	Glen Royall Mill Village Historic District	8/27/1999	District	Wake Forest
02000059	Downtown Wake Forest Historic District	2/20/2002	District	Wake Forest
02001719	Wakefield Dairy Complex	1/15/2003	Building	Wake Forest
03001301	Wake Forest Historic District	12/18/2003	District	Wake Forest
05001030	Thompson House	9/15/2005	Building	Wake Forest
07000879	Rock Cliff Farm	8/29/2007	District	Wake Forest
08001016	Purefoy-Chappell House and Outbuildings	10/22/2008	Building	Wake Forest
10001097	Bailey--Estes House	12/28/2010	Building	Wake Forest
14000265	South Brick House	5/27/2014	Building	Wake Forest
16000880	Jones, Dr. Calvin, House	12/22/2016	Building	Wake Forest

Source: National Parks Service, National Register of Historic Places, October 2018

Housing

The table below details key housing statistics for Wake Forest as compared to the County overall.

Table K.8 – Housing Statistics, Wake Forest, 2010-2017

Jurisdiction	Housing Units (2010)	Housing Units (2017)	Housing Units Percent Change (2010-2017)	Owner-Occupied, % (2017)	Vacant Units, % (2017)	Median Home Value (2017)
Wake County total	**371,836**	**411,632**	**10.7%**	**59.5%**	**7.2%**	**$250,700**
Town of Wake Forest	11,370	13,888	22.1%	67.2%	4.7%	$278,600

Source: U.S. Census Bureau 2010 Decennial Census, American Community Survey 2013-2017 5-Year Estimates
Note: Owner-Occupied and vacant-unit measures are reported as a percent of the total number of housing units.

Economy

The following tables present key economic statistics for Wake Forest as compared to the County overall.

Table K.9 – Employment Statistics, Wake Forest, 2017

Jurisdiction	Population in Labor Force	Percent Employed* (%)	Percent Unemployed* (%)	Percent Not in Labor Force* (%)	Unemployment Rate (%)
Wake County	**564,096**	**67.2**	**3.5**	**29.2**	**4.9**
Town of Wake Forest	19,229	65.6	3.8	30.5	5.4

Source: U.S. Census Bureau, American Community Survey 2013-2017 5-Year Estimates
Note: This table reports only the civilian labor force. The labor force in armed services accounted for 0.3% or less of the population 16 and over in all jurisdictions. *Population employed, population unemployed, and Population not in labor force are reported as a percent of the total population aged 16 years and older.

Table K.10 – Percent of Employed Population by Occupation, Wake Forest, 2017

Occupation	Management, business, science and arts (%)	Service (%)	Sales and Office (%)	Natural Resources, Construction, and Maintenance (%)	Production, transportation, and material moving (%)
Wake County	**50.1**	**13.8**	**23.4**	**6.0**	**6.7**
Town of Wake Forest	53.4	13.2	25.0	4.0	4.4

Source: U.S. Census Bureau, American Community Survey 2013-2017 5-Year Estimates

K.3 RISK ASSESSMENT

This section contains a hazard profile and vulnerability assessment for those hazards that were rated with a higher priority for the Town of Wake Forest than for Wake County as a whole. Risk and vulnerability findings are also presented here for those hazards that are spatially defined and have variations in risk that could be evaluated quantitatively on a jurisdictional level. The hazards included in this section are: Flood and Wildfire.

K.3.1 Flood

Table K.11 Details the acreage of the Town of Wake Forest by flood zone on the effective DFIRM. Per this assessment, over 9 percent of the Town of Wake Forest falls within the mapped 1%-annual-chance floodplains.

Table K.11 – Flood Zone Acreage in the Town of Wake Forest

Flood Zone	Acreage	Percent of Total (%)
Zone A	3.94	0.03
Zone AE	1,253.05	9.02

Flood Zone	Acreage	Percent of Total (%)
Zone X (500-year)	113.01	0.81
Zone X Unshaded	12,516.72	90.13
Total	**13,886.72**	--

Source: FEMA Effective DFIRM; Wake County GIS

Figure K.3 reflects the effective mapped flood hazard zones for the Town of Wake Forest, and Figure K.4 displays the depth of flooding estimated to occur in these areas during the 1%-annual-chance flood.

To supplement the IRISK assessment of property at risk from the 1% annual chance flood event in Section 4 and provide a clearer picture of the current property at risk in the Town of Wake Forest, current parcel data was evaluated to identify parcels developed since 2010. Using GIS analysis, parcels developed after 2010 were compared to the boundaries of the 1% annual chance floodplain to identify the exposure of newly developed property to the base flood. In most cases, a parcel was considered exposed to the floodplain if any portion of the parcel was located in the floodplain.

This assessment does not evaluate flood impacts or provide damage estimates. However, this summary of development in or near the floodplain since 2010 provides some context to understand the degree to which the IRISK exposure and vulnerability numbers differ from current conditions.

Table K.12 provides a summary by land class of parcel development located in the 1% annual chance floodplain from January 2011 to April 2019.

Table K.12– Parcels Developed 2011 or Later and Located in 100-Year Floodplain

Land Class	Number of Parcels	Sum of Building Value
Commercial	1	$6,625,596
Residential Less Than 10 Acres	26	$8,943,999
Grand Total	**27**	**$15,569,595**

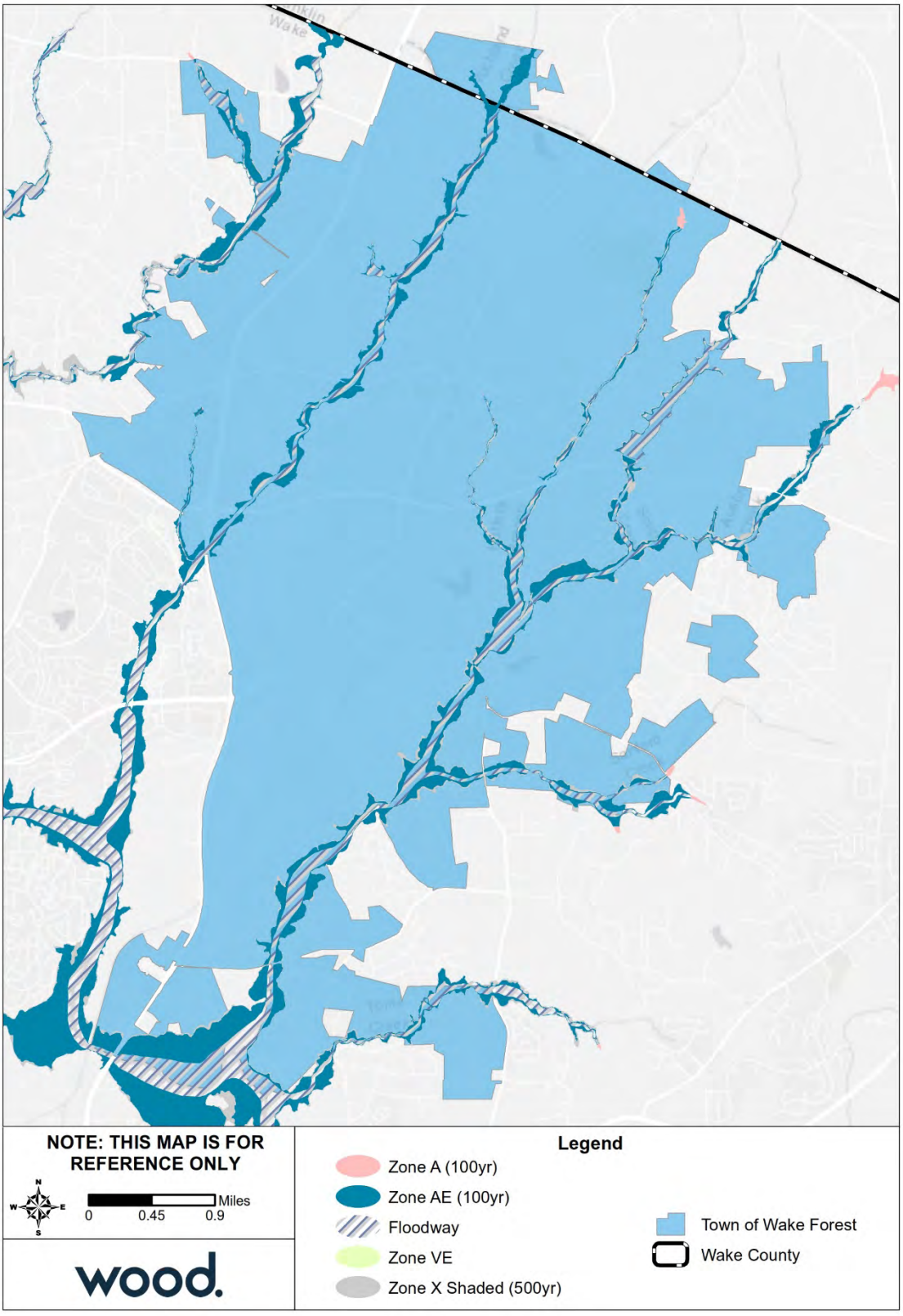
Source: Wake County Open Data; retrieved April 8, 2019; FEMA Effective DFIRM

Table K.13 provides building counts and estimated damages for Critical Infrastructure and Key Resources (CIKR) buildings by sector and flood event in the Town of Wake Forest.

Table K.13 – Critical Facilities Exposed to Flooding, Town of Wake Forest

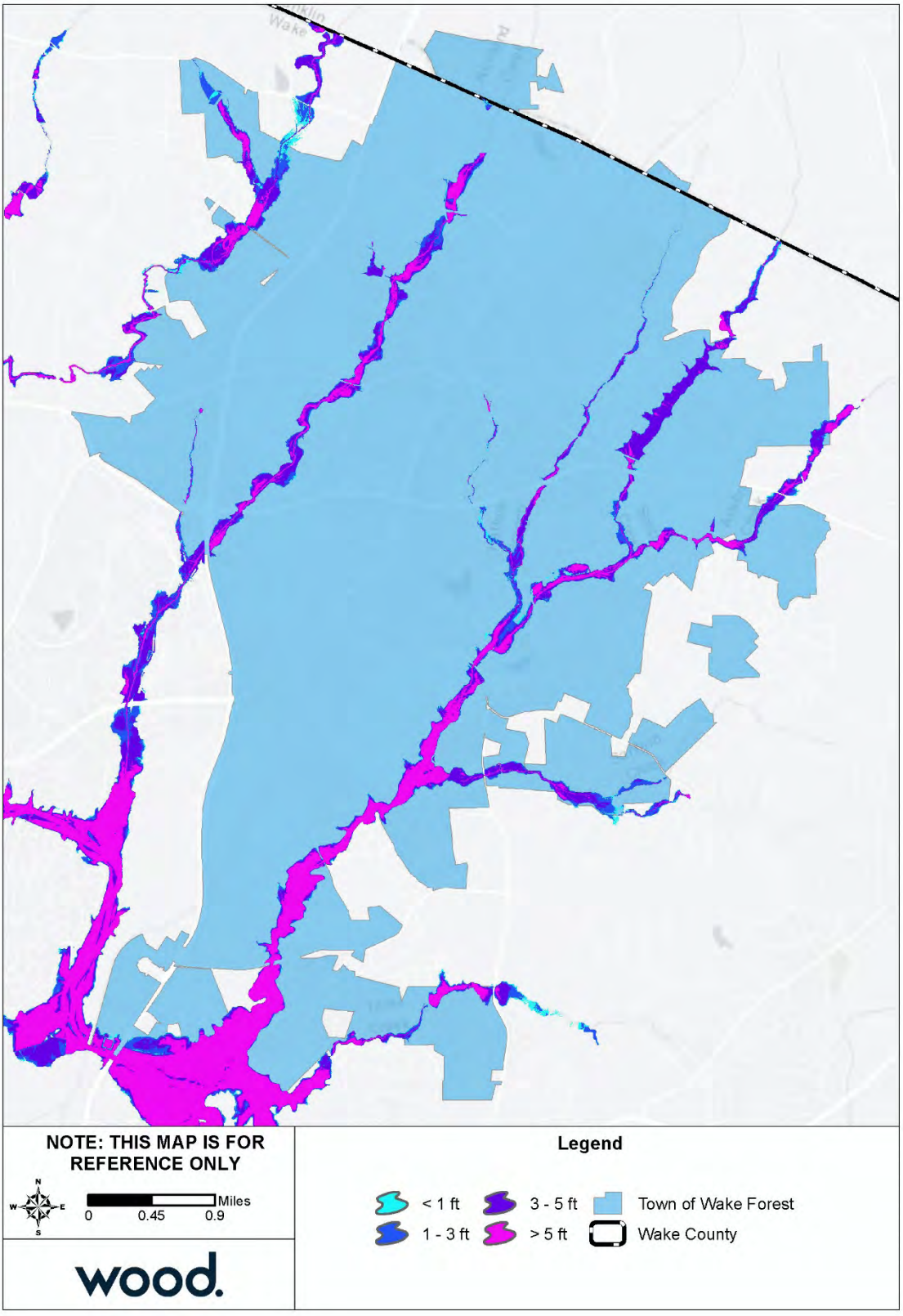
Sector	Event	Number of Buildings at Risk	Estimated Damages
Commercial Facilities	100 Year	1	$25,973
All Categories	**100 Year**	**1**	**$25,973**

Figure K.3 – FEMA Flood Hazard Areas, Town of Wake Forest



Source: FEMA Effective DFIRM

Figure K.4 – Flood Depth, 1%-Annual-Chance Floodplain, Town of Wake Forest



Source: FEMA Effective DFIRM

K.3.2 Wildfire

Table K.14 summarizes the acreage in the Town of Wake Forest that falls within the Wildland Urban Interface (WUI), categorized by housing density. Areas in the WUI are those where development may intermix with flammable vegetation. Over 10 percent of the Town of Wake Forest is not included in the WUI.

Table K.14 – Wildland Urban Interface Acreage, Town of Wake Forest

	Housing Density	Total Acreage	Percent of Total Acreage
	Not in WUI	*1,408.5*	*10.3%*
	LT 1hs/40ac	698.0	5.1%
	1hs/40ac to 1hs/20ac	645.8	4.7%
	1hs/20ac to 1hs/10ac	676.2	4.9%
	1hs/10ac to 1hs/5ac	968.5	7.1%
	1hs/5ac to 1hs/2ac	1,848.4	13.5%
	1hs/2ac to 3hs/1ac	7,033.4	51.5%
	GT 3hs/1ac	387.4	2.8%
	Total	13,666.3	

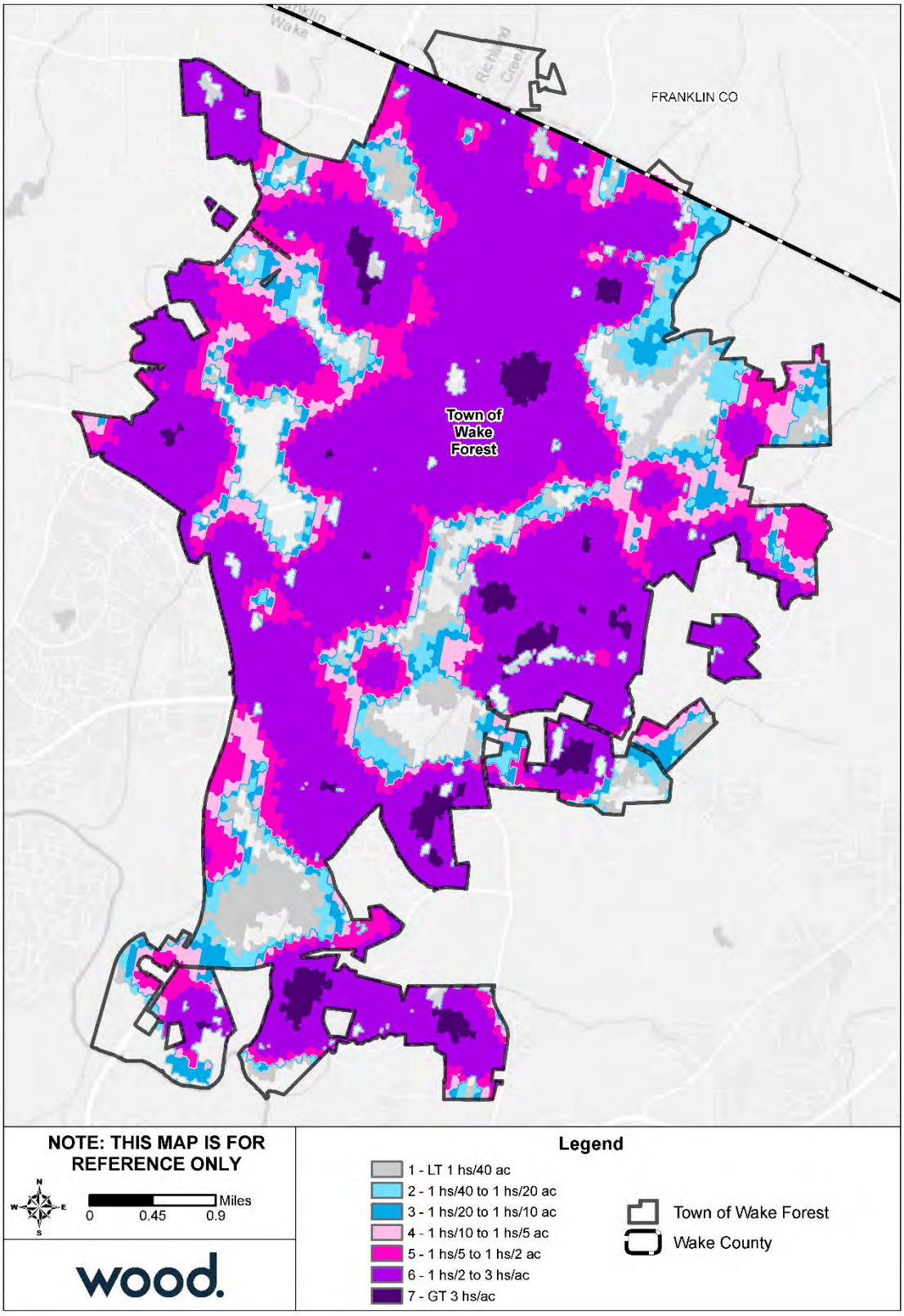
Source: Southern Wildfire Risk Assessment

Potential fire intensity is highest in central and west Wake Forest. These areas are in the WUI, but they do not have a high burn probability. Overall, the Town of Wake Forest does not have a high burn probability.

Figure K.5 depicts the WUI for the Town of Wake Forest. The WUI is the area where housing development is built near or among areas of vegetation that may be prone to wildfire. Figure K.6 depicts the Fire Intensity Scale, which indicates the potential severity of fire based on fuel loads, topography, and other factors. Figure K.7 depicts Burn Probability based on landscape conditions, percentile weather, historical ignition patterns, and historical prevention and suppression efforts.

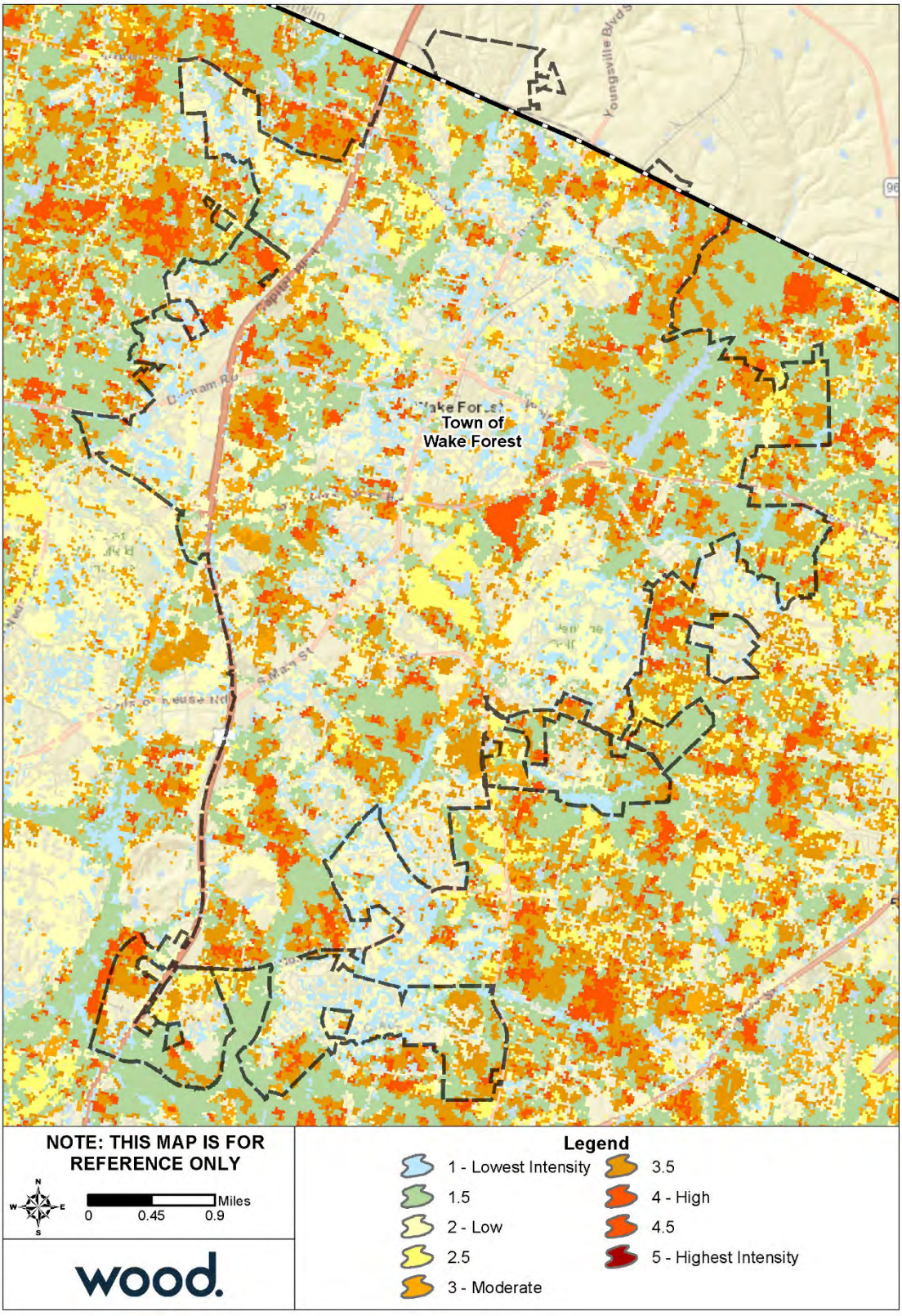
Potential fire intensity is highest in central and west Wake Forest. These areas are in the WUI, but they do not have a high burn probability. Overall, the Town of Wake Forest does not have a high burn probability.

Figure K.5 – Wildland Urban Interface, Town of Wake Forest



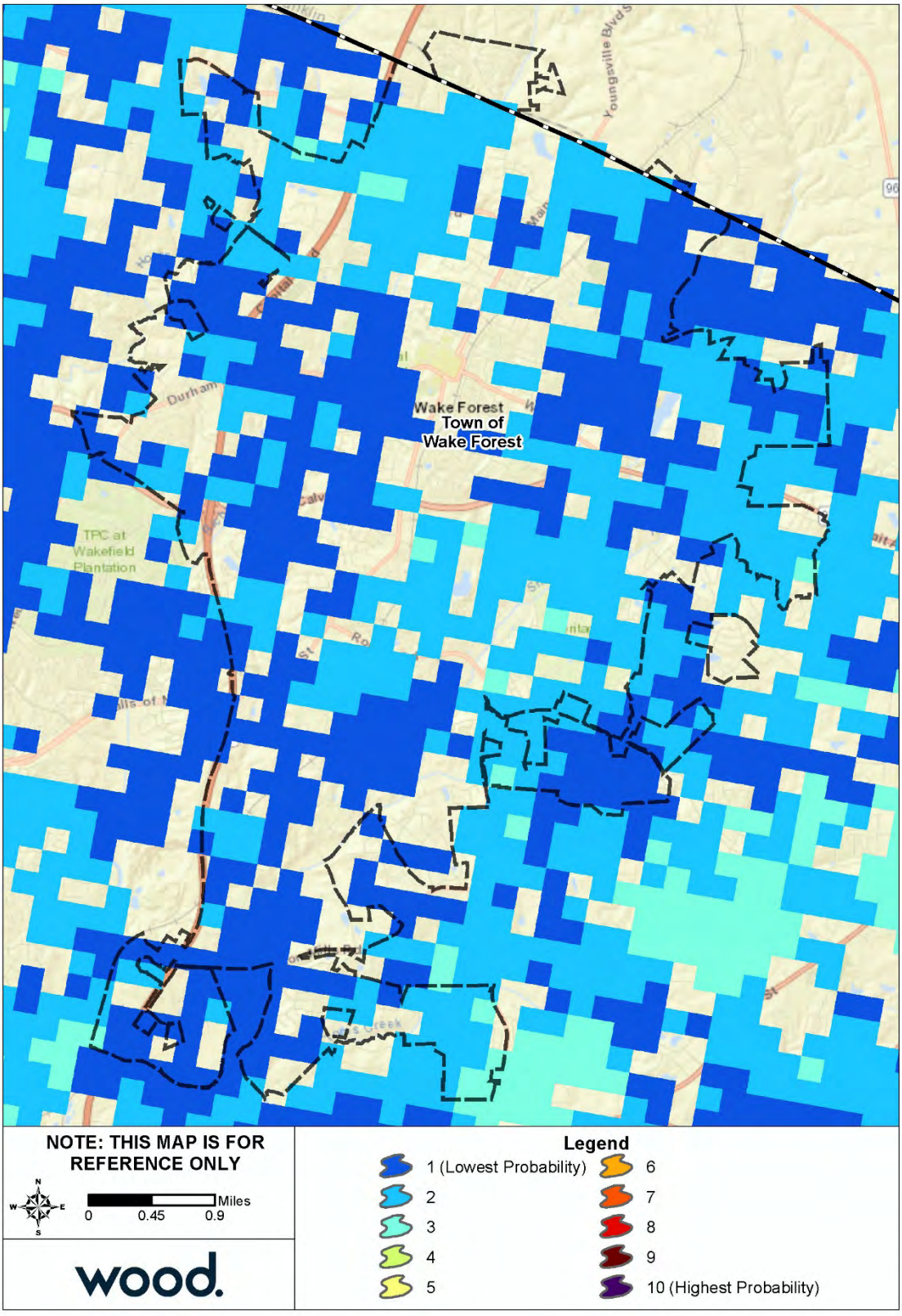
Source: Southern Wildfire Risk Assessment

Figure K.6 – Fire Intensity Scale, Town of Wake Forest



Source: Southern Wildfire Risk Assessment

Figure K.7 – Burn Probability, Town of Wake Forest



Source: Southern Wildfire Risk Assessment

K.4 CAPABILITY ASSESSMENT

K.4.1 Overall Capability

Details on the tools and resources in place and available to the Town of Wake Forest were provided by the Town's HMPC representatives and are summarized in Section 5 Capability Assessment. Based on that information and using the scoring methodology detailed in that section, Wake Forest has an overall capability rating of High. The Town's Self-Assessment of key capability areas is summarized in Table K.15 below.

Table K.15 – Capability Self-Assessment, Wake Forest

Capability Area	Rating
Plans, Ordinances, Codes and Programs	High
Administrative and Technical Capability	High
Fiscal Capability	High
Education and Outreach Capability	Moderate
Mitigation Capability	Limited
Political Capability	High
Overall Capability	High

K.4.2 Floodplain Management

The Town of Wake Forest joined the NFIP through emergency entry in March 1974 and has been a regular participant since July 1978. The following tables reflect NFIP policy and claims data for the Town categorized by structure type, flood zone, Pre-FIRM and Post-FIRM.

Table K.16 – NFIP Policy and Claims Data by Structure Type

Structure Type	Number of Policies in Force	Total Premium	Insurance in Force	Number of Closed Paid Losses	Total of Closed Paid Losses
Single Family	142	$56,421	$42,541,700		
2-4 Family	2	$501	$260,000		
All Other Residential	1	$298	$258,000		
Non-Residential	4	$3,219	$850,000		
Total	149	$60,439	$43,909,700	0	$0.00

Source: FEMA Community Information System, accessed November 2018

Table K.17 – NFIP Policy and Claims Data by Flood Zone

Flood Zone	Number of Policies in Force	Total Premium	Insurance in Force	Number of Closed Paid Losses	Total of Closed Paid Losses
A01-30 & AE Zones	27	$12,963	$8,050,200		
A Zones	0	$0	$0		
AO Zones	0	$0	$0		
AH Zones	0	$0	$0		
AR Zones	0	$0	$0		
A99 Zones	0	$0	$0		
V01-30 & VE Zones	0	$0	$0		
V Zones	0	$0	$0		

Flood Zone	Number of Policies in Force	Total Premium	Insurance in Force	Number of Closed Paid Losses	Total of Closed Paid Losses
D Zones	0	$0	$0		
B, C & X Zone					
Standard	6	$4,083	$1,877,500		
Preferred	116	$43,393	$33,982,000		
Total	149	$60,439	$43,909,700	0	$0.00

Source: FEMA Community Information System, accessed November 2018

Table K.18 – NFIP Policy and Claims Data Pre-FIRM

Flood Zone	Number of Policies in Force	Total Premium	Insurance in Force	Number of Closed Paid Losses	Total of Closed Paid Losses
A01-30 & AE Zones	0	$0	$0		
A Zones	0	$0	$0		
AO Zones	0	$0	$0		
AH Zones	0	$0	$0		
AR Zones	0	$0	$0		
A99 Zones	0	$0	$0		
V01-30 & VE Zones	0	$0	$0		
V Zones	0	$0	$0		
D Zones	0	$0	$0		
B, C & X Zone	4	$1,366	$1,085,000		
Standard	0	$0	$0		
Preferred	4	$1,366	$1,085,000		
Total	4	$1,366	$1,085,000	0	$0.00

Source: FEMA Community Information System, accessed November 2018

Table K.19 – NFIP Policy and Claims Data Post-FIRM

Flood Zone	Number of Policies in Force	Total Premium	Insurance in Force	Number of Closed Paid Losses	Total of Closed Paid Losses
A01-30 & AE Zones	27	$12,963	$8,050,200		
A Zones	0	$0	$0		
AO Zones	0	$0	$0		
AH Zones	0	$0	$0		
AR Zones	0	$0	$0		
A99 Zones	0	$0	$0		
V01-30 & VE Zones	0	$0	$0		
V Zones	0	$0	$0		
D Zones	0	$0	$0		
B, C & X Zone	118	$46,110	$34,774,500		
Standard	6	$4,083	$1,877,500		
Preferred	112	$42,027	$32,897,000		
Total	145	$59,073	$42,824,700	0	$0.00

Source: FEMA Community Information System, accessed November 2018

K.5 MITIGATION STRATEGY

Town of Wake Forest											
Action #	**Description**	**Goal**	**Objective**	**Hazard(s) Addressed**	**Relative Priority**	**Lead Agency/ Department**	**Estimated Cost**	**Potential Funding Sources**	**Implementation Schedule**	**2019 Status**	**Status Comments/Explanation**
Prevention											
P-1	Prepare a Storm Drainage Master Plan to include all storm drainage, infrastructure, and capacity analysis.	2	2	Flood	High	Wake Forest Engineering	$400,000	General Fund	2019	In-Progress – Carry Forward	75% complete, completion scheduled June 2019
P-2	Put electric distribution lines underground.	3	1	Hurricane, Severe Weather, Severe Winter Storm, Tornado, Wildfire	Low	Wake Forest Power	$10,000,000	Electric Fund, General Fund, and Bonds	2024	In-Progress – Carry Forward	Where feasible, electric lines have been put underground. However, there are still some lines that could be buried and the town will look into carrying that out going forward.
P-3	Become a CRS community	2	2	Flood	Low	Wake Forest Public Works	$100,000	General Fund	2022	New	Work towards becoming a CRS community
P-4	Explore the use of Stormwater Utility Fees	3	1	Flood	Moderate	Wake Forest Administration	$100,000	General Fund that would become a User Fee if implemented	2020	New	As subdivisions age, their covenants could expire after 20 years leaving the town with maintaining additional stormwater control measures. These fees could help offset necessary maintenance.
P-5	Maintain a GIS database of building footprints and use it to regularly update a map of critical facilities and vulnerable buildings.	2	2	All	Moderate	Wake Forest GIS	Staff time	General Fund	Ongoing Annually	New	Updated data will be used to identify properties that should be prioritized for mitigation.
Property Protection											
PP-1	Document each historic structure in Wake Forest town limits and ETJ	3	1	Hurricane, Severe Weather, Severe Winter Storm, Tornado, Wildfire, Flood	Moderate	Wake Forest Planning	$75,000	General Fund	2020	New	Photographs and taken every other year in the local historic district. A baseline photographic inventory of all historic structures in the town limits and ETJ will be taken and repeated every 5 years. If damage occurred due to a natural disaster, it would be easier to secure funding to replace/repair back to its historical integrity.
PP-2	Provide for primary or mobile generators to shelter sites.	2	1	All	Moderate	Wake County Emergency Management	$500,000	General Fund	2024	In-Progress – Carry Forward	Heritage High School has generators. Town is constructing Joyner Park with intention to be used as a shelter site if needed. Generator is being included with the building.
PP-3	Assess facilities for the need for emergency generation, giving consideration to alternate facility sites.	2	1	All	High	Wake Forest Power	$250,000	General Fund	2023	In-Progress – Carry Forward	The town has assessed facilities for the need for emergency generation and many facilities have been fitted with generators. However, additional facilities with emergency generation would be useful.
Natural Resource Protection											
NRP-1	Manage the Wake Forest Reservoir for hazard mitigation	2	1	Drought, Flood, Dam Failure	Moderate	Wake Forest Public Works	$300,000	General Fund	2021	New	The City of Raleigh is in the process of transferring the Wake Forest Reservoir to the town. Staff is investigating all details associated with the reservoir ownership from a hazard mitigation standpoint, such as flooding/breaching potential.
NRP-2	Expansion of our greenway trail network	3	2	Flood, Hurricane, Extreme Heat	Moderate	Wake Forest Planning	$16,100,000	General Fund and Bonds	2024	New	The Town has multiple greenway extensions and new routes planned. By installing greenways along our waterways, it gives the Town a better opportunity to remove fallen debris and trash that helps alleviate possible flooding.
Structural Projects											
SP-1	Conduct stream mitigation projects on Old Mill Stream, Richland Creek, and others subject to flooding or erosion.	3	2	Flood	Moderate	Wake Forest Engineering	$2,350,000	General Fund, Clean Water Management Trust Fund, Ecosystem Enhancement Program	2024	In-Progress – Carry Forward	Some mitigation projects have been conducted on these water bodies, but there is significant effort that is still needed to reduce potential erosion. Current projects include: Old Mill Stream and Richland Creek - construction plans @ 90%. Ailey Young Dam - completion June 2019; Smith Creek - quote has been requested for work to be done. Stream erosion throughout town continues to be an ongoing process as needed
Emergency Services											

Town of Wake Forest											
Action #	Description	Goal	Objective	Hazard(s) Addressed	Relative Priority	Lead Agency/ Department	Estimated Cost	Potential Funding Sources	Implementation Schedule	2019 Status	Status Comments/Explanation
ES-1	Investigate methods of encouraging gas stations to acquire backup generators.	1	1	All	High	Wake Forest Public Works and Inspections	$50,000	General Fund	2022	In-Progress – Carry Forward	Grocery stores and gas stations are encouraged to have back up generators. Wal-Mart added a generator with the help of the town. Wegmans which will be constructed in the next two years will have a generator on site. These sites will help provide necessary food and supplies to residents.
ES-2	See that all nursing homes and assisted living facilities have backup generators.	1	1	All	High	Property owners	$150,000	Property owners	2023	In-Progress – Carry Forward	New facilities are being encouraged to include generators. Existing facilities without generators are financially constrained and have little ability to add generators.
ES-3	Require, in the contract, that fuel suppliers have backup generators.	3	1	All	High	Wake Forest Administration, Finance, and Public Works	$25,000	General Fund	2024	In-Progress – Carry Forward	This is the Town's current policy and we continue to monitor new contracts for compliance.
ES-4	Adopt and Implement an Emergency Operations Plan	3	2	All	High	Wake Forest Administration	$100,000	General Fund	2021	New	A draft EOP has been created; adoption expected in 2019
ES-5	Adopt a SARA Title III Plan	4	2	All	Moderate	Wake Forest Fire Department	$150,000	General Fund	2023	New	Investigate the ability to create a SARA Title III Plan to have clearer knowledge and how to better handle chemical releases from facilities that could impact the town.
Public Education and Awareness											
PEA-1	Develop a policy and advise the public that all outside above ground LP or propane gas tanks be cut off during a major event.	1	1	All	Moderate	Wake Forest Communications	$10,000	General Fund	2020	In-Progress – Carry Forward	Past communications have included information advising the public of turning off propane tanks during a storm, but better outreach is needed to ensure this occurs. A policy should be put in place to ensure it is regularly communicated. Perhaps it can be included as part of the EOP.

Annex L Town of Wendell

L.1 PLANNING PROCESS

The table below lists the HMPC members who represented the Town of Wendell.

Table L.1 – HMPC Members

Agency	Representative	Position or Title
Planning Department	David Bergmark	Planning Director
Planning Department	Mackenzie Day	Planner
N/A	Jon Olson	Citizen Stakeholder

L.2 COMMUNITY PROFILE

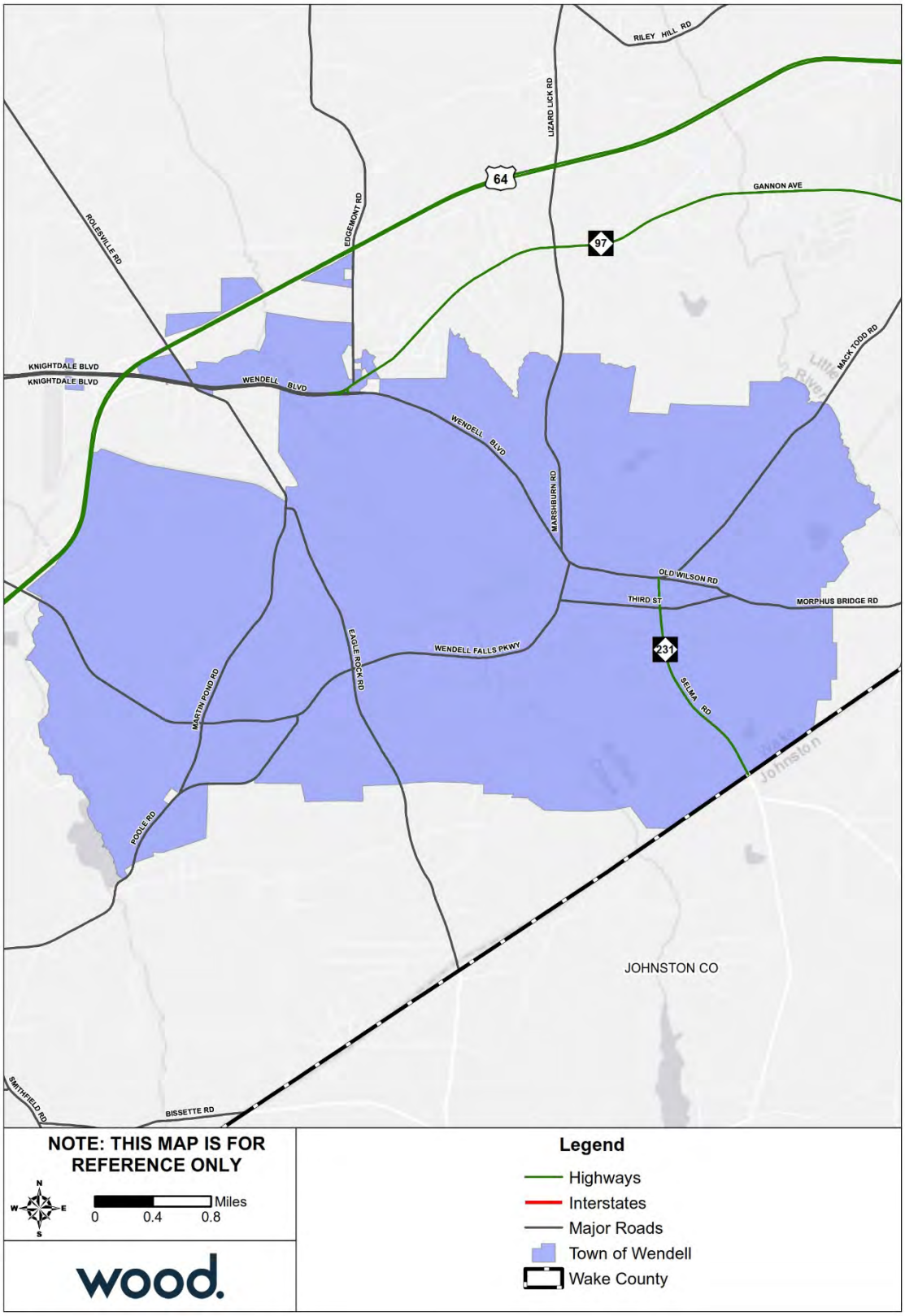
Geography

The Town of Wendell is located in eastern Wake County. It is neighbored by Knightdale to the west, Zebulon to the northeast, and Johnston County to the southeast. The Town is part of the Raleigh, NC Metropolitan Statistical Area, which falls within the larger Raleigh-Durham-Chapel Hill, NC Combined Statistical Area. Wendell comprises a total land area of 5.2 square miles.

According to data from the U.S. Fish and Wildlife Service's National Wetlands Inventory, there are approximately 1,549 acres of wetlands in Wendell.

Figure L.1 shows a base map of major transportation routes in the Town of Wendell.

Figure L.1 – Major Transportation Routes – Town of Wendell



Source: Wake County GIS Open Data

Population and Demographics

Table L.2 provides population counts and growth estimates for the Town of Wendell as compared to the County overall. Table L.3 provides demographic information for Wendell as compared to the whole County.

Table L.2 – Population Counts, Wendell, 2010-2017

Jurisdiction	2000 Census Population	2010 Census Population	2017 ACS Population Estimate	Total Change 2010-2017	% Change 2010-2017
Wake County total	**627,846**	**900,993**	**1,023,811**	**122,818**	**13.6%**
Town of Wendell	4,247	5,845	6,516	671	11.5%

Source: US Census Bureau Decennial Census 2000, Decennial Census 2010; American Community Survey 2013-2017 5-Year Estimates

Table L.3 – Racial Demographics, Wendell, 2017

Jurisdiction	White, %	Black, %	Asian, %	Other Race, %	Two or More Races, %	Persons of Hispanic or Latino Origin*, %
Wake County total	**66.5%**	**20.4%**	**6.5%**	**3.6%**	**2.7%**	**10.0%**
Town of Wendell	67.8%	19.4%	1.0%	3.6%	4.3%	12.9%

Source: US Census Bureau, American Community Survey 2013-2017 5-Year Estimates

*Persons of Hispanic origin may be of any race, so also are included in applicable race categories

Asset Inventory

The following tables summarize the asset inventory for Wendell in order to estimate the total physical exposure to hazards in this area. The locations of critical facilities are shown in Figure L.2 on the following page. Critical facilities are a subset of identified assets from the Critical Infrastructure & Key Resources dataset. Note that the counts are by building; where a critical facility comprises a cluster of buildings, each building is counted and displayed.

Table L.4 – Critical Infrastructure & Key Resources by Type

Jurisdiction	Food & Agriculture	Banking & Finance	Chemical	Commercial Facilities	Communications	Manufacturing	Defense	Government	Healthcare	IT	National Monuments	Nuclear	Postal & Shipping	Transportation	Energy	Emergency Services	Water	Other	Total
Town of Wendell	72	4	0	132	0	75	0	37	6	0	0	0	0	22	0	2	0	0	**350**

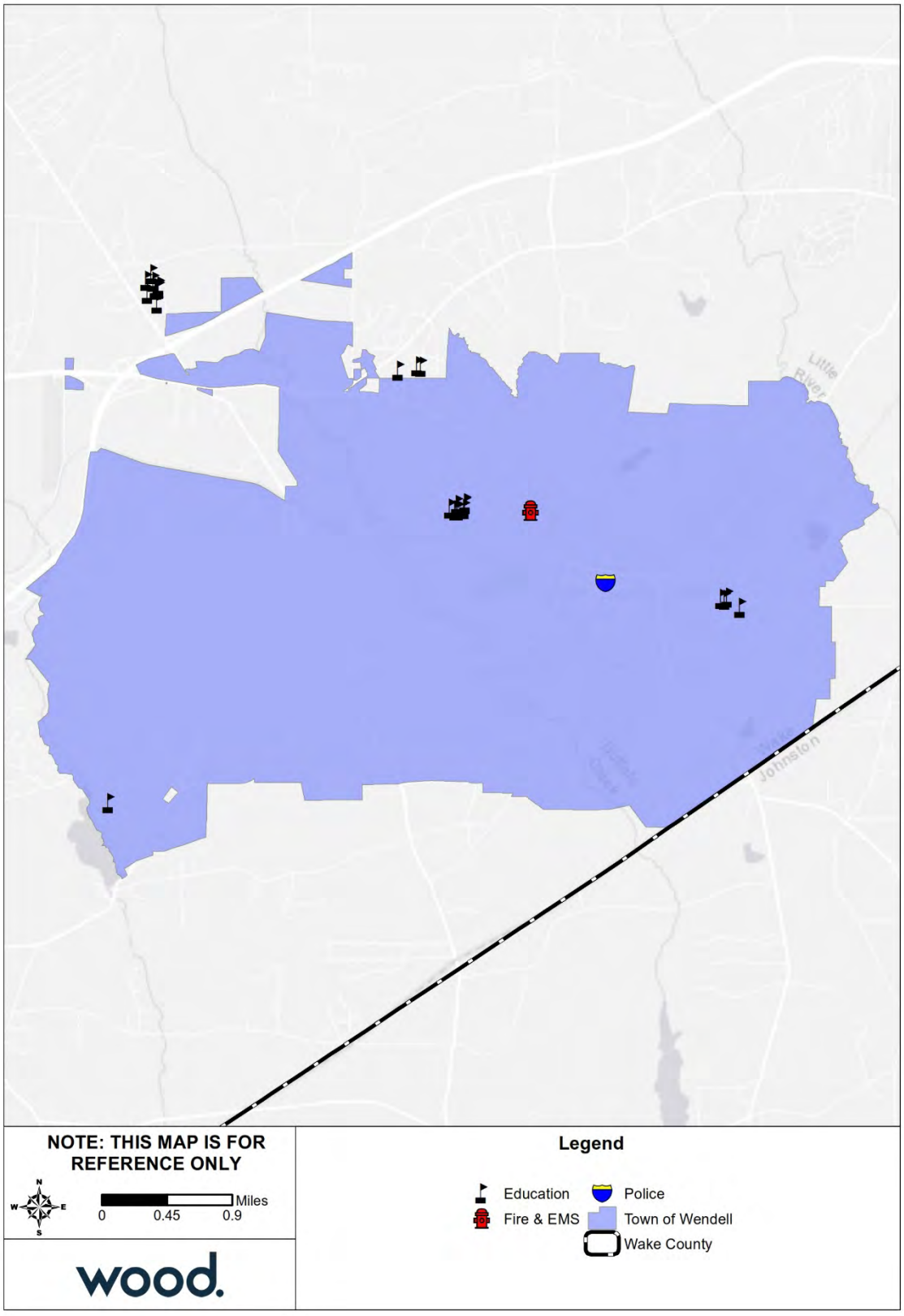
Source: NCEM Risk Management Tool

Table L.5 – High Potential Loss Facilities by Use

Jurisdiction	Residential	Commercial	Industrial	Government	Agricultural	Religious	Utilities	Other	Total
Town of Wendell	2	13	3	6	0	10	0	0	**34**

Source: NCEM Risk Management Tool

Figure L.2 – Critical Facilities, Town of Wendell



Source: NCEM IRISK Database, GIS Analysis

To supplement the asset inventory and provide a clearer picture of the current asset exposure in the Town of Wendell, current parcel data was evaluated to identify development since 2010. This information is not incorporated into the risk assessment, which was prepared using NCEM's IRISK database. However, this summary of development since 2010 provides some context to understand the degree to which the IRISK exposure and vulnerability numbers differ from current conditions.

Table L.6 provides a summary by land class of parcel development from January 2011 to April 2019.

Table L.6 – Parcels Developed 2011 or Later, Town of Wendell

Land Class	Number of Parcels	Sum of Building Value
Acres Greater Than 10 With House	2	$664,790
Agriculture	2	$181,123
Commercial	4	$5,349,812
EXEMPT	3	$1,864,053
HOA	1	-
Industrial	1	$923,086
Part Exempt	2	$632,131
Residential Less Than 10 Acres	729	$144,524,273
Grand Total	**744**	**$154,139,268**

Source: Wake County Open Data; retrieved April 8, 2019

There are six listings on the National Register of Historic Places for the Town of Fuquay-Varina, including two historic districts. These sites are listed in the table below.

Table L.7 – Historic Properties

Ref#	Property Name	Status Date	Category	City
98000947	Wendell Commercial Historic District	7/31/1998	District	Wendell
01000415	Riley Hill School	4/25/2001	Building	Wendell
01001113	Sunnyside	10/15/2001	Building	Wendell
03000928	Avera, Dr. Thomas H., House	9/11/2003	Building	Wendell
07001504	Harmony Plantation	1/29/2008	Building	Wendell
09000382	Wendell Boulevard Historic District	6/3/2009	District	Wendell

Source: National Parks Service, National Register of Historic Places, October 2018

Housing

The table below details key housing statistics for Wendell as compared to the County overall.

Table L.8 – Housing Statistics, Wendell, 2010-2017

Jurisdiction	Housing Units (2010)	Housing Units (2017)	Housing Units Percent Change (2010-2017)	Owner-Occupied, % (2017)	Vacant Units, % (2017)	Median Home Value (2017)
Wake County total	**371,836**	**411,632**	**10.7%**	**59.5%**	**7.2%**	**$250,700**
Town of Wendell	2,430	2,691	10.7%	64.8%	8.8%	$145,900

Source: U.S. Census Bureau 2010 Decennial Census, American Community Survey 2013-2017 5-Year Estimates
Note: Owner-Occupied and vacant-unit measures are reported as a percent of the total number of housing units.

Economy

The following tables present key economic statistics for Wendell as compared to the County overall.

Table L.9 – Employment Statistics, Wendell, 2017

Jurisdiction	Population in Labor Force	Percent Employed* (%)	Percent Unemployed* (%)	Percent Not in Labor Force* (%)	Unemployment Rate (%)
Wake County	**564,096**	**67.2**	**3.5**	**29.2**	**4.9**
Town of Wendell	2,939	60.5	1.7	37.9	2.7

Source: U.S. Census Bureau, American Community Survey 2013-2017 5-Year Estimates

Note: This table reports only the civilian labor force. The labor force in armed services accounted for 0.3% or less of the population 16 and over in all jurisdictions. *Population employed, population unemployed, and Population not in labor force are reported as a percent of the total population aged 16 years and older.

Table L.10 – Percent of Employed Population by Occupation, Wendell, 2017

Occupation	Management, business, science and arts (%)	Service (%)	Sales and Office (%)	Natural Resources, Construction, and Maintenance (%)	Production, transportation, and material moving (%)
Wake County	**50.1**	**13.8**	**23.4**	**6.0**	**6.7**
Town of Wendell	39.5	10.7	35.0	4.6	10.3

Source: U.S. Census Bureau, American Community Survey 2013-2017 5-Year Estimates

L.3 RISK ASSESSMENT

This section contains a hazard profile and vulnerability assessment for those hazards that were rated with a higher priority for the Town of Wendell than for Wake County as a whole. Risk and vulnerability findings are also presented here for those hazards that are spatially defined and have variations in risk that could be evaluated quantitatively on a jurisdictional level. The hazards included in this section are: Flood and Wildfire.

L.3.1 Flood

Table L.11 details the acreage of the Town of Wendell by flood zone on the effective DFIRM. Per this assessment, over 8 percent of the Town of Wendell falls within the mapped 1%-annual-chance floodplains.

Table L.11 – Flood Zone Acreage in the Town of Wendell

Flood Zone	Acreage	Percent of Total (%)
Zone A	19.15	0.20
Zone AE	814.47	8.39
Zone X (500-year)	102.78	1.06
Zone X Unshaded	8,774.84	90.36
Total	**9,711.24**	**--**

Source: FEMA Effective DFIRM; Wake County GIS

Figure L.3 reflects the effective mapped flood hazard zones for the Town of Wendell, and Figure L.4 displays the depth of flooding estimated to occur in these areas during the 1%-annual-chance flood.

To supplement the IRISK assessment of property at risk from the 1% annual chance flood event in Section 4 and provide a clearer picture of the current property at risk in Town of Wendell, current parcel data was evaluated to identify parcels developed since 2010. Using GIS analysis, parcels developed after 2010 were compared to the boundaries of the 1% annual chance floodplain to identify the exposure of newly developed property to the base flood. In most cases, a parcel was considered exposed to the floodplain if any portion of the parcel was located in the floodplain.

This assessment does not evaluate flood impacts or provide damage estimates. However, this summary of development in or near the floodplain since 2010 provides some context to understand the degree to which the IRISK exposure and vulnerability numbers differ from current conditions.

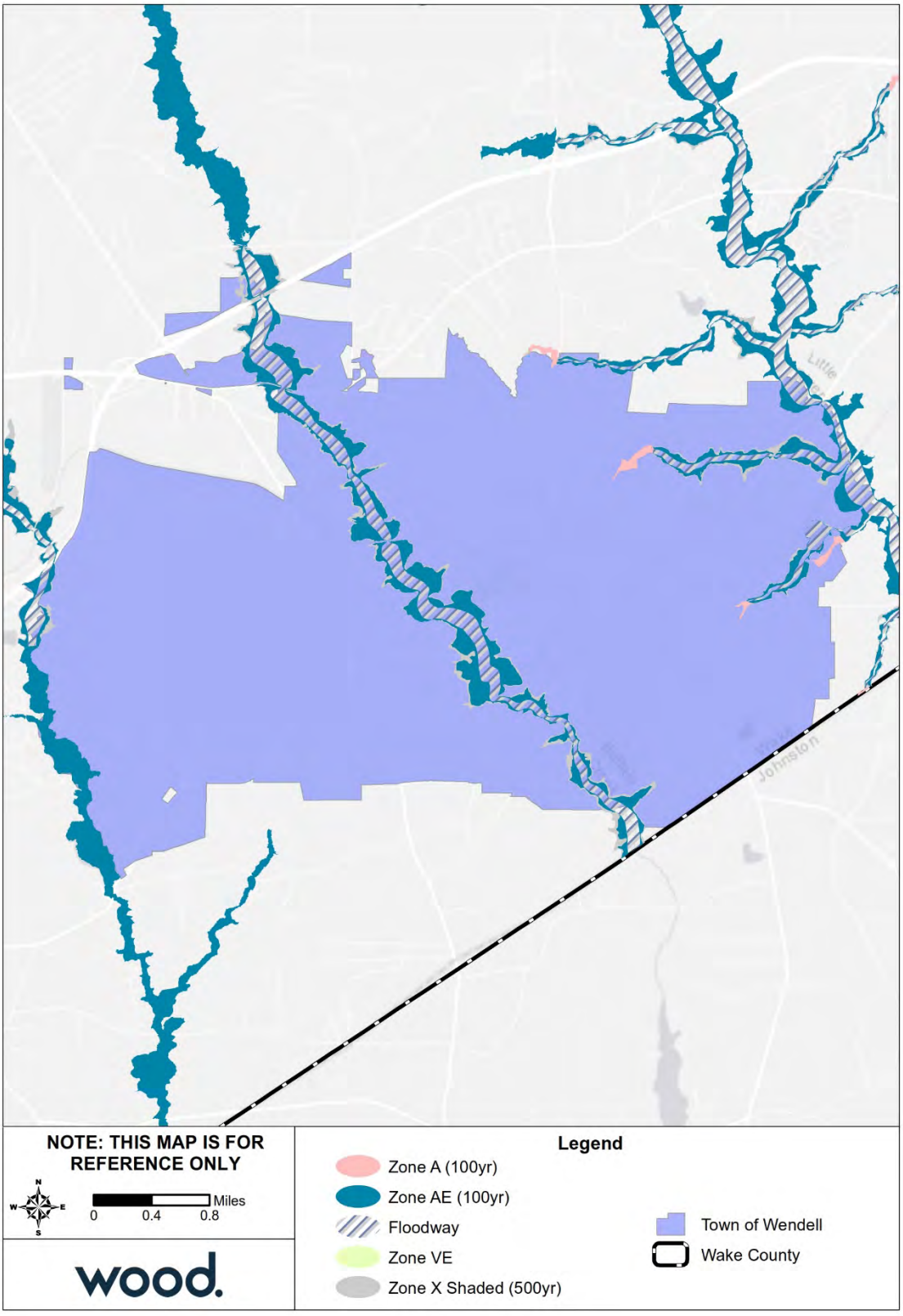
Table L.12 provides a summary by land class of parcel development located in the 1% annual chance floodplain from January 2011 to April 2019.

Table L.12 – Parcels Developed 2011 or Later and Located in 100-Year Floodplain, Town of Wendell

Land Class	Number of Parcels	Sum of Building Value
Acres Greater Than 10 With House	1	$229,734
Residential Less Than 10 Acres	22	$3,718,097
Grand Total	**23**	**$3,947,831**

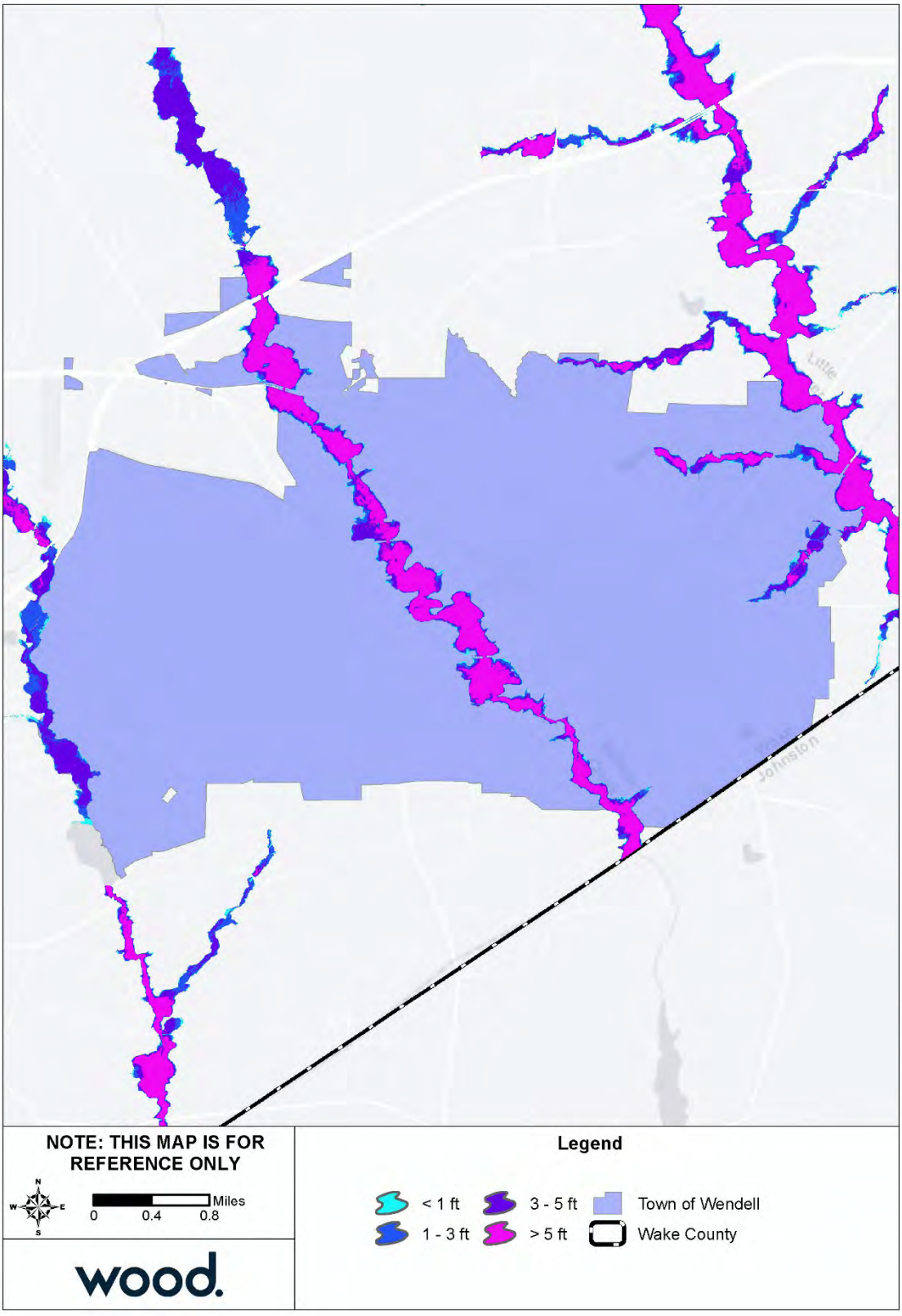
Source: Wake County Open Data; retrieved April 8, 2019; FEMA Effective DFIRM

Figure L.3 – FEMA Flood Hazard Areas, Town of Wendell



Source: FEMA Effective DFIRM

Figure L.4 – Flood Depth, 1%-Annual-Chance Floodplain, Town of Wendell



Source: FEMA Effective DFIRM

L.3.2 Wildfire

Table L.13 summarizes the acreage in the Town of Wendell that falls within the Wildland Urban Interface (WUI), categorized by housing density. Areas in the WUI are those where development may intermix with flammable vegetation. Over 20 percent of the Town of Wendell is not included in the WUI.

Table L.13 – Wildland Urban Interface Acreage, Town of Wendell

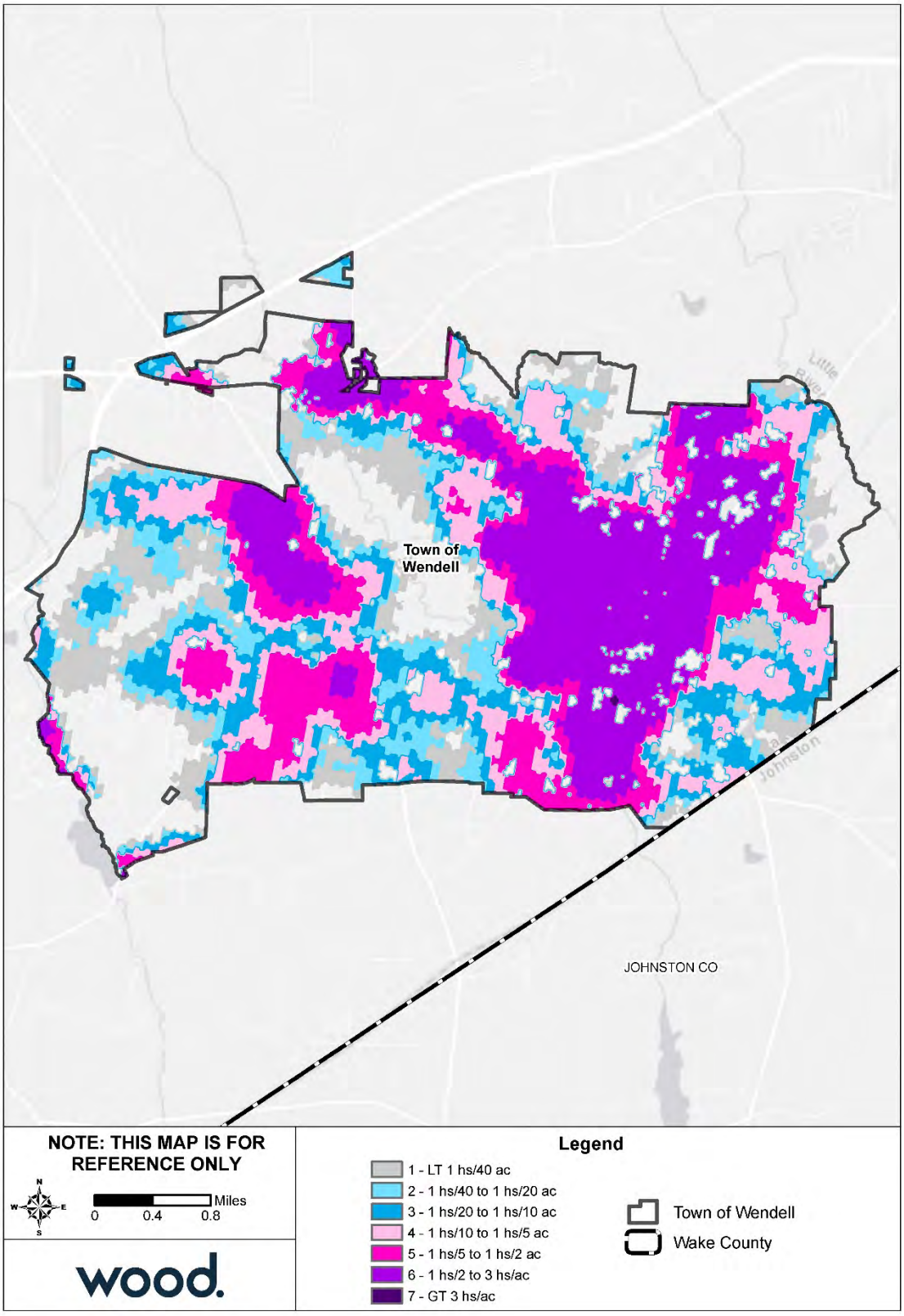
	Housing Density	Total Acreage	Percent of Total Acreage
	Not in WUI	*1,973.0*	*20.3%*
	LT 1hs/40ac	1,130.3	11.6%
	1hs/40ac to 1hs/20ac	774.1	8.0%
	1hs/20ac to 1hs/10ac	1,124.0	11.6%
	1hs/10ac to 1hs/5ac	1,265.8	13.0%
	1hs/5ac to 1hs/2ac	1,366.6	14.1%
	1hs/2ac to 3hs/1ac	2,070.3	21.3%
	GT 3hs/1ac	1.7	0.0%
	Total	115,066.8	

Source: Southern Wildfire Risk Assessment

Figure L.5 depicts the WUI for the Town of Wendell. The WUI is the area where housing development is built near or among areas of vegetation that may be prone to wildfire. Figure L.6 depicts the Fire Intensity Scale, which indicates the potential severity of fire based on fuel loads, topography, and other factors. Figure L.7 depicts Burn Probability based on landscape conditions, percentile weather, historical ignition patterns, and historical prevention and suppression efforts.

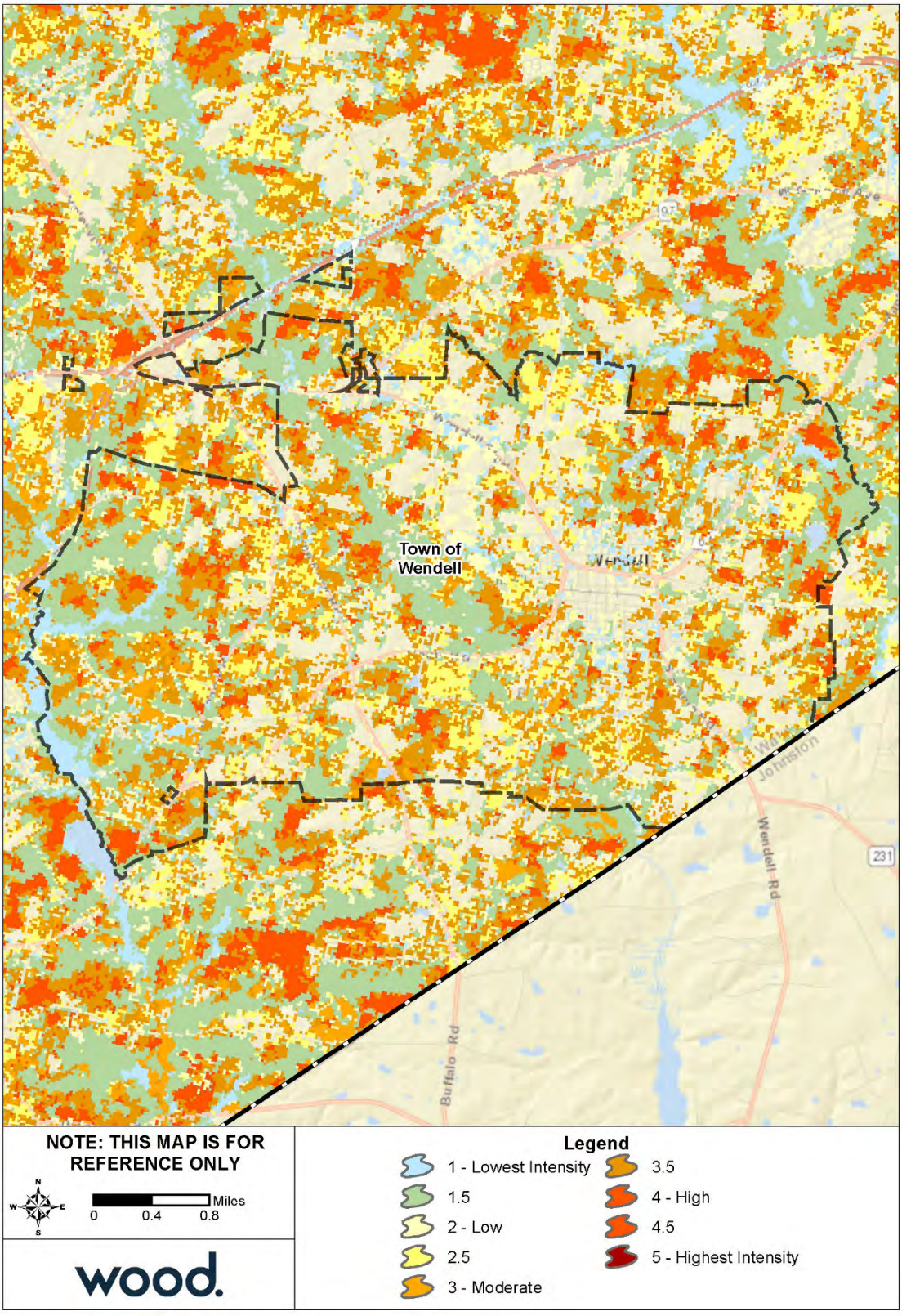
There are pockets of higher potential fire intensity throughout the Town of Wendell, none of which are too large. While some of these areas do fall within the WUI, the entirely of the Town has a relatively low burn probability.

Figure L.5 – Wildland Urban Interface, Town of Wendell



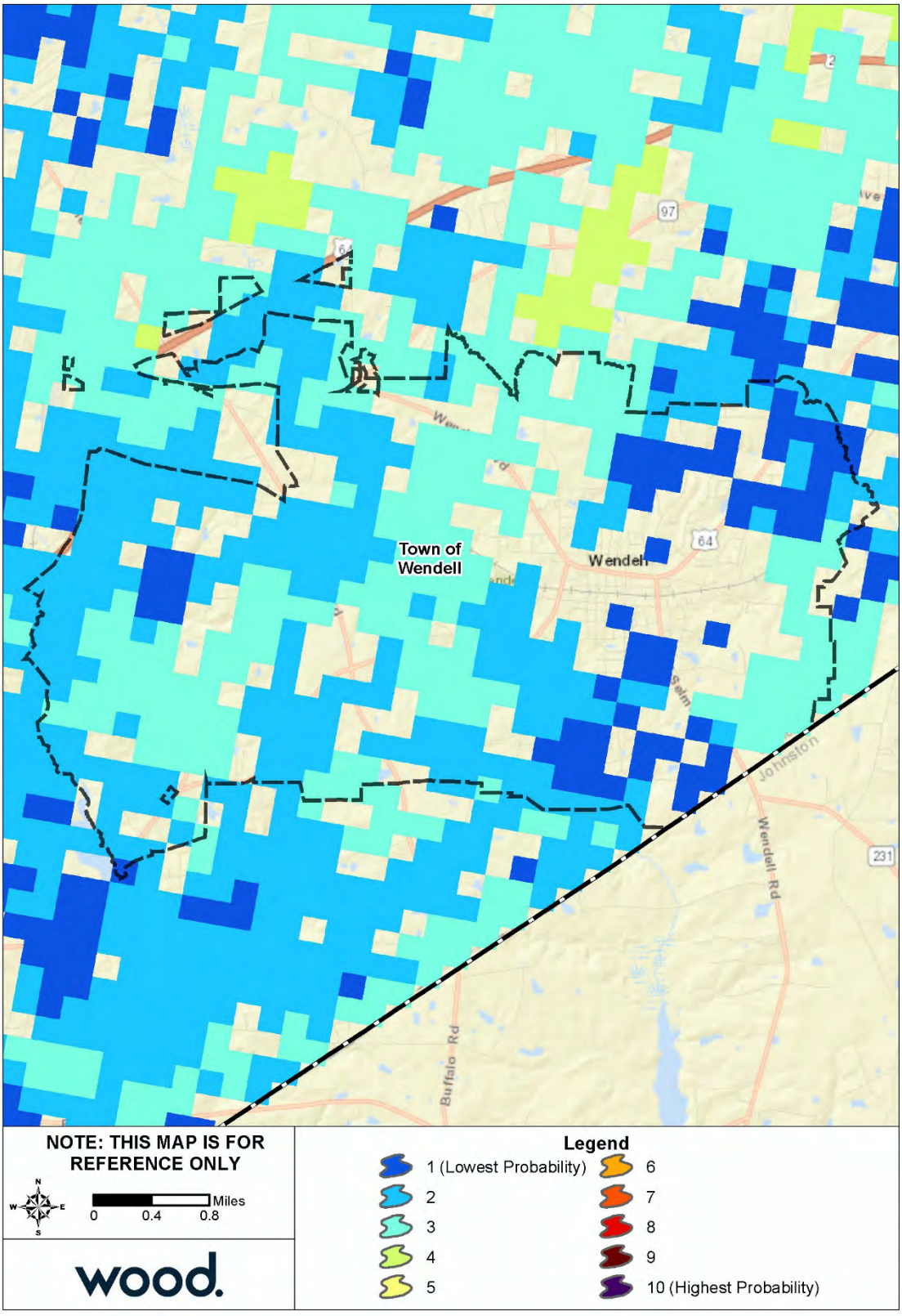
Source: Southern Wildfire Risk Assessment

Figure L.6 – Fire Intensity Scale, Town of Wendell



Source: Southern Wildfire Risk Assessment

Figure L.7 – Burn Probability, Town of Wendell



Source: Southern Wildfire Risk Assessment

L.4 CAPABILITY ASSESSMENT

L.4.1 Overall Capability

Details on the tools and resources in place and available to the Town of Wendell were provided by the Town's HMPC representatives and are summarized in Section 5 Capability Assessment. Based on that information and using the scoring methodology detailed in that section, Wendell has an overall capability rating of Limited. The Town's Self-Assessment of key capability areas is summarized in Table L.14 below.

Table L.14 – Capability Self-Assessment, Wendell

Capability Area	Rating
Plans, Ordinances, Codes and Programs	High
Administrative and Technical Capability	Moderate
Fiscal Capability	Limited
Education and Outreach Capability	Limited
Mitigation Capability	Limited
Political Capability	Limited
Overall Capability	Limited

L.4.2 Floodplain Management

The Town of Wendell joined the NFIP through emergency entry in January 1974 and has been a regular participant since June 1978. The following tables reflect NFIP policy and claims data for the Town categorized by structure type, flood zone, Pre-FIRM and Post-FIRM.

Table L.15 – NFIP Policy and Claims Data by Structure Type

Structure Type	Number of Policies in Force	Total Premium	Insurance in Force	Number of Closed Paid Losses	Total of Closed Paid Losses
Single Family	24	$11,725	$6,892,000	8	$144,907.36
2-4 Family	0	$0	$0	0	$0.00
All Other Residential	0	$0	$0	0	$0.00
Non-Residential	1	$4,211	$125,000	0	$0.00
Total	25	$15,936	$7,017,000	8	$144,907.36

Source: FEMA Community Information System, accessed November 2018

Table L.16 – NFIP Policy and Claims Data by Flood Zone

Flood Zone	Number of Policies in Force	Total Premium	Insurance in Force	Number of Closed Paid Losses	Total of Closed Paid Losses
A01-30 & AE Zones	12	$11,163	$3,062,000	5	$72,164.94
A Zones	0	$0	$0	0	$0.00
AO Zones	0	$0	$0	0	$0.00
AH Zones	0	$0	$0	0	$0.00
AR Zones	0	$0	$0	0	$0.00
A99 Zones	0	$0	$0	0	$0.00
V01-30 & VE Zones	0	$0	$0	0	$0.00
V Zones	0	$0	$0	0	$0.00
D Zones	0	$0	$0	0	$0.00
B, C & X Zone					

Flood Zone	Number of Policies in Force	Total Premium	Insurance in Force	Number of Closed Paid Losses	Total of Closed Paid Losses
Standard	0	$0	$0	0	$0.00
Preferred	13	$4,773	$3,955,000	3	$72,742.42
Total	25	$15,936	$7,017,000	8	$144,907.36

Source: FEMA Community Information System, accessed November 2018

Table L.17 – NFIP Policy and Claims Data Pre-FIRM

Flood Zone	Number of Policies in Force	Total Premium	Insurance in Force	Number of Closed Paid Losses	Total of Closed Paid Losses
A01-30 & AE Zones	2	$2,289	$209,000	4	$55,546.12
A Zones	0	$0	$0	0	$0.00
AO Zones	0	$0	$0	0	$0.00
AH Zones	0	$0	$0	0	$0.00
AR Zones	0	$0	$0	0	$0.00
A99 Zones	0	$0	$0	0	$0.00
V01-30 & VE Zones	0	$0	$0	0	$0.00
V Zones	0	$0	$0	0	$0.00
D Zones	0	$0	$0	0	$0.00
B, C & X Zone	5	$1,780	$1,365,000	1	$7,986.13
Standard	0	$0	$0	0	$0.00
Preferred	5	$1,780	$1,365,000	1	$7,986.13
Total	7	$4,069	$1,574,000	5	$63,532.25

Source: FEMA Community Information System, accessed November 2018

Table L.18 – NFIP Policy and Claims Data Post-FIRM

Flood Zone	Number of Policies in Force	Total Premium	Insurance in Force	Number of Closed Paid Losses	Total of Closed Paid Losses
A01-30 & AE Zones	10	$8,874	$2,853,000	1	$16,618.82
A Zones	0	$0	$0	0	$0.00
AO Zones	0	$0	$0	0	$0.00
AH Zones	0	$0	$0	0	$0.00
AR Zones	0	$0	$0	0	$0.00
A99 Zones	0	$0	$0	0	$0.00
V01-30 & VE Zones	0	$0	$0	0	$0.00
V Zones	0	$0	$0	0	$0.00
D Zones	0	$0	$0	0	$0.00
B, C & X Zone	8	$2,993	$2,590,000	2	$64,756.29
Standard	0	$0	$0	0	$0.00
Preferred	8	$2,993	$2,590,000	2	$64,756.29
Total	18	$11,867	$5,443,000	3	$81,375.11

Source: FEMA Community Information System, accessed November 2018

L.5 MITIGATION STRATEGY

Town of Wendell											
Action #	**Description**	**Goal**	**Objective**	**Hazard(s) Addressed**	**Relative Priority**	**Lead Agency/ Department**	**Estimated Cost**	**Potential Funding Sources**	**Implementation Schedule**	**2019 Status**	**Status Comments/Explanation**
Prevention											
P-1	Install generators as needed at lift stations.	3	2	All	High	City of Raleigh Public Utilities	To be determined	Internal	3-5 years	Not Started – Carry Forward	No funds were budgeted by CORPUD for this since 2014, but a new pump station is planned south of Hollybrook Rd, which would require a generator.
P-2	Amend the Town's Water Allocation Policy to add a new point category for voluntarily increasing undisturbed riparian buffer protections from 50 to 100 feet around Neuse perennial streams	4	1	Flood, Dam Failure, Hurricane	High	Wendell Planning	$0	N/A	1 year	New	N/A
P-3	Add environmentally sensitive and hazard areas to the Future Land Use Map and adopt updated Comprehensive Plan, which will allow environmental conditions and hazard areas to guide zoning and density decisions.	4	2	Flood, Dam Failure, Hazardous Materials Incident, Radiological Incident, Terrorism	High	Wendell Planning	$120,000	Town of Wendell	2-3 years	New	N/A
P-4	Consider amendments to the UDO to establish minimum ingress/egress standards for new residential development based on density/# of lots	4	1	Earthquake, Flood, Dam Failure, Hurricane, Wildfire, Tornado, Severe Winter Storm, Hazardous Materials Incident, Radiological Incident, Terrorism	High	Wendell Planning	$0	N/A	1 year	New	N/A
P-5	Encourage the use of low-impact development techniques through amendments to the Town's Water Allocation Policy	4	1	Flood, Dam Failure, Hurricane	High	Wendell Planning	$0	N/A	1 year	New	N/A
P-6	Consider regulations to regulate clear-cutting to help control erosion from construction sites	4	1	Flood, Drought	Moderate	Wendell Planning	$0	Town of Wendell	2-3 years	New	N/A
P-7	Evaluate potential changes to the Town's Arterial and Collector Street Plan to minimize adverse impacts to environmentally sensitive areas due to new roadway construction or widening	4	2	Flood	Moderate	Wendell Planning	$500	Town of Wendell	2-3 years	New	N/A
Natural Resource Protection											
NRP-1	Perform environmental asset mapping in order to identify areas most key for preservation and potential acquisition due to an array of environmental factors	2	2	Flood, Drought	Moderate	Wendell Planning	$10,000	Town of Wendell	2-3 years	New	N/A
NRP-2	Evaluate policy regarding greenway dedication requirements in order to expand greenway network and further protect riparian corridors	4	2	Flood	High	Wendell Planning	$0	Town of Wendell	2-3 years	New	N/A
Structural Projects											
SP-1	Perform improvements to existing open drainage device near intersection of 1st St & Pine St. to increase total water volume & flow	3	1	Flood	Moderate	Wendell Public Works	$5,000	Town of Wendell	3-5 years	New	N/A
Emergency Services											
ES-1	Make electrical improvements in the downtown in order to help ensure continuity of service during extreme weather	3	1	Severe Weather, Severe Winter Storm, Hurricane	High	Wendell Public Works	$5,000	Town of Wendell	2-3 years	New	N/A
ES-2	Develop Adverse Weather Plan Map for Public Works crew	2	1	Severe Weather, Severe Winter Storm, Hurricane	High	Wendell Planning	$0	N/A	1 year	New	N/A
ES-3	Evaluate potential locations for a future Public Works debris site, to accommodate debris associated with natural hazards	2	2	All	Moderate	Wendell Public Works	$0	Town of Wendell	3-5 years	New	N/A
ES-4	Provide written after-action report of response to severe weather and hazard events to include recommendations for process improvements and improve planning for future disasters	2	2	All	Moderate	Wendell Police Dept.	$0	Town of Wendell	2-3 years	New	N/A

Town of Wendell											
Action #	Description	Goal	Objective	Hazard(s) Addressed	Relative Priority	Lead Agency/ Department	Estimated Cost	Potential Funding Sources	Implementation Schedule	2019 Status	Status Comments/Explanation
ES-5	Secure and utilize visual warning barricades for vehicular and pedestrian traffic to block properties, roadways, etc. for public safety during or following hazard events	2	1	All	Moderate	Wendell Public Works	$2,000	Town of Wendell	3-5 years	New	N/A
ES-6	Conduct periodic training exercises, related to higher-risk hazard threats identified by the Hazard Mitigation Plan	2	2	All	Moderate	Wendell Police Dept.	$500	Town of Wendell	2-3 years	New	N/A
ES-7	Work with Wake County and the City of Raleigh to operate and update the County's Master Address Repository program, which will support emergency response following hazards.	2	2	All	High	Wendell Planning	$0	Town of Wendell	2-3 years	New	N/A
Public Education and Awareness											
PEA-1	Modify the Town's "Tell Wendell" webpage application to allow citizens to report flood issues and create a tracking mechanism for the Town	1	2	Flood	High	Wendell Planning	$0	Town of Wendell	2-3 years	New	N/A
PEA-2	Incorporate Hazard Awareness class into the Track-Out Camp run by the Wendell Parks & Recreation Dept.	1	1	Flood, Earthquake, Extreme Heat, Drought, Hurricane, Severe Weather, Severe Winter Storm, Tornado	Moderate	Wendell Parks and Recreation	$0	Town of Wendell	2-3 years	New	N/A
PEA-3	Post warning signage at local parks for lightning	1	2	Severe Weather	High	Wendell Parks and Recreation	$500	Town of Wendell	2-3 years	New	N/A
PEA-4	Facilitate community outreach and distribution of educational materials regarding hazard awareness to the community, to include participation at community events such as Public Safety Day.	1	1	All	Moderate	Wendell Public Works	$500	Town of Wendell	2-3 years	New	N/A
PEA-5	Perform Continuing Education Training for select Public Works personnel as it relates to state storm water regulations	2	2	Flood	High	Wendell Public Works	$1,200	Town of Wendell	2-3 years	New	N/A

Annex M Town of Zebulon

M.1 PLANNING PROCESS

The table below lists the HMPC members who represented the Town of Zebulon.

Table M.1 – HMPC Members

Agency	Representative	Position or Title
Public Works Department	Chris Ray	Public Works Director
Town of Zebulon	Joe Moore	Town Manager
Planning Department	Teresa Piner	Interim Planning Director
Planning Department	Meade Bradshaw	Assistant Planning Director

M.2 COMMUNITY PROFILE

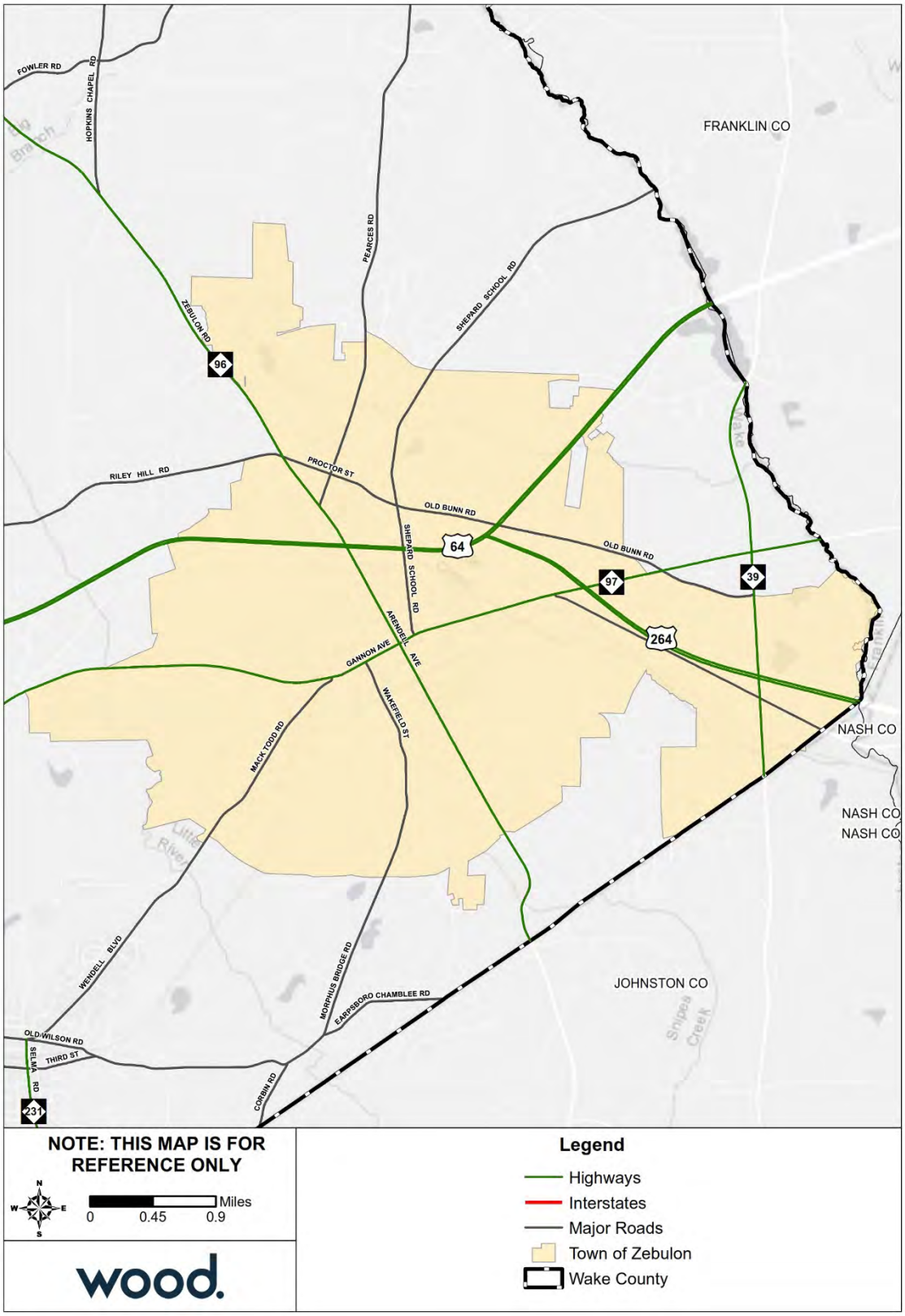
Geography

The Town of Zebulon is located in eastern Wake County. It is neighbored by Wendell to the southwest and Franklin, Nash, and Johnston Counties to the east. The Town is part of the Raleigh, NC Metropolitan Statistical Area, which falls within the larger Raleigh-Durham-Chapel Hill, NC Combined Statistical Area. Zebulon comprises a total land area of 4.1 square miles.

According to data from the U.S. Fish and Wildlife Service's National Wetlands Inventory, there are approximately 1,274 acres of wetlands in Zebulon.

Figure M.1 shows a base map of the major transportation routes in the Town of Zebulon.

Figure M.1 – Major Transportation Routes – Town of Zebulon



Source: Wake County GIS Open Data

Population and Demographics

Table M.2 provides population counts and growth estimates for the Town of Zebulon as compared to the County overall. Table M.3 provides demographic information for Zebulon as compared to the whole County.

Table M.2 – Population Counts, Zebulon, 2010-2017

Jurisdiction	2000 Census Population	2010 Census Population	2017 ACS Population Estimate	Total Change 2010-2017	% Change 2010-2017
Wake County total	**627,846**	**900,993**	**1,023,811**	**122,818**	**13.6%**
Town of Zebulon	4,046	4,433	4,943	510	11.5%

Source: US Census Bureau Decennial Census 2000, Decennial Census 2010; American Community Survey 2013-2017 5-Year Estimates

Table M.3 – Racial Demographics, Zebulon, 2017

Jurisdiction	White, %	Black, %	Asian, %	Other Race, %	Two or More Races, %	Persons of Hispanic or Latino Origin*, %
Wake County total	**66.5%**	**20.4%**	**6.5%**	**3.6%**	**2.7%**	**10.0%**
Town of Zebulon	50.0%	42.1%	1.2%	1.6%	5.1%	13.1%

Source: US Census Bureau American Community Survey 2013-2017 5-Year Estimates

*Persons of Hispanic origin may be of any race, so also are included in applicable race categories

Asset Inventory

The following tables summarize the asset inventory for Zebulon in order to estimate the total physical exposure to hazards in this area. The locations of critical facilities are shown in Figure M.2 on the following page. Critical facilities are a subset of identified assets from the Critical Infrastructure & Key Resources dataset. Note that the counts are by building; where a critical facility comprises a cluster of buildings, each building is counted and displayed.

Table M.4 – Critical Infrastructure & Key Resources by Type

Jurisdiction	Food & Agriculture	Banking & Finance	Chemical	Commercial Facilities	Communications	Manufacturing	Defense	Government	Healthcare	IT	National Monuments	Nuclear	Postal & Shipping	Transportation	Energy	Emergency Services	Water	Other	Total
Town of Zebulon	60	8	0	151	0	85	0	52	18	0	0	0	0	19	0	2	2	0	**397**

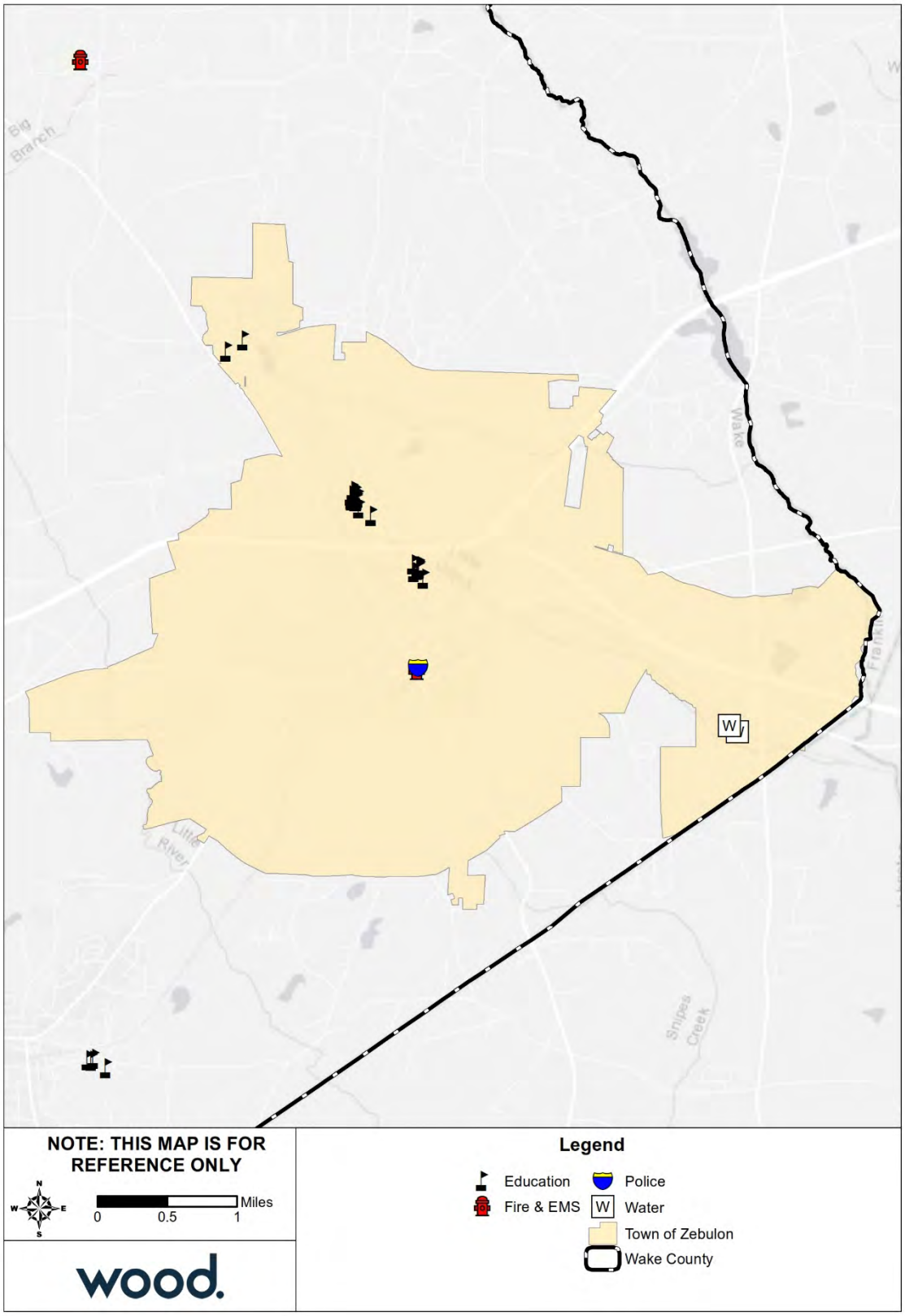
Source: NCEM Risk Management Tool

Table M.5 – High Potential Loss Facilities by Use

Jurisdiction	Residential	Commercial	Industrial	Government	Agricultural	Religious	Utilities	Other	Total
Town of Zebulon	3	21	15	16	0	5	2	0	**62**

Source: NCEM Risk Management Tool

Figure M.2 – Critical Facilities, Town of Zebulon



Source: NCEM IRISK Database, GIS Analysis

To supplement the asset inventory and provide a clearer picture of the current asset exposure in the Town of Zebulon, current parcel data was evaluated to identify development since 2010. This information is not incorporated into the risk assessment, which was prepared using NCEM's IRISK database. However, this summary of development since 2010 provides some context to understand the degree to which the IRISK exposure and vulnerability numbers differ from current conditions.

Table M.6 provides a summary by land class of parcel development from January 2011 to April 2019.

Table M.6 – Parcels Developed 2011 or Later, Town of Zebulon

Land Class	Number of Parcels	Sum of Building Value
Acres Greater Than 10 With House	2	$677,543
Commercial	5	$3,743,423
EXEMPT	2	$1,908,171
Industrial	2	$43,774,649
Residential Less Than 10 Acres	381	$65,244,585
Grand Total	**392**	**$115,348,371**

Source: Wake County Open Data; retrieved April 8, 2019

There are three listings on the National Register of Historic Places for the Town of Zebulon. These sites are listed in the table below.

Table M.7 – Historic Properties

Ref#	Property Name	Status Date	Category	City
76001345	Wakelon School	5/13/1976	Building	Zebulon
86000157	Bunn, Bennett, Plantation	2/4/1986	Building	Zebulon
07000881	Barbee, George and Neva, House	8/28/2007	Building	Zebulon

Source: National Parks Service, National Register of Historic Places, October 2018

Housing

The table below details key housing statistics for Zebulon as compared to the County overall.

Table M.8 – Housing Statistics, Zebulon, 2010-2017

Jurisdiction	Housing Units (2010)	Housing Units (2017)	Housing Units Percent Change (2010-2017)	Owner-Occupied, % (2017)	Vacant Units, % (2017)	Median Home Value (2017)
Wake County total	**371,836**	**411,632**	**10.7%**	**59.5%**	**7.2%**	**$250,700**
Town of Zebulon	1,862	1,790	-3.9%	52.1%	6.8%	$145,000

Source: U.S. Census Bureau 2010 Decennial Census, American Community Survey 2013-2017 5-Year Estimates
Note: Owner-Occupied and vacant-unit measures are reported as a percent of the total number of housing units.

Economy

The following tables present key economic statistics for Zebulon as compared to the County overall.

Table M.9 – Employment Statistics, Zebulon, 2017

Jurisdiction	Population in Labor Force	Percent Employed* (%)	Percent Unemployed* (%)	Percent Not in Labor Force* (%)	Unemployment Rate (%)
Wake County	**564,096**	**67.2**	**3.5**	**29.2**	**4.9**
Town of Zebulon	2,169	57.2	3.8	39.0	6.2

Source: U.S. Census Bureau, American Community Survey 2013-2017 5-Year Estimates

Note: This table reports only the civilian labor force. The labor force in armed services accounted for 0.3% or less of the population 16 and over in all jurisdictions. *Population employed, population unemployed, and Population not in labor force are reported as a percent of the total population aged 16 years and older.

Table M.10 – Percent of Employed Population by Occupation, Zebulon, 2017

Occupation	Management, business, science and arts (%)	Service (%)	Sales and Office (%)	Natural Resources, Construction, and Maintenance (%)	Production, transportation, and material moving (%)
Wake County	**50.1**	**13.8**	**23.4**	**6.0**	**6.7**
Town of Zebulon	35.0	22.9	20.9	8.4	12.7

Source: U.S. Census Bureau, American Community Survey 2013-2017 5-Year Estimates

M.3 RISK ASSESSMENT

This section contains a hazard profile and vulnerability assessment for those hazards that were rated with a higher priority for the Town of Zebulon than for Wake County as a whole. Risk and vulnerability findings are also presented here for those hazards that are spatially defined and have variations in risk that could be evaluated quantitatively on a jurisdictional level. The hazards included in this section are: Flood and Wildfire.

M.3.1 Flood

Table M.11 details the acreage of the Town of Zebulon by flood zone on the effective DFIRM. Per this assessment, over 7 percent of the Town of Zebulon falls within the mapped 1%-annual-chance floodplains.

Table M.11 – Flood Zone Acreage in the Town of Zebulon

Flood Zone	Acreage	Percent of Total (%)
Zone A	5.95	0.07
Zone AE	646.923	7.40
Zone X (500-year)	63.04	0.72
Zone X Unshaded	8,022.87	91.81
Total	**8,738.783**	--

Source: FEMA Effective DFIRM; Wake County GIS

Figure M.3 reflects the effective mapped flood hazard zones for the Town of Zebulon, and Figure M.4 displays the depth of flooding estimated to occur in these areas during the 1%-annual-chance flood.

To supplement the IRISK assessment of property at risk from the 1% annual chance flood event in Section 4 and provide a clearer picture of the current property at risk in PLACE, current parcel data was evaluated to identify parcels developed since 2010. Using GIS analysis, parcels developed after 2010 were compared to the boundaries of the 1% annual chance floodplain to identify the exposure of newly developed property to the base flood. In most cases, a parcel was considered exposed to the floodplain if any portion of the parcel was located in the floodplain.

This assessment does not evaluate flood impacts or provide damage estimates. However, this summary of development in or near the floodplain since 2010 provides some context to understand the degree to which the IRISK exposure and vulnerability numbers differ from current conditions.

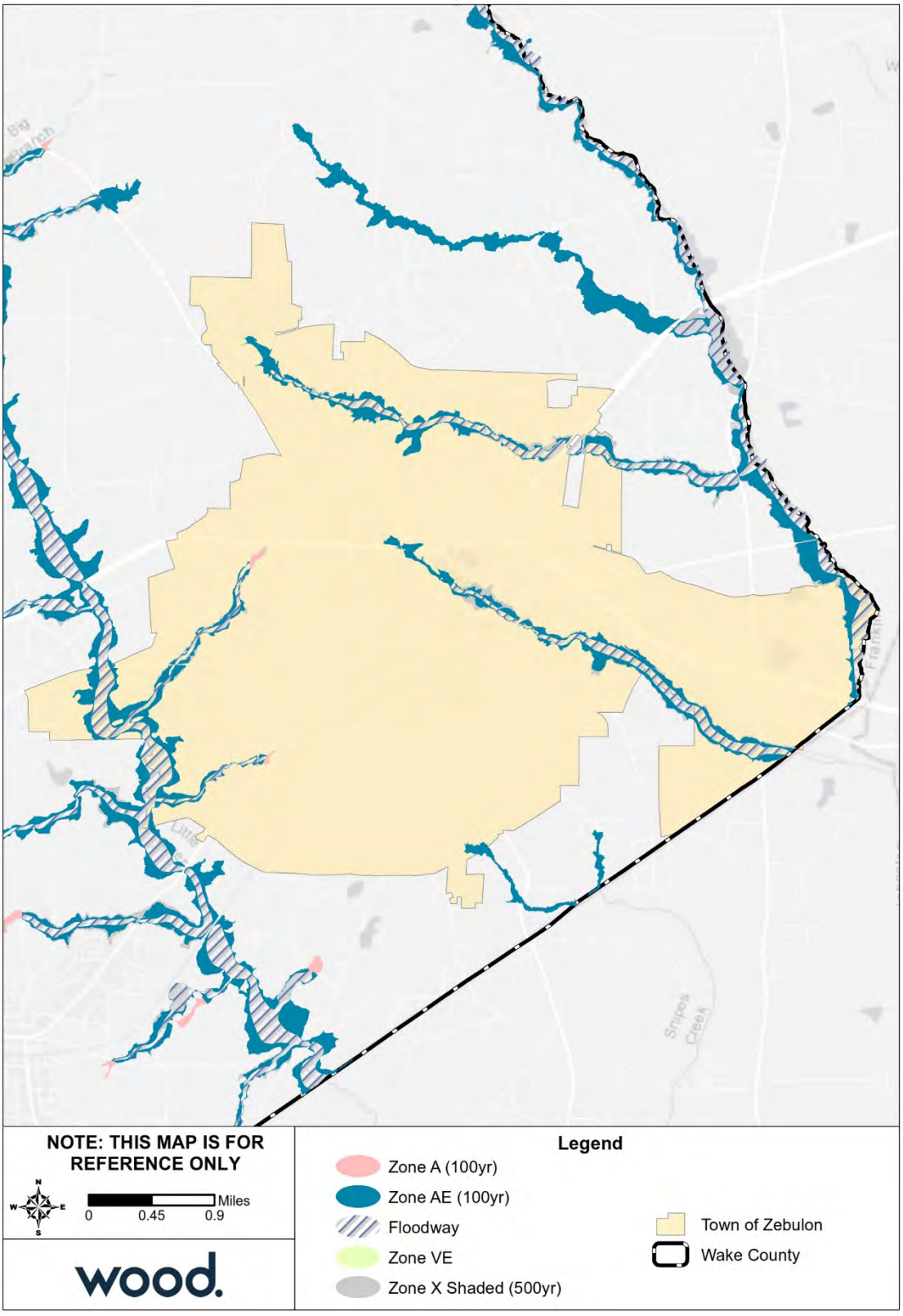
Table M.12 provides a summary by land class of parcel development located in the 1% annual chance floodplain from January 2011 to April 2019.

Table M.12 – Parcels Developed 2011 or Later and Located in 100-Year Floodplain

Land Class	Number of Parcels	Sum of Building Value
EXEMPT	1	-
Industrial	1	$1,156,500
Residential Less Than 10 Acres	4	$842,196
Grand Total	**6**	**$1,998,696**

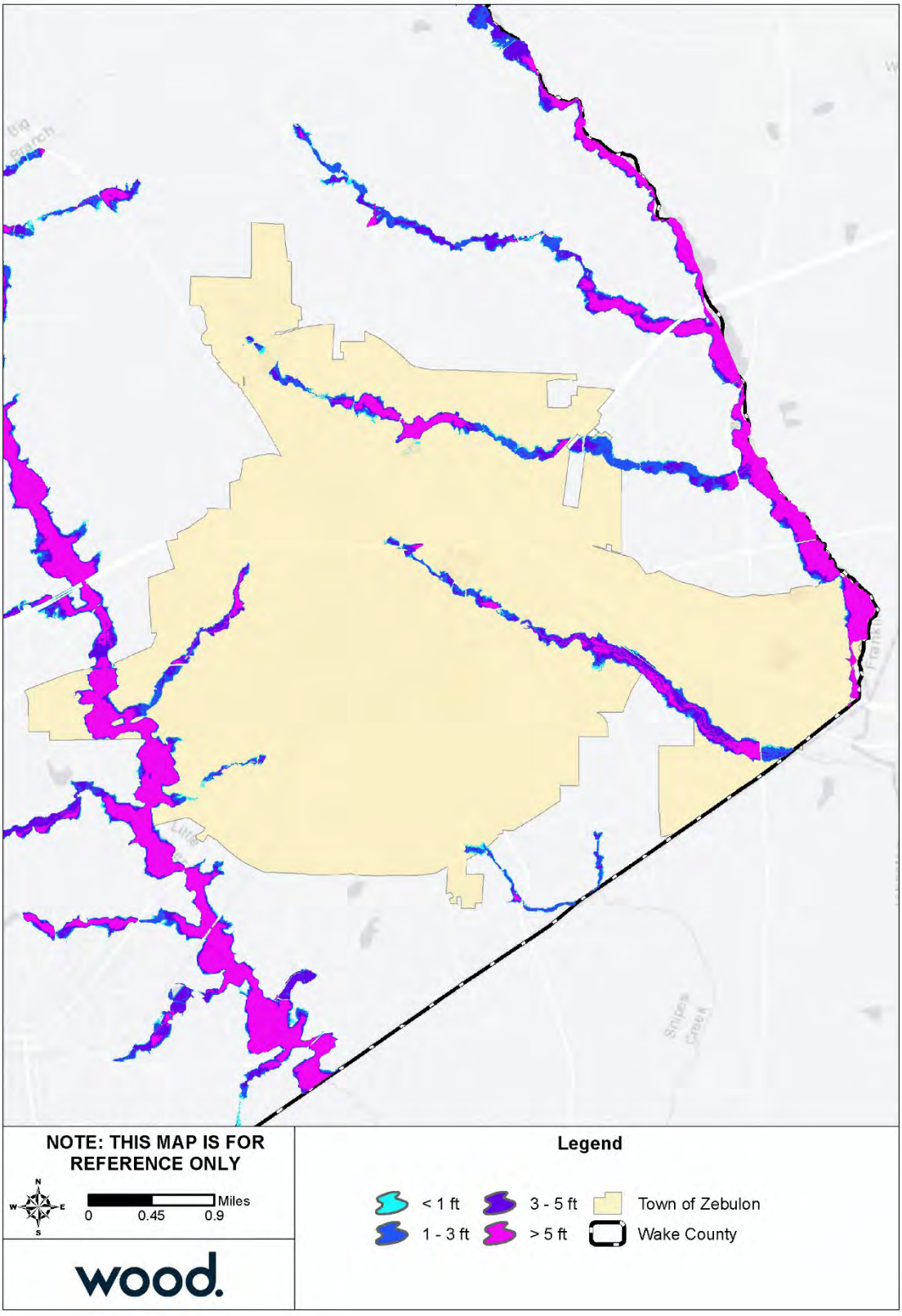
Source: Wake County Open Data; retrieved April 8, 2019; FEMA Effective DFIRM

Figure M.3 – FEMA Flood Hazard Areas, Town of Zebulon



Source: FEMA Effective DFIRM

Figure M.4 – Flood Depth, 1%-Annual-Chance Floodplain, Town of Zebulon



Source: FEMA Effective DFIRM

M.3.2 Wildfire

Table M.13 summarizes the acreage in the Town of Zebulon that falls within the Wildland Urban Interface (WUI), categorized by housing density. Areas in the WUI are those where development may intermix with flammable vegetation. 20 percent of the Town of Zebulon is not included in the WUI.

Table M.13 – Wildland Urban Interface Acreage, Town of Zebulon

	Housing Density	Total Acreage	Percent of Total Acreage
	Not in WUI	*1,747.8*	*20.0%*
	LT 1hs/40ac	1,200.3	13.8%
	1hs/40ac to 1hs/20ac	677.7	7.8%
	1hs/20ac to 1hs/10ac	932.6	10.7%
	1hs/10ac to 1hs/5ac	1,102.3	12.6%
	1hs/5ac to 1hs/2ac	1,471.9	16.9%
	1hs/2ac to 3hs/1ac	1,581.0	18.1%
	GT 3hs/1ac	7.2	0.1%
	Total	8,720.7	

Source: Southern Wildfire Risk Assessment

Figure M.5 depicts the WUI for the Town of Zebulon. The WUI is the area where housing development is built near or among areas of vegetation that may be prone to wildfire. Figure M.6 depicts the Fire Intensity Scale, which indicates the potential severity of fire based on fuel loads, topography, and other factors. Figure M.7 depicts Burn Probability based on landscape conditions, percentile weather, historical ignition patterns, and historical prevention and suppression efforts.

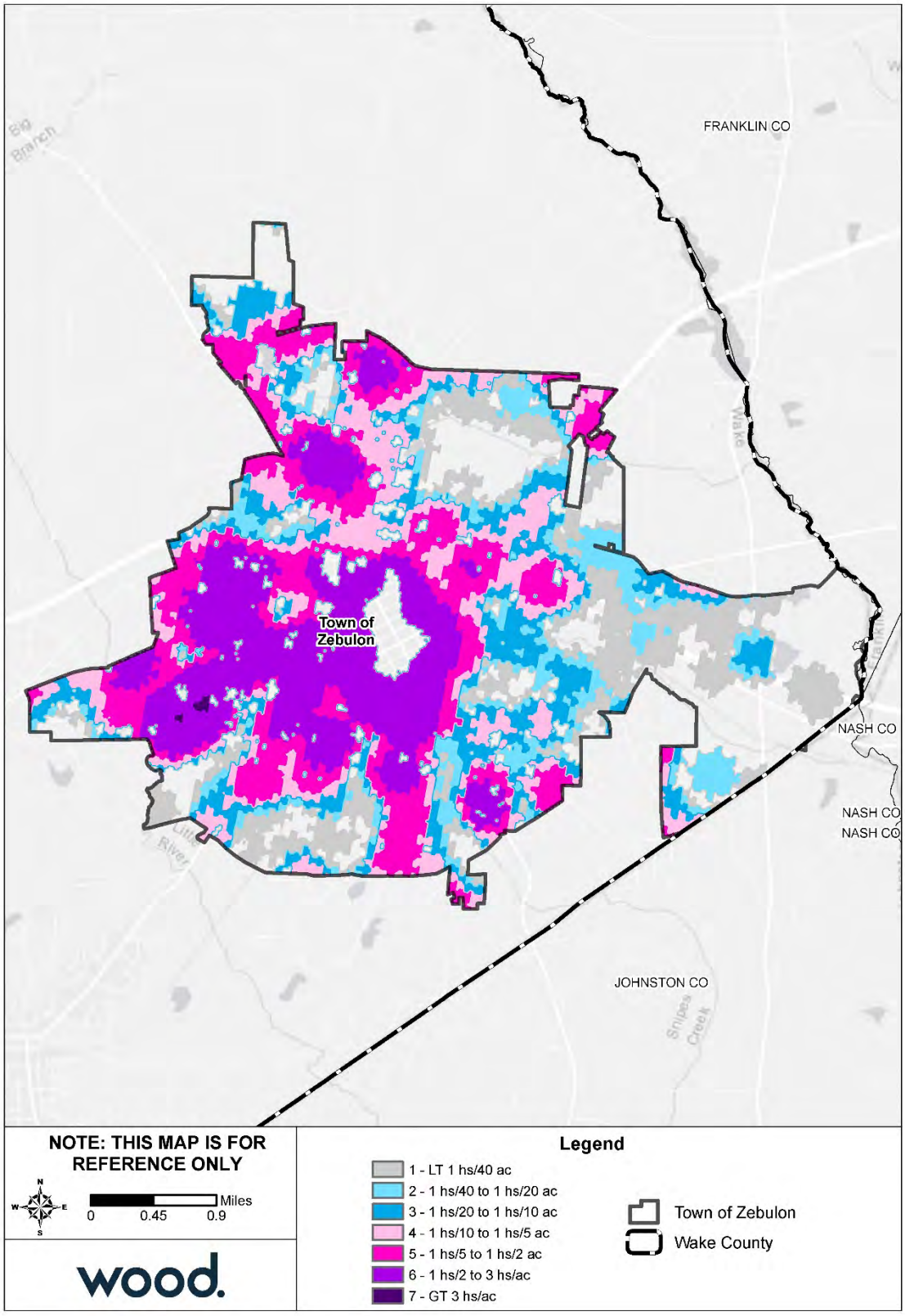
Potential fire intensity is highest in east and west Zebulon; however, these areas are largely outside of the WUI and have low burn probabilities. The area with the highest burn probability, in northwest Zebulon, does not overlay with high potential fire intensity and is partially outside of the WUI.

Table M.14 provides building counts and estimated damages for Critical Infrastructure and Key Resources (CIKR) buildings by sector at risk to wildfire hazard.

Table M.14 – Critical Facilities Exposed to Wildfire, Town of Knightdale

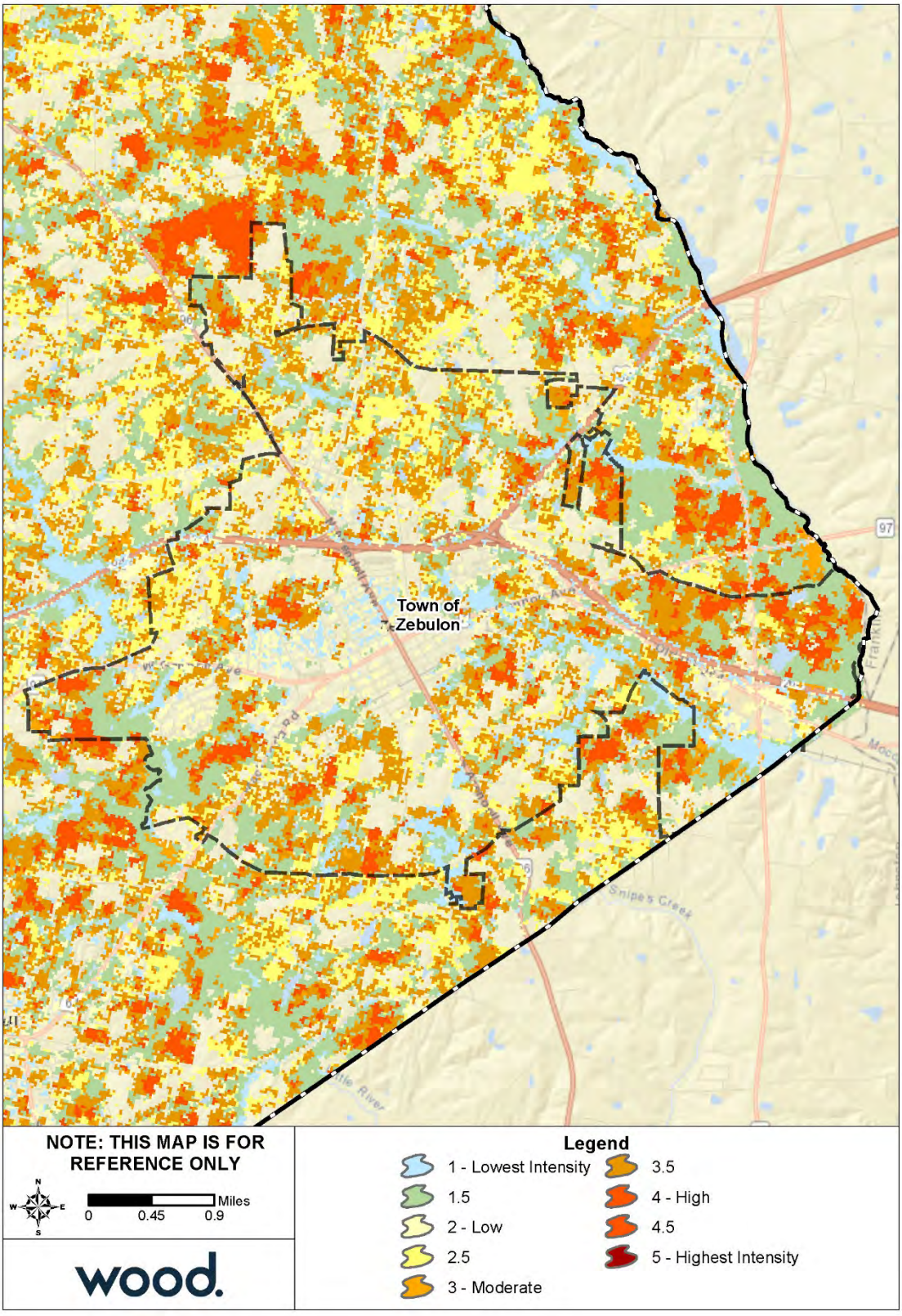
Sector	Event	Number of Buildings at Risk	Estimated Damages
Critical Manufacturing	Wildfire Hazard	1	$71,156
All Categories	**Wildfire Hazard**	**1**	**$71,156**

Figure M.5 – Wildland Urban Interface, Town of Zebulon



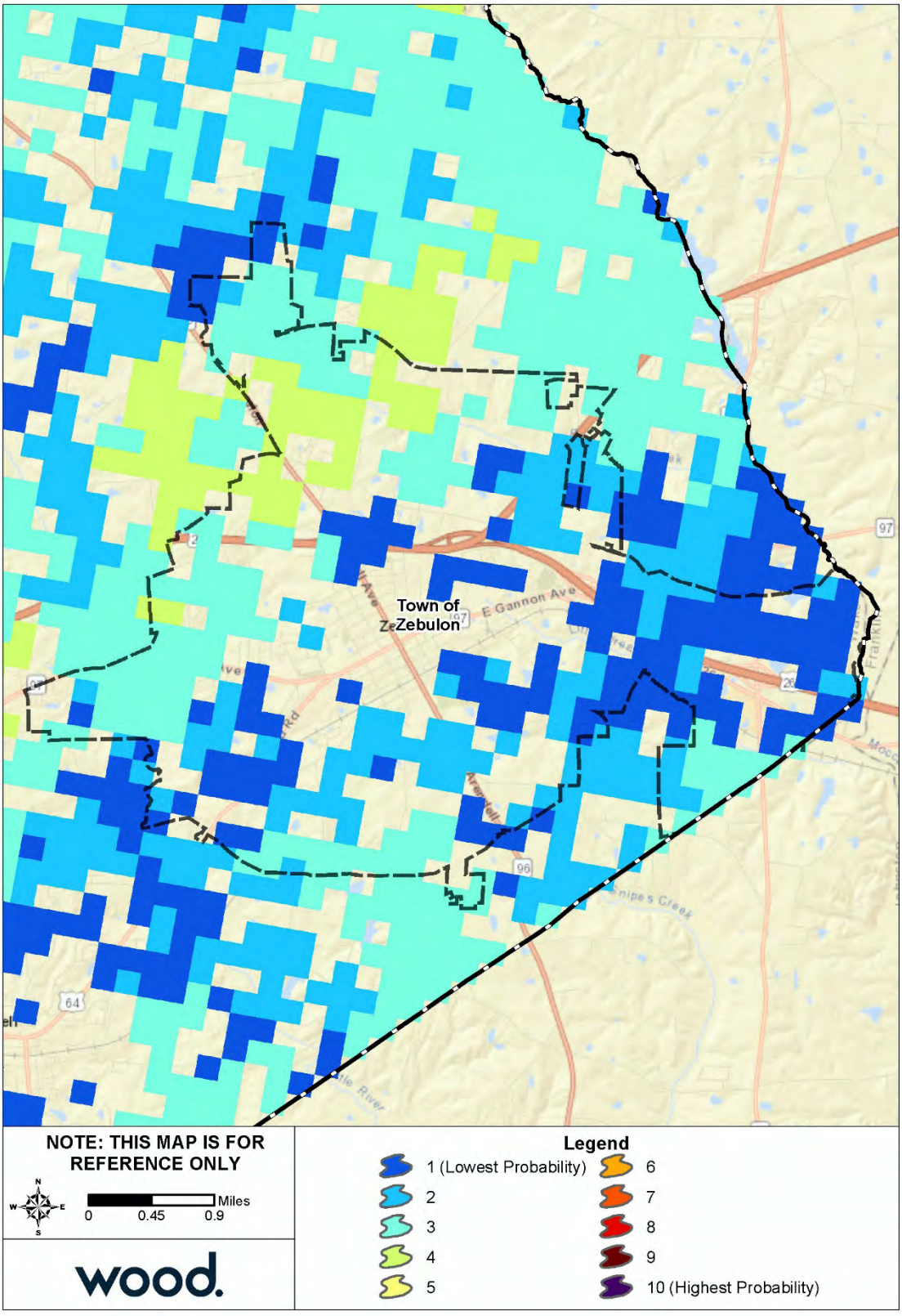
Source: Southern Wildfire Risk Assessment

Figure M.6 – Fire Intensity Scale, Town of Zebulon



Source: Southern Wildfire Risk Assessment

Figure M.7 – Burn Probability, Town of Zebulon



Source: Southern Wildfire Risk Assessment

M.4 CAPABILITY ASSESSMENT

M.4.1 Overall Capability

Details on the tools and resources in place and available to the Town of Zebulon were provided by the Town's HMPC representatives and are summarized in Section 5 Capability Assessment. Based on that information and using the scoring methodology detailed in that section, Zebulon has an overall capability rating of Moderate. The Town's Self-Assessment of key capability areas is summarized in Table M.15 below.

Table M.15 – Capability Self-Assessment, Zebulon

Capability Area	Rating
Plans, Ordinances, Codes and Programs	Moderate
Administrative and Technical Capability	Moderate
Fiscal Capability	Moderate
Education and Outreach Capability	Moderate
Mitigation Capability	Limited
Political Capability	Moderate
Overall Capability	Moderate

M.4.2 Floodplain Management

The Town of Zebulon joined the NFIP through emergency entry in August 1974 and has been a regular participant since July 1978. The following tables reflect NFIP policy and claims data for the Town categorized by structure type, flood zone, Pre-FIRM and Post-FIRM.

Table M.16 – NFIP Policy and Claims Data by Structure Type

Structure Type	Number of Policies in Force	Total Premium	Insurance in Force	Number of Closed Paid Losses	Total of Closed Paid Losses
Single Family	28	$11,775	$5,471,600	8	$173,307.69
2-4 Family	0	$0	$0	0	$0.00
All Other Residential	0	$0	$0	0	$0.00
Non-Residential	0	$0	$0	2	$13,757.62
Total	28	$11,775	$5,471,600	10	$187,065.31

Source: FEMA Community Information System, accessed November 2018

Table M.17 – NFIP Policy and Claims Data by Flood Zone

Flood Zone	Number of Policies in Force	Total Premium	Insurance in Force	Number of Closed Paid Losses	Total of Closed Paid Losses
A01-30 & AE Zones	18	$8,406	$2,616,600	4	$48,093.86
A Zones	0	$0	$0	0	$0.00
AO Zones	0	$0	$0	0	$0.00
AH Zones	0	$0	$0	0	$0.00
AR Zones	0	$0	$0	0	$0.00
A99 Zones	0	$0	$0	0	$0.00
V01-30 & VE Zones	0	$0	$0	0	$0.00
V Zones	0	$0	$0	0	$0.00
D Zones	0	$0	$0	0	$0.00

Flood Zone	Number of Policies in Force	Total Premium	Insurance in Force	Number of Closed Paid Losses	Total of Closed Paid Losses
B, C & X Zone					
Standard	0	$0	$0	3	$14,133.86
Preferred	10	$3,369	$2,855,000	3	$124,837.59
Total	28	$11,775	$5,471,600	10	$187,065.31

Source: FEMA Community Information System, accessed November 2018

Table M.18 – NFIP Policy and Claims Data Pre-FIRM

Flood Zone	Number of Policies in Force	Total Premium	Insurance in Force	Number of Closed Paid Losses	Total of Closed Paid Losses
A01-30 & AE Zones	0	$0	$0	1	$44,120.87
A Zones	0	$0	$0	0	$0.00
AO Zones	0	$0	$0	0	$0.00
AH Zones	0	$0	$0	0	$0.00
AR Zones	0	$0	$0	0	$0.00
A99 Zones	0	$0	$0	0	$0.00
V01-30 & VE Zones	0	$0	$0	0	$0.00
V Zones	0	$0	$0	0	$0.00
D Zones	0	$0	$0	0	$0.00
B, C & X Zone	1	$300	$175,000	4	$79,347.69
Standard	0	$0	$0	3	$14,133.86
Preferred	1	$300	$175,000	1	$65,213.83
Total	1	$300	$175,000	5	$123,468.56

Source: FEMA Community Information System, accessed November 2018

Table M.19 – NFIP Policy and Claims Data Post-FIRM

Flood Zone	Number of Policies in Force	Total Premium	Insurance in Force	Number of Closed Paid Losses	Total of Closed Paid Losses
A01-30 & AE Zones	18	$8,406	$2,616,600	3	$3,972.99
A Zones	0	$0	$0	0	$0.00
AO Zones	0	$0	$0	0	$0.00
AH Zones	0	$0	$0	0	$0.00
AR Zones	0	$0	$0	0	$0.00
A99 Zones	0	$0	$0	0	$0.00
V01-30 & VE Zones	0	$0	$0	0	$0.00
V Zones	0	$0	$0	0	$0.00
D Zones	0	$0	$0	0	$0.00
B, C & X Zone	9	$3,069	$2,680,000	2	$59,623.76
Standard	0	$0	$0	0	$0.00
Preferred	9	$3,069	$2,680,000	2	$59,623.76
Total	27	$11,475	$5,296,600	5	$63,596.75

Source: FEMA Community Information System, accessed November 2018

M.5 MITIGATION STRATEGY

Town of Zebulon											
Action #	**Description**	**Goal**	**Objective**	**Hazard(s) Addressed**	**Relative Priority**	**Lead Agency/ Department**	**Estimated Cost**	**Potential Funding Sources**	**Implementation Schedule**	**2019 Status**	**Status Comments/Explanation**
Prevention											
P-1	Prepare Plan maintenance report.	2	2	All	High	Zebulon Planning Department	Staff time	Town of Zebulon	2019, Annually	Not Started – Carry Forward	Plan maintenance meetings have been held annually and will continue to be held going forward.
P-2	Enforce subdivision standards for development in flood hazard areas.	3	2	Flood	High	Zebulon Planning & Inspections	Staff time	Town of Zebulon, Wake County	2019	In-Progress – Carry Forward	UDO Revision is in final stages.
P-3	Further restrict development in floodplain by prohibiting development or requiring 2 feet of freeboard.	3	2	Flood	High	Zebulon Planning	Staff time	Town of Zebulon	2019	In-Progress – Carry Forward	UDO Revision is in final stages.
P-4	Revise floodplain ordinance.	4	1	Flood	High	Zebulon Planning	Staff time	Town of Zebulon	2019	In-Progress – Carry Forward	UDO Revision is in final stages.
P-5	Require burial of power lines for new developments.	3	1	Hurricane, Tornadoes, Winter Storms/ Freezes	Moderate	Zebulon Planning	Unknown	Town of Zebulon	2019	In-Progress – Carry Forward	UDO Revision is in final stages.
Structural Projects											
SP-1	Resolve localize flooding issue that occurs in/around West Sycamore Streets, Gannon Avenue, and North Arendell Avenue during heavy rainfall events.	3	2	Flood	Moderate	Zebulon Administration, Zebulon Public Works	$900,000	Town of Zebulon	2020	New	The town has completed design and permitting of project improvements and is currently acquiring easements.
Emergency Services											
ES-1	Develop an Emergency Operations Plan	2	2	All	Moderate	Zebulon Fire Department	TBD	Town of Zebulon	2019	New	The Town has been in the process of developing an Emergency Operations Plan and hopes to adopt the plan within the year.
Public Education and Awareness											
PEA-3	Require disclosure of flood hazard in real estate transactions.	1	1	Flood	Moderate	Zebulon Planning Department	Little to no cost	Town of Zebulon	2019	In-Progress – Carry Forward	N/A
PEA-2	Develop a public education program to provide hazard risk and preparedness education via social media	1	1	All	High	Zebulon Fire Department	Staff time	Town of Zebulon	2019	New	The Town is currently using social media for some public education but will formalize a program for hazards awareness.

Appendix A Plan Review Tool

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LOCAL MITIGATION PLAN REVIEW TOOL

The *Local Mitigation Plan Review Tool* demonstrates how the Local Mitigation Plan meets the regulation in 44 CFR §201.6 and offers States and FEMA Mitigation Planners an opportunity to provide feedback to the community.

- The Regulation Checklist provides a summary of FEMA's evaluation of whether the Plan has addressed all requirements.
- The Plan Assessment identifies the plan's strengths as well as documents areas for future improvement.
- The Multi-jurisdiction Summary Sheet is an optional worksheet that can be used to document how each jurisdiction met the requirements of the each Element of the Plan (Planning Process; Hazard Identification and Risk Assessment; Mitigation Strategy; Plan Review, Evaluation, and Implementation; and Plan Adoption).

The FEMA Mitigation Planner must reference this *Local Mitigation Plan Review Guide* when completing the *Local Mitigation Plan Review Tool*.

<table>
<tr><td>Jurisdiction:
Wake County, NC</td><td colspan="2">Title of Plan: Wake County Multi-Jurisdictional Hazard Mitigation Plan</td><td>Date of Plan:
July 2019</td></tr>
<tr><td colspan="2">Local Point of Contact:
David Stroud</td><td colspan="2" rowspan="3">Address:
4021 Stirrup Creek Drive, Suite 100
Durham, NC 27703</td></tr>
<tr><td colspan="2">Title:</td></tr>
<tr><td colspan="2">Agency:</td></tr>
<tr><td colspan="2">Phone Number:
919-856-6485</td><td colspan="2">E-Mail:
David.stroud@woodplc.com</td></tr>
</table>

State Reviewer:	**Title:**	**Date:**

FEMA Reviewer:	**Title:**	
Date Received in FEMA Region ***(insert #)***		
Plan Not Approved		
Plan Approvable Pending Adoption		
Plan Approved		

SECTION 1:
REGULATION CHECKLIST

INSTRUCTIONS: The Regulation Checklist must be completed by FEMA. The purpose of the Checklist is to identify the location of relevant or applicable content in the Plan by Element/sub-element and to determine if each requirement has been 'Met' or 'Not Met.' The 'Required Revisions' summary at the bottom of each Element must be completed by FEMA to provide a clear explanation of the revisions that are required for plan approval. Required revisions must be explained for each plan sub-element that is 'Not Met.' Sub-elements should be referenced in each summary by using the appropriate numbers (A1, B3, etc.), where applicable. Requirements for each Element and sub-element are described in detail in this *Plan Review Guide* in Section 4, Regulation Checklist.

1. REGULATION CHECKLIST **Regulation** (44 CFR 201.6 Local Mitigation Plans)	**Location in Plan (section and/or page number)**	**Met**	**Not Met**
ELEMENT A. PLANNING PROCESS			
A1. Does the Plan document the planning process, including how it was prepared and who was involved in the process for each jurisdiction? (Requirement §201.6(c)(1))	Section 2 (p. 4-23)		
A2. Does the Plan document an opportunity for neighboring communities, local and regional agencies involved in hazard mitigation activities, agencies that have the authority to regulate development as well as other interests to be involved in the planning process? (Requirement §201.6(b)(2))	Section 2 (p. 7-8, 14); Appendix B (p.B.46-B.47)		
A3. Does the Plan document how the public was involved in the planning process during the drafting stage? (Requirement §201.6(b)(1))	Section 2 (p. 13-14); Appendix B (p.B.24-B.45)		
A4. Does the Plan describe the review and incorporation of existing plans, studies, reports, and technical information? (Requirement §201.6(b)(3))	Section 2 (p. 7-8)		
A5. Is there discussion of how the community(ies) will continue public participation in the plan maintenance process? (Requirement §201.6(c)(4)(iii))	Section 8 (p. 260)		
A6. Is there a description of the method and schedule for keeping the plan current (monitoring, evaluating and updating the mitigation plan within a 5-year cycle)? (Requirement §201.6(c)(4)(i))	Section 8 (p. 256-260)		
ELEMENT A: REQUIRED REVISIONS			

1. REGULATION CHECKLIST **Regulation** (44 CFR 201.6 Local Mitigation Plans)	Location in Plan (section and/or page number)	Met	Not Met
ELEMENT B. HAZARD IDENTIFICATION AND RISK ASSESSMENT			
B1. Does the Plan include a description of the type, location, and extent of all natural hazards that can affect each jurisdiction(s)? (Requirement §201.6(c)(2)(i))	Section 4.5 (p. 61-209; Hazard Description, Location, Extent, Hazard Summary by Jurisdiction), Annex A-M		
B2. Does the Plan include information on previous occurrences of hazard events and on the probability of future hazard events for each jurisdiction? (Requirement §201.6(c)(2)(i))	Section 4.5 (p. 61-209; Past Occurrences, Probability of Future Occurrence, Hazard Summary by Jurisdiction),		
B3. Is there a description of each identified hazard's impact on the community as well as an overall summary of the community's vulnerability for each jurisdiction? (Requirement §201.6(c)(2)(ii))	Section 4.5 (p. 61-209; Vulnerability Assessment, Hazard Summary by Jurisdiction), Annex A-M		
B4. Does the Plan address NFIP insured structures within the jurisdiction that have been repetitively damaged by floods? (Requirement §201.6(c)(2)(ii))	Section 4.5.5 (p.114)		
ELEMENT B: REQUIRED REVISIONS			
ELEMENT C. MITIGATION STRATEGY			
C1. Does the plan document each jurisdiction's existing authorities, policies, programs and resources and its ability to expand on and improve these existing policies and programs? (Requirement §201.6(c)(3))	Section 5 (p. 210-225)		
C2. Does the Plan address each jurisdiction's participation in the NFIP and continued compliance with NFIP requirements, as appropriate? (Requirement §201.6(c)(3)(ii))	Section 5 (p. 216-217)		
C3. Does the Plan include goals to reduce/avoid long-term vulnerabilities to the identified hazards? (Requirement §201.6(c)(3)(i))	Section 6 (p.226-228)		
C4. Does the Plan identify and analyze a comprehensive range of specific mitigation actions and projects for each jurisdiction being considered to reduce the effects of hazards, with emphasis on new and existing buildings and infrastructure? (Requirement §201.6(c)(3)(ii))	Section 6 (p. 229-230), Section 7 (p. 231-255)		
C5. Does the Plan contain an action plan that describes how the actions identified will be prioritized (including cost benefit review), implemented, and administered by each jurisdiction? (Requirement §201.6(c)(3)(iv)); (Requirement §201.6(c)(3)(iii))	Section 6 (p. 229-230), Section 7 (p. 231-255)		

1. REGULATION CHECKLIST **Regulation** (44 CFR 201.6 Local Mitigation Plans)	Location in Plan (section and/or page number)	Met	Not Met
C6. Does the Plan describe a process by which local governments will integrate the requirements of the mitigation plan into other planning mechanisms, such as comprehensive or capital improvement plans, when appropriate? (Requirement §201.6(c)(4)(ii))	Section 8 (p.256-257)		
ELEMENT C: REQUIRED REVISIONS			
ELEMENT D. PLAN REVIEW, EVALUATION, AND IMPLEMENTATION (applicable to plan updates only)			
D1. Was the plan revised to reflect changes in development? (Requirement §201.6(d)(3))	Section 3 (p. 24-45), Section 4 (p. 54-209; Asset Inventory, Vulnerability Assessment), Annex A-M		
D2. Was the plan revised to reflect progress in local mitigation efforts? (Requirement §201.6(d)(3))	Section 2 (p. 14-23), Section 5 (p.210-225)		
D3. Was the plan revised to reflect changes in priorities? (Requirement §201.6(d)(3))	Section 6 (p. 229-230), Section 7 (p. 231-255)		
ELEMENT D: REQUIRED REVISIONS			
ELEMENT E. PLAN ADOPTION			
E1. Does the Plan include documentation that the plan has been formally adopted by the governing body of the jurisdiction requesting approval? (Requirement §201.6(c)(5))	Plan will be adopted pending APA letter from FEMA; Adoption resolutions will be added to Section 9		
E2. For multi-jurisdictional plans, has each jurisdiction requesting approval of the plan documented formal plan adoption? (Requirement §201.6(c)(5))	Plan will be adopted pending APA letter from FEMA; Adoption resolutions will be added to Section 9		
ELEMENT E: REQUIRED REVISIONS			
ELEMENT F. ADDITIONAL STATE REQUIREMENTS (OPTIONAL FOR STATE REVIEWERS ONLY; NOT TO BE COMPLETED BY FEMA)			
F1.			
F2.			

1. REGULATION CHECKLIST **Regulation** (44 CFR 201.6 Local Mitigation Plans)	Location in Plan (section and/or page number)	Met	Not Met
ELEMENT F: REQUIRED REVISIONS			

SECTION 2:
PLAN ASSESSMENT

INSTRUCTIONS: The purpose of the Plan Assessment is to offer the local community more comprehensive feedback to the community on the quality and utility of the plan in a narrative format. The audience for the Plan Assessment is not only the plan developer/local community planner, but also elected officials, local departments and agencies, and others involved in implementing the Local Mitigation Plan. The Plan Assessment must be completed by FEMA. The Assessment is an opportunity for FEMA to provide feedback and information to the community on: 1) suggested improvements to the Plan; 2) specific sections in the Plan where the community has gone above and beyond minimum requirements; 3) recommendations for plan implementation; and 4) ongoing partnership(s) and information on other FEMA programs, specifically RiskMAP and Hazard Mitigation Assistance programs. The Plan Assessment is divided into two sections:

1. Plan Strengths and Opportunities for Improvement
2. Resources for Implementing Your Approved Plan

Plan Strengths and Opportunities for Improvement is organized according to the plan Elements listed in the Regulation Checklist. Each Element includes a series of italicized bulleted items that are suggested topics for consideration while evaluating plans, but it is not intended to be a comprehensive list. FEMA Mitigation Planners are not required to answer each bullet item, and should use them as a guide to paraphrase their own written assessment (2-3 sentences) of each Element.

The Plan Assessment must not reiterate the required revisions from the Regulation Checklist or be regulatory in nature, and should be open-ended and to provide the community with suggestions for improvements or recommended revisions. The recommended revisions are suggestions for improvement and are not required to be made for the Plan to meet Federal regulatory requirements. The italicized text should be deleted once FEMA has added comments regarding strengths of the plan and potential improvements for future plan revisions. It is recommended that the Plan Assessment be a short synopsis of the overall strengths and weaknesses of the Plan (no longer than two pages), rather than a complete recap section by section.

Resources for Implementing Your Approved Plan provides a place for FEMA to offer information, data sources and general suggestions on the overall plan implementation and maintenance process. Information on other possible sources of assistance including, but not limited to, existing publications, grant funding or training opportunities, can be provided. States may add state and local resources, if available.

A. Plan Strengths and Opportunities for Improvement

This section provides a discussion of the strengths of the plan document and identifies areas where these could be improved beyond minimum requirements.

Element A: Planning Process

How does the Plan go above and beyond minimum requirements to document the planning process with respect to:

- *Involvement of stakeholders (elected officials/decision makers, plan implementers, business owners, academic institutions, utility companies, water/sanitation districts, etc.);*
- *Involvement of Planning, Emergency Management, Public Works Departments or other planning agencies (i.e., regional planning councils);*
- *Diverse methods of participation (meetings, surveys, online, etc.); and*
- *Reflective of an open and inclusive public involvement process.*

Element B: Hazard Identification and Risk Assessment

In addition to the requirements listed in the Regulation Checklist, 44 CFR 201.6 Local Mitigation Plans identifies additional elements that should be included as part of a plan's risk assessment. The plan should describe vulnerability in terms of:

1) *A general description of land uses and future development trends within the community so that mitigation options can be considered in future land use decisions;*
2) *The types and numbers of existing and future buildings, infrastructure, and critical facilities located in the identified hazard areas; and*
3) *A description of potential dollar losses to vulnerable structures, and a description of the methodology used to prepare the estimate.*

How does the Plan go above and beyond minimum requirements to document the Hazard Identification and Risk Assessment with respect to:

- *Use of best available data (flood maps, HAZUS, flood studies) to describe significant hazards;*
- *Communication of risk on people, property, and infrastructure to the public (through tables, charts, maps, photos, etc.);*
- *Incorporation of techniques and methodologies to estimate dollar losses to vulnerable structures;*
- *Incorporation of Risk MAP products (i.e., depth grids, Flood Risk Report, Changes Since Last FIRM, Areas of Mitigation Interest, etc.); and*
- *Identification of any data gaps that can be filled as new data became available.*

Element C: Mitigation Strategy

How does the Plan go above and beyond minimum requirements to document the Mitigation Strategy with respect to:

- *Key problems identified in, and linkages to, the vulnerability assessment;*
- *Serving as a blueprint for reducing potential losses identified in the Hazard Identification and Risk Assessment;*
- *Plan content flow from the risk assessment (problem identification) to goal setting to mitigation action development;*
- *An understanding of mitigation principles (diversity of actions that include structural projects, preventative measures, outreach activities, property protection measures, post-disaster actions, etc);*
- *Specific mitigation actions for each participating jurisdictions that reflects their unique risks and capabilities;*
- *Integration of mitigation actions with existing local authorities, policies, programs, and resources; and*
- *Discussion of existing programs (including the NFIP), plans, and policies that could be used to implement mitigation, as well as document past projects.*

Element D: Plan Update, Evaluation, and Implementation (*Plan Updates Only*)

How does the Plan go above and beyond minimum requirements to document the 5-year Evaluation and Implementation measures with respect to:

- *Status of previously recommended mitigation actions;*
- *Identification of barriers or obstacles to successful implementation or completion of mitigation actions, along with possible solutions for overcoming risk;*
- *Documentation of annual reviews and committee involvement;*
- *Identification of a lead person to take ownership of, and champion the Plan;*
- *Reducing risks from natural hazards and serving as a guide for decisions makers as they commit resources to reducing the effects of natural hazards;*
- *An approach to evaluating future conditions (i.e. socio-economic, environmental, demographic, change in built environment etc.);*
- *Discussion of how changing conditions and opportunities could impact community resilience in the long term; and*
- *Discussion of how the mitigation goals and actions support the long-term community vision for increased resilience.*

B. Resources for Implementing Your Approved Plan

Ideas may be offered on moving the mitigation plan forward and continuing the relationship with key mitigation stakeholders such as the following:

- *What FEMA assistance (funding) programs are available (for example, Hazard Mitigation Assistance (HMA)) to the jurisdiction(s) to assist with implementing the mitigation actions?*
- *What other Federal programs (National Flood Insurance Program (NFIP), Community Rating System (CRS), Risk MAP, etc.) may provide assistance for mitigation activities?*
- *What publications, technical guidance or other resources are available to the jurisdiction(s) relevant to the identified mitigation actions?*
- *Are there upcoming trainings/workshops (Benefit-Cost Analysis (BCA), HMA, etc.) to assist the jurisdictions(s)?*
- *What mitigation actions can be funded by other Federal agencies (for example, U.S. Forest Service, National Oceanic and Atmospheric Administration (NOAA), Environmental Protection Agency (EPA) Smart Growth, Housing and Urban Development (HUD) Sustainable Communities, etc.) and/or state and local agencies?*

SECTION 3:
MULTI-JURISDICTION SUMMARY SHEET (OPTIONAL)

INSTRUCTIONS: For multi-jurisdictional plans, a Multi-jurisdiction Summary Spreadsheet may be completed by listing each participating jurisdiction, which required Elements for each jurisdiction were 'Met' or 'Not Met,' and when the adoption resolutions were received. This Summary Sheet does not imply that a mini-plan be developed for each jurisdiction; it should be used as an optional worksheet to ensure that each jurisdiction participating in the Plan has been documented and has met the requirements for those Elements (A through E).

MULTI-JURISDICTION SUMMARY SHEET													
#	Jurisdiction Name	Jurisdiction Type (city/borough/ township/ village, etc.)	Plan POC	Mailing Address	Email	Phone	Requirements Met (Y/N)					
							A. Planning Process	B. Hazard Identification & Risk Assessment	C. Mitigation Strategy	D. Plan Review, Evaluation & Implementation	E. Plan Adoption	F. State Require-ments
1	Wake County	County										
2	Raleigh	City										
3	Apex	Town										
4	Cary	Town										
5	Fuquay-Varina	Town										
6	Garner	Town										
7	Holly Springs	Town										
8	Knightdale	Town										
9	Morrisville	Town										

MULTI-JURISDICTION SUMMARY SHEET													
#	Jurisdiction Name	Jurisdiction Type (city/borough/ township/ village, etc.)	Plan POC	Mailing Address	Email	Phone	Requirements Met (Y/N)					
							A. Planning Process	B. Hazard Identification & Risk Assessment	C. Mitigation Strategy	D. Plan Review, Evaluation & Implementation	E. Plan Adoption	F. State Require-ments
10	Rolesville	Town										
11	Wake Forest	Town										
12	Wendell	Town										
13	Zebulon	Town										

Appendix B Planning Process Documentation

PLANNING STEP 1: ORGANIZE TO PREPARE THE PLAN

Table B.1 – HMPC Meeting Topics, Dates, and Locations

Meeting Title	Meeting Topic	Meeting Date	Meeting Location
HMPC Mtg. #1 – Project Kick-Off	1) Introduction to DMA, CRS, and FMA requirements and the planning process 2) Review of HMPC responsibilities and the project schedule.	November 14, 2018	Wake County Commons Bldg. 4011 Carya Drive, Raleigh
HMPC Mtg. #2 – East Working Group	1) Review and update plan goals 2) Brainstorm a vision statement 3) Report on status of actions from the 2015 plan 4) Complete the capability self-assessment	January 07, 2019	Wake County Eastern Regional Center 1002 Dogwood Drive, Room 157, Zebulon
HMPC Mtg. #2 – West Working Group		January 09, 2019	Page Walker Arts & History Center, 3rd fl., 119 Ambassador Loop, Cary
HMPC Mtg. #3 – East Working Group	1) Review Draft Hazard Identification & Risk Assessment (HIRA) 2) Draft objectives and Mitigation Action Plans	March 04, 2019	Knightdale Fire Dept. Training Rm 979 Steeple Square Ct, Knightdale, NC 27545
HMPC Mtg. #3 – West Working Group		March 08, 2019	Holly Springs Cultural Center, 300 West Ballentine Street, Holly Springs, NC 27540
HMPC Mtg. #4	1) Review the Draft Hazard Mitigation Plan 2) Solicit comments and feedback	April 22, 2019	Wake County Commons Bldg. 4011 Carya Drive, Raleigh

Note: All HMPC Meetings were open to the public.

HMPC Meeting Agendas, Minutes, and Sign-in Sheets

HMPC Meeting 1: November 14, 2018

Wake County Multi-Jurisdictional Hazard Mitigation Plan Update

Meeting 1: Hazard Mitigation Planning Committee Project Kick-Off Meeting
Time & Date: Wednesday, November 14, 2018, 3:00-4:30 p.m.
Location: Wake County Commons Building, 4011 Carya Drive

Agenda

1. Introductions
2. Project Overview
    a. Requirement for Update
    b. Trends in Disasters – Why Plan?
    c. Disaster Mitigation Act (DMA) Requirements
        i. Organize Resources
        ii. Risk Assessment
            1. Hazard Identification
            2. Vulnerability Assessment
            3. Capability Assessment
        iii. Develop Mitigation Plan
            1. Hazard Strategies
            2. Mitigation Categories
    d. Scope of Work
    e. Risk Management Tool
3. Project Schedule
4. Working Groups
5. Plan Website
6. Next Steps
    a. Capability Assessment
    b. Mitigation Action Status Updates
    c. Mitigation Goals Update
7. Questions
8. Adjourn

Page **1** of **1**

Wake County Multi-Jurisdictional Hazard Mitigation Plan

Meeting 1: Hazard Mitigation Planning Committee Project Kick-Off Meeting
Time & Date: Wednesday, November 14, 2018, 3:00-4:30 p.m.
Location: Wake County Commons Building, 4011 Carya Drive

Introductions

Josh Creighton, Wake County Emergency Management Director, welcomed everyone to the meeting, gave a brief overview of the previous multi-jurisdictional planning process, and reiterated the need for all communities to identify a primary contact, secondary contact, and citizen contact to participate in the planning effort. Josh then introduced David Stroud and Abby Moore, consultants from Wood, to facilitate the rest of the meeting. David began by providing the meeting agenda and had everyone in attendance introduce themselves. There were 26 people in attendance and recorded on the sign-in sheet, including representatives from 8 of the 13 jurisdictions participating in the plan update.

Hazard Mitigation Plan Update Requirement

David discussed the Disaster Mitigation Act of 2000 plan update requirement and the HMGP grant process. Communities are required to update their hazard mitigation plans every five years to remain eligible for federal disaster funding. HMGP funding is provided by the North Carolina Division of Emergency Management with a 75% federal/25% local cost share.

Trends in Disasters

Trends are resulting in increases costs for disaster response and recovery. There has been an increase in population and community growth in recent years, especially in Wake County, which means that more people are living in hazardous areas and there is greater exposure to hazard risk. Exposure to risk includes the people as well as the infrastructure and buildings. Because exposure has increased, when hazard events occur they cause more damage. There are also more hazards, with recognition of technological, civil, and terrorist hazards. There has been a continual increase in hazard expenses and an increase in the issuance of major disaster declarations. David reviewed a list of the 14 costliest natural disasters by NOAA estimates. All of them occurred within the last 30 years, and 4 of the top 5 occurred within the last 14 years. These figures did not include Hurricanes Florence and Michael because it is still too early to estimate the full costs of these disasters. David also noted that these costs are general damage estimates, but that the actual cost of disasters to state and local governments, businesses, insurance companies, homeowners, and others is much higher.

Four reasons why addressing these trends is a priority were presented: 1) the cost of doing nothing is too high as the costs of response and recovery continue to grow; 2) many events are predictable and repetitive; 3) loss reduction activities can be undertaken, and they work, they're cost effective and environmentally sound, and there are funds available to help; and 4) there are legal and moral responsibilities to act.

Planning Requirements

David reviewed the Disaster Mitigation Act (DMA) of 2000 planning requirements, which include a four-phase planning process: organize resources, risk assessment, develop a mitigation plan, and adoption and implementation. The approach that will be led by the consultant team at Wood blends this four-phase process with the processes of the Flood Mitigation Assistance (FMA) Program and the Community Rating System (CRS) Floodplain Management Planning. This completed Hazard Mitigation Plan (HMP) will meet the requirements of all three FEMA programs.

David discussed the main phases of this planning process, as follows:

Phase I: Organize Resources, will involve planning for public involvement and coordinating with other departments and agencies. The HMPC needs to finalize a list of stakeholders for involvement. Mr. Stroud recommended considering North Carolina Emergency Management, FEMA Region IV, NOAA, other adjoining communities, citizens, schools, businesses, and others in brainstorming this list.

Phase II: Risk Assessment entails hazard identification (what can happen here), vulnerability assessment (what will be affected or impacted), and capability assessment (how prepared we are). The HMPC agreed on profiling the following hazards: Flooding, Hurricane Wind, Severe Winter Weather, Extreme Heat, Earthquake, Wildfire, Dam Failure, Drought, Severe Thunderstorm, Landslide, Hazardous Materials Incident, Radiological Emergency, and Terrorism. The vulnerability assessment will use County parcel data, FEMA Hazus analysis, and NCEM I-Risk data. Hazards will be prioritized using the Priority Risk Index. Each community will self-assess capability to determine what mitigation activities can be undertaken and where gaps exist.

Phase III: Develop Mitigation Plan involves setting planning goals, reviewing mitigation alternatives, and drafting an action plan. Typical strategies are to alter the hazard, avert the hazard, adapt to the hazard, or avoid the hazard. In addition to reviewing actions from the previous plan, the HMPC may need to develop new actions.

Scope of Work

The plan will meet the following criteria:

- The plan will include all required elements, as defined in the FEMA Local Mitigation Plan Review Guide.
- The plan will meet or exceed the final rule for local mitigation planning found in 44 CFR, Section 201.6, in order to be approved by FEMA.
- Natural hazards assessed in the plan will coordinate with the current FEMA-approved State Mitigation Plan.
- The plan will include natural and human-caused hazards and mitigation measures.
- The plan will incorporate any local climate adaptation data and findings.

Risk Management Tool

Abby discussed North Carolina Emergency Management's new tool for mitigation planning, which will be used in this effort. NCEM will generate and maintain a digital version of the plan, which may be useful in plan maintenance and future updates.

Project Schedule

The anticipated project schedule was presented. The process will aim for completion of a final draft document by April 2019 to send to NCEM for review. It was noted that this timeline does not include final approval and adoption of the plan. The update must be approved and adopted by January 2020.

The HMPC will divide into working groups for the next two meetings. The next meeting will be held in January.

Working Groups

The breakdown of the working groups is as follows: West: Apex, Cary, Fuquay-Varina, Garner, Holly Springs, Morrisville; and East: Knightdale, Rolesville, Wake Forest, Wendell, Zebulon. Raleigh and Wake County representatives will participate in both working group meetings.

Plan Website

Abby presented the website for the planning process, which will be a tool for HMPC coordination and public outreach. The website is www.WakeCountyHMP.com. The site contains upcoming meetings announcements, meeting agendas and minutes, the public survey, draft documents of the plan update, information on the identified hazards, and opportunities to provide feedback. All communities are encouraged to place a link to this website on their local community pages to encourage more public involvement.

Next Steps

Community representatives need to complete the capability assessment and return it to Abby at abigail.moore@woodplc.com by January 11th. Representatives should come to the next meeting prepared to discuss the mitigation goals and past actions. It was noted that more substantial information than "ongoing" must be provided for continuing actions and that all actions must relate to a mitigation goal. Details on completed actions may be provided in the status and/or may be relevant to include in the capability assessment. Abby will send the capability assessment and past actions to all HMPC members for review and completion.

Wake County, NC
Hazard Mitigation Planning Committee Kick-Off Meeting
Wednesday, November 14th, 3:00 PM

	Name	Organization	Phone	E-Mail
1.	Abby Moore	Wood	919-768-9927	abigail.moore@woodplc.com
2.	DAVID STROUD	WOOD	919-325-6497	david.stroud@woodplc.com
3.	ERIC KULZ	CARY	919 462 3931	ERIC.KULZ@TOWNOFCARY.ORG
4.	John Mello	NCEM/Mitigation	919-825-2334	john.mello@ncdps.gov
5.	STEVE BOTHA	Mooresville	919 468 5932	stevehadean@gmail.com
6.	Edw. R. Gpaty	F-V	919-274-0744	eridpath@gmail.com
7.	KIMBERLY KEYES	TOWN OF HOLLY SPRINGS	919 557 2929	KIMBERLY.KEYES@HOLLYSPRINGSNC.US
8.	CHRIS CREW	NCEM	919 825 2305	JOHN.CREW@NCDPS.GOV
9.	Josh Creighton	WAKE Co	919 856 6485	joshua.creighton@wakegov.com
10.	Daniel Colavito	Holly Springs	919 567 4027	daniel.colavito@hollyspringsnc.us
11.	Kelly Lindsey	City of Raleigh	919-616-9032	Kelly.lindsey@raleighnc.gov
12.	Samantha Smith	Fuquay Varina	919 552 1421	ssmith@fuquay-varina.org
13.	Allyssa Stafford	Fuquay Varina	919 753 1874	astafford@fuquay-varina.org
14.	Bryon Coates	Wake Cnty	919-856-5434	bryon.coates@wakegov.com
15.	Dianne Khin	Town of Apex	919-249-3332	dianne.khin@apexnc.org
16.	Tom Hegele	CARY CERT	919-819-3415	Thegele@gmail.com
17.	Emily Barrett	Cary	469 5125	see sheet
18.	Sharon Peterson	Wake County Planning	919 856-6325	sharon.peterson@wakegov.com
19.	Emma D'Allaird	property owner	919 673 1973	jfjupiterfarm@aol.com
20.	John Sutherland	property owner	919-387-7342	jds4564@aol.com

Wake County, NC
Hazard Mitigation Planning Committee Kick-Off Meeting

Wednesday, November 14th, 3:00 PM

21.	Milton Carpenter	NCDPS	919-825-2307	Milton.Carpenter@NCDPS.gov
22.	Shelly Mayo	Town of Apex	919 249-1136	shelly.mayo@apexnc.org
23.	Dylan Bruchhaus	Town of Morrisville	919 463-6923	dbruchhaus@townofmorrisville.org
24.	Brad West	Town of Morrisville	919-463-6926	bwest@townofmorrisville.org
25.	David Bergmark	Town of Wendell	919-366-1464	dbergmark@townofwendell.com
26.	Jason Alvero	RDU (Wake County)	720-530-4545	jason.alvero@rdu.com
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HMPC Meeting 2 – East Wake Working Group: January 7, 2019

Wake County Multi-Jurisdictional Hazard Mitigation Plan Update

Meeting 2: Hazard Mitigation Planning Committee Meeting #2 – East Wake Working Group
Time & Date: Monday, January 7, 2019, 10:00 a.m.-12:00 p.m.
Location: Wake County Eastern Regional Center, 1002 Dogwood Drive, Room 157, Zebulon

Agenda

1. Review and Update Plan Goals
2. Create a Vision Statement
3. Review Existing Mitigation Projects
4. Report on Community Capability
5. Next Steps
6. Questions
7. Adjourn

Page 1 of 1

Wake County Multi-Jurisdictional Hazard Mitigation Plan

Meeting 2: Hazard Mitigation Planning Committee – East Wake Working Group
Time & Date: Monday, January 7, 2019, 10:00 a.m.-12:00 p.m.
Location: Wake County Eastern Regional Center, Room 157, 1002 Dogwood Drive

There were 12 people in attendance and recorded on the sign-in sheet, including HMPC representatives from Wake Forest, Zebulon, Rolesville, Wake County, Wendell, and Knightdale. David Stroud and Abby Moore, consultants from Wood, facilitated the meeting. David began by providing the meeting agenda.

Review and Update Plan Goals

As part of the plan update process, the HMPC must review the existing goals from the previous plan and make changes where needed. The consultants from Wood compiled the goals from the previous plan and presented them alongside a set of recommended changes. David reviewed each goal and the proposed changes for the HMPC to consider. The existing goals were as follows:

#1	Protect public health, life, safety, and welfare by increasing public awareness and education of hazards and by encouraging collective and individual responsibility for mitigating hazard risks.
#2	Improve technical capability to respond to hazards and to improve the effectiveness of hazard mitigation actions.
#3	Enhance existing or create new policies and ordinances that will help reduce the damaging effects of natural hazards.
#4	Minimize threats to life and property by protecting the most vulnerable populations, buildings, and critical facilities through the implementation of cost-effective and technically feasible mitigation actions.
#5	Generally reduce the impact of all natural hazards.
#6	Ensure that hazard mitigation is considered when redevelopment occurs after a natural disaster.
#7	Ensure that disaster response and recovery personnel have the necessary equipment and supplies available in order to serve the public in the event of a disaster.

The following changes were proposed:

- Re-word Goal #2 to emphasize implementing hazard mitigation in addition to hazard response.
- Delete Goal #3 and incorporate it as an objective under the existing Goal #6.
- Delete Goal #5.
- Modify Goal #6 to include new development in addition to post-disaster redevelopment. Emphasize the need for resilience.
- Delete Goal #7 and incorporate it as an objective under the existing Goal #2.

There were two comments on the goal revisions. For Goal #2, the scope of technical capability was questioned and the group decided it should include administrative resources as well as tools, data, and equipment. For Goal #6, it was recommended that the action specifically include recovery because a current capability gap for the County and jurisdictions is the lack of a recovery plan. With the inclusion of these comments, the HMPC approved of the recommended goal revisions.

The proposed new goals were as follows:

#1	Protect public health, life, safety, and welfare by increasing public awareness and education of hazards and by encouraging collective and individual responsibility for mitigating hazard risks.
#2	Improve technical capability (including administrative resources, tools, data, and equipment) to implement hazard mitigation and respond to hazard events.
#3	Minimize threats to life and property by protecting the most vulnerable populations, buildings, and critical facilities through the implementation of cost-effective and technically feasible mitigation actions.

#4 Incorporate resiliency into future growth by ensuring that hazard mitigation is considered for both new development and post-disaster redevelopment and recovery.

Vision Statement

The next meeting task was to develop a vision statement to guide the plan development. David explained that the East Working Group would generate a list of ideas and the consultant team would combine these recommendations with those to be generated by the West Working Group in order to develop a draft vision statement. This draft vision statement will then be sent out to the entire HMPC for comment, revision, and approval.

David led the group in brainstorming key words or concepts that should be included in the vision for the plan. HMPC members were asked to consider what the successful implementation of the plan would bring about, what outcomes the plan would generate, and what Wake County will look like in five years. With these guiding questions, the group developed the following list of vision concepts:

- Resilience – the County should have the ability to adapt to changing conditions
- Intentional – the County should think about long-term outcomes and act accordingly
- Sustainable – all resources (including personnel, time, funding, land, etc.) should be approached with a mindset of efficiency and reuse
- Scalable project – mitigation projects should build a foundation for larger scale future mitigation
- Managed growth – address having more people and a greater distribution of people; use long-term planning and encourage higher density where it's safe to build; pursue higher regulatory standards
- Prepared – the County, jurisdictions, and residents are more prepared for hazard events
- Coordination – planning efforts are integrated within and across jurisdictions; plans are consistent

Update Existing Mitigation Actions

HMPC representatives worked among their jurisdictional partners to review and determine the status of existing mitigation actions from the 2015 plan. Even if representatives had already provided feedback, they were asked to review their answers to ensure that it is clear for every action whether that action will be carried forward in this plan update or removed from this plan update.

David and Abby introduced a worksheet that will be used to collect details and prioritization criteria for all actions that are going to be carried forward as well as all new actions. Representatives were asked to fill out a worksheet for each action that they know will be carried forward. This information will be due to the consultant team by January 30th.

Update Capability Assessment

HMPC representatives were given time and print worksheets to provide any missing capability assessment information. This information will be due to the consultant team by January 11th.

Joshua Creighton, the Wake County Emergency Management Deputy Director, noted that the SARA Title III Plan, Radiological Emergency Plan, and Emergency Operations Plan (if adopted locally) cover all jurisdictions in the County. Additionally, with the exception of Cary, Raleigh, and Wake Forest, all jurisdictions are covered by a County-developed Historic Preservation Plan.

Next Steps

The Capability Assessment must be completed and returned by January 11th. The action status reporting and action prioritization worksheets for carried forward actions must be completed by January 30th. The HIRA will be presented at the next HMPC meeting, to be scheduled for February.

Wake County, NC
Hazard Mitigation Planning Committee Meeting #2 – East Wake Working Group

Monday, January 7th, 10:00 AM

	Name	Organization	Phone	E-Mail
1.	DAVID STROUD	WOOD	919 325 6497	david.stroude@woodplc.com
2.	Abby Moore	Wood	919 768 9927	abigail.moore@woodplc.com
3.	Patrick Reidy	Town of Wake Forest	919-435-9515	preidy@wakeforestnc.gov
4.	MEADE BRADSHAW	TOWN OF ZEBULON		MBRADSHAW@TOWNOFZEBULON.ORG
5.	DANNY JOHNSON	TOWN of ROLESVILLE	919-554-6517	danny.johnson@rolesville.nc.gov
6.	Byron Coates	Wake County	919-856-5636	byron.coates@wakegov.com
7.	Josh Creighton	WCEM	856 6485	joshua.creighton@wakegov.com
8.	Jason Alvero	RDUAA / Wake County	9/840-7541	jason.alvero@rdu.com
9.	David Bergmark	Wendell	919-365-4443	dbergmark@townofwendell.com
10.	Jason Brown	Knightdale	919-217-2245	jason.brown@knightdalenc.gov
11.	GRIF BOND	TOWN OF WAKE FOREST	919.247.5673	grifbond@embarqmail.com
12.	Jonathon Olson	EMS	9190566022	jolson@wakegov.com
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HMPC Meeting 2 – West Wake Working Group: January 9, 2019

Wake County Multi-Jurisdictional Hazard Mitigation Plan Update

Meeting 2: Hazard Mitigation Planning Committee Meeting #2 – West Wake Working Group
Time & Date: Wednesday, January 9, 2019, 10:00-11:30 a.m.
Location: Page Walker Arts & History Center, 3rd fl., 119 Ambassador Loop, Cary

Agenda

1. Review and Update Plan Goals
2. Create a Vision Statement
3. Review Existing Mitigation Projects
4. Report on Community Capability
5. Next Steps
6. Questions
7. Adjourn

Page 1 of 1

Wake County Multi-Jurisdictional Hazard Mitigation Plan

Meeting 2: Hazard Mitigation Planning Committee – West Wake Working Group
Time & Date: Wednesday, January 9, 2019, 10:00-11:30 a.m.
Location: Page Walker Arts & History Center, 3rd Fl., 119 Ambassador Loop

There were 16 people in attendance and recorded on the sign-in sheet, including HMPC representatives from Apex, Cary, Fuquay-Varina, Garner, Holly Springs, Morrisville, Raleigh, and Wake County, and Chris Crew from NC Emergency Management. David Stroud and Abby Moore, consultants from Wood, facilitated the meeting. David began by providing the meeting agenda.

Review and Update Plan Goals

As part of the plan update process, the HMPC must review the existing goals from the previous plan and make changes where needed. The consultants from Wood compiled the goals from the previous plan and presented them alongside a set of recommended changes. These changes incorporated input from gathered from the rest of the HMPC during the East Wake Working Group meeting held on Monday, January 7th. David reviewed each goal and the proposed changes for the HMPC to consider. The existing goals were as follows:

#1	Protect public health, life, safety, and welfare by increasing public awareness and education of hazards and by encouraging collective and individual responsibility for mitigating hazard risks.
#2	Improve technical capability to respond to hazards and to improve the effectiveness of hazard mitigation actions.
#3	Enhance existing or create new policies and ordinances that will help reduce the damaging effects of natural hazards.
#4	Minimize threats to life and property by protecting the most vulnerable populations, buildings, and critical facilities through the implementation of cost-effective and technically feasible mitigation actions.
#5	Generally reduce the impact of all natural hazards.
#6	Ensure that hazard mitigation is considered when redevelopment occurs after a natural disaster.
#7	Ensure that disaster response and recovery personnel have the necessary equipment and supplies available in order to serve the public in the event of a disaster.

The following changes were proposed:

- Re-word Goal #2 to emphasize implementing hazard mitigation in addition to hazard response. Clarify technical capability.
- Delete Goal #3 and incorporate it as an objective under the existing Goal #6.
- Delete Goal #5.
- Modify Goal #6 to include new development in addition to post-disaster redevelopment. Emphasize recovery development and the need for resilience.
- Delete Goal #7 and incorporate it as an objective under the existing Goal #2.

There was one comment on the goal revisions. For Goal #4, it was recommended that adaptation be included in addition to resiliency, to emphasize the need to consider future conditions during the development and redevelopment processes.

The proposed new goals were as follows:

#1	Protect public health, life, safety, and welfare by increasing public awareness and education of hazards and by encouraging collective and individual responsibility for mitigating hazard risks.
#2	Improve technical capability (including administrative resources, tools, data, and equipment) to implement hazard mitigation and respond to hazard events.

#3	Minimize threats to life and property by protecting the most vulnerable populations, buildings, and critical facilities through the implementation of cost-effective and technically feasible mitigation actions.
#4	Incorporate resiliency and adaptation into future growth by ensuring that hazard mitigation is considered for both new development and post-disaster redevelopment and recovery.

Vision Statement

The next meeting task was to develop a vision statement to guide the plan development. David explained that the East Working Group generated a list of ideas and the consultant team would combine these recommendations with those to be generated by the West Working Group in order to develop a draft vision statement. This draft vision statement will then be sent out to the entire HMPC for comment, revision, and approval. To generate the vision statement concepts, HMPC members were asked to consider what the successful implementation of the plan would achieve, what outcomes the plan would generate, and what Wake County will look like in five years.

David began by reviewing the list of concepts generated by the East Wake Working Group, which were as follows:

- Resilience – the County should have the ability to adapt to changing conditions
- Intentional – the County should think about long-term outcomes and act accordingly
- Sustainable – all resources (including personnel, time, funding, land, etc.) should be approached with a mindset of efficiency and reuse
- Scalable project – mitigation projects should build a foundation for larger scale future mitigation
- Managed growth – address having more people and a greater distribution of people; use long-term planning and encourage higher density where it's safe to build; pursue higher regulatory standards
- Prepared – the County, jurisdictions, and residents are more prepared for hazard events
- Coordination – planning efforts are integrated within and across jurisdictions; plans are consistent

HMPC members reviewed the above ideas and contributed the following additions, clarifications, and revisions:

- Acknowledge past success achieved through the previous plan and build on what we have already started.
- Incorporate a protective mindset within sustainability to address the need to protect sensitive land and water resources.
- Incorporate others scales of planning under coordination to encourage planning at a watershed and/or ecosystem level.
- Identify and consider the needs of vulnerable populations in planning mitigation projects.
- Combine resilience with adaptation, where resilience is the ability to react and recover and adaptation is the incorporation into recovery of intentional changes that reduce future vulnerability. Emphasize a commitment to re-evaluate conditions after every event and incorporate improvements during the return to "normal."

Update Existing Mitigation Actions

HMPC representatives worked among their jurisdictional partners to review and determine the status of existing mitigation actions from the 2015 plan. Even if representatives had already provided feedback, they were asked to review their answers to ensure that it is clear for every action whether that action will be carried forward in this plan update or removed from this plan update.

David introduced a worksheet that will be used to collect details and prioritization criteria for all actions that are going to be carried forward as well as all new actions. Representatives were asked to fill out a worksheet for each action that they know will be carried forward. This information will be due to the consultant team by January 30th.

Update Capability Assessment

HMPC representatives were given time and print worksheets to provide any missing capability assessment information. This information will be due to the consultant team by January 11th.

David shared information from Joshua Creighton, the Wake County Emergency Management Deputy Director, to note that the SARA Title III Plan, Radiological Emergency Plan, and Emergency Operations Plan (if adopted locally)

cover all jurisdictions in the County and can therefore be marked as "County Developed". Additionally, apart from Cary, Raleigh, and Wake Forest, all jurisdictions are covered by a County-developed Historic Preservation Plan.

Chris Crew, NC Emergency Management Mitigation Plans Manager, shared that the State Historic Preservation Office is interested in the mitigation planning process and would like to encourage jurisdictions to consider historic properties when evaluating vulnerabilities and developing new mitigation actions.

Next Steps

The Capability Assessment must be completed and returned by January 11th. The action status reporting and action prioritization worksheets for carried forward actions must be completed by January 30th. The HIRA will be presented at the next HMPC meeting, to be scheduled for February.

Wake County, NC
Hazard Mitigation Planning Committee Kick-Off Meeting #2 - West Wake
Wednesday, January 9th, 10:00 AM

	Name	Organization	Phone	E-Mail
1.	DAVID STRAUD	WOOD	919-325-6497	david.straude woodpc.com
2.	Abby Moore	Wood	919-768-9927	abigail.moore@woodplc.com
3.	ERIC KUTZ	TOC	919-462-3131	ERIC.KUTZ@TOWNOFCARY.ORG
4.	KIMBERLY HOLMES	TOH	910 391 7713	KIMBERLY.HOLMES@HOLLYSPRINGSNC.US
5.	Ed Kitzmiller	Fuquay-Varina	919-271-0714	e.r.d.puth@gmail.com
6.	David Bamford	GARNER	919-773-4443	dbamford@garnernc.gov
7.	DYLAN BRADHAM	Morrisville	(919) 463-6923	dbradham@morrisville.org
8.	Tom Hegele	CITY CENT	919-819-3413	Thegele@gmail.com
9.	CHRIS CRAN	NCEM	919 825 2305	JOHN.CRAN@NCDPS.GOV
10.	Kelly Lindsey	City of Raleigh	919-416-9032	kelly.lindsey@raleighnc.gov
11.	Shelly Mayo	Apex	919-249-1130	shelly.mayo@apexnc.org
12.	Alyssa Stafford	Fuquay-Varina	919-753-1874	astafford@fuquay-varina.org
13.	Brad West	Town of Morrisville	919-463-6926	bwest@townofmorrisville.org
14.	Emily Barrett	Town of Cary	469 9125	emily.barrett@townofcary.org
15.	Sharon Peterson	Wake County Planning	919 856-6325	sharon.peterson@wakegov.com
16.	Jim Scarborough	Apex	919-404-9404	jimes@hiwaay.net
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HMPC Meeting 3 – East Wake Working Group: March 4, 2019

Wake County Multi-Jurisdictional Hazard Mitigation Plan

Meeting 3: Hazard Mitigation Planning Committee – East Wake Working Group
Time & Date: Monday, March 4, 2019, 9:00 a.m.-11:00 p.m.
Location: Knightdale Fire Department Training Room, 979 Steeple Square Ct, Knightdale

There were 13 people in attendance and recorded on the sign-in sheet, including HMPC representatives from Knightdale, Raleigh, Wendell, Wake Forest, and Wake County. David Stroud and Abby Moore, consultants from Wood, facilitated the meeting.

David began with a review of the planning process as a whole and where we are in that process – Step 4 Assess the Hazard & Step 5 Assess the Problem. We have already completed Step 6 Set Goals. Moving forward, the next step will be to review potential new mitigation actions and draft the plan.

Review the Hazard Identification and Risk Assessment (HIRA)

David reviewed the HIRA methodology and process and provided a summary of each hazard in the plan, explaining the overall risk level assigned to each hazard. Hazards were identified for initial review based on the list of hazards included in the 2018 State Hazard Mitigation Plan and the 2015 Wake County plan. Major disaster declarations, NCEI storm events data, and other sources of hazard risk were reviewed to determine which hazards would be fully profiled in the plan. The full list of hazards profiled is as follows:

- Dam Failure
- Drought
- Earthquake
- Extreme Heat
- Flood
- Hurricane & Tropical Storm
- Landslide
- Severe Weather (Thunderstorm, Lightning, and Hail)
- Severe Winter Storm
- Tornado
- Hazardous Materials Incident
- Radiological Incident
- Terrorism

The detailed summary info that was presented on each hazard can be found in the PDF of the presentation. The following comments were noted during the discussion of hazards:

- Dam failure: the review of historical occurrences should also include near misses. The HMPC noted near misses at Fairlake Lewis Dam in Wake Forest and Lake Johnson leading into Lake Benson and Lake Wheeler in Raleigh.
- Radiological: it was noted that the name should read "Harris Nuclear Plant" for all direct references to the plant.
- Asset Inventory: There was a clarification that EMS facilities are accounted for under the "Fire" category in Critical Facilities.

Plan Objectives

The next meeting task was to identify plan objectives under each goal. David presented optional objectives suggested by Wood. There were no objections to these objectives. The HMPC will consider revisions and/or additional objectives as they work on reviewing potential new mitigation alternatives.

Next Steps

The draft HIRA is posted on the plan website. The HMPC can review the HIRA and submit comments until Friday, March 22nd. The HMPC should also work on developing new mitigation actions based on gaps and information in the HIRA. New mitigation actions are due to Wood by Friday, March 29th. John Mello from NCEM noted that there must be two actions for every hazard and there must be at least one Structural mitigation project. An all-hazards action (such as public outreach) can satisfy the requirement for one of the required actions for each hazard.

A Doodle poll will be sent out to schedule the final HMPC meeting for mid-April.

Wake County, NC
Hazard Mitigation Planning Committee Meeting #3
Monday, March 4th, 9:00 AM

	Name	Organization	Phone	E-Mail
1.	Abby Moore	Wood	919-768-9927	abigail.moore@woodplc.com
2.	DAVID STROUD	WOOD	919-325-6497	david.stroud@woodpc.com
3.	Nicole Goddard	city of Raleigh	919-996-4259	nicole.goddard@raleighnc.gov
4.	Whitney Schoenfeld	City of Raleigh	919-996-2704	Whitney.Schoenfeld@raleighnc.gov
5.	John Mello	NCEM/Mitigation	919-825-2334	john.mello@ncdps.gov
6.	Patrick Reidy	Town of Wake Forest	919-435-9515	preidy@wakeforestnc.gov
7.	Ben Brown	City of Raleigh	919-996-3515	ben.brown@raleighnc.gov
8.	Jon Olson	Wendell	919-796-6342	jolson@wdlgov.com
9.	Meggan Anderson	City Raleigh	8336 977 7376	meggan.anderson@raleighnc.gov
10.	Jeannine Navarra	Town of Wendell	919-365-4448	jnavarra@townofwendell.com
11.	Jason Brown	Town of Knightdale	919-217-2245	jason.brown@knightdale.gov
12.	Grif Bond	Town of Wake Forest	919.554.7283	grifbond@gmail.com
13.	Josh Creighton	Wake Co	919 856 6485	joshua.creighton@wakegov.com
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HMPC Meeting 3 – West Wake Working Group: March 8, 2019

Wake County Multi-Jurisdictional Hazard Mitigation Plan

Meeting 3: Hazard Mitigation Planning Committee – West Wake Working Group
Time & Date: Friday, March 8, 2019, 1:30-3:00 p.m.
Location: Holly Springs Cultural Center, 300 W Ballentine St, Holly Springs

There were 13 people in attendance and recorded on the sign-in sheet, including HMPC representatives from Apex, Cary, Fuquay-Varina, Garner, Holly Springs, Morrisville, and Wake County. David Stroud and Abby Moore, consultants from Wood, facilitated the meeting.

David began with a review of the planning process as a whole and where we are in that process – Step 4 Assess the Hazard & Step 5 Assess the Problem. We have already completed Step 6 Set Goals. Moving forward, the next step will be to review potential new mitigation actions and draft the plan.

Review the Hazard Identification and Risk Assessment (HIRA)

David reviewed the HIRA methodology and process and provided a summary of each hazard in the plan, explaining the overall risk level assigned to each hazard. Hazards were identified for initial review based on the list of hazards included in the 2018 State Hazard Mitigation Plan and the 2015 Wake County plan. Major disaster declarations, NCEI storm events data, and other sources of hazard risk were reviewed to determine which hazards would be fully profiled in the plan. The full list of hazards profiled is as follows:

- Dam Failure
- Drought
- Earthquake
- Extreme Heat
- Flood
- Hurricane & Tropical Storm
- Landslide
- Severe Weather (Thunderstorm, Lightning, and Hail)
- Severe Winter Storm
- Tornado
- Hazardous Materials Incident
- Radiological Incident
- Terrorism

The detailed summary info that was presented on each hazard can be found in the PDF of the presentation. The following comments were noted during the discussion of hazards:

- Drought: Vulnerability to water supply was brought up. Current HIRA discusses public water supply but not private wells, but there are an estimated 40,000 private wells in Wake County. This will be added to the vulnerability assessment. Quantitative risk data is not available, but the potential vulnerability will be noted.
- Extreme Heat: Time period should be shortened to reflect more recent trends.
- Radiological: The 50-mile Ingestion Pathway Zone, which indicates the area within which food and water sources may be contaminated. The spatial extent rating for the hazard should be increased.
- Asset Inventory: There was discussion regarding the limitations of the IRISK database, which provides vulnerability estimates based on a 2010 asset inventory. Many jurisdictions have grown substantially since 2010, making the IRISK data an underestimate of actual risk. Wood will discuss growth and development by jurisdiction in the Community Profile section of the plan in order to quantify the extent of growth since the 2010 data. This information will also be noted in the Jurisdictional Annexes. These findings will be noted in the hazard profiles where possible. Additionally, the newest available parcel data will be used to run an additional assessment of flood vulnerability by providing a count of buildings in the floodplain by jurisdiction.

Plan Objectives

The next meeting task was to identify plan objectives under each goal. David presented optional objectives suggested by Wood. There were no objections to these objectives. The HMPC will consider revisions and/or additional objectives as they work on reviewing potential new mitigation alternatives.

Next Steps

The draft HIRA is posted on the plan website. The HMPC can review the HIRA and submit comments until Friday, March 22nd. The HMPC should also work on developing new mitigation actions based on gaps and information in the HIRA. New mitigation actions are due to Wood by Friday, March 29th. Per FEMA requirements, each jurisdiction must have two actions for every hazard and at least one Structural mitigation project. An all-hazards action (such as public outreach) can satisfy the requirement for one of the required actions for each hazard.

A Doodle poll will be sent out to schedule the final HMPC meeting for mid-April.

Wake County, NC
Hazard Mitigation Planning Committee Meeting #3

Friday, March 8th, 1:30 PM

	Name	Organization	Phone	E-Mail
1.	Abby Moore	Wood	919-768-9927	abigail.moore@woodplc.com
2.	Allyssa Stafford	Fuquay-Varina	919-753-1874	astafford@fuquay-varina.org
3.	DAVID STROUD	WOOD	919-325-649	david.stroud@woodplc.com
4.	Kimberly Krays	Town of Holly Springs	910-557 2929	Kimberly.Krays@hollyspringsnc.us
5.	Dylan Bruchhaus	Town of Morrisville	919 463-8923	dbruchhaus@townofmorrisville.org
6.	Daniel Colavito	Town of Holly Springs	919.567.4027	daniel.colavito@hollyspringsnc.us
7.	Ed Ridpath	F-V	919-274-0744	eridpath@gmail.com
8.	Shelly Mayo	Apex	919-249-3421	shelly.mayo@apexnc.org
9.	ERIC KULZ	CARY	919-462-3931	ERIC.KULZ@TOWNOFCARY.ORG
10.	Josh Creighton	Wake Co	919 856 6485	joshua.creighton@wakegov.com
11.	Mike Dixon	Wake Co	919 464 7192	michael.dixon@wakegov.com
12.	David Bamford	GARNER	919-773-4443	dbamford@garnernc.gov
13.	Samantha Smith	FV	919 552 1421	ssmith@fquay.-
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HMPC Meeting 4: April 22, 2019

Wake County Multi-Jurisdictional Hazard Mitigation Plan

Meeting 4: Hazard Mitigation Planning Committee Meeting
Time & Date: Monday, April 22, 2019, 3:00-4:30 p.m.
Location: Wake County Commons Building, 4011 Carya Drive

There were 18 attendees recorded on the meeting sign-in sheet.

Planning Process Update

David Stroud, the consultant from Wood leading the plan update, began the meeting with a review of the planning process. The process is now in Step 7 (Review Possible Activities) and Step 8 (Draft an Action Plan). Once the plan is fully drafted and approved, all communities will adopt the plan (Step 9) and then implement, evaluate, and revise the plan (Step 10) over the next five years until the next update cycle begins.

Structure of the Plan

To prepare the HMPC to review and comment on the draft plan, David presented the structure of the plan, discussing each of the nine sections as well as the appendices and annexes to the plan. This summary of each plan section as well as annex content can be found in the presentation slides.

Additionally, David clarified where and how data on development since 2011 was added to the annexes to address concerns from the review of the HIRA. This data on development since 2011 provides a good indication of growth in each participating jurisdiction and puts the IRISK data presented in the HIRA into context. This data was also assessed in terms of flood risk, by comparing parcels (and building footprints, if available) to floodplains in the effective FIRM in order to estimate additional exposure to flooding.

David also noted that the IRISK data is updated only once the new FIRM is adopted, which is why newer data was not yet available for this plan update.

Review of Key Plan Components

David reviewed the major components of the plan as follows:

- Hazards Profiled: listed the hazards assessed in this plan; the list was coordinated with the hazards in the State Hazard Mitigation Plan
- Risk Assessment Summary & PRI Results: presented the Priority Risk Index scores for each hazard, demonstrating how hazards were classified as high, moderate, or low risk. Only natural hazards with a high or moderate risk rating need to be targeted for mitigation.
- Goals & Objectives: no comments were submitted on the objectives presented at the last meeting, and no new objectives were submitted. All mitigation actions must nest under one of these goals and objectives.
- Mitigation Action Plans: a set of example actions were presented. Each jurisdiction's representatives reviewed their mitigation actions with the planning consultants later in the meeting. A question was raised about whether certain mitigation actions should be carried across jurisdictions if they are regional. David advised that yes, the more actions are aligned the better in terms of encouraging implementation and showing coordination to FEMA. It was decided that representatives should review all mitigation action plans and look for opportunities to duplicate regional actions in their own mitigation action plans.

Plan Implementation & Maintenance

David reviewed the HMPC's responsibilities for implementing and maintaining the plan once it is adopted. The Disaster Mitigation Act of 2000 (DMA) requires that the HMPC conduct annual reviews of the plan to discuss implementation progress and any needed revisions. Each participating community can conduct these reviews internally and submit annual reports to their own governing bodies. David recommended that communities adhere to the CRS program requirements for quarterly reviews instead, because more regular meetings will help the committee make progress on implementation.

David and Abby also discussed the need for each participating jurisdiction to report on any ways that they integrated the 2015 plan with other local planning efforts as well as any ways they plan to integrate this plan update with other planning efforts moving forward.

Moving forward, the final components of the plan will be compiled into a complete draft, which will be posted for review on the plan website. Committee members and the public will have two weeks to review the draft. Comments and feedback will be compiled into a final draft plan, which will be sent to the State to review. Once the State has approved the plan, it will be sent to FEMA for review. After FEMA sends the Approval Pending Adoption (APA) letter, all communities must adopt the plan.

John Mello from NCEM noted that FEMA has 45 days to complete their review. He noted that the State can let us know when they submit the plan to FEMA so that communities will have a general idea of when they'll need to begin preparing for adoption of the plan.

John also mentioned that the State will work with communities to amend the plan and add new projects if needed, such as if a community wants to apply for HMGP funding for a project that is not currently listed in the plan.

Mitigation Actions Workshop

David and Abby worked with representatives from each participating jurisdiction present at the meeting to review their mitigation action plans and identify any gaps or necessary revisions and to discuss integration of the 2015 plan and this plan update.

Next Steps

HMPC representatives should try to submit any mitigation action revisions as well as any information on integration by Wednesday, May 1st. HMPC members also have until Friday, May 17th to review the draft plan. Comments and feedback on the plan can be sent to Abby at abigail.moore@woodplc.com.

Wake County, NC
Hazard Mitigation Planning Committee Meeting #4

Monday, April 22nd, 3:00 PM

	Name	Organization	Phone	E-Mail
1.	Ed Ridpath	Town of FV	919-274-0744	eridpath@gmail.com
2.	Patrick Reidy	Town of Wake Forest	919-435-9515	preidy@wakeforestnc.gov
3.	Brad West	Town of Morrisville	919-463-6926	bradofwest@gmail.com
4.	John Mello	NCEM/Mit Plans	919-825-2334	john.mello@ncdps.gov
5.	Mike Dixon	Wake Co	919-464-7192	michael.dixon@wakegov.com
6.	Jeannine Nguira	Town of Wendell	919-365-4448	jnguira@townofwendell.com
7.	DANNY JOHNSON	Town of Rolesville	919-554 6514	DANNY.JOHNSON@ROLESVILLENC.GOV
8.	Nicole Goddard	City of Raleigh	919-996-4259	nicole.goddard@raleighnc.gov
9.	Dylan Bruchhaus	Town of Morrisville	919-463-6923	dbruchhaus@townofmorrisville.org
10.	Jason Brown	Town of Knightdale	919-217-2245	jason.brown@knightdalenc.gov
11.	Whitney Schoenfeld	City of Raleigh	919-996-2204	whitney.schoenfeld@raleighnc.gov
12.	Ben Brown	City of Raleigh	919 996 3515	ben.brown@raleighnc.gov
13.	Shelly Mayo	Apex	919-249-1136	shelly.mayo@apexnc.org
14.	Alyssa Stafford	Fuquay-Varina	919-552-1429	astafford@fv.org
15.	Samantha Smith	"	"	ssmith@f-v.org
16.	Emily Barrett	Town of Cary	919 469 5125	emily.barrett@townofcary.org
17.	Abby Moore	Wood	919 768 9927	abigail.moore@woodplc.com
18.	DAVID STRAND	WOOD	919-325 6497	david.strande woodplc.com
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PLANNING STEP 2: INVOLVE THE PUBLIC

Table B.2 – Public Meeting Topics, Dates, Locations

Meeting Title	Meeting Topic	Meeting Date	Meeting Location
Public Meeting #1	1) Introduction to DMA, CRS, and FMA requirements and the planning process 2) Review of HMPC responsibilities and the project schedule.	November 14, 2018	Wake County Commons Bldg. 4011 Carya Drive, Raleigh
Public Meeting #2	1) Review "Draft" Hazard Mitigation Plan 2) Solicit comments and feedback	April 22, 2019	Wake County Commons Bldg. 4011 Carya Drive, Raleigh

Public Meeting Agendas, Minutes, Sign-in Sheets, and Announcements

Public Meeting 1: November 14, 2018

Wake County Multi-Jurisdictional Hazard Mitigation Plan Update

Meeting 1: Public Kick-Off Meeting
Time & Date: Wednesday, November 14, 2018, 5:00 p.m.
Location: Wake County Commons Building, 4011 Carya Drive

Agenda

1. Introductions
2. Project Overview
    a. Requirement for Update
    b. Trends in Disasters – Why Plan?
    c. Disaster Mitigation Act (DMA) Requirements
        i. Organize Resources
        ii. Risk Assessment
            1. Hazard Identification
            2. Vulnerability Assessment
            3. Capability Assessment
        iii. Develop Mitigation Plan
            1. Hazard Strategies
            2. Mitigation Categories
    d. Scope of Work
    e. Risk Management Tool
3. Project Schedule
4. Working Groups
5. Plan Website
6. Next Steps
    a. Plan Website
    b. Public Survey
7. Questions
8. Adjourn

Page 1 of 1

Wake County Multi-Jurisdictional Hazard Mitigation Plan

Meeting 1: Public Kick-Off Meeting
Time & Date: Wednesday, November 14, 2018, 5:00 p.m.
Location: Wake County Commons Building, 4011 Carya Drive

One member of the public came to the meeting. In lieu of providing the prepared presentation, David Stroud, consultant at Wood, discussed the key points of the presentation with the attendee and answered questions about the planning process. David provided information about the plan website and the public survey. The attendee provided his email in order to receive further information about the website and other ways to stay involved throughout the rest of the planning process.

WAKE COUNTY
NORTH CAROLINA

Wake County, NC
Hazard Mitigation Planning Public Meeting #1
Wednesday, November 14th, 5:00 PM

	Name	Organization (resident)	Phone	E-Mail
1.	Bill Carter	Town of Wendell	919-365-4424	bcarter@townofwendell.com
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WAKE COUNTY
NORTH CAROLINA

NEWS RELEASE

Contact: Communications Office
Alice Avery, Communications Specialist
Alice.Avery@wakegov.com, 919-856-7550
Communications Office After Hours, 919-857-WAKE
wakegov.com/news

For Release: Nov. 13, 2018

Residents Invited to Weigh in on Hazard Mitigation Plan

While natural disasters cannot be prevented, there are things communities can do to make their people and property less vulnerable to damage.

Residents are invited to share their thoughts on the Wake County Multi-Jurisdictional Hazard Mitigation Plan at a public meeting Wednesday, Nov. 13. The meeting will take place at 5 p.m. at the Wake County Commons Building, 4011 Carya Drive.

The Wake County Multi-Jurisdictional Hazard Mitigation Plan, which was developed five years ago, recommends structural solutions to reduce existing vulnerability. It also considers policies on community growth and development, incentives for natural resource protection, and public awareness and outreach activities. The plan brings together all jurisdictions in the county under one comprehensive document.

Wake County and its partners are now beginning the process to update the plan—which is why public input is important.

The meeting will take place in the lower level of the Commons Building, which can be accessed by an entrance on the right side of the building at the end of the driveway.
Learn more about Wake County's Hazard Mitigation Plan here.

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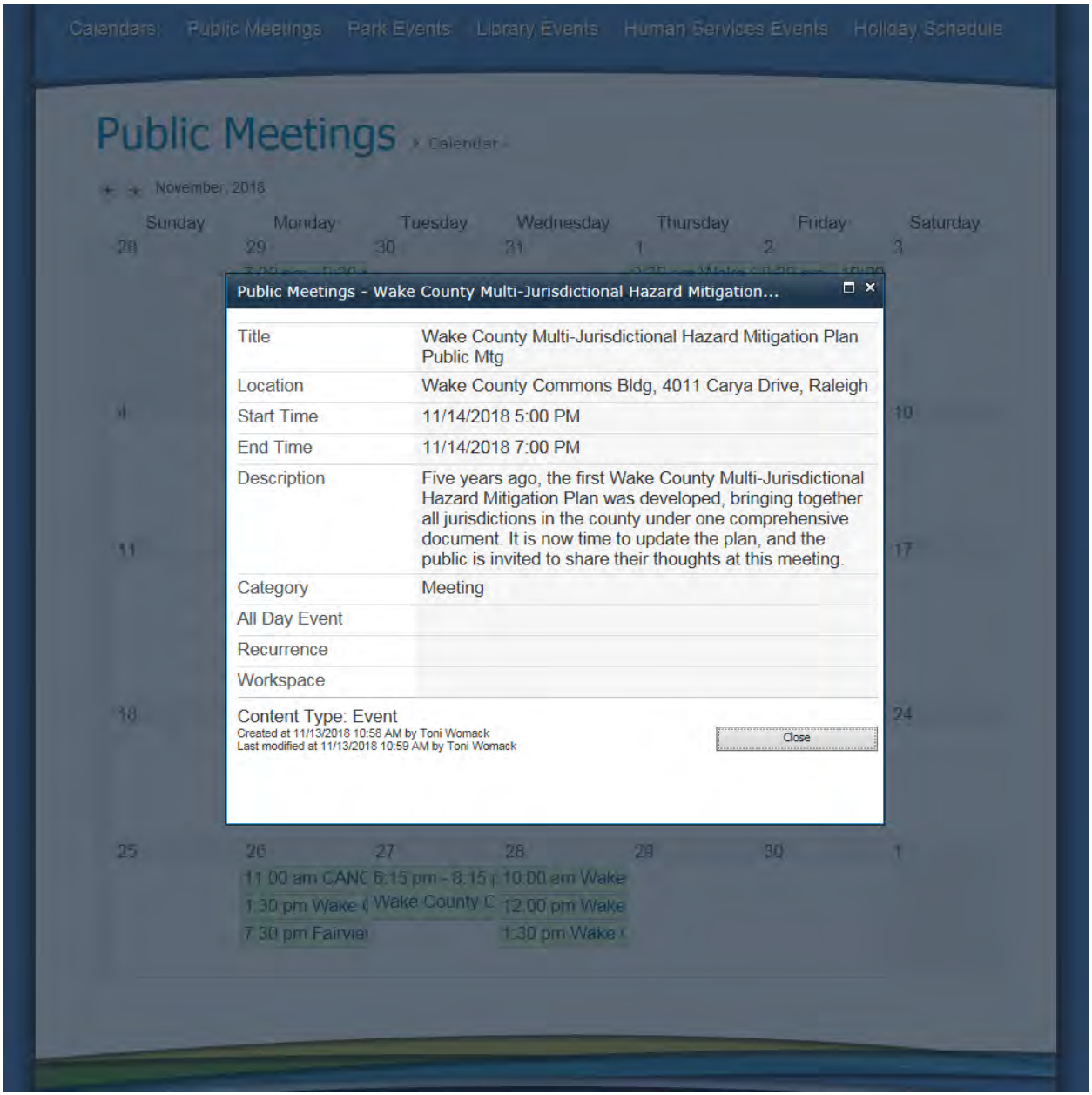
Calendars
Public Meetings
Park Events
Library Events
Human Services Events
Holiday Schedule
Public Meetings
Calendar
November, 2018
Sunday
Monday
Tuesday
Wednesday
Thursday
Friday
Saturday
Public Meetings - Wake County Multi-Jurisdictional Hazard Mitigation...
Title
Wake County Multi-Jurisdictional Hazard Mitigation Plan Public Mtg
Location
Wake County Commons Bldg, 4011 Carya Drive, Raleigh
Start Time
11/14/2018 5:00 PM
End Time
11/14/2018 7:00 PM
Description
Five years ago, the first Wake County Multi-Jurisdictional Hazard Mitigation Plan was developed, bringing together all jurisdictions in the county under one comprehensive document. It is now time to update the plan, and the public is invited to share their thoughts at this meeting.
Category
Meeting
All Day Event
Recurrence
Workspace
Content Type: Event
Created at 11/13/2018 10:58 AM by Toni Womack
Last modified at 11/13/2018 10:59 AM by Toni Womack
Close


Raleigh
Search
Vision: To pursue world-class quality of life by actively collaborating with our community towards a fulfilling and inspired future for all
Arts & Parks
Services
Government
Business & Development
Community
Projects
Public Safety
Sustainability
MyRaleigh
Departments
Maps
Directory
Calendar
Subscriptions
Pay
Utility Bill
Parking Citations
Safelight Citations
Public Meeting Set For Update to Wake County Hazard Mitigation Plan
News posted Nov. 13, 2018 - 6:00 am
On Nov. 14 at 5 p.m., the public is invited to a meeting on the update to Wake County Hazard Mitigation Plan at 5 p.m. at the Wake County Commons Building, 4011 Carya Drive in Raleigh.
Nearly five years ago, the first Wake County Multi-Jurisdictional Hazard Mitigation Plan was developed bringing together all jurisdictions in the County under one comprehensive document.
Subscribe to the City's News RSS Feed
0
News
Raleigh Names Convention Center Complex GM/Director (today)
[Alert] Traffic Closure: 7900 Block of Lead Mine Road for Sewer Repair (today)
Public Meeting Set For Update to Wake County Hazard Mitigation Plan
Events
Nov 13
City Council Meeting
Work Session
4:00 pm

Public Meeting 2: April 22, 2019

Wake County Multi-Jurisdictional Hazard Mitigation Plan

Meeting 2: Final Public Meeting
Time & Date: Monday, April 22, 2019, 5:00-6:00 p.m.
Location: Wake County Commons Building, 4011 Carya Drive

There were six attendees recorded on the meeting sign-in sheet including stakeholder representatives from North Carolina Department of Environmental Quality's Division of Water Resources and Triangle J Council of Governments. Additionally, HMPC representatives from Wake County and Cary attended the meeting.

Planning Process Update

David Stroud, the consultant from Wood leading the plan update, began the meeting with a review of the planning process, which is now in Step 7 (Review Possible Activities) and Step 8 (Draft an Action Plan). Once the plan is fully drafted and approved, all communities will adopt the plan (Step 9) and then implement, evaluate, and revise the plan (Step 10) over the next five years until the next update cycle begins.

Structure of the Plan

To prepare stakeholders and citizens to review and comment on the draft plan, David presented the structure of the plan, discussing each of the nine sections as well as the appendices and annexes to the plan. This summary of each plan section as well as annex content can be found in the presentation slides.

Review of Key Plan Components

David reviewed the major components of the plan as follows:

- Hazards Profiled: listed the hazards assessed in this plan; the list was coordinated with the hazards in the State Hazard Mitigation Plan to ensure consistency
- Risk Assessment Summary & PRI Results: presented the Priority Risk Index scores for each hazard, demonstrating how hazards were classified as high, moderate, or low risk. Only natural hazards with a high or moderate risk rating need to be targeted for mitigation.
- Goals & Objectives: presented the goals and their associated objectives as agreed upon by the HMPC. All mitigation actions must nest under one of these goals and objectives.
- Mitigation Action Plans: a set of example actions were presented. A complete set of draft mitigation action plans from each jurisdiction was made available for citizens and stakeholders to review.

Plan Implementation & Maintenance

David reviewed the HMPC's responsibilities for implementing and maintaining the plan once it is adopted, noting that continued public involvement is among these requirements. The HMPC or each participating community must conduct at least annual reviews internally and submit annual reports to their own governing bodies. The public will be able to review these annual reports to track implementation progress.

Moving forward, the final components of the plan will be compiled into a complete draft, which will be posted for review on the plan website. The public will have two weeks to review the draft. Comments and feedback will be compiled into a final draft plan, which will be sent to the State to review. Once the State has approved the plan, it will be sent to FEMA for review. After FEMA sends the Approval Pending Adoption (APA) letter, all communities must adopt the plan.

Next Steps

The draft plan will be posted on the website at http://www.wakecountyhmp.com/draftDocuments.html. Stakeholders will have until Friday, May 17th to review the draft plan. Comments and feedback on the plan can be sent to Abby at abigail.moore@woodplc.com.

Wake County Multi-Jurisdictional Hazard Mitigation Plan Update
Public Meeting 1

Page **1** of **1**

Wake County, NC
Hazard Mitigation Planning Public Meeting #2

Monday, April 22nd, 5:00 PM

	Name	Organization (resident)	Phone	E-Mail
1.	david.Strack	WOOD	919-325-6497	david.Strackwoodplc.com
2.	Abby Moore	wood	919-768-4927	abigail.moore@woodplc.com
3.	Celeste Sugg	DEQ IDWR	919-707-3628	celeste.sugg@ncdenr.gov
4.	Jim GREGSON	NCDEQ / DWR	919-707-9147	JIM.GREGSON@NCDENR.GOV
5.	Kelly Alberty	NC DWR	919 707 8035	KELLY.ALBERTY@NCDENR.GOV
6.	Jen Schmitt	TJCOG	919-438-0896	jschmitt@tjcog.org
7.				
8.				
9.				
10.				
11.				
12.				
13.				
14.				
15.				
16.				
17.				
18.				
19.				
20.				

The **Final** meetings for the Wake County HMP will be held on **Monday, April 22, 2019**. The **HMPC Meeting** will be held from **3PM to 4:30PM**. The **Public Meeting** will follow from **5PM to 6PM**. Both of the meetings will be held in the Wake County Commons Building, Room 100B & 100C - 4011 Carya Drive, Raleigh

WAKE MULTI-JURISDICTIONAL HAZARD MITIGATION PLAN

wood.

Wake County Multi-jurisdictional Hazard Mitigation Plan

Welcome to the website for the 2019 Wake County Multi-jurisdictional Hazard Mitigation Plan update. Wake County is updating its 2015 plan to better protect the people and property of the County from the effects of natural and human-caused hazards and to maintain eligibility for mitigation funding from the Federal Emergency Management Agency (FEMA). On this website you can find information about upcoming and past Hazard Mitigation Planning Committee meetings and public meetings, take a survey on hazard risk and mitigation options to inform the plan's development, review draft documents a summary of the hazards that affect Wake County, and learn more about the hazards that affect Wake County.

MEETING SCHEDULES, AGENDAS, AND MINUTES

TAKE THE PUBLIC SURVEY

REVIEW DRAFT DOCUMENTS

Plan Website Outreach

The **Final** meetings for the Wake County HMP will be held on **Monday, April 22, 2019**. The **HMPC Meeting** will be held from **3PM to 4:30PM**. The **Public Meeting** will follow from **5PM to 6PM**. Both of the meetings will be held in the Wake County Commons Building, Room 100B & 100C - 4011 Carya Drive, Raleigh

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MEETING SCHEDULES, AGENDAS, AND MINUTES

TAKE THE PUBLIC SURVEY

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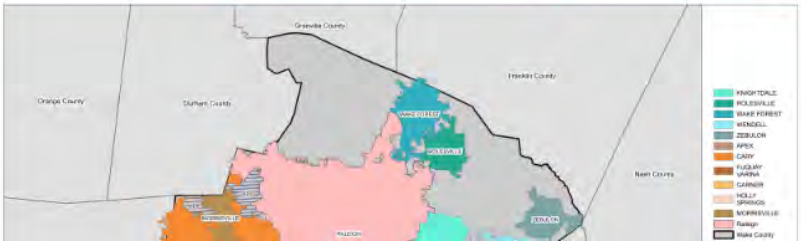
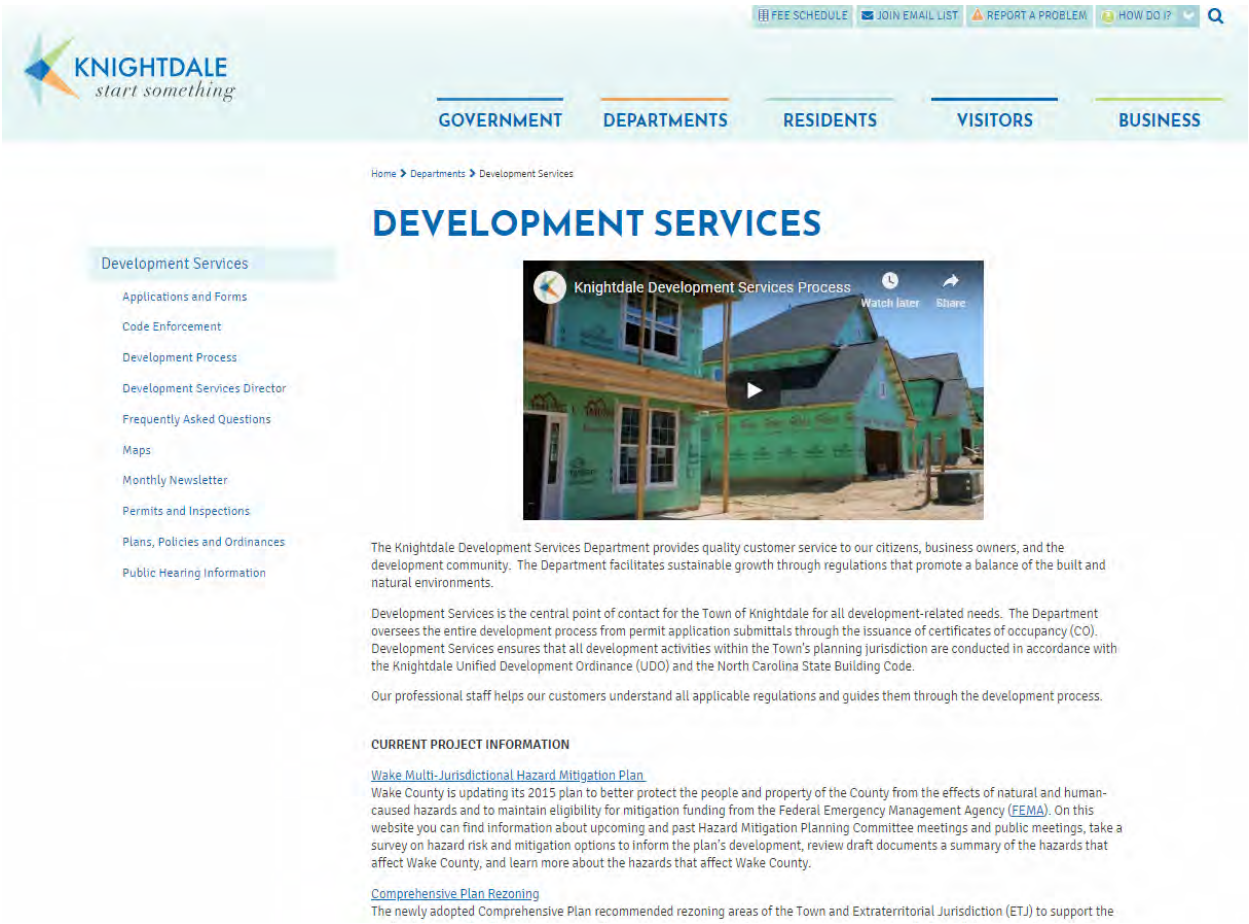
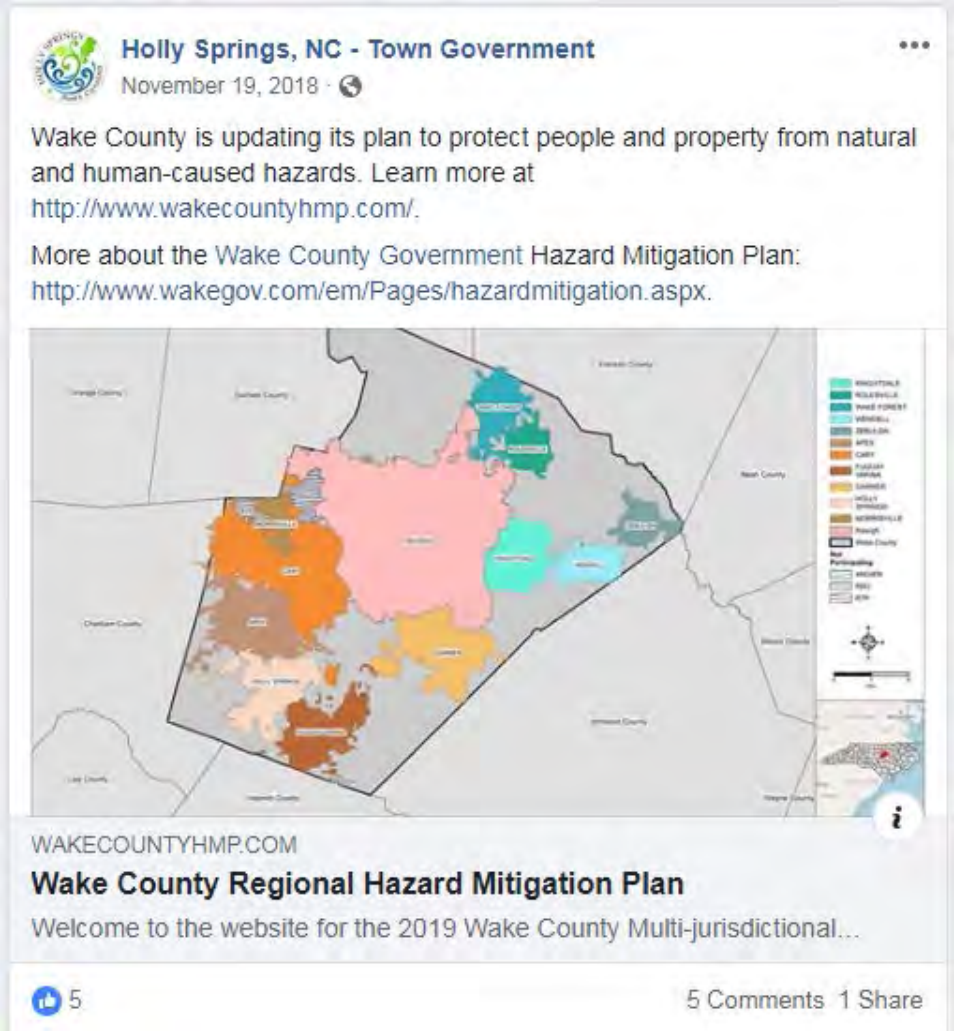



FEE SCHEDULE
JOIN EMAIL LIST
REPORT A PROBLEM
HOW DO I?
KNIGHTDALE
start something
GOVERNMENT
DEPARTMENTS
RESIDENTS
VISITORS
BUSINESS
Home > Departments > Development Services
DEVELOPMENT SERVICES
Development Services
Applications and Forms
Code Enforcement
Development Process
Development Services Director
Frequently Asked Questions
Maps
Monthly Newsletter
Permits and Inspections
Plans, Policies and Ordinances
Public Hearing Information
Knightdale Development Services Process
Watch later
Share
The Knightdale Development Services Department provides quality customer service to our citizens, business owners, and the development community. The Department facilitates sustainable growth through regulations that promote a balance of the built and natural environments.
Development Services is the central point of contact for the Town of Knightdale for all development-related needs. The Department oversees the entire development process from permit application submittals through the issuance of certificates of occupancy (CO). Development Services ensures that all development activities within the Town's planning jurisdiction are conducted in accordance with the Knightdale Unified Development Ordinance (UDO) and the North Carolina State Building Code.
Our professional staff helps our customers understand all applicable regulations and guides them through the development process.
CURRENT PROJECT INFORMATION
Wake Multi-Jurisdictional Hazard Mitigation Plan
Wake County is updating its 2015 plan to better protect the people and property of the County from the effects of natural and human-caused hazards and to maintain eligibility for mitigation funding from the Federal Emergency Management Agency (FEMA). On this website you can find information about upcoming and past Hazard Mitigation Planning Committee meetings and public meetings, take a survey on hazard risk and mitigation options to inform the plan's development, review draft documents a summary of the hazards that affect Wake County, and learn more about the hazards that affect Wake County.
Comprehensive Plan Rezoning
The newly adopted Comprehensive Plan recommended rezoning areas of the Town and Extraterritorial Jurisdiction (ETJ) to support the

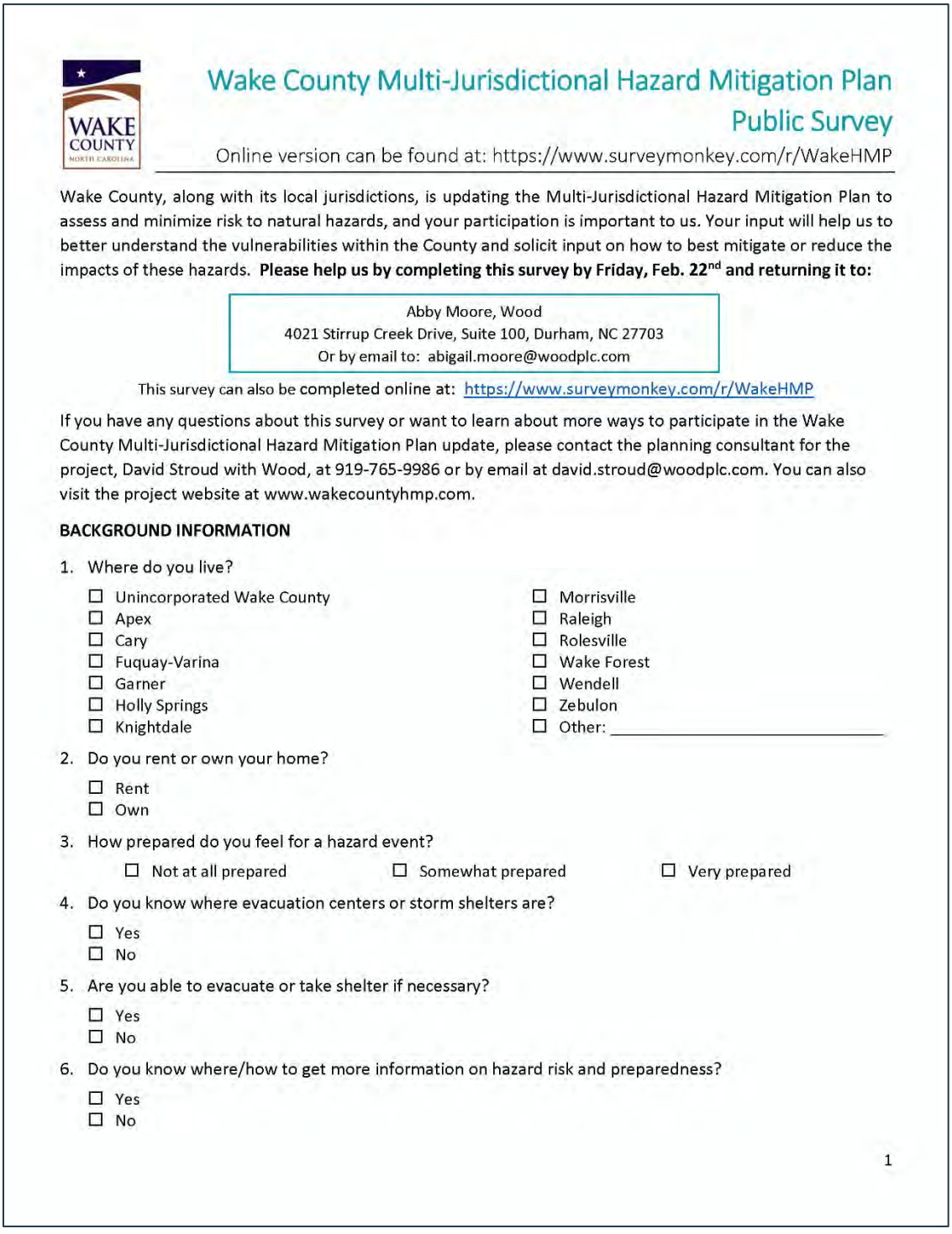

KnightdaleNext
January 8
Help Wake County and Knightdale, NC inform the Multi-Jurisdictional Hazard Mitigation Plan. Take the survey here:
http://www.wakecountyhmp.com/Survey.html
Wake County EMS Wake County Government Knightdale Fire Department Knightdale Police Department
WAKECOUNTYHMP.COM
Wake County Regional Hazard Mitigation Plan
1 Share


Holly Springs, NC - Town Government
November 19, 2018
Wake County is updating its plan to protect people and property from natural and human-caused hazards. Learn more at http://www.wakecountyhmp.com/.
More about the Wake County Government Hazard Mitigation Plan: http://www.wakegov.com/em/Pages/hazardmitigation.aspx.
WAKECOUNTYHMP.COM
Wake County Regional Hazard Mitigation Plan
Welcome to the website for the 2019 Wake County Multi-jurisdictional...
5
5 Comments 1 Share


Zebulon Planning
@tozplanning
Follow
2015 Hazard Mitigation Plan Update. Zebulon and Wake County need your assistance!
wakecountyhmp.com
2:04 PM - 19 Dec 2018
North Carolina 811 provides you a communications link

Public Survey

Wake County distributed a public survey, shown below, that requested public input into the Hazard Mitigation Plan planning process and the identification of mitigation activities that could lessen the risk and impact of future flood hazard events. The survey was announced at the first public meeting, provided via a link on participating jurisdictions web and social media accounts, and made available online on the plan website.



Wake County Multi-Jurisdictional Hazard Mitigation Plan
Public Survey

Online version can be found at: https://www.surveymonkey.com/r/WakeHMP

Wake County, along with its local jurisdictions, is updating the Multi-Jurisdictional Hazard Mitigation Plan to assess and minimize risk to natural hazards, and your participation is important to us. Your input will help us to better understand the vulnerabilities within the County and solicit input on how to best mitigate or reduce the impacts of these hazards. **Please help us by completing this survey by Friday, Feb. 22nd and returning it to:**

Abby Moore, Wood
4021 Stirrup Creek Drive, Suite 100, Durham, NC 27703
Or by email to: abigail.moore@woodplc.com

This survey can also be completed online at: https://www.surveymonkey.com/r/WakeHMP

If you have any questions about this survey or want to learn about more ways to participate in the Wake County Multi-Jurisdictional Hazard Mitigation Plan update, please contact the planning consultant for the project, David Stroud with Wood, at 919-765-9986 or by email at david.stroud@woodplc.com. You can also visit the project website at www.wakecountyhmp.com.

BACKGROUND INFORMATION

1. Where do you live?
   - ☐ Unincorporated Wake County
   - ☐ Apex
   - ☐ Cary
   - ☐ Fuquay-Varina
   - ☐ Garner
   - ☐ Holly Springs
   - ☐ Knightdale
   - ☐ Morrisville
   - ☐ Raleigh
   - ☐ Rolesville
   - ☐ Wake Forest
   - ☐ Wendell
   - ☐ Zebulon
   - ☐ Other: _____
2. Do you rent or own your home?
   - ☐ Rent
   - ☐ Own
3. How prepared do you feel for a hazard event?
   - ☐ Not at all prepared ☐ Somewhat prepared ☐ Very prepared
4. Do you know where evacuation centers or storm shelters are?
   - ☐ Yes
   - ☐ No
5. Are you able to evacuate or take shelter if necessary?
   - ☐ Yes
   - ☐ No
6. Do you know where/how to get more information on hazard risk and preparedness?
   - ☐ Yes
   - ☐ No

1

HAZARD INFORMATION

7. The hazards addressed in the Hazard Mitigation Plan are listed below. Please indicate the level of significance that you perceive for each hazard. Please rate these hazards 1 through 3 as follows: 1=low, 2=moderate, 3=high.

____ Dam Failure	____ Severe Weather (Thunderstorm/Lightning/Hail)
____ Drought	____ Severe Winter Storm
____ Earthquake	____ Tornado
____ Extreme Heat	____ Wildfire
____ Flood	____ Hazardous Materials Incident
____ Hurricane	____ Radiological Emergency
____ Landslide	____ Terrorism

8. Describe specific hazard issues/problem areas that you would like the planning committee to consider.

9. Describe any actions you have taken to mitigate hazard risk for your family, home, or neighborhood.

10. Which categories of mitigation actions do you feel would be most effective?

- ☐ Preventive activities (e.g. planning and zoning, building codes)
- ☐ Property protection (e.g. retrofitting, insurance, flood prone property buyout)
- ☐ Natural resource protection (e.g. wetlands protection, erosion control, forest health protection)
- ☐ Emergency services (e.g. hazard threat recognition, hazard warning systems, critical facilities protection)
- ☐ Structural projects (e.g. storm drain improvements, hazardous tree removal,
- ☐ Public information (e.g. outreach projects, environmental education, public education)

11. What is the best way for you to receive information about how to make your family, home, or neighborhood more resilient to hazards? Please check all that apply.

☐ Television News/Advertisements	☐ County website
☐ Radio News/Advertisements	☐ County social media
☐ Public Forums/Workshops	☐ Email
☐ Public Library	☐ Text messages
☐ Print Media – newspaper, phone book, informational brochures	☐ Other _____

Thank you for your input!

Please provide your name and email below if you would like to be informed of future meetings related to the planning process.

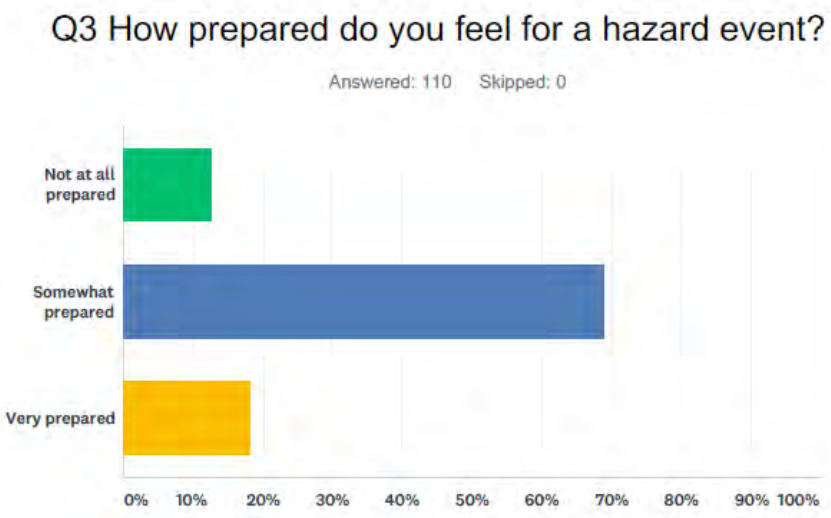
Name: _____ Email: _____

2

The County received 110 responses to the survey. The following bullet points summarize significant findings from the survey. Key questions and responses are detailed in Figure B.1 through Figure B.9.

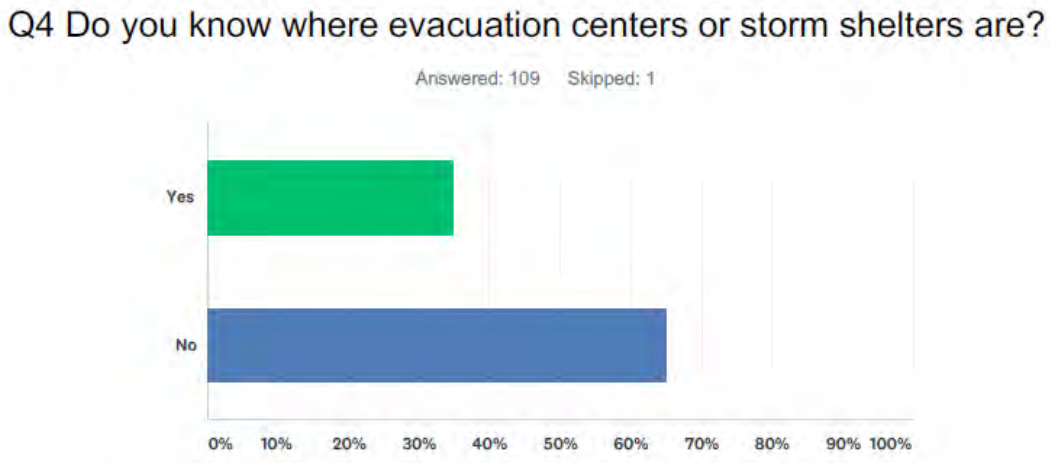
- 12.7% of respondents say they feel not at all prepared for a hazard event; 69.1% feel somewhat prepared.
- 65.1% of respondents do not know where evacuation centers or storm shelters are located; however, 96.3% of respondents say they are able to evacuate or take shelter if necessary, which indicates that most people manage evacuating or taking shelter through their own resources. It is possible that these results skew toward those with more awareness of hazard risk and resources to respond.
- Over 40% of respondents do not know where to get more information on hazard risk and preparedness.
- Hurricane was rated the most significant hazard, followed by tornado, severe winter storm, and severe weather. Landslide was rated the least significant hazard, followed by dam failure and earthquake.
- Many respondents who reported having taken steps to mitigate risk at home reported preparedness actions such as emergency kits and supplies and evacuation plans. Few respondents noted prevention or property protection actions; therefore, these may be important ideas to promote in outreach.
- Respondents largely favored emergency services projects and structural projects for mitigation.

Figure B.1 – Survey Response, Preparedness



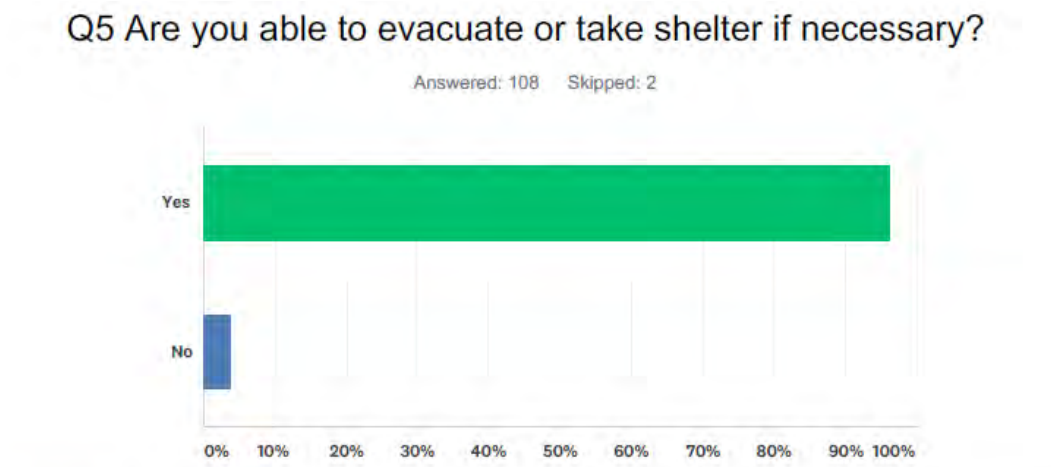
ANSWER CHOICES	RESPONSES	
Not at all prepared	12.73%	14
Somewhat prepared	69.09%	76
Very prepared	18.18%	20
TOTAL		110

Figure B.2 – Survey Response, Evacuation Center/Shelter Awareness



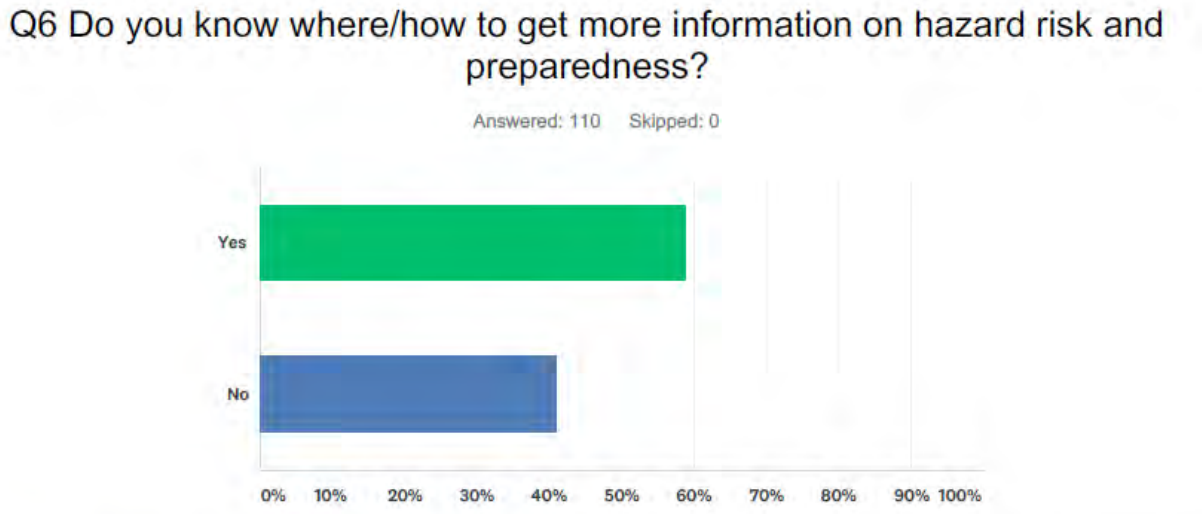
ANSWER CHOICES	RESPONSES	
Yes	34.86%	38
No	65.14%	71
TOTAL		109

Figure B.3 – Survey Response, Ability to Evacuate/Take Shelter



ANSWER CHOICES	RESPONSES	
Yes	96.30%	104
No	3.70%	4
TOTAL		108

Figure B.4 – Survey Response, Knowledge of Where to Find Hazard Information



ANSWER CHOICES	RESPONSES	
Yes	59.09%	65
No	40.91%	45
TOTAL		110

Figure B.5 – Survey Response, Hazard Significance Ratings

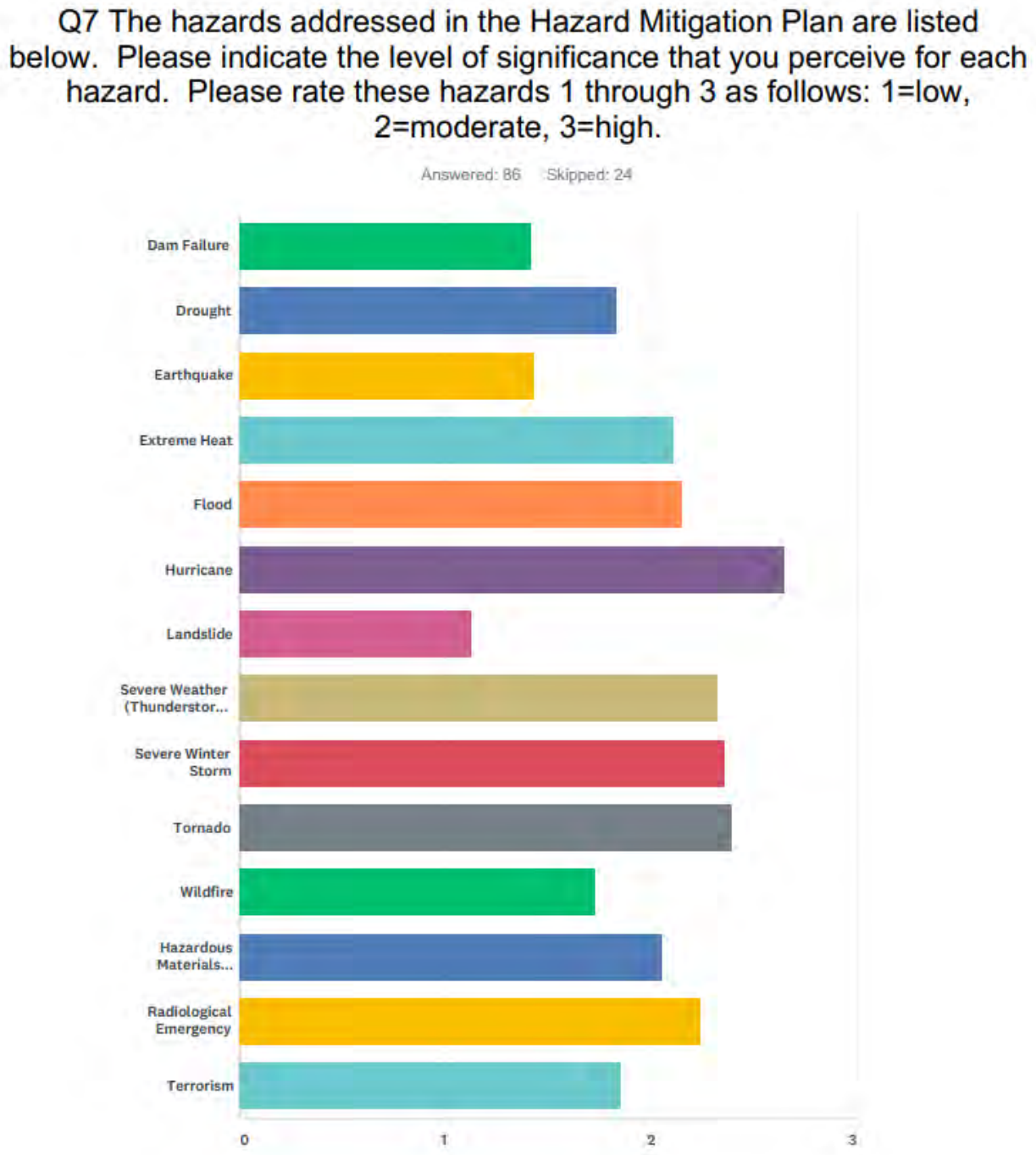


Figure B.6 – Survey Response, Key Hazard Issues/Concerns

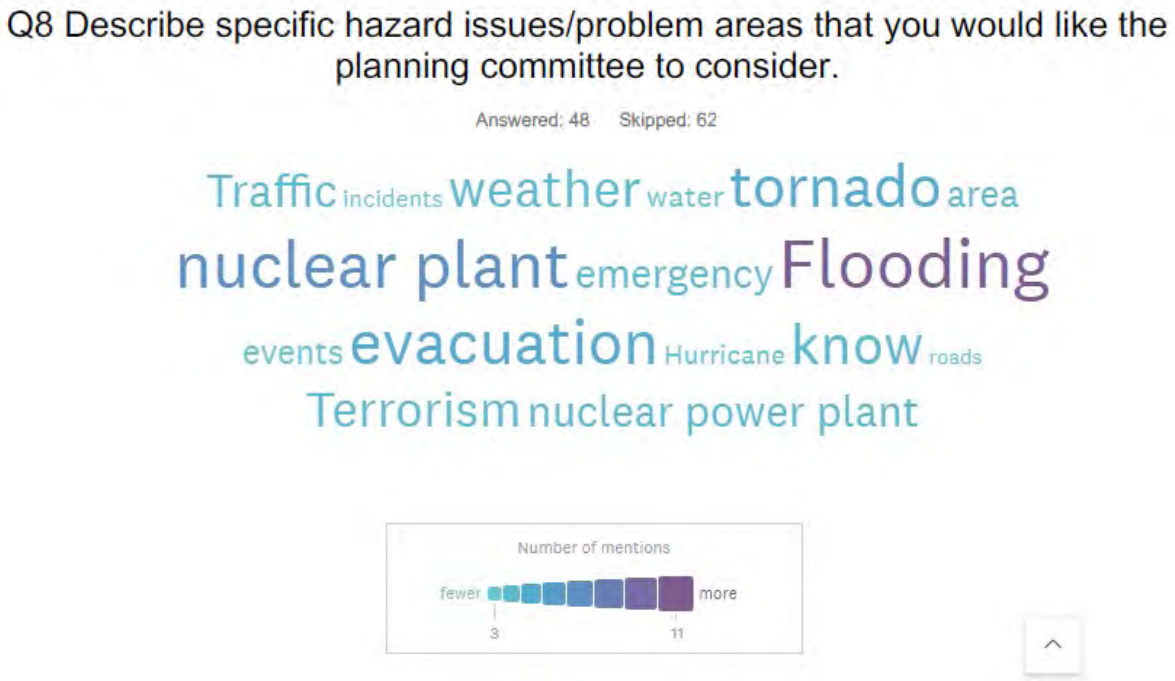
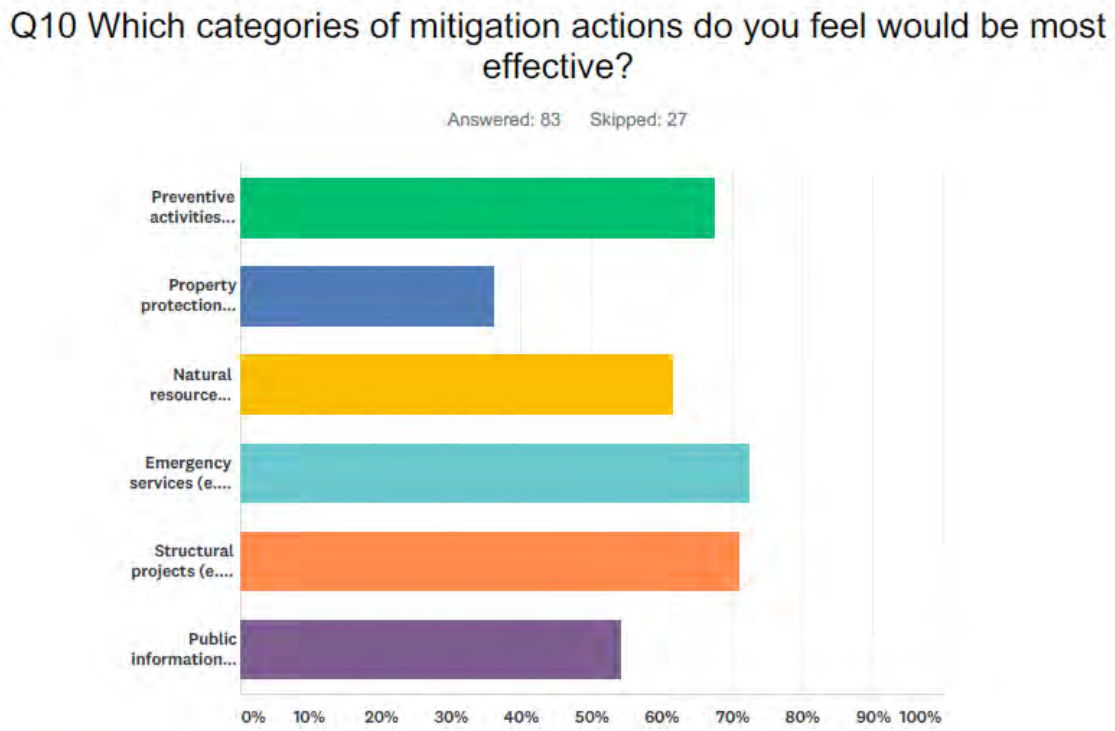


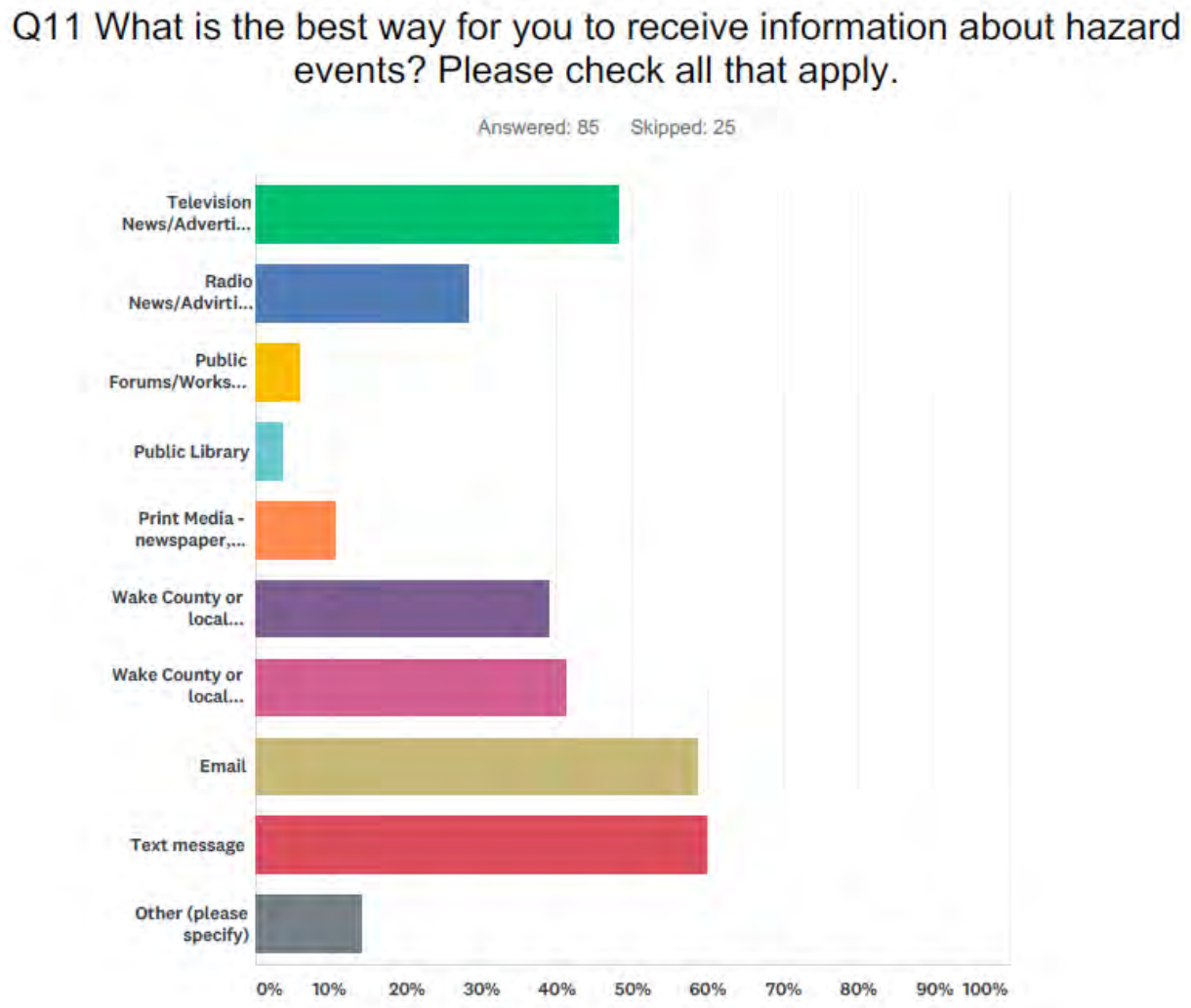
Figure B.7 – Survey Response, Personal Actions Taken for Mitigation

Figure B.8 – Survey Response, Preferred Mitigation Categories



ANSWER CHOICES	RESPONSES	
Preventive activities (e.g. planning and zoning, building codes)	67.47%	56
Property protection (e.g. retrofitting, insurance, flood prone property buyout)	36.14%	30
Natural resource protection (e.g. wetlands protection, erosion control, forest health protection)	61.45%	51
Emergency services (e.g. hazard threat recognition, hazard warning systems, critical facilities protection)	72.29%	60
Structural projects (e.g. storm drain improvements, hazardous tree removal,	71.08%	59
Public information (e.g. outreach projects, environmental education, public education)	54.22%	45
Total Respondents: 83		

Figure B.9 – Survey Response, Preferred Public Outreach Methods



PLANNING STEP 3: COORDINATE

This planning step credits the incorporation of other plans and other agencies' efforts into the development of the Hazard Mitigation Plan. Other agencies and organizations must be contacted to determine if they have studies, plans and information pertinent to the Hazard Mitigation Plan, to determine if their programs or initiatives may affect the community's program, and to see if they could support the community's efforts. To incorporate stakeholder input into the plan, a variety of stakeholders were identified by the HMPC and sent an email inviting them to attend a public meeting, review the draft plan, and provide feedback and comments. The coordination letter sent via email is provided below. A list of stakeholders detailing their involvement is provided in Table B.3.

Stakeholders were also involved through specific requests for data to support the development of the plan.

From: Moore, Abigail
To: rhowes@triangleland.org; brian@ncconservationnetwork.org; chris@ctnc.org; barry.porter@redcross.org; cgmoore@wcpss.net; mtbecker@ncsu.edu; gleasona@meredith.edu; daplautz@waketech.edu; doug.logan@granvillecounty.org; jlewis@franklincountync.us; brian.brantley@nashcountync.gov; kevin.hubbard@johnstonnc.com; ltsmith@harnett.org; alan.byrd@chathamnc.org; jgroves@dconc.gov; Edwardine.Marrone@fema.dhs.gov; ktodd@ISO.com; jbratcher@iso.com; sharper@iso.com; ewstrom@usgs.gov; Dan.Brubaker@ncdps.gov; jcrew@ncem.org; john.holley@ncdenr.gov; linda.culpepper@ncdenr.gov; tim.baumgartner@ncdenr.gov; Hannah.thompson@ncagr.gov; jschmitz@ticog.com; nfeit@thestate.com; mpaul@ba-nc.com; llong@carolinasmallbusiness.org; roy.mcclure@fema.dhs.gov; johnhc@ticog.org
Cc: Stroud, David A; Joshua Creighton
Subject: Wake County Hazard Mitigation Plan
Date: Tuesday, April 16, 2019 5:15:00 PM
Attachments: image002.png

Good afternoon,

Wake County, North Carolina is in the process of developing an update to the 2015 Wake County Multi-Jurisdictional Hazard Mitigation Plan. To assist with this process, the County and the Hazard Mitigation Planning Committee are seeking your input and expertise to support our planning effort.

We invite you to attend a public information meeting on the draft plan on Monday, April 22nd at 5 p.m. at the Wake County Commons Building, Room 100B & 100C (located at 4011 Carya Drive, Raleigh, NC, 27610). Additionally, soon after the public meeting we will be releasing the full draft of the plan for review. The draft will be posted on the plan website, here: http://www.wakecountyhmp.com/draftDocuments.html. The website already contains information on the risk assessment findings and the planning process, which we encourage you to review. We appreciate any input you may have! Please email any comments or feedback on the draft plan to me at abigail.moore@woodplc.com.

Thank you for your assistance in this important effort to make our communities safer and more resilient to hazards!

Abby Moore
Hazard Mitigation & Resiliency Planner
Direct: +1 (919) 768 9927
www.woodplc.com

wood.

Table B.3 – Stakeholder List

First Name	Last Name	Organization
Non-Profit Organizations		
Bo	Howes	Triangle Land Conservancy, Director
Brian	Buzby	NC Conservation Network
Chris	Canfield	Conservation Trust for North Carolina
Barry	Porter	American Red Cross Triangle Area - Regional CEO
Educational Institutions		
Cathy	Quiroz Moore	Wake County Public School System, Superintendent
Todd	Becker	NCSU Department of Emergency Management and Mission Continuity, Emergency Manager
Ann	Gleason	Meredith College, Incident Response Team Chair
Douglas	Plautz	Environmental, Health & Safety, Director
Surrounding Municipalities		
Doug	Logan	Granville County Emergency Management, Emergency Services Director
Jeff	Lewis	Franklin County Office of Emergency Services, Emergency Services Director
Brian	Brantley	Nash County Emergency Management, Emergency Services Director
Kevin	Hubbard	Johnston County Emergency Management, Emergency Management Director
Larry	Smith	Harnett County Emergency Management, Emergency Services Director
Alan	Byrd	Chatham County Emergency Management, Emergency Management Coordinator
Jim	Groves	Durham County Emergency Management, Emergency Management Director
Federal Government		
Roy	McClure	FEMA NFIP/CRS Specialist
Edwardine	Marrone	FEMA Mitigation Planning Specialist
Mandy	Todd	ISO/CRS Specialist
Mike	Bratcher	ISO/CRS Specialist
Sherry	Harper	ISO/CRS Technical Coordinator
Eric	Strom	USGS - Raleigh Field Office
State Government		
Dan	Brubaker	State NFIP Coordinator
Chris	Crew	State Hazard Mitigation Officer
John	Holley	NCDENR - Land Quality Section Regional Office
Linda	Culpepper	DEQ Division of Water Resources, Director
Tim	Baumgartner	DEQ Division of Mitigation Services, Director
Hannah	Thompson-Welch	NC Forest Service, Wildfire Mitigation Specialist
Regional Planning Organization		
John	Hodges-Copple	TJCOG Regional Planning Director
Jen	Schmitz	TJCOG
Business Community		
Noah	Feit	The News & Observer
Melanie	Paul	Business Alliance of North Carolina
Lenwood	Long Sr.	Carolina Small Business Development Fund, President/CEO

Appendix C Mitigation Alternatives

44 CFR Subsection D §201.6(c)(3)(ii): [The mitigation strategy section shall include] a section that identifies and analyzes a comprehensive range of specific mitigation actions and projects being considered to reduce the effects of each hazard, with particular emphasis on new buildings and infrastructure. All plans approved by FEMA after October 1, 2008, must also address the jurisdiction's participation in the NFIP, and continued compliance with NFIP requirements, as appropriate.

As part of the process of developing the mitigation action plans found in Section 7, the HMPC reviewed and considered a comprehensive range of mitigation options before selecting the actions identified for implementation. This section summarizes the full range of mitigation measures evaluated and considered by the HMPC, including a review of the categories of mitigation measures outlined in the 2017 CRS Coordinator's Manual, a discussion of current local implementation and CRS credits earned for those measures, and a list of the specific mitigation projects considered and recommended for implementation.

Mitigation alternatives identified for implementation by the HMPC were evaluated and prioritized using the criteria discussed in Section 6 of this plan.

C.1 CATEGORIES OF MITIGATION MEASURES CONSIDERED

Once it was determined which flood hazards warranted the development of specific mitigation actions, the HMPC analyzed viable mitigation options that supported the identified goals and objectives. The HMPC was provided with the following list of mitigation categories which are utilized as part of the CRS planning process.

- Prevention
- Property Protection
- Natural Resource Protection
- Structural Projects
- Emergency Services
- Public Information and Outreach

C.2 ALTERNATIVE MITIGATION MEASURES PER CATEGORY

Note: the CRS Credit Sections are based on the 2017 CRS Coordinator's Manual.

C.2.1 Preventative and Regulatory Measures

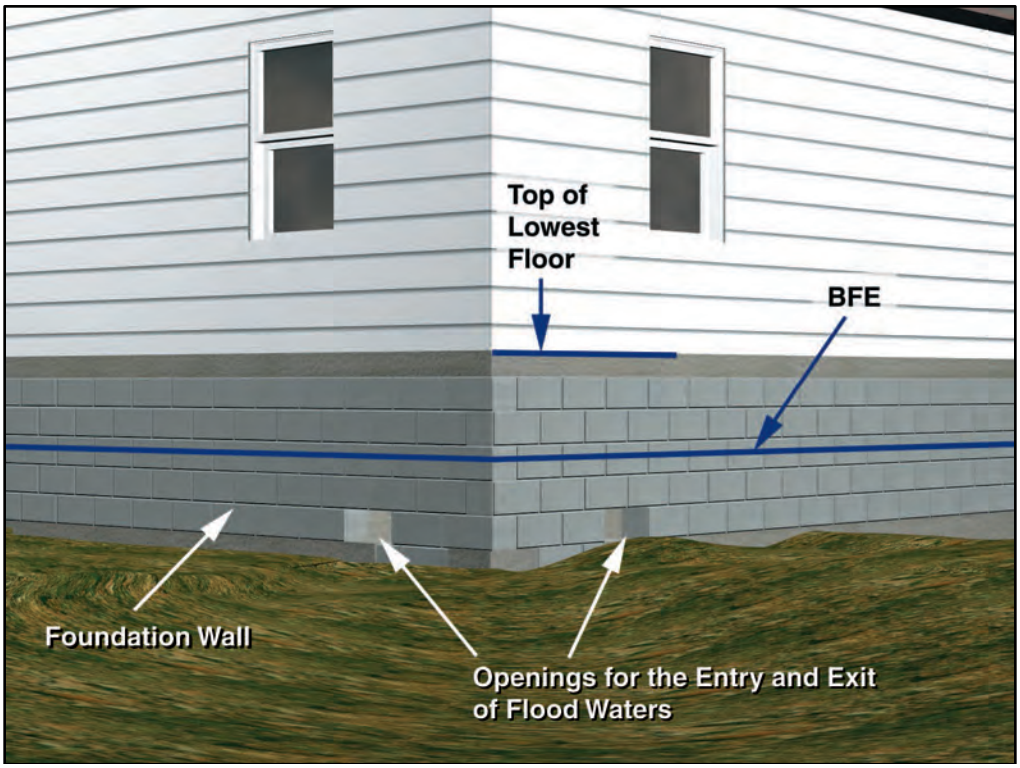
Preventative measures are designed to keep a problem - such as flooding - from occurring or from getting worse. The objective of preventative measures is to ensure that future development is not exposed to damage and does not cause an increase in damages to other properties. Building, zoning, planning and code enforcement offices usually administer preventative measures. Some examples of types of preventative measures include:

- Building codes
- Zoning ordinance
- Comprehensive or land use plan
- Open space preservation
- Floodplain regulations
- Subdivision regulations
- Stormwater management regulations

Building Codes

Building codes provide one of the best methods for addressing natural hazards. When properly designed and constructed according to code, the average building can withstand many of the impacts of natural hazards. Hazard protection standards for all new and improved or repaired buildings can be incorporated into the local building code. Building codes can ensure that the first floors of new buildings are constructed to be higher than the elevation of the 100-year flood (the flood that is expected to have a one percent chance of occurring in any given year). This is shown in Figure B.1.

Just as important as having code standards is the enforcement of the code. Adequate inspections are needed during the course of construction to ensure that the builder understands the requirements and is following them. Making sure a structure is properly elevated and anchored requires site inspections at each step.



Source: FEMA Publication: *Above the Flood: Elevating Your Floodprone House, 2000*

Figure B.1 – Building Codes and Flood Elevations

ASCE 24 is a referenced standard in the International Building Code. Any building or structure that falls within the scope of the IBC that is proposed in a flood hazard area is to be designed in accordance with ASCE 24. Freeboard is required as a function of the nature of occupancy and the flood zone. Dwellings and most other buildings have 1-foot of freeboard; certain essential facilities have 2-3 feet; only agricultural facilities, temporary facilities and minor storage facilities are allowed to have their lowest floors at the BFE.

Comprehensive or Land Use Plan

Building codes provide guidance on how to build in hazardous areas. Planning and zoning activities direct development away from these areas, particularly floodplains and wetlands. They do this by designating land uses that are compatible with the natural conditions of land that is prone to flooding, such as open

space or recreation. Planning and zoning activities can also provide benefits by simply allowing developers more flexibility in arranging improvements on a parcel of land through the planned development approach.

The 2030 City of Raleigh Comprehensive Plan was adopted via Resolution 2009-997 on October 7, 2009. The 2030 Comprehensive Plan is a long-range policy document adopted and amended by the City Council. The Plan establishes a vision for the City, provides policy guidance for growth and development and contains action items directed at the City to implement the vision. The Plan contains six strategic vision themes, which are referenced in every element, or chapter, of the document. The Plan is divided into four major sections: the Introduction and Framework, the Plan Elements, the Area Plans, and Implementation.

Open Space Preservation

Keeping the floodplain and other hazardous areas open and free from development is the best approach to preventing damage to new developments. Open space can be maintained in agricultural use or can serve as parks, greenway corridors and golf courses.

Comprehensive and capital improvement plans should identify areas to be preserved by acquisition and other means, such as purchasing an easement. With an easement, the owner is free to develop and use private property, but property taxes are reduced or a payment is made to the owner if the owner agrees to not build on the part set aside in the easement.

Although there are some federal programs that can help acquire or reserve open lands, open space lands and easements do not always have to be purchased. Developers can be encouraged to dedicate park land and required to dedicate easements for drainage and maintenance purposes.

The City of Raleigh has an extensive park and greenway system throughout the city. The City defines a broad vision for the entire park and greenway system primarily through two documents: the City of Raleigh 2030 Comprehensive Plan and the City of Raleigh Parks, Recreation and Cultural Resources System Plan. The documents provide a vision, goals, objectives and policies that guide staff. The System Plan is a supplemental document to the Comprehensive Plan and is the strategic system plan that guides the growth and development of the City's park and greenway system. Future park needs are compared with an existing inventory of park facilities over a twenty to thirty-year horizon. Included within this plan are recommendations for new park development, maintenance and continued renovation of existing parks and facilities, and guidelines that will allow the system to provide ample recreational opportunities for all citizens while remaining flexible to change with recreational trends, significant development opportunities and Raleigh's growing population. A system plan is developed every five to ten years. On May 6, 2014 the Raleigh City Council voted unanimously to approve the Parks, Recreation and Cultural Resources System Plan.

Zoning Ordinance

The City of Raleigh operates under a Unified Development Ordinance (UDO). This UDO divides the jurisdictions into zoning districts, including various residential, commercial, mixed-use and industrial districts. The zoning regulations describe what type of land use and specific activities are permitted in each district, and how to regulate how buildings, signs, parking, and other construction may be placed on a lot. The zoning regulations also provide procedures for rezoning and other planning applications. The zoning map and zoning

regulations provide properties in Raleigh planning and zoning jurisdiction with certain rights to development.

Floodplain Regulations

The City of Raleigh's Flood Damage Prevention Ordinance requires that all new residential construction or substantial improvement shall have the lowest floor, including the basement, elevated to no lower than two foot above the base flood elevation (BFE).

Vegetation along a stream bank is extremely beneficial for the health of the stream. Trees and other plants have an extensive root system that strengthen stream banks and help prevent erosion.

Vegetation that has sprouted up near streams should remain undisturbed unless removing it will significantly reduce a threat of flooding, or further destruction of the stream channel.

North Carolina regulations prohibit the removal of vegetation within 50 feet of all streams in the Raleigh area. These are known as the Neuse River Riparian Buffer Rules and the North Carolina Division of Water Resources should be consulted before any activities are undertaken in these areas.

Raleigh enforces reconstruction regulations to ensure that mitigation is integrated into recovery. Requiring permits for building repairs and conducting inspections are vital activities to ensure that damaged structures are safe for people to reenter and repair. There is a special requirement to do this in floodplains, regardless of the type of disaster or the cause of damage. The NFIP requires that local officials enforce the substantial damage regulations. These rules require that if the cost to repair a building in the mapped floodplain equals or exceeds 50% of the building's market value, the building must be retrofitted to meet the standards of a new building in the floodplain. In Raleigh, this means that a substantially damaged building must be elevated above the base flood elevation.

Stormwater Management Regulations

Stormwater runoff is increased when natural ground cover is replaced by urban development. Development in the watershed that drains to a river can aggravate downstream flooding, overload the community's drainage system, cause erosion, and impair water quality. There are three ways to prevent flooding problems caused by stormwater runoff:

1) Regulating development in the floodplain to ensure that it will be protected from flooding and that it won't divert floodwaters onto other properties;
2) Regulating all development to ensure that the post-development peak runoff will not be greater than it was under pre-development conditions; and
3) Set construction standards so buildings are protected from shallow water.

The City of Raleigh's Stormwater regulations requires that if more than one acre of land is disturbed, a permit must be obtained by North Carolina Department of Environmental Quality (NCDEQ). Further a stormwater management plan (SWMP) must be developed for all projects required to have a permit for land disturbing activities. These SWMPs must include better site design practices for stormwater management, treat stormwater runoff quality, provide stream channel protection, and provide downstream overbank flood protection. The SWMPs must also provide extreme flood protection such that there is no increase in flood elevations upstream or downstream from the 100-year flood.

Reducing Future Flood Losses

Zoning and comprehensive planning can work together to reduce future flood losses by directing development away from hazard prone areas. Creating or maintaining open space is the primary way to reduce future flood losses. The City of Raleigh has many open space and natural parcels and greenways which serve to reduce future flood losses by remaining open. These parks and natural preserved areas

create opportunities for the public to benefit from education and recreation while eliminating potential for future flooding. The City of Raleigh's Future Land Use Map designates preservation, conservation, and conservation-residential lands to maintain open space throughout the City.

Planning for open space must also be supplemented with development regulations to ensure that stormwater runoff is managed, and that development is protected from flooding. Future flood losses in Raleigh will be reduced through the implementation of the International Building Code, the City's Flood Damage Prevention Ordinance, and Stormwater Management Ordinance. Enforcement of the flood protection elevation requirement will provide an extra level of protection for buildings constructed in the City.

Stormwater management and the requirement that post-development runoff cannot exceed pre-development conditions is one way to prevent future flood losses. Retention and detention requirements also help to reduce future flood losses.

CRS Credit

The CRS encourages strong building codes. It provides credit in two ways: points are awarded based on the community's Building Code Effectiveness Grading Schedule (BCEGS) classification and points are awarded for adopting the International Code series. The HMPC was concerned about the State Building Code Council and the implementation of the most current version of the International Building Code.

CRS credits are available for regulations that encourage developers to preserve floodplains or other hazardous areas away from development. There is no credit for a plan, only for the enforceable regulations that are adopted pursuant to a plan. The City of Raleigh could receive credit for Activity 430 – Higher Regulatory Standards and for Activity 420 – Open Space Preservation for preserving parcels within the SFHA as open space. Preserving flood prone areas as open space is one of the highest priorities of the Community Rating System. The credits in the 2017 manual have doubled for OSP (Open Space Preservation). The City of Raleigh could also receive credit for Activity 450 – Stormwater Management for enforcing regulations for stormwater management and soil and erosion control. The HMPC did not recommend any changes to the City's Comprehensive Plan, Zoning Ordinance, or Subdivision Ordinance, but did agree that higher standards should be considered for the Flood Damage Prevention Ordinance.

Table C.1 – Prevention Mitigation Options and Recommended Projects

Action #	Mitigation Action	Reason for Pursuing / Not Pursuing	Funding
Prevention Measures Considered by HMPC and Not Recommended			
-	Encourage voluntary compliance with floodplain development regulations.	Could save money on enforcement but would not guarantee compliance with standards.	n/a
-	Manage growth and development in the City through a constantly updated Master Plan.	Limited staff resources and monies to support constant updates to a Master Plan.	n/a
-	Incorporate a lower substantial threshold for damage and improvement	No political appetite for lowering the 50% threshold. Would be difficult to get Council support.	n/a
Prevention Measures and Funding Recommended for Implementation			
P-1	Establish a Lake Preservation Policy that encourages private property owners to preserve existing lakes and ponds, and in certain circumstances provides for public assistance.	City Stormwater has also worked with the Stormwater Management Advisory Commission to develop recommendations to further enhance the lake preservation program. It is anticipated that the revised program will be considered by City Council	Operating Budget

Action #	Mitigation Action	Reason for Pursuing / Not Pursuing	Funding
		during calendar year 2019. Enhancements would include the continued ability to restore and upgrade dams and spillways associated with safety improvements as well as removal of dams to protect safety and restore natural conditions	
P-2	Develop ongoing multi-year program of detailed basin studies for each watershed in City's jurisdiction. Fifteen basin studies are complete with 10 additional studies budgeted in the capital program. (CRS 410).	City Stormwater is currently working on an Integrated Stormwater Management Master Plan. Basin studies will be reviewed and updated as needed with further improvement needs and opportunities identified and prioritized. Reduction of flooding hazards remains a key priority for improvement projects.	Operating Budget
P-3	Planning Commission to consider program to develop future conditions floodplain mapping for all FEMA mapped areas (this is already done for non-FEMA mapped areas). The program would consist of a multi-year capital program for mapping for all FEMA streams in the ETJ and consideration of changes to development regulations in these areas. Future conditions would be based on expected development per the Comprehensive Plan and zoning maps.	City Stormwater is working to help mitigate flooding throughout vulnerable areas of the City by increasing the standards by which full development occurs in a watershed. Future conditions modeling will make sure all runoff throughout the watershed is considered when each site is developed.	Operating Budget

C.2.2 Property Protection Measures

Property protection measures are used to modify buildings or property subject to damage. Property protection measures fall under three approaches:

- Modify the site to keep the hazard from reaching the building;
- Modify the building (retrofit) so it can withstand the impacts of the hazard; and
- Insure the property to provide financial relief after the damage occurs.

Property protection measures are normally implemented by the property owner, although in many cases technical and financial assistance can be provided by a government agency.

Keeping the Hazard Away

Generally, natural hazards do not damage vacant areas. As noted earlier, the major impact of hazards is to people and improved property. In some cases, properties can be modified so the hazard does not reach the damage-prone improvements. For example, a berm can be built to prevent floodwaters from reaching a house.

Flooding

There are five common methods to keep a flood from reaching and damaging a building:

- Erect a barrier between the building and the source of the flooding.

- Move the building out of the flood-prone area.
- Elevate the building above the flood level.
- Demolish the building.
- Replace the building with a new one that is elevated above the flood level.

The latter three approaches are the most effective types to consider in the City of Raleigh.

This low floodwall has landscaping to minimize the adverse impact on the property's appearance.

Barriers

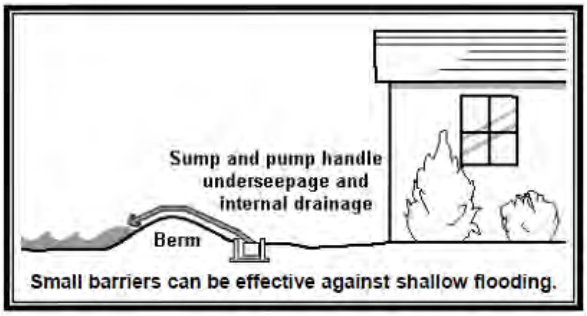
A flood protection barrier can be built of dirt or soil (a "berm") or concrete or steel (a "floodwall"). Careful design is needed so as not to create flooding or drainage problems on neighboring properties. Depending on how porous the ground is, if floodwaters will stay up for more than an hour or two, the design needs to account for leaks, seepage of water underneath, and rainwater that will fall inside the perimeter. This is usually done with a sump or drain to collect the internal groundwater and surface water and a pump and pipe to pump the internal drainage over the barrier. Barriers can only be built so high. They can be overtopped by a flood higher than expected. Barriers made of earth are susceptible to erosion from rain and floodwaters if not properly sloped, covered with grass, and properly maintained.

Small, wood frame buildings are the easiest to relocate

Source: Kennedy House Movers, Huntsville, AL

Relocation

Moving a building to higher ground is the surest and safest way to protect it from flooding. While almost any building can be moved, the cost increases for heavier structures, such as those with exterior brick and stone walls, and for large or irregularly shaped buildings. Relocation is also preferred for large lots that include buildable areas outside the floodplain or where the owner has a new flood-free lot (or portion of the existing lot) available.



Small barriers can be effective against shallow flooding.

Building Elevation

Raising a building above the flood level can be almost as effective as moving it out of the floodplain. Water flows under the building, causing little or no damage to the structure or its contents. Raising a building above the flood level is cheaper than moving it and can be less disruptive to a neighborhood. Elevation has proven to be an acceptable and reasonable means of complying with floodplain regulations that require new, substantially improved, and substantially damaged buildings to be elevated above the base flood elevation.

Demolition

Some buildings, especially heavily damaged or repetitively flooded ones, are not worth the expense to protect them from future damages. It is cheaper to demolish them and either replace them with new, flood protected structures, or relocate the occupants to a safer site. Demolition is also appropriate for buildings that are difficult to move – such as larger, slab foundation or masonry structures – and for dilapidated structures that are not cost-beneficial to protect.

Demolishing a repetitively flooded home

Pilot Reconstruction

If a building is not in good shape, elevating it may not be worthwhile or it may even be dangerous. An alternative is to demolish the structure and build a new one on the site that meets or exceeds all flood protection codes. FEMA funding programs refer to this approach as "pilot reconstruction." It is still a pilot program, and not a regularly funded option. Certain rules must be followed to qualify for federal funds for pilot reconstruction.

Retrofitting

An alternative to keeping the hazard away from a building is to modify or retrofit the site or building to minimize or prevent damage. There are a variety of techniques to do this, as described below.

- ***Dry Floodproofing***

  Dry floodproofing means making all areas below the flood protection level watertight. Walls are coated with waterproofing compounds or plastic sheeting. Openings, such as doors, windows and vents, are closed, either permanently, with removable shields, or with sandbags. Dry floodproofing of new and existing nonresidential buildings in the regulatory floodplain is permitted under state, FEMA and local regulations. Dry floodproofing of existing residential buildings in the floodplain is also permitted as long as the building is not substantially damaged or being substantially improved. Owners of buildings located outside the regulatory floodplain can always use dry floodproofing techniques.

  Dry floodproofing is only effective for shallow flooding, such as repetitive drainage problems. It does not protect from the deep flooding along lakes and larger rivers caused by hurricanes or other storms.

- ***Wet Floodproofing***

  The alternative to dry floodproofing is wet floodproofing: water is let in and everything that could be damaged by a flood is removed or elevated above the flood level. Structural components below the flood level are replaced with materials that are not subject to water damage. For example, concrete block walls are used instead of wooden studs and gypsum wallboard. The furnace, water heater and laundry facilities are permanently relocated to a higher floor. Where the flooding is not deep, these appliances can be raised on blocks or platforms.

Insurance

Technically, insurance does not mitigate damage caused by a natural hazard. However, it does help the owner repair, rebuild, and hopefully afford to incorporate some of the other property protection measures in the process. Insurance offers the advantage of protecting the property, so long as the policy is in force, without requiring human intervention for the measure to work.

- ***Private Property***

  Although most homeowner's insurance policies do not cover a property for flood damage, an owner can insure a building for damage by surface flooding through the NFIP. Flood insurance coverage is

provided for buildings and their contents damaged by a "general condition of surface flooding" in the area. Most people purchase flood insurance because it is required by the bank when they get a mortgage or home improvement loan. Usually these policies just cover the building's structure and not the contents. Contents coverage can be purchased separately. Renters can buy contents coverage, even if the owner does not buy structural coverage on the building. Most people don't realize that there is a 30-day waiting period to purchase a flood insurance policy and there are limits on coverage.

- ***Public Property***
  Governments can purchase commercial insurance policies. Larger local governments often self-insure and absorb the cost of damage to one facility, but if many properties are exposed to damage, self-insurance can drain the government's budget. Communities cannot expect federal disaster assistance to make up the difference after a flood.

Local Implementation/CRS Credit

The CRS provides the most credit points for acquisition and relocation under Activity 520, because this measure permanently removes insurable buildings from the floodplain. The City of Raleigh could receive credit for Activity 520 – Acquisition and Relocation, for acquiring and relocating buildings from the SFHA. The HMPC recommended that the City continue the purchase of repetitive loss buildings through its Stormwater Utility funding and other buildings which are subject to flood damage in order to return this land to open space.

The CRS also credits barriers and elevating existing buildings under Activity 530. The credit for Activity 530 is based on the combination of flood protection techniques used and the level of flood protection provided. Points are calculated for each protected building. Bonus points are provided for the protection of repetitive loss buildings and critical facilities. It may not be likely that the City of Raleigh could receive credit for Activity 530 – Flood Protection, but the City could receive credit for Activity 360 – Flood Protection Assistance. There is capable staff at the City who have the technical expertise to provide advice and assistance to homeowners who may want to flood proof their home or business. Advice is provided both on property protection techniques and on financial assistance programs to help fund mitigation. Though it was not selected as a mitigation action due because it is already established and ongoing, the HMPC did not agree that any mitigation project would be necessary for Activity 360 Flood Protection Assistance.

Flood insurance information for the City is provided in Section 5 and in greater detail in Annex B. The City of Raleigh publicizes the requirement for flood insurance to those requesting FIRM information through the Mandatory Purchase Requirement and through outreach brochures to residents of the SFHA and repetitive loss areas.

There is no credit for purchasing flood insurance, but the CRS does provide credit for local public information programs that, among other topics, explain flood insurance to property owners. The CRS also reduces the premiums for those people who do buy NFIP coverage. The City of Raleigh could receive credit for Activity 330 – Outreach Projects. The HMPC would like to focus outreach to property owners on the availability of Increased Cost of Compliance (ICC) coverage, which provides additional funds to repetitive loss properties and substantially damaged properties to offset the cost of improvements needed to bring these properties up to code.

Table C.2 – Property Protection Mitigation Options and Recommended Projects

Action #	Mitigation Action	Reason for Pursuing / Not Pursuing	Funding
Prevention Measures Considered by HMPC and Not Recommended			
-	Continue to publicize technical assistance for Activity 360 Flood Protection Assistance.	This service is already well-established, and no additional effort is required for ongoing implementation to continue.	n/a
Prevention Measures and Funding Recommended for Implementation			
PP-1	Develop ongoing program designed to utilize Federal grant resources to assist private property owners in relocating existing structures out of flood hazard zones. (CRS 500/510/520)	Acquisition and demolition of repetitive loss structures completely removes the flood problem and eliminates vulnerability while also expanding open space and enhancing the land's natural and beneficial flood management functions.	HMGP and Stormwater Utility Funding
PP-2	Develop an ongoing program designed to utilize Federal grant resources to assist private property owners in elevating existing structures located within flood hazard zones. (CRS 510/530)	Pre-FIRM properties vulnerable to major flooding should be mitigated to prevent substantial damages, and substantially damaged properties already face high costs to be brought up to code and may benefit from alternative mitigation such as elevation.	HMGP, FMA
9	Develop an ongoing program designed to utilize Federal grant resources to assist private property owners in renovating and retrofitting existing structures in flood hazard zones to reduce vulnerability to flooding damage.	City staff evaluates potential candidates and approaches property owners for mitigation help.	HMGP, FMA, Stormwater Utility Funding

C.2.3 Natural Resource Protection

Resource protection activities are generally aimed at preserving (or in some cases restoring) natural areas. These activities enable the naturally beneficial functions of fields, floodplains, wetlands, and other natural lands to operate more effectively. Natural and beneficial functions of watersheds, floodplains and wetlands include:

- Reduction in runoff from rainwater and stormwater in pervious areas
- Infiltration that absorbs overland flood flow
- Removal and filtering of excess nutrients, pollutants and sediments
- Storage of floodwaters
- Absorption of flood energy and reduction in flood scour
- Water quality improvement
- Groundwater recharge
- Habitat for flora and fauna
- Recreational and aesthetic opportunities

As development occurs, many of the above benefits can be achieved through regulatory steps for protecting natural areas or natural functions. This section covers the resource protection programs and standards that can help mitigate the impact of natural hazards, while they improve the overall environment. Six areas were reviewed:

- Wetland protection
- Erosion and sedimentation control
- Stream/River restoration
- Best management practices
- Dumping regulations
- Farmland protection

Wetland Protection

Wetlands are often found in floodplains and topographically depressed areas of a watershed. Many wetlands receive and store floodwaters, thus slowing and reducing downstream flows. They also serve as a natural filter, which helps to improve water quality, and they provide habitat for many species of fish, wildlife and plants.

Erosion and Sedimentation Control

Farmlands and construction sites typically contain large areas of bare exposed soil. Surface water runoff can erode soil from these sites, sending sediment into downstream waterways. Erosion also occurs along stream banks and shorelines as the volume and velocity of flow or wave action destabilize and wash away the soil. Sediment suspended in the water tends to settle out where flowing water slows down. This can clog storm drains, drain tiles, culverts and ditches and reduce the water transport and storage capacity of river and stream channels, lakes and wetlands.

There are two principal strategies to address these problems: minimize erosion and control sedimentation. Techniques to minimize erosion include phased construction, minimal land clearing, and stabilizing bare ground as soon as possible with vegetation and other soil stabilizing practices. The City of Raleigh has adopted a soil and erosion control ordinance.

Stream/River Restoration

There is a growing movement that has several names, such as "stream conservation," "bioengineering," or "riparian corridor restoration." The objective of these approaches is to return streams, stream banks and adjacent land to a more natural condition, including the natural meanders. Another term is "ecological restoration," which restores native indigenous plants and animals to an area.

A key component of these efforts is to use appropriate native plantings along the banks that resist erosion. This may involve retrofitting the shoreline with willow cuttings, wetland plants, or rolls of landscape material covered with a natural fabric that decomposes after the banks are stabilized with plant roots.

In all, restoring the right vegetation to a stream has the following advantages:

- Reduces the amount of sediment and pollutants entering the water
- Enhances aquatic habitat by cooling water temperature
- Provides food and shelter for both aquatic and terrestrial wildlife
- Can reduce flood damage by slowing the velocity of water
- Increases the beauty of the land and its property value
- Prevents property loss due to erosion
- Provides recreational opportunities, such as hunting, fishing and bird watching
- Reduces long-term maintenance costs

As required by state and federal regulations, Raleigh works with municipal governments to monitor its storm water drainage outfalls and control storm water runoff.

Best Management Practices

Point source pollutants come from pipes such as the outfall of a municipal wastewater treatment plant. They are regulated by the US EPA. Nonpoint source pollutants come from non-specific locations and harder to regulate. Examples of nonpoint source pollutants are lawn fertilizers, pesticides, other chemicals, animal wastes, oils from street surfaces and industrial areas, and sediment from agriculture, construction, mining and forestry. These pollutants are washed off the ground's surface by stormwater and flushed into receiving storm sewers, ditches and streams.

The term "best management practices" (BMPs) refers to design, construction and maintenance practices and criteria that minimize the impact of stormwater runoff rates and volumes, prevent erosion, protect natural resources and capture nonpoint source pollutants (including sediment). They can prevent increases in downstream flooding by attenuating runoff and enhancing infiltration of stormwater. They also minimize water quality degradation, preserve beneficial natural features onsite, maintain natural base flows, minimize habitat loss, and provide multiple usages of drainage and storage facilities.

Raleigh's Stormwater Management Ordinance contains regulations for stormwater BMPs.

Dumping Regulations

BMPs usually address pollutants that are liquids or are suspended in water that are washed into a lake or stream. Dumping regulations address solid matter, such as shopping carts, appliances and landscape waste that can be accidentally or intentionally thrown into channels or wetlands. Such materials may not pollute the water, but they can obstruct even low flows and reduce the channels' and wetlands' abilities to convey or clean stormwater.

Many cities have nuisance ordinances that prohibit dumping garbage or other "objectionable waste" on public or private property. Waterway dumping regulations need to also apply to "non-objectionable" materials, such as grass clippings or tree branches, which can kill ground cover or cause obstructions in channels. Regular inspections to catch violations should be scheduled.

Many people do not realize the consequences of their actions. They may, for example, fill in the ditch in their front yard without realizing that is needed to drain street runoff. They may not understand how regarding their yard, filling a wetland, or discarding leaves or branches in a watercourse can cause a problem to themselves and others. Therefore, a dumping enforcement program should include public information materials that explain the reasons for the rules as well as the penalties.

Farmland Protection

Farmland protection is an important piece of comprehensive planning and zoning throughout the United States. The purpose of farmland protection is to provide mechanisms for prime, unique, or important agricultural land to remain as such, and to be protected from conversion to nonagricultural uses.

Frequently, farm owners sell their land to residential or commercial developers and the property is converted to non-agricultural land uses. With development comes more buildings, roads and other infrastructure. Urban sprawl occurs, which can lead to additional stormwater runoff and emergency management difficulties.

Farms on the edge of cities are often appraised based on the price they could be sold for to urban developers. This may drive farmers to sell to developers because their marginal farm operations cannot afford to be taxed as urban land. The Farmland Protection Program in the United States Department of

Agriculture's 2002 Farm Bill (Part 519) allows for funds to go to state, tribal, and local governments as well as nonprofit organizations to help purchase easements on agricultural land to protect against the development of the land.

Because of the urbanization of the City of Raleigh, the HMPC did not recommend any projects related to farmland protection.

Local Implementation/CRS Credit

There is credit for preserving open space in its natural condition or restored to a state approximating its natural condition. The credit is based on the percentage of the floodplain that can be documented as wetlands protected from development by ownership or local regulations. The City of Raleigh could receive credit for Activity 420 – Open Space Preservation for preserving a portion of the SFHA as open space.

Additionally, the City of Raleigh could receive credit for Activity 540 – Drainage System Maintenance. By having a portion of the City's drainage system inspected regularly throughout the year and maintenance performed as needed would earn credit. The City could also get credit under this activity for providing a listing of problem sites that are inspected more frequently, and for implementing an ongoing Capital Improvements Program.

Credit is available for the Erosion and Sediment Control (ESC) element under Activity 450 for regulating activities throughout the watershed to minimize erosion on construction sites that could result in sedimentation and water pollution. The City of Raleigh could receive credit for soil and erosion control regulations under Activity 450 – Stormwater Management. The HMPC proposes protecting wetland and conservation areas along with promoting LID techniques to protect these natural floodplain functions.

Table C.3 – Natural Resource Protection Mitigation Options and Recommended Projects

Action #	Mitigation Action	Reason for Pursuing / Not Pursuing	Funding
Natural Resource Protection Measures Considered by HMPC and Not Recommended			
-	Develop a natural area restoration plan	Developing a Natural Floodplain Functions plan instead, which addresses restoration among other issues and can earn CRS credit.	n/a
-	Promote low-impact development projects where applicable to improve water quality and reduce runoff.	The City already has a requirement for developers to consider LID techniques when developing sites	n/a
-	Enact deed restrictions and other growth management tools to preserve wetland and natural resource areas and conserve their natural and ecological functions.	The City already has an established program for preserving wetlands and natural resource areas will protect these important areas for future flood protection and continued water quality improvement.	n/a
Natural Resource Protection Measures and Funding Recommended for Implementation			
-	*none identified*	-	-

C.2.4 Emergency Services Measures

Emergency services measures protect people during and after a disaster. A good emergency management program addresses all hazards, and it involves all local government departments. This section reviews emergency services measures following a chronological order of responding to an emergency. It starts with identifying an impending problem (threat recognition) and continues through post-disaster activities.

Threat Recognition

The first step in responding to a flood is to know when weather conditions are such that an event could occur. With a proper and timely threat recognition system, adequate warnings can be disseminated.

The National Weather Service (NWS) is the prime agency for detecting meteorological threats. Severe weather warnings are transmitted through NOAA's Weather Radio System. Local emergency managers can then provide more site-specific and timely recognition after the Weather Service issues a watch or a warning. A flood threat recognition system predicts the time and height of a flood crest. This can be done by measuring rainfall, soil moisture, and stream flows upstream of the community and calculating the subsequent flood levels.

On smaller rivers and streams, locally established rainfall and river gauges are needed to establish a flood threat recognition system. The NWS may issue a "flash flood watch." This is issued to indicate current or developing hydrologic conditions that are favorable for flash flooding in and close to the watch area, but the occurrence is neither certain nor imminent. These events are so localized and so rapid that a "flash flood warning" may not be issued, especially if no remote threat recognition equipment is available. In the absence of a gauging system on small streams, the best threat recognition system is to have local personnel monitor rainfall and stream conditions. While specific flood crests and times will not be predicted, this approach will provide advance notice of potential local or flash flooding.

Warning

The next step in emergency response following threat recognition is to notify the public and staff of other agencies and critical facilities. More people can implement protection measures if warnings are early and include specific detail.

The NWS issues notices to the public using two levels of notification:

- Watch: conditions are right for flooding, thunderstorms, tornadoes or winter storms.
- Warning: a flood, tornado, etc., has started or been observed.

A more specific warning may be disseminated by the community in a variety of ways. The following are the more common methods:

- CodeRED countywide mass telephone emergency communication system
- Commercial or public radio or TV stations
- The Weather Channel
- Cable TV emergency news inserts
- Telephone trees/mass telephone notification
- NOAA Weather Radio
- Tone activated receivers in key facilities
- Outdoor warning sirens
- Sirens on public safety vehicles
- Door-to-door contact
- Mobile public address systems
- Email notifications

Just as important as issuing a warning is telling people what to do in case of an emergency. A warning program should include a public information component.

StormReady

The National Weather Service (NWS) established the StormReady program to help local governments improve the timeliness and effectiveness of hazardous weather-related warnings for the public. To be officially StormReady, a community must:

- Establish a 24-hour warning point and emergency operations center
- Have more than one way to receive severe weather warnings and forecasts and to alert the public
- Create a system that monitors weather conditions locally
- Promote the importance of public readiness through community seminars
- Develop a formal hazardous weather plan, which includes training severe weather spotters and holding emergency exercises

Being designated a NWS StormReady community is a good measure of a community's emergency warning program for weather hazards.

Response

The protection of life and property is the most important task of emergency responders. Concurrent with threat recognition and issuing warnings, a community should respond with actions that can prevent or reduce damage and injuries. Typical actions and responding parties include the following:

- Activating the emergency operations center (emergency preparedness)
- Closing streets or bridges (police or public works)
- Shutting off power to threatened areas (utility company)
- Passing out sand and sandbags (public works)
- Holding children at school or releasing children from school (school superintendent)
- Opening evacuation shelters (the American Red Cross)
- Monitoring water levels (public works)
- Establishing security and other protection measures (police)

An emergency action plan ensures that all bases are covered and that the response activities are appropriate for the expected threat. These plans are developed in coordination with the agencies or offices that are given various responsibilities.

Emergency response plans should be updated annually to keep contact names and telephone numbers current and to ensure that supplies and equipment that will be needed are still available. They should be critiqued and revised after disasters and exercises to take advantage of the lessons learned and of changing conditions. The end result is a coordinated effort implemented by people who have experience working together so that available resources will be used in the most efficient manner possible.

Evacuation and Shelter

There are six key components to a successful evacuation:

- Adequate warning
- Adequate routes
- Proper timing to ensure the routes are clear
- Traffic control
- Knowledgeable travelers
- Care for special populations (e.g., disabled persons, prisoners, hospital patients, schoolchildren)

Those who cannot get out of harm's way need shelter. Typically, the American Red Cross will staff a shelter and ensure that there is adequate food, bedding, and wash facilities. Shelter management is a

specialized skill. Managers must deal with problems like scared children, families that want to bring in their pets, and the potential for an overcrowded facility.

Local Implementation /CRS Credit

Flash flood warnings are issued by National Weather Service Offices, which have the local and county warning responsibility. Flood warnings are forecasts of coming floods, are distributed to the public by the NOAA Weather Radio, commercial radio and television, and through local emergency agencies. The warning message tells the expected degree of flooding, the affected river, when and where flooding will begin, and the expected maximum river level at specific forecast points during flood crest. The County has a Flood Incident Management (FIM) plan, as part of the Emergency Operations Plan. The FIM plan includes flood threat recognition, emergency warning dissemination, flood response operations, and critical facilities planning.

The City of Raleigh could receive credit for Activity 610 – Flood Warning Program for maintaining a program that provides timely identification of impending flood threats, disseminates warnings to appropriate floodplain residents, and coordinates flood response activities (based on Wake County's Emergency Management Program). Community Rating System credits are based on the number and types of warning media that can reach the community's flood prone population. Depending on the location, communities can receive credit for the telephone calling system and more credits for additional measures, like telephone trees. Being designated as a StormReady community also provides additional credits.

Table C.4 – Emergency Services Mitigation Options and Recommended Projects

Action #	Mitigation Action	Reason for Pursuing / Not Pursuing	Funding
Emergency Services Measures Considered by HMPC and Not Recommended			
-	Develop post-disaster mitigation procedures that assign responsibilities for public information, code enforcement, planning, and other efforts that encourage loss reduction.	To avoid redundancy, these responsibilities are identified in the County's Emergency Operations Plan, and the other mitigation projects identified in this FMP can be used as a guide for flood loss reduction in post-disaster mitigation.	n/a
Emergency Services Measures and Funding Recommended for Implementation			
ES-1	Provide and enhance technical rescue capabilities more equitably throughout the City.	Ensure proper training of first responders to reduce danger when called throughout the City during flooding events.	Operating Budget
ES-2	Provide after-action report of emergency response to severe weather events in order to improve planning for future disasters.	Details from After Action Reports are valuable to help plan for future disasters to know what went well and what went wrong.	Operating Budget
ES-3	Maintain a standard operating guideline to direct operational planning prior to anticipated weather emergencies.	Staff turnover is a key condition to make sure that SOP's are in place to guide new staff members.	Operating Budget
ES-4	Design GIS programming capable of providing real-time data to emergency managers and historic data for future emergency response planning.	Current up-to-date information is critical to make sure that those in danger can be protected or rescued from that danger.	Operating Budget
ES-5	Continue to conduct disaster tabletop exercise program.	Training and exercises must be conducted so staff is properly trained on all possible issues that may arise in various events.	Operating Budget

Action #	Mitigation Action	Reason for Pursuing / Not Pursuing	Funding
ES-6	Program to install emergency electrical generators at all public utility facilities. Current focus on redundant generators at critical facilities, second fuel truck and completion of 100% generator coverage in Garner area.	This all hazards project will ensure that facilities can remain functional during times when power is lost due to various disasters.	Operating Budget

C.2.5 Structural Projects

Four general types of flood control projects are reviewed here: levees, reservoirs, diversions, and dredging. These projects have three advantages not provided by other mitigation measures:

- They can stop most flooding, protecting streets and landscaping in addition to buildings.
- Many projects can be built without disrupting citizens' homes and businesses.
- They are constructed and maintained by a government agency, a more dependable long-term management arrangement than depending on many individual private property owners.

However, as shown below, structural measures also have shortcomings. The appropriateness of using flood control depends on individual project area circumstances.

- Advantages
  - They may provide the greatest amount of protection for land area used
  - Because of land limitations, they may be the only practical solution in some circumstances
  - They can incorporate other benefits into structural project design, such as water supply and recreational uses
  - Regional detention may be more cost-efficient and effective than requiring numerous small detention basins
- Disadvantages
  - They can disturb the land and disrupt the natural water flows, often destroying wildlife habitat
  - They require regular maintenance
  - They are built to a certain flood protection level that can be exceeded by larger floods
  - They can create a false sense of security
  - They promote more intensive land use and development in the floodplain

Levees and Floodwalls

Probably the best-known flood control measure is a barrier of earth (levee) or concrete (floodwall) erected between the watercourse and the property to be protected. Levees and floodwalls confine water to the stream channel by raising its banks. They must be well designed to account for large floods, underground seepage, pumping of internal drainage, and erosion and scour.

Reservoirs and Detention

Reservoirs reduce flooding by temporarily storing flood waters behind dams or in storage or detention basins. Reservoirs lower flood heights by holding back, or detaining, runoff before it can flow downstream. Flood waters are detained until the flood has subsided, and then the water in the reservoir or detention basin is released or pumped out slowly at a rate that the river can accommodate downstream.

Reservoirs can be dry and remain idle until a large rain event occurs. Or they may be designed so that a lake or pond is created. The lake may provide recreational benefits or water supply (which could also help mitigate a drought).

Retention pond

Flood control reservoirs are most commonly built for one of two purposes. Large reservoirs are constructed to protect property from existing flood problems. Smaller reservoirs, or detention basins, are built to protect property from the stormwater runoff impacts of new development.

Diversion

A diversion is a new channel that sends floodwaters to a different location, thereby reducing flooding along an existing watercourse. Diversions can be surface channels, overflow weirs, or tunnels. During normal flows, the water stays in the old channel. During floods, the floodwaters spill over to the diversion channel or tunnel, which carries the excess water to a receiving lake or river.

Local Implementation /CRS Credit

The City of Raleigh may not be eligible to receive credit for Activity 530 – Flood Protection. Structural flood control projects that provide at least 100-year flood protection and that result in revisions to the Flood Insurance Rate Map are not credited by the CRS so as not to duplicate the larger premium reduction provided by removing properties from the mapped floodplain. Other flood control projects can be accepted by offering a 25-year flood protection.

Table C.5 – Structural Projects Mitigation Options and Recommended Projects

Action #	Mitigation Action	Reason for Pursuing / Not Pursuing	Funding
Structural Project Measures Considered by HMPC and Not Recommended			
-	Promote detention and retention facilities to provide flood protection.	The City of Raleigh already requires developers to hold back water on site through either detention or retention.	n/a
-	Develop stormwater conveyance systems to alleviate flooding for existing and new development.	The City of Raleigh already has a program for improving stormwater conveyance systems in areas where drainage is currently inadequate will reduce stormwater flooding and prevent losses.	n/a
Structural Project Measures and Funding Recommended for Implementation			
SP-1	Install cameras in flood prone areas throughout the City of Raleigh to allow us to view these locations and make informed decisions as it relates to flooding	This project will enable the City to identify locations for stormwater improvement projects.	Not yet identified

C.2.6 Public Information

Outreach Projects

Outreach projects are the first step in the process of orienting property owners to the hazards they face and to the concept of property protection. They are designed to encourage people to seek out more information in order to take steps to protect themselves and their properties.

Awareness of the hazard is not enough; people need to be told what they can do about the hazard. Thus, projects should include information on safety, health and property protection measures. Research has shown that a properly run local information program is more effective than national advertising or publicity campaigns. Therefore, outreach projects should be locally designed and tailored to meet local conditions.

Community newsletters/direct mailings: The most effective types of outreach projects are mailed or distributed to everyone in the community. In the case of floods, they can be sent only to floodplain property owners.

News media: Local newspapers can be strong allies in efforts to inform the public. Local radio stations and cable TV channels can also help. These media offer interview formats and cable TV may be willing to broadcast videos on the hazards.

Libraries and Websites

The two previous activities tell people that they are exposed to a hazard. The next step is to provide information to those who want to know more. The community library and local websites are obvious places for residents to seek information on hazards, hazard protection, and protecting natural resources.

Books and pamphlets on hazard mitigation can be given to libraries, and many of these can be obtained for free from state and federal agencies. Libraries also have their own public information campaigns with displays, lectures and other projects, which can augment the activities of the local government. Today, websites are commonly used as research tools. They provide fast access to a wealth of public and private sites for information. Through links to other websites, there is almost no limit to the amount of up to date information that can be accessed on the Internet.

In addition to online floodplain maps, websites can link to information for homeowners on how to retrofit for floods or a website about floods for children.

Technical Assistance

Hazard Information

Residents and business owners that are aware of the potential hazards can take steps to avoid problems or reduce their exposure to flooding. Communities can easily provide map information from FEMA's FIRMs and Flood Insurance Studies. They may also assist residents in submitting requests for map amendments and revisions when they are needed to show that a building is located outside the mapped floodplain.

Some communities supplement what is shown on the FIRM with information on additional hazards, flooding outside mapped areas and zoning. When the map information is provided, community staff can explain insurance, property protection measures and mitigation options that are available to property owners. They should also remind inquirers that being outside the mapped floodplain is no guarantee that a property will never flood.

Property Protection Assistance

While general information provided by outreach projects or the library is beneficial, most property owners do not feel ready to retrofit their buildings without more specific guidance. Local building department

staffs are experts in construction. They can provide free advice, not necessarily to design a protection measure, but to steer the owner onto the right track. Building or public works department staffs can provide the following types of assistance:

- Visit properties and offer protection suggestions
- Recommend or identify qualified or licensed contractors
- Inspect homes for anchoring of roofing and the home to the foundation
- Explain when building permits are needed for home improvements.

Public Information Program

A Program for Public Information (PPI) is a document that receives CRS credit. It is a review of local conditions, local public information needs, and a recommended plan of activities. A PPI consists of the following parts, which are incorporated into this plan:

- The local flood hazard
- The property protection measures appropriate for the flood hazard
- Flood safety measures appropriate for the local situation
- The public information activities currently being implemented within the community, including those being carried out by non-government agencies
- Goals for the community's public information program
- The outreach projects that will be done each year to reach the goals
- The process that will be followed to monitor and evaluate the projects

Local Implementation /CRS Credit

The City of Raleigh could receive credit under Activity 330 – Outreach Projects as well as Activity 350 – Flood Protection Information. The City sends out a monthly newsletter with its water bill which can contain flood protection information. Credit is also provided for general outreach projects including publications in local newspapers and expos at fairs. Credit is also provided for publications relating to floodplain management which are available in the reference section of the local Library. Credit is also provided for floodplain information displayed on the City's website.

Table C.6 – Public Information and Outreach Mitigation Options and Recommended Projects

Action #	Mitigation Action	Reason for Pursuing / Not Pursuing	Funding
Public Information and Outreach Measures Considered by HMPC and Not Recommended			
-	Provide flood-related information on the City's website.	The City's website already has flood-related information posted.	n/a
Public Information and Outreach Measures and Funding Recommended for Implementation			
PEA-2	Increase public awareness and participation in the Ready Wake program and resources.	Create a public information campaign to keep all residents of Wake County aware of natural disaster and other weather-related events in order to better protection people.	Operating Budget and Federal Funding

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