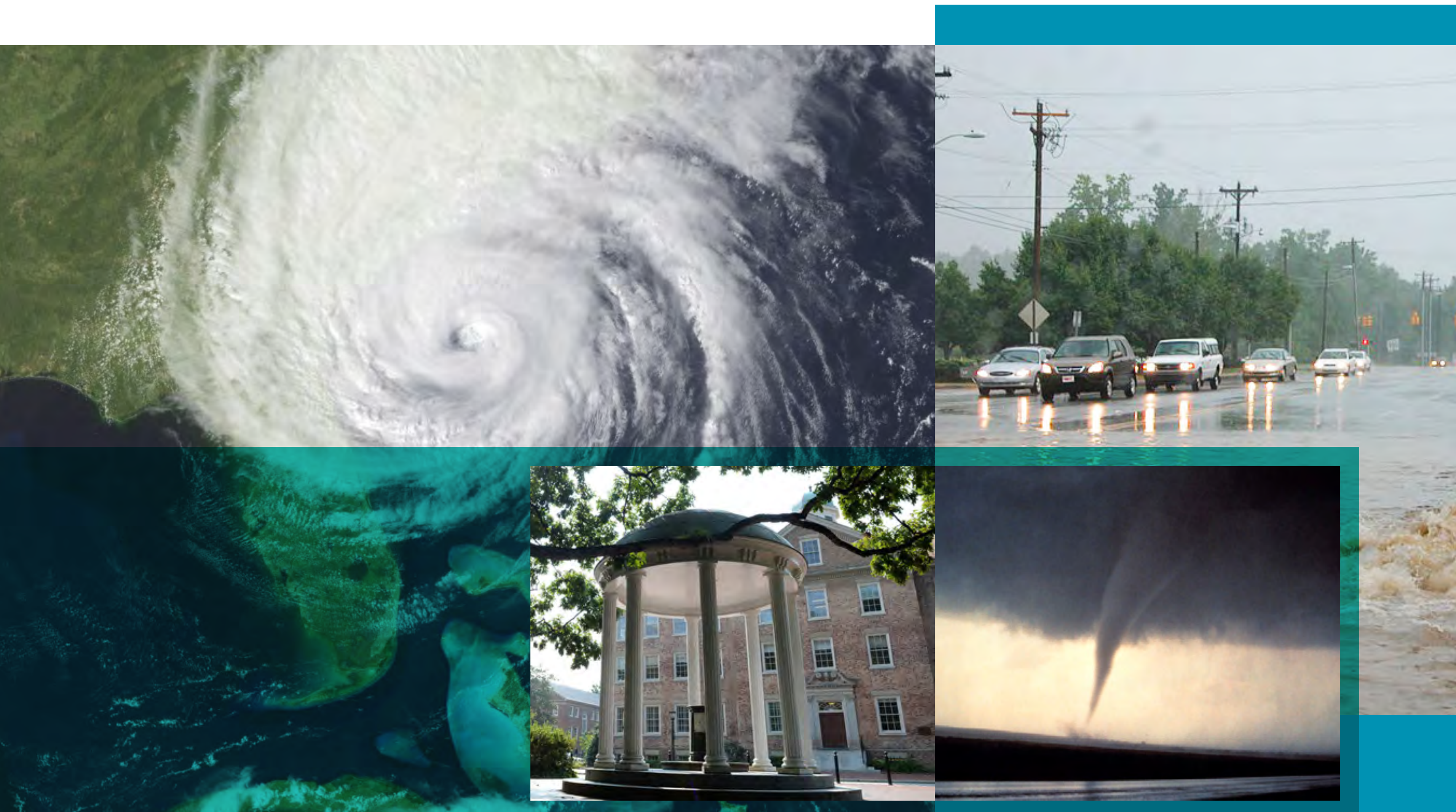
THE UNIVERSITY OF NORTH CAROLINA SYSTEM

UNC System Eastern Campuses Regional Hazard Mitigation Plan



East Carolina University
Elizabeth City State University
Fayetteville State University
North Carolina Central University
North Carolina School of Science and Mathematics
North Carolina State University
University of North Carolina at Chapel Hill
University of North Carolina at Pembroke
University of North Carolina at Wilmington

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1 Introduction

Section 1 provides a general introduction to hazard mitigation and an introduction to the UNC Eastern Campuses Disaster Resistant University 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

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 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 Building Resilient Infrastructure and Communities (BRIC) 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 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 various departments from each participating campus as well as other outside stakeholders. This plan will ensure all nine participating UNC Eastern Campuses are eligible for federal disaster assistance including the FEMA HMGP, BRIC, and FMA programs.

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. Additionally, development of this plan followed the guidance outlined in the FEMA 2003 publication "Building a Disaster-Resistant University."

This plan will be adopted by each participating campus in accordance with standard local procedures. Copies of adoption resolutions are provided in Section 6 Plan Adoption.

1.3 SCOPE

This document comprises a Hazard Mitigation Plan for the University of North Carolina (UNC) System Eastern Campuses. The planning area includes the main campuses of the following UNC system schools:

- East Carolina University (ECU)
- Elizabeth City State University (ECSU)
- Fayetteville State University (FSU)
- North Carolina Central University (NCCU)
- North Carolina School of Science and Math (NCSSM)
- North Carolina State University (NCSU)
- University of North Carolina Chapel Hill (UNC-CH)
- University of North Carolina Pembroke (UNC-P)
- University of North Carolina Wilmington (UNC-W)

It should be noted that several of the participating schools and universities have satellite campuses that were not evaluated as part of this planning process.

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 campus' capabilities to mitigate them. The hazards profiled in this plan include:

- Natural Hazards:
  - Dam Failure
  - Drought
  - Earthquake
  - Extreme Heat
  - Flood
  - Geological: Landslide & Sinkhole
  - Hurricane & Tropical Storm
  - Severe Winter Weather
  - Tornado/Thunderstorm
  - Wildfire
- Technological / Human-Caused Hazards:
  - Cyber Threat
  - Hazardous Materials Incidents
  - Infectious Disease
  - Terrorism
  - Vandalism/Theft

The focus of this plan is on those hazards deemed "high" or "moderate" priority hazards for each campus, 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 each campus action plan.

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 443. Building a Disaster-Resistant University. August 2003.
- 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 C.

1.5 PLAN ORGANIZATION

The UNC Eastern Campuses Hazard Mitigation Plan is organized into the following sections:

- Section 1: Introduction
- Section 2: Planning Process
- Section 3: Hazard Identification & Hazard Profiles
- Section 4: Mitigation Strategy
- Section 5: Plan Implementation and Maintenance
- Section 6: Plan Adoption
- Annexes:
    - Campus Profile
    - Asset Inventory
    - Hazard Risk & Vulnerability Assessment
    - Capability Assessment
    - Mitigation Action Plan
- Appendix A: Local Plan Review Tool
- Appendix B: Planning Process Documentation
- Appendix C: 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 this plan. This section consists of the following subsections:

- 2.1 Purpose
- 2.2 What's Changed in the Plan
- 2.3 Preparing the Plan
- 2.4 Hazard Mitigation Planning Committee
- 2.5 Involving the Public
- 2.6 Outreach Efforts
- 2.7 Involving the Stakeholders
- 2.8 Documentation of Plan Progress

2.1 PURPOSE

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

2.2 WHAT'S CHANGED IN THE PLAN

The UNC Eastern Campuses previously developed campus-level Pre-Disaster Mitigation plans between 2008 and 2011. This Hazard Mitigation Plan is a new regional planning effort, but it compiles and updates information from the existing Pre-Disaster Mitigation plans into a single regional plan document. The existing plans referenced and updated for this regional planning effort are as follows:

- Elizabeth City State University Pre-Disaster Mitigation Plan, Fall 2011
- East Carolina University Pre-Disaster Mitigation Plan, Fall 2011
- Fayetteville State University Pre-Disaster Mitigation Plan, August 2010
- North Carolina Central University Pre-Disaster Mitigation Plan, August 2010
- North Carolina School of Science and Mathematics Pre-Disaster Mitigation Plan, Fall 2011
- North Carolina State University Pre-Disaster Mitigation Plan, August 2010

- The University of North Carolina at Chapel Hill Natural Hazard Mitigation Plan, September 2020, Revised February 2011
- The University of North Carolina at Pembroke Pre-Disaster Mitigation Plan, January 2011
- University of North Carolina at Wilmington Hazard Mitigation Plan, June 2008

2.2.1 Summary of Key Updates

The development of this regional hazard mitigation plan involved a comprehensive review of each of the existing campus plans and an assessment of the success of each campus 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 regional plan. The following requirements were addressed during the development of this 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.

In addition to the specific changes in hazard analyses in Section 2.5, the following items were also addressed in this plan:

- GIS was used, to the extent data allowed, to analyze the priority hazards as part of the vulnerability assessment.
- Assets exposed to risk were identified using County parcel data from 2020, campus building inventory and values from the University System's Division of Information Technology, building footprints and values from the NCEM iRisk Database, property values provided by the NC Department of Insurance, and critical facility inventories provided by campus planning committees.
- A discussion on climate change and its projected effect on specific hazards was included in each hazard profile in the risk assessment.
- A discussion on growth and development was added to evaluate potential future changes in risk.
- Enhanced public outreach and stakeholder coordination efforts were conducted throughout the plan update process.

2.3 PREPARING THE PLAN

The planning process for preparing the UNC Eastern Campuses 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 (FMA) programs. Thus, the modified 10-step process used for this plan meets the requirements of six major programs: FEMA's HMGP;

BRIC; CRS; FMA; and Severe Repetitive Loss programs as well as 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 3 – Wildfire Annexes – 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	Annexes – Wildfire Annexes – Capability
Establish community hazard reduction priorities and recommendations to reduce structural ignitability	Step 6, 7, and 8	Section 4 – Mitigation Strategy Annexes – Mitigation Action Plans
Develop an action plan and assessment strategy	Step 8 and 10	Annexes – Mitigation Action Plans Section 5 – Plan Implementation and Maintenance
Finalize the CWPP	Step 9	Section 6 – 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 nine campuses' commitment to participate in the DMA planning process, campus 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. Representatives from the campuses' Emergency Management, Safety and Security, and Environmental Health and Safety departments led each individual campus' effort to reorganize and coordinate for the plan update. Consultants from Wood Environment and Infrastructure Solutions, Inc. assisted by leading the Eastern Campuses 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 2.5 and Section 2.6.

Planning Step 3: Coordinate

The planning committees formed for development of the previous plans – developed between 2009 and 2011 – were reconvened for this plan update where possible; however, many new representatives were added. More details on the Hazard Mitigation Planning Committee (HMPC) are provided in Section 2.4. Stakeholder coordination was incorporated into the formation of the HMPC and was sought through additional outreach. These efforts are detailed in Section 2.7.

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. The UNC Eastern Campuses and surrounding communities use a variety of planning mechanisms, such as Strategic Plans, Campus Master Plans, Community 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. 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; a detailed listing of resources referenced can be found in each campus' annex.

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. Overviews of the Hazard Identification and Risk Assessment and Capability Assessment can be found in Section 3 and Section 5, respectively. Detailed data is contained in each campus' annex.

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. A more detailed description of the risk assessment process and results is included in Section 3 Hazard

Identification and Hazard Profiles and in each campus annex under the Hazard Risk & Vulnerability Assessment section.

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. The findings of the capability assessment are provided in each campus annex.

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 4 Mitigation Strategy.

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 campuses.

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 campuses. Adoption resolutions are provided in Section 6.

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 5 Plan Implementation and 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. Section 5 also discusses opportunities for incorporating the plan into existing planning mechanisms and how to address continued public involvement.

2.4 HAZARD MITIGATION PLANNING COMMITTEE

This Hazard Mitigation Plan was developed under the guidance of a Hazard Mitigation Planning Committee (HMPC). Each of the nine campuses identified members for its own campus-level committee. The campus committees worked together as a joint HMPC to represent each campus' interests while fostering a regional planning approach.

To form the planning committee, the Emergency Management leads from each campus were designated as the primary representatives and were asked to identify additional members from a variety of campus departments. Where possible, an invitation was sent to contacts from the previous planning effort, or new staff in the same position. Table 2.3 lists all HMPC members and the campus and department they represented.

Table 2.3 – HMPC Members

Campus	Representative	Role; Department
ECU	Phil Lewis	EHS Professional, Environmental Health and Safety
ECU	Bill Koch	Associate Vice Chancellor, Campus Safety and Auxiliary Service
ECU	Jon Barnwell	Chief of Police, ECU Police
ECU	Chris Sutton	Public Safety Supervisor, ECU Police
ECU	Jason Sugg	Deputy Chief, ECU Police
ECU	Curtis Hayes	Public Safety Supervisor, ECU Police
ECU	Kelly Shook	EHS Professional, Environmental Health and Safety
ECU	Blake Halsey	EHS Professional, Environmental Health and Safety
ECU	Bill Bagnell	Associate Vice Chancellor; Campus Operations
ECU	Ricky Hill	Director; Facilities Services (Main Campus)
ECU	Grif Avin	Director; Facilities Services (Health Sciences Campus)
ECU	Bill McCartney	Associate Vice Chancellor; Housing Operations
ECU	Aaron Lucier	Director; Housing Operations
ECU	Jamie Brown Kruse	Director; ECU Center for Natural Hazards Research
ECU	Mike O'Driscoll	Associate Professor; Department of Coastal Studies
ECU	Merrill Flood	Director of Planning and Development; Community Engagement and Research
ECU	Anuradha Mukherji	Associate Professor; Geography, Planning, and Environment
ECU	Randy Gentry	Director; Pitt County Emergency Management
ECSU	Rickey Freeman	EM/EHS Coordinator; University Police
ECSU	Dennis Leary	Director; Facilities Management
ECSU	Harley Grimes	Interim Director; Campus Facilities & Planning
ECSU	Alyn Goodson	Vice Chancellor, General Council; Campus Operations
ECSU	John Manley	Director of Public Safety; University Police
ECSU	Derrick Wilkins	Vice Chancellor and Chief of Staff; Office of the Chancellor
ECSU	Sabrina Williams	Director; Housing and Residence Life
ECSU	Kevin Wade	Associate Vice Chancellor; Student Affairs
ECSU	Kevin Kupietz	Emergency Management Coordinator; Aviation & Emergency Management
ECSU	Robert Thibeault	Director of Budgets; Business and Finance
ECSU	Dr. Karrie Dixon	Chancellor
FSU	Melvin Lewis	Director of Emergency Management; Police & Public Safety
FSU	Renarde Earl	Chief of Police, Associated Vice Chancellor of Public Safety; Police & Public Safety
FSU	Nicole Lucas	Sr. Vice Chancellor; Academic Affairs
FSU	Gregory Moyd	Assistant Vice Chancellor; Student Affairs
FSU	Donald Pearsall	Director of Business Services; Business & Finance
FSU	Conroy Campbell	Database Administrator; Information Technology
FSU	Harold Miller	Director, Planning & Construction; Facilities Management
FSU	Terri Tibbs	Associate Vice Chancellor; Human Resources
FSU	Benita Angel Powell	Assistant General Counsel; Legal Office
NCCU	Thomas Verrault	Emergency Management Coordinator; Environment and Occupational Health & Safety
NCCU	Joel Faison	Director of Infrastructure & Information Security; Information Technology Services
NCCU	Ayana Hernandez	Associate Vice Chancellor; Office of Communications & Marketing

Campus	Representative	Role; Department
NCCU	Dr. Undi Hoffler	Director, Research Compliance and Technology Transfer; Division of Research & Sponsored Programs
NCCU	Ondin Mihalcescu	Director of Design, Planning, and Construction; Capital Projects Management
NCCU	Timothy Williams	Architectural Project Manager; Capital Projects Management
NCCU	Lori Blake-Reid	Director of Facilities Services; Facilities Operations
NCCU	Chuck Batten	Construction Engineer; Facilities Operations
NCCU	Kelly White	Chief of Police; Campus Police
NCCU	Dr. Kristin Long	Director of Environmental Health & Safety; Environmental and Occupational Health and Safety
NCCU	Atty. Fenita Morris-Shepard	General Counsel; Legal Affairs
NCCU	Akua Matherson	Interim CFO & Vice Chancellor; Administration and Finance
NCCU	Michael Hill	Chief Human Resources Officer; Human Resources
NCSSM	Rick Hess	Director of Security; Campus Safety & Security
NCSSM	Crystal Donaldson	Assistant Director of Safety & Security; Campus Safety & Security
NCSSM	Garry Covington	Director; Plant Facilities
NCSSM	Robert Allen	Vice Chancellor; Finance and Operations
NCSSM	Joyce Boni	Chief Audit Officer; Chancellor's Office
NCSSM	Paul Menchini	IT Security Director, Operations & Systems Analyst; IT Services
NCSU	Todd Becker	Emergency Manager; Emergency Management & Mission Continuity
NCSU	Amy Orders	Director; Emergency Management & Mission Continuity
NCSU	Jon Brann	University Fire Marshal; Fire and Life Safety
NCSU	David Rainer	Associate Vice Chancellor; Environmental Health & Public Safety
NCSU	Doug Morton	Associate Vice Chancellor; Facilities
NCSU	Allen Boyette	Senior Director, Energy Systems; Facilities
NCSU	Steve Olmstead	Director; Insurance and Risk Management
NCSU	Greg Sparks	Associate Vice Chancellor; Communication Technologies
UNC-CH	Darrell Jeter	Director; Emergency Management & Planning
UNC-CH	Abbas Piran	Director, Facilities Technology; Facilities Services
UNC-CH	Cindy Register	Assistant Director Engineering Services & Energy Management; Facilities Services
UNC-CH	John Albrechtsen	Facilities Operations; Facilities Services
UNC-CH	Ben Poulson	Associated Director, Energy Services; Facilities Services
UNC-CH	Rahsheem Holland	Assistant Chief/Patrol; Campus Police
UNC-CH	Carly Ann Perin	Executive Director of Finance & Financial Shared Services; SCE Finances
UNC-CH	Andrew Fulmer	Capital Projects Accountant; SCE Finances
UNC-CH	Cathy Brennan	Executive Director; Environmental Health & Safety
UNC-CH	Dawn Wedig	Emergency Management Planner; Emergency Management & Planning
UNC-P	Travis Bryant	Associate Vice Chancellor for Campus Safety & Emergency Operations; Student Affairs
UNC-P	McDuffie Cummings	Chief/Director; Police and Public Safety
UNC-P	Michael Bullard	Environmental Health and Safety Professional; Environmental Health & Safety
UNC-P	Cora Bullard	Director, Student Health Services
UNC-P	Annie Angueira	Assistant Vice Chancellor for Facilities; Facilities Management

Campus	Representative	Role; Department
UNC-P	Dr. Scott Billingsley	Associated Provost; Academic Affairs
UNC-P	Paul O'Neil	Senior Associate Director; Athletics
UNC-P	Katina Blue	Associate Vice Chancellor for Information Resources, Chief Information Officer; Division of Information Technology
UNC-P	Paul Posener	Director; Housing and Residence Life
UNC-P	Mark Vesely	Director of Operations and Maintenance; Facilities Management
UNC-P	Charles Chavis	Environmental Health and Safety Professional; Environmental Health and Safety
UNC-W	Eric Griffin	Assistant Director, Emergency Management; Environmental Health and Safety
UNC-W	Jeff Campbell	Director; Environmental Health and Safety
UNC-W	Jodie Ruskin	Business Continuity Planner; Environmental Health and Safety
UNC-W	Stuart Borrett	Associate Provost; Research and Innovation
UNC-W	Carey Gibson	Executive Director for Infrastructure Operations; ITS
UNC-W	Wesley Merrill	Director of Facilities and Event Management; Athletics
UNC-W	Paul Townend	Associate Vice Chancellor & Dean; Undergraduate Studies
UNC-W	Larry Wray	Executive Director; Campus Life
UNC-W	Andrew Mauk	Associate Provost; Institutional Research and Planning
UNC-W	Peter Groenendyk	Director; Housing & Residence Life
UNC-W	Laura McBrayer	Senior Associate Director; Library Information Technology & Scholarly Research
UNC-W	Kristy Burnette	Institutional Risk Management Coordinator; Enterprise Risk Management
UNC-W	Mark Morgan	Associate Vice Chancellor; Facilities
UNC-W	Steven Still	Emergency Management Director; New Hanover County Emergency Management

The DMA planning regulations and guidance stress that to satisfy multi-jurisdictional participation requirements, each campus 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 UNC Eastern Campuses HMPC, "participation" meant the following:

- Providing facilities for meetings;
- Attending and participating in the HMPC meetings;
- Collecting and providing requested data (as available);
- Providing information on local capability;
- 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.

During the planning process, the HMPC members communicated through Zoom video conference 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 and the public could easily access and review them and provide comments.

The formal HMPC meetings followed the 10 CRS Planning Steps. These meetings were essential 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. The meeting dates, locations, and topics discussed are summarized in Table 2.4. More details on each meeting, including agendas, minutes, and sign-in sheets for the HMPC meetings are included in Appendix B. All HMPC meetings were open to the public. Public meetings are summarized in Table 2.5.

In many cases, routine discussions and additional meetings were held by campus staff to accomplish planning tasks specific to their department or agency. For example, completing the capability assessment, reporting on the status of existing actions, 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.

Table 2.4 – Summary of HMPC Meetings

Meeting Title	Meeting Topic	Meeting Date	Meeting Location
Meeting #1 - Kickoff			
NCCU HMPC	1) Introduction to DMA, CRS, and FMA requirements and the planning process 2) Review of HMPC responsibilities and the project schedule 3) Preliminary hazard identification 4) Complete data collection guide	March 31, 2020	Zoom Video Conference Call
UNC-CH HMPC		April 7, 2020	Zoom Video Conference Call
UNC-P HMPC		April 16, 2020	Zoom Video Conference Call
FSU HMPC		April 21, 2020	Zoom Video Conference Call
ECU HMPC		April 30, 2020	Zoom Video Conference Call
UNC-W HMPC		May 5, 2020	Zoom Video Conference Call
NCSSM HMPC		May 7, 2020	Zoom Video Conference Call
ECSU HMPC		May 12, 2020	Zoom Video Conference Call
NCSU HMPC		July 10, 2020	Zoom Video Conference Call
Meeting #2			
All-Campuses HMPC	1) Review and update plan goals 2) Report on status of previous mitigation actions	August 20, 2020	Zoom Video Conference Call

Meeting Title	Meeting Topic	Meeting Date	Meeting Location
Meeting #3			
All-Campuses HMPC	1) Review Draft Hazard Identification & Risk Assessment (HIRA) 2) Draft Mitigation Action Plans	December 15, 2020	Zoom Video Conference Call
Meeting #4			
All-Campuses HMPC	1) Review the Draft Hazard Mitigation Plan 2) Solicit comments and feedback	January 19, 2021	Zoom Video Conference Call

2.5 INVOLVING THE PUBLIC

An important component of any mitigation planning process is public participation. Community-based input from faculty, staff, students, and the surrounding community 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. Additionally, HMPC meetings were open to the public.

All public meetings were advertised on the plan website, which was shared on campus websites and social media. Copies of meeting announcements are provided in Appendix B. The public meetings held during the planning process are summarized in Table 2.5.

Table 2.5 – 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 planning process, hazards identified, public survey and website, and the project schedule.	September 22, 2020 5:30 p.m.	Zoom Video Conference Call
Public Meeting #2	1) Review “Draft” Hazard Mitigation Plan 2) Solicit comments and feedback	January 19, 2021 5:00 p.m.	Zoom Video Conference Call

2.6 OUTREACH EFFORTS

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

Table 2.6 – 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

Location	Date	Event/Message
Campus websites	Ongoing	Link to the plan website shared to expand reach
Campus social media	Ongoing	Meeting announcements, survey, and website link shared
Campus e-newsletters & distribution lists	Sept. 2020 & Jan 2021	Meeting announcements, survey, and website link shared
Public survey	Ongoing	Survey hosted online and made available via shareable link
Plan website - HIRA and Annex drafts	December 2020	Draft HIRA and Campus Annexes made available for review and comment online
Plan website - Draft Plan	January 2021	Full draft plan made available for review and comment online

A public outreach survey was made available in April 2020 and remained open for response through December 2020. 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 announced at the first HMPC and public meetings and was made available online on the plan website. In total, 119 survey responses were received.

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

- The majority of responses came from individuals associated with ECSU, followed by UNC-P and NCSSM. All campuses had at least one associated response to the survey.
- Most respondents (62%) feel somewhat prepared for a hazard impacting their campus, but approximately 22% of respondents feel somewhat to very unprepared, while 16% feel very prepared.
- 48% of respondents do not know where storm shelters are located on their campus.
- 28% of respondents do not know where to get more information on hazard risk and preparedness. More outreach may be needed and it may be beneficial to pursue new methods of outreach.
- Hurricane was rated the most significant hazard, followed by infectious disease, flooding, tornado/thunderstorm, and cyber threat. Earthquake, dam failure, wildfire, geological hazards, and drought were rated the least significant hazards. Severe winter weather, extreme heat, and hazardous materials incidents received moderate risk ratings.
- Many respondents noted concerns related to flooding, including stormwater flooding issues and ice and freeze issues during the winter in flood prone areas. Cyber threat concerns were mentioned frequently, including the need for improved preparation and protection as well as communication to campus staff and students. Hurricane preparedness was also a common concern, as was the current COVID-19 pandemic. In both cases, respondents noted issues with sheltering in place, evacuation issues, and communication issues.
- Respondents favored prevention activities for mitigation; the least favored option was natural resource protection.
- Text message and email were the most preferred methods of communication for information on hazard events.

Detailed survey results are provided in Appendix B.

2.7 INVOLVING STAKEHOLDERS

In addition to representatives in campus operations at each campus, the Hazard Mitigation Planning Committee also included stakeholder participants. Stakeholders on the HMPC included ECU professors from the Department of Geography, Planning, and Environment and the Department of Coastal Studies; the ECU Director for the Center for Natural Hazards Research; and the ECSU Aviation & Emergency Management Coordinator; as well as local government representatives, including the Pitt County Emergency Manager and the New Hanover County Emergency Management Director. Representatives from North Carolina Emergency Management (NCEM) also attended HMPC meetings. Input from additional stakeholders, including surrounding 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.

2.8 DOCUMENTATION OF PLAN PROGRESS

Progress on the mitigation strategies developed in the previous campus plans is documented in this regional plan. Table 2.7 summarizes the status of mitigation actions from the previous plans.

A list of all completed and deleted actions from the previous plans is provided in each campus annex along with the Mitigation Action Plans detailing carried forward and new mitigation actions.

Table 2.7 – Status of Previous Mitigation Actions

Campus	Completed	Deleted	Carried Forward and/or Combined
ECU	12	5	36
ECSU	3	2	39
FSU	22	7	34
NCCU	10	15	18
NCSSM	10	10	32
NCSU	11	10	6
UNC-CH	56	1	74
UNC-P	21	10	14
UNC-W	19	4	40

3 Hazard Identification & Hazard Profiles

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.

This section describes the hazard identification and risk assessment process for the development of the UNC Eastern Campuses Hazard Mitigation Plan (HMP). It documents how the participating schools met Step 4: Assess the Hazard, and Step 5: Assess the Problem from the 10-step planning process and provides an overview of all hazards evaluated for the plan.

3.1 OVERVIEW

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."

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 hazards in the planning area 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:

This four-step process was organized into a UNC Eastern Campuses system-wide hazard identification and a more detailed campus-level risk and vulnerability assessment. The system-wide portion of the risk assessment presented here contains the overall hazard identification and hazard profiles, and is broken into the following sub-sections:

- **Section 3.2**: **Hazard Identification** identifies the natural and human-caused hazards that threaten the UNC Eastern Campuses.
- **Section 3.3: Risk Assessment Methodology** describing the approach to evaluating hazards and the organization of this information in the plan.
- **Section 3.4**: **Hazard Profiles** describes each hazard, discusses climate change implications for the hazard, evaluates potential consequences of the hazard, and summarizes the applicable campuses and their risk conclusions.
- **Section 3.5: Conclusions on Hazard Risk** presents the results of the Priority Risk Index by defining each hazard as a Low, Moderate, or High risk hazard for each campus.

3.2 HAZARD IDENTIFICATION

To identify a full range of hazards relevant to all or part of the UNC Eastern Campuses, HMPC representatives from each campus began with a review of the list of hazards identified in the 2018 North Carolina State Hazard Mitigation Plan and the previous campus Pre-Disaster Mitigation (PDM) plans, as summarized in Table 3.1. The HMPC used these lists to identify a full range of hazards for potential inclusion in this plan update and to ensure consistency across state, regional, and campus planning efforts.

Table 3.1 – Hazards Included in Previous Planning Efforts

Hazard	Included in 2018 State HMP?	Included in Previous Campus PDM Plan?
Flooding	Yes	Yes
Hurricanes and Coastal Hazards	Yes	Yes
Severe Winter Weather	Yes	Yes
Extreme Heat	Yes	No
Earthquakes	Yes	Yes
Wildfire	Yes	No
Dam Failures	Yes	No
Drought	Yes	No
Tornadoes/Thunderstorms	Yes	Yes
Geological (Landslides, Sinkholes, Coastal Erosion)	Yes	No
Hazardous Substances	Yes	No
Infectious Disease	Yes	No
Radiological Emergency	Yes	No
Terrorism	Yes	No
Cyber Threat	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 previous campus PDM plans 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.

3.3 RISK ASSESSMENT METHODOLOGY

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 where it may occur, the severity of potential events, records of past events, the probability of future occurrences, and potential impacts from the hazard. A vulnerability assessment was conducted for each hazard using quantitative and/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.

To account for regional differences in hazard risk across each of the campuses, this risk assessment is divided into two parts:

1) a set of summary hazard profiles describing each hazard and summarizing the risk findings for each campus, presented in Section 3.4; and
2) a campus-specific risk assessment profiling the location, extent, historical occurrences, probability of future occurrence, and vulnerability of each campus, presented in each campus annex.

In the summary hazard profiles located in Section 3.4, each hazard is profiled in the following format:

Hazard Description

This section provides a description of the hazard, including discussion of its duration and speed of onset or warning time, as well as any secondary effects.

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.

Consequence Analysis

This section summarizes the potential negative consequences of the hazard across the seven criteria set by the Emergency Management Accreditation Program (EMAP).

Problem Statements

This section summarizes key mitigation planning concerns related to this hazard. Where possible, problem statements are identified at a campus level.

3.3.1 Priority Risk Index

The conclusions drawn from the hazard profiling and vulnerability assessment process are used to prioritize all potential hazards to the UNC Eastern Campuses 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 (probability, impact, spatial extent, warning time, and duration) for each hazard. Each degree of risk was assigned a value (1 to 4) and a weighting factor as summarized in Table 3.2.

PRI ratings are provided by category throughout each hazard profile. Ratings specific to each campus are provided at the beginning of each hazard profile and are detailed in the campus annexes. The results of the risk assessment and overall PRI scoring are provided in Section 3.5 Conclusions on Hazard Risk.

Table 3.2 – 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 lowest possible PRI value is a 1.0 and 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 prioritize all potential hazards for each campus in the UNC Eastern Campuses 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.

3.4 HAZARD PROFILES

3.4.1 Dam Failure

Applicable Campuses

ECU	ECSU	FSU	NCCU	NCSSM	NCSU	UNC-CH	UNC-P	UNC-W
						✓		

PRI Summary by Campus

Campus	Probability	Impact	Spatial Extent	Warning Time	Duration	PRI Score
UNC-CH	Possible	Critical	Negligible	Less than 6 hrs	Less than 1 week	2.4

Hazard Description

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 farmland, 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

Climate Change

Studies have been conducted to investigate the impact of climate change scenarios on dam safety. Climate change impacts on dam failure will most likely be those related to changes in precipitation and flood likelihood. Climate change projections suggest that precipitation may increase and occur in more extreme events, which may increase risk of flooding, putting stress on dams and increasing likelihood of dam failure. 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.

Consequence Analysis

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.

Category	Consequences
Public Confidence in the Jurisdiction's Governance	Localized impact expected to primarily adversely affect only the dam owner and local entities. A catastrophic failure could result in more widespread loss of public confidence.

Problem Statement

- While a dam failure has not occurred in Orange County to date, failure in the future is still possible. There are 3 high hazard dams in Chapel Hill; Chapel Hill is the nearest downstream location of one additional high hazard dam.

3.4.2 Drought

Applicable Campuses

ECU	ECSU	FSU	NCCU	NCSSM	NCSU	UNC-CH	UNC-P	UNC-W
						✓		

PRI Summary by Campus

Campus	Probability	Impact	Spatial Extent	Warning Time	Duration	PRI Score
UNC-CH	Likely	Minor	Large	More than 24 hrs	More than 1 week	2.5

Hazard Description

Drought is a deficiency in precipitation over an extended period. It is a normal, recurrent feature of climate that occurs in virtually all climate zones. The duration of 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 3.3.

Table 3.3 – 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.

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) is a measure of meteorological drought devised in 1965, and 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. One benefit of the PDSI is that it can capture impacts of climate change on drought because it accounts for key measures in evapotranspiration.

The **Standardized Precipitation Index** (SPI) is a way of measuring drought that, like the PDSI, is negative for drought and positive for wet conditions. However, 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).

By definition, drought develops and worsens over a period of time. It inherently has a slow speed of onset and a long duration. Additionally, due to the variety of indices for tracking drought, there is significant time to issue hazard warnings. Drought warnings can be regularly updated and allow for response to escalate depending on the severity of conditions.

Warning Time: 1 – More than 24 hours

Duration: 4 – More than one week

The North Carolina Drought Management Advisory Council, established in 1992, was given official statutory status and assigned the responsibility for issuing drought advisories in 2003. The drought advisories provide accurate and consistent information to assist local governments and other water users in taking appropriate drought response actions in specific areas of the state that are exhibiting impending or existing drought conditions.

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.

According to the *2020 North Carolina Climate Science Report*, droughts are a natural part of the climate of North Carolina. Future droughts are projected to be warmer than historical events with a high level of confidence. The warmer conditions will lead to more rapid drying through increases in potential evapotranspiration. Thus, it is likely that future droughts in their multiple forms will be more frequent and severe in terms of soil moisture deficits and the impacts on rainfed agriculture and natural vegetation.

Consequence Analysis

Category	Consequences
Public	Drought can cause anxiety or depression about economic losses, conflicts over water shortages, reduced incomes, and fewer recreational activities.
Responders	Impacts to responders are unlikely. Exceptional drought conditions may impact the amount of water immediately available to respond to structure fire and 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. During extreme drought conditions, alternative water supplies may be needed.
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 and seek alternate supplies.
Environment	Environmental impacts include strain on local plant and wildlife; increased probability of erosion and wildfire; and decreased water quality.

Category	Consequences
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.

Problem Statements

- Orange County experienced drought periods of 100 weeks or longer three times between 2000-2019: 100 weeks from August 2010 through July 2012 – 18 weeks at D2 level; 150 weeks from May 2007 through September 2008 – 42 weeks at D2 or higher; and October 2001 through March 2003 – 48 weeks at D2 or higher.
- Critical functions at UNC-CH rely on a chilled water system; UNC-CH has attempted to mitigate impacts to these functions during periods of drought by integrating the use of reclaimed water systems.

3.4.3 Earthquake

Applicable Campuses

ECU	ECSU	FSU	NCCU	NCSSM	NCSU	UNC-CH	UNC-P	UNC-W
✓	✓	✓	✓	✓	✓	✓	✓	✓

PRI Summary by Campus

Campus	Probability	Impact	Spatial Extent	Warning Time	Duration	PRI Score
ECU	Unlikely	Minor	Large	Less than 6 hours	Less than 6 hours	1.9
ECSU	Unlikely	Minor	Large	Less than 6 hours	Less than 6 hours	1.9
FSU	Unlikely	Minor	Large	Less than 6 hours	Less than 6 hours	1.9
NCCU	Unlikely	Minor	Large	Less than 6 hours	Less than 6 hours	1.9
NCSSM	Unlikely	Minor	Large	Less than 6 hours	Less than 6 hours	1.9
NCSU	Unlikely	Minor	Large	Less than 6 hours	Less than 6 hours	1.9
UNC-CH	Unlikely	Minor	Large	Less than 6 hours	Less than 6 hours	1.9
UNC-P	Unlikely	Minor	Large	Less than 6 hours	Less than 6 hours	1.9
UNC-W	Unlikely	Minor	Large	Less than 6 hours	Less than 6 hours	1.9

Hazard Description

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.

Earthquakes generally occur with little to no warning and last for a short period of time. However, earthquakes can often be followed by periods of aftershocks that vary in severity but can compound damages.

Warning Time: 4 – Less than 6 hours

Duration: 1 – Less than 6 hours

Climate Change

Earthquakes can be triggered or inhibited by changes in the amount of stress on a fault. The largest climate variable that could change fault stress loads is surface water in the form of rain and snow. Changing ice caps and sea-levels could redistribute weight over fault lines and, therefore, potentially have an influence on earthquake occurrences. According to an article by NASA's *"Global Climate Change: Vital Signs of the Planet"*, these types of correlations are typically seen in microseismicity, tiny earthquakes with magnitudes less than zero, far smaller than humans can feel.

The complex issue to address is taking the knowledge of microseismicity and scaling it up to apply to a larger earthquake that could be felt. Climate-related stress changes might or might not promote an earthquake to occur, but currently, there is no way of knowing by how much. Scientists currently do not know when a fault may be at the critical point where a non-tectonic force related to a climate process could be the tipping point, resulting in a sizeable earthquake. Scientists are not in a position at this point to say that climate processes could trigger a large earthquake.

Consequence Analysis

Category	Consequences
Public	Impact expected to be moderate to 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 need to enter compromised structures or 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 peak ground shaking may require relocation of operations and lines of succession execution. Disruption of lines of communication and damage of facilities may 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, and infrastructure. Cascading impacts may result if buildings, infrastructure, or vehicles housing hazardous materials are impacted.
Environment	May cause extensive damage, creating denial or delays in the use of some areas. Remediation may be needed.
Economic Condition of the Jurisdiction	If ground shaking is severe, local economy and finances expected to be adversely affected, possibly for an extended period of time. Minor shaking may cause economic losses due to damage to local businesses or loss of inventory.
Public Confidence in the Jurisdiction's Governance	Ability to respond and recover may be questioned and challenged if response, and recovery are not timely and effective.

Problem Statements

While earthquakes are an unlikely hazard event for the UNC Eastern Campuses, an arbitrary earthquake scenario was modeled for each campus within FEMA's Hazus software. The Hazus models did predict impacts within the census tracts which encompass the campuses, as follows:

- ECSU – moderate damage to a communication utility and bridge structure.
- ECU - moderate damage to buildings, one hospital, five schools, three police stations, one fire station, and one bus facility.
- FSU – moderate damage to buildings, one hospital, five schools, three police stations, one fire station and one transportation facility within the two census tracts.
- NCCU – moderate damage to two school structures.
- NCSSM – moderate damage to buildings, one school, and one bus facility.
- NCSU – moderate damage to buildings, three schools, and four bridges.
- UNC-CH – moderate damage to two school structures.
- UNC-P – moderate damage to buildings.
- UNC-W – moderate damage to buildings, one highway bridge, and one bus facility.

3.4.4 Extreme Heat

Applicable Campuses

ECU	ECSU	FSU	NCCU	NCSSM	NCSU	UNC-CH	UNC-P	UNC-W
							✓	

PRI Summary by Campus

Campus	Probability	Impact	Spatial Extent	Warning Time	Duration	PRI Score
UNC-P	Highly Likely	Limited	Large	12 to 24 hrs	Less than 1 week	3.1

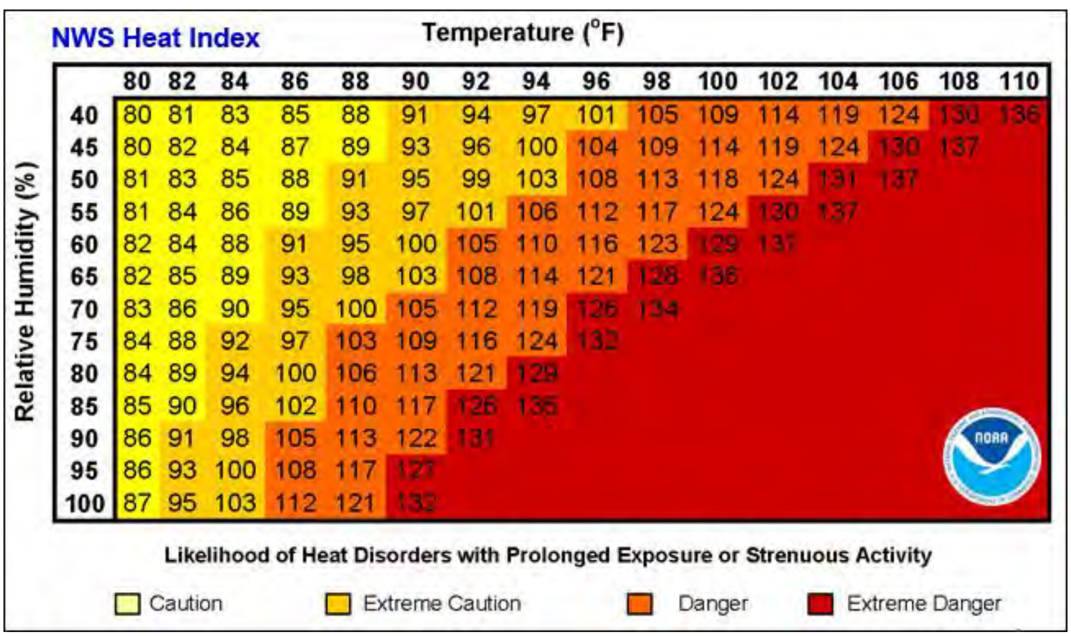
Hazard Description

As defined by FEMA, in most of the United States extreme heat is classified by a long period (2 to 3 days) of high heat and humidity with temperatures above 90 degrees. Under extreme heat conditions, evaporation is slowed, and the body must work harder 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 and relative humidity determine heat conditions. The relationship of these factors creates what is known as the apparent temperature. The Heat Index Chart in Figure 3.1 uses both of these factors to produce a guide for the apparent temperature or relative intensity of heat conditions, known as the heat index. 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, which would be exacerbated with continued exposure and/or physical activity.

Figure 3.1 – Heat Index Chart


NWS Heat Index

Temperature (°F)

Relative Humidity (%)	80	82	84	86	88	90	92	94	96	98	100	102	104	106	108	110
40	80	81	83	85	88	91	94	97	101	105	109	114	119	124	130	136
45	80	82	84	87	89	93	96	100	104	109	114	119	124	130	137	
50	81	83	85	88	91	95	99	103	108	113	118	124	131	137		
55	81	84	86	89	93	97	101	106	112	117	124	130	137			
60	82	84	88	91	95	100	105	110	116	123	129	131				
65	82	85	89	93	98	103	108	114	121	128	136					
70	83	86	90	95	100	105	112	119	126	134						
75	84	88	92	97	103	109	116	124	132							
80	84	89	94	100	106	113	121	129								
85	85	90	96	102	110	117	126	135								
90	86	91	98	105	113	122	131									
95	86	93	100	108	117	127										
100	87	95	103	112	121	132										

Source: National Weather Service (NWS) https://www.weather.gov/safety/heat-index

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 overexposed 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 3.4 lists typical symptoms and health impacts of heat exposure.

Table 3.4 – 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 (NWS) 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. The National Weather Service Forecast Office in Peachtree City/Atlanta sets the following criteria for heat advisory and excessive heat:

- **Heat Advisory** – At least 80% chance of heat index of 105°F or greater or daytime air temperature of 103°F or greater for any duration within 12 to 24 hours.
- **Excessive Heat Watch** – At least 50% chance for heat index of 110°F or greater or daytime air temperature of 105°F or greater within 36 to 72 hours.
- **Excessive Heat Warning** – At least 80% change for heat index of 110°F or greater or daytime air temperature of 105°F or greater for any duration within 12 to 24 hours.

While heat conditions may last several days, a warning can be issued even for one day of expected heat conditions.

Impacts of extreme heat are not only focused on human health, as prolonged heat exposure can have negative 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: 2 – 12 to 24 hours

Duration: 3 – Less than one week

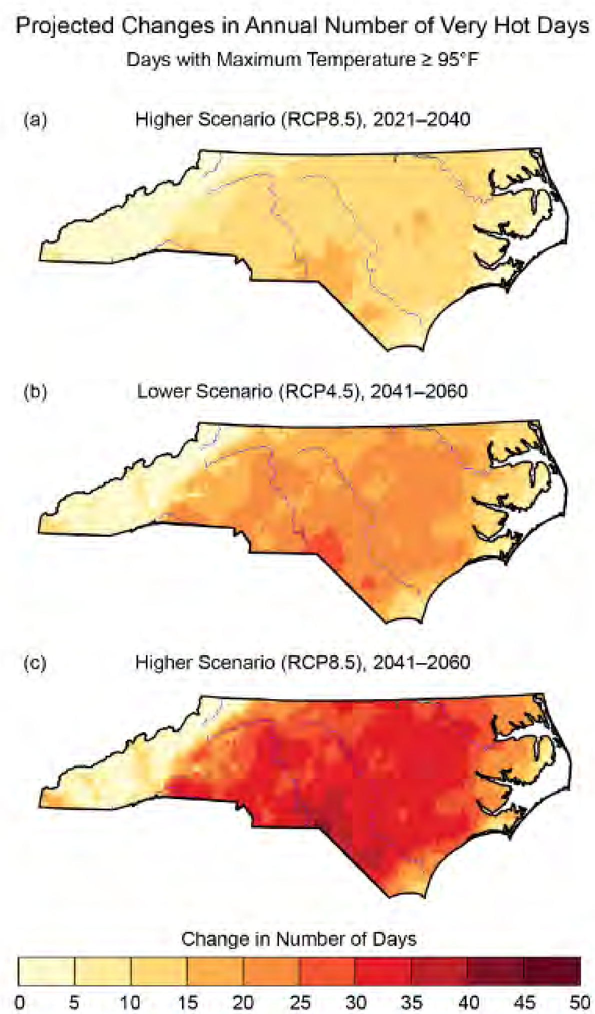
Climate Change

According to the 2020 North Carolina Climate Science Report, North Carolina's annual average temperature has increased approximately 1°F since 1895. This is less than the temperature increases in the northern and western portions of the United States. North Carolina is part of a larger region of the southeastern United States that has exhibited less overall warming in surface temperatures than the rest of the United States over the 20th century.

However, climate models do suggest the current warming trend will continue and project significant increases by the middle and end of the century. Projected values are shown for two climate futures: a higher scenario, in which greenhouse gas emissions continue to increase, and a lower scenario, in which emissions increase at a slower rate. By 2050, models project that the annual average temperature in North Carolina will increase by 2°–4°F under a lower scenario and by 2°–5°F under a higher scenario, compared to the average temperature for 1996–2015. By 2100, the average temperature is projected to increase by 2°–6°F under a lower scenario and by 6°–10°F under a higher scenario, compared to the average temperature for 1996–2015.

For extreme temperatures, the frequency of very hot days (maximum temperature of 95°F or higher) is projected. The projected changes in the annual number of very hot days for North Carolina for two mid-century time periods and two climate futures is presented in Figure 3.2. All projected values are shown as changes compared to the 1996–2015 average. For 2021–2040, climate models project little to no change in the number of very hot days in the Mountains. However, across much of the Piedmont and Coastal Plain, the number of very hot days is projected to increase by 10 to 20 days per year. By 2041-2060, The number of very hot days is projected to increase by 10 to 15 days per year in the Mountains; by 20 days or more in the westernmost tip of the state; and increases of 25 days or more are expected across the majority of the Piedmont and Coastal Plain

Figure 3.2 – Projected Change in Number of Days Over 95°F



Source: North Carolina Climate Science Report 2020; https://ncics.org/programs/nccsr/

Consequence Analysis

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. Complications may arise if electricity demand results in power outages; however, this should be managed for critical operations with backup power and system redundancies.
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.

Problem Statement

- UNC-P is located within Robeson County which currently averages 91 hours per year with heat index temperatures above 100°F and there is a 100% annual chance of heat index values exceeding 100°F in any given year.

3.4.5 Flood

Applicable Campuses

ECU	ECSU	FSU	NCCU	NCSSM	NCSU	UNC-CH	UNC-P	UNC-W
✓	✓	✓	✓	✓	✓	✓	✓	✓

PRI Summary by Campus

Campus	Probability	Impact	Spatial Extent	Warning Time	Duration	PRI Score
ECU	Likely	Critical	Small	6 to 12 hours	Less than 1 week	2.8
ECSU	Highly Likely	Minor	Small	6 to 12 hours	Less than 1 week	2.5
FSU	Likely	Minor	Small	6 to 12 hours	Less than 1 week	2.2
NCCU	Likely	Minor	Negligible	6 to 12 hours	Less than 6 hours	1.8
NCSSM	Likely	Minor	Negligible	6 to 12 hours	Less than 6 hours	1.8
NCSU	Highly Likely	Limited	Small	6 to 12 hours	Less than 1 week	2.8
UNC-CH	Likely	Minor	Negligible	6 to 12 hours	Less than 6 hours	1.8
UNC-P	Highly Likely	Minor	Negligible	6 to 12 hours	Less than 6 hours	2.1
UNC-W	Highly Likely	Minor	Negligible	6 to 12 hours	Less than 6 hours	2.1

Hazard Description

Flooding is defined by the rising and overflowing of water onto normally dry land. As specified 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 can be attributed to three main sources as noted below.

Riverine Flooding: Riverine flooding is defined as an event when a watercourse exceeds its "bank-full" capacity and is the most common type of flood event. Riverine floods result from precipitation over large areas. This type of flood occurs in river systems whose tributaries may drain large geographic areas and include many independent river basins. Riverine flooding generally occurs as a result of prolonged rainfall, or rainfall that is combined with soils already saturated from previous rain events. The duration of riverine floods may vary from a few hours to many days. Factors that directly affect the amount of flood runoff include precipitation, intensity and distribution, the amount of soil moisture, seasonal variation in vegetation, snow depth, and water-resistance of the surface areas due to urbanization. The area adjacent to a river channel is its floodplain. In its common usage, "floodplain" most often refers to that area that is inundated by the 100-year flood, the flood that has a 1-percent chance in any given year of being equaled or exceeded. The 1-percent annual flood, or base flood event, is the national standard to which communities regulate their floodplains through the National Flood Insurance Program.

Flash or Rapid 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 severe thunderstorms and sometimes combined with rapid snowmelt, ice jam release, frozen ground, saturated soil, or impermeable surfaces. 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. Flash floods may be the result of severe summer thunderstorms that produce high rainfall intensities scattered over small areas. Rapid onset allows little or no time for protective measures. Flash flood waters move at very fast speeds and can damage buildings and infrastructure, tear out trees, and scour channels. Flash flooding can result in higher loss of life, both human and animal, than slower developing river and stream flooding.

Localized/Stormwater Flooding: Localized stormwater flooding can occur throughout the UNC campuses. Localized stormwater flooding occurs when heavy rainfall and an accumulation of runoff overburden the stormwater drainage system. The cause of localized stormwater flooding can be attributed primarily to the large amount of developed and impervious land, which limits ground absorption and increases surface water runoff.

The following structural drainage issues may cause or exacerbate localized flooding:

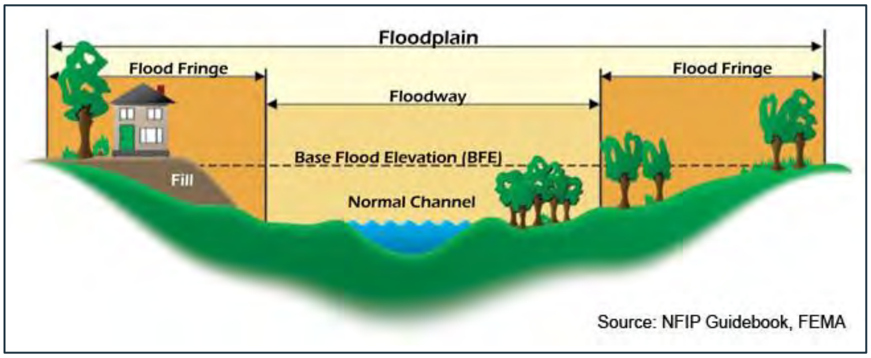
- **Inadequate Capacity –** An undersized/under capacity pipe system can cause water to back-up behind a structure which can lead to areas of ponded water and/or overtopping of banks.
- **Clogged Inlets** – Debris covering the asphalt apron and the top of grate at catch basin inlets may contribute to 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.

While localized flooding may not be as destructive as riverine or flash flooding, it is a chronic problem. The repetitive damage caused by such flooding can add up. Sewers may back up, yards can be inundated, and mechanical systems can be damaged when homes, businesses and vehicles are flooded. These impacts, and other localized flooding impacts, can create public health and safety concerns. Drainage and sewer systems not designed to carry the capacity currently needed to handle increased storm runoff will only continue to cause flooding without mitigation.

Flooding and Floodplains

A floodplain, as shown in Figure 3.3, 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 3.3 – Characteristics of a Floodplain



In its common usage, the floodplain most often refers to that area that is inundated by the "100-year flood," better defined as the "1-percent-annual-chance flood" because it is the flood that has a 1 percent chance in any given year of being equaled or exceeded. The NFIP utilizes the 1-percent-annual-chance flood as a basis for floodplain management. The "500-year flood" or "0.2-percent-annual-chance 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. Similarly, 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 1-percent-annual-chance 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. Individual campuses are not required to maintain flood insurance as North Carolina is a self-insuring state. All state-owned facilities are covered by the NC General Assembly.

Since floods have an annual probability of occurrence, have a known magnitude, depth and velocity for each event, and in many cases, have a map indicating where they will likely occur, they are in many ways often the most predictable and manageable hazard.

While weather forecasting can project periods of heavy rain, the likelihood of flooding is difficult to predict, leaving limited warning time for flood events. Especially as heavy rain events become more common, as discussed below under Climate Change, warning time for flooding may decrease, thereby increasing risk to those in harm's way.

Warning Time: 3 – 6 to 12 hours

Duration: 3 – Less than 1 week

Repetitive Loss Properties

The identification of repetitive loss properties, defined as those properties with two or more flood insurance claims totaling $1,000 or more within any 10-year period, is typically an important consideration of flood mitigation planning. For the UNC System Eastern Campuses, there are no identified repetitive loss properties.

However, this does not necessarily mean that there have not been repeat property damages resulting from flooding in the planning area. Public buildings, including all UNC System campus buildings, are generally self-insured; therefore, there have not been claims made to the National Flood Insurance Program for any campus buildings, nor was data available on any past loss amounts.

Climate Change

Per the Fourth National Climate Assessment, frequency and intensity of heavy precipitation events is expected to increase across the country. More specifically, it is "very likely" (90-100% probability) that most areas of the United States will exhibit an increase of at least 5% in the maximum 5-day precipitation by late 21st century. Additionally, increases in precipitation totals are expected in the Southeast. The mean change in the annual number of days with rainfall over 1 inch for the Southeastern United States is 0.5 to 1.5 days. Therefore, with more rainfall falling in more intense incidents, the planning area 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.

Consequence Analysis

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 can be 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.

Problem Statements

Problem statements for individual UNC Eastern Campuses are provided below:

- ECSU - The 1% annual chance floodplain does not impact any structures on the ECSU campus. However, the 0.2% annual chance floodplain (or 500-year floodplain) does extend onto the ECSU campus and could potentially impact the Central Utility Plant and roadways during these flood events.

- ECSU - In 2019, a flash flood event was reported on several campus streets at Elizabeth City State University.
- ECU - The 1% annual chance floodplain extends onto the ECU Campus. There are no critical facilities within the SFHA; however, four buildings on the ECU campus are impacted by the 1% annual chance floodplain and one of these buildings is located within the floodway. Along with these buildings, there is potential for many roadways to be impacted as well during these flood events.
- FSU - The 1% annual chance floodplain does not impact any structures on the FSU campus. However, the 0.2% annual chance floodplain (or 500-year floodplain) does extend onto the FSU campus and could potentially impact the Bronco Student Plaza, Bryant Hall, and adjacent roadways during these flood events.
- NCCU - The 1% annual chance floodplain does not impact the NCCU campus. However, the 0.2% annual chance floodplain (or 500-year floodplain) does extend onto the NCCU campus and could potentially impact roadways within the southeastern corner of the campus boundary during these flood events.
- NCCU - In 2019, a flash flood event was reported on several campus streets.
- NCSSM - The 1% annual chance floodplain does not impact the NCSSM campus.
- NCSU - The 1% annual chance floodplain extends onto the NCSU Campus. There are no critical facilities within the SFHA; however, two buildings on the NCSU Central campus (Carmichael Gymnasium and Dail Softball Stadium Batting Cage) are impacted by the 1% annual chance floodplain. Along with these buildings, there is potential for many roadways to be impacted as well during these flood events.
- NCSU - During a flash flood event in September 2010, Sullivan Drive on campus was closed due water over the roadway.
- UNC-CH - The 1% annual chance floodplain does not impact structures on the NCCU campus. However, the 0.2% annual chance floodplain (or 500-year floodplain) does extend onto the NCCU campus and could potentially impact roadways within the southeastern corner of the campus boundary during these flood events.
- UNC-CH - In 2019, a flash flood event was reported on several campus streets.
- UNC-P - The 1% annual chance floodplain does not impact the UNC-P campus.
- UNC-W - The 1% annual chance floodplain does not impact the UNC-W campus.
- All Campuses - Flooding may also occur on all campus when an intense rainfall occurs within the urban area and cannot be carried away by natural or urban drainage systems as fast as it is falling.

3.4.6 Geological – Landslides & Sinkhole

Applicable Campuses

ECU	ECSU	FSU	NCCU	NCSSM	NCSU	UNC-CH	UNC-P	UNC-W
✓		✓	✓	✓		✓	✓	✓

PRI Summary by Campus

Campus	Probability	Impact	Spatial Extent	Warning Time	Duration	PRI Score
ECU	Unlikely	Minor	Negligible	6 to 12 hours	Less than 6 hours	1.2
FSU	Unlikely	Minor	Negligible	6 to 12 hours	Less than 6 hours	1.2
NCCU	Unlikely	Minor	Small	6 to 12 hours	Less than 6 hours	1.4
NCSSM	Unlikely	Minor	Small	6 to 12 hours	Less than 6 hours	1.4
UNC-CH	Possible	Minor	Small	6 to 12 hours	Less than 6 hours	1.7
UNC-P	Unlikely	Minor	Negligible	6 to 12 hours	Less than 6 hours	1.2
UNC-W	Possible	Limited	Negligible	Less than 6 hours	Less than 6 hours	1.9

Hazard Description

Landslide

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 six hours

Sinkhole

Sinkholes are a natural and common geologic feature in areas with underlying limestone and other rock types that are soluble in natural water. Most limestone is porous, allowing the acidic water of rain to percolate through their strata, dissolving some limestone and carrying it away in solution. Over time, this persistent erosional process can create extensive underground voids and drainage systems in much of the carbonate rocks. Collapse of overlying sediments into the underground cavities produces sinkholes.

The three general types of sinkholes are: subsidence, solution, and collapse. Collapse sinkholes are most common in areas where the overburden (the sediments and water contained in the unsaturated zone, surficial aquifer system, and the confining layer above an aquifer) is thick, but the confining layer is breached or absent. Collapse sinkholes can form with little warning and leave behind a deep, steep sided hole. Subsidence sinkholes form gradually where the overburden is thin and only a veneer of sediments is overlying the limestone. Solution sinkholes form where no overburden is present, and the limestone is exposed at land surface.

Sinkholes occur in many shapes, from steep-walled holes to bowl or cone shaped depressions. Sinkholes can be dramatic because the land generally stays intact for a while until the underground spaces get too big. If there is not enough support for the land above the spaces, then a sudden collapse of the land surface can occur. Under natural conditions, sinkholes form slowly and expand gradually. However, human activities such as dredging, constructing reservoirs, diverting surface water, and pumping groundwater can accelerate the rate of sinkhole expansions, resulting in the abrupt formation of collapse sinkholes.

Although a sinkhole can form without warning, specific signs can signal potential development:

- Slumping or falling fenceposts, trees, or foundations;
- Sudden formation of small ponds;
- Wilting vegetation;
- Discolored well water; and/or
- Structural cracks in walls, floors.

Sinkhole formation can be accelerated by urbanization. Development increases water usage, alters drainage pathways, overloads the ground surface, and redistributes soil. According to FEMA, the number of human-induced sinkholes has doubled since 1930, insurance claims for damages as a result of sinkholes has increased 1,200 percent from 1987 to 1991, costing nearly $100 million.

Warning Time: 4 – Less than six hours

Duration: 1 – Less than six hours

Climate Change

NOAA research has found that extreme precipitation events are likely to become more common in the future as the climate warms, and in some areas, this may lead to a higher frequency of landslide activity.

Direct effects from changing climate conditions such as an increase in droughts and could also contribute to an increase in sinkholes. These changes raise the likelihood of extreme weather, meaning the torrential rain and flooding conditions which often lead to the exposure of sinkholes are likely to become increasingly common. Certain events such as a heavy precipitation following a period of drought can trigger a sinkhole due to low levels of groundwater combined with a heavy influx of rain.

Consequence Analysis

Category	Consequences
Public	Impacts are expected to be minimal to the larger population. Individuals may sustain injuries if they are in an affected structure or using affected infrastructure when the event occurs. Impacts for those effected could cause anxiety or depression about economic and property losses and personal injury.
Responders	First responders will be impacted similarly to other events that have advance warning. Personnel responsible for debris cleanup or roadway closures may face increased risk.
Continuity of Operations (including Continued Delivery of Services)	Temporary road closures may occur. Continuity of operations is generally not disrupted by sinkholes or landslide.
Property, Facilities and Infrastructure	Buildings and infrastructure may incur minor damages as a result of landslide. Although sinkhole extents are localized, buildings located on or adjacent to a sinkhole are susceptible to foundation damage or building collapse. If the building is located close enough to the sinkhole it can be completely destroyed or in worst cases, completely collapse into the sinkhole. Remediation costs can be high due to costly foundation shoring or cost of stabilization of the sinkhole itself.
Environment	Environmental impacts are expected to be minimal. Landslide may cause terrain and drainage changes and may temporarily increase sediment loads in nearby waterways. Sinkholes are natural occurring process and local plants and animals adjust quickly. Many naturally occurring sinkholes fill with rainwater creating new aquatic habitat.
Economic Condition of the Jurisdiction	Economic impacts are not expected from landslides. Sinkholes located in open areas or that impact only small numbers of buildings, while having a high impact to the local property owner, do not have substantial impacts to the economy. Sinkholes that open up in major traffic thoroughfares can include significant impact to daily work traffic and flow of goods.
Public Confidence in the Jurisdiction's Governance	Landslides and sinkholes in the planning area are unlikely to be severe and would not be expected to affect public confidence.

Problem Statements

- While landslides are an unlikely hazard event for the UNC Eastern Campuses, a landslide event could 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.
- Sinkholes are possible in the coastal plain, but events that could affect UNC-W are not considered severe and would likely be related to infrastructure and drainage issues.

3.4.7 Hurricane

Applicable Campuses

ECU	ECSU	FSU	NCCU	NCSSM	NCSU	UNC-CH	UNC-P	UNC-W
✓	✓	✓	✓	✓	✓	✓	✓	✓

PRI Summary by Campus

Campus	Probability	Impact	Spatial Extent	Warning Time	Duration	PRI Score
ECU	Likely	Catastrophic	Large	More than 24 hrs	Less than 24 hrs	3.2
ECSU	Likely	Catastrophic	Large	More than 24 hrs	Less than 24 hrs	3.2
FSU	Likely	Critical	Large	More than 24 hrs	Less than 24 hrs	2.9
NCCU	Likely	Critical	Large	More than 24 hrs	Less than 24 hrs	2.9
NCSSM	Likely	Critical	Large	More than 24 hrs	Less than 24 hrs	2.9
NCSU	Likely	Critical	Large	More than 24 hrs	Less than 24 hrs	2.9
UNC-CH	Possible	Limited	Large	More than 24 hrs	Less than 24 hrs	2.3
UNC-P	Likely	Critical	Large	More than 24 hrs	Less than 24 hrs	2.9
UNC-W	Likely	Catastrophic	Large	More than 24 hrs	Less than 24 hrs	3.2

Hazard Description

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 counterclockwise 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

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.

According to the *2020 North Carolina Climate Science Report*, the intensity of the strongest hurricanes is likely to increase with warming, and this could result in stronger hurricanes impacting North Carolina. Heavy precipitation accompanying hurricanes is very likely to increase, increasing freshwater flood potential. The frequency of hurricane impacts on North Carolina in the future is not clear at this time, but earlier projections of decreases in hurricane activity now appear less confident in light of recent high-resolution modeling studies.

Consequence Analysis

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.

Problem Statements

- Historical tracks of multiple hurricane events pass within 5-miles of all the UNC Eastern Campuses
- For the 20-year period from 2000 through 2019, there have been multiple hurricane events reported in the counties where each of the UNC Eastern Campuses are located:
    - 7 hurricane wind events causing over $5 million dollars in damage for Pasquotank County;

- 9 hurricane wind events causing over $50 million dollars in damage for Pitt County;
- 6 hurricane wind events causing over $2.5 million dollars in damage for Cumberland County;
- 3 hurricane wind events causing over $400,000 in damage for Durham County;
- 4 hurricane wind events causing around $71,000 in damage for Robeson County; and
- 4 hurricane wind events causing over $1 billion in damage for New Hanover County.

3.4.8 Severe Winter Weather

Applicable Campuses

ECU	ECSU	FSU	NCCU	NCSSM	NCSU	UNC-CH	UNC-P	UNC-W
✓	✓	✓	✓	✓	✓	✓	✓	

PRI Summary by Campus

Campus	Probability	Impact	Spatial Extent	Warning Time	Duration	PRI Score
ECU	Highly Likely	Limited	Large	More than 24 hrs	Less than 1 week	3.0
ECSU	Highly Likely	Limited	Large	More than 24 hrs	Less than 1 week	3.0
FSU	Highly Likely	Limited	Large	More than 24 hrs	Less than 1 week	3.0
NCCU	Highly Likely	Limited	Large	More than 24 hrs	Less than 1 week	3.0
NCSSM	Highly Likely	Limited	Large	More than 24 hrs	Less than 1 week	3.0
NCSU	Highly Likely	Limited	Large	More than 24 hrs	Less than 1 week	3.0
UNC-CH	Highly Likely	Limited	Large	More than 24 hrs	Less than 1 week	3.0
UNC-P	Highly Likely	Limited	Large	More than 24 hrs	Less than 1 week	3.0

Hazard Description

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 and can be accompanied by extreme cold temperatures. 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 (NWS) 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 several days after the initial incident until cleanup is completed.

Warning Time: 1 – More than 24 hours

Duration: 3 – Less than 1 week

Climate Change

A shorter overall winter season and fewer days of extreme cold may have both positive and negative indirect impacts. Warmer winter temperatures may result in changing distributions of native plant and animal species and/or an increase in pests and non-native species. As both temperature and precipitation increase during the winter months, freezing rain will be more likely. Additional wintertime precipitation in any form will contribute to saturation and increase the risk and/or severity of spring flooding.

According to the *2020 North Carolina Climate Science Report*, regional studies of trends in winter storms are challenged to provide definitive results regarding changes in the frequency or intensity of storms, but regardless of these properties, it is very likely that storms of even similar intensity will produce heavier precipitation. Also, with rising sea levels, coastal flooding from storms is very likely to increase.

Consequence Analysis

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.

Problem Statements

- ECSU – There have been 32 severe winter weather related events in Pasquotank County during the 20-year period from 2000 through 2019. The events have also resulted in two presidential disaster declarations for the County.
- ECU – There have been 25 severe winter weather related events in Pitt County during the 20-year period from 2000 through 2019. The events have also resulted in two presidential disaster declarations for the County.
- FSU – There have been 31 severe winter weather related events in Cumberland County during the 20-year period from 2000 through 2019. None of the events resulted in a presidential disaster declaration.

- NCCU, NCSSM – There have been 52 severe winter weather related events in Durham County during the 20-year period from 2000 through 2019. The events have also resulted in three presidential disaster declarations for the County.
- NCSU – There have been 50 severe winter weather related events in Wake County during the 20-year period from 2000 through 2019. The events have also resulted in four presidential disaster declarations for the County.
- UNC-CH – There have been 61 severe winter weather related events in Orange County during the 20-year period from 2000 through 2019. The events have also resulted in three presidential disaster declarations for the County.
- UNC-P – There have been 27 severe winter weather related events in Robeson County during the 20-year period from 2000 through 2019. None of the events resulted in a presidential disaster declaration.

3.4.9 Tornado/Thunderstorm

Applicable Campuses

ECU	ECSU	FSU	NCCU	NCSSM	NCSU	UNC-CH	UNC-P	UNC-W
✓	✓	✓	✓	✓	✓	✓	✓	✓

PRI Summary by Campus

Campus	Probability	Impact	Spatial Extent	Warning Time	Duration	PRI Score
ECU	Likely	Critical	Large	Less than 6 hrs	Less than 6 hrs	3.1
ECSU	Likely	Critical	Large	Less than 6 hrs	Less than 6 hrs	3.1
FSU	Likely	Critical	Large	Less than 6 hrs	Less than 6 hrs	3.1
NCCU	Likely	Critical	Large	Less than 6 hrs	Less than 6 hrs	3.1
NCSSM	Likely	Critical	Large	Less than 6 hrs	Less than 6 hrs	3.1
NCSU	Likely	Critical	Large	Less than 6 hrs	Less than 6 hrs	3.1
UNC-CH	Likely	Critical	Large	Less than 6 hrs	Less than 6 hrs	3.1
UNC-P	Likely	Critical	Large	Less than 6 hrs	Less than 6 hrs	3.1
UNC-W	Likely	Critical	Large	Less than 6 hrs	Less than 6 hrs	3.1

Hazard Description

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 – Less than six hours

Duration: 1 – Less than six hours

Hail

As defined by 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 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 cause 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 six hours

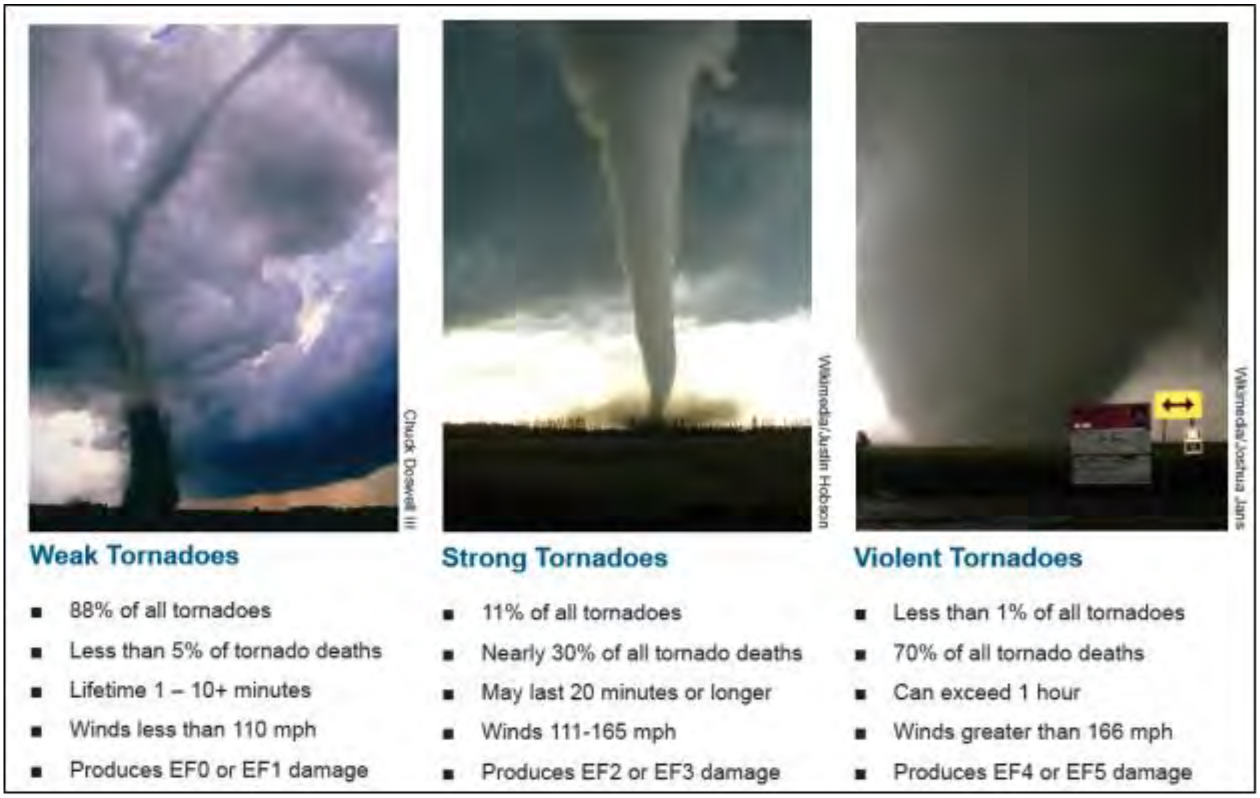
Duration: 1 – Less than six hours

Tornado

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). **Figure 3.4** shows tornado activity in the United States based on the number of recorded tornadoes per 1,000 square miles.

Figure 3.4 – Tornado Activity in the U.S.

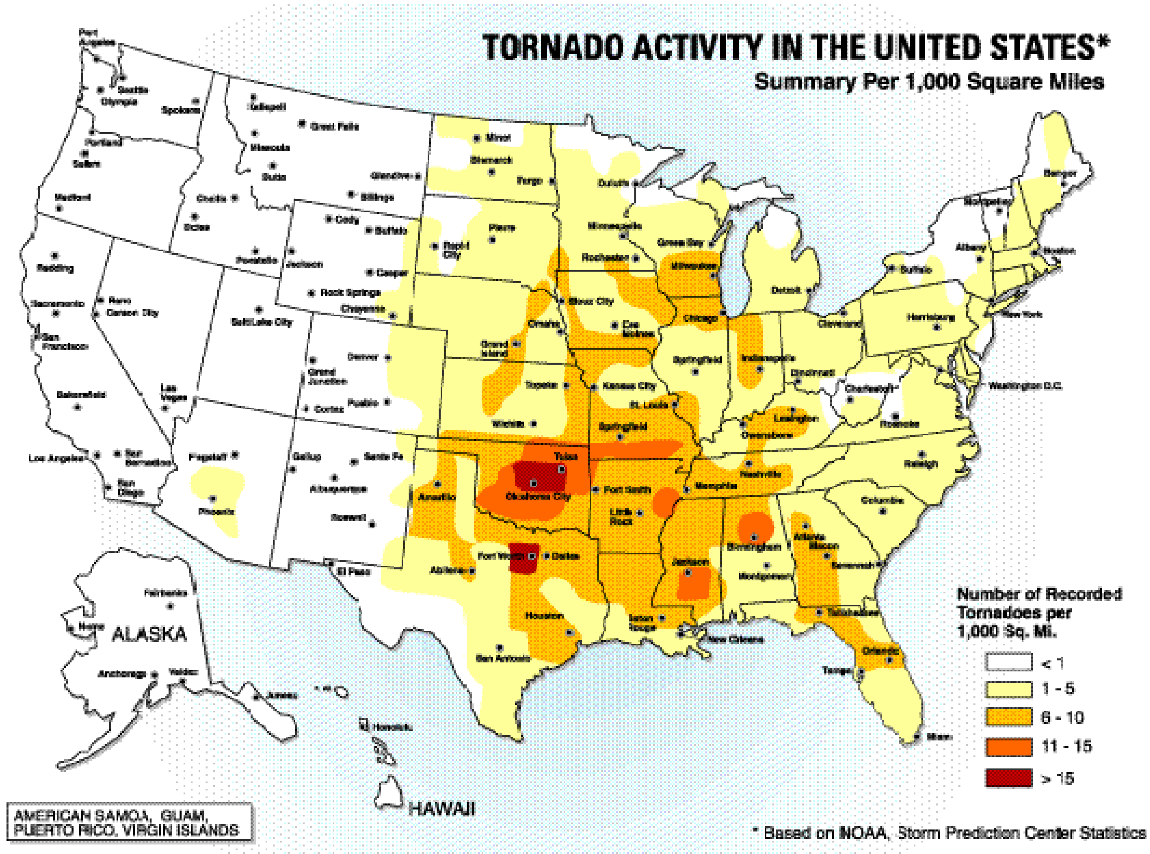


Figure I.1 The number of tornadoes recorded per 1,000 square miles

Source: American Society of Civil Engineers

Climate Change

NASA's Earth Observatory provides an analysis on how climate change could, theoretically, increase potential storm energy by warming the surface and putting more moisture in the air through evaporation. The presence of warm, moist air near the surface is a key ingredient for summer storms that meteorologists have termed "convective available potential energy," or CAPE. With an increase in CAPE, there is greater potential for cumulus clouds to form. The study also counters this theory with the theory that warming in the Arctic could lead to less wind shear in the mid-latitude areas prone to summer storms, making the storms less likely.

Predicted increases in temperature could help create atmospheric conditions that are fertile breeding grounds for severe thunderstorms and tornadoes in North Carolina. Possible impacts include an increased risk to life and property in both the public and private sectors. Public utilities and manufactured housing developments will be especially prone to damages. The UNC Eastern Campuses should be prepared for more of these events, and should thus prioritize mitigation actions such as construction of safe rooms, retrofitting and/or hardening existing structures, improving warning systems and public education, and reinforcing utilities and additional critical infrastructure.

Consequence Analysis

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. 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 fire ignition from lightning; hail damage to wildlife and foliage; devastating impacts from tornado in storm's path
Economic Condition of the Jurisdiction	Lightning damage contingent on target; can severely impact/destroy critical infrastructure and other economic drivers. Tornado impact contingent on tornado's path; can severely impact/destroy critical infrastructure and other economic drivers
Public Confidence in the Jurisdiction's Governance	Public confidence is not generally affected by severe weather events, but may be influenced by severe tornado events if response and recovery are not timely and effective.

Problem Statements

Thunderstorms and tornadoes are frequent hazard events on all of the UNC Eastern Campuses. Problems statements for the individual campuses include:

ECSU

- The strongest recorded thunderstorm wind event for Elizabeth City occurred on January 14, 2006 with a measured gust of 60 mph. The event reportedly caused $10,000 in property damages.
- The average hailstone size recorded between 2000 and 2019 in Elizabeth City was a little over 1" in diameter; the largest hailstone recorded was 1.75", recorded on April 16, 2002 and July 17, 2009.
- The most intense tornado to pass through Elizabeth City in the past 20 years was an EF0 on May 9, 2005. NCEI reports this event causing around $15,000 in property damage.
- Reported damages for Elizabeth City for the 20-year period from 2000-1019 include $90,000 for thunderstorm winds, $5,000 for lightning strikes, and $15,000 for tornado events.

ECU

- The strongest recorded thunderstorm wind event for Greenville occurred on July 1, 2012 with a measured gust of 65 mph. The event reportedly did not cause any property damages.
- The average hailstone size recorded between 2000 and 2019 in Greenville was a little over 1" in diameter; the largest hailstone recorded was 1.75", recorded on June 6, 2006, March 28, 2007, April 20, 2009, and August 29, 2011.
- Greenville experienced one tornado incident between 2000 and 2019, causing no property damage.

- Reported damages for Greenville for the 20-year period from 2000-1019 within Greenville include $21,000 for thunderstorm winds, $151,000 for lightning strikes.

FSU

- The strongest recorded thunderstorm wind event for Fayetteville occurred on July 8, 2015 with a measured gust of 64 mph. The event reportedly resulted in no property damage.
- The average hailstone size recorded between 2000 and 2019 in Fayetteville was a little over 1" in diameter; the largest hailstone recorded was 2.5", recorded on July 1, 2012.
- The most intense tornado to pass near Fayetteville in the past 20 years was an EF3 on April 16, 2011. NCEI reports this event causing around $100,000,000 in property damage.
- Reported damages for Fayetteville for the 20-year period from 2000-1019 include $135,000 for thunderstorm winds, $255,000 for lightning strikes, and $100,525,000 for tornado events.

NCCU and NCSSM

- The strongest recorded thunderstorm wind event for Durham occurred on September 28, 2004 with a measured gust of 60 mph.
- The average hailstone size recorded between 2000 and 2019 in Durham was a little over 1" in diameter; the largest hailstone recorded was 1.75", recorded on April 17, 2000, July 28, 2005, May 14, 2006 and March 14, 2016.
- The most intense tornado to pass through Durham in the past 20 years was an EF1 on May 15, 2004.
- Reported damages for Durham for the 20-year period from 2000-1019 include $230,750 for thunderstorm winds, $10,000 for lightning strikes, and $350,000 for tornado events.

NCSU

- The strongest recorded thunderstorm wind event for Raleigh occurred on January 11, 2014 with a measured gust of 75 mph. The event reportedly caused $350,000 in property damages.
- The average hailstone size recorded between 2000 and 2019 in Raleigh was a little over 1" in diameter; the largest hailstone recorded was 4 inches, recorded on March 28, 2005.
- The most intense tornado to pass through Raleigh in the past 20 years was an EF3 on April 16, 2011. NCEI reports this event caused around $115,000,000 in property damage.
- Reported damages for Raleigh for the 20-year period from 2000-1019 include $581,500 for thunderstorm winds, $210,000 for lightning strikes, and $116,163,000 for tornado events.

UNC-P

- The strongest recorded thunderstorm wind event for Robeson County occurred on May 11, 2014 with a measured gust of 109 mph. The event reportedly caused $878,000 in property damages.
- The average hailstone size recorded between 2000 and 2019 in Robeson County was a little over 1" in diameter; the largest diameter hail recorded in the County was 3 inches, which occurred on February 24, 2016.
- Reported damages for Robeson County for the 20-year period from 2000-1019 include $3,598,750 for thunderstorm winds, $506,500 for lightning strikes, $170,400 for hail, and $5,018,000 for tornado events.

UNC-W

- The strongest recorded thunderstorm wind event for Wilmington occurred on May 31, 2003 with a measured gust of 87 mph. The event reportedly caused $750,000 in property damages.

- The average hailstone size recorded between 2000 and 2019 in Wilmington was a little under 1” in diameter; the largest hailstone recorded was 1.75”, recorded on June 8, 2006.
- The most intense tornado to pass through Wilmington in the past 20 years was an EF1 on September 15, 2018. NCEI reports this event caused around $50,000 in property damage.
- Reported damages for Wilmington the 20-year period from 2000-1019 include $1,237,000 for thunderstorm winds, $377,000 for lightning strikes, and $110,000 for tornado events.

3.4.10 Wildfire

Applicable Campuses

ECU	ECSU	FSU	NCCU	NCSSM	NCSU	UNC-CH	UNC-P	UNC-W
✓	✓	✓	✓	✓	✓	✓	✓	✓

PRI Summary by Campus

Campus	Probability	Impact	Spatial Extent	Warning Time	Duration	PRI Score
ECU	Possible	Limited	Large	More than 24 hrs	More than 1 week	2.5
ECSU	Possible	Limited	Large	More than 24 hrs	More than 1 week	2.5
FSU	Possible	Limited	Large	More than 24 hrs	More than 1 week	2.5
NCCU	Unlikely	Limited	Moderate	More than 24 hrs	More than 1 week	2.0
NCSSM	Unlikely	Minor	Small	More than 24 hrs	More than 1 week	1.5
NCSU	Likely	Limited	Large	More than 24 hrs	More than 1 week	2.8
UNC-CH	Possible	Limited	Large	More than 24 hrs	More than 1 week	2.5
UNC-P	Likely	Limited	Large	More than 24 hrs	More than 1 week	2.8
UNC-W	Likely	Critical	Large	More than 24 hrs	More than 1 week	3.1

Hazard Description

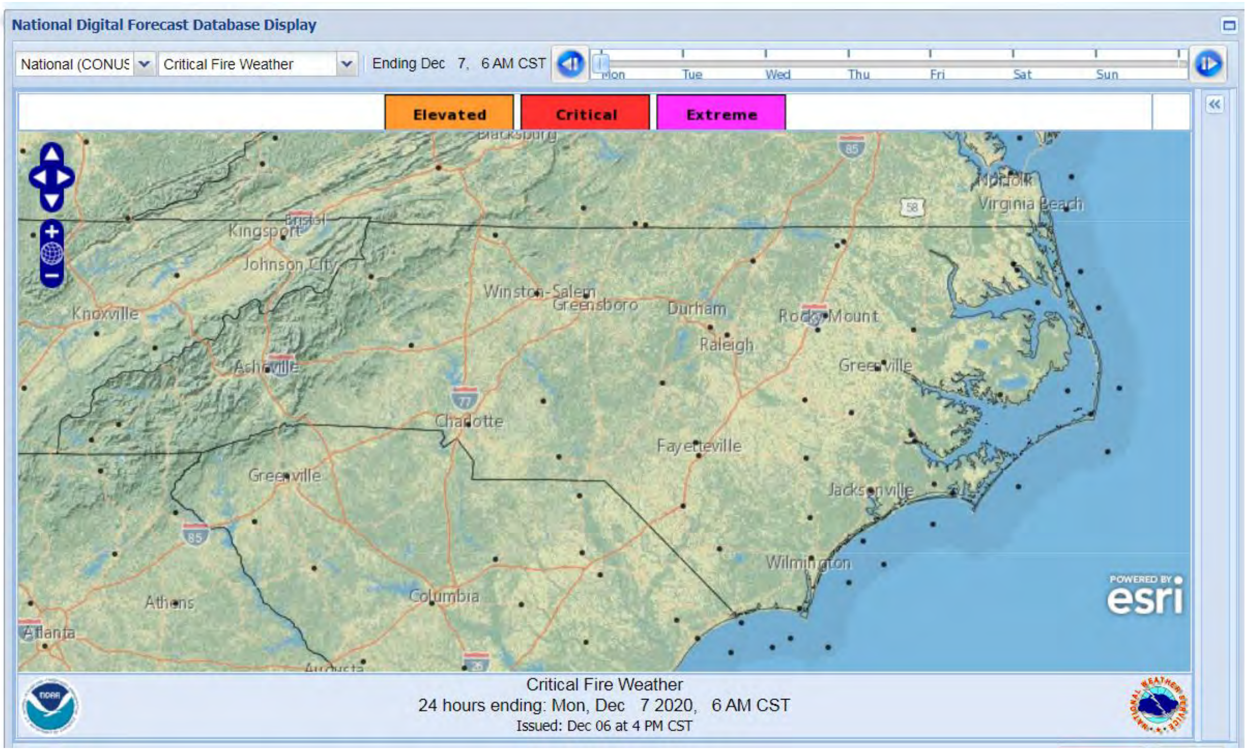
A wildfire is an uncontained fire that spreads through the environment. Wildfires have the ability to consume large areas, including infrastructure, property, and resources. When massive fires, or conflagrations, develop near populated areas, evacuations possibly ensue. Not only do the flames impact 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 3.5, the National Weather Service National Headquarters provides year-round fire weather forecasts.

Figure 3.5 – Fire Weather Forecast, North Carolina, December 7, 2020



Source: National Weather Service

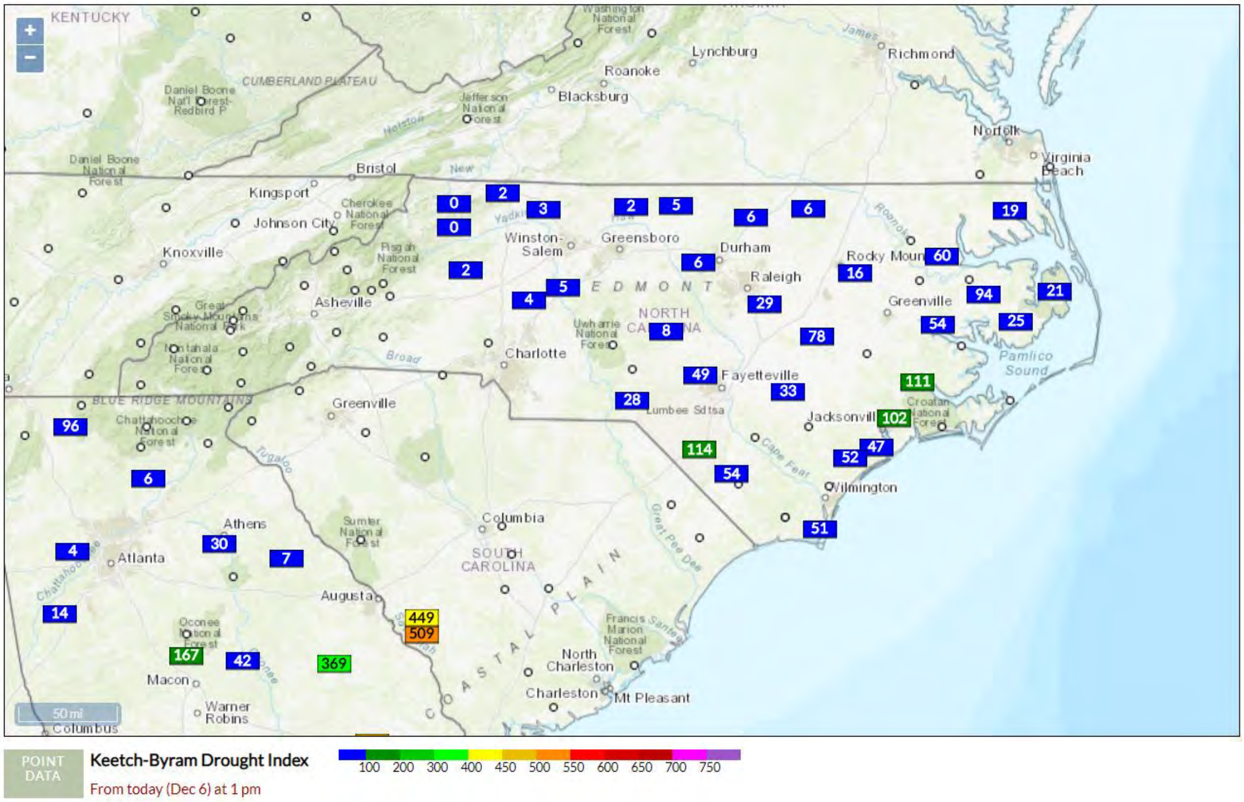
Weather conditions favorable to wildfire include drought, which increases flammability of surface fuels, and winds, which aid a wildfire's progress. The combination of wind, temperature, and humidity affects how fast wildland fires can spread. Rapid response can contain wildfires and limit their threat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

North Carolina experiences a variety of wildfire conditions found in the Keetch-Byram Drought Index, which is described in Table 3.5. The Keetch-Byram Drought Index (KBDI) for December 6, 2020 is shown in Figure 3.6 along with a Daily Fire Danger Estimate Adjective Rating for certain points across the state. The KBDI ranges from 0 to 114 across the State of North Carolina.

Table 3.5 – 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 3.6 – Keetch-Byram Drought Index, December 2019



Source: State Climate Office of North Carolina

Warning Time: 4 – Less than 6 hours

Duration: 3 – Less than 1 week

Climate Change

According to the *2020 North Carolina Climate Science Report*, future increases in annual and seasonal average temperatures and associated increases in drying rates are very likely. Changes in other climate elements that affect wildfire likelihood are uncertain. In particular, there is substantial uncertainty about future changes in precipitation. Nevertheless, it is certain that severe droughts will occur in the future, as they are a natural part of the climate system. Future droughts are very likely to be warmer, increasing the drying rate of fuels and leading to higher wildfire likelihood. Thus, it is likely that conditions conducive to wildfire occurrence will increase in the future.

Consequence Analysis

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.

Category	Consequences
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.
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 actions taken pre-disaster to mitigate and prepare for impacts, including the amount of public education provided; efforts to provide warning to residents; response actions; and speed and effectiveness of recovery.

Problem Statements

- ECU: The Information Technology Center is a critical campus building and is within an area of campus that would face major impacts in the event of a fire. Sprinkler systems in the Information Technology Center could cause loss of campus servers in the event of a fire.

3.4.11 Cyber Threat

Applicable Campuses

ECU	ECSU	FSU	NCCU	NCSSM	NCSU	UNC-CH	UNC-P	UNC-W
✓	✓		✓		✓		✓	✓

PRI Summary by Campus

Campus	Probability	Impact	Spatial Extent	Warning Time	Duration	PRI Score
ECSU	Possible	Critical	Large	Less than 6 hrs	More than 1 week	3.1
ECU	Possible	Critical	Large	Less than 6 hrs	More than 1 week	3.1
NCCU	Possible	Critical	Large	Less than 6 hrs	More than 1 week	3.1
NCSU	Possible	Critical	Large	Less than 6 hrs	More than 1 week	3.1
UNC-P	Possible	Critical	Large	Less than 6 hrs	More than 1 week	3.1
UNC-W	Possible	Critical	Large	Less than 6 hrs	More than 1 week	3.1

Hazard Description

The State of North Carolina Hazard Mitigation Plan defines cyber attacks as “deliberate attacks on information technology systems in an attempt to gain illegal access to a computer, or purposely cause damage.” Cyber-attacks use malicious code to alter computer operations or data. The vulnerability of computer systems to attacks is a growing concern as people and institutions become more dependent upon networked technologies. The Federal Bureau of Investigation (FBI) reports that “cyber intrusions are becoming more commonplace, more dangerous, and more sophisticated,” with implications for private- and public-sector networks.

There are many types of cyber-attacks. Among the most common is a direct denial of service, or DDoS attack. This is when a server or website will be queried or pinged rapidly with information requests, overloading the system and causing it to crash.

Malware, or malicious software, can cause numerous problems once on a computer or network, from taking control of users’ machines to discreetly sending out confidential information. Ransomware is a specific type of malware that blocks access to digital files and demands a payment to release them. Hospitals, school districts, state and local governments, law enforcement agencies, businesses, and even individuals can be targeted by ransomware.

Cyber spying or espionage is the act of illicitly obtaining intellectual property, government secrets, or other confidential digital information, and often is associated with attacks carried out by professional agents working on behalf of a foreign government or corporation. According to cybersecurity firm Symantec, in 2016 “…the world of cyber espionage experienced a notable shift towards more overt activity, designed to destabilize and disrupt targeted organizations and countries.”

Major data breaches - when hackers gain access to large amounts of personal, sensitive, or confidential information - have become increasingly common. The Symantec report says more than seven billion identities have been exposed in data breaches over the last eight years. In addition to networked systems, data breaches can occur due to the mishandling of external drives, as has been the case with losses of some state employee data.

Cyber crime can refer to any of the above incidents when motivated primarily by financial gain or other criminal intent.

The most severe type of attack is cyber terrorism, which aims to disrupt or damage systems in order to cause fear, injury, and loss to advance a political agenda.

The North Carolina State Bureau of investigation' Computer Crime Unit helps law enforcement across North Carolina solve sophisticated crimes involving digital evidence.

Warning Time: 4 – Less than six hours

Duration: 4 – More than one week

Climate Change

Cyber Disruption is considered a human-caused/technological hazard and is not directly impacted by changes in weather patterns/climate. However, climate change and its implications can have destabilizing impacts on society. When livelihoods are in danger, this will spark insecurity and drive resource competition. Individuals that have no other means of providing for their families could turn to cybercrime, which is often seen as a low-risk activity with a potentially high yield. Additionally, as changes in climate increase the frequency and/or magnitude of natural hazard events, information technology systems can be threatened by the structural forces of the hazard event, inflationary factors, and the evolution of technology that may arise out of the event.

Consequence Analysis

Category	Consequences
Public	Cyber attacks can impact personal data and accounts. Injuries or fatalities could potentially result from a major cyber terrorist attacks against critical infrastructure.
Responders	Cyber attacks can impact personal data and accounts. Injuries or fatalities could potentially result from a major cyber terrorist attacks against critical infrastructure.
Continuity of Operations (including Continued Delivery of Services)	Agencies that rely on electronic backup of critical files are vulnerable. The delivery of services can be impacted since governments rely, to a great extent, upon electronic delivery of services.
Property, Facilities and Infrastructure	Rare. Most attacks affect only data and computer systems. Sabotage of utilities and infrastructure from a major cyber terrorist attacks could potentially result in system failures that damage property on a scale equal with natural disasters. Facilities and infrastructure may become unusable as a result of a cyber-attack.
Environment	Rare. A major attack could theoretically result in a hazardous materials release.
Economic Condition of the Jurisdiction	Could greatly affect the economy. In an electronic-based commerce society, any disruption to daily activities can have disastrous impacts to the economy. It is difficult to measure the true extent of the impact.
Public Confidence in the Jurisdiction's Governance	The government's inability to protect critical systems or confidential personal data could impact public confidence. An attack could raise questions regarding the security of using electronic systems for government services.

Problem Statements

- Cyber-attacks occur daily, but most have negligible impacts at the local or regional level. The possibility of a larger disruption affecting systems within the region is a constant threat, but difficult to quantify.
- Each University has a specific Office and/or Division of Information Technology which addresses IT security through policies addressing users, physical security, system security, password administration, communications, wireless devices, computer viruses, disaster recovery, and compliance with law and policy.

3.4.12 Hazardous Material Incidents

Applicable Campuses

ECU	ECSU	FSU	NCCU	NCSSM	NCSU	UNC-CH	UNC-P	UNC-W
✓	✓		✓	✓	✓	✓	✓	✓

PRI Summary by Campus

Campus	Probability	Impact	Spatial Extent	Warning Time	Duration	PRI Score
ECU	Highly Likely	Minor	Negligible	Less than 6 hrs	Less than 24 hrs	2.3
ECSU	Likely	Minor	Negligible	Less than 6 hrs	Less than 24 hrs	2.0
NCCU	Highly Likely	Minor	Negligible	Less than 6 Hrs	Less than 24 Hrs	2.3
NCSSM	Highly Likely	Minor	Negligible	Less than 6 Hrs	Less than 24 Hrs	2.3
NCSU	Highly Likely	Minor	Negligible	Less than 6 Hrs	Less than 24 Hrs	2.3
UNC-CH	Likely	Minor	Negligible	Less than 6 hrs	Less than 24 hrs	2.0
UNC-P	Possible	Limited	Small	Less than 6 Hrs	Less than 24 Hrs	2.2
UNC-W	Highly Likely	Minor	Negligible	Less than 6 Hrs	Less than 24 Hrs	2.3

Hazard Description

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 release of chemical substances or mixtures during production or handling at a fixed facility. Hazardous materials releases can be accidental or intentional, as with a terror attack, addressed in **Section 3.4.14**.

Fixed facilities with hazardous materials can include industrial, commercial, and federal facilities. The Emergency Planning and Community Right-to-Know Act (EPCRA) created several methods for tracking facilities with hazardous materials. Section 313 of the EPCRA created the Toxics Release Inventory (TRI). The TRI tracks toxic chemical releases and pollution prevention activities reported by industrial and federal facilities. TRI data is made publicly available by the U.S. Environmental Protection Agency (EPA). Section 312 of the EPCRA mandated additional reporting of hazard materials by businesses and organizations with quantities of hazardous materials over a certain threshold. Tier II reports must be submitted annually, and help local fire departments, Local Emergency Planning Committees (LEPC) and State Emergency Response Commissions (SERCs) plan for and respond to chemical emergencies.

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 North Carolina 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: 4 – Less than six hours

Duration: 2 – Less than 24 hours

Climate Change

Accidental or incidental releases of hazardous materials are non-natural incidents and therefore, there are no implications for impacts from climate change. However, there is growing evidence that hazardous material releases triggered by natural hazards can pose significant risks. In these incidences, the impact of climate change is of a secondary nature. It may exacerbate the natural hazard event by triggering release of hazardous materials.

Consequence Analysis

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.

Problem Statements

- Highway transportation routes for hazardous materials are located adjacent to all of the UNC Eastern Campuses.
- Pipeline transportation routes for hazardous materials are located adjacent to the NCCU and NCSU Campuses.
- Rail transportation routes are located adjacent to the UNC-P campus.
- Reported hazardous materials incidents have occurred in the past year in all communities encompassing the university campuses with the exception of Pembroke and UNC-P.

3.4.13 Infectious Disease

Applicable Campuses

ECU	ECSU	FSU	NCCU	NCSSM	NCSU	UNC-CH	UNC-P	UNC-W
✓	✓		✓		✓		✓	✓

PRI Summary by Campus

Campus	Probability	Impact	Spatial Extent	Warning Time	Duration	PRI Score
ECU	Possible	Critical	Large	More than 24 hrs	More than 1 week	2.8
ECSU	Possible	Critical	Large	More than 24 hrs	More than 1 week	2.8
NCCU	Possible	Critical	Large	More than 24 hrs	More than 1 week	2.8
NCSU	Possible	Critical	Large	More than 24 hrs	More than 1 week	2.8
UNC-P	Possible	Critical	Large	More than 24 hrs	More than 1 week	2.8
UNC-W	Possible	Critical	Large	More than 24 hrs	More than 1 week	2.8

Hazard Description

Public health emergencies can take many forms—disease epidemics, large-scale incidents of food or water contamination, or extended periods without adequate water and sewer services. There can also be harmful exposure to chemical, radiological, or biological agents, and largescale infestations of disease-carrying insects or rodents. The first part of this section focuses on emerging public health concerns and potential pandemics, while the second part addresses natural and human-caused air and water pollution.

Public health emergencies can occur as primary events by themselves, or they may be secondary to another disaster or emergency, such as tornado, flood, or hazardous material incident. For more information on those particular incidents, see Sections 3.4.9 (Tornado/Thunderstorm), 3.4.5 (Flood), and 3.4.12 (Hazardous Materials). The common characteristic of most public health emergencies is that they adversely impact, or have the potential to adversely impact, a large number of people. Public health emergencies can be worldwide or localized in scope and magnitude.

The primary communicable, or infectious, disease addressed within this plan is influenza:

Influenza - Whether natural or manmade, health officials say the threat of a dangerous new strain of influenza (flu) virus in pandemic proportions is a very real possibility in the years ahead. Unlike most illnesses, the flu is especially dangerous because it is spread through the air. A classic definition of influenza is a respiratory infection with fever. Each year, flu infects humans and spreads around the globe. There are three types of influenza virus: Types A, B, and C. Type A is the most common, most severe, and the primary cause of flu epidemics. Type B cases occur sporadically and sometimes as regional or widespread epidemics. Type C cases are quite rare and hence sporadic, but localized outbreaks have occurred. Seasonal influenza usually is treatable, and the mortality rate remains low. Each year, scientists estimate which particular strain of flu is likely to spread, and they create a vaccine to combat it. A flu pandemic occurs when the virus suddenly changes or mutates and undergoes an —antigenic shift, permitting it to attach to a person's respiratory system and leave the body's immune system defenseless against the invader.

Additional diseases of public health concern include tuberculosis, Smallpox, St. Louis Encephalitis, Meningitis, Lyme disease, West Nile, Zika, Ebola, and Coronaviruses, including SARS. These communicable diseases are introduced within this plan, but full vulnerability analyses are not included at this time.

Tuberculosis - Tuberculosis, or TB, is the leading cause of infectious disease worldwide. It is caused by a bacteria called Mycobacterium tuberculosis that most often affects the lungs. TB is an airborne disease spread by coughing or sneezing from one person to another. The World Health Organization (WHO) estimates that one-third of the world's population, approximately two billion people, has latent TB, which means people have been infected by TB bacteria but are not yet ill with the disease and cannot transmit the disease. In 2015, 10.4 million people fell ill with TB and 1.8 million died from the disease (including 0.4 million among people with HIV). Over 95% of TB deaths occur in low- and middle- income countries.

Smallpox - Smallpox is a contagious, sometimes fatal, infectious disease. There is no specific treatment for smallpox disease, and the only prevention is vaccination. Smallpox is caused by the variola virus that emerged in human populations thousands of years ago. It is generally spread by face- to-face contact or by direct contact with infected bodily fluids or contaminated objects (such as bedding or clothing). A person with smallpox is sometimes contagious with onset of fever, but the person becomes most contagious with the onset of rash. The rash typically develops into sores that spread over all parts of the body. The infected person remains contagious until the last smallpox scab is gone. Smallpox outbreaks have occurred periodically for thousands of years, but the disease is now largely eradicated after a worldwide vaccination program was implemented. After the disease was eliminated, routine vaccination among the general public was stopped. The last case of smallpox in the United States was in 1949.

St. Louis Encephalitis - In the United States, the leading type of epidemic flaviviral Encephalitis is St. Louis encephalitis (SLE), which is transmitted by mosquitoes that become infected by feeding on birds infected with the virus. SLE is the most common mosquito-transmitted pathogen in the United States. There is no evidence to suggest that the virus can be spread from person to person.

Meningitis- Meningitis is an infection of fluid that surrounds a person’s spinal cord and brain. High fever, headache, and stiff neck are common symptoms of meningitis, which can develop between several hours to one to two days after exposure. Meningitis can be caused by either a viral or bacterial infection; however, a correct diagnosis is critically important, because treatments for the two varieties differ. Meningitis is transmitted through direct contact with respiratory secretions from an infected carrier. Primary risk groups include infants and young children, household contact with patients, and refugees. In the United States, periodic outbreaks continue to occur, particularly among adolescents and young adults. About 2,600 people in the United States get the disease each year. Generally, 10 to 14 percent of cases are fatal, and 11 to 19 percent of those who recover suffer from permanent hearing loss, mental retardation, loss of limbs, or other serious effects. Two vaccines are available in the United States.

Lyme Disease - Lyme disease was named after the town of Lyme, Connecticut, where an unusually large frequency of arthritis-like symptoms was observed in children in 1977. It was later found that the problem was caused by bacteria transmitted to humans by infected deer ticks, causing an average of more than 16,000 reported infections in the United States each year (however, the disease is greatly under-reported). Lyme disease bacteria are not transmitted from person to person. Following a tick bite, 80 percent of patients develop a red ―bulls-eye‖ rash accompanied by tiredness, fever, headache, stiff neck, muscle aches, and joint pain. If untreated, some patients may develop arthritis, neurological abnormalities, and cardiac problems, weeks to months later. Environmental issues addressed in this profile focus on air and water pollution, because contamination of those media can have widespread impacts on public health and devastating consequences. Particular issues of primary concern associated with sources of air and water pollution change over time depending on recent industrial activity, economic development, enforcement of environmental regulations, new scientific information on adverse health effects of particular contaminants or concentrations, and other factors. Lyme disease is rarely fatal. During early stages of the disease, oral antibiotic treatment is generally effective, while intravenous treatment may be required in more severe cases.

West Nile Virus - West Nile virus is a flavivirus spread by infected mosquitoes and is commonly found in Africa, West Asia, and the Middle East. It was first documented in the United States in 1999. Although it is not known where the U.S. virus originated, it most closely resembles strains found in the Middle East. It is closely related to St. Louis encephalitis and can infect humans, birds, mosquitoes, horses, and other mammals.

Most people who become infected with West Nile virus will have either no symptoms or only mild effects. However, on rare occasions, the infection can result in severe and sometimes fatal illness. There is no evidence to suggest that the virus can be spread from person to person.

An abundance of dead birds in an area may indicate that West Nile virus is circulating between the birds and mosquitoes in that area. Although birds are particularly susceptible to the virus, most infected birds survive. The continued expansion of West Nile virus in the United States indicates that it is permanently established in the Western Hemisphere.

Zika Virus - Discovered in the Zika forest of Uganda in 1947, the Zika virus is a member of the flavivirus family. It is transmitted to humans through the bite of an infected Aedes species mosquito (Ae. aegypti and Ae. albopictus). Zika virus can also be transmitted from an infected pregnant woman to her baby during pregnancy and can result in serious birth defects, including microcephaly. Less commonly, the virus can be spread through intercourse or blood transfusion. However, most people infected with the Zika virus do not become sick.

Ebola - previously known as Ebola hemorrhagic fever, is a rare and deadly disease caused by infection with one of the Ebola virus species. It was first discovered in 1976 near the Ebola River in what is now the Democratic Republic of the Congo. Since then, outbreaks have appeared sporadically in Africa.

Coronavirus - Coronaviruses are a large family of viruses that can cause illness in animals or humans. In humans there are several known coronaviruses that cause respiratory infections. These coronaviruses range from the common cold to more severe diseases such as severe acute respiratory syndrome (SARS), Middle East respiratory syndrome (MERS), and COVID-19.

- **Severe Acute Respiratory Syndrome** - Severe acute respiratory syndrome (SARS) is a respiratory illness that has recently been reported in Asia, North America, and Europe. Although the cause of SARS is currently unknown, scientists have detected in SARS patients a previously unrecognized coronavirus that appears to be a likely source of the illness. In general, humans infected with SARS exhibit fevers greater than 100.4 F, headaches, an overall feeling of discomfort, and body aches. Some people also experience mild respiratory symptoms. After two to seven days, SARS patients may develop a dry cough and have trouble breathing. The primary way that SARS appears to spread is by close person-to-person contact; particularly by an infected person coughing or sneezing contaminated droplets onto another person, with a transfer of those droplets to the victim's eyes, nose, or mouth.
- **COVID**-19 - COVID-19 was identified in Wuhan, China in December 2019. COVID-19 is caused by the virus severe acute respiratory syndrome coronavirus 2 (SARS-CoV-2), a new virus in humans causing respiratory illness which can be spread from person-to-person. Early in the outbreak, many patients were reported to have a link to a large seafood and live animal market, however, later cases with no link to the market confirmed person-to-person transmission of the disease through respiratory droplets. Data from several countries suggest that 14%-19% of those infected are hospitalized and 3%-5% will need intense care unit admission.

Warning Time: 1 – More than 24 hours

Duration: 4 – More than one week

Climate Change

According to the U.S. Global Change Research Program, the influences of climate change on public health is significant and varied. The influences range from the clear threats of temperature extremes and severe storms to less obvious connections related to insects. Climate and weather can also affect water and food quality in particular areas, with implications for public health.

Hot days can be unhealthy—even dangerous. High air temperatures can cause heat stroke and dehydration, and affect people's cardiovascular and nervous systems. Midwestern cities like St. Louis are vulnerable to heat waves, because many houses and apartments lack air conditioning, and urban areas are typically warmer than their rural surroundings. In recent decades, severe heat waves have killed hundreds of people across the Midwest. Heat stress is expected to increase as climate change brings hotter summer temperatures and more humidity. Certain people are especially vulnerable, including children, the elderly, the sick, and the poor.

Higher temperatures and wetter conditions tend to increase mosquito and tick activity, leading to an increased risk of zoonotic diseases. Mosquitos are known to carry diseases such as West Nile virus (WNV), La Crosse/California encephalitis, Jamestown Canyon virus, St. Louis encephalitis, and Eastern equine encephalitis. The two major concerns associated with warmer and wetter conditions are that the mosquito species already found in Missouri and the diseases that they carry will become more prevalent, and that new species carrying unfamiliar diseases will start to appear for the first time.

Warmer winters with fewer hard freezes in areas that already see WNV-carrying mosquitos are likely to observe both a higher incidence of WNV and a longer WNV season, ultimately leading to an increase in human cases. Non-native mosquito species may move into Missouri if the climate becomes more suitable for them, bringing with them diseases such as Jamestown Canyon virus, Chikungunya, and Dengue Fever.

Ticks are also well-known disease vectors in North Carolina, carrying pathogens such as Lyme disease, anaplasmosis, Ehrlichiosis, Powassan virus, and Babesiosis. Warmer, wetter weather can lead to an increase in algal blooms and declining beach health. An increase in flood events may also be associated with an increased incidence of mold problems in homes and businesses, as well as contamination of wells and surface waters due to sewer overflows and private septic system failures.

If these predictions come true, communities must contend with the human health impacts related to the increased prevalence of infectious diseases, heat waves, and changes in air and water quality. Public health officials will need to focus on spreading information and enacting pest and disease reduction. Floodprone communities will need to focus on continuously improving flood controls and mitigation strategies, including restricting building and chemical storage in floodplains, upgrading well and septic requirements, and providing water testing kits to residents.

Consequence Analysis

Category	Consequences
Public	Adverse impact expected to be severe for unprotected personnel and moderate to light for protected personnel.
Responders	Adverse impact expected to be severe for unprotected personnel and uncertain for trained and protected personnel, depending on the nature of the incident.
Continuity of Operations (including Continued Delivery of Services)	Danger to 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	Access to facilities and infrastructure in the area of the incident may be denied until decontamination completed.

Category	Consequences
Environment	Incident may cause denial or delays in the use of some areas. Remediation needed.
Economic Condition of the Jurisdiction	Local economy and finances 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 not timely and effective.

Problem Statements

- With the current COVID-19 pandemic, it is clear that all of the UNC Eastern Campus populations are susceptible to the infectious disease pandemic.
- ECSU, ECU, NCCU, NCSU, UNC-P, and UNC-W each have a pandemic influenza plan in place to provide a guide for the University to follow in the event of an influenza pandemic in North Carolina.

3.4.14 Terrorism

Applicable Campuses

ECU	ECSU	FSU	NCCU	NCSSM	NCSU	UNC-CH	UNC-P	UNC-W
					✓			✓

PRI Summary by Campus

Campus	Probability	Impact	Spatial Extent	Warning Time	Duration	PRI Score
NCSU	Unlikely	Catastrophic	Large	More than 24 hrs	More than 1 week	2.8
UNC-W	Unlikely	Catastrophic	Large	More than 24 hrs	More than 1 week	2.8

Hazard Description

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.

For this analysis, this hazard encompasses the following sub-hazards: enemy attack, biological terrorism, agro-terrorism, chemical terrorism, conventional terrorism, cyber terrorism, 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.

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.

Biological terrorism is the use of biological agents against persons or property. 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. Effects of chemical contaminants are similar to biological agents.

Radiological terrorism is the use of radiological materials against persons or property. 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.

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.

Mass demonstrations, or direct conflict by large groups of citizens, as in marches, protect rallies, 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 (SPLC) reports 32 active hate groups in North Carolina, listed in Table 3.6. 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 3.6 – Hate Groups Active in North Carolina

Group	Type	Location
American Christian Dixie Knights of the Ku Klux Klan	Ku Klux Klan	Statewide
American Identity Movement	White Nationalist	Statewide
Americans for Legal Immigration (ALIPAC)	Anti-Immigrant	Raleigh
Asatru Folk Assembly	Neo-Volkisch	Statewide
Blood and Honour Social Club	Racist Skinhead	Statewide
Blood and Honour USA	Racist Skinhead	Statewide
Confederate Hammerskins	Racist Skinhead	Statewide
Crew 38	Racist Skinhead	Statewide
Great Millstone	Black Separatist	Charlotte
Heirs to the Confederacy	Neo-Confederate	Asheboro
Identity Dixie	Neo-Confederate	Statewide
Israel United In Christ	Black Separatist	Concord
Israelite School of Universal Practical Knowledge	Black Separatist	Charlotte
Israelite School of Universal Practical Knowledge	Black Separatist	Durham
Israelite School of Universal Practical Knowledge	Black Separatist	Fayetteville
Israelite School of Universal Practical Knowledge	Black Separatist	Greensboro
Israelite School of Universal Practical Knowledge	Black Separatist	Greenville
Israelite School of Universal Practical Knowledge	Black Separatist	Winston-Salem
Israelites Saints of Christ	Black Separatist	Statewide
Loyal White Knights of the Ku Klux Klan	Ku Klux Klan	Pelham
Masharah Yasharahla - Government of Israel	Black Separatist	Raleigh
Nation of Islam	Black Separatist	Charlotte

Group	Type	Location
Nation of Islam	Black Separatist	Durham
Nation of Islam	Black Separatist	Greensboro
Nation of Islam	Black Separatist	Wilmington
Nation of Islam	Black Separatist	Winston-Salem
New Black Panther Party for Self Defense	Black Separatist	Charlotte
Patriot Front	White Nationalist	Statewide
Proud Boys	General Hate	Statewide
Southern Revivalism	Neo-Confederate	Statewide
The Right Stuff	White Nationalist	Statewide
The United Nuwaupians Worldwide/All Eyes on Egipt	General Hate	Charlotte

Source: SPLC, https://www.splcenter.org/hate-map

Warning Time: 4 – Less than six 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.

Climate Change

The 2017 Climate Diplomacy report *"Insurgency, Terrorism and Organized Crime in a Warming Climate"* analyzes the links between climate change and terrorist groups. Through case studies, the report concludes that the complex risks which arise from climate change can contribute to the emergence, and growth, of non-state armed groups. This does not mean that there is a direct link between climate change and terrorism. But climate change, coupled with other challenges such as poverty, inequality or marginalization, can provide a fertile ground for terrorist groups to thrive, and further contest authorities.

Consequence Analysis

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. Human impacts may be long-term based on attack vector.
Responders	Injuries; fatalities are possible. Responders face increased risks during an effort to stop an attack or rescue others while an attack is underway. Potential impacts to response capabilities may result from an attack.
Continuity of Operations (including Continued Delivery of Services)	Potential impacts to continuity of operations due to attack impacts; delays in providing services; impacts tied to attack vector
Property, Facilities and Infrastructure	Impacted roads; downed power lines and power loss; utility disruption. Several key critical sites could be targeted in an attack, causing cascading impacts to daily life in the region
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

Problem Statement

- There are no records of past terrorism incidents for the NCSU or UNC-W Campuses.
- There are active hate groups within North Carolina.
- When identified, credible threats may increase the probability of an incident; these threats are generally tracked by law enforcement.

3.4.15 Vandalism/Theft

Applicable Campuses

ECU	ECSU	FSU	NCCU	NCSSM	NCSU	UNC-CH	UNC-P	UNC-W
				✓				

PRI Summary by Campus

Campus	Probability	Impact	Spatial Extent	Warning Time	Duration	PRI Score
NCSSM	Highly Likely	Minor	Large	More than 24 hrs	Less than 6 hrs	2.5

Hazard Description

Vandalism can be defined as the willful or malicious damage to property, such as equipment or buildings. Vandalism includes graffiti, trash dumping, light smashing, removing/bending signage or ornamentation, breaking windows, or other defacing of property. Graffiti is a pervasive type of vandalism. Graffiti vandals use a variety of instruments to tag or mark property including, spray paint, broad-tipped markers, metal objects, etching pens, or shoe polish bottles.

Vandalism is not senseless property damage. Individuals vandalize for a variety of reasons including: to convey a message, to express frustration, to stake revenge, to make money, or as part of a game. Vandalism is often associated with other signs of social disorder, such as disturbing the peace and trespassing. Regardless of the vandal's reasoning, vandalism incidents are burdensome to the University and neighboring businesses by generating costs associated with repairs and cleaning, which the victims are often left to cover themselves.

Theft or school break-ins categorized as follows:

- Nuisance break-ins, in which individuals break into a school building, seemingly as an end in itself. There is little serious damage and nothing of value is taken.
- Professional break-ins, in which offenders use a high level of skill to enter the school building, break into storage rooms containing expensive equipment, and remove bulky items from the scene.
- Malicious break-ins entail significant damage to the school's interior and may include arson. Offenders sometimes destroy rather than steal items of value.

While school vandalism and theft/break-ins generally comprise many often-trivial incidents, in the aggregate, these acts pose a serious problem for schools and communities, and the police and fire departments charged with protecting them.

Warning Time: More than 24 hours

Duration: Less than 6 hours

Climate Change

In post-disaster situations, vandalism and theft/school break-ins have the potential to increase, as there is often a breakdown in governance, even if only temporarily. Lack of governance creates a vacuum that offenders can exploit. Police and other first responders are focused on disaster response and rescue efforts and may be limited in time and resources to focus on the criminal element, whether that be nuisance, professional, or malicious offenders. As changes in climate increase the frequency and magnitude natural hazard events, the opportunity for vandalism and theft/break-ins also increases.

Consequence Analysis

Category	Consequences
Public	Localized impact expected to be severe for unprotected personnel and moderate to light for protected personnel.
Responders	Localized impact 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 temporary relocation of operations; localized disruption of lines of communication and destruction of facilities may postpone delivery of some services.
Property, Facilities, and Infrastructure	Localized impact to facilities and infrastructure in the area of the incident. Some severe damage possible.
Environment	May cause extensive damage in isolated cases and some denial or delays in the use of some areas. Remediation needed.
Economic Condition of Jurisdiction	Local economy and finances adversely affected, possibly for an extended period of time, 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.

Problem Statement

- Incidents of vandalism and/or theft can occur throughout the NCSSM campus
- Incidents of vandalism occur on a regular basis in the area surrounding the NCSSM Campus.

3.5 CONCLUSIONS ON HAZARD RISK

Priority Risk Index

As discussed in Section 3.3, 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 results from the PRI have been classified into three categories based on the assigned risk value, as follows:

- **High Risk (3.0 – 4.0)** – Widespread potential impact. This ranking carries a high threat to the general population and/or built environment. The potential for damage is widespread.
- **Moderate Risk (2.0 – 2.9)** – 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 (1.0 – 1.9)** – Minimal potential impact. The occurrence and potential cost of damage to life and property is minimal. This is not a priority hazard.

The conclusions drawn from this process are summarized below.

Table 3.7 summarizes the degree of risk assigned to each identified hazard using the PRI method.

Table 3.7 – Summary of PRI Results

Hazard	ECU	ECSU	FSU	NCCU	NCSSM	NCSU	UNC-CH	UNC-P	UNC-W
Dam Failure	n/a	n/a	n/a	n/a	n/a	n/a	2.4	n/a	n/a
Drought	n/a	n/a	n/a	n/a	n/a	n/a	2.5	n/a	n/a
Earthquake	1.9	1.9	1.9	1.9	1.9	1.9	1.9	1.9	1.9
Extreme Heat	n/a	n/a	n/a	n/a	n/a	n/a	n/a	3.1	n/a
Flood	2.5	2.5	2.2	1.8	1.8	2.8	1.8	2.1	2.1
Geological	1.1	n/a	1.1	1.3	1.3	n/a	1.3	1.1	1.9
Hurricane	3.2	3.2	2.9	2.9	2.9	2.9	2.3	2.9	3.2
Severe Winter Weather	3.1	3.1	3.1	3.1	3.1	3.1	3.1	3.1	n/a
Tornado/Thunderstorm	3.1	3.1	3.1	3.1	3.1	3.1	3.1	3.1	3.1
Wildfire	2.5	2.5	2.5	2.0	1.5	2.8	2.5	2.8	3.1
Cyber	3.1	3.1	n/a	3.1	n/a	3.1	n/a	3.1	3.1
Hazardous Materials	2.3	2.0	n/a	2.3	2.3	2.3	2.0	2.2	2.3
Infectious Disease	2.8	2.8	n/a	2.8	n/a	2.8	n/a	2.8	2.8
Terrorism	n/a	n/a	n/a	n/a	n/a	2.8	n/a	n/a	2.8
Vandalism/Theft	n/a	n/a	n/a	n/a	2.5	n/a	n/a	n/a	n/a

4 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 mitigation strategy process and mitigation action plan development for the UNC Eastern Campuses Hazard Mitigation Plan. It describes how the campuses met Step 6: Set Goals, Step 7: Review Possible Activities, and Step 8: Draft an Action Plan from the 10-step planning process. This section contains the following subsections:

- 3.1 Goals and Objectives
- 3.2 Identification and Analysis of Mitigation Activities

Mitigation action plans are located in each campus annex.

4.1 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.

Section 3 and the campus annexes document the hazards and associated risks that threaten the UNC Eastern Campuses, including the vulnerability of structures, infrastructure, and critical facilities. Based on this understanding of risks, the HMPC must identify mitigation actions to reduce exposure, vulnerability, and overall risk. The intent of goal setting is to guide the review of possible mitigation actions. This Hazard Mitigation Plan needs to make sure that recommended actions are consistent with what is appropriate for the campuses. Mitigation goals should reflect campus priorities and should be consistent with other campus, local, and regional plans.

- **Goals** are general guidelines that explain what is to be achieved. They are usually broad-based, long-term policy type statements that represent global visions. Goals help define the benefits that the plan is trying to achieve.
- **Objectives** are short term aims which, when combined, form a strategy or course of action to meet a goal. Objectives provide more specific methods for achieving goals.

4.1.1 Goal Setting

At the second planning meeting, held on August 20, 2020, the HMPC reviewed and discussed the goals from the existing PDM plans. One key consideration in evaluating these goals was to ensure that the goals of the Hazard Mitigation Plan align with other community planning efforts such as campus strategic and master plans as well as local and regional comprehensive and land use plans. These documents are important guides for future growth on the campuses within the surrounding communities. Therefore, the HMPC should strive to achieve consistency in the plans' goals.

The five goals from the 2010 UNC Eastern Campuses Pre-Disaster Mitigation plan primarily addressed inherent pieces of the planning process itself rather than mitigation. Changes were made to more directly address mitigation. These proposed changes were presented to the HMPC and subsequently validated. The HMPC then reviewed, discussed, and revised a set of objectives recommended by the planning consultant to further guide the creation of mitigation actions. The goals and objectives approved by the HMPC are presented below.

4.1.2 Resulting Goals and Objectives

Goal 1: Reduce the impact of hazards on campus buildings, critical facilities, and critical infrastructure.

Objective 1.1: Retrofit or otherwise protect critical facilities and infrastructure.

Objective 1.2: Protect critical research and campus operations.

Objective 1.3: Preserve and protect natural systems and resources that provide hazard mitigation benefits.

Goal 2: Protect the public health, safety, and welfare of people on campus from hazard risk.

Objective 2.1: Implement outreach activities to create a culture of preparedness by educating campus communities on local risks, property protection, and personal protection.

Objective 2.2: Improve hazard monitoring and warning systems to enable earlier response actions.

Objective 2.3: Create or update existing campus evacuation and shelter in place procedures.

Goal 3: Build campus resilience to minimize interruption and ensure speedy recovery from hazard events.

Objective 3.1: Develop or revise plans, policies, and regulations to reduce vulnerability of new construction on campus.

Objective 3.2: Improve campus mitigation and response capabilities.

4.2 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, the HMPC targeted those hazards considered high and moderate priorities for the planning area, based on the analysis provided in Section 3 Hazard Identification & Risk Assessment and the campus annexes. The following table indicates which hazards were determined based on the Priority Risk Index scores to be high and moderate priority hazards for each campus.

Table 4.1 – Priority Hazards by Campus

Hazard	ECU	ECSU	FSU	NCCU	NCSSM	NCSU	UNC-CH	UNC-P	UNC-W
Dam Failure							✓		
Drought							✓		
Earthquake									
Extreme Heat								✓	
Flood	✓	✓	✓			✓		✓	✓
Geological									
Hurricane	✓	✓	✓	✓	✓	✓	✓	✓	✓
Severe Winter Weather	✓	✓	✓	✓	✓	✓	✓	✓	
Tornado/Thunderstorm	✓	✓	✓	✓	✓	✓	✓	✓	✓

Hazard	ECU	ECSU	FSU	NCCU	NCSSM	NCSU	UNC-CH	UNC-P	UNC-W
Wildfire	✓	✓	✓	✓		✓	✓	✓	✓
Cyber	✓	✓		✓		✓		✓	✓
Hazardous Materials	✓	✓		✓	✓	✓	✓	✓	✓
Infectious Disease	✓	✓		✓		✓		✓	✓
Terrorism						✓			✓
Vandalism/Theft					✓				

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 during the committee meeting, in discussion with the planning consultants, and through review of the FEMA Mitigation Ideas publication. The HMPC was instructed to consider both future and existing buildings in evaluating possible mitigation actions. The HMPC also considered which incomplete actions from the existing plans should be carried forward in this plan.

4.2.1 Prioritization Process

In the process of identifying continuing and new mitigation actions, the HMPC was provided with a set of criteria to assist in deciding why one action might be more important, more effective, or more likely to be implemented than another. HMPC members were asked to rate each action with an approach modified from the FEMA STAPLEE criteria. The considerations for action prioritization were as follows:

- **Socially Acceptable:** Is the action acceptable to the community? Does it have a greater impact on a certain segment of the population? Are the benefits fair?
- **Technically Feasible:** Is the action technically feasibly? Is it a long-term solution to the problem? Does it capitalize on existing planning mechanisms for implementation?
- **Administrative Resources:** Are there adequate staffing, funding and other capabilities to implement the project? Is there adequate additional capability to ensure ongoing maintenance?
- **Politically Supported:** Will there be adequate political and public support for the project? Does the project have a local champion to support implementation?
- **Legally Allowable:** Does the community have the legal authority to implement the action?
- **Economically Sound:** Can the action be funded locally? Will the action need to be funded by an outside entity, and has that funding been secured? How much will the project cost? Can the benefits be quantified, and do they outweigh the costs?
- **Environmentally Sound:** Does the action comply with environmental regulations? Does the action meet the community's environmental goals? Does the action impact land, water, endangered species, or other natural assets?

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.

The prioritization ranking, simplified as High, Medium, or Low, for each mitigation action considered by the HMPC is provided in the Mitigation Action plans found in each campus' annex.

5 Plan Implementation and 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 each campus 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

5.1 IMPLEMENTATION

Each campus participating in this plan update has its own Mitigation Action Plan (found in each campus annex) and is responsible for implementing their own specific mitigation actions. This approach enables individual campuses to implement, update, and revise their own unique mitigation action list as needed without altering the broader focus of the regional plan. Proposed actions in each Mitigation Action Plan are assigned to specific campus departments to ensure responsibility and accountability and to increase the likelihood of subsequent implementation.

In addition to the assignment of a campus lead department, 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 campuses may seek outside funding sources to implement mitigation projects in both the pre-disaster and post-disaster environments. Where 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 planning 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 campus 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 planning documents for their campus and/or local community are consistent with the goals and actions of the Hazard Mitigation Plan and will not contribute to increased hazard vulnerability in the campus planning areas. 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.

Opportunities to integrate the requirements of this Plan into other 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 campus 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 campus hazard mitigation actions at this time.

5.2 MONITORING, EVALUATION, AND ENHANCEMENT

5.2.1 Role of HMPC in Implementation, Monitoring and Maintenance

With adoption of this plan, each campus will be responsible for the implementation and maintenance of their mitigation actions. The emergency management coordinators or other campus safety staff were assigned as the planning leads for each campus. Each identified campus lead will oversee all plan monitoring and update procedures for their campus. As such, the campus leads agree to continue their relationship with the campus HMPCs 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 local governing boards; and
- Inform and solicit input from the public.

The primary duty of the campus HMPCs moving forward is to see the plan successfully carried out and report to the campus administration, 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 mitigation, passing concerns on to appropriate entities, and providing relevant information for continued public involvement.

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 campuses 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.

5.2.2 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. Each campus lead will be responsible for convening their HMPC and initiating regular reviews. Regular maintenance will take place through 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 campus administration 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 2021, the next plan update for the UNC Eastern Campuses will be completed by 2026.

5.2.3 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; 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 campus will be responsible for tracking and reporting on their mitigation actions. Representatives should provide input on whether the action as implemented met the defined objectives and/or is likely to successfully reduce vulnerability.
- If the action does not meet identified objectives, the HMPC 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 during annual 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 priority but were identified as potential mitigation activities will be reviewed during the monitoring and update of the 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 campus administration.

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 campus leads to reconvene the HMPC and ensure the appropriate stakeholders are invited to participate in the plan revision and update process following declared disaster events.

5.3 CONTINUED PUBLIC INVOLVEMENT

Continued public involvement is imperative to the overall success of the plan's implementation. The annual 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 campus news, public bulletin boards and/or campus office buildings and community spaces;
- Designating willing members of the public as official members of the HMPC;
- Utilizing campus media to update the public of any maintenance and/or review activities;

- Utilizing campus websites and social media to advertise any maintenance and/or review activities;
- Maintaining copies of the plan in campus libraries or other appropriate venues;
- Posting annual progress reports on the plan to campus 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 campus newspapers/newsletters.

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.

6 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 from all participating campuses, raise awareness of the plan, and formalize the plan's implementation. The adoption of this plan completes Planning Step 9 of the 10-step planning process: Adopt the Plan, in accordance with the requirements of DMA 2000. Each participating campus will adopt the Hazard Mitigation Plan by passing a resolution. Copies of these adoption resolutions are provided in the following pages.

U. S. Department of Homeland Security
Region IV
3005 Chamblee Tucker Road
Atlanta, GA 30341

FEMA

July 16, 2021

Mr. Steve McGugan
State Hazard Mitigation Officer
Assistant Director / Mitigation Section Chief
Division of Emergency Management
NC Department of Public Safety
200 Park Offices Drive
Durham, NC 27713

Reference: University of North Carolina – Eastern Campuses

Dear Mr. McGugan:

We are pleased to inform you that the University of North Carolina – Eastern Campuses Hazard Mitigation Plan Update is in compliance with the Federal hazard mitigation planning requirements resulting from the Disaster Mitigation Act of 2000, as contained in 44 CFR 201.6. The plan is approved for a period of five (5) years effective July 16, 2021 to July 15, 2026.

This plan approval extends to the following participating jurisdiction that provided a copy of their resolution adopting the plan:

- University of North Carolina – Eastern Campuses

The approved participating jurisdiction is hereby an eligible applicant through the State for the following mitigation grant programs administered by the Federal Emergency Management Agency (FEMA):

- Hazard Mitigation Grant Program (HMGP)
- Flood Mitigation Assistance (FMA)
- Building Resilient Infrastructure and Communities (BRIC)

National Flood Insurance Program (NFIP) participation is required for some programs.

We commend the participants in the University of North Carolina – Eastern Campuses Hazard Mitigation Plan for development of a solid, workable plan that will guide hazard mitigation activities over the coming years. Please note, all requests for funding will be evaluated individually according to the specific eligibility and other requirements of the particular program under which the application is submitted. For example, a specific mitigation activity or project identified in the plan may not meet the eligibility requirements for FEMA funding, and even eligible mitigation activities are not automatically approved for FEMA funding under any of the aforementioned programs.

We strongly encourage each community to perform an annual review and assessment of the effectiveness of their hazard mitigation plan; however, a formal plan update is required at least every five (5) years. We also encourage each community to conduct a plan update process within one (1) year of being included within a Presidential Disaster Declaration or of the adoption of major modifications to their local Comprehensive Land Use Plan or other plans that affect hazard mitigation or land use and development.

When you prepare a comprehensive plan update, it must be resubmitted through the State as a "plan update" and is subject to a formal review and approval process by our office. If the plan is not updated prior to the required five (5) year update, please ensure that the Draft update is submitted at least six (6) months prior to expiration of this plan approval.

The State and the participants in the University of North Carolina – Eastern Campuses Hazard Mitigation Plan should be commended for their close coordination and communications with our office in the review and subsequent approval of the plan. If you or the participants in the University of North Carolina – Eastern Campuses Hazard Mitigation Plan have any questions or need any additional information, please do not hesitate to contact Celicia Davis, of the Hazard Mitigation Assistance Branch, at (202) 997-7490, Carol Maldonado, of the Hazard Mitigation Assistance Branch, at (470) 307-6294, Hailey Peterson, of the Hazard Mitigation Assistance Branch, at (202) 655-8757 or Edwardine S. Marrone, of my staff, at (404) 433-3968.

Sincerely,

Kristen M. Martinenza, P.E., CFM
Branch Chief
Risk Analysis
FEMA Region IV

2

ECU

Office of the Chancellor
[illegible] | Greenville, NC [illegible]
252-328-6212 office | 252-328-4155 fax

EAST CAROLINA UNIVERSITY RESOLUTION
ADOPTING THE UNC SYSTEM EASTERN CAMPUSES
REGIONAL HAZARD MITIGATION PLAN

WHEREAS, East Carolina University has undertaken a comprehensive Multi-Hazard Mitigation planning process under the guidelines of 44 CFR Part 201, a Federal Law that provides funding for communities and universities to promote hazard mitigation and disaster planning in order to protect teaching and learning, research and innovation, and public service; and

WHEREAS, East Carolina University has a need to protect infrastructure, as well as the health, safety and security of human life that resides, attends academic or other activities, and/or works on the campus, making it a community of more than 30,000 during the academic year; and

WHEREAS, an educational campus, in order to be eligible to receive Federal Mitigation Project Implementation funds for future projects and/or FEMA reimbursement funding, must have a FEMA-approved local plan that meets Federal requirements; and

WHEREAS, East Carolina University has developed an acceptable, comprehensive set of planning guidelines consistent with the Stafford Act and other FEMA guidance that can be used as their own Local Hazard Mitigation Plan; and

WHEREAS, various officials of East Carolina University have been involved over the two year project with the Campus Core Committee for Multi-Hazard Mitigation Planning, and support this regional planning process as it becomes a continuing activity going forward;

THEREFORE, BE IT RESOLVED, that East Carolina University Adopts the UNC-System Eastern Campuses Regional Hazard Mitigation Plan which is hereby approved, and will be submitted to the Office of the President of the University for submittal to North Carolina Emergency Management.

ADOPTED AND APPROVED this 1st day of June, 2021.

By: ______________________________
Dr. Philip G. Rogers, Chancellor

Date: 6-2-21

ELIZABETH CITY STATE UNIVERSITY RESOLUTION
ADOPTING THE UNC SYSTEM EASTERN CAMPUSES
REGIONAL HAZARD MITIGATION PLAN

WHEREAS, Elizabeth City State University has undertaken a comprehensive Multi-Hazard Mitigation planning process under the guidelines of 44 CFR Part 201, a Federal Law that provides funding for communities and universities to promote hazard mitigation and disaster planning in order to protect teaching and learning, research and innovation, and public service; and

WHEREAS, Elizabeth City State University has a need to protect infrastructure, as well as the health, safety and security of human life that resides and/or works on the campus, making it a community of up to 2,600 during the academic year; and

WHEREAS, an educational campus, in order to be eligible to receive Federal Mitigation Project Implementation funds for future projects and/or FEMA reimbursement funding, must have a FEMA-approved local plan that meets Federal requirements; and

WHEREAS, Elizabeth City State University has developed an acceptable, comprehensive set of planning guidelines consistent with the Stafford Act and other FEMA guidance that can be used as their own Local Hazard Mitigation Plan; and

WHEREAS, various officials of Elizabeth City State University have been involved over the two-year project with the Campus Core Committee for Multi-Hazard Mitigation Planning, and support this regional planning process as it becomes a continuing activity going forward;

THEREFORE, BE IT RESOLVED, that Elizabeth City State University Adopts the UNC-System Eastern Campuses Regional Hazard Mitigation Plan, which is hereby approved, and will be submitted to the Office of the President of the University for submittal to North Carolina Emergency Management.

ADOPTED AND APPROVED this 15th day of April, 2021.

By: ______________________
Dr. Karrie G. Dixon, Chancellor

Date: April 15, 2021

Office of the Chancellor
1704 Weeksville Rd. Elizabeth City, NC 27909

p: 252. 335. 3228 | f: 252. 335. 3731 | www.ecsu.edu

ECSU is a constituent institution of the University of North Carolina System.

FAYETTEVILLE STATE UNIVERSITY

Office of the Chancellor

APRIL 6, 2021

FAYETTEVILLE STATE UNIVERSITY RESOLUTION ADOPTING THE UNC SYSTEM EASTERN CAMPUSES REGIONAL HAZARD MITIGATION PLAN

WHEREAS, Fayetteville State University has undertaken a comprehensive Multi-Hazard Mitigation planning process under the guidelines of 44 CFR Part 201, a Federal Law that provides funding for communities and universities to promote hazard mitigation and disaster planning in order to protect teaching and learning, research and innovation, and public service; and

WHEREAS, Fayetteville State University has a need to protect infrastructure, as well as the health, safety and security of human life that resides and/or works on the campus, making it a community of up to 7,231 during the academic year; and

WHEREAS, an educational campus, in order to be eligible to receive Federal Mitigation Project Implementation funds for future projects and/or FEMA reimbursement funding, must have a FEMA-approved local plan that meets Federal requirements; and

WHEREAS, Fayetteville State University has developed an acceptable, comprehensive set of planning guidelines consistent with the Stafford Act and other FEMA guidance that can be used as their own Local Hazard Mitigation Plan; and

WHEREAS, various officials of Fayetteville State University have been involved over the five year project with the Campus Core Committee for Multi-Hazard Mitigation Planning, and support this regional planning process as it becomes a continuing activity going forward;

THEREFORE, BE IT RESOLVED, that Fayetteville State University Adopts the UNC-System Eastern Campuses Regional Hazard Mitigation Plan, which is hereby approved, and will be submitted to the Office of the President of the University for submittal to North Carolina Emergency Management.

ADOPTED AND APPROVED this 6th day of April, 2021.

By: ______________________

Darrel T. Allison
Chancellor

Date: 4-6-2021

[illegible]

Office of The Chancellor

NORTH CAROLINA CENTRAL UNIVERSITY RESOLUTION
ADOPTING THE UNC SYSTEM EASTERN CAMPUSES
REGIONAL HAZARD MITIGATION PLAN

WHEREAS, North Carolina Central University has undertaken a comprehensive Multi-Hazard Mitigation planning process under the guidelines of 44 CFR Part 201, a Federal Law that provides funding for communities and universities to promote hazard mitigation and disaster planning in order to protect teaching and learning, research and innovation, and public service; and

WHEREAS, North Carolina Central University has a need to protect infrastructure, as well as the health, safety and security of human life that resides and/or works on the campus, making it a community of up to 9,100 during the academic year; and

WHEREAS, an educational campus, in order to be eligible to receive Federal Mitigation Project Implementation funds for future projects and/or FEMA reimbursement funding, must have a FEMA-approved local plan that meets Federal requirements; and

WHEREAS, North Carolina Central University has developed an acceptable, comprehensive set of planning guidelines consistent with the Stafford Act and other FEMA guidance that can be used as their own Local Hazard Mitigation Plan; and

WHEREAS, various officials of North Carolina Central University have been involved over the two-year project with the Campus Core Committee for Multi-Hazard Mitigation Planning, and support this regional planning process as it becomes a continuing activity going forward;

THEREFORE, BE IT RESOLVED, that North Carolina Central University adopts the UNC-System Eastern Campuses Regional Hazard Mitigation Plan which is hereby approved, and will be submitted to the Office of the President of the University for submittal to North Carolina Emergency Management.

ADOPTED AND APPROVED this 25 day of March, 2021.

By: ______________________
Johnson O. Akinleye, Ph.D.
Chancellor

Date: 4/8/2021

NORTH CAROLINA CENTRAL UNIVERSITY • 1801 FAYETTEVILLE STREET • P.O. BOX 19617 • DURHAM, NC 27707 • 919-530-6104 • 919-530-5014

NORTH CAROLINA CENTRAL UNIVERSITY IS A CONSTITUENT INSTITUTION OF THE UNIVERSITY OF NORTH CAROLINA.

North Carolina School of Science and Mathematics

Igniting innovation. cultivating community.

NCSSM RESOLUTION
ADOPTING THE UNC SYSTEM EASTERN CAMPUSES
REGIONAL HAZARD MITIGATION PLAN

WHEREAS, NCSSM has undertaken a comprehensive Multi-Hazard Mitigation planning process under the guidelines of 44 CFR Part 201, a Federal Law that provides funding for communities and universities to promote hazard mitigation and disaster planning in order to protect teaching and learning, research and innovation, and public service; and

WHEREAS, NCSSM has a need to protect infrastructure, as well as the health, safety and security of human life that resides and/or works on the campus, making it a community of up to 1000 during the academic year; and

WHEREAS, an educational campus, in order to be eligible to receive Federal Mitigation Project Implementation funds for future projects and/or FEMA reimbursement funding, must have a FEMA-approved local plan that meets Federal requirements; and

WHEREAS, NCSSM has developed an acceptable, comprehensive set of planning guidelines consistent with the Stafford Act and other FEMA guidance that can be used as their own Local Hazard Mitigation Plan; and

WHEREAS, various officials of NCSSM have been involved over the two year project with the Campus Core Committee for Multi-Hazard Mitigation Planning, and support this regional planning process as it becomes a continuing activity going forward;

THEREFORE, BE IT RESOLVED, that NCSSM Adopts the UNC-System Eastern Campuses Regional Hazard Mitigation Plan which is hereby approved, and will be submitted to the Office of the President of the University for submittal to North Carolina Emergency Management.

ADOPTED AND APPROVED this 25th/ day of March, 2021.

By: Todd Roberts, Chancellor
Name, Title

Date: 3/25/2021

North Carolina School of Science and Mathematics
1219 Broad Street, Durham, NC 27705 • NCSSM.edu

NORTH CAROLINA STATE UNIVERSITY
ADOPTION OF THE UNC SYSTEM EASTERN CAMPUSES
REGIONAL HAZARD MITIGATION PLAN

WHEREAS, **North Carolina State University ("NC State")** has undertaken a comprehensive Multi-Hazard Mitigation planning process under the guidelines of 44 CFR Part 201, a Federal Law that provides funding for communities and universities to promote hazard mitigation and disaster planning in order to protect teaching and learning, research and innovation, and public service; and

WHEREAS, NC State has a need to protect infrastructure, as well as the health, safety and security of human life that resides and/or works on the campus, making it a community of over 45,000 students, employees, and visitors during the academic year; and

WHEREAS, an educational campus, in order to be eligible to receive Federal Mitigation Project Implementation funds for future projects and/or FEMA reimbursement funding, must have a FEMA-approved local plan that meets Federal requirements; and

WHEREAS, NC State has developed an acceptable, comprehensive set of planning guidelines consistent with the Stafford Act and other FEMA guidance that can be used as their own Local Hazard Mitigation Plan; and

WHEREAS, various NC State officials have been involved over the two year project with the Campus Core Committee for Multi-Hazard Mitigation Planning, and support this regional planning process as it becomes a continuing activity going forward;

THEREFORE, NC State adopts the UNC-System Eastern Campuses Regional Hazard Mitigation Plan and will be submitted to the Office of the President of the University of North Carolina for submittal to the North Carolina Emergency Management division.

By: Charles Maimone
Charles Maimone
Vice Chancellor, Finance and Administration

Date: ____________

By: ____________
David Rainer
Associate Vice Chancellor, Environmental Health and Public Safety

Date: 3/25/2021

{N0037107.1}

UNC INSTITUTIONAL INTEGRITY AND RISK MANAGEMENT

GEORGE E. BATTLE, III, JD
VICE CHANCELLOR FOR INSTITUTIONAL INTEGRITY AND RISK MANAGEMENT

[illegible]
[illegible]

THE UNIVERSITY OF NORTH CAROLINA AT CHAPEL HILL
INSTITUTIONAL INTEGRITY AND RISK MANAGEMENT
[illegible] | Campus Box 1005
123 West Franklin Street | Chapel Hill, NC 27599-1005
[illegible]

UNIVERSITY OF NORTH CAROLINA AT CHAPEL HILL RESOLUTION
ADOPTING THE UNC SYSTEM EASTERN CAMPUSES
REGIONAL HAZARD MITIGATION PLAN

WHEREAS, the University of North Carolina at Chapel Hill has undertaken a comprehensive Multi-Hazard Mitigation planning process under the guidelines of 44 CFR Part 201, a Federal Law that provides funding for communities and universities to promote hazard mitigation and disaster planning in order to protect teaching and learning, research and innovation, and public service; and

WHEREAS, the University of North Carolina at Chapel Hill has a need to protect infrastructure, as well as the health, safety and security of human life that resides and/or works on the campus, making it a community of over 45,000 during the academic year; and

WHEREAS, an educational campus, in order to be eligible to receive Federal Mitigation Project Implementation funds for future projects and/or FEMA reimbursement funding, must have a FEMA-approved local plan that meets Federal requirements; and

WHEREAS, the University of North Carolina at Chapel Hill has developed an acceptable, comprehensive set of planning guidelines consistent with the Stafford Act and other FEMA guidance that can be used as their own Local Hazard Mitigation Plan; and

WHEREAS, various officials of the University of North Carolina at Chapel Hill have been involved over the two year project with the Campus Core Committee for Multi-Hazard Mitigation Planning, and support this regional planning process as it becomes a continuing activity going forward;

THEREFORE, BE IT RESOLVED, that the University of North Carolina at Chapel Hill adopts the UNC-System Eastern Campuses Regional Hazard Mitigation Plan which is hereby approved, and will be submitted to the Office of the President of the University for submittal to North Carolina Emergency Management.

ADOPTED AND APPROVED this 7th day of May, 2021.

By: ____________________
George E. Battle, III, J.D.
Vice Chancellor of Institutional Integrity & Risk Management

Date: 5/7/21

One University Drive
P.O. Box 1510
Pembroke, NC 28372

Office of the Chancellor
910.775.4471
chancellor@uncp.edu

THE UNIVERSITY OF NORTH CAROLINA AT PEMBROKE RESOLUTION
ADOPTING THE UNC SYSTEM EASTERN CAMPUSES
REGIONAL HAZARD MITIGATION PLAN

WHEREAS, THE UNIVERSITY OF NORTH CAROLINA AT PEMBROKE (UNCP) has undertaken a comprehensive Multi-Hazard Mitigation planning process under the guidelines of 44 CFR Part 201, a Federal Law that provides funding for communities and universities to promote hazard mitigation and disaster planning in order to protect teaching and learning, research and innovation, and public service; and

WHEREAS, UNCP has a need to protect infrastructure, as well as the health, safety and security of human life that resides and/or works on the campus, making it a community of approximately 9,200 individuals during the academic year; and

WHEREAS, an educational campus, in order to be eligible to receive Federal Mitigation Project Implementation funds for future projects and/or FEMA reimbursement funding, must have a FEMA-approved local plan that meets Federal requirements; and

WHEREAS, UNCP has developed an acceptable, comprehensive set of planning guidelines consistent with the Stafford Act and other FEMA guidance that can be used as their own Local Hazard Mitigation Plan; and

WHEREAS, various officials of UNCP have been involved over the two-year project with the Campus Core Committee for Multi-Hazard Mitigation Planning, and support this regional planning process as it becomes a continuing activity going forward;

THEREFORE, BE IT RESOLVED, that UNCP Adopts the UNC-System Eastern Campuses Regional Hazard Mitigation Plan, which is hereby approved and will be submitted to the Office of the President of the University for submittal to North Carolina Emergency Management.

By: ______________________
Robin Gary Cummings, MD
Chancellor

Date: 4/21/21

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UNCW

UNIVERSITY OF NORTH CAROLINA WILMINGTON

**UNIVERSITY OF NORTH CAROLINA WILMINGTON RESOLUTION
ADOPTING THE UNC SYSTEM EASTERN CAMPUSES
REGIONAL HAZARD MITIGATION PLAN**

WHEREAS, the University of North Carolina Wilmington (UNCW) has undertaken a comprehensive Multi-Hazard Mitigation planning process under the guidelines of 44 CFR Part 201, a Federal Law that provides funding for communities and universities to promote hazard mitigation and disaster planning in order to protect teaching and learning, research and innovation, and public service; and

WHEREAS, UNCW has a need to protect infrastructure, as well as the health, safety and security of human life that resides and/or works on the campus, making it a community of up to 21,000 persons daily during the academic year; and

WHEREAS, UNCW, an educational campus, in order to be eligible to receive Federal Mitigation Project Implementation funds for future projects and/or FEMA reimbursement funding, must have a FEMA-approved local plan that meets Federal requirements; and

WHEREAS, has developed an acceptable, comprehensive set of planning guidelines consistent with the Stafford Act and other FEMA guidance that can be used as their own Local Hazard Mitigation Plan; and

WHEREAS, various officials of UNCW have been involved over the two year project with the Campus Core Committee for Multi-Hazard Mitigation Planning, and support this regional planning process as it becomes a continuing activity going forward;

THEREFORE, BE IT RESOLVED, that University of North Carolina Wilmington adopts the UNC-System Eastern Campuses Regional Hazard Mitigation Plan which is hereby approved, and will be submitted to North Carolina Emergency Management.

ADOPTED AND APPROVED this 26th day of May, 2021.

By: ______________________________
Miles Lackey, Vice Chancellor for Business Affairs

Date: 5-26-21

BUSINESS AFFAIRS

[illegible] South College Road • Wilmington, North Carolina 28403-5918 • Tel [illegible] • Fax [illegible]

THE UNIVERSITY OF NORTH CAROLINA SYSTEM

UNC System Eastern Campuses Regional Hazard Mitigation Plan

Annex A: East Carolina University

wood.

TABLE OF CONTENTS

Annex A East Carolina University

This section provides planning process, campus profile, hazard risk, vulnerability, capability, and mitigation action information specific to East Carolina University (ECU). This section contains the following subsections:

- A.1 Planning Process Details
- A.2 Campus Profile
- A.3 Asset Inventory
- A.4 Hazard Identification
- A.5 Hazard Profiles, Analysis, and Vulnerability
- A.6 Capability Assessment
- A.7 Mitigation Strategy

A.1 PLANNING PROCESS DETAILS

The table below lists the HMPC members who represented ECU during the planning process.

Table A.1 – HMPC Members

Representative	Role; Department
Phil Lewis	EHS Professional, Environmental Health and Safety
Bill Koch	Associate Vice Chancellor, Campus Safety and Auxiliary Service
Jon Barnwell	Chief of Police, ECU Police
Chris Sutton	Public Safety Supervisor, ECU Police
Jason Sugg	Deputy Chief, ECU Police
Curtis Hayes	Public Safety Supervisor, ECU Police
Kelly Shook	EHS Professional, Environmental Health and Safety
Blake Halsey	EHS Professional, Environmental Health and Safety
Bill Bagnell	Associate Vice Chancellor; Campus Operations
Ricky Hill	Director; Facilities Services (Main Campus)
Grif Avin	Director; Facilities Services (Health Sciences Campus)
Bill McCartney	Associate Vice Chancellor; Housing Operations
Aaron Lucier	Director; Housing Operations
Jamie Brown Kruse	Director; ECU Center for Natural Hazards Research
Mike O'Driscoll	Associate Professor; Department of Coastal Studies
Merrill Flood	Director of Planning and Development; Community Engagement and Research
Anuradha Mukherji	Associate Professor; Geography, Planning, and Environment
Randy Gentry	Director; Pitt County Emergency Management

Coordination with Other Community Planning Efforts and Hazard Mitigation Activities

The table below lists campus and community resources referenced throughout the planning process and used in the plan development.

Table A.2 – Summary of Existing Studies and Plans Reviewed

Resource Referenced	Use in this Plan
ECU Comprehensive Campus Master Plan	The ECU Comprehensive Campus Master Plan, developed in 2012, was referenced for the Campus Profile in Section A.2 as well as the Capability Assessment in Section A.6

Resource Referenced	Use in this Plan
City of Greensboro Comprehensive Plan	The Comprehensive Plan, developed by the City in 2020, was referenced for the Campus Profile in Section A.2.
Pitt County and Incorporated Areas Flood Insurance Study (FIS), Revised 6/19/2019	The FIS report was referenced in the preparation of flood hazard profile in Section A.5.
ECU Pre-Disaster Mitigation Plan, 2011	The previous ECU Pre-Disaster Mitigation Plan was used in preparation of the hazard profiles in Section A.5. The plan was additionally used to track implementation progress and develop the mitigation plan (Section A.7).
Neuse River Basin Regional Hazard Mitigation Plan, 2020	The Neuse River Basin Regional Hazard Mitigation Plan, which includes Greensboro, was referenced in compiling the Hazard Identification and Risk Assessment in Section A.5.

A.2 CAMPUS PROFILE

This section provides a general overview of the East Carolina University (ECU) campus and area of concern to be addressed in this plan. It consists of the following subsections:

- Location and Setting
- Geography and Climate
- History
- Cultural and Natural Resources
- Land Use
- Population and Demographics
- Social Vulnerability
- Growth and Development Trends

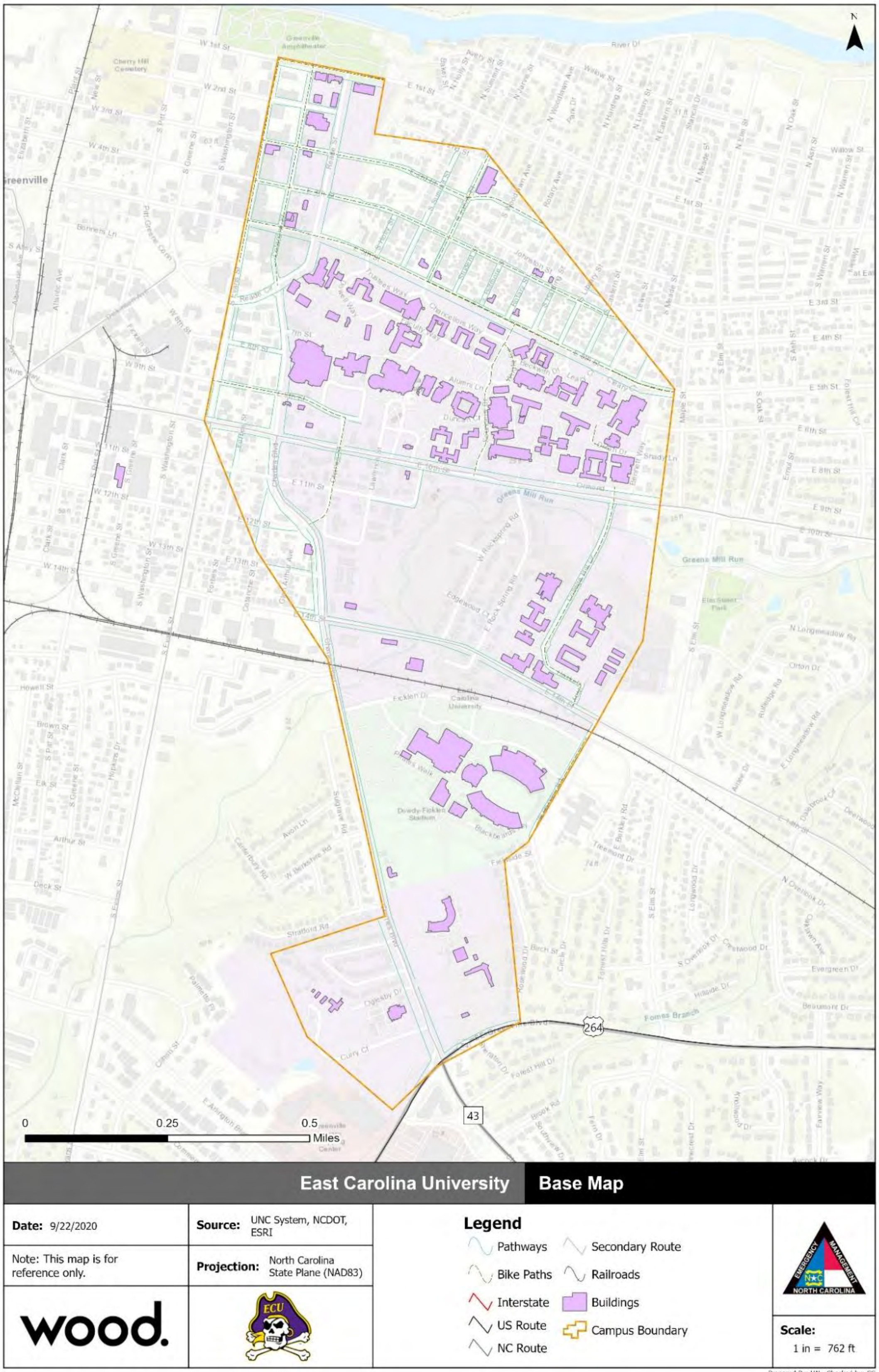
A.2.1 Location and Setting

East Carolina University Main Campus is located in an urban residential area of downtown Greenville. The University sits on 565 acres of land and offers 87 bachelor's degree programs, 68 master's degree programs, and 18 doctoral programs, and 125 online degrees and certificate programs. A wide variety of cultural and educational resources are accessible to ECU students as well, and over 500 student organizations are available on campus to help cater to any area of interest a student may have and promote a sense of belonging. ECU is dedicated to the integration of teaching, mentoring, research, and service and is the only University in North Carolina with a dental school, medical school, and college of engineering at the same institution.

United States Highways 13 and 264 make ECU easily accessible by automobile. The University provides shuttle services on and off campus, to include the airport in Raleigh, a bicycle rental program, and they maintain bicycle and pedestrian amenities.

Figure A.1 provides a base map of the campus. For a more details on-campus buildings and critical facilities, see Section A.3.

Figure A.1 – ECU Campus Base Map



A.2.2 Geography and Climate

Greenville is located in the Coastal Plain region of the state. This region borders the Atlantic Ocean and the land provides agricultural as well as manufacturing opportunities. The topography of the Coastal Plain can be seen as the result of erosion. This area represents a mixture of maritime, pine and hardwood forests. Located closest to the shore, Greenville is surrounded by lakes, wetlands and streams. Greenville has mild climate with temperatures dropping to 31 degrees Fahrenheit on average in January and climbing to 90 degrees Fahrenheit in July on average. The annual precipitation for the City is approximately 49 inches per year.

A.2.3 History

The East Carolina University (ECU) was originally founded and chartered as the East Carolina Teachers Training School (ECTTS) by the North Carolina General Assembly under the Public Laws of North Carolina, 1907, Chapter 820, titled An Act to Stimulate High School Instruction in the Public Schools of the State and Teacher Training on March 8, 1907. Groundbreaking ceremonies for the first buildings were held on July 2, 1908 in Greenville, North Carolina and classes started on October 5, 1909.

From a coeducational high school institution with a two-year teacher's program, ECTTS developed into a four-year teacher's college and was renamed East Carolina Teachers College (ECTC), awarding its first bachelor's degree in education in 1921 and its first master's degree in 1933. By 1948, progress toward full college states was made, awarding degrees for Bachelor of Arts in education as a liberal arts degree and a Bachelor of Science in education as a teaching degree.

In 1951, ECTC was renamed as East Carolina College (ECC) and became the largest college in the South. Regional university status was granted on July 1, 1967, separate from the existing university system under the Consolidated University of North Carolina. During this time, the college also assumed its present name as East Carolina University (ECU).

On July 1, 1972, ECU was incorporated into the University of North Carolina System. By the 1980s, East Carolina University had attained "full institutional maturity" and awarded its first M.D. and Ph.D. degrees. The ECU School of Medicine reached a milestone in 1981 when the first class of four-year students graduated with Medical Doctorates.

In 2007, ECU celebrated its 100th anniversary under the leadership of Chancellor Steven Ballard. Steven Ballard served as ECU's Chancellor for 12 years and was then proceeded by Cecil Staton who served as ECU's 11th Chancellor from April 2016 until May 2019. Dr. Philip G. Rogers will begin his duties as the 12th chancellor of ECU on March 15, 2021, following Interim Chancellor Ron Mitchelson, who has led the university since October 2019.

With a mission of teaching, research, and service, East Carolina University is a dynamic institution connecting people and ideas, finding solutions to problems, and seeking the challenges of the future.

A.2.4 Cultural and Natural Resources

National Register of Historic Places

There are 16 listings in the National Register of Historic Places for Greenville. Some of these include College View Historic District, Dickinson Avenue Historic District, E.B. Ficklen House, James L. Fleming House, and the Pitt County Courthouse.

Natural Features and Resources

The City of Greenville is host to a myriad of wetlands, creeks, rivers and lakes. The City currently owns and is responsible for more than 20 parks. Greenville strives to provide both larger parks (50+ acres) for active and passive use; neighborhood parks (2-20 acres) within walking and biking distance of most homes; and connectors like greenways and bikeways. Greenville's River Park North is a 324-acre nature park offering a variety of activities for the community.

Approximately 58 acres of the land on The East Carolina University campus are located within a 100-year Special Flood Hazard Area. There are 32 acres designated as Zone AE and 26 acres located within the Floodway; an additional 7 acres of land on ECU's campus is located within the 500-year floodplain, and the remaining 501 acres are designated as Unshaded Zone X.

Natural and Beneficial Floodplain Functions

Under natural conditions, a flood causes little or no damage in floodplains. Nature ensures that floodplain flora and fauna can survive the more frequent inundations, and the vegetation stabilizes soils during flooding. Floodplains reduce flood damage by allowing flood waters to spread over a large area. This reduces flood velocities and provides flood storage to reduce peak flows downstream.

Threatened and Endangered Species

The U.S. Fish and Wildlife Service maintains a regular listing of threatened species, endangered species, at-risk species, and candidate species for counties across the United States. Last updated in October 2015, Pitt County has 10 species that are listed with the U.S. Fish and Wildlife Services. **Table A.3** below shows the 10 species identified as threatened and endangered in Pitt County.

Table A.3 – Threatened and Endangered Species in Pitt County

Common Name	Scientific Name	Federal Status
Green floater	*Lasmigona subviridis*	Under Review
Neuse River waterdog	*Necturus lewisi*	Proposed Threatened
American alligator	*Alligator mississippiensis*	Threatened
Yellow lance	*Elliptio lanceolata*	Threatened
Red-cockaded woodpecker	*Picoides borealis*	Endangered
West Indian Manatee	*Trichechus manatus*	Threatened
Tar River spinymussel	*Elliptio steinstansana*	Endangered
Atlantic pigtoe	*Fusconaia masoni*	Proposed Threatened
Carolina madtom	*Noturus furiosus*	Proposed Endangered
Dwarf wedgemussel	*Alasmidonta heterodon*	Endangered

Source: U.S. Fish & Wildlife Service (https://ecos.fws.gov/ecp/report/species-listings-by-current-range-county?fips=37063)

A.2.5 Land Use

Articles on ECU's website mentions major building and renovation updates including construction of a life sciences and biotechnology building which was expected to begin construction Summer of 2019, and the renovation of Greene Hall and plans for construction of a new student service facility at the corner of Fourth and Reade streets. ECU stated to have over 100 projects, big and small, ongoing at that time, and the University plans to continue renovations and updates to the campus to accommodate to the ever-growing student population. Some of the current construction opportunities can be found on ECU's website at the following link: https://campusoperations.ecu.edu/feas/upcoming-construction-opportunities/

A.2.6 Population and Demographics

Table A.4 provides population counts and percent change in population since 2010 for Pitt County and the City of Greenville.

Table A.4 – Population Counts for Surrounding Jurisdictions

Jurisdiction	2010 Census Population	2019 Estimated Population	% Change 2010-2019
Pitt County	168,176	180,742	7.5
Greenville	84,711	93,400	10.3

Source: U.S. Census Bureau QuickFacts 2010 vs 2019 (V2019) data

Table A.5 provides population counts for East Carolina University from Fall 2020, including the number of undergraduate and graduate students, full-time and in-state students, and faculty.

Table A.5 – Population Counts for East Carolina University, Fall 2020

Group	2020 Population
Students	28,798
Undergraduate Students	23,056
Graduate Students	4,937
Full-time Students	21,471
Part-time Students	7,327
In-State Residency	26,110
Out-of-State Residency	2,688
Faculty	2,026
Professors	425
Associate Professors	605
Assistant Professors	664
Instructors	332

According to The East Carolina University's Fall 2020 ECU by the Numbers page, all 100 North Carolina counties, 47 states, and 99 countries are represented throughout the University's student body. Among the ECU student population, the most popular majors for undergraduates were Nursing, Management, and Biology. The top graduate majors were Business Administration, Nursing (MSN plus DNP), and Medicine.

The racial characteristics of the County, City, and college are presented below in **Table A.6**. These characteristics for the County and City are based on the 2010 Census Bureau. White persons make up most of the population for the County, City, and ECU.

Table A.6 – Demographics of Pitt County, City of Greenville and ECU Students

Jurisdiction	African-American Persons, Percent	American Indian or Alaska Native, Percent	Asian Persons, Percent	Hispanic or Latino Persons, Percent	White Persons, Percent
Pitt County[1]	35.9	0.5	2.1	6.5	59.1
Greenville[1]	39.3	0.4	2.5	4.7	53.1
East Carolina University[2]	16.4	1	2.8	7.4	65

Source: U.S. Census Bureau, 2010

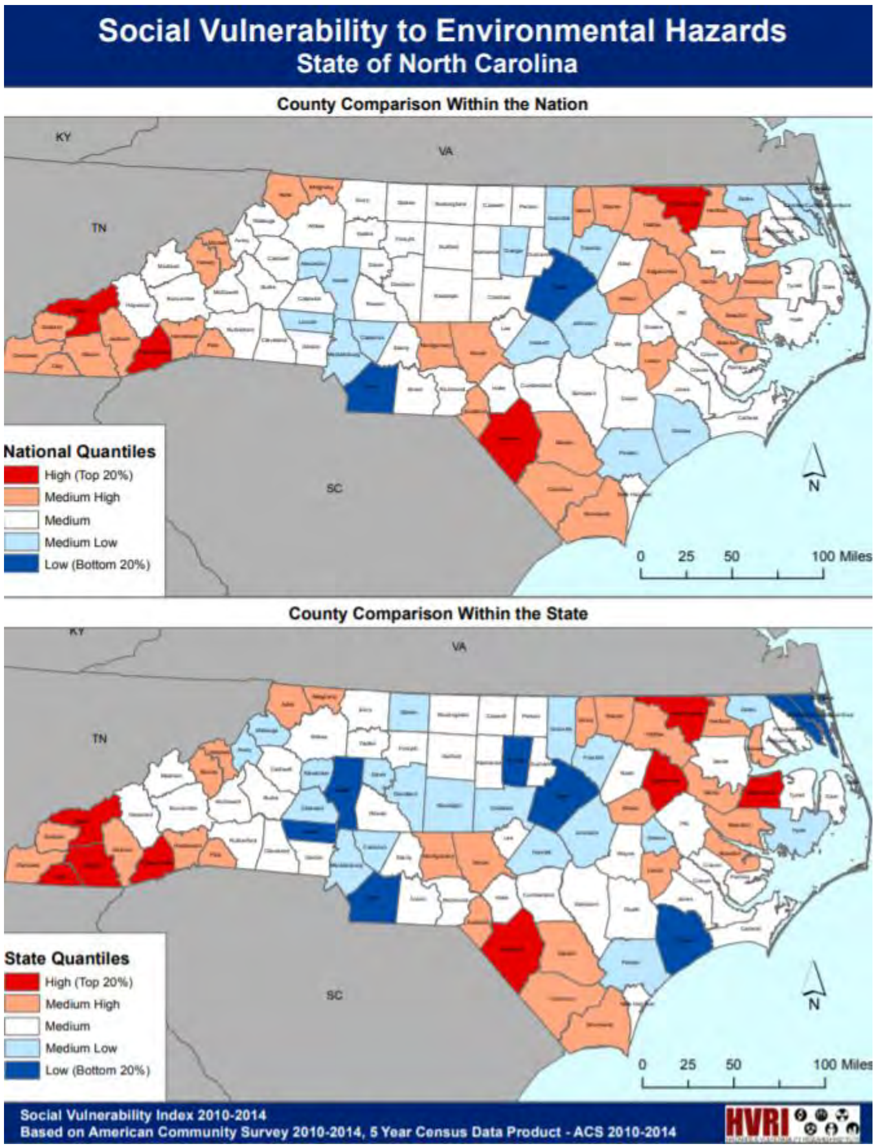
[1]Persons of Hispanic Origin may be of any race, so are also included in applicable race category in Pitt County figures.

[2]Source: The East Carolina University Facts Sheet, Fall 2020

A.2.7 Social Vulnerability

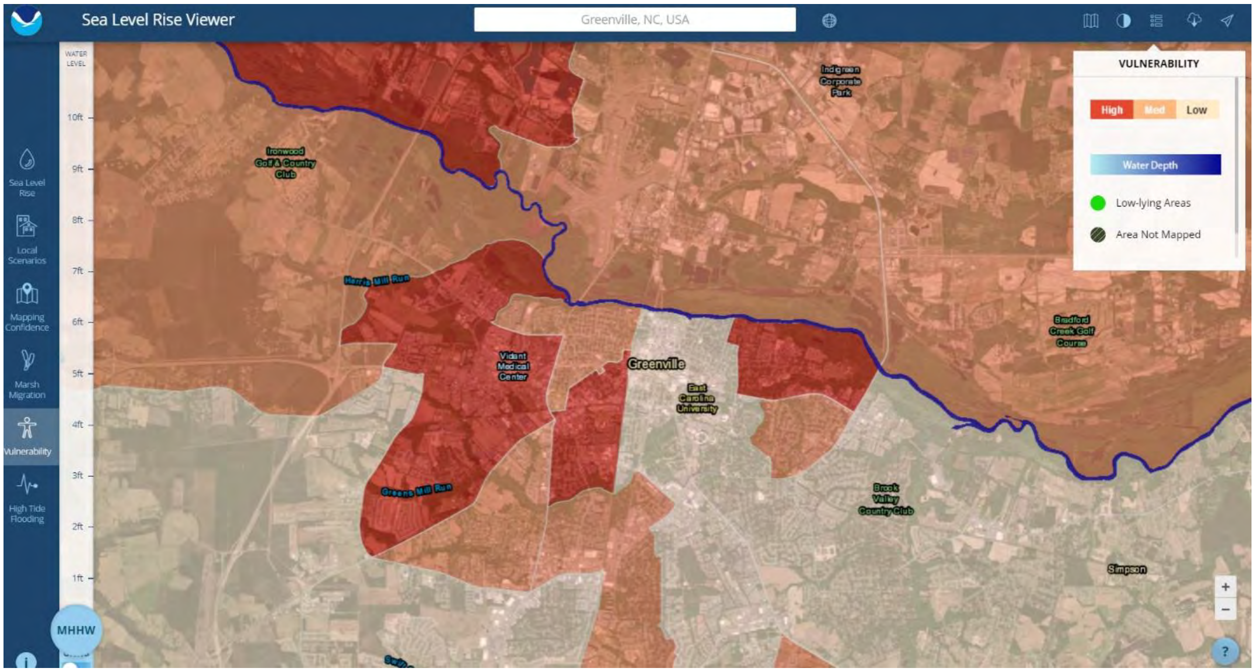
The Hazards and Vulnerability Research Institute at the University of South Carolina has created the Social Vulnerability Index (SoVI), to measure comparative social vulnerability to environmental hazards in the U.S. at a county level. SoVI combines 29 socioeconomic variables to determine vulnerability. The seven most significant components for explaining vulnerability are race and class, wealth, elderly residents, Hispanic ethnicity, special needs individuals, Native American ethnicity, and service industry employment. The index also factors in family structure, language barriers, vehicle availability, medical disabilities, and healthcare access, among other variables. **Figure A.2** displays the SoVI index by county with comparisons within the Nation and within the State. In both comparisons, Pitt County ranks among the medium quantiles for social vulnerability

Figure A.2 – SoVI Index for North Carolina



Using data from SoVI, NOAA created a social vulnerability viewer by census tract for their Digital Coast Sea Level Rise Viewer, which gives a much more detailed picture of variations in social vulnerability by location. **Figure A.3** displays social vulnerability at and around Greenville and the ECU campus, with darker shades corresponding to higher levels of vulnerability. Based on Pitt County's medium vulnerability rating from SoVI and Greenville's low level of vulnerability according to the NOAA viewer, ECU can be assumed to have an overall medium-low level of social vulnerability to environmental hazards.

Figure A.3 – Social Vulnerability at and around ECU

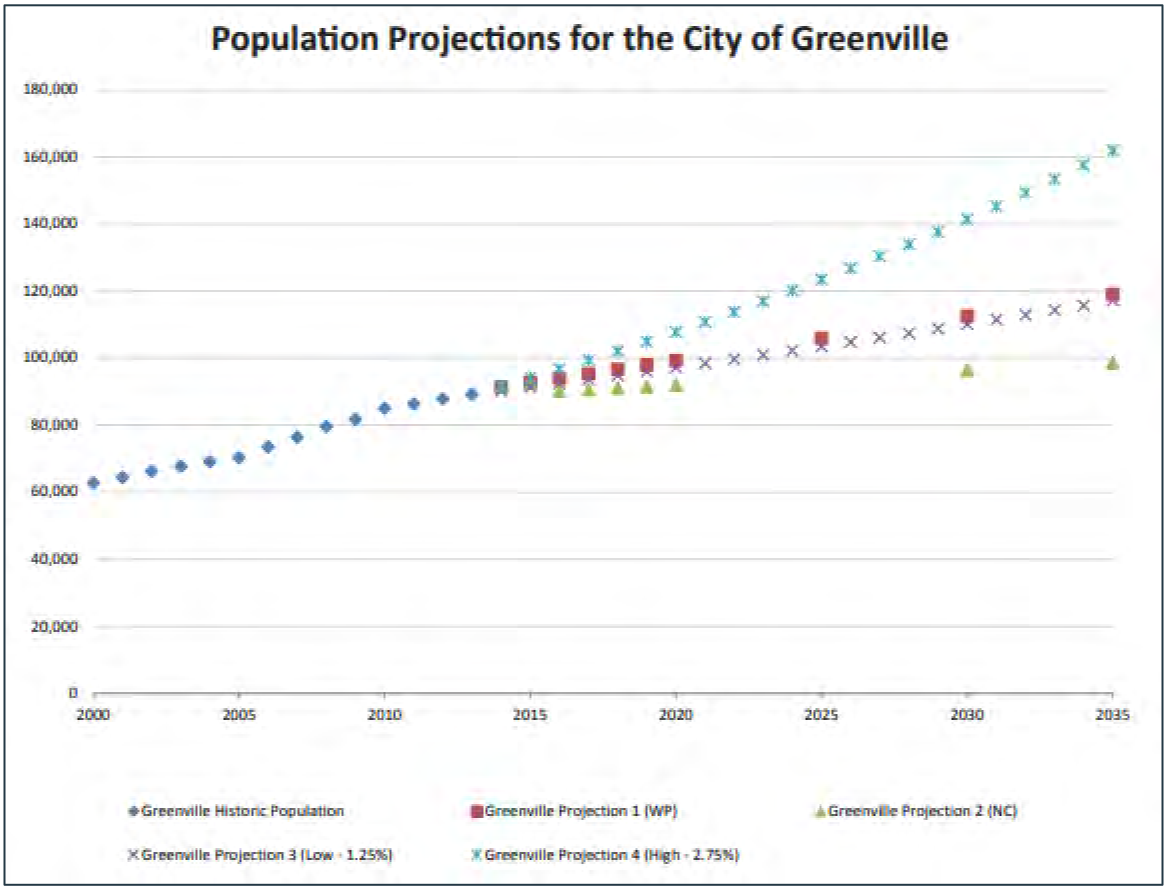


Source: NOAA Office for Coastal Management, Digital Coast, July 2016

A.2.8 Growth and Development Trends

Based on 2010 Census data, Greenville had an estimated population of 93,400 residents in 2019. In the City of Greenville's 2015 Community Profile, they provided population projections up to 2035 for the City. A graph of these projections can be found below in **Figure A.4**. the City used 4 different methods which results in 4 different projections, all shown in the image below. Based on these projections, the City may grow to as little as 98,600 or as large as 161,000 residents by 2035. Considering the estimated 2019 population of 93,400 residents, it appears as if the City's population is trending closest to Projection 2 as of right now. The ECU Strategic Framework for Comprehensive Facilities Master Plan projects growth of the student population to nearly 39,000 undergraduate and graduate by 2025.

Figure A.4 – City Population Growth Projections (2015 – 2035)



Source: https://greenvillenc.gov/home/showdocument?id=13728

The estimated population for Greenville in 2019 was 93,400, which is a 3.2% increase over the 2015 estimated population, and a 10.3% increase from the 2010 Census population. **Table A.7** shows estimated population growth based on the 2010 Census population for the City of Greenville.

Table A.7 – City of Greenville Population Growth (2010 – 2019)

Year	Population	Growth	Percent Growth
2010	84,711	--	--
2015	90,499	5,955	7.0
2019	93,400	2,901	3.2

Source: U.S. Census Bureau

A.3 ASSET INVENTORY

An inventory of assets was compiled to identify the total count and value of property exposure on the ECU campus. This asset inventory serves as the basis for evaluating exposure and vulnerability by hazard. Assets identified for analysis include buildings, critical facilities, and critical infrastructure.

A.3.1 Building Exposure

Table A.8 provides total building exposure for the campus, which was estimated by summarizing building footprints provided by the University of North Carolina System Division of Information Technology and the North Carolina Emergency Management (NCEM) iRisk database and property values provided by the North Carolina Department of Insurance and NCEM iRisk database. All occupancy types were summarized into the following four categories: administration, critical facilities, educational/extracurricular, and housing. Note: estimated content values were not available.

Table A.8 – ECU Building Exposure by Occupancy

Occupancy	Estimated Building Count	Structure Value
Administration	21	$44,654,929
Critical Facilities	10	$56,602,562
Educational/Extracurricular	63	$1,194,161,682
Housing	18	$342,523,349
Total	**112**	**$1,637,942,522**

Source: UNC Division of Information Technology; NCEM iRisk; NC Department of Insurance

A.3.2 Critical Buildings and Infrastructure Exposure

Of significant concern with respect to any disaster event is the location of critical facilities and infrastructure in the planning area. Critical facilities are those essential services and lifelines that, if damaged during an emergency event, would disrupt campus continuity of operations or result in severe consequences to public health, safety, and welfare.

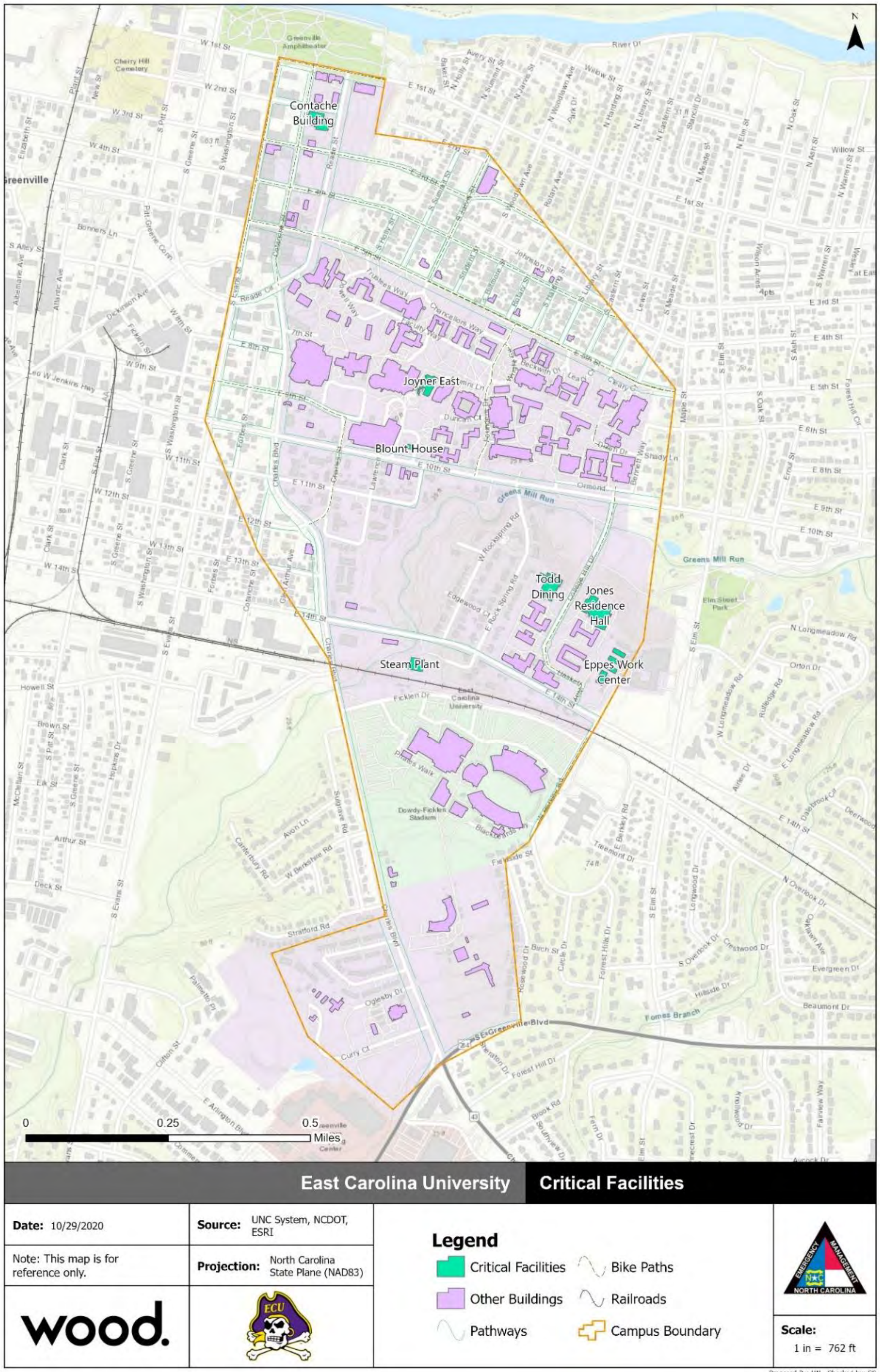
Critical buildings are a subset of the total building exposure and were identified by ECU's HMPC representatives. After reviewing the following criteria designed to evaluate all critical buildings in the UNC System Hazard Mitigation Plan, the ECU HMPC maintained the list of critical facilities from the previous PDM plan. Factors considered for critical building evaluation included:

- the building's use for emergency response,
- the building's use for essential campus operations
- the building's use as an emergency shelter or for essential sheltering services,
- the presence of a generator or generator hook-ups,
- the building's use for provision of energy, chilled water or HVAC for sensitive or essential systems,
- the storage of hazardous materials,
- the building's use for sensitive research functions,
- the building's cultural or historical significance, and
- building-specific hazard vulnerabilities

The identified critical facilities for ECU, as shown in **Figure A.5**, include the following:

- Contanche Building
- Eppes Carpentry Shop 126B
- Steam Plant
- Jones Residence Hall
- Blount House
- Todd Dining
- Eppes Work Center
- Joyner East
- Eppes Facilities Services 126A
- Eppes Building Services 126D

Figure A.5 – ECU Map of Critical Facilities



A.4 HAZARD IDENTIFICATION & RISK ASSESSMENT

A.4.1 Hazard Identification

To identify a full range of hazards relevant to the ECU Main Campus, HMPC representatives from each campus began with a review of the list of hazards identified in the 2018 North Carolina State Hazard Mitigation Plan and the 2011 ECU Pre-Disaster Mitigation Plan, as summarized in **Table A.9**. This ensured consistency with the state and regional hazard mitigation plans and across each campus' planning efforts.

Table A.9 – Hazards Included in Previous Planning Efforts

Hazard	Included in 2018 State HMP?	Included in 2011 ECU Pre-Disaster Mitigation Plan?
Flooding	Yes	Yes, as Driving rain and Flood
Hurricanes and Coastal Hazards	Yes	Yes, as High wind (hurricane)
Severe Winter Weather	Yes	Yes, as Ice storm and Snow
Extreme Heat	Yes	No
Earthquakes	Yes	Yes
Wildfire	Yes	Yes
Dam Failures	Yes	No
Drought	Yes	No
Tornadoes/Thunderstorms	Yes	Yes
Geological (Landslides, Sinkholes, Coastal Erosion)	Yes	Yes, as Landslide
Hazardous Materials Incidents	Yes	No
Infectious Disease	Yes	No
Radiological Emergency	Yes	No
Terrorism/Mass Casualty	Yes	No
Cyber Threat	Yes	No

ECU's HMPC representatives evaluated the above list of hazards by considering existing hazard data, past disaster declarations, local knowledge, and information from the 2018 State Plan and the 2011 ECU Pre-Disaster Mitigation Plan in order to determine whether each hazard was significant enough to assess in this updated Hazard Mitigation Plan. Significance was measured in general terms and focused on key criteria such as frequency, severity, and resulting damage, including deaths and injuries, as well as property and economic damage.

One key resource in this effort was the National Oceanic and Atmospheric Administration's (NOAA) National Center for Environmental Information (NCEI), which has been tracking various types of weather events 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), which compiles their information from a variety of sources, including but 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. While NCEI is not a comprehensive list of past hazard events, it can provide an indication of relevant hazards to the planning area and offers some statistics on injuries, deaths, damages, as well as narrative descriptions of past impacts.

Data for Pitt County was used to approximate past events that may have affected the ECU campus. The NCEI database contains 342 records of storm events that occurred in Pitt County in the 20-year period from 2000 through 2019. **Table A.10** summarizes these events.

Table A.10 – NCEI Severe Weather Data for Pitt County , 2000 – 2019

Type	# of Events	Property Damage	Crop Damage	Deaths	Injuries
Drought	3	$0	$0	0	0
Flash Flood	24	$100,000	$100,000	1	0
Flood	14	$0	$0	0	0
Frost/Freeze	1	$0	$0	0	0
Funnel Cloud	1	$0	$0	0	0
Hail	102	$150,000	$800,000	0	0
Heat	2	$0	$0	3	0
Heavy Rain	10	$0	$0	0	0
Heavy Snow	5	$0	$0	0	0
High Wind	4	$5,000	$0	0	0
Hurricane (Typhoon)	3	$2,200,000	$300,000	0	0
Ice Storm	1	$0	$0	0	0
Lightning	3	$151,000	$0	0	0
Strong Wind	5	$3,100	$0	0	0
Thunderstorm Wind	123	$374,000	$0	1	3
Tornado	17	$1,890,000	$0	0	5
Tropical Storm	6	$10,035,000	$38,000,000	3	1
Winter Storm	10	$0	$0	0	2
Winter Weather	8	$0	$0	0	0
Grand Total	**342**	**$14,908,100**	**$39,200,000**	**8**	**11**

Source: National Center for Environmental Information Events Database, retrieved October 2020
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 Pitt 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 1954. Since then, Pitt County has been designated in 22 major disaster declarations, as detailed in **Table A.11**, and 10 emergency declarations, as detailed in **Table A.12**.

Table A.11 – FEMA Major Disaster Declarations, Pitt County

Disaster #	Dec. Date	Incident Type	Event Title	Individual Assistance Applications Approved	Total Individual and Households Program Dollars Approved	Total Public Assistance Grant Dollars Obligated
DR-28-NC	17-Oct-54	Hurricane	HURRICANE	N/A	N/A	N/A
DR-37-NC	13-Aug-55	Hurricane	HURRICANES	N/A	N/A	N/A
DR-56-NC	24-Apr-56	Severe Storm(s)	SEVERE STORM	N/A	N/A	N/A
DR-87-NC	01-Oct-58	Hurricane	HURRICANE & SEVERE STORM	N/A	N/A	N/A
DR-107-NC	16-Sep-60	Hurricane	HURRICANE DONNA	N/A	N/A	N/A

Disaster #	Dec. Date	Incident Type	Event Title	Individual Assistance Applications Approved	Total Individual and Households Program Dollars Approved	Total Public Assistance Grant Dollars Obligated
DR-130-NC	16-Mar-62	Flood	SEVERE STORM, HIGH TIDES & FLOODING	N/A	N/A	N/A
DR-179-NC	13-Oct-64	Flood	SEVERE STORMS & FLOODING	N/A	N/A	N/A
DR-234-NC	10-Feb-68	Severe Ice Storm	SEVERE ICE STORM	N/A	N/A	N/A
DR-699-NC	30-Mar-84	Tornado	SEVERE STORMS & TORNADOES	N/A	N/A	N/A
DR-1087-NC	13-Jan-96	Snow	BLIZZARD OF 96	N/A	N/A	N/A
DR-1127-NC	18-Jul-96	Hurricane	HURRICANE BERTHA	N/A	N/A	N/A
DR-1134-NC	06-Sep-96	Hurricane	HURRICANE FRAN	N/A	N/A	N/A
DR-1240-NC	27-Aug-98	Hurricane	HURRICANE BONNIE	N/A	N/A	N/A
DR-1292-NC	16-Sep-99	Hurricane	HURRICANE FLOYD MAJOR DISASTER DECLARATIONS	N/A	N/A	$298,105,794
DR-1490-NC	18-Sep-03	Hurricane	HURRICANE ISABEL	7790	$21,289,504	$18,285,917
DR-1942-NC	14-Oct-10	Severe Storm(s)	SEVERE STORMS, FLOODING, AND STRAIGHT-LINE WINDS	2037	$8,587,054	$19,065,881
DR-1969-NC	20-Apr-11	Severe Storm(s)	SEVERE STORMS, TORNADOES, AND FLOODING	1778	$5,391,278	N/A
DR-4019-NC	31-Aug-11	Hurricane	HURRICANE IRENE	10270	$37,238,655	$88,847,065
DR-4285-NC	10-Oct-16	Hurricane	HURRICANE MATTHEW	28971	$98,842,213	$291,092,954
DR-4393-NC	15-Sep-18	Hurricane	HURRICANE FLORENCE	34713	$133,948,455	$632,937,402
DR-4465-NC	04-Oct-19	Hurricane	HURRICANE DORIAN	N/A	N/A	$28,138,271
DR-4487-NC	25-Mar-20	Biological	COVID-19 PANDEMIC	N/A	N/A	$174,898,697

Source: FEMA Disaster Declarations Summary, October 2020

Note: Number of applications approved, and all dollar values represent totals for all counties included in disaster declaration.

Table A.12 – FEMA Emergency Declarations, Pitt County

Disaster #	Dec. Date	Incident Type	Event Title/Description
EM-3146-NC	15-Sep-99	Hurricane	HURRICANE FLOYD EMERGENCY DECLARATIONS
EM-3222-NC	05-Sep-05	Hurricane	HURRICANE KATRINA EVACUATION
EM-3254-NC	15-Sep-05	Hurricane	HURRICANE OPHELIA
EM-3314-NC	02-Sep-10	Hurricane	HURRICANE EARL
EM-3327-NC	25-Aug-11	Hurricane	HURRICANE IRENE
EM-3380-NC	07-Oct-16	Hurricane	HURRICANE MATTHEW
EM-3401-NC	11-Sep-18	Hurricane	HURRICANE FLORENCE
EM-3423-NC	04-Sep-19	Hurricane	HURRICANE DORIAN
EM-3471-NC	13-Mar-20	Biological	COVID-19
EM-3534-NC	02-Aug-20	Hurricane	HURRICANE ISAIAS

Source: FEMA Disaster Declarations Summary, October 2020

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. **Table A.13** summaries the determination made for each hazard.

Table A.13 – Hazard Evaluation Results

Hazard	Included in this plan update?	Explanation for Decision
Natural Hazards		
Hurricane	Yes	The 2011 ECU PDM plan found Hurricane to be a moderate threat hazard. The County has had 10 disaster declarations related to hurricanes wind.
Coastal Hazards	No	The 2011 ECU PDM plan did not address this hazard.
Tornadoes / Thunderstorms (Wind, Lightning, Hail)	Yes	The 2011 ECU PDM plan found tornadoes to be a low threat hazard. The County has had no disaster declarations related to tornadoes. The HMPC expressed interest in addressing this hazard in combination with thunderstorms (wind, lightning, hail).
Flood	Yes	The 2011 ECU PDM plan rated flood a significant threat hazard for the planning area. The County has had 2 disaster declarations related to flooding.
Severe Winter Weather	Yes	The 2011 ECU PDM plan found ice/snow to be a low threat hazard. The HMPC expressed interest in addressing this hazard as severe winter weather to include cold/wind chill; extreme cold; freezing fog; frost/freeze; heavy snow; ice storm; winter storm; and winter weather.
Drought	No	The 2011 ECU PDM plan did not address this hazard.
Wildfire	Yes	The 2011 ECU PDM plan did not a assign a threat and/or risk level for this hazard; however, the HMPC expressed interest in addressing this hazard.
Earthquake*	Yes	The 2011 ECU PDM plan did not a assign a threat and/or risk level for this hazard; however, the HMPC expressed interest in addressing this hazard.
Geological Hazards (Sinkhole & Landslide)*	Yes	The 2011 ECU PDM plan did not a assign a threat and/or risk level for this hazard; however, the HMPC expressed interest in re-evaluating landslides in this plan update.
Dam Failure	No	The 2011 ECU PDM plan did not address this hazard.
Extreme Heat	No	The 2011 ECU PDM plan did not address this hazard.
Technological and Human-Caused Hazards & Threats		
Hazardous Materials Incidents	Yes	The 2011 ECU PDM plan did not address this hazard; however, there are fixed facility sites and transportation routes with hazardous materials in the planning area and the HMPC expressed interest in addressing this hazard.
Infectious Disease	Yes	The 2011 ECU PDM plan did not address this hazard; however, due to the COVID-19 pandemic that occurred during this planning process, the HMPC determined infectious disease should be addressed.
Cyber Attack	Yes	The 2011 ECU PDM plan did not address this hazard; however, the HMPC expressed interest in re-evaluating cyber-attacks in this plan update.
Civil Unrest	No	The 2011 ECU PDM plan did not address this hazard and the HMPC did not express interest in re-evaluating civil unrest in this plan update.

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

A.5 HAZARD PROFILES, ANALYSIS, AND VULNERABILITY

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 where it may occur, the severity of potential events, records of past events, the probability of future occurrences, and potential impacts from the hazard. A vulnerability assessment was conducted for each hazard using quantitative and/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.

To account for regional differences in hazard risk across each of the campuses, this risk assessment is divided into two parts:

1) a set of summary hazard profiles describing each hazard and summarizing the risk findings for each campus, presented in Section 3.5; and
2) a campus-specific risk assessment profiling the location, extent, historical occurrences, probability of future occurrence, and vulnerability of each campus, presented in each campus annex.

In the campus-level hazard profiles presented here, each hazard is profiled in the following format:

Location

This section includes information on the hazard's physical extent, describing where on ECU's Main Campus the hazard can occur, with mapped boundaries where applicable.

Extent

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

Historical Occurrences

This section contains information on historical events, including the location and consequences of all past events on record within or near the planning area, approximated by Pitt County in some cases. Where possible, this plan uses a consistent 20-year period of record except for hazards with significantly longer average recurrence intervals or where data limitations otherwise restrict the period of record.

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)

Vulnerability Assessment

This section quantifies, to the extent feasible using best available data, assets at risk to natural hazards and potential loss estimates. Details on hazard specific methodologies and assumptions are provided where applicable. People, properties and critical facilities, and environmental assets that are vulnerable to the hazard are identified.

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

- Geographic Information System (GIS) datasets, including County parcel data from 2020, campus building inventory and values from the University System's Division of Information Technology, NCEM iRisk Database, and property values provided by the NC Department of Insurance, topography, transportation layers, and critical facility and infrastructure locations;
- Hazard layer GIS datasets from state and federal agencies;
- Written descriptions of inventory and risks provided by the 2018 State of North Carolina Hazard Mitigation Plan;
- Written descriptions of inventory and risks provided by the 2020 Neuse River Regional Hazard Mitigation Plan; and
- Exposure and vulnerability estimates derived using local parcel data.

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. For applicable hazards, the quantitative analysis involved the use of FEMA's Hazus-MH, a nationally applicable standardized set of models for estimating potential losses from earthquakes, floods, and hurricanes. Hazus uses a statistical approach and mathematical modeling of risk to predict a hazard's frequency of occurrence and estimated impacts based on recorded or historic damage information. The Hazus risk assessment methodology is parametric, in that distinct hazard and inventory parameters—such as wind speed and building type—were modeled using the Hazus software to determine the impact on the built environment. ECU's GIS-based risk assessment was completed using data collected from local, regional and national sources that included Pitt County, NCEM, and FEMA.

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. Other information can be collected in regard to the hazard area, such as the location of critical facilities and infrastructure, historic resources, 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.

The data collected for the hazard profiles and vulnerability assessment was obtained from multiple sources covering a variety of spatial areas including county-, jurisdictional-, and campus-level information. The table below presents the source data and the associated geographic coverages.

Table A.14 – Summary of Hazard Data Sources and Geographic Coverage

Hazard	Hazard Data Sources	Profile Geographic Area	Vulnerability Methodology	Vulnerability Geographic Area
Earthquake	USGS, NCEI	County	Hazus 4.2	Census Tract
Flood	NCEI, FEMA	Jurisdiction	GIS Spatial Analysis	Campus

Hazard	Hazard Data Sources	Profile Geographic Area	Vulnerability Methodology	Vulnerability Geographic Area
Hurricane	NHC	County	Hazus 4.2	Census Tract
Landslide	USGS	County	Qualitative Analysis	Campus
Severe Winter Weather	NWS, NCEI	County	Statistical Analysis	County
Tornado / Thunderstorm	NWS, NCEI	Jurisdiction	Statistical Analysis	Jurisdiction
Wildfire	NCFS, SouthWRAP	County, Campus	GIS Spatial Analysis	Campus
Cyber Threat	Internet Research	County, Higher Education	Qualitative Analysis	Higher Education
Hazardous Materials Incidents	EPA; USDOT	Jurisdiction	GIS Spatial Analysis	Campus
Infectious Disease	CDC; WHO	National, Higher Education	Qualitative Analysis	Higher Education

CDC = Centers for Disease Control and Prevention; EPA = United States Environmental Protection Agency; FEMA = Federal Emergency Management Agency; NCEI = National Centers for Environmental Information; NCFS = North Carolina Forest Service; NHC = National Hurricane Center; NWS = National Weather Service; SouthWRAP = Southern Group of State Foresters, Wildfire Risk Assessment Portal; USDOT = United States Department of Transportation; USGS = United States Geological Survey; WHO = World Health Organization

Changes in Development

This section describes how changes in development have impacted vulnerability since the last plan was adopted. 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.

Problem Statements

This section summarizes key mitigation planning concerns related to this hazard.

Priority Risk Index

The conclusions drawn from the hazard profiling and vulnerability assessment process are used to prioritize all potential hazards to the ECU 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 A.15**.

PRI ratings are provided by category throughout each hazard profile for the planning area as a whole. Ratings specific to each jurisdiction are provided at the end of each hazard profile. The results of the risk assessment and overall PRI scoring are provided in Section A.5.12 Conclusions on Hazard Risk.

Table A.15 – 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 lowest possible PRI value is a 1.0 and 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 campus 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.

A.5.1 Earthquake

Hazard	Probability	Impact	Spatial Extent	Warning Time	Duration	PRI Score
Earthquake	Unlikely	Minor	Large	Less than 6 hours	Less than 6 hours	1.9

Location

The United States Geological Survey (USGS) Quaternary faults database was consulted to determine the sources of potential earthquakes within range of Pitt County. Quaternary faults are active faults recognized at the surface which have evidence of movement in the past 2.58 million years. No active faults were noted in Pitt County.

Earthquakes are generally felt over a wide area, with impacts occurring hundreds of miles from the epicenter. Therefore, any earthquake that impacts Pitt County is likely to be felt across most, if not all, of the planning area.

Spatial Extent: 4 – Large

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 A.16**. 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 A.17** 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 A.16 – 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 A.17 – 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.

MMI	Richter Scale	Felt Intensity
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.
VIII	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 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.

Impact: 1 – Minor

Historical Occurrences

The USGS Earthquake Hazards Program maintains a database of historical earthquakes of a magnitude 2.5 and greater from 1900 to 2020. Earthquake events that occurred within 100 miles of Pitt County include one event in the town of Bayboro, North Carolina within Pamlico County. This historic event was a 2.9 magnitude earthquake on February 11, 2014.

The National Center for Environmental Information (NCEI) maintains a database of the felt intensity of earthquakes from 1638 to 1985 including the maximum intensity for each locality that felt the earthquake. According to this database, in the 100-year period from 1885-1985, there was one earthquake felt in Greenville. This event occurred on September 1, 1886.

Probability of Future Occurrence

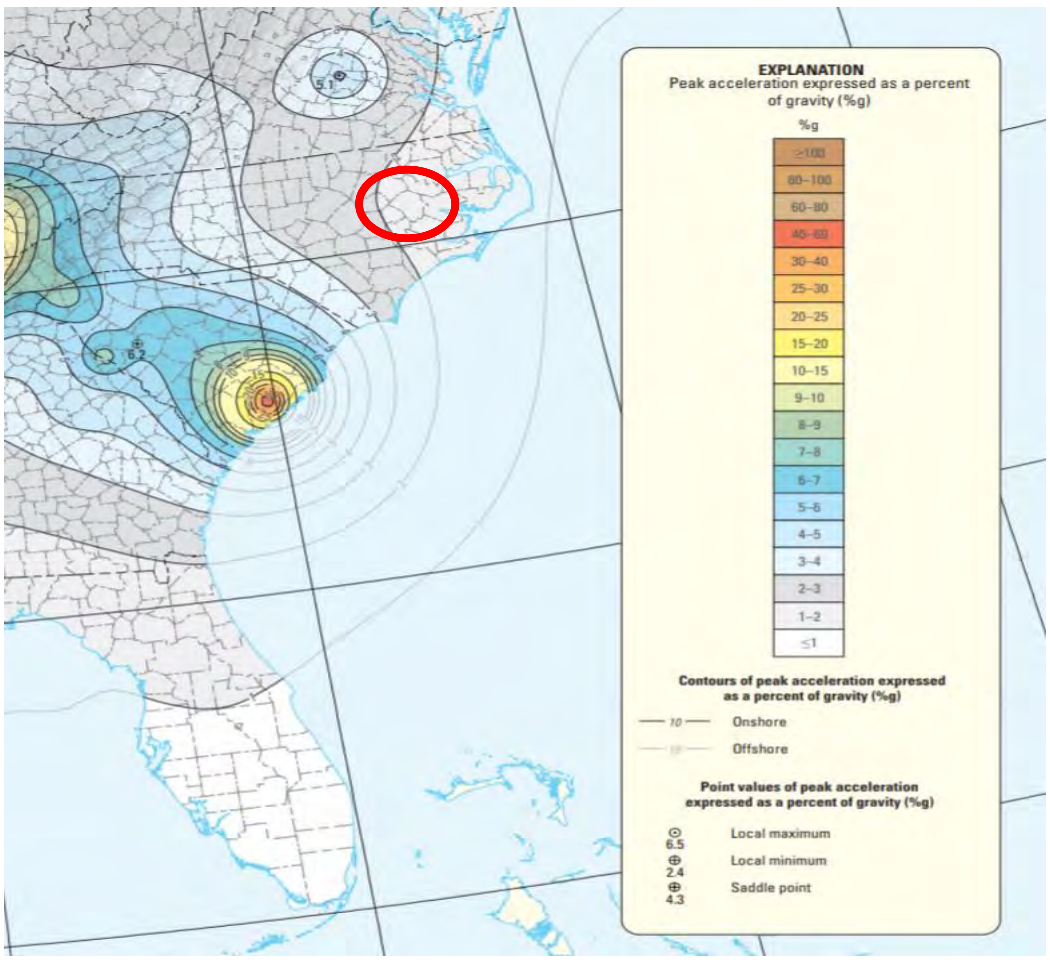
Ground motion is the movement of the earth's surface due to earthquakes or explosions. It is produced by waves generated by a sudden slip on a fault or sudden pressure at the explosive source and travels through the earth and along its surface. Ground motion is amplified when surface waves of unconsolidated 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 that have a common given probability of being exceeded in 50 years.

Figure A.6 on the following page reflects the seismic hazard for Pitt 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 occurrence 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. All of Pitt County is located within a zone with peak acceleration of 6-10% g, which indicates low to moderate earthquake risk.

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

Probability: 1 – Unlikely

Figure A.6 – Seismic Hazard Information for Pitt County



Vulnerability Assessment

Methodology & Assumptions

To quantify vulnerability, Wood performed a Level 1 earthquake analysis in Hazus 4.2 utilizing general building stock information based on the 2010 Census. The ECU campus is located within three census tracts encompassing 7.44 square miles. The earthquake scenario was modeled after an arbitrary earthquake event of magnitude 5.0 with an epicenter in the ECU campus and depth of 10km.

People

Hazus estimates that the modeled magnitude 5.0 event would result in 311 households requiring temporary shelter. Additionally, Hazus estimates potential injuries and fatalities depending on the time of day of an event. Casualty estimates are shown in **Figure A.7**. Casualties are broken down into the following four levels that describe the extent of injuries:

- Level 1: Injuries will require medical attention but hospitalization is not needed.
- Level 2: Injuries will require hospitalization but are not considered life-threatening.
- Level 3: Injuries will require hospitalization and can become life threatening if not promptly treated.
- Level 4: Victims are killed by the earthquake.

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. Impacts of earthquakes also include debris clean-up and service disruption. Per the Hazus analysis, a 5.0 magnitude earthquake could produce an estimated 70,000 tons of debris.

Pitt County has not been impacted by an earthquake with more than a moderate intensity, so major damage to the built environment is unlikely. **Table A.18** details the estimated buildings impacted by a magnitude 5.0 earthquake event, as modeled by Hazus. Note that building value estimates are inherent to Hazus and do not necessarily reflect damages to the asset inventory for the ECU Campus.

Table A.18 – Estimated Buildings Impacted by 5.0 Magnitude Earthquake Event

Occupancy Type	Estimated Building Damage	Estimated Content Loss	Estimated Total Damage
Residential	$19,140,000	$0	$19,140,000
Commercial	$7,440,000	$0	$7,440,000
Industrial	$1,000,000	$0	$1,000,000
Other	$2,830,000	$0	$2,830,000
Total	**$30,410,000**	**$0**	**$30,410,000**

Source: Hazus

Figure A.7 – Casualty Estimate from a 5.0 Magnitude Earthquake Event

		Level 1	Level 2	Level 3	Level 4
2 AM	Commercial	0	0	0	0
	Commuting	0	0	0	0
	Educational	0	0	0	0
	Hotels	0	0	0	0
	Industrial	1	0	0	0
	Other-Residential	42	9	1	3
	Single Family	8	1	0	0
	Total	**51**	**11**	**1**	**3**
2 PM	Commercial	28	6	1	2
	Commuting	0	0	0	0
	Educational	40	9	1	2
	Hotels	0	0	0	0
	Industrial	4	1	0	0
	Other-Residential	7	2	0	0
	Single Family	1	0	0	0
	Total	**80**	**18**	**2**	**5**
5 PM	Commercial	21	5	1	1
	Commuting	0	0	0	0
	Educational	19	4	1	1
	Hotels	0	0	0	0
	Industrial	2	1	0	0
	Other-Residential	17	4	1	1
	Single Family	3	1	0	0
	Total	**62**	**14**	**2**	**4**

Source: Hazus 4.2

All critical facilities should be considered at risk to minor damage should an earthquake event occur. However, the essential facilities included in Hazus for Pitt County—which include 1 hospitals, 5 schools, 1 fire stations, and 3 police stations—were estimated to sustain at least moderate damages, and all were estimated to maintain at least 50 percent functionality after day one following an event. Additionally, Hazus projected one bus facility to sustain at least moderate damage.

Environment

An earthquake is unlikely to cause substantial impacts to the natural environment in Pitt 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.

Changes in Development

Building codes substantially reduce the costs of damage to future structures from earthquakes. Future construction on the ECU campus must follow the applicable requirements of the NC building codes, the State of North Carolina statutes for state owned buildings and zoning for the local jurisdiction.

Development changes at ECU have not affected the risk characteristics of earthquakes. The probability, impact, spatial extent, warning time, and duration of earthquakes have not changed.

Problem Statement

- While earthquakes are an unlikely hazard event for the ECU campus, the Hazus model did predict moderate damage to buildings, one hospital, five schools, three police stations, one fire station, and one bus facility within the three census tracts encompassing the campus.

A.5.2 Flood

Hazard	Probability	Impact	Spatial Extent	Warning Time	Duration	PRI Score
Flood	Likely	Critical	Small	6 to 12 hrs	Less than 1 week	2.8

Location

Regulated floodplains are illustrated on inundation maps called Flood Insurance Rate Maps (FIRMs). A FIRM 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 1-percent-annual-chance flood event. Structures located within the SFHA have a 26-percent chance of flooding during the life of a standard 30-year mortgage.

For this risk assessment, flood prone areas were identified within the ECU Campus using the FIRM dated July 7, 2014. **Figure A.8** reflects the 2014 mapped flood insurance zones. **Table A.19** summarizes the flood insurance zones identified by the Digital FIRM (DFIRM).

Spatial Extent: 2 – Small

Table A.19 – Mapped Flood Insurance Zones

Zone	Description
A	Zone A is the flood insurance rate zone that corresponds to the 1% annual chance floodplains that are determined in the FIS Report by approximate methods. Because detailed hydraulic analyses are not performed for such areas, no Base Flood Elevations or depths are shown within this zone.
AE	Zone AE is the flood insurance rate zone that corresponds to the 1% annual chance floodplains that are determined in the FIS Report by detailed methods. In most instances, whole-foot Base Flood Elevations derived from the detailed hydraulic analyses are shown at selected intervals within this zone.
AH	Zone AH is the flood insurance rate zone that corresponds to the areas of 1% annual chance shallow flooding (usually areas of ponding) where average depths are between 1 and 3 feet. Whole-foot Base Flood Elevations derived from the detailed hydraulic analyses are shown at selected intervals within this zone.
AO	Zone AO is the flood insurance rate zone that corresponds to the areas of 1% annual chance shallow flooding (usually sheet flow on sloping terrain) where average depths are between 1 and 3 feet. Average whole-foot depths derived from the detailed hydraulic analyses are shown within this zone.
VE	Zone VE is the flood insurance rate zone that corresponds to the 1% annual chance coastal floodplains that have additional hazards associated with storm waves. Whole-foot Base Flood Elevations derived from the detailed hydraulic analyses are shown at selected intervals within this zone.
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 0.2-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 10.2 percent of the ECU Campus falls within the SFHA. **Table A.20** provides a summary of the ECU Campus' total area by flood zone on the 2014 effective DFIRM.

Figure A.8 – FEMA Flood Hazard Areas in ECU's Campus Boundary

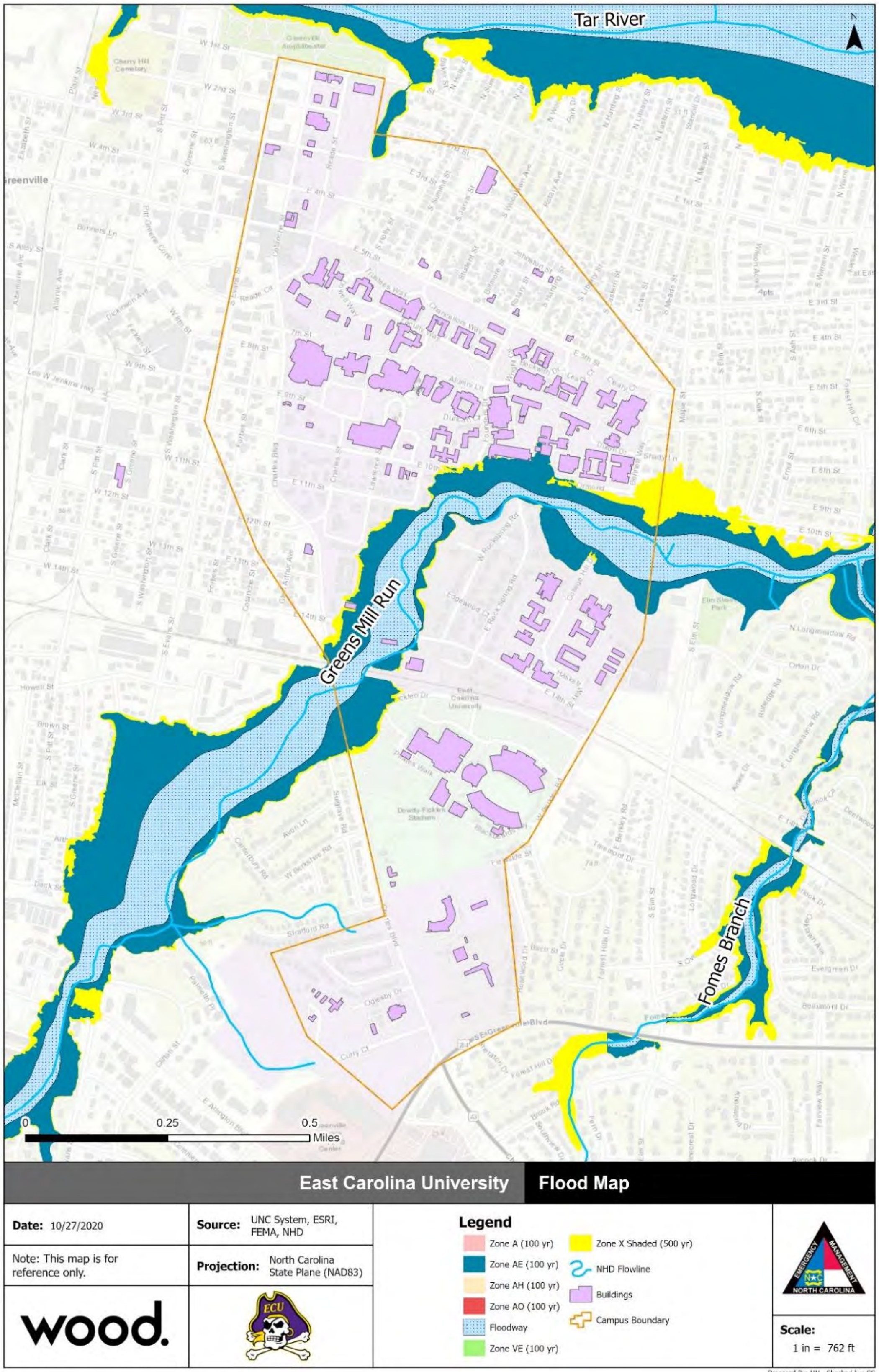


Table A.20 – Flood Zone Acreage on ECU's Campus

Flood Zone	Acreage	Percent of Total (%)
A	0	0.0%
AE	32	5.6%
AH	0	0.0%
AO	0	0.0%
Floodway	26	4.6%
VE	0	0.0%
0.2% Annual Chance Flood Hazard	7	1.2%
Unshaded X	501	88.7%
Total	565	**--**
SFHA Total	**58**	**10.2%**

Source: FEMA 2014 DFIRM

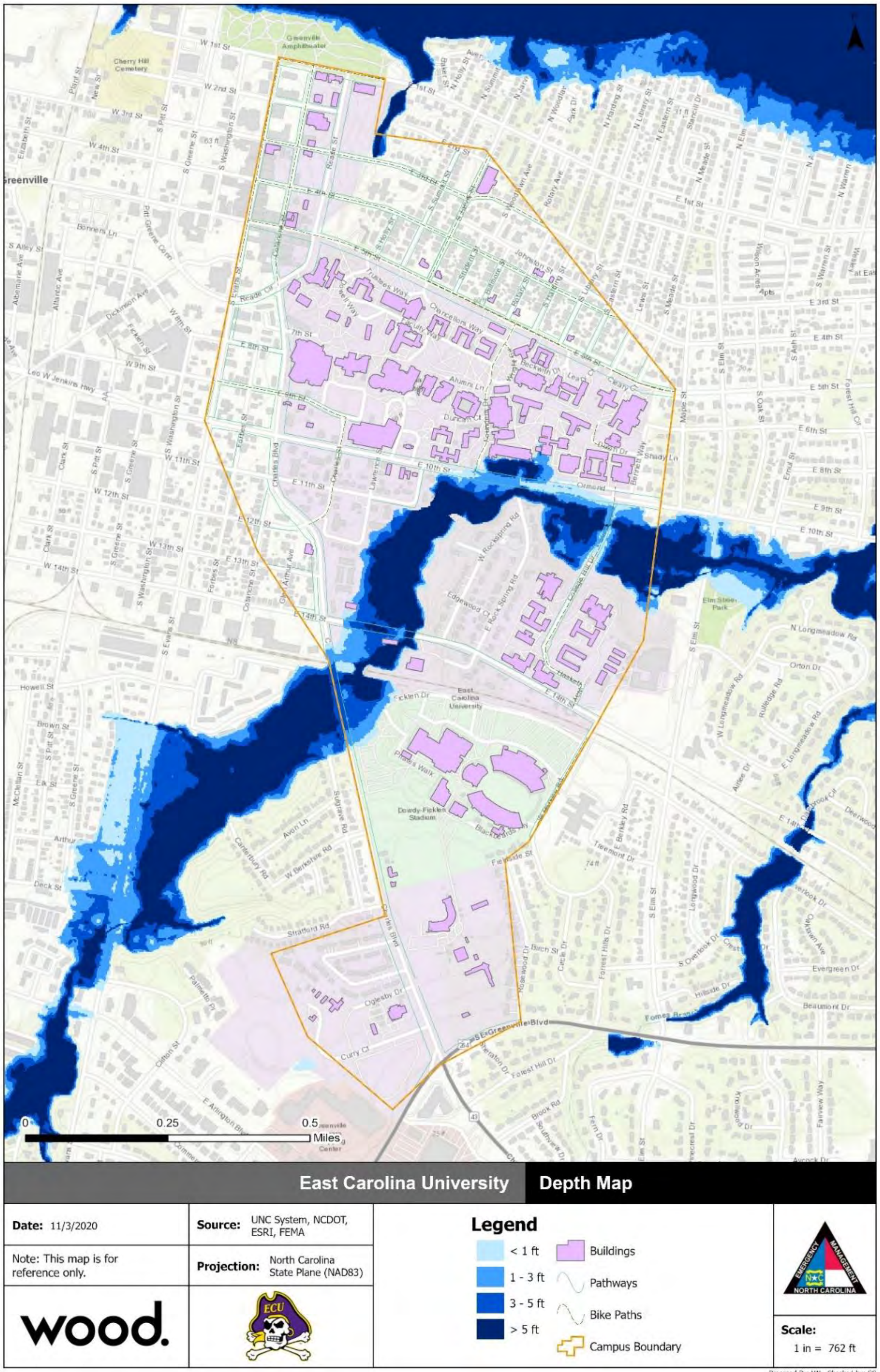
Although this assessment focuses on riverine flooding, it is also important to note that localized stormwater flooding can also occur on campus and may affect areas outside the mapped floodplain. Data was not available to evaluate the location or extent of stormwater flooding on campus.

Extent

Flood extent can be defined by the amount of land in the floodplain, detailed above, and the potential magnitude of flooding as measured by flood depth and velocity. **Figure A.9** shows the depth of flooding predicted from a 1% annual chance flood. Flood damage is closely related to depth, with greater flood depths generally resulting in more damages.

Impact: 3 – Critical

Figure A.9 – Flood Depth, 1-Percent-Annual-Chance Flood, ECU Campus



Historical Occurrences

Table A.21 details the historical occurrences of flooding for Greenville identified from 2000 through 2019 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 A.21 – Flood Depth, 1-Percemt-Annual-Chance Flood, ECU Campus

Location	Date	Deaths/Injuries	Reported Property Damage	Reported Crop Damage
Flash Flood				
GREENVILLE	10/11/2002	0	$0	$0
GREENVILLE	8/5/2003	0	$0	$0
GREENVILLE	7/29/2005	0	$0	$0
GREENVILLE	10/8/2005	0	$0	$0
GREENVILLE	10/8/2016*	0	$0	$0
GREENVILLE	9/1/2017	0	$0	$0
Flood				
GREENVILLE	7/10/2010	0	$0	$0
GREENVILLE	7/29/2010	0	$0	$0
GREENVILLE	5/23/2012*	0	$0	$0
	Total	**0/0**	**$0**	**$0**

Source: NCEI
*Note: Multiple events occurred on these dates. Injuries, fatalities, and property damage are totaled, wind speed is highest reported.

According to NCEI, 14 recorded flood-related events occurred on 9 separate days in Greenville from 2000 to 2019 causing no property damage, injuries, fatalities, or crop damage. Based on the NCEI event narratives there might be property and crop damages that occurred but weren't recorded.

The following event narratives are provided in the NCEI Storm Events Database and illustrate the impacts of flood events on the county:

- **10/11/2002** - Up to 4 to 6 inches of rain fell across Pitt county as the remnants of Tropical Storm Kyle moved across the area. Numerous roads were closed in and around Greenville. Several vehicles became flooded and were abandoned.
- **09/30/2010** - Torrential rain moved across most of Pitt County during the evening of September 30th as the remnants of Tropical Storm Nicole moved north across the region. This rain fell on saturated ground from very heavy rain the previous few days. Significant flash flooding developed especially for areas from Greenville east toward Simpson. A few homes were flooded especially near Chicod Creek near Simpson. Some crops were also damaged from the flooding.
- **10/8/2016** - Flooding from Tyson creek has flooded Windham Road making it impassable. High water from severe flooding has trapped several cars along Fire Tower Road near Arlington Boulevard. Roundtree Road collapsed due to severe flooding near Ayden. Severe flooding with water to the tops of cars near Pirates Place Apartments in Greenville. High water flowing swiftly over Williams Road near Dickenson Avenue. Severe flooding at the intersection of Arlington Boulevard and Fire Tower Road; both roads were impassable.

The state of North Carolina has had two FEMA Major Disaster Declarations for severe storms that include elements of flooding in 1962 and 1964, in addition to four Major Disaster Declarations for Hurricanes in 1954, 1955, 1958, and 1960 which also may have included damages associated with flooding. Pitt County has had two FEMA Major Disaster Declarations for severe storms that include elements of flooding in

2010 and 2011. Additionally, eight Major Disaster Declarations were made for Hurricanes in 1996, 1998, 1999, 2003, 2011, 2016, 2018, 2019 which also may have included damages associated with flooding.

Probability of Future Occurrence

By definition, SFHAs are those areas that will be inundated by the flood event having a 1-percent chance of being equaled or exceeded in any given year. While exposure to flood hazards varies across jurisdictions, all jurisdictions have at least some area of land in FEMA-mapped flood hazard areas. This delineation is a useful way to identify the most at-risk areas, but flooding does not occur in set intervals; any given flood may be more or less severe than the defined 1-percent-annual-chance flood. There is also risk of localized and stormwater flooding in areas outside the SFHA and at different intervals than the 1% annual chance flood.

Floods of varying severity occur regularly in Greenville and impacts from past flood events have been noted by NCEI. NCEI reports 14 flood-related events in the 20-year period from 2000-2019, which equates to an annual probability of 70% for Greenville. Therefore, the probability of flooding is considered likely (between 10% and 100% annual probability).

Probability: 3 – Likely

Vulnerability Assessment

Methodology & Assumptions

To quantify vulnerability, Wood performed a GIS spatial analysis of the flood hazard by overlaying the depth raster for the SFHA on the building footprints provided by the UNC Division of Information Technology and NCEM iRisk database. In all, there are 112 buildings on ECU's campus; of these, 4 fall inside the SFHA. These were the parcels analyzed as part of this analysis.

Flood damage is directly related to the depth of flooding by the application of a depth damage curve. In applying the curve, a specific depth of water translates to a specific percentage of damage to the structure, which translates to the same percentage of the structure's replacement value. **Figure A.9** depicts the depth of flooding that can be expected within the ECU campus during the 1-percent-annual-chance flood event. **Table A.22** provides the depth damage factors that were used to calculate flood losses for the planning area. These depth damage factors are based on depth damage curve developed by the USACE Wilmington District for educational structures.

Table A.22 – Depth Damage Percentages

Depth (ft)	Educational Facility Percent Damage
-4	0
-3	0
-2	0
-1	0
0	0
1	5
2	7
3	9
4	9
5	10
6	11
7	13
8	15
9	17

Depth (ft)	Educational Facility Percent Damage
-4	0
-3	0
10	20
11	24
12	28
13	33
14	39
15	45
16	52
17	59
18	64
19	69
20	74
21	79
22	84
23	89
24	94

Source: USACE Wilmington District

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 systems lose 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 high risk when driving through flooded streets. However, NCEI does not contain any records of deaths in Greenville caused by flood events.

An estimate of population at risk to flooding can be developed based on the assessment of housing property at risk. For the ECU campus, there are no housing properties at risk.

Property

Administration buildings, education and/or extracurricular facilities, housing, as well as critical facilities and infrastructure such as transportation, water, energy, and communication systems may be damaged or destroyed by flood waters.

Table A.23 details the estimated losses for the 1%-annual-chance flood event for the campus. The total damage estimate value is based on damages to the total of building value. Land value is not included in any of the loss estimates as generally land is not subject to loss from floods.

Table A.23 – Estimated Building Damage and Content Loss for 1% Annual Chance Flood

Occupancy Type	Total Buildings with Loss	Total Value	Estimated Building Damage	Loss Ratio
Administration	2	$632,779	$127,198	20%
Critical Facilities	0	$0	$0	0%
Education/ Extracurricular	2	$166,037,535	$15,332,622	9%
Housing	0	$0	$0	0%
Total	**4**	**$166,670,314**	**$15,459,820**	**29%**

Source: UNC Division of Information Technology; NCEM iRisk; NC Department of Insurance

The loss ratio is the loss estimate divided by the total potential exposure (i.e., total of improved and contents value for all buildings located within the Zone AE) and displayed as a percentage of loss. FEMA considers loss ratios greater than 10% to be significant and an indicator a community may have more difficulties recovering from a flood. The loss ratio for administration buildings, as well as the total loss ratio for all buildings on campus, is greater than 10%. This means that in the event of a flood with a magnitude of the 1%-annual-chance event or greater, the planning area would face severe difficulty in recovery.

None of the critical facilities identified for ECU are located within the 1%-annual-chance floodplain, therefore there are no estimated damages.

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 planning area. According to 2020 NFIP records, there are no repetitive loss properties on the ECU campus.

Environment

During a flood event, chemicals and other hazardous materials 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.

Changes in Development

The likelihood of future flood damage can be reduced through appropriate land use planning, building siting and building design. In addition, the ECU Facilities Services works to maintain compliance with all applicable state and federal regulations regarding water resources, provides a regulatory framework to ensure development has minimal impact on the environment, and manages the stormwater infrastructure.

Problem Statement

- The 1% annual chance floodplain extends onto the ECU Campus. There are no critical facilities within the SFHA; however, four buildings on the ECU campus are impacted by the 1% annual chance floodplain and one of these buildings is located within the floodway. Along with these buildings, there is potential for many roadways to be impacted as well during these flood events.

A.5.3 Geological – Landslide

Hazard	Probability	Impact	Spatial Extent	Warning Time	Duration	PRI Score
Landslide	Unlikely	Minor	Negligible	6 to 12 hrs	Less than 6 hrs	1.2

Location

Pitt County is located within the Coastal Plain physiographic province of North Carolina. This province encompasses approximately 45 percent of the area of the state and is characterized by flat land to gently rolling hills and valleys. Elevations range from sea level near the coast to about 600 feet in the Sandhills of the southern Inner Coastal Plain.

The U.S. Geological Survey (USGS) has produced landslide susceptibility and incidence mapping of the U.S., as shown in Figure A.10. 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, Pitt County faces low susceptibility and incidence of landslide.

Spatial Extent: 1 – Negligible

Extent

In low-relief areas, such as the Pitt County area, landslides may occur as cut-and fill failures (roadway and building excavations), river bluff failures, lateral spreading landslides, collapse of mine-waste piles (especially coal), and a wide variety of slope failures associated with quarries and open-pit mines. In these instances, impacts are limited to the defined area. Event magnitude is also dependent on topography; landslide risk is higher in areas with steeper slopes. Given the gentle topography the county, the magnitude of any landslides on ECU's campus would be minor.

Impact: 3 – Minor

Historical Occurrences

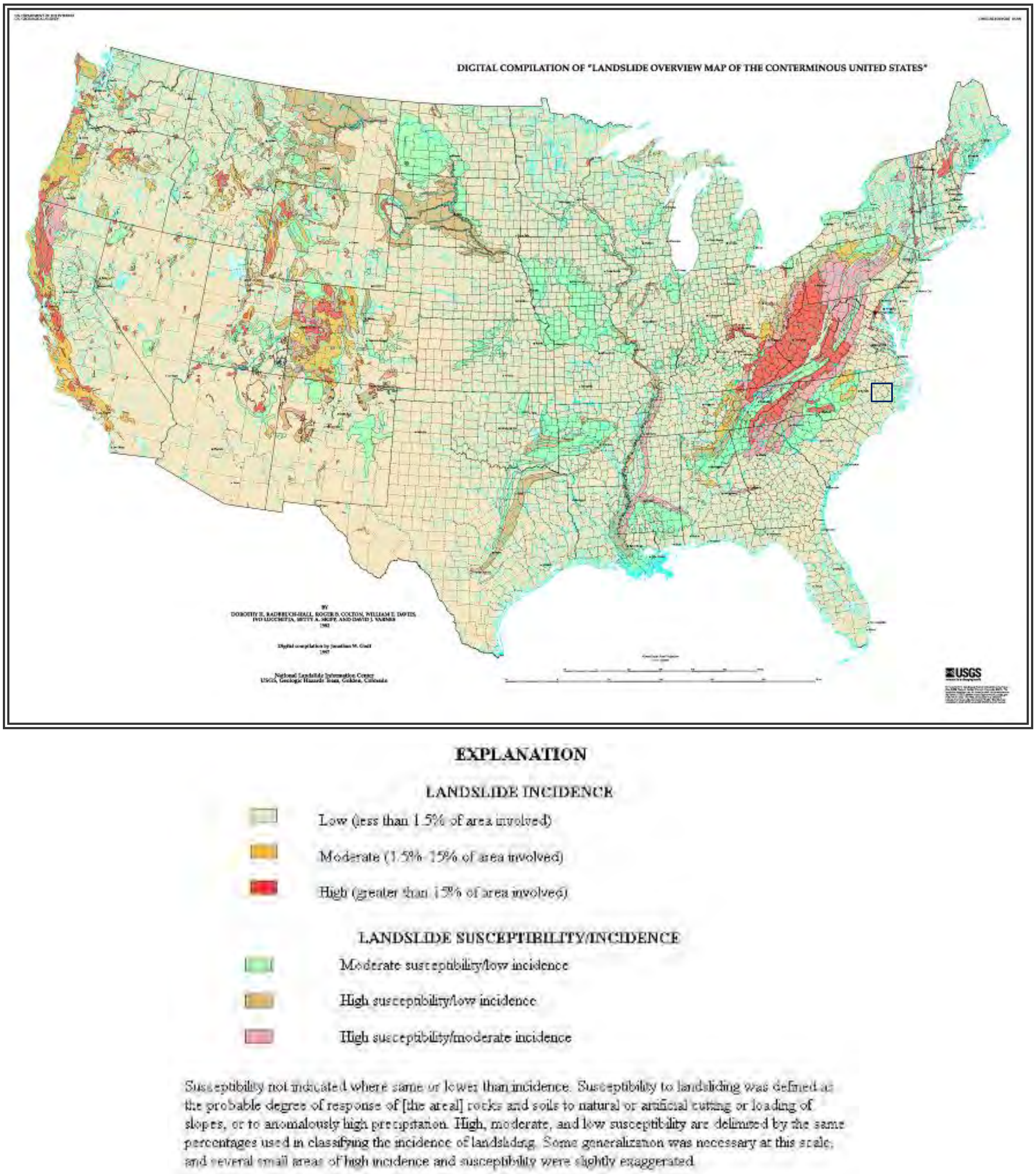
There were no available records of past landslide events for the County. When looking at the map in Figure A.10, it is shown that all of Pitt County is in an area with low incidence and susceptibility to landslides.

Probability of Future Occurrence

There were no records found for any landslide events occurring in Pitt County between 2000 and 2019. Since this area does not have any historical occurrences or susceptibility, it is 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

Figure A.10 – Landslide Incidence and Susceptibility



Source: USGS

Vulnerability Assessment

People

People are unlikely to sustain serious physical harm as a result of landslides in Pitt 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 Pitt 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 Pitt County are unlikely to cause any more severe impacts.

Changes in Development

Although Pitt County faces low susceptibility and incidence of landside, future development projects should consider slope and soil slippage potential at the planning, engineering and architectural design stage with the goal of reducing vulnerability.

Problem Statement

- A landslide event 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.

A.5.4 Hurricane

Hazard	Probability	Impact	Spatial Extent	Warning Time	Duration	PRI Score
Hurricane & Tropical Storm	Likely	Catastrophic	Large	More than 24 hrs	Less than 24 hrs	3.2

Location

While coastal areas are most vulnerable to hurricanes, the wind and rain impacts of these storms can be felt hundreds of miles inland. Hurricane-related events can occur anywhere within Pitt County.

Storm surges, or storm floods, are limited to the coastal counties of North Carolina. ECU is located more inland and is only impacted by the storm surges of Category 4 and Category 5 hurricanes. **Figure A.11** through **Figure A.14** below shows the different storm surge extents related to ECU's campus for hurricane categories 2-5. The Category 1 storm surge is not featured because the extents are not close enough to the campus boundary to be seen in the figure. Around 1% to 10% of the campus is inundated during Category 4 and Category 5 storm surge events. However, hurricane winds can impact the entire campus, so the spatial extent was determined to be large.

Spatial Extent: 4 – Large

Extent

Hurricane intensity is classified by the Saffir-Simpson Scale (**Table A.24**), which rates hurricane intensity on a scale of 1 to 5, with 5 being the most intense.

Table A.24 – 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

Figure A.11 -- Category 2 Storm Surge Inundation Areas, ECU

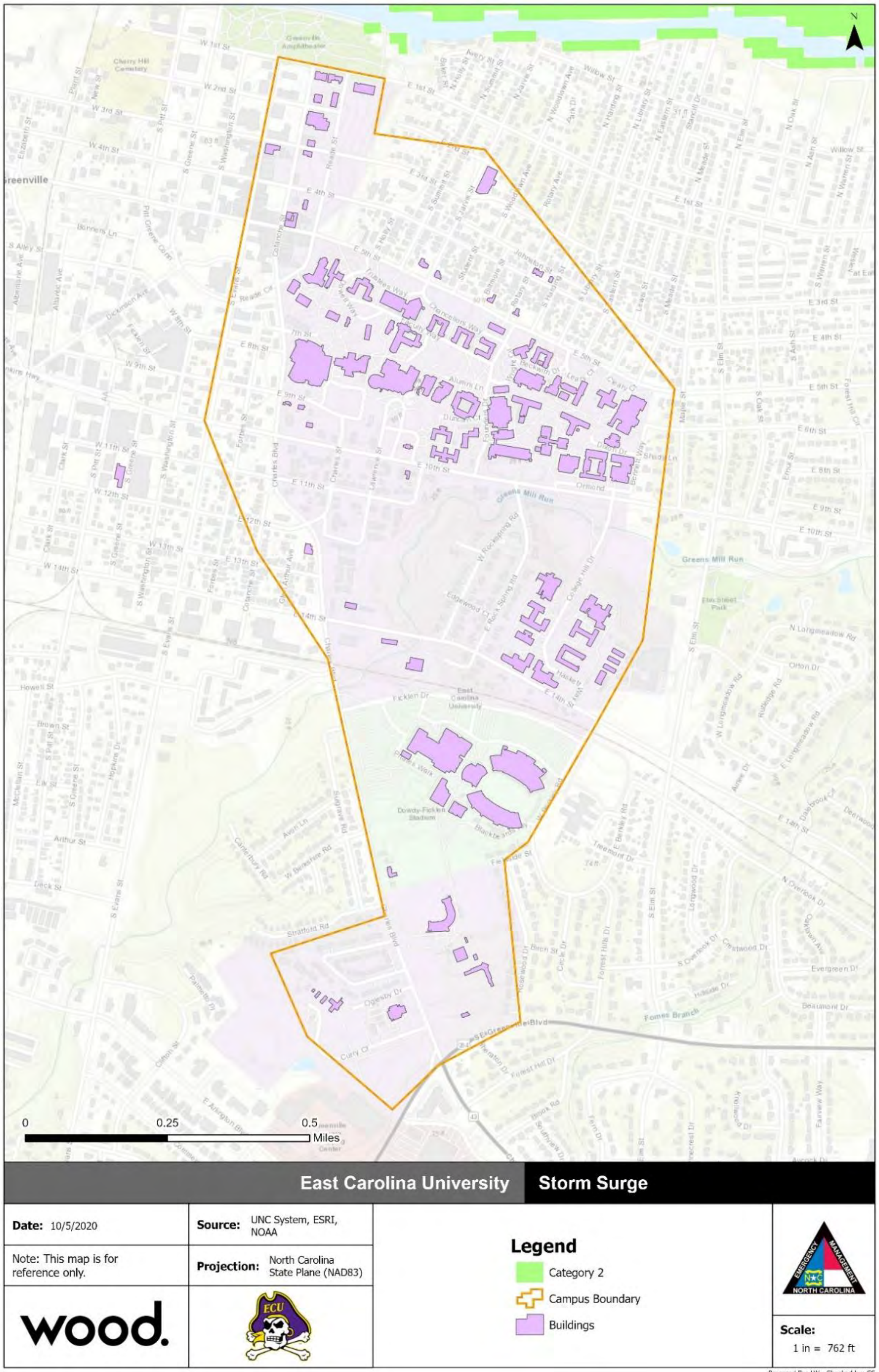


Figure A.12 -- Category 3 Storm Surge Inundation Areas, ECU

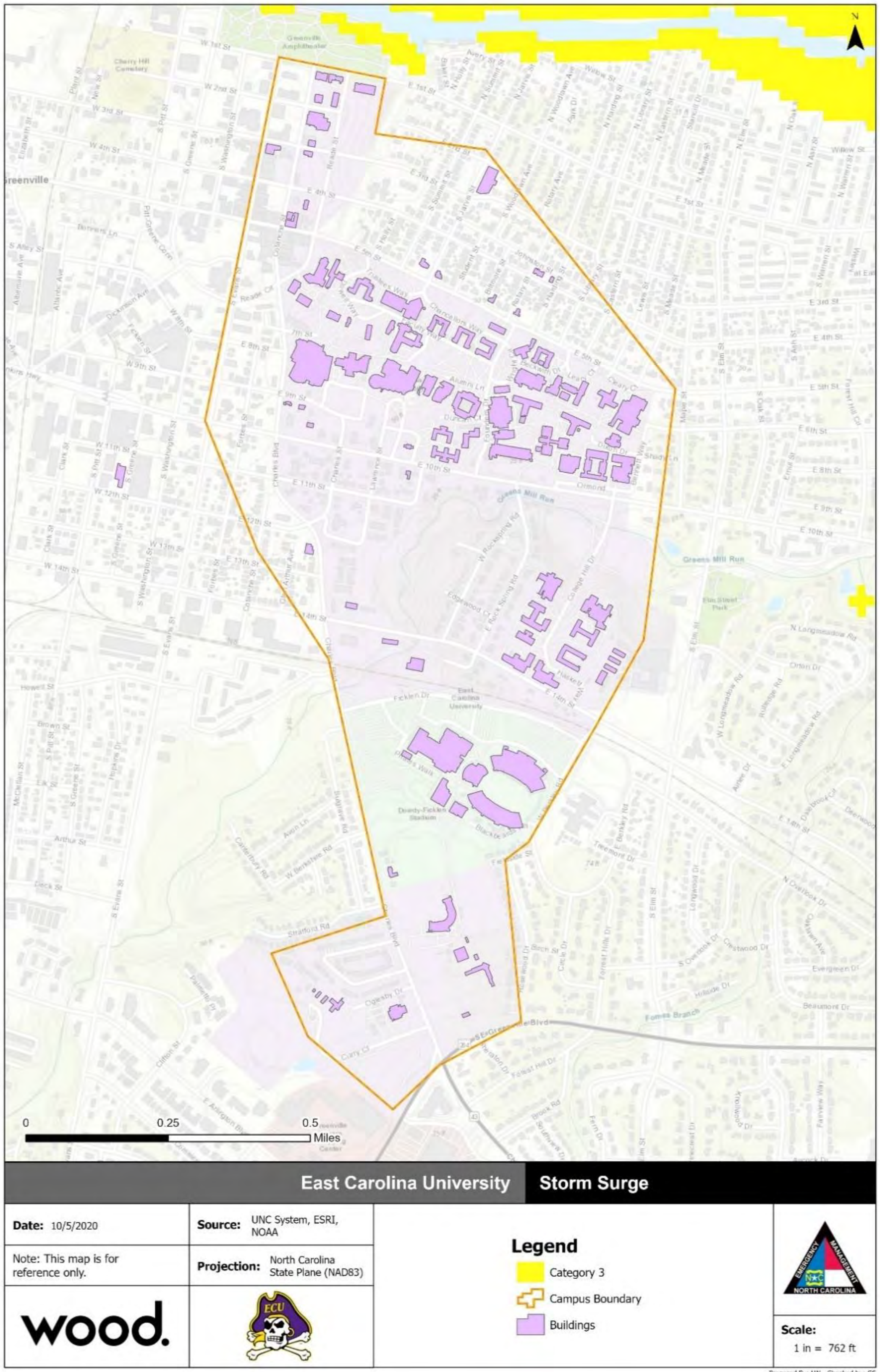


Figure A.13 -- Category 4 Storm Surge Inundation Areas, ECU

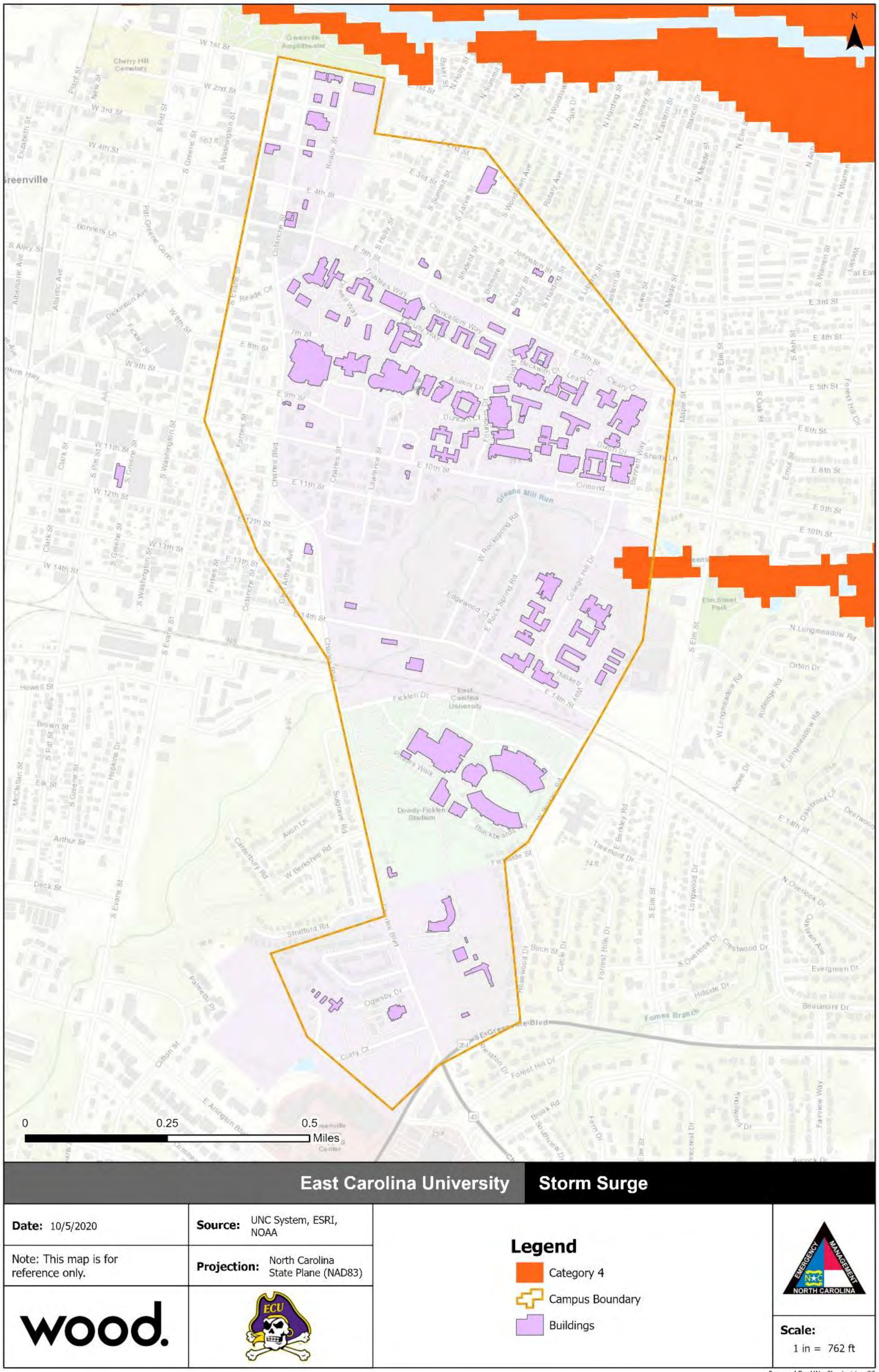
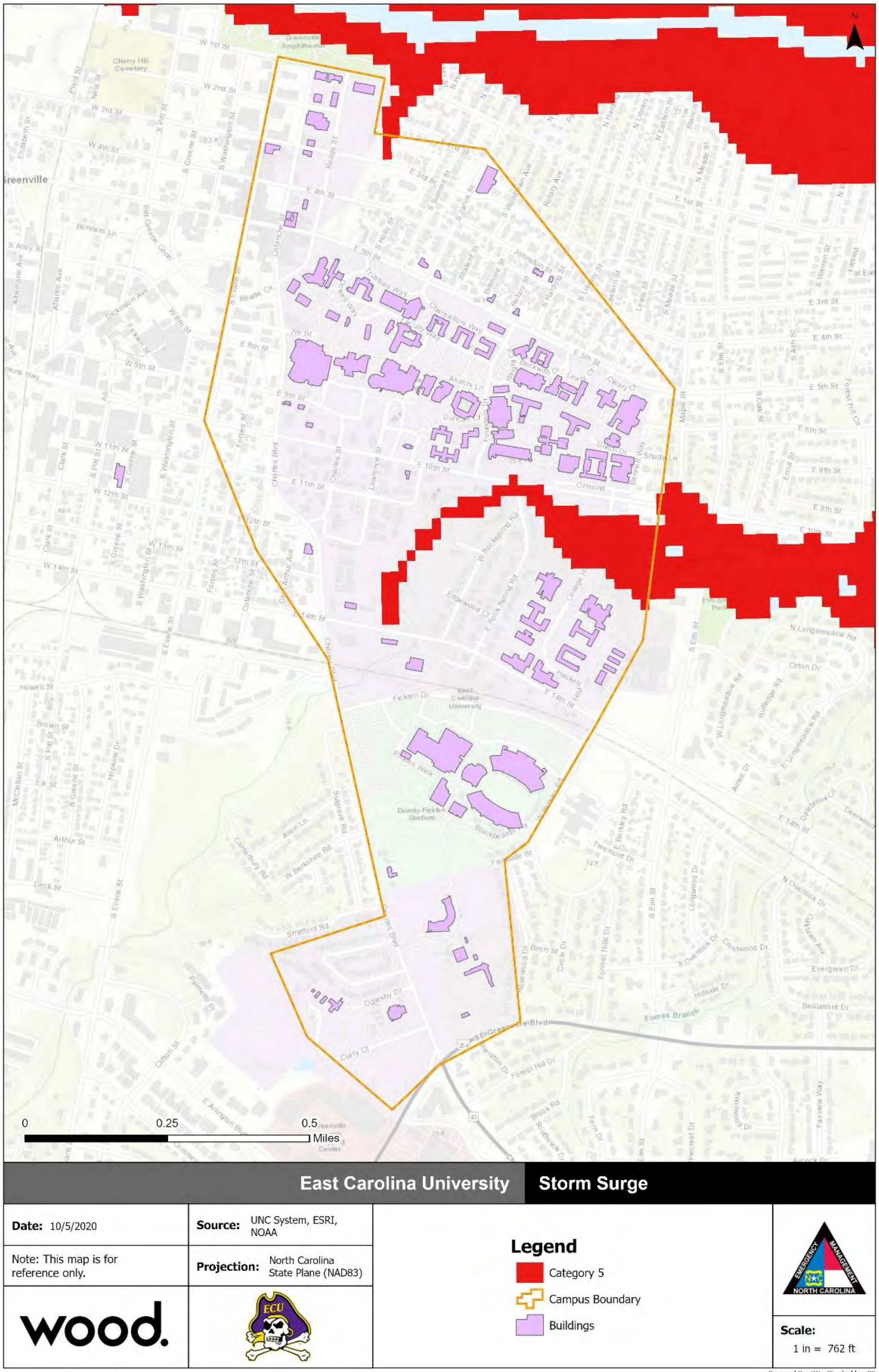


Figure A.14 -- Category 5 Storm Surge Inundation Areas, ECU



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 A.25** 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 A.25 – 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

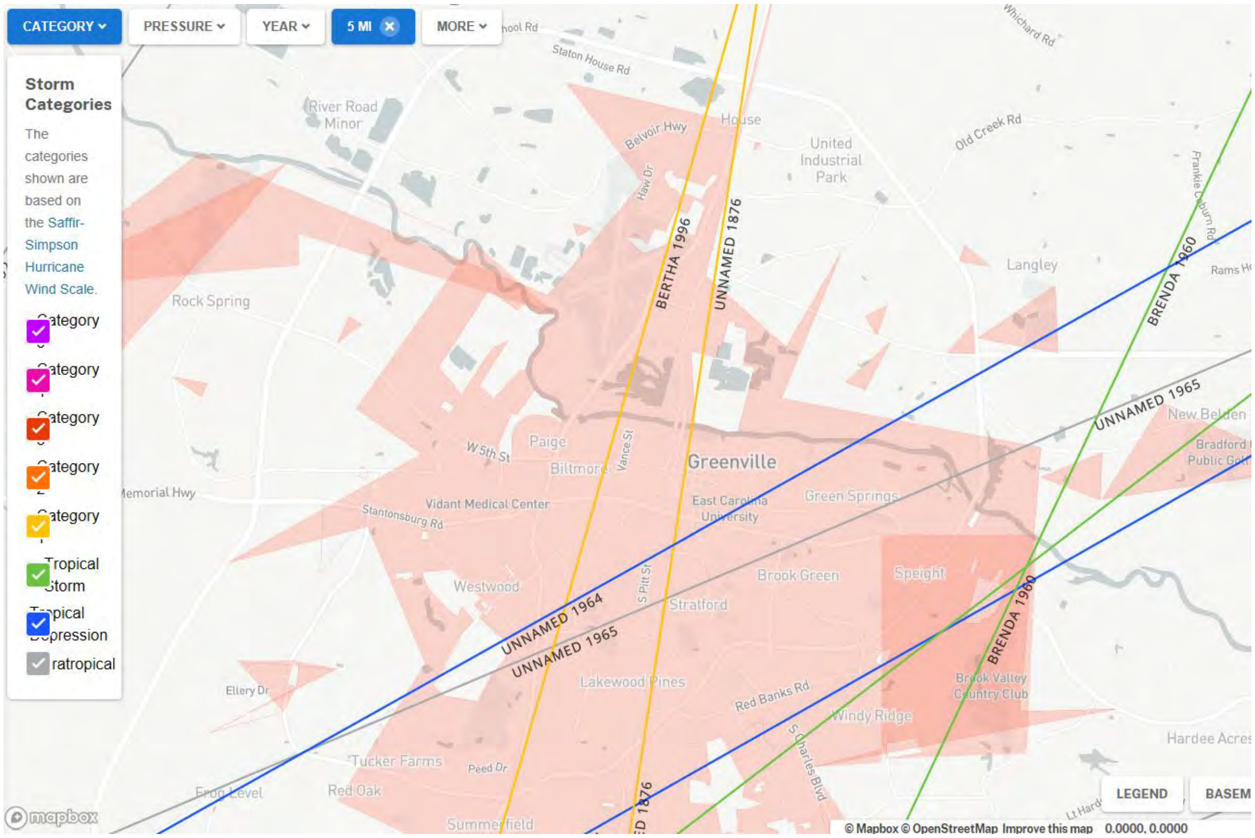
Pitt County may experience any category of hurricane force winds. A storm on record that directly impacted ECU was an unnamed tropical depression whose path moved through the campus in 1964 with maximum wind speeds of around 23 mph. However, an unnamed hurricane passed within 5 miles of ECU's campus as a Category 1 storm with wind speeds around 92 mph in 1876. Hurricane Bertha also passed within 5 miles of ECU's campus as Category 1 storm with wind speeds around 75 mph.

Impact: 4 – Catastrophic

Historical Occurrences

Storm tracks for hurricane-related events that have passed within 5 miles of ECU's campus were obtained from NOAA's database and are shown in **Figure A.15**. The NCEI Storm Events database has recorded nine hurricane-related events that passed through Pitt County between 2000 and 2019. **Table A.26** details these historical occurrences.

Figure A.15 – Hurricane and Tropical Storm Tracks within 5 Miles of ECU



Source: NOAA Office of Coastal Management; image captured directly from website.

Table A.26 – Recorded Hurricane and Tropical Storm Events for Pitt County, 2000-2019

Date	Type	Storm	Deaths/ Injuries	Property Damage	Crop Damage
9/17/2003	Hurricane (Typhoon)	Hurricane Isabel	0/0	$2,000,000	$0
8/14/2004	Hurricane (Typhoon)	Hurricane Charley	0/0	$200,000	$300,000
9/13/2005	Hurricane (Typhoon)	Hurricane Ophelia	0/0	$0	$0
8/31/2006	Tropical Storm	Tropical Storm Ernesto	0/0	$25,000	$0
9/5/2008	Tropical Storm	Tropical Storm Hanna	0/0	$10,000	$0
8/26/2011	Tropical Storm	Hurricane Irene	2/0	$10,000,000	$38,000,000
6/6/2013	Tropical Storm	Tropical Storm Andrea	0/0	$0	$0
10/8/2016	Tropical Storm	Hurricane Matthew	1/1	$0	$0
9/6/2019	Tropical Storm	Hurricane Dorian	0/0	$0	$0
		Total	**3/1**	**$12,235,000**	**$38,300,000**

Source: NCEI

According to NCEI, nine recorded hurricane-related events affected Pitt County from 2000 to 2019 causing an estimated $12,235,000 in property damage and $38,300,000 in crop damage. There was one injury and three fatalities recorded during these events.

The following event narratives are provided in the NCEI Storm Events Database and illustrate the impacts of hurricane and tropical storm events on the county:

Hurricane Charley (2004) – Hurricane Charley had weakened to a tropical storm by the time it moved northeast across the Coastal Plains of Eastern North Carolina during the afternoon hours on August 14th. Onslow county received the most damage, with estimates over 5 million dollars, as winds gusted to near hurricane force toppling trees and power lines with structural damage to homes and businesses. Winds gusted from 60-70 mph across Inland areas near the center of the storm resulting in wind damage to structures, and damage to crops reaching into the millions. Winds gusted from 40 to 50 mph across locations across Eastern North Carolina with minor wind damage reported. Storm surge values were highest along the Onslow County coastline where a 2 to 3 foot surge was estimated, and 8 foot waves caused minor beach erosion along the south facing beaches. Water levels rose up to 2 feet across the lower reaches of the Neuse and the Pamlico Rivers, and across the Outer Banks. Storm total rainfall, estimated between 4 to 6 inches, occurred across a large part of the area resulting in freshwater flooding in 7 counties across the Coastal Plains. Five weak tornadoes were reported across the area associated with Charley with damage reported. The most significant damage related to a tornado occurred along the Outer Banks in Nags Head.

Hurricane Irene (2011) – Across Pitt County winds gusted near hurricane force resulting in minor to major structural damage to 2,000 homes and businesses, mainly due to fallen trees. Agricultural losses were estimated at 38 million dollars from flooding and winds. Storm total rainfall was 7 to 13 inches with flooding of roads and low-lying areas. Two direct deaths were reported from Hurricane Irene. One fatality was due to a tree falling on a house, and a second fatality resulted from a car that struck a tree.

Hurricane Matthew (2016) – Widespread heavy rain and strong winds developed over the region from the afternoon of October 8th through the morning of October 9th. Rainfall was generally 7 to 11 inches over the county with a storm total of 10.74 inches reported in Farmville. The heavy rainfall produced significant flash flooding with many roads washed out. One fatality occurred when a car drove into flood waters during the early morning hours of October 9th east of Greenville. Devastating river flooding developed along the Tar River days after the rainfall ended. The Tar River crested at 24.46 feet at Greenville in major flood well above the 13 foot flood stage. Many homes and businesses were flooded and damaged with numerous roads closed for days. Gusty north winds developed on the backside of Matthew with a peak wind gust of 59 mph recorded at the Greenville Airport at 7:45 pm on October 8th. The gusty winds combined with saturated ground led to many downed trees with widespread power outages.

The state of North Carolina has had four FEMA Major Disaster Declarations for Hurricanes in 1954, 1955, 1958, 1960. Additionally, Pitt County has received nine Major Disaster Declarations for Hurricanes in 1996, 1998, 1999, 2003, 2011, 2016, 2018 and 2019.

Probability of Future Occurrence

In the 20-year period from 2000 through 2019, nine hurricanes and tropical storms have impacted Pitt County, which equates to a 45 percent annual probability of hurricane winds impacting the county. This probability does not account for impacts from hurricane rains, which may also be severe. Overall, the probability of a hurricane or tropical storm impacting the County is likely.

Probability: 3 – Likely

Vulnerability Assessment

Methodologies and Assumptions

To quantify vulnerability, Wood performed a Level 1 hurricane wind analysis in Hazus 4.2 for three scenarios: a historical recreation of Hurricane Fran (1996) and simulated probabilistic wind losses for a 200-year and a 500-year event storm. The analysis utilized general building stock information based on the 2010 Census. The ECU campus is located within 3 census tracts encompassing 7.45 square miles. The vulnerability assessment results are for wind-related damages. Hurricanes may also cause substantial damages from heavy rains and subsequent flooding, which is addressed in Section A.5.2 Flood.

People

The very young, the elderly and disabled individuals are more vulnerable to harm from hurricanes, as are those who are unable to evacuate for medical reasons, including 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 or ongoing treatment. For all affected populations, 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.

Table A.27 details the likelihood of building damages by occupancy type from varying magnitudes of hurricane events.

Table A.27 – Likelihood of Buildings Damages Impacted by Hurricane Wind Events

Occupancy	Buildings at Risk	Value at Risk	Likelihood of Damage (%)				
			None	Minor	Moderate	Severe	Destruction
Hurricane Fran (1996)							
Agriculture	7	$1,829,000	98.49%	1.37%	0.11%	0.03%	0.00%
Commercial	362	$319,739,000	98.16%	1.68%	0.16%	0.00%	0.00%
Education	15	$50,152,000	98.63%	1.35%	0.02%	0.00%	0.00%
Government	35	$45,211,000	98.58%	1.40%	0.02%	0.00%	0.00%
Industrial	67	$43,764,000	98.56%	1.40%	0.04%	0.01%	0.00%
Religion	41	$32,493,000	98.85%	1.13%	0.02%	0.00%	0.00%
Residential	3,475	$1,511,367,000	97.64%	2.10%	0.26%	0.01%	0.01%
200-year Hurricane Event							
Agriculture	6	$1,829,000	79.65%	14.38%	4.04%	1.76%	0.18%
Commercial	298	$319,739,000	80.70%	13.94%	5.03%	0.32%	0.01%
Education	12	$50,152,000	83.25%	13.16%	3.39%	0.20%	0.00%
Government	29	$45,211,000	82.85%	13.24%	3.68%	0.23%	0.00%
Industrial	57	$43,764,000	83.25%	12.72%	3.53%	0.47%	0.03%
Religion	34	$32,493,000	83.93%	13.46%	2.49%	0.12%	0.00%
Residential	2,702	$1,511,367,000	75.93%	18.41%	5.53%	0.11%	0.02%
500-year Hurricane Event							
Agriculture	4	$1,829,000	62.43%	23.22%	9.22%	4.49%	0.64%

Occupancy	Buildings at Risk	Value at Risk	Likelihood of Damage (%)				
			None	Minor	Moderate	Severe	Destruction
Commercial	235	$319,739,000	63.57%	21.54%	13.09%	1.77%	0.03%
Education	10	$50,152,000	67.16%	20.91%	10.36%	1.57%	0.00%
Government	24	$45,211,000	67.86%	20.24%	10.34%	1.56%	0.00%
Industrial	45	$43,764,000	65.52%	20.69%	11.22%	2.43%	0.13%
Religion	27	$32,493,000	66.43%	23.53%	8.85%	1.20%	0.00%
Residential	2,083	$1,511,367,000	58.53%	28.02%	12.82%	0.50%	0.12%

Table A.28 details the estimated building and content damages by occupancy type for varying magnitudes of hurricane events.

Table A.28 – Estimated Buildings Impacted by Hurricane Wind Events

Area	Residential	Commercial	Industrial	Others	Total
Hurricane Fran (1996)					
Building	$3,904,230	$139,290	$11,390	$26,300	$4,081,210
Content	$688,990	$14,170	$1,380	$180	$704,720
Inventory	$0	$0	$290	$20	$310
Total	**$4,593,220**	**$153,460**	**$13,060**	**$26,500**	**$4,786,240**
200-year Hurricane Event					
Building	$26,552,760	$1,896,740	$207,360	$517,300	$29,174,160
Content	$4,348,350	$577,890	$96,440	$146,660	$5,169,340
Inventory	$0	$9,450	$15,630	$740	$25,820
Total	**$30,901,110**	**$2,484,080**	**$319,430**	**$664,700**	**$34,369,320**
500-year Hurricane Event					
Building	$46,618,600	$5,058,200	$707,410	$1,453,790	$53,838,000
Content	$9,424,280	$2,127,040	$447,710	$584,350	$12,583,380
Inventory	$0	$40,530	$66,900	$2,150	$109,580
Total	**$56,042,880**	**$7,225,770**	**$1,222,020**	**$2,040,290**	**$66,530,960**

The damage estimates for the 500-year hurricane wind event total $66,530,960, which equates to a loss ratio of 4.1 percent of the total building exposure. These damage estimates account for only wind impacts and actual damages would likely be higher due to flooding. As noted in Section A.5.2, four buildings and surrounding roadways are located within the 500-year floodplain. Therefore, the planning area would likely experience a higher overall loss ratio from the 500-year hurricane event and may face some difficulty recovering from such an event.

Environment

Hurricane winds can cause massive damage to the natural environment, uprooting trees and other debris within the storm's path. Animals can either be killed directly by the storm or impacted indirectly through changes in habitat and food availability caused by high winds and intense rainfall. Endangered species can be dramatically impacted. Forests can be completely defoliated by strong winds.

Changes in Development

Future development that occurs in the planning area should consider high wind hazards at the planning, engineering, and architectural design stages. The University should consider evacuation planning in the event of a hurricane event.

Problem Statement

- Historical tracks of multiple hurricane events pass within 5-miles of the ECU Campus.
- For the 20-year period from 2000 through 2019, there have been 9 hurricane wind events causing over $50 million dollars in damage for Pitt County.

A.5.5 Severe Winter Weather

Hazard	Probability	Impact	Spatial Extent	Warning Time	Duration	PRI Score
Severe Winter Weather	Highly Likely	Limited	Large	More than 24 hrs	Less than 1 week	3.0

Location

Severe winter weather is usually a countywide or regional hazard, impacting the entire county at the same time. 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. Pitt 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, severe winter weather can occur anywhere in the county.

Spatial Extent: 4 – Large

Extent

The National Oceanic and Atmospheric Administration (NOAA) uses the Regional Snowfall Index (RSI), shown in **Table A.29** for the Pitt County region, to assess the societal impact of winter storms in the six easternmost regions in the United States. The index makes use of population and regional differences to assess the impact of snowfall. For example, areas which receive very little snowfall on average may be more adversely affected than other regions, resulting in a higher severity. The County may experience any level on the RSI scale. Pitt County receives an average of 2 inches of snowfall per year. According to NCEI, the greatest snowfall amounts to impact Pitt County have been between 7-10 inches on December 26, 2010. During this snowstorm, the County was classified as a Category 1 on the RSI scale. It is possible that more severe events and impacts could be felt in the future.

Table A.29 – Regional Snowfall Index (RSI) Values

Category	RSI Value	Description
1	1-3	Notable
2	3-6	Significant
3	6-10	Major
4	10-18	Crippling
5	18+	Extreme

Source: NOAA

Severe winter weather often involves 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 A.16**, provides a formula for calculating the dangers of winter winds and freezing temperatures. This presents wind chill temperatures which are based on the rate of heat loss from exposed skin caused by wind and cold. As the wind increases, it draws heat from the body, driving down skin temperature and eventually the internal body temperature.

Figure A.16 – NWS Wind Chill Temperature Index

Wind Chill Chart

Temperature (°F)

Wind (mph)	40	35	30	25	20	15	10	5	0	-5	-10	-15	-20	-25	-30	-35	-40	-45
5	36	31	25	19	13	7	1	-5	-11	-16	-22	-28	-34	-40	-46	-52	-57	-63
10	34	27	21	15	9	3	-4	-10	-16	-22	-28	-35	-41	-47	-53	-59	-66	-72
15	32	25	19	13	6	0	-7	-13	-19	-26	-32	-39	-45	-51	-58	-64	-71	-77
20	30	24	17	11	4	-2	-9	-15	-22	-29	-35	-42	-48	-55	-61	-68	-74	-81
25	29	23	16	9	3	-4	-11	-17	-24	-31	-37	-44	-51	-58	-64	-71	-78	-84
30	28	22	15	8	1	-5	-12	-19	-26	-33	-39	-46	-53	-60	-67	-73	-80	-87
35	28	21	14	7	0	-7	-14	-21	-27	-34	-41	-48	-55	-62	-69	-76	-82	-89
40	27	20	13	6	-1	-8	-15	-22	-29	-36	-43	-50	-57	-64	-71	-78	-84	-91
45	26	19	12	5	-2	-9	-16	-23	-30	-37	-44	-51	-58	-65	-72	-79	-86	-93
50	26	19	12	4	-3	-10	-17	-24	-31	-38	-45	-52	-60	-67	-74	-81	-88	-95
55	25	18	11	4	-3	-11	-18	-25	-32	-39	-46	-54	-61	-68	-75	-82	-89	-97
60	25	17	10	3	-4	-11	-19	-26	-33	-40	-48	-55	-62	-69	-76	-84	-91	-98

Frostbite Times: 30 minutes; 10 minutes; 5 minutes

$$\text{Wind Chill (°F)} = 35.74 + 0.6215T - 35.75(V^{0.16}) + 0.4275T(V^{0.16})$$

Where, T= Air Temperature (°F) V= Wind Speed (mph)

Effective 11/01/01

Source: https://www.weather.gov/safety/cold-wind-chill-chart

The most significant recorded snow depth over the last 20 years took place in December 2010, with recorded depths of up to 10 inches across the county.

Impact: 2 – Limited

Historical Occurrences

To get a full picture of the range of impacts of a severe winter weather, data for the following weather types as defined by the National Weather Service (NWS) 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.

According to the NCEI Storm Events Database, there was one frost/freeze event, five heavy snow events, one ice storm, and 18 combined winter storm/winter weather events in Pitt County during the 20-year period from 2000 through 2019. As reported in NCEI, winter storms caused two injuries. There were not any reported fatalities, property damage, or crop damage, though these types of impacts may not have been reported and are possible in future events. Events in Pitt County by incident are recorded in **Table A.30**.

Table A.30 – Recorded Severe Winter Weather Events in Pitt County, 2000-2019

Event Type	Event Count	Fatalities	Injuries	Property Damage	Crop Damage
Frost/Freeze	1	0	0	$0	$0
Heavy Snow	5	0	0	$0	$0
Ice Storm	1	0	0	$0	$0
Winter Storm	10	0	2	$0	$0
Winter Weather	8	0	0	$0	$0
Total	**25**	**0**	**2**	**0**	**$0**

Source: NCEI

Storm impacts from NCEI are summarized below:

January 2, 2002 – The coastal plain of North Carolina experienced a one two punch of winter weather on January 2nd and again on the 3rd. Snow, sleet and freezing rain blanketed inland areas with one to two inches of accumulation late on January 2nd. Gusty winds of 20 mph on the morning of the 3rd caused numerous trees and power lines to fall casing minor damage and numerous power outages. A second snow event began on the evening of the 3rd and dropped anywhere from 4 to 8 inches of snow across the region. Snowfall rates of over 2 inches per hour were observed in many locations. Two injuries occurred in a head- on collision between two vehicles in Pitt county due to ice covered roads.

December 26, 2010 – Widespread snow developed during the early morning hours and continued into the afternoon. Total snowfall amounts across the county were in the 7 to 10 inch range.

January 28, 2014 – Snow began during the afternoon of January 28th and continued into the early morning hours of January 29th. The snow mixed with sleet and freezing rain at times. Total snow accumulations were 3 to 6 inches across the county. Roads were icy for several days during and after the event.

Pitt County received two FEMA Major Disaster Declarations for a severe ice storm in 1968 and a blizzard in 1996.

Probability of Future Occurrence

NCEI records 25 severe winter weather related events during the 20-year period from 2000 through 2019, which equates to an annual probability greater than 100%. Therefore, the overall probability of severe winter weather in the county is considered highly likely (near or more than 100% annual probability).

Probability: 4 – Highly Likely

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.

The loss of use estimates provided in **Table A.31** were calculated using FEMA's publication *What is a Benefit?: Guidance on Benefit-Cost Analysis of Hazard Mitigation Project*, June 2009. These figures are used to provide estimated costs associated with the loss of power in relation to the populations served on campus. The loss of use is provided in the heading as the loss of use cost per person per day of loss. The estimated loss of use provided for the campus represents the loss of service of the indicated utility for one day for 10 percent of the population. These figures do not take into account physical damages to utility equipment and infrastructure. The estimated on-campus population used in the table below was determined by taking 25% of the current enrollment for ECU, which is 28,651 students.

Table A.31 – Loss of Use Estimates for Power Failure Associated with Severe Winter Weather

Estimated On-Campus Population (Fall 2020)	Estimated Affected Population (10%)	Electric Loss of Use Estimate ($126 per person per day)
7,163	716.3	$90,254

Property

No property damage was reported in association with any winter weather events recorded by the NCEI between 2000 and 2019 for Pitt County. Therefore, no annualized loss estimate could be calculated for this hazard.

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.

Changes in Development

Future development could potentially increase vulnerability to this hazard by increasing demand on the utilities and increasing the exposure of infrastructure networks. ECU may wish to consider developing a flexible emergency power network to provide efficient back-up power for vulnerable populations, critical facilities, and research facilities.

Problem Statement

- Severe winter weather events are highly likely for Pitt County and the ECU campus. The events have also resulted in two presidential disaster declarations for the County.

A.5.6 Tornadoes/Thunderstorms

Hazard	Probability	Impact	Spatial Extent	Warning Time	Duration	PRI Score
Tornado/Thunderstorm	Likely	Critical	Large	Less than 6 hrs	Less than 6 hrs	3.1

Location

Thunderstorm wind, lightning, and hail events do not have a defined vulnerability zone. The scope of lightning and hail is generally confined to the footprint of its associated thunderstorm. Although these events occur similarly throughout the planning area, they are more frequently reported in more urbanized areas because damages are more likely to occur where exposure is greater in more densely developed urban areas.

Thunderstorm Winds

The entirety of ECU's campus can be affected by severe weather hazards. Thunderstorm wind events can span many miles and travel long distances, covering a significant area in one event. Due to the small size of the planning area, any given event will impact the entire planning area, approximately 50% to 100% of the planning area could be impacted by one event.

Spatial Extent: 4 – Large

Lightning

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 ECU is exposed to lightning.

Spatial Extent: 4 – Large

Hail

Hailstorms frequently accompany thunderstorms, so their locations and spatial extents coincide. However, large-scale hail tends to occur in a more localized area within the storm.

Spatial Extent: 4 – Large

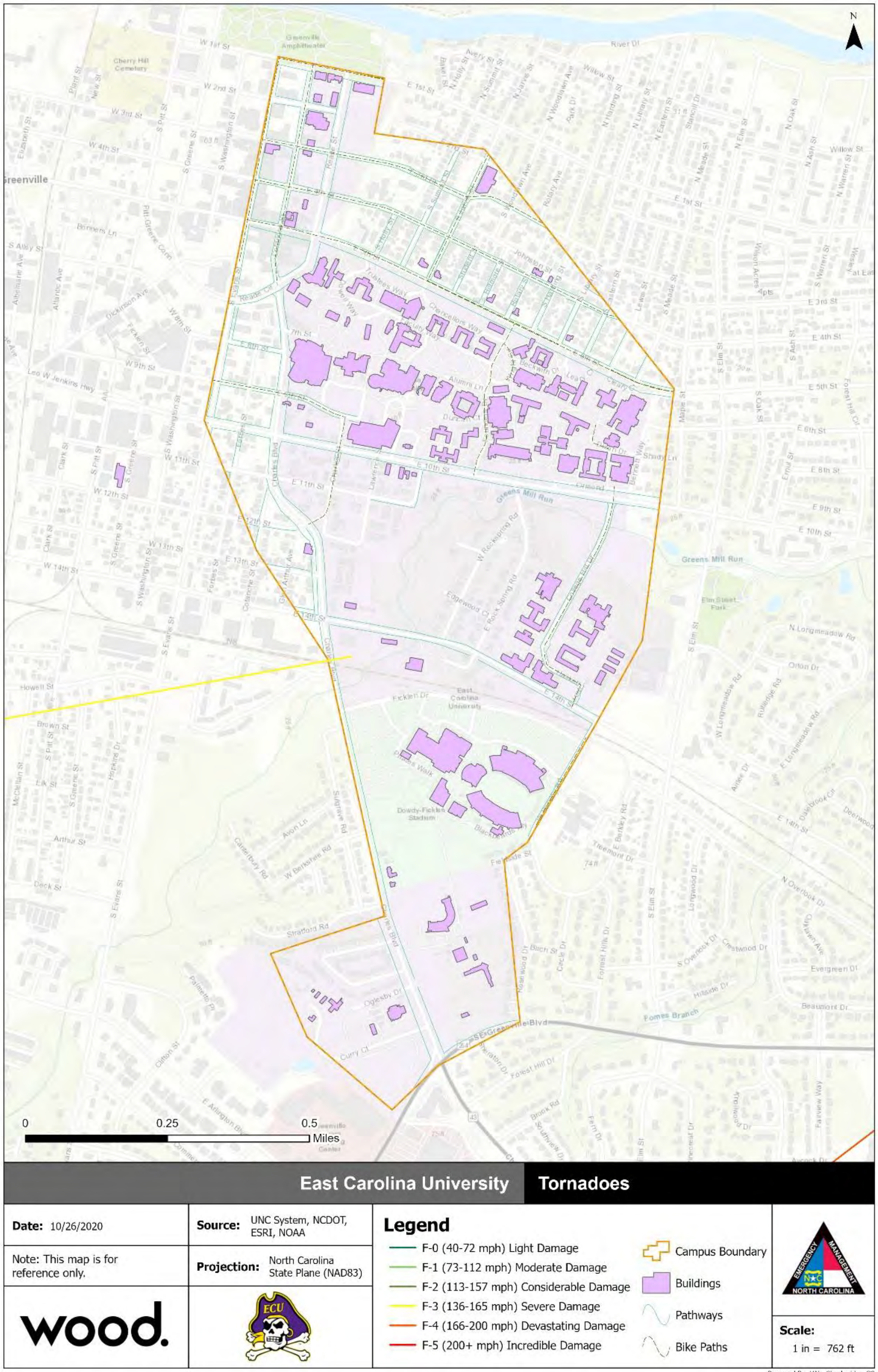
Tornado

Figure A.17 reflects the tracks of past tornados that intersected the ECU campus from 2000 through 2019 according to data from the NOAA/National Weather Service Storm Prediction Center.

Tornados can occur anywhere on ECU's campus. Tornadoes typically impact a small area, but damage may be extensive. Tornado locations are completely random, meaning risk to tornado is not increased in one area of the campus versus another. All of ECU is exposed to this hazard.

Spatial Extent: 4 – Large

Figure A.17 – Tornado Paths Intersecting the ECU Campus, 2000-2019



Extent

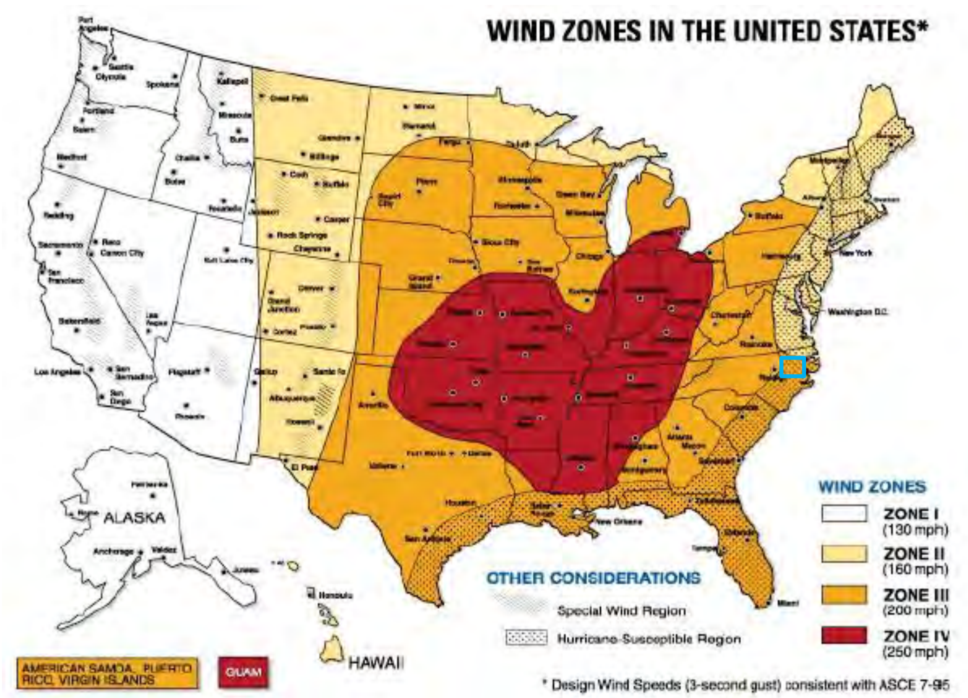
Thunderstorm Winds

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.

Figure A.18 shows wind zones in the United States. Pitt County, indicated by the blue square, is within Wind Zone III, which indicates that speeds of up to 200 mph may occur within the county.

Figure A.18 – Wind Zones in the United States



Source: FEMA 320, Taking Shelter from the Storm, 3rd edition, https://www.fema.gov/pdf/library/ism2_s1.pdf

The strongest recorded thunderstorm wind event for Greenville occurred on July 1, 2012 with a measured gust of 65 mph. The event reportedly did not cause any property damages and resulted in no fatalities, injuries, or crop damages.

Impact: 2 – Limited

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, shown in **Table A.32**, is a common parameter that is part of fire weather forecasts nationwide.

Table A.32 – 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

Hail

The National Weather Service classifies hail by diameter size, and corresponding everyday objects to help relay scope and severity to the population. **Table A.33** indicates the hailstone measurements utilized by the National Weather Service.

Table A.33 – 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
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 A.34** describes typical intensity and damage impacts of the various sizes of hail.

Table A.34 – 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 damaged
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 2000 and 2019 in Greenville was a little over 1" in diameter; the largest hailstone recorded was 1.75", recorded on June 6, 2006, March 28, 2007, April 20, 2009, and August 29, 2011.

Impact: 1 – Minor

Tornado

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 and better correlation between damage and wind speed. It is also more precise because it considers the materials affected and the construction of structures damaged by a tornado. **Table A.35** shows the wind speeds associated with the enhanced Fujita scale ratings and the damage that could result at different levels of intensity.

Table A.35 – 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.

EF Number	3 Second Gust (mph)	Damage
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 directly through Greenville in the past 20 years was an F0 on June 4, 2004. NCEI reports this event causing no property or crop damage, and narratives of the event approximate damage to a few power lines. The tornado was 0.1 miles long and 25 yards wide.

Impact: 3 – Critical

Historical Occurrences

Thunderstorm Winds

Between January 1, 2000 and December 31, 2019, the NCEI recorded wind speeds for 21 separate incidents of thunderstorm winds, occurring on 16 separate days, for Greenville. These events caused $21,000 in recorded property damage and no injuries or fatalities. The recorded gusts averaged 54.4 miles per hour, with the highest gusts recorded at 65 mph on July 1, 2012. Of these events, two caused property damage. Wind gusts with property damage recorded averaged $10,500 in damage, with the highest reported damage being $20,000 on May 27, 2000. These incidents are aggregated by the date the events occurred and are recorded in **Table A.36**.

Table A.36 – Recorded Thunderstorm Winds, Greenville, 2000-2019

Location	Date	Wind Speed (mph)	Fatalities	Injuries	Property Damage
GREENVILLE	5/27/2000	N/A	0	0	$20,000
GREENVILLE	5/26/2001	61	0	0	$0
GREENVILLE	5/13/2002	52	0	0	$0
GREENVILLE	11/11/2002	52	0	0	$1,000
GREENVILLE	7/10/2003	50	0	0	$0
GREENVILLE	7/11/2003*	50	0	0	$0
GREENVILLE	1/14/2006	52	0	0	$0
GREENVILLE	4/3/2006	55	0	0	$0
GREENVILLE	1/7/2009	50	0	0	$0
GREENVILLE	4/5/2011	50	0	0	$0
GREENVILLE	6/23/2011	50	0	0	$0
GREENVILLE	7/1/2012*	65	0	0	$0
GREENVILLE	4/30/2014	52	0	0	$0
GREENVILLE	2/16/2016	52	0	0	$0
GREENVILLE	6/22/2016*	50	0	0	$0
GREENVILLE	7/6/2017	62	0	0	$0
		Total	**0**	**0**	**$21,000**

Source: NCEI

*Note: Multiple events occurred on these dates. Injuries, fatalities, and property damage are totaled, wind speed is highest reported.

The State of North Carolina received one FEMA Major Disaster Declaration in 1956 for severe storms included heavy rains and high winds. Additionally, Pitt County received two FEMA Major Disaster Declarations in 2010 and 2011 for severe storms with straight line winds.

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

May 27, 2000 – A roof was blown off a house just south of Greenville.

July 1, 2012 – Public reported a 10 by 20 barn destroyed by strong winds.

June 22, 2016 – Strong winds blew down a four foot by eight foot sign on Greenville Blvd in Greenville. Strong winds also blew down a tree near Arlington Blvd in Greenville.

Lightning

According to NCEI data, there were three lightning strikes reported between 2000 and 2019. These events caused $151,000 in property damage and no fatalities, injuries, or crop damage. 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. These lightning strike events averaged $50,333 in damage, with the highest reported damage being $100,000 on August 15, 2002. **Table A.37** details NCEI-recorded lightning strikes from 2000 through 2019 for Greenville.

Table A.37 – Recorded Lightning Strikes in Greenville, 2000-2019

Location	Date	Time	Fatalities	Injuries	Property Damage
GREENVILLE	7/27/2002	1730	0	0	$1,000
GREENVILLE	8/15/2002	1900	0	0	$100,000
GREENVILLE	7/29/2010	1430	0	0	$50,000
		Total	**0**	**0**	**$151,000**

Source: NCEI

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

August 15, 2002 – Lightning struck a Pitt County Office Building main transformer and caused substantial damage to the building and electronics.

July 29, 2010 – House caught on fire and burned after lightning strike.

Hail

Between January 1, 2000 and December 31, 2019, the NCEI recorded 27 separate hail incidents, occurring on 20 separate days, for Greenville. These events caused $50,000 in recorded property damage, $300,000 in recorded crop damage, and no injuries or fatalities. The largest diameter hail recorded in the City was 1.75 inches, which occurred on four separate occasions: June 6, 2006, March 28, 2007, April 20, 2009, and August 29, 2011. The average hail size of all events in the City was just over one inch in diameter. **Table A.38** summarizes hail events for Greenville. In some cases, hail was reported for multiple locations on the same day.

Table A.38 – Summary of Hail Occurrences in Greenville

Beginning Location	Date	Hail Diameter
GREENVILLE	8/13/2000	1.25
GREENVILLE	5/26/2001	0.75
GREENVILLE	7/4/2002*	0.88
GREENVILLE	7/5/2002	1
GREENVILLE	7/10/2002	0.75

Beginning Location	Date	Hail Diameter
GREENVILLE	5/22/2004	0.75
GREENVILLE	8/3/2005	1
GREENVILLE	4/3/2006	0.75
GREENVILLE	6/6/2006	1.75
GREENVILLE	7/29/2006	0.75
GREENVILLE	3/28/2007	1.75
GREENVILLE	5/12/2007	0.75
GREENVILLE	4/20/2008	0.75
GREENVILLE	4/20/2009*	1.75
GREENVILLE	6/26/2009	0.75
GREENVILLE	8/29/2011	1.75
GREENVILLE	5/23/2012*	1
GREENVILLE	2/24/2016	1.25
GREENVILLE	6/22/2016	0.75
GREENVILLE	5/31/2019	1

Source: NCEI

*Note: Multiple events occurred on these dates. Hail diameter is highest reported for that specific date.

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

March 28, 2007 – Spotters, media and public reported golf ball sized hail in Greenville that lasted 5 to 10 minutes.

August 29, 2011 – Golf ball size hail reported near Highway 43 and Highway 264 near Greenville.

February 24, 2016 – Report of half dollar size hail in Greenville.

Tornado

NCEI storm reports were reviewed from 2000 through 2019 to assess whether recent trends varied from the longer historical record. According to NCEI, Greenville experienced one tornado incident between 2000 and 2019, causing no injuries, fatalities, property damage or crop damage. It is likely that there have been several tornados that occurred but went unreported. **Table A.39** shows historical tornadoes in Greenville during this time.

Table A.39 – Recorded Tornadoes in Greenville, 2000-2019

Beginning Location	Date	Time	Magnitude	Deaths	Injuries	Property Damage	Crop Damage
GREENVILLE	6/4/2004	1309	F0	0	0	$0	$0

Source: NCEI

Pitt County received two FEMA Major Disaster Declarations in 1984 and 2011 for severe storms with tornadoes.

Narratives from NCEI illustrate that damage occurred in many of these incidents even if a monetary value was not recorded. Specific incidents for Greenville and surrounding areas include:

May 9, 2008 – Brief tornado touchdown with damage to power lines near Belvoir Crossroads.

April 25, 2014 –Trained spotter observed a tornado briefly touch down about 5 miles west of Greenville. There was no observed damage.

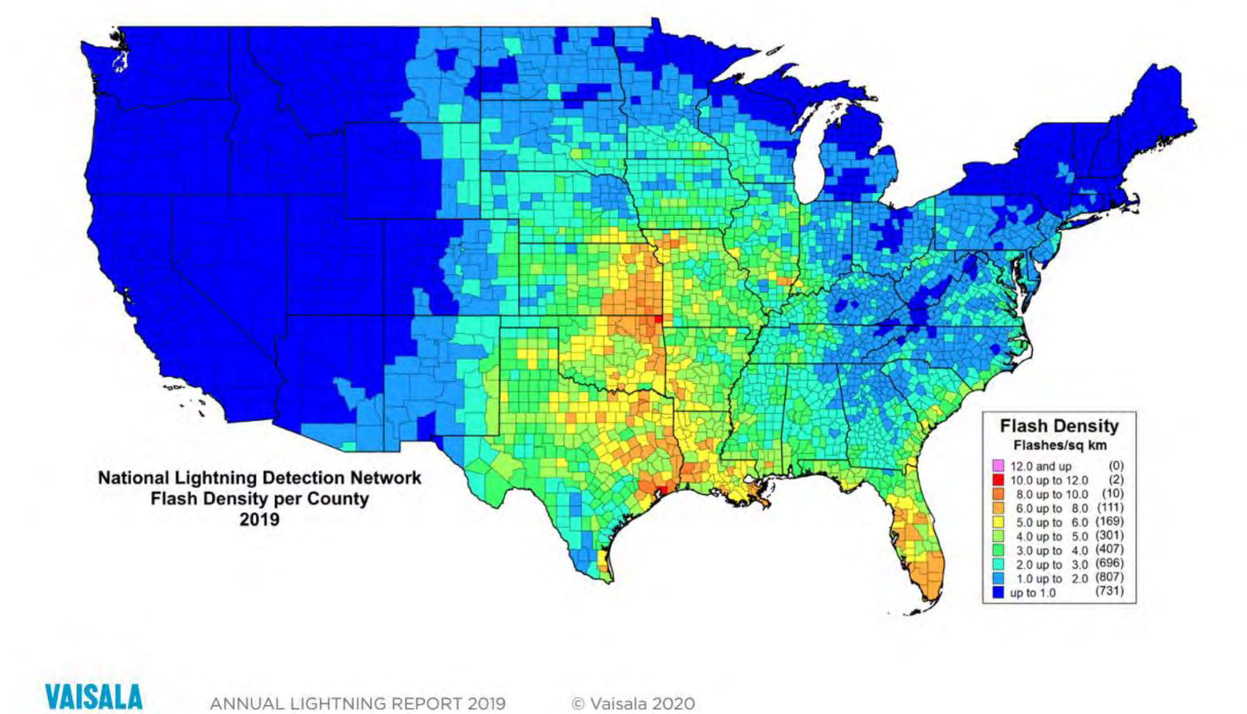
Probability of Future Occurrence

Based on historical occurrences recorded by NCEI for the 20-year period from 2000 through 2019, Greenville averages 0.8 days with wind events per year. Over this same period, three lightning events were reported as having caused death, injury, or property damage, which equates to an average of 0.15 damaging lightning strikes per year.

The average hail storm in Greenville occurs in the evening and has a hail stone with a diameter of just over one inch. Over the 20-year period from 2000 through 2019, Greenville experienced 20 days with reported hail incidents; this averages to 1 day per year with reported incidents somewhere in the planning area.

Based on the Vaisala 2019 Annual Lightning Report, North Carolina experienced 3,641,417 documented cloud-to-ground lightning flashes. According to Vaisala's flash density map, shown in **Figure A.19**, Pitt County is located in an area that experiences up to 1 lightning flashes per square kilometer per year. It should be noted that future lightning occurrences may exceed these figures.

Figure A.19 – Lightning Flash Density per County (2019)



Source: Vaisala

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

In a 20-year span between 2000 and 2019, Greenville experienced one tornado incident. This correlates to a 5 percent annual probability that the City will experience a tornado somewhere in its boundaries. This past tornado event was a magnitude F0; therefore, the annual probability of a significant tornado event is highly unlikely.

Based on these historical occurrences, there is between a 10% to 100% chance that Greenville will experience severe weather each year. The probability of a damaging impacts is likely.

Probability: 3 – Likely

Vulnerability Assessment

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. Since 2000, NCEI records reported no injuries attributed to lightning strikes in Greenville, but NCEI reported five injuries occurring in surrounding areas, so future occurrences of injuries due to lightning strikes are still possible.

Similar to the loss of use estimates provided for Severe Winter Weather, the loss of use estimates for a tornadoes/thunderstorms were estimated as $90,254 per day, assuming 10-percent of the on-campus population is impacted.

Table A.40 – Loss of Use Estimates for Power Failure Associated with Severe Winter Weather

Estimated On-Campus Population (Fall 2020)	Estimated Affected Population (10%)	Electric Loss of Use Estimate ($126 per person per day)
7,163	716.3	$90,254

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 2018 American Community Survey (ACS) 5-Year Estimates, 544 occupied housing units (1.3 percent) in Greenville are classified as "mobile homes". Using the 2018 ACS average persons per household estimate of 2.51, the population at risk due to their housing type was estimated at 1,365 residents within Greenville. Individuals who work outdoors may also face increased risk.

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. Therefore, the estimated 1,365 residents mentioned above residing in mobile homes in Greenville are also at a greater risk to tornado damage due to their housing type.

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 Greenville, two of the events with significant recorded property damage was due to both property damages by fire and secondary impacts due to lightning striking a transformer.

NCEI records lightning impacts over 20 years (2000-2019), with $151,000 in property damage recorded throughout three separate events occurring in 2002 and 2010. Based on these records, the planning area experiences an annualized loss of $7,550 in property damage. The average impact from lightning per incident in Greenville is $50,333.

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, 2000 and December 31, 2019 in Greenville, NCEI reported $50,000 in property damage and $300,000 in crop damage as a direct result of hail. This damage was from only two storms.

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 Greenville, thus the NCEI is still used to form a baseline.

Wind events reported in NCEI for the 20-year period from 2000 through 2019 totaled $21,000 in property damage, which equates to an annualized loss of $1,050 across the planning area.

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.

NCEI data has no record of documented property or crop damages for the historical tornado event in Greenville. There have been recorded property damages up to $1,000,000 for surrounding areas, so the potential for direct and indirect property damages by tornadoes for Greenville exists.

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.

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.

Changes in Development

Future development projects should consider severe thunderstorms hazards and tornado and high wind hazards at the planning, engineering and architectural design stage with the goal of reducing vulnerability. University buildings with high occupancies should consider inclusion of a tornado shelters to accommodate occupants in the event of a tornado. Future development will also affect current stormwater drainage patterns and capacities.

Problem Statement

- The strongest recorded thunderstorm wind event for Greenville occurred on July 1, 2012 with a measured gust of 65 mph. The event reportedly did not cause any property damages.
- The average hailstone size recorded between 2000 and 2019 in Greenville was a little over 1” in diameter; the largest hailstone recorded was 1.75”, recorded on June 6, 2006, March 28, 2007, April 20, 2009, and August 29, 2011.
- Greenville experienced one tornado incident between 2000 and 2019, causing no property damage.
- Thunderstorms and tornadoes are frequent hazard events in Pitt County and the ECU campus. Reported damages for the 20-year period from 2000-1019 within Greenville include $21,000 for thunderstorm winds, $151,000 for lightning strikes. Additionally, around reported damages include around $1,000,000 for tornado events for the same 20-year period that have occurred in other jurisdictions within the County.

A.5.7 Wildfire

Hazard	Probability	Impact	Spatial Extent	Warning Time	Duration	PRI Score
Wildfire	Possible	Limited	Large	More than 24 hrs	More than 1 week	2.5

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 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. Over 40% of the ECU campus falls outside the WUI. **Table A.41** details the WUI acreage in the ECU campus, and **Figure A.20** below shows the WUI areas. On a county level, the outer perimeter of Pitt County is predominately classified as non-WUI vegetated with very little to no housing density. Central Pitt County is classified as non-vegetated or agriculture with large pockets of WUI interface and intermix areas and medium to high density housing in the agricultural areas.

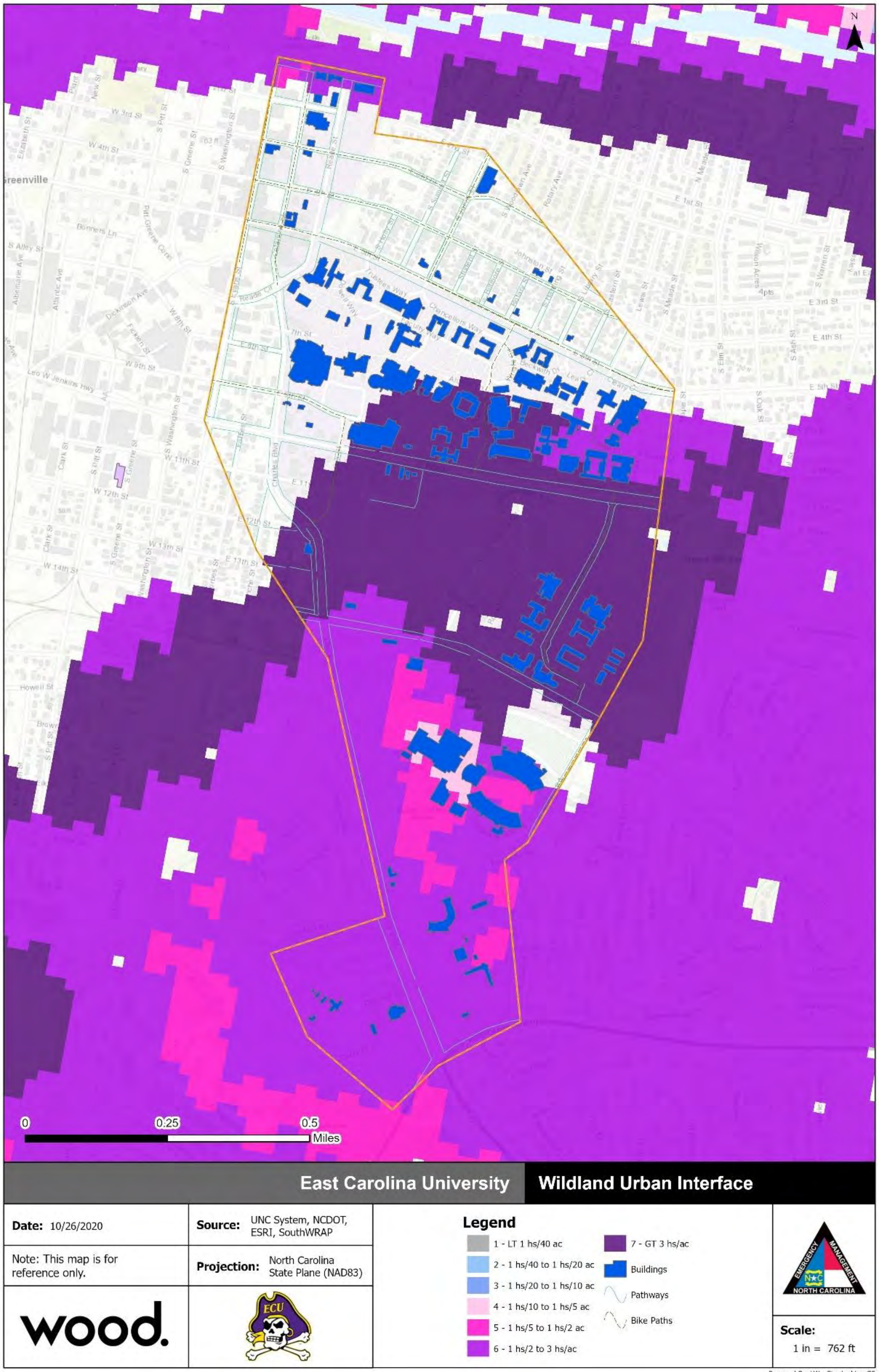
Table A.41 – Wildland Urban Interface, Population and Acres

	Housing Density	WUI Acres	Percent of WUI Acres
	Not in WUI	*228*	*40.2%*
	LT 1hs/40ac	0	0.0%
	1hs/40ac to 1hs/20ac	0	0.0%
	1hs/20ac to 1hs/10ac	0	0.0%
	1hs/10ac to 1hs/5ac	6	1.1%
	1hs/5ac to 1hs/2ac	26	4.6%
	1hs/2ac to 3hs/1ac	138	24.4%
	GT 3hs/1ac	168	29.7%
	Total	**566**	**--**

Source: Southern Wildfire Risk Assessment

Spatial Extent: 4 – Large

Figure A.20 – Wildland Urban Interface Areas, ECU



Extent

The entire state is at risk to a wildfire occurrence. However, several factors such as drought conditions or high levels of fuel on the forest floor may make a wildfire more likely in certain areas. 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, shown in **Table A.42**, consists of five classes, as defined by Southern Wildfire Risk Assessment. **Figure A.21** shows the potential fire intensity within the WUI across East Carolina University.

Table A.42 – 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

The majority of the campus (82.7%) is rated non-burnable on the Potential Fire Intensity scale. Only about 1.4 percent, of ECU's campus may experience a Class 4 or higher Fire Intensity, which poses significant harm or damage to life and property; these small areas with greatest potential fire intensity are within the WUI. An additional 3.5 percent of the campus 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 planning area (12.4%) would face a Class 1 or Class 2 Fire Intensity, which are easily suppressed.

The WUI Risk Index is used to rate the potential impact of a wildfire on people and their homes. It reflects housing density (per acre) consistent with Federal Register National standards. The WUI Risk Index ranges of values from -1 to -9, with -1 representing the least negative impact and -9 representing the most negative impact. **Figure A.22** maps the WUI Risk Index for ECU. The WUI areas within the campus of ECU range from -5 to -8 on the WUI Risk Index.

Impact: 2 – Limited

Figure A.21 – Characteristic Fire Intensity, ECU

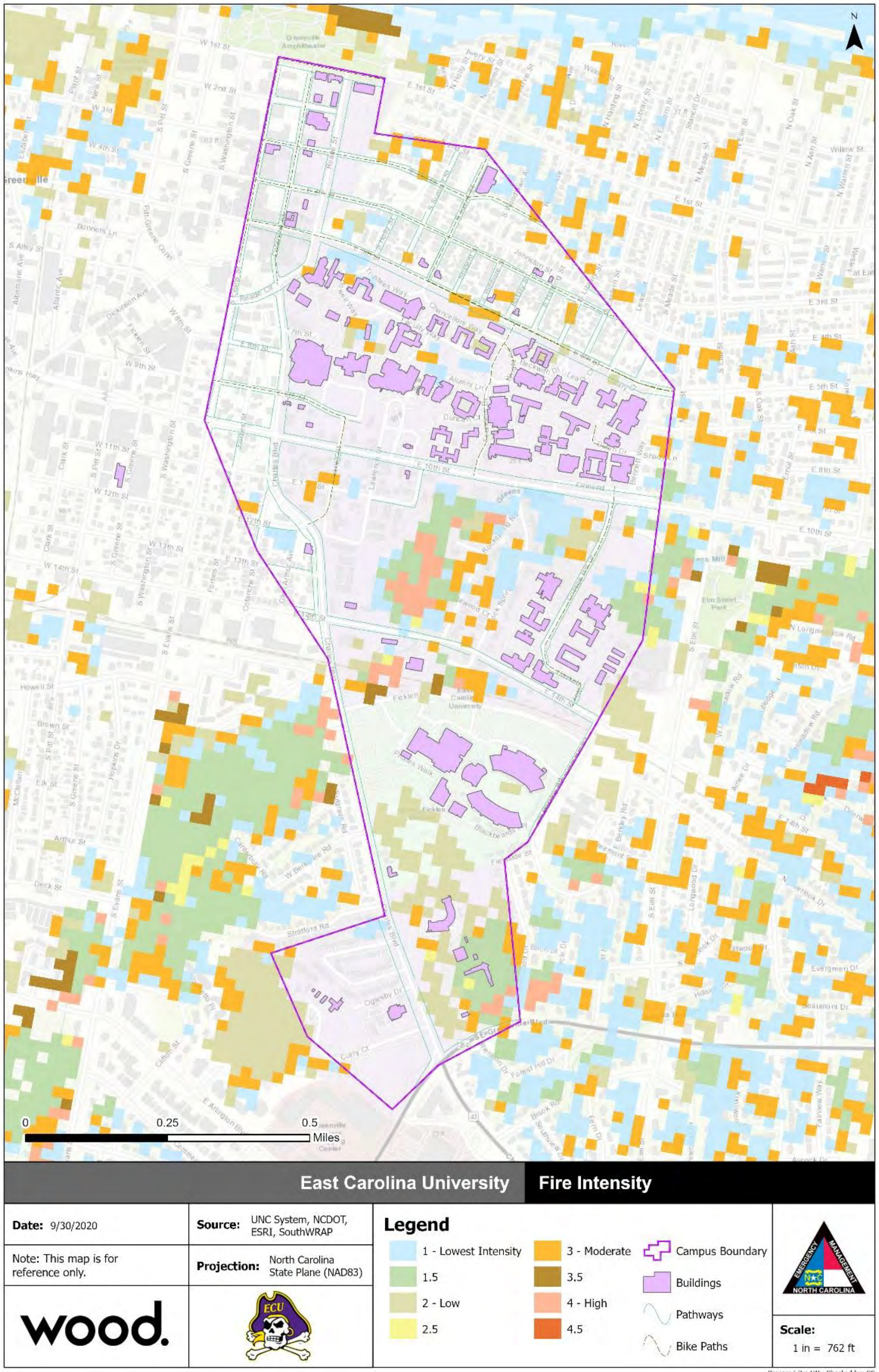
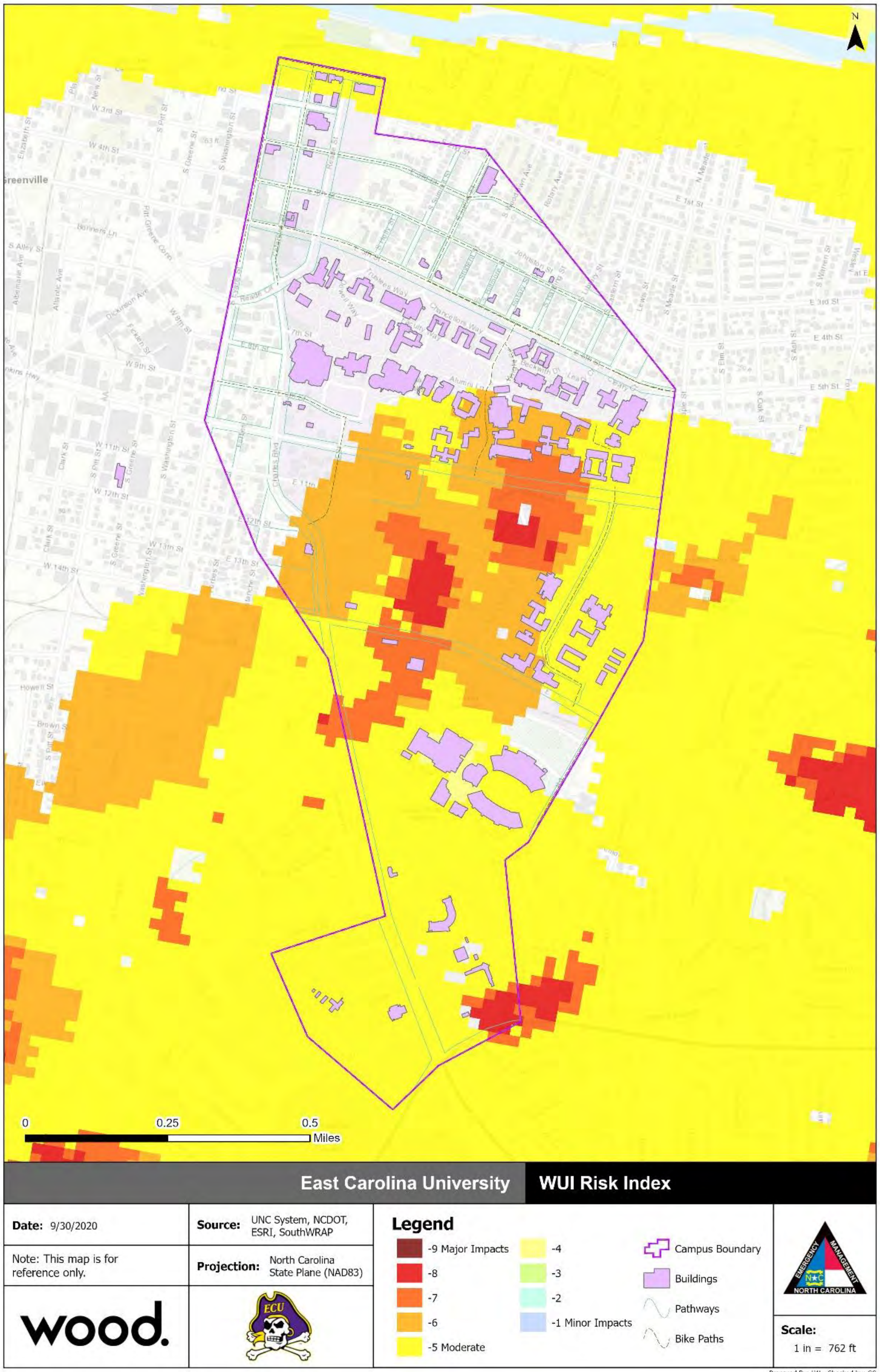


Figure A.22 – WUI Risk Index, ECU



Historical Occurrences

According to the North Carolina Forest Service (NCFS), there were 402 noted wildfires within Pitt County between 1999 and 2018. The total acreage burned during this period was 2,060 acres. There were no additional data records regarding specific communities or school districts within Pitt County. The data is from NCFS records only and may not include data on fires burned within jurisdictional limits that did not require NCFS assistance to suppress. Actual number of fires and acreage burned may be higher than what is reported here.

On average, Pitt County experiences 20.1 fires and 103 acres burned annually from fires reported by the NCFS. Based on these records, the average wildfire event can be calculated as 5.12 acres. Actual number of fires and acreage burned is likely higher because smaller fires within jurisdictional boundaries are managed by local fire departments. The most known cause was noted as debris. Machine use and children were the next leading causes following debris burning.

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 East Carolina University is detailed in **Table A.43** illustrated in **Figure A.23**.

Table A.43 – Burn Probability, ECU

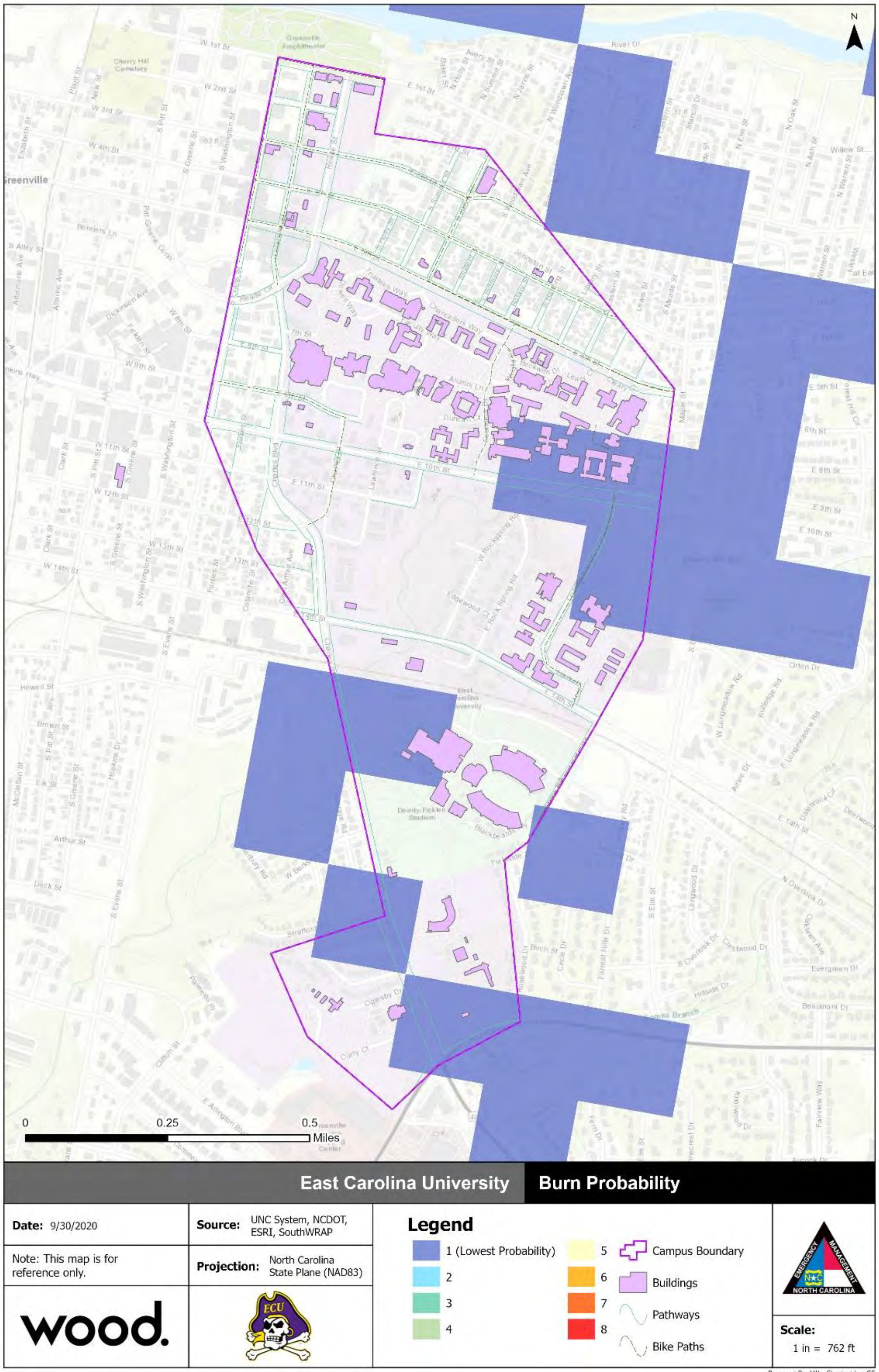
	Class	Acres	Percent
	No probability	*473*	*83.5%*
	1	93	16.5%
	2	0	0.0%
	3	0	0.0%
	4	0	0.0%
	5	0	0.0%
	6	0	0.0%
	7	0	0.0%
	8	0	0.0%
	9	0	0.0%
	10	0	0.0%
	Total	**566**	--

Source: Southern Wildfire Risk Assessment

A limited portion of the campus is located within an area defined as Class 1 having the lowest probability. Located within this low burn probability area are the Science and Technology Building, Howell Science Complex, Bate Building, Rawl Building and Annex, Austin Building, Croatan, Christenbury Memorial Gym, Brewster Building, Fletcher Music Center, Minges Coliseum, Ward Sports Medicine Building, Belk Building, Joyner Stadium, Buildings 123 and 158, and the critical facility, Jones Residence Hall.

Probability: 2 – Possible

Figure A.23 – Burn Probability, ECU



Vulnerability Assessment

People

Wildfire can cause fatalities and human health hazards. Ensuring procedures are in place for rapid warning and evacuation are essential to reducing vulnerability.

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.

Using the Wildland Urban Interface Risk Index (WUIRI) from the Southern Wildfire Risk Assessment, a GIS analysis was used to estimate the exposure of buildings most at risk to loss due to wildfire. The WUIRI shows a rating of the potential impact of wildfire on homes and people. This index ranges from 0 to -9, where lower values are relatively more severe. **Table A.44** summarizes the number of buildings and their total value that fall within areas rated -5 or less on the WUIRI. This table represents potential risks and counts every building within the area rated under -5, actual damages in the event of a wildfire may differ.

Table A.44 – Building Counts and Values within WUIRI under -5

Jurisdiction	Buildings at Risk	Structure Value
Administration	2	$7,029,118
Critical Facilities	3	$40,570,872
Extracurricular/Educational	25	$401,791,674
Housing	6	$166,280,183
Total	**36**	**$615,671,847**

Source: GIS Analysis, Southern Wildfire Risk Assessment

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.

Changes in Development

Growth on the ECU campus within the wildland-urban interface area will increase the vulnerability of people, property, and infrastructure to wildfires. Although a wildfire community protection plan exists for the state of North Carolina, there are no community wildfire protection plans and no wildfire mitigation review requirements or regulations for development in the wildland-urban interface in Pitt County.

Problem Statement

- Approximately 32 percent of all buildings on the ECU campus fall within areas rated -5 or lower on the WUI Risk Index; this includes 3 of ECU's identified critical facilities.

A.5.8 Cyber Threat

Hazard	Probability	Impact	Spatial Extent	Warning Time	Duration	PRI Score
Cyber Threat	Possible	Critical	Large	Less than 6 hrs	More than 1 week	3.1

Location

Cyber disruption events can occur and/or impact virtually any location in the state where computing devices are used. Incidents may involve a single location or multiple geographic areas. A disruption can have far-reaching effects beyond the location of the targeted system; disruptions that occur far outside the region can still impact people, businesses, and institutions within the region.

On the ECU campus, the Information Security division of Information Technology Services (ITS) is responsible for safeguarding the confidentiality, integrity, and availability of all information processed, stored or transmitted using university electronic resources while also taking proactive measures to counter threats, vulnerabilities and cyber-attacks. The University's critical applications require passwords for access. Modifications of the application software are protected from abuse by an electronic software control procedure. Information security is managed and controlled in accordance with the university's Information Security Policy.

Spatial Extent: 4 – Large

Extent

The extent or magnitude/severity of a cyber disruption event is variable depending on the nature of the event. A disruption affecting a small, isolated system could impact only a few functions/processes. Disruptions of large, integrated systems could impact many functions/processes, as well as many individuals that rely on those systems.

There is no universally accepted scale to quantify the severity of cyber-attacks. The strength of a DDoS attack is sometimes explained in terms of a data transmission rate. One of the largest DDoS disruptions ever, which brought down some of the internet's most popular sites on October 21, 2016, peaked at 1.2 terabytes per second.

Data breaches are often described in terms of the number of records or identities exposed. With the amount of data retained by universities – including student, staff, and faculty personal information as well as research data – a data breach on the ECU campus could cause significant disruption and impact a large number of records.

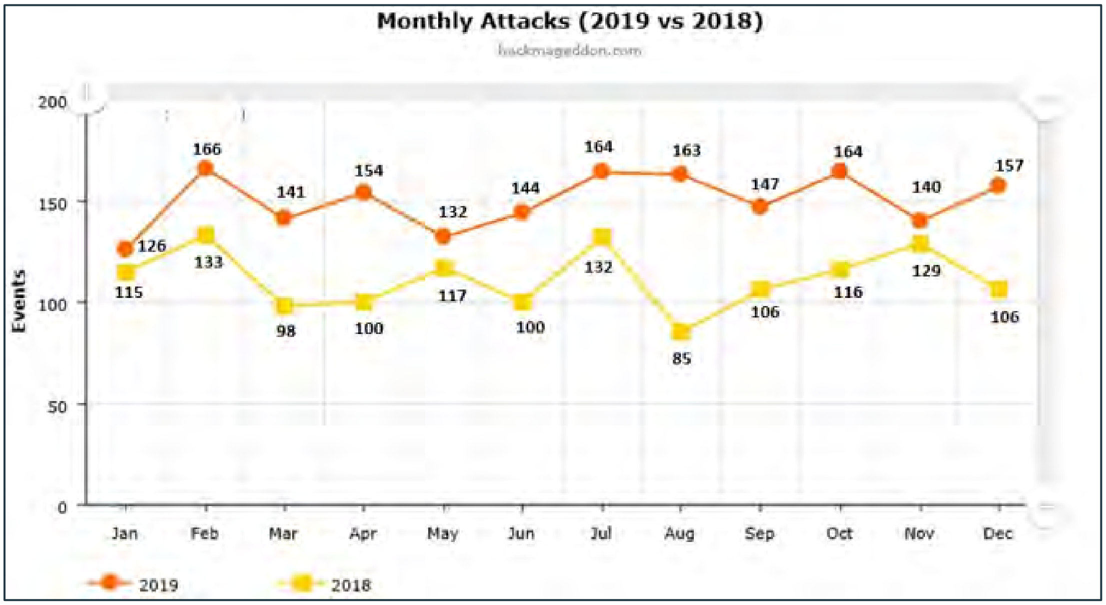
Impact: 3 – Critical

Historical Occurrences

As cyber disruption is an emerging hazard, the reporting and tracking of disruptive events is difficult. In most cases, it is not required to report an event, and when it is reported most of the information is protected due to the sensitive nature of the systems that have been disrupted. However, there currently exists several complex databases that track cyber disruption occurrences. Each system makes use of its own definitions and tracking methods. Hackmageddon is one online source that tracks Cyber Attack Statistics. Hackmageddon was developed by Paolo Passeri, an expert in the computer security industry for more than 15 years and current Principal Sales Engineer at OpenDNS (now part of Cisco). The timelines collect the major cyber events of the related months chosen among events published by open sources (such as blogs or news sites). It should be noted that this database collects cyber-attacks worldwide and this data is provided to show how this hazard is trending in general. During 2019, this database collected reports of a total of 1,802 cyber-attacks.

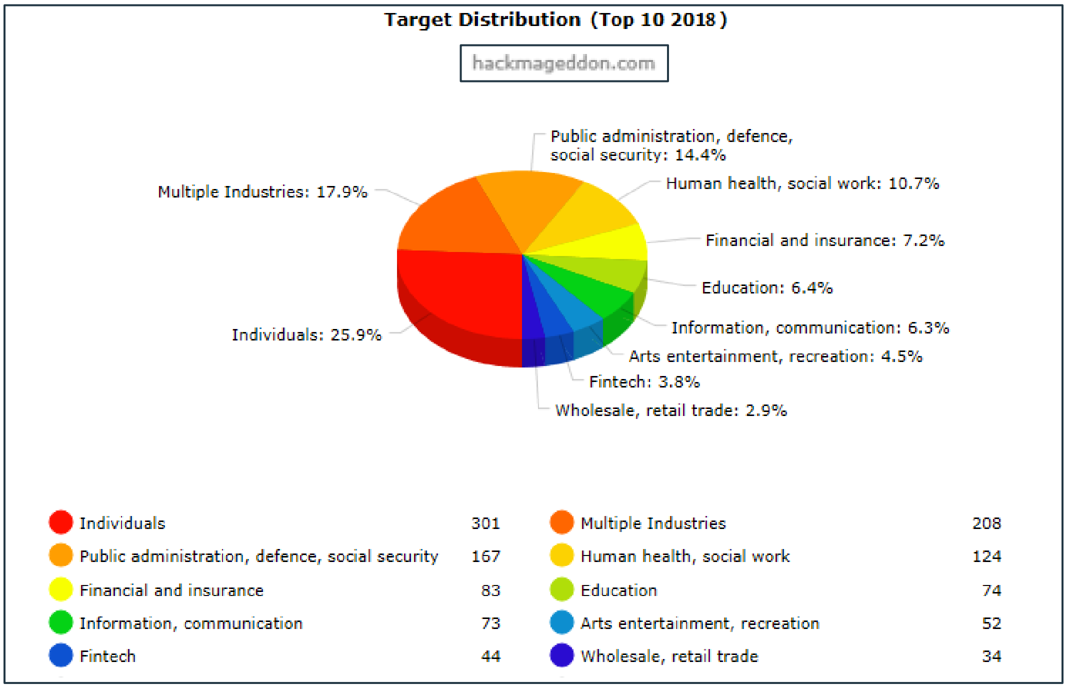
The graphic in **Figure A.24** provides a comparison of the number of attacks collected during 2018 and 2019. The two following images in **Figure A.25** and **Figure A.26** shows the top 10 target distributions for 2018 and 2019. The main finding from the top 10 attack techniques is the percentage of 'other' targeted attacks appearing at 14.1% in 2019. Attacks targeted towards Education slightly increased from 6.4% in 2018 to 7.1% in 2019. Most other target distributions experienced a percentage decrease in 2019. Some of this is probably due to the difference in distribution categories between 2018 and 2019.

Figure A.24– Comparison of Monthly Attacks Collected by Hackmageddon (2018-2019)



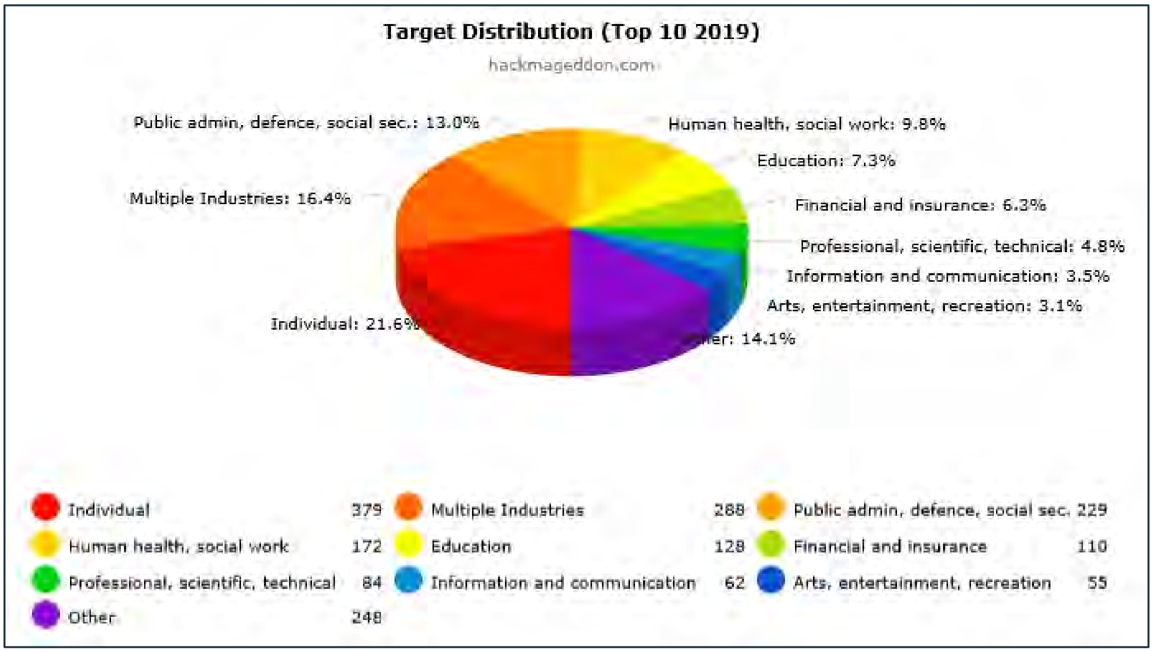
Source: Hackmageddon, https://www.hackmageddon.com/2020/01/23/2019-cyber-attacks-statistics/

Figure A.25 – Top 10 Cyber Attack Target Distributions, 2018



Source: Hackmageddon

Figure A.26 – Top 10 Cyber Attack Target Distributions, 2019



Source: Hackmageddon

There have been some notable disruption events within the Education target distribution that attained national attention in the last few years:

August 2020, The University of North Carolina Wilmington's Division of University Advancement (DUA) was hacked by a ransomware attack. The data included names, addresses, phone numbers, email addresses, and history of gifts made to UNCW; the University reported that no vulnerable financial or personal information was included. (https://portcitydaily.com/story/2020/08/06/uncw-reports-ransomware-attack-hackers-accessed-personal-details-but-no-financial-info/)

November 2019, The University of North Carolina Chapel Hill School of Medicine reported over 3,500 individuals having private information stolen in phishing cyber-attack, (https://www.databreaches.net/the-university-of-north-carolina-chapel-hill-school-of-medicine-notifying-patients-after-2018-phishing-incident/).

October 2019, Randolph Community College's entire computer network and other devices were compromised following cyberattack. In total, 1,200 devices were affected during the two week attack, (https://www.yourdailyjournal.com/news/89334/report-rcc-cyber-attack-was-first-successful-of-this-scale-at-nc-community-college).

December 2018, The Cape Cod Community College notifies its employees that Hackers stole more than $800,000 when they infiltrated the school's bank accounts, (https://www.databreaches.net/hackers-steal-800000-from-cape-cod-community-college/).

September 2018, The Henderson school district in Texas is hit with a business email compromise (BEC) attack resulting in a $600,000 loss for the district. The attack took place on September, 26th, (https://www.scmagazine.com/home/security-news/bec-attack-scamstexas-school-district-out-of-600000/).

April 2018, Partial social security numbers of more than 1,200 employees at Irvington schools are distributed via email to an unknown number of recipients by an unidentified attacker, (https://www.databreaches.net/hacker-sent-email-with-1200-partial-social-security-numbers-to-school-staff/).

March 2018, Florida Virtual Learning School notifies 368,000 current and former students, after an individual with the moniker $2a$45 uploads information of 35,000 students on a forum. Leon County Schools is among the affected organizations, (https://www.databreaches.net/leon-county-schools-vendors-data-leak-exposed-368000-current-and-former-flvs-students-details-lcs-teacher-data-and-more/).

November 2017, Monticello Central School District warns of a sophisticated e-mail phishing attack occurred on November 1st, 2017. Potentially 2,598 individuals are affected, (https://www.databreaches.net/monticello-central-school-district-notifying-almost-2600-of-phishing-attack-last-year/).

October 2017, The Los Angeles Valley College (LAVC) is forced to pay $28,000 in bitcoin after cybercriminals successfully infected its computer networks, email systems and voicemail lines with ransomware, (https://www.ibtimes.co.uk/la-school-pays-hackers-28000-bitcoin-after-computer-systems-hit-ransomware-1600304).

July 2017, Tax information for dozens of University of Louisville employees is compromised after a hack of the online system the university uses to give employees access to tax documents, (https://www.databreaches.net/tax-information-of-some-university-of-louisville-employees-hacked/).

April 2017, Westminster College in Missouri reveals the details of a breach discovered on March 26 after a phishing scam duped a staffer into sending off W-2 statements, (https://www.scmagazine.com/home/security-news/data-breach/w-2-data-breach-at-westminster-college/).

Probability of Future Occurrence

Cyber attacks occur daily, but most have negligible impacts at the local or regional level. The possibility of a larger disruption affecting systems within the region is a constant threat, but it is difficult to quantify the exact probability due to such highly variable factors as the type of attack and intent of the attacker. Minor attacks against business and government systems have become a commonplace occurrence but are usually stopped with minimal impact. Similarly, data breaches impacting the information of students and faculty of ECU are almost certain to happen in coming years. Major attacks or breaches specifically targeting systems at the University are less likely but cannot be ruled out.

Probability: 2 – Possible

Vulnerability Assessment

As discussed above, the impacts from a cyber attack vary greatly depending on the nature, severity, and success of the attack.

People

Cyber-attacks can have a significant cumulative economic impact. Check Point Research reports that in 2018, cybercrime rates were estimated to have generated around 1.5 trillion dollars. A major cyber-attack has the potential to undermine public confidence and build doubt in their government's ability to protect them from harm. Injuries or fatalities from cyber attacks would generally only be possible from a major cyber terrorist attack against critical infrastructure.

Property

Short of a major cyber terrorist attacks against critical infrastructure, property damage from cyber attacks is typically limited to computer systems.

Environment

Short of a major cyber terrorist attacks against critical infrastructure, property damage from cyber attacks is typically limited to computer systems. A major cyber terrorism attack could potentially impact the environment by triggering a release of a hazardous materials, or by causing an accident involving hazardous materials by disrupting traffic-control devices.

Changes in Development

With enrollment increasing since the last plan, the number of users of campus networks and software have significantly increased. Additionally, with fewer buildings located on campus, the number of network access points have decreased.

For future development, as the number of users and/or access points to the network and campus software increases, the opportunity for cyber-attacks is also likely to increase.

Problem Statement

- Cyber-attacks occur daily, but most have negligible impacts at the local or regional level. The possibility of a larger disruption affecting systems within the region is a constant threat, but difficult to quantify.
- The University's Information Security division addresses IT security through policies addressing users, physical security, system security, password administration, communications, wireless devices, computer viruses, disaster recovery, and compliance with law and policy.

A.5.9 Hazardous Materials Incidents

Hazard	Probability	Impact	Spatial Extent	Warning Time	Duration	PRI Score
Hazardous Materials Incident	Highly Likely	Minor	Negligible	Less than 6 hrs	Less than 24 hrs	2.3

Location

Hazardous materials releases at fixed sites can cause a range of contamination from very minimal to catastrophic. The releases can go into the air, onto the surface, or into the ground and possibly into groundwater, or a combination of all. Although releases into the air or onto the ground surface can pose a great and immediate risk to human health, they are generally easier to remediate than those releases which enter into the ground or groundwater. Soil and groundwater contamination may take years to remediate causing possible long-term health problems for individuals and rendering land unusable for many years.

The Toxics Release Inventory (TRI) Program run by the 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 recorded 8 sites reporting hazardous material incidents in Greenville from 2016-2018. These sites are detailed by location and sector in **Table A.45**. HMPC identified one critical facility, Steam Plant, on ECU's campus with hazardous materials.

Table A.45 – Toxic Release Inventory Facilities in Greenville, 2016-2018

Facility Name	Sector
Greenville	
DENSO MANUFACTURING NORTH CAROLINA INC - GREENVILLE PLANT	Transportation Equipment
ARGOS READY MIX GREENVILLE CONCRETE PLANT	Nonmetallic Mineral Product
GRADY WHITE BOATS INC	Transportation Equipment
UNX INC	Chemicals
METALLIX REFINING INC	Primary Metals
PATHEON MANUFACTURING SERVICES LLC PART OF THERMO FISHER SC	Chemicals
TRIEST AG GROUP INC	Chemicals
COASTAL AGROBUSINESS INC-TCS	Other

Source: EPA Toxic Release Inventory

Transportation HAZMAT Incidents can occur when hazardous materials are being transported from one location to another in the normal course of business for manufacturing, refining, or other industrial purposes. Additionally, HAZMAT Incidents can occur as hazardous waste is transported for final storage and/or disposal. **Figure A.27** below shows the modes of transportation for hazardous materials adjacent to or through ECU's campus.

Spatial Extent: 1 – Negligible

Figure A.27 – HAZMAT Transportation Map, ECU

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.

Prior to 2002, however, a "serious incident" regarding hazardous materials was defined as follows:

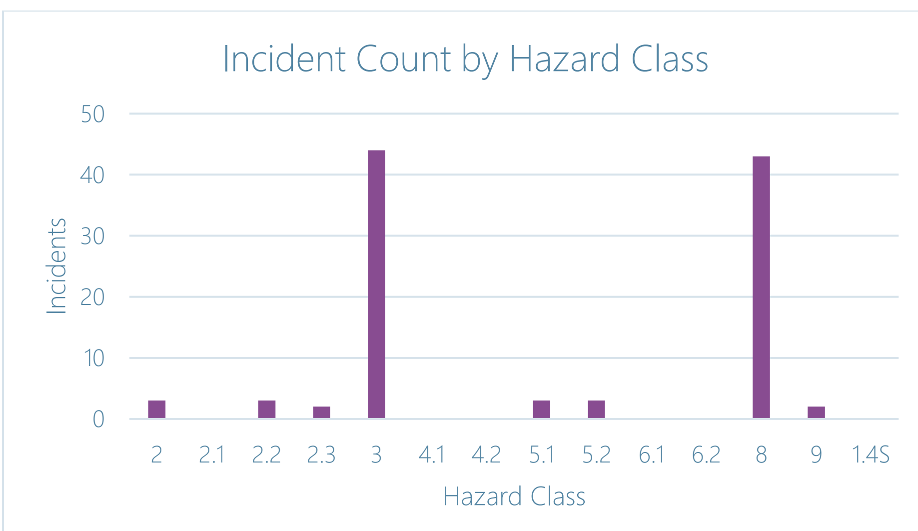
- a fatality or major injury due to a hazardous material
- closure of a major transportation artery or facility or evacuation of six or more persons due to the presence of hazardous material, or
- a vehicle accident or derailment resulting in the release of a hazardous material.

Impact: 1 – Minor

Historical Occurrences

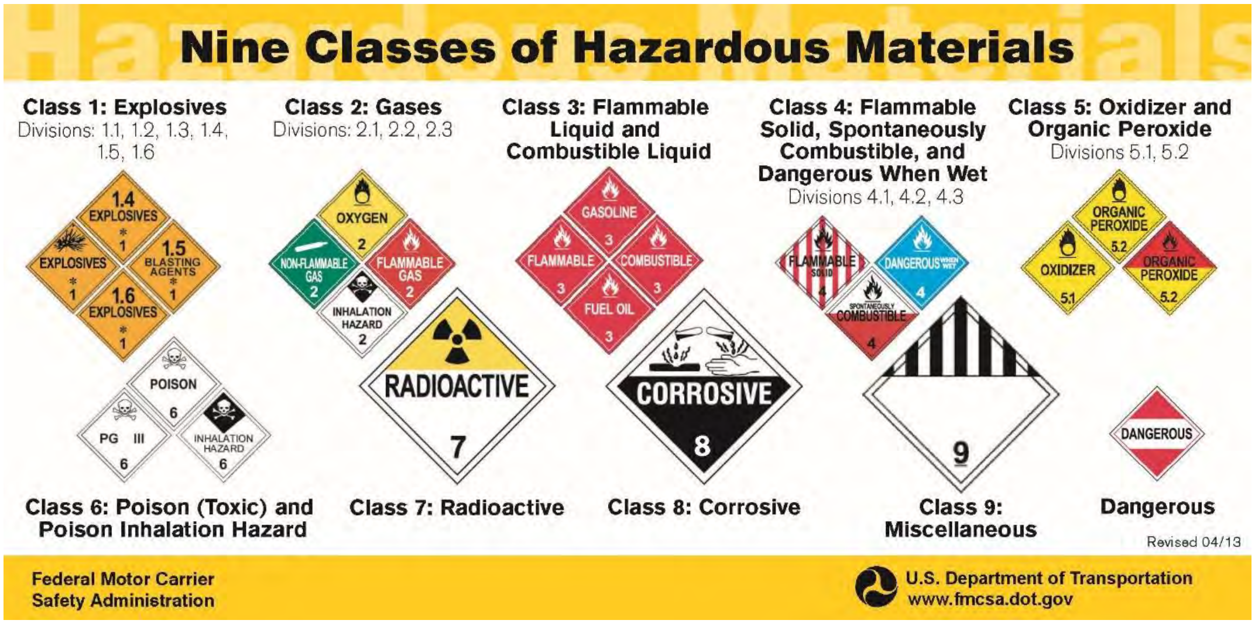
The USDOT's PHMSA maintains a database of reported hazardous materials incidents by location and hazardous material class. According to PHMSA records, there were 103 recorded releases in Greenville from 2000 through 2019. **Figure A.28** categorizes these incidents by hazardous material class. The most common materials spilled in the City were Class 3 (Flammable and Combustible Liquids) and Class 8 (Corrosives). **Figure A.29** describes all nine hazard classes.

Figure A.28 – Hazardous Materials Classes



Source: PHMSA Incident Reports, Office of Hazardous Materials Safety, Incident Reports Database Search.

Figure A.29 – Hazardous Materials Classes



Source: U.S. Department of Transportation

Probability of Future Occurrence

Based on historical occurrences recorded by PHMSA, there have been 103 incidents of hazardous materials release in the 20-year period from 2000 through 2019. Using historical occurrences as an indication of future probability, there is over a 100 percent annual probability of a hazardous materials incident occurring throughout the City of Greenville.

Probability: 4 – Highly Likely

Vulnerability Assessment

People

Hazardous materials incidents can cause injuries, hospitalizations, and even fatalities to people nearby. People living near hazardous facilities and along transportation routes may be at a higher risk of exposure, particularly those living or working downstream and downwind from such facilities. For example, a toxic spill or a release of an airborne chemical near a populated area can lead to significant evacuations and have a high potential for loss of life. Individuals working with or transporting hazardous materials are also at heightened risk.

In addition to the immediate health impacts of releases, a handful of studies have found long term health impacts such as increased incidence of certain cancers and birth defects among people living near certain chemical facilities. However there has not been sufficient research done on the subject to allow detailed analysis.

The primary economic impact of hazardous material incidents results from lost business, delayed deliveries, property damage, and potential contamination. Large and publicized hazardous material-related events can deter tourists and could potentially discourage residents and businesses. Economic effects from major transportation corridor closures can be significant.

Property

The impact of a fixed hazardous facility, such as a chemical processing facility is typically localized to the property where the incident occurs. The impact of a small spill (i.e. liquid spill) may also be limited to the extent of the spill and remediated if needed. While cleanup costs from major spills can be significant, they do not typically cause significant long-term impacts to property.

Hazardous materials spills reported by PHMSA for the 20-year period from 2000 through 2019 totaled $718,699 in damage, which equates to an annualized loss of $35,935 across the City of Greenville.

Impacts of hazardous material incidents on critical facilities are most often limited to the area or facility where they occurred, such as at a transit station, airport, fire station, hospital, or railroad. However, they can cause long-term traffic delays and road closures resulting in major delays in the movement of goods and services. These impacts can spread beyond the planning area to affect neighboring counties, or vice-versa. While cleanup costs from major spills can be significant, they do not typically cause significant long-term impacts to critical facilities, but there is a chance they may be impacted.

Environment

Hazardous material incidents may affect a small area at a regulated facility or cover a large area outside such a facility. Widespread effects occur when hazards contaminate the groundwater and eventually the municipal water supply, or they migrate to a major waterway or aquifer. Impacts on wildlife and natural resources can also be significant.

Changes in Development

Structures located near fixed facilities, highways and other high traffic roadways are most at risk to a hazardous materials event. Any development that takes place in these areas will place more people and structures in the risk area for hazardous materials events, however since most hazardous material spills are localized to an extremely small area this will not have an effect on the overall risk assessment for this hazard.

Problem Statement

- Transportation routes for hazardous materials are located within and adjacent to the ECU campus.
- The number of reported incidents within Greenville can be approximated to over a 100 percent annual probability.

A.5.11 Infectious Disease

Hazard	Probability	Impact	Spatial Extent	Warning Time	Duration	PRI Score
Infectious Disease	Possible	Critical	Large	More than 24 hrs	More than 1 week	2.8

Location

Infectious disease outbreaks can occur anywhere in the planning area, especially where there are groups of people in close quarters.

Spatial Extent: 4 – Large

Extent

When on an epidemic scale, diseases can lead to high infection rates in the population causing isolation, quarantine, and potential mass fatalities. An especially severe influenza pandemic or other major disease outbreak could lead to high levels of illness, death, social disruption, and economic loss. Impacts could range from school and business closings to the interruption of basic services such as public transportation, health care, and the delivery of food and essential medicines.

Table A.46 describes the World Health Organization's six main phases to a pandemic flu as part of their planning guidance.

Table A.46 – World Health Organization's Pandemic Flu Phases

Phase	Description
1	No animal influenza virus circulating among animals have been reported to cause infection in humans.
2	An animal influenza virus circulating in domesticated or wild animals is known to have caused infection in humans and is therefore considered a specific potential pandemic threat.
3	An animal or human-animal influenza reassortant virus has caused sporadic cases or small clusters of disease in people, but has not resulted in human-to-human transmission sufficient to sustain community-level breakouts. assort
4	Human-to-human transmission of an animal or human-animal influenza reassortant virus able to sustain community-level breakouts has been verified.
5	The same identified virus has caused sustained community-level outbreaks in two or more countries in one WHO region.
6	In addition to the criteria defined in Phase 5, the same virus has caused sustained community-level outbreaks in at least one other country in another WHO region.
Post-Peak Period	Levels of pandemic influenza in most countries with adequate surveillance have dropped below peak levels.
Post-Pandemic Period	Levels of influenza activity have returned to levels seen for seasonal influenza in most countries with adequate surveillance.

Source: World Health Organization

Impact: 3 – Critical

Historical Occurrences

Since the early 1900s, four lethal pandemics have swept the globe: Spanish Flu of 1918-1919; Asian Flu of 1957-1958; Hong Kong Flu of 1968-1969; and Swine Flu of 2009-2010. The Spanish Flu was the most severe pandemic in recent history. The number of deaths was estimated to be 50-100 million worldwide and 675,000 in the United States. Its primary victims were mostly young, healthy adults. The 1957 Asian Flu pandemic killed about 70,000 people in the United States, mostly the elderly and chronically ill. The 1968 Hong Kong Flu pandemic killed 34,000 Americans. The 2009 Swine Flu caused 12,469 deaths in the

United States. These historic pandemics are further defined in the following paragraphs along with several "pandemic scares".

Spanish Flu (H1N1 virus) of 1918-1919

In 1918, when World War I was in its fourth year, another threat began that rivaled the war itself as the greatest killer in human history. The Spanish Flu swept the world in three waves during a two-year period, beginning in March 1918 with a relatively mild assault.

The first reported case occurred at Camp Funston (Fort Riley), Kansas, where 60,000 soldiers trained to be deployed overseas. Within four months, the virus traversed the globe, as American soldiers brought the virus to Europe. The first wave sickened thousands of people and caused many deaths (46 died at Camp Funston), but it was considered mild compared to what was to come. The second and deadliest wave struck in the autumn of 1918 and killed millions. At Camp Funston alone, there were 14,000 cases and 861 deaths reported during the first three weeks of October 1918.

Outbreaks caused by a new variant exploded almost simultaneously in many locations including France, Sierra Leone, Boston, and New York City, where more than 20,000 people died that fall. The flu gained its name from Spain, which was one of the hardest hit countries. From there, the flu went through the Middle East and around the world, eventually returning to the United States along with the troops.

Of the 57,000 Americans who died in World War I, 43,000 died because of the Spanish Flu. At one point, more than 10 percent of the American workforce was bedridden. By a conservative estimate, a fifth of the human race suffered the fever and aches of influenza between 1918 and 1919 and 20 million people died. At the height of the flu outbreak during the winter of 1918-1919, at least 20% of North Carolinians were infected by the disease. Ultimately, 10,000 citizens of the state succumbed to this disease.

Asian Flu (H2N2 virus) of 1957-1958

This influenza pandemic was first identified in February 1957 in the Far East. Unlike the Spanish Flu, the 1957 virus was quickly identified, and vaccine production began in May 1957. Several small outbreaks occurred in the United States during the summer of 1957, with infection rates highest among school children, young adults, and pregnant women; however, the elderly had the highest rates of death. A second wave of infections occurred early the following year, which is typical of many pandemics.

Hong Kong Flu (H3N2 virus) of 1968-1969

This influenza pandemic was first detected in early 1968 in Hong Kong. The first cases in the United States were detected in September 1968, although widespread illness did not occur until December. This became the mildest pandemic of the twentieth century, with those over the age of 65 the most likely to die. People infected earlier by the Asian Flu virus may have developed some immunity against the Hong Kong Flu virus. Also, this pandemic peaked during school holidays in December, limiting student-related infections.

Pandemic Flu Threats: Swine Flu of 1976, Russian Flu of 1977, and Avian Flu of 1997 and 1999

Three notable flu scares occurred in the twentieth century. In 1976, a swine-type influenza virus appeared in a U.S. military barracks (Fort Dix, New Jersey). Scientists determined it was an antigenically drifted variant of the feared 1918 virus. Fortunately, a pandemic never materialized, although the news media made a significant argument about the need for a Swine Flu vaccine.

In May 1977, influenza viruses in northern China spread rapidly and caused epidemic disease in children and young adults. By January 1978, the virus, subsequently known as the Russian Flu, had spread around the world, including the United States. A vaccine was developed for the virus for the 1978–1979 flu season. Because illness occurred primarily in children, this was not considered a true pandemic.

In March 1997, scores of chickens in Hong Kong's rural New Territories began to die—6,800 on three farms alone. The Avian Flu virus was especially virulent and made an unusual jump from chickens to humans. At least 18 people were infected, and six died in the outbreak. Chinese authorities acted quickly to exterminate over one million chickens and successfully prevented further spread of the disease. In 1999, a new avian flu virus appeared. The new virus caused illness in two children in Hong Kong. Neither of these avian flu viruses started pandemics.

Swine Flu (H1N1 virus) of 2009–2010

This influenza pandemic emerged from Mexico in 2009. The first U.S. case of H1N1, or Swine Flu, was diagnosed on April 15, 2009. The U.S. government declared H1N1 a public health emergency on April 26. By June, approximately 18,000 cases of H1N1 had been reported in the United States. A total of 74 countries were affected by the pandemic.

The CDC estimates that 43 million to 89 million people were infected with H1N1 between April 2009 and April 2010. There were an estimated 8,870 to 18,300 H1N1 related deaths. On August 10, 2010, the World Health Organization (WHO) declared an end to the global H1N1 flu pandemic.

Historical occurrences of pandemics other than influenza include the following:

Meningitis, 1996-1997, 2005

During 1996 and 1997, 213,658 cases of meningitis were reported, with 21,830 deaths, in Africa. According to the North Carolina Disease Data Dashboard, there were 28 cases in North Carolina in 2005.

Lyme Disease, 2015

In the United States, Lyme disease is mostly found in the northeastern, mid-Atlantic, and upper north-central regions, and in several counties in northwestern California. In 2015, 95-percent of confirmed Lyme Disease cases were reported from 14 states: Connecticut, Delaware, Maine, Maryland, Massachusetts, Minnesota, New Hampshire, New Jersey, New York, Pennsylvania, Rhode Island, Vermont, Virginia, and Wisconsin. Lyme disease is the most reported vector-borne illness in the United States. In 2015, it was the sixth most common nationally notifiable disease. However this disease does not occur nationwide and is concentrated heavily in the northeast and upper Midwest.

Severe Acute Respiratory Syndrome, 2003

During November 2002-July 2003, a total of 8,098 probable SARS cases were reported to the World Health Organization (WHO) from 29 countries. In the United States, only 8 cases had laboratory evidence of infection. Since July 2003, when SARS transmission was declared contained, active global surveillance for SARS disease has detected no person-to-person transmission. CDC has therefore archived the case report summaries for the 2003 outbreak. Across North Carolina, there was one confirmed SARS case – a man in Orange County tested positive in June 2003.

Zika Virus, 2015

In May 2015, the Pan American Health Organization issued an alert noting the first confirmed case of a Zika virus infection in Brazil. Since that time, Brazil and other Central and South America countries and territories, as well as the Caribbean, Puerto Rico, and the U.S. Virgin Islands have experienced ongoing Zika virus transmission. In August 2016, the Centers for Disease Control and Prevention (CDC) issued guidance for people living in or traveling to a 1-square-mile area Miami, Florida, identified by the Florida Department of Health as having mosquito-borne spread of Zika. In October 2016, the transmission area was expanded to include a 4.5-square-mile area of Miami Beach and a 1-squre mile area of Miami-Dade County. In addition, all of Miami-Dade County was identified as a cautionary area with an unspecified level of risk. As of the end of 2018, the CDC reported 74 cases of Zika across the United States.

Ebola, 2014-2016

In March 2014, West Africa experienced the largest outbreak of Ebola in history. Widespread transmission was found in Liberia, Sierra Leone, and Guinea with the number of cases totaling 28,616 and the number of deaths totaling 11,310. In the United States, four cases of Ebola were confirmed in 2014 including a medical aid worker returning to New York from Guinea, two healthcare workers at Texas Presbyterian Hospital who provided care for a diagnosed patient, and the diagnosed patient who traveled to Dallas, Texas from Liberia. All three healthcare workers recovered. The diagnosed patient passed away in October 2014.

In March 2016, the WHO terminated the public health emergency for the Ebola outbreak in West Africa.

Coronavirus Disease (COVID-19), 2020

During the update of this plan, the Coronavirus disease 2019, also known as COVID-19, outbreak became a worldwide pandemic. COVID-19 was caused by severe acute respiratory syndrome coronavirus 2 (SARS-Cov-2). First identified in Wuhan, China in December 2019, the virus quickly spread throughout China and then globally. As of October 18, 2020, there were over 39.5 million cases worldwide resulting in over 1.1 million deaths. In the United States, COVID-19 was first identified in late January in Washington State and rapidly spread throughout the Country, with large epicenters on both the east and west coasts.

To curb the spread of the virus, Governor Roy Cooper issued a statewide Stay at Home Order on March 27, 2020. According to the North Carolina Department of Health and Human services, as of October 23, 2020, there were over 255,708 confirmed cases and 4,114 deaths across all 100 counties in the State. In Pitt County, as of October 23, 2020, there were a total of 6,007 cases and 38 deaths. Case counts are still rising in North Carolina and Pitt County at the time of this assessment.

Probability of Future Occurrence

It is impossible to predict when the next pandemic will occur or its impact. The CDC continually monitors and assesses pandemic threats and prepares for an influenza pandemic. Novel influenza A viruses with pandemic potential include Asian lineage avian influenza A (H5N1) and (H7N9) viruses. These viruses have all been evaluated using the Influenza Risk Assessment Tool (IRAT) to assess their potential pandemic risk. Because the CDC cannot predict how severe a future pandemic will be, advance planning is needed at the national, state and local level; this planning is done through public health partnerships at the national, state and local level.

Today, a much larger percentage of the world's population is clustered in cities, making them ideal breeding grounds for epidemics. Additionally, the explosive growth in air travel means the virus could literally be spread around the globe within hours. Under such conditions, there may be very little warning time. Most experts believe we will have just one to six months between the time that a dangerous new influenza strain is identified and the time that outbreaks begin to occur in the United States. Outbreaks are expected to occur simultaneously throughout much of the nation, preventing shifts in human and material resources that normally occur with other natural disasters. These and many other aspects make influenza pandemic unlike any other public health emergency or community disaster.

Probability: 2 – Possible

Vulnerability Assessment

People

Disease spread and mortality is affected by a variety of factors, including virulence, ease of spread, aggressiveness of the virus and its symptoms, resistance to known antibiotics and environmental factors.

While every pathogen is different, diseases normally have the highest mortality rate among the very young, the elderly or those with compromised immune systems. As an example, the unusually deadly 1918 H1N1 influenza pandemic had a mortality rate of 20%. If an influenza pandemic does occur, it is likely that many age groups would be seriously affected. The greatest risks of hospitalization and death—as seen during the last two pandemics in 1957 and 1968 as well as during annual outbreaks of influenza—will be to infants, the elderly, and those with underlying health conditions. However, in the 1918 pandemic, most deaths occurred in young adults. Few people, if any, would have immunity to a new virus.

Approximately twenty percent of people exposed to West Nile Virus through a mosquito bite develop symptoms related to the virus; it is not transmissible from one person to another. Preventive steps can be taken to reduce exposure to mosquitos carrying the virus; these include insect repellent, covering exposed skin with clothing and avoiding the outdoors during twilight periods of dawn and dusk, or in the evening when the mosquitos are most active.

Property

For the most part, property itself would not be impacted by a human disease epidemic or pandemic. However, as concerns about contamination increase, property may be quarantined or destroyed as a precaution against spreading illness. Furthermore, staffing shortages could affect the function of critical facilities.

Environment

A widespread pandemic would not have an impact on the natural environment unless the disease was transmissible between humans and animals. However, affected areas could result in denial or delays in the use of some areas, and may require remediation.

Changes in Development

With enrollment decreasing since the last plan, the number of students and employees on campus has decreased. Additionally, with fewer buildings located on campus, the number of indoor meeting locations has decreased.

For future development, as the number of students and employees increase, the opportunity for spread of a pandemic would increase, should in-person educational and/or extracurricular meetings take place.

Problem Statement

- With the current COVID-19 pandemic, it is clear the ECU campus population is susceptible to the infectious disease pandemic.
- ECU has a pandemic influenza plan in place to provide a guide for the University to follow in the event of an influenza pandemic in North Carolina.

A.5.12 Conclusions on Hazard Risk

Priority Risk Index

As discussed in **Section A.5**, 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 A.47 summarizes the degree of risk assigned to each identified hazard using the PRI method.

Table A.47 – Summary of PRI Results

Hazard	Probability	Impact	Spatial Extent	Warning Time	Duration	PRI Score
Earthquake	Unlikely	Minor	Large	Less than 6 hours	Less than 6 hours	1.9
Flood	Likely	Critical	Small	6 to 12 hrs	Less than 1 week	2.8
Geological – Landslide	Unlikely	Minor	Negligible	6 to 12 hrs	Less than 6 hrs	1.2
Hurricane	Likely	Catastrophic	Large	More than 24 hrs	Less than 24 hrs	3.2
Severe Winter Weather	Highly Likely	Limited	Large	More than 24 hrs	Less than 1 week	3.0
Tornado / Thunderstorm	Likely	Critical	Large	Less than 6 hrs	Less than 6 hrs	3.1
Wildfire	Possible	Limited	Large	More than 24 hrs	More than 1 week	2.5
Hazardous Materials Incidents	Highly Likely	Minor	Negligible	Less than 6 hrs	Less than 24 hrs	2.3
Infections Disease	Possible	Critical	Large	More than 24 hrs	More than 1 week	2.8

[1]Note: Severe Weather hazards average to a score of 2.6 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 A.48**:

- **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.
- **Moderate 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 minimal. This is not a priority hazard.

Table A.48 – Summary of Hazard Risk Classification

High Risk (≥ 3.0)	Hurricane Severe Winter Weather Tornado / Thunderstorm
Moderate Risk (2.0 – 2.9)	Flood Wildfire Hazardous Materials Infectious Disease
Low Risk (< 2.0)	Earthquake Geological – Landslide

It should be noted that the above list of hazards and hazard risk prioritization are applicable to ECU's Main Campus. Although the risk assessment conducted for this planning process did not evaluate exposure and vulnerability of the Health Sciences Campus, the hazards that affect the Main Campus are also considered applicable to the Health Sciences Campus. Additionally, ECU's Outer Banks Campus may be impacted by these and other hazards, including coastal erosion, flooding, and storm surge. The HMPC recommended evaluation of these campuses and their vulnerabilities in the future to support mitigation efforts beyond the Main Campus.

A.6 CAPABILITY ASSESSMENT

This section discusses the mitigation capabilities, including planning, programs, policies and land management tools, typically used to implement hazard mitigation activities. It consists of the following subsections:

- A.6.1 Overview of Capability Assessment
- A.6.2 Planning and Regulatory Capability
- A.6.3 Administrative and Technical Capability
- A.6.4 Fiscal Capability

A.6.1 Overview of Capability Assessment

The purpose of conducting a capability assessment is to determine the ability of the college to implement feasible mitigation actions based on an understanding of the capacity of the departments and staff tasked with their implementation. A capability assessment should also identify opportunities for establishing or enhancing specific mitigation policies or programs. The process of conducting a capability assessment includes developing an inventory of relevant plans, policies, or programs already in place; as well as assessing the college's ability to implement existing and/or new policies. Conclusions drawn from the capability assessment should identify any existing gaps or weaknesses in existing programs and policies as well as positive measures already in place which can and should be supported through future mitigation efforts.

A.6.2 Planning and Regulatory Capability

Planning and regulatory capabilities include plans, ordinances, policies and programs that guide development on campus. **Table A.49** lists these local resources currently in place at ECU.

Table A.49 – Planning and Regulatory Capability

Regulatory Tool (ordinances, codes, plans)	Y/N	Comments
Strategic Plan	Y	ECU Strategic Plan 2017-2022
Zoning code	Y	City of Greenville Zoning Ordinance
Growth management ordinance	N	
Floodplain ordinance	Y	City of Greenville Flood Ordinance
Building code	Y	NC building codes; the State of North Carolina statutes for state owned buildings; and zoning for local jurisdiction
Erosion or sediment control program	N	
Stormwater management program	N	
Site plan review requirements	N	
Capital improvements plan	Y	ECU Budget Priorities
Economic development plan	Y	ECU Annual Report
Local emergency operations plan	Y	Continuity of Operations Plan Emergency Preparedness
Flood Insurance study or other engineering study for streams	Y	July 7, 2014
Elevation certificates	Y	City of Greenville

A description of applicable plans, ordinances and programs follows to provide more detail on the relevance of each regulatory tool in examining the capabilities for each community.

Strategic Plan

A Strategic Plan, in broad terms, is a policy statement to guide the future placement and development of campus facilities. The Strategic Plan identifies a future vision, values, principals and goals for the college, determines the projected growth for the college, and identifies policies to plan, direct and accommodate anticipated growth. ECU's 2017-2022 Strategic plan sets commitments for future growth and identified responsibilities and areas of distinction.

Zoning Code

Zoning typically consists of both a zoning map and a written ordinance/code that divides the planning area into zoning districts. The zoning regulations describe what type of land use and specific activities are permitted in each district, and also regulate how buildings, signs, parking, and other construction may be placed on a parcel. The zoning regulations also provide procedures for rezoning and other planning applications. Zoning is implemented by the local municipality, the City of Greenville.

Flood Insurance Study/Floodplain Ordinance

A Flood Insurance Study (FIS) provides information on the existence and severity of flood hazards within a community based on the 100-year flood event. The FIS also includes revised digital Flood Insurance Rate Maps (FIRMs) which reflect updated Special Flood Hazard Areas (SFHAs) and flood zones for the community. FIRMs are developed and provided by FEMA.

A floodplain ordinance is perhaps the most important flood mitigation tool. 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 will be protected from damage by a 100-year flood event and that new development in the floodplain will not exacerbate existing flood problems or increase damage to other properties. Floodplain management is conducted by the City of Greenville, but responsibility is shared and additional flood mitigation activities are implemented by the university. For example, following Hurricane Floyd, ECU provided flood protection for several buildings that experienced damages. ECU retrofitted Bate Building, Howell Science Building, and Christenbury Gym with drain back flow preventers, as well as a flood gate at the Howell Science basement.

Stormwater Management Program

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. A Stormwater Management Program can prevent flooding problems caused by stormwater runoff by 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) Setting construction standards so buildings are protected from shallow water. A stormwater ordinance provides regulatory authority to implement stormwater management standards.

Erosion and Sediment Control Program

Surface water runoff can erode soil from development sites, sending sediment into downstream waterways. This can clog storm drains, drain tiles, culverts and ditches and reduce the water transport and storage capacity of channels. The purpose of an erosion, sedimentation and pollution control ordinance is to minimize soil erosion and prevent off-site sedimentation by using soil erosion and sediment control practices designed in accordance with certain standards and specifications.

Site Plan Review

The purpose of the Site Plan Review Process is to review site plans for specific types of development to ensure compliance with all appropriate land development regulations and consistency with the General Plan.

Building Code

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).

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. An Elevation Certificate serves as the official record that shows new buildings and substantial improvements in all identified SFHAs are properly elevated. This elevation information is needed to show compliance with the floodplain ordinance.

Capital Improvement Plan

A Capital Improvement Plan (CIP) is a planning document that typically provides a five-year outlook for anticipated capital projects designed to facilitate decision makers in the replacement of capital assets. The projects are primarily related to improvement in public service, parks and recreation, public utilities and facilities. The mitigation strategy may include structural projects that could potentially be included in a CIP and funded through a Capital Improvement Program.

Emergency Operations Plan

An emergency operations plan outlines responsibilities and the means by which resources are deployed during and following an emergency or disaster. ECU has a Campus Emergency Operations Plan and Emergency Coordination operating procedures. Additionally, the campus has an Information Technology Services Disaster Recovery Plan.

A.6.3 Administrative and Technical Capability

Administrative and technical capability refers to the college's staff and their skills and tools that can be used for mitigation planning and to implement specific mitigation actions. It also refers to the ability to access and coordinate these resources effectively. The personnel should be considered as well as the level of knowledge and technical expertise of these resources. Resources include engineers, planners, emergency managers, GIS analysts, building inspectors, grant writers, floodplain managers, and more. **Table A.50** provides a summary of the administrative and technical capabilities for ECU.

Table A.50 – Administrative and Technical Capability

Personnel Resources	Yes/No	Department/Position
Planner/Engineer with knowledge of land development/land management practices	Yes	Facilities Services
Engineer/Professional trained in construction practices related to buildings and/or infrastructure	Yes	Facilities Services
Planner/Engineer/Scientist with an understanding of natural hazards	Yes	Office of Environmental Health and Safety

Personnel Resources	Yes/No	Department/Position
Personnel skilled in GIS	Yes	Facilities Services
Full time building official	Yes	City of Greenville
Floodplain Manager	Yes	City of Greenville
Emergency Manager	Yes	Office of Environmental Health and Safety
Grant Writer	No	
Public Information Officer	Yes	Office of Public Relations, News & Communications
Student Engagement	Yes	Student Affairs
Warning Systems	Yes	ECU Alert

The following support services and resources noted in the 2011 plan may also provide administrative capability to implement mitigation:

Facilities Engineering and Architectural Services

Facilities Engineering and Architectural Services is responsible for development of the real property of the University to support the mission of teaching, research, public service, and patient care. All the traditional services of urban planners, architects, engineers, and other environmental design disciplines are procured and managed by this department. Key responsibilities include the design and construction of new buildings, renovations of existing facilities, management and implementation of the University's utility infrastructure master plan and management of the University's repair and renovation program.

Facilities Services

Facilities Services is responsible for the facilities support of all University real property including repair planning, minor renovation and construction, utilities, maintenance, grounds, and housekeeping.

Enterprise Risk Management

Under the office of Administration and Finance, Enterprise Risk Management's mission is to provide leadership and management experience to better identify and manage the university's strategic, financial, operational, regulatory compliance, and reputational risks holistically as an enterprise.

Environmental Health and Safety

The Office of Environmental Health & Safety operates in collaboration with the Office of Prospective Health, university committees, and the campus community to provide policies, education, program management, and consultative services that supports the mission of the University while continuously improving the safety, health and sustainability of the campus environment.

A.6.4 Fiscal Capability

Financial capabilities are the resources that an entity has access to or is eligible to use to fund mitigation actions. The costs associated with implementing mitigation activities vary. Some mitigation actions such as building assessment or outreach efforts require little to no costs other than staff time and existing operating budgets. Other actions, such as structural projects, could require a substantial monetary commitment from local, State, and Federal funding sources. **Table A.51** provides a summary of the fiscal resources at ECU.

Table A.51 – Fiscal Resources

Resource	Ability to Use for Mitigation Projects? Y/N
Community Development Block Grants	N

Resource	Ability to Use for Mitigation Projects? Y/N
Capital improvements project funding	Y
In-Kind Services	Y
Tuition & Fees	Y
Federal funding with HMA grants	Y
Revenue Bonds	Y
State Appropriations	Y
Sales & Services	Y
Other Sources (Gifts, Investment Income, Permanent Endowments)	Y

A.7 MITIGATION STRATEGY

A.7.1 Implementation Progress

Progress on the mitigation strategy developed in the previous plan is also documented in this plan update. **Table A.52** details the status of mitigation actions from the previous plan. **Table A.53** on the following pages details all completed and deleted actions from the 2011 plan. More detail on the actions being carried forward is provided in the Mitigation Action Plan.

Table A.52 – Status of Previous Mitigation Actions

Campus	Completed	Deleted	Carried Forward and/or Combined
ECU	12	5	36

Table A.53 – Completed and Deleted Actions from the ECU 2011 Plan

Vulnerability	Action	2020 Status	2020 Implementation Status Comments
The hot site data center uses potable water for heat rejection from a Leibert unit during power outages. The water is dumped into undersized floor drains and can flood the room. This method of heat rejection is incapable of carrying the full heat load of the room.	Install an appropriately sized drain line to accommodate the maximum water flow.	Completed	A floor drain was not installed but rather a chiller that specifically feeds the data center with the CUP as the backup providing N+1 redundancy. Using potable water would only be used if both systems failed
There are a number of antennae cables loosely attached to the exterior façade of the mechanical penthouse.	Attach all antennae cables to the exterior façade of the structure to prevent them from becoming windborne.	Completed	
The University performs periodic tape backups; however, the tapes are stored in the Cotanche Building.	The University should relocate the tape backup archive to, at minimum, a different building. Co-locating the primary copy of data and its backup is inadvisable, even considering the hot-site in Brody.	Completed	
This facility is the single point of failure for much of the campus telecom network including the mobile 'crash-cart' used to provide telephone service to the campus emergency operations center (EOC).	An alternate means of providing telephone service to the emergency operations center should be identified in the event that the fiber node in Joyner East is unavailable.	Completed	
The facility is unable to provide radiation therapy during power outages. During extended outages patients would need to be transported as far as Charlotte to continue treatment plans due to special equipment requirements.	Provide standby power capable of powering vital radiation therapy equipment.	Deleted	The cancer center modalities were relocated to Vidant Medical Center
There are materials improperly stored in the emergency generator building.	Proper clearances between stored materials and electrical switchgear should be maintained in accordance with code. If necessary, install additional storage adjacent to building.	Completed	
There is a skylight over the staging area for radiation treatment that is reported to leak during intense storms.	Replace the skylights with an impact resistant system that is appropriately sealed or fill in the skylights.	Completed	Skylight over radiation oncology area was removed
The facility is unable to provide climate control without chilled water supplied by the Central Utility Plant.	Install a chiller on standby power at the adjacent Central Utility Plant to provide adequate emergency cooling for patient treatment areas.	Deleted	Cancer Treatment equipment was relocated to Vidant Medical Center

Vulnerability	Action	2020 Status	2020 Implementation Status Comments
There is a potable water backflow preventer exposed to vehicle impacts on the western perimeter of the site.	Install bollards to protect backflow preventer from potential vehicle impacts.	Completed	
The electrical switchgear at the southern end of the site between the cooling towers and the fuel tank is exposed to vehicle impacts.	Install bollards to protect switchgear from potential vehicle impacts.	Completed	
There is no source of emergency HVAC for the data fiber hub.	Install a mini-split system on standby power to provide HVAC to the fiber hub during power outages.	Completed	
The facility has a limited ability to dispense diesel to generators during extended outages.	Obtain a large vehicle mounted tank or a small tanker to enable rapid fuel deliveries to emergency generators during extended outages.	Completed	Added second vehicle with tank
Blount House - The dispatch area is not protected against accidental vehicle strikes on its eastern facade.	Vehicle barriers should be installed to prevent accidental damage to the dispatch center.	Deleted	This property protection measure addresses hazards outside of this plan.
Brody Medical Sciences - The building has no source of chilled water during power outages even though secondary pumps and air handlers are on standby power. Both vivariums and the hot site data center would be affected.	Install a chiller on standby power at the adjacent Central Utility Plant to provide adequate emergency cooling for vivariums and the hot site data center.	Completed	
Edward Nelson Warren Life Science Building - Although the air handlers for the vivariums are on emergency power, there is no means of providing chilled water for cooling. Spot coolers have limited capacity to maintain environmental conditions.	Install a chiller on standby power at the adjacent Central Utility Plant to provide adequate emergency cooling for patient treatment areas.	Completed	
Edward Nelson Warren Life Science Building - There is a large tree overhanging the roof near the northeast corner of the facility.	Trees adjacent to the facility should be pruned to prevent limbs from overhanging the roof which could shed debris and clog roof drains.	Deleted	Maintenance action, not mitigation.
Steam Plant - The fuel pumps on site may not be sufficiently protected from vehicle impacts.	Install additional bollards to adequately protect fuel pumps from potential vehicle impacts.	Deleted	This property protection measure addresses hazards outside of this plan.

A.7.2 Mitigation Action Plan

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.

The following table comprises the mitigation action plan for ECU. Each mitigation action recommended for implementation is listed in these tables along with detail on the hazards addressed, the goal and objective addressed, the priority rating, the lead agency responsible for implementation, potential funding sources for the action, a projected implementation timeline, and the 2020 status and progress toward implementation for actions that were carried forward from the 2011 PDM plan.

It should be noted that while the focus of this plan is on ECU's Main Campus, the 2011 PDM plan identified mitigation activities for the Health Sciences Campus, some of which have been carried forward in this plan. Although the risk assessment conducted for this planning process did not evaluate exposure and vulnerability of the Health Sciences Campus, hazard mitigation on the Health Sciences Campus is a priority for the ECU HMPC. Additionally, future planning efforts may also expand to include the Outer Banks campus located in Dare County, which faces additional unique hazards that warrant evaluation for future mitigation.

Table A.40 – Mitigation Action Plan, ECU

Action #	Action Description	Hazard(s) Addressed	Goal & Objective Addressed	Priority	Mitigation Category	Lead Agency / Department	Estimated Cost	Potential Funding Source	Implementation Timeline	2020 Status	2020 Implementation Status Comments
ECU1	Campus-Wide – Major mechanical systems (HVAC equipment, heat pumps, chillers, generators, fuel tanks, gas cylinders, and boilers) should be anchored to their foundations. This includes, but is not limited to, the following campus buildings: Blount House, Cotanche Building; Edward Nelson Warren Life Science Building; Eppes Complex; Jones Hall; Joyner East; Medical Central Utility Plant; Steam Plant; and Todd Dining Hall.	All Hazards	1.1	M	Property Protection	Facilities Services	$5,000-$25,000 per site	Operating Budget, State/Federal Grants	2021-2026	Carry Forward	No progress has been made on this action.
ECU2	Campus-Wide – Upgrade back-up power capabilities to critical facilities including, but not limited to: Leo W. Jenkins Cancer Center; and Medical Central Utility Plant.	All Hazards	1.2	M	Structural Projects	Facilities Services	$25,000-$100,000 per site	State/Federal Grants	2021-2026	Carry Forward	Reviewing power requirements; Identifying funding options for further implementation
ECU3	Blount House - The windows in the dispatch area are unreinforced against wind-borne debris impact. The windows in the dispatch area should be reinforced to prevent shattering as a result of wind-borne debris impact.	Tornado/ Thunderstorm, Hurricane	1.1	M	Property Protection	Campus Safety & Auxiliary Services	<$5,000	Operating Budget	2021-2026	Carry Forward	No progress has been made on this action.
ECU4	Blount House - The basement sump pump is undersized relative to the rate of water infiltration during intense storms. A secondary or single large sump pump should be installed in the basement to prevent flooding.	Flood	1.1	M	Structural Projects	Facilities Services	<$5,000	State/Federal Grants	2021-2026	Carry Forward	No progress has been made on this action.
ECU5	Blount House - There is only one direct fiber optic link with Joyner East. If this line were severed, there would be a significant disruption to VOIP and data services. A redundant fiber path should be on standby to maintain normal operations in the event the existing Blount- Joyner fiber path is damaged.	All Hazards	2.2	M	Structural Projects	ITCS	$5,000-$25,000	State/Federal Grants	2021-2026	Carry Forward	No progress has been made on this action.
ECU6	Blount House - The room designated as the EOC is too small to house even a partially staffed EOC. The room also has several unreinforced windows. The dispatch area is too small to allow consolidation of the primary and Brody Hall 911 call centers. The EOC should be relocated to another facility to allow a fully staffed EOC to meet in a single location. The 911 call/dispatch centers from Blount and Brody should be consolidated into this new facility.	All Hazards	3.2	M	Emergency Services	Campus Safety & Auxiliary Services	>$100,000	Operating Budget, State/Federal Grants	2021-2026	Carry Forward	No progress has been made on this action.
ECU7	Brody Medical Sciences - The radio and paging system closets in the mechanical penthouse do not have smokeheads or temperature sensors. Install smokeheads and temperature sensors to monitor vital radio and paging systems.	Human-caused Hazard	1.2	M	Property Protection	Facilities Services	$5,000-$25,000	State/Federal Grants	2021-2026	Carry Forward	No progress has been made on this action.
ECU8	Brody Medical Sciences - The exterior façade of the building suffers extensive water infiltration during intense storms. Seal the exterior façade of the building to prevent water infiltration and prevent further damage and/or mold growth.	Tornado/ Thunderstorm, Hurricane	1.1	M	Property Protection	Facilities Services	>$100,000	Operating Budget	2021-2026	Carry Forward	Funding has not been available to date to address this issue
ECU9	Brody Medical Sciences - The data center is in a room with wet sprinklers. Replace the wet sprinklers in the data center with a gas-based fire suppression system.	Human-caused Hazard	1.1	M	Property Protection	Facilities Services	$25,000-$100,000	State/Federal Grants	2021-2026	Carry Forward	A study was conducted to look at various types of systems, but funding has not been available to implement
ECU10	Cotanche Building - The EOC telecommunication equipment relies on the (non-redundant) fiber connection to Joyner East. An alternate fiber path to Joyner East should be on standby, or some other redundant communication system in place, allowing the EOC to communicate in the event that the Joyner East fiber hub is offline.	All Hazards	2.2	M	Structural Projects	ITCS	$25,000-$100,000	State/Federal Grants	2021-2026	Carry Forward	No progress has been made on this action.

Action #	Action Description	Hazard(s) Addressed	Goal & Objective Addressed	Priority	Mitigation Category	Lead Agency / Department	Estimated Cost	Potential Funding Source	Implementation Timeline	2020 Status	2020 Implementation Status Comments
ECU11	Edward Nelson Warren Life Science Building - The guy wires on exhaust stacks for the BSL level 3 lab are slack. Guy wires supporting exhaust stacks should be tensioned to reduce wind induced movement.	Tornado/ Thunderstorm, Hurricane	1.1	M	Structural Projects	Facilities Services	<$5,000	Operating Budget	2021-2026	Carry Forward	No progress has been made on this action.
ECU12	Eppes Complex - The buildings are not sprinklered and many areas have only a pull station with no fire detection equipment. This includes areas such as the paint shop and carpentry shop that contain flammable materials. Areas that store flammable materials should have adequate fire suppression and/or detection equipment installed.	Human-caused Hazard	1.1	M	Property Protection	Facilities Services	$5,000-$25,000	State/Federal Grants	2021-2026	Carry Forward	No progress has been made on this action.
ECU13	Eppes Complex - There is an unreinforced window above the server area that, if broken, could permit water damage to equipment. Windows in areas containing sensitive electronics should have a film coating and water catchment system to minimize the likelihood of damage resulting from wind borne debris and rain.	Tornado/ Thunderstorm, Hurricane	1.2	M	Property Protection	Facilities Services	<$5,000	Operating Budget	2021-2026	Carry Forward	No progress has been made on this action.
ECU14	Jones Hall - The fire pump building, emergency generator, and chiller have large trees adjacent to them. The trees adjacent to the generator, chiller, and fire pump building should be routinely inspected and pruned by an arborist to mitigate the potential for wind related damage.	Tornado/ Thunderstorm, Hurricane, Severe Winter Weather	1.1	M	Property Protection	Facilities Services	<$5,000	Operating Budget	2021-2026	Carry Forward	No progress has been made on this action.
ECU15	Joyner East - There are pipes collecting water from roof drains suspended from the ceiling over sensitive electronic equipment. Pipes above sensitive electronics should have a secondary catchment in the event of a leak.	Human-caused Hazard	1.2	M	Structural Projects	Facilities Services	<$5,000	Operating Budget, State/Federal Grants	2021-2026	Carry Forward	No progress has been made on this action.
ECU16	Joyner East - There are a number of pipes in a crawlspace adjacent to the network hub that could burst and cause water damage. A water detection system should be installed to monitor for the presence of water in the crawlspace.	Flood	1.2	M	Structural Projects	Facilities Services	<$5,000	Operating Budget	2021-2026	Carry Forward	No progress has been made on this action.
ECU17	Medical Central Utility Plant - There are several pine trees surrounding the well pumps. Have an arborist inspect and trim/remove the adjacent to the well pumps.	Severe Winter Weather	1.1	M	Property Protection	Facilities Services	<$5,000	Operating Budget	2021-2026	Carry Forward	No progress has been made on this action.
ECU18	Steam Plant - The facility does not have the ability to back-feed power to any existing EOC location during outages. Relocate the EOC to a facility with redundant connections to campus voice/data networks and on a circuit which can be back-fed from either of campus's two points of back-up power delivery.	All Hazards	1.2	M	Emergency Services	Campus Safety & Auxiliary Services	>$100,000	Operating Budget, State/Federal Grants	2021-2026	Carry Forward	No progress has been made on this action.
ECU19	Steam Plant - There are large trees overhanging the Greenville Run utility crossing, fuel tanks, fuel pumps, and primary switchgear for campus. Large trees overhanging critical equipment and utilities should be regularly pruned and inspected by an arborist to minimize the likelihood of storm related damage. The largest trees near the steam crossing should be cut down.	Tornado/ Thunderstorm, Hurricane, Severe Winter Weather	1.1	M	Property Protection	Facilities Services	$5,000-$100,000	Operating Budget	2021-2026	Carry Forward	No progress has been made on this action.
ECU20	Steam Plant - Beams supporting the main natural gas line have deteriorating concrete encasement that appears to be causing corrosion to the gas pipe in addition to posing a debris hazard to workers below. The deteriorating concrete should be removed from above the gas line and the corrosion repaired.	Severe Winter Weather	1.1	H	Structural Projects	Facilities Services	<$5,000	Operating Budget	2021-2026	Carry Forward	No progress has been made on this action.
ECU21	Steam Plant - While the facility is out of the 100-year floodplain, the transformer yard is in the 100-year flood plain. Ensure all critical components in the transformer yard have sufficient freeboard above anticipated floodwater elevation.	Flood	1.1	M	Property Protection	Facilities Services	<$5,000 for the study, $25,000-$100,000 if action required	State/Federal Grants	2021-2026	Carry Forward	No progress has been made on this action.

Action #	Action Description	Hazard(s) Addressed	Goal & Objective Addressed	Priority	Mitigation Category	Lead Agency / Department	Estimated Cost	Potential Funding Source	Implementation Timeline	2020 Status	2020 Implementation Status Comments
ECU22	Todd Dining Hall - There is a large tree adjacent to the emergency generator which could fall and damage the generator and/or chiller. The large tree adjacent to the generator and chiller should be routinely pruned to reduce the possibility of wind related damage to the equipment.	Tornado/ Thunderstorm, Hurricane	1.1	M	Property Protection	Facilities Services	<$5,000	Operating Budget	2021-2026	Carry Forward	No progress has been made on this action.
ECU23	Todd Dining Hall - There are trees adjacent to the facility which grow over the roof and deposit debris which could clog roof drains. Trees should be pruned back from the facility to prevent trees from depositing debris on the roof and potentially clogging roof drains.	Severe Winter Weather	1.1	M	Property Protection	Facilities Services	<$5,000	Operating Budget	2021-2026	Carry Forward	No progress has been made on this action.
ECU24	Post hazard mitigation information, along with other public University resources, plans, and links to outside agency resources, on the University website. Disseminate information to the campus community that explains the risk of hazards and outline precautionary measures that can be taken to help reduce impacts of disaster to themselves and property.	All Hazards	2.1	H	Public Education and Awareness	EH&S	<$5,000	Operating Budget	2021-2026	New	
ECU25	Provide periodic training sessions on hazard mitigation to Chancellor's executive council, Crisis Policy Team and Emergency Management Team.	All Hazards	2.1	H	Public Education and Awareness	EH&S	<$5,000	Operating Budget	2021-2026	New	
ECU26	Disseminate information on emergency action plans, including evacuation and shelter-in-place procedures, to the campus community (residential and non-residential) and conduct periodic drills/exercises to test and evaluate plans.	All Hazards	2.1	H	Public Education and Awareness	EH&S	<$5,000	Operating Budget	2021-2026	New	
ECU27	Evaluate vulnerability for Outer Banks Campus, Dental Community Service-Learning Centers and other satellite locations.	All Hazards	1.2	H	Prevention	EH&S	<$5,000	Operating Budget	2021-2026	New	

THE UNIVERSITY OF NORTH CAROLINA SYSTEM

UNC System Eastern Campuses Regional Hazard Mitigation Plan

Annex B: Elizabeth City State University

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Annex B Elizabeth City State University

This section provides planning process, campus profile, hazard risk, vulnerability, capability, and mitigation action information specific to Elizabeth City State University (ECSU). This section contains the following subsections:

- B.1 Planning Process Details
- B.2 Campus Profile
- B.3 Asset Inventory
- B.4 Hazard Identification
- B.5 Hazard Profiles, Analysis, and Vulnerability
- B.6 Capability Assessment
- B.7 Mitigation Strategy

B.1 PLANNING PROCESS DETAILS

The table below lists the HMPC members who represented ECSU during the planning process.

Table B.1 – HMPC Members

Representative	Role; Department
Rickey Freeman	EM/EHS Coordinator; University Police
Dennis Leary	Director; Facilities Management
Harley Grimes	Interim Director; Campus Facilities & Planning
Alyn Goodson	Vice Chancellor, General Council; Campus Operations
John Manley	Director of Public Safety; University Police
Derrick Wilkins	Vice Chancellor and Chief of Staff; Office of the Chancellor
Sabrina Williams	Director; Housing and Residence Life
Kevin Wade	Associate Vice Chancellor; Student Affairs
Kevin Kupietz	Emergency Management Coordinator; Aviation & Emergency Management
Robert Thibeault	Director of Budgets; Business and Finance
Dr. Karrie Dixon	Chancellor

Coordination with Other Community Planning Efforts and Hazard Mitigation Activities

The table below lists campus and community resources referenced throughout the planning process and incorporated into the plan development.

Table B.2 – Summary of Existing Studies and Plans Reviewed

Resource Referenced	Use in this Plan
ECSU Campus Master Plan	The ECSU Campus Master Plan, developed in 2003, was referenced for the Campus Profile in Section B.2 as well as the Capability Assessment in Section B.6
Pasquotank County Elizabeth City Advanced Core Land Use Plan	The Land Use Plan, updated in 2012, was referenced for the Campus Profile in Section B.2.
Pasquotank County and Incorporated Areas Flood Insurance Study (FIS), Revised 12/21/2018	The FIS report was referenced in the preparation of flood hazard profile in Section B.5.

Resource Referenced	Use in this Plan
ESCU Pre-Disaster Mitigation Plan, 2011	The previous ESCU Pre-Disaster Mitigation Plan was used in preparation of the hazard profiles in Section B.5. The plan was additionally used to track implementation progress and develop the mitigation plan (Section B.7).
Albemarle Regional Hazard Mitigation Plan, 2020	The Albemarle Regional Hazard Mitigation Plan, which includes Elizabeth City, was referenced in compiling the Hazard Identification and Risk Assessment in Section B.5.

B.2 CAMPUS PROFILE

This section provides a general overview of the Elizabeth City State University (ECSU) campus and area of concern to be addressed in this plan. It consists of the following subsections:

- Location and Setting
- Geography and Climate
- History
- Cultural and Natural Resources
- Land Use
- Population and Demographics
- Social Vulnerability
- Growth and Development Trends

B.2.1 Location and Setting

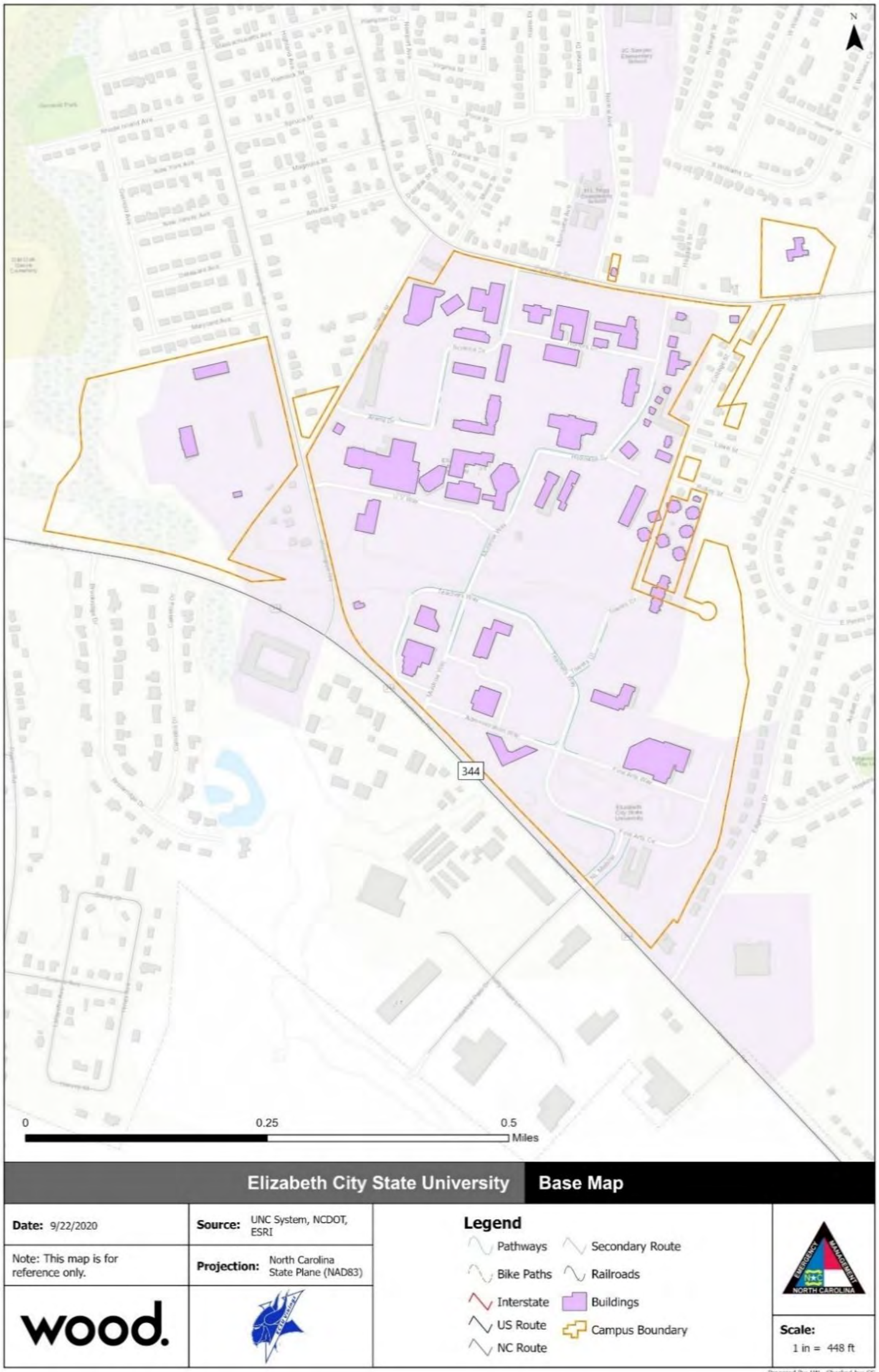
Located in the historic Albemarle area near the mouth of the Pasquotank River, Elizabeth City State University offers students the opportunity to receive an excellent education while enjoying a wide variety of recreational and cultural amenities. Favored by a mild climate and proximity to the world-renowned Outer Banks recreation area, ECSU has features that help make student living and learning both exciting and fulfilling. In addition, the university offers students a variety of social programs, cultural programs, religious and musical organizations and clubs. Honor and Recognition societies, as well as fraternities and sororities are also available to students. ECSU also has a variety of athletic sports events.

Students may also wish to take advantage of the historical sites in the greater Albemarle and southeastern Virginia areas. Williamsburg, Jamestown, Roanoke Island, Yorktown, several antebellum plantations, beaches and waterways are among sites within an easy drive from the campus.

United States Highways 17 and 158 make the city and the university easily accessible by automobile. City bus routes, hotels and motels are available to accommodate overnight visitors, and the university is just over an hour's drive from the Norfolk (Virginia) International Airport. The university is situated on 114 acres which represent the campus proper. Another 68 acres comprise the former farm on Weeksville Road (N.C. 34); a 639-acre tract in Currituck County helps preserve the nation's diminishing wetlands and provides for educational research; and 35 acres serve residential or expansion purposes. There are also small sites in Utah and Virginia used, respectively, for geological instruction and institutional enhancement.

Figure B.1 provides a base map of the main campus. For more details on on-campus buildings and critical facilities, see Section B.3.

Figure B.1 – ECSU Campus Base Map



B.2.2 Geography and Climate

Elizabeth City is part of the low-lying Coastal Plain of North Carolina. The Coastal Plain slopes generally toward the coast from about 300 feet in elevation where it meets the Piedmont to sea level. The land in Elizabeth City is relatively flat and sits approximately 12 feet above sea level. Elizabeth City State University is conveniently located just fifty miles from the Atlantic coast beaches. Elizabeth City, recently named one of the best small towns in the United States, is found on the Pasquotank River, in eastern North Carolina. Elizabeth City has a mild climate, dropping to 52 degrees Fahrenheit on average in January and climbing to 89 degrees Fahrenheit in July on average. The annual precipitation for the city is approximately 49 inches per year.

B.2.3 History

Elizabeth City State University was founded on March 3, 1891, when House Bill 383 was enacted by the North Carolina General Assembly, establishing a normal school for the specific purpose of "teaching and training teachers of the colored race to teach in the common schools of North Carolina." The bill was sponsored by Hugh Cale, an African American representative from Pasquotank County. Between 1891 and 1928, curricula and resources were expanded under the leadership of Peter Wedderick Moore. Enrollment increased from 23 to 355 and the faculty from 2 to 15 members by the time Dr. Moore retired as President-Emeritus on July 1, 1928.

Under the leadership of John Henry Bias, the second president, who served from July 1, 1928 until his death on July 15, 1939, the institution was elevated from a two-year normal school to a four-year teachers college in 1937. The institution's name was officially changed to Elizabeth City State Teachers College on March 30, 1939, and the mission was expanded to include the training of elementary school principals for rural and city schools. The first Bachelor of Science degrees in Elementary Education were awarded in May 1939.

The number of majors increased between 1959 and 1963 from a single elementary education major to 12 academic majors. The college was granted full membership in the Southern Association of Colleges and Schools in December 1961. Its accreditation has since been reaffirmed. The name changed from Elizabeth City State Teachers College to Elizabeth City State College by the General Assembly in 1963. Effective July 1, 1969, the college became Elizabeth City State University. In 1971, the General Assembly redefined The University of North Carolina system with sixteen public institutions. Including ECSU, those institutions are constituents of The University of North Carolina (July 1972).

Currently, ECSU offers 32 undergraduate and graduate degrees programs, along with several online degree options. A few of the available programs include business, education, aviation, military science, and emergency management. ECSU is a proud NC Promise campus committed to providing an affordable, high-quality education; the university has earned national acclaim for its advances in academics: U.S. News and World Report ranked ECSU #7 Top Public Schools, #14 Top Performers in Social Mobility, #22 Top HBCUs, #36 Best Regional College, South (2020-21). Washington Monthly ranked ECSU #11 Best Bang for the Buck Colleges (2020-21). Best Historically Black Colleges ranked ECSU #6 (2020). CollegeNET, Inc. ranked ECSU #7 for Social Mobility Innovator (2019). ECSU was ranked a Top 5 Military Friendly School for small public institutions, receiving a gold medal award for its service to the men and women who serve or have served in the United States military (2020-21). Military Times ranked ECSU 84th in the nation for Best Bet for Vets (2020)

On December 14, 2018, Dr. Karrie Dixon was named 12th Chief Executive Officer and 7th Chancellor of Elizabeth City State University.

B.2.4 Cultural and Natural Resources

National Register of Historic Places

There are 11 listings in the National Register of Historic Places for Elizabeth City. A few historic districts such as The Elizabeth City State Teachers College Historic District and the Riverside Historic District neighbor the ECSU campus.

Natural Features and Resources

Elizabeth City is host to a myriad of wetlands, creeks, rivers and harbors. The City currently owns and is responsible for approximately 2,100 acres of parks and open space. Elizabeth City strives to provide both larger parks (50+ acres) for active and passive use; neighborhood parks (2-20 acres) within walking and biking distance of most homes; connectors like greenways and bikeways; and unique waterfront parks with public access to waterways whenever possible. A future land use map for the City can be found on the following page in Figure 1.

Approximately 7 acres of the land on The Elizabeth City State University campus is located within a 100-year special flood hazard area. These 7 acres are designated as Zone AE; 6 acres of land on ECSU's campus is located within the 500-year floodplain, and the remaining 154 acres are designated as Unshaded Zone X.

Natural and Beneficial Floodplain Functions

Under natural conditions, a flood causes little or no damage in floodplains. Nature ensures that floodplain flora and fauna can survive the more frequent inundations, and the vegetation stabilizes soils during flooding. Floodplains reduce flood damage by allowing flood waters to spread over a large area. This reduces flood velocities and provides flood storage to reduce peak flows downstream.

Threatened and Endangered Species

The U.S. Fish and Wildlife Service maintains a regular listing of threatened species, endangered species, at-risk species, and candidate species for counties across the United States. Last updated in October 2015, Pasquotank County has 2 species that are listed with the U.S. Fish and Wildlife Services. **Table B.3** below shows the 2 species identified as threatened in Pasquotank County.

Table B.3 – Threatened and Endangered Species in Pasquotank County

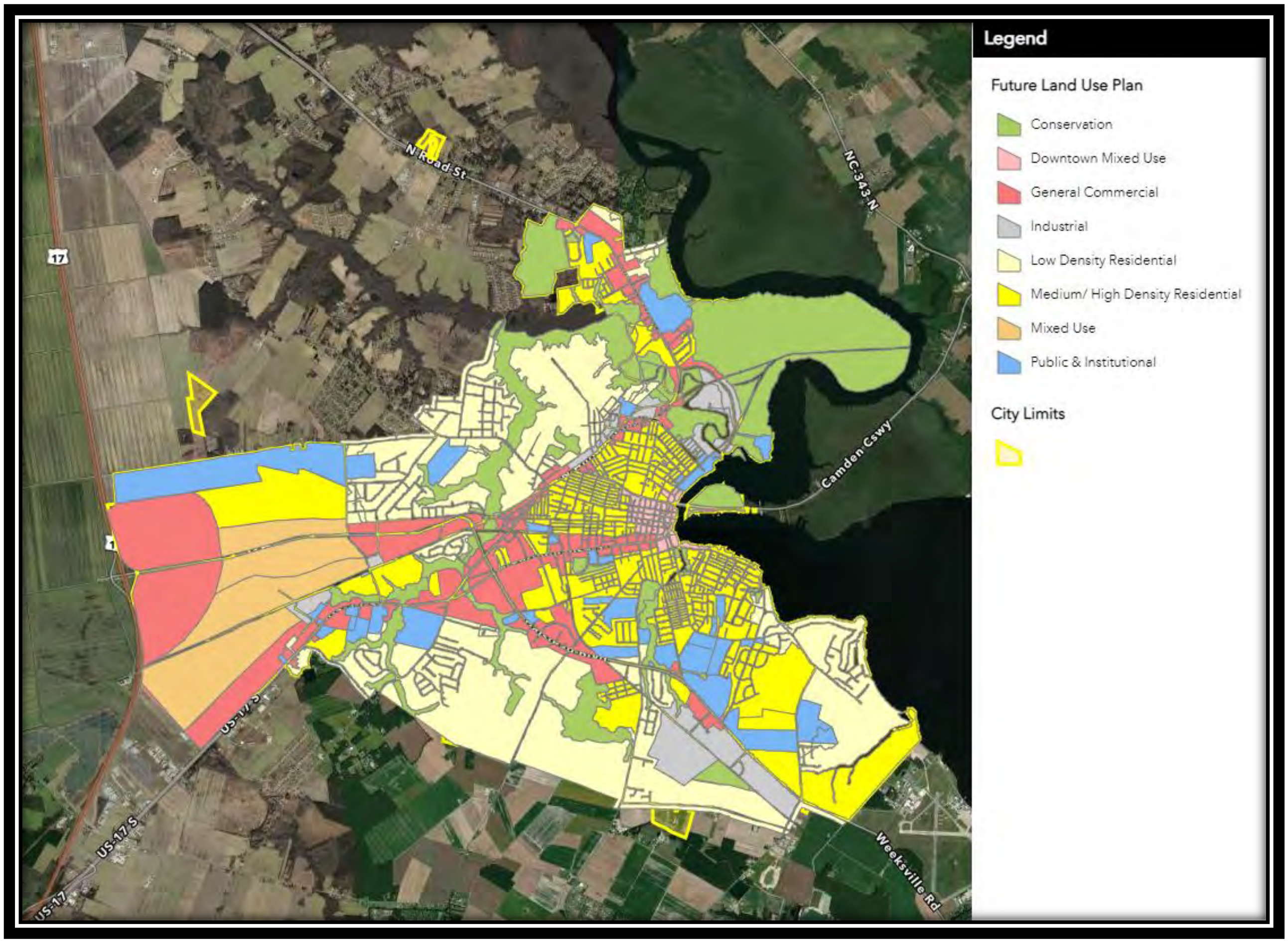
Common Name	Scientific Name	Federal Status
Red Knot	*Calidris canutus rufa*	Threatened
Northern Long-Eared Bat	*Myotis septentrionalis*	Threatened

Source: U.S. Fish & Wildlife Service (https://ecos.fws.gov/ecp/report/species-listings-by-current-range-county?fips=37139)

B.2.5 Land Use

Elizabeth City strives to cater to its community and future residents by continuing developments and improvements across the City to accommodate and welcome prosperous growth. A map of the proposed land use found on the City's website can be found below in Figure B.2. Along with the City, ECSU's regional development goal is to build partnerships and industry to drive economic development, promote and support faculty applied research and consulting, and grow community-based experiences and develop opportunities for community involvement. This involves updating and renovating facilities on campus to accommodate a growing student population. One of ECSU's projects that is currently under construction is the new Aviation Complex. More updates on recent and current projects can be found on the University's website at the following link: https://www.ecsu.edu/administration/chancellor/design-construction/recent_projects.html

Figure B.2 – City of Elizabeth City Future Land Use



Source: https://data-ecity.opendata.arcgis.com/app/8d9c1bd7400442c8ab92929fb64d01d7

B.2.6 Population and Demographics

Table B.4 provides population counts and percent change in population since 2010 for Elizabeth City County and City of Elizabeth City.

Table B.4 – Population Counts for Surrounding Jurisdictions

Jurisdiction	2010 Census Population	2019 Estimated Population	% Change 2010-2019
Pasquotank County	40,661	39,824	-2.1
Elizabeth City	18,683	17,751	-4.8

Source: U.S. Census Bureau QuickFacts 2010 vs 2019 (V2019) data

Table B.5 provides population counts for The Elizabeth City State University, including the number of full-time, part-time, and off-campus students, cadets, faculty, and staff.

Table B.5 – Population Counts for The Elizabeth City State University, 2020

Group	2020 Population
Students	2,002
Undergraduate Students	1,910
Graduate Students	92
Full-Time Students	1,650

Group	2020 Population
Part-Time Students	352
In-State	1,630
Off-Campus	1,280
On-Campus	772
Faculty	352
Staff	473

Based on the 2010 Census, the largest number of residents in both Elizabeth City and Pasquotank County fall in the age range of 5-18, making up 24.3% and 22% of the populations, respectively. The largest percentage of students on ECSU's campus (33.6%) are ages 20-21. The racial characteristics of the County, City, and college are presented below in **Table B.6**. White persons make up the majority of the population for the City and County; however, African-Americans make up the majority of the population at Elizabeth City State University.

Table B.6 – Demographics of Elizabeth City County and Elizabeth City State University Students

Jurisdiction	African-American Persons, Percent	American Indian or Alaska Native, Percent	Asian Persons, Percent	Hispanic or Latino Persons, Percent	White Persons, Percent
Pasquotank County[1]	36.6	0.6	1.6	5.8	58.5
Elizabeth City[1]	49.1	0.1	1.1	7.9	45.2
Elizabeth City State University[2]	67.3	0.3	0.5	4.7	18.3

Source: U.S. Census Bureau, 2010

[1]Persons of Hispanic Origin may be of any race, so are also included in applicable race category in Elizabeth City County figures.

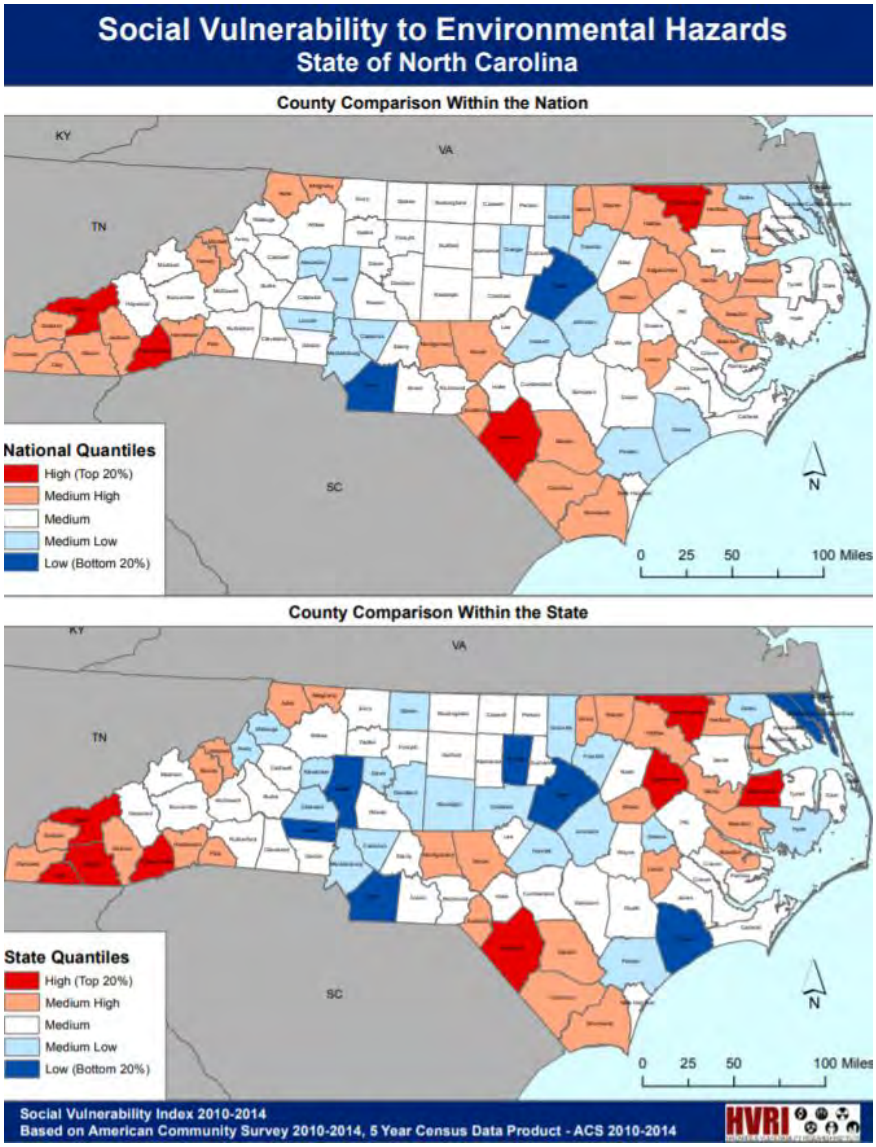
[2]Source: The Elizabeth City State University Student Enrollment Profile, Fall 2020

According to The Elizabeth City State University's Fall 2020 Student Enrollment Profile, 18.6% of students are from out of State. 59.7% of the undergraduate students are female, and 76% of graduate students are female. Among the ECSU student population, the most popular majors are Business Administration, Biology, Criminal Justice, Social Work, Kinesiology, Aviation Science, and Pharmaceutical Science.

B.2.7 Social Vulnerability

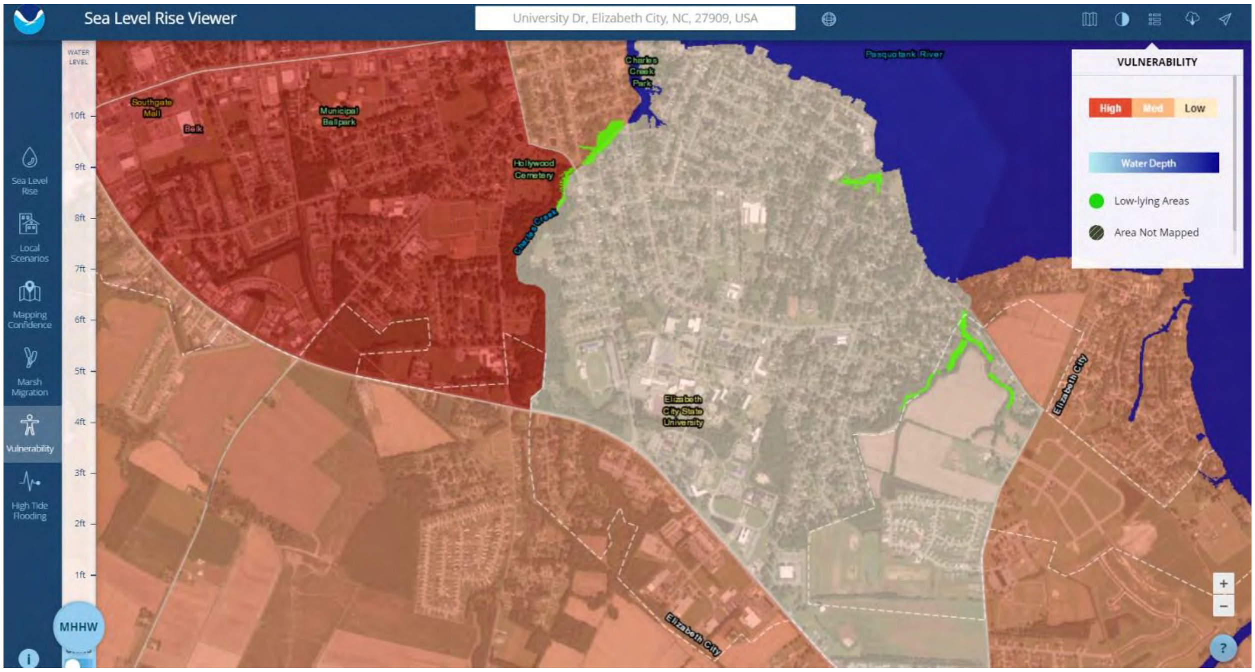
The Hazards and Vulnerability Research Institute at the University of South Carolina has created the Social Vulnerability Index (SoVI), to measure comparative social vulnerability to environmental hazards in the U.S. at a county level. SoVI combines 29 socioeconomic variables to determine vulnerability. The seven most significant components for explaining vulnerability are race and class, wealth, elderly residents, Hispanic ethnicity, special needs individuals, Native American ethnicity, and service industry employment. The index also factors in family structure, language barriers, vehicle availability, medical disabilities, and healthcare access, among other variables. **Figure B.3** displays the SoVI index by county with comparisons within the Nation and within the State. In both comparisons, Pasquotank County ranks among the medium quantiles for social vulnerability.

Figure B.3 – SoVI Index for North Carolina



Using data from SoVI, NOAA created a social vulnerability viewer by census tract for their Digital Coast Sea Level Rise Viewer, which gives a much more detailed picture of variations in social vulnerability by location. **Figure B.4** displays social vulnerability at and around Elizabeth City and the ECSU campus, with darker shades corresponding to higher levels of vulnerability. Based on Pasquotank County's medium vulnerability rating from SoVI and Elizabeth City's low level of vulnerability according to the NOAA viewer, ECSU can be assumed to have an overall medium-low level of social vulnerability to environmental hazards.

Figure B.4 – Social Vulnerability at and around ECSU



Source: NOAA Office for Coastal Management, Digital Coast, July 2016

B.2.8 Growth and Development Trends

Based on 2010 Census data, Elizabeth City had an estimated population of 17,751 residents in 2019 and currently has an annual growth rate of 0.4% even though its population has still decreased since the 2010 census. Elizabeth City does not have any public population projections available. Although population projections for the City were unavailable, the North Carolina Office of State Budget and Management (OSBM) have population projections for Pasquotank County. OSBM estimates the population for Pasquotank County as of July 2020 to be 39,685 and that the population will be around 39,951 in July 2030, which is a -0.2% decline.

The population in Elizabeth City in 2019 was 17,751, which is a 0.5% increase over the 2015 population, but still a 5% decrease from the 2010 population. **Table B.7** shows historic population growth based on the 2010 Census population for Elizabeth City.

Table B.7 – City of Elizabeth City Population Growth (2010-2019)

Year	Population	Growth	Percent Growth
2010	18,683	--	--
2015	17,660	-1,023	-5.5
2019	17,751	91	0.5

Source: U.S. Census Bureau

B.3 ASSET INVENTORY

An inventory of assets was compiled to identify the total count and value of property exposure on the ECSU campus. This asset inventory serves as the basis for evaluating exposure and vulnerability by hazard. Assets identified for analysis include buildings, critical facilities, and critical infrastructure.

B.3.1 Building Exposure

Table B.8 provides total building exposure for the campus, which was estimated by summarizing building footprints provided by the University of North Carolina System Division of Information Technology and the North Carolina Emergency Management (NCEM) iRisk database and property values provided by the North Carolina Department of Insurance and NCEM iRisk database. All occupancy types were summarized into the following four categories: administration, critical facilities, educational/extracurricular, and housing. Note: estimated content values were not available.

Table B.8 – ECSU Building Exposure by Occupancy

Occupancy	Estimated Building Count	Structure Value
Administration	2	$2,265,747
Critical Facilities	10	$24,126,888
Educational/Extracurricular	36	$41,848,457
Housing	10	$13,698,369
Total	**58**	**$81,939,461**

Source: UNC Division of Information Technology; NCEM iRisk; NC Department of Insurance

B.3.2 Critical Buildings and Infrastructure Exposure

Of significant concern with respect to any disaster event is the location of critical facilities and infrastructure in the planning area. Critical facilities are those essential services and lifelines that, if damaged during an emergency event, would disrupt campus continuity of operations or result in severe consequences to public health, safety, and welfare.

Critical buildings are a subset of the total building exposure and were identified by ECSU's HMPC representatives. The ECSU HMPC updated the list of critical facilities from the previous PDM plan and ranked each facility on a set of standardized criteria designed to evaluate all critical buildings in the UNC System Hazard Mitigation Plan. Factors considered for this ranking included:

- the building's use for emergency response,
- the building's use for essential campus operations,
- the building's use as an emergency shelter or for essential sheltering services,
- the presence of a generator or generator hook-ups,
- the building's use for provision of energy, chilled water or HVAC for sensitive or essential systems,
- the storage of hazardous materials,
- the building's use for sensitive research functions,
- the building's cultural or historical significance, and
- building-specific hazard vulnerabilities

Figure B.5 below shows the scoring sheet used to rate critical buildings on campus.

Figure B.5 – Critical Building Scoring Worksheet

Critical Building Scoring Worksheet

Campus:
Facility Name:

#	Question	Score
1	Does the facility serve as the campus Emergency Operations Center (EOC)? Yes, Primary EOC = 6 pts Yes, Secondary EOC = 3 pts No = 0 pts	0
2	Does the facility house functions essential to campus operations? Main Telecommunication Center = 3 pts; Maintenance = 1 pt Computer Network Hub = 3 pts; Public Safety = 1 pt Adminstrative Operations = 1 pts	0
3	Is the facility equiped with a generator or hook-ups? Generator = 3 pts Hook-ups = 1 pt Neither = 0 pts	0
4	Does the facility serve as a pre or post disaster shelter? Both pre and post disaster shelter = 6 pts Either pre or post disaster shelter = 3 pts Neither = 0 pts	0
5	Does the facility provide services essential to sheltering? Resident Housing = 1 pt; Food Preperation Facility = 1 pt Assesmbly Space = 1 pt; Shower Facilities = 1 pt	0
6	Does the facility provide chilled water distribution or contain HVAC systems necessary to sensitive or essential systems? Yes = 3 pts No = 0 pts	0
7	Are there hazardous materials on-site? (greater than 25 gallons) Yes = 3 pts No = 0 pts	0
8	Does the facility house research functions that have a low level of tolerance for disruption? Yes = 2 pts No = 0 pts	0
9	Does the facility serve as storage for rare or unique collections (art, artifacts, letters, etc) or is it a historically or culturally significant building? Yes = 2 pts No = 0 pts	0
10	Does the facility have hazard specific vulnerabilities (basement susceptible to flood, etc.) Yes = 3 pts No = 0 pts	0
Notes/ Comments		

Total Score:	0
Total Possible Score:	**42**

The identified critical facilities for ECSU, as shown in **Figure B.6** on the following page, are listed below along with their scores:

- Robert L Vaugh Center (14)
- KE White Graduate & Continuing Education Center (12)
- C W Griffin Center (10)
- Information Technology Center (10)
- Marion Thorpe Administration (9)
- Thomas-Jenkins Building (8)
- STEM Complex (5)
- Jimmy R Jenkins Science Complex (2)
- Moore Hall (2)
- EV Wilkins Academic Computing Center (0)

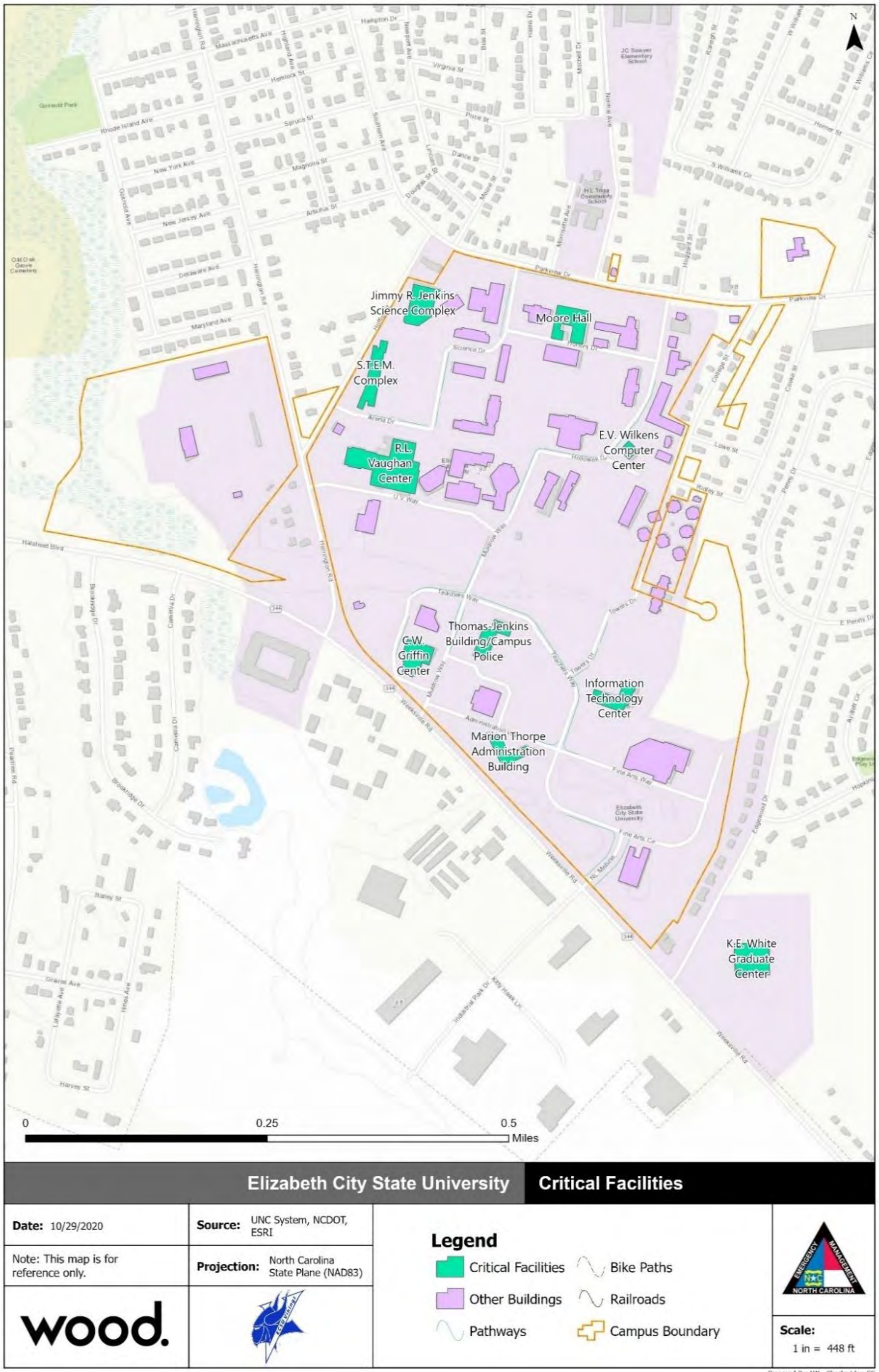
C. W. Griffin Center and the Thorpe Administration Building serve as primary Emergency Operations Centers for the campus. The STEM building will serve as a backup EOC. The Thomas-Jenkins Building provides essential campus functions, including only telecommunications center on campus, as well as maintenance and public safety functions.

The Robert L Vaugh Center and KE White Center serve as shelters and provide essential sheltering services. The KE White Center is used by the Red Cross and also serves as a backup phone center.

The STEM building and Vaugh Center store hazardous materials on site. The STEM building also houses aviation simulators and will be the home of an EM/UAS lab. The Jimmy Jenkins Complex has the potential to be used for sensitive research and may store specialized chemicals or equipment.

Moore Hall is significant as a historical building. The Thorpe Administration building, STEM building, KE White Center, and Vaugh Center house important records, artwork, and/or artifacts of significance to the campus. The Thorpe Building is also significant as the face of ECSU.

Figure B.6 – ECSU Map of Critical Facilities



B.4 HAZARD IDENTIFICATION & RISK ASSESSMENT

B.4.1 Hazard Identification

To identify a full range of hazards relevant to the UNC Eastern Campuses, HMPC representatives from each campus began with a review of the list of hazards identified in the 2018 North Carolina State Hazard Mitigation Plan and the 2011 ECSU Pre-Disaster Mitigation Plan, as summarized in **Table B.9.** This ensured consistency with the state and regional hazard mitigation plans and across each campus' planning efforts.

Table B.9 – Hazards Included in Previous Planning Efforts

Hazard	Included in 2018 State HMP?	Included in 2011 ECSU Pre-Disaster Mitigation Plan?
Flooding	Yes	Yes, as Driving rain and Flood
Hurricanes and Coastal Hazards	Yes	Yes, as High wind (hurricane)
Severe Winter Weather	Yes	Yes, as Ice storm and Snow
Extreme Heat	Yes	No
Earthquakes	Yes	Yes
Wildfire	Yes	Yes
Dam Failures	Yes	No
Drought	Yes	No
Tornadoes/Thunderstorms	Yes	Yes
Geological (Landslides, Sinkholes, Coastal Erosion)	Yes	Yes, as Landslide
Hazardous Materials Incidents	Yes	No
Infectious Disease	Yes	No
Radiological Emergency	Yes	No
Terrorism/Mass Casualty	Yes	No
Cyber Threat	Yes	No

ECSU's HMPC representatives evaluated the above list of hazards by considering existing hazard data, past disaster declarations, local knowledge, and information from the 2018 State Plan and the 2011 ECSU Pre-Disaster Mitigation Plan in order to determine whether each hazard was significant enough to assess in this updated Hazard Mitigation Plan. Significance was measured in general terms and focused on key criteria such as frequency, severity, and resulting damage, including deaths and injuries, as well as property and economic damage.

One key resource in this effort was the National Oceanic and Atmospheric Administration's (NOAA) National Center for Environmental Information (NCEI), which has been tracking various types of weather events 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), which compiles their information from a variety of sources, including but 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. While NCEI is not a comprehensive list of past hazard events, it can provide an indication of relevant hazards to the planning area and offers some statistics on injuries, deaths, damages, as well as narrative descriptions of past impacts.

Data for Pasquotank County was used to approximate past events that may have affected the ECSU campus. The NCEI database contains 166 records of storm events that occurred in Pasquotank County in the 20-year period from 2000 through 2019. **Table B.10** summarizes these events.

Table B.10 – NCEI Severe Weather Data for Pasquotank County, 2000 – 2019

Type	# of Events	Property Damage	Crop Damage	Deaths	Injuries
Blizzard	1	0	0	0	0
Coastal Flood	2	0	0	0	0
Extreme Heat	1	0	0	0	0
Flash Flood	10	$5,000	0	0	0
Flood	5	$250,000	0	0	0
Frost/Freeze	3	0	0	0	0
Funnel Cloud	1	0	0	0	0
Hail	17	0	0	0	0
Heat	1	0	0	0	0
Heavy Rain	23	0	0	0	0
High Wind	6	$133,000	0	0	0
Hurricane	2	$5,000,000	$500,000	0	0
Lightning	2	$5,000	0	0	2
Strong Wind	6	$11,000	0	0	0
Thunderstorm Wind	45	$157,000	0	0	0
Tornado	8	$1,615,000	0	0	2
Tropical Storm	5	$30,000	0	0	0
Winter Storm	18	0	0	0	0
Winter Weather	10	0	0	0	0
Total:	**166**	**$7,206,000**	**$500,000**	**0**	**4**

Source: National Center for Environmental Information Events Database, retrieved October 2020
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 Pasquotank 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 1954. Since then, Pasquotank County has been designated in 16 major disaster declarations, as detailed in **Table B.11**, and 10 emergency declarations, as detailed in **Table B.12**.

Table B.11 – FEMA Major Disaster Declarations, Pasquotank County

Disaster #	Dec. Date	Incident Type	Event Title	Individual Assistance Applications Approved	Total Individual and Households Program Dollars Approved	Total Public Assistance Grant Dollars Obligated
DR-28-NC	17-Oct-54	Hurricane	HURRICANE	N/A	N/A	N/A
DR-37-NC	13-Aug-55	Hurricane	HURRICANES	N/A	N/A	N/A
DR-56-NC	24-Apr-56	Severe Storm(s)	SEVERE STORM	N/A	N/A	N/A
DR-87-NC	1-Oct-58	Hurricane	HURRICANE & SEVERE STORM	N/A	N/A	N/A
DR-107-NC	16-Sep-60	Hurricane	HURRICANE DONNA	N/A	N/A	N/A

Disaster #	Dec. Date	Incident Type	Event Title	Individual Assistance Applications Approved	Total Individual and Households Program Dollars Approved	Total Public Assistance Grant Dollars Obligated
DR-130-NC	16-Mar-62	Flood	SEVERE STORM, HIGH TIDES & FLOODING	N/A	N/A	N/A
DR-179-NC	13-Oct-64	Flood	SEVERE STORMS & FLOODING	N/A	N/A	N/A
DR-234-NC	10-Feb-68	Severe Ice Storm	SEVERE ICE STORM	N/A	N/A	N/A
DR-1087-NC	13-Jan-96	Snow	BLIZZARD OF 96	N/A	N/A	N/A
DR-1240-NC	27-Aug-98	Hurricane	HURRICANE BONNIE	N/A	N/A	N/A
DR-1292-NC	16-Sep-99	Hurricane	HURRICANE FLOYD MAJOR DISASTER DECLARATIONS	N/A	N/A	$298,105,794
DR-1490-NC	18-Sep-03	Hurricane	HURRICANE ISABEL	7790	$21,289,504	$18,285,917
DR-4019-NC	31-Aug-11	Hurricane	HURRICANE IRENE	10270	$37,238,655	$88,847,065
DR-4285-NC	10-Oct-16	Hurricane	HURRICANE MATTHEW	28971	$98,842,213	$291,092,954
DR-4465-NC	4-Oct-19	Hurricane	HURRICANE DORIAN	N/A	N/A	$28,138,271
DR-4487-NC	25-Mar-20	Biological	COVID-19 PANDEMIC	N/A	N/A	$174,898,697

Source: FEMA Disaster Declarations Summary, October 2020

Note: Number of applications approved, and all dollar values represent totals for all counties included in disaster declaration.

Table B.12 – FEMA Emergency Declarations, Pasquotank County

Disaster #	Dec. Date	Incident Type	Event Title/Description
EM-3146-NC	15-Sep-99	Hurricane	HURRICANE FLOYD EMERGENCY DECLARATIONS
EM-3222-NC	5-Sep-05	Hurricane	HURRICANE KATRINA EVACUATION
EM-3254-NC	15-Sep-05	Hurricane	HURRICANE OPHELIA
EM-3314-NC	2-Sep-10	Hurricane	HURRICANE EARL
EM-3327-NC	25-Aug-11	Hurricane	HURRICANE IRENE
EM-3380-NC	7-Oct-16	Hurricane	HURRICANE MATTHEW
EM-3401-NC	11-Sep-18	Hurricane	HURRICANE FLORENCE
EM-3423-NC	4-Sep-19	Hurricane	HURRICANE DORIAN
EM-3471-NC	13-Mar-20	Biological	COVID-19
EM-3534-NC	2-Aug-20	Hurricane	HURRICANE ISAIAS

Source: FEMA Disaster Declarations Summary, October 2020

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. **Table B.13** summaries the determination made for each hazard.

Table B.13 – Hazard Evaluation Results

Hazard	Included in this plan update?	Explanation for Decision
Natural Hazards		
Hurricane	Yes	The 2011 ECSU PDM plan found Hurricane to be a moderate threat hazard. The County has had 10 disaster declarations related to hurricanes wind.
Coastal Hazards	No	The 2011 ECSU PDM plan did not address this hazard.

Hazard	Included in this plan update?	Explanation for Decision
Tornadoes / Thunderstorms (Wind, Lightning, Hail)	Yes	The 2011 ECSU PDM plan found tornadoes to be a low threat hazard. The County has had no disaster declarations related to tornadoes. The HMPC expressed interest in addressing this hazard in combination with thunderstorms (wind, lightning, hail).
Flood	Yes	The 2011 ECSU PDM plan rated flood a significant threat hazard for the planning area. The County has had 2 disaster declarations related to flooding.
Severe Winter Weather	Yes	The 2011 ECSU PDM plan found ice/snow to be a low threat hazard. The HMPC expressed interest in addressing this hazard as severe winter weather to include cold/wind chill; extreme cold; freezing fog; frost/freeze; heavy snow; ice storm; winter storm; and winter weather.
Drought	No	The 2011 ECSU PDM plan did not address this hazard.
Wildfire	Yes	The 2011 ECSU PDM plan did not assign a threat and/or risk level for this hazard; however, the HMPC expressed interest in addressing this hazard.
Earthquake*	Yes	The 2011 ECSU PDM plan did not assign a threat and/or risk level for this hazard; however, the HMPC expressed interest in addressing this hazard.
Geological Hazards (Sinkhole & Landslide)	No	The 2011 ECSU PDM plan did not assign a threat and/or risk level for this hazard; and the HMPC did not express an interest in addressing this hazard.
Dam Failure	No	The 2011 ECSU PDM plan did not address this hazard.
Extreme Heat	No	The 2011 ECSU PDM plan did not address this hazard.
Technological and Human-Caused Hazards & Threats		
Hazardous Materials Incidents	Yes	The 2011 ECSU PDM plan did not address this hazard; however, there are fixed facility sites and transportation routes with hazardous materials in the planning area and the HMPC expressed interest in addressing this hazard.
Infectious Disease	Yes	The 2011 ECSU PDM plan did not address this hazard; however, due to the COVID-19 pandemic that occurred during this planning process, the HMPC determined infectious disease should be addressed.
Cyber Attack	Yes	The 2011 ECSU PDM plan did not address this hazard; however, the HMPC expressed interest in re-evaluating cyber-attacks in this plan update.
Civil Unrest	No	The 2011 ECSU PDM plan did not address this hazard and the HMPC did not express interest in re-evaluating civil unrest in this plan update.

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

B.5 HAZARD PROFILES, ANALYSIS, AND VULNERABILITY

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 where it may occur, the severity of potential events, records of past events, the probability of future occurrences, and potential impacts from the hazard. A vulnerability assessment was conducted for each hazard using quantitative and/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.

To account for regional differences in hazard risk across each of the campuses, this risk assessment is divided into two parts:

1) a set of summary hazard profiles describing each hazard and summarizing the risk findings for each campus, presented in Section 3.5; and
2) a campus-specific risk assessment profiling the location, extent, historical occurrences, probability of future occurrence, and vulnerability of each campus, presented in each campus annex.

In the campus-level hazard profiles presented here, each hazard is profiled in the following format:

Location

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

Extent

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

Historical Occurrences

This section contains information on historical events, including the location and consequences of all past events on record within or near the Pasquotank County planning area. Where possible, this plan uses a consistent 20-year period of record except for hazards with significantly longer average recurrence intervals or where data limitations otherwise restrict the period of record.

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)

Vulnerability Assessment

This section quantifies, to the extent feasible using best available data, assets at risk to natural hazards and potential loss estimates. Details on hazard specific methodologies and assumptions are provided where applicable. People, properties and critical facilities, and environmental assets that are vulnerable to the hazard are identified.

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

- Geographic Information System (GIS) datasets, including County parcel data from 2020, campus building inventory and values from the University System's Division of Information Technology, NCEM iRisk Database, and property values provided by the NC Department of Insurance, topography, transportation layers, and critical facility and infrastructure locations;
- Hazard layer GIS datasets from state and federal agencies;
- Written descriptions of inventory and risks provided by the 2018 State of North Carolina Hazard Mitigation Plan;
- Written descriptions of inventory and risks provided by the 2020 Albemarle Regional Hazard Mitigation Plan; and
- Exposure and vulnerability estimates derived using local parcel data.

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. For applicable hazards, the quantitative analysis involved the use of FEMA's Hazus-MH, a nationally applicable standardized set of models for estimating potential losses from earthquakes and hurricanes. Hazus uses a statistical approach and mathematical modeling of risk to predict a hazard's frequency of occurrence and estimated impacts based on recorded or historic damage information. The Hazus risk assessment methodology is parametric, in that distinct hazard and inventory parameters—such as wind speed and building type—were modeled using the Hazus software to determine the impact on the built environment. Additionally, quantitative analysis can be performed through a GIS-based risk assessment for the flood, wildfire, and hazardous materials 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. Other information can be collected in regard to the hazard area, such as the location of critical facilities and infrastructure, historic resources, 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.

The data collected for the hazard profiles and vulnerability assessment was obtained from multiple sources covering a variety of spatial areas including county-, jurisdictional-, and campus-level information. The table below presents the source data and the associated geographic coverages.

Table B.14 – Summary of Hazard Data Sources and Geographic Coverage

Hazard	Hazard Data Sources	Profile Geographic Area	Vulnerability Methodology	Vulnerability Geographic Area
Earthquake	USGS, NCEI	County	Hazus 4.2	Census Tract
Flood	NCEI, FEMA	Jurisdiction	GIS Spatial Analysis	Campus

Hazard	Hazard Data Sources	Profile Geographic Area	Vulnerability Methodology	Vulnerability Geographic Area
Hurricane	NHC	County	Hazus 4.2	Census Tract
Severe Winter Weather	NWS, NCEI	County	Statistical Analysis	County
Tornado / Thunderstorm	NWS, NCEI	Jurisdiction	Statistical Analysis	Jurisdiction
Wildfire	NCFS, SouthWRAP	County, Campus	GIS Spatial Analysis	Campus
Cyber Threat	Internet Research	County, Higher Education	Qualitative Analysis	Higher Education
Hazardous Materials Incidents	EPA; USDOT	Jurisdiction	GIS Spatial Analysis	Campus
Infections Disease	CDC; WHO	National, Higher Education	Qualitative Analysis	Higher Education

CDC = Centers for Disease Control and Prevention; EPA = United States Environmental Protection Agency; FEMA = Federal Emergency Management Agency; NCEI = National Centers for Environmental Information; NCFS = North Carolina Forest Service; NHC = National Hurricane Center; NWS = National Weather Service; SouthWRAP = Southern Group of State Foresters, Wildfire Risk Assessment Portal; USDOT = United States Department of Transportation; USGS = United States Geological Survey; WHO = World Health Organization

Changes in Development

This section describes how changes in development have impacted vulnerability since the last plan was adopted. 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.

Problem Statements

This section summarizes key mitigation planning concerns related to this hazard.

Priority Risk Index

The conclusions drawn from the hazard profiling and vulnerability assessment process are used to prioritize all potential hazards to the ECSU 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 B.15** on the following page.

PRI ratings are provided by category throughout each hazard profile for the planning area as a whole. Ratings specific to each jurisdiction are provided at the end of each hazard profile. The results of the risk assessment and overall PRI scoring are provided in Section B.5.11 Conclusions on Hazard Risk.

The sum of all five risk assessment categories equals the final PRI value, demonstrated in the equation below (the lowest possible PRI value is a 1.0 and 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 campus 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.

Table B.15 – 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	

B.5.1 Earthquake

Hazard	Probability	Impact	Spatial Extent	Warning Time	Duration	PRI Score
Earthquake	Unlikely	Minor	Large	Less than 6 hours	Less than 6 hours	1.9

Location

The United States Geological Survey (USGS) Quaternary faults database was consulted to determine the sources of potential earthquakes within range of Pasquotank County. Quaternary faults are active faults recognized at the surface which have evidence of movement in the past 2.58 million years. No active faults were noted in Pasquotank County.

Earthquakes are generally felt over a wide area, with impacts occurring hundreds of miles from the epicenter. Therefore, any earthquake that impacts Pasquotank County is likely to be felt across most if not all of the planning area.

Spatial Extent: 4 – Large

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 B.16.** 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 B.17** 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 B.16 – 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 B.17 – 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.

MMI	Richter Scale	Felt Intensity
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.
VIII	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 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.

Impact: 1 – Minor

Historical Occurrences

The USGS Earthquake Hazards Program maintains a database of historical earthquakes of a magnitude 2.5 and greater from 1900 to 2020. Earthquake events that occurred within 100 miles of Pasquotank County include one event in the town of Bayboro, North Carolina within Pamlico County. This historic event was a 2.9 magnitude earthquake on February 11, 2014.

The National Center for Environmental Information (NCEI) maintains a database of the felt intensity of earthquakes from 1638 to 1985 including the maximum intensity for each locality that felt the earthquake. According to this database, in the 100-year period from 1885-1985, there were no earthquakes felt in and around Elizabeth City.

Probability of Future Occurrence

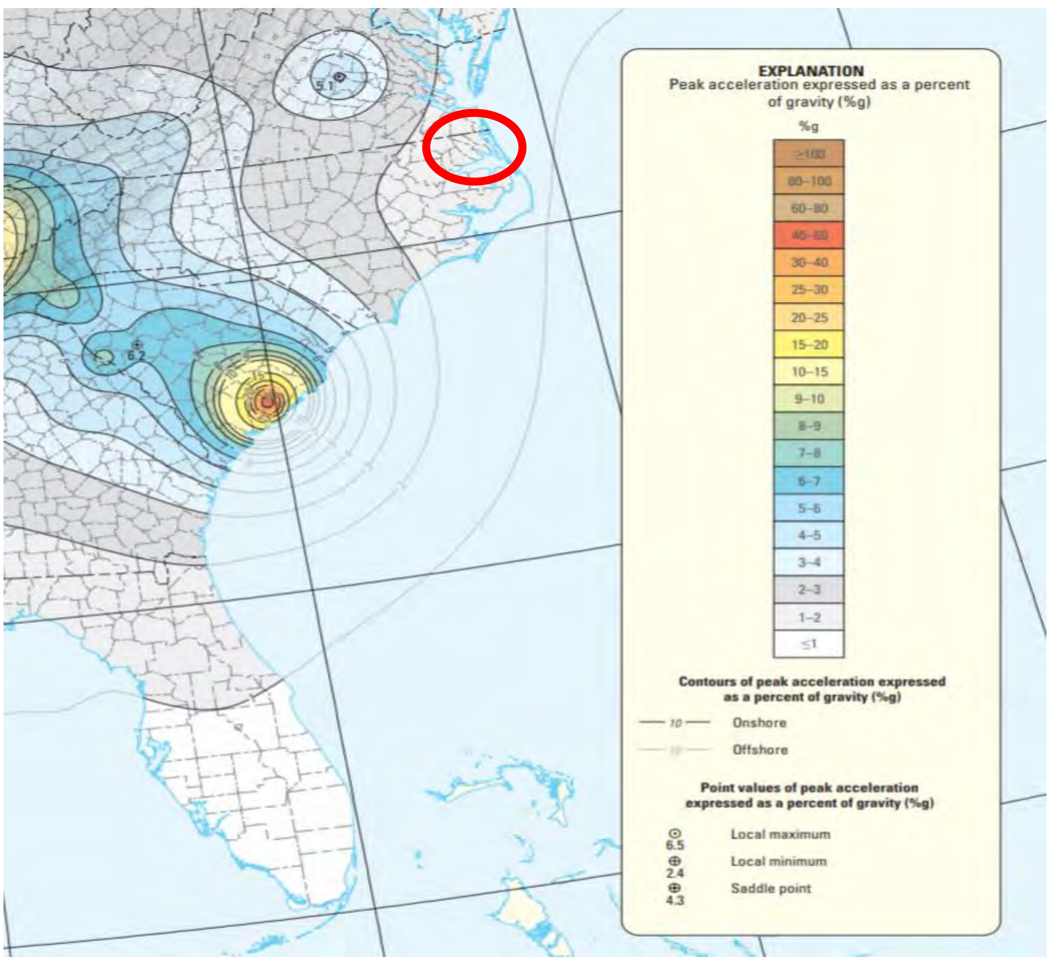
Ground motion is the movement of the earth's surface due to earthquakes or explosions. It is produced by waves generated by a sudden slip on a fault or sudden pressure at the explosive source and travels through the earth and along its surface. Ground motion is amplified when surface waves of unconsolidated 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 that have a common given probability of being exceeded in 50 years.

Figure B.7 reflects the seismic hazard for Pasquotank 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. All of Pasquotank County is located within a zone with peak acceleration of 1-2% g, which indicates low earthquake risk.

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

Probability: 1 – Unlikely

Figure B.7 – Seismic Hazard Information for Pasquotank County



Source: USGS Earthquake Hazards Program

Vulnerability Assessment

Methodology & Assumptions

To quantify vulnerability, Wood performed a Level 1 earthquake analysis in Hazus 4.2 utilizing general building stock information based on the 2010 Census. The ECSU campus is located within a single census tract encompassing 1.64 square miles. The earthquake scenario was modeled after an arbitrary earthquake event of magnitude 5.0 with an epicenter in the ECSU campus and depth of 10km.

People

Hazus estimates that the modeled magnitude 5.0 event would result in no households requiring temporary shelter. Additionally, Hazus estimates potential injuries and fatalities depending on the time of day of an event. Casualty estimates are shown in **Figure B.8**. Casualties are broken down into the following four levels that describe the extent of injuries:

- Level 1: Injuries will require medical attention, but hospitalization is not needed.
- Level 2: Injuries will require hospitalization but are not considered life-threatening.
- Level 3: Injuries will require hospitalization and can become life threatening if not promptly treated.
- Level 4: Victims are killed by the earthquake.

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. Impacts of earthquakes also include debris clean-up and service disruption. Per the Hazus analysis, a 5.0 magnitude earthquake could not produce debris.

Pasquotank County has not been impacted by an earthquake with more than a low intensity, so major damage to the built environment is unlikely. **Table B.18** details the estimated buildings impacted by a magnitude 5.0 earthquake event, as modeled by Hazus. Note that building value estimates are inherent to Hazus and do not necessarily reflect damages to the asset inventory for the ECSU Campus.

Table B.18 – Estimated Buildings Impacted by 5.0 Magnitude Earthquake Event

Occupancy Type	Estimated Building Damage	Estimated Content Loss	Estimated Total Damage
Residential	$0	$0	$0
Commercial	$0	$0	$0
Industrial	$0	$0	$0
Other	$0	$0	$0
Total	**$0**	**$0**	**$0**

Source: Hazus

Figure B.8 – Casualty Estimate from a 5.0 Magnitude Earthquake Event

		Level 1	Level 2	Level 3	Level 4
2 AM	Commercial	0	0	0	0
	Commuting	0	0	0	0
	Educational	0	0	0	0
	Hotels	0	0	0	0
	Industrial	0	0	0	0
	Other-Residential	0	0	0	0
	Single Family	0	0	0	0
	Total	**0**	**0**	**0**	**0**
2 PM	Commercial	0	0	0	0
	Commuting	0	0	0	0
	Educational	0	0	0	0
	Hotels	0	0	0	0
	Industrial	0	0	0	0
	Other-Residential	0	0	0	0
	Single Family	0	0	0	0
	Total	**0**	**0**	**0**	**0**
5 PM	Commercial	0	0	0	0
	Commuting	0	0	0	0
	Educational	0	0	0	0
	Hotels	0	0	0	0
	Industrial	0	0	0	0
	Other-Residential	0	0	0	0
	Single Family	0	0	0	0
	Total	**0**	**0**	**0**	**0**

Source: Hazus 4.2

All critical facilities should be considered at risk to minor damage should an earthquake event occur. However, none of the essential facilities included in Hazus—which include four schools and one police station—were estimated to sustain damages. Additionally, Hazus projected one bridge and one communication utility to experience at least moderate damage.

Environment

An earthquake is unlikely to cause substantial impacts to the natural environment in Pasquotank 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.

Changes in Development

Building codes substantially reduce the costs of damage to future structures from earthquakes. Future construction on the ECSU campus must follow the applicable requirements of the NC building codes, the State of North Carolina statutes for state owned buildings and zoning for the local jurisdiction.

Development changes at ECSU have not affected the risk characteristics of earthquakes. The probability, impact, spatial extent, warning time, and duration of earthquakes have not changed.

Problem Statement

- While earthquakes are an unlikely hazard event for the ECSU campus, the Hazus model did predict impacts to a communication utility and bridge structure.

B.5.2 Flood

Hazard	Probability	Impact	Spatial Extent	Warning Time	Duration	PRI Score
Flood	Highly Likely	Minor	Small	6 to 12 hrs	Less than 1 week	2.5

Location

Regulated floodplains are illustrated on inundation maps called Flood Insurance Rate Maps (FIRMs). A FIRM 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 1-percent-annual-chance flood event. Structures located within the SFHA have a 26-percent chance of flooding during the life of a standard 30-year mortgage.

For this risk assessment, flood prone areas were identified within the ECSU Campus using the FIRM dated December 21, 2018. **Figure B.9** reflects the 2018 mapped flood insurance zones. **Table B.19** summarizes the flood insurance zones identified by the Digital FIRM (DFIRM).

Spatial Extent: 2 – Small

Table B.19 – Mapped Flood Insurance Zones

Zone	Description
A	Zone A is the flood insurance rate zone that corresponds to the 1% annual chance floodplains that are determined in the FIS Report by approximate methods. Because detailed hydraulic analyses are not performed for such areas, no Base Flood Elevations or depths are shown within this zone.
AE	Zone AE is the flood insurance rate zone that corresponds to the 1% annual chance floodplains that are determined in the FIS Report by detailed methods. In most instances, whole-foot Base Flood Elevations derived from the detailed hydraulic analyses are shown at selected intervals within this zone.
AH	Zone AH is the flood insurance rate zone that corresponds to the areas of 1% annual chance shallow flooding (usually areas of ponding) where average depths are between 1 and 3 feet. Whole-foot Base Flood Elevations derived from the detailed hydraulic analyses are shown at selected intervals within this zone.
AO	Zone AO is the flood insurance rate zone that corresponds to the areas of 1% annual chance shallow flooding (usually sheet flow on sloping terrain) where average depths are between 1 and 3 feet. Average whole-foot depths derived from the detailed hydraulic analyses are shown within this zone.
VE	Zone VE is the flood insurance rate zone that corresponds to the 1% annual chance coastal floodplains that have additional hazards associated with storm waves. Whole-foot Base Flood Elevations derived from the detailed hydraulic analyses are shown at selected intervals within this zone.
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 0.2-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 4.4 percent of the ECSU Campus falls within the SFHA. **Table B.20** provides a summary of the ECSU Campus' total area by flood zone on the 2018 effective DFIRM.

Figure B.9 – FEMA Flood Hazard Areas in ECSU's Campus Boundary

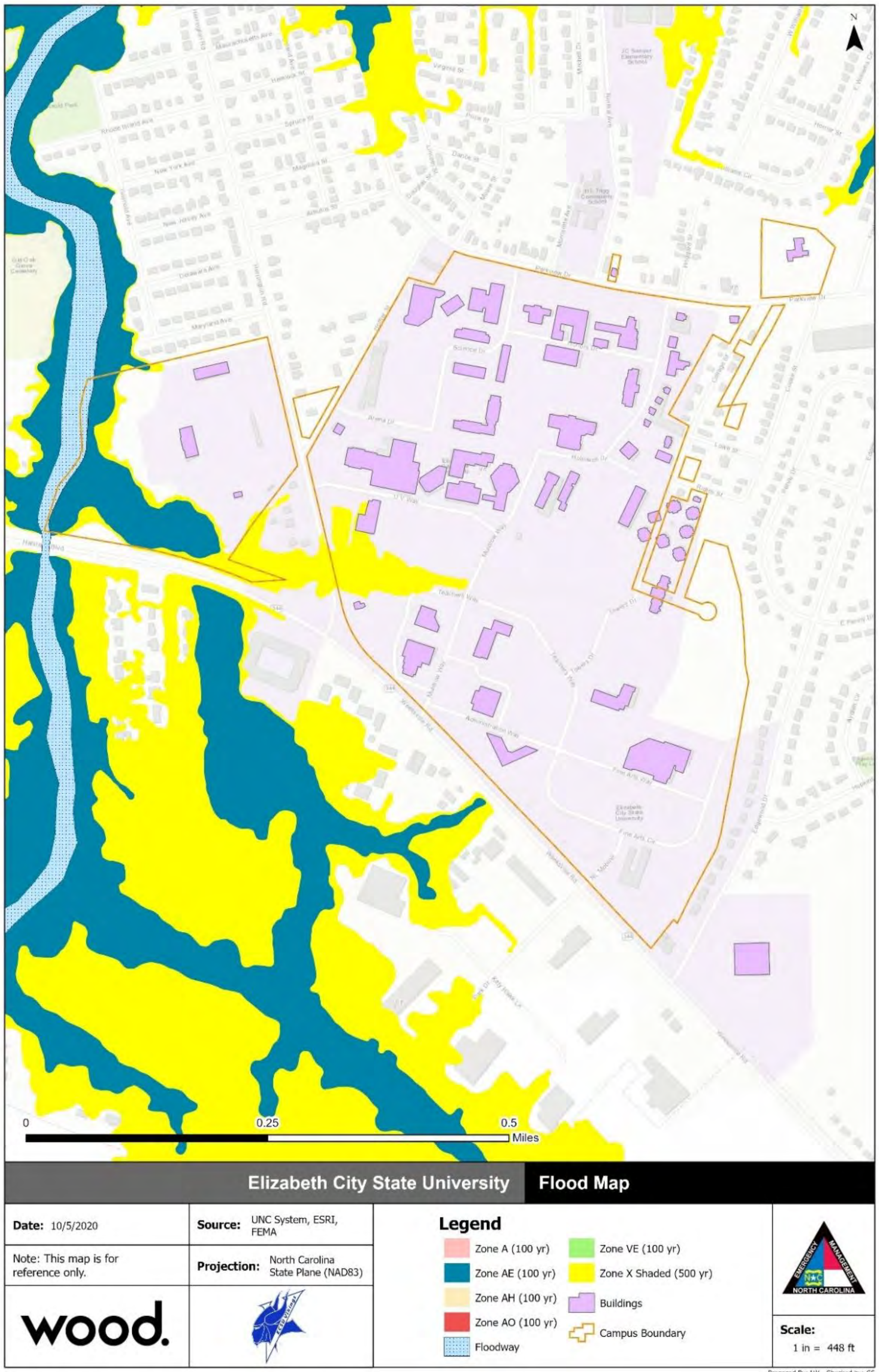


Table B.20 – Flood Zone Acreage on ECSU Campus

Flood Zone	Acreage	Percent of Total (%)
A	0	0.0%
AE	6.80	4.1%
AH	0	0.0%
AO	0	0.0%
Floodway	1	0.3%
VE	0	0.0%
0.2% Annual Chance Flood Hazard	6	3.7%
Unshaded X	154	91.9%
Total	167	---
SFHA Total	7	4.4%

Source: FEMA 2018 DFIRM

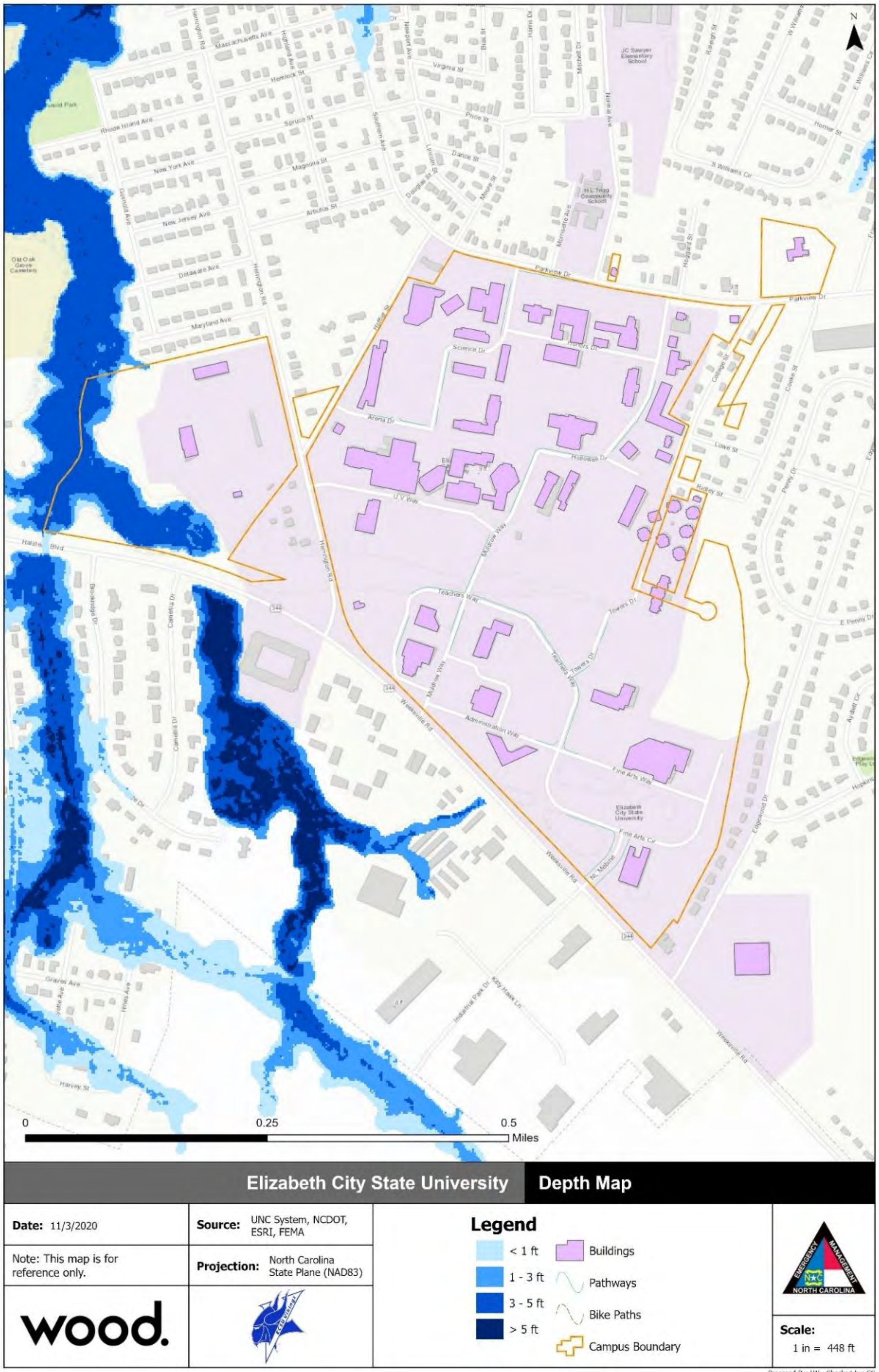
Although this assessment focuses on riverine flooding, it is also important to note that localized stormwater flooding can also occur on campus and may affect areas outside the mapped floodplain. Data was not available to evaluate the location or extent of stormwater flooding on campus.

Extent

Flood extent can be defined by the amount of land in the floodplain, detailed above, and the potential magnitude of flooding as measured by flood depth and velocity. **Figure B.10** shows the depth of flooding predicted from a 1% annual chance flood. Flood damage is closely related to depth, with greater flood depths generally resulting in more damages.

Impact: 1 – Minor

Figure B.10 – Flood Depth, 1-Percent-Annual-Chance Flood, ECSU Campus



Historical Occurrences

Table B.21 details the historical occurrences of flooding for Elizabeth City identified from 2000 through 2019 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 B.21 – NCEI Records of Flooding, 2000-2019

Location	Date	Deaths/Injuries	Reported Property Damage	Reported Crop Damage
Flash Flood				
ELIZABETH CITY	8/9/2005	0/0	$0	$0
ELIZABETH CITY	8/30/2006	0/0	$0	$0
ELIZABETH CITY	9/1/2006	0/0	$0	$0
ELIZABETH CITY	7/6/2008	0/0	$5,000	$0
ELIZABETH CITY	9/6/2019	0/0	$0	$0
Flood				
(ECG)ELIZABETH CITY	8/27/2011	0/0	$0	$0
ELIZABETH CITY	7/24/2018	0/0	$0	$0
Heavy Rain				
(ECG)ELIZABETH CITY	10/24/2007	0/0	$0	$0
(ECG)ELIZABETH CITY	12/10/2008	0/0	$0	$0
(ECG)ELIZABETH CITY	11/11/2009	0/0	$0	$0
ELIZABETH CITY	3/29/2010	0/0	$0	$0
ELIZABETH CITY	7/11/2013	0/0	$0	$0
(ECG)ELIZABETH CITY	5/16/2014	0/0	$0	$0
ELIZABETH CITY	7/16/2014	0/0	$0	$0
(ECG)ELIZABETH CITY	11/9/2015	0/0	$0	$0
ELIZABETH CITY	9/19/2016	0/0	$0	$0
(ECG)ELIZABETH CITY	10/8/2016	0/0	$0	$0
ELIZABETH CITY	7/28/2017	0/0	$0	$0
ECG CST GRD AIR STN	7/29/2017	0/0	$0	$0
ELIZABETH CITY	8/13/2017	0/0	$0	$0
ECG CST GRD AIR STN	6/20/2018	0/0	$0	$0
(ECG)ELIZABETH CITY	9/6/2019	0/0	$0	$0
ELIZABETH CITY	10/20/2019	0/0	$0	$0
	Total	**0/0**	**$5,000**	**$0**

Source: NCEI

According to NCEI, 23 recorded flood-related events affected the planning area from 2000 to 2019 causing an estimated $5,000 in property damage, with no injuries, fatalities, or crop damage.

The following event narratives are provided in the NCEI Storm Events Database and illustrate the impacts of flood events on the county:

- **09/1/2006** - Numerous roads closed countywide. National Guard was rescuing people from houses due to flooding.
- **08/27/2011** - Heavy rains associated with Hurricane Irene produced widespread low-land flooding across much of the county, including roadways which were washed out or closed. Storm total rainfall generally ranged from four to ten inches. Burnt Mills reported 7.80 inches of rain. Elizabeth City reported 7.50 inches of rain.
- **10/8/2016** - Numerous roads were impassable or closed, and some small creeks or streams were out of their banks due to heavy rain causing flash flooding across much of the county.
- **9/6/2019** - Flash flooding was reported on several campus streets at Elizabeth City State University. In addition, several buildings reported having water in interior entrances. Several streets were flooded and closed in the Elizabeth City area. Also, vehicles were stranded. Flora Street was impassable due to flash flooding.

The state of North Carolina has had two FEMA Major Disaster Declarations for severe storms that include elements of flooding in 1962 and 1964 along with four Major Disaster Declarations for Hurricanes in 1954, 1955, 1958, 1960 which may have included damages associated with flooding. Additionally, Pasquotank County has received 6 Major Disaster Declarations for Hurricanes in, 1998, 1999, 2003, 2011, 2016, and 2019 which also may have included damages associated with flooding.

Probability of Future Occurrence

By definition, SFHAs are those areas that will be inundated by the flood event having a 1-percent chance of being equaled or exceeded in any given year. While exposure to flood hazards varies across jurisdictions, all jurisdictions have at least some area of land in FEMA-mapped flood hazard areas. This delineation is a useful way to identify the most at-risk areas, but flooding does not occur in set intervals; any given flood may be more or less severe than the defined 1-percent-annual-chance flood. There is also risk of localized and stormwater flooding in areas outside the SFHA and at different intervals than the 1% annual chance flood.

Floods of varying severity occur regularly in Pasquotank County, and impacts from past flood events have been noted by NCEI. NCEI reports 23 flood-related events in the 20-year period from 2000-2019, which equates to an annual probability greater than 100% for Elizabeth City alone. Therefore, the overall probability of flooding is considered highly likely (near or more than 100% annual probability).

Probability: 4 – Highly Likely

Vulnerability Assessment

Methodology & Assumptions

To quantify vulnerability, Wood performed a GIS spatial analysis of the flood hazard by overlaying the mapped SFHA on the building footprints provided by the UNC Division of Information Technology and NCEM iRisk database. For the ECSU campus, there are no structures located within the SFHA.

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 systems lose 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 high risk when driving through flooded streets. However, NCEI does not contain any records of deaths in Pasquotank County caused by flood events.

An estimate of population at risk to flooding can be developed based on the assessment of housing property at risk. For the ECSU campus, there are no housing properties at risk.

Property

Administration buildings, education and/or extracurricular facilities, housing, as well as critical facilities and infrastructure such as transportation, water, energy, and communication systems may be damaged or destroyed by flood waters.

During the critical facility identification process, it was noted that the Information Technology Center is vulnerable to flooding, including servers on the main floor. There is a history of water encroaching in the server room, and water sensors have been installed.

Table B.22 details the estimated losses for the 1%-annual-chance flood event for the campus. The total damage estimate value is based on damages to the total of building value. Land value is not included in any of the loss estimates as generally land is not subject to loss from floods.

Table B.22 – Estimated Building Damage and Content Loss for 1% Annual Chance Flood

Occupancy Type	Total Buildings with Loss	Total Value	Estimated Building Damage	Loss Ratio
Administration	0	$0	$0	0%
Critical Facilities	0	$0	$0	0%
Education/ Extracurricular	0	$0	$0	0%
Housing	0	$0	$0	0%
Total	**0**	**$0**	**$0**	**0%**

Source: UNC Division of Information Technology; NCEM iRisk; NC Department of Insurance; USACE Wilmington District Depth-Damage Function

The loss ratio is the loss estimate divided by the total potential exposure (i.e., total of improved value for all buildings located within the Zone AE) and displayed as a percentage of loss. FEMA considers loss ratios greater than 10% to be significant and an indicator a community may have more difficulties recovering from a flood. Loss ratios for all occupancy types with identified structures on the ECSU campus are 0%, meaning that in the event of a flood with a magnitude of the 1%-annual-chance event or greater, the planning area would be minimally impacted.

None of the critical facilities identified for ECSU are located within the 1%-annual-chance floodplain, therefore there are no estimated damages. However, the Central Utility Plant is located within the 0.2%-annual-chance-floodplain.

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 planning area. According to 2020 NFIP records, there are no repetitive loss properties on the ECSU campus.

Environment

During a flood event, chemicals and other hazardous materials 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.

Changes in Development

The likelihood of future flood damage can be reduced through appropriate land use planning, building siting and building design. In addition, the ECSU Facilities Management works to maintain compliance with all applicable state and federal regulations regarding water resources, provides a regulatory framework to ensure development has minimal impact on the environment, and manages the stormwater infrastructure.

Problem Statement

- The 1% annual chance floodplain does not impact any structures on the ECSU campus. However, the 0.2% annual chance floodplain (or 500-year floodplain) does extend onto the ECSU campus and could potentially impact the Central Utility Plant and roadways during these flood events.
- In 2019, a flash flood event was reported on several campus streets at Elizabeth City State University.

B.5.3 Hurricane

Hazard	Probability	Impact	Spatial Extent	Warning Time	Duration	PRI Score
Hurricane	Likely	Catastrophic	Large	More than 24 hrs	Less than 24 hrs	3.2

Location

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

Storm surges, or storm floods, are limited to the coastal counties of North Carolina. ECSU is located close to the coast and is therefore impacted by the storm surges of all five hurricane categories. **Figure B.11** through **Figure B.15** below shows the different storm surge extents for hurricane categories 1-5 at ECSU. The entire campus is completely inundated during Category 4 and Category 5 storm surge events. Additionally, hurricane winds can impact the entire campus, so the spatial extent was determined to be large.

Spatial Extent: 4 – Large

Extent

Hurricane intensity is classified by the Saffir-Simpson Scale (**Table B.23**), which rates hurricane intensity on a scale of 1 to 5, with 5 being the most intense.

Table B.23 – 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 (NCH)

Figure B.11 -- Category 1 Storm Surge Inundation Areas, ECSU

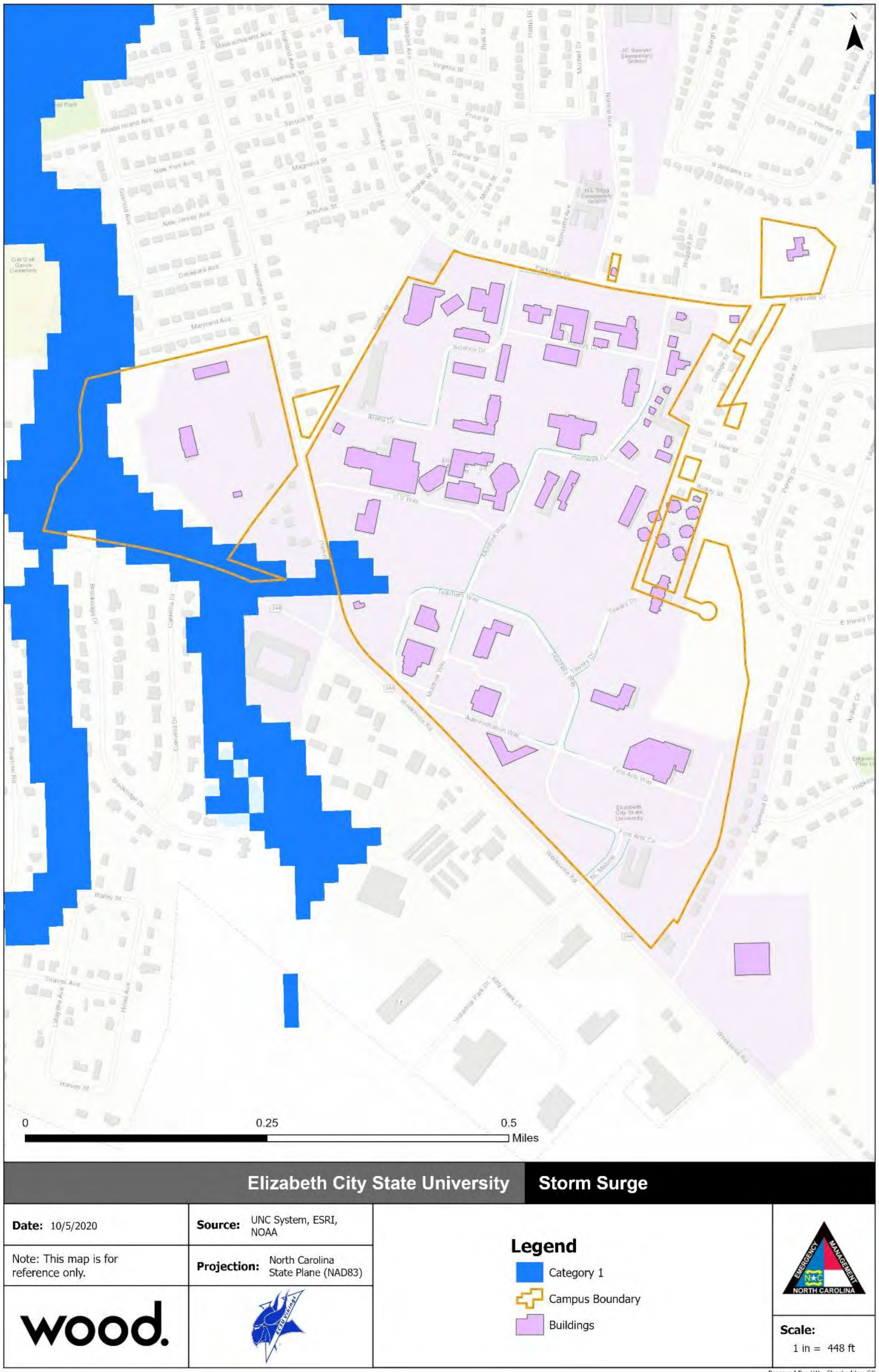


Figure B.12 -- Category 2 Storm Surge Inundation Areas, ECSU

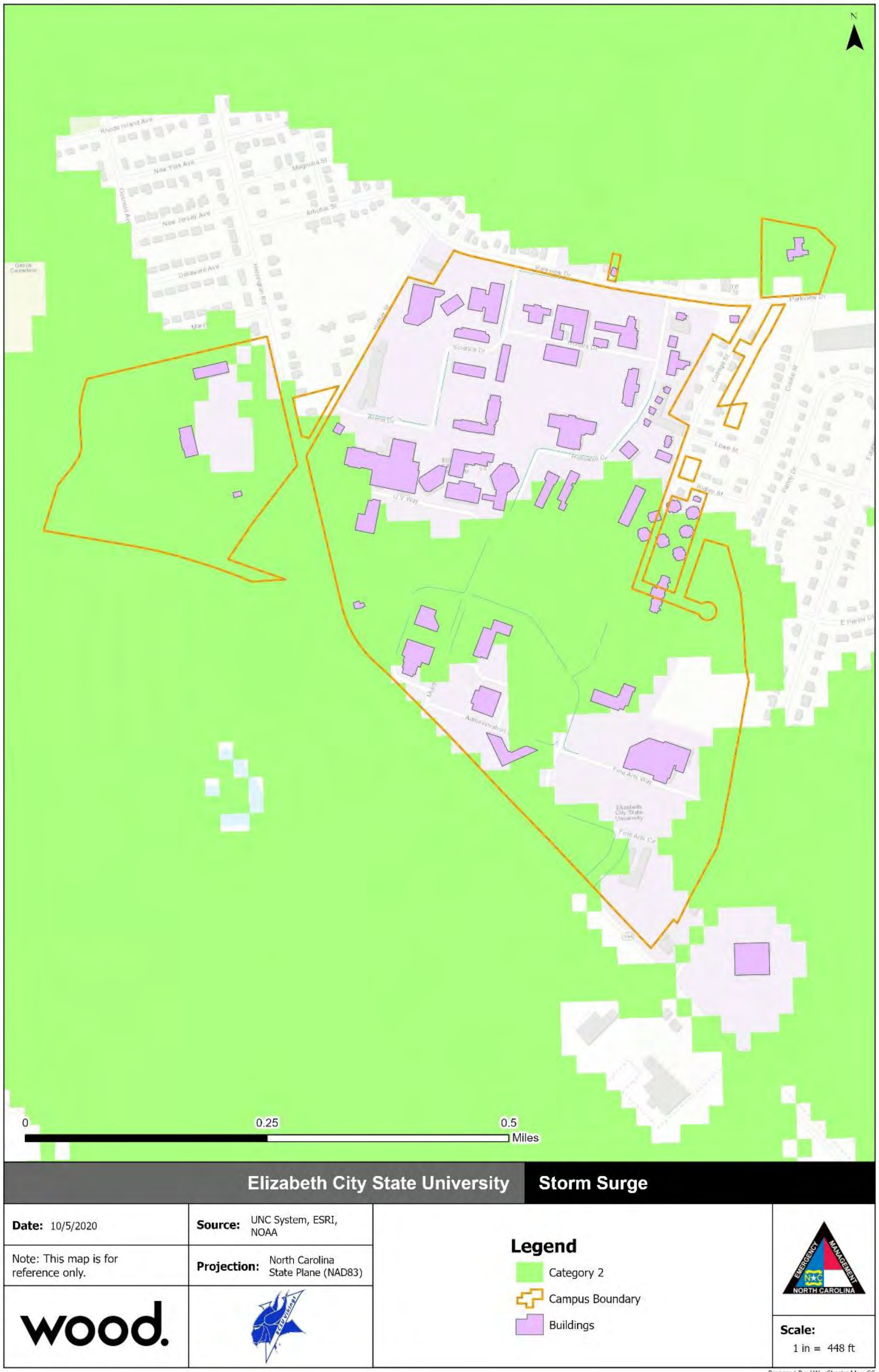


Figure B.13 -- Category 3 Storm Surge Inundation Areas, ECSU

Figure B.14 -- Category 4 Storm Surge Inundation Areas, ECSU

Figure B.15 -- Category 5 Storm Surge Inundation Areas, ECSU

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 B.24** 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 B.24 – 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

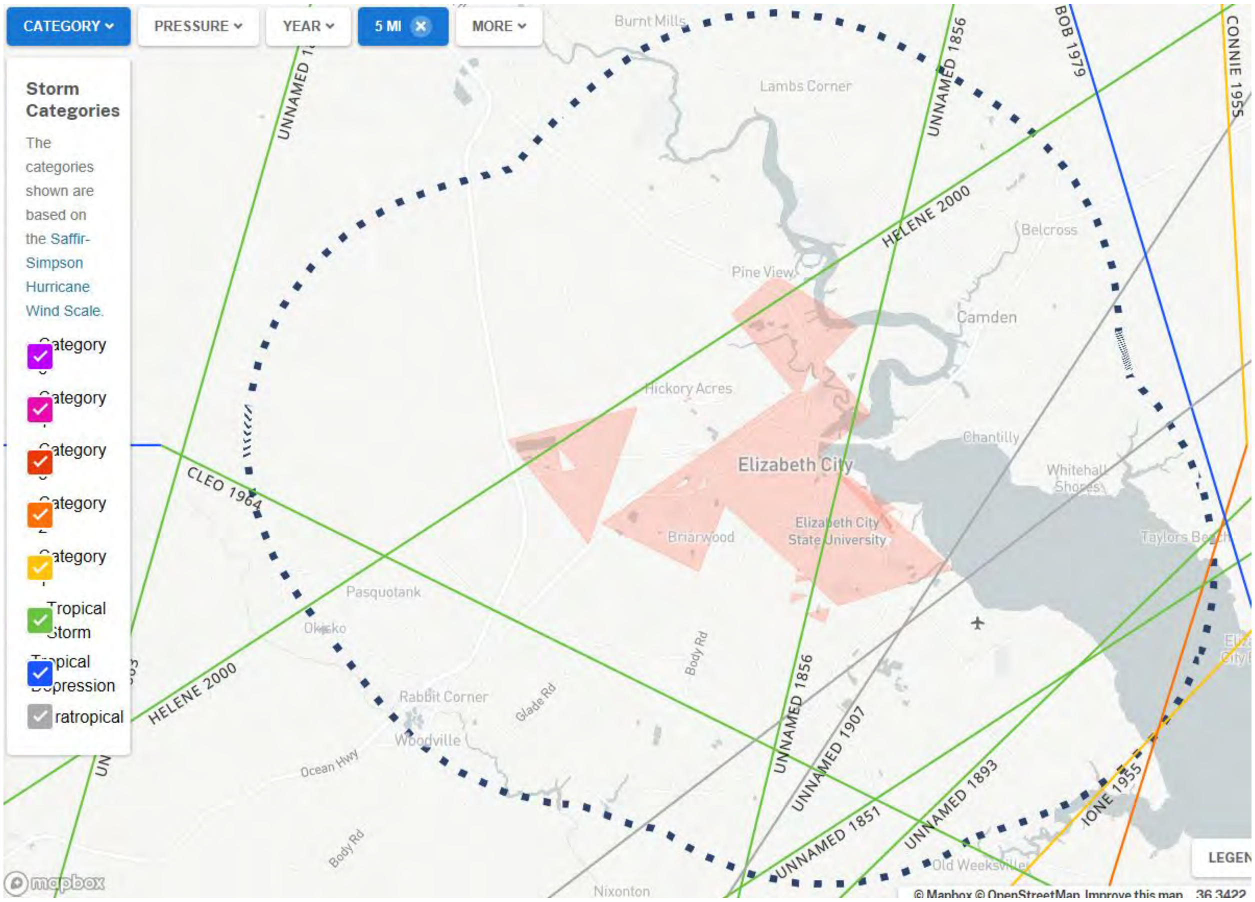
Pasquotank County may experience any category of hurricane force winds. A storm on record that directly impacted ECSU was an unnamed tropical storm whose path moved through the campus in 1856 with maximum wind speeds of around 57 mph. However, Hurricane Connie passed within 5 miles of ECSU's campus as a Category 2 storm with wind speeds around 98 mph in 1955.

Impact: 4 – Catastrophic

Historical Occurrences

Storm tracks for hurricane-related events that have passed within 5 miles of ECSU's campus were obtained from NOAA 's database and are shown in **Figure B.16**. The NCEI Storm Events database has recorded seven hurricanes and tropical storms that passed through Pasquotank County between 2000 and 2019. **Table B.25** details the historical occurrences.

Figure B.16 – Hurricane and Tropical Storm Tracks within 5 Miles of ECSU



Source: NOAA Office of Coastal Management; image captured directly from website. Dashed line is a 5-mile buffer zone.

Table B.25 – Recorded Hurricane and Tropical Storm Events for Pasquotank County, 2000-2019

Date	Type	Storm	Deaths/ Injuries	Property Damage	Crop Damage
9/18/2003	Hurricane (Typhoon)	Hurricane Isabel	0	$4,500,000	$0
8/14/2004	Tropical Storm	N/A	0	$0	$0
9/6/2008	Tropical Storm	Tropical Storm Hanna	0	$5,000	$0
8/27/2011	Hurricane (Typhoon)	Hurricane Irene	0	$500,000	$500,000
7/4/2014	Tropical Storm	Hurricane Arthur	0	$0	$0
9/2/2016	Tropical Storm	Tropical Storm Hermine	0	$0	$0
9/5/2019	Tropical Storm	Hurricane Dorian	0	$25,000	$0
		Total	**0/0**	**$5,030,000**	**$500,000**

Source: NCEI

According to NCEI, seven recorded hurricane-related events affected Pasquotank County from 2000 to 2019 causing an estimated $5,030,000 in property damage and $500,000 in crop damage. There were no injuries or fatalities recorded for any of these events.

The following event narratives are provided in the NCEI Storm Events Database and illustrate the impacts of hurricane and tropical storm events on the county:

Hurricane Isabel (2003) –Sustained tropical storm force winds with frequent gusts to hurricane force occurred over coastal northeast North Carolina. Isabel made landfall near Ocracoke Inlet in North Carolina, tracked northwest into central Virginia just west of Richmond, then continued northward into western Pennsylvania. The highest sustained wind speed recorded was 73 mph at Duck (DUCN7). Other sustained wind speed was 59 mph at Elizabeth City (ECG). The highest gusts recorded were 97 mph at Elizabeth City (from Clemson University observation site in Elizabeth City), 92 mph at Duck (DUCN7), and 74 mph at Elizabeth City (ECG). The unusually large wind field uprooted many thousands of trees, downed many power lines, damaged hundreds of houses, and snapped thousands of telephone poles and cross arms. Hundreds of roads, including major highways, were blocked by fallen trees. Local power companies reported many thousands of customers were without power. On the Albemarle Sound, storm surge values around 7 feet occurred at Edenton, with a surge around 5 feet observed on the Pasquotank River in Elizabeth City. Isabel will be remembered for the greatest wind and storm surge in the region since Hazel in 1954, and the 1933 Chesapeake-Potomac Hurricane. Also, Isabel will be remembered for the extensive power outages in northeast North Carolina, and permanent change to the landscape from all the fallen trees and storm surge. Rainfall amounts ranged from 2 to 5 inches across coastal northeast North Carolina. Inland flooding due to heavy rainfall occurred over parts of coastal northeast North Carolina.

Hurricane Irene (2011) – Tropical storm force winds and Hurricane force wind gusts knocked down numerous trees and power lines, as well as caused some structural damage. In addition, heavy rains contributed to minor crop damage. The highest sustained wind of 43 knots (50 mph) with a peak gust of 64 knots (74 mph) was recorded at ECG (Elizabeth City). Storm total rainfall generally ranged from four to ten inches.

Hurricane Dorian (2019) – Tropical storm winds downed and uprooted several trees and power lines, produced minor structural damage, and caused power outages across the county. Wind gust of 61 knots (70 mph) was measured at ECG.

The state of North Carolina has had four FEMA Major Disaster Declarations for Hurricanes in 1954, 1955, 1958, 1960. Additionally, Pasquotank County has received 6 Major Disaster Declarations for Hurricanes in, 1998, 1999, 2003, 2011, 2016, and 2019.

Probability of Future Occurrence

In the 20-year period from 2000 through 2019, seven hurricanes and tropical storms have impacted the Pasquotank County, which equates to a 35 percent annual probability of hurricane winds impacting the county. This probability does not account for impacts from hurricane rains, which may also be severe. Overall, the probability of a hurricane or tropical storm impacting the County is likely.

Probability: 3 – Likely

Vulnerability Assessment

Methodologies and Assumptions

To quantify vulnerability, Wood performed a Level 1 hurricane wind analysis in Hazus 4.2 for three scenarios: a historical recreation of Hurricane Fran (1996) and simulated probabilistic wind losses for a 200-year and a 500-year event storm. The analysis utilized general building stock information based on the 2010 Census. The ECSU campus is located within a single census tract encompassing 1.64 square miles. The vulnerability assessment results are for wind-related damages. Hurricanes may also cause substantial damages from heavy rains and subsequent flooding, which is addressed in Section A.5.2. Flood.

People

The very young, the elderly and disabled individuals are more vulnerable to harm from hurricanes, as are those who are unable to evacuate for medical reasons, including 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 or ongoing treatment. For all affected populations, 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.

Table B.26 details the likelihood of building damages by occupancy type from varying magnitudes of hurricane events.

Table B.26 – Likelihood of Buildings Damages Impacted by Hurricane Wind Events

Occupancy	Buildings at Risk	Value at Risk	Likelihood of Damage (%)				
			None	Minor	Moderate	Severe	Destruction
Hurricane Fran (1996)							
Agriculture	2	$327,000	99.80%	0.20%	0.00%	0.00%	0.00%
Commercial	55	$23,758,000	99.70%	0.30%	0.00%	0.00%	0.00%
Education	2	$4,154,000	99.69%	0.31%	0.00%	0.00%	0.00%
Government	1	$138,000	99.68%	0.32%	0.00%	0.00%	0.00%
Industrial	14	$3,888,000	99.68%	0.32%	0.00%	0.00%	0.00%
Religion	6	$3,645,000	99.79%	0.21%	0.00%	0.00%	0.00%
Residential	1,612	$464,235,000	99.87%	0.13%	0.00%	0.00%	0.00%
200-year Hurricane Event							
Agriculture	1	$327,000	65.12%	21.37%	8.66%	4.27%	0.58%
Commercial	36	$23,758,000	66.17%	20.17%	11.69%	1.96%	0.01%
Education	1	$4,154,000	68.27%	19.34%	10.34%	2.05%	0.00%
Government	1	$138,000	68.12%	19.03%	10.68%	2.17%	0.00%
Industrial	9	$3,888,000	66.67%	18.80%	11.04%	3.28%	0.22%
Religion	4	$3,645,000	68.91%	21.30%	8.32%	1.47%	10.00%
Residential	1,021	$464,235,000	63.26%	26.97%	8.99%	0.53%	0.26%
500-year Hurricane Event							

Occupancy	Buildings at Risk	Value at Risk	Likelihood of Damage (%)				
			None	Minor	Moderate	Severe	Destruction
Agriculture	1	$327,000	47.16%	28.12%	14.77%	8.38%	1.57%
Commercial	27	$23,758,000	48.45%	24.95%	20.58%	5.98%	0.04%
Education	1	$4,154,000	50.62%	23.94%	18.73%	6.70%	0.00%
Government	1	$138,000	50.50%	23.94%	19.22%	7.04%	0.00%
Industrial	7	$3,888,000	48.99%	22.74%	19.13%	8.56%	0.59%
Religion	3	$3,645,000	51.11%	28.08%	15.94%	4.87%	0.00%
Residential	734	$464,235,000	45.45%	34.26%	17.45%	2.04%	0.80%

Table B.27 details the estimated building and content damages by occupancy type for varying magnitudes of hurricane events.

Table B.27 – Estimated Buildings Impacted by Hurricane Wind Events

Area	Residential	Commercial	Industrial	Others	Total
Hurricane Fran (1996)					
Building	$150	$0	$0	$0	$150
Content	$15,410	$0	$0	$0	$15,410
Inventory	$0	$0	$0	$0	$0
Total	**$15,560**	**$0**	**$0**	**$0**	**$15,560**
200-year Hurricane Event					
Building	$12,550,190	$345,550	$66,330	$97,170	$13,059,240
Content	$3,550,420	$157,350	$44,570	$44,980	$3,797,320
Inventory	$0	$1,850	$8,080	$380	$10,310
Total	**$16,100,610**	**$504,750**	**$118,980**	**$142,530**	**$16,866,870**
500-year Hurricane Event					
Building	$24,670,030	$796,170	$156,170	$236,950	$25,859,320
Content	$8,002,050	$425,270	$113,590	$125,930	$8,666,840
Inventory	$0	$4,890	$20,200	$850	$25,940
Total	**$32,672,080**	**$1,226,330**	**$289,960**	**$363,730**	**$34,552,100**

The damage estimates for the 500-year hurricane wind event total $34,552,100. These damage estimates account for only wind impacts and actual damages would likely be higher due to flooding. As noted in Section A.5.2, the Central Utility Plant and surrounding roadways are located within the 500-year floodplain. Therefore, the FSU campus would likely experience a higher overall loss from the 500-year hurricane event and may face difficulty recovering from such an event.

Environment

Hurricane winds can cause massive damage to the natural environment, uprooting trees and other debris within the storm's path. Animals can either be killed directly by the storm or impacted indirectly through changes in habitat and food availability caused by high winds and intense rainfall. Endangered species can be dramatically impacted. Forests can be completely defoliated by strong winds.

Changes in Development

Future development that occurs in the planning area should consider high wind hazards at the planning, engineering and architectural design stages. The University should consider evacuation planning in the event of a hurricane event.

Problem Statement

- Historical tracks of multiple hurricane events pass within 5-miles of the ECSU Campus.
- For the 20-year period from 2000 through 2019, there have been 7 hurricane wind events causing over $5 million dollars in damage for Pasquotank County.

B.5.4 Severe Winter Weather

Hazard	Probability	Impact	Spatial Extent	Warning Time	Duration	PRI Score
Severe Winter Weather	Highly Likely	Limited	Large	More than 24 hrs	Less than 1 week	3.0

Location

Severe winter weather is usually a countywide or regional hazard, impacting the entire county at the same time. 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. Pasquotank 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, severe winter weather can occur anywhere in the county.

Spatial Extent: 4 – Large

Extent

The National Oceanic and Atmospheric Administration (NOAA) uses the Regional Snowfall Index (RSI), shown in **Table B.28** for the Pasquotank County region, to assess the societal impact of winter storms in the six easternmost regions in the United States. The index makes use of population and regional differences to assess the impact of snowfall. For example, areas which receive very little snowfall on average may be more adversely affected than other regions, resulting in a higher severity. The County may experience any level on the RSI scale. Pasquotank County receives an average of 2 inches of snowfall per year. According to NCEI, the greatest snowfall amounts to impact Pasquotank County have been between 5-12 inches, with Elizabeth City reporting around 9 inches of snowfall. During the snowstorm of December 24 to December 26, 2010, from which 8-9.5 inches were reported near Elizabeth City, the county was classified as a Category 1 on the RSI scale. It is possible that more severe events and impacts could be felt in the future.

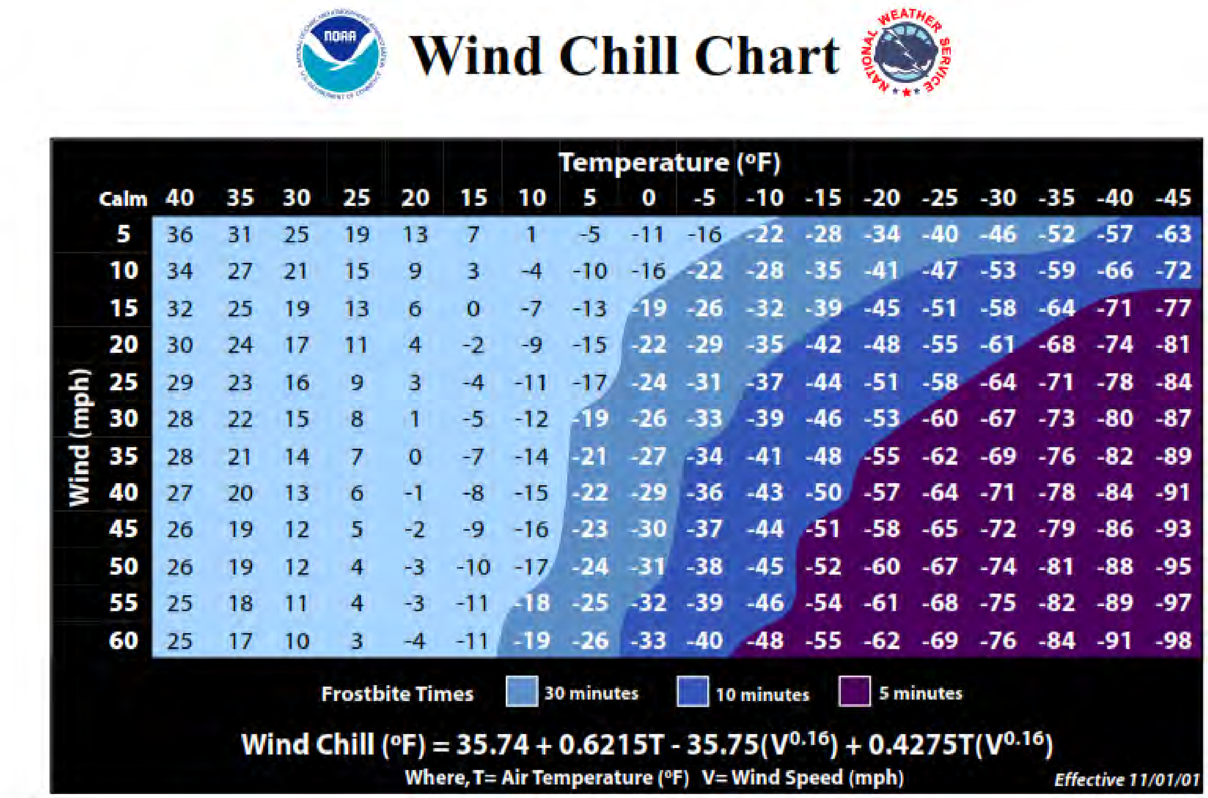
Table B.28 – Regional Snowfall Index (RSI) Values

Category	RSI Value	Description
1	1-3	Notable
2	3-6	Significant
3	6-10	Major
4	10-18	Crippling
5	18+	Extreme

Source: NOAA

Severe winter weather often involves 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 B.17**, provides a formula for calculating the dangers of winter winds and freezing temperatures. This presents wind chill temperatures which are based on the rate of heat loss from exposed skin caused by wind and cold. As the wind increases, it draws heat from the body, driving down skin temperature and eventually the internal body temperature.

Figure B.17 – NWS Wind Chill Temperature Index



Wind (mph)	Calm 40	35	30	25	20	15	10	5	0	-5	-10	-15	-20	-25	-30	-35	-40	-45
5	36	31	25	19	13	7	1	-5	-11	-16	-22	-28	-34	-40	-46	-52	-57	-63
10	34	27	21	15	9	3	-4	-10	-16	-22	-28	-35	-41	-47	-53	-59	-66	-72
15	32	25	19	13	6	0	-7	-13	-19	-26	-32	-39	-45	-51	-58	-64	-71	-77
20	30	24	17	11	4	-2	-9	-15	-22	-29	-35	-42	-48	-55	-61	-68	-74	-81
25	29	23	16	9	3	-4	-11	-17	-24	-31	-37	-44	-51	-58	-64	-71	-78	-84
30	28	22	15	8	1	-5	-12	-19	-26	-33	-39	-46	-53	-60	-67	-73	-80	-87
35	28	21	14	7	0	-7	-14	-21	-27	-34	-41	-48	-55	-62	-69	-76	-82	-89
40	27	20	13	6	-1	-8	-15	-22	-29	-36	-43	-50	-57	-64	-71	-78	-84	-91
45	26	19	12	5	-2	-9	-16	-23	-30	-37	-44	-51	-58	-65	-72	-79	-86	-93
50	26	19	12	4	-3	-10	-17	-24	-31	-38	-45	-52	-60	-67	-74	-81	-88	-95
55	25	18	11	4	-3	-11	-18	-25	-32	-39	-46	-54	-61	-68	-75	-82	-89	-97
60	25	17	10	3	-4	-11	-19	-26	-33	-40	-48	-55	-62	-69	-76	-84	-91	-98

Temperature (°F)

Frostbite Times: 30 minutes, 10 minutes, 5 minutes

$$\text{Wind Chill (°F)} = 35.74 + 0.6215T - 35.75(V^{0.16}) + 0.4275T(V^{0.16})$$

Where, T= Air Temperature (°F) V= Wind Speed (mph)

Effective 11/01/01

Source: https://www.weather.gov/safety/cold-wind-chill-chart

The most significant recorded snow depth over the last 20 years took place in December 2010, with recorded depths of up to 12 inches across the county.

Impact: 2 – Limited

Historical Occurrences

To get a full picture of the range of impacts of a severe winter weather, data for the following weather types as defined by the National Weather Service (NWS) 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.

According to the NCEI Storm Events Database, there was one blizzard event, three frost/freeze events, and 27 combined winter storm/winter weather events in Pasquotank County during the 20-year period from 2000 through 2019. As reported in NCEI, severe winter weather did not cause any fatalities, injuries, property damage, or crop damage, though these types of impacts may not have been reported and are possible in future events. Events in Pasquotank County by incident are recorded in **Table B.29.**

Table B.29 – Recorded Severe Winter Weather Events in Pasquotank County, 2000-2019

Event Type	Event Count	Fatalities	Injuries	Property Damage	Crop Damage
Blizzard	1	0	0	$0	$0
Frost/Freeze	3	0	0	$0	$0
Winter Storm	17	0	0	$0	$0
Winter Weather	10	0	0	$0	$0
Total	**32**	**0**	**0**	**0**	**$0**

Source: NCEI

Storm impacts from NCEI are summarized below:

December 26, 2010 – Snowfall amounts were generally between five and twelve inches across the county. Lynch's Corner reported 11.8 inches of snow. Elizabeth City reported between 8.0 inches and 9.5 inches of snow.

January 28, 2014 – Snow began during the afternoon of January 28th and continued into the early morning hours of January 29th. The snow mixed with sleet and freezing rain at times. Total snow accumulations were 3 to 6 inches across the county. Roads were icy for several days during and after the event.

April 5, 2016 – Freezing temperatures between 25 and 28 degrees occurred. The average duration was around 10 hours. Widespread damage to fruit trees and bushes was noted across the county. Winter wheat, barley, and hay grasses were also damaged.

January 17, 2018 – Low pressure deepening off the North Carolina coast produced significant snowfall over most of eastern North Carolina during the late evening of January 17th through the early morning of January 18th. Snowfall over the region ranged from less than 1 inch over the southwest tier to 8 inches or more over the north coast. There was one weather related traffic fatality reported in Washington county on the morning of January 18th.

Pasquotank County received two FEMA Major Disaster Declarations for a severe ice storm in 1968 and a blizzard in 1996.

Probability of Future Occurrence

NCEI records 32 severe winter weather related events during the 20-year period from 2000 through 2019, which equates to an annual probability greater than 100%. Therefore, the overall probability of severe winter weather in the county is considered highly likely (near or more than 100% annual probability).

Probability: 4 – Highly Likely

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.

The loss of use estimates provided in **Table B.30** were calculated using FEMA's publication *What is a Benefit?: Guidance on Benefit-Cost Analysis of Hazard Mitigation Project*, June 2009. These figures are used to provide estimated costs associated with the loss of power in relation to the populations served on campus. The loss of use is provided in the heading as the loss of use cost per person per day of loss. The estimated loss of use provided for the campus represents the loss of service of the indicated utility for one day for 10 percent of the population. These figures do not take into account physical damages to utility equipment and infrastructure.

Table B.30 – Loss of Use Estimates for Power Failure Associated with Severe Winter Weather

On-Campus Population (Fall 2020)	Estimated Affected Population (10%)	Electric Loss of Use Estimate ($126 per person per day)
772	77.2	$9,727

Property

No property damage was reported in association with any winter weather events recorded by the NCEI between 2000 and 2019 for Pasquotank County. Therefore, no annualized loss estimate could be calculated for this hazard.

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.

Changes in Development

Future development could potentially increase vulnerability to this hazard by increasing demand on the utilities and increasing the exposure of infrastructure networks. ECSU may wish to consider developing a flexible emergency power network to provide efficient back-up power for vulnerable populations, critical facilities, and research facilities.

Problem Statement

- Severe winter weather events are highly likely for Pasquotank County and the ECSU campus. The events have also resulted in two presidential disaster declarations for the County.

B.5.5 Tornadoes/Thunderstorms

Hazard	Probability	Impact	Spatial Extent	Warning Time	Duration	PRI Score
Tornado/Thunderstorm	Likely	Critical	Large	Less than 6 hrs	Less than 6 hrs	3.1

Location

Thunderstorm wind, lightning, and hail events do not have a defined vulnerability zone. The scope of lightning and hail is generally confined to the footprint of its associated thunderstorm. Although these events occur similarly throughout the planning area, they are more frequently reported in more urbanized areas because damages are more likely to occur where exposure is greater in more densely developed urban areas.

Thunderstorm Winds

The entirety of ECSU's campus can be affected by severe weather hazards. Thunderstorm wind events can span many miles and travel long distances, covering a significant area in one event. Due to the small size of the planning area, any given event will impact the entire planning area, approximately 50% to 100% of the planning area could be impacted by one event.

Spatial Extent: 4 – Large

Lightning

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 ECSU is exposed to lightning.

Spatial Extent: 4 – Large

Hail

Hailstorms frequently accompany thunderstorms, so their locations and spatial extents coincide. However, large-scale hail tends to occur in a more localized area within the storm.

Spatial Extent: 4 – Large

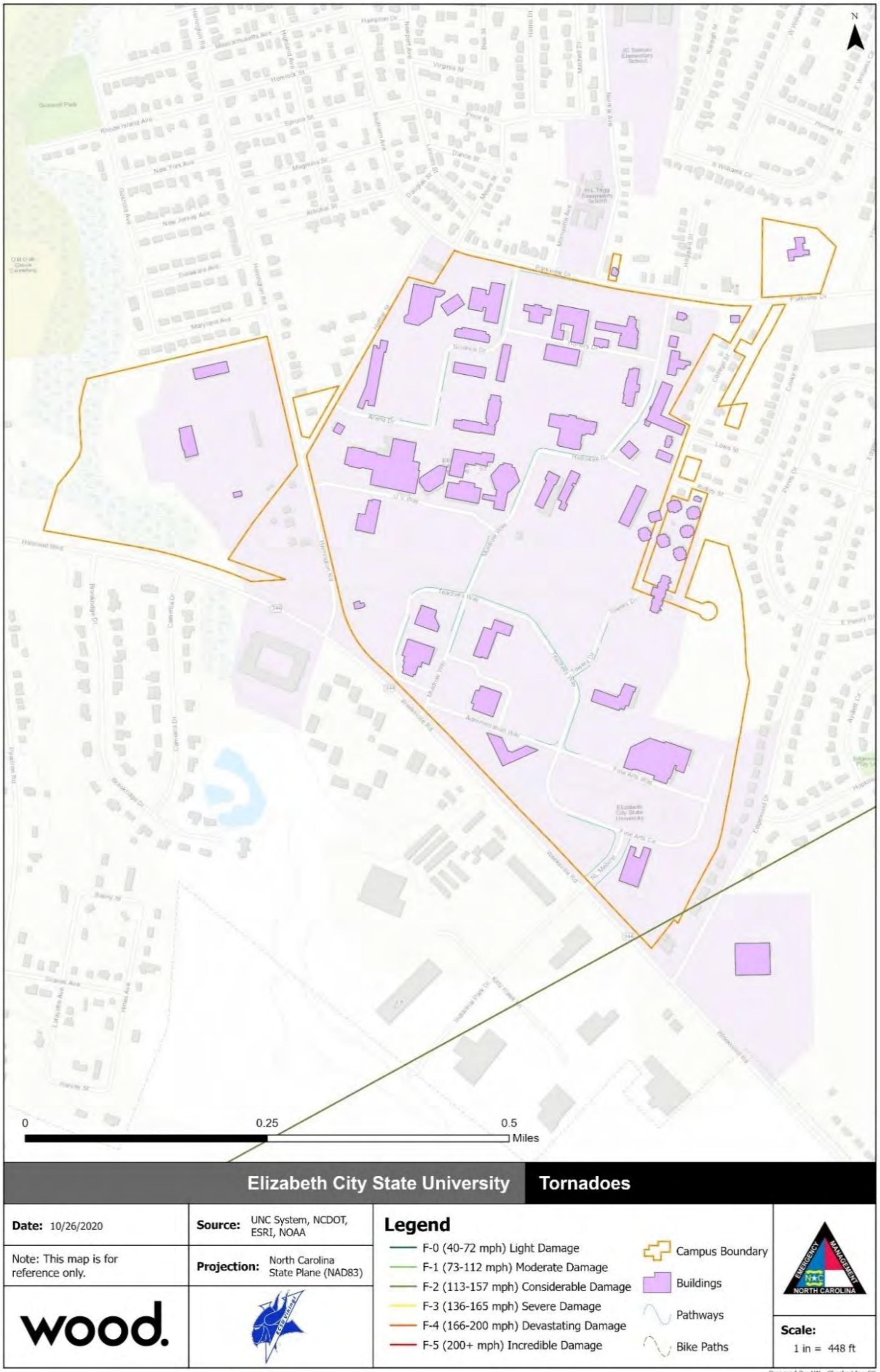
Tornado

Figure B.18 reflects the tracks of past tornados that intersected the ECSU campus from 2000 through 2019 according to data from the NOAA/National Weather Service Storm Prediction Center.

Tornados can occur anywhere on ECSU's campus. 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 campus versus another. All of ECSU is exposed to this hazard.

Spatial Extent: 4 – Large

Figure B.18 – Tornado Paths Intersecting the ECSU Campus, 2000-2019



Extent

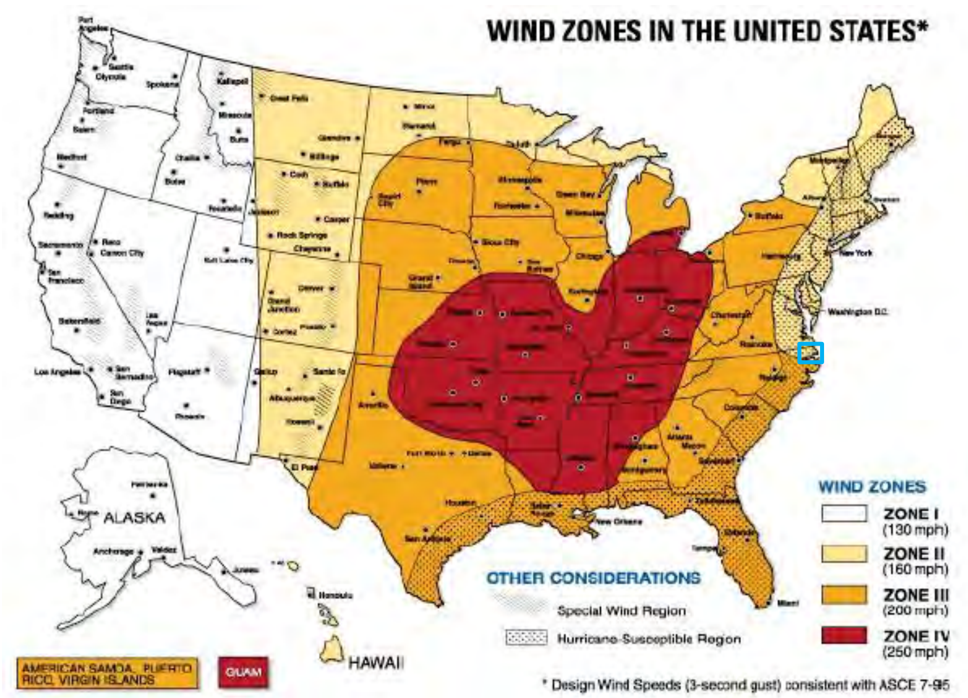
Thunderstorm Winds

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.

Figure B.19 shows wind zones in the United States. Pasquotank County, indicated by the blue square, is within Wind Zone II, which indicates that speeds of up to 160 mph may occur within the county.

Figure B.19 – Wind Zones in the United States



Source: FEMA 320, Taking Shelter from the Storm, 3rd edition, https://www.fema.gov/pdf/library/ism2_s1.pdf

The strongest recorded thunderstorm wind event for Elizabeth City occurred on January 14, 2006 with a measured gust of 60 mph. The event reportedly caused $10,000 in property damages and resulted in no fatalities, injuries, or crop damages.

Impact: 2 – Limited

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, shown in **Table B.31**, is a common parameter that is part of fire weather forecasts nationwide.

Table B.31 – 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

Hail

The National Weather Service classifies hail by diameter size, and corresponding everyday objects to help relay scope and severity to the population. **Table B.32** indicates the hailstone measurements utilized by the National Weather Service.

Table B.32 – 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
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 B.33** describes typical intensity and damage impacts of the various sizes of hail.

Table B.33 – 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 damaged
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 2000 and 2019 in Elizabeth City was a little over 1" in diameter; the largest hailstone recorded was 1.75", recorded on April 16, 2002 and July 17, 2009.

Impact: 1 – Minor

Tornado

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 and better correlation between damage and wind speed. It is also more precise because it considers the materials affected and the construction of structures damaged by a tornado. **Table B.34** shows the wind speeds associated with the enhanced Fujita scale ratings and the damage that could result at different levels of intensity.

Table B.34 – 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.

EF Number	3 Second Gust (mph)	Damage
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 Elizabeth City in the past 20 years was an EF0 on May 9, 2005. NCEI reports this event causing around $15,000 in property damage, and narratives of the event approximate damage to a mobile home that was shifted off its foundation and trees falling on a building. The tornado was 0.5 miles long and 50 yards wide.

Impact: 3 – Critical

Historical Occurrences

Thunderstorm Winds

Between January 1, 2000 and December 31, 2019, the NCEI recorded wind speeds for 25 separate incidents of thunderstorm winds, occurring on 22 separate days, for Elizabeth City. These events caused $101,000 in recorded property damage and no injuries or fatalities. The recorded gusts averaged 51.6 miles per hour, with the highest gusts recorded at 60 mph on January 14, 2006. Of these events, 22 caused property damage. Wind gusts with property damage recorded averaged $4,591 in damage, with the highest reported damage being a total of $35,000 between two events on June 20, 2019. These incidents are aggregated by the date the events occurred and are recorded in **Table B.35.** These records specifically note Thunderstorm Wind impacts for Elizabeth City.

Table B.35 – Recorded Thunderstorm Winds, Elizabeth City, 2000-2019

Location	Date	Wind Speed (mph)	Fatalities	Injuries	Property Damage
ELIZABETH CITY ARPT	8/16/2000	55	0	0	$5,000
ECG CST GRD AIR STN	4/28/2002*	50	0	0	$10,000
ECG CST GRD AIR STN	5/2/2002	56	0	0	$0
(ECG)ELIZABETH CITY	4/26/2003	54	0	0	$0
ELIZABETH CITY	7/7/2004	50	0	0	$2,000
ELIZABETH CITY	3/8/2005	50	0	0	$5,000
ELIZABETH CITY	4/23/2005	50	0	0	$2,000
ELIZABETH CITY	7/27/2005*	51	0	0	$5,000
ELIZABETH CITY	1/14/2006	60	0	0	$10,000
ELIZABETH CITY	7/28/2006	50	0	0	$2,000
ELIZABETH CITY	2/18/2008	50	0	0	$2,000
ELIZABETH CITY	1/7/2009	50	0	0	$1,000
ELIZABETH CITY	7/27/2009	50	0	0	$1,000
ECG CST GRD AIR STN	7/17/2010	50	0	0	$3,000
ELIZABETH CITY	6/1/2012	50	0	0	$2,000
ELIZABETH CITY	6/29/2012	50	0	0	$2,000
(ECG)ELIZABETH CITY	6/13/2013	56	0	0	$0

Location	Date	Wind Speed (mph)	Fatalities	Injuries	Property Damage
(ECG)ELIZABETH CITY	6/30/2016	54	0	0	$1,000
ELIZABETH CITY	5/5/2017	50	0	0	$2,000
ELIZABETH CITY	6/2/2019	50	0	0	$2,000
ELIZABETH CITY	6/20/2019*	50	0	0	$35,000
ELIZABETH CITY	8/9/2019*	55	0	0	$4,000
		Total	**0**	**0**	**$90,000**

Source: NCEI
*Note: Multiple events occurred on these dates. Injuries, fatalities, and property damage are totaled, wind speed is highest reported.

The State of North Carolina received a FEMA Major Disaster Declaration in 1956 for severe storms that included heavy rains and high winds.

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

July 7, 2004 – Numerous trees twisted or down in and around Edgewood section. Also, windows blown out of a house.

July 17, 2010 – The front of a building was blown off and power lines were downed.

June 20, 2019 – Extensive roof and interior damage was reported to the building that houses Flour Girls Bakery and several condominiums. Tractor trailer was blown over on Route 17 Bypass.

August 9, 2019 – Several power poles were downed in the Ehringhaus Street area causing power outages in Elizabeth City.

Lightning

According to NCEI data, there were 2 lightning strikes reported between 2000 and 2019. Of these, one recorded property damage of $5,000 due to lightning striking a vehicle. One event caused two injuries. No crop damage or fatalities were 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. **Table B.36** details NCEI-recorded lightning strikes from 2000 through 2019 for Elizabeth City.

Table B.36 – Recorded Lightning Strikes in Elizabeth City, 2000-2019

Location	Date	Time	Fatalities	Injuries	Property Damage
ELIZABETH CITY	8/1/2004	1405	0	2	$0
ELIZABETH CITY	6/19/2014	2000	0	0	$5,000
		Total	**0**	**2**	**$5,000**

Source: NCEI

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

June 25, 2001 – Two golfers injured on the golf course by lightning strike. One was critical.

June 22, 2004 – Officials reported a vehicle was struck by lightning with the owner standing outside. No injuries were reported.

Hail

NCEI records 13 days with hail incidents between January 1, 2000 and December 31, 2019 in Elizabeth City. None of these events were reported to have caused death, injury, property damage or crop damage. The largest diameter hail recorded in the City was 1.75 inches, which occurred on two occasions: April 16, 2002 and July 17, 2009. The average hail size of all events in the City was just over one inch in diameter.

Table B.37 summarizes hail events for Elizabeth City. In some cases, hail was reported for multiple locations on the same day.

Table B.37 – Summary of Hail Occurrences in Elizabeth City

Beginning Location	Date	Hail Diameter
ELIZABETH CITY	5/10/2000	0.75
ELIZABETH CITY	8/16/2000	1
ELIZABETH CITY	4/16/2002	1.75
ELIZABETH CITY	4/25/2002	0.75
ELIZABETH CITY	4/23/2005	0.75
ELIZABETH CITY	7/2/2005	1
ECG CST GRD AIR STN	4/3/2006	1
ELIZABETH CITY	4/22/2009	1
ELIZABETH CITY	6/22/2009*	1
ELIZABETH CITY	7/17/2009	1.75
ELIZABETH CITY	10/14/2010	1
ELIZABETH CITY	3/31/2017*	1.25
ELIZABETH CITY	8/9/2019	1.5

Source: NCEI

*Note: Multiple events occurred on these dates. Hail diameter is highest reported for that specific date.

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

April 22, 2009 – Quarter size hail was reported on Church Street.

June 22, 2009 – Quarter size hail was reported along Route 17.

March 31, 2017 – Quarter size hail was reported. Half dollar size hail was reported at Elizabeth City State University

Tornado

NCEI storm reports were reviewed from 2000 through 2019 to assess whether recent trends varied from the longer historical record. According to NCEI, Elizabeth City experienced 3 tornado incidents between 2000 and 2019, causing $15,000 in property damage and no injuries, fatalities, or crop damage. It is likely that there have been several tornados that occurred but went unreported. **Table B.38** shows historical tornadoes in Elizabeth City during this time.

Table B.38 – Recorded Tornadoes in Elizabeth City, 2000-2019

Beginning Location	Date	Time	Magnitude	Deaths	Injuries	Property Damage	Crop Damage
ELIZABETH CITY	5/9/2008	830	EF0	0	0	$15,000	$0
ELIZABETH CITY ARPT	6/1/2012	1618	EF0	0	0	$0	$0
ELIZABETH CITY	4/25/2014	1912	EF0	0	0	$0	$0

Source: NCEI

Narratives from NCEI illustrate that damage occurred in many of these incidents even if a monetary value was not recorded. Specific incidents include:

May 9, 2008 – Tornado shifted a mobile home off its foundation. Trees were downed and one tree fell on a building near North Side Road. Tornado was observed by residents.

June 1, 2012 – State police reported a tornado touchdown in farmland just west of Highway 17 near Elizabeth City.

April 25, 2014 – A weak EF-0 tornado touched down north of Elizabeth City near the intersection of Highway 17 and North St. The tornado tracked northeast removing shingles from homes and snapping numerous trees.

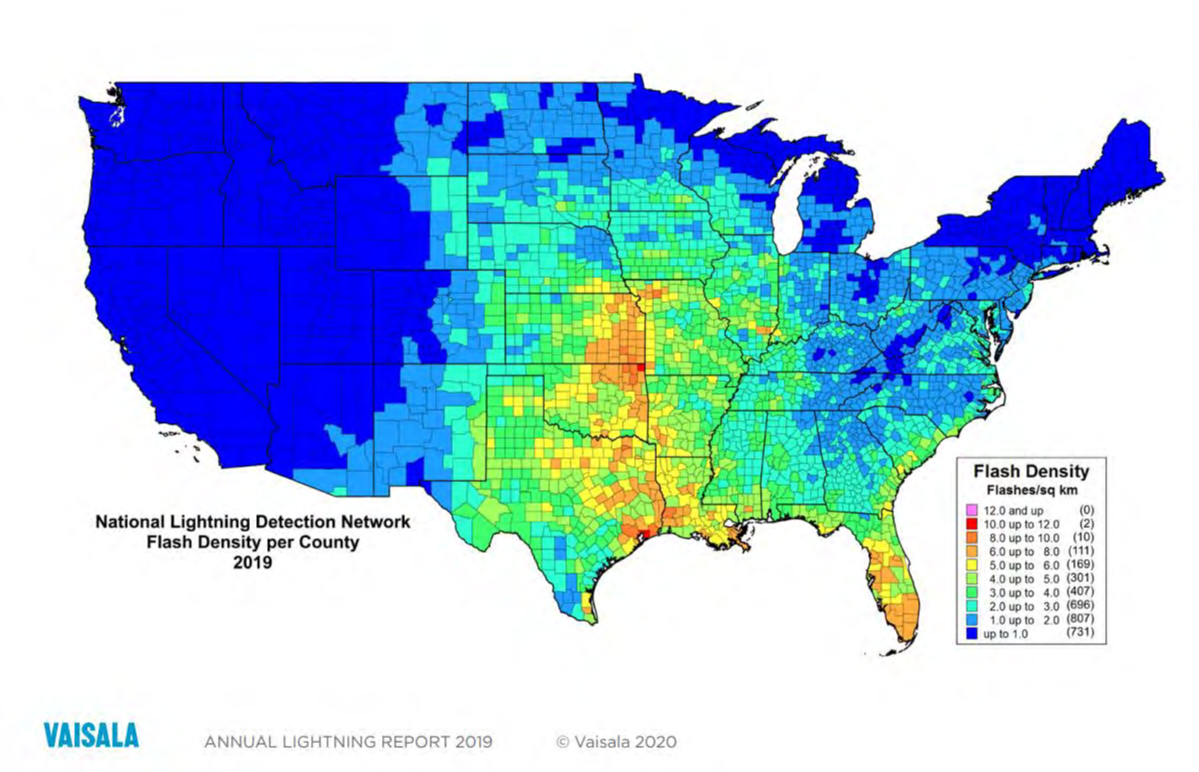
Probability of Future Occurrence

Based on historical occurrences recorded by NCEI for the 20-year period from 2000 through 2019, Elizabeth City averages 1.1 days with wind events per year. Over this same period, 2 lightning events were reported as having caused death, injury, or property damage, which equates to an average of 0.1 damaging lightning strikes per year.

The average hailstorm in Elizabeth City occurs in the evening and has a hail stone with a diameter of just over one inch. Over the 20-year period from 2000 through 2019, Elizabeth City experienced 13 days with reported hail incidents; this averages to 0.65 days per year with reported incidents somewhere in the planning area.

Based on the Vaisala 2019 Annual Lightning Report, North Carolina experienced 3,641,417 documented cloud-to-ground lightning flashes. According to Vaisala's flash density map, shown in **Figure B.20**, Pasquotank County is located in an area that experiences 2 to 3 lightning flashes per square kilometer per year. It should be noted that future lightning occurrences may exceed these figures.

Figure B.20 – Lightning Flash Density per County (2019)



Source: Vaisala

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

In a twenty-year span between 2000 and 2019, Elizabeth City experienced 3 separate tornado incidents over 3 separate days. This correlates to a 15 percent annual probability that the City will experience a tornado somewhere in its boundaries. All three of these past tornado events were a magnitude EF0; therefore, the annual probability of a significant tornado event is highly unlikely.

Based on these historical occurrences, there is between a 10% to 100% chance that Elizabeth City will experience severe weather each year. The probability of a damaging impacts is likely.

Probability: 3 – Likely

Vulnerability Assessment

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. Since 2000, NCEI records report 2 injuries attributed to lightning strikes in Elizabeth City.

Similar to the loss of use estimates provided for Severe Winter Weather, the loss of use estimates for a tornadoes/thunderstorms were estimated as $9,727 per person per day, assuming 10-percent of the on-campus population is impacted.

Table B.39 – Loss of Use Estimates for Power Failure Associated with Tornado/Thunderstorm

On-Campus Population (Fall 2020)	Estimated Affected Population (10%)	Electric Loss of Use Estimate ($126 per person per day)
772	77.2	$9,727

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 2018 American Community Survey (ACS) 5-Year Estimates, 412 occupied housing units (5.1 percent) in Elizabeth City are classified as “mobile homes or other types of housing.” Using the 2018 ACS average persons per household estimate of 2.51, the population at risk due to their housing type was estimated at 1,034 residents within Elizabeth City. Individuals who work outdoors may also face increased risk.

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. Therefore, the estimated 1,034 residents mentioned above residing in mobile homes in Elizabeth City are also at a greater risk to tornado damage due to their housing type.

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 Elizabeth City, the only event with recorded property damage was due to lightning striking a vehicle.

NCEI records lightning impacts over 20 years (2000-2019), with $5,000 in property damage recorded during one event in 2014. Based on these records, the planning area experiences an annualized loss of $250 in property damage. The average impact from lightning per incident in Elizabeth City is $2,500.

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, 2000 and December 31, 2019 in Elizabeth City, NCEI did not report any property damage as a direct result of hail.

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 Elizabeth City, thus the NCEI is still used to form a baseline.

Wind events reported in NCEI for the 20-year period from 2000 through 2019 totaled $90,000 in property damage, which equates to an annualized loss of $4,500 across the planning area.

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 2000, damaging tornadoes in the City are directly responsible for $15,000 worth of damage to property according to NCEI data. This equates to an annualized loss of $750.

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.

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.

Changes in Development

Future development projects should consider severe thunderstorms hazards and tornado and high wind hazards at the planning, engineering and architectural design stage with the goal of reducing vulnerability. University buildings with high occupancies should consider inclusion of a tornado shelters to accommodate occupants in the event of a tornado. Future development will also affect current stormwater drainage patterns and capacities.

Problem Statement

- The strongest recorded thunderstorm wind event for Elizabeth City occurred on January 14, 2006 with a measured gust of 60 mph. The event reportedly caused $10,000 in property damages.
- The average hailstone size recorded between 2000 and 2019 in Elizabeth City was a little over 1” in diameter; the largest hailstone recorded was 1.75”, recorded on April 16, 2002 and July 17, 2009.
- The most intense tornado to pass through Elizabeth City in the past 20 years was an EF0 on May 9, 2005. NCEI reports this event causing around $15,000 in property damage.
- Thunderstorms and tornadoes are frequent hazard events in Pasquotank County and the ECSU campus. Reported damages for the 20-year period from 2000-1019 include $90,000 for thunderstorm winds, $5,000 for lightning strikes, and $15,000 for tornado events.

B.5.6 Wildfire

Hazard	Probability	Impact	Spatial Extent	Warning Time	Duration	PRI Score
Wildfire	Possible	Limited	Large	More than 24 hrs	More than 1 week	2.5

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 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 B.40** details the extent of the WUI on the UNC-P campus, and **Figure B.21** shows the WUI areas. ECSU is defined by high housing density, with the northwest portion of the campus, accounting for 12.3% of the campus area, falling outside the WUI. On a county level, Pasquotank County is predominately classified as non-WUI vegetated with noted pockets of WUI intermix and interface areas and medium to high density housing in the agricultural areas.

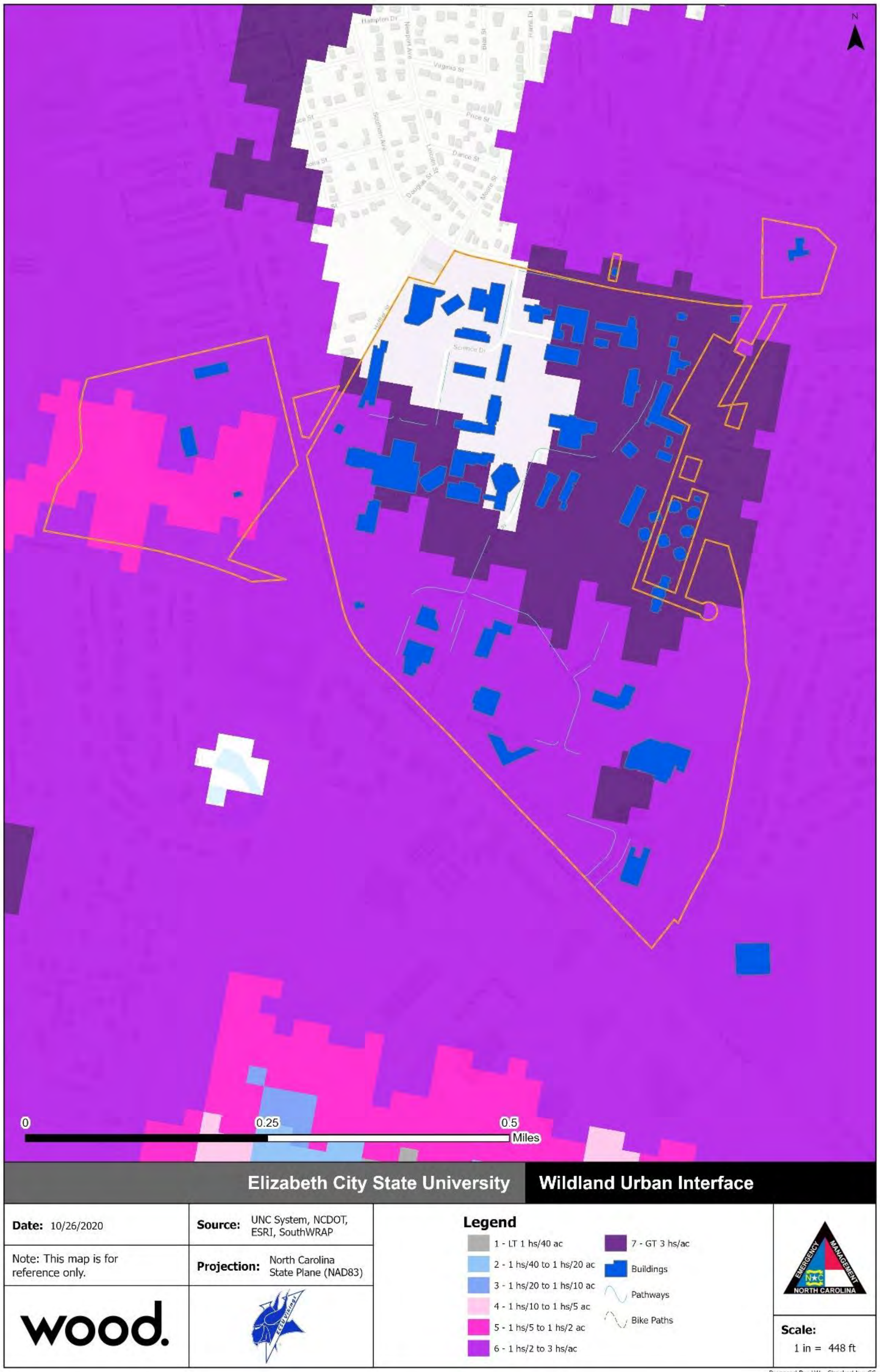
Table B.40 – Wildland Urban Interface, Population and Acres

	Housing Density	WUI Acres	Percent of WUI Acres
	Not in WUI	21	12.3%
	LT 1hs/40ac	0	0.0%
	1hs/40ac to 1hs/20ac	0	0.0%
	1hs/20ac to 1hs/10ac	0	0.0%
	1hs/10ac to 1hs/5ac	0	0.0%
	1hs/5ac to 1hs/2ac	13	8.0%
	1hs/2ac to 3hs/1ac	82	49.2%
	GT 3hs/1ac	51	30.5%
	Total	**167**	--

Source: Southern Wildfire Risk Assessment

Spatial Extent: 4 – Large

Figure B.21 – Wildland Urban Interface Areas, ECSU



Extent

The entire state is at risk to a wildfire occurrence. However, several factors such as drought conditions or high levels of fuel on the forest floor may make a wildfire more likely in certain areas. 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, shown in **Table B.41**, consists of five classes, as defined by Southern Wildfire Risk Assessment. **Figure B.22** shows the potential fire intensity within the WUI across Elizabeth City State University.

Table B.41 – 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

A limited portion, approximately 1.4 percent, of ECSU's campus may experience up to a Class 4 or 4.5 Fire Intensity, which poses significant harm or damage to life and property. These areas, primarily on the eastern edge of the campus, do coincide with development. Another 4.3 percent of the campus may experience Class 3 or 3.5 Fire Intensity, which has potential for harm to life and property but is easier to suppress with dozer and plows. The remainder of the planning area is either non-burnable (71.9%) or would face a Class 1 or Class 2 Fire Intensity, which are easily suppressed.

The WUI Risk Index is used to rate the potential impact of a wildfire on people and their homes. It reflects housing density (per acre) consistent with Federal Register National standards. The WUI Risk Index ranges of values from -1 to -9, with -1 representing the least negative impact and -9 representing the most negative impact. **Figure B.23** maps the WUI Risk Index for Elizabeth City State University (ECSU). The WUI areas within the campus of ECSU range from -5 to -8 on the WUI Risk Index.

Impact: 2 – Limited

Figure B.22 – Characteristic Fire Intensity, ECSU

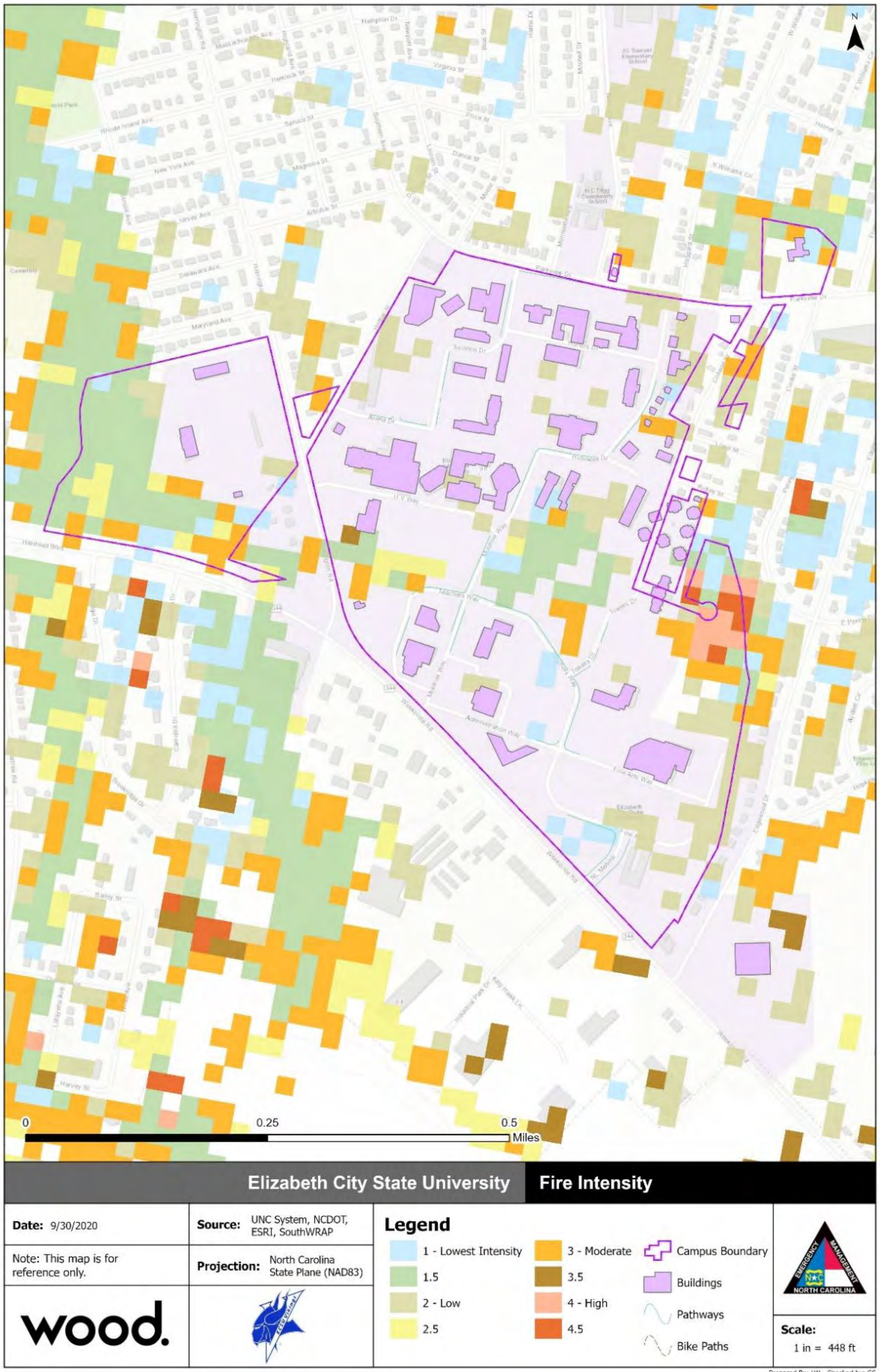
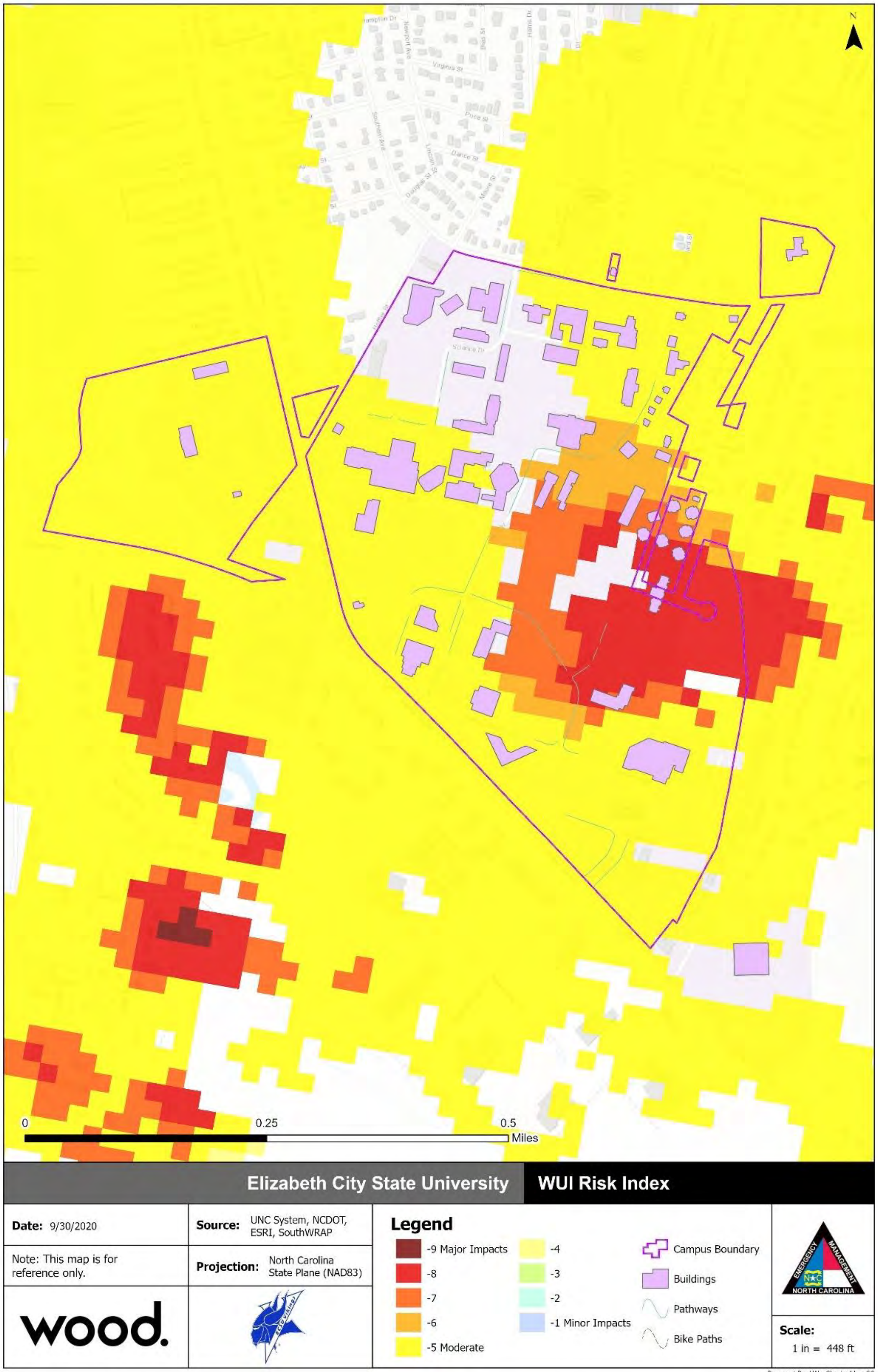


Figure B.23 – WUI Risk Index, ECSU



Historical Occurrences

According to the North Carolina Forest Service (NCFS), there were 257 noted wildfires within Pasquotank County between 2000 and 2019. The total acreage burned during this period was 692.1 acres. There were no additional data records regarding specific cities or school districts within Pasquotank County. The data is from NCFS records only and may not include data on fires burned within jurisdictional limits that did not require NCFS assistance to suppress. Actual number of fires and acreage burned may be higher than what is reported here.

On average, Pasquotank County experiences 12.9 fires and 34.6 acres burned annually from fires reported by the NCFS. Actual number of fires and acreage burned is likely higher because smaller fires within jurisdictional boundaries are managed by local fire departments. Based on these records, the average wildfire event can be calculated as 2.7 acres. Actual number of fires and acreage burned is likely higher because smaller fires within jurisdictional boundaries are managed by local fire departments. The most known cause was noted as debris. Machine use, children and miscellaneous causes were the next leading causes following debris burning.

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 ECSU is detailed in **Table B.42** and illustrated in **Figure B.24.**

Table B.42 – Burn Probability, ECSU

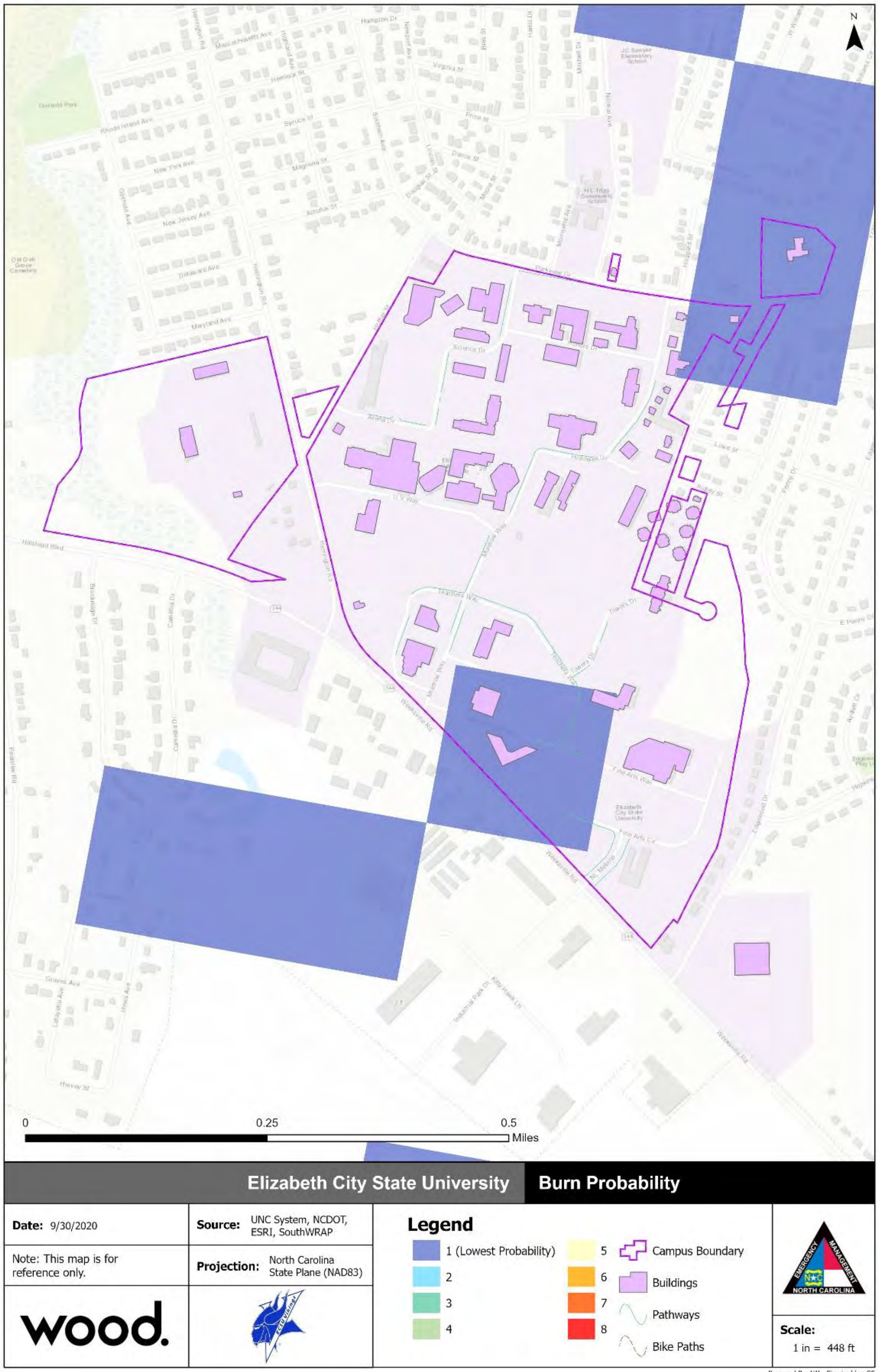
Class	Acres	Percent
No probability	*147*	*88.2%*
1	20	11.8%
2	0	0.0%
3	0	0.0%
4	0	0.0%
5	0	0.0%
6	0	0.0%
7	0	0.0%
8	0	0.0%
9	0	0.0%
10	0	0.0%
Total	**167**	--

Source: Southern Wildfire Risk Assessment

A limited portion of the campus is located within an area defined as Class 1 having the lowest probability. Located within this low burn probability area are the Mason D. Thorpe, Sr. Administration Building, the McDonald Dixon and Bishop M. Patterson Hall, and the Information Technology Center.

Probability: 2 – Possible

Figure B.24 – Burn Probability, ECSU



Vulnerability Assessment

People

Wildfire can cause fatalities and human health hazards. Ensuring procedures are in place for rapid warning and evacuation are essential to reducing vulnerability.

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.

Using the Wildland Urban Interface Risk Index (WUIRI) from the Southern Wildfire Risk Assessment, a GIS analysis was used to estimate the exposure of buildings most at risk to loss due to wildfire. The WUIRI shows a rating of the potential impact of wildfire on homes and people. This index ranges from 0 to -9, where lower values are relatively more severe. **Table B.43** summarizes the number of buildings and their total value that fall within areas rated -5 or less on the WUIRI. This table represents potential risks and counts every building within the area rated under -5, actual damages in the event of a wildfire may differ.

Table B.43 – Building Counts and Values within WUIRI under -5

Jurisdiction	Buildings	Building Value
Administration	0	$0
Critical Facility	5	$41,857,610
Extracurricular/Educational	12	$35,355,016
Housing	4	$13,934,624
Total	**21**	**$91,147,250**

Source: GIS Analysis, Southern Wildfire Risk Assessment

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.

Changes in Development

Growth on the ECSU campus within the wildland-urban interface area will increase the vulnerability of people, property, and infrastructure to wildfires.

Problem Statement

- The Information Technology Center is a critical campus building and is within an area of campus that would face major impacts in the event of a fire.
- Sprinkler systems in the Information Technology Center could cause loss of campus servers in the event of a fire.

B.5.7 Cyber Threat

Hazard	Probability	Impact	Spatial Extent	Warning Time	Duration	PRI Score
Cyber Threat	Possible	Critical	Large	Less than 6 hrs	More than 1 week	3.1

Location

Cyber disruption events can occur and/or impact virtually any location in the state where computing devices are used. Incidents may involve a single location or multiple geographic areas. A disruption can have far-reaching effects beyond the location of the targeted system; disruptions that occur far outside the region can still impact people, businesses, and institutions within the region.

On the ECSU campus, the Division of Information Technology (DIT) provides integrated technology support for administrative computing, client services, IT infrastructure systems, and IT security. The University's critical applications require passwords for access. Modifications of the application software are protected from abuse by an electronic software control procedure. Information security is managed and controlled in accordance with the university's Information Security Policy.

Spatial Extent: 4 – Large

Extent

The extent or magnitude/severity of a cyber disruption event is variable depending on the nature of the event. A disruption affecting a small, isolated system could impact only a few functions/processes. Disruptions of large, integrated systems could impact many functions/processes, as well as many individuals that rely on those systems.

There is no universally accepted scale to quantify the severity of cyber-attacks. The strength of a distributed denial-of-service (DDoS) attack is sometimes explained in terms of a data transmission rate. One of the largest DDoS disruptions ever, which brought down some of the internet's most popular sites on October 21, 2016, peaked at 1.2 terabytes per second.

Data breaches are often described in terms of the number of records or identities exposed. With the amount of data retained by universities – including student, staff, and faculty personal information as well as research data – a data breach on the UNC-W campus could cause significant disruption and impact a large number of records.

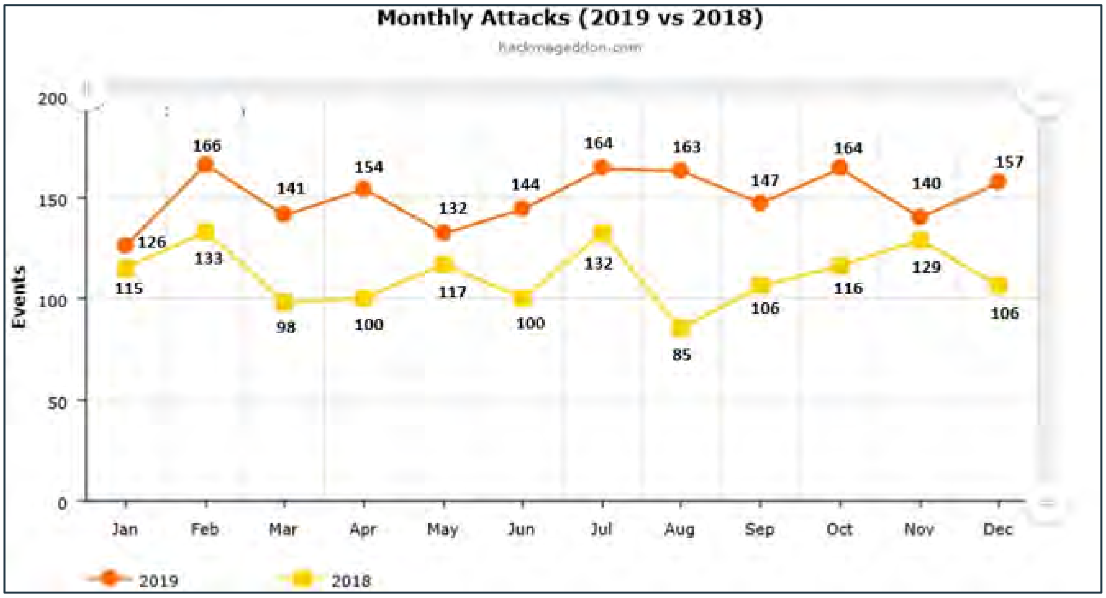
Impact: 3 – Critical

Historical Occurrences

As cyber disruption is an emerging hazard, the reporting and tracking of disruptive events is difficult. In most cases, it is not required to report an event, and when it is reported most of the information is protected due to the sensitive nature of the systems that have been disrupted. However, there currently exists several complex databases that track cyber disruption occurrences. Each system makes use of its own definitions and tracking methods. Hackmageddon is one online source that tracks Cyber Attack Statistics. Hackmageddon was developed by Paolo Passeri, an expert in the computer security industry for more than 15 years and current Principal Sales Engineer at OpenDNS (now part of Cisco). The timelines collect the major cyber events of the related months chosen among events published by open sources (such as blogs or news sites). It should be noted that this database collects cyber-attacks worldwide and this data is provided to show how this hazard is trending in general. During 2019, this database collected reports of a total of 1,802 cyber-attacks.

The graphic in **Figure B.25** provides a comparison of the number of attacks collected during 2018 and 2019. The two following images in **Figure B.26** and **Figure B.27** shows the top 10 target distributions for 2018 and 2019. The main finding from the top 10 attack techniques is the percentage of 'other' targeted attacks appearing at 14.1% in 2019. Attacks targeted towards Education slightly increased from 6.4% in 2018 to 7.1% in 2019. Most other target distributions experienced a percentage decrease in 2019. Some of this is probably due to the difference in distribution categories between 2018 and 2019.

Figure B.25 – Comparison of Monthly Attacks Collected by Hackmageddon (2018-2019)



Source: Hackmageddon, https://www.hackmageddon.com/2020/01/23/2019-cyber-attacks-statistics/

Figure B.26 – Top 10 Cyber Attack Target Distributions, 2018

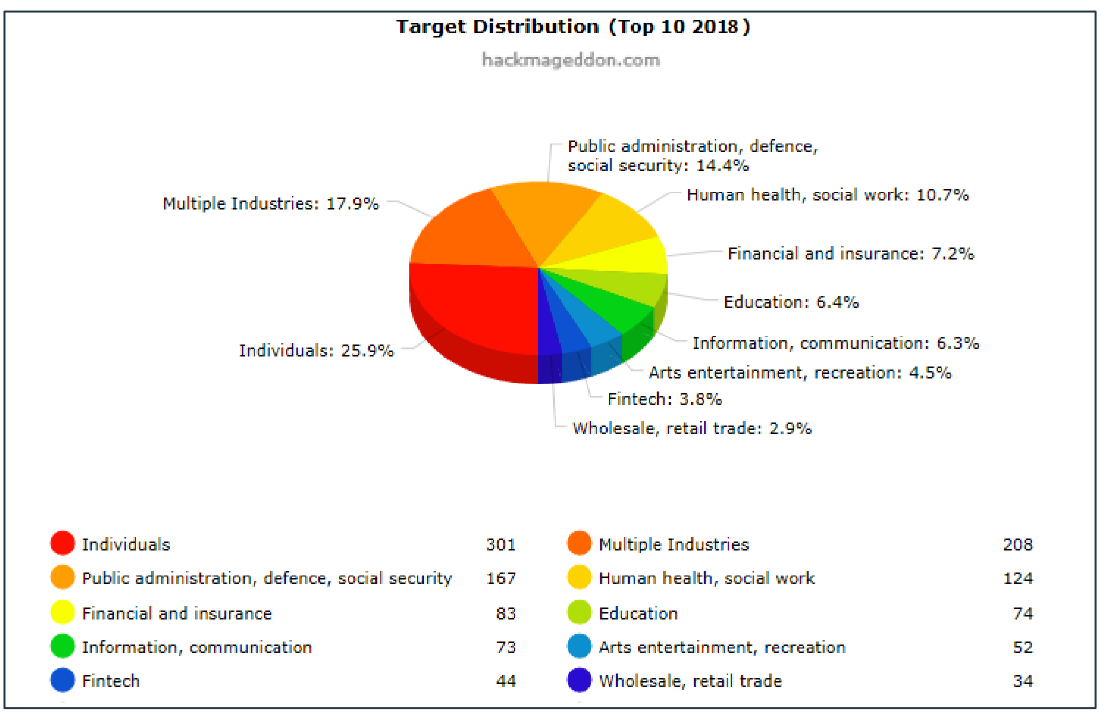
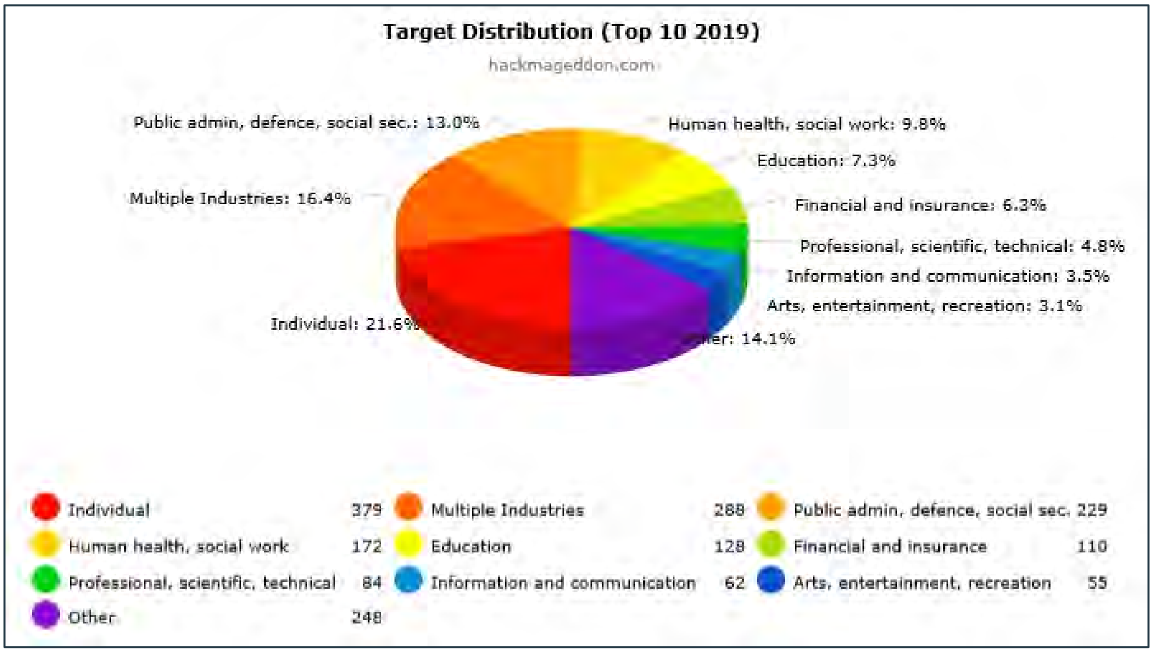


Figure B.27 – Top 10 Cyber Attack Target Distributions, 2019



There have been some notable disruption events within the Education target distribution that attained national attention in the last few years:

August 2020, The University of North Carolina Wilmington's Division of University Advancement (DUA) was hacked by a ransomware attack. The data included names, addresses, phone numbers, email addresses, and history of gifts made to UNCW; the University reported that no vulnerable financial or personal information was included. (https://portcitydaily.com/story/2020/08/06/uncw-reports-ransomware-attack-hackers-accessed-personal-details-but-no-financial-info/)

November 2019, The University of North Carolina Chapel Hill School of Medicine reported over 3,500 individuals having private information stolen in phishing cyber-attack, (https://www.databreaches.net/the-university-of-north-carolina-chapel-hill-school-of-medicine-notifying-patients-after-2018-phishing-incident/).

October 2019, Randolph Community College's entire computer network and other devices were compromised following cyberattack. In total, 1,200 devices were affected during the two week attack, (https://www.yourdailyjournal.com/news/89334/report-rcc-cyber-attack-was-first-successful-of-this-scale-at-nc-community-college).

December 2018, The Cape Cod Community College notifies its employees that Hackers stole more than $800,000 when they infiltrated the school's bank accounts, (https://www.databreaches.net/hackers-steal-800000-from-cape-cod-community-college/).

September 2018, The Henderson school district in Texas is hit with a business email compromise (BEC) attack resulting in a $600,000 loss for the district. The attack took place on September, 26th, (https://www.scmagazine.com/home/security-news/bec-attack-scamstexas-school-district-out-of-600000/).

May 2018, Cyber Attack shut down Pasquotank County website, compromising crucial files, (https://www.dailyadvance.com/news/local/cyberattack-shuts-down-pasquotank-website-files/article_fae0c688-0b7a-5475-92a6-266bfc38cdd8.html).

April 2018, Partial social security numbers of more than 1,200 employees at Irvington schools are distributed via email to an unknown number of recipients by an unidentified attacker, (https://www.databreaches.net/hacker-sent-email-with-1200-partial-social-security-numbers-to-school-staff/).

March 2018, Florida Virtual Learning School notifies 368,000 current and former students, after an individual with the moniker $2a$45 uploads information of 35,000 students on a forum. Leon County Schools is among the affected organizations, (https://www.databreaches.net/leon-county-schools-vendors-data-leak-exposed-368000-current-and-former-flvs-students-details-lcs-teacher-data-and-more/).

November 2017, Monticello Central School District warns of a sophisticated e-mail phishing attack occurred on November 1st, 2017. Potentially 2,598 individuals are affected, (https://www.databreaches.net/monticello-central-school-district-notifying-almost-2600-of-phishing-attack-last-year/).

October 2017, The Los Angeles Valley College (LAVC) is forced to pay $28,000 in bitcoin after cybercriminals successfully infected its computer networks, email systems and voicemail lines with ransomware, (https://www.ibtimes.co.uk/la-school-pays-hackers-28000-bitcoin-after-computer-systems-hit-ransomware-1600304).

July 2017, Tax information for dozens of University of Louisville employees is compromised after a hack of the online system the university uses to give employees access to tax documents, (https://www.databreaches.net/tax-information-of-some-university-of-louisville-employees-hacked/).

April 2017, Westminster College in Missouri reveals the details of a breach discovered on March 26 after a phishing scam duped a staffer into sending off W-2 statements, (https://www.scmagazine.com/home/security-news/data-breach/w-2-data-breach-at-westminster-college/).

Probability of Future Occurrence

Cyber-attacks occur daily, but most have negligible impacts at the local or regional level. The possibility of a larger disruption affecting systems within the region is a constant threat, but it is difficult to quantify the exact probability due to such highly variable factors as the type of attack and intent of the attacker. Minor attacks against business and government systems have become a commonplace occurrence but are usually stopped with minimal impact. Similarly, data breaches impacting the information of students and faculty of ECSU are almost certain to happen in coming years. Major attacks or breaches specifically targeting systems at the University are less likely but cannot be ruled out.

Probability: 2 – Possible

Vulnerability Assessment

As discussed above, the impacts from a cyber-attack vary greatly depending on the nature, severity, and success of the attack.

People

Cyber-attacks can have a significant cumulative economic impact. Check Point Research reports that in 2018, cybercrime rates were estimated to have generated around 1.5 trillion dollars. A major cyber-attack has the potential to undermine public confidence and build doubt in their government's ability to protect them from harm. Injuries or fatalities from cyber-attacks would generally only be possible from a major cyber terrorist attack against critical infrastructure.

Property

Short of a major cyber terrorist attacks against critical infrastructure, property damage from cyber-attacks is typically limited to computer systems.

Environment

Short of a major cyber terrorist attacks against critical infrastructure, property damage from cyber-attacks is typically limited to computer systems. A major cyber terrorism attack could potentially impact the environment by triggering a release of a hazardous materials, or by causing an accident involving hazardous materials by disrupting traffic-control devices.

Changes in Development

With enrollment decreasing since the last plan, the number of users of campus networks and software has decreased. Additionally, with fewer buildings located on campus, the number of network access points has decreased.

For future development, as the number of users and/or access points to the network and campus software increases, the opportunity for cyber-attacks is also likely to increase.

Problem Statement

- Cyber-attacks occur daily, but most have negligible impacts at the local or regional level. The possibility of a larger disruption affecting systems within the region is a constant threat, but difficult to quantify.
- The University's Division of Information Technology (DIT) addresses IT security through policies addressing users, physical security, system security, password administration, communications, wireless devices, computer viruses, disaster recovery, and compliance with law and policy.

B.5.8 Hazardous Materials Incident

Hazard	Probability	Impact	Spatial Extent	Warning Time	Duration	PRI Score
Hazardous Materials Incident	Likely	Minor	Negligible	Less than 6 Hrs	Less than 24 Hrs	2.0

Location

Hazardous materials releases at fixed sites can cause a range of contamination from very minimal to catastrophic. The releases can go into the air, onto the surface, or into the ground and possibly into groundwater, or a combination of all. Although releases into the air or onto the ground surface can pose a great and immediate risk to human health, they are generally easier to remediate than those releases which enter into the ground or groundwater. Soil and groundwater contamination may take years to remediate causing possible long-term health problems for individuals and rendering land unusable for many years.

The Toxics Release Inventory (TRI) Program run by the 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 2 sites reporting hazardous materials in Elizabeth City from 2016-2018. These sites are detailed by location and sector in **Table B.44**.

Table B.44 – Toxic Release Inventory Facilities in Elizabeth City

Facility Name	Sector
FORTRESS WOOD PRODUCTS INC	Wood Products
UFP ELIZABETH CITY LLC	Wood Products

Source: EPA Toxic Release Inventory

Transportation hazardous materials Incidents can occur when hazardous materials are being transported from one location to another in the normal course of business for manufacturing, refining, or other industrial purposes. Additionally, hazardous materials incidents can occur as hazardous waste is transported for final storage and/or disposal. **Figure B.28** shows the routes of transportation for hazardous materials adjacent to or through ECSU's campus. According to data collected by the UNC System, one pipeline intersects the critical facility, Steam Plant, on campus.

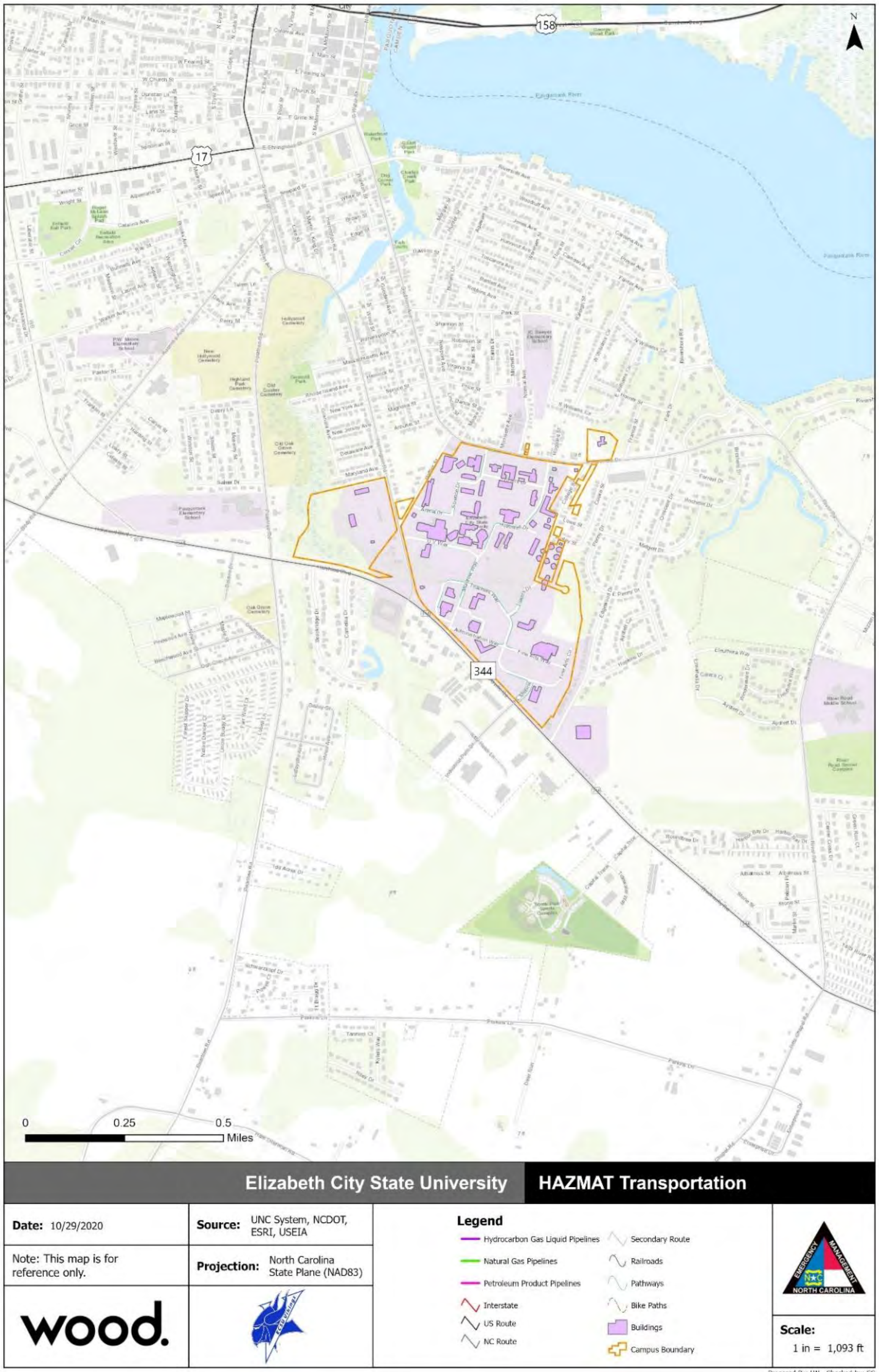
Spatial Extent: 1 – Negligible

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.

Figure B.28 – Hazardous Materials Transportation Routes near the ECSU Campus



Prior to 2002, however, a "serious incident" regarding hazardous materials was defined as follows:

- a fatality or major injury due to a hazardous material
- closure of a major transportation artery or facility or evacuation of six or more persons due to the presence of hazardous material, or
- a vehicle accident or derailment resulting in the release of a hazardous material.

Impact: 1 – Minor

Historical Occurrences

The USDOT's Pipeline and Hazardous Materials Safety Administration (PHMSA) maintains a database of reported hazardous materials incidents by location and hazardous material class. According to PHMSA records, there two recorded releases in Elizabeth City in the 10-year period from 2010 through 2019. Both events were Class 3 flammable liquids. **Figure B.29** describes all nine hazard classes.

Figure B.29 – Hazardous Materials Classes

Source: U.S. Department of Transportation

Probability of Future Occurrence

Based on historical occurrences recorded by PHMSA, there have been two incidents of hazardous materials release in the 20-year period from 2000 through 2019. Using historical occurrences as an indication of future probability, there is a 10 percent annual probability of a hazardous materials incident occurring.

Probability: 3 – Likely

Vulnerability Assessment

People

Hazardous materials incidents can cause injuries, hospitalizations, and even fatalities to people nearby. People living near hazardous facilities and along transportation routes may be at a higher risk of exposure, particularly those living or working downstream and downwind from such facilities. For example, a toxic spill or a release of an airborne chemical near a populated area can lead to significant evacuations and have a high potential for loss of life. Individuals working with or transporting hazardous materials are also at heightened risk.

In addition to the immediate health impacts of releases, a handful of studies have found long term health impacts such as increased incidence of certain cancers and birth defects among people living near certain chemical facilities. However there has not been sufficient research done on the subject to allow detailed analysis.

The primary economic impact of hazardous material incidents results from lost business, delayed deliveries, property damage, and potential contamination. Large and publicized hazardous material-related events can deter tourists and could potentially discourage residents and businesses. Economic effects from major transportation corridor closures can be significant.

Property

The impact of a fixed hazardous facility, such as a chemical processing facility is typically localized to the property where the incident occurs. The impact of a small spill (i.e. liquid spill) may also be limited to the extent of the spill and remediated if needed. While cleanup costs from major spills can be significant, they do not typically cause significant long-term impacts to property.

Impacts of hazardous material incidents on critical facilities are most often limited to the area or facility where they occurred, such as at a transit station, airport, fire station, hospital, or railroad. However, they can cause long-term traffic delays and road closures resulting in major delays in the movement of goods and services. These impacts can spread beyond the planning area to affect neighboring counties, or vice-versa. While cleanup costs from major spills can be significant, they do not typically cause significant long-term impacts to critical facilities, but there is a chance they may be impacted.

Environment

Hazardous material incidents may affect a small area at a regulated facility or cover a large area outside such a facility. Widespread effects occur when hazards contaminate the groundwater and eventually the municipal water supply, or they migrate to a major waterway or aquifer. Impacts on wildlife and natural resources can also be significant.

Changes in Development

Structures located near fixed facilities, highways and other high traffic roadways are most at risk to a hazardous materials event. Any development that takes place in these areas will place more people and structures in the risk area for hazardous materials events, however since most hazardous material spills are localized to an extremely small area this will not have an effect on the overall risk assessment for this hazard.

Problem Statement

- Transportation routes for hazardous materials are located adjacent to the ECSU Campus.
- The number of reported incidents within Elizabeth City can be approximated to a 10 percent annual probability

B.5.10 Infectious Disease

Hazard	Probability	Impact	Spatial Extent	Warning Time	Duration	PRI Score
Infectious Disease	Possible	Critical	Large	More than 24 hrs	More than 1 week	2.8

Location

Infectious disease outbreaks can occur anywhere in the planning area, especially where there are groups of people in close quarters.

Spatial Extent: 4 – Large

Extent

When on an epidemic scale, diseases can lead to high infection rates in the population causing isolation, quarantine, and potential mass fatalities. An especially severe influenza pandemic or other major disease outbreak could lead to high levels of illness, death, social disruption, and economic loss. Impacts could range from school and business closings to the interruption of basic services such as public transportation, health care, and the delivery of food and essential medicines.

Table B.45 describes the World Health Organization's six main phases to a pandemic flu as part of their planning guidance.

Table B.45 – World Health Organization's Pandemic Flu Phases

Phase	Description
1	No animal influenza virus circulating among animals have been reported to cause infection in humans.
2	An animal influenza virus circulating in domesticated or wild animals is known to have caused infection in humans and is therefore considered a specific potential pandemic threat.
3	An animal or human-animal influenza reassortant virus has caused sporadic cases or small clusters of disease in people, but has not resulted in human-to-human transmission sufficient to sustain community-level breakouts.
4	Human-to-human transmission of an animal or human-animal influenza reassortant virus able to sustain community-level breakouts has been verified.
5	The same identified virus has caused sustained community-level outbreaks in two or more countries in one WHO region.
6	In addition to the criteria defined in Phase 5, the same virus has caused sustained community-level outbreaks in at least one other country in another WHO region.
Post-Peak Period	Levels of pandemic influenza in most countries with adequate surveillance have dropped below peak levels.
Post-Pandemic Period	Levels of influenza activity have returned to levels seen for seasonal influenza in most countries with adequate surveillance.

Source: World Health Organization

Impact: 3 – Critical

Historical Occurrences

Since the early 1900s, four lethal pandemics have swept the globe: Spanish Flu of 1918-1919; Asian Flu of 1957-1958; Hong Kong Flu of 1968-1969; and Swine Flu of 2009-2010. The Spanish Flu was the most severe pandemic in recent history. The number of deaths was estimated to be 50-100 million worldwide and 675,000 in the United States. Its primary victims were mostly young, healthy adults. The 1957 Asian Flu pandemic killed about 70,000 people in the United States, mostly the elderly and chronically ill. The

1968 Hong Kong Flu pandemic killed 34,000 Americans. The 2009 Swine Flu caused 12,469 deaths in the United States. These historic pandemics are further defined in the following paragraphs along with several "pandemic scares".

Spanish Flu (H1N1 virus) of 1918-1919

In 1918, when World War I was in its fourth year, another threat began that rivaled the war itself as the greatest killer in human history. The Spanish Flu swept the world in three waves during a two-year period, beginning in March 1918 with a relatively mild assault.

The first reported case occurred at Camp Funston (Fort Riley), Kansas, where 60,000 soldiers trained to be deployed overseas. Within four months, the virus traversed the globe, as American soldiers brought the virus to Europe. The first wave sickened thousands of people and caused many deaths (46 died at Camp Funston), but it was considered mild compared to what was to come. The second and deadliest wave struck in the autumn of 1918 and killed millions. At Camp Funston alone, there were 14,000 cases and 861 deaths reported during the first three weeks of October 1918.

Outbreaks caused by a new variant exploded almost simultaneously in many locations including France, Sierra Leone, Boston, and New York City, where more than 20,000 people died that fall. The flu gained its name from Spain, which was one of the hardest hit countries. From there, the flu went through the Middle East and around the world, eventually returning to the United States along with the troops.

Of the 57,000 Americans who died in World War I, 43,000 died because of the Spanish Flu. At one point, more than 10 percent of the American workforce was bedridden. By a conservative estimate, a fifth of the human race suffered the fever and aches of influenza between 1918 and 1919 and 20 million people died. At the height of the flu outbreak during the winter of 1918-1919, at least 20% of North Carolinians were infected by the disease. Ultimately, 10,000 citizens of the state succumbed to this disease.

Asian Flu (H2N2 virus) of 1957-1958

This influenza pandemic was first identified in February 1957 in the Far East. Unlike the Spanish Flu, the 1957 virus was quickly identified, and vaccine production began in May 1957. Several small outbreaks occurred in the United States during the summer of 1957, with infection rates highest among school children, young adults, and pregnant women; however, the elderly had the highest rates of death. A second wave of infections occurred early the following year, which is typical of many pandemics.

Hong Kong Flu (H3N2 virus) of 1968-1969

This influenza pandemic was first detected in early 1968 in Hong Kong. The first cases in the United States were detected in September 1968, although widespread illness did not occur until December. This became the mildest pandemic of the twentieth century, with those over the age of 65 the most likely to die. People infected earlier by the Asian Flu virus may have developed some immunity against the Hong Kong Flu virus. Also, this pandemic peaked during school holidays in December, limiting student-related infections.

Pandemic Flu Threats: Swine Flu of 1976, Russian Flu of 1977, and Avian Flu of 1997 and 1999

Three notable flu scares occurred in the twentieth century. In 1976, a swine-type influenza virus appeared in a U.S. military barracks (Fort Dix, New Jersey). Scientists determined it was an antigenically drifted variant of the feared 1918 virus. Fortunately, a pandemic never materialized, although the news media made a significant argument about the need for a Swine Flu vaccine.

In May 1977, influenza viruses in northern China spread rapidly and caused epidemic disease in children and young adults. By January 1978, the virus, subsequently known as the Russian Flu, had spread around

the world, including the United States. A vaccine was developed for the virus for the 1978–1979 flu season. Because illness occurred primarily in children, this was not considered a true pandemic.

In March 1997, scores of chickens in Hong Kong's rural New Territories began to die—6,800 on three farms alone. The Avian Flu virus was especially virulent and made an unusual jump from chickens to humans. At least 18 people were infected, and six died in the outbreak. Chinese authorities acted quickly to exterminate over one million chickens and successfully prevented further spread of the disease. In 1999, a new avian flu virus appeared. The new virus caused illness in two children in Hong Kong. Neither of these avian flu viruses started pandemics.

Swine Flu (H1N1 virus) of 2009–2010

This influenza pandemic emerged from Mexico in 2009. The first U.S. case of H1N1, or Swine Flu, was diagnosed on April 15, 2009. The U.S. government declared H1N1 a public health emergency on April 26. By June, approximately 18,000 cases of H1N1 had been reported in the United States. A total of 74 countries were affected by the pandemic.

The CDC estimates that 43 million to 89 million people were infected with H1N1 between April 2009 and April 2010. There were an estimated 8,870 to 18,300 H1N1 related deaths. On August 10, 2010, the World Health Organization (WHO) declared an end to the global H1N1 flu pandemic.

Historical occurrences of pandemics other than influenza include the following:

Meningitis, 1996-1997, 2005

During 1996 and 1997, 213,658 cases of meningitis were reported, with 21,830 deaths, in Africa. According to the North Carolina Disease Data Dashboard, there were 28 cases in North Carolina in 2005.

Lyme Disease, 2015

In the United States, Lyme disease is mostly found in the northeastern, mid-Atlantic, and upper north-central regions, and in several counties in northwestern California. In 2015, 95-percent of confirmed Lyme Disease cases were reported from 14 states: Connecticut, Delaware, Maine, Maryland, Massachusetts, Minnesota, New Hampshire, New Jersey, New York, Pennsylvania, Rhode Island, Vermont, Virginia, and Wisconsin. Lyme disease is the most reported vector-borne illness in the United States. In 2015, it was the sixth most common nationally notifiable disease. However this disease does not occur nationwide and is concentrated heavily in the northeast and upper Midwest.

Severe Acute Respiratory Syndrome, 2003

During November 2002-July 2003, a total of 8,098 probable SARS cases were reported to the World Health Organization (WHO) from 29 countries. In the United States, only 8 cases had laboratory evidence of infection. Since July 2003, when SARS transmission was declared contained, active global surveillance for SARS disease has detected no person-to-person transmission. CDC has therefore archived the case report summaries for the 2003 outbreak. Across North Carolina, there was one confirmed SARS case – a man in Orange County tested positive in June 2003.

Zika Virus, 2015

In May 2015, the Pan American Health Organization issued an alert noting the first confirmed case of a Zika virus infection in Brazil. Since that time, Brazil and other Central and South America countries and territories, as well as the Caribbean, Puerto Rico, and the U.S. Virgin Islands have experienced ongoing Zika virus transmission. In August 2016, the Centers for Disease Control and Prevention (CDC) issued guidance for people living in or traveling to a 1-square-mile area Miami, Florida, identified by the Florida Department of Health as having mosquito-borne spread of Zika. In October 2016, the transmission area

was expanded to include a 4.5-square-mile area of Miami Beach and a 1-squre mile area of Miami-Dade County. In addition, all of Miami-Dade County was identified as a cautionary area with an unspecified level of risk. As of the end of 2018, the CDC reported 74 cases of Zika across the United States.

Ebola, 2014-2016

In March 2014, West Africa experienced the largest outbreak of Ebola in history. Widespread transmission was found in Liberia, Sierra Leone, and Guinea with the number of cases totaling 28,616 and the number of deaths totaling 11,310. In the United States, four cases of Ebola were confirmed in 2014 including a medical aid worker returning to New York from Guinea, two healthcare workers at Texas Presbyterian Hospital who provided care for a diagnosed patient, and the diagnosed patient who traveled to Dallas, Texas from Liberia. All three healthcare workers recovered. The diagnosed patient passed away in October 2014.

In March 2016, the WHO terminated the public health emergency for the Ebola outbreak in West Africa.

Coronavirus Disease (COVID-19), 2020

During the update of this plan, the Coronavirus disease 2019, also known as COVID-19, outbreak became a worldwide pandemic. COVID-19 was caused by severe acute respiratory syndrome coronavirus 2 (SARS-Cov-2). First identified in Wuhan, China in December 2019, the virus quickly spread throughout China and then globally. As of October 18, 2020, there were over 39.5 million cases worldwide resulting in over 1.1 million deaths. In the United States, COVID-19 was first identified in late January in Washington State and rapidly spread throughout the Country, with large epicenters on both the east and west coasts.

In order to curb the spread of the virus, Governor Roy Cooper issued a statewide Stay at Home Order on March 27, 2020. According to the North Carolina Department of Health and Human services, as of October 23, 2020, there were over 255,708 confirmed cases and 4,114 deaths across all 100 counties in the State. In Pasquotank County, as of October 23, 2020, there were a total of 840 cases and 35 deaths. Case counts are still rising in North Carolina and Pasquotank County at the time of this assessment. On the ECSU Campus, as of November 15, 2020, there have been 9 employees and 63 students with confirmed cases.

Probability of Future Occurrence

It is impossible to predict when the next pandemic will occur or its impact. The CDC continually monitors and assesses pandemic threats and prepares for an influenza pandemic. Novel influenza A viruses with pandemic potential include Asian lineage avian influenza A (H5N1) and (H7N9) viruses. These viruses have all been evaluated using the Influenza Risk Assessment Tool (IRAT) to assess their potential pandemic risk. Because the CDC cannot predict how severe a future pandemic will be, advance planning is needed at the national, state and local level; this planning is done through public health partnerships at the national, state and local level.

Today, a much larger percentage of the world's population is clustered in cities, making them ideal breeding grounds for epidemics. Additionally, the explosive growth in air travel means the virus could literally be spread around the globe within hours. Under such conditions, there may be very little warning time. Most experts believe we will have just one to six months between the time that a dangerous new influenza strain is identified and the time that outbreaks begin to occur in the United States. Outbreaks are expected to occur simultaneously throughout much of the nation, preventing shifts in human and material resources that normally occur with other natural disasters. These and many other aspects make influenza pandemic unlike any other public health emergency or community disaster.

Probability: 2 – Possible

Vulnerability Assessment

People

Disease spread and mortality is affected by a variety of factors, including virulence, ease of spread, aggressiveness of the virus and its symptoms, resistance to known antibiotics and environmental factors. While every pathogen is different, diseases normally have the highest mortality rate among the very young, the elderly or those with compromised immune systems. As an example, the unusually deadly 1918 H1N1 influenza pandemic had a mortality rate of 20%. If an influenza pandemic does occur, it is likely that many age groups would be seriously affected. The greatest risks of hospitalization and death—as seen during the last two pandemics in 1957 and 1968 as well as during annual outbreaks of influenza—will be to infants, the elderly, and those with underlying health conditions. However, in the 1918 pandemic, most deaths occurred in young adults. Few people, if any, would have immunity to a new virus.

Approximately twenty percent of people exposed to West Nile Virus through a mosquito bite develop symptoms related to the virus; it is not transmissible from one person to another. Preventive steps can be taken to reduce exposure to mosquitos carrying the virus; these include insect repellent, covering exposed skin with clothing and avoiding the outdoors during twilight periods of dawn and dusk, or in the evening when the mosquitos are most active.

Property

For the most part, property itself would not be impacted by a human disease epidemic or pandemic. However, as concerns about contamination increase, property may be quarantined or destroyed as a precaution against spreading illness. Furthermore, staffing shortages could affect the function of critical facilities.

Environment

A widespread pandemic would not have an impact on the natural environment unless the disease was transmissible between humans and animals. However, affected areas could result in denial or delays in the use of some areas, and may require remediation.

Changes in Development

With enrollment decreasing since the last plan, the number of students and employees on campus has decreased. Additionally, with fewer buildings located on campus, the number of indoor meeting locations has decreased.

For future development, as the number of students and employees increase, the opportunity for spread of a pandemic would increase, should in-person educational and/or extracurricular meetings take place.

Problem Statement

- With the current COVID-19 pandemic, it is clear the ECSU campus population is susceptible to the infectious disease pandemic.
- ECSU has a pandemic influenza plan in place to provide a guide for the University to follow in the event of an influenza pandemic in North Carolina.

B.5.11 Conclusions on Hazard Risk

Priority Risk Index

As discussed in **Section B.5**, 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 B.46 summarizes the degree of risk assigned to each identified hazard using the PRI method.

Table B.46 – Summary of PRI Results

Hazard	Probability	Impact	Spatial Extent	Warning Time	Duration	PRI Score
Earthquake	Unlikely	Minor	Large	Less than 6 hours	Less than 6 hours	1.9
Flood	Highly Likely	Minor	Small	6 to 12 hrs	Less than 1 week	2.5
Hurricane	Likely	Catastrophic	Large	More than 24 hrs	Less than 24 hrs	3.2
Severe Winter Weather	Highly Likely	Limited	Large	More than 24 hrs	Less than 1 week	3.0
Tornado / Thunderstorm	Likely	Critical	Large	Less than 6 hrs	Less than 6 hrs	3.1
Wildfire	Possible	Limited	Large	More than 24 hrs	More than 1 week	2.5
Cyber Threat	Possible	Critical	Large	Less than 6 hrs	More than 1 week	3.1
Hazardous Materials Incidents	Likely	Minor	Negligible	Less than 6 Hrs	Less than 24 Hrs	2.0
Infectious Disease	Possible	Critical	Large	More than 24 hrs	More than 1 week	2.8

The results from the PRI have been classified into three categories based on the assigned risk value which are summarized in **Table B.47**:

- **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.
- **Moderate 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 minimal. This is not a priority hazard.

Table B.47 – Summary of Hazard Risk Classification

High Risk (≥ 3.0)	Hurricane Tornado / Thunderstorm Severe Winter Weather
Moderate Risk (2.0 – 2.9)	Flood Wildfire Cyber Threat Hazardous Materials Infectious Disease
Low Risk (< 2.0)	Earthquake

B.6 CAPABILITY ASSESSMENT

This section discusses the mitigation capabilities, including planning, programs, policies and land management tools, typically used to implement hazard mitigation activities. It consists of the following subsections:

- B.6.1 Overview of Capability Assessment
- B.6.2 Planning and Regulatory Capability
- B.6.3 Administrative and Technical Capability
- B.6.4 Fiscal Capability

B.6.1 Overview of Capability Assessment

The purpose of conducting a capability assessment is to determine the ability of the college to implement feasible mitigation actions based on an understanding of the capacity of the departments and staff tasked with their implementation. A capability assessment should also identify opportunities for establishing or enhancing specific mitigation policies or programs. The process of conducting a capability assessment includes developing an inventory of relevant plans, policies, or programs already in place; as well as assessing the college's ability to implement existing and/or new policies. Conclusions drawn from the capability assessment should identify any existing gaps or weaknesses in existing programs and policies as well as positive measures already in place which can and should be supported through future mitigation efforts.

B.6.2 Planning and Regulatory Capability

Planning and regulatory capabilities include plans, ordinances, policies and programs that guide development on campus. **Table B.48** lists these local resources currently in place at ECSU.

Table B.48 – Planning and Regulatory Capability

Regulatory Tool (ordinances, codes, plans)	Y/N	Comments
Strategic Plan	Y	ECSU Strategic Plan 2020-2025
Zoning code	Y	Elizabeth City Zoning Ordinance
Growth management ordinance	N	
Floodplain ordinance	Y	Elizabeth City Flood Ordinance
Building code	Y	NC building codes; the State of North Carolina statutes for state owned buildings; and zoning for local jurisdiction
Erosion or sediment control program	N	
Stormwater management program	N	
Site plan review requirements	N	
Capital improvements plan	Y	ECSU Budget Office
Economic development plan	Y	ECSU Annual Report
Local emergency operations plan	Y	Emergency Operations Plan 2014
Flood Insurance study or other engineering study for streams	Y	December 21, 2018
Elevation certificates	Y	Elizabeth City

A description of applicable plans, ordinances and programs follows to provide more detail on the relevance of each regulatory tool in examining capability.

Strategic Master Plan

A Strategic Plan, in broad terms, is a policy statement to guide the future placement and development of campus facilities. The Strategic Master Plan identifies a future vision, values, principals and goals for the college, determines the projected growth for the college, and identifies policies to plan, direct and accommodate anticipated growth. ECSU developed its first campus Strategic Plan in 1995 and has gone through multiple updates, most recently with the completion of the 2020-2025 Strategic Plan. The Plan clarifies the university's mission and values and sets a vision, goals, and objectives for institutional growth.

Zoning Code

Zoning typically consists of both a zoning map and a written ordinance/code that divides the planning area into zoning districts. The zoning regulations describe what type of land use and specific activities are permitted in each district, and also regulate how buildings, signs, parking, and other construction may be placed on a parcel. The zoning regulations also provide procedures for rezoning and other planning applications. Zoning is undertaken at the municipal level, by Elizabeth City.

Flood Insurance Study/Floodplain Ordinance

A Flood Insurance Study (FIS) provides information on the existence and severity of flood hazards within a community based on the 100-year flood event. The FIS also includes revised digital Flood Insurance Rate Maps (FIRMs) which reflect updated Special Flood Hazard Areas (SFHAs) and flood zones for the community. FIRMs are developed and provided by FEMA.

A floodplain ordinance is perhaps the most important flood mitigation tool. 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 will be protected from damage by a 100-year flood event and that new development in the floodplain will not exacerbate existing flood problems or increase damage to other properties. Floodplain management is undertaken at the municipal level by Elizabeth City.

Stormwater Management Program

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. A Stormwater Management Program can prevent flooding problems caused by stormwater runoff by 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) Setting construction standards so buildings are protected from shallow water. A stormwater ordinance provides regulatory authority to implement stormwater management standards.

Erosion and Sediment Control Program

Surface water runoff can erode soil from development sites, sending sediment into downstream waterways. This can clog storm drains, drain tiles, culverts and ditches and reduce the water transport and storage capacity of channels. The purpose of an erosion, sedimentation and pollution control ordinance is to minimize soil erosion and prevent off-site sedimentation by using soil erosion and sediment control practices designed in accordance with certain standards and specifications.

Site Plan Review

The purpose of the Site Plan Review Process is to review site plans for specific types of development to ensure compliance with all appropriate land development regulations and consistency with the General Plan.

Building Code

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).

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. An Elevation Certificate serves as the official record that shows new buildings and substantial improvements in all identified SFHAs are properly elevated. This elevation information is needed to show compliance with the floodplain ordinance.

Capital Improvement Plan

A Capital Improvement Plan (CIP) is a planning document that typically provides a five-year outlook for anticipated capital projects designed to facilitate decision makers in the replacement of capital assets. The projects are primarily related to improvement in public service, parks and recreation, public utilities and facilities. The mitigation strategy may include structural projects that could potentially be included in a CIP and funded through a Capital Improvement Program. Capital improvements planning on campus is led by the ECSU Budget Office.

Emergency Operations Plan

An emergency operations plan outlines responsibilities and the means by which resources are deployed during and following an emergency or disaster. ECSU has an Emergency Operations Plan, developed in 2014, which establishes policies, procedures, and an organizational structure for response to emergencies or disaster that may cause a significant disruption to the functions of all or portions of the university.

B.6.3 Administrative and Technical Capability

Administrative and technical capability refers to the college's staff and their skills and tools that can be used for mitigation planning and to implement specific mitigation actions. It also refers to the ability to access and coordinate these resources effectively. The personnel should be considered as well as the level of knowledge and technical expertise of these resources. Resources include engineers, planners, emergency managers, GIS analysts, building inspectors, grant writers, floodplain managers, and more. **Table B.49** provides a summary of the administrative and technical capabilities for ECSU.

Table B.49 – Administrative and Technical Capability

Personnel Resources	Yes/No	Department/Position
Planner/Engineer with knowledge of land development/land management practices	Yes	Elizabeth City
Engineer/Professional trained in construction practices related to buildings and/or infrastructure	Yes	Office of Design & Construction

Personnel Resources	Yes/No	Department/Position
Planner/Engineer/Scientist with an understanding of natural hazards	Yes	Emergency Management Department and Emergency Management Degree Program, Faculty and Students
Personnel skilled in GIS	Yes	Office of Design & Construction
Full time building official	Yes	Elizabeth City
Floodplain Manager	Yes	Elizabeth City
Emergency Manager	Yes	Public Safety/Campus Police ECSU CERT and DART response teams Pasquotank-Camden-Elizabeth City Emergency Management Agency
Grant Writer	No	
Public Information Officer	Yes	Communications & Marketing
Student Engagement	Yes	Division of Student Affairs
Warning Systems	Yes	Public Safety/Campus Police

Additional resources and departments that may support administrative capabilities include the following:

Bachelor of Science in Emergency Management Degree Program

The Bachelor of Science in Emergency Management degree program regularly takes on local service projects in and around the surrounding campus. In the past, Elizabeth City has been used for a risk analysis project where flooding was found to be a concern for smaller rain events. Currently, the Emergency Management program is working with the ECSU Aviation Department students to examine long term mitigation aspects for university aircraft, as well as plans for protection of high value training simulators on the first floor of the STEM complex.

Design and Construction

The Design and Construction Department tracks all facility deficiencies and manages schedules and budgets for facilities improvements. Integration with the Budget Office to plan for capital improvements and inclusion of hazard vulnerabilities in facility deficiency tracking could support improvement mitigation capability on campus.

Facilities Management

The Facilities Management Department is responsible for building maintenance and upgrades. Facilities services recently undertook improvements to several campus buildings to increase energy efficiency, improve sustainability, and reduce operations costs. Continued improvements of this nature may support campus resiliency to hazard events.

Division of Student Affairs

The Division of Student Affairs (SA) coordinates with the Emergency Management Department to disseminate hazard information on all student social media platforms, E4U, Student List Moderator, and via the Vikings Engage app. Additionally, Housing and Residence Life ensures that this information is shared with residential students. Further, when students are impacted on campus due to hazard event, SA takes immediate action to incorporate residence hall departure and shelter-in-place plans. SA works directly with Academic Affairs as it relates to classes, and Auxiliary Services for meal/dining, so that this information can be communicated to both students and their families. SA requires essential workers to be at work and/or on call. In most cases, these areas include: Student Health Services, Student Counseling Services, Student Engagement, and Housing and Residence Life. Communication is consistent and frequent and shared with students and families whether they remain on campus in an identified shelter space or home with their families/guardians.

Emergency Shelters

ECSU maintains two emergency shelter sites on campus in conjunction with the American Red Cross (ARC). One shelter site is maintained for the students that are unable to evacuate during a disaster. It is setup and staffed by university employees and volunteers. The second shelter site is on campus but is designated for use by area residents and is run by the ARC though ECSU employees. Volunteers assist with the setup and other aspects. Pasquotank County has a poverty rate of more than 24% which is more than 60% of that of the national average. The County also has more than 370 citizens using home electrical medical assisting devices for their health and more than 6% of the population do not speak English. It is understood that in a major emergency and/or disaster event, many of this vulnerable population would seek shelter at the ECSU site.

B.6.4 Fiscal Capability

Financial capabilities are the resources that an entity has access to or is eligible to use to fund mitigation actions. The costs associated with implementing mitigation activities vary. Some mitigation actions such as building assessment or outreach efforts require little to no costs other than staff time and existing operating budgets. Other actions, such as structural projects, could require a substantial monetary commitment from local, State, and Federal funding sources. **Table B.50** provides a summary of the fiscal resources at ECSU.

Table B.50 – Fiscal Resources

Resource	Ability to Use for Mitigation Projects? Y/N
Community Development Block Grants	N
Capital improvements project funding	Y
In-Kind Services	Y
Tuition & Fees	Y
Federal funding with HMA grants	Y
Revenue Bonds	Y
State Appropriations	Y
Sales & Services	Y
Other Sources (Gifts, Investment Income, Permanent Endowments)	Y

B.7 MITIGATION STRATEGY

B.7.1 Implementation Progress

Progress on the mitigation strategy developed in the previous plan is also documented in this plan update. **Table B.51** details the status of mitigation actions from the previous plan. **Table B.52** on the following pages details all completed and deleted actions from the 2011 plan. More detail on the actions being carried forward is provided in the Mitigation Action Plan.

Table B.51 – Status of Previous Mitigation Actions

Campus	Completed	Deleted	Carried Forward and/or Combined
ECSU	3	2	39

Table B.52 – Completed and Deleted Actions from the ECSU 2011 Plan

Vulnerability	Action	2020 Status	2020 Implementation Status Comments
K.E. White Graduate and Continuing Education Center – The roof is deteriorating and the spray on polymer coating is peeling away.	The facility should be reroofed.	Completed	
Moore Hall – There is a below grade mechanical room that relies on a sump pump.	A redundant sump pump should be installed in the event that the existing pump fails.	Completed	
Thomas Jenkins Building - The incident command center does not have sufficient standby power to run lights and outlets.	Provide generator power to the lights and outlets in the incident command center.	Completed	
Information Technology Center - Facility personnel report that there are leaks that occur in the ceiling of the downstairs data center after intense rain storms.	The cause of water leakage in the ground floor data center should be identified and remedied.	Deleted	Maintenance action, not mitigation.
Thomas Jenkins Building - The emergency generator and vehicle gas pumps are susceptible to impacts.	Place barriers (curbs, bollards, etc.) in the vicinity of the gas pumps and generator to prevent impacts.	Deleted	This property protection measure addresses hazards outside of this plan.

B.7.2 Mitigation Action Plan

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.

The following table comprises the mitigation action plan for ECSU. Each mitigation action recommended for implementation is listed in these tables along with detail on the hazards addressed, the goal and objective addressed, the priority rating, the lead agency responsible for implementation, potential funding sources and estimated cost for the action, a projected implementation timeline, and the 2020 status and progress toward implementation for actions that were carried forward from the 2011 PDM plan.

Table B.53 – Mitigation Action Plan, ECSU

Action #	Action Description	Hazard(s) Addressed	Goal & Objective Addressed	Priority	Mitigation Category	Lead Agency / Department	Estimated Cost	Potential Funding Source	Implementation Timeline	2020 Status	2020 Implementation Status Comments
ECSU1	Campus-Wide – Major mechanical systems (HVAC equipment, heat pumps, chillers, generators, fuel tanks, gas cylinders, transformers and boilers) should be anchored to their foundations. This includes, but is not limited to, the following campus buildings: Central Utility Plant; E.V. Wilkins Academic Computing Center; Jimmy R. Jenkins Science Complex; K.E. White Graduate and Continuing Education Center; Marion D. Thorpe Administration Building; Moore Hall; Robert L. Vaughn Center; Thomas Jenkins Building; and Williams Hall.	All Hazards	1.1	H	Property Protection	Facilities Dept.	$5,000-$25,000 per site	General funds	2021-2026	Carry Forward	No progress was made on this action.
ECSU2	Campus-Wide – Upgrade back-up power capabilities to critical facilities including, but not limited to: Information Technology Center; K.E. White Graduate and Continuing Education Center; Marion D. Thorpe Administration Building; and Robert L. Vaughn Center.	All Hazards	1.1	H	Property Protection	Facilities Dept.	>$100,000 per site	State/Federal grants	2021-2026	Carry Forward	No progress was made on this action.
ECSU3	Central Utility Plant - Out on the plant floor there is a large bank of electrical gear with numerous water lines running nearby overhead. During future system modifications relocate or attempt to route water lines further from the electrical switchgear.	Human-caused Hazard	1.1	M	Property Protection	Facilities Dept.	$25,000-$100,000	General funds	2021-2026	Carry Forward	No progress was made on this action.
ECSU4	E.V. Wilkins Academic Computing Center - There are a number of unreinforced IGU windows that could be broken by wind borne debris near sensitive electrical equipment. The windows in the server and UPS area should be reinforced with shatter resistant film to prevent water intrusion in the event of glass breakage.	Tornado/ Thunderstorm, Hurricane	1.1	M	Property Protection	Facilities Dept.	$5,000-$25,000	General funds	2021-2026	Carry Forward	No progress was made on this action.
ECSU5	E.V. Wilkins Academic Computing Center - Roof drainage relies exclusively on two drains which if clogged could lead to significant ponding. When the roof is replaced, consider installing one or more scuppers as emergency overflow to prevent roof ponding (which would be significant given the existing parapets).	Flood	1.1	M	Property Protection	Facilities Dept.	$5,000-$25,000	General funds	2021-2026	Carry Forward	No progress was made on this action.
ECSU6	Information Technology Center - There is no redundant HVAC for either the upstairs or downstairs data center and there is insufficient emergency cooling available if the chiller or the downstairs supplemental system fail. The data centers should each have a primary and a backup cooling system capable of cooling the computers if they would be operationally necessary in an emergency.	Tornado/ Thunderstorm, Hurricane	1.2	M	Property Protection	Facilities Dept.	>$100,000	General funds	2021-2026	Carry Forward	No progress was made on this action.
ECSU7	Information Technology Center - There are a number of mechanical and electrical systems serving critical functions that are not bolted to their foundations including transformers, the chiller, the boiler, air handling units, and UPS systems. All mechanical and electrical systems serving critical facilities should be bolted to their foundations in compliance with the building code.	Tornado/ Thunderstorm, Hurricane	1.1	H	Property Protection	Facilities Dept.	<$5,000	General funds	2021-2026	Carry Forward	No progress was made on this action.
ECSU8	Information Technology Center - There is an unreinforced window in the network switching/call manager closet. Wind borne debris could break the window and driving rain could damage the equipment located there. The window located in the network/call manager room should be reinforced or protected against wind borne debris impacts.	Tornado/ Thunderstorm, Hurricane	1.1	L	Property Protection	Facilities Dept.	<$5,000	General funds	2021-2026	Carry Forward	No progress was made on this action.
ECSU9	Jimmy R. Jenkins Science Complex - Several of the guy wires securing rooftop exhaust stacks have become slack. Guy wires for rooftop exhaust vents should be properly tensioned to prevent roof damage during high wind events.	Tornado/ Thunderstorm, Hurricane	1.1	L	Property Protection	Facilities Dept.	<$5,000	General funds	2021-2026	Carry Forward	No progress was made on this action.

Action #	Action Description	Hazard(s) Addressed	Goal & Objective Addressed	Priority	Mitigation Category	Lead Agency / Department	Estimated Cost	Potential Funding Source	Implementation Timeline	2020 Status	2020 Implementation Status Comments
ECSU10	Jimmy R. Jenkins Science Complex - The roof of the planetarium ponds water and this reportedly leads to above normal humidity inside the planetarium. The roof over the planetarium should be replaced with a roof that has been properly sloped toward drains and provides increased resistance to wind and driving rain.	Tornado/ Thunderstorm, Hurricane	1.1	L	Property Protection	Facilities Dept.	$25,000-$100,000	General funds	2021-2026	Carry Forward	No progress was made on this action.
ECSU11	Jimmy R. Jenkins Science Complex - In certain laboratories there appears to be expensive analytical equipment near windows which in an intense storm could break and allow rain to damage instruments. Locate expensive analytical equipment away from windows or install shatter resistant film over select windows.	Tornado	1.2	M	Property Protection	Facilities Dept.	$5,000-$25,000	General funds	2021-2026	Carry Forward	No progress was made on this action.
ECSU12	K.E. White Graduate and Continuing Education Center - There are two locations at the rear of the facility where the new masonry is cracking around window openings. The cause of masonry damage should be investigated and remedied before further damage occurs.	Severe Winter Weather	1.1	L	Property Protection	Facilities Dept.	<$5,000	General funds	2021-2026	Carry Forward	No progress was made on this action.
ECSU13	K.E. White Graduate and Continuing Education Center - There is a clogged roof drain and standing water over the boiler room. Roof drains should be regularly inspected and cleaned. Trees adjacent to the facility should be pruned to prevent them from dropping leaves onto the roof deck.	Tornado/ Thunderstorm, Hurricane	1.1	M	Prevention	Facilities Dept.	<$5,000	General funds	2021-2026	Carry Forward	No progress was made on this action.
ECSU14	K.E. White Graduate and Continuing Education Center - The guy wires supporting the boiler exhaust are slack. Guy wires supporting the rooftop exhaust stack should be taut to prevent wind related damage.	Tornado/ Thunderstorm, Hurricane	1.1	L	Property Protection	Facilities Dept.	<$5,000	General funds	2021-2026	Carry Forward	No progress was made on this action.
ECSU15	Marion D. Thorpe Administration Building - There are several large pine trees near one corner of the building which could fall and damage the structure during high winds. The large pines adjacent to the facility should be routinely inspected by an arborist to ensure that the trees are healthy. If the tree is in poor health, it should be cut down to prevent damage to the structure as a result of high winds.	Severe Winter Weather	1.1	M	Prevention	Facilities Dept.	<$5,000	General funds	2021-2026	Carry Forward	No progress was made on this action.
ECSU16	Marion D. Thorpe Administration Building - At the time of the site visit the center of the roof membrane was debonded from the deck and billowing upward in the wind. There were also a number of pine needles on the roof beginning to clog roof drains. The roof of the building should be replaced with one that provides increased resistance to wind and driving rain.	Tornado/ Thunderstorm, Hurricane	1.1	L	Property Protection	Facilities Dept.	>$100,000	General funds	2021-2026	Carry Forward	No progress was made on this action.
ECSU17	Marion D. Thorpe Administration Building - The network core switch located in the auditor's office on the first floor lacks proper HVAC. During normal conditions the switch operates above ideal temperatures. During a power outage the switch would eventually overheat cutting off telephone service to the EOC. The network core switch on the first floor should have an independent HVAC unit installed that is powered by the generator.	All Hazards	1.1	H	Property Protection	Facilities Dept.	$5,000-$25,000	State/Federal grants	2021-2026	Carry Forward	No progress was made on this action.
ECSU18	Moore Hall - The steam lines located in the adjacent street should either be relocated or have better barriers installed to prevent accidental impacts. Place barriers in the vicinity of the steam lines to prevent impacts.	Tornado/ Thunderstorm, Hurricane	1.1	M	Property Protection	Facilities Dept.	$5,000-$25,000	General funds	2021-2026	Carry Forward	No progress was made on this action.
ECSU19	Robert L. Vaughn Center - There is no pedestrian sidewalk in the relatively high traffic area between the building and the tennis courts at the rear, exposing pedestrian to vehicle strike. Install a non-skid, ice-resistance pedestrian sidewalk between the rear of the facility and the tennis courts to protect pedestrians during snow/ice events.	Severe Winter Weather	1.1	M	Prevention	Facilities Dept.	$5,000-$25,000	General funds	2021-2026	Carry Forward	No progress was made on this action.
ECSU20	Robert L. Vaughn Center - There is widespread and serious damage to the brick façade around embedded steel columns. The cause of masonry damage should be investigated and remedied before further damage occurs.	Severe Winter Weather	1.1	M	Property Protection	Facilities Dept.	$25,000-$100,000	General funds	2021-2026	Carry Forward	No progress was made on this action.

Action #	Action Description	Hazard(s) Addressed	Goal & Objective Addressed	Priority	Mitigation Category	Lead Agency / Department	Estimated Cost	Potential Funding Source	Implementation Timeline	2020 Status	2020 Implementation Status Comments
ECSU21	Robert L. Vaughn Center - There is minor cracking and spalling of reinforced concrete columns on the exterior of the swimming pool. Concrete damage should be repaired to prevent further deterioration.	Severe Winter Weather	1.1	L	Property Protection	Facilities Dept.	<$5,000	General funds	2021-2026	Carry Forward	No progress was made on this action.
ECSU22	Robert L. Vaughn Center - Hollowell Drive adjacent to the facility floods so severely during intense rain storms that the University must be temporarily closed for safety. This also significantly limits emergency vehicle access. The University should enhance their existing stormwater capture and detention system to prevent road flooding and University closure.	Flood	1.1	H	Structural Projects	Facilities Dept.	>$100,000	State/Federal grants	2021-2026	Carry Forward	No progress was made on this action.
ECSU23	Thomas Jenkins Building - There are unreinforced windows in the 911/dispatch area that could break as a result of wind borne debris. Replace or reinforce the windows in the 911/dispatch center with shatter resistant film to protect equipment and personnel in the event of a wind borne debris strike.	Tornado/ Thunderstorm, Hurricane	1.1	M	Property Protection	Facilities Dept.	$5,000-$25,000	General funds	2021-2026	Carry Forward	No progress was made on this action.
ECSU24	Thomas Jenkins Building - The roof is reported to leak in the vicinity of the 911/dispatch area. The roof should be repaired with one that provides increased resistance to wind and driving rain.	Tornado/ Thunderstorm, Hurricane	1.1	M	Property Protection	Facilities Dept.	<$5,000	General funds	2021-2026	Carry Forward	No progress was made on this action.
ECSU25	Williams Hall - There is an unreinforced window in the room housing the radio station's electronic equipment. The window could be broken by wind borne debris, allowing rain to damage sensitive electronics. The window in the room with sensitive radio station electronics should be reinforced or covered with a protective Plexiglas shield to prevent water damage in the event that wind borne debris breaks the window.	Hurricane, Tornado/ Thunderstorm, Flood	1.1	L	Property Protection	Facilities Dept.	<$5,000	General funds	2021-2026	Carry Forward	No progress was made on this action.
ECSU26	Williams Hall - One of the three sets of guy wires for the radio tower is surrounded by tall pines that could cause serious or catastrophic damage if they were to fall as a result of high winds. Large trees adjacent to the antennae guy wires should be cut down. Severe damage to the guy wires could result in catastrophic failure.	Tornado/ Thunderstorm, Hurricane, Severe Winter Weather	1.1	M	Prevention	Facilities Dept.	$5,000-$25,000	General funds	2021-2026	Carry Forward	No progress was made on this action.
ECSU27	Williams Hall - Facility personnel report scattered leaks in the roof in the area of the gymnasium. The cause of roof leaks should be identified and repaired to prevent further damage to the building.	Flood	1.1	L	Property Protection	Facilities Dept.	$5,000-$25,000	General funds	2021-2026	Carry Forward	No progress was made on this action.

THE UNIVERSITY OF NORTH CAROLINA SYSTEM

UNC System Eastern Campuses Regional Hazard Mitigation Plan

Annex C: Fayetteville State University

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TABLE OF CONTENTS

Annex C Fayetteville State University

This section provides planning process, campus profile, hazard risk, vulnerability, capability, and mitigation action information specific to Fayetteville State University (FSU). This section contains the following subsections:

- C.1 Planning Process Details
- C.2 Campus Profile
- C.3 Asset Inventory
- C.4 Hazard Identification
- C.5 Hazard Profiles, Analysis, and Vulnerability
- C.6 Capability Assessment
- C.7 Mitigation Strategy

C.1 PLANNING PROCESS DETAILS

The table below lists the HMPC members who represented FSU during the planning process.

Table C.1 – HMPC Members

Representative	Role; Department
Melvin Lewis	Director of Emergency Management; Police & Public Safety
Renarde Earl	Chief of Police, Associated Vice Chancellor of Public Safety; Police & Public Safety
Nicole Lucas	Interim Director Institutional Effectiveness; Academic Affairs
Gregory Moyd	Assistant Vice Chancellor; Student Affairs
Donald Pearsall	Director of Business Services; Business & Finance
Conroy Campbell	Database Administrator; Information Technology
Harold Miller	Director, Planning & Construction; Facilities Management
Terri Tibbs	Associate Vice Chancellor; Human Resources
Benita Angel Powell	Assistant General Counsel; Legal Office

Coordination with Other Community Planning Efforts and Hazard Mitigation Activities

The table below lists campus and community resources referenced throughout the planning process and used in the plan development.

Table C.2 – Summary of Existing Studies and Plans Reviewed

Resource Referenced	Use in this Plan
FSU Campus Master Plan	The FSU Campus Master Plan was developed in 2013 and has since been updated. It was referenced for the Campus Profile in Section C.2 as well as the Capability Assessment in Section C.6
City of Fayetteville Comprehensive Plan	The Comprehensive Plan, developed by the City of Fayetteville Planning & Zoning Department, was referenced for the Campus Profile in Section C.2.
Cumberland County and Incorporated Areas Flood Insurance Study (FIS), Revised 6/20/2018	The FIS report was referenced in the preparation of flood hazard profile in Section C.5.
FSU Pre-Disaster Mitigation Plan, 2010	The previous FSU Pre-Disaster Mitigation Plan was used in preparation of the hazard profiles in Section C.5. The plan was additionally used to track implementation progress (Section 2) and develop the mitigation plan (Section 7).

Resource Referenced	Use in this Plan
Cumberland-Hoke Regional Hazard Mitigation Plan, 2016	The Cumberland-Hoke Regional Hazard Mitigation Plan, which includes Fayetteville, was referenced in compiling the Hazard Identification and Risk Assessment in Section C.5. FSU is also part of the Cumberland-Hoke County Hazard Mitigation Plan update for 2021-2026.

C.2 CAMPUS PROFILE

This section provides a general overview of the Fayetteville State University (FSU) campus and area of concern to be addressed in this plan. It consists of the following subsections:

- Location and Setting
- Geography and Climate
- History
- Cultural and Natural Resources
- Land Use
- Population and Demographics
- Social Vulnerability
- Growth and Development Trends

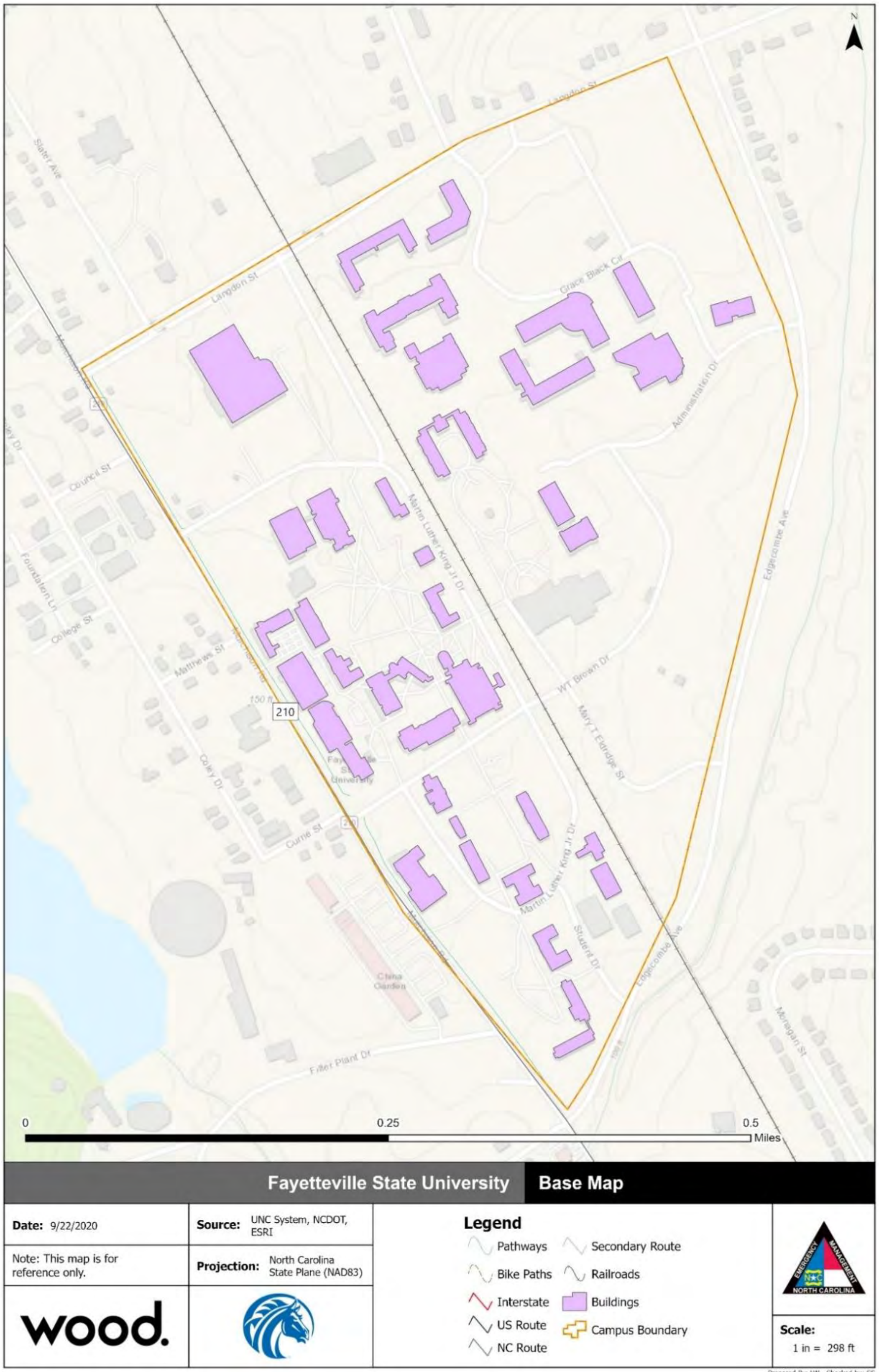
C.2.1 Location and Setting

Located just outside of downtown Fayetteville, Fayetteville State University offers students the opportunity to receive an excellent education while enjoying a wide variety of recreational and cultural amenities. Favored by a mild climate and proximity to Glenville Lake and Mazarick Park, FSU has features that help make student living and learning both exciting and fulfilling. In addition, the university is rich with an array of exciting co-curricular experiences including over 100 different clubs and student organizations, intramural sports, social activities, speakers and cultural events.

United States Highways 210, 24, and 401 make the city and the university easily accessible by automobile. FSU offers Zipcars and Lime Bikes as campus transportation, and Fast Bus services are available city wide. Hotels and motels are available to accommodate overnight visitors. The university is situated on 156 acres and consists of 38 buildings, 4 of which were built in the last 10 years.

Figure C.1 provides a base map of the FSU main campus. For more details on on-campus buildings and critical facilities, see Section C.3.

Figure C.1 – FSU Campus Base Map



C.2.2 Geography and Climate

Fayetteville is in the Sandhills of North Carolina, which are between the coastal plain to the southeast and the Piedmont to the northwest. The land in Fayetteville sits approximately 102 feet above sea level. The City is built on the Cape Fear River, which empties into the Atlantic Ocean. Fayetteville has a mild climate with temperatures dropping to 32 degrees Fahrenheit on average in January and climbing to 90 degrees Fahrenheit in July on average. The annual precipitation for the city is approximately 47 inches per year.

C.2.3 History

Fayetteville State University is a constituent institution of the University of North Carolina and the second-oldest public institution of higher education in the state. Founded in 1867 as the Howard School for the education of African Americans, today FSU serves a growing student body of over 6,700 and ranks among the nation’s most diverse campus communities.

In 1867, seven black men - Matthew N. Leary, A. J. Chesnutt, Robert Simmons, George Grainger, Thomas Lomax, Nelson Carter, and David A. Bryant - paid $136 for two lots on Gillespie Street and converted themselves into a self-perpetuating Board of Trustees to maintain this property permanently as a site for the education of black children in Fayetteville. General O. O. Howard of the Freedman's Bureau, one of the best-known friends of black education, erected a building on this site, and the institution became known as the Howard School.

By a legislative act of 1877, the North Carolina General Assembly provided for the establishment of a Normal School for the education of black teachers. The Howard School was chosen as the most promising because of its successful record during the previous ten years. It was designated a teacher training institution, and its name was changed to the State Colored Normal School. Five Administrative Officers served for relatively short periods until 1899: Robert L. Harris, Charles W. Chesnutt, Ezekiel E. Smith, George Williams, and the Rev. L. E. Fairley.

In 1899, Dr. Smith returned to the institution. Under his administration, the school grew from three rooms in a small frame structure to a physical plant of ten buildings on a fifty-acre tract of land. In order to pay for the land, Dr. Smith, along with F. D. Williston, E. N. Williams, J. G. Smith and Dr. P. N. Melchor, endorsed a note for $3,000.00. The note was renewed several times and eventually paid off by Dr. Smith, who later deeded the land to the State. Dr. Smith retired in 1933 at the age of 80 with more than 40 years of service to the institution.

Dr. J. Ward Seabrook succeeded Dr. Smith and under his presidency the school became Fayetteville State Teachers College, thereafter, being authorized to grant the Bachelor of Science degree in Education. The college received both state and regional accreditation in 1947. Dr. Seabrook retired in 1956 and was succeeded by Dr. Rudolph Jones. During his administration, the curriculum was expanded to include majors in secondary education and programs leading to degrees outside the teaching field. The name of the school was changed to Fayetteville State College in 1963. Also, under the leadership of Dr. Jones, six additions were made to the physical plant to accommodate a rapidly expanding enrollment.

In 1969, the institution acquired its present name, "Fayetteville State University," and Dr. Charles "A" Lyons, Jr. was elected president. By a legislative act, Fayetteville State University became a constituent institution of the University of North Carolina System in 1972 and Dr. Lyons became its first chancellor. During his tenure, the curriculum was expanded to include a variety of both baccalaureate and master's level programs. In addition, the Fort Bragg-Pope AFB Extension Center, in conjunction with the Weekend and Evening College, was established in order to provide military personnel and other persons employed full-time with the opportunity to further their education. The general academic structure took its present configuration in 1985 when the university became a Comprehensive Level I Institution. In addition to expanding program offerings and services, eight buildings were added to the physical plant during this period.

On January 1, 1988, Dr. Lloyd V. Hackley became the seventh Chief Executive Officer of the university. In his seven years as Chancellor, the university expanded its master's level program offerings to include biology, business administration, education, English, history, mathematics, psychology, sociology, and teaching; FSU's first doctoral program in Educational Leadership was established; and, baccalaureate program offerings were also increased to include 36 disciplines in the arts and sciences, business and economics, and education. The addition of the $6.3 million ultra-modern School of Business and Economics Building, and the new $10.9 million Health and Physical Education Building, underscored Dr. Hackley's commitment to FSU's continued expansion and growth.

Chancellor Hackley strengthened FSU's community outreach to at-risk children in the public schools, establishing numerous scholarship and tutoring/mentoring programs to encourage more young people to aspire to academic excellence and a college education. FSU's first major public capital campaign was also completed during Dr. Hackley's tenure, which enabled the university to increase the number of privately funded scholarships. On December 31, 1995, Dr. Hackley left his post to become President of the North Carolina Department of Community Colleges, the first African American to lead the state's system of 59 community colleges. Dr. Donna J. Benson, Associate Vice President for Academic Affairs of the University of North Carolina served as Interim Chancellor from January 1, 1995 to November 15, 1995.

Dr. Willis McLeod, a 1964 graduate of Fayetteville State University, was appointed Chancellor on November 15, 1995. Dr. McLeod is the ninth Chief Executive Officer of the 130-year-old institution, and the first alumnus to serve as Chancellor since FSU became a constituent of The University of North Carolina in 1972. Dr. McLeod earned his master's and doctoral degrees in school administration from the University of Virginia, and has over 30 years of experience in education as a teacher, assistant superintendent, and superintendent of public school systems in Virginia, Louisiana, and North Carolina.

Several major initiatives were established by Dr. McLeod. The Freshman Year Initiative, (or F.Y.I.) a program designed to enhance students' educational outcomes, was initiated in fall 1996; new outreach efforts aimed at forging stronger community ties and involving the community in University life have been undertaken; campus improvements such as expansion of the Rudolph Jones Student Center and master planning to accommodate an expected enrollment increase of 50%; and Dr. McLeod was instrumental in forming a regional partnership of public school, community college, and university leaders to focus on strengthening the educational pipeline from pre-school to post-graduate studies.

Dr. T. J. Bryan assumed the position of Chancellor on July 1, 2003. The tenth chief executive officer of the university, Dr. Bryan is the first woman to serve as chancellor and the first African- American woman selected to lead a constituent institution of the University of North Carolina. Dr. Bryan earned the B.A. and M.A. from Morgan State College and the Ph.D. from the University of Maryland at College Park. Prior to appointment as chancellor, she served as a faculty member, department chair, and dean at Coppin State College. She also served as Associate Vice President for Academic Affairs for the University System of Maryland and Vice President for Academic and Student Affairs for the Pennsylvania State System of Higher Education.

Dr. Bryan's top priorities included developing new academic programs, obtaining specialized accreditation, strengthening student recruitment and support programs, establishing a first-rate international studies program, increasing funding from external sources, and improving physical facilities. Under her leadership, 10 new academic programs, including a four-year nursing program, Fire Science program, and an Honors Program, were established.

Dr. James A. Anderson was named the 11th Chief Executive Officer of Fayetteville State University on March 7, 2008. Dr. Anderson, who comes to FSU from the University of Albany in New York, began his duties as Chancellor of the state's second-oldest public institution on June 9, 2008. The appointment was made by Erskine Bowles, President of the 17-campus University of North Carolina System. He instituted global initiatives with 14 countries, successfully completed the 2009-2015 Strategic Plan, "The Future is Calling", and FSU was reaffirmed by SACS, NCATE, DPI, and AACSB. Dr. Anderson broadened community collaborations with the expansion of Bronco Square, the Farmer's Market, and sponsored entrepreneurial activities in schools and with community youth groups. FSU established the Center for Defense and Homeland Security, established eight certificate programs, increased online degree programs, and ranked high as a Military Friendly institution.

Dr. Peggy Valentine was appointed Interim Chancellor of Fayetteville State University on July 15, 2019. She assumed her duties on August 7.

On February 18, 2021, Darrell Allison was named the 12th Chancellor of Fayetteville State University. Allison previously served on the Board of Governors from 2017 to late 2020. He was the inaugural chair of the Historically Minority-Serving Institutions Committee and led efforts that resulted in all 17 campuses gaining at least $2 million for repairs and renovations. He also initiated a partnership with UNC-Chapel Hill's NC Policy Collaboratory, which awarded $6 million for COVID-19 programming and research at historically minority-serving institutions. Allison will assume the role of Chancellor on March 15, 2021.

C.2.4 Cultural and Natural Resources

National Register of Historic Places

There are 59 listings in the National Register of Historic Places for Fayetteville. A few historic places that are located near the FSU campus is Barge's Tavern and the Belden-Horne House.

Natural Features and Resources

The City of Fayetteville is host of many creeks, rivers and lakes. The City currently owns and is responsible for more than 10 parks. Fayetteville strives to provide both larger parks (50+ acres) for active and passive use; neighborhood parks (2-20 acres) within walking and biking distance of most homes; connectors like greenways and bikeways; and unique waterfront parks with public access to waterways whenever possible.

Approximately 9.4 acres of the land on The Fayetteville State University campus are located within a 100-year Special Flood Hazard Area. These 9.4 acres are designated as Zone AE; an additional 7 acres of land on FSU's campus is located within the 500-year floodplain, and the remaining 110 acres are designated as Unshaded Zone X.

Natural and Beneficial Floodplain Functions

Under natural conditions, a flood causes little or no damage in floodplains. Nature ensures that floodplain flora and fauna can survive the more frequent inundations, and the vegetation stabilizes soils during flooding. Floodplains reduce flood damage by allowing flood waters to spread over a large area. This reduces flood velocities and provides flood storage to reduce peak flows downstream.

Threatened and Endangered Species

The U.S. Fish and Wildlife Service maintains a regular listing of threatened species, endangered species, at-risk species, and candidate species for counties across the United States. Cumberland County has nine species that are listed with the U.S. Fish and Wildlife Services. **Table C.3** below shows the nine species identified as threatened and endangered in Cumberland County.

Table C.3 – Threatened and Endangered Species in Cumberland County

Common Name	Scientific Name	Federal Status
Atlantic pigtoe	*Fusconaia masoni*	Proposed Threatened
Pondberry	*Lindera melissifolia*	Endangered
Saint Francis' satyr butterfly	*Neonympha mitchellii francisci*	Endangered
Red-cockaded woodpecker	*Picoides borealis*	Endangered
Rough-leaved loosestrife	*Lysimachia asperulaefolia*	Endangered
American chaffseed	*Schwalbea americana*	Endangered
American alligator	*Alligator mississippiensis*	Threatened
Michaux's sumac	*Rhus michauxii*	Endangered
Cape Fear shiner	*Notropis mekistocholas*	Endangered

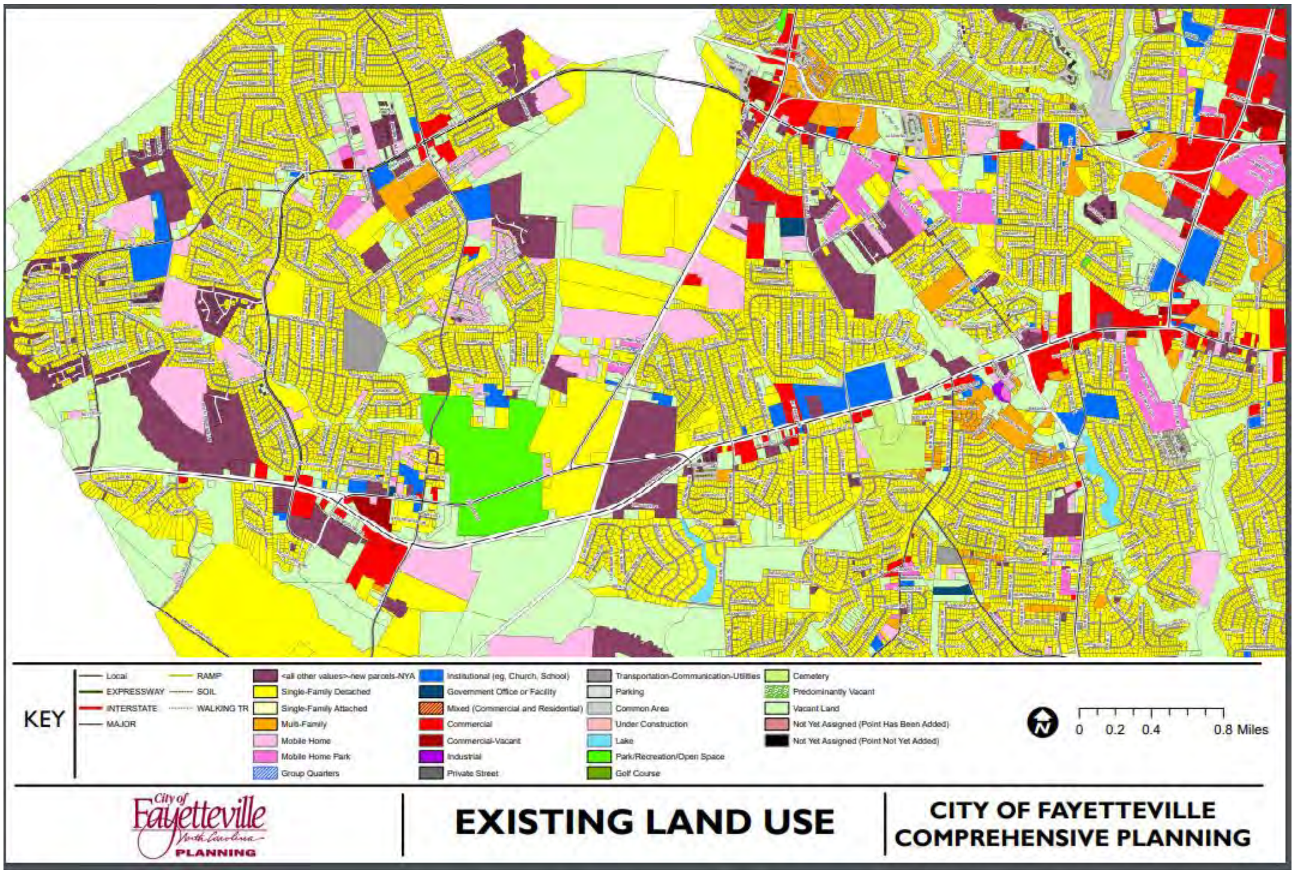
Source: U.S. Fish & Wildlife Service (https://ecos.fws.gov/ecp/report/species-listings-by-current-range-county?fips=37051)

C.2.5 Land Use

The Fayetteville State University campus is located just outside the heart of the City of Fayetteville. Based on the City of Fayetteville's 2019 Downtown Urban Design Plan, the urban growth goal for the City includes creating a Downtown District, strategically locating cultural venues, improving mobility and streetscapes, and enhancing parks and trail connections. Specific action items listed to help carry out these goals included updating the zoning and development standards, focus on economic development strategies, and improving stormwater management and flood mitigation. Many different proposed future land use maps along with further details on the City's development plans can be found in the City of Fayetteville's 2019 Downtown Urban Design Plan:

https://www.fayettevillenc.gov/home/showdocument?id=13595

Figure C.1 – City of Fayetteville Existing Land Use



Source: https://www.fayettevillenc.gov/home/showdocument?id=6057

C.2.6 Population and Demographics

Table C.4 provides population counts and percent change in population since 2010 for Cumberland County and the City of Fayetteville.

Table C.4 – Population Counts for Surrounding Jurisdictions

Jurisdiction	2010 Census Population	2019 Estimated Population	% Change 2010-2019
Cumberland County	319,431	335,509	5.0
Fayetteville	200,565	211,657	5.5

Source: U.S. Census Bureau QuickFacts 2010 vs 2019 (V2019) data

Table C.5 provides population counts for Fayetteville State University, including the number of undergraduate and graduate students, in-state students, off-campus students, and faculty.

Table C.5 – Population Counts for Fayetteville State University, 2020

Group	2020 Population
Students	6,726
Undergraduate Students	5,661
Graduate Students	1,065
In-State	6,322
Off-Campus	5,650
On-Campus	1,076

Group	2020 Population
Faculty	333
Full-Time Faculty	266
Part-Time Faculty	67

According to The Fayetteville State University's Fall 2020 Student Enrollment Profile, 6% of students are from out of State. 70% of all students are female, and 80% of all students are people of color. Among the FSU student population, the most popular majors are Nursing, Psychology, and Business Administration.

Based on the 2010 Census, the largest number of residents in both Fayetteville and Cumberland County fall in the age range of 5-18, making up 24.7% and 23.5% of the populations, respectively. Fifty percent of FSU's student population is older than 24 years old. The racial characteristics of the County, City, and college are presented below in **Table C.6**. White persons make up the majority of the population for the City and County; however, African-Americans make up the majority of the population at Fayetteville State University.

Table C.6 – Demographics of Cumberland County and Fayetteville State University Students

Jurisdiction	African-American Persons, Percent	American Indian or Alaska Native, Percent	Asian Persons, Percent	Hispanic or Latino Persons, Percent	White Persons, Percent
Cumberland County[1]	39.1	1.9	2.7	12.1	51.1
Fayetteville[1]	42.1	1.1	2.9	12.4	44.6
Fayetteville State University[2]	59	2.2	1.9	8.2	18.8

Source: U.S. Census Bureau, 2010

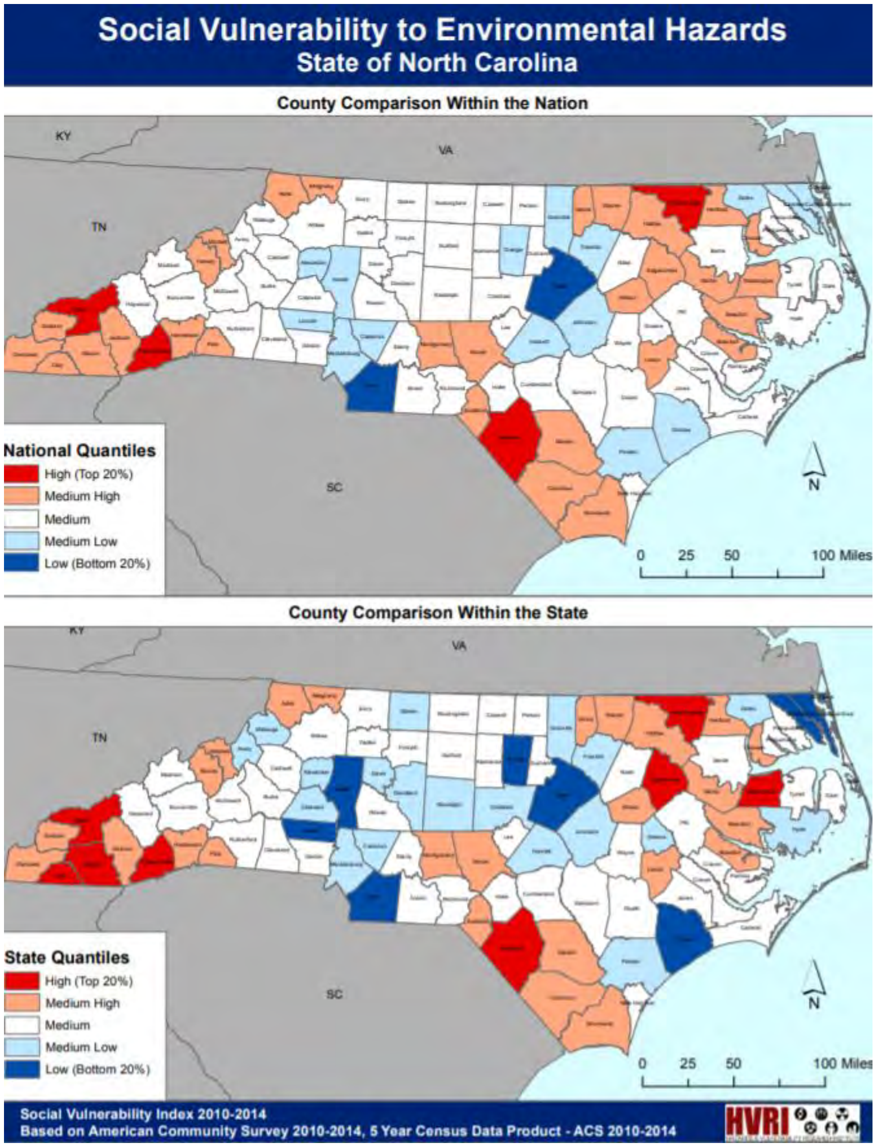
[1]Persons of Hispanic Origin may be of any race, so are also included in applicable race category in Fayetteville County figures.

[2]Source: The Fayetteville State University Student Enrollment Profile, Fall 2020

C.2.7 Social Vulnerability

The Hazards and Vulnerability Research Institute at the University of South Carolina has created the Social Vulnerability Index (SoVI), to measure comparative social vulnerability to environmental hazards in the U.S. at a county level. SoVI combines 29 socioeconomic variables to determine vulnerability. The seven most significant components for explaining vulnerability are race and class, wealth, elderly residents, Hispanic ethnicity, special needs individuals, Native American ethnicity, and service industry employment. The index also factors in family structure, language barriers, vehicle availability, medical disabilities, and healthcare access, among other variables. **Figure C.2** displays the SoVI index by county with comparisons within the Nation and within the State. In both comparisons, Cumberland County ranks among the medium quantiles for social vulnerability.

Figure C.2 – SoVI Index for North Carolina



C.2.8 Growth and Development Trends

Based on 2010 Census data, Fayetteville is the sixth largest city in North Carolina with an estimated population of 211,657 residents in 2019. In 2010 the City population of Fayetteville had reached 200,564 and the City's share of the County population increased to about 63%. Since then, the populations for both the County and City have experienced a healthy amount of natural increase, but also a large amount of negative net migration. Due to the influence of Fort Bragg, the age groups most likely to produce new births will continue to dominate the City's age structure and therefore help result in a population increase for the City over time. As shown in **Figure C.3**, the population of Cumberland County and the City of Fayetteville are projected to be over 368,000 and 232,000, respectively, by 2040. Even though the 2019 Census population estimates for Fayetteville already exceeds the 2020 population projection shown below, these projections were still deemed the most reasonable and are based on the arithmetic method and 10 years of past growth.

Figure C.3 – County and City Population Growth Projections (2010 – 2040)

Projected City Population

Reference Dates	Projected County Population (See Chart K)	Assumed City Share of County Population	Projected City Population
2010 Census	319,431	62.7869%=63%	200,564
2018 ACS	332,106	63.1928%=63%	209,867
2020	335,899	63%	211,616
2030	352,367	63%	221,991
2040	368,835	63%	232,366

Source: https://www.fayettevillenc.gov/home/showdocument?id=14419

The estimated population for Fayetteville in 2019 was 211,657, which is a 1% increase over the 2015 estimated population, and a 5.5% increase from the 2010 Census population. **Table C.7** shows estimated population growth based on the 2010 Census population for the City of Fayetteville.

Table C.7 – City of Fayetteville Population Growth (2010 – 2019)

Year	Population	Growth	Percent Growth
2010	200,565	--	--
2015	209,596	9,031	4.5
2019	211,657	2,061	1.0

Source: U.S. Census Bureau

C.3 ASSET INVENTORY

An inventory of assets was compiled to identify the total count and value of property exposure on the FSU campus. This asset inventory serves as the basis for evaluating exposure and vulnerability by hazard. Assets identified for analysis include buildings, critical facilities, and critical infrastructure.

C.3.1 Building Exposure

Table C.8 provides total building exposure for the campus, which was estimated by summarizing building footprints provided by the University of North Carolina System Division of Information Technology and the North Carolina Emergency Management (NCEM) iRisk database and property values provided by the North Carolina Department of Insurance and NCEM iRisk database. All occupancy types were summarized into the following four categories: administration, critical facilities, educational/extracurricular, and housing. Note: estimated content values were not available.

Table C.8 – FSU Building Exposure by Occupancy

Occupancy	Estimated Building Count	Structure Value
Administration	7	$7,223,535
Critical Facilities	12	$54,391,349
Educational/Extracurricular	15	$27,391,216
Housing	8	$17,321,872
Total	**42**	**$106,327,972**

Source: UNC Division of Information Technology; NCEM iRisk; NC Department of Insurance

C.3.2 Critical Buildings and Infrastructure Exposure

Of significant concern with respect to any disaster event is the location of critical facilities and infrastructure in the planning area. Critical facilities are those essential services and lifelines that, if damaged during an emergency event, would disrupt campus continuity of operations or result in severe consequences to public health, safety, and welfare.

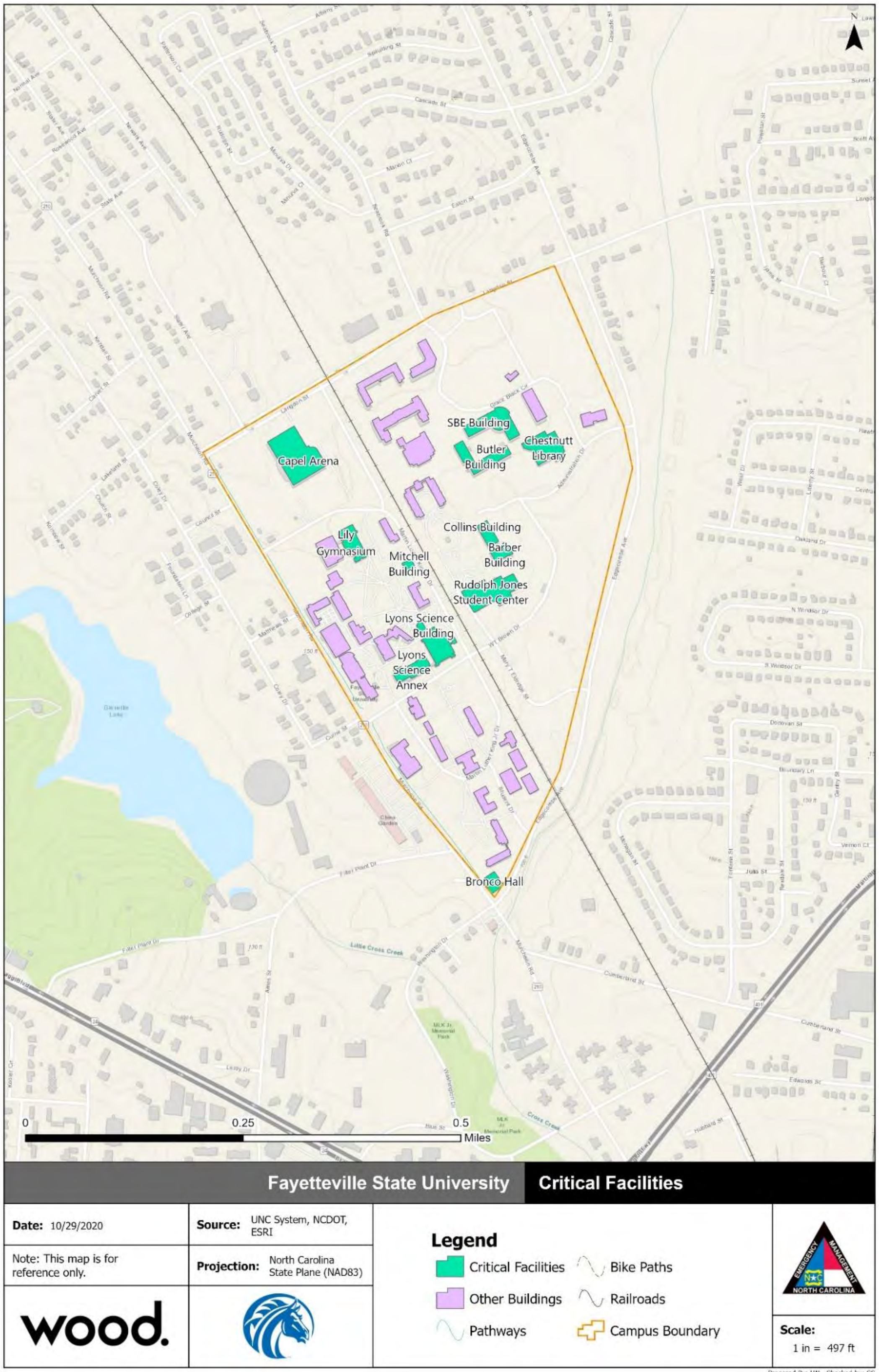
Critical buildings are a subset of the total building exposure and were identified by FSU's HMPC representatives. After reviewing the following criteria designed to evaluate all critical buildings in the UNC System Hazard Mitigation Plan, the FSU HMPC maintained the list of critical facilities from the previous PDM plan. Factors considered for critical building evaluation included:

- the building's use for emergency response,
- the building's use for essential campus operations
- the building's use as an emergency shelter or for essential sheltering services,
- the presence of a generator or generator hook-ups,
- the building's use for provision of energy, chilled water or HVAC for sensitive or essential systems,
- the storage of hazardous materials,
- the building's use for sensitive research functions,
- the building's cultural or historical significance, and
- building-specific hazard vulnerabilities

The identified critical facilities for FSU, as shown in **Figure C.4**, include the following:

- Barber Building
- Bronco Student Plaza
- Butler Building
- Capel Arena
- Chestnutt Library
- Collins Building
- Lily Gymnasium
- Lyons Science Annex
- Lyons Science Building
- Mitchell Building
- Rudolph Jones Student Center
- SBE Building

Figure C.4 – FSU Map of Critical Facilities



C.4 HAZARD IDENTIFICATION & RISK ASSESSMENT

C.4.1 Hazard Identification

To identify a full range of hazards relevant to the UNC Eastern Campuses, HMPC representatives from each campus began with a review of the list of hazards identified in the 2018 North Carolina State Hazard Mitigation Plan and the 2010 FSU Pre-Disaster Mitigation Plan, as summarized in **Table C.9**. This ensured consistency with the state and regional hazard mitigation plans and across each campus' planning efforts.

Table C.9 – Hazards Included in Previous Planning Efforts

Hazard	Included in 2018 State HMP?	Included in 2010 FSU Pre-Disaster Mitigation Plan?
Flooding	Yes	Yes, as Driving rain and Flood
Hurricanes and Coastal Hazards	Yes	Yes, as High wind (hurricane)
Severe Winter Weather	Yes	Yes, as Ice storm and Snow
Extreme Heat	Yes	No
Earthquakes	Yes	Yes
Wildfire	Yes	Yes
Dam Failures	Yes	No
Drought	Yes	Yes
Tornadoes/Thunderstorms	Yes	Yes
Geological (Landslides, Sinkholes, Coastal Erosion)	Yes	Yes, as Landslide
Hazardous Substances	Yes	No
Infectious Disease	Yes	No
Radiological Emergency	Yes	No
Terrorism/Mass Casualty	Yes	No
Cyber Threat	Yes	No

FSU's HMPC representatives evaluated the above list of hazards by considering existing hazard data, past disaster declarations, local knowledge, and information from the 2018 State Plan and the 2010 FSU Pre-Disaster Mitigation Plan in order to determine whether each hazard was significant enough to assess in this updated Hazard Mitigation Plan. Significance was measured in general terms and focused on key criteria such as frequency, severity, and resulting damage, including deaths and injuries, as well as property and economic damage.

One key resource in this effort was the National Oceanic and Atmospheric Administration's (NOAA) National Center for Environmental Information (NCEI), which has been tracking various types of weather events 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), which compiles their information from a variety of sources, including but 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. While NCEI is not a comprehensive list of past hazard events, it can provide an indication of relevant hazards to the planning area and offers some statistics on injuries, deaths, damages, as well as narrative descriptions of past impacts.

Data for Cumberland County was used to approximate past events that may have affected the FSU campus. The NCEI database contains 361 records of storm events that occurred in Cumberland County in the 20-year period from 2000 through 2019. **Table C.10** summarizes these events.

Table C.10 – NCEI Severe Weather Data for Cumberland County, 2000 – 2019

Type	# of Events	Property Damage	Crop Damage	Deaths	Injuries
Flash Flood	47	$3,254,000	$0	0	0
Flood	3	$97,410,000	$50,000,000	2	0
Hail	84	$1,025,000	$0	0	0
Heat	1	$0	$0	1	0
Heavy Rain	2	$1,500,000	$0	0	0
High Wind	4	$1,101,000	$0	0	0
Hurricane (Typhoon)	1	$28,000	$0	0	0
Lightning	16	$1,836,000	$0	0	22
Strong Wind	10	$128,000	$7,000	0	1
Thunderstorm Wind	151	$1,248,500	$0	0	4
Tornado	6	$100,525,000	$0	1	89
Tropical Storm	5	$2,610,000	$0	0	0
Winter Storm	21	$0	$0	0	0
Winter Weather	10	$10,000	$0	1	0
Grand Total	**361**	**$210,675,500**	**$50,007,000**	**5**	**116**

Source: National Center for Environmental Information Events Database, retrieved October 2020
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 Cumberland 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 1954. Since then, Cumberland County has been designated in 17 major disaster declarations, as detailed in **Table C.11**, and ten emergency declarations, as detailed in **Table C.12**.

Table C.11 – FEMA Major Disaster Declarations, Cumberland County

Disaster #	Dec. Date	Incident Type	Event Title	Individual Assistance Applications Approved	Total Individual and Households Program Dollars Approved	Total Public Assistance Grant Dollars Obligated
DR-28-NC	17-Oct-54	Hurricane	HURRICANE	N/A	N/A	N/A
DR-37-NC	13-Aug-55	Hurricane	HURRICANES	N/A	N/A	N/A
DR-56-NC	24-Apr-56	Severe Storm(s)	SEVERE STORM	N/A	N/A	N/A
DR-87-NC	1-Oct-58	Hurricane	HURRICANE & SEVERE STORM	N/A	N/A	N/A
DR-107-NC	16-Sep-60	Hurricane	HURRICANE DONNA	N/A	N/A	N/A
DR-130-NC	16-Mar-62	Flood	SEVERE STORM, HIGH TIDES & FLOODING	N/A	N/A	N/A
DR-179-NC	13-Oct-64	Flood	SEVERE STORMS & FLOODING	N/A	N/A	N/A
DR-699-NC	30-Mar-84	Tornado	SEVERE STORMS & TORNADOES	N/A	N/A	N/A

Disaster #	Dec. Date	Incident Type	Event Title	Individual Assistance Applications Approved	Total Individual and Households Program Dollars Approved	Total Public Assistance Grant Dollars Obligated
DR-1134-NC	6-Sep-96	Hurricane	HURRICANE FRAN	N/A	N/A	N/A
DR-1240-NC	27-Aug-98	Hurricane	HURRICANE BONNIE	N/A	N/A	N/A
DR-1292-NC	16-Sep-99	Hurricane	HURRICANE FLOYD MAJOR DISASTER DECLARATIONS	N/A	N/A	$298,105,794
DR-1490-NC	18-Sep-03	Hurricane	HURRICANE ISABEL	7790	$21,289,504	$18,285,917
DR-1546-NC	10-Sep-04	Hurricane	TROPICAL STORM FRANCES	25950	$45,380,867	$70,854,432
DR-1969-NC	20-Apr-11	Severe Storm(s)	SEVERE STORMS, TORNADOES, AND FLOODING	1778	$5,391,278	N/A
DR-4285-NC	10-Oct-16	Hurricane	HURRICANE MATTHEW	28971	$98,842,213	$291,092,954
DR-4393-NC	15-Sep-18	Hurricane	HURRICANE FLORENCE	34713	$133,948,455	$632,937,402
DR-4487-NC	25-Mar-20	Biological	COVID-19 PANDEMIC	N/A	N/A	$174,898,697

Source: FEMA Disaster Declarations Summary, October 2020
Note: Number of applications approved and all dollar values represent totals for all counties included in disaster declaration.

Table C.12 – FEMA Emergency Declarations, Cumberland County

Disaster #	Dec. Date	Incident Type	Event Title/Description
EM-3146-NC	15-Sep-99	Hurricane	HURRICANE FLOYD EMERGENCY DECLARATIONS
EM-3222-NC	5-Sep-05	Hurricane	HURRICANE KATRINA EVACUATION
EM-3254-NC	15-Sep-05	Hurricane	HURRICANE OPHELIA
EM-3380-NC	7-Oct-16	Hurricane	HURRICANE MATTHEW
EM-3401-NC	11-Sep-18	Hurricane	HURRICANE FLORENCE
EM-3423-NC	4-Sep-19	Hurricane	HURRICANE DORIAN
EM-3471-NC	13-Mar-20	Biological	COVID-19
EM-3534-NC	2-Aug-20	Hurricane	HURRICANE ISAIAS
EM-3146-NC	15-Sep-99	Hurricane	HURRICANE FLOYD EMERGENCY DECLARATIONS
EM-3222-NC	5-Sep-05	Hurricane	HURRICANE KATRINA EVACUATION

Source: FEMA Disaster Declarations Summary, October 2020

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. **Table C.13** summaries the determination made for each hazard.

Table C.13 – Hazard Evaluation Results

Hazard	Included in this plan update?	Explanation for Decision
Natural Hazards		
Hurricane	Yes	The 2010 FSU PDM plan found Hurricane to be a moderate threat hazard. The County has had 10 disaster declarations related to hurricanes wind.
Coastal Hazards	No	The 2010 FSU PDM plan did not address this hazard. Fayetteville is 90 miles from the Atlantic Ocean. The National Weather Service has awarded FSU Weather Ready Nation Ambassador of Excellence in 2020 Certification.

Hazard	Included in this plan update?	Explanation for Decision
Tornadoes / Thunderstorms (Wind, Lightning, Hail)	Yes	The 2010 FSU PDM plan found tornadoes to be a low threat hazard. The County has had no disaster declarations related to tornadoes. The HMPC expressed interest in addressing this hazard in combination with thunderstorms (wind, lightning, hail).
Flood	Yes	The 2010 FSU PDM plan rated flood a significant threat hazard for the planning area. The County has had 2 disaster declarations related to flooding.
Severe Winter Weather	Yes	The 2010 FSU PDM plan found ice/snow to be a low threat hazard. The HMPC expressed interest in addressing this hazard as severe winter weather to include cold/wind chill; extreme cold; freezing fog; frost/freeze; heavy snow; ice storm; winter storm; and winter weather.
Drought	No	The 2010 FSU PDM plan did not address this hazard.
Wildfire	Yes	The 2010 FSU PDM plan did not assign a threat and/or risk level for this hazard; however, the HMPC expressed interest in addressing this hazard.
Earthquake*	Yes	The 2010 FSU PDM plan did not assign a threat and/or risk level for this hazard; however, the HMPC expressed interest in addressing this hazard.
Geological Hazards (Sinkhole & Landslide)*	Yes	The 2010 FSU PDM plan did not assign a threat and/or risk level for this hazard; however, the HMPC expressed interest in re-evaluating landslides in this plan update.
Dam Failure	No	The 2010 FSU PDM plan did not address this hazard.
Extreme Heat	No	The 2010 FSU PDM plan did not address this hazard.
Technological and Human-Caused Hazards & Threats		
Hazardous Substances	No	The 2010 FSU PDM plan did not address this hazard and the HMPC did not express interest in addressing.
Infectious Disease	No	The 2010 FSU PDM plan did not address this hazard and the HMPC did not express interest in addressing.
Cyber Attack	No	The 2010 FSU PDM plan did not address this hazard and the HMPC did not express interest in addressing.
Civil Unrest	No	The 2010 FSU PDM plan did not address this hazard and the HMPC did not express interest in addressing.

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

C.5 HAZARD PROFILES, ANALYSIS, AND VULNERABILITY

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 where it may occur, the severity of potential events, records of past events, the probability of future occurrences, and potential impacts from the hazard. A vulnerability assessment was conducted for each hazard using quantitative and/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.

To account for regional differences in hazard risk across each of the campuses, this risk assessment is divided into two parts:

1) a set of summary hazard profiles describing each hazard and summarizing the risk findings for each campus, presented in Section 3.5; and
2) a campus-specific risk assessment profiling the location, extent, historical occurrences, probability of future occurrence, and vulnerability of each campus, presented in each campus annex.

In the campus-level hazard profiles presented here, each hazard is profiled in the following format:

Location

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

Extent

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

Historical Occurrences

This section contains information on historical events, including the location and consequences of all past events on record within or near the Cumberland County planning area. Where possible, this plan uses a consistent 20-year period of record except for hazards with significantly longer average recurrence intervals or where data limitations otherwise restrict the period of record.

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)

Vulnerability Assessment

This section quantifies, to the extent feasible using best available data, assets at risk to natural hazards and potential loss estimates. Details on hazard specific methodologies and assumptions are provided where applicable. People, properties and critical facilities, and environmental assets that are vulnerable to the hazard are identified.

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

- Geographic Information System (GIS) datasets, including County parcel data from 2020, campus building inventory fand values from the University System's Division of Information Technology, NCEM iRisk Database, and property values provided by the NC Department of Insurance, topography, transportation layers, and critical facility and infrastructure locations;
- Hazard layer GIS datasets from state and federal agencies;
- Written descriptions of inventory and risks provided by the 2018 State of North Carolina Hazard Mitigation Plan;
- Written descriptions of inventory and risks provided by the 2016 Cumberland-Hoke Regional Hazard Mitigation Plan; and
- Exposure and vulnerability estimates derived using local parcel data.

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. For applicable hazards, the quantitative analysis involved the use of FEMA's Hazus-MH, a nationally applicable standardized set of models for estimating potential losses from earthquakes, floods, and hurricanes. Hazus uses a statistical approach and mathematical modeling of risk to predict a hazard's frequency of occurrence and estimated impacts based on recorded or historic damage information. The Hazus risk assessment methodology is parametric, in that distinct hazard and inventory parameters—such as wind speed and building type—were modeled using the Hazus software to determine the impact on the built environment. Cumberland County's GIS-based risk assessment was completed using data collected from local, regional and national sources that included Cumberland County, NCEM, and FEMA.

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. Other information can be collected in regard to the hazard area, such as the location of critical facilities and infrastructure, historic resources, 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.

The data collected for the hazard profiles and vulnerability assessment was obtained from multiple sources covering a variety of spatial areas including county-, jurisdictional-, and campus-level information. The table below presents the source data and the associated geographic coverages.

Table C.14 – Summary of Hazard Data Sources and Geographic Coverage

Hazard	Hazard Data Sources	Profile Geographic Area	Vulnerability Methodology	Vulnerability Geographic Area
Earthquake	USGS, NCEI	County	Hazus 4.2	Census Tract
Flood	NCEI, FEMA	Jurisdiction	GIS Spatial Analysis	Campus

Hazard	Hazard Data Sources	Profile Geographic Area	Vulnerability Methodology	Vulnerability Geographic Area
Hurricane	NHC	County	Hazus 4.2	Census Tract
Landslide	USGS	County	Qualitative Analysis	Campus
Severe Winter Weather	NWS, NCEI	County	Statistical Analysis	County
Tornado / Thunderstorm	NWS, NCEI	Jurisdiction	Statistical Analysis	Jurisdiction
Wildfire	NCFS, SouthWRAP	County, Campus	GIS Spatial Analysis	Campus

CDC = Centers for Disease Control and Prevention; EPA = United States Environmental Protection Agency; FEMA = Federal Emergency Management Agency; NCEI = National Centers for Environmental Information; NCFS = North Carolina Forest Service; NHC = National Hurricane Center; NWS = National Weather Service; SouthWRAP = Southern Group of State Foresters, Wildfire Risk Assessment Portal; USDOT = United States Department of Transportation; USGS = United States Geological Survey; WHO = World Health Organization

Changes in Development

This section describes how changes in development have impacted vulnerability since the last plan was adopted. 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.

Problem Statements

This section summarizes key mitigation planning concerns related to this hazard.

Priority Risk Index

The conclusions drawn from the hazard profiling and vulnerability assessment process are used to prioritize all potential hazards to the FSU 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 C.15**.

PRI ratings are provided by category throughout each hazard profile for the planning area as a whole. Ratings specific to each jurisdiction are provided at the end of each hazard profile. The results of the risk assessment and overall PRI scoring are provided in Section C.5.8 Conclusions on Hazard Risk.

The sum of all five risk assessment categories equals the final PRI value, demonstrated in the equation below (the lowest possible PRI value is a 1.0 and 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 campus 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.

Table C.15 – 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	

C.5.1 Earthquake

Hazard	Probability	Impact	Spatial Extent	Warning Time	Duration	PRI Score
Earthquake	Unlikely	Minor	Large	Less than 6 hours	Less than 6 hours	1.9

Location

The United States Geological Survey (USGS) Quaternary faults database was consulted to determine the sources of potential earthquakes within range of Cumberland County. Quaternary faults are active faults recognized at the surface which have evidence of movement in the past 2.58 million years. No active faults were noted in Cumberland County.

Earthquakes are generally felt over a wide area, with impacts occurring hundreds of miles from the epicenter. Therefore, any earthquake that impacts Cumberland County is likely to be felt across most if not all of the planning area.

Spatial Extent: 4 – Large

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 C.16.** 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 C.17** 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 C.16 – 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 C.17 – 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.

MMI	Richter Scale	Felt Intensity
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.
VIII	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 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.

Impact: 1 – Minor

Historical Occurrences

The USGS Earthquake Hazards Program maintains a database of historical earthquakes of a magnitude 2.5 and greater from 1900 to 2020. Earthquake events that occurred within 100 miles of the FSU campus are presented in **Table C.18** and **Figure C.5**.

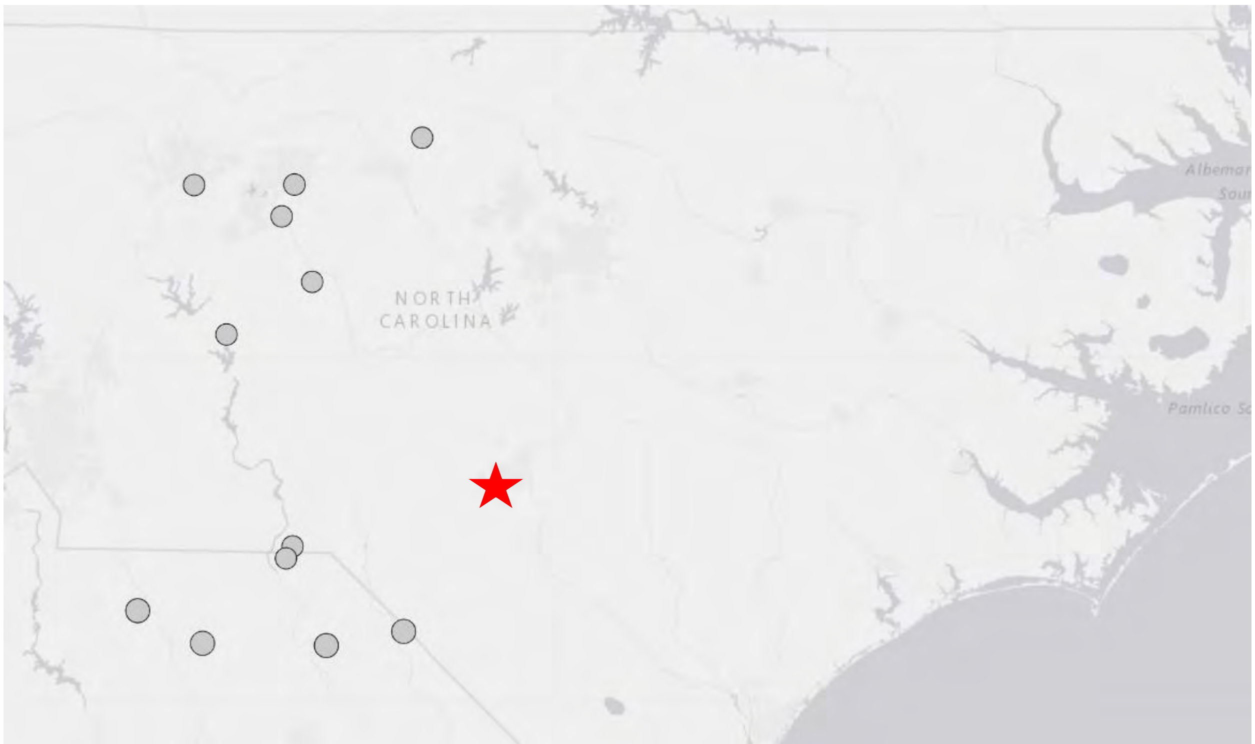
Table C.18 – Historical Earthquakes within 100 Miles of FSU, 1900-2020

Year	Magnitude	MMI	Location
1959	3.9	III	South Carolina
1978	2.7	II	Virginia-North Carolina border region
1981	2.8	II	North Carolina
1993	2.7	II	Virginia-North Carolina border region
1998	3.5	III	South Carolina
2006	2.5	II	Virginia-North Carolina border region
2006	2.6	II	7km S of Winston-Salem, North Carolina
2006	3.7	III	7km W of Rowland, North Carolina
2006	3.4	III	13km S of Bennettsville, South Carolina

Year	Magnitude	MMI	Location
2011	2.9	II	9km S of Cordova, North Carolina
2012	2.5	II	10km NNE of Cheraw, South Carolina
2015	2.58	II	10km S of Denton, North Carolina
2019	2.5	II	8km E of Archdale, North Carolina

Source: USGS

Figure C.5 – Historical Earthquakes within 100 Miles of FSU, 1900-2020



Source: USGS

The National Center for Environmental Information (NCEI) maintains a database of the felt intensity of earthquakes from 1638 to 1985 including the maximum intensity for each locality that felt the earthquake. According to this database, in the 100-year period from 1885-1985, there was one earthquake felt in and around Fayetteville: on September 1, 1886 with an epicenter approximately 260 miles from Fayetteville.

Probability of Future Occurrence

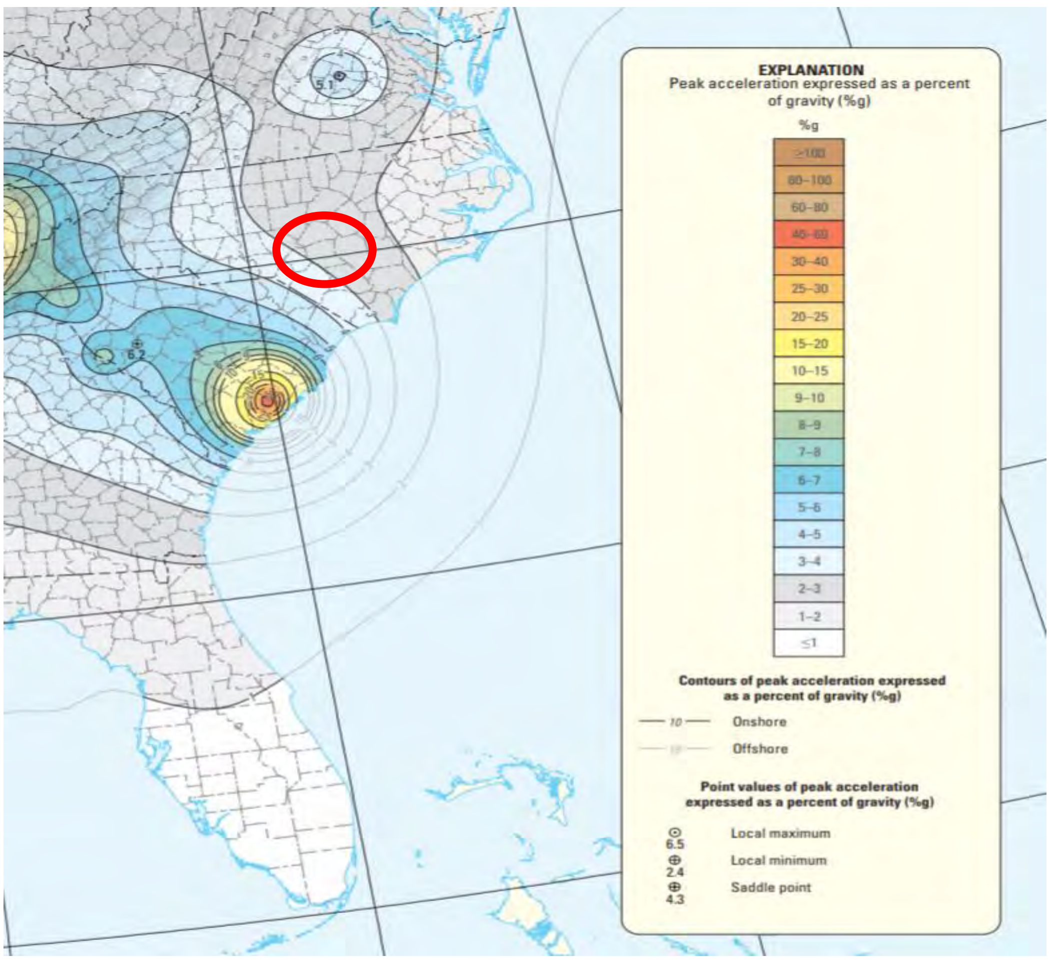
Ground motion is the movement of the earth's surface due to earthquakes or explosions. It is produced by waves generated by a sudden slip on a fault or sudden pressure at the explosive source and travels through the earth and along its surface. Ground motion is amplified when surface waves of unconsolidated 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 that have a common given probability of being exceeded in 50 years.

Figure C.6 on the following page reflects the seismic hazard for Cumberland 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 occurrence 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. All of Cumberland County is located within a zone with peak acceleration of 2-3% g, which indicates low earthquake risk.

In simplified terms, based on the record of past occurrences over a 120-year period from 1900 to 2020 there were no earthquakes that have or could have caused building damage in Fayetteville, defined for this purpose as an MMI of VI or greater. All noted earthquakes were located outside Cumberland County and defined as MMI of III (Felt indoors. Hanging objects swing. Vibration like passing of light trucks. Duration estimated. May not be recognized as an earthquake.), or an MMI of II (Felt by persons at rest, on upper floors, or favorably placed). Based on this data, it can be reasonably assumed that an earthquake event affecting Cumberland County is unlikely.

Probability: 1 – Unlikely

Figure C.6 – Seismic Hazard Information for Cumberland County



Source: USGS Earthquake Hazards Program

Vulnerability Assessment

Methodology & Assumptions

To quantify vulnerability, Wood performed a Level 1 earthquake analysis in Hazus 4.2 utilizing general building stock information based on the 2010 Census. The FSU campus is located across two census tracts which encompass 3.07 square miles. The earthquake scenario was modeled after an arbitrary earthquake event of magnitude 5.0 with an epicenter in the FSU campus and depth of 10km.

People

Hazus estimates that the modeled magnitude 5.0 event would result in 57 households requiring temporary shelter. Additionally, Hazus estimates potential injuries and fatalities depending on the time of day of an event. Casualty estimates are shown in **Figure C.7**. Casualties are broken down into the following four levels that describe the extent of injuries:

- Level 1: Injuries will require medical attention, but hospitalization is not needed.
- Level 2: Injuries will require hospitalization but are not considered life-threatening.
- Level 3: Injuries will require hospitalization and can become life threatening if not promptly treated.
- Level 4: Victims are killed by the earthquake.

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. Impacts of earthquakes also include debris clean-up and service disruption. Per the Hazus analysis, a 5.0 magnitude earthquake could produce an estimated 20,000 tons of debris.

Cumberland County has not been impacted by an earthquake with more than a low intensity, so major damage to the built environment is unlikely. However, there is potential for impacts to certain masonry buildings, as well as environmental damages with secondary impacts on structures.

Table C.19 details the estimated buildings impacted by a magnitude 5.0 earthquake event, as modeled by Hazus. Note that building value estimates are inherent to Hazus and do not necessarily reflect damages to the asset inventory for the FSU Campus.

Table C.19 – Estimated Buildings Impacted by 5.0 Magnitude Earthquake Event

Occupancy Type	Estimated Building Damage	Estimated Content Loss	Estimated Total Damage
Residential	$6,430,000	$0	$6,430,000
Commercial	$1,270,000	$0	$1,270,000
Industrial	$230,000	$0	$230,000
Other	$610,000	$0	$610,000
Total	**$8,540,000**	**$0**	**$8,540,000**

Source: Hazus

Figure C.7 – Casualty Estimate from a 5.0 Magnitude Earthquake Event

		Level 1	Level 2	Level 3	Level 4
2 AM	Commercial	0	0	0	0
	Commuting	0	0	0	0
	Educational	0	0	0	0
	Hotels	0	0	0	0
	Industrial	0	0	0	0
	Other-Residential	9	2	0	1
	Single Family	6	1	0	0
	Total	**15**	**3**	**0**	**1**
2 PM	Commercial	9	2	0	1
	Commuting	0	0	0	0
	Educational	12	3	0	1
	Hotels	0	0	0	0
	Industrial	2	0	0	0
	Other-Residential	3	1	0	0
	Single Family	2	0	0	0
	Total	**27**	**6**	**1**	**2**
5 PM	Commercial	7	2	0	0
	Commuting	0	0	0	0
	Educational	5	1	0	0
	Hotels	0	0	0	0
	Industrial	1	0	0	0
	Other-Residential	4	1	0	0
	Single Family	2	0	0	0
	Total	**18**	**4**	**1**	**1**

Source: Hazus 4.2

All critical facilities should be considered at risk to minor damage should an earthquake event occur. Within the Hazus model—which include 3 hospitals, 8 schools, 2 fire stations, 3 police station, and 1 emergency operation facilities— there were estimated moderate damages for 1 hospital, 5 schools, 3 police stations, and 1 fire station. Additionally, Hazus projected moderate impacts to one bus facility.

Environment

An earthquake is unlikely to cause substantial impacts to the natural environment in Cumberland 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.

Changes in Development

Building codes substantially reduce the costs of damage to future structures from earthquakes. Future construction on the FSU campus must follow the applicable requirements of the NC building codes, the State of North Carolina statutes for state owned buildings and zoning for the local jurisdiction.

Development changes at FSU have not affected the risk characteristics of earthquakes. The probability, impact, spatial extent, warning time, and duration of earthquakes have not changed.

Problem Statement

- While earthquakes are an unlikely hazard event for the FSU campus, the Hazus model did predict moderate damage to buildings, one hospital, five schools, three police stations, one fire station and one transportation facility within the two census tracts.

C.5.2 Flood

Hazard	Probability	Impact	Spatial Extent	Warning Time	Duration	PRI Score
Flood	Likely	Minor	Small	6 to 12 hrs	Less than 1 week	2.2

Location

Regulated floodplains are illustrated on inundation maps called Flood Insurance Rate Maps (FIRMs). A FIRM 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 1-percent-annual-chance flood event. Structures located within the SFHA have a 26-percent chance of flooding during the life of a standard 30-year mortgage.

For this risk assessment, flood prone areas were identified within the FSU Campus using the FIRM dated January 5, 2007. **Figure C.8** reflects the 2007 mapped flood insurance zones. **Table C.20** summarizes the flood insurance zones identified by the Digital FIRM (DFIRM).

Spatial Extent: 2 – Small

Table C.20 – Mapped Flood Insurance Zones

Zone	Description
A	Zone A is the flood insurance rate zone that corresponds to the 1% annual chance floodplains that are determined in the FIS Report by approximate methods. Because detailed hydraulic analyses are not performed for such areas, no Base Flood Elevations or depths are shown within this zone.
AE	Zone AE is the flood insurance rate zone that corresponds to the 1% annual chance floodplains that are determined in the FIS Report by detailed methods. In most instances, whole-foot Base Flood Elevations derived from the detailed hydraulic analyses are shown at selected intervals within this zone.
AH	Zone AH is the flood insurance rate zone that corresponds to the areas of 1% annual chance shallow flooding (usually areas of ponding) where average depths are between 1 and 3 feet. Whole-foot Base Flood Elevations derived from the detailed hydraulic analyses are shown at selected intervals within this zone.
AO	Zone AO is the flood insurance rate zone that corresponds to the areas of 1% annual chance shallow flooding (usually sheet flow on sloping terrain) where average depths are between 1 and 3 feet. Average whole-foot depths derived from the detailed hydraulic analyses are shown within this zone.
VE	Zone VE is the flood insurance rate zone that corresponds to the 1% annual chance coastal floodplains that have additional hazards associated with storm waves. Whole-foot Base Flood Elevations derived from the detailed hydraulic analyses are shown at selected intervals within this zone.
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 0.2-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 7.5 percent of the FSU Campus falls within the SFHA. **Table C.21** provides a summary of the FSU Campus' total area by flood zone on the 2007 effective DFIRM.

Figure C.8 – FEMA Flood Hazard Areas in FSU's Campus Boundary

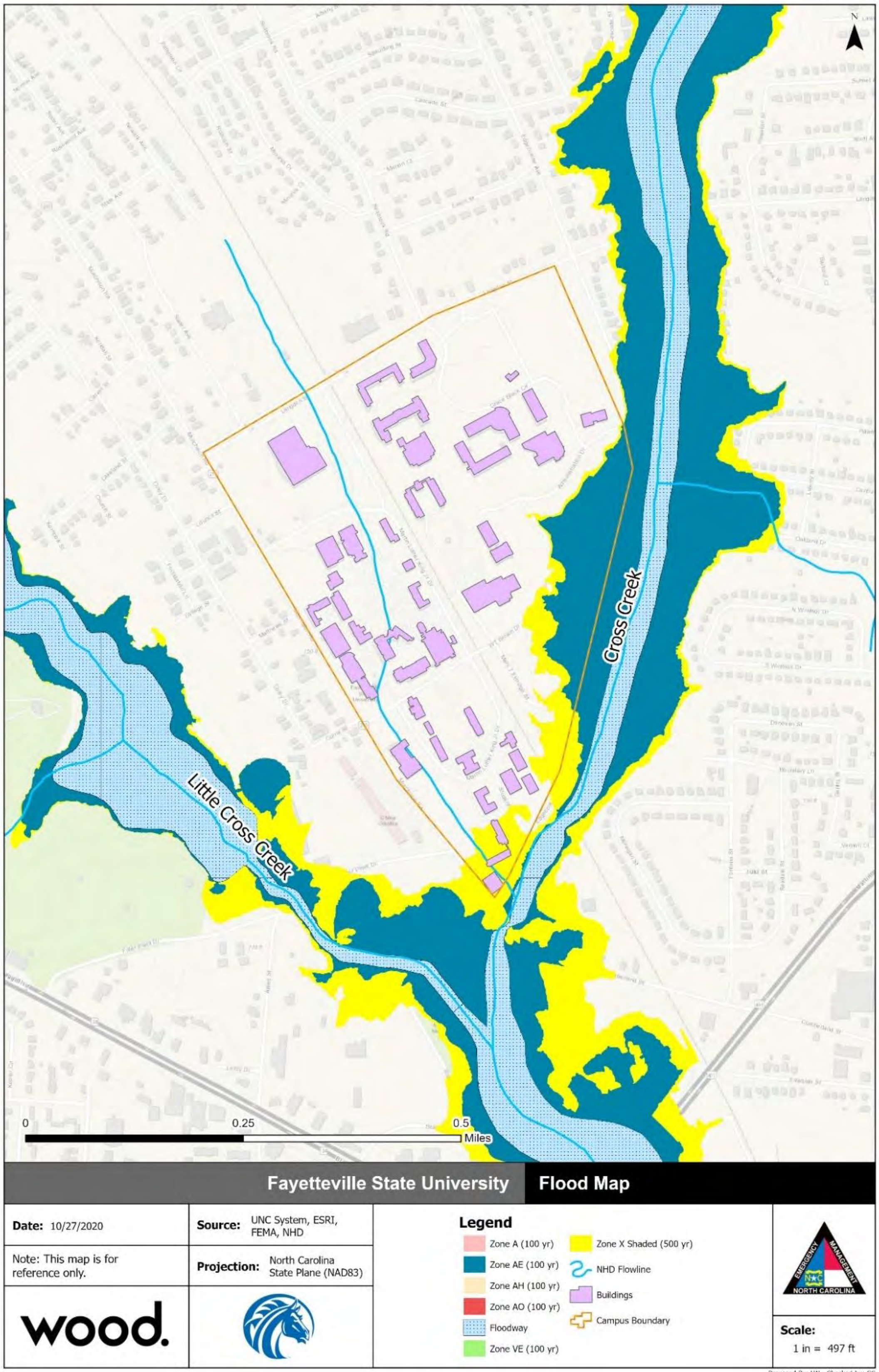


Table C.21 – Flood Zone Acreage on FSU Campus

Flood Zone	Acreage	Percent of Total (%)
A	0.0	0.0%
AE	9.4	7.5%
AH	0.0	0.0%
AO	0.0	0.0%
Floodway	0.0	0.0%
VE	0.0	0.0%
0.2% Annual Chance Flood Hazard	7.0	5.5%
Unshaded X	110.0	87.0%
Total	126.4	--
SFHA Total	**9.4**	**7.5%**

Source: FEMA 2007 DFIRM

Although this assessment focuses on riverine flooding, it is also important to note that localized stormwater flooding can also occur on campus and may affect areas outside the mapped floodplain. Data was not available to evaluate the location or extent of stormwater flooding on campus.

Extent

Flood extent can be defined by the amount of land in the floodplain, detailed above, and the potential magnitude of flooding as measured by flood depth and velocity. As shown in **Figure C.8** the SFHA intersects with 9.4 acres (7.5%) of the FSU campus, but does not intersect with any building footprints. The 0.2% annual chance floodplain intersects with 7 acres (5.5%) of the FSU campus including the Bronco Student Plaza, Bryant Hall, and adjacent roadways.

Impact: 1 – Minor

Historical Occurrences

Table C.22 details the historical occurrences of flooding for Fayetteville identified from 2000 through 2019 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 C.22 – NCEI Records of Flooding Events in Fayetteville, 2000-2019

Location	Date	Deaths/Injuries	Reported Property Damage	Reported Crop Damage
Flash Flood				
FAYETTEVILLE	6/16/2001	0/0	$0	$0
FAYETTEVILLE	8/28/2002	0/0	$0	$0
FAYETTEVILLE	9/18/2002	0/0	$0	$0
FAYETTEVILLE	5/25/2003	0/0	$0	$0
FAYETTEVILLE	7/19/2003	0/0	$0	$0
FAYETTEVILLE	7/29/2003	0/0	$0	$0
FAYETTEVILLE	6/8/2005	0/0	$0	$0
FAYETTEVILLE	7/20/2006	0/0	$0	$0
FAYETTEVILLE	8/22/2006	0/0	$0	$0
(FAY)GRANNIS FLD FAY	7/8/2008	0/0	$0	$0
(FAY)GRANNIS FLD FAY	6/25/2010	0/0	$10,000	$0
FAYETTEVILLE	6/21/2011	0/0	$0	$0
FAYETTEVILLE	9/2/2014	0/0	$2,000	$0

Location	Date	Deaths/Injuries	Reported Property Damage	Reported Crop Damage
(FBG)FT BRAGG	10/8/2016	0/0	$0	$0
Flood				
(FBG)FT BRAGG	10/9/2016	2/0	$62,100,000	$20,000,000
(FBG)FT BRAGG	9/17/2018	0/0	$35,310,000	$30,000,000
Heavy Rain				
FAYETTEVILLE	12/11/2008	0/0	$1,500,000	$0
Total		**2/0**	**$98,922,000**	**$50,000,000**

Source: NCEI

According to NCEI, 17 recorded flood-related events affected the planning area from 2000 to 2019 causing an estimated $98,922,000 in property damage, $50,000,000 in crop damage, two, fatalities, and no injuries.

The following event narratives are provided in the NCEI Storm Events Database and illustrate the impacts of flood events on the county:

- **05/25/2003** - Numerous roads were flooded, stranding cars, and some people had to be rescued. Water entered houses on Butterwood Circle and Smith Street. A small dam broke on Dundle Road, flooding the road.
- **10/8/2016** - Torrential rainfall of 12 to 15 inches caused widespread flash flooding across the county. The heavy rains caused at least 8 dams to breach in Cumberland County. Numerous roads were closed due to flooding, including portions of Interstate 95. Numerous homes and businesses were flooded as well, with numerous water rescues from people trapped in homes and vehicles.
- **10/9/2016** - Torrential rainfall of 12 to 15 inches caused widespread flash flooding across the county. The heavy rains caused at least 8 dams to breach in Cumberland County. Additional rainfall upstream resulted in major flooding at both the Little River at Manchester and Cape Fear at Fayetteville. Flooding damaged approximately 4,050 structures throughout the county, resulting in $62.1 million in property damage and and at least $20 million in crop damage. There was more than 700 swift water rescues in Cumberland County alone. The flooding resulted in 2 direct fatalities. A 81 year old female was found dead inside her vehicle in the 100 block of Rhodes Pond Road. After flood waters receded, a 53-year-old male was found less than 100 yards away from his vehicle near the Clinton Road exit on the southbound side of I-95. There were also 2 indirect fatality. A 63-year-old man died several days later from a pre-existing health condition after he was unable to refill his prescription medication due to flooded and impassable roadways. The second indirect fatality occurred several weeks later when a construction equipment operator died while repairing an earthen dam damaged by Hurricane Matthew. The victim was operating a Bobcat when the equipment overturned, trapping him underwater at McFayden Lake.
- **9/17/2018** - Torrential rainfall of 15 to 20 inches caused widespread flooding across the county. Additional rainfall upstream resulted in all-time record major flooding along the Little River at Manchester and major flooding along the Cape Fear River at Fayetteville. Flooding damaged approximately 1,052 structures throughout the county, resulting in $35.3 million in property damage and and at least $30 million in crop damage. The Star Lite Motel along the Little River was partially washed away into the river. The Cape Fear River reached the base of both the Person Street and Grove Street bridges at its crest. Numerous roads were closed due to flooding and much of East Fayetteville was evacuated based on forecast river flooding.

The state of North Carolina has had two FEMA Major Disaster Declarations for severe storms that include elements of flooding in 1962 and 1964 along with four Major Disaster Declarations for Hurricanes in 1954, 1955, 1958, 1960 which may have included damages associated with flooding. Additionally, Cumberland County has received one Major Disaster Declaration for a severe storm that included elements of flooding in 2011. The County also received seven Major Disaster Declarations for Hurricanes in 1996, 1998, 1999, 2003, 2004, 2016, and 2018 which also may have included damages associated with flooding.

Probability of Future Occurrence

By definition, SFHAs are those areas that will be inundated by the flood event having a 1-percent chance of being equaled or exceeded in any given year. While exposure to flood hazards varies across jurisdictions, all jurisdictions have at least some area of land in FEMA-mapped flood hazard areas. This delineation is a useful way to identify the most at-risk areas, but flooding does not occur in set intervals; any given flood may be more or less severe than the defined 1-percent-annual-chance flood. There is also risk of localized and stormwater flooding in areas outside the SFHA and at different intervals than the 1% annual chance flood.

Floods of varying severity occur regularly in Cumberland County, and impacts from past flood events have been noted by NCEI. NCEI reports 17 flood-related events in the 20-year period from 2000-2019, which equates to an annual probability of 85% for Fayetteville. Therefore, the overall probability of flooding is considered likely (between 10% and 100% annual probability).

Probability: 3 – Likely

Vulnerability Assessment

Methodology & Assumptions

To quantify vulnerability, Wood performed a GIS spatial analysis of the flood hazard by overlaying the mapped SFHA on the building footprints provided by the UNC Division of Information Technology and NCEM iRisk database. For the FSU campus, there are no structures located within the SFHA.

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 systems lose 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 high risk when driving through flooded streets. NCEI contains records of two deaths caused by flood events in Fayetteville.

An estimate of population at risk to flooding can be developed based on the assessment of housing property at risk. For the FSU campus, there are no housing properties at risk.

Property

Administration buildings, education and/or extracurricular facilities, housing, as well as critical facilities and infrastructure such as transportation, water, energy, and communication systems may be damaged or destroyed by flood waters.

Table C.23 details the estimated losses for the 1%-annual-chance flood event for the campus. The total damage estimate value is based on damages to the total of building value. Land value is not included in any of the loss estimates as generally land is not subject to loss from floods.

Table C.23 – Estimated Building Damage and Content Loss for 1% Annual Chance Flood

Occupancy Type	Total Buildings with Loss	Total Value	Estimated Building Damage	Loss Ratio
Administration	0	$0	$0	0%
Critical Facilities	0	$0	$0	0%
Education/ Extracurricular	0	$0	$0	0%
Housing	0	$0	$0	0%
Total	**0**	**$0**	**$0**	**0%**

Source: UNC Division of Information Technology; NCEM iRisk; NC Department of Insurance; USACE Wilmington District Depth-Damage Function

The loss ratio is the loss estimate divided by the total potential exposure (i.e., total of improved value for all buildings located within the Zone AE) and displayed as a percentage of loss. FEMA considers loss ratios greater than 10% to be significant and an indicator a community may have more difficulties recovering from a flood. Loss ratios for all occupancy types with identified structures on the FSU campus are 0%, meaning that in the event of a flood with a magnitude of the 1%-annual-chance event or greater, the planning area would be minimally impacted.

None of the critical facilities identified for FSU are located within the 1%-annual-chance floodplain, therefore there are no estimated damages. However, the Bronco Student Plaza is located within the 0.2%-annual-chance-floodplain.

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 planning area. According to 2020 NFIP records, there are no repetitive loss properties on the FSU campus.

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.

Changes in Development

The likelihood of future flood damage can be reduced through appropriate land use planning, building siting and building design. In addition, the FSU Facilities Management are dedicated to the operation and maintenance of the campus facilities.

Problem Statement

- The 1% annual chance floodplain does not impact any structures on the FSU campus. However, the 0.2% annual chance floodplain (or 500-year floodplain) does extend onto the FSU campus and could potentially impact the Bronco Student Plaza, Bryant Hall, and adjacent roadways during these flood events.
- Cumberland County has received one Major Disaster Declaration for a severe storm that included elements of flooding in 2011. The County also received seven Major Disaster Declarations for Hurricanes in 1996, 1998, 1999, 2003, 2004, 2016, and 2018 which also may have included damages associated with flooding.

C.5.3 Geological – Landslide

Hazard	Probability	Impact	Spatial Extent	Warning Time	Duration	PRI Score
Landslide	Unlikely	Minor	Negligible	6 to 12 hrs	Less than 6 hrs	1.2

Location

Cumberland County is located within the Coastal Plain physiographic province of North Carolina. This province encompasses approximately 45 percent of the area of the state and is characterized by flat land to gently rolling hills and valleys. Elevations range from sea level near the coast to about 600 feet in the Sandhills of the southern Inner Coastal Plain.

The U.S. Geological Survey (USGS) has produced landslide susceptibility and incidence mapping of the U.S., as shown in **Figure C.9**. 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, Cumberland County faces low susceptibility and incidence of landslide.

Spatial Extent: 4 – Negligible

Extent

In low-relief areas, such as the Cumberland County area, landslides may occur as cut-and fill failures (roadway and building excavations), river bluff failures, lateral spreading landslides, collapse of mine-waste piles (especially coal), and a wide variety of slope failures associated with quarries and open-pit mines. In these instances, impacts are limited to the defined area. Event magnitude is also dependent on topography; landslide risk is higher in areas with steeper slopes. Given the gentle topography the county, the magnitude of any landslides on FSU's campus would be minor.

Impact: 3 – Minor

Historical Occurrences

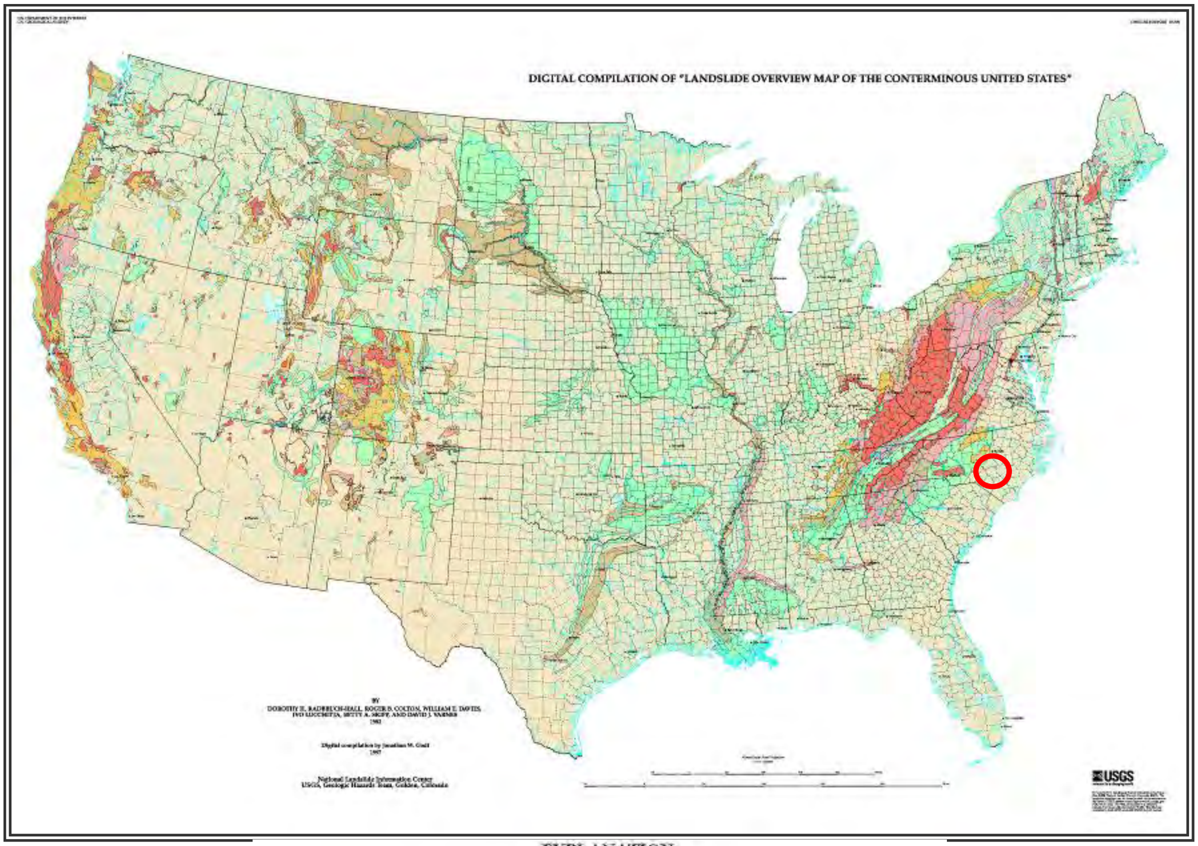
There were no available records of past landslide events for the County. When looking at the map in **Figure C.9**, it is shown that all of Cumberland County is in an area with low incidence and susceptibility to landslides.

Probability of Future Occurrence

There were no records found for any landslide events occurring in Cumberland County between 2000 and 2019. Since this area does not have any historical occurrences or susceptibility, it is 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

Figure C.9 – Landslide Incidence and Susceptibility



EXPLANATION

LANDSLIDE INCIDENCE

- Low (less than 1.5% of area involved)
- Moderate (1.5%-15% of area involved)
- High (greater than 15% of area involved)

LANDSLIDE SUSCEPTIBILITY/INCIDENCE

- Moderate susceptibility/low incidence
- High susceptibility/low incidence
- High susceptibility/moderate incidence

Susceptibility not indicated where same or lower than incidence. Susceptibility to landsliding was defined as the probable degree of response of [the areal] rocks and soils to natural or artificial cutting or loading of slopes, or to anomalously high precipitation. High, moderate, and low susceptibility are delimited by the same percentages used in classifying the incidence of landsliding. Some generalization was necessary at this scale, and several small areas of high incidence and susceptibility were slightly exaggerated.

Source: USGS

Vulnerability Assessment

People

People are unlikely to sustain serious physical harm as a result of landslides in Cumberland 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 Cumberland 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 Cumberland County are unlikely to cause any more severe impacts.

Changes in Development

Although Cumberland County faces low susceptibility and incidence of landside, future development projects should consider slope and soil slippage potential at the planning, engineering and architectural design stage with the goal of reducing vulnerability.

Problem Statement

- A landslide event 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.

C.5.4 Hurricane

Hazard	Probability	Impact	Spatial Extent	Warning Time	Duration	PRI Score
Hurricane	Likely	Critical	Large	More than 24 hrs	Less than 24 hrs	2.9

Location

While coastal areas are most vulnerable to hurricanes, the wind and rain impacts of these storms can be felt hundreds of miles inland. Hurricanes and tropical storms can occur anywhere within Cumberland County. Storm surges, or storm floods, are limited to the coastal counties of North Carolina. FSU is not located on the coast and is therefore not impacted by storm surges. However, hurricane winds can impact the entire campus, so the spatial extent was determined to be large.

Spatial Extent: 4 – Large

Extent

Hurricane intensity is classified by the Saffir-Simpson Scale (**Table C.24**), which rates hurricane intensity on a scale of 1 to 5, with 5 being the most intense.

Table C.24 – 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 C.25** 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 C.25 – 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

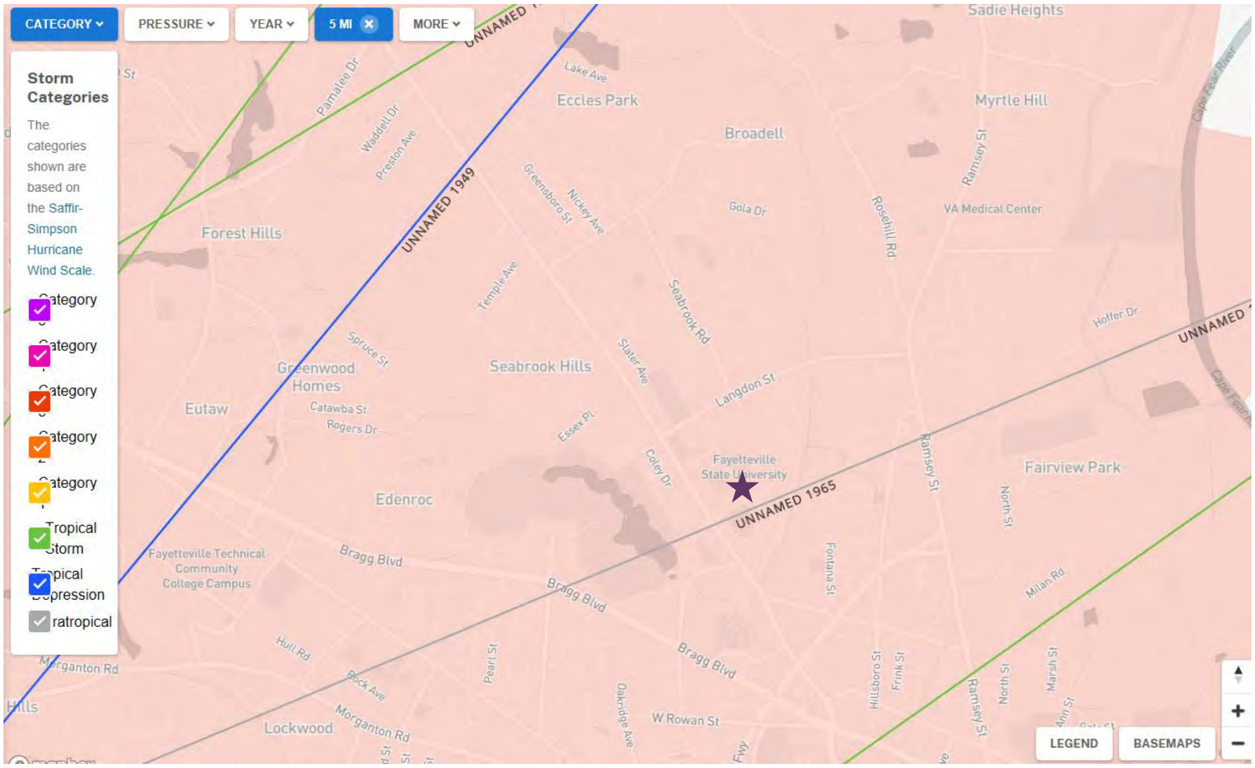
Tropical cyclones weaken relatively quickly after making landfall; therefore, Cumberland County will not typically experience major hurricane force winds, though these occurrences are possible. A storm on record that impacted FSU was an unnamed tropical depression whose path moved through the campus in 1965 with maximum wind speeds of around 40 mph. However, an unnamed hurricane passed within 5 miles of FSU's campus as a Category 1 storm with maximum wind speeds around 86 mph in 1899.

Impact: 3 – Critical

Historical Occurrences

Storm tracks for hurricane-related events that have passed within 5 miles of FSU's campus were obtained from NOAA 's database and are shown in **Figure C.10**. The NCEI Storm Events database has recorded six hurricanes and tropical storms that passed through Cumberland County between 2000 and 2019. **Table C.26** details the historical occurrences.

Figure C.10 – Hurricane and Tropical Storm Tracks near FSU



Source: NOAA Office of Coastal Management

Table C.26 – Recorded Hurricane and Tropical Storm Events for Cumberland County, 2000-2019

Date	Type	Storm	Deaths/ Injuries	Property Damage	Crop Damage
9/18/2003	Hurricane (Typhoon)	Hurricane Isabel	0/0	$28,000	$0
9/1/2006	Tropical Storm	Tropical Storm Ernesto	0/0	$0	$0
9/2/2016	Tropical Storm	Tropical Storm Hermine	0/0	$10,000	$0
9/13/2018	Tropical Storm	Hurricane Florence	0/0	$1,500,000	$0
10/11/2018	Tropical Storm	Tropical Storm Michael	0/0	$100,000	$0
9/5/2019	Tropical Storm	Hurricane Dorian	0/0	$1,000,000	$0
		Total	**0/0**	**$2,638,000**	**$0**

Source: NCEI

According to NCEI, six recorded hurricane-related events affected Cumberland County from 2000 to 2019 causing an estimated $2,638,000 in property damage. There were no injuries or fatalities recorded for any of these events.

The following event narratives are provided in the NCEI Storm Events Database and illustrate the impacts of hurricane and tropical storm events on the county:

Hurricane Isabel (2003) – Hurricane Isabel made landfall along the Outer Banks just north of Cape Lookout around 1 pm on September 18, 2003. The eye of the storm tracked northeast passing over eastern Halifax County. Winds gusts to near Hurricane force were recorded over Halifax county. Many locations across the Coastal Plain and even back into the Triangle received wind gusts between 50 to 70 mph late in the afternoon until early evening. Many trees were uprooted falling on vehicles and homes all across the area.

One person was killed in Franklin county when their vehicle struck a downed tree. Up to 6 inches of rain fell across Edgecombe, Halifax and Wilson counties resulting in flooding of several roads.

Hurricane Florence (2018) – Frequent wind gusts of 50 to 70 mph resulted in numerous trees down across Cumberland County, including on homes, cars, power lines and damage to structures. Numerous customers lost power in Cumberland County because of the tropical storm force winds from Hurricane Florence. A husband and wife died (indirect) in a house fire. The couple was using candles and lanterns, due to a loss of power. A ridge of high pressure over eastern North America stalled Florence's forward motion a few miles off the southeast North Carolina coast on September 13th. Hurricane Florence made landfall near Wrightsville Beach early on Saturday, September 15, and weakened further as it moved slowly inland. Despite making landfall as a weakened. Category 1 hurricane, Florence still produced 40 to 70 mph wind gusts, enough wind speed to uproot trees and cause widespread power outages throughout the Carolinas. As the storm moved inland, from September 15 to 17, heavy rain of 10 to 25 inches caused widespread inland flooding, inundating cities such as Fayetteville, Smithfield, Goldsboro, Durham, and Chapel Hill, and causing major river flooding on main-stem rivers such as the Neuse, Cape Fear, and Little River. Most major roads and highways in the area experienced some flooding, with large stretches of I-40 and I-95 remaining impassable for days after the storm had passed. The storm also spawned tornadoes in several places along its path. There were 3 direct and 6 indirect deaths attributed to the storm with in the WFO RAH CWA.

Hurricane Dorian (2019) – Frequent wind gusts of 35 to 55 mph resulted in scattered to numerous trees and power lines down across Cumberland County, including some on homes. Numerous customers lost power in Cumberland County because of the tropical storm force winds from Hurricane Dorian.

The state of North Carolina has had four FEMA Major Disaster Declarations for Hurricanes in 1954, 1955, 1958, 1960. Additionally, Cumberland County has received seven Major Disaster Declarations for Hurricanes in 1996, 1998, 1999, 2003, 2004, 2016, and 2018.

Probability of Future Occurrence

Probability: 3 – Likely

In the 20-year period from 2000 through 2019, six hurricanes and tropical storms have impacted Cumberland County, which equates to a 30 percent annual probability of hurricane winds impacting the County. This probability does not account for impacts from hurricane rains, which may also be severe. Overall, the probability of a hurricane or tropical storm impacting the County is likely.

Vulnerability Assessment

Methodologies and Assumptions

To quantify vulnerability, Wood performed a Level 1 hurricane wind analysis in Hazus 4.2 for three scenarios: a historical recreation of Hurricane Fran (1996) and simulated probabilistic wind losses for a 200-year and a 500-year event storm. The analysis utilized general building stock information based on the 2010 Census. The FSU campus is located across two census tracts encompassing 3.07 square miles. The vulnerability assessment results are for wind-related damages. Hurricanes may also cause substantial damages from heavy rains and subsequent flooding, which is addressed in Section C.5.2 Flood.

People

The very young, the elderly and disabled individuals are more vulnerable to harm from hurricanes, as are those who are unable to evacuate for medical reasons, including 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 or ongoing treatment. For all affected populations, 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.

Table C.27 details the likelihood of building damages by occupancy type from varying magnitudes of hurricane events.

Table C.27 – Likelihood of Buildings Damages Impacted by Hurricane Wind Events

Occupancy	Buildings at Risk	Value at Risk	Likelihood of Damage (%)				
			None	Minor	Moderate	Severe	Destruction
Hurricane Fran (1996)							
Agriculture	3	$491,000	98.50%	1.35%	0.12%	0.03%	0.00%
Commercial	114	$51,840,000	98.42%	1.47%	0.11%	0.00%	0.00%
Education	14	$11,200,000	98.61%	1.37%	0.02%	0.00%	0.00%
Government	-	$0	0.00%	0.00%	0.00%	0.00%	0.00%
Industrial	25	$9,994,000	98.48%	1.46%	0.06%	0.01%	0.00%
Religion	21	$18,970,000	98.85%	1.13%	0.02%	0.00%	0.00%
Residential	2,269	$513,904,000	98.20%	1.73%	0.07%	0.00%	0.00%
200-year Hurricane Event							
Agriculture	3	$491,000	88.54%	8.68%	1.93%	0.79%	0.06%
Commercial	105	$51,840,000	90.43%	7.76%	1.70%	0.11%	0.00%
Education	13	$11,200,000	91.68%	7.30%	0.99%	0.03%	0.00%
Government	-	$0	0.00%	0.00%	0.00%	0.00%	0.00%
Industrial	23	$9,940,000	90.65%	7.59%	1.45%	0.29%	0.02%
Religion	19	$18,970,000	91.35%	7.79%	0.84%	0.03%	0.00%
Residential	2,022	$513,904,000	87.48%	11.14%	1.35%	0.03%	0.01%
500-year Hurricane Event							
Agriculture	2	$491,000	72.55%	18.32%	5.99%	2.79%	0.34%
Commercial	88	$51,840,000	76.15%	16.36%	6.63%	0.84%	0.02%
Education	11	$11,200,000	78.37%	15.97%	5.17%	0.50%	0.00%
Government	-	$0	0.00%	0.00%	0.00%	0.00%	0.00%
Industrial	19	$9,940,000	15.99%	15.99%	6.26%	1.40%	0.11%
Religion	16	$18,970,000	17.78%	17.78%	4.54%	0.41%	0.00%
Residential	1,659	$513,904,000	22.64%	22.64%	5.29%	0.21%	0.09%

Table C.28 details the estimated building and content damages by occupancy type for varying magnitudes of hurricane events.

Table C.28 – Estimated Buildings Impacted by Hurricane Wind Events

Area	Residential	Commercial	Industrial	Others	Total
Hurricane Fran (1996)					
Building	$1,416,450	$20,590	$2,670	$6,620	$1,446,330
Content	$355,560	$1,470	$470	$50	$357,550
Inventory	$0	$0	$100	$10	$110
Total	**$1,772,010**	**$22,060**	**$3,240**	**$6,680**	**$1,803,990**
200-year Hurricane Event					
Building	$4,959,530	$140,310	$24,970	$50,790	$5,175,600
Content	$1,106,570	$33,590	$10,080	$7,940	$1,158,180
Inventory	$0	$730	$1,900	$80	$2,710
Total	**$6,066,100**	**$174,630**	**$36,950**	**$58,810**	**$6,336,490**
500-year Hurricane Event					
Building	$10,531,880	$471,000	$94,010	$187,770	$11,284,660
Content	$2,608,430	$181,440	$50,550	$51,730	$2,892,150
Inventory	$0	$4,430	$9,110	$320	$13,860
Total	**$13,140,310**	**$656,870**	**$153,670**	**$239,820**	**$14,190,670**

The damage estimates for the 500-year hurricane wind event total $14,190,670. These damage estimates account for only wind impacts and actual damages would likely be higher due to flooding. As noted in Section C.5.2, Bronco Student Plaza, Bryant Hall, and surrounding roadways are located within the 500-year floodplain. Therefore, the FSU Campus would likely experience a higher overall loss from the 500-year hurricane event.

Environment

Hurricane winds can cause massive damage to the natural environment, uprooting trees and other debris within the storm's path. Animals can either be killed directly by the storm or impacted indirectly through changes in habitat and food availability caused by high winds and intense rainfall. Endangered species can be dramatically impacted. Forests can be completely defoliated by strong winds.

Changes in Development

Future development that occurs in the planning area should consider high wind hazards at the planning, engineering and architectural design stages. The University should consider evacuation planning in the event of a hurricane event.

Problem Statement

- Historical tracks of multiple hurricane events pass within 5-miles of the FSU Campus.
- For the 20-year period from 2000 through 2019, there have been 6 hurricane wind events causing over $2.5 million dollars in damage for Cumberland County.

C.5.5 Severe Winter Weather

Hazard	Probability	Impact	Spatial Extent	Warning Time	Duration	PRI Score
Severe Winter Weather	Highly Likely	Limited	Large	More than 24 hrs	Less than 1 week	3.0

Location

Severe winter weather is usually a countywide or regional hazard, impacting the entire county at the same time. 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. Cumberland 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, severe winter weather can occur anywhere in the county.

Spatial Extent: 4 – Large

Extent

The National Oceanic and Atmospheric Administration (NOAA) uses the Regional Snowfall Index (RSI), shown in **Table C.29** for the Cumberland County region, to assess the societal impact of winter storms in the six easternmost regions in the United States. The index makes use of population and regional differences to assess the impact of snowfall. For example, areas which receive very little snowfall on average may be more adversely affected than other regions, resulting in a higher severity. The County may experience any level on the RSI scale. Cumberland County receives an average of 2 inches of snowfall per year. According to NCEI, the greatest snowfall amounts to impact Cumberland County have been between 7-9 inches, with Fayetteville reporting around 7-9 inches of snowfall as well. During the snowstorm of December 24 to December 26, 2010, from which 7-9 inches were reported near Fayetteville, the county was classified as a Category 1 on the RSI scale. It is possible that more severe events and impacts could be felt in the future.

Table C.29 – Regional Snowfall Index (RSI) Values

Category	RSI Value	Description
1	1-3	Notable
2	3-6	Significant
3	6-10	Major
4	10-18	Crippling
5	18+	Extreme

Source: NOAA

Severe winter weather often involves 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 C.11**, provides a formula for calculating the dangers of winter winds and freezing temperatures. This presents wind chill temperatures which are based on the rate of heat loss from exposed skin caused by wind and cold. As the wind increases, it draws heat from the body, driving down skin temperature and eventually the internal body temperature.

Figure C.11 – NWS Wind Chill Temperature Index

Wind Chill Chart

Wind (mph)	Calm / Temperature (ºF): 40	35	30	25	20	15	10	5	0	-5	-10	-15	-20	-25	-30	-35	-40	-45
5	36	31	25	19	13	7	1	-5	-11	-16	-22	-28	-34	-40	-46	-52	-57	-63
10	34	27	21	15	9	3	-4	-10	-16	-22	-28	-35	-41	-47	-53	-59	-66	-72
15	32	25	19	13	6	0	-7	-13	-19	-26	-32	-39	-45	-51	-58	-64	-71	-77
20	30	24	17	11	4	-2	-9	-15	-22	-29	-35	-42	-48	-55	-61	-68	-74	-81
25	29	23	16	9	3	-4	-11	-17	-24	-31	-37	-44	-51	-58	-64	-71	-78	-84
30	28	22	15	8	1	-5	-12	-19	-26	-33	-39	-46	-53	-60	-67	-73	-80	-87
35	28	21	14	7	0	-7	-14	-21	-27	-34	-41	-48	-55	-62	-69	-76	-82	-89
40	27	20	13	6	-1	-8	-15	-22	-29	-36	-43	-50	-57	-64	-71	-78	-84	-91
45	26	19	12	5	-2	-9	-16	-23	-30	-37	-44	-51	-58	-65	-72	-79	-86	-93
50	26	19	12	4	-3	-10	-17	-24	-31	-38	-45	-52	-60	-67	-74	-81	-88	-95
55	25	18	11	4	-3	-11	-18	-25	-32	-39	-46	-54	-61	-68	-75	-82	-89	-97
60	25	17	10	3	-4	-11	-19	-26	-33	-40	-48	-55	-62	-69	-76	-84	-91	-98

Frostbite Times: 30 minutes | 10 minutes | 5 minutes

$$\text{Wind Chill (ºF)} = 35.74 + 0.6215T - 35.75(V^{0.16}) + 0.4275T(V^{0.16})$$

Where, T= Air Temperature (ºF) V= Wind Speed (mph)

Effective 11/01/01

Source: https://www.weather.gov/safety/cold-wind-chill-chart

The most significant recorded snow depth over the last 20 years took place in December 2010, with recorded depths of up to 12 inches across the county.

Impact: 2 – Limited

Historical Occurrences

To get a full picture of the range of impacts of a severe winter weather, data for the following weather types as defined by the National Weather Service (NWS) 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.

According to the NCEI Storm Events Database, there were 31 combined winter storm/winter weather events in Cumberland County during the 20-year period from 2000 through 2019. As reported in NCEI, severe winter weather directly caused one fatality and $10,000 in property damage. There were no reported injuries or crop damage, though these types of impacts may not have been reported and are possible in future events. Events in Cumberland County by incident are recorded in **Table C.30**.

Table C.30 – Recorded Severe Winter Weather Events in Cumberland County, 2000-2019

Event Type	Event Count	Fatalities	Injuries	Property Damage	Crop Damage
Winter Storm	21	0	0	$0	$0
Winter Weather	10	1	0	$10,000	$0
Total	**31**	**1**	**0**	**$10,000**	**$0**

Source: NCEI

Storm impacts from NCEI are summarized below:

March 2, 2010 – Around 1 to 2 inches of snow fell across the county. Around 8000 customers were without power in the region.

December 16, 2010 – A prolonged period of light snow and freezing rain in the morning resulted in a half inch of snow with a tenth of an inch of freezing rain. This combination created hazardous driving conditions during the morning commute. A 50-year-old man was killed in Fayetteville when a truck in the opposite lane slid on the ice striking a car in the oncoming traffic.

December 25, 2010 – Seven to nine inches of snow fell countywide including in Fayetteville. Many roads were impassible due to the heavy snow, however, other than a few minor accidents no other problems were reported due to the holiday.

January 10, 2011 – Three to five inches of snow fell across the area during the morning and afternoon hours. Snow changed over to freezing rain during the afternoon resulting in nearly a quarter inch of ice in some locations on top of the snow. All area roads were covered in snow resulting in the closure of schools and businesses.

Probability of Future Occurrence

NCEI records 31 severe winter weather related events during the 20-year period from 2000 through 2019, which equates to an annual probability greater than 100%. Therefore, the overall probability of severe winter weather in the county is considered highly likely (near or more than 100% annual probability).

Probability: 4 – Highly Likely

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.

The loss of use estimates provided in **Table C.31** were calculated using FEMA's publication *What is a Benefit?: Guidance on Benefit-Cost Analysis of Hazard Mitigation Project*, June 2009. These figures are used to provide estimated costs associated with the loss of power in relation to the populations served on campus. The loss of use is provided in the heading as the loss of use cost per person per day of loss. The estimated loss of use provided for the campus represents the loss of service of the indicated utility for one day for 10 percent of the population. These figures do not take into account physical damages to utility equipment and infrastructure.

Table C.31 – Loss of Use Estimates for Power Failure Associated with Severe Winter Weather

On-Campus Population (Fall 2019)	Estimated Affected Population (10%)	Electric Loss of Use Estimate ($126 per person per day)
1436	143.6	$18,093.60

Property

No property damage was reported in association with any winter weather events recorded by the NCEI between 2000 and 2019 for Cumberland County. Therefore, no annualized loss estimate could be calculated for this hazard.

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.

Changes in Development

Future development could potentially increase vulnerability to this hazard by increasing demand on the utilities and increasing the exposure of infrastructure networks. FSU may wish to consider developing a flexible emergency power network to provide efficient back-up power for vulnerable populations, critical facilities, and research facilities.

Problem Statement

- Severe winter weather events are highly likely for Cumberland County and the FSU campus.

C.5.6 Tornadoes/Thunderstorms

Hazard	Probability	Impact	Spatial Extent	Warning Time	Duration	PRI Score
Tornado/Thunderstorm	Likely	Critical	Large	Less than 6 hrs	Less than 6 hrs	3.1

Location

Thunderstorm wind, lightning, and hail events do not have a defined vulnerability zone. The scope of lightning and hail is generally confined to the footprint of its associated thunderstorm. Although these events occur similarly throughout the planning area, they are more frequently reported in more urbanized areas because damages are more likely to occur where exposure is greater in more densely developed urban areas.

Thunderstorm Winds

The entirety of FSU's campus can be affected by severe weather hazards. Thunderstorm wind events can span many miles and travel long distances, covering a significant area in one event. Due to the small size of the planning area, any given event will impact the entire planning area, approximately 50% to 100% of the planning area could be impacted by one event.

Spatial Extent: 4 – Large

Lightning

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 FSU is exposed to lightning. All of FSU is exposed to this hazard.

Spatial Extent: 4 – Large

Hail

Hailstorms frequently accompany thunderstorms, so their locations and spatial extents coincide. However, large-scale hail tends to occur in a more localized area within the storm. All of FSU is exposed to this hazard.

Spatial Extent: 4 – Large

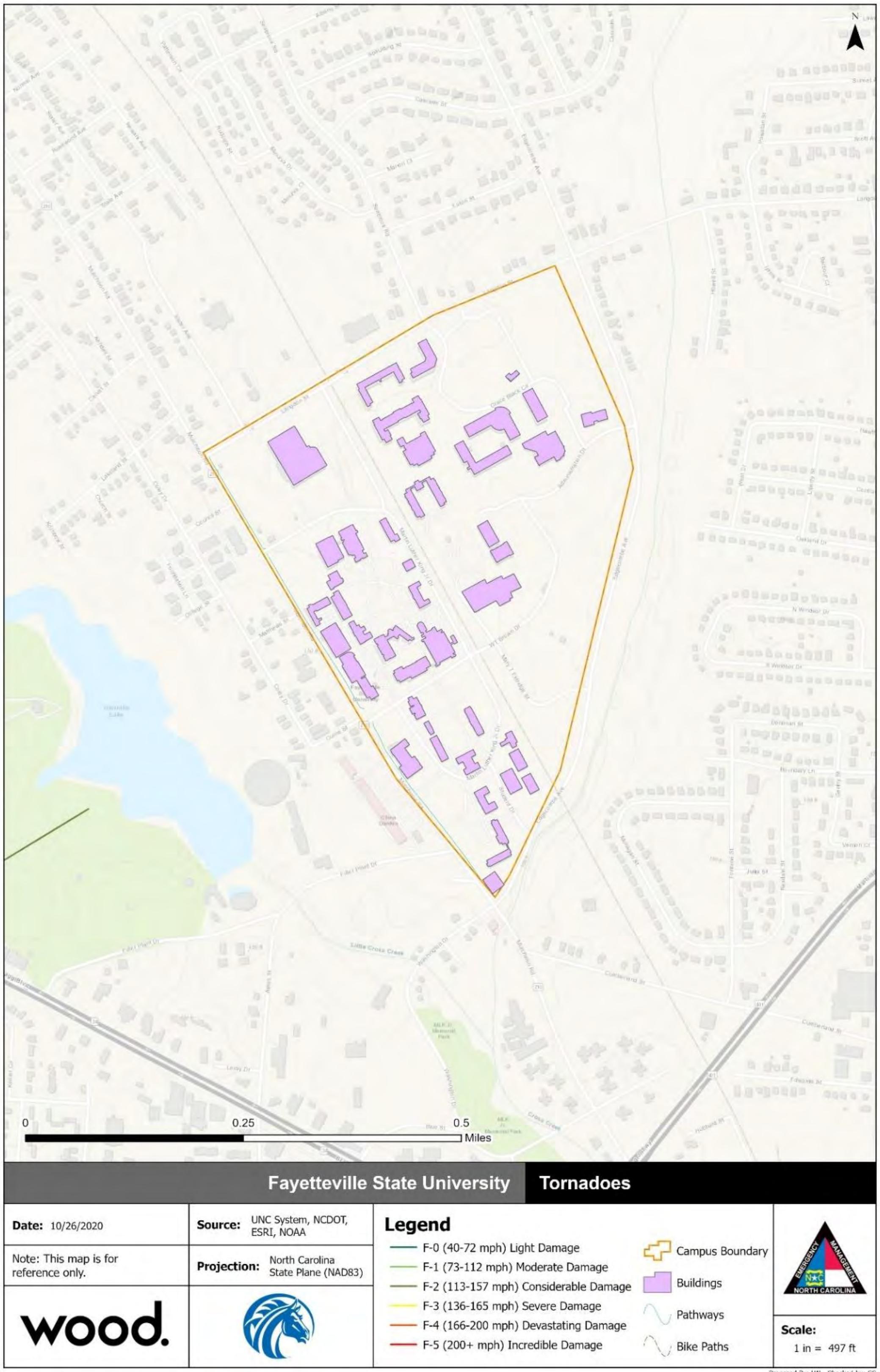
Tornado

Figure C.12 reflects the tracks of past tornados that intersected the FSU campus from 2000 through 2019 according to data from the NOAA/National Weather Service Storm Prediction Center.

Tornados can occur anywhere on FSU's campus. 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 campus versus another. All of FSU is exposed to this hazard.

Spatial Extent: 4 – Large

Figure C.12 – Tornado Paths within 10 Miles of FSU, 2000-2019



Extent

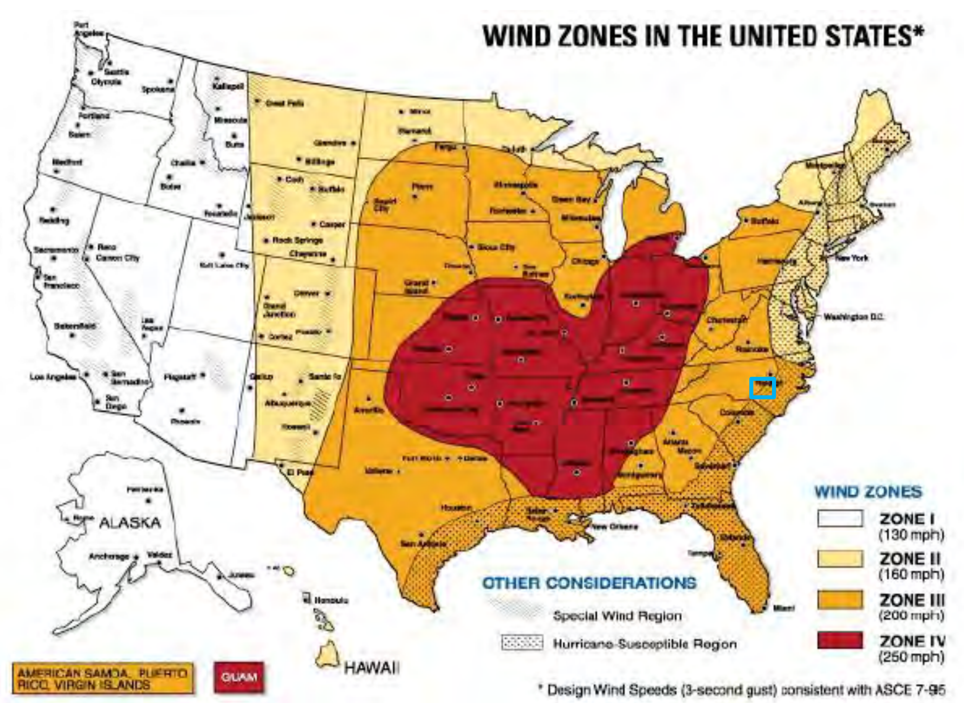
Thunderstorm Winds

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.

Figure C.13 shows wind zones in the United States. Cumberland County, indicated by the blue square, is within Wind Zone III, which indicates that speeds of up to 200 mph may occur within the county.

Figure C.13 – Wind Zones in the United States



Source: FEMA 320, Taking Shelter from the Storm, 3rd edition, https://www.fema.gov/pdf/library/ism2_s1.pdf

The strongest recorded thunderstorm wind event for Fayetteville occurred on July 8, 2015 with a measured gust of 64 mph. The event reportedly resulted in no fatalities, injuries, property or crop damages.

Impact: 2 – Limited

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, shown in **Table C.32**, is a common parameter that is part of fire weather forecasts nationwide.

Table C.32 – 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 campus 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

Hail

The National Weather Service classifies hail by diameter size, and corresponding everyday objects to help relay scope and severity to the population. **Table C.33** indicates the hailstone measurements utilized by the National Weather Service.

Table C.33 – 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
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 C.34** describes typical intensity and damage impacts of the various sizes of hail.

Table C.34 – 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 damaged
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 2000 and 2019 in Fayetteville was a little over 1" in diameter; the largest hailstone recorded was 2.5", recorded on July 1, 2012.

Impact: 1 – Minor

Tornado

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 and better correlation between damage and wind speed. It is also more precise because it considers the materials affected and the construction of structures damaged by a tornado. **Table C.35** shows the wind speeds associated with the enhanced Fujita scale ratings and the damage that could result at different levels of intensity.

Table C.35 – 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.

EF Number	3 Second Gust (mph)	Damage
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 near Fayetteville in the past 20 years was an EF3 on April 16, 2011. NCEI reports this event causing around $100,000,000 in property damage. The tornado exited Hoke County and continued to move northeast crossing into Cumberland County, just north of NC Highway 401. The tornado event caused 1 death and 85 injuries.

Impact: 3 – Critical

Historical Occurrences

Thunderstorm Winds

Between January 1, 2000 and December 31, 2019, the NCEI recorded wind speeds for 49 separate incidents of thunderstorm winds, occurring on 38 separate days, for Fayetteville. These events caused $135,000 in recorded property damage, three injuries, and no fatalities. The recorded gusts averaged 51.9 miles per hour, with the highest gusts recorded at 64 mph on July 8, 2015. Of these events, four caused property damage. Wind gusts with property damage recorded averaged $33,750 in damage, with the highest reported damage being a total of $105,000 on July 24, 2012. These incidents are aggregated by the date the events occurred and are recorded in **Table C.36**. These records specifically note Thunderstorm Wind impacts for Fayetteville.

Table C.36 – Recorded Thunderstorm Winds, Fayetteville, 2000-2019

Location	Date	Wind Speed (mph)	Fatalities	Injuries	Property Damage
FAYETTEVILLE ARPT	5/28/2000	58	0	0	$0
FAYETTEVILLE	9/25/2000	50	0	0	$0
FAYETTEVILLE ARPT	4/1/2001	58	0	3	$0
FAYETTEVILLE	5/28/2001	50	0	0	$0
FAYETTEVILLE	6/22/2001	60	0	0	$0
FAYETTEVILLE	5/25/2003	60	0	0	$0
FAYETTEVILLE	3/8/2005	50	0	0	$0
FAYETTEVILLE	7/28/2005	55	0	0	$0
FAYETTEVILLE	4/17/2006*	56	0	0	$0
FAYETTEVILLE	7/20/2006	50	0	0	$0
FAYETTEVILLE	7/28/2006*	50	0	0	$0
(FBG)FT BRAGG	3/2/2007	55	0	0	$0
(POB)POPE AFB FAYETT	6/29/2007	52	0	0	$0
FAYETTEVILLE	8/21/2007	50	0	0	$0
(FBG)FT BRAGG	3/4/2008	51	0	0	$0
(POB)POPE AFB FAYETT	6/20/2008	50	0	0	$0

Location	Date	Wind Speed (mph)	Fatalities	Injuries	Property Damage
FAYETTEVILLE	8/7/2008*	51	0	0	$0
FAYETTEVILLE	6/26/2009	50	0	0	$0
(FAY)GRANNIS FLD FAY	7/1/2009	50	0	0	$0
FAYETTEVILLE	6/18/2011	50	0	0	$0
FAYETTEVILLE	6/21/2011	50	0	0	$0
(FAY)GRANNIS FLD FAY	8/7/2011	50	0	0	$0
(FAY)GRANNIS FLD FAY	6/23/2012*	51	0	0	$0
FAYETTEVILLE	7/24/2012*	50	0	0	$105,000
(POB)POPE AFB FAYETT	8/2/2012	50	0	0	$0
(FAY)GRANNIS FLD FAY	2/21/2014	50	0	0	$0
(FAY)GRANNIS FLD FAY	6/19/2014	50	0	0	$0
(FAY)GRANNIS FLD FAY	6/19/2015*	50	0	0	$0
FAYETTEVILLE	6/30/2015	50	0	0	$0
(FBG)FT BRAGG	7/8/2015	64	0	0	$0
(FAY)GRANNIS FLD FAY	6/5/2016*	50	0	0	$30,000
(FBG)FT BRAGG	7/4/2016*	52	0	0	$0
(FBG)FT BRAGG	7/7/2016	50	0	0	$0
(FBG)FT BRAGG	7/15/2016	53	0	0	$0
(FBG)FT BRAGG	4/15/2018	60	0	0	$0
(FBG)FT BRAGG	4/19/2019*	56	0	0	$0
(FBG)FT BRAGG	5/30/2019	52	0	0	$0
(FAY)GRANNIS FLD FAY	8/19/2019	50	0	0	$0
		Total	**0**	**3**	**$135,000**

Source: NCEI
*Note: Multiple events occurred on these dates. Injuries, fatalities, and property damage are totaled, wind speed is highest reported.

The State of North Carolina received a FEMA Major Disaster Declaration in 1956 for severe storms that included heavy rains and high winds.

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

April 1, 2001 – Two girls were injured and taken to a hospital when a tree fell through a house off Ramsey St. Another child was injured when a swingset blew over. Two banks on Bragg Blvd. sustained damage, and numerous large trees and powerlines were blown down.

July 24, 2012 – Moderate to severe damage was reported to 5 structures in the city of Fayetteville, North Carolina. At least one home was uninhabitable. One tree was reported down at Gruber Road and Longstreet Road on Fort Bragg.

June 5, 2016 – Homes were reported damaged along Goshawk Drive and Screech Owl Drive. Power lines and power poles were reported down at the intersection of Sandhill Road and South Forty Drive.

Lightning

According to NCEI data, there were three lightning strikes reported in Fayetteville between 2000 and 2019. These events reportedly caused $255,000 in property damage and one direct injury. No crop damage or fatalities were 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. **Table C.37** details NCEI-recorded lightning strikes from 2000 through 2019 for Fayetteville.

Table C.37 – Recorded Lightning Strikes in Fayetteville, 2000-2019

Location	Date	Time	Fatalities	Injuries	Property Damage
FAYETTEVILLE	7/22/2002	1640	0	0	$180,000
FAYETTEVILLE	8/19/2002	1330	0	0	$75,000
FAYETTEVILLE	7/27/2006	1715	0	1	$0
		Total	**0**	**1**	**$255,000**

Source: NCEI

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

July 22, 2002 – Lightning set fire to a home.

August 19, 2002 – Lightning started a fire in a house.

July 27, 2006 – Nine-year-old girl struck by lightning while inside her home paying a video game.

Hail

NCEI records 13 days with hail incidents between January 1, 2000 and December 31, 2019 in Fayetteville. Two of these events were reported to have caused a total of $1,025,000 in property damage, with the highest reported damage being $1,000,000 on July 1, 2012. There were no reports of any injuries, deaths, or crop damage during these events. The largest diameter hail recorded in the City was 2.5 inches, which occurred on July 1, 2012. The average hail size of all events in the City was around 1.3 inches in diameter. **Table C.38** summarizes hail events for Fayetteville. In some cases, hail was reported for multiple locations on the same day.

Table C.38 – Summary of Hail Occurrences in Fayetteville

Beginning Location	Date	Hail Diameter
FAYETTEVILLE	3/31/2002	1.75
FAYETTEVILLE	4/26/2003	0.75
FAYETTEVILLE	4/3/2006	1.5
(FAY)GRANNIS FLD FAY	5/20/2008	0.75
(FAY)GRANNIS FLD FAY	6/20/2008	0.75
(FBG)FT BRAGG	8/7/2008	1.75
FAYETTEVILLE	6/21/2011	1
FAYETTEVILLE	7/1/2012*	2.5
(FBG)FT BRAGG	4/25/2014	1
(FAY)GRANNIS FLD FAY	4/9/2015	1
(POB)POPE AFB FAYETT	6/26/2015	1
(FAY)GRANNIS FLD FAY	6/5/2016	1.75
FAYETTEVILLE	6/25/2018	1.5

Source: NCEI;

*Note: Multiple events occurred on these dates. Hail diameter is highest reported for that specific date.

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

July 1, 2012 – Large hail up to the size of tennis balls fell at Stewart Nissan, causing damage to nearly all 300 cars parked at the dealership. Some rear and front windows were shattered along with lots of dented cars. Half dollar size hail was covering the ground at Fort Bragg Road and Oakridge Avenue.

June 25, 2018 – Ping Pong size hail was reported in Downtown Fayetteville.

Tornado

NCEI storm reports were reviewed from 2000 through 2019 to assess whether recent trends varied from the longer historical record. According to NCEI, the city of Fayetteville has experienced one tornado incident between 2000 and 2019, causing no injuries, fatalities, property damage, or crop damage. It is likely that there have been several tornados that occurred in Fayetteville but went unreported. However, neighboring communities surrounding Fayetteville have five reported tornado incidents between 2000 and 2019, causing 89 injuries, 1 death, and $100,525,000 in property damage. **Table C.39** shows historical tornadoes in Fayetteville along with its surrounding communities during this time.

Table C.39 – Recorded Tornadoes in Fayetteville and Surrounding Communities, 2000-2019

Beginning Location	Date	Time	Magnitude	Deaths	Injuries	Property Damage	Crop Damage
HOPE MILLS	5/28/2000	1206	F0	0	0	$0	$0
POPE AFB	12/17/2000	N/A	F0	0	0	$0	$0
HOPE MILLS	3/27/2009	1613	EF1	0	0	$225,000	$0
FENIX	4/16/2011	1437	EF3	1	85	$100,000,000	$0
CEDAR CREEK	4/16/2011	1527	EF2	0	4	$250,000	$0
STEDMAN	4/29/2014	1452	EF1	0	0	$50,000	$0
			Total	**1**	**89**	**$100,525,000**	**$0**

Source: NCEI

Narratives from NCEI illustrate that damage occurred in many of these incidents even if a monetary value was not recorded. Specific incidents include:

March 27, 2009 – An EF-1 tornado touched down just north of the Robeson County line and southeast of Hope Mills in the Roslin community. The tornado damage track was about 50 yards wide and stretched northeast for approximately 5 miles. On Roslin Farm Road, a brick home lost more than eighty percent of its roof structure. Several sheds and outbuildings in the area were also destroyed. A neighboring house also suffered minor structural damage to the garage. The tornado then tracked northeast over bare fields, before reaching Braxton Road. At Braxton Road the tornado continued with EF-1 intensity winds causing significant damage to a recently built two-story home. The home was condemned when it experienced around twenty percent roof loss with major damage to the upstairs structure. Numerous sheds and fences were also blown over in the area. The tornado continued northeast crossing Chicken Foot Road and Corporation Drive, along which several trees were snapped. The tornado crossed Interstate 95 where numerous trees were blown down and snapped near Tim Starling Road. It was just north of this intersection where a tractor trailer was overturned by the high winds. Just west of Interstate 95 near the intersection of Tim Starling Road and Research Drive, a large industrial building suffered significant roof damage. The wind of the tornado caused the roof to buckle enough for the Fire Marshall to order an evacuation of the building. Rocks on the roof of the building were blown into the parking lot shattering the windows of numerous vehicles. A house currently under construction on Tim Starling Drive also sustained significant damage. The tornado continued tracking northeast along Research Road while weakening to an EF-0 as it approached Claude Lee Road. Numerous trees were blown down and sheds were destroyed along Catherine Drive and Arlie Drive. Several homes in the area lost shingles and suffered minor damage to trim and siding. The tornado then lifted off the ground just as it approached the Fayetteville Regional Airport.

April 16, 2011 – The tornado exited Hoke County and continued to move northeast crossing into Cumberland County, just north of NC Highway 401. EF0 damage continued near the Clifdale community, where the damage was more sporadic across Bones Creek and Stewarts Creek. Strong tornado damage then occurred in and near the Beaver Creek community along Reilly Road and Yadkin Road west of Fayetteville. Damage was mostly EF1 and EF2, but was briefly EF3 damage, with wind speeds near 140 mph, causing major damage to a business and some dwellings along Yadkin Road. EF0 and EF1 damage was then observed across Simmons Army Airfield, along Andrews Road and across from the Pine Forest High School. The Goodyear Plant on NC Highway 401 sustained minor damage as well. The tornado continued northeast through the Carlos and Slocomb communities, with mainly EF0 tree damage. Just south of the Linden community, a small area of EF2 damage occurred near McBryde Road where several homes were heavily damaged, including a mobile home that was destroyed. One fatality occurred when the tornado hit a double-wide mobile home. The victim suffered massive head injuries. Two other occupants of the mobile home survived and were taken to Betsy Johnson Hospital. In total, approximately 1000 homes were damaged, of which 310 homes suffered major damage, with 287 homes being destroyed. There were also 40 businesses that experienced damage as well. The tornado exited Bladen County and moved into Cumberland County just west of NC Highway 242. The tornado moved northeast, crossing NC Highway 210 near Smith Road and Peters Creek road. In this area, a few homes were damaged with one home sustaining heavy damage rated EF2. There were four injuries sustained by some of the occupants. Hundreds of trees were also downed in this vicinity. Damage was also observed along Broadwater Bridge Road, east of Smith Road.

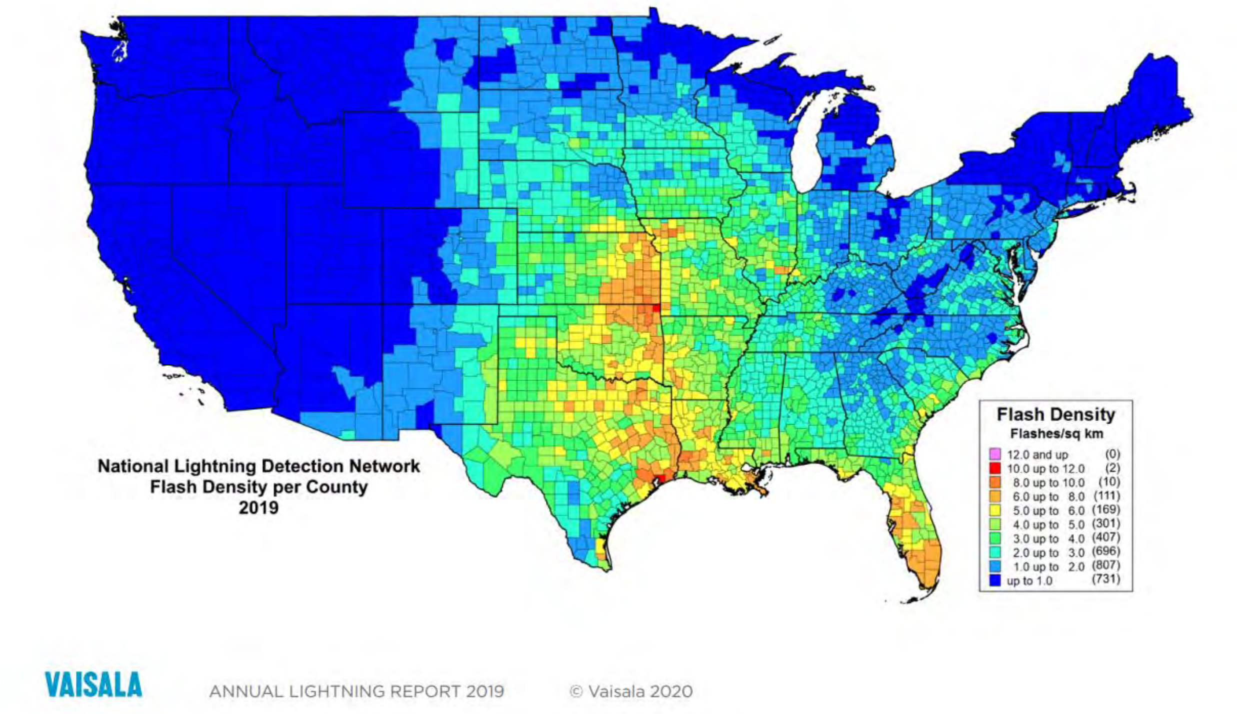
Probability of Future Occurrence

Based on historical occurrences recorded by NCEI for the 20-year period from 2000 through 2019, Fayetteville averages 1.9 days with wind events per year. Over this same period, 3 lightning events were reported as having caused death, injury, or property damage, which equates to an average of 0.15 damaging lightning strikes per year.

The average hail storm in Fayetteville occurs in the late afternoon and has a hail stone with a diameter of 1.3 inches. Over the 20-year period from 2000 through 2019, Fayetteville experienced 13 days with reported hail incidents; this averages to 0.65 days per year with reported incidents somewhere in the planning area.

Based on the Vaisala 2019 Annual Lightning Report, North Carolina experienced 3,641,417 documented cloud-to-ground lightning flashes. According to Vaisala's flash density map, shown in **Figure C.14**, Cumberland County is located in an area that experiences 1 to 2 lightning flashes per square kilometer per year. It should be noted that future lightning occurrences may exceed these figures.

Figure C.14 – Lightning Flash Density per County (2019)



Source: Vaisala

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

In a 20-year span between 2000 and 2019, Cumberland County experienced 6 separate tornado incidents over 5 separate days. This correlates to a 25 percent annual probability that the County will experience a tornado somewhere in its boundaries. Two of these past tornado events were a magnitude EF2 or greater; therefore, the annual probability of a significant tornado event is approximately 10 percent.

Based on these historical occurrences, there is between a 10% to 100% chance that Fayetteville will experience severe weather each year. The probability of a damaging impacts is likely.

Probability: 3 – Likely

Vulnerability Assessment

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. Since 2000, NCEI records report one injury attributed to lightning strikes in Fayetteville.

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 2018 American Community Survey (ACS) 5-Year Estimates, 2,971 occupied housing units (3.1 percent) in Fayetteville are classified as "mobile homes or other types of housing." Using the 2018 ACS average persons per household estimate of 2.51, the population at risk due to their housing type was estimated at 7,457 residents within Fayetteville. Individuals who work outdoors may also face increased risk.

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. Therefore, the estimated 7,457 residents mentioned above residing in mobile homes in Fayetteville are also at a greater risk to tornado damage due to their housing type.

Similar to the loss of use estimates provided for Severe Winter Weather, the loss of use estimates for a tornadoes/thunderstorms were estimated as $9,727 per person per day, assuming 10-percent of the on-campus population is impacted.

Table C.40 – Loss of Use Estimates for Power Failure Associated with Tornado/Thunderstorm

On-Campus Population (Fall 2019)	Estimated Affected Population (10%)	Electric Loss of Use Estimate ($126 per person per day)
1436	143.6	$18,093.60

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 Fayetteville, two events with recorded property damage were due to fires caused by lightning strikes.

NCEI records lightning impacts over 20 years (2000-2019), with $255,000 in property damage recorded between two events, both occurring in 2002. Based on these records, the planning area experiences an annualized loss of $12,750 in property damage. The average impact from lightning per incident in Fayetteville is $85,000.

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, 2000 and December 31, 2019 in Fayetteville, NCEI reported $1,025,000 in property damage as a direct result of hail. This damage was from only two storms.

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 Fayetteville, thus the NCEI is still used to form a baseline.

Wind events reported in NCEI for the 20-year period from 2000 through 2019 totaled $135,000 in property damage, which equates to an annualized loss of $6,750 across the planning area.

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.

From 2000 to 2019, damaging tornadoes in and surrounding the City were directly responsible for $100,525,000 worth of damage to property according to NCEI data. This equates to an annualized loss of $5,026,250.

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.

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.

Changes in Development

Future development projects should consider severe thunderstorms hazards and tornado and high wind hazards at the planning, engineering and architectural design stage with the goal of reducing vulnerability. University buildings with high occupancies should consider inclusion of a tornado shelters to accommodate occupants in the event of a tornado. Future development will also affect current stormwater drainage patterns and capacities.

Problem Statement

- The strongest recorded thunderstorm wind event for Fayetteville occurred on July 8, 2015 with a measured gust of 64 mph. The event reportedly resulted in no property damage.
- The average hailstone size recorded between 2000 and 2019 in Fayetteville was a little over 1" in diameter; the largest hailstone recorded was 2.5", recorded on July 1, 2012.
- The most intense tornado to pass near Fayetteville in the past 20 years was an EF3 on April 16, 2011. NCEI reports this event causing around $100,000,000 in property damage.
- Thunderstorms and tornadoes are frequent hazard events in Cumberland County and the FSU campus. Reported damages for the 20-year period from 2000-1019 include $135,000 for thunderstorm winds, $255,000 for lightning strikes, and $100,525,000 for tornado events.

C.5.7 Wildfire

Hazard	Probability	Impact	Spatial Extent	Warning Time	Duration	PRI Score
Wildfire	Possible	Limited	Large	More than 24 hrs	More than 1 week	2.5

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 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 C.41** details the WUI on the FSU campus, and **Figure C.15** below shows the WUI areas. The entire campus is characterized by high housing density WUI. On a county level, Cumberland County is predominately classified as WUI intermix and interface areas and medium to high density housing in the agricultural areas with noted pockets of very low to no housing in Non-WUI vegetated areas.

Table C.41 – Wildland Urban Interface, Population and Acres

	Housing Density	WUI Acres	Percent of WUI Acres
	LT 1hs/40ac	0	0.0%
	1hs/40ac to 1hs/20ac	0	0.0%
	1hs/20ac to 1hs/10ac	0	0.0%
	1hs/10ac to 1hs/5ac	0	0.0%
	1hs/5ac to 1hs/2ac	0	0.0%
	1hs/2ac to 3hs/1ac	73	57.4%
	GT 3hs/1ac	54	42.6%
	Total	**126**	**--**

Source: Southern Wildfire Risk Assessment

Spatial Extent: 4 – Large

Figure C.15 – Wildland Urban Interface Areas, FSU

Extent

The entire state is at risk to a wildfire occurrence. However, several factors such as drought conditions or high levels of fuel on the forest floor may make a wildfire more likely in certain areas. 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, shown in **Table C.42**, consists of five classes, as defined by Southern Wildfire Risk Assessment. **Figure C.16** shows the potential fire intensity within the WUI across Fayetteville State University.

Table C.42 – 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

The majority of the campus (76.3%) is rated non-burnable on the Potential Fire Intensity scale. About 6.8 percent, of FSU's campus may experience a Class 4 or higher Fire Intensity, which poses significant harm or damage to life and property; these small areas with greatest potential fire intensity are within the WUI and in the event of a fire could cause significant damage. An additional 4.5 percent of the campus 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 planning area (12.4%) would face a Class 1 or Class 2 Fire Intensity, which are easily suppressed.

The WUI Risk Index is used to rate the potential impact of a wildfire on people and their homes. It reflects housing density (per acre) consistent with Federal Register National standards. The WUI Risk Index ranges of values from -1 to -9, with -1 representing the least negative impact and -9 representing the most negative impact. **Figure C.17** maps the WUI Risk Index for Fayetteville State University (FSU). The WUI areas within the campus of FSU range from -5 to -8 on the WUI Risk Index.

Impact: 2 – Limited

Figure C.16 – Characteristic Fire Intensity, FSU

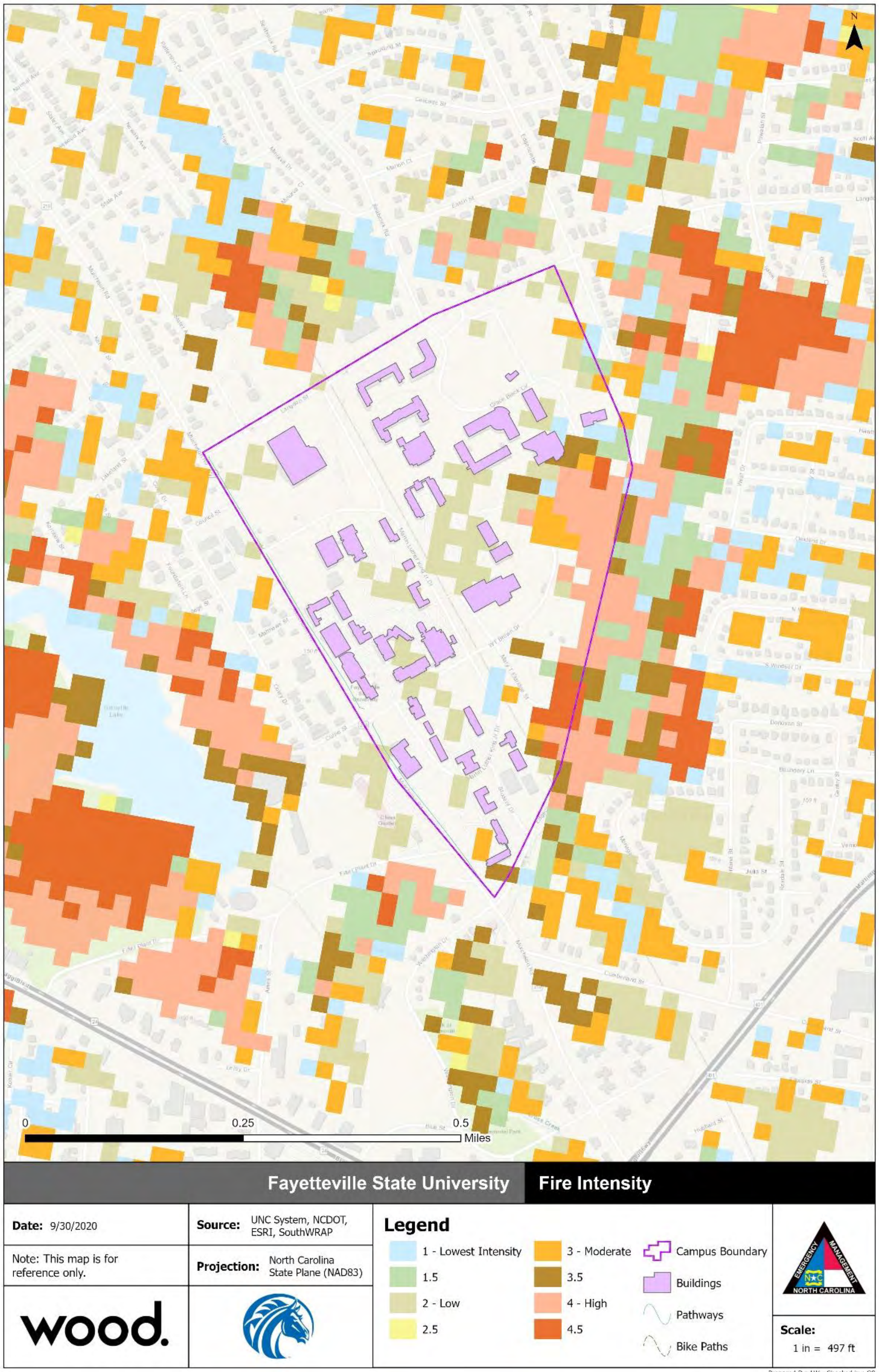
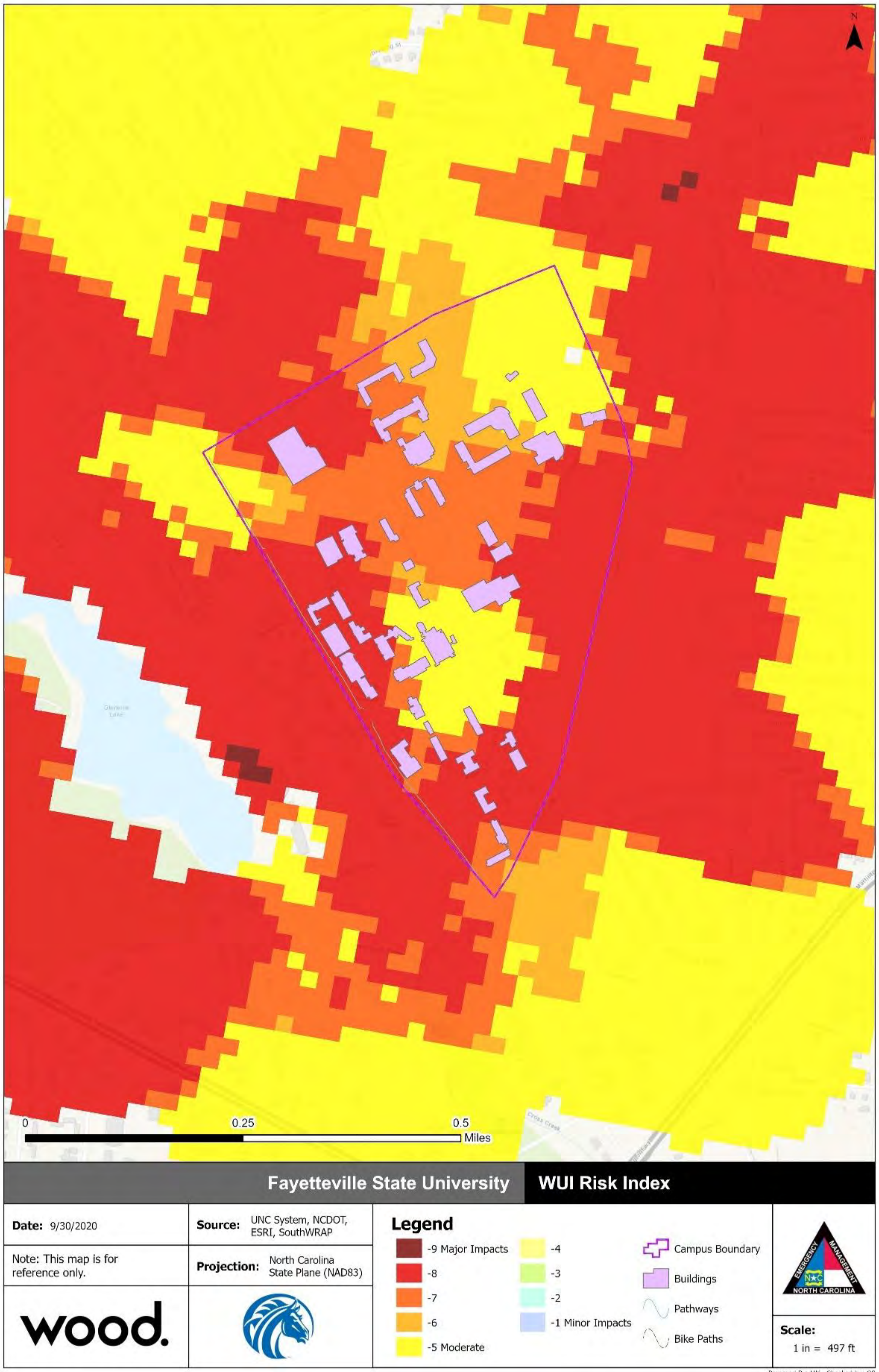


Figure C.17 – WUI Risk Index, FSU



Historical Occurrences

Wildfire data on a county level is no longer publicly available for Cumberland County, but wildfire data for the state is provided by the North Carolina Forest Service and is reported annually from 1970 to 2018. Below in **Figure C.18** is the number of documented wildfires in North Carolina from 1999-2018 including the acreage burned and different causes. Debris burning appears to continue to be the largest cause of fires in the state.

Figure C.18 – North Carolina Wildfires by Cause for 1999-2018

Year	Fires	Acres	Lightning	Camping	Smoking	Debris Burning	Incendaiary	Machine Use	Railroad	Children	MISC.
2018	3,597	10,994	43	29	35	1,601	191	364	22	140	1,172
2017	5,153	20,479	60	40	79	2,413	322	485	36	159	1,559
2016	4,195	77,741	48	65	78	1,566	402	438	18	175	1,405
2015	3,886	10,588	77	32	82	1,671	444	416	4	223	937
2014	4,593	13,327	53	41	90	2,237	706	460	30	210	766
2013	3,374	9,451	20	37	102	1,492	580	344	14	200	583
2012	3,550	11,992	129	46	91	1,221	715	384	36	228	668
2011	5,265	63,547	200	28	216	2,102	1,012	522	40	298	803
2010	4,053	14,703	71	36	166	1,642	801	435	24	268	602
2009	3,291	12,328	56	38	186	1,309	618	283	26	246	528
2008	4,378	49,929	197	36	246	1,565	758	384	58	332	802
2007	7,260	36,850	215	105	503	2,461	1,476	614	98	614	1,174
2006	5,767	23,364	98	60	360	2,414	1,031	489	53	452	810
2005	4,078	14,981	49	47	278	1,697	764	347	45	311	540
2004	4,406	14,221	29	49	255	2,046	693	337	36	335	626
2003	2,041	31,843	10	21	121	864	355	187	15	154	314
2002	5,655	27,678	261	73	369	2,250	975	397	65	501	764
2001	8,240	28,576	82	110	708	3,227	1,593	635	121	749	1,015
2000	5,039	24,660	57	60	358	2,049	956	372	118	443	626
1999	6,341	27,389	110	75	439	2,629	1,195	412	107	598	776

Source: https://www.ncforestservice.gov/fire_control/fc_statisticsCause.htm

With 94,162 wildfires noted within North Carolina between 1999 and 2018, the likelihood of occurrence can be calculated to be 4,708 wildfire events throughout the state per year. With the total acreage burned during this same period as 524,641 acres, the annual average acreage burned can be calculated as 26,232 acres burned per year and the average event can be calculated as 5.6 acres.

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 FSU is presented in **Table C.43** and illustrated in **Figure C.19**.

Table C.43 – Burn Probability, FSU

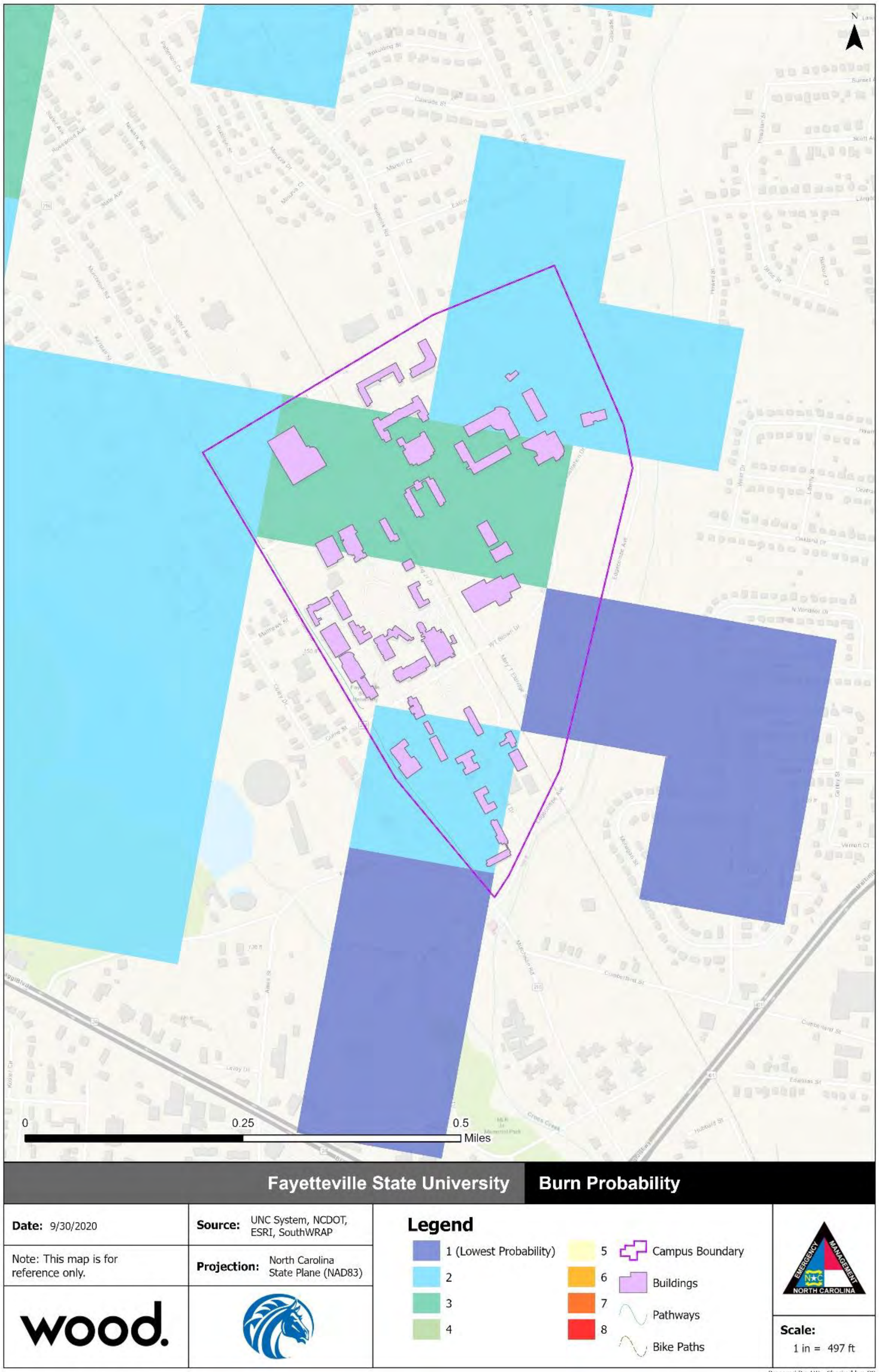
	Class	Acres	Percent
	No probability	*47*	*37.5%*
	1	6	5.1%
	2	37	28.9%
	3	36	28.5%
	4	0	0.0%
	5	0	0.0%
	6	0	0.0%
	7	0	0.0%
	8	0	0.0%
	9	0	0.0%
	10	0	0.0%
	Total	**126**	**--**

Source: Southern Wildfire Risk Assessment

Nearly 58 percent of FSU has a burn probability between 2 and 3. These areas of low to moderate burn probability are located primarily in the northern half of the campus, as well as the southern corner. The probability of wildfire across the campus is therefore considered likely, defined as between a 10% and 100% annual chance of occurrence.

Probability: 2 – Possible

Figure C.19 – Burn Probability, FSU



Vulnerability Assessment

People

Wildfire can cause fatalities and human health hazards. Ensuring procedures are in place for rapid warning and evacuation are essential to reducing vulnerability.

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.

Using the Wildland Urban Interface Risk Index (WUIRI) from the Southern Wildfire Risk Assessment, a GIS analysis was used to estimate the exposure of buildings most at risk to loss due to wildfire. The WUIRI shows a rating of the potential impact of wildfire on homes and people. This index ranges from 0 to -9, where lower values are relatively more severe. **Table C.44** summarizes the number of buildings and their total value that fall within areas rated -5 or less on the WUIRI. This table represents potential risks and counts every building within the area rated under -5, actual damages in the event of a wildfire may differ.

Table C.44 – Building Counts and Values within WUIRI under -5

Jurisdiction	Buildings	Building Value
Administration	7	$7,223,535
Critical Facility	12	$54,391,349
Extracurricular/Educational	15	$27,391,216
Housing	8	$17,321,872
Total	**42**	**$106,327,972**

Source: GIS Analysis, Southern Wildfire Risk Assessment

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.

Changes in Development

Growth on the FSU campus within the wildland-urban interface area will increase the vulnerability of people, property, and infrastructure to wildfires. Currently, there are no community wildfire protection plans and no wildfire mitigation review requirements or regulations for development in the wildland-urban interface in Cumberland County.

Problem Statement

- The entirety of the FSU campus falls within the WUI; 42 buildings are contained within WUIRI areas under -5. This includes 12 critical facilities.

C.5.8 Conclusions on Hazard Risk

Priority Risk Index

As discussed in **Section C.5**, 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 C.45 summarizes the degree of risk assigned to each identified hazard using the PRI method.

Table C.45 – Summary of PRI Results

Hazard	Probability	Impact	Spatial Extent	Warning Time	Duration	PRI Score
Earthquake	Unlikely	Minor	Large	Less than 6 hours	Less than 6 hours	1.9
Flood	Likely	Minor	Small	6 to 12 hrs	Less than 1 week	2.2
Geological – Landslide	Unlikely	Minor	Negligible	6 to 12 hrs	Less than 6 hrs	1.2
Hurricane	Likely	Critical	Large	More than 24 hrs	Less than 24 hrs	2.9
Severe Winter Weather	Highly Likely	Limited	Large	More than 24 hrs	Less than 1 week	3.0
Tornado/Thunderstorm	Likely	Critical	Large	Less than 6 hrs	Less than 6 hrs	3.1
Wildfire	Possible	Limited	Large	More than 24 hrs	More than 1 week	2.5

[1]Note: Severe Weather hazards average to a score of 2.6 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 C.46:**

- **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.
- **Moderate 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 minimal. This is not a priority hazard.

Table C.46 – Summary of Hazard Risk Classification

High Risk (≥ 3.0)	Severe Winter Weather Tornado/Thunderstorms
Moderate Risk (2.0 – 2.9)	Hurricane Flood Wildfire
Low Risk (< 2.0)	Earthquake Landslide

C.6 CAPABILITY ASSESSMENT

This section discusses the mitigation capabilities, including planning, programs, policies and land management tools, typically used to implement hazard mitigation activities. It consists of the following subsections:

- C.6.1 Overview of Capability Assessment
- C.6.2 Planning and Regulatory Capability
- C.6.3 Administrative and Technical Capability
- C.6.4 Fiscal Capability

C.6.1 Overview of Capability Assessment

The purpose of conducting a capability assessment is to determine the ability of the college to implement feasible mitigation actions based on an understanding of the capacity of the departments and staff tasked with their implementation. A capability assessment should also identify opportunities for establishing or enhancing specific mitigation policies or programs. The process of conducting a capability assessment includes developing an inventory of relevant plans, policies, or programs already in place; as well as assessing the college's ability to implement existing and/or new policies. Conclusions drawn from the capability assessment should identify any existing gaps or weaknesses in existing programs and policies as well as positive measures already in place which can and should be supported through future mitigation efforts.

C.6.2 Planning and Regulatory Capability

Planning and regulatory capabilities include plans, ordinances, policies and programs that guide development on campus. **Table C.47** lists these local resources currently in place at FSU.

Table C.47 – Planning and Regulatory Capability

Regulatory Tool (ordinances, codes, plans)	Y/N	Comments
Strategic Plan	Y	FSU Strategic Plan 2020-2025
Zoning code	Y	City of Fayetteville Zoning Ordinance
Growth management ordinance	N	
Floodplain ordinance	Y	City of Fayetteville Flood Ordinance
Building code	Y	NC building codes; the State of North Carolina statutes for state owned buildings; and zoning for local jurisdiction
Erosion or sediment control program	N	
Stormwater management program	N	
Site plan review requirements	N	
Capital improvements plan	Y	FSU Division of Business and Finance
Economic development plan	Y	FSU Annual Report
Local emergency operations plan	Y	Emergency Operations Plan, No date available
Flood Insurance study or other engineering study for streams	Y	January 5, 2007
Elevation certificates	Y	City of Fayetteville

A description of applicable plans, ordinances and programs follows to provide more detail on the relevance of each regulatory tool in examining the capabilities for each community.

Strategic Plan

A Strategic Plan, in broad terms, is a policy statement to guide the future placement and development of campus facilities. The Strategic Plan identifies a future vision, values, principles and goals for the college, determines the projected growth for the college, and identifies policies to plan, direct and accommodate anticipated growth. Strategic planning is conducted by FSU, and the campus recently developed an updated Strategic Plan to guide development for 2020-2025.

Zoning Code

Zoning typically consists of both a zoning map and a written ordinance/code that divides the planning area into zoning districts. The zoning regulations describe what type of land use and specific activities are permitted in each district, and also regulate how buildings, signs, parking, and other construction may be placed on a parcel. The zoning regulations also provide procedures for rezoning and other planning applications.

Flood Insurance Study/Floodplain Ordinance

A Flood Insurance Study (FIS) provides information on the existence and severity of flood hazards within a community based on the 100-year flood event. The FIS also includes revised digital Flood Insurance Rate Maps (FIRMs) which reflect updated Special Flood Hazard Areas (SFHAs) and flood zones for the community. FIRMs are developed and provided by FEMA.

A floodplain ordinance is perhaps the most important flood mitigation tool. 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 will be protected from damage by a 100-year flood event and that new development in the floodplain will not exacerbate existing flood problems or increase damage to other properties. Floodplain management is handled by the local municipality, the City of Fayetteville.

Stormwater Management Program

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. A Stormwater Management Program can prevent flooding problems caused by stormwater runoff by 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) Setting construction standards so buildings are protected from shallow water. A stormwater ordinance provides regulatory authority to implement stormwater management standards.

Erosion and Sediment Control Program

Surface water runoff can erode soil from development sites, sending sediment into downstream waterways. This can clog storm drains, drain tiles, culverts and ditches and reduce the water transport and storage capacity of channels. The purpose of an erosion, sedimentation and pollution control ordinance is to minimize soil erosion and prevent off-site sedimentation by using soil erosion and sediment control practices designed in accordance with certain standards and specifications.

Site Plan Review

The purpose of the Site Plan Review Process is to review site plans for specific types of development to ensure compliance with all appropriate land development regulations and consistency with the General Plan.

Building Code

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).

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. An Elevation Certificate serves as the official record that shows new buildings and substantial improvements in all identified SFHAs are properly elevated. This elevation information is needed to show compliance with the floodplain ordinance.

Capital Improvement Plan

A Capital Improvement Plan (CIP) is a planning document that typically provides a five-year outlook for anticipated capital projects designed to facilitate decision makers in the replacement of capital assets. The projects are primarily related to improvement in public service, parks and recreation, public utilities and facilities. The mitigation strategy may include structural projects that could potentially be included in a CIP and funded through a Capital Improvement Program.

Emergency Operations Plan

An emergency operations plan outlines responsibilities and the means by which resources are deployed during and following an emergency or disaster. FSU has an Emergency Warning and Communications Plan as well as a Safety Manual.

C.6.3 Administrative and Technical Capability

Administrative and technical capability refers to the college's staff and their skills and tools that can be used for mitigation planning and to implement specific mitigation actions. It also refers to the ability to access and coordinate these resources effectively. The personnel should be considered as well as the level of knowledge and technical expertise of these resources. Resources include engineers, planners, emergency managers, GIS analysts, building inspectors, grant writers, floodplain managers, and more. **Table C.48** provides a summary of the administrative and technical capabilities for FSU.

Table C.48 – Administrative and Technical Capability

Personnel Resources	Yes/No	Department/Position
Planner/Engineer with knowledge of land development/land management practices	Yes	Facilities Management
Engineer/Professional trained in construction practices related to buildings and/or infrastructure	Yes	Facilities Management
Planner/Engineer/Scientist with an understanding of natural hazards	Yes	Office of Emergency Management
Personnel skilled in GIS	Yes	Facilities Management
Full time building official	Yes	City of Fayetteville
Floodplain Manager	Yes	City of Fayetteville
Emergency Manager	Yes	Office of Emergency Management
Grant Writer	No	

Personnel Resources	Yes/No	Department/Position
Public Information Officer	Yes	Office of Emergency Management Communications
Student Engagement	Yes	Division of Student Affairs
Warning Systems	Yes	Office of Emergency Management Campus Safety

Additional support services and resources detailed in the 2010 plan that may provide administrative capability include the following:

Environmental Health and Safety, and HAZMAT

The Office of Environmental Health and Safety provide services in cases of emergency situations, emergency response, hurricane instructions, winter weather, and railroad safety. The Office also prepares and provides a campus Safety Manual, which could be used for hazard education and awareness purposes.

Facilities and Housekeeping Services

The Division of Facilities Management oversees designing, constructing, maintaining, and operating the physical facilities of FSU. Among the services that they provide are electrical, housekeeping, HVAC and plumbing, motor pool, planning and construction, roads and grounds and structural maintenance. This group could be tasked with tracking mitigation needs of individual facilities in order to improve property protection against hazards on campus.

Volunteer Services

Under the Career Services Center, the Volunteer Services Program promotes civic responsibility by encouraging student involvement in meaningful and reciprocal service to the community. The Volunteer Services Program has three primary goals: a) Increase student volunteerism at Fayetteville State University; b) Connect students with volunteer opportunities that align with their professional and personal goals and c) Maintain a growing database of volunteer opportunities in the Fayetteville/Cumberland county area. The Volunteer Services Program serves as a liaison between local agencies and Fayetteville State University students. This group could serve to support mitigation project implementation.

C.6.4 Fiscal Capability

Financial capabilities are the resources that an entity has access to or is eligible to use to fund mitigation actions. The costs associated with implementing mitigation activities vary. Some mitigation actions such as building assessment or outreach efforts require little to no costs other than staff time and existing operating budgets. Other actions, such as structural projects, could require a substantial monetary commitment from local, State, and Federal funding sources. **Table C.49** provides a summary of the fiscal resources at FSU.

Table C.49 – Fiscal Resources

Resource	Ability to Use for Mitigation Projects? Y/N
Community Development Block Grants	N
Capital improvements project funding	Y
In-Kind Services	Y
Tuition & Fees	Y
Federal funding with HMA grants	Y
Revenue Bonds	Y

Resource	Ability to Use for Mitigation Projects? Y/N
State Appropriations	Y
Sales & Services	Y
Other Sources (Gifts, Investment Income, Permanent Endowments)	Y

C.7 MITIGATION STRATEGY

C.7.1 Implementation Progress

Progress on the mitigation strategy developed in the previous plan is also documented in this plan update. **Table C.50** details the status of mitigation actions from the previous plan. **Table C.51** on the following pages details all completed and deleted actions from the 2010 plan. More detail on the actions being carried forward is provided in the Mitigation Action Plan.

Table C.50 – Status of Previous Mitigation Actions

Campus	Completed	Deleted	Carried Forward and/or Combined
FSU	22	7	34

Table C.51 – Completed and Deleted Actions from the FSU 2010 Plan

Vulnerability	Action	2020 Status	2020 Implementation Status Comments
C.J. Barber Admin: Some trees on site overhang the roof and deposit leaves and twigs which can clog roof drains. Roof drains have debris collecting around drain cages.	Trees overhanging the roof should be pruned away from the roof or removed. An inspection schedule of roof systems (including drains) should be implemented promptly to proactively address roof drainage issues across campus.	Completed	Tree removed
Capel Arena: The roof drains had debris buildup around the cages. Additionally, some roof scuppers appeared to be too high to act as a redundant source of roof drainage.	A roof maintenance/inspection schedule should be implemented to ensure proper operation of roof drainage systems across campus. The roof scuppers on Capel should be lowered such that water can drain from scuppers without significant ponding.	Completed	Roof replaced
Capel Arena: The roof drains had debris buildup around the cages. Additionally, some roof scuppers appeared to be too high to act as a redundant source of roof drainage.	The cooling tower should be replaced.	Completed	Cooling tower replaced
Capel Arena: Many utility systems are not properly anchored to their foundations, including: cooling tower, generator, and chiller. The cooling tower on the roof needs immediate maintenance.	All utility systems on site and in the facility should be properly anchored to their foundation in accordance with building code requirements.	Completed	All systems checked/ replaced as needed
Capel Arena: There is heavy corrosion in areas storing chemicals for the pool.	All chemicals should be properly stored in a location not as prone to corrosion damage.	Completed	Chemicals removed
Chesnutt Library: The EOC and telecommunication systems are not on back-up power. The facility does not have any equipment or personnel available to quickly set up a phone bank for the EOC.	The EOC and its telecommunication systems should be placed on backup power. The supporting telecom switch in Seabrook should also be provided with emergency power.	Completed	Telecom added to generator
Chesnutt Library: There has been a long history of water infiltration through the roof.	The cause of roof leakage should be identified and remedied to contain mold/fungal growth.	Completed	Roof replaced
Chesnutt Library: Many utility systems on site and in the building are not anchored to their foundations.	All utility systems on site and in the facility should be properly anchored to their foundations in accordance with building code requirements.	Completed	Checked and repaired as needed
G.L. Butler: The south basement mechanical room is prone to flooding, which has damaged electrical components in the past. The current sump pump is considerably undersized.	Larger drainage should be placed in the pit leading into the basement mechanical room on the south side of the building. A larger sump pump, on generator power, should be installed.	Completed	Flood mitigation measures taken

Vulnerability	Action	2020 Status	2020 Implementation Status Comments
G.L. Butler: The network topology on campus is hierarchical which can cause significant disruptions if a facility in an upper hierarchy loses connectivity.	Enhance redundant network paths to provide greater network redundancy. This will be even more critical as the telephone system is transitioned to voice over IP.	Completed	Enhanced network redundancy
G.L. Butler: There are areas of concrete deterioration and rebar corrosion on exterior walkways.	The damaged concrete on walkways should be removed; the corroded reinforcing steel cleaned and coated, and a protective epoxy mortar installed to prevent further deterioration. Ensure the walkways and stairs have appropriate drainage paths to prevent further environmental deterioration.	Completed	Some improvements have been completed
Lilly Gym: A recent flood closed one of the stairwells in the new addition. According to facility personnel, the flood occurred about a year before the inspection; subsequent repairs were made and flooding has not recurred, however a small water pump remains on the floor.	The stairwell should be reopened immediately since there is only one other stairwell available for evacuations. Verify repairs have mitigated future flooding.	Completed	Stairwells are reopened
Lilly Gym: There was loose metal debris on roof at the time of the inspection.	All loose metal debris on roof should be removed immediately to prevent it from becoming airborne in a windstorm and damaging other buildings or harming people nearby.	Completed	Roof replaced
Lilly Gym: The original wing is rapidly falling into disrepair, mostly from water penetration of the façade and a lack of climate control; it is likely to detract from the ability of the university to maintain the newly renovated wing.	The original wing should be renovated or demolished. Deterioration of this original wing will eventually contribute to problems in newly renovated areas.	Completed	Phased renovation
Lilly Gym: Some roof drains were clogged and had standing water around them.	Roof drains should be cleaned and regularly inspected/serviced to prevent clogging.	Completed	Roof replaced during renovation
Lyons Science Annex: Many utility systems are not properly anchored to their foundation. Included are: chiller, cooling tower, boiler, and heat pumps.	All utilities should be properly anchored to their foundation in accordance with building code requirements.	Completed	Checked and repaired
Lyons Science Annex: Roof drains were holding standing water after an extended period without rain.	Clogged drains should be cleared of debris. The drains should be inspected regularly.	Completed	Envelope renovation project completed
Lyons Science Building - There are numerous façade panel joints with deteriorating caulking.	The caulk joints between the precast panels should be replaced. Water intrusion through the joints supports mold and fungal growth.	Completed	Envelope Renovation Project Completed
Mitchell Building: The facility does not have fire suppression, detection, or alarm systems.	The facility should be outfitted with smoke detectors and fire extinguishers at a minimum.	Completed	Checked and repaired

Vulnerability	Action	2020 Status	2020 Implementation Status Comments
Rudolph Jones Student Center: Several roof drains are surrounded by debris and are not able to properly drain.	Roof drains should be cleaned and an inspection/maintenance schedule should be adopted.	Completed	
Rudolph Jones Student Center: During the inspection, some roof shingles and coping were either missing or damaged.	All missing roof shingles and damaged coping should be replaced as soon as possible.	Completed	Roof repaired
SBE: Several roof drains had debris collecting around drain cages.	A campus-wide roof inspection schedule should be implemented to monitor roof condition and maintenance and clear debris from roof drains as necessary.	Completed	Roof repaired
G.L. Butler Building - The generator is not adequately protected from potential vehicle impacts.	The generator should be properly protected by bollards to prevent accidental vehicle impacts.	Deleted	This property protection measure addresses hazards outside of this plan.
Mitchell Building - The natural gas line and ATS are exposed to vehicle impacts.	Bollards should be installed by the gas line and ATS to prevent potential vehicle impacts.	Deleted	This property protection measure addresses hazards outside of this plan.
Rudolph Jones Student Center - There is a retaining wall at the southernmost corner of the facility where the brick veneer is separating from the wall. The generator power lines are mounted on the brick and are also exposed to vehicle impacts at some points along the wall	The retaining wall should be inspected by an engineer and the cause of the brick/wall separation should be remedied at once. The emergency generator power delivery lines are connected to the wall and must be protected. Additionally, bollards should be placed to protect generator power lines. Verify that the generator will fully power the kitchen.	Deleted	This property protection measure addresses hazards outside of this plan.
School of Business and Economics (SBE) - The brick façade on the southeast facing side of the courtyard is sliding off shelf-angle supports at the third floor level.	The cause of brick façade movement should be determined and corrected immediately. The façade should be thoroughly inspected to ensure there are not other areas experiencing similar failures.	Deleted	This property protection measure addresses hazards outside of this plan.
School of Business and Economics (SBE) - There is a network hub too close to an electrical panel in a 3rd floor utility closet.	The network cable rack should be relocated to provide code-required clearances around electrical panels.	Deleted	This property protection measure addresses hazards outside of this plan.
School of Business and Economics (SBE) - Operable windows in computer labs could be accidentally left open during storms.	Consideration should be given to placing locks on operable windows in computer labs to prevent water damage during a storm from windows being accidentally left open.	Deleted	This property protection measure addresses hazards outside of this plan.

Vulnerability	Action	2020 Status	2020 Implementation Status Comments
William R. Collins Administration Building - The covered walkway connecting Collins and Barber has some longitudinal cracks in reinforced concrete.	Deteriorating concrete on the walkway connecting Collins and Barber should be repaired before damage becomes worse.	Deleted	This property protection measure addresses hazards outside of this plan.

C.7.2 Mitigation Action Plan

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.

The following table comprises the mitigation action plan for FSU. Each mitigation action recommended for implementation is listed in these tables along with detail on the hazards addressed, the goal and objective addressed, the priority rating, the lead agency responsible for implementation, potential funding sources for the action, a projected implementation timeline, and the 2020 status and progress toward implementation for actions that were carried forward from the 2010 plan.

Table C.52 – Mitigation Action Plan, FSU

Action #	Action Description	Hazard(s) Addressed	Goal & Objective Addressed	Priority	Mitigation Category	Lead Agency / Department	Estimated Cost	Potential Funding Source	Implementation Timeline	2020 Status	2020 Implementation Status Comments
FSU1	Campus-Wide – Major mechanical systems (HVAC equipment, heat pumps, chillers, generators, fuel tanks, gas cylinders, transformers and boilers) should be anchored to their foundations. This includes, but is not limited to, the following campus buildings: Bronco Hall; C.J. Barber Administration Building; G.L. Butler Building; Lilly Gym; Lyons Science Building; Mitchell Building; Rudolph Jones Student Center; School of Business and Economics (SBE); and William R. Collins Administration Building.	All Hazards	1.1	H	Property Protection	Facilities Department	$5,000 - $25,000 per site	Operating Budget, State/Federal Grants	2021-2026	Carry Forward	No progress was made on this action.
FSU2	Campus-Wide – Upgrade back-up power capabilities to critical facilities including, but not limited to: Bronco Hall; C.J. Barber Administration Building; Capel Arena; Lilly Gym; Lyons Science Building; Lyons Science Annex; and Mitchell Building.	All Hazards	2.2	M	Emergency Services/Property Protection	Facilities Department	$5,000-$100,000 per site	Operating Budget, State/Federal Grants	2021-2026	Carry Forward	No progress was made on this action.
FSU3	Campus-Wide – Upgrade fire suppression systems at campus facilities including: C.J. Barber Administration Building; Chesnutt Library; G.L. Butler Building; Lyons Science Building; and William R. Collins Administration Building.	Human-caused hazard	1.1	M	Property Protection	Facilities Department	$25,000-$100,000 per site	Operating Budget, State/Federal Grants	2021-2026	Carry Forward	No progress was made on this action.
FSU4	Bronco Hall - Several member-to-member connections in the steel-framed penthouse do not appear to be constructed in accordance with standard practice. Certain welds do not appear to have sufficient penetration and/or length. Welds in the penthouse should be inspected by a Certified Weld Inspector and repairs made in accordance with his recommendations.	Hurricane, Tornado/ Thunderstorm	1.1	L	Structural Projects	Facilities Department	$5,000-$25,000	Operating Budget	2021-2026	Carry Forward	No progress was made on this action.
FSU5	Bronco Hall - Some of the large trees on site are near the potable water back-flow preventer off Langdon St. Consideration should be given to removing trees near the potable water backflow preventer. If trees are to remain, they should be periodically evaluated and pruned by an arborist.	Severe Winter Weather	1.2	L	Property Protection	Facilities Department	<$5,000	Operating Budget	2021-2026	Carry Forward	No progress was made on this action.
FSU6	Capel Arena - The campus' lone connection to power comes via overhead lines and runs to a switchgear that is exposed to vehicle impacts and train derailment. Redundant connection(s) should be made to the PWC power grid, preferably underground. The switchgear and poles should be better protected from vehicle impacts (possibly a guardrail).	All Hazards	1.2	M	Property Protection	Facilities Department	$25,000-$100,000	State/Federal Grants	2021-2026	Carry Forward	No progress was made on this action.
FSU7	Chesnutt Library - The archives/rare books collection has no means of providing environmental control in the event of a power outage. Personnel reported trouble maintaining environmental control under normal conditions. Mold and fungal growth will occur if environmental conditions are not properly and constantly maintained. The existing emergency generator is too small to power HVAC equipment. A stand-alone cooling system, on back-up power, should be installed in the archives/rare books collection, providing HVAC redundancy in the event the main system or power goes down.	All Hazards	1.1	H	Property Protection	Facilities Department	>$100,000	State/Federal Grants	2021-2026	Carry Forward	No progress was made on this action.

Action #	Action Description	Hazard(s) Addressed	Goal & Objective Addressed	Priority	Mitigation Category	Lead Agency / Department	Estimated Cost	Potential Funding Source	Implementation Timeline	2020 Status	2020 Implementation Status Comments
FSU8	Chesnutt Library - The seals around windows and skylights in the rare books collection are frequently reported to leak. This could lead to water damage and mold/fungal growth. The skylights also permit UV rays to deteriorate exposed artifacts. The skylights in the rare books area should be removed and properly sealed. The seals around windows should be repaired and a film to provide UV protection should be added to windows.	Severe Winter Weather, Flood, Hurricane	1.1	M	Property Protection	Facilities Department	$5,000-$25,000	Operating Budget	2021-2026	Carry Forward	No progress was made on this action.
FSU9	G.L. Butler Building - The server room lacks under-floor water detection. The server room should have under-floor water detection equipment. There should also be proper signage warning occupants of the suffocation risk in the event the FM-200 is released.	Flood	1.1	H	Property Protection	Facilities Department	$5,000-$25,000	State/Federal Grants	2021-2026	Carry Forward	No progress was made on this action.
FSU10	Lyons Science Annex - There was a significant amount of debris left on the roof which could become airborne during a high wind event and damage surrounding facilities or harm people outside. All debris should be cleared off the roof to prevent debris from becoming airborne during a high wind event.	Hurricane, Tornado/ Thunderstorm	1.1	L	Property Protection	Facilities Department	<$5,000	Operating Budget	2021-2026	Carry Forward	No progress was made on this action.
FSU11	Mitchell Building - If the fiber connection to Lyons is severed, Mitchell will be isolated from the campus in terms of data and communications. An additional fiber path should be laid to another telecom switch to add redundancy to the fiber network Mitchell depends on for telephone and data services.	All Hazards	1.2	M	Structural Projects	Facilities Department	$5,000-$25,000	State/Federal Grants	2021-2026	Carry Forward	No progress was made on this action.
FSU12	Mitchell Building - Exterior windows are unreinforced, while many interior windows are bullet-resistant. The exterior window in the dispatch center (and possibly other offices) should retrofitted with impact resistant film to mitigate potential damage from windborne debris.	Tornado/ Thunderstorm, Hurricane	1.1	L	Structural Projects	Facilities Department	<$5,000	Operating Budget	2021-2026	Carry Forward	No progress was made on this action.
FSU13	Rudolph Jones Student Center - A concrete arch on the roof is experiencing rebar corrosion and deterioration. The arch on the roof sits over skylights and should be repaired immediately.	Tornado/ Thunderstorm, Hurricane	1.1	H	Property Protection	Facilities Department	<$5,000	Operating Budget	2021-2026	Carry Forward	No progress was made on this action.
FSU14	William R. Collins Administration Building - The single ply roof is in poor condition and has several patches that are becoming debonded. Collins should be re-roofed to provide increased resistance to wind and driving rain.	Tornado/ Thunderstorm, Hurricane	1.1	L	Property Protection	Facilities Department	$25,000-$100,000	Operating Budget, State/Federal Grants	2021-2026	Carry Forward	No progress was made on this action.
FSU15	William R. Collins Administration Building - Roof drain covers were coated with a layer of debris, indicating a lack of an adequate roof drain inspection/maintenance schedule. A campus-wide roof/roof drain inspection schedule should be implemented to ensure proper function and maintenance of roof and roof drains.	Flood	1.2	M	Property Protection	Facilities Department	<$5,000	Operating Budget	2021-2026	Carry Forward	No progress was made on this action.
FSU16	Bryant Hall is in a floodplain and borders Murchison Road and Edgecombe Avenue Extension. The building should be closed or flood protection should be put in place.	Flood	1.1	H	Property Protection	Facilities Department, Emergency Management	To be determined	Operating Budget, State/Federal Grants	2021	New	The building has been taken offline, and no students or activities are held in the building.
FSU17	Flood warning signs should be posted in Cross Creek tributary, which is in the floodplain at Fayetteville State University, the retention pools near Mary Eldridge Drive and Edgecombe Extension, as well as behind the University Place Apartments on Coley Drive.	Flood	2.1	H	Public Education & Awareness	Emergency Management	<$5,000	Operating Budget	2021	New	In progress

THE UNIVERSITY OF NORTH CAROLINA SYSTEM

UNC System Eastern Campuses Regional Hazard Mitigation Plan

Annex D: North Carolina Central University

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Annex D North Carolina Central University

This section provides planning process, campus profile, hazard risk, vulnerability, capability, and mitigation action information specific to North Carolina Central University (NCCU). This section contains the following subsections:

- D.1 Planning Process Details
- D.2 Campus Profile
- D.3 Asset Inventory
- D.4 Hazard Identification
- D.5 Hazard Profiles, Analysis, and Vulnerability
- D.6 Capability Assessment
- D.7 Mitigation Strategy

D.1 PLANNING PROCESS DETAILS

The table below lists the HMPC members who represented NCCU during the planning process.

Table D.1 – HMPC Members

Representative	Role; Department
Thomas Verrault	Emergency Management Coordinator; Environment and Occupational Health & Safety
Joel Faison	Director of Infrastructure & Information Security; Information Technology Services
Ayana Hernandez	Associate Vice Chancellor; Office of Communications & Marketing
Dr. Undi Hoffler	Director, Research Compliance and Technology Transfer; Division of Research & Sponsored Programs
Ondin Mihalcescu	Director of Design, Planning, and Construction; Capital Projects Management
Timothy Williams	Architectural Project Manager; Capital Projects Management
Lori Blake-Reid	Director of Facilities Services; Facilities Operations
Chuck Batten	Construction Engineer; Facilities Operations
Kelly White	Chief of Police; Campus Police
Dr. Kristin Long	Director of Environmental Health & Safety; Environmental and Occupational Health and Safety
Atty. Fenita Morris-Shepard	General Counsel; Legal Affairs
Akua Matherson	Interim CFO & Vice Chancellor; Administration and Finance
Michael Hill	Chief Human Resources Officer; Human Resources

Coordination with Other Community Planning Efforts and Hazard Mitigation Activities

The table below lists campus and community resources referenced throughout the planning process and used in the plan development.

Table D.2 – Summary of Existing Studies and Plans Reviewed

Resource Referenced	Use in this Plan
NCCU Campus Master Plan	The NCCU Campus Master Plan, developed in 2007 and updated in 2017, was referenced for the Campus Profile in Section D.2 as well as the Capability Assessment in Section D.6
City of Durham/ Durham County Comprehensive Plan	The Comprehensive Plan, developed jointly by the City of Durham and Durham County, was referenced for the Campus Profile in Section D.2.

Resource Referenced	Use in this Plan
Durham County and Incorporated Areas Flood Insurance Study (FIS), Revised 12/6/2019	The FIS report was referenced in the preparation of flood hazard profile in Section D.5.
NCCU Pre-Disaster Mitigation Plan, 2010	The previous NCCU Pre-Disaster Mitigation Plan was used in preparation of the hazard profiles in Section D.5. The plan was additionally used to track implementation progress and develop the mitigation plan (Section D.7).
Eno-Haw Regional Hazard Mitigation Plan, 2020	The Eno-Haw Regional Hazard Mitigation Plan, which includes Durham, was referenced in compiling the Hazard Identification and Risk Assessment in Section D.5.

D.2 CAMPUS PROFILE

This section provides a general overview of the North Carolina Central University (NCCU) campus and area of concern to be addressed in this plan. It consists of the following subsections:

- Location and Setting
- Geography and Climate
- History
- Cultural and Natural Resources
- Land Use
- Population and Demographics
- Social Vulnerability
- Growth and Development Trends

D.2.1 Location and Setting

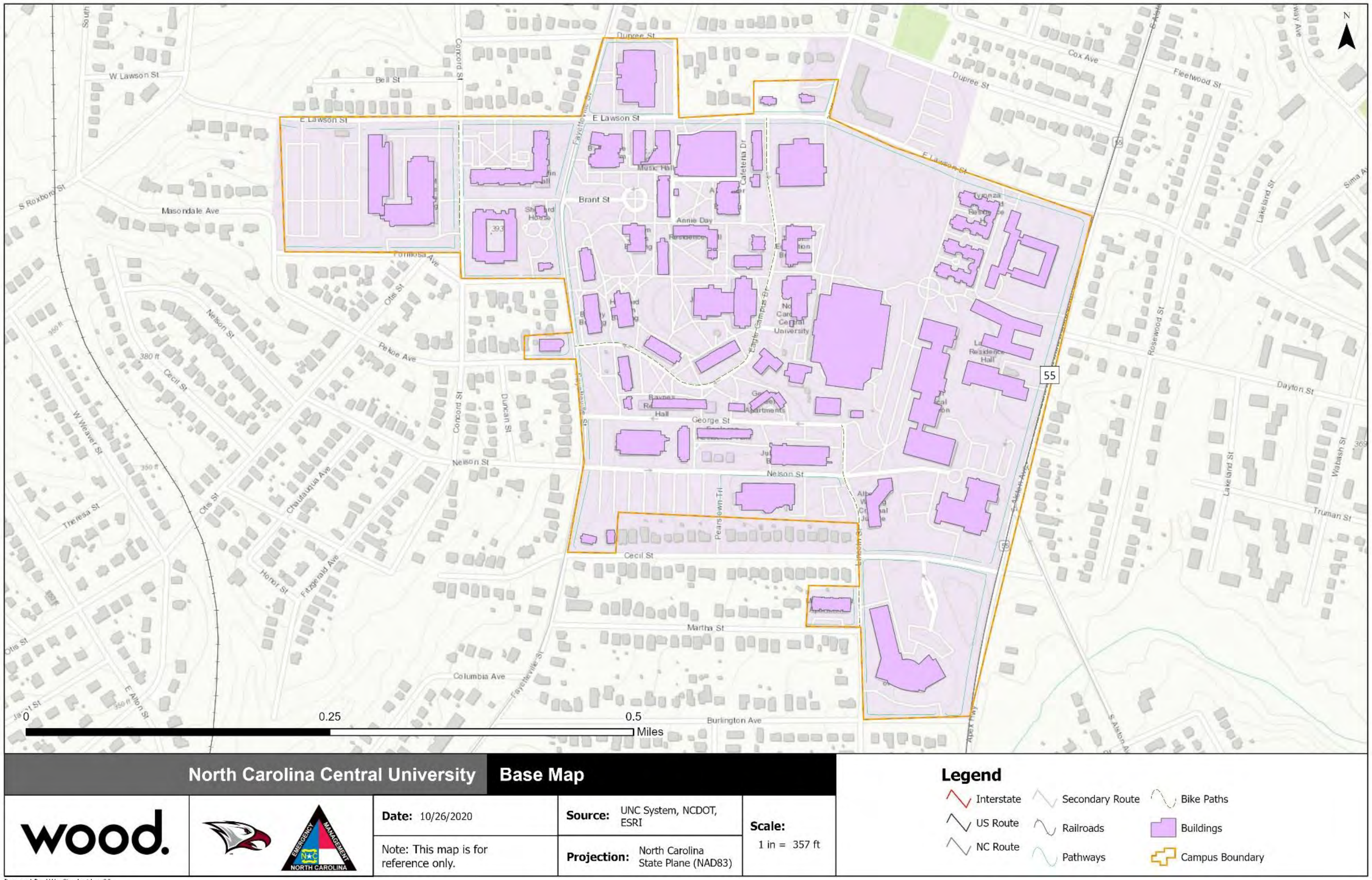
North Carolina Central University is located south of downtown Durham near the Hayti District. The University is situated on 135 acres and consists of 64 buildings. A wide variety of cultural and educational resources are accessible to NCCU students, and 135 Student Clubs are available on campus. Musical organizations and activities in the area include blues, jazz, and gospel festivals, community bands, symphony orchestras and choral societies. Museums dedicated to art, the sciences, history and other topics are in the region, as are theaters performing both classical and contemporary drama. Located in the Research Triangle, the University advances research in the biotechnological, biomedical, informational, computational, behavioral, social, and health sciences.

Durham is the primary beneficiary of North Carolina Central University's innovative Community Services Program, which ensures that NCCU students have experience with voluntary public service. NCCU students serve as tutors in local schools, help build Habitat for Humanity housing, assist with a variety of youth programs, promote the causes of nonprofit service agencies, and volunteer in a variety of other endeavors as they meet the university's standard of 15 hours of community service per semester.

United States Highways 501, 147, and 55 make the University easily accessible by automobile. The City of Durham is on two Interstate highways, I-40 and I-85, and is served by Raleigh-Durham International Airport. Durham is also home to Duke University.

Figure D.1 provides a base map of the NCCU campus. For more details on campus buildings and critical facilities, see Section D.3

Figure D.1 – NCCU Campus Base Map



D.2.2 Geography and Climate

North Carolina Central University is in Durham, in the eastern part of North Carolina's Piedmont region. NCCU's campus is largely flat with a few rolling hills, which reflects the topography of the Piedmont region. In addition, the central location of Durham provides driving access to both the coastal region in the east and to the mountains in the west. Durham has a mild climate with temperatures dropping to 29 degrees Fahrenheit on average in January and climbing to 89 degrees Fahrenheit in July on average. The annual precipitation for the city is approximately 44 inches per year.

D.2.3 History

North Carolina Central University, a state-supported liberal arts institution, was chartered in 1909 as a private institution and opened to students on July 5, 1910. It was founded by Dr. James E. Shepard. From the beginning, when it was known as the National Religious Training School and Chautauqua for the Colored Race, its purpose has been the development in young men and women of the character and sound academic training requisite for real service to the nation. To this end, the training of all students has been entrusted to the most capable teachers available.

The institution's early years were characterized by a wealth of enthusiasm and high endeavor, but not of money. Private donations and student fees constituted the total financial support of the school, and the heavy burden of collecting funds rested on the President.

In 1915 the school was sold and reorganized, then becoming the National Training School. During this period, Mrs. Russell Sage of New York was a generous benefactor of the school. In 1923 the North Carolina legislature appropriated funds for the purchase and maintenance of the school. That was the beginning of its state support, and the institution was renamed the Durham State Normal School. Two years later, the legislature converted the institution into the North Carolina College for Negroes, dedicating it to the offering of liberal arts education and the preparation of teachers and principals of secondary schools. North Carolina College for Negroes became the nation's first state-supported liberal arts college for African-American students.

At its 1927 session, the legislature authorized money for a physical expansion of the college plant to meet the needs of an enlarged academic program. The interest of Gov. Angus W. McLean and his belief in the institution aided greatly in the promotion of this program. State appropriations were supplemented by a generous gift from Benjamin N. Duke, a member of the Durham tobacco family, and by contributions from citizens of Durham in 1929. In the 1930s, federal grants and state appropriations financed further expansion and improvement of educational facilities.

The College was accredited by the Southern Association of Colleges and Secondary Schools as an "A" class institution in 1937 and was admitted to membership in that association in 1957. In 1939, the legislature authorized the establishment of graduate work in liberal arts and the professions. The first graduate courses in the Arts and Sciences were offered in that same year; the School of Law began operation in 1940, and the School of Library Science was established in 1941.

In 1947 the General Assembly changed the name of the institution to North Carolina College at Durham. On October 6, 1947, Dr. Shepard, the founder and president of the college, died. The Board of Trustees appointed an interim committee consisting of Dr. Albert E. Manley, Dean of the College of Arts and Sciences; Ruth G. Rush, Dean of Women, and Dr. Albert L. Turner, Dean of the School of Law, to direct the affairs of the college until the election of the second president. On January 20, 1948, Dr. Alfonso Elder was elected president of North Carolina College. At the time, he was serving as head of the Graduate Department of Education and had formerly been Dean of the College of Arts and Sciences. Dr. Elder retired Sept. 1, 1963.

Dr. Samuel P. Massie was elected as the third president on August 9, 1963. Dr. Massie came to the institution from Washington, where he was Associate Program Director for Undergraduate Science Education of the National Science Foundation and Professor and Chairman of the Department of Pharmaceutical Chemistry at Howard University. He resigned in February 1966 to accept an appointment as a chemistry professor at the U.S. Naval Academy.

The administration of the college was then assumed by a second interim committee, whose members were William Jones, business manager; Dr. Helen G. Edmonds, graduate dean; and Dr. William H. Brown, professor of education. The committee served until July 1, 1967, when Dr. Albert N. Whiting assumed his duties as president. Whiting served as president at first, then assumed the title of chancellor when the institution was brought into the University of North Carolina system in 1972. He retired on June 30, 1983.

Under Whiting's leadership, North Carolina College at Durham became North Carolina Central University in 1969. Among the significant developments during his 16 years of service was the creation of the NCCU School of Business. Programs in public administration and criminal justice were also launched during those years. On July 1, 1972, all the state's public four-year colleges and universities were joined to become the Consolidated University of North Carolina. The reconstituted UNC, with 16 individual campuses, was headed by a single president and governed by the University of North Carolina Board of Governors.

Whiting was succeeded by Dr. LeRoy T. Walker in the role of interim chancellor. Walker had served the institution as chairman of the Department of Physical Education and Recreation, head track coach, and vice chancellor for university relations. He had served as the United States' head track and field coach at the 1976 Olympic games, and was a key administrator in the early years of the U.S. Peace Corps. At their February 1986 meeting, the University of North Carolina Board of Governors, at the request of NCCU's Board of Trustees, retroactively awarded Walker the title of chancellor, effective as of the beginning of his term in 1983.

Dr. Tyronza R. Richmond, formerly dean of the School of Business, succeeded Walker as chancellor on July 1, 1986. Before his arrival at NCCU, Richmond served as associate dean and professor at the School of Business and Public Administration at Howard University. Richmond's tenure saw the creation of the School of Education (formerly the Department of Education) and a reorganization of the academic administrative structure. Richmond resigned as chancellor to return to the classroom and was succeeded on Jan. 1, 1992, by Dr. Donna J. Benson, who served as interim chancellor for one year.

Benson was succeeded in January 1993, by Julius L. Chambers, who had been director-counsel (chief executive) of the NAACP Legal Defense and Educational Fund. Chambers, a distinguished civil rights attorney, was the first NCCU alumnus to serve as chief administrator, having received his bachelor's degree in history from North Carolina College at Durham in 1958. Chambers launched a major capital construction effort including an additional residence facility on the site of the existing Chidley Hall, a biomedical/biotechnology research facility, a new School of Education building as well as substantial renovations to all student residence halls and most classroom facilities. James H. Ammons became chancellor June 1, 2001. Under his leadership, the university experienced significant enrollment growth, making NCCU the fastest growing of the 16 UNC campuses.

Charlie Nelms, was the chancellor from 2007 to 2013, where he was then followed by Debra Saunders-White. Dr. Saunders-White was the first woman to hold the office as a permanent position. In 2016, Dr. Johnson O. Akinleye was appointed as acting chancellor after Dr. Saunders-White took a leave of absence. Following her death in November 2016, Akinleye became interim chancellor.

Dr. Johnson O. Akinleye is the 12th chancellor of NCCU and was elected the position in June of 2017. So far since he's been in this position, he's worked to expand the university's academic partnerships, including agreements with community colleges. He's also introduced an impressive online, distance-education program, NCCU Online. He continues to enhance the NCCU legacy with his platform, The Eagle Promise, which focuses on six strategic priorities.

D.2.4 Cultural and Natural Resources

National Register of Historic Places

There are 75 listings in the National Register of Historic Places for Durham. The University itself is listed as one of the historic places in Durham.

Natural Features and Resources

The City of Durham is host of many creeks, lakes, and open space. Durham currently manages 68 parks throughout the City. Durham strives to provide both larger parks (50+ acres) for active and passive use; neighborhood parks (2-20 acres) within walking and biking distance of most homes; connectors like bike boulevards.

Approximately 0.23 acres of the land on The North Carolina Central University campus are located within a 100-year Special Flood Hazard Area. These 0.23 acres are designated as Zone AE; an additional 0.17 acres of land on NCCU's campus is located within the 500-year floodplain, and the remaining 115 acres are designated as Unshaded Zone X.

Natural and Beneficial Floodplain Functions

Under natural conditions, a flood causes little or no damage in floodplains. Nature ensures that floodplain flora and fauna can survive the more frequent inundations, and the vegetation stabilizes soils during flooding. Floodplains reduce flood damage by allowing flood waters to spread over a large area. This reduces flood velocities and provides flood storage to reduce peak flows downstream.

Threatened and Endangered Species

The U.S. Fish and Wildlife Service maintains a regular listing of threatened species, endangered species, at-risk species, and candidate species for counties across the United States. Durham County has eight species that are listed with the U.S. Fish and Wildlife Services. **Table D.3** below shows the eight species identified as threatened and endangered in Durham County.

Table D.3 – Threatened and Endangered Species in Durham County

Common Name	Scientific Name	Federal Status
Green floater	*Lasmigona subviridis*	Under Review
Neuse River waterdog	*Necturus lewisi*	Proposed Threatened
Carolina madtom	*Noturus furiosus*	Proposed Endangered
Little brown bat	*Myotis lucifugus*	Under Review
Dwarf wedgemussel	*Alasmidonta heterodon*	Endangered
Smooth coneflower	*Echinacea laevigata*	Endangered
Michaux's sumac	*Rhus michauxii*	Endangered
Atlantic pigtoe	*Fusconaia masoni*	Proposed Threatened

Source: U.S. Fish & Wildlife Service (https://ecos.fws.gov/ecp/report/species-listings-by-current-range-county?fips=37063)

D.2.5 Land Use

The North Carolina Central University campus is currently growing as a result of three new capital projects. A new Student Center and School of Business are under construction on campus. The Student Center is being paid for by student debt service fees, and the School of Business is supported with $30 million from the Connect NC Bond and an additional $8.6 million from the North Carolina State Legislature. Three new residential buildings are also being constructed on campus to expand housing capacity at NCCU. This is a

P3 project and will result in the George Street Residence Hall, Lawson Street Resident Hall, and Chidley South Residence Hall. Digital images of the proposed designs along with updates of the construction progress are available on the University's website: https://www.nccu.edu/life-nc-central/campus-life/capital-projects-management.

D.2.6 Population and Demographics

Table D.4 provides population counts and percent change in population since 2010 for Durham County and the City of Durham.

Table D.4 – Population Counts for Surrounding Jurisdictions

Jurisdiction	2010 Census Population	2019 Estimated Population	% Change 2010-2019
Durham County	270,001	321,488	19.1
Durham	229,892	278,993	21.4

Source: U.S. Census Bureau QuickFacts 2010 vs 2019 (V2019) data

Table D.5 provides population counts for North Carolina Central University from Fall 2019, including the number of undergraduate and graduate students, staff, and faculty.

Table D.5 – Population Counts for The North Carolina Central University, Fall 2019

Group	2019 Population
Students	8,011
Undergraduate Students	6,101
Graduate Students	1,910
Off-Campus	5,344
On-Campus (Undergraduate)	2,667
Faculty	578
Staff	819

According to The North Carolina Central University's Fall 2019 Quick Facts page, 70% of all students were female, and 55.4% of undergraduates were Pell eligible. Among the NCCU student population, the most popular majors were Nursing/Pre-Nursing, Biology, Business Administration, Criminal Justice, and Computer Science and Business.

Based on the 2010 Census, the largest number of residents in both Durham and Durham County fall in the age range of 5-18, making up 21.7% and 20.4% of the populations, respectively. The racial characteristics of the County, City, and college are presented below in **Table D.6**. White persons make up the majority of the population for the City and County; however, African-Americans make up the majority of the population at North Carolina Central University.

Table D.6 – Demographics of Durham County and North Carolina Central University Students

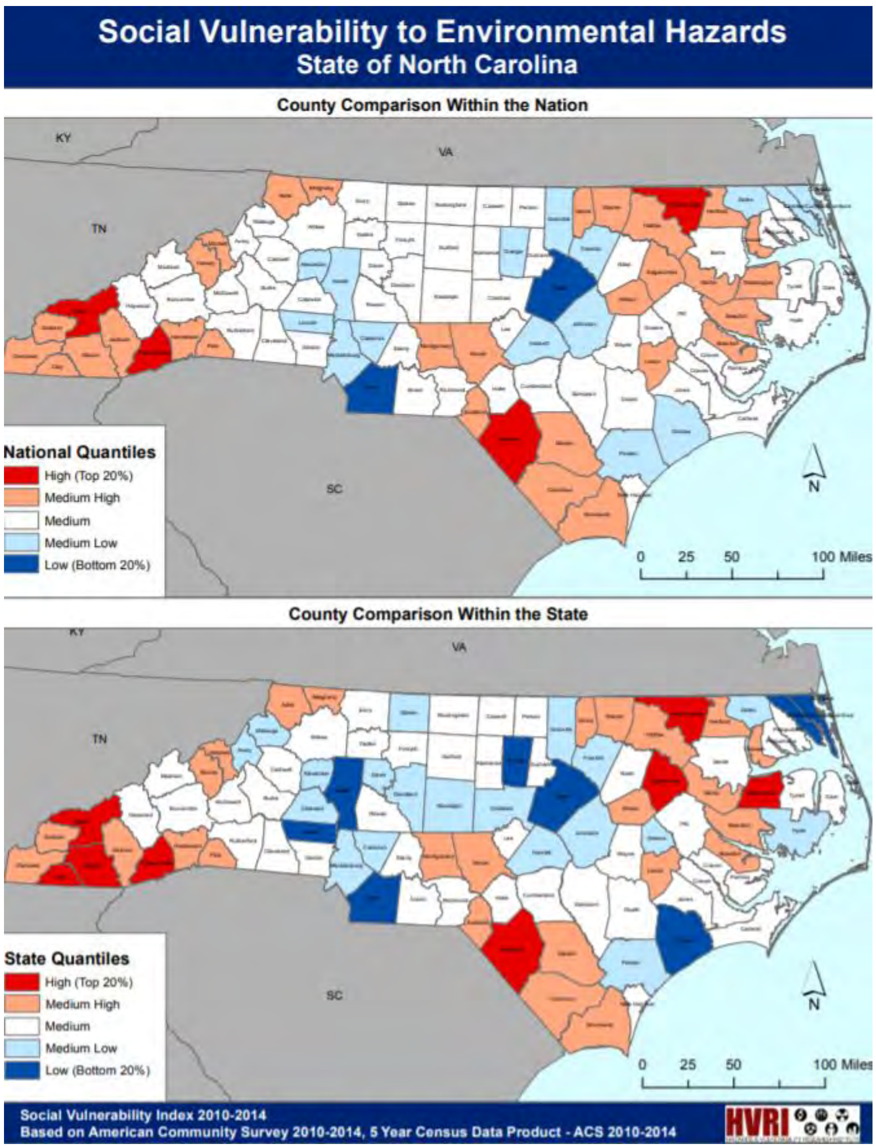
Jurisdiction	African-American Persons, Percent	American Indian or Alaska Native, Percent	Asian Persons, Percent	Hispanic or Latino Persons, Percent	White Persons, Percent
Durham County[1]	36.9	0.9	5.5	13.7	54
Durham[1]	38.7	0.3	5.4	13.8	49.2
North Carolina Central University[2]	75	*not available*	*not available*	6	10

Source: U.S. Census Bureau, 2010
[1]Persons of Hispanic Origin may be of any race, so are also included in applicable race category in Durham County figures.
[2]Source: The North Carolina Central University Student Enrollment Profile, Spring 2019

D.2.7 Social Vulnerability

The Hazards and Vulnerability Research Institute at the University of South Carolina has created the Social Vulnerability Index (SoVI), to measure comparative social vulnerability to environmental hazards in the U.S. at a county level. SoVI combines 29 socioeconomic variables to determine vulnerability. The seven most significant components for explaining vulnerability are race and class, wealth, elderly residents, Hispanic ethnicity, special needs individuals, Native American ethnicity, and service industry employment. The index also factors in family structure, language barriers, vehicle availability, medical disabilities, and healthcare access, among other variables. **Figure D.2** displays the SoVI index by county with comparisons within the Nation and within the State. In both comparisons, Durham County ranks among the medium quantiles for social vulnerability.

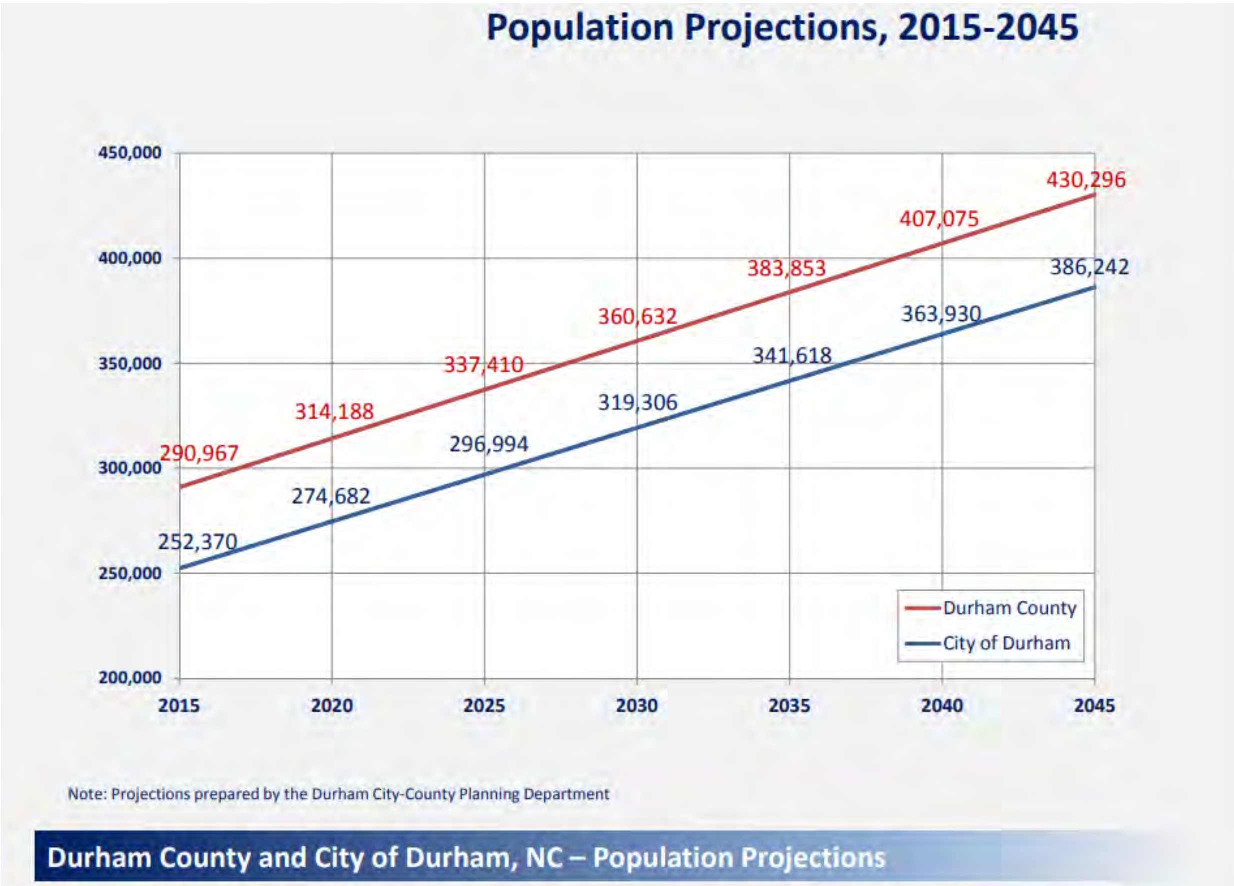
Figure D.2 – SoVI Index for North Carolina



D.2.8 Growth and Development Trends

Based on 2010 Census data, Durham is the fourth largest city in North Carolina with an estimated population of 278,993 residents in 2019 and is currently growing at an annual rate of 1.6%. As shown in **Figure D.3** on the following page, the population of Durham County and the City of Durham are projected to be over 430,000 and 386,000, respectively, by 2045. Even though the 2019 Census population estimates for Durham already exceeds the 2020 population projection shown below, these projections were still deemed the most reasonable and are based on the arithmetic method and 10 years of past growth.

Figure D.3 – County and City Population Growth Projections (2015 – 2045)



Source: https://durhamnc.gov/DocumentCenter/View/12987/Population-Projections?bidId=

The estimated population for Durham in 2019 was 278,993, which is a 0.8% increase over the 2015 estimated population, and a 4.7% increase from the 2010 Census population. **Table D.7** shows estimated population growth based on the 2010 Census population for the City of Durham.

Table D.7 – City of Durham Population Growth (2010 – 2019)

Year	Population	Growth	Percent Growth
2010	229,892	--	--
2015	258,647	9,031	3.9
2019	278,993	2,061	0.8

Source: U.S. Census Bureau

D.3 ASSET INVENTORY

An inventory of assets was compiled to identify the total count and value of property exposure on the NCCU campus. This asset inventory serves as the basis for evaluating exposure and vulnerability by hazard. Assets identified for analysis include buildings, critical facilities, and critical infrastructure.

D.3.1 Building Exposure

Table D.8 provides total building exposure for the campus, which was estimated by summarizing building footprints provided by the University of North Carolina System Division of Information Technology and the North Carolina Emergency Management (NCEM) iRisk database and property values provided by the North Carolina Department of Insurance and NCEM iRisk database. All occupancy types were summarized into the following four categories: administration, critical facilities, educational/extracurricular, and housing. Note: estimated content values were not available.

Table D.8 – NCCU Building Exposure by Occupancy

Occupancy	Estimated Building Count	Structure Value
Administration	5	$4,344,913
Critical Facilities	26	$93,611,050
Educational/Extracurricular	21	$54,159,646
Housing	8	$9,264,428
Total	**60**	**$161,380,037**

Source: UNC Division of Information Technology; NCEM iRisk; NC Department of Insurance

D.3.2 Critical Buildings and Infrastructure Exposure

Of significant concern with respect to any disaster event is the location of critical facilities and infrastructure in the planning area. Critical facilities are those essential services and lifelines that, if damaged during an emergency event, would disrupt campus continuity of operations or result in severe consequences to public health, safety, and welfare.

Critical buildings are a subset of the total building exposure and were identified by NCCU's HMPC representatives. The NCCU HMPC updated the list of critical facilities from the previous PDM plan and evaluated each facility on a set of standardized criteria designed to evaluate all critical buildings in the UNC System Hazard Mitigation Plan. Factors considered for this ranking included:

- the building's use for emergency response,
- the building's use for essential campus operations
- the building's use as an emergency shelter or for essential sheltering services,
- the presence of a generator or generator hook-ups,
- the building's use for provision of energy, chilled water or HVAC for sensitive or essential systems,
- the storage of hazardous materials,
- the building's use for sensitive research functions,
- the building's cultural or historical significance, and
- building-specific hazard vulnerabilities

The NCCU HMPC used these criteria to rank the most critical facilities on campus in two tiers. The identified critical facilities for NCCU, as shown in **Figure D.4**, include the following:

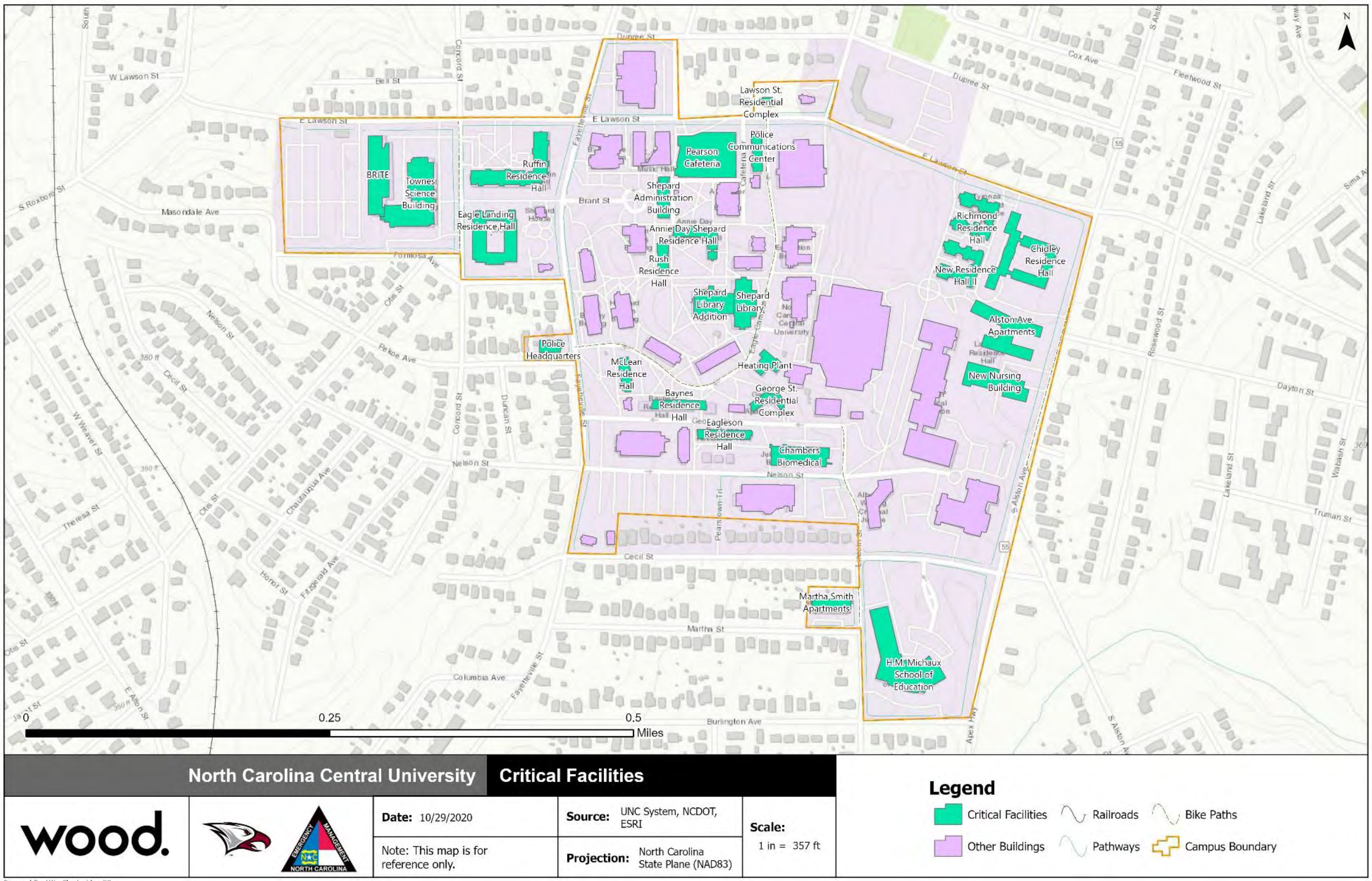
- Admin/Academic - Tier 1
  - Police Headquarters
  - Police Communications Center
  - H.M. Michaux School of Education

- James Shepard Library
- New Nursing Building
- Shepard Administration Building
- Julius Chambers BBRI
- BRITE
- Mary Townes Science Complex
- Heating Plant
- Pearson Cafeteria

▸ Residential - Tier 2

- Benjamin S. Ruffin
- Eagle Landing
- Annie Day Shepard
- Rush
- McLean
- Baynes
- Eagleson
- George St. Residential Complex
- Martha St. Apartments
- Richmond Hall
- New Residence II
- Chidley North
- Alston Ave. Apartments
- Lawson St. Residential Complex (Under Construction)

Figure D.4 – NCCU Map of Critical Facilities



D.4 HAZARD IDENTIFICATION & RISK ASSESSMENT

D.4.1 Hazard Identification

To identify a full range of hazards relevant to the UNC Eastern Campuses, HMPC representatives from each campus began with a review of the list of hazards identified in the 2018 North Carolina State Hazard Mitigation Plan and the 2010 NCCU Pre-Disaster Mitigation Plan, as summarized in **Table D.9**. This ensured consistency with the state and regional hazard mitigation plans and across each campus' planning efforts.

Table D.9 – Hazards Included in Previous Planning Efforts

Hazard	Included in 2018 State HMP?	Included in 2010 NCCU Pre-Disaster Mitigation Plan?
Flooding	Yes	Yes
Hurricanes and Coastal Hazards	Yes	Yes, as High Wind, Hurricane
Severe Winter Weather	Yes	Yes, as Ice storm and Snow
Extreme Heat	Yes	No
Earthquakes	Yes	Yes
Wildfire	Yes	Yes
Dam Failures	Yes	No
Drought	Yes	Yes
Tornadoes/Thunderstorms	Yes	Yes
Geological (Landslides, Sinkholes, Coastal Erosion)	Yes	Yes, as Landslide
Hazardous Materials Incidents	Yes	No
Infectious Disease	Yes	No
Radiological Emergency	Yes	No
Terrorism/Mass Casualty	Yes	No
Cyber Threat	Yes	No

NCCU's HMPC representatives evaluated the above list of hazards by considering existing hazard data, past disaster declarations, local knowledge, and information from the 2018 State Plan and the 2010 NCCU Pre-Disaster Mitigation Plan in order to determine whether each hazard was significant enough to assess in this updated DRU plan. Significance was measured in general terms and focused on key criteria such as frequency, severity, and resulting damage, including deaths and injuries, as well as property and economic damage.

One key resource in this effort was the National Oceanic and Atmospheric Administration's (NOAA) National Center for Environmental Information (NCEI), which has been tracking various types of weather events 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), which compiles their information from a variety of sources, including but 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. While NCEI is not a comprehensive list of past hazard events, it can provide an indication of relevant hazards to the planning area and offers some statistics on injuries, deaths, damages, as well as narrative descriptions of past impacts.

Data for Durham County was used to approximate past events that may have affected the NCCU campus. The NCEI database contains 324 records of storm events that occurred in Durham County in the 20-year period from 2000 through 2019. **Table D.10** summarizes these events.

Table D.10 – NCEI Severe Weather Data for Durham County, 2000 – 2019

Type	# of Events	Property Damage	Crop Damage	Deaths	Injuries
Flash Flood	46	$425,000	$0	0	0
Flood	4	$11,050,000	$5,000,000	0	0
Funnel Cloud	3	$0	$0	0	0
Hail	69	$15,000	$0	0	0
Heavy Rain	1	$0	$0	0	0
Heavy Snow	1	$0	$0	0	0
High Wind	2	$1,000	$0	0	0
Hurricane (Typhoon)	1	$205,000	$0	0	0
Ice Storm	1	$400,000	$0	0	0
Lightning	7	$163,000	$0	1	1
Strong Wind	16	$433,450	$6,000	1	1
Thunderstorm Wind	118	$972,750	$0	1	1
Tornado	3	$350,000	$0	0	0
Tropical Storm	2	$200,000	$25,000	0	0
Winter Storm	25	$1,000,000	$0	0	0
Winter Weather	25	$30,000	$0	0	0
Total	**324**	**$15,245,200**	**$5,031,000**	**3**	**3**

Source: National Center for Environmental Information Events Database, retrieved October 2020
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 Durham 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 1954. Since then, Durham County has been designated in 17 major disaster declarations, as detailed in **Table D.11**, and 10 emergency declarations, as detailed in **Table D.12**.

Table D.11 – FEMA Major Disaster Declarations, Durham County

Disaster #	Dec. Date	Incident Type	Event Title	Individual Assistance Applications Approved	Total Individual and Households Program Dollars Approved	Total Public Assistance Grant Dollars Obligated
DR-28-NC	17-Oct-54	Hurricane	HURRICANE	N/A	N/A	N/A
DR-37-NC	13-Aug-55	Hurricane	HURRICANES	N/A	N/A	N/A
DR-56-NC	24-Apr-56	Severe Storm(s)	SEVERE STORM	N/A	N/A	N/A
DR-87-NC	01-Oct-58	Hurricane	HURRICANE & SEVERE STORM	N/A	N/A	N/A
DR-107-NC	16-Sep-60	Hurricane	HURRICANE DONNA	N/A	N/A	N/A
DR-130-NC	16-Mar-62	Flood	SEVERE STORM, HIGH TIDES & FLOODING	N/A	N/A	N/A

Disaster #	Dec. Date	Incident Type	Event Title	Individual Assistance Applications Approved	Total Individual and Households Program Dollars Approved	Total Public Assistance Grant Dollars Obligated
DR-179-NC	13-Oct-64	Flood	SEVERE STORMS & FLOODING	N/A	N/A	N/A
DR-827-NC	17-May-89	Tornado	TORNADOES	N/A	N/A	N/A
DR-1087-NC	13-Jan-96	Snow	BLIZZARD OF 96	N/A	N/A	N/A
DR-1134-NC	06-Sep-96	Hurricane	HURRICANE FRAN	N/A	N/A	N/A
DR-1211-NC	22-Mar-98	Severe Storm(s)	SEVERE STORMS TORNADOES, AND FLOODING	N/A	N/A	N/A
DR-1292-NC	16-Sep-99	Hurricane	HURRICANE FLOYD MAJOR DISASTER DECLARATIONS	N/A	N/A	$298,105,794
DR-1312-NC	31-Jan-00	Severe Storm(s)	SEVERE WINTER STORM	N/A	N/A	$27,368,108
DR-1448-NC	12-Dec-02	Severe Ice Storm	SEVERE ICE STORM	N/A	N/A	$86,565,180
DR-1490-NC	18-Sep-03	Hurricane	HURRICANE ISABEL	7790	$21,289,504	$18,285,917
DR-4393-NC	15-Sep-18	Hurricane	HURRICANE FLORENCE	34713	$133,948,455	$632,937,402
DR-4487-NC	25-Mar-20	Biological	COVID-19 PANDEMIC	N/A	N/A	$174,898,697

Source: FEMA Disaster Declarations Summary, October 2020

Note: Number of applications approved and all dollar values represent totals for all counties included in disaster declaration.

Table D.12 – FEMA Emergency Declarations, Durham County

Disaster #	Dec. Date	Incident Type	Event Title/Description
EM-3033-NC	02-Mar-77	Snow	DROUGHT & FREEZING
EM-3049-NC	11-Aug-77	Drought	DROUGHT
EM-3110-NC	17-Mar-93	Snow	SEVERE SNOWFALL & WINTER STORM
EM-3146-NC	15-Sep-99	Hurricane	HURRICANE FLOYD EMERGENCY DECLARATIONS
EM-3222-NC	05-Sep-05	Hurricane	HURRICANE KATRINA EVACUATION
EM-3380-NC	07-Oct-16	Hurricane	HURRICANE MATTHEW
EM-3401-NC	11-Sep-18	Hurricane	HURRICANE FLORENCE
EM-3423-NC	04-Sep-19	Hurricane	HURRICANE DORIAN
EM-3471-NC	13-Mar-20	Biological	COVID-19
EM-3534-NC	02-Aug-20	Hurricane	HURRICANE ISAIAS

Source: FEMA Disaster Declarations Summary, October 2020

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. **Table D.13** summaries the determination made for each hazard.

Table D.13 – Hazard Evaluation Results

Hazard	Included in this plan update?	Explanation for Decision
Natural Hazards		
Hurricane	Yes	The 2010 NCCU PDM plan found Hurricane to be a moderate threat hazard. The County has had 10 disaster declarations related to hurricanes wind.
Coastal Hazards	No	The 2010 NCCU PDM plan did not address this hazard.
Tornadoes / Thunderstorms (Wind, Lightning, Hail)	Yes	The 2010 NCCU PDM plan found tornadoes to be a low threat hazard. The County has had no disaster declarations related to tornadoes. The HMPC expressed interest in addressing this hazard in combination with thunderstorms (wind, lightning, hail).
Flood*	Yes	The 2010 NCCU PDM plan rated flood a significant threat hazard for the planning area. The County has had 2 disaster declarations related to flooding.
Severe Winter Weather	Yes	The 2010 NCCU PDM plan found ice/snow to be a low threat hazard. The HMPC expressed interest in addressing this hazard as severe winter weather to include cold/wind chill; extreme cold; freezing fog; frost/freeze; heavy snow; ice storm; winter storm; and winter weather.
Drought	No	The 2010 NCCU PDM plan did not address this hazard.
Wildfire	Yes	The 2010 NCCU PDM plan did not a assign a threat and/or risk level for this hazard; however, the HMPC expressed interest in addressing this hazard.
Earthquake*	Yes	The 2010 NCCU PDM plan did not a assign a threat and/or risk level for this hazard; however, the HMPC expressed interest in addressing this hazard.
Geological Hazards (Sinkhole & Landslide)*	Yes	The 2010 NCCU PDM plan did not a assign a threat and/or risk level for this hazard; however the HMPC did expressed an interest in addressing this hazard.
Dam Failure	No	The 2010 NCCU PDM plan did not address this hazard.
Extreme Heat	No	The 2010 NCCU PDM plan did not address this hazard.
Technological and Human-Caused Hazards & Threats		
Hazardous Materials Incidents	Yes	The 2010 NCCU PDM plan did not address this hazard; however, there are fixed facility sites and transportation routes with hazardous materials in the planning area and the HMPC expressed interest in addressing this hazard.
Infectious Disease	Yes	The 2010 NCCU PDM plan did not address this hazard; however, due to the COVID-19 pandemic that occurred during this planning process, the HMPC determined infectious disease should be addressed.
Cyber Attack	Yes	The 2010 NCCU PDM plan did not address this hazard; however, the HMPC expressed interest in re-evaluating cyber-attacks in this plan update.
Civil Unrest	No	The 2010 NCCU PDM plan did not address this hazard and the HMPC did not express interest in re-evaluating civil unrest in this plan update.

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

D.5 HAZARD PROFILES, ANALYSIS, AND VULNERABILITY

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 where it may occur, the severity of potential events, records of past events, the probability of future occurrences, and potential impacts from the hazard. A vulnerability assessment was conducted for each hazard using quantitative and/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.

To account for regional differences in hazard risk across each of the campuses, this risk assessment is divided into two parts:

1) a set of summary hazard profiles describing each hazard and summarizing the risk findings for each campus, presented in Section 3.5; and
2) a campus-specific risk assessment profiling the location, extent, historical occurrences, probability of future occurrence, and vulnerability of each campus, presented in each campus annex.

In the campus-level hazard profiles presented here, each hazard is profiled in the following format:

Location

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

Extent

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

Historical Occurrences

This section contains information on historical events, including the location and consequences of all past events on record within or near the Durham County planning area. Where possible, this plan uses a consistent 20-year period of record except for hazards with significantly longer average recurrence intervals or where data limitations otherwise restrict the period of record.

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)

Vulnerability Assessment

This section quantifies, to the extent feasible using best available data, assets at risk to natural hazards and potential loss estimates. Details on hazard specific methodologies and assumptions are provided where applicable. People, properties and critical facilities, and environmental assets that are vulnerable to the hazard are identified.

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

- Geographic Information System (GIS) datasets, including County parcel data from 2020, campus building inventory fand values from the University System's Division of Information Technology, NCEM iRisk Database, and property values provided by the NC Department of Insurance, topography, transportation layers, and critical facility and infrastructure locations;
- Hazard layer GIS datasets from state and federal agencies;
- Written descriptions of inventory and risks provided by the 2018 State of North Carolina Hazard Mitigation Plan;
- Written descriptions of inventory and risks provided by the 2020 Eno-Haw Regional Hazard Mitigation Plan; and
- Exposure and vulnerability estimates derived using local parcel data.

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. For applicable hazards, the quantitative analysis involved the use of FEMA's Hazus-MH, a nationally applicable standardized set of models for estimating potential losses from earthquakes, floods, and hurricanes. Hazus uses a statistical approach and mathematical modeling of risk to predict a hazard's frequency of occurrence and estimated impacts based on recorded or historic damage information. The Hazus risk assessment methodology is parametric, in that distinct hazard and inventory parameters—such as wind speed and building type—were modeled using the Hazus software to determine the impact on the built environment. Durham County's GIS-based risk assessment was completed using data collected from local, regional and national sources that included Durham County, NCEM, and FEMA.

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. Other information can be collected in regard to the hazard area, such as the location of critical facilities and infrastructure, historic resources, 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.

The data collected for the hazard profiles and vulnerability assessment was obtained from multiple sources covering a variety of spatial areas including county-, jurisdictional-, and campus-level information. The table below presents the source data and the associated geographic coverages.

Table D.14 – Summary of Hazard Data Sources and Geographic Coverage

Hazard	Hazard Data Sources	Profile Geographic Area	Vulnerability Methodology	Vulnerability Geographic Area
Earthquake	USGS, NCEI	County	Hazus 4.2	Census Tract
Flood	NCEI, FEMA	Jurisdiction	GIS Spatial Analysis	Campus

Hazard	Hazard Data Sources	Profile Geographic Area	Vulnerability Methodology	Vulnerability Geographic Area
Hurricane	NHC	County	Hazus 4.2	Census Tract
Landslide	USGS	County	Qualitative Analysis	Campus
Severe Winter Weather	NWS, NCEI	County	Statistical Analysis	County
Tornado / Thunderstorm	NWS, NCEI	Jurisdiction	Statistical Analysis	Jurisdiction
Wildfire	NCFS, SouthWRAP	County	GIS Spatial Analysis	Campus
Cyber Threat	Internet Research	County, Higher Education	Qualitative Analysis	Higher Education
Hazardous Materials Incidents	EPA; USDOT	Jurisdiction	GIS Spatial Analysis	Campus
Infections Disease	CDC; WHO	National, Higher Education	Qualitative Analysis	Higher Education

CDC = Centers for Disease Control and Prevention; EPA = United States Environmental Protection Agency; FEMA = Federal Emergency Management Agency; NCEI = National Centers for Environmental Information; NCFS = North Carolina Forest Service; NHC = National Hurricane Center; NWS = National Weather Service; SouthWRAP = Southern Group of State Foresters, Wildfire Risk Assessment Portal; USDOT = United States Department of Transportation; USGS = United States Geological Survey; WHO = World Health Organization

Changes in Development

This section describes how changes in development have impacted vulnerability since the last plan was adopted. 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.

Problem Statements

This section summarizes key mitigation planning concerns related to this hazard.

Priority Risk Index

The conclusions drawn from the hazard profiling and vulnerability assessment process are used to prioritize all potential hazards to the NCCU 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 D.15**.

PRI ratings are provided by category throughout each hazard profile for the planning area as a whole. Ratings specific to each jurisdiction are provided at the end of each hazard profile. The results of the risk assessment and overall PRI scoring are provided in Section 0 Conclusions on Hazard Risk.

The sum of all five risk assessment categories equals the final PRI value, demonstrated in the equation below (the lowest possible PRI value is a 1.0 and 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 campus 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.

Table D.15 – 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**	

D.5.1 Earthquake

Hazard	Probability	Impact	Spatial Extent	Warning Time	Duration	PRI Score
Earthquake	Unlikely	Minor	Large	Less than 6 hours	Less than 6 hours	1.9

Location

The United States Geological Survey (USGS) Quaternary faults database was consulted to determine the sources of potential earthquakes within range of Durham County. Quaternary faults are active faults recognized at the surface which have evidence of movement in the past 2.58 million years. No active faults were noted in Durham County.

Earthquakes are generally felt over a wide area, with impacts occurring hundreds of miles from the epicenter. Therefore, any earthquake that impacts Durham County is likely to be felt across most if not all of the planning area.

Spatial Extent: 4 – Large

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 D.16**. 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 D.17** 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 D.16 – 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 D.17 – 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.

MMI	Richter Scale	Felt Intensity
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.
VIII	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 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.

Impact: 1 – Minor

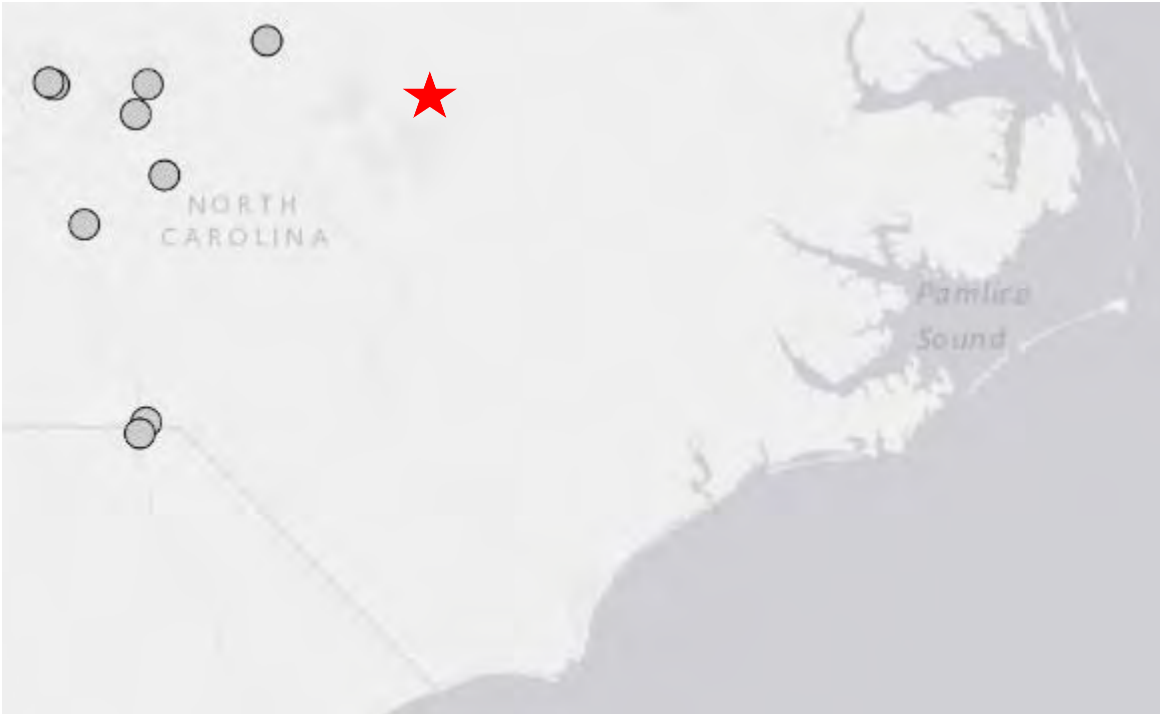
Historical Occurrences

The USGS Earthquake Hazards Program maintains a database of historical earthquakes of a magnitude 2.5 and greater from 1900 to 2020. Earthquake events that occurred within 100 miles of the NCCU campus are presented in **Table D.18** and **Figure D.5**.

Table D.18 – Historical Earthquakes within 100 Miles of NCCU, 1900-2020

Year	Magnitude	MMI	Location
1978	2.7	II	Virginia-North Carolina border region
1981	2.8	II	North Carolina
1993	2.7	II	Virginia-North Carolina border region
2006	2.5	II	Virginia-North Carolina border region
2006	2.6	II	7km S of Winston-Salem, North Carolina
2011	2.9	II	9km S of Cordova, North Carolina
2012	2.5	II	10km NNE of Cheraw, South Carolina
2015	2.58	II	10km S of Denton, North Carolina
2019	2.5	II	8km E of Archdale, North Carolina

Figure D.5 – Historical Earthquakes within 100 Miles of NCCU, 1900-2020



Source: USGS

The National Center for Environmental Information (NCEI) maintains a database of the felt intensity of earthquakes from 1638 to 1985 including the maximum intensity for each locality that felt the earthquake. According to this database, in the 100-year period from 1885-1985, there were two earthquakes felt in and around Durham: on September 1, 1886 with an epicenter approximately 365 miles from Durham; and on November 20, 1969 a 4.3 magnitude with an epicenter approximately 242 miles from Durham.

Probability of Future Occurrence

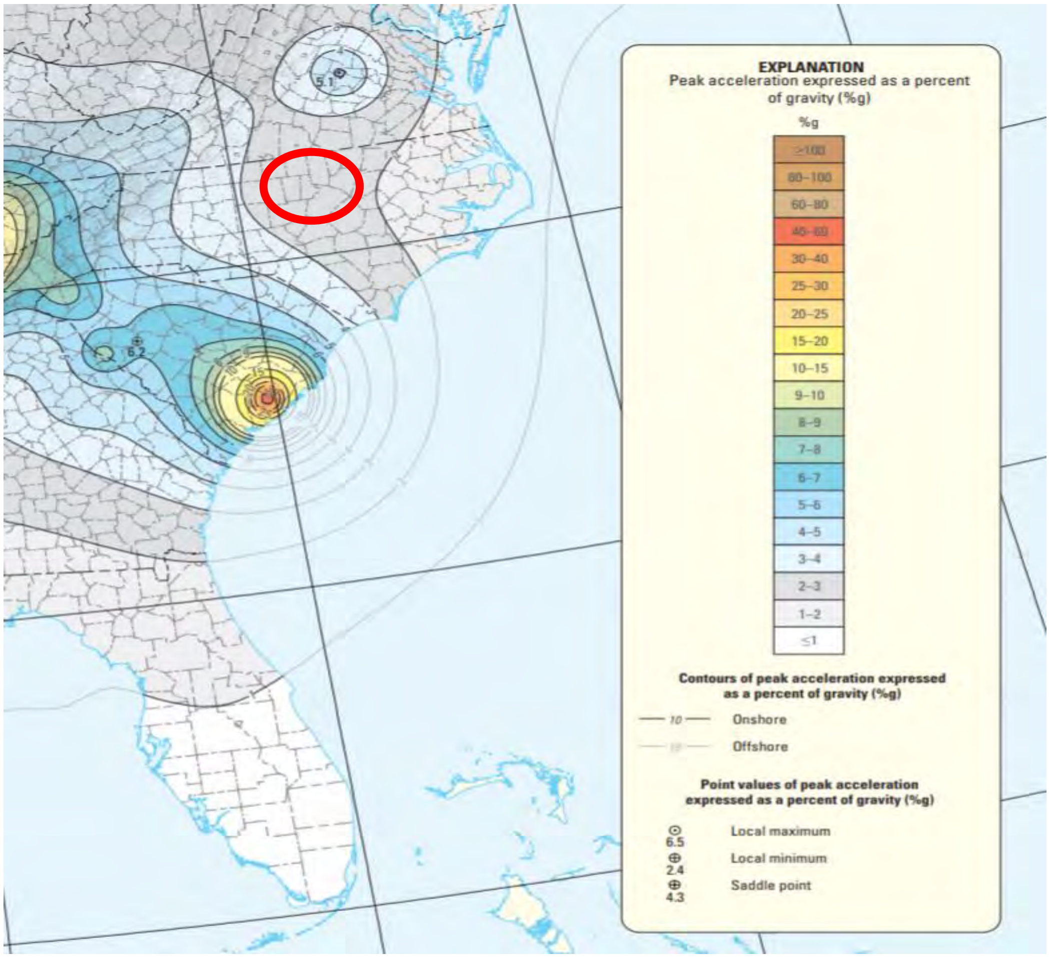
Ground motion is the movement of the earth's surface due to earthquakes or explosions. It is produced by waves generated by a sudden slip on a fault or sudden pressure at the explosive source and travels through the earth and along its surface. Ground motion is amplified when surface waves of unconsolidated 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 that have a common given probability of being exceeded in 50 years.

Figure D.6 on the following page reflects the seismic hazard for Durham 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 occurrence 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. All of Durham County is located within a zone with peak acceleration of 2-3% g, which indicates low earthquake risk.

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

Probability: 1 – Unlikely

Figure D.6 – Seismic Hazard Information for Durham County



Source: USGS Earthquake Hazards Program

Vulnerability Assessment

Methodology & Assumptions

To quantify vulnerability, Wood performed a Level 1 earthquake analysis in Hazus 4.2 utilizing general building stock information based on the 2010 Census. The NCCU campus is located within a single census tract encompassing 0.58 square miles. The earthquake scenario was modeled after an arbitrary earthquake event of magnitude 5.0 with an epicenter in the NCCU campus and depth of 10km.

People

Hazus estimates that the modeled magnitude 5.0 event would result in no households requiring temporary shelter. Additionally, Hazus estimates potential injuries and fatalities depending on the time of day of an event. Casualty estimates are shown in **Figure D.7**. Casualties are broken down into the following four levels that describe the extent of injuries:

- Level 1: Injuries will require medical attention, but hospitalization is not needed.
- Level 2: Injuries will require hospitalization but are not considered life-threatening.
- Level 3: Injuries will require hospitalization and can become life threatening if not promptly treated.
- Level 4: Victims are killed by the earthquake.

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. Impacts of earthquakes also include debris clean-up and service disruption. Per the Hazus analysis, a 5.0 magnitude earthquake could not produce debris.

Durham County has not been impacted by an earthquake with more than a low intensity, so major damage to the built environment is unlikely. **Table D.19** details the estimated buildings impacted by a magnitude 5.0 earthquake event, as modeled by Hazus. Note that building value estimates are inherent to Hazus and do not necessarily reflect damages to the asset inventory for the NCCU Campus.

Table D.19 – Estimated Buildings Impacted by 5.0 Magnitude Earthquake Event

Occupancy Type	Estimated Building Damage	Estimated Content Loss	Estimated Total Damage
Residential	$0	$0	$0
Commercial	$0	$0	$0
Industrial	$0	$0	$0
Other	$0	$0	$0
Total	**$0**	**$0**	**$0**

Source: Hazus

Figure D.7 – Casualty Estimate from a 5.0 Magnitude Earthquake Event

		Level 1	Level 2	Level 3	Level 4
2 AM	Commercial	0	0	0	0
	Commuting	0	0	0	0
	Educational	0	0	0	0
	Hotels	0	0	0	0
	Industrial	0	0	0	0
	Other-Residential	0	0	0	0
	Single Family	0	0	0	0
	Total	**0**	**0**	**0**	**0**
2 PM	Commercial	0	0	0	0
	Commuting	0	0	0	0
	Educational	0	0	0	0
	Hotels	0	0	0	0
	Industrial	0	0	0	0
	Other-Residential	0	0	0	0
	Single Family	0	0	0	0
	Total	**0**	**0**	**0**	**0**
5 PM	Commercial	0	0	0	0
	Commuting	0	0	0	0
	Educational	0	0	0	0
	Hotels	0	0	0	0
	Industrial	0	0	0	0
	Other-Residential	0	0	0	0
	Single Family	0	0	0	0
	Total	**0**	**0**	**0**	**0**

Source: Hazus 4.2

All critical facilities should be considered at risk to minor damage should an earthquake event occur. However, of the essential facilities included in Hazus—which include three schools and one police station—two schools were estimated to sustain moderate damages, and the remaining school and police station were estimated to maintain at least 50 percent functionality after day one following an event. Additionally, Hazus did not project any impacts to utility system facilities or pipelines.

Environment

An earthquake is unlikely to cause substantial impacts to the natural environment in Durham 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.

Changes in Development

Building codes substantially reduce the costs of damage to future structures from earthquakes. Future construction on the NCCU campus must follow the applicable requirements of the NC building codes, the State of North Carolina statutes for state owned buildings and zoning for the local jurisdiction.

Development changes at NCCU have not affected the risk characteristics of earthquakes. The probability, impact, spatial extent, warning time, and duration of earthquakes have not changed.

Problem Statement

- While earthquakes are an unlikely hazard event for the NCCU campus, the Hazus model did predict impacts to two school structures located within the associated census tract.

D.5.2 Flood

Hazard	Probability	Impact	Spatial Extent	Warning Time	Duration	PRI Score
Flood	Likely	Minor	Negligible	6 to 12 hrs	Less than 6 hours	1.8

Location

Regulated floodplains are illustrated on inundation maps called Flood Insurance Rate Maps (FIRMs). A FIRM 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 1-percent-annual-chance flood event. Structures located within the SFHA have a 26-percent chance of flooding during the life of a standard 30-year mortgage.

For this risk assessment, flood prone areas were identified within the NCCU Campus using the FIRM dated October 19, 2018. **Figure D.8** reflects the 2018 mapped flood insurance zones.

Table D.20 – Mapped Flood Insurance Zones

Zone	Description
A	Zone A is the flood insurance rate zone that corresponds to the 1% annual chance floodplains that are determined in the FIS Report by approximate methods. Because detailed hydraulic analyses are not performed for such areas, no Base Flood Elevations or depths are shown within this zone.
AE	Zone AE is the flood insurance rate zone that corresponds to the 1% annual chance floodplains that are determined in the FIS Report by detailed methods. In most instances, whole-foot Base Flood Elevations derived from the detailed hydraulic analyses are shown at selected intervals within this zone.
AH	Zone AH is the flood insurance rate zone that corresponds to the areas of 1% annual chance shallow flooding (usually areas of ponding) where average depths are between 1 and 3 feet. Whole-foot Base Flood Elevations derived from the detailed hydraulic analyses are shown at selected intervals within this zone.
AO	Zone AO is the flood insurance rate zone that corresponds to the areas of 1% annual chance shallow flooding (usually sheet flow on sloping terrain) where average depths are between 1 and 3 feet. Average whole-foot depths derived from the detailed hydraulic analyses are shown within this zone.
VE	Zone VE is the flood insurance rate zone that corresponds to the 1% annual chance coastal floodplains that have additional hazards associated with storm waves. Whole-foot Base Flood Elevations derived from the detailed hydraulic analyses are shown at selected intervals within this zone.
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 0.2-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 0.2% percent of the NCCU Campus falls within the SFHA. **Table D.21** provides a summary of the NCCU Campus' total area by flood zone on the 2018 effective DFIRM.

Spatial Extent: 1 – Negligible

Figure D.8 – FEMA Flood Hazard Areas in NCCU's Campus Boundary

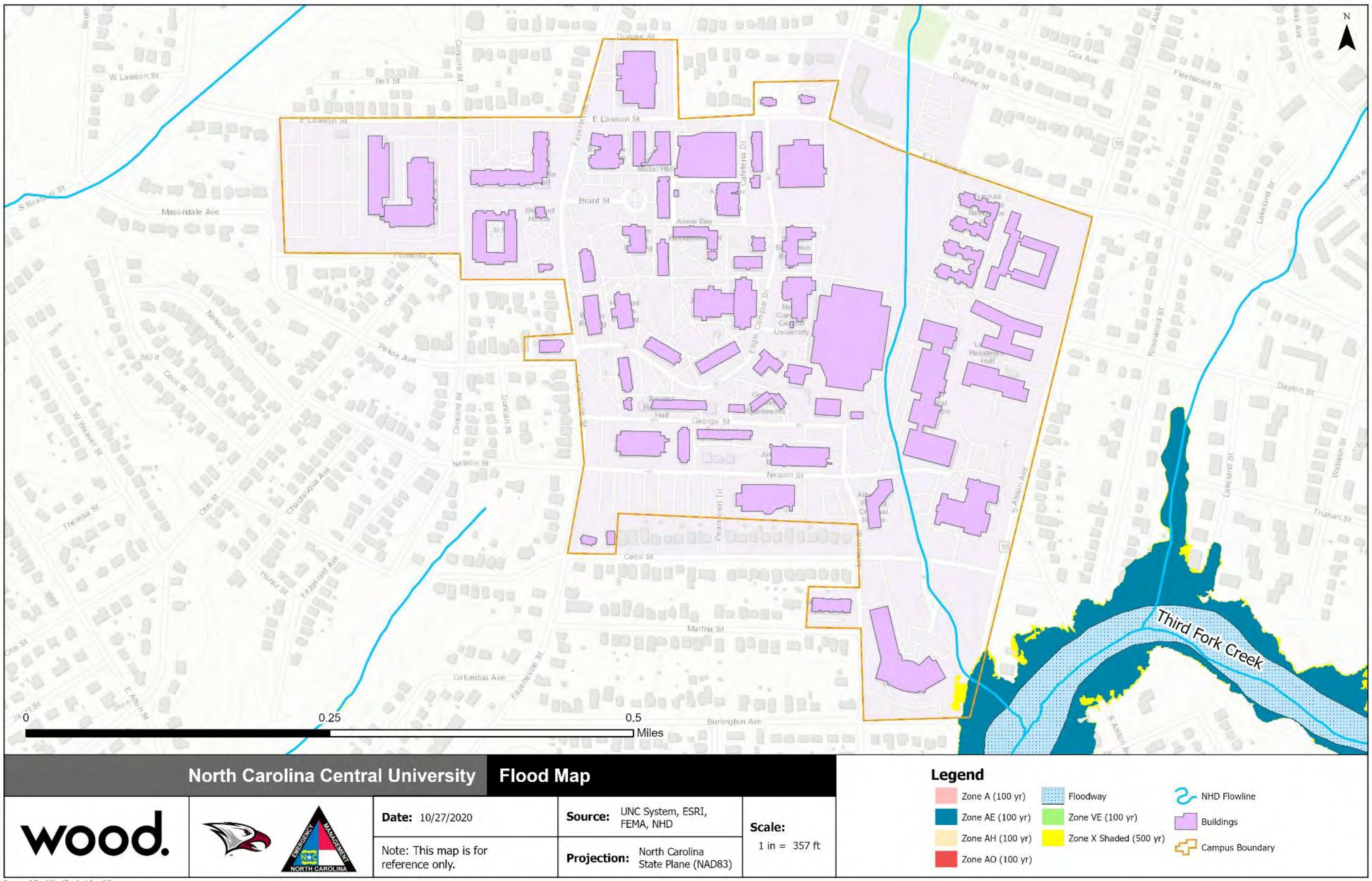


Table D.21 – Flood Zone Acreage on NCCU Campus

Flood Zone	Acreage	Percent of Total (%)
A	0	0.0%
AE	0	0.2%
AH	0	0.0%
AO	0	0.0%
Floodway	0	0.0%
VE	0	0.0%
0.2% Annual Chance Flood Hazard	0	0.1%
Unshaded X	115	99.7%
Total	115	**--**
SFHA Total	**0**	**0.2%**

Source: FEMA 2018 DFIRM

Although no detailed study was completed by FEMA, it should be noted that a tributary of Third Fork Creek runs through campus and could be a source of flooding.

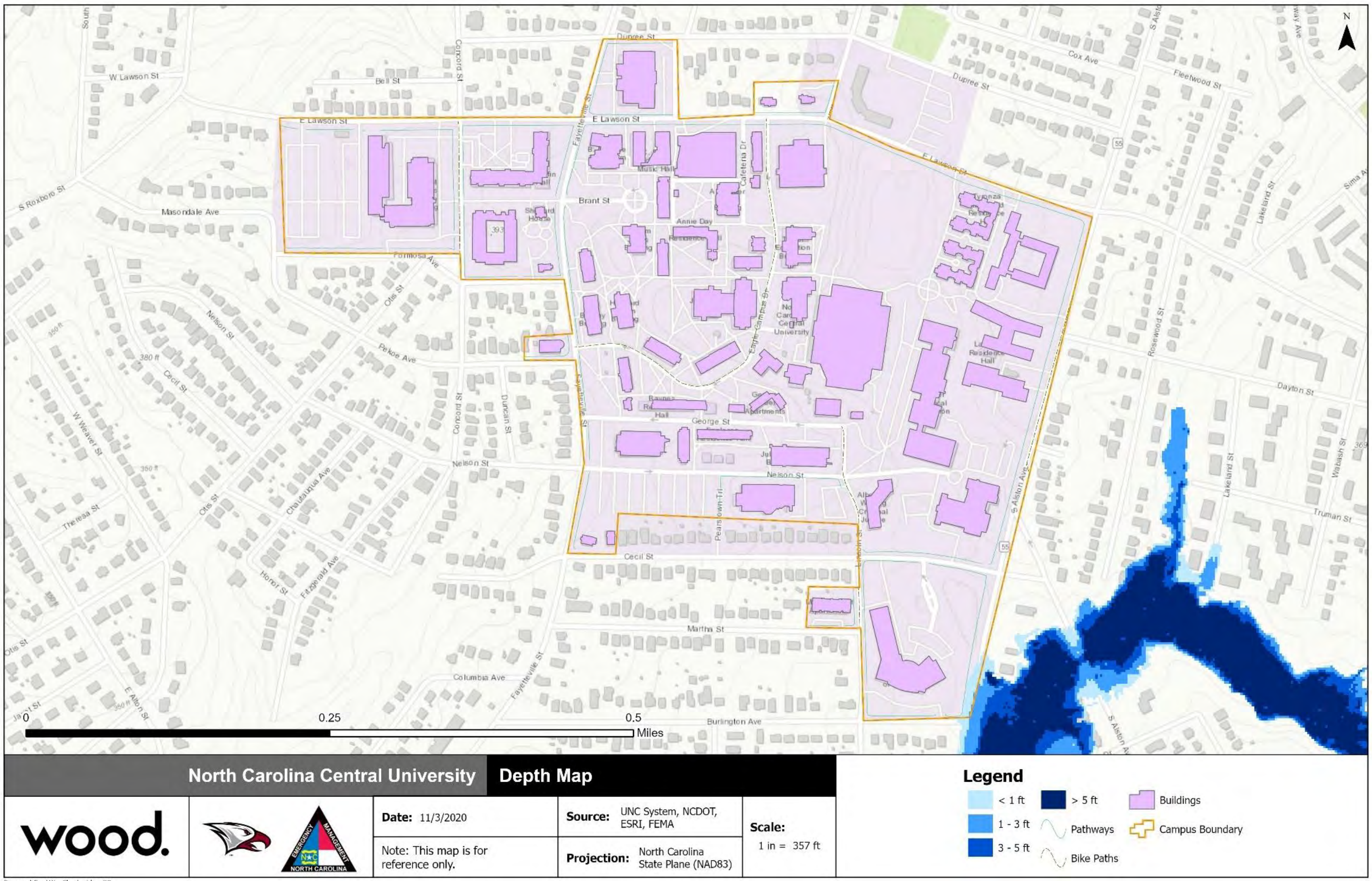
Additionally, although this assessment focuses on riverine flooding, it is also important to note that localized stormwater flooding can also occur on campus and may affect areas outside the mapped floodplain. Data was not available to evaluate the location or extent of stormwater flooding on campus.

Extent

Flood extent can be defined by the amount of land in the floodplain, detailed above, and the potential magnitude of flooding as measured by flood depth and velocity. **Figure D.9** shows the depth of flooding predicted from a 1% annual chance flood. Flood damage is closely related to depth, with greater flood depths generally resulting in more damages.

Impact: 1 – Minor

Figure D.9 – Flood Depth, 1-Percent-Annual-Chance Flood, NCCU Campus



Historical Occurrences

Table D.22 details the historical occurrences of flooding for Durham identified from 2000 through 2019 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 D.22 – NCEI Records of Flooding for the City of Durham, 2000-2019

Location	Date	Deaths/Injuries	Reported Property Damage	Reported Crop Damage
Flash Flood				
DURHAM	7/23/2000	0/0	$0	$0
DURHAM	8/4/2000	0/0	$0	$0
DURHAM	6/22/2001	0/0	$0	$0
DURHAM	10/11/2002	0/0	$0	$0
DURHAM	10/11/2002	0/0	$0	$0
DURHAM	5/23/2004	0/0	$0	$0
DURHAM	8/12/2004	0/0	$0	$0
DURHAM	7/13/2006	0/0	$0	$0
DURHAM	11/16/2006	0/0	$0	$0
EAST DURHAM	9/6/2011	0/0	$0	$0
DURHAM	6/11/2014	0/0	$0	$0
DURHAM	12/30/2015	0/0	$10,000	$0
WEST DURHAM	4/15/2018	0/0	$0	$0
DURHAM	4/12/2019	0/0	$30,000	$0
Heavy Rain				
DURHAM	11/22/2006	0/0	$0	$0
	Total	**0/0**	**$40,000**	**$0**

Source: NCEI

According to NCEI, 15 recorded flood-related events affected the City of Durham from 2000 to 2019 causing an estimated $40,000 in property damage, with no injuries, fatalities, or crop damage.

The following event narratives are provided in the NCEI Storm Events Database and illustrate the impacts of flood events on the county:

- **08/4/2000** - Flooding on Hwy 147, 6 to 8 inches of water covered roads in the South Square area.
- **12/30/2015** - Flooding caused minor damage to the Hillandale Road VA Clinic in Durham, where 1-2 inches of water got inside the building. In addition, high water signs were deployed across Durham.
- **4/12/2019** - Flash flooding was reported on several campus streets at North Carolina Central University. In addition, several buildings reported having water in interior entrances. Several streets were flooded and closed in the Durham area. Also, vehicles were stranded. Flora Street was impassable due to flash flooding.

The state of North Carolina has had two FEMA Major Disaster Declarations for severe storms that include elements of flooding in 1962 and 1964 along with four Major Disaster Declarations for Hurricanes in 1954, 1955, 1958, 1960 which may have included damages associated with flooding. Additionally, Durham County has received one Major Disaster Declaration for a severe storm including elements of flooding in

1998 along with four Major Disaster Declarations for Hurricanes in, 1996, 1999, 2003, 2018 which also may have included damages associated with flooding.

Probability of Future Occurrence

By definition, SFHAs are those areas that will be inundated by the flood event having a 1-percent chance of being equaled or exceeded in any given year. While exposure to flood hazards varies across jurisdictions, all jurisdictions have at least some area of land in FEMA-mapped flood hazard areas. This delineation is a useful way to identify the most at-risk areas, but flooding does not occur in set intervals; any given flood may be more or less severe than the defined 1-percent-annual-chance flood. There is also risk of localized and stormwater flooding in areas outside the SFHA and at different intervals than the 1% annual chance flood.

Floods of varying severity occur regularly in Durham and impacts from past flood events have been noted by NCEI. NCEI reports 15 flood-related events in the 20-year period from 2000-2019, which equates to an annual probability of 75% for Durham. Therefore, the probability of flooding is considered likely (between 10% and 100% annual probability).

Probability: 3 – Likely

Vulnerability Assessment

Methodology & Assumptions

To quantify vulnerability, Wood performed a GIS spatial analysis of the flood hazard by overlaying the mapped SFHA on the building footprints provided by the UNC Division of Information Technology and NCEM iRisk database. For the NCCU campus, there are no structures located within the SFHA.

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 systems lose 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 high risk when driving through flooded streets. However, NCEI does not contain any records of deaths caused by flood events in Durham.

An estimate of population at risk to flooding can be developed based on the assessment of housing property at risk. For the NCCU campus, there are no housing properties at risk.

Property

Administration buildings, education and/or extracurricular facilities, housing, as well as critical facilities and infrastructure such as transportation, water, energy, and communication systems may be damaged or destroyed by flood waters.

Table D.23 details the estimated losses for the 1%-annual-chance flood event for the campus. The total damage estimate value is based on damages to the total of building value. Land value is not included in any of the loss estimates as generally land is not subject to loss from floods.

Table D.23 – Estimated Building Damage and Content Loss for 1% Annual Chance Flood

Occupancy Type	Total Buildings with Loss	Total Value	Estimated Building Damage	Loss Ratio
Administration	0	$0	$0	0%
Critical Facilities	0	$0	$0	0%
Education/ Extracurricular	0	$0	$0	0%
Housing	0	$0	$0	0%
Total	**0**	**$0**	**$0**	**0%**

Source: UNC Division of Information Technology; NCEM iRisk; NC Department of Insurance; USACE Wilmington District Depth-Damage Function

The loss ratio is the loss estimate divided by the total potential exposure (i.e., total of improved value for all buildings located within the Zone AE) and displayed as a percentage of loss. FEMA considers loss ratios greater than 10% to be significant and an indicator a community may have more difficulties recovering from a flood. Loss ratios for all occupancy types with identified structures on the NCCU campus are 0%, meaning that in the event of a flood with a magnitude of the 1%-annual-chance event or greater, the planning area would be minimally impacted.

None of the critical facilities identified for NCCU are located within the 1%-annual-chance floodplain, therefore there are no estimated damages.

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 planning area. According to 2020 NFIP records, there are no repetitive loss properties on the NCCU campus.

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.

Changes in Development

The likelihood of future flood damage can be reduced through appropriate land use planning, building siting and building design. In addition, the NCCU Facilities Management works to maintain compliance with all applicable state and federal regulations regarding water resources, provides a regulatory framework to ensure development has minimal impact on the environment, and manages the stormwater infrastructure.

Problem Statement

- While the 1% annual chance floodplain does not impact the NCCU campus, the 0.2% annual chance floodplain (or 500-year floodplain) does extend onto the NCCU campus and could potentially impact roadways within the southeastern corner of the campus boundary during these flood events.
- In 2019, a flash flood event was reported on several campus streets at North Carolina Central University.

D.5.3 Geological – Landslide

Hazard	Probability	Impact	Spatial Extent	Warning Time	Duration	PRI Score
Landslide	Unlikely	Minor	Small	6 to 12 hrs	Less than 6 hrs	1.4

Location

Durham County is located within the Piedmont physiographic province of North Carolina. The Piedmont province lies between the Coastal Plain and the Blue Ridge Mountains and encompasses approximately 45 percent of the area of the state. The Piedmont province is characterized by gently rolling, well-rounded hills and long low ridges with a few hundred feet of elevation difference between the hills and valleys.

The U.S. Geological Survey (USGS) has produced landslide susceptibility and incidence mapping of the U.S., as shown in **Figure D.10**. 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, Durham County faces moderate susceptibility and low incidence of landslides.

Spatial Extent: 2 – Small

Extent

In low-relief areas, such as the Durham County area, landslides may occur as cut-and fill failures (roadway and building excavations), river bluff failures, lateral spreading landslides, collapse of mine-waste piles (especially coal), and a wide variety of slope failures associated with quarries and open-pit mines. In these instances, impacts are limited to the defined area. Event magnitude is also dependent on topography; landslide risk is higher in areas with steeper slopes. Given the gentle topography the county, the magnitude of any landslides on NCCU's campus would be minor.

Impact: 1 – Minor

Historical Occurrences

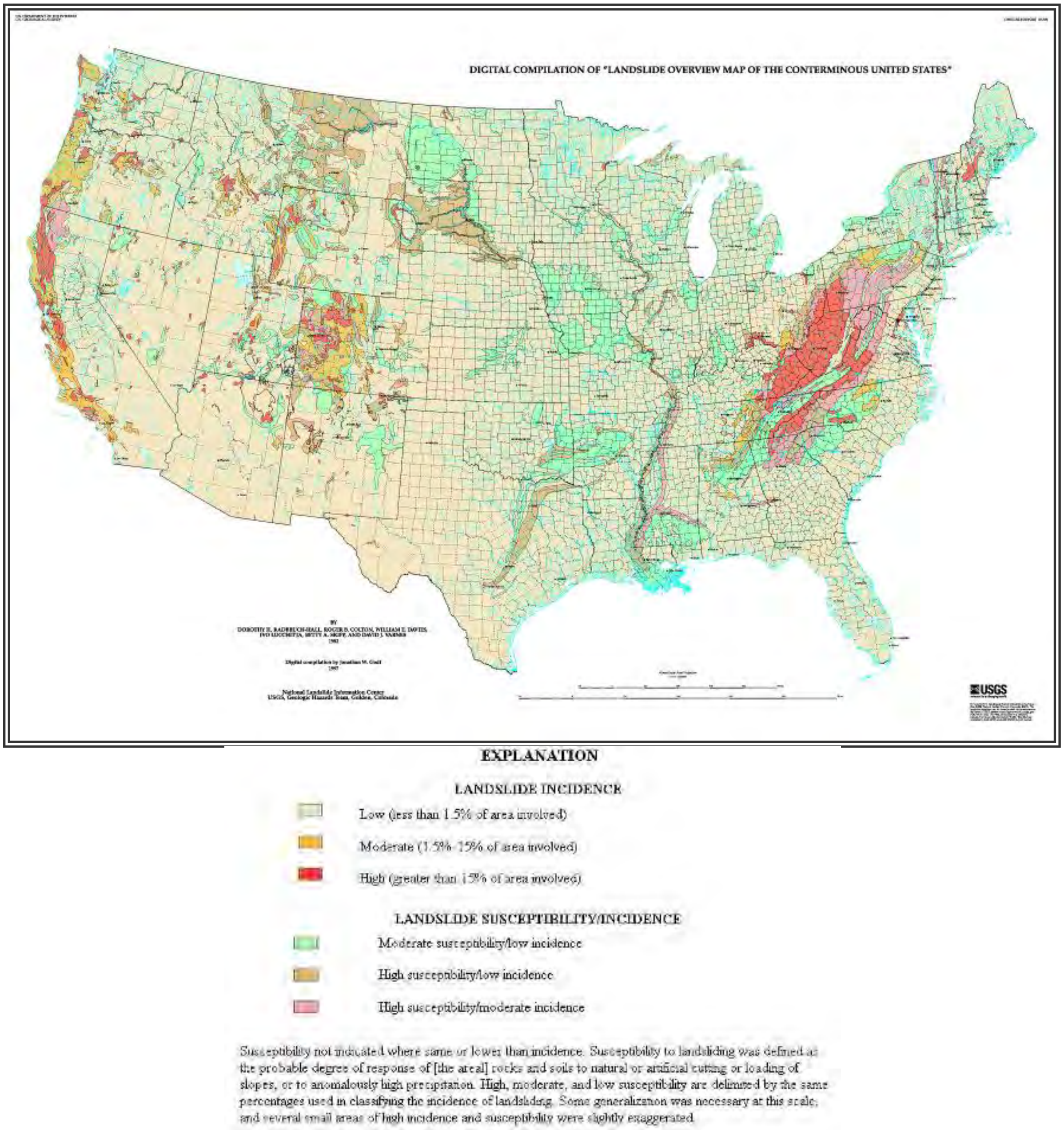
There were no available records of past landslide events for Durham County. When looking at the map in **Figure D.10**, it is shown that all of Durham County is in an area with moderate susceptibility and low incidence to landslides.

Probability of Future Occurrence

There were no records found for any landslide events occurring in Durham County between 2000 and 2019. Since this area does not have any historical occurrences, it is 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

Figure D.10 – Landslide Incidence and Susceptibility



Source: USGS

Vulnerability Assessment

People

People are unlikely to sustain serious physical harm as a result of landslides in Durham 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 Durham 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 Durham County are unlikely to cause any more severe impacts.

Changes in Development

Although Durham County faces moderate susceptibility and low incidence of landslides, future development projects should consider slope and soil slippage potential at the planning, engineering and architectural design stage with the goal of reducing vulnerability.

Problem Statement

- A landslide event 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.

D.5.4 Hurricane

Hazard	Probability	Impact	Spatial Extent	Warning Time	Duration	PRI Score
Hurricane	Likely	Critical	Large	More than 24 hrs	Less than 24 hrs	2.9

Location

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

Storm surges, or storm floods, are limited to the coastal counties of North Carolina, therefore NCCU is not exposed to storm surge. However, hurricane winds can impact the entire campus, so the spatial extent was determined to be large.

Spatial Extent: 4 – Large

Extent

Hurricane intensity is classified by the Saffir-Simpson Scale (**Table D.24**), which rates hurricane intensity on a scale of 1 to 5, with 5 being the most intense.

Table D.24 – 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 D.25** 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 D.25 – 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

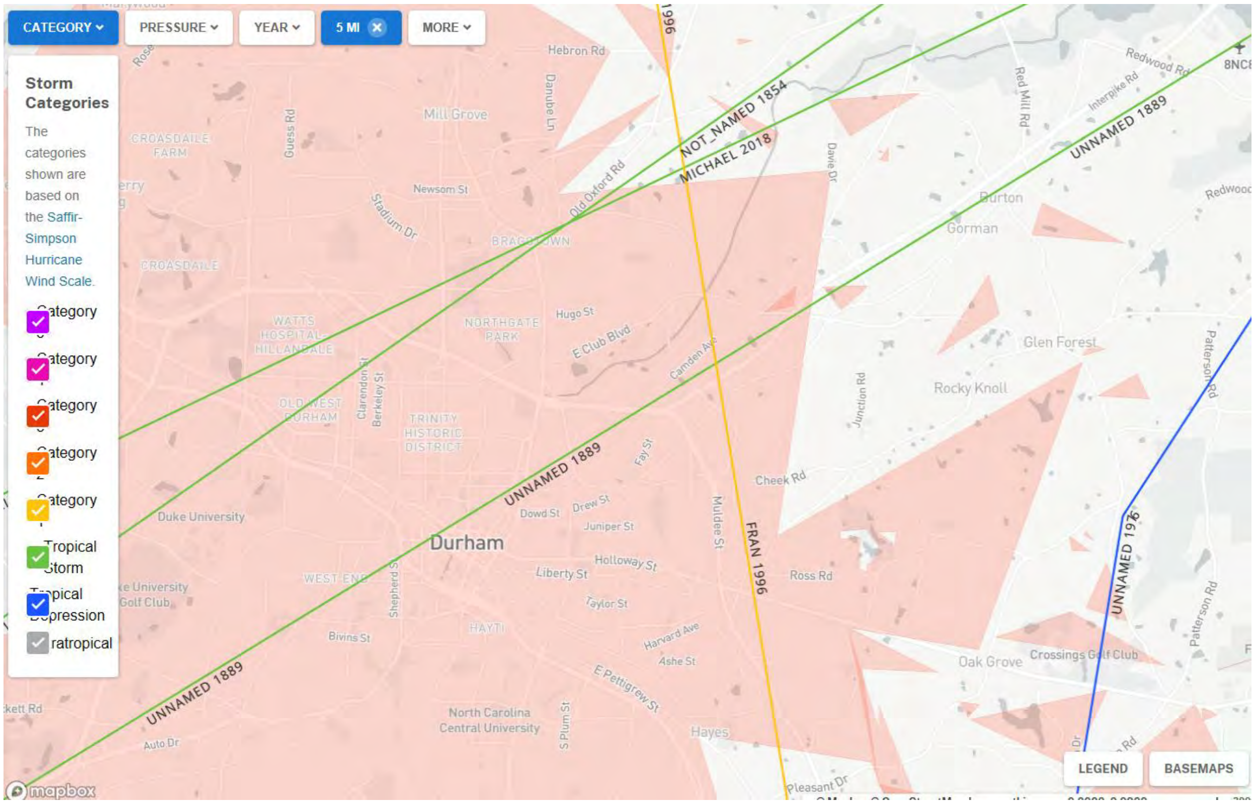
Tropical cyclones weaken relatively quickly after making landfall; therefore, Durham County will not typically experience major hurricane force winds, though these occurrences are possible. Hurricane Fran passed within 5 miles of NCCU's campus as a Category 1 storm with wind speeds around 75 mph in 1996.

Impact: 3 – Critical

Historical Occurrences

Storm tracks for hurricane-related events that have passed within 5 miles of NCCU's campus were obtained from NOAA's database and are shown in **Figure D.11**. The NCEI Storm Events database has recorded three hurricanes and tropical storms that passed through Durham County between 2000 and 2019. **Table D.26** details the historical occurrences.

Figure D.11 – Hurricane and Tropical Storm Tracks within 5 Miles of NCCU



Source: NOAA Office of Coastal Management; image captured directly from website.

Table D.26 – Recorded Hurricane and Tropical Storm Events for Durham County, 2000-2019

Date	Type	Storm	Deaths/ Injuries	Property Damage	Crop Damage
9/18/2003	Hurricane (Typhoon)	Hurricane Isabel	0/0	$205,000	$0
9/14/2018	Tropical Storm	Hurricane Florence	0/0	$0	$25,000
10/11/2018	Tropical Storm	Tropical Storm Michael	0/0	$200,000	$0
		Total	**0/0**	**$405,000**	**$25,000**

Source: NCEI

According to NCEI, three recorded hurricane-related events affected Durham County from 2000 to 2019 causing an estimated $405,000 in property damage and $25,000 in crop damage. There were no injuries or fatalities recorded for any of these events.

The following event narratives are provided in the NCEI Storm Events Database and illustrate the impacts of hurricane and tropical storm events on the county:

Hurricane Isabel (2003) –Hurricane Isabel made landfall along the Outer Banks just north of Cape Lookout around 1 pm on September 18, 2003. The eye of the storm tracked northeast passing over eastern Halifax County. Winds gusts to near Hurricane force were recorded over Halifax county. Many locations across the Coastal Plain and even back into the Triangle received wind gusts between 50 to 70 mph late in the afternoon until early evening. Many trees were uprooted falling on vehicles and homes all across the area. One person was killed in Franklin county when their vehicle struck a downed tree. Up to 6 inches of rain fell across Edgecombe, Halifax and Wilson counties resulting in flooding of several roads.

Hurricane Florence (2018) – A ridge of high pressure over eastern North America stalled Florence's forward motion a few miles off the southeast North Carolina coast on September 13th. Hurricane Florence made landfall near Wrightsville Beach early on Saturday, September 15, and weakened further as it moved slowly inland. Despite making landfall as a weakened Category 1 hurricane, Florence still produced 40 to 70 mph wind gusts, enough wind speed to uproot trees and cause widespread power outages throughout the Carolinas. As the storm moved inland, from September 15 to 17, heavy rain of 10 to 25 inches caused widespread inland flooding, inundating cities such as Fayetteville, Smithfield, Goldsboro, Durham, and Chapel Hill, and causing major river flooding on main-stem rivers such as the Neuse, Cape Fear, and Little River. Most major roads and highways in the area experienced some flooding, with large stretches of I-40 and I-95 remaining impassable for days after the storm had passed. The storm also spawned tornadoes in several places along its path. There were 3 direct and 6 indirect deaths attributed to the storm with in the WFO RAH CWA.

Tropical Storm Michael (2018) – Tropical Storm Michael moved through North Carolina on Thursday, October 11th. Michael brought heavy rain and strong damaging winds to central North Carolina. While heavy rainfall of 3 to 6 inches produced minor flash flooding across the area, it was high wind gusts of 40 to 60 mph that caused the biggest problems, knocking down score of trees, leading to blocked roadways and thousands without power.

The state of North Carolina has had four FEMA Major Disaster Declarations for Hurricanes in 1954, 1955, 1958, 1960. Additionally, Durham County has received four Major Disaster Declarations for Hurricanes in 1996, 1999, 2003, 2018.

Probability of Future Occurrence

In the 20-year period from 2000 through 2019, three hurricanes and tropical storms have impacted Durham County, which equates to a 15 percent annual probability of hurricane winds impacting the county. This probability does not account for impacts from hurricane rains, which may also be severe. Overall, the probability of a hurricane or tropical storm impacting the County is likely.

Probability: 3 – Likely

Vulnerability Assessment

Methodologies and Assumptions

To quantify vulnerability, Wood performed a Level 1 hurricane wind analysis in Hazus 4.2 for three scenarios: a historical recreation of Hurricane Fran (1996) and simulated probabilistic wind losses for a 200-year and a 500-year event storm. The analysis utilized general building stock information based on the 2010 Census. The NCCU campus is located within a single census tract encompassing 0.58 square miles. The vulnerability assessment results are for wind-related damages. Hurricanes may also cause substantial damages from heavy rains and subsequent flooding, which is addressed in Section D.5.2 Flood.

People

The very young, the elderly and disabled individuals are more vulnerable to harm from hurricanes, as are those who are unable to evacuate for medical reasons, including 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 or ongoing treatment. For all affected populations, 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.

Table D.27 details the likelihood of building damages by occupancy type from varying magnitudes of hurricane events.

Table D.27 – Likelihood of Buildings Damages Impacted by Hurricane Wind Events

Occupancy	Buildings at Risk	Value at Risk	Likelihood of Damage (%)				
			None	Minor	Moderate	Severe	Destruction
Hurricane Fran (1996)							
Agriculture	-	$0	0.00%	0.00%	0.00%	0.00%	0.00%
Commercial	27	$14,035,000	98.02%	1.83%	0.16%	0.00%	0.00%
Education	4	$6,488,000	98.32%	1.64%	0.04%	0.00%	0.00%
Government	-	$0	0.00%	0.00%	0.00%	0.00%	0.00%
Industrial	9	$2,219,000	98.31%	1.65%	0.04%	0.00%	0.00%
Religion	7	$6,190,000	98.37%	1.56%	0.07%	0.00%	0.00%
Residential	771	$274,856,000	96.98%	2.91%	0.11%	0.00%	0.00%
200-year Hurricane Event							
Agriculture	-	$0	0.00%	0.00%	0.00%	0.00%	0.00%
Commercial	27	$14,035,000	97.49%	2.28%	0.22%	0.01%	0.00%
Education	4	$6,488,000	97.88%	2.05%	0.07%	0.00%	0.00%
Government	-	$0	0.00%	0.00%	0.00%	0.00%	0.00%
Industrial	9	$2,219,000	97.88%	2.05%	0.06%	0.00%	0.00%
Religion	7	$6,190,000	97.91%	1.99%	0.09%	0.01%	0.00%
Residential	764	$274,856,000	96.05%	3.77%	0.17%	0.00%	0.00%
500-year Hurricane Event							
Agriculture	-	$0	0.00%	0.00%	0.00%	0.00%	0.00%
Commercial	26	$14,035,000	92.70%	6.17%	1.08%	0.05%	0.00%
Education	4	$6,488,000	93.65%	5.72%	0.61%	0.02%	0.00%
Government	-	$0	0.00%	0.00%	0.00%	0.00%	0.00%
Industrial	8	$2,219,000	93.69%	5.69%	0.60%	0.02%	0.00%
Religion	7	$6,190,000	93.33%	6.07%	0.56%	0.04%	0.00%
Residential	700	$274,856,000	88.10%	10.60%	1.28%	0.01%	0.01%

Table D.28 details the estimated building and content damages by occupancy type for varying magnitudes of hurricane events.

Table D.28 – Estimated Buildings Impacted by Hurricane Wind Events

Area	Residential	Commercial	Industrial	Others	Total
Hurricane Fran (1996)					
Building	$602,210	$6,540	$670	$4,420	$613,840
Content	$167,290	$550	$0	$0	$167,840
Inventory	$0	$0	$0	$0	$0
Total	**$769,500**	**$7,090**	**$670**	**$4,420**	**$781,680**
200-year Hurricane Event					
Building	$752,410	$8,210	$890	$5,690	$767,200
Content	$200,910	$1,170	$0	$0	$202,080
Inventory	$0	$20	$0	$0	$20
Total	**$953,320**	**$9,400**	**$890**	**$5,690**	**$969,300**
500-year Hurricane Event					
Building	$1,637,080	$26,980	$2,780	$17,050	$1,683,890
Content	$392,140	$5,630	$560	$2,550	$400,880
Inventory	$0	$120	$60	$0	$180
Total	**$2,029,220**	**$32,730**	**$3,400**	**$19,600**	**$2,084,950**

The damage estimates for the 500-year hurricane wind event total $2,084,950. These damage estimates account for only wind impacts and actual damages would likely be higher due to flooding. As noted in Section D.5.2, major roadways surrounding the southeastern portion of the campus are located within the 500-year floodplain. Therefore, the area would likely experience a higher overall loss ratio from the 500-year hurricane event and may face difficulty recovering from such an event.

Environment

Hurricane winds can cause massive damage to the natural environment, uprooting trees and other debris within the storm's path. Animals can either be killed directly by the storm or impacted indirectly through changes in habitat and food availability caused by high winds and intense rainfall. Endangered species can be dramatically impacted. Forests can be completely defoliated by strong winds.

Changes in Development

Future development that occurs in the planning area should consider high wind hazards at the planning, engineering and architectural design stages. The University should consider evacuation planning in the event of a hurricane event.

Problem Statement

- Historical tracks of multiple hurricane events pass within 5-miles of the NCCU Campus.
- For the 20-year period from 2000 through 2019, there have been 3 hurricane wind events causing over $400,000 in damage for Durham County.

D.5.5 Severe Winter Weather

Hazard	Probability	Impact	Spatial Extent	Warning Time	Duration	PRI Score
Severe Winter Weather	Highly Likely	Limited	Large	More than 24 hrs	Less than 1 week	3.0

Location

Severe winter weather is usually a countywide or regional hazard, impacting the entire county at the same time. 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. Durham 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, severe winter weather can occur anywhere in the county.

Spatial Extent: 4 – Large

Extent

The National Oceanic and Atmospheric Administration (NOAA) uses the Regional Snowfall Index (RSI), shown in **Table D.29** for the Durham County region, to assess the societal impact of winter storms in the six easternmost regions in the United States. The index makes use of population and regional differences to assess the impact of snowfall. For example, areas which receive very little snowfall on average may be more adversely affected than other regions, resulting in a higher severity. The County may experience any level on the RSI scale. Durham County receives an average of 2 inches of snowfall per year. According to NCEI, the greatest snowfall amounts to impact Durham County have been between 7-12 inches, with Durham reporting around 9 inches of snowfall. During the snowstorm of January 17, 2018, the county was classified as a Category 1 on the RSI scale. It is possible that more severe events and impacts could be felt in the future.

Table D.29 – Regional Snowfall Index (RSI) Values

Category	RSI Value	Description
1	1-3	Notable
2	3-6	Significant
3	6-10	Major
4	10-18	Crippling
5	18+	Extreme

Source: NOAA

Severe winter weather often involves 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 D.12**, provides a formula for calculating the dangers of winter winds and freezing temperatures. This presents wind chill temperatures which are based on the rate of heat loss from exposed skin caused by wind and cold. As the wind increases, it draws heat from the body, driving down skin temperature and eventually the internal body temperature.

Figure D.12 – NWS Wind Chill Temperature Index

Wind Chill Chart

Wind (mph)	Temperature (°F)																	
Calm	40	35	30	25	20	15	10	5	0	-5	-10	-15	-20	-25	-30	-35	-40	-45
5	36	31	25	19	13	7	1	-5	-11	-16	-22	-28	-34	-40	-46	-52	-57	-63
10	34	27	21	15	9	3	-4	-10	-16	-22	-28	-35	-41	-47	-53	-59	-66	-72
15	32	25	19	13	6	0	-7	-13	-19	-26	-32	-39	-45	-51	-58	-64	-71	-77
20	30	24	17	11	4	-2	-9	-15	-22	-29	-35	-42	-48	-55	-61	-68	-74	-81
25	29	23	16	9	3	-4	-11	-17	-24	-31	-37	-44	-51	-58	-64	-71	-78	-84
30	28	22	15	8	1	-5	-12	-19	-26	-33	-39	-46	-53	-60	-67	-73	-80	-87
35	28	21	14	7	0	-7	-14	-21	-27	-34	-41	-48	-55	-62	-69	-76	-82	-89
40	27	20	13	6	-1	-8	-15	-22	-29	-36	-43	-50	-57	-64	-71	-78	-84	-91
45	26	19	12	5	-2	-9	-16	-23	-30	-37	-44	-51	-58	-65	-72	-79	-86	-93
50	26	19	12	4	-3	-10	-17	-24	-31	-38	-45	-52	-60	-67	-74	-81	-88	-95
55	25	18	11	4	-3	-11	-18	-25	-32	-39	-46	-54	-61	-68	-75	-82	-89	-97
60	25	17	10	3	-4	-11	-19	-26	-33	-40	-48	-55	-62	-69	-76	-84	-91	-98

Frostbite Times: 30 minutes; 10 minutes; 5 minutes

$$\text{Wind Chill (°F)} = 35.74 + 0.6215T - 35.75(V^{0.16}) + 0.4275T(V^{0.16})$$

Where, T= Air Temperature (°F) V= Wind Speed (mph)

Effective 11/01/01

Source: https://www.weather.gov/safety/cold-wind-chill-chart

The most significant recorded snow depth over the last 20 years took place in January 2018, with recorded depths of up to 12 inches across the county.

Impact: 2 – Limited

Historical Occurrences

To get a full picture of the range of impacts of a severe winter weather, data for the following weather types as defined by the National Weather Service (NWS) 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.

According to the NCEI Storm Events Database, there was one heavy snow event, one ice storm, and 50 combined winter storm/winter weather events in Durham County during the 20-year period from 2000 through 2019. As reported in NCEI, severe winter weather caused $1,430,000 in property damage, but they did not cause any fatalities, injuries, or crop damage, though these types of impacts may not have been reported and are possible in future events. Events in Durham County by incident are recorded in **Table D.30**.

Table D.30 – Recorded Severe Winter Weather Events in Durham County, 2000-2019

Event Type	Event Count	Fatalities	Injuries	Property Damage	Crop Damage
Heavy Snow	1	0	0	$0	$0
Ice Storm	1	0	0	$400,000	$0
Winter Storm	25	0	0	$1,000,000	$0
Winter Weather	25	0	0	$30,000	$0
Total	**52**	**0**	**0**	**$1,430,000**	**$0**

Source: NCEI

Storm impacts from NCEI are summarized below:

January 29, 2010 – Between 5 to 7 inches of snow fell across the county. Over 600 automobile accidents were reported in the county. Due to the cold temperatures icy road conditions persisted for several days resulting in the closure of schools and businesses.

March 6, 2014 – One quarter of an inch of ice from freezing rain resulted in widespread downed trees and power-lines. A strong surface low deepening off the Carolina coast brought a wintry mix of snow, sleet, and freezing rain to the northern-northwestern Piedmont counties. Snowfall amounts of 4 to 7 inches fell Forsyth, Person and Guilford counties. Just to the south and east of this area, a corridor of mainly sleet mixed with freezing rain produced significant icing of a quarter to half inch. This icing produced widespread downed trees and power outages over the northwest Piedmont. At the peak of the storm, over a 400,000 customers were without power. A natural disaster was declared in 7 counties across the Raleigh CWA that were impacted by this storm.

February 25, 2015 – Snowfall/sleet amounts of 6 to 8 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 40,000 customers were without power in the county.

January 17, 2018 – Total snowfall amounts ranged from 7 to 12 inches across the county.

Durham County received three FEMA Major Disaster Declarations for a blizzard in 1996 and severe winter storms in 2000 and 2002.

Probability of Future Occurrence

NCEI records 52 severe winter weather related events during the 20-year period from 2000 through 2019, which equates to an annual probability greater than 100%. Therefore, the overall probability of severe winter weather in the county is considered highly likely (near or more than 100% annual probability).

Probability: 4 – Highly Likely

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.

The loss of use estimates provided in **Table D.31** were calculated using FEMA's publication *What is a Benefit?: Guidance on Benefit-Cost Analysis of Hazard Mitigation Project*, June 2009. These figures are used to provide estimated costs associated with the loss of power in relation to the populations served on campus. The loss of use is provided in the heading as the loss of use cost per person per day of loss. The estimated loss of use provided for the campus represents the loss of service of the indicated utility for one day for 10 percent of the population. These figures do not take into account physical damages to utility equipment and infrastructure. The estimated on-campus population used in the table below was determined by taking 25% of the current enrollment for NCCU, which is 8,078 students.

Table D.31 – Loss of Use Estimates for Power Failure Associated with Severe Winter Weather

On-Campus Population (Fall 2020)	Estimated Affected Population (10%)	Electric Loss of Use Estimate ($126 per person per day)
2,020	202	$25,452

Property

The NCEI reported $1,430,000 of property damage in association with any winter weather events between 2000 and 2019 for Durham County. Based on these records, the County experiences an estimated annualized loss of $71,500 in property damage. The average impact from winter weather events per incident in Durham is $27,500.

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.

Changes in Development

Future development could potentially increase vulnerability to this hazard by increasing demand on the utilities and increasing the exposure of infrastructure networks. NCCU may wish to consider developing a flexible emergency power network to provide efficient back-up power for vulnerable populations, critical facilities, and research facilities.

Problem Statement

- Severe winter weather events are highly likely for Durham County and the NCCU campus. The events have also resulted in three presidential disaster declarations for the County.

D.5.6 Tornadoes/Thunderstorms

Hazard	Probability	Impact	Spatial Extent	Warning Time	Duration	PRI Score
Tornado/Thunderstorm	Likely	Critical	Large	Less than 6 hrs	Less than 6 hrs	3.1

Location

Thunderstorm wind, lightning, and hail events do not have a defined vulnerability zone. The scope of lightning and hail is generally confined to the footprint of its associated thunderstorm. Although these events occur similarly throughout the planning area, they are more frequently reported in more urbanized areas because damages are more likely to occur where exposure is greater in more densely developed urban areas.

Thunderstorm Winds

The entirety of NCCU's campus can be affected by severe weather hazards. Thunderstorm wind events can span many miles and travel long distances, covering a significant area in one event. Due to the small size of the planning area, any given event will impact the entire planning area, approximately 50% to 100% of the planning area could be impacted by one event.

Spatial Extent: 4 – Large

Lightning

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 NCCU is exposed to lightning.

Spatial Extent: 4 – Large

Hail

Hailstorms frequently accompany thunderstorms, so their locations and spatial extents coincide. However, large-scale hail tends to occur in a more localized area within the storm.

Spatial Extent: 4 – Large

Tornado

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

Spatial Extent: 4 – Large

Extent

Thunderstorm Winds

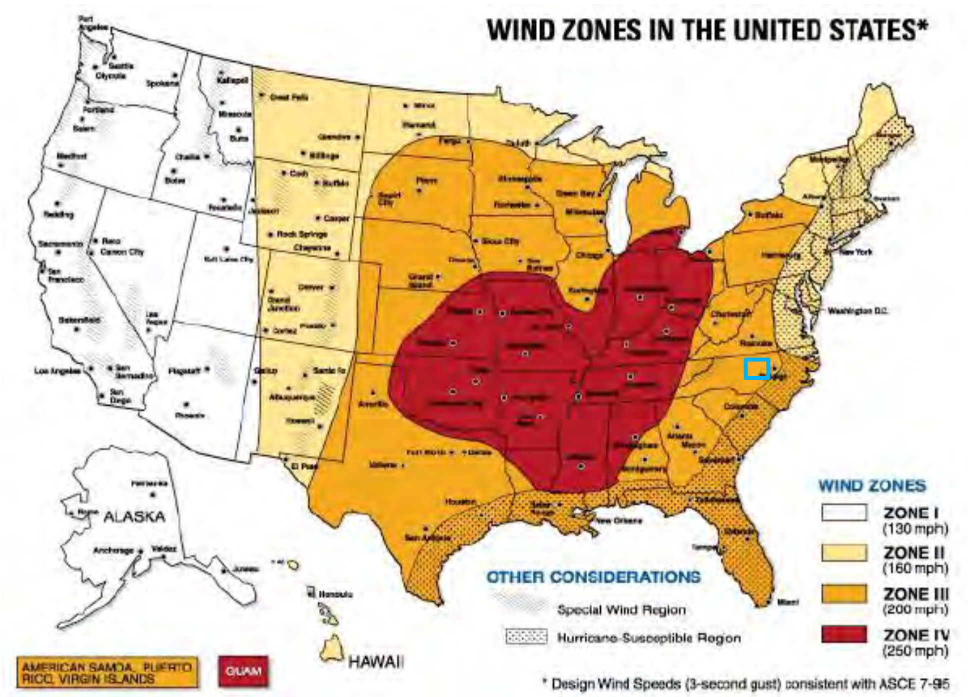
The magnitude of a thunderstorm event can be defined by the storm's maximum wind speed and its impacts. NCEI divides wind events into several types including High Wind, Strong Wind, Thunderstorm Wind, Tornado and Hurricane. For this severe weather risk assessment, High Wind, Strong Wind and Thunderstorm 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.

Figure D.13 shows wind zones in the United States. Durham County, indicated by the blue square, is within Wind Zone III, which indicates that speeds of up to 200 mph may occur within the county.

Figure D.13 – Wind Zones in the United States



Source: FEMA 320, Taking Shelter from the Storm, 3rd edition, https://www.fema.gov/pdf/library/ism2_s1.pdf

The strongest recorded thunderstorm wind event for Durham occurred on September 28, 2004 with a measured gust of 60 mph. The event reportedly resulted in no fatalities, injuries, property damages or crop damages.

Impact: 2 – Limited

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, shown in **Table D.32**, is a common parameter that is part of fire weather forecasts nationwide.

Table D.32 – 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

Lightning Activity Level Scale	
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

Hail

The National Weather Service classifies hail by diameter size, and corresponding everyday objects to help relay scope and severity to the population. **Table D.33** indicates the hailstone measurements utilized by the National Weather Service.

Table D.33 – 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
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 D.34** describes typical intensity and damage impacts of the various sizes of hail.

Table D.34 – 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

Intensity Category	Diameter (mm)	Diameter (inches)	Size Description	Typical Damage Impacts
Destructive	51-60	2.0-2.4	Hen's egg	Bodywork of grounded aircraft dented, brick walls Durhamed
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 2000 and 2019 in Durham was a little over 1" in diameter; the largest hailstone recorded was 1.75", recorded on April 17, 2000, July 28, 2005, May 14, 2006 and March 14, 2016.

Impact: 1 – Minor

Tornado

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 and better correlation between damage and wind speed. It is also more precise because it considers the materials affected and the construction of structures damaged by a tornado. **Table D.35** shows the wind speeds associated with the enhanced Fujita scale ratings and the damage that could result at different levels of intensity.

Table D.35 – 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 Durham in the past 20 years was an EF1 on May 15, 2004. NCEI reports this event causing around $250,000 in property damage, and narratives of the event approximate damage to roughly 40 homes experiencing roof and/or other structural damage. The tornado was 0.76 miles long and 150 yards wide.

Impact: 3 – Critical

Historical Occurrences

Thunderstorm Winds

Between January 1, 2000 and December 31, 2019, the NCEI recorded wind speeds for 46 separate incidents of thunderstorm winds, occurring on 35 separate days, for Durham. These events caused $230,750 in recorded property damage and no injuries or fatalities. The recorded gusts averaged 50.5 miles per hour, with the highest gusts recorded at 60 mph on May 25, 2000 and September 28, 2004. Of these events, 12 caused property damage. Wind gusts with property damage recorded averaged $4,591 in damage, with the highest reported damage being a total of $100,000 between multiple events on May 11, 2017. These incidents are aggregated by the date the events occurred and are recorded in **Table D.36**. These records specifically note Thunderstorm Wind impacts for Durham.

Table D.36 – Recorded Thunderstorm Winds, Durham, 2000-2019

Location	Date	Wind Speed (mph)	Fatalities	Injuries	Property Damage
DURHAM	4/8/2000	50	0	0	$0
DURHAM	5/20/2000*	50	0	0	$0
DURHAM	5/25/2000	60	0	0	$0
DURHAM	8/10/2000	50	0	0	$0
DURHAM	12/17/2000	50	0	0	$0
DURHAM	8/27/2001	50	0	0	$0
DURHAM	5/13/2002	50	0	0	$0
DURHAM	9/15/2002	50	0	0	$0
DURHAM	2/22/2003	50	0	0	$0
DURHAM	6/11/2004	50	0	0	$0
DURHAM	9/28/2004	60	0	0	$0
DURHAM	1/14/2005	50	0	0	$0
DURHAM	7/28/2005	50	0	0	$0
DURHAM	4/3/2006	50	0	0	$0
DURHAM	7/19/2006	50	0	0	$0
EAST DURHAM	6/9/2007*	50	0	0	$0
WEST DURHAM	7/4/2008	50	0	0	$0
WEST DURHAM	7/9/2008	50	0	0	$0
EAST DURHAM	5/9/2009	50	0	0	$0
EAST DURHAM	5/28/2010*	50	0	0	$0
DURHAM	6/23/2010	50	0	0	$15,000
WEST DURHAM	8/5/2010	50	0	0	$0
DURHAM	4/5/2011	50	0	0	$25,000
DURHAM	2/24/2012	50	0	0	$0
WEST DURHAM	6/29/2012	50	0	0	$10,000
WEST DURHAM	9/8/2012	50	0	0	$750
DURHAM	6/11/2014	50	0	0	$25,000
WEST DURHAM	6/19/2014*	50	0	0	$8,000

Location	Date	Wind Speed (mph)	Fatalities	Injuries	Property Damage
EAST DURHAM	6/29/2016*	50	0	0	$0
WEST DURHAM	5/11/2017*	50	0	0	$100,000
WEST DURHAM	6/10/2018	50	0	0	$1,000
DURHAM	7/22/2018	50	0	0	$5,000
WEST DURHAM	4/19/2019*	50	0	0	$16,000
WEST DURHAM	6/20/2019	50	0	0	$5,000
DURHAM	7/4/2019	50	0	0	$20,000
		Total	**0**	**0**	**$230,750**

Source: NCEI
*Note: Multiple events occurred on these dates. Injuries, fatalities, and property damage are totaled, wind speed is highest reported.

The State of North Carolina received a FEMA Major Disaster Declaration in 1956 for severe storms that included heavy rains and high winds.

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

April 8, 2000 – Strong wind gusts knocked down a tree that crashed into a mobile home and ripped a roof off a building.

April 3, 2006 – Tin roofs torn off a carport and barn and blown 1000 to 1500 feet downwind. Well house knocked down and shingles torn off a home on Shaw Road.

June 11, 2014 – Multiple trees were blown down within the city of Durham. In addition, 2 trees fell onto cars and 1 tree fell on a house. Monetary damages were unknown and were estimated.

July 4, 2019 – One tree was blown down onto a residence along Dacian Avenue in Durham. A lightning strike also resulted in a house fire near the 100 block of Presidents Drive.

Lightning

According to NCEI data, there was 1 lightning strike reported between 2000 and 2019. This lightning strike event recorded an estimated $10,000 worth of property damage. No crop damage, injuries, fatalities were recorded by this strike. 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. **Table D.37** details NCEI-recorded lightning strikes from 2000 through 2019 for Durham.

Table D.37 – Recorded Lightning Strikes in Durham, 2000-2019

Location	Date	Time	Fatalities	Injuries	Property Damage
DURHAM	3/27/2007	2200	0	0	$10,000
		Total	**0**	**0**	**$10,000**

Source: NCEI

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

March 27, 2007 – Lightning struck an apartment complex and sparked a fire. There was no immediate information on the extent of the damage.

Hail

NCEI records 21 days with hail incidents between January 1, 2000 and December 31, 2019 in Durham. None of these events were reported to have caused death, injury, property damage or crop damage. The largest diameter hail recorded in the City was 1.75 inches, which occurred on four different occasions in

2000, 2005, 2006, and 2016. The average hail size of all events in the City was just over one inch in diameter. **Table D.38** summarizes hail events for Durham. In some cases, hail was reported for multiple locations on the same day.

Table D.38 – Summary of Hail Occurrences in Durham

Beginning Location	Date	Hail Diameter
DURHAM	4/17/2000	1.75
DURHAM	4/29/2000	1
DURHAM	8/13/2000	0.75
DURHAM	8/27/2001	0.88
DURHAM	4/26/2003	0.75
EAST DURHAM	8/22/2003	0.75
DURHAM	10/3/2004	0.88
DURHAM	6/7/2005	0.75
DURHAM	7/28/2005	1.75
DURHAM	4/8/2006	0.75
DURHAM	5/14/2006	1.75
DURHAM	8/7/2006	0.75
DURHAM	7/27/2007	0.88
WEST DURHAM	3/4/2008	0.75
NORTH DURHAM	5/31/2008	1.25
NORTH DURHAM	6/2/2009	0.88
WEST DURHAM	5/27/2011	1
WEST DURHAM	3/24/2012	1.25
DURHAM SKYPARK ARPT	5/22/2012	1
NORTH DURHAM	3/14/2016	1.75
EAST DURHAM	6/29/2016	1

Source: NCEI

*Note: Multiple events occurred on these dates. Hail diameter is highest reported for that specific date.

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

July 28, 2005 – Golfball size hail was reported in Research Triangle Park.

May 22, 2012 – Quarter sized hail was reported covering the ground along Interstate 85 near mile marker 184.

March 14, 2016 – Hail up to the size of golf balls was reported along a swath from Duke Homestead Boulevard near Highway 157 to approximately 5 miles west-northwest of Gorman.

Tornado

NCEI storm reports were reviewed from 2000 through 2019 to assess whether recent trends varied from the longer historical record. According to NCEI, the city of Durham does not have any recorded tornado incidents between 2000 and 2019. It is likely that there have been several tornados that occurred in Durham but went unreported. However, neighboring communities surrounding Durham have three reported tornado incidents between 2000 and 2019, causing $350,000 in property damage and no injuries or deaths. **Table D.39** shows historical tornadoes in Durham along with its surrounding communities during this time.

Table D.39 – Recorded Tornadoes in Durham and Surrounding Communities, 2000-2019

Beginning Location	Date	Time	Magnitude	Deaths	Injuries	Property Damage	Crop Damage
GORMAN	5/14/2006	1710	F0	0	0	$0	$0
HOPE VLY	5/15/2014	1710	EF1	0	0	$250,000	$0
HUCKLEBERRY SPG	2/24/2016	1600	EF1	0	0	$100,000	$0

Source: NCEI

Narratives from NCEI illustrate that damage occurred in many of these incidents even if a monetary value was not recorded. Specific incidents include:

May 15, 2014 – A storm survey confirmed an EF-1 tornado near Durham. Damage consisted of dozens of snapped and uprooted trees and approximately 40 homes that experienced roof or other structural damage. Most of the damage to the homes was caused by falling trees and other debris. However, there were at least a half a dozen homes that experienced minor roof damage solely from the wind. In one case, a large oak tree was uprooted and fell onto a home, slicing through the roof and an exterior wall.

February 24, 2016 – The National Weather Service in Raleigh, NC has confirmed a brief tornado touchdown 5 miles northwest of downtown Durham in Durham County North Carolina. The touchdown occurred in a dense forest area near the intersection of Hillandale Road and Rose of Sharon Road. In this area, tree damage was extensive, mainly consisting of snapped trees.

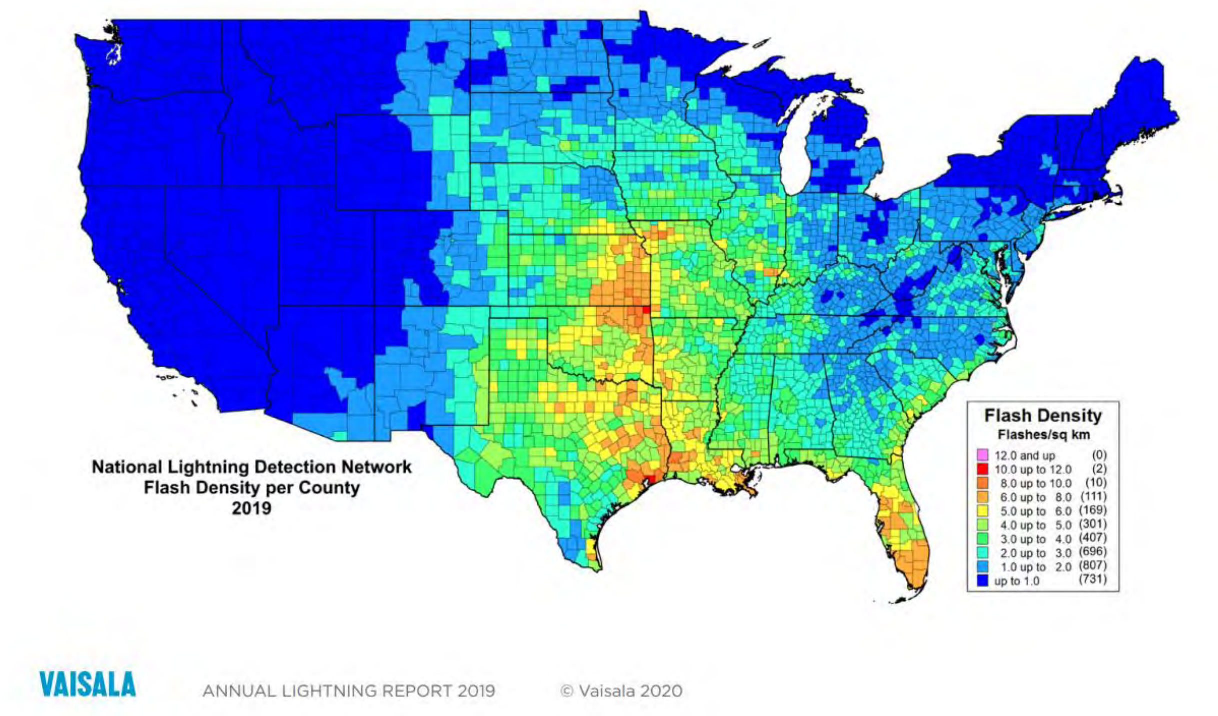
Probability of Future Occurrence

Based on historical occurrences recorded by NCEI for the 20-year period from 2000 through 2019, Durham averages 1.75 days with wind events per year. Over this same period, one lightning event was reported as having caused property damage, which equates to an average of 0.05 damaging lightning strikes per year.

The average hailstorm in Durham occurs in the evening and has a hail stone with a diameter of just over one inch. Over the 20-year period from 2000 through 2019, Durham experienced 21 days with reported hail incidents; this averages to 1.05 days per year with reported incidents somewhere in the City.

Based on the Vaisala 2019 Annual Lightning Report, North Carolina experienced 3,641,417 documented cloud-to-ground lightning flashes. According to Vaisala's flash density map, shown in **Figure D.14**, Durham County is located in an area that experiences 1 to 2 lightning flashes per square kilometer per year. It should be noted that future lightning occurrences may exceed these figures.

Figure D.14 – Lightning Flash Density per County (2019)



Source: Vaisala

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

In a twenty-year span between 2000 and 2019, Durham County has experienced three separate tornado incidents over three separate days. This correlates to a 15 percent annual probability that the County will experience a tornado somewhere in its boundaries. One of these past tornado events was a magnitude F0, and the other two tornado events were a magnitude of EF1; therefore, the annual probability of a significant tornado event is highly unlikely.

Based on these historical occurrences, there is between a 10% to 100% chance that Durham will experience severe weather each year. The probability of a damaging impacts is likely.

Probability: 3 – Likely

Vulnerability Assessment

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.

Similar to the loss of use estimates provided for Severe Winter Weather, the loss of use estimates for a tornadoes/thunderstorms were estimated as $25,446 per day, assuming 10-percent of the on-campus population is impacted.

Table D.40 – Loss of Use Estimates for Power Failure Associated with Severe Winter Weather

On-Campus Population (Fall 2020)	Estimated Affected Population (10%)	Electric Loss of Use Estimate ($126 per person per day)
2,020	202	$25,452

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 2018 American Community Survey (ACS) 5-Year Estimates, 934 occupied housing units (0.08 percent) in Durham are classified as “mobile homes or other types of housing.” Using the 2018 ACS average persons per household estimate of 2.35, the population at risk due to their housing type was estimated at 2,195 residents within Durham. Individuals who work outdoors may also face increased risk.

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. Therefore, the estimated 2,195 residents mentioned above residing in mobile homes in Durham are also at a greater risk to tornado damage due to their housing type.

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 Durham, the only event with recorded property damage was due to lightning striking a vehicle.

NCEI records lightning impacts over 20 years (2000-2019), with $10,000 in property damage recorded during one event in 2007. Based on these records, the planning area experiences an annualized loss of $500 in property damage. The average impact from lightning per incident in Durham is $5,000.

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, 2000 and December 31, 2019 in Durham, NCEI did not report any property damage as a direct result of hail.

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 Durham, thus the NCEI is still used to form a baseline.

Wind events reported in NCEI for the 20-year period from 2000 through 2019 totaled $230,750 in property damage, which equates to an annualized loss of $11,537.50 across the City.

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 2000, damaging tornadoes in the City are directly responsible for $350,000 worth of damage to property according to NCEI data. This equates to an annualized loss of $17,500.

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.

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.

Changes in Development

Future development projects should consider severe thunderstorms hazards and tornado and high wind hazards at the planning, engineering and architectural design stage with the goal of reducing vulnerability. University buildings with high occupancies should consider inclusion of a tornado shelters to accommodate occupants in the event of a tornado. Future development will also affect current stormwater drainage patterns and capacities.

Problem Statement

- Thunderstorms and tornadoes are frequent hazard events in Durham County and the NCCU campus. Reported damages for the 20-year period from 2000-1019 include $230,750 for thunderstorm winds, $10,000 for lightning strikes, and $350,000 for tornado events.

D.5.7 Wildfire

Hazard	Probability	Impact	Spatial Extent	Warning Time	Duration	PRI Score
Wildfire	Unlikely	Limited	Moderate	More than 24 hrs	More than 1 week	2.0

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 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 D.41** details the WUI on the NCCU campus, and **Figure D.15** below shows the WUI area. Over 73% of the campus falls outside the WUI. On a county level, Durham County is predominately classified as WUI intermix and interface areas and medium to high density housing in the agricultural areas with noted pockets of very low to no housing in non-WUI vegetated areas.

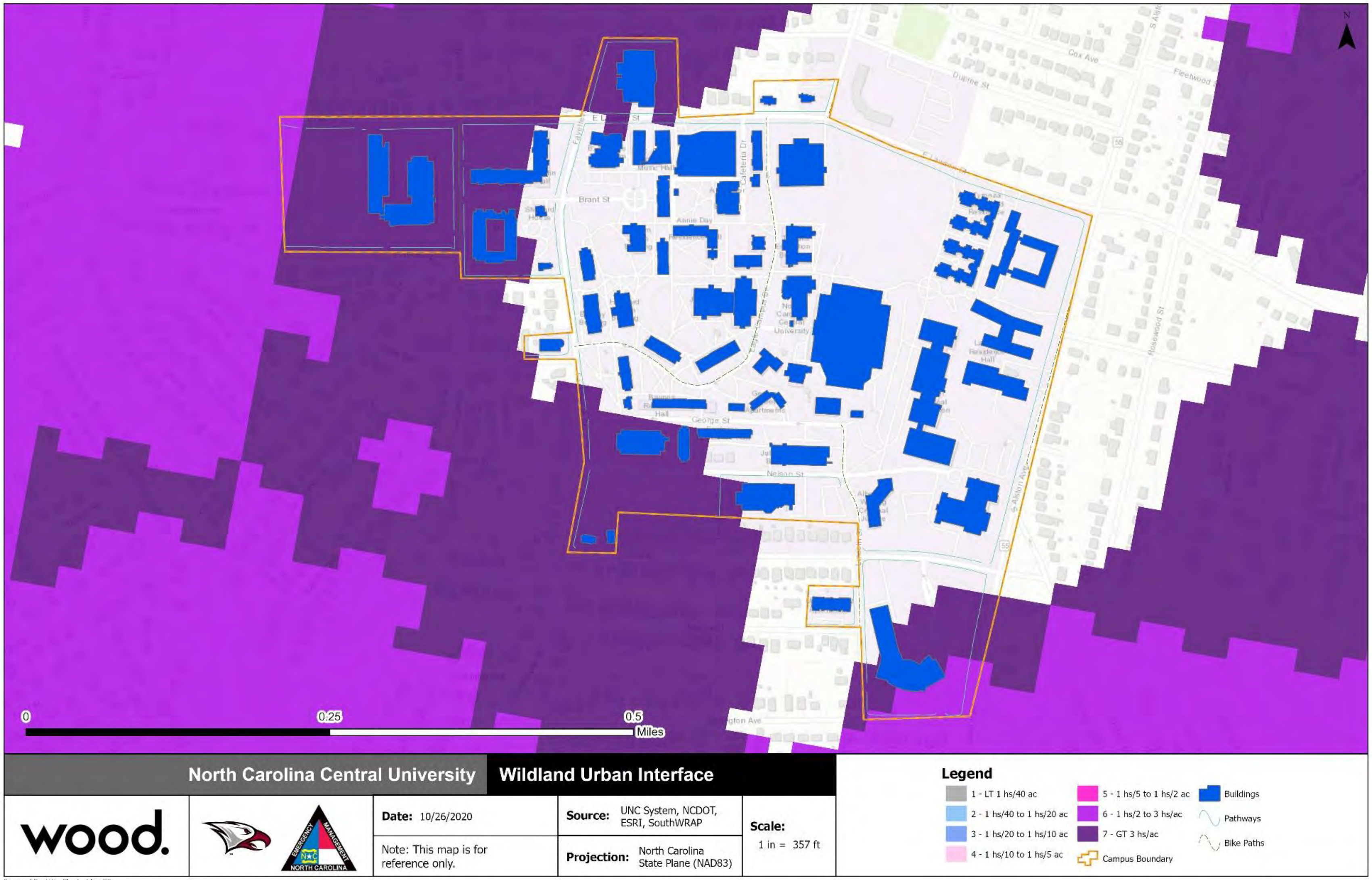
Table D.41 – Wildland Urban Interface, Population and Acres

	Housing Density	WUI Acres	Percent of WUI Acres
	Not in WUI	85	73.3%
	LT 1hs/40ac	0	0.0%
	1hs/40ac to 1hs/20ac	0	0.0%
	1hs/20ac to 1hs/10ac	0	0.0%
	1hs/10ac to 1hs/5ac	0	0.0%
	1hs/5ac to 1hs/2ac	0	0.0%
	1hs/2ac to 3hs/1ac	2	2.1%
	GT 3hs/1ac	28	24.6%
	Total	**115**	--

Source: Southern Wildfire Risk Assessment

Spatial Extent: 3 – Moderate

Figure D.15 – Wildland Urban Interface Areas, NCCU



Extent

The entire state is at risk to a wildfire occurrence. However, several factors such as drought conditions or high levels of fuel on the forest floor may make a wildfire more likely in certain areas. 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, shown in **Table D.42**, consists of five classes, as defined by Southern Wildfire Risk Assessment. **Figure D.16** shows the potential fire intensity within the WUI across North Carolina Central University.

Table D.42 – 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.

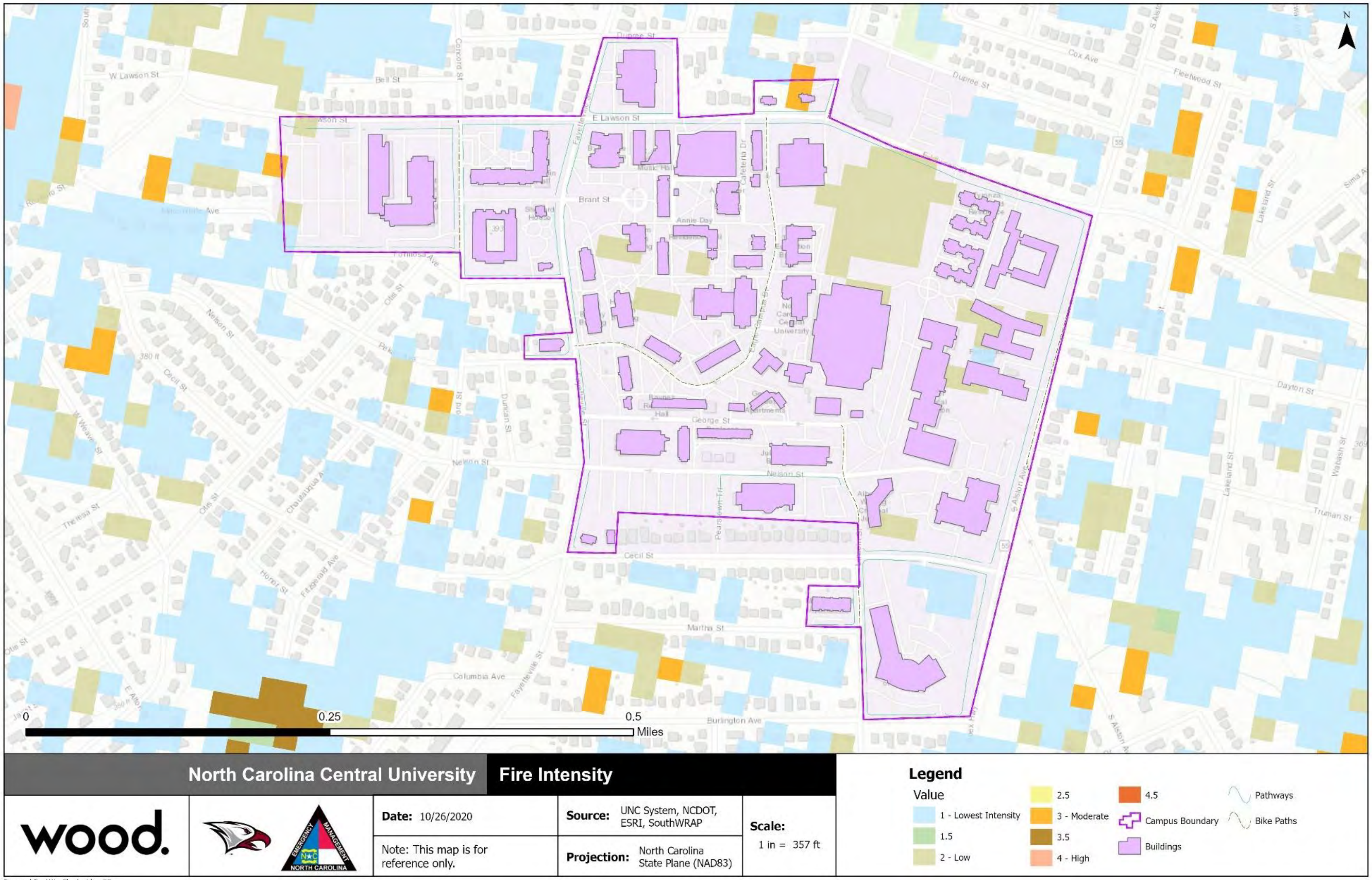
Source: Southern Wildfire Risk Assessment

The entirety of the NCCU campus is rated 3 or lower on the potential fire intensity scale. In fact, for the majority of NCCU's campus (89.6%) there is no potential fire intensity. An additional 10.1 percent would face a Class 1 or Class 2 Fire Intensity, which is easily suppressed. Only 0.3 percent of the campus may experience Class 3 Fire Intensity, which has potential for harm to life and property but is relatively easy to suppress with dozer and plows.

The WUI Risk Index is used to rate the potential impact of a wildfire on people and their homes. It reflects housing density (per acre) consistent with Federal Register National standards. The WUI Risk Index ranges of values from -1 to -9, with -1 representing the least negative impact and -9 representing the most negative impact. **Figure D.17** maps the WUI Risk Index for North Carolina Central University (NCCU). The WUI areas within the campus of NCCU have a value of -5 on the WUI Risk Index.

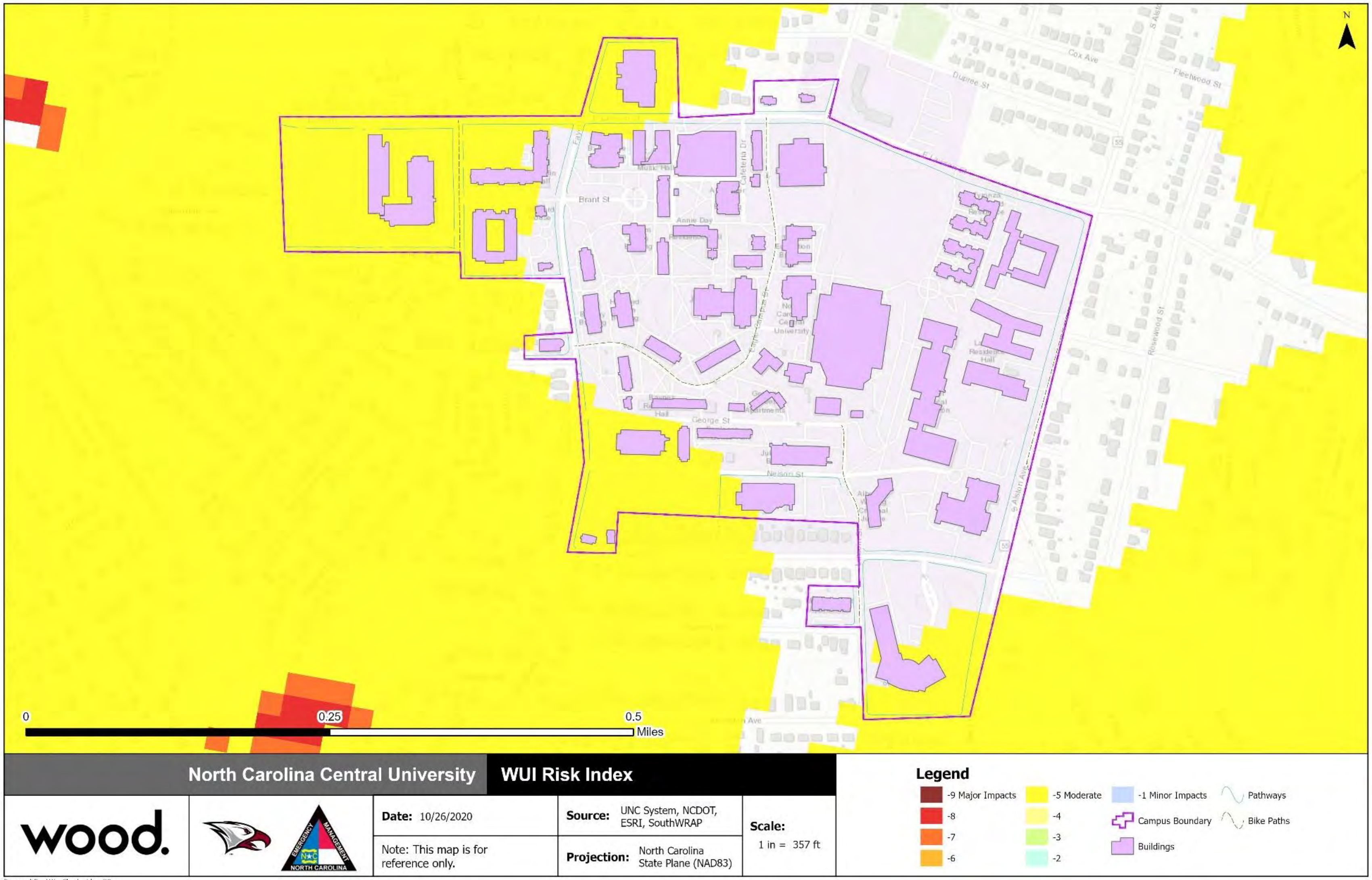
Impact: 2 – Limited

Figure D.16 – Characteristic Fire Intensity, North Carolina Central University



Prepared By: LW - Checked by: GS

Figure D.17 – WUI Risk Index, North Carolina Central University



Historical Occurrences

According to the North Carolina Forest Service (NCFS) there were 496 noted wildfires within Durham County between 2000 and 2019. The total acreage burned during this period was 1130.8 acres. There were no additional data records regarding specific cities or school districts within Durham County. The data is from NCFS records only and may not include data on fires burned within jurisdictional limits that did not require NCFS assistance to suppress. Actual number of fires and acreage burned may be higher than what is reported here.

On average, Durham County experiences 24.8 fires and 56.5 acres burned annually from fires reported by the NCFS. Actual number of fires and acreage burned is likely higher because smaller fires within jurisdictional boundaries are managed by local fire departments. Based on these records, the average wildfire event can be calculated as 2.3 acres. Actual number of fires and acreage burned is likely higher because smaller fires within jurisdictional boundaries are managed by local fire departments. The most known cause was noted as debris.

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 NCCU is detailed in **Table D.43** and illustrated in **Figure D.18.**

Table D.43 – Burn Probability, NCCU

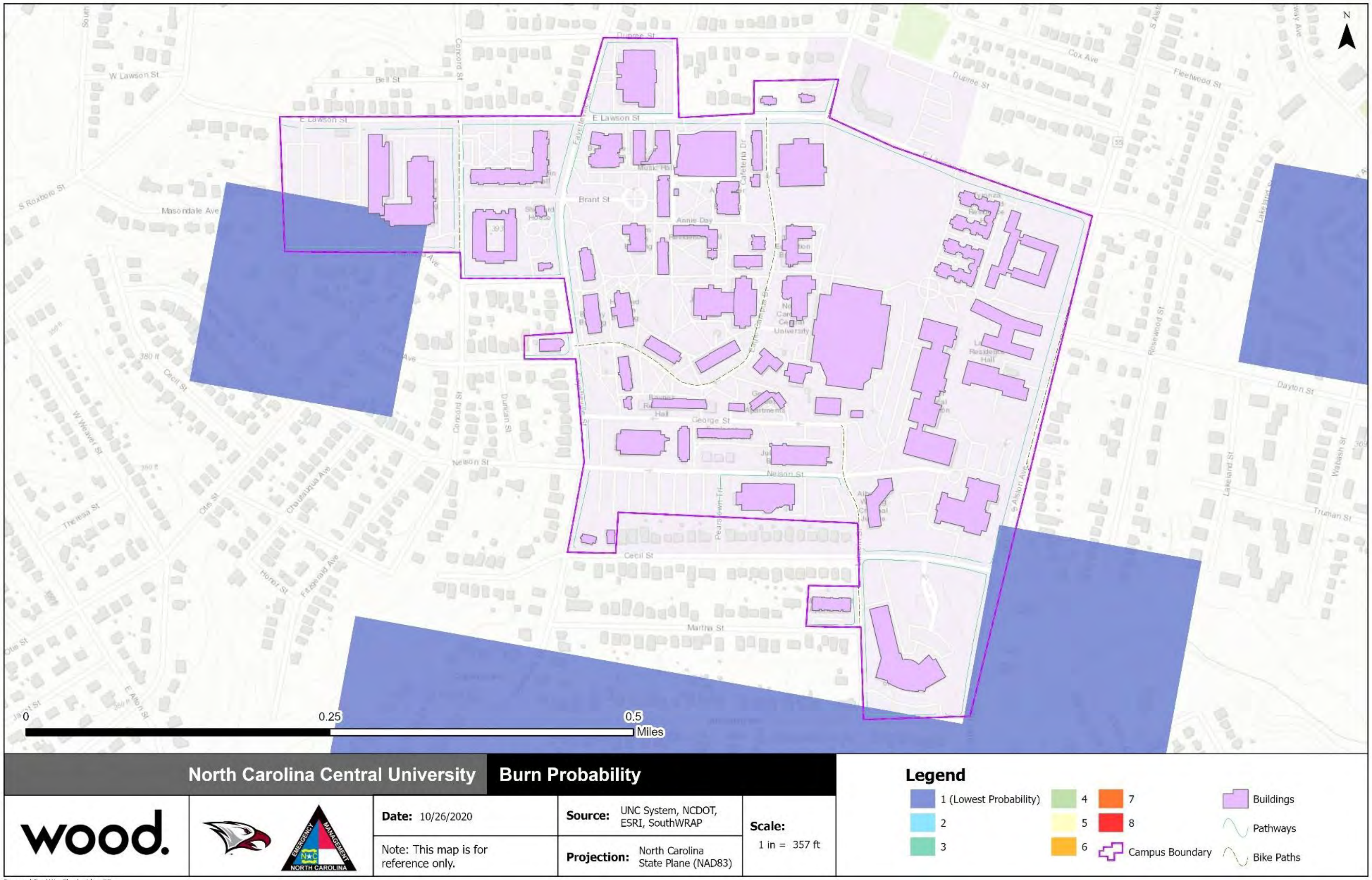
	Class	Acres	Percent
	No probability	111	96.5%
	1	4	3.5%
	2	0	0.0%
	3	0	0.0%
	4	0	0.0%
	5	0	0.0%
	6	0	0.0%
	7	0	0.0%
	8	0	0.0%
	9	0	0.0%
	10	0	0.0%
	Total	**115**	--

Source: Southern Wildfire Risk Assessment

A limited portion of the campus is located within an area defined as Class 1 having the lowest probability. Located within this low burn probability area are the critical facilities BRITE and Townes Science Building.

Probability: 1 – Unlikely

Figure D.18 – Burn Probability, North Carolina Central University



Vulnerability Assessment

People

Wildfire can cause fatalities and human health hazards. Ensuring procedures are in place for rapid warning and evacuation are essential to reducing vulnerability.

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.

Using the Wildland Urban Interface Risk Index (WUIRI) from the Southern Wildfire Risk Assessment, a GIS analysis was used to estimate the exposure of buildings most at risk to loss due to wildfire. The WUIRI shows a rating of the potential impact of wildfire on homes and people. This index ranges from 0 to -9, where lower values are relatively more severe. **Table D.44** summarizes the number of buildings and their total value that fall within areas rated -5 or less on the WUIRI. This table represents potential risks and counts every building within the area rated under -5, actual damages in the event of a wildfire may differ.

Table D.44 – Building Counts and Values within WUIRI under -5

Jurisdiction	Buildings	Building Value
Administration	1	$754,862
Critical Facility	6	$49,701,855
Extracurricular/Educational	5	$10,224,113
Housing	2	$1,053,788
Total	**14**	**$61,734,618**

Source: GIS Analysis, Southern Wildfire Risk Assessment

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.

Changes in Development

Growth on the NCCU campus within the wildland-urban interface area will increase the vulnerability of people, property, and infrastructure to wildfires. Although a wildfire community protection plan exists for the state of North Carolina, there are no community wildfire protection plans and no wildfire mitigation review requirements or regulations for development in the wildland-urban interface in Durham County. However, Durham County has a Forest Protection Program to provide urban and community forestry planning and forest fire protection, among other programs.

Problem Statement

- There are 14 buildings within areas of moderate impact risk, including 5 critical buildings: H.M. Michaux School of Education, Eagle Landing Residence Hall, Townes Science Building, BRITE, and Ruffin Residence Hall.

D.5.8 Cyber Threat

Hazard	Probability	Impact	Spatial Extent	Warning Time	Duration	PRI Score
Cyber Threat	Possible	Critical	Large	Less than 6 hrs	More than 1 week	3.1

Location

Cyber disruption events can occur and/or impact virtually any location in the state where computing devices are used. Incidents may involve a single location or multiple geographic areas. A disruption can have far-reaching effects beyond the location of the targeted system; disruptions that occur far outside the region can still impact people, businesses, and institutions within the region.

On the NCCU campus, the Information Technology Services (ITS) provides integrated technology support for administrative computing, client services, IT infrastructure systems, and IT security. The University's critical applications require passwords for access. Modifications of the application software are protected from abuse by an electronic software control procedure. Information security is managed and controlled in accordance with the university's Information Security Policy.

Spatial Extent: 4 – Large

Extent

The extent or magnitude/severity of a cyber disruption event is variable depending on the nature of the event. A disruption affecting a small, isolated system could impact only a few functions/processes. Disruptions of large, integrated systems could impact many functions/processes, as well as many individuals that rely on those systems.

There is no universally accepted scale to quantify the severity of cyber-attacks. The strength of a DDoS attack is sometimes explained in terms of a data transmission rate. One of the largest DDoS disruptions ever, which brought down some of the internet's most popular sites on October 21, 2016, peaked at 1.2 terabytes per second.

Data breaches are often described in terms of the number of records or identities exposed. With the amount of data retained by universities – including student, staff, and faculty personal information as well as research data – a data breach on the NCCU campus could cause significant disruption and impact a large number of records.

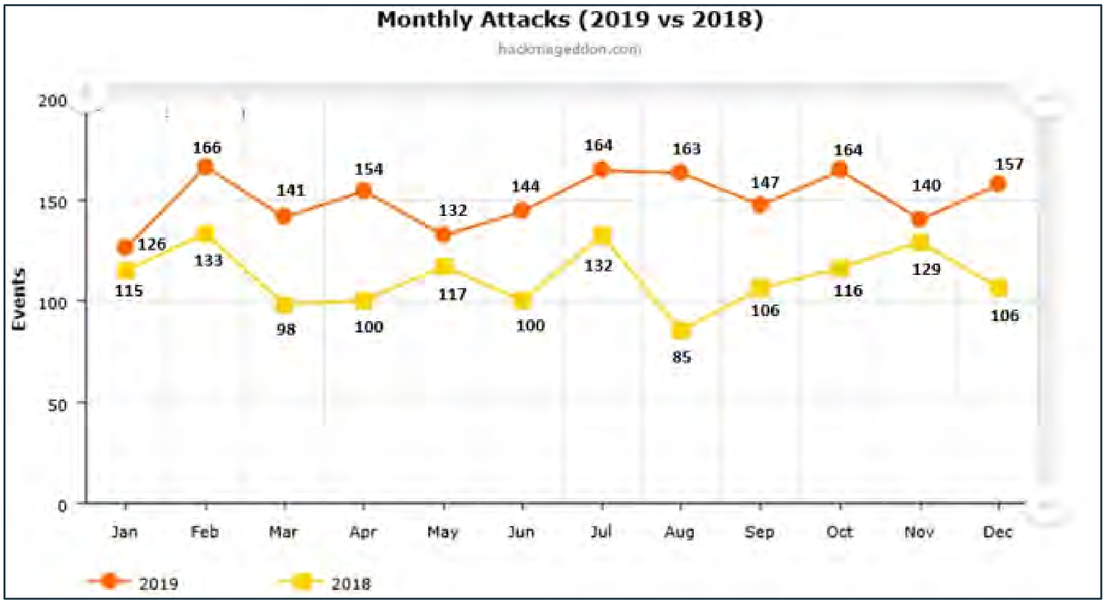
Impact: 3 – Critical

Historical Occurrences

As cyber disruption is an emerging hazard, the reporting and tracking of disruptive events is difficult. In most cases, it is not required to report an event, and when it is reported most of the information is protected due to the sensitive nature of the systems that have been disrupted. However, there currently exists several complex databases that track cyber disruption occurrences. Each system makes use of its own definitions and tracking methods. Hackmageddon is one online source that tracks Cyber Attack Statistics. Hackmageddon was developed by Paolo Passeri, an expert in the computer security industry for more than 15 years and current Principal Sales Engineer at OpenDNS (now part of Cisco). The timelines collect the major cyber events of the related months chosen among events published by open sources (such as blogs or news sites). It should be noted that this database collects cyber-attacks worldwide and this data is provided to show how this hazard is trending in general. During 2019, this database collected reports of a total of 1,802 cyber-attacks.

The graphic in **Figure D.19** provides a comparison of the number of attacks collected during 2018 and 2019. The two following images in **Figure D.20** and **Figure D.21** shows the top 10 target distributions for 2018 and 2019. The main finding from the top 10 attack techniques is the percentage of 'other' targeted attacks appearing at 14.1% in 2019. Attacks targeted towards Education slightly increased from 6.4% in 2018 to 7.1% in 2019. Most other target distributions experienced a percentage decrease in 2019. Some of this is probably due to the difference in distribution categories between 2018 and 2019.

Figure D.19 – Comparison of Monthly Attacks Collected by Hackmageddon (2018-2019)



Source: Hackmageddon, https://www.hackmageddon.com/2020/01/23/2019-cyber-attacks-statistics/

Figure D.20 – Top 10 Cyber Attack Target Distributions, 2018

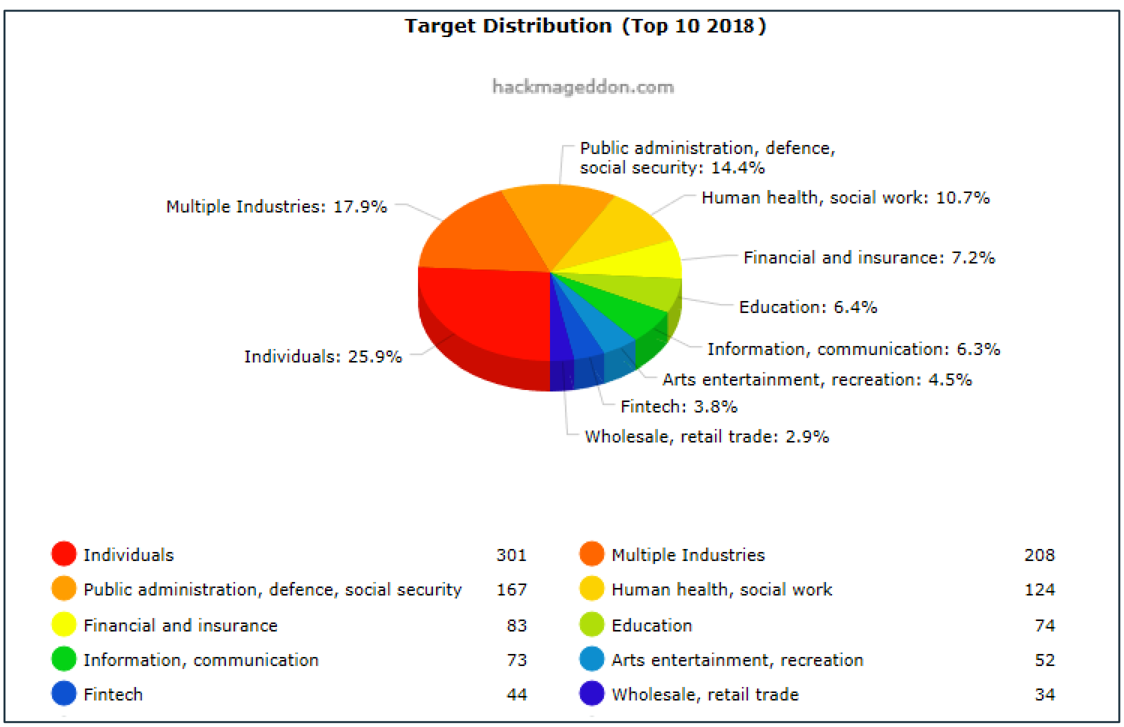
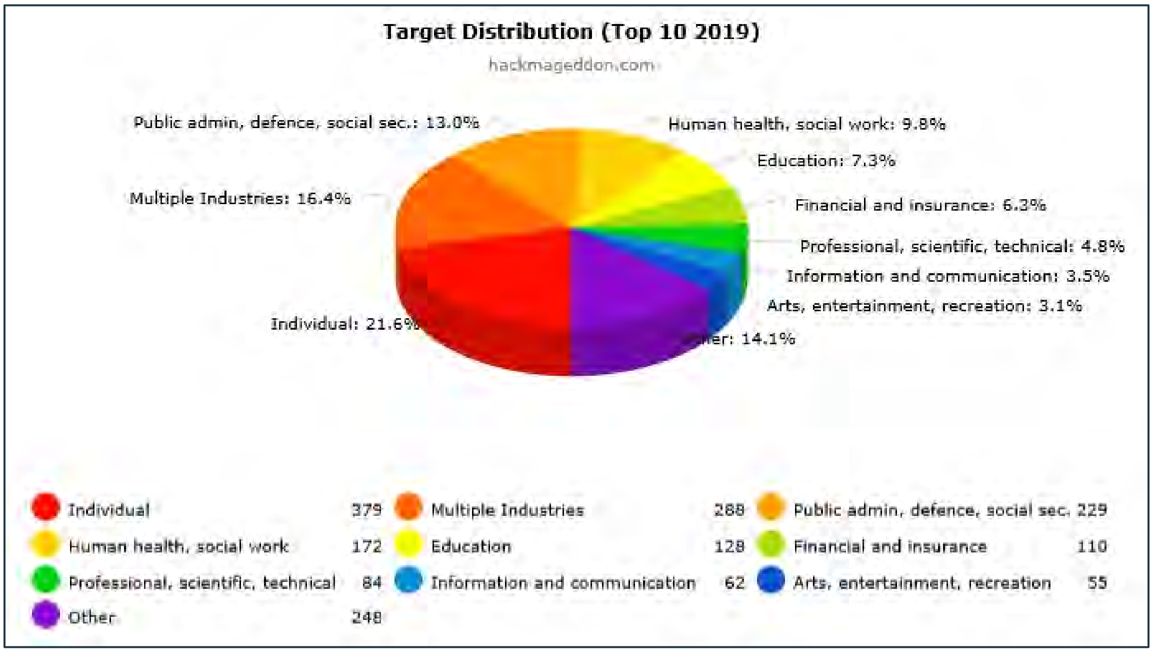


Figure D.21 – Top 10 Cyber Attack Target Distributions, 2019



There have been some notable disruption events within the Education target distribution that attained national attention in the last few years:

August 2020, The University of North Carolina Wilmington's Division of University Advancement (DUA) was hacked by a ransomware attack. The data included names, addresses, phone numbers, email addresses, and history of gifts made to UNCW; the University reported that no vulnerable financial or personal information was included. (https://portcitydaily.com/story/2020/08/06/uncw-reports-ransomware-attack-hackers-accessed-personal-details-but-no-financial-info/)

November 2019, The University of North Carolina Chapel Hill School of Medicine reported over 3,500 individuals having private information stolen in phishing cyber-attack, (https://www.databreaches.net/the-university-of-north-carolina-chapel-hill-school-of-medicine-notifying-patients-after-2018-phishing-incident/).

October 2019, Randolph Community College's entire computer network and other devices were compromised following cyberattack. In total, 1,200 devices were affected during the two week attack, (https://www.yourdailyjournal.com/news/89334/report-rcc-cyber-attack-was-first-successful-of-this-scale-at-nc-community-college).

December 2018, The Cape Cod Community College notifies its employees that Hackers stole more than $800,000 when they infiltrated the school's bank accounts, (https://www.databreaches.net/hackers-steal-800000-from-cape-cod-community-college/).

September 2018, The Henderson school district in Texas is hit with a business email compromise (BEC) attack resulting in a $600,000 loss for the district. The attack took place on September, 26th, (https://www.scmagazine.com/home/security-news/bec-attack-scamstexas-school-district-out-of-600000/).

April 2018, Partial social security numbers of more than 1,200 employees at Irvington schools are distributed via email to an unknown number of recipients by an unidentified attacker, (https://www.databreaches.net/hacker-sent-email-with-1200-partial-social-security-numbers-to-school-staff/).

March 2018, Florida Virtual Learning School notifies 368,000 current and former students, after an individual with the moniker $2a$45 uploads information of 35,000 students on a forum. Leon County Schools is among the affected organizations, (https://www.databreaches.net/leon-county-schools-vendors-data-leak-exposed-368000-current-and-former-flvs-students-details-lcs-teacher-data-and-more/).

November 2017, Monticello Central School District warns of a sophisticated e-mail phishing attack occurred on November 1st, 2017. Potentially 2,598 individuals are affected, (https://www.databreaches.net/monticello-central-school-district-notifying-almost-2600-of-phishing-attack-last-year/).

October 2017, The Los Angeles Valley College (LAVC) is forced to pay $28,000 in bitcoin after cybercriminals successfully infected its computer networks, email systems and voicemail lines with ransomware, (https://www.ibtimes.co.uk/la-school-pays-hackers-28000-bitcoin-after-computer-systems-hit-ransomware-1600304).

July 2017, Tax information for dozens of University of Louisville employees is compromised after a hack of the online system the university uses to give employees access to tax documents, (https://www.databreaches.net/tax-information-of-some-university-of-louisville-employees-hacked/).

April 2017, Westminster College in Missouri reveals the details of a breach discovered on March 26 after a phishing scam duped a staffer into sending off W-2 statements, (https://www.scmagazine.com/home/security-news/data-breach/w-2-data-breach-at-westminster-college/).

Probability of Future Occurrence

Cyber attacks occur daily, but most have negligible impacts at the local or regional level. The possibility of a larger disruption affecting systems within the region is a constant threat, but it is difficult to quantify the exact probability due to such highly variable factors as the type of attack and intent of the attacker. Minor attacks against business and government systems have become a commonplace occurrence but are usually stopped with minimal impact. Similarly, data breaches impacting the information of students and faculty of NCCU are almost certain to happen in coming years. Major attacks or breaches specifically targeting systems at the University are less likely but cannot be ruled out.

Probability: 2 – Possible

Vulnerability Assessment

As discussed above, the impacts from a cyber attack vary greatly depending on the nature, severity, and success of the attack.

People

Cyber-attacks can have a significant cumulative economic impact. Check Point Research reports that in 2018, cybercrime rates were estimated to have generated around 1.5 trillion dollars. A major cyber-attack has the potential to undermine public confidence and build doubt in their government’s ability to protect them from harm. Injuries or fatalities from cyber attacks would generally only be possible from a major cyber terrorist attack against critical infrastructure.

Property

Short of a major cyber terrorist attacks against critical infrastructure, property damage from cyber attacks is typically limited to computer systems.

Environment

Short of a major cyber terrorist attacks against critical infrastructure, property damage from cyber attacks is typically limited to computer systems. A major cyber terrorism attack could potentially impact the environment by triggering a release of a hazardous materials, or by causing an accident involving hazardous materials by disrupting traffic-control devices.

Changes in Development

With enrollment decreasing since the last plan, the number of users of campus networks and software has decreased. Additionally, with fewer buildings located on campus, the number of network access points has decreased.

For future development, as the number of users and/or access points to the network and campus software increases, the opportunity for cyber-attacks is also likely to increase.

Problem Statement

- Cyber-attacks occur daily, but most have negligible impacts at the local or regional level. The possibility of a larger disruption affecting systems within the region is a constant threat, but difficult to quantify.
- The University's Information Technology Services (ITS) addresses IT security through policies addressing users, physical security, system security, password administration, communications, wireless devices, computer viruses, disaster recovery, and compliance with law and policy.

D.5.9 Hazardous Materials Incidents

Hazard	Probability	Impact	Spatial Extent	Warning Time	Duration	PRI Score
Hazardous Materials Incident	Highly Likely	Minor	Negligible	Less than 6 Hrs	Less than 24 Hrs	2.3

Location

Hazardous materials releases at fixed sites can cause a range of contamination from very minimal to catastrophic. The releases can go into the air, onto the surface, or into the ground and possibly into groundwater, or a combination of all. Although releases into the air or onto the ground surface can pose a great and immediate risk to human health, they are generally easier to remediate than those releases which enter into the ground or groundwater. Soil and groundwater contamination may take years to remediate causing possible long-term health problems for individuals and rendering land unusable for many years.

The Toxics Release Inventory (TRI) Program run by the 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 9 sites reporting hazardous materials incidents in Durham from 2016-2018. These sites are by location and sector in **Table D.45.** HMPC identified one critical facility, Heating Plant, on NCCU's campus with hazardous materials.

Table D.45 – Toxic Release Inventory Facilities in Durham

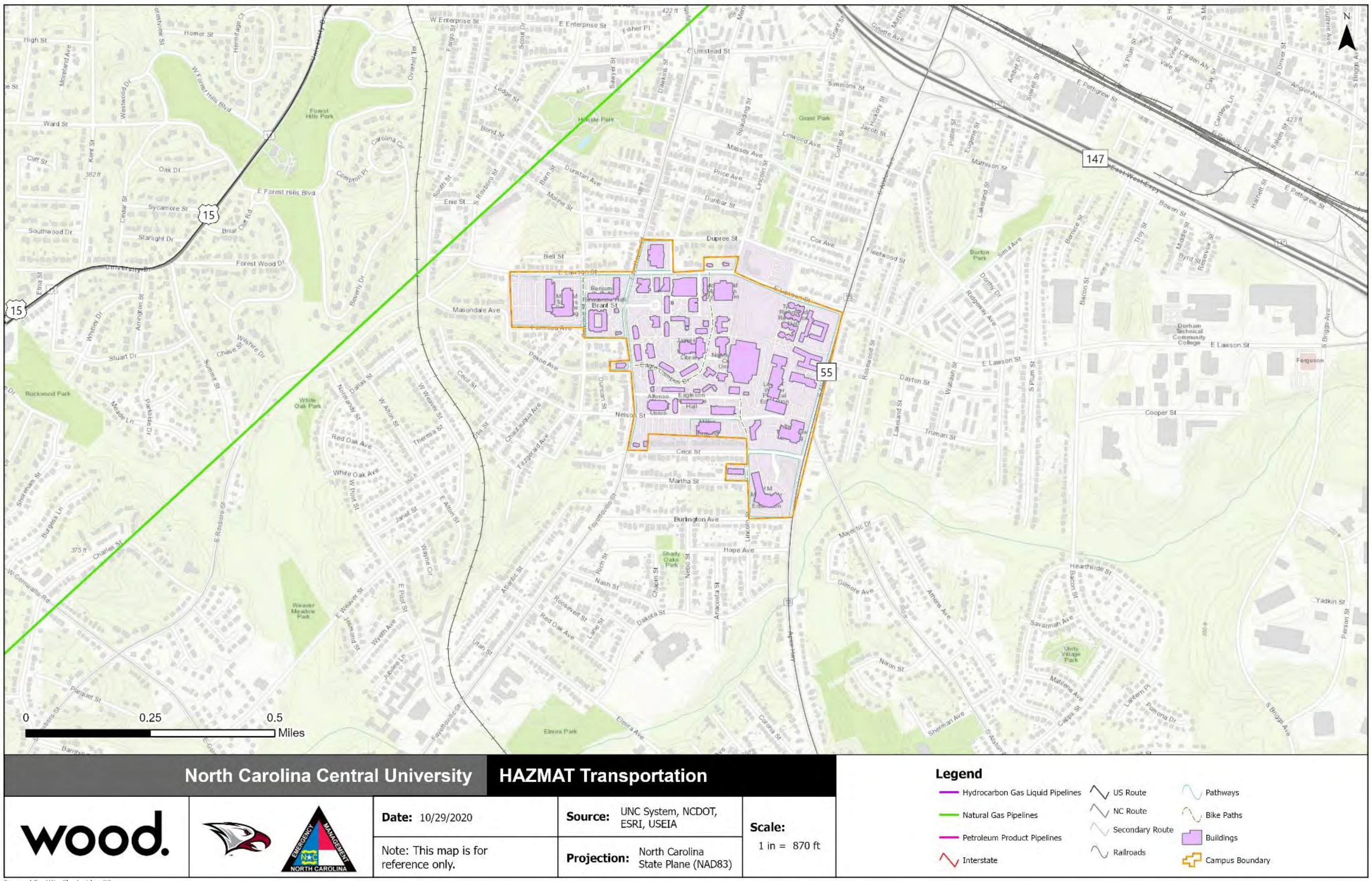
Facility Name	Sector
Durham	
ARGOS READY MIX PLUM ST CONCRETE PLANT	Nonmetallic Mineral Product
IPS STRUCTURAL ADHESIVES INC	Chemicals
AW NORTH CAROLINA	Transportation Equipment
CREE INC	Computers and Electronic Products
CORMETECH INC	Nonmetallic Mineral Product
BRENNTAG MID-SOUTH	Chemical Wholesalers
FOUNDATION LABS BY PLY GEM LLC	Miscellaneous Manufacturing
ARGOS READY MIX HWY 55 CONCRETE PLANT	Nonmetallic Mineral Product
GENERAL ELECTRIC AVIATION - DURHAM ENGINE FACILITY	Transportation Equipment

Source: EPA Toxic Release Inventory

Transportation hazardous materials Incidents can occur when hazardous materials are being transported from one location to another in the normal course of business for manufacturing, refining, or other industrial purposes. Additionally, hazardous materials incidents can occur as hazardous waste is transported for final storage and/or disposal. **Figure D.22** below shows the modes of transportation for hazardous materials adjacent to or through NCCU's campus.

Spatial Extent: 1 – Negligible

Figure D.22 – HAZMAT Transportation Map, NCCU



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.

Prior to 2002, however, a “serious incident” regarding hazardous materials was defined as follows:

- a fatality or major injury due to a hazardous material
- closure of a major transportation artery or facility or evacuation of six or more persons due to the presence of hazardous material, or
- a vehicle accident or derailment resulting in the release of a hazardous material.

Impact: 1 – Minor

Historical Occurrences

The USDOT’s PHMSA maintains a database of reported hazardous materials incidents by location and hazardous material class. According to PHMSA records, there were 264 recorded releases in Durham from 2000 through 2019. **Figure D.23** categorizes these incidents by hazardous material class. The most common materials spilled in the City were Class 3 (Flammable and Combustible Liquids) and Class 8 (Corrosives). **Figure D.24** describes all nine hazard classes.

Figure D.23 – Hazardous Materials Incidents by Class

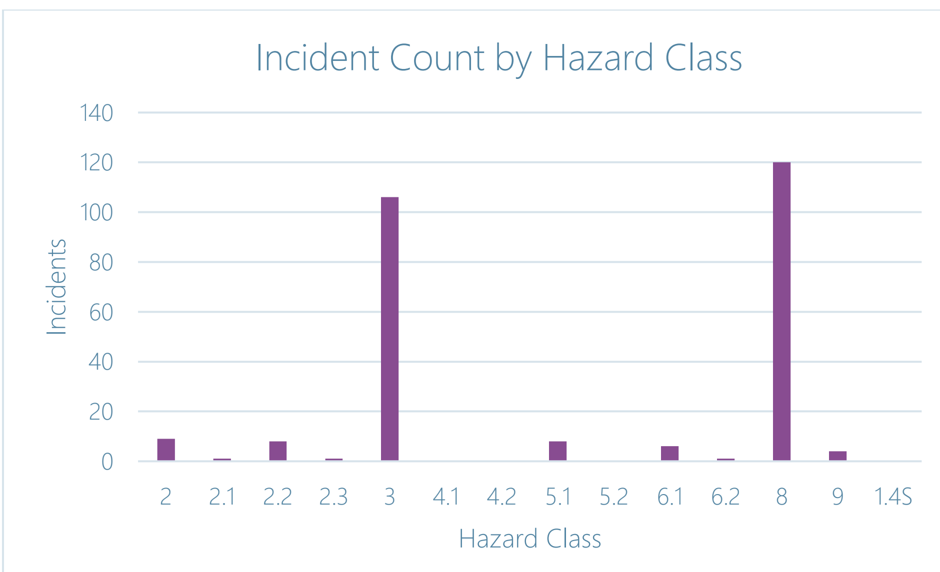
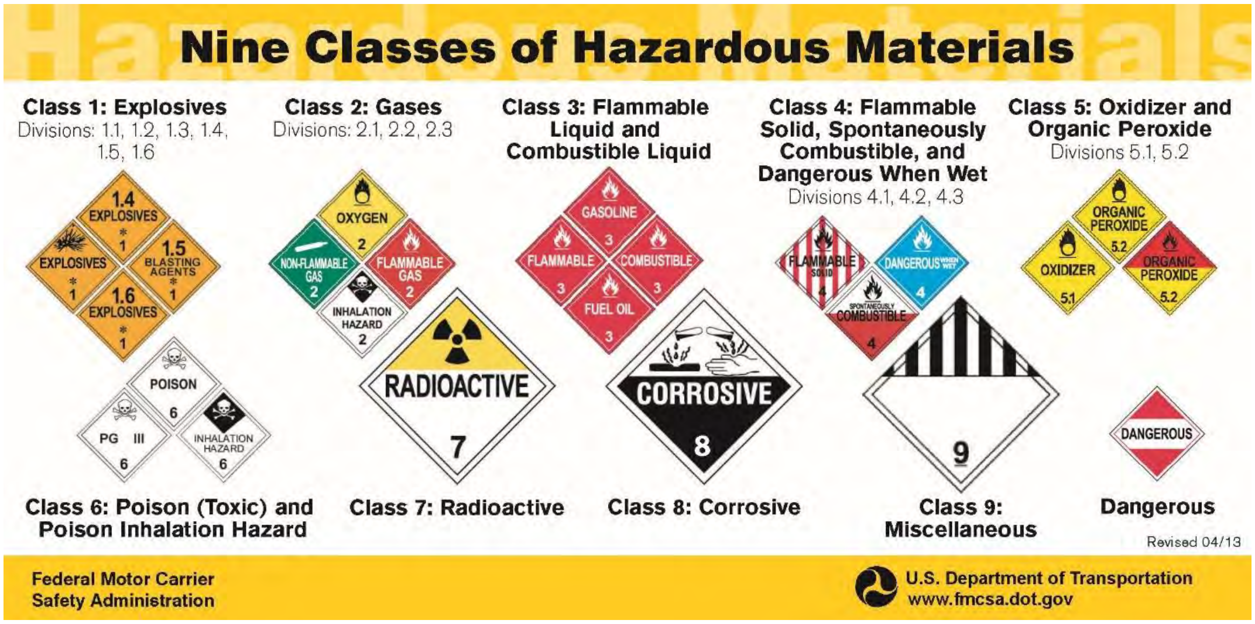


Figure D.24 – Hazardous Materials Classes



Source: U.S. Department of Transportation

Probability of Future Occurrence

Based on historical occurrences recorded by PHMSA, there have been 264 incidents of hazardous materials release in the 20-year period from 2000 through 2019. Using historical occurrences as an indication of future probability, there is over a 100 percent annual probability of a hazardous materials incident occurring throughout the City of Durham.

Probability: 4 – Highly Likely

Vulnerability Assessment

People

Hazardous materials incidents can cause injuries, hospitalizations, and even fatalities to people nearby. People living near hazardous facilities and along transportation routes may be at a higher risk of exposure, particularly those living or working downstream and downwind from such facilities. For example, a toxic spill or a release of an airborne chemical near a populated area can lead to significant evacuations and have a high potential for loss of life. Individuals working with or transporting hazardous materials are also at heightened risk.

In addition to the immediate health impacts of releases, a handful of studies have found long term health impacts such as increased incidence of certain cancers and birth defects among people living near certain chemical facilities. However there has not been sufficient research done on the subject to allow detailed analysis.

The primary economic impact of hazardous material incidents results from lost business, delayed deliveries, property damage, and potential contamination. Large and publicized hazardous material-related events can deter tourists and could potentially discourage residents and businesses. Economic effects from major transportation corridor closures can be significant.

Property

The impact of a fixed hazardous facility, such as a chemical processing facility is typically localized to the property where the incident occurs. The impact of a small spill (i.e. liquid spill) may also be limited to the extent of the spill and remediated if needed. While cleanup costs from major spills can be significant, they do not typically cause significant long-term impacts to property.

Hazardous materials spills reported by PHMSA for the 20-year period from 2000 through 2019 totaled $407,202 in damage, which equates to an annualized loss of $20,360 across the City of Durham.

Impacts of hazardous material incidents on critical facilities are most often limited to the area or facility where they occurred, such as at a transit station, airport, fire station, hospital, or railroad. However, they can cause long-term traffic delays and road closures resulting in major delays in the movement of goods and services. These impacts can spread beyond the planning area to affect neighboring counties, or vice-versa. While cleanup costs from major spills can be significant, they do not typically cause significant long-term impacts to critical facilities, but there is a chance they may be impacted.

Environment

Hazardous material incidents may affect a small area at a regulated facility or cover a large area outside such a facility. Widespread effects occur when hazards contaminate the groundwater and eventually the municipal water supply, or they migrate to a major waterway or aquifer. Impacts on wildlife and natural resources can also be significant.

Changes in Development

Structures located near fixed facilities, highways and other high traffic roadways are most at risk to a hazardous materials event. Any development that takes place in these areas will place more people and structures in the risk area for hazardous materials events, however since most hazardous material spills are localized to an extremely small area this will not have an effect on the overall risk assessment for this hazard.

Problem Statement

- Transportation and pipeline routes for hazardous materials are located adjacent to the NCCU campus.
- The number of reported incidents within Durham can be approximated to over a 100 percent annual probability.

D.5.10 Infectious Disease

Hazard	Probability	Impact	Spatial Extent	Warning Time	Duration	PRI Score
Infectious Disease	Possible	Critical	Large	More than 24 hrs	More than 1 week	2.8

Location

Infectious disease outbreaks can occur anywhere in the planning area, especially where there are groups of people in close quarters.

Spatial Extent: 4 – Large

Extent

When on an epidemic scale, diseases can lead to high infection rates in the population causing isolation, quarantine, and potential mass fatalities. An especially severe influenza pandemic or other major disease outbreak could lead to high levels of illness, death, social disruption, and economic loss. Impacts could range from school and business closings to the interruption of basic services such as public transportation, health care, and the delivery of food and essential medicines.

Table D.46 describes the World Health Organization's six main phases to a pandemic flu as part of their planning guidance.

Table D.46 – World Health Organization's Pandemic Flu Phases

Phase	Description
1	No animal influenza virus circulating among animals have been reported to cause infection in humans.
2	An animal influenza virus circulating in domesticated or wild animals is known to have caused infection in humans and is therefore considered a specific potential pandemic threat.
3	An animal or human-animal influenza reassortant virus has caused sporadic cases or small clusters of disease in people, but has not resulted in human-to-human transmission sufficient to sustain community-level breakouts.
4	Human-to-human transmission of an animal or human-animal influenza reassortant virus able to sustain community-level breakouts has been verified.
5	The same identified virus has caused sustained community-level outbreaks in two or more countries in one WHO region.
6	In addition to the criteria defined in Phase 5, the same virus has caused sustained community-level outbreaks in at least one other country in another WHO region.
Post-Peak Period	Levels of pandemic influenza in most countries with adequate surveillance have dropped below peak levels.
Post-Pandemic Period	Levels of influenza activity have returned to levels seen for seasonal influenza in most countries with adequate surveillance.

Source: World Health Organization

Impact: 3 – Critical

Historical Occurrences

Public Health Emergencies – Influenza Pandemics

Since the early 1900s, four lethal pandemics have swept the globe: Spanish Flu of 1918-1919; Asian Flu of 1957-1958; Hong Kong Flu of 1968-1969; and Swine Flu of 2009-2010. The Spanish Flu was the most severe pandemic in recent history. The number of deaths was estimated to be 50-100 million worldwide and 675,000 in the United States. Its primary victims were mostly young, healthy adults. The 1957 Asian

Flu pandemic killed about 70,000 people in the United States, mostly the elderly and chronically ill. The 1968 Hong Kong Flu pandemic killed 34,000 Americans. The 2009 Swine Flu caused 12,469 deaths in the United States. These historic pandemics are further defined in the following paragraphs along with several "pandemic scares".

Spanish Flu (H1N1 virus) of 1918-1919

In 1918, when World War I was in its fourth year, another threat began that rivaled the war itself as the greatest killer in human history. The Spanish Flu swept the world in three waves during a two-year period, beginning in March 1918 with a relatively mild assault.

The first reported case occurred at Camp Funston (Fort Riley), Kansas, where 60,000 soldiers trained to be deployed overseas. Within four months, the virus traversed the globe, as American soldiers brought the virus to Europe. The first wave sickened thousands of people and caused many deaths (46 died at Camp Funston), but it was considered mild compared to what was to come. The second and deadliest wave struck in the autumn of 1918 and killed millions. At Camp Funston alone, there were 14,000 cases and 861 deaths reported during the first three weeks of October 1918.

Outbreaks caused by a new variant exploded almost simultaneously in many locations including France, Sierra Leone, Boston, and New York City, where more than 20,000 people died that fall. The flu gained its name from Spain, which was one of the hardest hit countries. From there, the flu went through the Middle East and around the world, eventually returning to the United States along with the troops.

Of the 57,000 Americans who died in World War I, 43,000 died because of the Spanish Flu. At one point, more than 10 percent of the American workforce was bedridden. By a conservative estimate, a fifth of the human race suffered the fever and aches of influenza between 1918 and 1919 and 20 million people died. At the height of the flu outbreak during the winter of 1918-1919, at least 20% of North Carolinians were infected by the disease. Ultimately, 10,000 citizens of the state succumbed to this disease.

Asian Flu (H2N2 virus) of 1957-1958

This influenza pandemic was first identified in February 1957 in the Far East. Unlike the Spanish Flu, the 1957 virus was quickly identified, and vaccine production began in May 1957. Several small outbreaks occurred in the United States during the summer of 1957, with infection rates highest among school children, young adults, and pregnant women; however, the elderly had the highest rates of death. A second wave of infections occurred early the following year, which is typical of many pandemics.

Hong Kong Flu (H3N2 virus) of 1968-1969

This influenza pandemic was first detected in early 1968 in Hong Kong. The first cases in the United States were detected in September 1968, although widespread illness did not occur until December. This became the mildest pandemic of the twentieth century, with those over the age of 65 the most likely to die. People infected earlier by the Asian Flu virus may have developed some immunity against the Hong Kong Flu virus. Also, this pandemic peaked during school holidays in December, limiting student-related infections.

Pandemic Flu Threats: Swine Flu of 1976, Russian Flu of 1977, and Avian Flu of 1997 and 1999

Three notable flu scares occurred in the twentieth century. In 1976, a swine-type influenza virus appeared in a U.S. military barracks (Fort Dix, New Jersey). Scientists determined it was an antigenically drifted variant of the feared 1918 virus. Fortunately, a pandemic never materialized, although the news media made a significant argument about the need for a Swine Flu vaccine.

In May 1977, influenza viruses in northern China spread rapidly and caused epidemic disease in children and young adults. By January 1978, the virus, subsequently known as the Russian Flu, had spread around

the world, including the United States. A vaccine was developed for the virus for the 1978–1979 flu season. Because illness occurred primarily in children, this was not considered a true pandemic.

In March 1997, scores of chickens in Hong Kong's rural New Territories began to die—6,800 on three farms alone. The Avian Flu virus was especially virulent and made an unusual jump from chickens to humans. At least 18 people were infected, and six died in the outbreak. Chinese authorities acted quickly to exterminate over one million chickens and successfully prevented further spread of the disease. In 1999, a new avian flu virus appeared. The new virus caused illness in two children in Hong Kong. Neither of these avian flu viruses started pandemics.

Swine Flu (H1N1 virus) of 2009–2010

This influenza pandemic emerged from Mexico in 2009. The first U.S. case of H1N1, or Swine Flu, was diagnosed on April 15, 2009. The U.S. government declared H1N1 a public health emergency on April 26. By June, approximately 18,000 cases of H1N1 had been reported in the United States. A total of 74 countries were affected by the pandemic.

The CDC estimates that 43 million to 89 million people were infected with H1N1 between April 2009 and April 2010. There were an estimated 8,870 to 18,300 H1N1 related deaths. On August 10, 2010, the World Health Organization (WHO) declared an end to the global H1N1 flu pandemic.

Public Health Emergencies – Other Pandemics

Meningitis, 1996-1997, 2005

During 1996 and 1997, 213,658 cases of meningitis were reported, with 21,830 deaths, in Africa. According to the North Carolina Disease Data Dashboard, there were 28 cases in North Carolina in 2005.

Lyme Disease, 2015

In the United States, Lyme disease is mostly found in the northeastern, mid-Atlantic, and upper north-central regions, and in several counties in northwestern California. In 2015, 95-percent of confirmed Lyme Disease cases were reported from 14 states: Connecticut, Delaware, Maine, Maryland, Massachusetts, Minnesota, New Hampshire, New Jersey, New York, Pennsylvania, Rhode Island, Vermont, Virginia, and Wisconsin. Lyme disease is the most reported vector-borne illness in the United States. In 2015, it was the sixth most common nationally notifiable disease. However this disease does not occur nationwide and is concentrated heavily in the northeast and upper Midwest.

Severe Acute Respiratory Syndrome, 2003

During November 2002-July 2003, a total of 8,098 probable SARS cases were reported to the World Health Organization (WHO) from 29 countries. In the United States, only 8 cases had laboratory evidence of infection. Since July 2003, when SARS transmission was declared contained, active global surveillance for SARS disease has detected no person-to-person transmission. CDC has therefore archived the case report summaries for the 2003 outbreak. Across North Carolina, there was one confirmed SARS case – a man in Orange County tested positive in June 2003.

Zika Virus, 2015

In May 2015, the Pan American Health Organization issued an alert noting the first confirmed case of a Zika virus infection in Brazil. Since that time, Brazil and other Central and South America countries and territories, as well as the Caribbean, Puerto Rico, and the U.S. Virgin Islands have experienced ongoing Zika virus transmission. In August 2016, the Centers for Disease Control and Prevention (CDC) issued guidance for people living in or traveling to a 1-square-mile area Miami, Florida, identified by the Florida Department of Health as having mosquito-borne spread of Zika. In October 2016, the transmission area

was expanded to include a 4.5-square-mile area of Miami Beach and a 1-squre mile area of Miami-Dade County. In addition, all of Miami-Dade County was identified as a cautionary area with an unspecified level of risk. As of the end of 2018, the CDC reported 74 cases of Zika across the United States.

Ebola, 2014-2016

In March 2014, West Africa experienced the largest outbreak of Ebola in history. Widespread transmission was found in Liberia, Sierra Leone, and Guinea with the number of cases totaling 28,616 and the number of deaths totaling 11,310. In the United States, four cases of Ebola were confirmed in 2014 including a medical aid worker returning to New York from Guinea, two healthcare workers at Texas Presbyterian Hospital who provided care for a diagnosed patient, and the diagnosed patient who traveled to Dallas, Texas from Liberia. All three healthcare workers recovered. The diagnosed patient passed away in October 2014.

In March 2016, the WHO terminated the public health emergency for the Ebola outbreak in West Africa.

Coronavirus Disease (COVID-19), 2020

During the update of this plan, the Coronavirus disease 2019, also known as COVID-19, outbreak became a worldwide pandemic. COVID-19 was caused by severe acute respiratory syndrome coronavirus 2 (SARS-Cov-2). First identified in Wuhan, China in December 2019, the virus quickly spread throughout China and then globally. As of October 18, 2020, there were over 39.5 million cases worldwide resulting in over 1.1 million deaths. In the United States, COVID-19 was first identified in late January in Washington State and rapidly spread throughout the Country, with large epicenters on both the east and west coasts.

In order to curb the spread of the virus, Governor Roy Cooper issued a statewide Stay at Home Order on March 27, 2020. According to the North Carolina Department of Health and Human services, as of October 23, 2020, there were over 255,708 confirmed cases and 4,114 deaths across all 100 counties in the State. In Durham County, as of October 23, 2020, there were a total of 8,745 cases and 99 deaths. Case counts are still rising in North Carolina and Durham County at the time of this assessment.

Probability of Future Occurrence

It is impossible to predict when the next pandemic will occur or its impact. The CDC continually monitors and assesses pandemic threats and prepares for an influenza pandemic. Novel influenza A viruses with pandemic potential include Asian lineage avian influenza A (H5N1) and (H7N9) viruses. These viruses have all been evaluated using the Influenza Risk Assessment Tool (IRAT) to assess their potential pandemic risk. Because the CDC cannot predict how severe a future pandemic will be, advance planning is needed at the national, state and local level; this planning is done through public health partnerships at the national, state and local level.

Today, a much larger percentage of the world's population is clustered in cities, making them ideal breeding grounds for epidemics. Additionally, the explosive growth in air travel means the virus could literally be spread around the globe within hours. Under such conditions, there may be very little warning time. Most experts believe we will have just one to six months between the time that a dangerous new influenza strain is identified and the time that outbreaks begin to occur in the United States. Outbreaks are expected to occur simultaneously throughout much of the nation, preventing shifts in human and material resources that normally occur with other natural disasters. These and many other aspects make influenza pandemic unlike any other public health emergency or community disaster.

Probability: 2 – Possible

Vulnerability Assessment

People

Disease spread and mortality is affected by a variety of factors, including virulence, ease of spread, aggressiveness of the virus and its symptoms, resistance to known antibiotics and environmental factors. While every pathogen is different, diseases normally have the highest mortality rate among the very young, the elderly or those with compromised immune systems. As an example, the unusually deadly 1918 H1N1 influenza pandemic had a mortality rate of 20%. If an influenza pandemic does occur, it is likely that many age groups would be seriously affected. The greatest risks of hospitalization and death—as seen during the last two pandemics in 1957 and 1968 as well as during annual outbreaks of influenza—will be to infants, the elderly, and those with underlying health conditions. However, in the 1918 pandemic, most deaths occurred in young adults. Few people, if any, would have immunity to a new virus.

Approximately twenty percent of people exposed to West Nile Virus through a mosquito bite develop symptoms related to the virus; it is not transmissible from one person to another. Preventive steps can be taken to reduce exposure to mosquitos carrying the virus; these include insect repellent, covering exposed skin with clothing and avoiding the outdoors during twilight periods of dawn and dusk, or in the evening when the mosquitos are most active.

Property

For the most part, property itself would not be impacted by a human disease epidemic or pandemic. However, as concerns about contamination increase, property may be quarantined or destroyed as a precaution against spreading illness. Furthermore, staffing shortages could affect the function of critical facilities.

Environment

A widespread pandemic would not have an impact on the natural environment unless the disease was transmissible between humans and animals. However, affected areas could result in denial or delays in the use of some areas, and may require remediation.

Changes in Development

With enrollment decreasing since the last plan, the number of students and employees on campus has decreased. Additionally, with fewer buildings located on campus, the number of indoor meeting locations has decreased.

For future development, as the number of students and employees increase, the opportunity for spread of a pandemic would increase, should in-person educational and/or extracurricular meetings take place.

Problem Statement

- With the current COVID-19 pandemic, it is clear the NCCU campus population is susceptible to the infectious disease pandemic.
- NCCU has a pandemic influenza plan in place to provide a guide for the University to follow in the event of an influenza pandemic in North Carolina.

D.5.12 Conclusions on Hazard Risk

Priority Risk Index

As discussed in **Section D.5**, 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 D.47 summarizes the degree of risk assigned to each identified hazard using the PRI method.

Table D.47 – Summary of PRI Results

Hazard	Probability	Impact	Spatial Extent	Warning Time	Duration	PRI Score
Earthquake	Unlikely	Minor	Large	Less than 6 hours	Less than 6 hours	1.9
Flood	Likely	Minor	Negligible	6 to 12 hrs	Less than 6 hours	1.8
Geological – Landslide	Unlikely	Minor	Small	6 to 12 hrs	Less than 6 hrs	1.4
Hurricane	Likely	Critical	Large	More than 24 hrs	Less than 24 hrs	2.9
Severe Winter Weather	Highly Likely	Limited	Large	More than 24 hrs	Less than 1 week	3.0
Tornado / Thunderstorm	Likely	Critical	Large	Less than 6 hrs	Less than 6 hrs	3.1
Wildfire	Unlikely	Limited	Moderate	More than 24 hrs	More than 1 week	2.0
Cyber Threat	Possible	Critical	Large	Less than 6 hrs	More than 1 week	3.1
Hazardous Materials Incidents	Highly Likely	Minor	Negligible	Less than 6 Hrs	Less than 24 Hrs	2.3
Infections Disease	Possible	Critical	Large	More than 24 hrs	More than 1 week	2.8

[1]Note: Severe Weather hazards average to a score of 2.6 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 D.48**:

- **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.
- **Moderate 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 minimal. This is not a priority hazard.

Table D.48 – Summary of Hazard Risk Classification

High Risk (≥ 3.0)	Severe Winter Weather Tornado / Thunderstorm
Moderate Risk (2.0 – 2.9)	Hurricane Wildfire Cyber Threat Hazardous Materials Infectious Disease
Low Risk (< 2.0)	Earthquake Flood Geological – Landslide

D.6 CAPABILITY ASSESSMENT

This section discusses the mitigation capabilities, including planning, programs, policies and land management tools, typically used to implement hazard mitigation activities. It consists of the following subsections:

- D.6.1 Overview of Capability Assessment
- D.6.2 Planning and Regulatory Capability
- D.6.3 Administrative and Technical Capability
- D.6.4 Fiscal Capability

D.6.1 Overview of Capability Assessment

The purpose of conducting a capability assessment is to determine the ability of the college to implement feasible mitigation actions based on an understanding of the capacity of the departments and staff tasked with their implementation. A capability assessment should also identify opportunities for establishing or enhancing specific mitigation policies or programs. The process of conducting a capability assessment includes developing an inventory of relevant plans, policies, or programs already in place; as well as assessing the college's ability to implement existing and/or new policies. Conclusions drawn from the capability assessment should identify any existing gaps or weaknesses in existing programs and policies as well as positive measures already in place which can and should be supported through future mitigation efforts.

D.6.2 Planning and Regulatory Capability

Planning and regulatory capabilities include plans, ordinances, policies and programs that guide development on campus. **Table D.49** lists these local resources currently in place at NCCU.

Table D.49 – Planning and Regulatory Capability

Regulatory Tool (ordinances, codes, plans)	Y/N	Comments
Strategic Plan	Y	NCCU Strategic Plan 2019-2024
Zoning code	Y	City of Durham Zoning Ordinance
Growth management ordinance	N	
Floodplain ordinance	Y	City of Durham Flood Ordinance
Building code	Y	NC building codes; the State of North Carolina statutes for state owned buildings; and zoning for local jurisdiction
Erosion or sediment control program	N	
Stormwater management program	Y	NCCU Facilities Management maintains storm drains
Site plan review requirements	N	
Capital improvements plan	Y	NCCU Facilities Management Facilities Projects
Economic development plan	Y	NCCU Annual Financial Report
Local emergency operations plan	Y	NCCU Emergency Operations Plan, updated annually
Flood Insurance study or other engineering study for streams	Y	October 19, 2018
Elevation certificates	Y	City of Durham

A description of applicable plans, ordinances and programs follows to provide more detail on the relevance of each regulatory tool in examining the capabilities for each community.

Strategic Plan

A Strategic Plan, in broad terms, is a policy statement to guide the future placement and development of campus facilities. The Strategic Plan identifies a future vision, values, principals and goals for the college, determines the projected growth for the college, and identifies policies to plan, direct and accommodate anticipated growth. NCCU has also developed a Campus Master Plan to define objectives for future physical development in addition to the Strategic Plan goals for institutional development.

Zoning Code

Zoning typically consists of both a zoning map and a written ordinance/code that divides the planning area into zoning districts. The zoning regulations describe what type of land use and specific activities are permitted in each district, and also regulate how buildings, signs, parking, and other construction may be placed on a parcel. The zoning regulations also provide procedures for rezoning and other planning applications.

Flood Insurance Study/Floodplain Ordinance

A Flood Insurance Study (FIS) provides information on the existence and severity of flood hazards within a community based on the 100-year flood event. The FIS also includes revised digital Flood Insurance Rate Maps (FIRMs) which reflect updated Special Flood Hazard Areas (SFHAs) and flood zones for the community.

A floodplain ordinance is perhaps the most important flood mitigation tool. 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 will be protected from damage by a 100-year flood event and that new development in the floodplain will not exacerbate existing flood problems or increase damage to other properties.

Stormwater Management Program

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. A Stormwater Management Program can prevent flooding problems caused by stormwater runoff by 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) Setting construction standards so buildings are protected from shallow water. A stormwater ordinance provides regulatory authority to implement stormwater management standards.

Erosion and Sediment Control Program

Surface water runoff can erode soil from development sites, sending sediment into downstream waterways. This can clog storm drains, drain tiles, culverts and ditches and reduce the water transport and storage capacity of channels. The purpose of an erosion, sedimentation and pollution control ordinance is to minimize soil erosion and prevent off-site sedimentation by using soil erosion and sediment control practices designed in accordance with certain standards and specifications.

Site Plan Review

The purpose of the Site Plan Review Process is to review site plans for specific types of development to ensure compliance with all appropriate land development regulations and consistency with the General Plan.

Building Code

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).

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. An Elevation Certificate serves as the official record that shows new buildings and substantial improvements in all identified SFHAs are properly elevated. This elevation information is needed to show compliance with the floodplain ordinance.

Capital Improvement Plan

A Capital Improvement Plan (CIP) is a planning document that typically provides a five-year outlook for anticipated capital projects designed to facilitate decision makers in the replacement of capital assets. The projects are primarily related to improvement in public service, parks and recreation, public utilities and facilities. The mitigation strategy may include structural projects that could potentially be included in a CIP and funded through a Capital Improvement Program.

At NCCU, repair and renovation(R&R) work has been performed regarding storm drainage, steam line replacement, roof repair, and mold mitigation.

Emergency Operations Plan

An emergency operations plan outlines responsibilities and the means by which resources are deployed during and following an emergency or disaster.

D.6.3 Administrative and Technical Capability

Administrative and technical capability refers to the college’s staff and their skills and tools that can be used for mitigation planning and to implement specific mitigation actions. It also refers to the ability to access and coordinate these resources effectively. The personnel should be considered as well as the level of knowledge and technical expertise of these resources. Resources include engineers, planners, emergency managers, GIS analysts, building inspectors, grant writers, floodplain managers, and more. **Table D.50** provides a summary of the administrative and technical capabilities for NCCU.

Table D.50 – Administrative and Technical Capability

Personnel Resources	Yes/No	Department/Position
Planner/Engineer with knowledge of land development/land management practices	Yes	Facilities Management Capital Projects
Engineer/Professional trained in construction practices related to buildings and/or infrastructure	Yes	Facilities Management Capital Projects
Planner/Engineer/Scientist with an understanding of natural hazards	Yes	Facilities Management Capital Projects
Personnel skilled in GIS	Yes	Several Faculty
Full time building official	Yes	Facilities Management Capital Projects
Floodplain Manager	Yes	City of Durham

Personnel Resources	Yes/No	Department/Position
Emergency Manager	Yes	Emergency Management University Police
Grant Writer	Yes	Faculty
Public Information Officer	Yes	Communications and Marketing AVC
Student Engagement	Yes	Division of Student Affairs
Warning Systems	Yes	Emergency Management RAVE Mobility System Alterus System Rave Guardian Mobile App

Additional resources that may support administrative capability include the following:

Environmental Health and Safety, and HAZMAT

The Office of Environmental & Occupational Health & Safety (EOHS) is in charge of developing and managing an on-going, comprehensive occupational safety and health program with written policies and procedures mandated by the North Carolina Employees' Workplace Requirements Program for Safety & Health and the NC Department of Labor, Division of Occupational Safety and Health. This is done by identifying and addressing safety and health needs as required by the NC Department of Labor, Division of Occupational Safety and Health, NC Department of Environment, Health, and Natural Resources, NC Department of Insurance, City of Durham Fire Department and other applicable federal, state, and local regulatory bodies. EOHS establishes goals and objectives based on the University's needs related to occupational safety and health, which could include hazard resilience in future planning initiatives.

Facilities and Housekeeping Services

The NCCU Facilities Management Department is in charge of facilities services, design and construction services, facilities information, energy conservation projects and recycling programs of the university. The Facilities Department has overseen previous work performed regarding storm drainage, steam line replacement, roof repair, and mold mitigation, among other things, and it therefore well equipped to plan and oversee additional property protection improvements for hazard mitigation.

Resource Sharing & Coordination

EOHS, Emergency Management, and University Police all have standing MOU's with other UNC System Institutions. The Police Department also has MOU's with the Durham Police Department, Durham County Sheriff's Office, and Durham Technical Community College Police Department. NCCU also coordinates with the Durham Fire Department to conduct fire safety programs. These relationships may prove beneficial to support mitigation project implementation on campus.

Community Emergency Response Team training was previously done but the program is currently dormant. This is an opportunity to reinstate the CERT program.

Safety and Security Committee

The Campus Safety and Security Committee was established to review safety and security concerns throughout the campus and establish goals for implementation. There was a concentrated focus on campus-wide Emergency Notification and Response to Emergency Incidents. The committee is made up of students, faculty, and staff. Meetings are held monthly to develop and implement projects and goals to enhance safety and security of the University community. The committee submits their findings and suggestions to the Chief and the University Administration. This committee may be well positioned to expand their focus to include the objectives of this hazard mitigation plan.

Warning & Notification

The campus has three outdoor warning sirens that are activated by the Police Communications Center via RF. The campus also uses Rave Alert and Alertus to send messages via phone call/SMS/email and Rave Guardian, a mobile safety application.

Another important consideration related to emergency notifications is ensuring outreach to vulnerable populations. Vulnerable populations on campus have been identified, which is an important first step to providing sufficient outreach and response planning for these groups. For example, the School of Education has a communications disorders program that conducts on-campus meetings. Additionally, minor students are present on campus at the Early College High School.

D.6.4 Fiscal Capability

Financial capabilities are the resources that an entity has access to or is eligible to use to fund mitigation actions. The costs associated with implementing mitigation activities vary. Some mitigation actions such as building assessment or outreach efforts require little to no costs other than staff time and existing operating budgets. Other actions, such as structural projects, could require a substantial monetary commitment from local, State, and Federal funding sources. **Table D.51** provides a summary of the fiscal resources at NCCU.

Table D.51 – Fiscal Resources

Resource	Ability to Use for Mitigation Projects? Y/N
Community Development Block Grants	N
Capital improvements project funding	Y, Repair and Renovation Funds
In-Kind Services	Y
Tuition & Fees	Y, Limited availability
Federal funding with HMA grants	Y
Revenue Bonds	Y
State Appropriations	Y
Sales & Services	Y
Other Sources (Gifts, Investment Income, Permanent Endowments)	Y

D.7 MITIGATION STRATEGY

D.7.1 Implementation Progress

Progress on the mitigation strategy developed in the previous plan is also documented in this plan update. **Table D.52** details the status of mitigation actions from the previous plan. **Table D.53** on the following pages details all completed and deleted actions from the 2011 plan. More detail on the actions being carried forward is provided in the Mitigation Action Plan.

Table D.52 – Status of Previous Mitigation Actions

Campus	Completed	Deleted	Carried Forward
NCCU	10	15	18

Table D.53 – Completed and Deleted Actions from the NCCU 2011 Plan

Vulnerability	Action	2020 Status	2020 Implementation Status Comments
Baynes: Extensive damage to the brick façade	Contract licensed engineer to repair brick façade and implement repairs with an experienced contractor.	Deleted	Demolition planned in Fall 2021
Baynes: Window air conditioning units in every window could reduce the stability of window frames due to environmental deterioration.	Switch to in-room HVAC systems to replace both window units and steam heat.	Deleted	Demolition planned in Fall 2021
Baynes: Water intrusion evidence in a telecom closet.	Window in telecom closet can be repaired and reinforced to prevent water intrusion or vandalism.	Deleted	Demolition planned in Fall 2021
Baynes: The generator only provides life-safety function to the building in the event of a power outage.	Install a transfer switch and connection point to permit the facility to be powered by a large portable generator.	Deleted	Demolition planned in Fall 2021
Baynes: Several non-structural brick features showed signs of ongoing damage; examples included a two-foot retaining wall and brick work supporting a patio.	The non-structural brick work should be repaired to prevent further damage.	Deleted	Demolition planned in Fall 2021
Baynes: Some utility lines were not properly connected to their supporting structure.	All utility systems and lines should be properly anchored to adequate structural elements.	Deleted	Demolition planned in Fall 2021
Brite Mary Towers: Ceiling tiles near HVAC registers showed signs of water damage; this is likely due to rainwater infiltration into mechanical equipment or ductwork. This increases potential for mold growth which may affect occupants or sensitive research. The leaks in ductwork/mechanical equipment appeared minor at the time of inspection, however, these leaks could become more severe, exposing contents to water damage.	The cause of water infiltration should be remedied as soon as possible to mitigate the potential for further water damage or mold growth.	Completed	
Brite Mary Towers: NCCU relies on a star network topology to route data to the NOC in Shepard Library, if network connections between Brite and Shepard are damaged, the EOC in Brite could lose communication capabilities.	A redundant network connection should be installed to strengthen network communications with the EOC.	Completed	
Dent Annex: A pedestrian bridge leading to the second floor of the facility is structurally deficient as a result of reinforcing corrosion and concrete deterioration. Reinforcing tendons can be picked apart by hand and the concrete is cracking and spalling heavily.	Promptly after seeing the pedestrian bridge, recommendations were made to close the bridge and have a more thorough evaluation conducted to determine what course of action is needed. The bridge should be repaired, replaced, or demolished.	Completed	

Vulnerability	Action	2020 Status	2020 Implementation Status Comments
McDougal-McLendon Gym: Upon inspecting the building, it appeared that there were not enough restrooms or water distribution points to satisfy code requirements, let alone serve as a shelter for campus.	If the gym is to serve as a shelter in any capacity, additional restrooms and water distribution points will be necessary, if not for code requirements alone.	Deleted	Gym no longer considered a possible mass sheltering site
McDougal-McLendon Gym: There is inadequate back-up power for the gymnasium.	If the facility is to serve as a shelter in any capacity, a transfer switch should be installed to allow for an off-site generator to be hooked up to the building in the event of a power outage.	Deleted	Gym no longer considered a possible mass sheltering site
Physical Plant: A retaining wall between the boiler plant and main building appeared to be an unreinforced brick wall sitting on a partially exposed concrete foundation.	An engineered retaining wall should replace the brick wall; it appeared that the intersecting faces of the wall were separating; prior repairs appeared inadequate.	Completed	
Physical Plant: Ceiling tiles were damaged from water infiltration through inadequate roof seals.	It appeared that seals were failing near a new heat pump on the roof above water damage in ceiling tiles near the entrance. Other seals were noted to be in similar condition. These should be repaired as soon as possible.	Completed	
Physical Plant: Debris piles outside the HVAC offices expose campus facilities to debris hazards.	The site should be cleared of unnecessary debris piles.	Completed	
Police Communications/Student Health: Due to code deficiencies, the 911 center is limited in its capability.	Plans to make the 911 call center compliant with NFPA-72 were in place; as soon as funding becomes available, these plans should be executed. Primarily, a two-hour fire wall and second means of egress are necessary.	Deleted	Plans no longer include this project; monitoring is conducted by a third-party
Police Communications/Student Health: Currently, each building on campus has two outside phone lines devoted to a connection with the off-site fire alarm monitoring vendor. This adds extra expense to the university to maintain these lines; additionally, response time to fire alarms is slower than if monitored on-site with MUX pads in the call center.	Plans to make the 911 call center compliant with NFPA-72 were in place; as soon as funding becomes available, these plans should be executed. Primarily, a two-hour fire wall and second means of egress are necessary.	Deleted	Plans no longer include this project; monitoring is conducted by a third-party
Police Communications/Student Health: Medical records are maintained in an area with windows and reliant on window units to provide climate control.	Placing the entire building on a central HVAC system would permit the window units to be removed; during intense storms, these window units could be damaged or fall from the building.	Deleted	Relocation of Student Health Center planner for the future.
Robinson: Several teachers reported the interior air is very humid, especially on the first floor. This may be due to (what appeared to be) backed-up floor drains in the air handler rooms on each floor.	The cause of moisture in the air should be identified and remedied. The water damage around drains should be repaired.	Completed	No further complaints regarding the issues

Vulnerability	Action	2020 Status	2020 Implementation Status Comments
Shepard Library: The generator does not have sufficient capacity to power HVAC systems for the NOC or moisture control for the special collections. Campus telephony would become inoperable after several hours without power due to lack of HVAC.	A new generator should be installed capable of powering all NOC computer and HVAC systems. This is critical to maintaining telephony and data services.	Completed	NOC has individual generator support
Shepard Library: The generator does not have sufficient capacity to power HVAC systems for the NOC or moisture control for the special collections. Campus telephony would become inoperable after several hours without power due to lack of HVAC.	A transfer switch and connection point for a larger portable generator should be installed to power HVAC and controls in the facility for the special collections area. Facility personnel reported three power outages in the last four years lasting two or more days.	Completed	NOC has individual generator support
Shepard Library: The wet-pipe sprinkler system was visible in the special collections room and NOC.	The wet-pipe sprinklers in the NOC and special collections area should be replaced with a non-water based fire suppression system.	Completed	
Dent Annex: Roof access was not locked at the time of inspection; this was typical of nearly all roof access points across campus.	Roof access points across campus should be locked.	Deleted	This property protection measure addresses hazards outside of this plan.
McDougal-McLendon Gym: The south facade of the gym had several recent repairs; numerous cracks were developing in the repaired areas. CMU on the other side of brick façade had matching cracks. Additionally, a parapet wall had significant cracking. Facility personnel stated that the south wall was initially a temporary wall from original construction but was never reinforced to be permanent.	Areas with brick and CMU damage should be investigated by an engineer to determine the cause and necessary repairs; repairs should be implemented by an experienced contractor to prevent further deterioration and restore structural capacity.	Deleted	This property protection measure addresses hazards outside of this plan.
Taylor - There are several areas of the brick façade with large cracks.	The cracking of brick elements in the building should be monitored to ensure conditions do not deteriorate; if cracking worsens, an engineer should investigate the cause and suggest repairs.	Deleted	This property protection measure addresses hazards outside of this plan.
Taylor - Fan coil units were installed in most rooms; overhead lines provide cold or hot water to units; these lines tend to develop heavy condensation during cooling season causing interior water damage. The current air conditioning infrastructure is dated and causing deterioration of ceiling and wall elements	The insulation on cold water piping should be replaced with something more effective at preventing condensation.	Deleted	This property protection measure addresses hazards outside of this plan.

D.7.2 Mitigation Action Plan

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.

The following table comprises the mitigation action plan for NCCU. Each mitigation action recommended for implementation is listed in these tables along with detail on the hazards addressed, the goal and objective addressed, the priority rating, the lead agency responsible for implementation, potential funding sources for the action, a projected implementation timeline, and the 2020 status and progress toward implementation for actions that were carried forward from the 2010 plan.

Table D.54 – Mitigation Action Plan, NCCU

Action #	Action Description	Hazard(s) Addressed	Goal & Objective Addressed	Priority	Mitigation Category	Lead Agency / Department	Estimated Cost	Potential Funding Source	Implementation Timeline	2020 Status	2020 Implementation Status Comments
NCCU1	Campus-Wide – Major mechanical systems (HVAC equipment, heat pumps, chillers, generators, fuel tanks, gas cylinders, and boilers) should be anchored to their foundations. This includes, but is not limited to, the following campus buildings: Dent Annex; McDougal-McLendon Gymnasium; Pearson Cafeteria; Physical Plant; Police Communications/Student Health Building; Robinson; Shepard Library; and Taylor	All Hazards	1.1	M	Property Protection	Facilities Operations	<$5,000 per site	Operating Budget	Inspections in FY2021, request funding for repairs in FY2022	Carry Forward	Require inspection by proper persons. No progress made due to administrative limitations.
NCCU2	Campus-Wide – Upgrade back-up power capabilities to critical facilities including, but not limited to: Brite Mary Townes; and Pearson Cafeteria.	All Hazards	1.2	M	Property Protection	Capital Projects/Facilities Operations	$5,000 - >$100,000 per site	Operating Budget, State/Federal Grants	2022-2026	Carry Forward	Brite Mary Townes - Generator does not currently provide full power to the building, modifications would be required to do so. Pearson Cafeteria -Requires installation of modified switch or potentially a larger generator. No progress made due to funding limitations.
NCCU3	Pearson Cafeteria - Some food storage areas do not have sufficient shelving to secure contents in the event of a seismic event. All storage areas should have appropriately anchored shelving units to secure contents.	Earthquake	1.1	M	Property Protection	Business & Auxiliary Services	<$5,000	Operating Budget	FY2022	Carry Forward	Can be implemented internally by Bus. & Aux Services or Food Services vendor. No progress made due to administrative limitations.
NCCU4	Physical Plant - Several large trees were adjacent to the fuel tanks. Large trees that pose a threat to the building, fuel oil tanks, or spill containment area should be removed or pruned back.	Hurricane, Tornado/ Thunderstorm, Severe Winter Weather	1.1	L	Property Protection	Facilities Operations	<$5,000	Operating Budget	2021-2026	Carry Forward	No progress has been made. Need to determine if tank(s) are still operational or required
NCCU5	Physical Plant - The spill containment measures and tank construction are inadequate and do not meet local code requirements. The spill containment area and fuel tanks should be brought into code compliance immediately.	Flood	1.2	L	Structural Projects	Facilities Operations	>$100,000	Federal/State Grants	2021-2026	Carry Forward	No progress has been made. Need to determine if tank(s) are still operational or required
NCCU6	Physical Plant - Windows in the HVAC office area leak significantly during rain events. Windows in the HVAC office area should be replaced.	Hurricane, Tornado/ Thunderstorm	1.1	L	Property Protection	Facilities Operations	<$5,000	Operating Budget	2021-2026	Carry Forward	Project will need to be established to find funding for window replacement. No progress made due to funding limitations.
NCCU7	Police Communications/Student Health Building - Medical records are maintained in an area with windows and reliant on window units to provide climate control. The area with medical records should have windows made inoperable to ensure contents are not damaged in the event a window is left open during a downpour. Consider reinforcing the windows against debris impact.	Hurricane, Tornado/ Thunderstorm, Flood	1.2	M	Property Protection	Student Health	<$5,000	Operating Budget	2021-2026	Carry Forward	No progress made due to funding limitations. Consider housing records in weatherproof container(s) or reinforcing/ covering windows.
NCCU8	Robinson - There were windows with evidence of recent water intrusion. Consider upgrading windows throughout the facility if water intrusion becomes a more persistent issue.	Flood	1.1	L	Property Protection	Facilities Operations	$25,000-$100,000	Operating Budget, State/Federal Grants	2021-2026	Carry Forward	Project will need to be established to find funding for window replacement. No progress made due to funding limitations.

Action #	Action Description	Hazard(s) Addressed	Goal & Objective Addressed	Priority	Mitigation Category	Lead Agency / Department	Estimated Cost	Potential Funding Source	Implementation Timeline	2020 Status	2020 Implementation Status Comments
NCCU9	Shepard Library - Some shelving units in the library did not have bracing to prevent tipping during a seismic event. All shelving units should have braces installed to reduce the possibility of tipping.	Earthquake	1.1	L	Property Protection	Facilities Operations	$5,000-$25,000	Operating Budget	2021-2026	Carry Forward	Assessment of building and identification of shelving to be anchored must be carried out. No progress made due to administrative limitations.
NCCU10	Shepard Library - Windows in the special collections area increase the potential for exposure of articles to moisture intrusion. Consider installing shatter resistant film and upgraded windows in the special collections area.	Hurricane, Tornado/ Thunderstorm	1.2	L	Property Protection	Facilities Operations	$5,000-$25,000	Operating Budget	2021-2026	Carry Forward	Pricing will need to be determined for such windows. No progress made due to funding limitations.
NCCU11	Develop public information process by which EHS/UPD can send emergency information to community and provide education on safety related matters	All Hazards	1.2	M	Property Protection	EHS	<$5,000	Operating Budget	FY2021	New	

THE UNIVERSITY OF NORTH CAROLINA SYSTEM

UNC System Eastern Campuses Regional Hazard Mitigation Plan

Annex E: North Carolina School of Science and Mathematics

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Annex E North Carolina School of Science and Mathematics

This section provides planning process, campus profile, hazard risk, vulnerability, capability, and mitigation action information specific to North Carolina School of Science and Mathematics (NCSSM). This section contains the following subsections:

- E.1 Planning Process Details
- E.2 Campus Profile
- E.3 Asset Inventory
- E.4 Hazard Identification
- E.5 Hazard Profiles, Analysis, and Vulnerability
- E.6 Capability Assessment
- E.7 Mitigation Strategy

E.1 PLANNING PROCESS DETAILS

The table below lists the HMPC members who represented NCSSM during the planning process.

Table E.1 – HMPC Members

Representative	Role; Department
Rick Hess	Director of Security; Campus Safety & Security
Crystal Donaldson	Assistant Director of Safety & Security; Campus Safety & Security
Garry Covington	Director; Plant Facilities
Robert Allen	Vice Chancellor; Finance and Operations
Joyce Boni	Chief Audit Officer; Chancellor's Office
Paul Menchini	IT Security Director, Operations & Systems Analyst; IT Services

Coordination with Other Community Planning Efforts and Hazard Mitigation Activities

The table below lists campus and community resources referenced throughout the planning process and use in the plan development.

Table E.2 – Summary of Existing Studies and Plans Reviewed

Resource Referenced	Use in this Plan
NCSSM Strategic Plan	The NCSSM Strategic Plan, developed in 2019, was referenced for the Campus Profile in Section E.2 as well as the Capability Assessment in Section E.6
City of Durham/ Durham County Comprehensive Plan	The Comprehensive Plan, developed jointly by the City of Durham and Durham County, was referenced for the Campus Profile in Section E.2.
Durham County and Incorporated Areas Flood Insurance Study (FIS), Revised 12/6/2019	The FIS report was referenced in the preparation of flood hazard profile in Section E.5.
NCSSM Pre-Disaster Mitigation Plan, 2011	The previous NCSSM Pre-Disaster Mitigation Plan was used in preparation of the hazard profiles in Section E.5. The plan was additionally used to track implementation progress and develop the mitigation plan (Section E.7).

Resource Referenced	Use in this Plan
Eno-Haw Regional Hazard Mitigation Plan, 2020	The Eno-Haw Regional Hazard Mitigation Plan, which includes Durham, was referenced in compiling the Hazard Identification and Risk Assessment in Section E.5.

E.2 CAMPUS PROFILE

This section provides a general overview of the North Carolina School of Science and Mathematics (NCSSM) campus and area of concern to be addressed in this plan. It consists of the following subsections:

- Location and Setting
- Geography and Climate
- History
- Cultural and Natural Resources
- Land Use
- Population and Demographics
- Social Vulnerability
- Growth and Development Trends

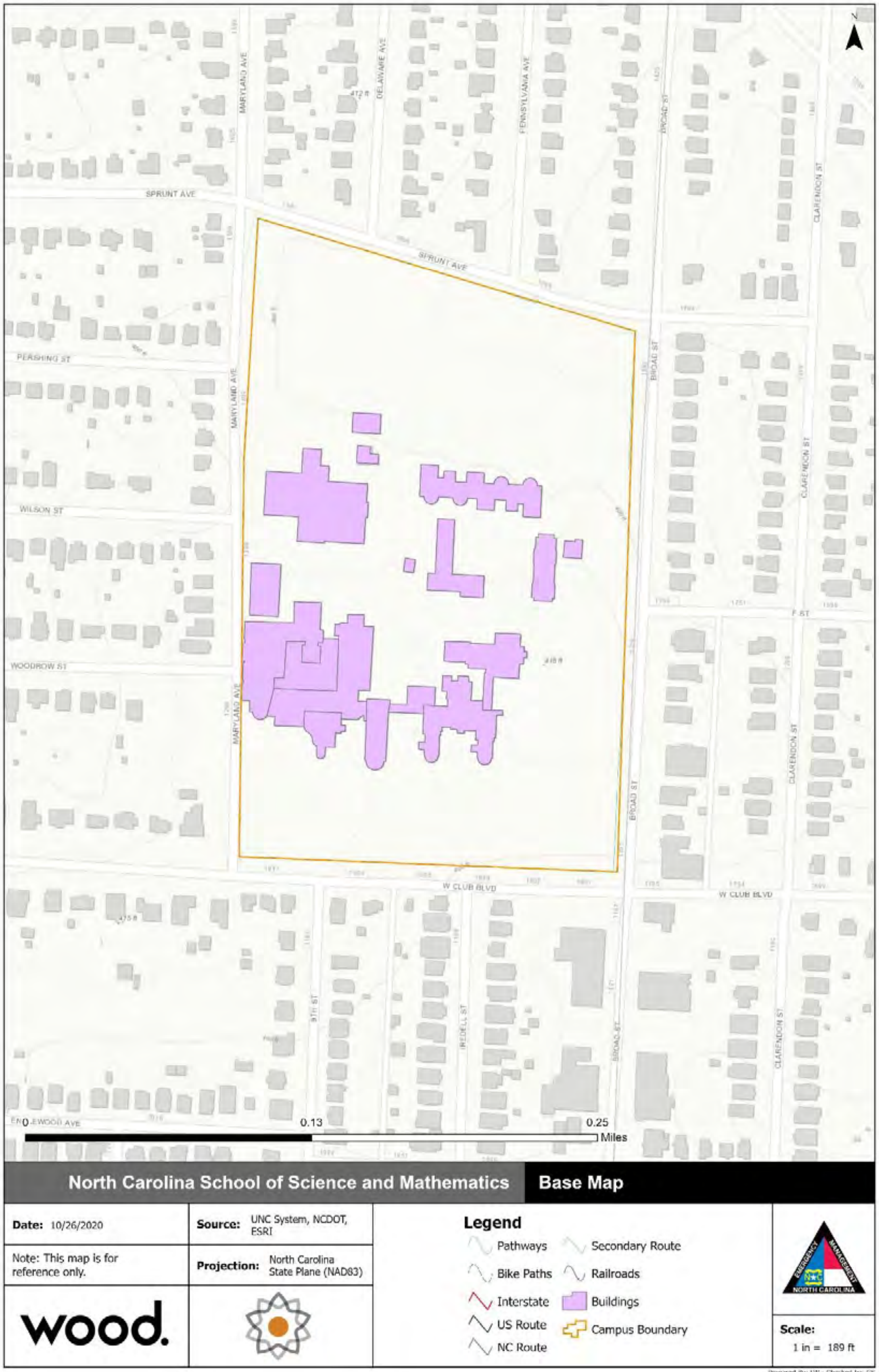
E.2.1 Location and Setting

North Carolina School of Science and Mathematics is located in northwestern Durham. The 2-year public residential and online high school is situated on 28 acres and focuses on the intensive study of science, mathematics and technology. The school also offers summer programs for students who are rising 5th graders A wide variety of cultural and educational resources are accessible to NCSSM students, and nearly 70 student clubs and organizations are available on campus. NCSSM is known for educating and nurturing academically talented students to become state, national, and global leaders who work for the betterment of their community.

United States Highways 501, 147, and 55 make the school easily accessible by automobile. The City of Durham is on two Interstate highways, I-40 and I-85, and is served by Raleigh-Durham International Airport. Durham is also home to Duke University.

Figure E.1 provides a base map of the campus. For more information on campus buildings and critical facilities, see Section E.3.

Figure E.1 – NCSSM Campus Base Map



E.2.2 Geography and Climate

North Carolina School of Science and Mathematics is in Durham, in the eastern part of North Carolina's Piedmont region. NCSSM's campus is largely flat with a few rolling hills, which reflects the topography of the Piedmont region. In addition, the central location of Durham provides driving access to both the coastal region in the east and to the mountains in the west. Durham has a favorable, mild climate with temperatures dropping to 29 degrees Fahrenheit on average in January and climbing to 89 degrees Fahrenheit in July on average. The annual precipitation for the city is approximately 44 inches per year.

E.2.3 History

NCSSM's three founders — former North Carolina Governor James B. Hunt Jr., Senator and Duke University President Terry Sanford; and academician and author John Ehle — envisioned an institution that would invest in the state's human and intellectual capital to build leadership and economic progress. In 1978, The North Carolina General Assembly establishes North Carolina School of Science and Mathematics to provide challenging educational opportunities for students with special interests and potential in the sciences and mathematics.

In 1980, during Governor Hunt's first administration, North Carolina School of Science and Mathematics opened on the grounds of the former Watts Hospital in Durham with 150 high school juniors. It was the first school of its kind — a public, residential high school welcoming students from across the state to study a specialized curriculum emphasizing science and mathematics but also offering humanities courses, athletics, and extracurricular opportunities.

In 1988, together with peers at a handful of similar schools, NCSSM leaders help found the National Consortium of Specialized Secondary Schools of Math, Science and Technology, now the National Consortium of Secondary STEM Schools.

NCSSM offers its first distance education classes in 1994, broadcasting on public television channels. In 2007 NCSSM became the 17th constituent institution of the University of North Carolina (UNC) system.

The founders' early vision has matured into a vital institution that models and advocates for excellence in public education. Eighteen similar schools have sprung from NCSSM's model, in the U.S. and abroad.

E.2.4 Cultural and Natural Resources

National Register of Historic Places

There are 75 listings in the National Register of Historic Places for Durham. The University itself is listed as one of the historic places in Durham.

Natural Features and Resources

The City of Durham is host of many creeks, lakes, and open space. Durham currently manages 68 parks throughout the City. Durham strives to provide both larger parks (50+ acres) for active and passive use; neighborhood parks (2-20 acres) within walking and biking distance of most homes; connectors like bike boulevards.

None of The North Carolina School of Science and Mathematics campus is located within a 100-year Special Flood Hazard Area. All 28 acres of land on NCSSM's campus are designated as Unshaded Zone X.

Natural and Beneficial Floodplain Functions

Under natural conditions, a flood causes little or no damage in floodplains. Nature ensures that floodplain flora and fauna can survive the more frequent inundations, and the vegetation stabilizes soils during flooding. Floodplains reduce flood damage by allowing flood waters to spread over a large area. This reduces flood velocities and provides flood storage to reduce peak flows downstream. While there are no designated floodplains on the NCSSM campus, maintaining the natural and beneficial functions of floodplains within the watershed is still importance to minimizing flood risks on campus.

Threatened and Endangered Species

The U.S. Fish and Wildlife Service maintains a regular listing of threatened species, endangered species, at-risk species, and candidate species for counties across the United States. Durham County has eight species that are listed with the U.S. Fish and Wildlife Services. **Table E.3** below shows the eight species identified as threatened and endangered in Durham County.

Table E.3 – Threatened and Endangered Species in Durham County

Common Name	Scientific Name	Federal Status
Green floater	*Lasmigona subviridis*	Under Review
Neuse River waterdog	*Necturus lewisi*	Proposed Threatened
Carolina madtom	*Noturus furiosus*	Proposed Endangered
Little brown bat	*Myotis lucifugus*	Under Review
Dwarf wedgemussel	*Alasmidonta heterodon*	Endangered
Smooth coneflower	*Echinacea laevigata*	Endangered
Michaux's sumac	*Rhus michauxii*	Endangered
Atlantic pigtoe	*Fusconaia masoni*	Proposed Threatened

Source: U.S. Fish & Wildlife Service (https://ecos.fws.gov/ecp/report/species-listings-by-current-range-county?fips=37063)

E.2.5 Land Use

The North Carolina School of Science and Mathematics in Durham has many undergoing projects, including the construction of a new Discovery Center. The Center will be 214,500 square feet and filled with flexible spaces that anticipate multiple uses and the constant change of student populations, methods of learning and teaching, and the innovations and evolutions of resources and technology. **Figure E.2** below is an image of the proposed layout of campus after the new addition of the Discovery Center.

Figure E.2 – Plan View of NSCCM Durham Campus Addition

E.2.6 Population and Demographics

Table E.4 provides population counts and percent change in population since 2010 for Durham County and the City of Durham.

Table E.4 – Population Counts for Surrounding Jurisdictions

Jurisdiction	2010 Census Population	2019 Estimated Population	% Change 2010-2019
Durham County	270,001	321,488	19.1
Durham	229,892	278,993	21.4

Source: U.S. Census Bureau QuickFacts 2010 vs 2019 (V2019) data

Table E.5 provides population counts for North Carolina School of Science and Mathematics from Fall 2019, including the number of residential and online students and those who attended the summer program.

Table E.5 – Population Counts for North Carolina School of Science and Mathematics, Fall 2019

Group	2019 Population
Students	205
Residential Students	67
Online Students	45
Video Conferencing	2
Summer Programs	91

For all students enrolled in the NCSSM program throughout the entire state during the 2019-2020 school year, 50.4% of the residential students were female. Research has shown positive impacts from attending NCSSM for rural and underrepresented minority students, including increased application and acceptance rates to highly selective universities.

The racial characteristics of the County, City, and college are presented below in **Table E.6**. White persons make up the majority of the population for the City and County. The demographics below for NCSSM represent all participating students throughout the state; white persons make up the majority of the population at NCSSM as well.

Table E.6 – Demographics of Durham County, City of Durham, and all NCSSM Students

Jurisdiction	African-American Persons, Percent	American Indian or Alaska Native, Percent	Asian Persons, Percent	Hispanic or Latino Persons, Percent	White Persons, Percent
Durham County[1]	36.9	0.9	5.5	13.7	54
Durham[1]	38.7	0.3	5.4	13.8	49.2
North Carolina School of Science and Mathematics [2]	8.7	0.4	27.8	1	46.3

Source: U.S. Census Bureau, 2010

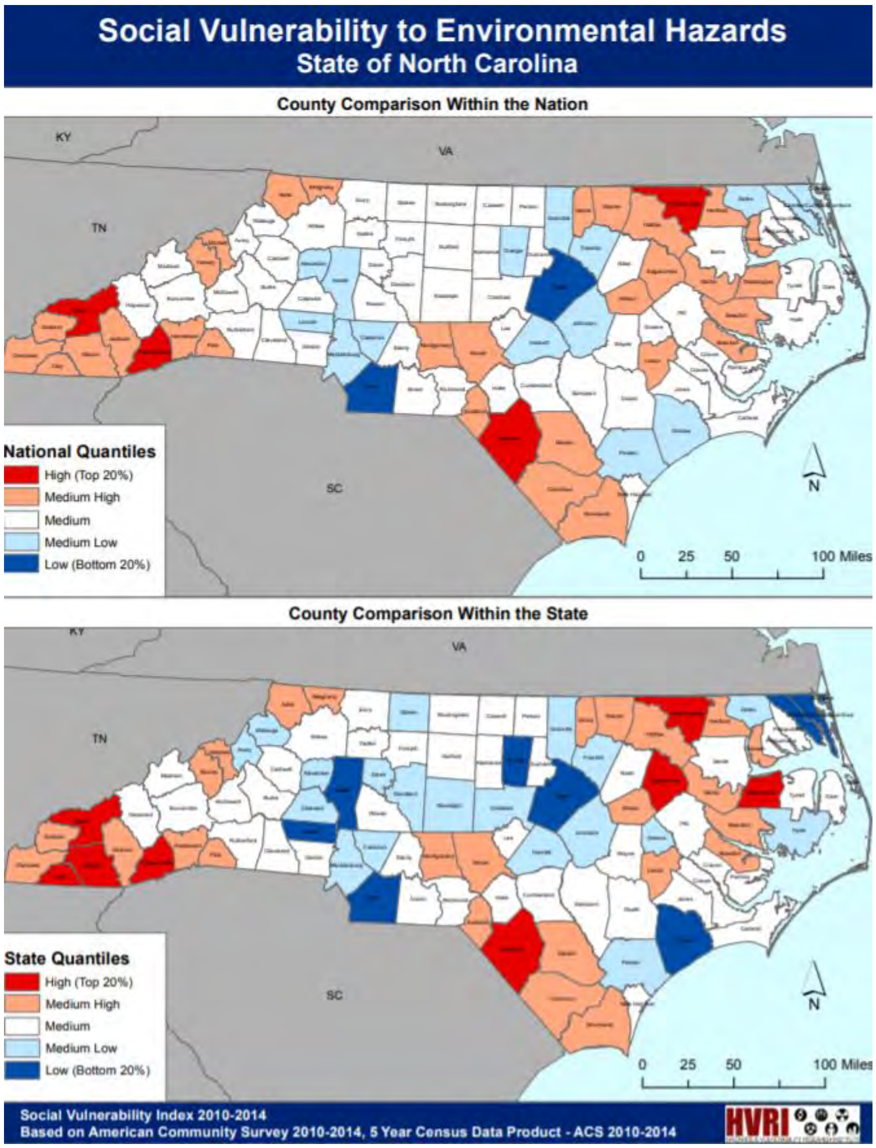
[1]Persons of Hispanic Origin may be of any race, so are also included in applicable race category in Durham County figures.

[2]Source: https://www.ednc.org/nc-school-of-science-and-math/

E.2.7 Social Vulnerability

The Hazards and Vulnerability Research Institute at the University of South Carolina has created the Social Vulnerability Index (SoVI), to measure comparative social vulnerability to environmental hazards in the U.S. at a county level. SoVI combines 29 socioeconomic variables to determine vulnerability. The seven most significant components for explaining vulnerability are race and class, wealth, elderly residents, Hispanic ethnicity, special needs individuals, Native American ethnicity, and service industry employment. The index also factors in family structure, language barriers, vehicle availability, medical disabilities, and healthcare access, among other variables. **Figure E.3** displays the SoVI index by county with comparisons within the Nation and within the State. In both comparisons, Durham County ranks among the medium quantiles for social vulnerability.

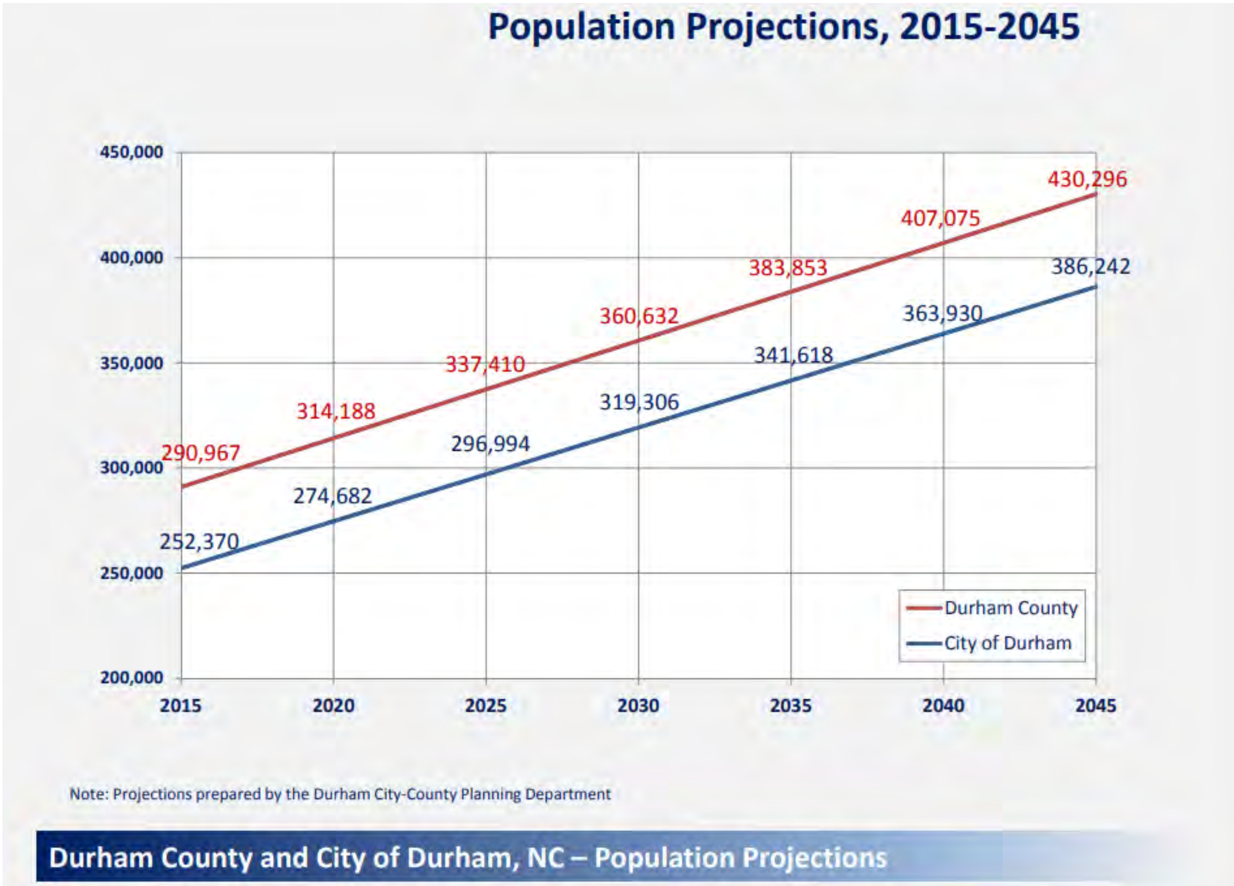
Figure E.3 – SoVI Index for North Carolina



E.2.8 Growth and Development Trends

Based on 2010 Census data, Durham is the fourth largest city in North Carolina with an estimated population of 278,993 residents in 2019 and is currently growing at an annual rate of 1.6%. As shown in **Figure E.4** on the following page, the population of Durham County and the City of Durham are projected to be over 430,000 and 386,000, respectively, by 2045. Even though the 2019 Census population estimates for Durham already exceeds the 2020 population projection shown below, these projections were still deemed the most reasonable and are based on the arithmetic method and 10 years of past growth.

Figure E.4 – County and City Population Growth Projections (2015 – 2045)



Th Source: https://durhamnc.gov/DocumentCenter/View/12987/Population-Projections?bidId=

The estimated population for Durham in 2019 was 278,993, which is a 0.8% increase over the 2015 estimated population, and a 4.7% increase from the 2010 Census population. **Table E.7** shows estimated population growth based on the 2010 Census population for the City of Durham.

Table E.7 – City of Durham Population Growth (2010 – 2019)

Year	Population	Growth	Percent Growth
2010	229,892	--	--
2015	258,647	9,031	3.9
2019	278,993	2,061	0.8

Source: U.S. Census Bureau

In addition to the Durham campus, NCSSM plans to open a second campus in Morganton, NC in 2022. The Morganton campus is currently being planned and constructed, and the location will serve approximately 300 more students. Future mitigation planning efforts may need to consider hazard risk and vulnerability on this new campus.

E.3 ASSET INVENTORY

An inventory of assets was compiled to identify the total count and value of property exposure on the NCSSM campus. This asset inventory serves as the basis for evaluating exposure and vulnerability by hazard. Assets identified for analysis include buildings, critical facilities, and critical infrastructure.

E.3.1 Building Exposure

Table E.8 provides total building exposure for the campus, which was estimated by summarizing building footprints provided by the University of North Carolina System Division of Information Technology and the North Carolina Emergency Management (NCEM) iRisk database and property values provided by the North Carolina Department of Insurance and NCEM iRisk database. All occupancy types were summarized into the following four categories: administration, critical facilities, educational/extracurricular, and housing. Note: estimated content values were not available.

Table E.8 – NCSSM Building Exposure by Occupancy

Occupancy	Estimated Building Count	Structure Value
Administration	2	$272,375
Critical Facilities	13	$23,047,448
Educational/Extracurricular	1	$189,842
Housing	0	$0
Total	**16**	**$23,509,665**

Source: UNC Division of Information Technology; NCEM iRisk; NC Department of Insurance

E.3.2 Critical Buildings and Infrastructure Exposure

Of significant concern with respect to any disaster event is the location of critical facilities and infrastructure in the planning area. Critical facilities are those essential services and lifelines that, if damaged during an emergency event, would disrupt campus continuity of operations or result in severe consequences to public health, safety, and welfare.

Critical buildings are a subset of the total building exposure and were identified by NCSSM's HMPC representatives. The NCSSM HMPC updated the list of critical facilities from the previous DRU plan and ranked each facility on a set of standardized criteria designed to evaluate all critical buildings in the UNC System DRU plans. Factors considered for this ranking included:

- the building's use for emergency response,
- the building's use for essential campus operations
- the building's use as an emergency shelter or for essential sheltering services,
- the presence of a generator or generator hook-ups,
- the building's use for provision of energy, chilled water or HVAC for sensitive or essential systems,
- the storage of hazardous materials,
- the building's use for sensitive research functions,
- the building's cultural or historical significance, and
- building-specific hazard vulnerabilities

Figure E.5 below shows the scoring sheet used to rate critical buildings on campus.

Figure E.5 – Critical Building Scoring Worksheet

Critical Building Scoring Worksheet

Campus:
Facility Name:

		Score
1	Does the facility serve as the campus Emergency Operations Center (EOC)? Yes, Primary EOC = 6 pts Yes, Secondary EOC = 3 pts No = 0 pts	0
2	Does the facility house functions essential to campus operations? Main Telecommunication Center = 3 pts; Maintenance = 1 pt Computer Network Hub = 3 pts; Public Safety = 1 pt Adminstrative Operations = 1 pts	0
3	Is the facility equiped with a generator or hook-ups? Generator = 3 pts Hook-ups = 1 pt Neither = 0 pts	0
4	Does the facility serve as a pre or post disaster shelter? Both pre and post disaster shelter = 6 pts Either pre or post disaster shelter = 3 pts Neither = 0 pts	0
5	Does the facility provide services essential to sheltering? Resident Housing = 1 pt; Food Preperation Facility = 1 pt Assesmbly Space = 1 pt; Shower Facilities = 1 pt	0
6	Does the facility provide chilled water distribution or contain HVAC systems necessary to sensitive or essential systems? Yes = 3 pts No = 0 pts	0
7	Are there hazardous materials on-site? (greater than 25 gallons) Yes = 3 pts No = 0 pts	0
8	Does the facility house research functions that have a low level of tolerance for disruption? Yes = 2 pts No = 0 pts	0
9	Does the facility serve as storage for rare or unique collections (art, artifacts, letters, etc) or is it a historically or culturally significant building? Yes = 2 pts No = 0 pts	0
10	Does the facility have hazard specific vulnerabilities (basement susceptible to flood, etc.) Yes = 3 pts No = 0 pts	0
Notes/ Comments		

Total Score:	0
Total Possible Score:	**42**

The identified critical facilities for NCSSM, as shown in **Figure E.6**, are listed below along with their scores:

- Beall Hall/Bryan Center/Bryan Lobby (26)
- Royall Center (24)
- Physical Education Center (PEC) (21)
- Educational Technology Center (ETC) (15)
- Reynolds Residence Hall (14)
- Hill House (12)
- Watts Hall (12)
- Hunt Residence Hall (11)
- Boiler Plant (10)
- Chiller Plant (7)
- Plant Facilities Building (4)
- Cottage (3)

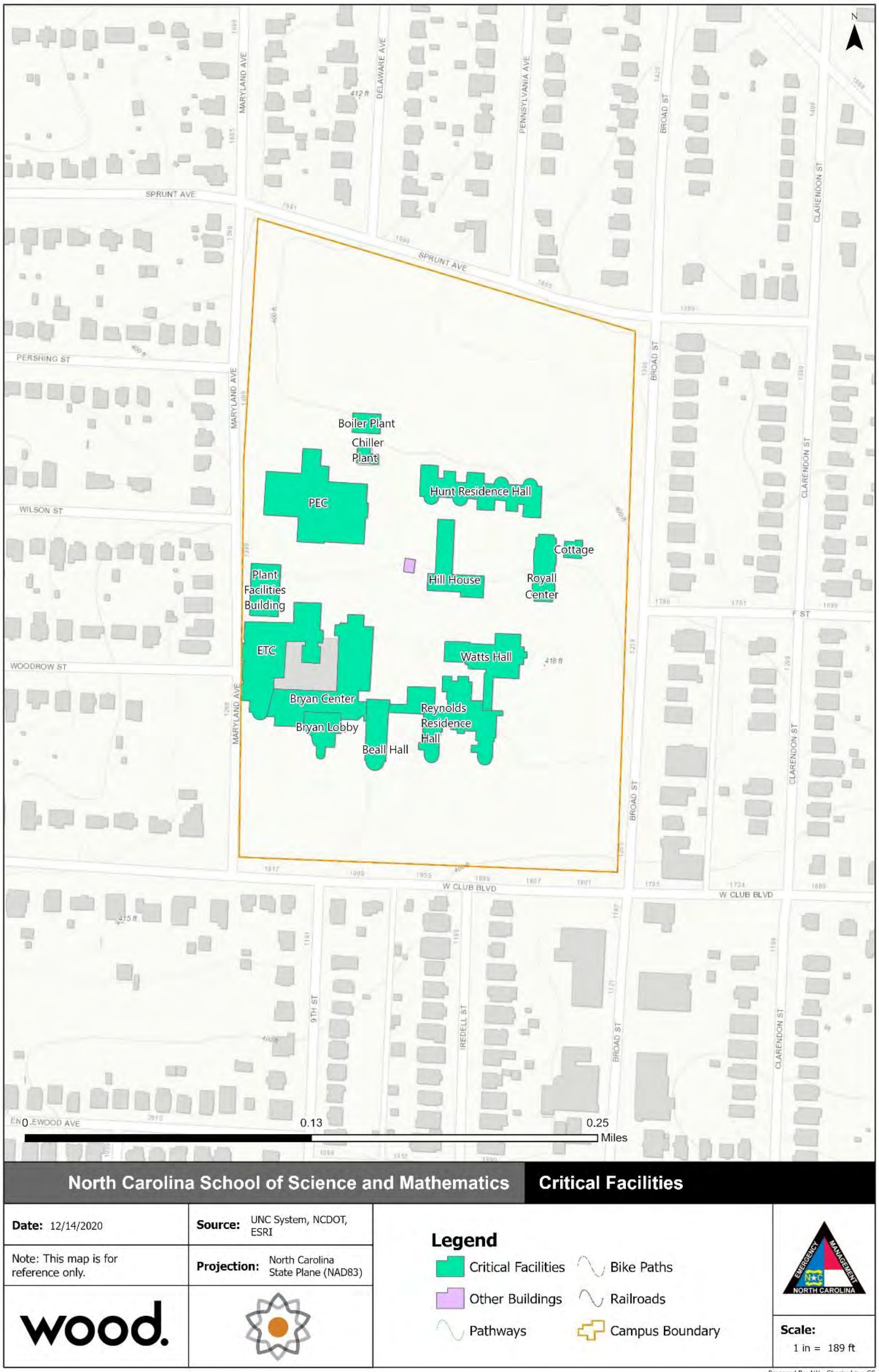
The Royall Center and PEC serve as primary Emergency Operations Centers (EOC) for the Campus; the Beall/Bryan complex services as the secondary EOC. The Beall/Bryan Complex, Royall Center, ETC, Reynolds Hall, Watts Hall, Boiler Plant, Chiller Plant, and Cottage all provide essential campus functions.

The PEC serves as the only emergency shelter on campus; however, the Beall/Bryan Complex, Royall Center, ETC, Reynolds Residence Hall, Hill House, Watts Hall, Hunt Residence Hall, and Plant Facilities Building all provide services essential to sheltering to support the PEC. The following buildings also host generators: Beall/Bryan Complex, Royall Center, PEC, Reynold Residence Hall, Hill House, Hunt Residence Hall, and Boiler Plant.

The Beall/Bryan Complex, Royall Center, PEC, ETC, Hill House, Watts House, Hunt Residence Hall, Boiler Plant, Chiller Plan, and Plant Facilities Building all provide chilled water distribution or contain HVAC systems necessary to sensitive or essential systems. The Boiler Plant, Chiller Plant, PEC, and Beall/Bryan complex also house hazardous materials on site.

Other critical campus buildings host research functions with low tolerance for disruption (Beall/Bryan Complex, ETC, Watts Hall, Hunt Residence Hall, Cottage), stores rare or unique collections or is historically significance (Royall Center, ETC, Reynolds Residence Hall, and Watts Hall), or have hazard specific vulnerabilities such as a basement (Beall/Bryan Complex, Royall Center, ETC, Reynolds, Hill House, and Watts Hall).

Figure E.6 – NCSSM Map of Critical Facilities



E.4 HAZARD IDENTIFICATION & RISK ASSESSMENT

E.4.1 Hazard Identification

To identify a full range of hazards relevant to the UNC Eastern Campuses, HMPC representatives from each campus began with a review of the list of hazards identified in the 2018 North Carolina State Hazard Mitigation Plan and the 2011 NCSSM Pre-Disaster Mitigation Plan, as summarized in **Table E.9**. This ensured consistency with the state and regional hazard mitigation plans and across each campus' planning efforts.

Table E.9 – Hazards Included in Previous Planning Efforts

Hazard	Included in 2018 State HMP?	Included in 2011 NCSSM Pre-Disaster Mitigation Plan?
Flooding	Yes	Yes
Hurricanes and Coastal Hazards	Yes	Yes, as High Wind, Hurricane
Severe Winter Weather	Yes	Yes, as Ice storm and Snow
Extreme Heat	Yes	No
Earthquakes	Yes	Yes
Wildfire	Yes	Yes
Dam Failures	Yes	No
Drought	Yes	No
Tornadoes/Thunderstorms	Yes	Yes
Geological (Landslides, Sinkholes, Coastal Erosion)	Yes	Yes, as Landslide
Hazardous Materials Incidents	Yes	No
Infectious Disease	Yes	No
Radiological Emergency	Yes	No
Terrorism/Mass Casualty	Yes	No
Cyber Threat	Yes	No

NCSSM's HMPC representatives evaluated the above list of hazards by considering existing hazard data, past disaster declarations, local knowledge, and information from the 2018 State Plan and the 2011 NCSSM Pre-Disaster Mitigation Plan in order to determine whether each hazard was significant enough to assess in this updated Hazard Mitigation Plan. Significance was measured in general terms and focused on key criteria such as frequency, severity, and resulting damage, including deaths and injuries, as well as property and economic damage.

One key resource in this effort was the National Oceanic and Atmospheric Administration's (NOAA) National Center for Environmental Information (NCEI), which has been tracking various types of weather events 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), which compiles their information from a variety of sources, including but 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. While NCEI is not a comprehensive list of past hazard events, it can provide an indication of relevant hazards to the planning area and offers some statistics on injuries, deaths, damages, as well as narrative descriptions of past impacts.

Data for Durham County was used to approximate past events that may have affected the NCSSM campus. The NCEI database contains 324 records of storm events that occurred in Durham County in the 20-year period from 2000 through 2019. **Table E.10** summarizes these events.

Table E.10 – NCEI Severe Weather Data for Durham County, 2000 – 2019

Type	# of Events	Property Damage	Crop Damage	Deaths	Injuries
Flash Flood	46	$425,000	$0	0	0
Flood	4	$11,050,000	$5,000,000	0	0
Funnel Cloud	3	$0	$0	0	0
Hail	69	$15,000	$0	0	0
Heavy Rain	1	$0	$0	0	0
Heavy Snow	1	$0	$0	0	0
High Wind	2	$1,000	$0	0	0
Hurricane (Typhoon)	1	$205,000	$0	0	0
Ice Storm	1	$400,000	$0	0	0
Lightning	7	$163,000	$0	1	1
Strong Wind	16	$433,450	$6,000	1	1
Thunderstorm Wind	118	$972,750	$0	1	1
Tornado	3	$350,000	$0	0	0
Tropical Storm	2	$200,000	$25,000	0	0
Winter Storm	25	$1,000,000	$0	0	0
Winter Weather	25	$30,000	$0	0	0
Total	**324**	**$15,245,200**	**$5,031,000**	**3**	**3**

Source: National Center for Environmental Information Events Database, retrieved October 2020
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 Durham 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 1954. Since then, Durham County has been designated in 17 major disaster declarations, as detailed in **Table E.11**, and 10 emergency declarations, as detailed in **Table E.12**.

Table E.11 – FEMA Major Disaster Declarations, Durham County

Disaster #	Dec. Date	Incident Type	Event Title	Individual Assistance Applications Approved	Total Individual and Households Program Dollars Approved	Total Public Assistance Grant Dollars Obligated
DR-28-NC	17-Oct-54	Hurricane	HURRICANE	N/A	N/A	N/A
DR-37-NC	13-Aug-55	Hurricane	HURRICANES	N/A	N/A	N/A
DR-56-NC	24-Apr-56	Severe Storm(s)	SEVERE STORM	N/A	N/A	N/A
DR-87-NC	01-Oct-58	Hurricane	HURRICANE & SEVERE STORM	N/A	N/A	N/A
DR-107-NC	16-Sep-60	Hurricane	HURRICANE DONNA	N/A	N/A	N/A

Disaster #	Dec. Date	Incident Type	Event Title	Individual Assistance Applications Approved	Total Individual and Households Program Dollars Approved	Total Public Assistance Grant Dollars Obligated
DR-130-NC	16-Mar-62	Flood	SEVERE STORM, HIGH TIDES & FLOODING	N/A	N/A	N/A
DR-179-NC	13-Oct-64	Flood	SEVERE STORMS & FLOODING	N/A	N/A	N/A
DR-827-NC	17-May-89	Tornado	TORNADOES	N/A	N/A	N/A
DR-1087-NC	13-Jan-96	Snow	BLIZZARD OF 96	N/A	N/A	N/A
DR-1134-NC	06-Sep-96	Hurricane	HURRICANE FRAN	N/A	N/A	N/A
DR-1211-NC	22-Mar-98	Severe Storm(s)	SEVERE STORMS TORNADOES, AND FLOODING	N/A	N/A	N/A
DR-1292-NC	16-Sep-99	Hurricane	HURRICANE FLOYD MAJOR DISASTER DECLARATIONS	N/A	N/A	$298,105,794
DR-1312-NC	31-Jan-00	Severe Storm(s)	SEVERE WINTER STORM	N/A	N/A	$27,368,108
DR-1448-NC	12-Dec-02	Severe Ice Storm	SEVERE ICE STORM	N/A	N/A	$86,565,180
DR-1490-NC	18-Sep-03	Hurricane	HURRICANE ISABEL	7790	$21,289,504	$18,285,917
DR-4393-NC	15-Sep-18	Hurricane	HURRICANE FLORENCE	34713	$133,948,455	$632,937,402
DR-4487-NC	25-Mar-20	Biological	COVID-19 PANDEMIC	N/A	N/A	$174,898,697

Source: FEMA Disaster Declarations Summary, October 2020
Note: Number of applications approved and all dollar values represent totals for all counties included in disaster declaration.

Table E.12 – FEMA Emergency Declarations, Durham County

Disaster #	Dec. Date	Incident Type	Event Title/Description
EM-3033-NC	02-Mar-77	Snow	DROUGHT & FREEZING
EM-3049-NC	11-Aug-77	Drought	DROUGHT
EM-3110-NC	17-Mar-93	Snow	SEVERE SNOWFALL & WINTER STORM
EM-3146-NC	15-Sep-99	Hurricane	HURRICANE FLOYD EMERGENCY DECLARATIONS
EM-3222-NC	05-Sep-05	Hurricane	HURRICANE KATRINA EVACUATION
EM-3380-NC	07-Oct-16	Hurricane	HURRICANE MATTHEW
EM-3401-NC	11-Sep-18	Hurricane	HURRICANE FLORENCE
EM-3423-NC	04-Sep-19	Hurricane	HURRICANE DORIAN
EM-3471-NC	13-Mar-20	Biological	COVID-19
EM-3534-NC	02-Aug-20	Hurricane	HURRICANE ISAIAS

Source: FEMA Disaster Declarations Summary, October 2020

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. **Table E.13** summaries the determination made for each hazard.

Table E.13 – Hazard Evaluation Results

Hazard	Included in this plan update?	Explanation for Decision
Natural Hazards		
Hurricane	Yes	The 2011 NCSSM PDM plan found Hurricane to be a moderate threat hazard. The County has had 10 disaster declarations related to hurricanes wind.
Coastal Hazards	No	The 2011 NCSSM PDM plan did not address this hazard.
Tornadoes / Thunderstorms (Wind, Lightning, Hail)	Yes	The 2011 NCSSM PDM plan found tornadoes to be a low threat hazard. The County has had no disaster declarations related to tornadoes. The HMPC expressed interest in addressing this hazard in combination with thunderstorms (wind, lightning, hail).
Flood*	Yes	The 2011 NCSSM PDM plan rated flood a significant threat hazard for the planning area. The County has had 2 disaster declarations related to flooding.
Severe Winter Weather	Yes	The 2011 NCSSM PDM plan found ice/snow to be a low threat hazard. The HMPC expressed interest in addressing this hazard as severe winter weather to include cold/wind chill; extreme cold; freezing fog; frost/freeze; heavy snow; ice storm; winter storm; and winter weather.
Drought	No	The 2011 NCSSM PDM plan did not address this hazard.
Wildfire*	Yes	The 2011 NCSSM PDM plan did not a assign a threat and/or risk level for this hazard; however, the HMPC expressed interest in addressing this hazard.
Earthquake*	Yes	The 2011 NCSSM PDM plan did not a assign a threat and/or risk level for this hazard; however, the HMPC expressed interest in addressing this hazard.
Geologic Hazards (Sinkhole & Landslide)*	No	The 2011 NCSSM PDM plan did not a assign a threat and/or risk level for this hazard; and the HMPC did not express an interest in addressing this hazard.
Dam Failure	No	The 2011 NCSSM PDM plan did not address this hazard.
Extreme Heat	No	The 2011 NCSSM PDM plan did not address this hazard.
Technological and Human-Caused Hazards & Threats		
Hazardous Materials Incidents	Yes	The 2011 NCSSM PDM plan did not address this hazard; however, there are fixed facility sites and transportation routes with hazardous materials in the planning area and the HMPC expressed interest in addressing this hazard.
Vandalism/Theft	Yes	The 2011 NCSSM PDM plan did not address this hazard; however, there have been instances of vandalism/theft during 2020 and the HMPC expressed interest in addressing this as a hazard.
Infectious Disease	No	The 2011 NCSSM PDM plan did not address this hazard and the HMPC did not express interest in evaluating civil unrest in this plan update.
Cyber Attack	No	The 2011 NCSSM PDM plan did not address this hazard and the HMPC did not express interest in evaluating civil unrest in this plan update.
Civil Unrest	No	The 2011 NCSSM PDM plan did not address this hazard and the HMPC did not express interest in evaluating civil unrest in this plan update.

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

E.5 HAZARD PROFILES, ANALYSIS, AND VULNERABILITY

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 where it may occur, the severity of potential events, records of past events, the probability of future occurrences, and potential impacts from the hazard. A vulnerability assessment was conducted for each hazard using quantitative and/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.

To account for regional differences in hazard risk across each of the campuses, this risk assessment is divided into two parts:

1) a set of summary hazard profiles describing each hazard and summarizing the risk findings for each campus, presented in Section 3.5; and
2) a campus-specific risk assessment profiling the location, extent, historical occurrences, probability of future occurrence, and vulnerability of each campus, presented in each campus annex.

In the campus-level hazard profiles presented here, each hazard is profiled in the following format:

Location

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

Extent

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

Historical Occurrences

This section contains information on historical events, including the location and consequences of all past events on record within or near the Durham County planning area. Where possible, this plan uses a consistent 20-year period of record except for hazards with significantly longer average occurrence intervals or where data limitations otherwise restrict the period of record.

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)

Vulnerability Assessment

This section quantifies, to the extent feasible using best available data, assets at risk to natural hazards and potential loss estimates. Details on hazard specific methodologies and assumptions are provided where applicable. People, properties and critical facilities, and environmental assets that are vulnerable to the hazard are identified.

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

- Geographic Information System (GIS) datasets, including County parcel data from 2020, campus building inventory fand values from the University System's Division of Information Technology, NCEM iRisk Database, and property values provided by the NC Department of Insurance, topography, transportation layers, and critical facility and infrastructure locations;
- Hazard layer GIS datasets from state and federal agencies;
- Written descriptions of inventory and risks provided by the 2018 State of North Carolina Hazard Mitigation Plan;
- Written descriptions of inventory and risks provided by the 2020 Eno-Haw Regional Hazard Mitigation Plan; and
- Exposure and vulnerability estimates derived using local parcel data.

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. For applicable hazards, the quantitative analysis involved the use of FEMA's Hazus-MH, a nationally applicable standardized set of models for estimating potential losses from earthquakes, floods, and hurricanes. Hazus uses a statistical approach and mathematical modeling of risk to predict a hazard's frequency of occurrence and estimated impacts based on recorded or historic damage information. The Hazus risk assessment methodology is parametric, in that distinct hazard and inventory parameters—such as wind speed and building type—were modeled using the Hazus software to determine the impact on the built environment. Durham County's GIS-based risk assessment was completed using data collected from local, regional and national sources that included Durham County, NCEM, and FEMA.

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. Other information can be collected in regard to the hazard area, such as the location of critical facilities and infrastructure, historic resources, 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.

The data collected for the hazard profiles and vulnerability assessment was obtained from multiple sources covering a variety of spatial areas including county-, jurisdictional-, and campus-level information. The table below presents the source data and the associated geographic coverages.

Table E.14 – Summary of Hazard Data Sources and Geographic Coverage

Hazard	Hazard Data Sources	Profile Geographic Area	Vulnerability Methodology	Vulnerability Geographic Area
Earthquake	USGS, NCEI	County	Hazus 4.2	Census Tract
Flood	NCEI, FEMA	Jurisdiction	GIS Spatial Analysis	Campus

Hazard	Hazard Data Sources	Profile Geographic Area	Vulnerability Methodology	Vulnerability Geographic Area
Hurricane	NHC	County	Hazus 4.2	Census Tract
Landslide	USGS	County	Qualitative Analysis	Campus
Severe Winter Weather	NWS, NCEI	County	Statistical Analysis	County
Tornado / Thunderstorm	NWS, NCEI	Jurisdiction	Statistical Analysis	Jurisdiction
Wildfire	NCFS, SouthWRAP	County, Campus	GIS Spatial Analysis	Campus
Hazardous Materials Incidents	EPA; USDOT	Jurisdiction	GIS Spatial Analysis	Campus
Vandalism/Theft	Internet Research	County, Higher Education	Qualitative Analysis	Higher Education

CDC = Centers for Disease Control and Prevention; EPA = United States Environmental Protection Agency; FEMA = Federal Emergency Management Agency; NCEI = National Centers for Environmental Information; NCFS = North Carolina Forest Service; NHC = National Hurricane Center; NWS = National Weather Service; SouthWRAP = Southern Group of State Foresters, Wildfire Risk Assessment Portal; USDOT = United States Department of Transportation; USGS = United States Geological Survey; WHO = World Health Organization

Changes in Development

This section describes how changes in development have impacted vulnerability since the last plan was adopted. 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.

Problem Statements

This section summarizes key mitigation planning concerns related to this hazard.

Priority Risk Index

The conclusions drawn from the hazard profiling and vulnerability assessment process are used to prioritize all potential hazards to the NCSSM 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 E.15**.

PRI ratings are provided by category throughout each hazard profile for the planning area as a whole. Ratings specific to each jurisdiction are provided at the end of each hazard profile. The results of the risk assessment and overall PRI scoring are provided in Section 0 Conclusions on Hazard Risk.

The sum of all five risk assessment categories equals the final PRI value, demonstrated in the equation below (the lowest possible PRI value is a 1.0 and 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 campus 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.

Table E.15 – 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	

E.5.1 Earthquake

Hazard	Probability	Impact	Spatial Extent	Warning Time	Duration	PRI Score
Earthquake	Unlikely	Minor	Large	Less than 6 hours	Less than 6 hours	1.9

Location

The United States Geological Survey (USGS) Quaternary faults database was consulted to determine the sources of potential earthquakes within range of Durham County. Quaternary faults are active faults recognized at the surface which have evidence of movement in the past 2.58 million years. No active faults were noted in Durham County.

Earthquakes are generally felt over a wide area, with impacts occurring hundreds of miles from the epicenter. Therefore, any earthquake that impacts Durham County is likely to be felt across most if not all of the planning area.

Spatial Extent: 4 – Large

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 E.16**. 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 E.17** 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 E.16 – 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 E.17 – 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.

MMI	Richter Scale	Felt Intensity
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.
VIII	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 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.

Impact: 1 – Minor

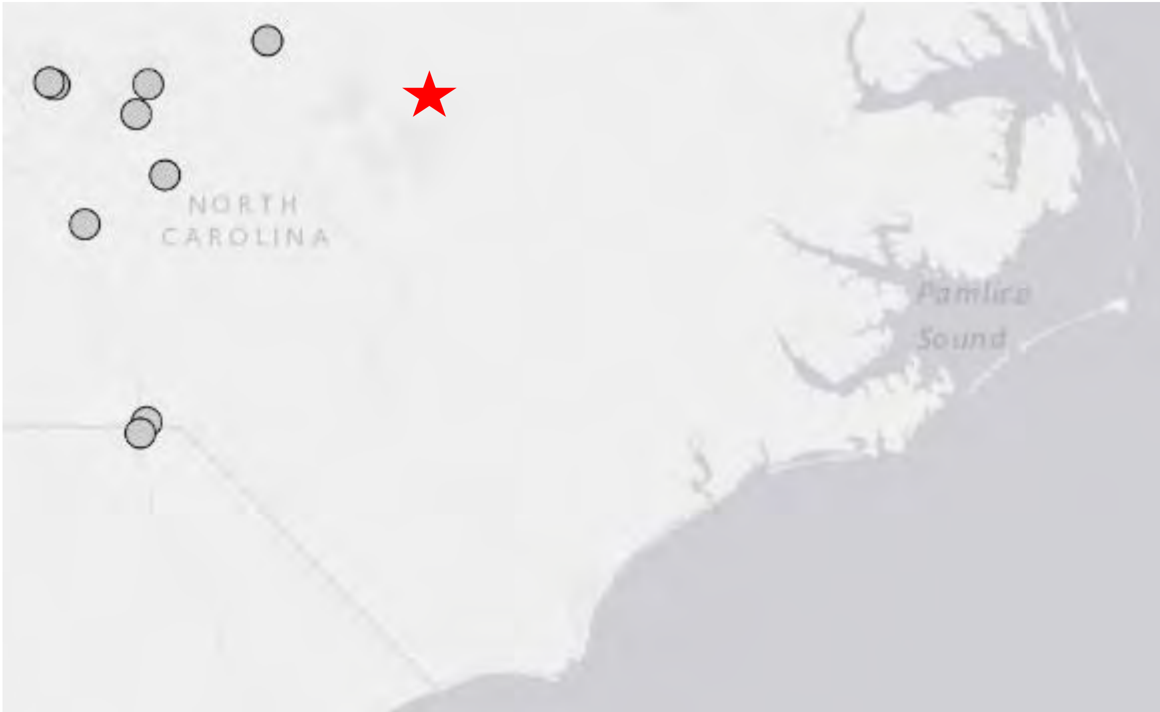
Historical Occurrences

The USGS Earthquake Hazards Program maintains a database of historical earthquakes of a magnitude 2.5 and greater from 1900 to 2020. Earthquake events that occurred within 100 miles of the NCSSM campus are presented in **Table E.18** and **Figure E.7**.

Table E.18 – Historical Earthquakes within 100 Miles of NCSSM, 1900-2020

Year	Magnitude	MMI	Location
1978	2.7	II	Virginia-North Carolina border region
1981	2.8	II	North Carolina
1993	2.7	II	Virginia-North Carolina border region
2006	2.5	II	Virginia-North Carolina border region
2006	2.6	II	7km S of Winston-Salem, North Carolina
2011	2.9	II	9km S of Cordova, North Carolina
2012	2.5	II	10km NNE of Cheraw, South Carolina
2015	2.58	II	10km S of Denton, North Carolina
2019	2.5	II	8km E of Archdale, North Carolina

Figure E.7 – Historical Earthquakes within 100 Miles of NCSSM, 1900-2020



Source: USGS

The National Center for Environmental Information (NCEI) maintains a database of the felt intensity of earthquakes from 1638 to 1985 including the maximum intensity for each locality that felt the earthquake. According to this database, in the 100-year period from 1885-1985, there were two earthquakes felt in and around Durham: on September 1, 1886 with an epicenter approximately 365 miles from Durham; and on November 20, 1969 a 4.3 magnitude with an epicenter approximately 242 miles from Durham.

Probability of Future Occurrence

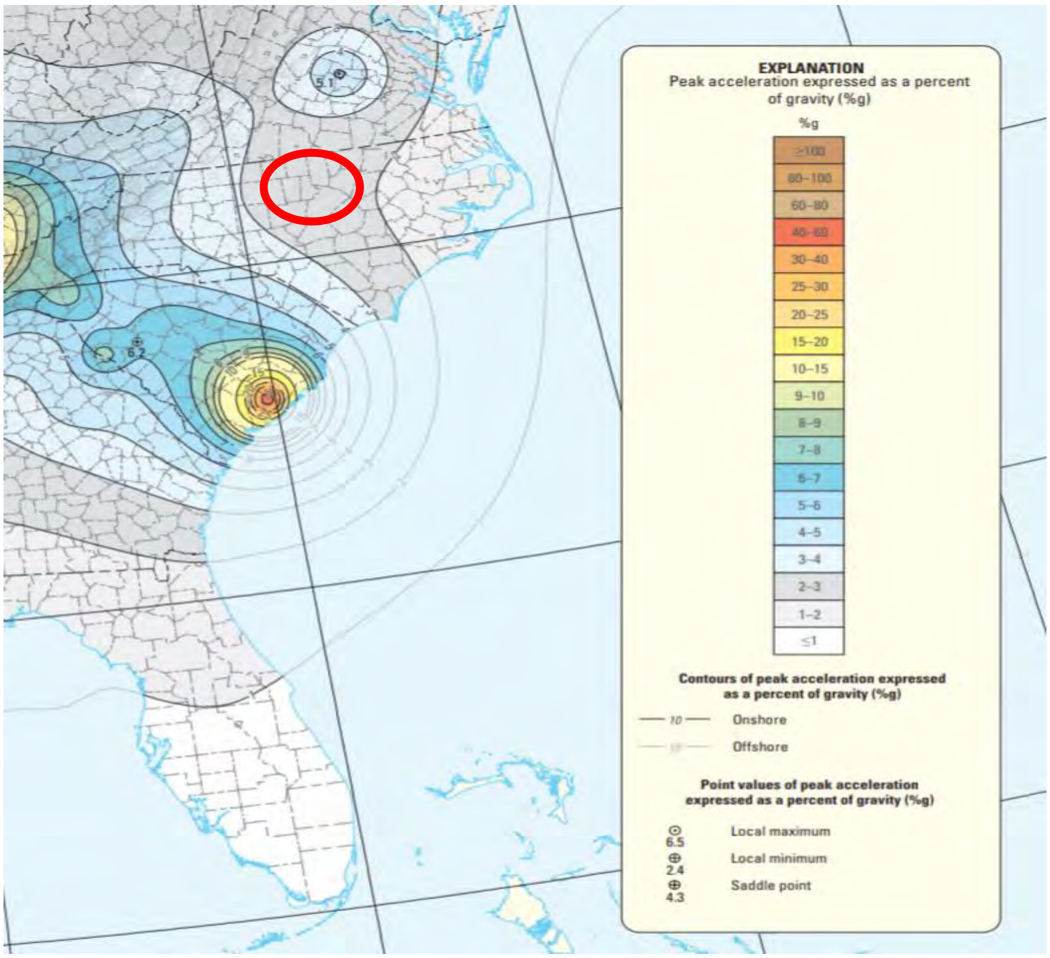
Ground motion is the movement of the earth's surface due to earthquakes or explosions. It is produced by waves generated by a sudden slip on a fault or sudden pressure at the explosive source and travels through the earth and along its surface. Ground motion is amplified when surface waves of unconsolidated 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 that have a common given probability of being exceeded in 50 years.

Figure E.8 on the following page reflects the seismic hazard for Durham 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 occurrence 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. All of Durham County is located within a zone with peak acceleration of 2-3% g, which indicates low earthquake risk.

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

Probability: 1 – Unlikely

Figure E.8 – Seismic Hazard Information for Durham County



Source: USGS Earthquake Hazards Program

Vulnerability Assessment

Methodology & Assumptions

To quantify vulnerability, Wood performed a Level 1 earthquake analysis in Hazus 4.2 utilizing general building stock information based on the 2010 Census. The NCSSM campus is located within a single census tract encompassing 1.31 square miles. The earthquake scenario was modeled after an arbitrary earthquake event of magnitude 5.0 with an epicenter in the NCSSM campus and depth of 10km.

People

Hazus estimates that the modeled magnitude 5.0 event would result in no households requiring temporary shelter. Additionally, Hazus estimates potential injuries and fatalities depending on the time of day of an event. Casualty estimates are shown in **Figure E.9**. Casualties are broken down into the following four levels that describe the extent of injuries:

- Level 1: Injuries will require medical attention, but hospitalization is not needed.
- Level 2: Injuries will require hospitalization but are not considered life-threatening.
- Level 3: Injuries will require hospitalization and can become life threatening if not promptly treated.
- Level 4: Victims are killed by the earthquake.

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. Impacts of earthquakes also include debris clean-up and service disruption. Per the Hazus analysis, a 5.0 magnitude earthquake could not produce debris.

Durham County has not been impacted by an earthquake with more than a low intensity, so major damage to the built environment is unlikely. **Table E.19** details the estimated buildings impacted by a magnitude 5.0 earthquake event, as modeled by Hazus. Note that building value estimates are inherent to Hazus and do not necessarily reflect damages to the asset inventory for the NCSSM Campus.

Table E.19 – Estimated Buildings Impacted by 5.0 Magnitude Earthquake Event

Occupancy Type	Estimated Building Damage	Estimated Content Loss	Estimated Total Damage
Residential	$10,000	$0	$10,000
Commercial	$0	$0	$0
Industrial	$0	$0	$0
Other	$0	$0	$0
Total	**$10,000**	**$0**	**$10,000**

Source: Hazus

Figure E.9 – Casualty Estimate from a 5.0 Magnitude Earthquake Event

		Level 1	Level 2	Level 3	Level 4
2 AM	Commercial	0	0	0	0
	Commuting	0	0	0	0
	Educational	0	0	0	0
	Hotels	0	0	0	0
	Industrial	0	0	0	0
	Other-Residential	0	0	0	0
	Single Family	0	0	0	0
	Total	**0**	**0**	**0**	**0**
2 PM	Commercial	0	0	0	0
	Commuting	0	0	0	0
	Educational	0	0	0	0
	Hotels	0	0	0	0
	Industrial	0	0	0	0
	Other-Residential	0	0	0	0
	Single Family	0	0	0	0
	Total	**0**	**0**	**0**	**0**
5 PM	Commercial	0	0	0	0
	Commuting	0	0	0	0
	Educational	0	0	0	0
	Hotels	0	0	0	0
	Industrial	0	0	0	0
	Other-Residential	0	0	0	0
	Single Family	0	0	0	0
	Total	**0**	**0**	**0**	**0**

Source: Hazus 4.2

All critical facilities should be considered at risk to minor damage should an earthquake event occur. Of the essential facilities included in Hazus, one school was estimated to sustain moderate damage. Additionally, Hazus projected impacts to one bus facility.

Environment

An earthquake is unlikely to cause substantial impacts to the natural environment in Durham 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.

Changes in Development

Building codes substantially reduce the costs of damage to future structures from earthquakes. Future construction on the NCSSM campus must follow the applicable requirements of the NC building codes, the State of North Carolina statutes for state owned buildings and zoning for the local jurisdiction.

Development changes at NCSSM have not affected the risk characteristics of earthquakes. The probability, impact, spatial extent, warning time, and duration of earthquakes have not changed.

Problem Statement

- While earthquakes are an unlikely hazard event for the NCSSM campus, the Hazus model did predict impacts to buildings, one school, and one bus facility within the census tract.

E.5.2 Flood

Hazard	Probability	Impact	Spatial Extent	Warning Time	Duration	PRI Score
Flood	Likely	Minor	Negligible	6 to 12 hrs	Less than 6 hours	1.8

Location

Regulated floodplains are illustrated on inundation maps called Flood Insurance Rate Maps (FIRMs). A FIRM 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 1-percent-annual-chance flood event. Structures located within the SFHA have a 26-percent chance of flooding during the life of a standard 30-year mortgage.

For this risk assessment, flood prone areas were identified within the NCSSM Campus using the FIRM dated October 19, 2018. **Figure E.10** reflects the 2018 mapped flood insurance zones.

Table E.20 – Mapped Flood Insurance Zones within NCSSM

Zone	Description
A	Zone A is the flood insurance rate zone that corresponds to the 1% annual chance floodplains that are determined in the FIS Report by approximate methods. Because detailed hydraulic analyses are not performed for such areas, no Base Flood Elevations or depths are shown within this zone.
AE	Zone AE is the flood insurance rate zone that corresponds to the 1% annual chance floodplains that are determined in the FIS Report by detailed methods. In most instances, whole-foot Base Flood Elevations derived from the detailed hydraulic analyses are shown at selected intervals within this zone.
AH	Zone AH is the flood insurance rate zone that corresponds to the areas of 1% annual chance shallow flooding (usually areas of ponding) where average depths are between 1 and 3 feet. Whole-foot Base Flood Elevations derived from the detailed hydraulic analyses are shown at selected intervals within this zone.
AO	Zone AO is the flood insurance rate zone that corresponds to the areas of 1% annual chance shallow flooding (usually sheet flow on sloping terrain) where average depths are between 1 and 3 feet. Average whole-foot depths derived from the detailed hydraulic analyses are shown within this zone.
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 0.2-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.

None of the NCSSM Campus is located within the SFHA. **Table E.21** provides a summary of the NCSSM Campus' total area by flood zone on the 2018 effective DFIRM.

Spatial Extent: 1 – Negligible

Figure E.10 – FEMA Flood Hazard Areas in NCSSM's Campus Boundary

Table E.21 – Flood Zone Acreage on NCSSM Campus

Flood Zone	Acreage	Percent of Total (%)
A	0	0.0%
AE	0	0.0%
Floodway	0	0.0%
0.2% Annual Chance Flood Hazard	0	0.0%
Unshaded X	28	100.0%
Total	28	--
SFHA Total	**0**	**0.0%**

Source: FEMA 2018 DFIRM

Extent

Flood extent can be defined by the amount of land in the floodplain, detailed above, and the potential magnitude of flooding as measured by flood depth and velocity. As shown in **Figure E.10** the SFHA does not intersect with the NCSSM campus. However, flooding may also occur on the campus when an intense rainfall occurs within the urban area and cannot be carried away by natural or urban drainage systems as fast as it is falling.

Impact: 1 – Minor

Historical Occurrences

Table E.22 details the historical occurrences of flooding for Durham identified from 2000 through 2019 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 E.22 – NCEI Records of Flooding for the City of Durham, 2000-2019

Location	Date	Deaths/Injuries	Reported Property Damage	Reported Crop Damage
Flash Flood				
DURHAM	7/23/2000	0/0	$0	$0
DURHAM	8/4/2000	0/0	$0	$0
DURHAM	6/22/2001	0/0	$0	$0
DURHAM	10/11/2002	0/0	$0	$0
DURHAM	10/11/2002	0/0	$0	$0
DURHAM	5/23/2004	0/0	$0	$0
DURHAM	8/12/2004	0/0	$0	$0
DURHAM	7/13/2006	0/0	$0	$0
DURHAM	11/16/2006	0/0	$0	$0
EAST DURHAM	9/6/2011	0/0	$0	$0
DURHAM	6/11/2014	0/0	$0	$0
DURHAM	12/30/2015	0/0	$10,000	$0
WEST DURHAM	4/15/2018	0/0	$0	$0
DURHAM	4/12/2019	0/0	$30,000	$0
Heavy Rain				
DURHAM	11/22/2006	0/0	$0	$0
	Total	**0/0**	**$40,000**	**$0**

Source: NCEI

According to NCEI, 15 recorded flood-related events affected the City of Durham from 2000 to 2019 causing an estimated $40,000 in property damage, with no injuries, fatalities, or crop damage.

The following event narratives are provided in the NCEI Storm Events Database and illustrate the impacts of flood events on the county:

- **08/4/2000** - Flooding on Hwy 147, 6 to 8 inches of water covered roads in the South Square area.
- **12/30/2015** - Flooding caused minor damage to the Hillandale Road VA Clinic in Durham, where 1-2 inches of water got inside the building. In addition, high water signs were deployed across Durham.
- **4/12/2019** - Multiple roads were closed due to flash flooding near Durham. Hillandale Road at Sprunt Avenue, Morreene Road at American Drive and Hillandale Road at Peppertree Street were all closed due to flooding. A car became stranded in flood waters near the intersection of Belleavue Avenue and Hillsborough Road.

The state of North Carolina has had two FEMA Major Disaster Declarations for severe storms that include elements of flooding in 1962 and 1964 along with four Major Disaster Declarations for Hurricanes in 1954, 1955, 1958, 1960 which may have included damages associated with flooding. Additionally, Durham County has received one Major Disaster Declaration for a severe storm including elements of flooding in 1998 along with four Major Disaster Declarations for Hurricanes in, 1996, 1999, 2003, 2018 which also may have included damages associated with flooding.

Probability of Future Occurrence

By definition, SFHAs are those areas that will be inundated by the flood event having a 1-percent chance of being equaled or exceeded in any given year. While exposure to flood hazards varies across jurisdictions, all jurisdictions have at least some area of land in FEMA-mapped flood hazard areas. This delineation is a useful way to identify the most at-risk areas, but flooding does not occur in set intervals; any given flood may be more or less severe than the defined 1-percent-annual-chance flood. There is also risk of localized and stormwater flooding in areas outside the SFHA and at different intervals than the 1% annual chance flood.

Floods of varying severity occur regularly in Durham and impacts from past flood events have been noted by NCEI. NCEI reports 15 flood-related events in the 20-year period from 2000-2019, in the 20-year period from 2000-2019, which equates to an annual probability of 75% for Durham. Therefore, the probability of flooding is considered likely (between 10% and 100% annual probability).

Probability: 3 – Likely

Vulnerability Assessment

Methodology & Assumptions

To quantify vulnerability, Wood performed a GIS spatial analysis of the flood hazard by overlaying the mapped SFHA on the building footprints provided by the UNC Division of Information Technology and NCEM iRisk database. For the NCSSM campus, there are no structures located within the SFHA.

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 systems lose 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 high risk when driving through flooded streets. However, NCEI does not contain any records of deaths caused by flood events in Durham County.

An estimate of population at risk to flooding was developed based on the assessment of residential property at risk. For the NCSSM campus, there are no housing properties at risk.

Property

Administration buildings, education and/or extracurricular facilities, housing, as well as critical facilities and infrastructure such as transportation, water, energy, and communication systems may be damaged or destroyed by flood waters.

Table E.23 details the estimated losses for the 1%-annual-chance flood event for the campus. The total damage estimate value is based on damages to the total of building value. Land value is not included in any of the loss estimates as generally land is not subject to loss from floods.

Table E.23 – Estimated Building Damage and Content Loss for 1% Annual Chance Flood

Occupancy Type	Total Buildings with Loss	Total Value	Estimated Building Damage	Loss Ratio
Administration	0	$0	$0	0%
Critical Facilities	0	$0	$0	0%
Education/ Extracurricular	0	$0	$0	0%
Housing	0	$0	$0	0%
Total	**0**	**$0**	**$0**	**0%**

Source: UNC Division of Information Technology; NCEM iRisk; NC Department of Insurance; USACE Wilmington District Depth-Damage Function

The loss ratio is the loss estimate divided by the total potential exposure (i.e., total of improved value for all buildings located within the Zone AE) and displayed as a percentage of loss. FEMA considers loss ratios greater than 10% to be significant and an indicator a community may have more difficulties recovering from a flood. Loss ratios for all occupancy types with identified structures on the NCSSM campus are 0%, meaning that in the event of a flood with a magnitude of the 1%-annual-chance event or greater, the planning area would be minimally impacted.

None of the critical facilities identified for NCSSM are located within the 1%-annual-chance floodplain, therefore there are no estimated damages.

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 planning area. According to 2020 NFIP records, there are no repetitive loss properties on the NCSSM campus.

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.

Changes in Development

The likelihood of future flood damage can be reduced through appropriate land use planning, building siting and building design. In addition, the NCSSM Plant Facilities and Grounds Departments work to maintain compliance with all applicable state and federal regulations regarding water resources, provides a regulatory framework to ensure development has minimal impact on the environment, and manages the stormwater infrastructure.

Problem Statement

- While the 1% annual chance floodplain does not impact the NCSSM campus, flooding may also occur on the campus when an intense rainfall occurs within the urban area and cannot be carried away by natural or urban drainage systems as fast as it is falling.

E.5.3 Geological – Landslide

Hazard	Probability	Impact	Spatial Extent	Warning Time	Duration	PRI Score
Landslide	Unlikely	Minor	Small	6 to 12 hrs	Less than 6 hrs	1.4

Location

Durham County is located within the Piedmont physiographic province of North Carolina. The Piedmont province lies between the Coastal Plain and the Blue Ridge Mountains and encompasses approximately 45 percent of the area of the state. The Piedmont province is characterized by gently rolling, well-rounded hills and long low ridges with a few hundred feet of elevation difference between the hills and valleys.

The U.S. Geological Survey (USGS) has produced landslide susceptibility and incidence mapping of the U.S., as shown in **Figure E.11**. 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, Durham County faces moderate susceptibility and low incidence of landslides.

Spatial Extent: 4 – Small

Extent

In low-relief areas, such as the Durham County area, landslides may occur as cut-and fill failures (roadway and building excavations), river bluff failures, lateral spreading landslides, collapse of mine-waste piles (especially coal), and a wide variety of slope failures associated with quarries and open-pit mines. In these instances, impacts are limited to the defined area. Event magnitude is also dependent on topography; landslide risk is higher in areas with steeper slopes. Given the gentle topography the county, the magnitude of any landslides on NCSSM's campus would be minor.

Impact: 3 – Minor

Historical Occurrences

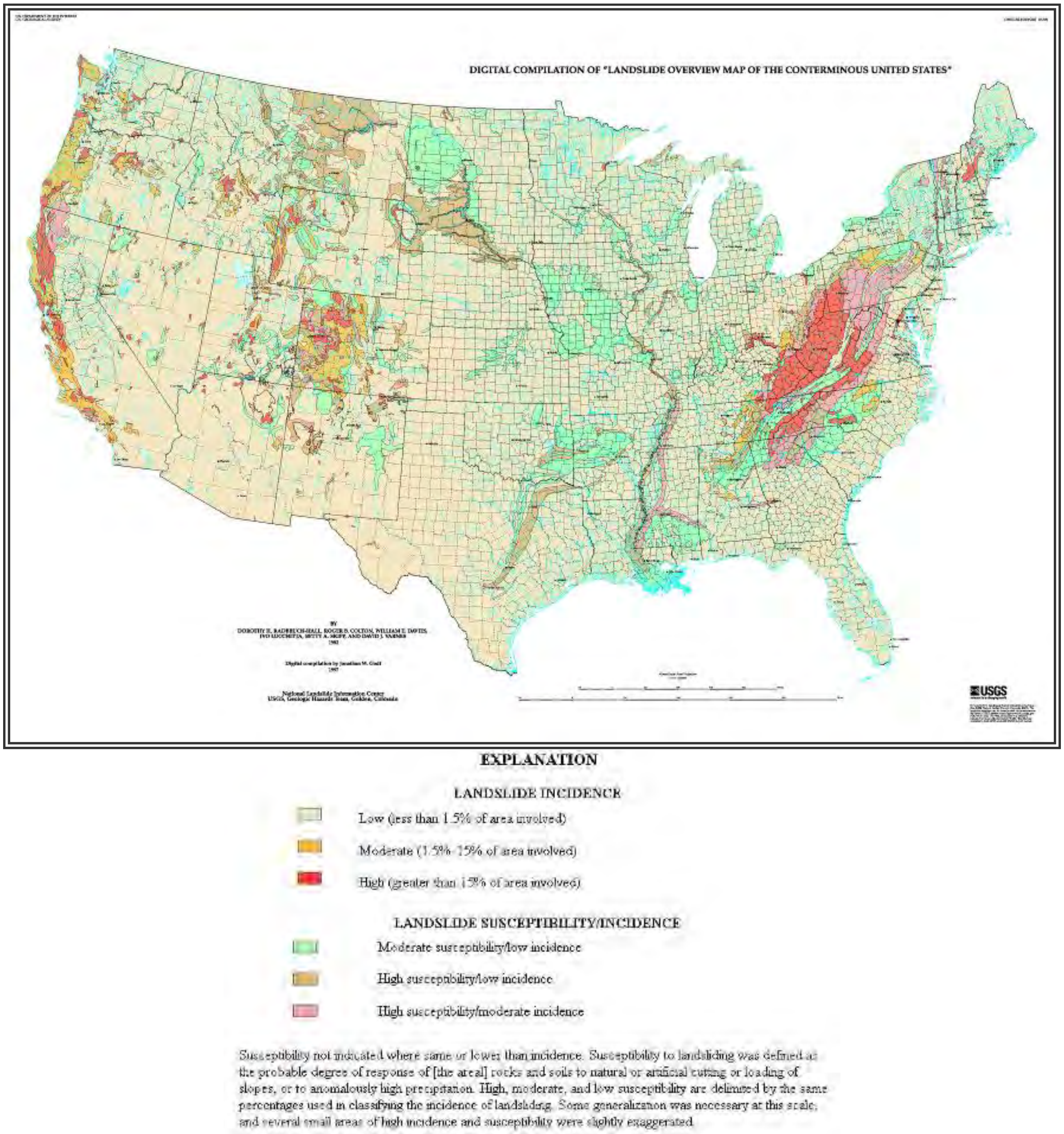
There were no available records of past landslide events for Durham County. When looking at the map in **Figure E.11**, it is shown that all of Durham County is in an area with moderate susceptibility and low incidence to landslides.

Probability of Future Occurrence

There were no records found for any landslide events occurring in Durham County between 2000 and 2019. Since this area does not have any historical occurrences, it is 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

Figure E.11 – Landslide Incidence and Susceptibility



Source: USGS

Vulnerability Assessment

People

People are unlikely to sustain serious physical harm as a result of landslides in Durham 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 Durham 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 Durham County are unlikely to cause any more severe impacts.

Changes in Development

Although Durham County faces moderate susceptibility and low incidence of landslides, future development projects should consider slope and soil slippage potential at the planning, engineering and architectural design stage with the goal of reducing vulnerability.

Problem Statement

- A landslide event 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.

E.5.4 Hurricane

Hazard	Probability	Impact	Spatial Extent	Warning Time	Duration	PRI Score
Hurricane	Likely	Critical	Large	More than 24 hrs	Less than 24 hrs	2.9

Location

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

Storm surges, or storm floods, are limited to the coastal counties of North Carolina, therefore NCSSM is not exposed to storm surge. However, hurricane winds can impact the entire campus, so the spatial extent was determined to be large

Spatial Extent: 4 – Large

Extent

Hurricane intensity is classified by the Saffir-Simpson Scale (**Table E.24**), which rates hurricane intensity on a scale of 1 to 5, with 5 being the most intense.

Table E.24 – 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 E.25** describes the damage that could be expected for each category of hurricane. Damage during hurricanes

Table E.25 – 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

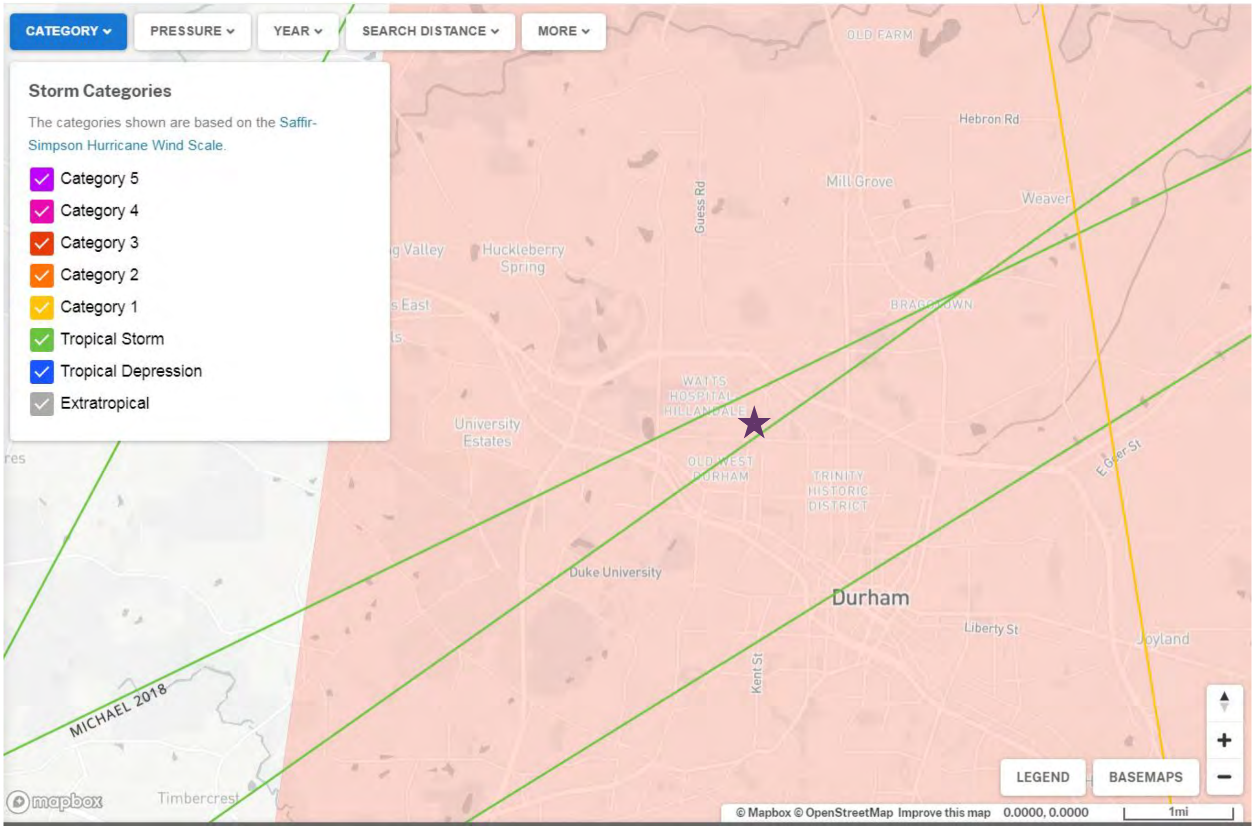
Tropical cyclones weaken relatively quickly after making landfall; therefore, Durham County will not typically experience major hurricane force winds, though these occurrences are possible. Two storms on record that would have directly impacted NCSSM was an unnamed tropical depression and Tropical Storm Michael whose paths moved through where the campus is currently located in 1854 and 2018, respectively, with maximum wind speeds of around 57 mph and 52 mph, respectively. Hurricane Fran passed within 5 miles of NCSSM's campus as a Category 1 storm with wind speeds around 75 mph in 1996.

Impact: 3 – Critical

Historical Occurrences

Storm tracks for hurricane-related events that have passed within 5 miles of NCSSM's campus were obtained from NOAA 's database and are shown in **Figure E.12**. NCSSM's location is noted in the figure by the purple star. The NCEI Storm Events database has recorded three hurricanes and tropical storms that passed through Durham County between 2000 and 2019. **Table E.26** details the historical occurrences.

Figure E.12 – Hurricane and Tropical Storm Tracks near NCSSM



Source: NOAA Historical Hurricane Tracks

Table E.26 – Recorded Hurricane and Tropical Storm Events for Durham County, 2000-2019

Date	Type	Storm	Deaths/ Injuries	Property Damage	Crop Damage
9/18/2003	Hurricane (Typhoon)	Hurricane Isabel	0/0	$205,000	$0
9/14/2018	Tropical Storm	Hurricane Florence	0/0	$0	$25,000
10/11/2018	Tropical Storm	Tropical Storm Michael	0/0	$200,000	$0
		Total	**0/0**	**$405,000**	**$25,000**

Source: NCEI

According to NCEI, three recorded hurricane-related events affected Durham County from 2000 to 2019 causing an estimated $405,000 in property damage and $25,000 in crop damage. There were no injuries or fatalities recorded for any of these events.

The following event narratives are provided in the NCEI Storm Events Database and illustrate the impacts of hurricane and tropical storm events on the county:

Hurricane Isabel (2003) –Hurricane Isabel made landfall along the Outer Banks just north of Cape Lookout around 1 pm on September 18, 2003. The eye of the storm tracked northeast passing over eastern Halifax County. Winds gusts to near Hurricane force were recorded over Halifax county. Many locations across the Coastal Plain and even back into the Triangle received wind gusts between 50 to 70 mph late in the afternoon until early evening. Many trees were uprooted falling on vehicles and homes all across the area.

One person was killed in Franklin county when their vehicle struck a downed tree. Up to 6 inches of rain fell across Edgecombe, Halifax and Wilson counties resulting in flooding of several roads.

Hurricane Florence (2018) – A ridge of high pressure over eastern North America stalled Florence's forward motion a few miles off the southeast North Carolina coast on September 13th. Hurricane Florence made landfall near Wrightsville Beach early on Saturday, September 15, and weakened further as it moved slowly inland. Despite making landfall as a weakened Category 1 hurricane, Florence still produced 40 to 70 mph wind gusts, enough wind speed to uproot trees and cause widespread power outages throughout the Carolinas. As the storm moved inland, from September 15 to 17, heavy rain of 10 to 25 inches caused widespread inland flooding, inundating cities such as Fayetteville, Smithfield, Goldsboro, Durham, and Chapel Hill, and causing major river flooding on main-stem rivers such as the Neuse, Cape Fear, and Little River. Most major roads and highways in the area experienced some flooding, with large stretches of I-40 and I-95 remaining impassable for days after the storm had passed. The storm also spawned tornadoes in several places along its path. There were 3 direct and 6 indirect deaths attributed to the storm with in the WFO RAH CWA.

Tropical Storm Michael (2018) – Tropical Storm Michael moved through North Carolina on Thursday, October 11th. Michael brought heavy rain and strong damaging winds to central North Carolina. While heavy rainfall of 3 to 6 inches produced minor flash flooding across the area, it was high wind gusts of 40 to 60 mph that caused the biggest problems, knocking down score of trees, leading to blocked roadways and thousands without power.

The state of North Carolina has had four FEMA Major Disaster Declarations for Hurricanes in 1954, 1955, 1958, 1960. Additionally, Durham County has received four Major Disaster Declarations for Hurricanes in 1996, 1999, 2003, 2018.

Probability of Future Occurrence

In the 20-year period from 2000 through 2019, three hurricanes and tropical storms have impacted Durham County, which equates to a 15 percent annual probability of hurricane winds impacting the county. This probability does not account for impacts from hurricane rains, which may also be severe. Overall, the probability of a hurricane or tropical storm impacting the County is likely.

Probability: 3 – Likely

Vulnerability Assessment

Methodologies and Assumptions

To quantify vulnerability, Wood performed a Level 1 hurricane wind analysis in Hazus 4.2 for three scenarios: a historical recreation of Hurricane Fran (1996) and simulated probabilistic wind losses for a 200-year and a 500-year event storm. The analysis utilized general building stock information based on the 2010 Census. The NCSSM campus is located within a single census tract encompassing 1.31 square miles. The vulnerability assessment results are for wind-related damages. Hurricanes may also cause substantial damages from heavy rains and subsequent flooding, which is addressed in Section A.5.2. Flood.

People

The very young, the elderly and disabled individuals are more vulnerable to harm from hurricanes, as are those who are unable to evacuate for medical reasons, including 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 or ongoing treatment. For all affected populations, 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.

Table E.27 details the likelihood of building damages by occupancy type from varying magnitudes of hurricane events.

Table E.27 – Likelihood of Buildings Damages Impacted by Hurricane Wind Events

Occupancy	Buildings at Risk	Value at Risk	Likelihood of Damage (%)				
			None	Minor	Moderate	Severe	Destruction
Hurricane Fran (1996)							
Agriculture	2	$407,000	98.24%	1.56%	0.16%	0.04%	0.00%
Commercial	100	$61,944,000	98.25%	1.60%	0.15%	0.00%	0.00%
Education	3	$3,115,000	98.60%	1.37%	0.03%	0.00%	0.00%
Government	-	$0	0.00%	0.00%	0.00%	0.00%	0.00%
Industrial	21	$6,588,000	98.52%	1.43%	0.04%	0.01%	0.00%
Religion	4	$3,365,000	98.67%	1.28%	0.05%	0.00%	0.00%
Residential	1,152	$301,329,000	98.10%	1.83%	0.07%	0.00%	0.00%
200-year Hurricane Event							
Agriculture	2	$407,000	97.51%	2.14%	0.27%	0.08%	0.00%
Commercial	100	$61,944,000	97.65%	2.11%	0.24%	0.00%	0.00%
Education	3	$3,115,000	98.13%	1.82%	0.05%	0.00%	0.00%
Government	-	$0	0.00%	0.00%	0.00%	0.00%	0.00%
Industrial	21	$6,588,000	98.02%	1.89%	0.08%	0.01%	0.00%
Religion	4	$3,365,000	98.17%	1.76%	0.06%	0.01%	0.00%
Residential	1,140	$301,329,000	97.10%	2.78%	0.11%	0.00%	0.00%
500-year Hurricane Event							
Agriculture	2	$407,000	92.10%	6.18%	1.22%	0.47%	0.03%
Commercial	95	$61,944,000	93.33%	5.54%	1.08%	0.05%	0.00%
Education	3	$3,115,000	94.55%	4.98%	0.45%	0.02%	0.00%
Government	-	$0	0.00%	0.00%	0.00%	0.00%	0.00%
Industrial	20	$6,588,000	94.28%	5.06%	0.57%	0.09%	0.00%
Religion	4	$3,365,000	94.26%	5.28%	0.43%	0.03%	0.00%
Residential	1,062	$301,329,000	90.48%	8.83%	0.67%	0.01%	0.00%

Table E.28 details the estimated building and content damages by occupancy type for varying magnitudes of hurricane events.

Table E.28 – Estimated Buildings Impacted by Hurricane Wind Events

Area	Residential	Commercial	Industrial	Others	Total
Hurricane Fran (1996)					
Building	$1,100,960	$23,230	$1,520	$1,840	$1,127,550
Content	$373,780	$1,480	$150	$40	$375,450
Inventory	$0	$0	$30	$0	$30
Total	**$1,474,740**	**$24,710**	**$1,700**	**$1,880**	**$1,503,030**
200-year Hurricane Event					
$1,410,140	$33,270	$2,270	$2,570	$1,448,250	$1,410,140
$468,100	$2,970	$300	$80	$471,450	$468,100
$0	$0	$60	$10	$70	$0
$1,878,240	**$36,240**	**$2,630**	**$2,660**	**$1,919,770**	**$1,878,240**
500-year Hurricane Event					
Building	$2,714,730	$107,150	$8,700	$8,790	$2,839,370
Content	$890,300	$21,960	$2,410	$1,100	$915,770
Inventory	$0	$400	$440	$50	$890
Total	**$3,605,030**	**$129,510**	**$11,550**	**$9,940**	**$3,756,030**

The damage estimates for the 500-year hurricane wind event total $3,756,030. These damage estimates account for only wind impacts and actual damages would likely be higher due to flooding.

Environment

Hurricane winds can cause massive damage to the natural environment, uprooting trees and other debris within the storm's path. Animals can either be killed directly by the storm or impacted indirectly through changes in habitat and food availability caused by high winds and intense rainfall. Endangered species can be dramatically impacted. Forests can be completely defoliated by strong winds.

Changes in Development

Future development that occurs in the planning area should consider high wind hazards at the planning, engineering and architectural design stages. The University should consider evacuation planning in the event of a hurricane event.

Problem Statement

- Historical tracks of multiple hurricane events pass within 5-miles of the NCSSM Campus.
- For the 20-year period from 2000 through 2019, there have been 3 hurricane wind events causing over $400,000 in damage for Durham County.

E.5.5 Severe Winter Weather

Hazard	Probability	Impact	Spatial Extent	Warning Time	Duration	PRI Score
Severe Winter Weather	Highly Likely	Limited	Large	More than 24 hrs	Less than 1 week	3.0

Location

Severe winter weather is usually a countywide or regional hazard, impacting the entire county at the same time. 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. Durham 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, severe winter weather can occur anywhere in the county.

Spatial Extent: 4 – Large

Extent

The National Oceanic and Atmospheric Administration (NOAA) uses the Regional Snowfall Index (RSI), shown in **Table E.29** for the Durham County region, to assess the societal impact of winter storms in the six easternmost regions in the United States. The index makes use of population and regional differences to assess the impact of snowfall. For example, areas which receive very little snowfall on average may be more adversely affected than other regions, resulting in a higher severity. The County may experience any level on the RSI scale. Durham County receives an average of 2 inches of snowfall per year. According to NCEI, the greatest snowfall amounts to impact Durham County have been between 7-12 inches, with Durham reporting around 9 inches of snowfall. During the snowstorm of January 17, 2018, the county was classified as a Category 1 on the RSI scale. It is possible that more severe events and impacts could be felt in the future.

Table E.29 – Regional Snowfall Index (RSI) Values

Category	RSI Value	Description
1	1-3	Notable
2	3-6	Significant
3	6-10	Major
4	10-18	Crippling
5	18+	Extreme

Source: NOAA

Severe winter weather often involves 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 E.13**, provides a formula for calculating the dangers of winter winds and freezing temperatures. This presents wind chill temperatures which are based on the rate of heat loss from exposed skin caused by wind and cold. As the wind increases, it draws heat from the body, driving down skin temperature and eventually the internal body temperature.

Figure E.13 – NWS Wind Chill Temperature Index

Wind Chill Chart

Wind (mph) \ Temperature (°F)	40	35	30	25	20	15	10	5	0	-5	-10	-15	-20	-25	-30	-35	-40	-45
Calm	40	35	30	25	20	15	10	5	0	-5	-10	-15	-20	-25	-30	-35	-40	-45
5	36	31	25	19	13	7	1	-5	-11	-16	-22	-28	-34	-40	-46	-52	-57	-63
10	34	27	21	15	9	3	-4	-10	-16	-22	-28	-35	-41	-47	-53	-59	-66	-72
15	32	25	19	13	6	0	-7	-13	-19	-26	-32	-39	-45	-51	-58	-64	-71	-77
20	30	24	17	11	4	-2	-9	-15	-22	-29	-35	-42	-48	-55	-61	-68	-74	-81
25	29	23	16	9	3	-4	-11	-17	-24	-31	-37	-44	-51	-58	-64	-71	-78	-84
30	28	22	15	8	1	-5	-12	-19	-26	-33	-39	-46	-53	-60	-67	-73	-80	-87
35	28	21	14	7	0	-7	-14	-21	-27	-34	-41	-48	-55	-62	-69	-76	-82	-89
40	27	20	13	6	-1	-8	-15	-22	-29	-36	-43	-50	-57	-64	-71	-78	-84	-91
45	26	19	12	5	-2	-9	-16	-23	-30	-37	-44	-51	-58	-65	-72	-79	-86	-93
50	26	19	12	4	-3	-10	-17	-24	-31	-38	-45	-52	-60	-67	-74	-81	-88	-95
55	25	18	11	4	-3	-11	-18	-25	-32	-39	-46	-54	-61	-68	-75	-82	-89	-97
60	25	17	10	3	-4	-11	-19	-26	-33	-40	-48	-55	-62	-69	-76	-84	-91	-98

Frostbite Times: 30 minutes | 10 minutes | 5 minutes

Wind Chill (°F) = $35.74 + 0.6215T - 35.75(V^{0.16}) + 0.4275T(V^{0.16})$

Where, T= Air Temperature (°F) V= Wind Speed (mph)

Effective 11/01/01

Source: https://www.weather.gov/safety/cold-wind-chill-chart

The most significant recorded snow depth over the last 20 years took place in January 2018, with recorded depths of up to 12 inches across the county.

Impact: 2 – Limited

Historical Occurrences

To get a full picture of the range of impacts of a severe winter weather, data for the following weather types as defined by the National Weather Service (NWS) 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.

According to the NCEI Storm Events Database, there was one heavy snow event, one ice storm, and 50 combined winter storm/winter weather events in Durham County during the 20-year period from 2000 through 2019. As reported in NCEI, severe winter weather caused $1,430,000 in property damage, but they did not cause any fatalities, injuries, or crop damage, though these types of impacts may not have been reported and are possible in future events. Events in Durham County by incident are recorded in **Table E.30.**

Table E.30 – Recorded Severe Winter Weather Events in Durham County, 2000-2019

Event Type	Event Count	Fatalities	Injuries	Property Damage	Crop Damage
Heavy Snow	1	0	0	$0	$0
Ice Storm	1	0	0	$400,000	$0
Winter Storm	25	0	0	$1,000,000	$0
Winter Weather	25	0	0	$30,000	$0
Total	**52**	**0**	**0**	**$1,430,000**	**$0**

Source: NCEI

Storm impacts from NCEI are summarized below:

January 29, 2010 – Between 5 to 7 inches of snow fell across the county. Over 600 automobile accidents were reported in the county. Due to the cold temperatures icy road conditions persisted for several days resulting in the closure of schools and businesses.

March 6, 2014 – One quarter of an inch of ice from freezing rain resulted in widespread downed trees and powerlines. A strong surface low deepening off the Carolina coast brought a wintry mix of snow, sleet, and freezing rain to the northern-northwestern Piedmont counties. Snowfall amounts of 4 to 7 inches fell Forsyth, Person and Guilford counties. Just to the south and east of this area, a corridor of mainly sleet mixed with freezing rain produced significant icing of a quarter to half inch. This icing produced widespread downed trees and power outages over the northwest Piedmont. At the peak of the storm, over 400,000 customers were without power. A natural disaster was declared in 7 counties across the Raleigh CWA that were impacted by this storm.

February 25, 2015 – Snowfall/sleet amounts of 6 to 8 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 40,000 customers were without power in the county.

January 17, 2018 – Total snowfall amounts ranged from 7 to 12 inches across the county.

Durham County received three FEMA Major Disaster Declarations for a blizzard in 1996 and severe winter storms in 2000 and 2002.

Probability of Future Occurrence

NCEI records 52 severe winter weather related events during the 20-year period from 2000 through 2019, which equates to an annual probability greater than 100%. Therefore, the overall probability of severe winter weather in the county is considered highly likely (near or more than 100% annual probability).

Probability: 4 – Highly Likely

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.

The loss of use estimates provided in **Table E.31** were calculated using FEMA's publication *What is a Benefit?: Guidance on Benefit-Cost Analysis of Hazard Mitigation Project*, June 2009. These figures are used to provide estimated costs associated with the loss of power in relation to the populations served on campus. The loss of use is provided in the heading as the loss of use cost per person per day of loss. The estimated loss of use provided for the campus represents the loss of service of the indicated utility for one day for 10 percent of the population. These figures do not take into account physical damages to utility equipment and infrastructure. The estimated on-campus population used in the table below was determined by taking 25% of the current enrollment for NCSSM, which is 8,078 students.

Table E.31 – Loss of Use Estimates for Power Failure Associated with Severe Winter Weather

On-Campus Population (Fall 2020)	Estimated Affected Population (10%)	Electric Loss of Use Estimate ($126 per person per day)
680	68	$8,568

Property

The NCEI reported $1,430,000 of property damage in association with any winter weather events between 2000 and 2019 for Durham County. Based on these records, the County experiences an estimated annualized loss of $71,500 in property damage. The average impact from winter weather events per incident in Durham is $27,500.

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.

Changes in Development

Future development could potentially increase vulnerability to this hazard by increasing demand on the utilities and increasing the exposure of infrastructure networks. NCSSM may wish to consider developing a flexible emergency power network to provide efficient back-up power for vulnerable populations, critical facilities, and research facilities.

Problem Statement

- Severe winter weather events are highly likely for Durham County and the NCSSM campus. The events have also resulted in three presidential disaster declarations for the County.

E.5.6 Tornadoes/Thunderstorms

Hazard	Probability	Impact	Spatial Extent	Warning Time	Duration	PRI Score
Tornado/Thunderstorm	Likely	Critical	Large	Less than 6 hrs	Less than 6 hrs	3.1

Location

Thunderstorm wind, lightning, and hail events do not have a defined vulnerability zone. The scope of lightning and hail is generally confined to the footprint of its associated thunderstorm. Although these events occur similarly throughout the planning area, they are more frequently reported in more urbanized areas because damages are more likely to occur where exposure is greater in more densely developed urban areas.

Thunderstorm Winds

The entirety of NCSSM's campus can be affected by severe weather hazards. Thunderstorm wind events can span many miles and travel long distances, covering a significant area in one event. Due to the small size of the planning area, any given event will impact the entire planning area, approximately 50% to 100% of the planning area could be impacted by one event.

Spatial Extent: 4 – Large

Lightning

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 NCSSM is exposed to lightning.

Spatial Extent: 4 – Large

Hail

Hailstorms frequently accompany thunderstorms, so their locations and spatial extents coincide. However, large-scale hail tends to occur in a more localized area within the storm.

Spatial Extent: 4 – Large

Tornado

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

Spatial Extent: 4 – Large

Extent

Thunderstorm Winds

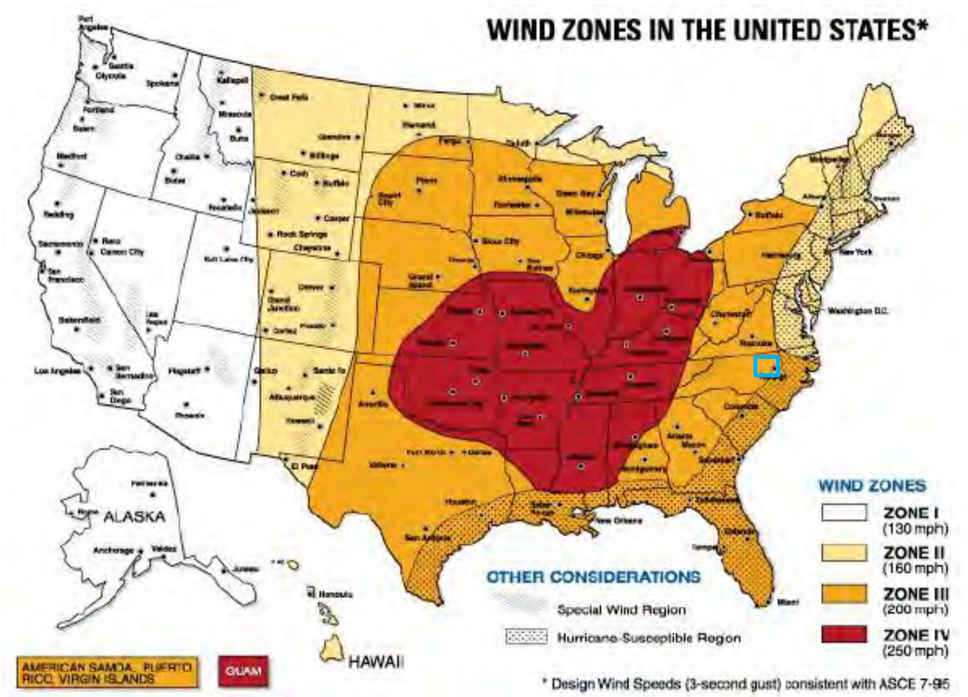
The magnitude of a thunderstorm event can be defined by the storm's maximum wind speed and its impacts. NCEI divides wind events into several types including High Wind, Strong Wind, Thunderstorm Wind, Tornado and Hurricane. For this severe weather risk assessment, High Wind, Strong Wind and Thunderstorm 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.

Figure E.14 shows wind zones in the United States. Durham County, indicated by the blue square, is within Wind Zone III, which indicates that speeds of up to 200 mph may occur within the county.

Figure E.14 – Wind Zones in the United States



Source: FEMA 320, Taking Shelter from the Storm, 3rd edition, https://www.fema.gov/pdf/library/ism2_s1.pdf

The strongest recorded thunderstorm wind event for Durham occurred on September 28, 2004 with a measured gust of 60 mph. The event reportedly resulted in no fatalities, injuries, property damages or crop damages.

Impact: 2 – Limited

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, shown in **Table E.32**, is a common parameter that is part of fire weather forecasts nationwide.

Table E.32 – 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

Lightning Activity Level Scale	
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

Hail

The National Weather Service classifies hail by diameter size, and corresponding everyday objects to help relay scope and severity to the population. **Table E.33** indicates the hailstone measurements utilized by the National Weather Service.

Table E.33 – 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
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 E.34** describes typical intensity and damage impacts of the various sizes of hail.

Table E.34 – 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

Intensity Category	Diameter (mm)	Diameter (inches)	Size Description	Typical Damage Impacts
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 2000 and 2019 in Durham was a little over 1" in diameter; the largest hailstone recorded was 1.75", recorded on April 17, 2000, July 28, 2005, May 14, 2006 and March 14, 2016.

Impact: 1 – Minor

Tornado

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 and better correlation between damage and wind speed. It is also more precise because it considers the materials affected and the construction of structures damaged by a tornado. **Table E.35** shows the wind speeds associated with the enhanced Fujita scale ratings and the damage that could result at different levels of intensity.

Table E.35 – 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 Durham in the past 20 years was an EF1 on May 15, 2004. NCEI reports this event causing around $250,000 in property damage, and narratives of the event approximate damage to roughly 40 homes experiencing roof and/or other structural damage. The tornado was 0.76 miles long and 150 yards wide.

Impact: 3 – Critical

Historical Occurrences

Thunderstorm Winds

Between January 1, 2000 and December 31, 2019, the NCEI recorded wind speeds for 46 separate incidents of thunderstorm winds, occurring on 35 separate days, for Durham. These events caused $101,000 in recorded property damage and no injuries or fatalities. The recorded gusts averaged 51.6 miles per hour, with the highest gusts recorded at 60 mph on January 14, 2006. Of these events, 22 caused property damage. Wind gusts with property damage recorded averaged $4,591 in damage, with the highest reported damage being a total of $35,000 between two events on June 20, 2019. These incidents are aggregated by the date the events occurred and are recorded in **Table E.36.** These records specifically note Thunderstorm Wind impacts for Durham.

Table E.36 – Recorded Thunderstorm Winds, Durham, 2000-2019

Location	Date	Wind Speed (mph)	Fatalities	Injuries	Property Damage
DURHAM	4/8/2000	50	0	0	$0
DURHAM	5/20/2000*	50	0	0	$0
DURHAM	5/25/2000	60	0	0	$0
DURHAM	8/10/2000	50	0	0	$0
DURHAM	12/17/2000	50	0	0	$0
DURHAM	8/27/2001	50	0	0	$0
DURHAM	5/13/2002	50	0	0	$0
DURHAM	9/15/2002	50	0	0	$0
DURHAM	2/22/2003	50	0	0	$0
DURHAM	6/11/2004	50	0	0	$0
DURHAM	9/28/2004	60	0	0	$0
DURHAM	1/14/2005	50	0	0	$0
DURHAM	7/28/2005	50	0	0	$0
DURHAM	4/3/2006	50	0	0	$0
DURHAM	7/19/2006	50	0	0	$0
EAST DURHAM	6/9/2007*	50	0	0	$0
WEST DURHAM	7/4/2008	50	0	0	$0
WEST DURHAM	7/9/2008	50	0	0	$0
EAST DURHAM	5/9/2009	50	0	0	$0
EAST DURHAM	5/28/2010*	50	0	0	$0
DURHAM	6/23/2010	50	0	0	$15,000
WEST DURHAM	8/5/2010	50	0	0	$0
DURHAM	4/5/2011	50	0	0	$25,000
DURHAM	2/24/2012	50	0	0	$0
WEST DURHAM	6/29/2012	50	0	0	$10,000
WEST DURHAM	9/8/2012	50	0	0	$750
DURHAM	6/11/2014	50	0	0	$25,000
WEST DURHAM	6/19/2014*	50	0	0	$8,000

Location	Date	Wind Speed (mph)	Fatalities	Injuries	Property Damage
EAST DURHAM	6/29/2016*	50	0	0	$0
WEST DURHAM	5/11/2017*	50	0	0	$100,000
WEST DURHAM	6/10/2018	50	0	0	$1,000
DURHAM	7/22/2018	50	0	0	$5,000
WEST DURHAM	4/19/2019*	50	0	0	$16,000
WEST DURHAM	6/20/2019	50	0	0	$5,000
DURHAM	7/4/2019	50	0	0	$20,000
		Total	**0**	**0**	**$230,750**

Source: NCEI
*Note: Multiple events occurred on these dates. Injuries, fatalities, and property damage are totaled, wind speed is highest reported.

The State of North Carolina received a FEMA Major Disaster Declaration in 1956 for severe storms that included heavy rains and high winds.

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

April 8, 2000 – Strong wind gusts knocked down a tree that crashed into a mobile home and ripped a roof off a building.

April 3, 2006 – Tin roofs torn off a carport and barn and blown 1000 to 1500 feet downwind. Well house knocked down and shingles torn off a home on Shaw Road.

June 11, 2014 – Multiple trees were blown down within the city of Durham. In addition, 2 trees fell onto cars and 1 tree fell on a house. Monetary damages were unknown and were estimated.

July 4, 2019 – One tree was blown down onto a residence along Dacian Avenue in Durham. A lightning strike also resulted in a house fire near the 100 block of Presidents Drive.

Lightning

According to NCEI data, there was 1 lightning strike reported between 2000 and 2019. This lightning strike event recorded an estimated $10,000 worth of property damage. No crop damage, injuries, fatalities were recorded by this strike. 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. **Table E.37** details NCEI-recorded lightning strikes from 2000 through 2019 for Durham.

Table E.37 – Recorded Lightning Strikes in Durham, 2000-2019

Location	Date	Time	Fatalities	Injuries	Property Damage
DURHAM	3/27/2007	2200	0	0	$10,000
		Total	**0**	**0**	**$10,000**

Source: NCEI

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

March 27, 2007 – Lightning struck an apartment complex and sparked a fire. There was no immediate information on the extent of the damage.

Hail

NCEI records 21 days with hail incidents between January 1, 2000 and December 31, 2019 in Durham. None of these events were reported to have caused death, injury, property damage or crop damage. The largest diameter hail recorded in the City was 1.75 inches, which occurred on four different occasions in 2000, 2005, 2006, and 2016. The average hail size of all events in the City was just over one inch in diameter. **Table E.38** summarizes hail events for Durham. In some cases, hail was reported for multiple locations on the same day.

Table E.38 – Summary of Hail Occurrences in Durham

Beginning Location	Date	Hail Diameter
DURHAM	4/17/2000	1.75
DURHAM	4/29/2000	1
DURHAM	8/13/2000	0.75
DURHAM	8/27/2001	0.88
DURHAM	4/26/2003	0.75
EAST DURHAM	8/22/2003	0.75
DURHAM	10/3/2004	0.88
DURHAM	6/7/2005	0.75
DURHAM	7/28/2005	1.75
DURHAM	4/8/2006	0.75
DURHAM	5/14/2006	1.75
DURHAM	8/7/2006	0.75
DURHAM	7/27/2007	0.88
WEST DURHAM	3/4/2008	0.75
NORTH DURHAM	5/31/2008	1.25
NORTH DURHAM	6/2/2009	0.88
WEST DURHAM	5/27/2011	1
WEST DURHAM	3/24/2012	1.25
DURHAM SKYPARK ARPT	5/22/2012	1
NORTH DURHAM	3/14/2016	1.75
EAST DURHAM	6/29/2016	1

Source: NCEI
*Note: Multiple events occurred on these dates. Hail diameter is highest reported for that specific date.

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

July 28, 2005 – Golfball size hail was reported in Research Triangle Park.

May 22, 2012 – Quarter sized hail was reported covering the ground along Interstate 85 near mile marker 184.

March 14, 2016 – Hail up to the size of golf balls was reported along a swath from Duke Homestead Boulevard near Highway 157 to approximately 5 miles west-northwest of Gorman.

Tornado

NCEI storm reports were reviewed from 2000 through 2019 to assess whether recent trends varied from the longer historical record. According to NCEI, the city of Durham does not have any recorded tornado incidents between 2000 and 2019. It is likely that there have been several tornados that occurred in Durham but went unreported. However, neighboring communities surrounding Durham have three reported tornado incidents between 2000 and 2019, causing $350,000 in property damage and no injuries or deaths. **Table E.39** shows historical tornadoes in Durham along with its surrounding communities during this time.

Table E.39 – Recorded Tornadoes in Durham and Surrounding Communities, 2000-2019

Beginning Location	Date	Time	Magnitude	Deaths	Injuries	Property Damage	Crop Damage
GORMAN	5/14/2006	1710	F0	0	0	$0	$0
HOPE VLY	5/15/2014	1710	EF1	0	0	$250,000	$0
HUCKLEBERRY SPG	2/24/2016	1600	EF1	0	0	$100,000	$0

Source: NCEI

Narratives from NCEI illustrate that damage occurred in many of these incidents even if a monetary value was not recorded. Specific incidents include:

May 15, 2014 – A storm survey confirmed an EF-1 tornado near Durham. Damage consisted of dozens of snapped and uprooted trees and approximately 40 homes that experienced roof or other structural damage. Most of the damage to the homes was caused by falling trees and other debris. However, there were at least a half a dozen homes that experienced minor roof damage solely from the wind. In one case, a large oak tree was uprooted and fell onto a home, slicing through the roof and an exterior wall.

February 24, 2016 – The National Weather Service in Raleigh, NC has confirmed a brief tornado touchdown 5 miles northwest of downtown Durham in Durham County North Carolina. The touchdown occurred in a dense forest area near the intersection of Hillandale Road and Rose of Sharon Road. In this area, tree damage was extensive, mainly consisting of snapped trees.

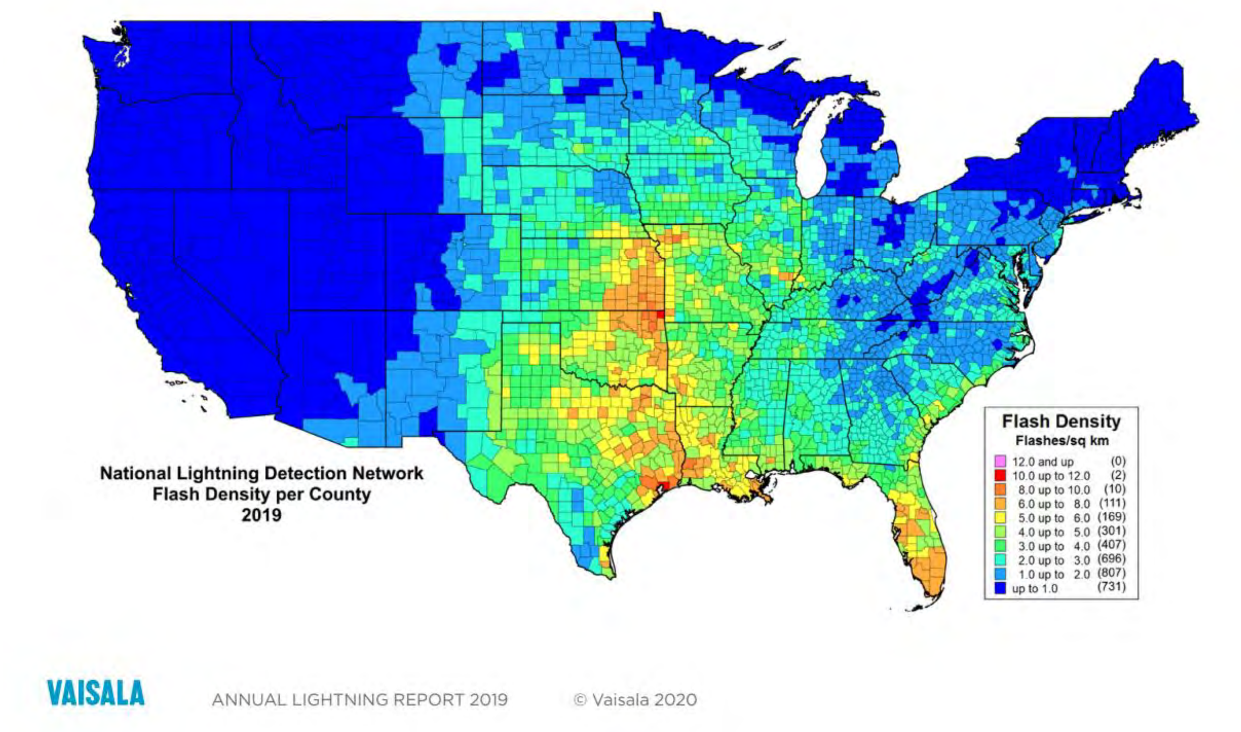
Probability of Future Occurrence

Based on historical occurrences recorded by NCEI for the 20-year period from 2000 through 2019, Durham averages 1.75 days with wind events per year. Over this same period, one lightning event was reported as having caused property damage, which equates to an average of 0.05 damaging lightning strikes per year.

The average hailstorm in Durham occurs in the evening and has a hail stone with a diameter of just over one inch. Over the 20-year period from 2000 through 2019, Durham experienced 21 days with reported hail incidents; this averages to 1.05 days per year with reported incidents somewhere in the City.

Based on the Vaisala 2019 Annual Lightning Report, North Carolina experienced 3,641,417 documented cloud-to-ground lightning flashes. According to Vaisala's flash density map, shown in **Figure E.15** Durham County is located in an area that experiences 1 to 2 lightning flashes per square kilometer per year. It should be noted that future lightning occurrences may exceed these figures.

Figure E.15 – Lightning Flash Density per County (2019)



Source: Vaisala

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

In a twenty-year span between 2000 and 2019, Durham County has experienced three separate tornado incidents over three separate days. This correlates to a 15 percent annual probability that the County will experience a tornado somewhere in its boundaries. One of these past tornado events was a magnitude F0, and the other two tornado events were a magnitude of EF1; therefore, the annual probability of a significant tornado event is highly unlikely.

Based on these historical occurrences, there is between a 10% to 100% chance that Durham will experience severe weather each year. The probability of a damaging impacts is likely.

Probability: 3 –Likely

Vulnerability Assessment

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.

Similar to the loss of use estimates provided for Severe Winter Weather, the loss of use estimates for a tornadoes/thunderstorms were estimated as $8,568 per day, assuming 10-percent of the on-campus population is impacted.

Table E.40 – Loss of Use Estimates for Power Failure Associated with Severe Winter Weather

On-Campus Population (Fall 2020)	Estimated Affected Population (10%)	Electric Loss of Use Estimate ($126 per person per day)
680	68	$8,568

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 2018 American Community Survey (ACS) 5-Year Estimates, 934 occupied housing units (0.08 percent) in Durham are classified as “mobile homes or other types of housing.” Using the 2018 ACS average persons per household estimate of 2.35, the population at risk due to their housing type was estimated at 2,195 residents within Durham. Individuals who work outdoors may also face increased risk.

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. Therefore, the estimated 2,195 residents mentioned above residing in mobile homes in Durham are also at a greater risk to tornado damage due to their housing type.

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 Durham, the only event with recorded property damage was due to lightning striking a vehicle.

NCEI records lightning impacts over 20 years (2000-2019), with $10,000 in property damage recorded during one event in 2007. Based on these records, the planning area experiences an annualized loss of $500 in property damage. The average impact from lightning per incident in Durham is $5,000.

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, 2000 and December 31, 2019 in Durham, NCEI did not report any property damage as a direct result of hail.

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 Durham, thus the NCEI is still used to form a baseline.

Wind events reported in NCEI for the 20-year period from 2000 through 2019 totaled $230,750 in property damage, which equates to an annualized loss of $11,537.50 across the City.

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 2000, damaging tornadoes in the City are directly responsible for $350,000 worth of damage to property according to NCEI data. This equates to an annualized loss of $17,500.

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.

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.

Changes in Development

Future development projects should consider severe thunderstorms hazards and tornado and high wind hazards at the planning, engineering and architectural design stage with the goal of reducing vulnerability. University buildings with high occupancies should consider inclusion of a tornado shelters to accommodate occupants in the event of a tornado. Future development will also affect current stormwater drainage patterns and capacities.

Problem Statement

- Thunderstorms and tornadoes are frequent hazard events in Durham County and the NCSSM campus. Reported damages for the 20-year period from 2000-1019 include $230,750 for thunderstorm winds, $10,000 for lightning strikes, and $350,000 for tornado events.

E.5.7 Wildfire

Hazard	Probability	Impact	Spatial Extent	Warning Time	Duration	PRI Score
Wildfire	Unlikely	Minor	Small	More than 24 hrs	More than 1 week	1.5

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 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 E.41** details the WUI on the NCSSM campus, and **Figure E.16** below shows the WUI areas. Most of the campus falls outside the WUI. On a county level, Durham County is predominately classified as WUI intermix and interface areas and medium to high density housing in the agricultural areas with noted pockets of very low to no housing in Non-WUI vegetated areas.

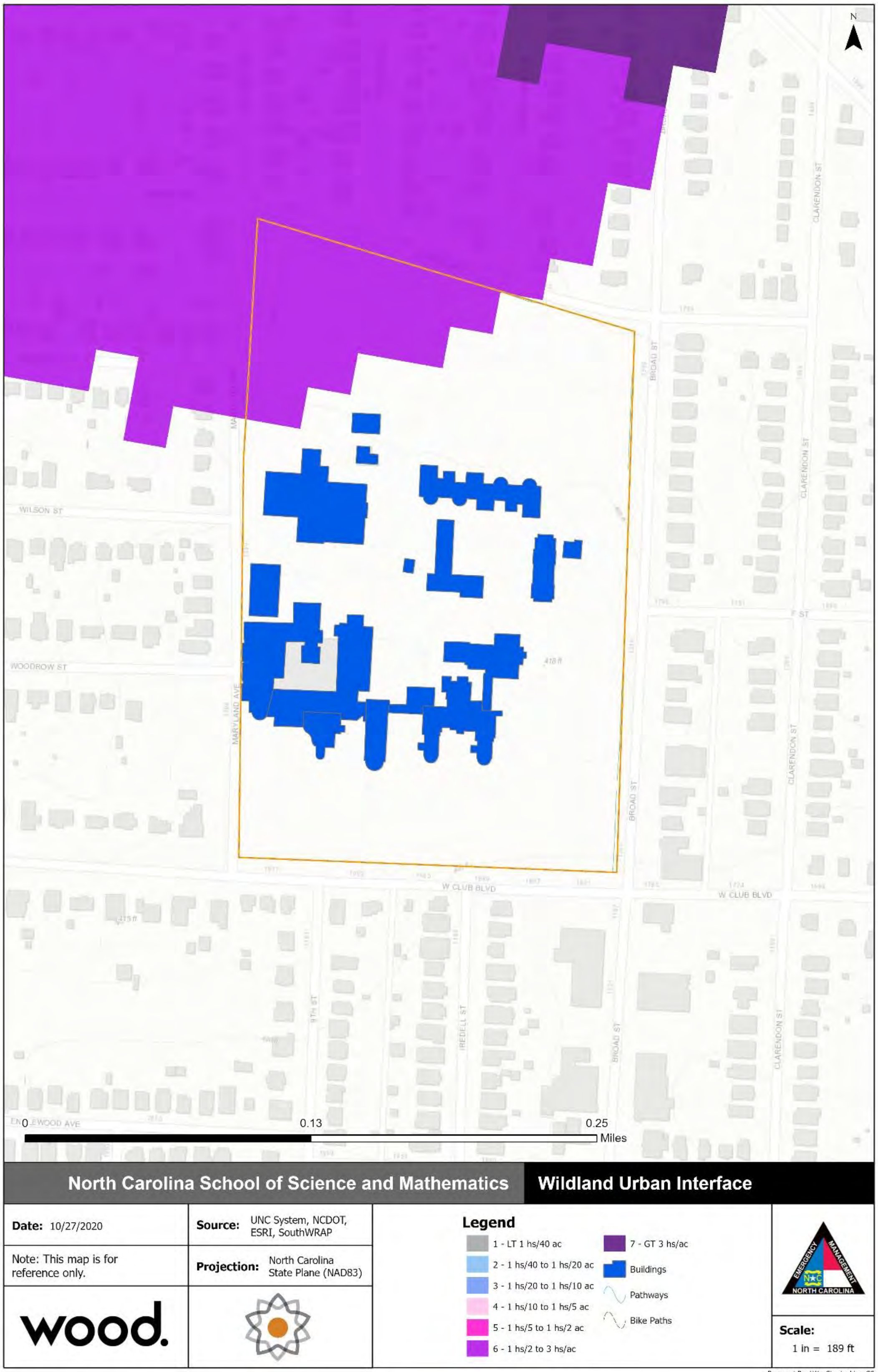
Table E.41 – Wildland Urban Interface, Population and Acres

	Housing Density	WUI Acres	Percent of WUI Acres
	LT 1hs/40ac	24	86.9%
	1hs/40ac to 1hs/20ac	0	0.0%
	1hs/20ac to 1hs/10ac	0	0.0%
	1hs/10ac to 1hs/5ac	0	0.0%
	1hs/5ac to 1hs/2ac	0	0.0%
	1hs/2ac to 3hs/1ac	0	0.0%
	GT 3hs/1ac	4	13.1%
	Total	0	0.0%

Source: Southern Wildfire Risk Assessment

Spatial Extent: 2 – Small

Figure E.16 – Wildland Urban Interface Areas, NCSSM



Extent

The entire state is at risk to a wildfire occurrence. However, several factors such as drought conditions or high levels of fuel on the forest floor may make a wildfire more likely in certain areas. 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, shown in **Table E.42**, consists of five classes, as defined by Southern Wildfire Risk Assessment. **Figure E.17** shows the potential fire intensity within the WUI across North Carolina School of Science and Mathematics.

Table E.42 – 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

The entirety of the NCSSM campus is rated 3 or lower on the potential fire intensity scale. In fact, for the majority of NCSSM's campus (60.1%) there is no potential fire intensity. An additional 39.5 percent would face a Class 1 or Class 2 Fire Intensity, which is easily suppressed. Only 0.3 percent of the campus may experience Class 3 Fire Intensity, which has potential for harm to life and property but is relatively easy to suppress with dozer and plows.

The WUI Risk Index is used to rate the potential impact of a wildfire on people and their homes. It reflects housing density (per acre) consistent with Federal Register National standards. The WUI Risk Index ranges of values from -1 to -9, with -1 representing the least negative impact and -9 representing the most negative impact. **Figure E.18** maps the WUI Risk Index for North Carolina School of Science and Mathematics (NCSSM). The WUI areas within the campus of NCSSM are -5 on the WUI Risk Index.

Impact: 1 – Minor

Figure E.17 – Characteristic Fire Intensity, North Carolina School of Science and Mathematics

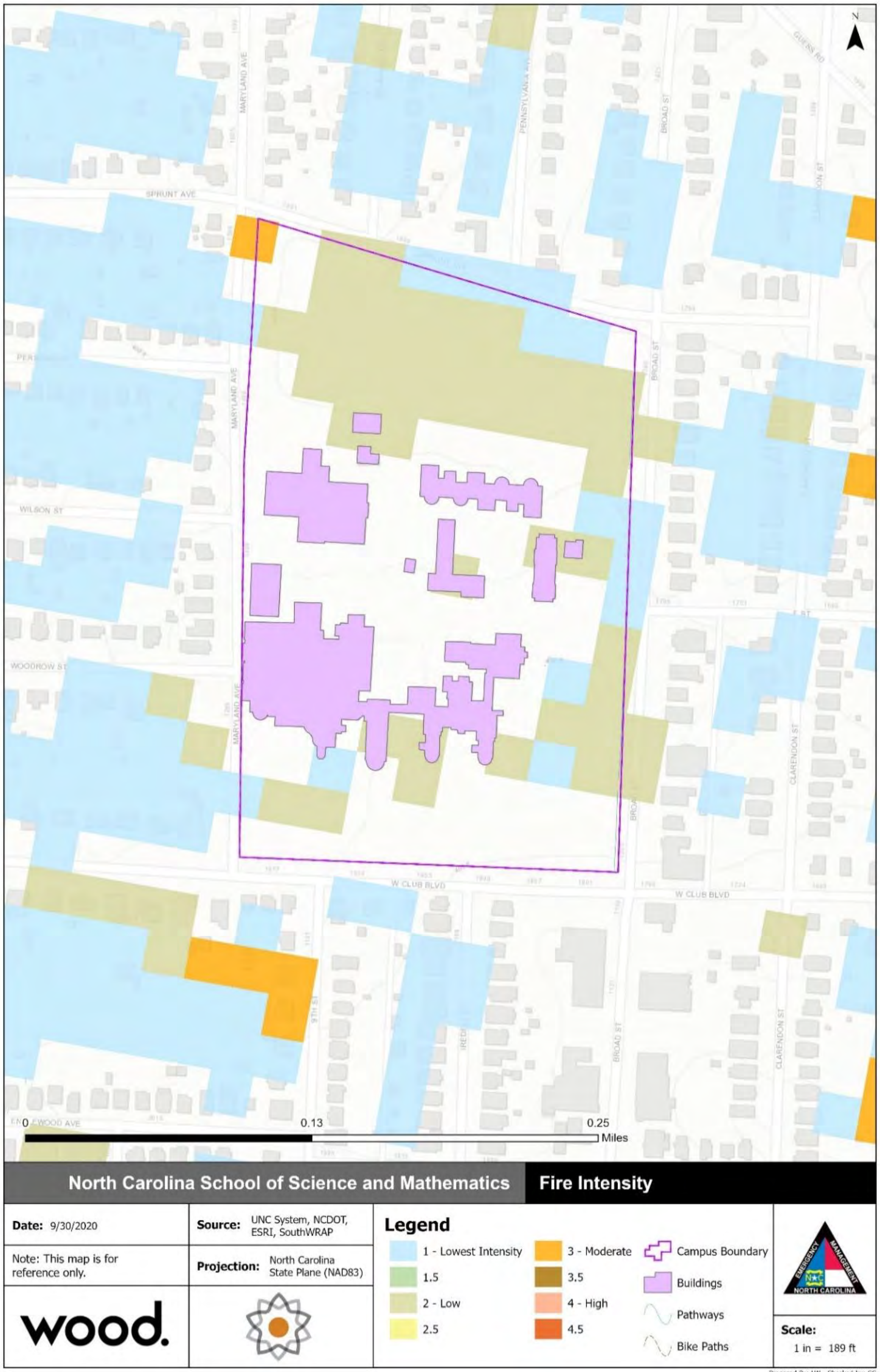
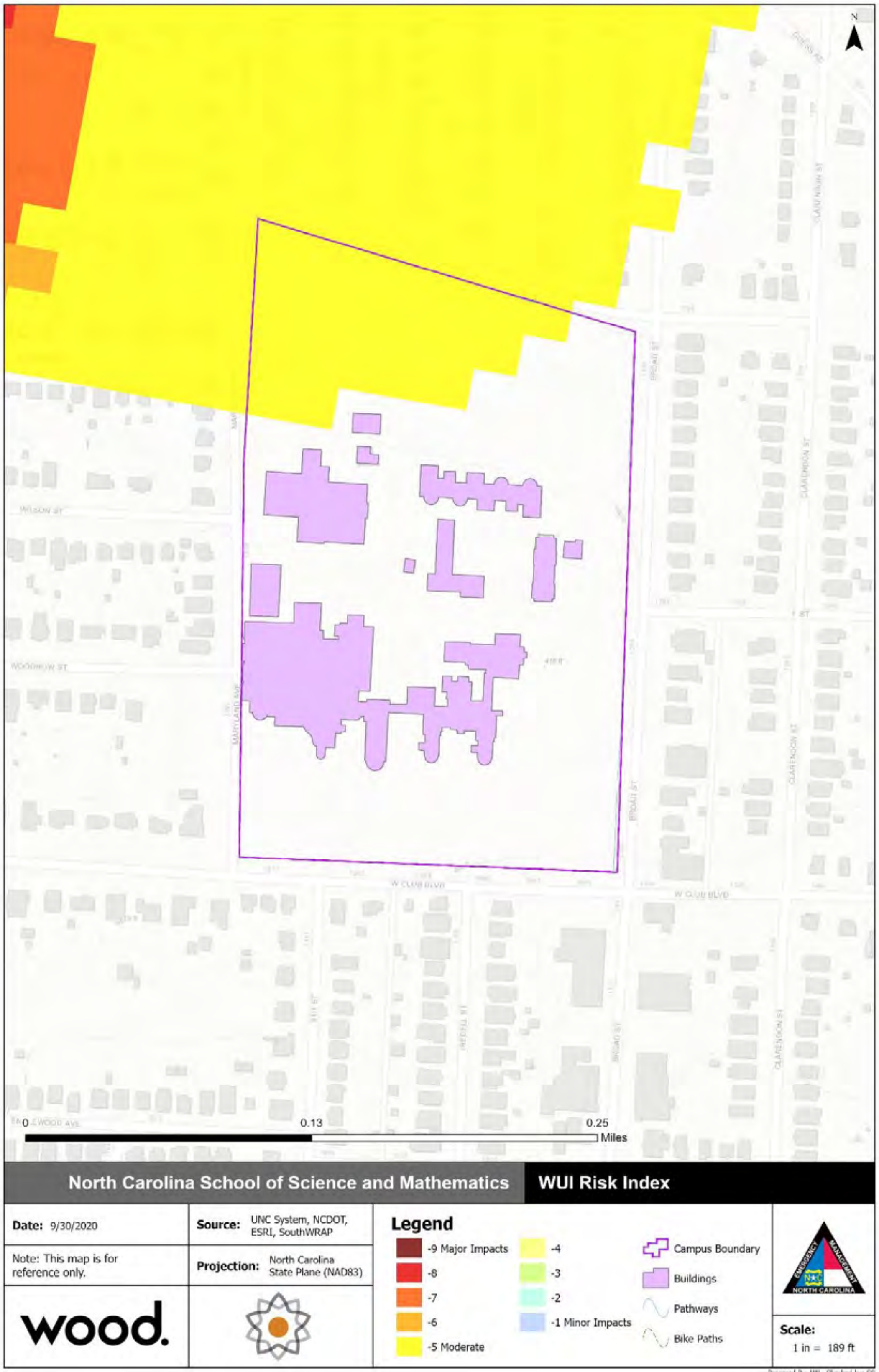


Figure E.18 – WUI Risk Index, North Carolina School of Science and Mathematics



Historical Occurrences

According to the North Carolina Forest Service (NCFS) there were 496 noted wildfires within Durham County between 2000 and 2019. The total acreage burned during this period was 1130.8 acres. There were no additional data records regarding specific cities or school districts within Durham County. The data is from NCFS records only and may not include data on fires burned within jurisdictional limits that did not require NCFS assistance to suppress. Actual number of fires and acreage burned may be higher than what is reported here.

On average, Durham County experiences 24.8 fires and 56.5 acres burned annually from fires reported by the NCFS. Actual number of fires and acreage burned is likely higher because smaller fires within jurisdictional boundaries are managed by local fire departments. Based on these records, the average wildfire event can be calculated as 2.3 acres. Actual number of fires and acreage burned is likely higher because smaller fires within jurisdictional boundaries are managed by local fire departments. The most known cause was noted as debris.

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 NCSSM is presented in **Table E.43** and illustrated in **Figure E.19.**

Table E.43 – Burn Probability, North Carolina School of Science and Mathematics

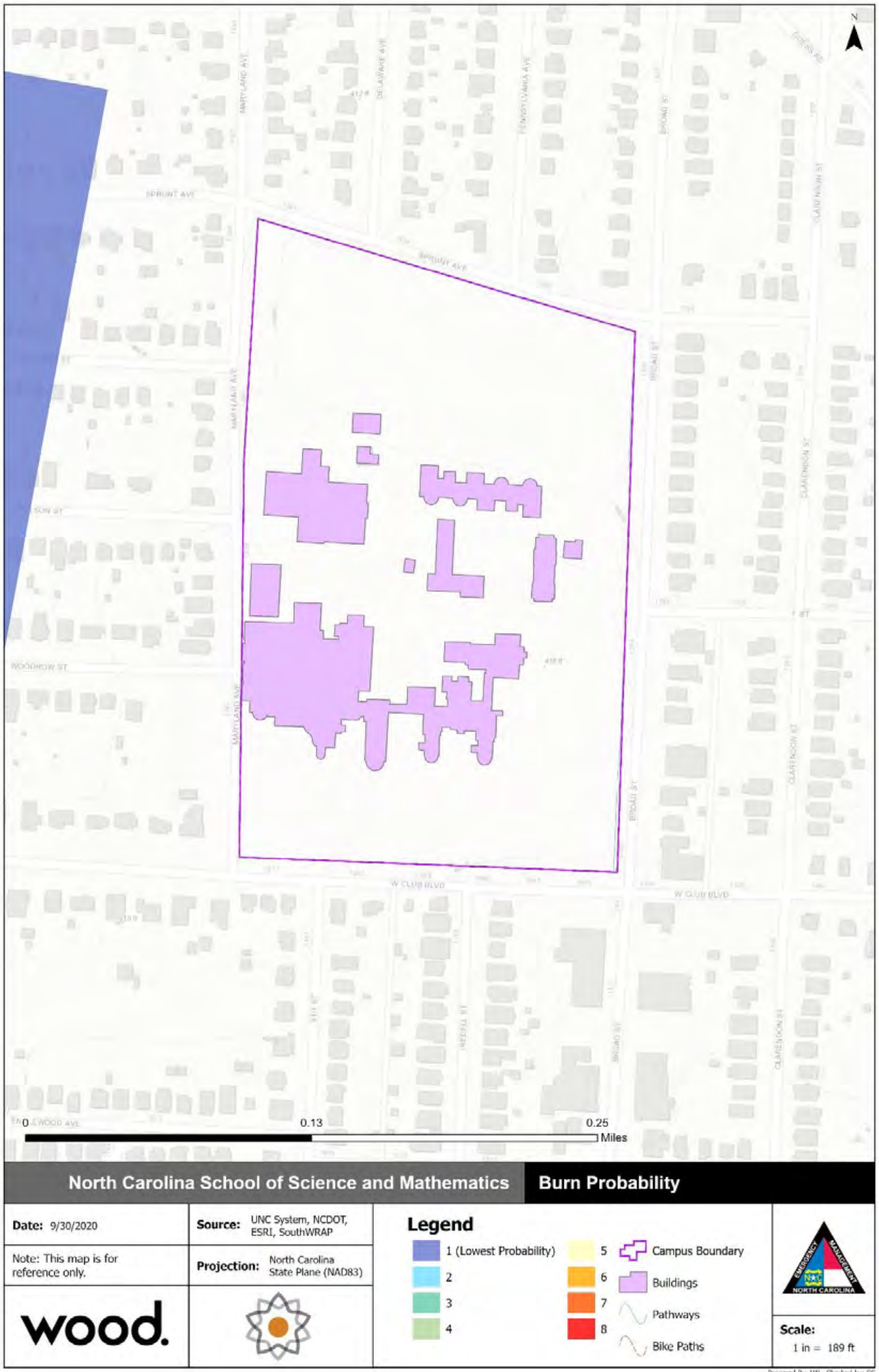
	Class	Acres	Percent
	No probability	28	100.0%
	1	0	0.0%
	2	0	0.0%
	3	0	0.0%
	4	0	0.0%
	5	0	0.0%
	6	0	0.0%
	7	0	0.0%
	8	0	0.0%
	9	0	0.0%
	10	0	0.0%
	Total	**28**	**--**

Source: Southern Wildfire Risk Assessment

NCSSM has no areas of identified burn probability. The areas closest to those with a burn probability of 1 are located on the northwestern border of the campus boundary. The probability of wildfire across the campus is considered unlikely, defined as less than a 1% annual chance of occurrence.

Probability: 1 – Unlikely

Figure E.19 – Burn Probability, North Carolina School of Science and Mathematics



Vulnerability Assessment

People

Wildfire can cause fatalities and human health hazards. Ensuring procedures are in place for rapid warning and evacuation are essential to reducing vulnerability.

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.

Using the Wildland Urban Interface Risk Index (WUIRI) from the Southern Wildfire Risk Assessment, a GIS analysis was performed to estimate the exposure of buildings most at risk to loss due to wildfire. The WUIRI shows a rating of the potential impact of wildfire on homes and people. This index ranges from 0 to -9, where lower values are relatively more severe. There are no buildings on the NCSSM campus that intersect the WUIRI.

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.

Changes in Development

Growth on the NCSSM campus within the wildland-urban interface area will increase the vulnerability of people, property, and infrastructure to wildfires. Although NCSSM has no buildings within WUIRI areas less than -5, there are undeveloped pieces of campus within this area – development of these areas would also increase vulnerability.

Although a wildfire community protection plan exists for the state of North Carolina, there are no community wildfire protection plans and no wildfire mitigation review requirements or regulations for development in the wildland-urban interface in Durham County. However, Durham County has a Forest Protection Program to provide urban and community forestry planning and forest fire protection, among other programs.

Problem Statement

- The northern edge of campus falls within an area of moderate impact risk; however, no campus buildings are exposed in this area.

E.5.8 Hazardous Materials Incidents

Hazard	Probability	Impact	Spatial Extent	Warning Time	Duration	PRI Score
Hazardous Materials Incident	Highly Likely	Minor	Negligible	Less than 6 Hrs	Less than 24 Hrs	2.3

Location

Hazardous materials releases at fixed sites can cause a range of contamination from very minimal to catastrophic. The releases can go into the air, onto the surface, or into the ground and possibly into groundwater, or a combination of all. Although releases into the air or onto the ground surface can pose a great and immediate risk to human health, they are generally easier to remediate than those releases which enter into the ground or groundwater. Soil and groundwater contamination may take years to remediate causing possible long-term health problems for individuals and rendering land unusable for many years.

The Toxics Release Inventory (TRI) Program run by the 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 9 sites reporting hazardous materials incidents in Durham from 2016-2018. These sites are by location and sector in **Table E.44.** HMPC identified one critical facility, Heating Plant, on NCSSM's campus with hazardous materials.

Table E.44 – Toxic Release Inventory Facilities in Durham

Facility Name	Sector
Durham	
ARGOS READY MIX PLUM ST CONCRETE PLANT	Nonmetallic Mineral Product
IPS STRUCTURAL ADHESIVES INC	Chemicals
AW NORTH CAROLINA	Transportation Equipment
CREE INC	Computers and Electronic Products
CORMETECH INC	Nonmetallic Mineral Product
BRENNTAG MID-SOUTH	Chemical Wholesalers
FOUNDATION LABS BY PLY GEM LLC	Miscellaneous Manufacturing
ARGOS READY MIX HWY 55 CONCRETE PLANT	Nonmetallic Mineral Product
GENERAL ELECTRIC AVIATION - DURHAM ENGINE FACILITY	Transportation Equipment

Source: EPA Toxic Release Inventory

Transportation hazardous materials Incidents can occur when hazardous materials are being transported from one location to another in the normal course of business for manufacturing, refining, or other industrial purposes. Additionally, hazardous materials incidents can occur as hazardous waste is transported for final storage and/or disposal. **Figure E.20** below shows the modes of transportation for hazardous materials adjacent to or through NCSSM's campus.

Spatial Extent: 1 – Negligible

Figure E.20 – HAZMAT Transportation Map, NCSSM

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.

Prior to 2002, however, a "serious incident" regarding hazardous materials was defined as follows:

- a fatality or major injury due to a hazardous material
- closure of a major transportation artery or facility or evacuation of six or more persons due to the presence of hazardous material, or
- a vehicle accident or derailment resulting in the release of a hazardous material.

Impact: 1 - Minor

Historical Occurrences

The USDOT's PHMSA maintains a database of reported hazardous materials incidents by location and hazardous material class. According to PHMSA records, there were 264 recorded releases in Durham from 2000 through 2019. **Figure E.21** categorizes these incidents by hazardous material class. The most common materials spilled in the City were Class 3 (Flammable and Combustible Liquids) and Class 8 (Corrosives). **Figure E.22** describes all nine hazard classes.

Figure E.21 – Hazardous Materials Incidents by Class

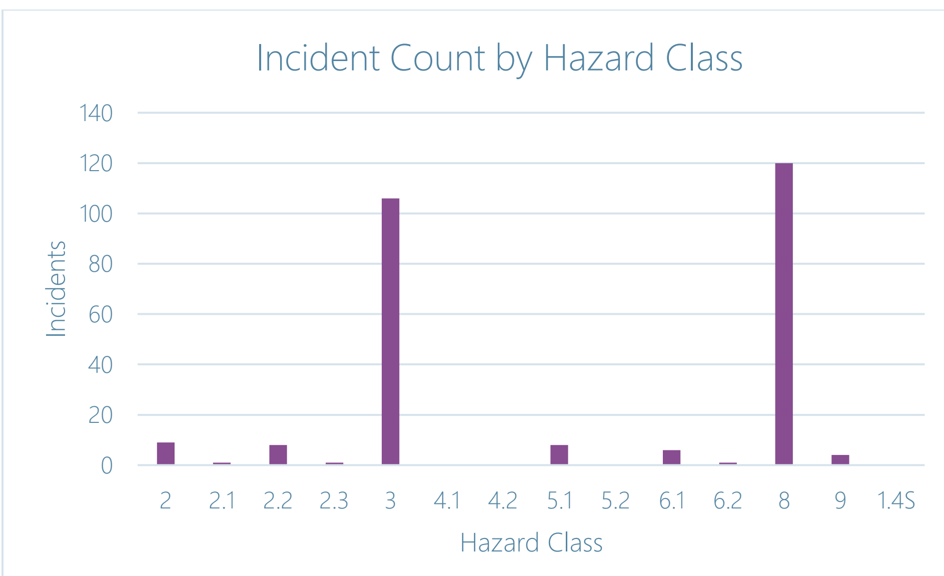
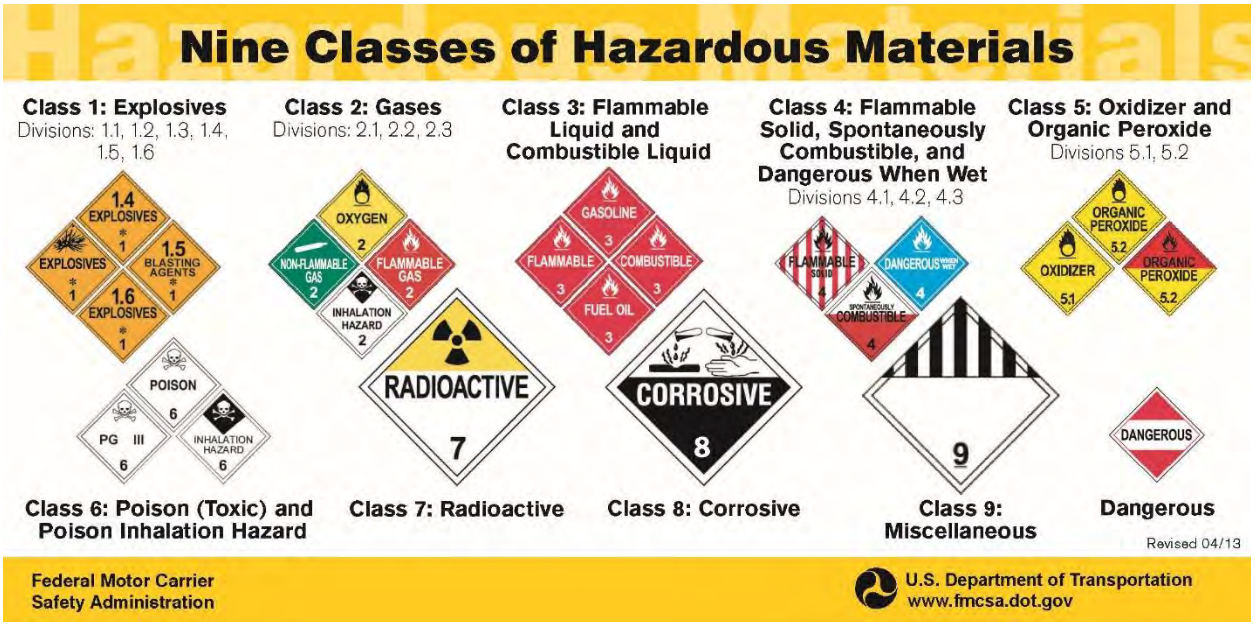


Figure E.22 – Hazardous Materials Classes



Source: U.S. Department of Transportation

Probability of Future Occurrence

Based on historical occurrences recorded by PHMSA, there have been 264 incidents of hazardous materials release in the 20-year period from 2000 through 2019. Using historical occurrences as an indication of future probability, there is over a 100 percent annual probability of a hazardous materials incident occurring throughout the City of Durham.

Probability: 4 – Highly Likely

Vulnerability Assessment

People

Hazardous materials incidents can cause injuries, hospitalizations, and even fatalities to people nearby. People living near hazardous facilities and along transportation routes may be at a higher risk of exposure, particularly those living or working downstream and downwind from such facilities. For example, a toxic spill or a release of an airborne chemical near a populated area can lead to significant evacuations and have a high potential for loss of life. Individuals working with or transporting hazardous materials are also at heightened risk.

In addition to the immediate health impacts of releases, a handful of studies have found long term health impacts such as increased incidence of certain cancers and birth defects among people living near certain chemical facilities. However there has not been sufficient research done on the subject to allow detailed analysis.

The primary economic impact of hazardous material incidents results from lost business, delayed deliveries, property damage, and potential contamination. Large and publicized hazardous material-related events can deter tourists and could potentially discourage residents and businesses. Economic effects from major transportation corridor closures can be significant.

Property

The impact of a fixed hazardous facility, such as a chemical processing facility is typically localized to the property where the incident occurs. The impact of a small spill (i.e. liquid spill) may also be limited to the extent of the spill and remediated if needed. While cleanup costs from major spills can be significant, they do not typically cause significant long-term impacts to property.

Hazardous materials spills reported by PHMSA for the 20-year period from 2000 through 2019 totaled $407,202 in damage, which equates to an annualized loss of $20,360 across the City of Durham.

Impacts of hazardous material incidents on critical facilities are most often limited to the area or facility where they occurred, such as at a transit station, airport, fire station, hospital, or railroad. However, they can cause long-term traffic delays and road closures resulting in major delays in the movement of goods and services. These impacts can spread beyond the planning area to affect neighboring counties, or vice-versa. While cleanup costs from major spills can be significant, they do not typically cause significant long-term impacts to critical facilities, but there is a chance they may be impacted.

Environment

Hazardous material incidents may affect a small area at a regulated facility or cover a large area outside such a facility. Widespread effects occur when hazards contaminate the groundwater and eventually the municipal water supply, or they migrate to a major waterway or aquifer. Impacts on wildlife and natural resources can also be significant.

Changes in Development

Structures located near fixed facilities, highways and other high traffic roadways are most at risk to a hazardous materials event. Any development that takes place in these areas will place more people and structures in the risk area for hazardous materials events, however since most hazardous material spills are localized to an extremely small area this will not have an effect on the overall risk assessment for this hazard.

Problem Statement

- Transportation routes for hazardous materials are located adjacent to the NCSSM campus.
- The number of reported incidents within Durham can be approximated to over a 100 percent annual probability.

E.5.9 Vandalism/Theft

Hazard	Probability	Impact	Spatial Extent	Warning Time	Duration	PRI Score
Vandalism/Theft	Highly Likely	Minor	Large	More than 24 hrs	Less than 6 hrs	2.8

Location

Similar to the City of Durham, incidents of vandalism and/or theft can occur throughout the NCSSM campus. For safety and preventative measures, the NCSSM Campus Safety and Security Department serves as the security oversight on campus with uniformed officers, as well as one uniformed City of Durham Police officer, on duty 24 hours a day, 7 days a week, during the academic year.

Spatial Extent: 4 – Large

Extent

There are many cases of vandalism reported every year all across the country. Individuals who engage in acts of vandalism such as keying a car are often charged with "criminal mischief", however, the State of North Carolina specifically uses the term vandalism. Graffiti vandalism is a Class 1 misdemeanor and is punishable by a minimum fine of $500 and 24 hours of community service. The incident may be classified as a Class H, or low level, felony if the following additional circumstances apply:

- The person has two or more prior convictions for violations of this section.
- The current violation was committed after the second conviction for violation of this section.
- The violation resulting in the second conviction was committed after the first conviction for violation of this section.

Additionally, the Municipal Code of the City of Durham states it shall be unlawful for any person willfully and without authority to destroy, defile, deface, desecrate, place any mark upon or otherwise damage any building or structure used or designated for use as a place of public or private educational purposes, or any part thereof or appurtenance thereto, or willfully and without authority to break, deface or otherwise damage any book, picture, furniture, ornament, furnishing, musical instrument, article of silver or plated ware or any other chattel or personal property kept in any building or structure for use in connection with public or private educational work.

Impact: 1 – Minor

Historical Occurrences

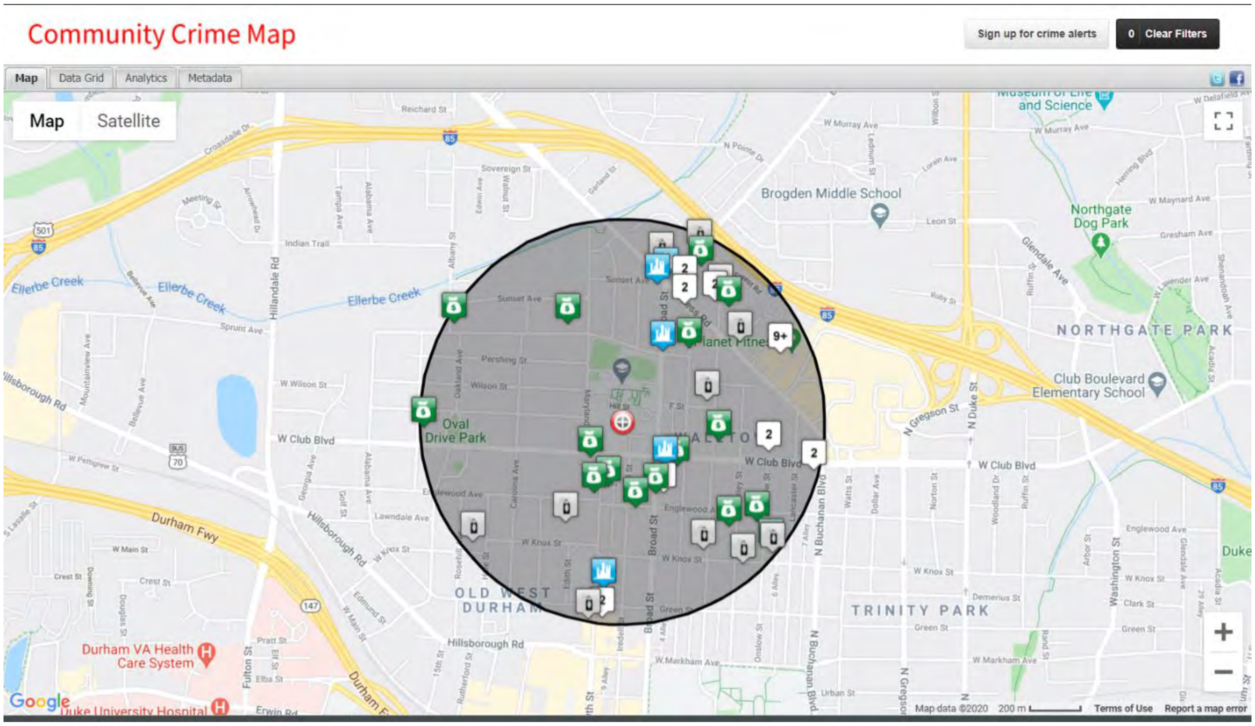
Previous occurrences of vandalism/theft were obtained through the LexisNexis Community Crime Map. This online service provides crime statistics across the United States, including the City of Durham, as provided by the Durham Police Department. **Table E.45** presents the number of incidents of commercial burglary, theft, and vandalism within a 0.5-mile radius of the NCSSM Campus. **Figure E.23** presents the incidents for January 1, 2010 through November 20, 2020.

Table E.45 – Crime Statistics, 0.5 Mile Radius of NCSSM Campus

Crime	2010	2011	2012	2013	2014	2015	2016	2017	2018	2019	2020	Total
Burglary - Commercial	12	2	11	7	10	6	8	18	18	4	14	**110**
Theft	40	39	45	52	49	37	41	39	44	44	28	**458**
Vandalism	51	30	26	26	14	14	21	36	11	22	14	**265**
Total	**103**	**71**	**82**	**85**	**73**	**57**	**70**	**93**	**73**	**70**	**56**	**833**

Source: LexisNexis Community Crime Map - https://communitycrimemap.com/

Figure E.23 – Crime Statistics, 0.5 Mile Radius of NCSSM Campus, 2020



Probability of Future Occurrence

Based on historical occurrences presented by the LexisNexis Community Crime Map, there have been 833 incidents of commercial burglary, theft, and vandalism for the nearly 11-year period from January 1, 2010 through November 20, 2020. This calculates to approximately 75 events per year and over a 100 percent annual probability of an incident occurring on or near the NCSSM campus.

Probability: 4 – Highly Likely

Vulnerability Assessment

People

Our North Carolina schools should be safe havens for teaching and learning, free of crime and violence. Any instance of crime or violence at school not only affects the individuals involved but also may disrupt the educational process and affect bystanders, the school itself, and the surrounding community.

Property

According to the U.S. Small Business Administration, a single incident of vandalism costs on average $3,370. In addition to this cost, vandalized structures could put instruction and educational activities on the NCSSM Campus on hold during repairs, clean up or because of the costs. Damaging property with graffiti in some incidences is a sign of gang infiltration; students and/or parents may become worried about having their vehicles damaged or stolen and, fearing for their personal safety, may seek to obtain their education elsewhere.

Environment

The environmental impacts of vandalism, specifically graffiti, include the emission of volatile organic compounds (VOCs) from the aerosol sprays and the cleaning substances used to remove paint from the walls can also be harmful to the environment.

Changes in Development

The most frequent targets of vandalism are those located in public spaces, or those on private properties that are open to public view. Properties where no one has direct responsibility for the area, or those that seem less well guarded, are also frequent targets of vandalism or graffiti. Businesses located near downtown areas, high traffic areas, or concentrations of low-income residents are particularly vulnerable to vandalism. Development around the NCSSM campus may play a larger role in the probability of vandalism incidents than development on the campus itself. Campus security will be necessary to deter vandalism and monitor vacant buildings when classes are not in session.

Problem Statement

- Incidents of vandalism and/or theft can occur throughout the NCSSM campus
- Incidents of vandalism occur on a regular basis in the area surrounding the NCSSM Campus.

E.5.10 Conclusions on Hazard Risk

Priority Risk Index

As discussed in **Section E.5**, 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 E.46 summarizes the degree of risk assigned to each identified hazard using the PRI method.

Table E.46 – Summary of PRI Results

Hazard	Probability	Impact	Spatial Extent	Warning Time	Duration	PRI Score
Earthquake	Unlikely	Minor	Large	Less than 6 hours	Less than 6 hours	1.9
Flood	Likely	Minor	Negligible	6 to 12 hrs	Less than 6 hours	1.8
Geological – Landslide	Unlikely	Minor	Small	6 to 12 hrs	Less than 6 hrs	1.4
Hurricane	Likely	Critical	Large	More than 24 hrs	Less than 24 hrs	2.9
Severe Winter Weather	Highly Likely	Limited	Large	More than 24 hrs	Less than 1 week	3.0
Tornado / Thunderstorm	Likely	Critical	Large	Less than 6 hrs	Less than 6 hrs	3.1
Wildfire	Unlikely	Minor	Small	More than 24 hrs	More than 1 week	1.5
Hazardous Materials Incidents	Highly Likely	Minor	Negligible	Less than 6 Hrs	Less than 24 Hrs	2.3
Vandalism/Theft	Highly Likely	Minor	Large	More than 24 hrs	Less than 6 hrs	2.8

[1]Note: Severe Weather hazards average to a score of 2.6 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 E.47**:

- **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.
- **Moderate 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 minimal. This is not a priority hazard.

Table E.47 – Summary of Hazard Risk Classification

High Risk (≥ 3.0)	Severe Winter Weather Tornado / Thunderstorm
Moderate Risk (2.0 – 2.9)	Hurricane Hazardous Materials Vandalism/Theft
Low Risk (< 2.0)	Wildfire Earthquake Flood Geological – Landslide

E.6 CAPABILITY ASSESSMENT

This section discusses the mitigation capabilities, including planning, programs, policies and land management tools, typically used to implement hazard mitigation activities. It consists of the following subsections:

- E.6.1 Overview of Capability Assessment
- E.6.2 Planning and Regulatory Capability
- E.6.3 Administrative and Technical Capability
- E.6.4 Fiscal Capability

E.6.1 Overview of Capability Assessment

The purpose of conducting a capability assessment is to determine the ability of the college to implement feasible mitigation actions based on an understanding of the capacity of the departments and staff tasked with their implementation. A capability assessment should also identify opportunities for establishing or enhancing specific mitigation policies or programs. The process of conducting a capability assessment includes developing an inventory of relevant plans, policies, or programs already in place; as well as assessing the college's ability to implement existing and/or new policies. Conclusions drawn from the capability assessment should identify any existing gaps or weaknesses in existing programs and policies as well as positive measures already in place which can and should be supported through future mitigation efforts.

E.6.2 Planning and Regulatory Capability

Planning and regulatory capabilities include plans, ordinances, policies and programs that guide development on campus. **Table E.48** lists these local resources currently in place at NCSSM.

Table E.48 – Planning and Regulatory Capability

Regulatory Tool (ordinances, codes, plans)	Y/N	Comments
Strategic Plan	Y	NCSSM Strategic Plan 2019-2024
Zoning code	Y	City of Durham Zoning Ordinance
Growth management ordinance	N	
Floodplain ordinance	Y	City of Durham Flood Ordinance
Building code	Y	NC building codes; the State of North Carolina statutes for state owned buildings; and zoning for local jurisdiction
Erosion or sediment control program	N	
Stormwater management program	N	Plant Facilities, Grounds Staff
Site plan review requirements	N	
Capital improvements plan	Y	Submitted during biennial budget development
Economic development plan	Y	NCSSM Annual Report
Local emergency operations plan	Y	NCSSM Emergency Operations Plan, no date available
Flood Insurance study or other engineering study for streams	Y	October 19, 2018
Elevation certificates	Y	City of Durham

A description of applicable plans, ordinances and programs follows to provide more detail on the relevance of each regulatory tool in examining the capabilities for each community.

Strategic Plan

A Strategic Plan, in broad terms, is a policy statement to guide the future placement and development of campus facilities. The Strategic Plan identifies a future vision, values, principles and goals for the college, determines the projected growth for the college, and identifies policies to plan, direct and accommodate anticipated growth.

Zoning Code

Zoning typically consists of both a zoning map and a written ordinance/code that divides the planning area into zoning districts. The zoning regulations describe what type of land use and specific activities are permitted in each district, and also regulate how buildings, signs, parking, and other construction may be placed on a parcel. The zoning regulations also provide procedures for rezoning and other planning applications. Zoning is undertaken by the City of Durham.

Flood Insurance Study/Floodplain Ordinance

A Flood Insurance Study (FIS) provides information on the existence and severity of flood hazards within a community based on the 100-year flood event. The FIS also includes revised digital Flood Insurance Rate Maps (FIRMs) which reflect updated Special Flood Hazard Areas (SFHAs) and flood zones for the community. FIRMs are produced and provided by FEMA.

A floodplain ordinance is perhaps the most important flood mitigation tool. 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 will be protected from damage by a 100-year flood event and that new development in the floodplain will not exacerbate existing flood problems or increase damage to other properties. Floodplain management activities are undertaken by the City of Durham.

Stormwater Management Program

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. A Stormwater Management Program can prevent flooding problems caused by stormwater runoff by 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) Setting construction standards so buildings are protected from shallow water. A stormwater ordinance provides regulatory authority to implement stormwater management standards. NCSSM’s Plant Facilities and Grounds staff are responsible for stormwater maintenance activities. Additionally, NCSSM follows the Durham County Stormwater Management Rules.

Erosion and Sediment Control Program

Surface water runoff can erode soil from development sites, sending sediment into downstream waterways. This can clog storm drains, drain tiles, culverts and ditches and reduce the water transport and storage capacity of channels. The purpose of an erosion, sedimentation and pollution control ordinance is to minimize soil erosion and prevent off-site sedimentation by using soil erosion and sediment control practices designed in accordance with certain standards and specifications.

Site Plan Review

The purpose of the Site Plan Review Process is to review site plans for specific types of development to ensure compliance with all appropriate land development regulations and consistency with the General Plan.

Building Code

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).

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. An Elevation Certificate serves as the official record that shows new buildings and substantial improvements in all identified SFHAs are properly elevated. This elevation information is needed to show compliance with the floodplain ordinance.

The State Building Code is enforced on campus by the State Construction Office.

Capital Improvement Plan

A Capital Improvement Plan (CIP) is a planning document that typically provides a five-year outlook for anticipated capital projects designed to facilitate decision makers in the replacement of capital assets. The projects are primarily related to improvement in public service, parks and recreation, public utilities and facilities. The mitigation strategy may include structural projects that could potentially be included in a CIP and funded through a Capital Improvement Program.

Emergency Operations Plan

An emergency operations plan outlines responsibilities and the means by which resources are deployed during and following an emergency or disaster.

E.6.3 Administrative and Technical Capability

Administrative and technical capability refers to the college's staff and their skills and tools that can be used for mitigation planning and to implement specific mitigation actions. It also refers to the ability to access and coordinate these resources effectively. The personnel should be considered as well as the level of knowledge and technical expertise of these resources. Resources include engineers, planners, emergency managers, GIS analysts, building inspectors, grant writers, floodplain managers, and more. **Table E.49** provides a summary of the administrative and technical capabilities for NCSSM.

Table E.49 – Administrative and Technical Capability

Personnel Resources	Yes/No	Department/Position
Planner/Engineer with knowledge of land development/land management practices	No	Plant Facilities, Grounds Staff
Engineer/Professional trained in construction practices related to buildings and/or infrastructure	No	Plant Facilities, Grounds Staff
Planner/Engineer/Scientist with an understanding of natural hazards	Yes	NCSSM Campus Safety & Security
Personnel skilled in GIS	Yes	Various Faculty
Full time building official	Yes	City of Durham

Personnel Resources	Yes/No	Department/Position
Floodplain Manager	Yes	City of Durham
Emergency Manager	Yes	NCSSM Campus Safety & Security City of Durham
Grant Writer	Yes	Various Faculty
Public Information Officer	Yes	Communications/Director of Communications
Student Engagement	Yes	Student Services
Warning Systems	Yes	Fire Alarm (including smoke & sprinklers) 2 Outdoor Warning Sirens RAVE Alert System

Additional resources that may support administrative capability for mitigation include the following:

Communications Office

The Communications Office is responsible for providing information about NCSSM to the media, the full range of the NCSSM community, and to the general public. The Communications Office coordinates all community interactions with media and serves as the initial contact with anyone requesting information about NCSSM. Additional functions include managing the NCSSM Web site, preparing School publications, and meeting the commercial design and print needs of other offices. The Communications Office may be able to support public education and outreach on hazard risk.

Emergency Preparedness and Response

The basement of NCSSM buildings are used as shelters for our students and staff. Additionally, NCSSM has participated in tabletop exercises with local emergency management entities.

E.6.4 Fiscal Capability

Financial capabilities are the resources that an entity has access to or is eligible to use to fund mitigation actions. The costs associated with implementing mitigation activities vary. Some mitigation actions such as building assessment or outreach efforts require little to no costs other than staff time and existing operating budgets. Other actions, such as structural projects, could require a substantial monetary commitment from local, State, and Federal funding sources. **Table E.50** provides a summary of the fiscal resources at NCSSM.

Table E.50 – Fiscal Resources

Resource	Ability to Use for Mitigation Projects? Y/N
Community Development Block Grants	N
Capital improvements project funding	Y, State Repair & Renovation Funding/Fundraising Initiatives
In-Kind Services	Y
Tuition & Fees	Y
Federal funding with HMA grants	Y
Revenue Bonds	Y
State Appropriations	Y, Repair & Renovation
Sales & Services	Y
Other Sources (Gifts, Investment Income, Permanent Endowments)	Y

E.7 MITIGATION STRATEGY

E.7.1 Implementation Strategy

Progress on the mitigation strategy developed in the previous plan is also documented in this plan update. **Table E.51** details the status of mitigation actions from the previous plan. **Table E.52** on the following pages details all completed and deleted actions from the 2011 plan. More detail on the actions being carried forward is provided in the Mitigation Action Plan.

Table E.51 – Status of Previous Mitigation Actions

Campus	Completed	Deleted	Carried Forward and/or Combined
NCSSM	10	10	32

Table E.52 – Completed and Deleted Actions from the NCSSM 2011 Plan

Location	Vulnerability	Action	2020 Status	2020 Implementation Status Comments
Bryan Center and Beall Hall	A number of mechanical systems were not anchored to their foundation including the generator, the chiller and the generator.	Mechanical systems serving critical facilities should be anchored to their foundations.	Deleted	It was recommended that these generators not be anchored
Educational Technology Complex	The data center has water based fire suppression with no pre-action interlock.	Consider installing a non-water based fire suppression system in the data center and UPS area.	Completed	The computer equipment has been relocated
Educational Technology Complex	The data center has a single Liebert unit, which is in poor condition. The heat pump was not anchored to the structure.	The existing Liebert unit should be replaced and supplemented by an additional unit for redundancy.	Completed	The computer equipment has been relocated
Educational Technology Complex	Areas of flat roof were observed to have significant moss buildup and partially clogged drains.	The flat roofs and their drains should be cleaned to prevent water damage during intense downpours.	Completed	Drains have been cleaned
Educational Technology Complex	The courtyard area has only one source of drainage which were it to fail could flood the ground floor.	The courtyard should have an emergency drain installed in the event that the primary drain fails.	Deleted	This has not created any issues even with heavy downpours
Hill House	Several mechanical systems were observed to have no anchorage to foundation including pumps and air compressors.	Mechanical systems serving critical facilities should be anchored to their foundations.	Deleted	It was recommended that this equipment not be anchored
Hunt Hall	The roof has reached the end of its service life and should be replaced before water damage occurs.	The roof of the building should be replaced.	Completed	Completed
Hunt Hall	A number of mechanical systems were not anchored to their foundation including water heaters and air handlers.	Mechanical systems serving critical facilities should be anchored to their foundations.	Deleted	It was recommended that this equipment not be anchored
Physical Education Center	The building acts as an emergency shelter however is not wired to provide heating or ventilation during a power outage. The existing generator is adequate to supply power to these mechanical systems. The steam/condensate pumps, air compressors, and controls are already wired for emergency power.	The exhaust fans in the gymnasium should be wired to operate on generator power to provide minimal cooling/ventilation for occupants.	Completed	Completed
Plant Facilities	There are no snow guards on the roof and facility personnel report large sheets fall off during winter storms. They have damaged gutters in the past.	Snow guards should be installed to protect occupants from falling ice/snow.	Completed	Completed

Location	Vulnerability	Action	2020 Status	2020 Implementation Status Comments
Plant Facilities	The gutter downspouts have been detached from the gutter system as a result of falling snow/ice sheets.	The gutters should be repaired to prevent water damage to the façade.	Completed	Completed
Plant Facilities	A tall interior CMU wall has several large cracks. Facility personnel report no visible change in cracks with time.	An engineer should evaluate if the walls were constructed in accordance with design requirements and determine what, if any, remedial actions are required to return the walls to their design strength.	Completed	Completed
Plant Facilities	There is an unanchored heat pump on the facility's exterior.	Mechanical equipment should be anchored to its foundation.	Deleted	Action not necessary
Royall Center	The emergency generator is not anchored to its foundation.	The emergency generator should be anchored to its foundation.	Completed	Completed
Chiller Plant and Boiler Plant	The buildings have numerous unanchored mechanical systems including boilers, pumps, the chiller, and cooling towers.	Mechanical systems considered to be part of critical infrastructure should be anchored to their foundations.	Deleted	Action not necessary
Chiller Plant and Boiler Plant	The roof of the Boiler Plant had ponding water well in excess of the 24-hour period after a rainfall.	The drainage problem on the roof of the Boiler Plant should be corrected to prevent early deterioration of the roof.	Completed	Completed
Bryan Center and Beall Hall	There is ongoing damage to the masonry parapet of the Bryan penthouse. The cause of damage to the Bryan penthouse masonry parapet should be corrected before more significant damage occurs.	The cause of damage to the Bryan penthouse masonry parapet should be corrected before more significant damage occurs.	Deleted	This property protection measure addresses hazards outside of this plan.
Plant Facilities	The facility's façade and electrical switchgear are subject to vehicle impacts during ice/snow events.	The façade and electrical switchgear should be protected by vehicle barriers to prevent accidental collisions.	Deleted	This property protection measure addresses hazards outside of this plan.
Reynold's, ITS, and Art Studio	The ITS server room has limited HVAC and no redundancy. There is no environmental monitoring in the server room.	The ITS server room should have a more robust HVAC unit installed. The room should have environmental sensors capable of alerting staff when the HVAC has failed.	Deleted	This property protection measure addresses hazards outside of this plan.
Reynold's, ITS, and Art Studio	ITS does not have the ability to perform regular data backups.	ITS should implement a regular, offsite data backup to prevent data loss.	Deleted	This property protection measure addresses hazards outside of this plan.

E.7.2 Mitigation Action Plan

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.

The following table comprises the mitigation action plan for NCSSM. Each mitigation action recommended for implementation is listed in these tables along with detail on the hazards addressed, the goal and objective addressed, the priority rating, the lead agency responsible for implementation, potential funding sources for the action, a projected implementation timeline, and the 2020 status and progress toward implementation for actions that were carried forward from the 2011 plan.

Table E.53 – Mitigation Action Plan, NCSSM

Action #	Action Description	Hazard(s) Addressed	Goal & Objective Addressed	Priority	Mitigation Category	Lead Agency / Department	Estimated Cost	Potential Funding Source	Implementation Timeline	2020 Status	2020 Implementation Status Comments
NCSSM1	Campus-Wide – Major mechanical systems (HVAC equipment, heat pumps, chillers, generators, fuel tanks, gas cylinders, and boilers) should be anchored to their foundations. This includes, but is not limited to, the following campus buildings: Physical Education Center.	All Hazards	1.1	Low	Property Protection	Plant Facilities	<$5,000 per site	Operating Budget, State/ Federal Grants	2021-2026	Carry Forward	Scheduled to be completed fiscal year 20-21
NCSSM2	Campus-Wide – Upgrade back-up power capabilities to critical facilities including, but not limited to: Bryan Center and Beall Hall; Hill House; Physical Education Center; Plant Facilities; and Royall Center.	All Hazards	1.1	Medium	Property Protection	Plant Facilities	$5,000-$100,000 per site	Operating Budget	2021-2026	Carry Forward	No progress made due to funding limitations.
NCSSM3	Bryan Center and Beall Hall - Beall Hall does not have snow guards on the roof. Personnel report large sheets of snow/ice fall off of roof during winter weather. Snow guards should be added to the roof in areas frequented by pedestrians or where falling debris causes gutter damage.	Severe Winter Weather	1.2	High	Property Protection	Plant Facilities	<$5,000	Operating Budget	2021-2026	Carry Forward	No progress made due to funding limitations.
NCSSM4	Bryan Center and Beall Hall - The cupolas and dumb waiter towers are in poor condition and rapidly deteriorating. The cupolas and dumb waiters should be repaired before a severe storm causes more extensive damage.	Hurricane, Tornado/ Thunderstorm	1.2	Medium	Property Protection	Plant Facilities	$25,000-$100,000	Operating Budget	2021-2026	Carry Forward	No progress made due to funding limitations.
NCSSM5	Bryan Center and Beall Hall - The radio equipment in the Bryan penthouse was not properly secured to the structure. The radio gear in the Bryan penthouse should be securely anchored to the structure in an enclosure. Consideration should be given to adding a limited battery backup.	Tornado/ Thunderstorm	1.1	Low	Property Protection	Plant Facilities	$5,000-$25,000	Operating Budget, State/ Federal Grants	2021-2026	Carry Forward	No progress made due to funding limitations.
NCSSM6	Educational Technology Complex - Several areas of the roof do not have snow guards and personnel report large chunks of ice/snow fall off the roof during winter weather. Snow guards should be added to the roof in areas frequented by pedestrians.	Severe Winter Weather	1.2	High	Property Protection	Plant Facilities	<$5,000	Operating Budget	2021-2026	Carry Forward	No progress made due to funding limitations.
NCSSM7	Educational Technology Complex - Several clay tiles were observed to be missing at the time of the inspection. The missing roof tiles should be replaced and the fascia boards repainted to prevent further deterioration.	Severe Winter Weather	1.2	Medium	Property Protection	Plant Facilities	$25,000-$100,000	Operating Budget	2021-2026	Carry Forward	No progress made due to funding limitations.
NCSSM8	Educational Technology Complex - Flashing was found to be falling off the façade in several locations. The fascia boards were showing signs of weathering and need to be repainted. The deteriorating flashing should be repaired to prevent water damage.	Flood	1.2	Low	Property Protection	Plant Facilities	$25,000-$100,000	Operating Budget	2021-2026	Carry Forward	No progress made due to funding limitations.
NCSSM9	Hill House - There is an area of the tunnel roof experiencing water intrusion, leading to moisture damage. The moisture intrusion issue in the tunnel should be corrected to prevent further structural deterioration.	Flood	1.2	Medium	Property Protection	Plant Facilities	<$5,000	Operating Budget	2021-2026	Carry Forward	No progress made due to funding limitations.
NCSSM10	Hunt Hall - The EIFS coating has reached the end of its service life and needs to be waterproofed to prevent water intrusion. The EIFS system should be re-waterproofed to prevent water intrusion and mold growth.	Flood	1.2	High	Property Protection	Plant Facilities	$5,000-$25,000	Operating Budget	2021-2026	Carry Forward	No progress made due to funding limitations.
NCSSM11	Hunt Hall - The outdoor water heater should be relocated to the mechanical basement to protect it from severe weather. The outdoor water heater should be relocated to the basement mechanical room to protect it from severe weather.	Severe Winter Weather, Flood	1.2	Medium	Property Protection	Plant Facilities	<$5,000	Operating Budget	2021-2026	Carry Forward	No progress made due to funding limitations.

Action #	Action Description	Hazard(s) Addressed	Goal & Objective Addressed	Priority	Mitigation Category	Lead Agency / Department	Estimated Cost	Potential Funding Source	Implementation Timeline	2020 Status	2020 Implementation Status Comments
NCSSM12	Physical Education Center - The existing fiberglass skylight panels are degrading and are close to the end of their service life. The fiberglass skylight panels should be retrofitted or replaced to ensure their performance during storm events.	Hurricane, Tornado/ Thunderstorm	1.2	Medium	Property Protection	Plant Facilities	$25,000-$100,000	Operating Budget	2021-2026	Carry Forward	No progress made due to funding limitations.
NCSSM13	Reynold's, ITS, and Art Studio - Reynolds Hall does not have snow guards on the roof. Personnel report large sheets of snow/ice fall off of roof during winter weather. Snow guards should be added to the roof over areas frequented by pedestrians or where falling debris causes gutter damage.	Severe Winter Weather	1.2	High	Property Protection	Plant Facilities	>$100,000	Operating Budget	2021-2026	Carry Forward	No progress made due to funding limitations.
NCSSM14	Reynold's, ITS, and Art Studio - The cupolas and dumb waiter towers are in poor condition and rapidly deteriorating. The cupolas and dumb waiters should be repaired before a severe storm causes more extensive damage.	Hurricane, Tornado/ Thunderstorm	1.2	Medium	Property Protection	Plant Facilities	<$5,000	Operating Budget	2021-2026	Carry Forward	Partially complete, waiting on funding
NCSSM15	Reynold's, ITS, and Art Studio - Gutters were in poor condition with numerous missing or damaged segments. The gutters and downspouts should be repaired to reduce water damage to the facility's facade.	Flood	1.2	Medium	Property Protection	Plant Facilities	$5,000-$25,000	Operating Budget	2021-2026	Carry Forward	Partially complete, waiting on funding
NCSSM16	Reynold's, ITS, and Art Studio - The drains in Reynolds wing C have clogged in the past causing water damage. Reynolds wing C should have an emergency drain added at ground level to prevent water damage in the event of primary drainage failure.	Flood	1.2	Low	Structural Projects	Plant Facilities	$5,000-$25,000	Operating Budget, State/ Federal Grants	2021-2026	Carry Forward	No progress made due to funding limitations.
NCSSM17	Reynold's, ITS, and Art Studio - Many of the windows, particularly in the breezeway are in poor condition and would likely blow open in an intense storm. Older windows should be repaired and upgraded to withstand intense storms.	Hurricane, Tornado/ Thunderstorm	1.2	High	Property Protection	Plant Facilities	<$5,000	Operating Budget	2021-2026	Carry Forward	No progress made due to funding limitations.
NCSSM18	Royall Center - Royall Center does not have snow guards on the roof. Personnel report large sheets of snow/ice fall off of roof during winter weather. Snow guards should be added to the roof in areas frequented by pedestrians or where falling debris causes gutter damage.	Severe Winter Weather	1.2	High	Property Protection	Plant Facilities	<$5,000	Operating Budget	2021-2026	Carry Forward	No progress made due to funding limitations.
NCSSM19	Royall Center - The building only has one network path back to ITS. The existing network path must pass through three other buildings before reaching ITS. The facility hosts critical network services. A supplemental direct network connection should be installed between Royall and ITS to enhance redundancy.	All Hazards	1.1	High	Prevention	Plant Facilities	$5,000-$25,000	Operating Budget	2021-2026	Carry Forward	No progress made due to funding limitations.
NCSSM20	Chiller Plant and Boiler Plant - The Boiler Plant's electrical service enters through a switch and transformer located below windows which are already damaged and could allow water to damage the equipment. The windows in the Boiler Plant should be replaced with impact resistant windows to prevent water damage to electrical equipment.	Tornado/ Thunderstorm	1.2	Low	Property Protection	Plant Facilities	<$5,000	Operating Budget	2021-2026	Carry Forward	No progress made due to funding limitations.
NCSSM21	Chiller Plant and Boiler Plant - The steam distribution piping has exceeded its service life and has many leaks. The steam distribution system should be repaired as required to ensure it is serviceable during an emergency.	All Hazards	1.2	High	Property Protection	Plant Facilities	<$5,000	Operating Budget	2021-2026	Carry Forward	Partially complete, waiting on funding
NCSSM22	Watts Hall - Many areas of gutter are either missing or damaged. The gutters and downspouts should be repaired to direct water away from the facility.	Flood	1.2	High	Property Protection	Plant Facilities	<$5,000	Operating Budget	2021-2026	Carry Forward	No progress made due to funding limitations.
NCSSM23	Watts Hall - The wood framed windows are beginning to deteriorate from moisture damage. The windows should be repaired and painted as necessary to prevent further deterioration.	Hurricane, Tornado/ Thunderstorm	1.2	High	Property Protection	Plant Facilities	$25,000-$100,000	Operating Budget	2021-2026	Carry Forward	No progress made due to funding limitations.

Action #	Action Description	Hazard(s) Addressed	Goal & Objective Addressed	Priority	Mitigation Category	Lead Agency / Department	Estimated Cost	Potential Funding Source	Implementation Timeline	2020 Status	2020 Implementation Status Comments
NCSSM24	Watts Hall - The basement stairwells rely on gravity drains. Flooding of the basement would ruin insulation on cold/hot water piping. Supplemental emergency drainage should be installed in the basement area to prevent another flood event.	Flood	1.2	High	Structural Projects	Plant Facilities	$5,000-$25,000	Operating Budget, State/ Federal Grants	2021-2026	Carry Forward	No progress made due to funding limitations.
NCSSM25	Watts Hall - The building's dewatering system is poorly designed and there is evidence of ongoing water penetration through the basement walls. Existing design requires facility personnel to manually connect dewatering pumps to power using an extension cord. The dewatering system should be modified to allow it to continuously pump automatically, rather than relying on manual operation.	Flood	1.2	High	Property Protection	Plant Facilities	$5,000-$25,000	Operating Budget	2021-2026	Carry Forward	No progress made due to funding limitations.
NCSSM26	Watts Hall - Reynolds Hall does not have snow guards on the roof. Personnel report large sheets of snow/ice fall off of roof during winter weather. Snow guards should be added to the roof in areas frequented by pedestrians or where falling debris causes gutter damage.	Severe Winter Weather	1.2	High	Property Protection	Plant Facilities	$5,000-$25,000	Operating Budget	2021-2026	Carry Forward	No progress made due to funding limitations.

THE UNIVERSITY OF NORTH CAROLINA SYSTEM

UNC System Eastern Campuses Regional Hazard Mitigation Plan

Annex F: North Carolina State University

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Annex F North Carolina State University

This section provides planning process, campus profile, hazard risk, vulnerability, capability, and following subsections:

- F.1 Planning Process Details
- F.2 Campus Profile
- F.3 Asset Inventory
- F.4 Hazard Identification
- F.5 Hazard Profiles, Analysis, and Vulnerability
- F.6 Capability Assessment
- F.7 Mitigation Strategy

F.1 PLANNING PROCESS DETAILS

The table below lists the HMPC members who represented NCSU during the planning process.

Table F.1 – HMPC Members

Representative	Role; Department
Todd Becker	Emergency Manager; Emergency Management & Mission Continuity
Amy Orders	Director; Emergency Management & Mission Continuity
Jon Brann	University Fire Marshal; Fire and Life Safety
David Rainer	Associate Vice Chancellor; Environmental Health & Public Safety
Doug Morton	Associate Vice Chancellor; Facilities
Allen Boyette	Senior Director, Energy Systems; Facilities
Steve Olmstead	Director; Insurance and Risk Management
Greg Sparks	Associate Vice Chancellor; Communication Technologies

Coordination with Other Community Planning Efforts and Hazard Mitigation Activities

The table below lists campus and community resources referenced throughout the planning process and used in the plan development.

Table F.2 – Summary of Existing Studies and Plans Reviewed

Resource Referenced	Use in this Plan
NCSU Physical Master Plan	The NCSU Physical Master Plan, developed in 2014, was referenced for the Campus Profile in Section F.2 as well as the Capability Assessment in Section F.6
City of Raleigh Comprehensive Plan	The Comprehensive Plan, developed by the Raleigh Planning and Zoning Department, was referenced for the Campus Profile in Section F.2.
Wake County and Incorporated Areas Flood Insurance Study (FIS), Revised 12/6/2019	The FIS report was referenced in the preparation of flood hazard profile in Section F.5.
NCSU Pre-Disaster Mitigation Plan, 2011	The previous NCSU Pre-Disaster Mitigation Plan was used in preparation of the hazard profiles in Section F.5. The plan was additionally used to track implementation progress (Section 2) and develop the mitigation plan (Section 7).
Wake County Multi-Jurisdictional Hazard Mitigation Plan, 2019	The Wake County Multi-Jurisdictional Hazard Mitigation Plan was referenced in compiling the Hazard Identification and Risk Assessment in Section F.5.

F.2 CAMPUS PROFILE

This section provides a general overview of the North Carolina State University (NCSU) campus and area of concern to be addressed in this plan. It consists of the following subsections:

- Location and Setting
- Geography and Climate
- History
- Cultural and Natural Resources
- Land Use
- Population and Demographics
- Social Vulnerability
- Growth and Development Trends

F.2.1 Location and Setting

The North Carolina State University is located in Raleigh, North Carolina. Situated midway between the Blue Ridge Mountains and the Atlantic Ocean, Raleigh is North Carolina's capital city and is located in the heart of the state's Triangle region and minutes from world-renowned Research Triangle Park, the largest research park in the world and home to industry giants like IBM Cisco, GlaxoSmithKline, Lenovo, Nortel Networks, Sony Ericsson and others.

With a campus size of 2,137 acres consisting of over 1,000 buildings, NCSU is the largest four-year college in the state and offers more than 300 undergraduate and graduate degree programs through 65 departments. NCSU also has more than 700 student organizations, along with 70 intramural and club sports programs and 23 Division I varsity teams, which help cater to any area of interest a student may have, whether it be political, athletic, professional, social, ethnic, or academic.

As a land-grant university, NCSU strives to help create a better world through community service. NCSU's students serve those in need on campus, across North Carolina and around the globe, and their commitment to service is a key reason NC State made the 2012 President's Higher Education Community Service Honor Roll.

Interstates 40 and 440 along with US Highways 401 and 70 make the University easily accessible by automobile. Raleigh also offers different modes of public transportation throughout the city.

Figure F.1, **Figure F.2**, and **Figure F.3** provide base maps of the Centennial, North, Central, South, and West campuses that make up NCSU's main campus. For more detail on campus buildings and critical facilities, see Section F.3.

Figure F.1 – NCSU Campus Base Map – Centennial Campus

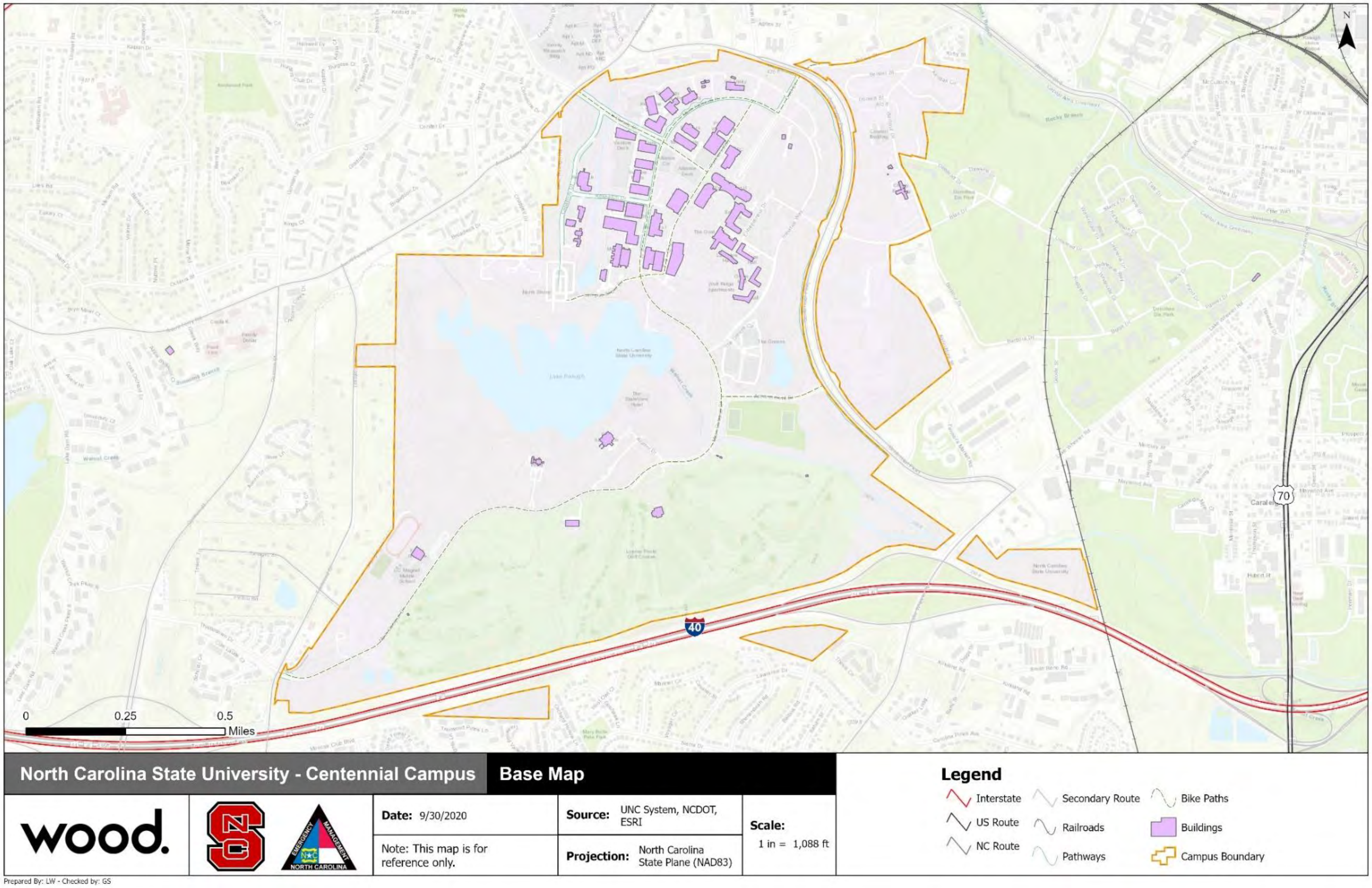


Figure F.2 – NCSU Campus Base Map – North, Central, and South Campus

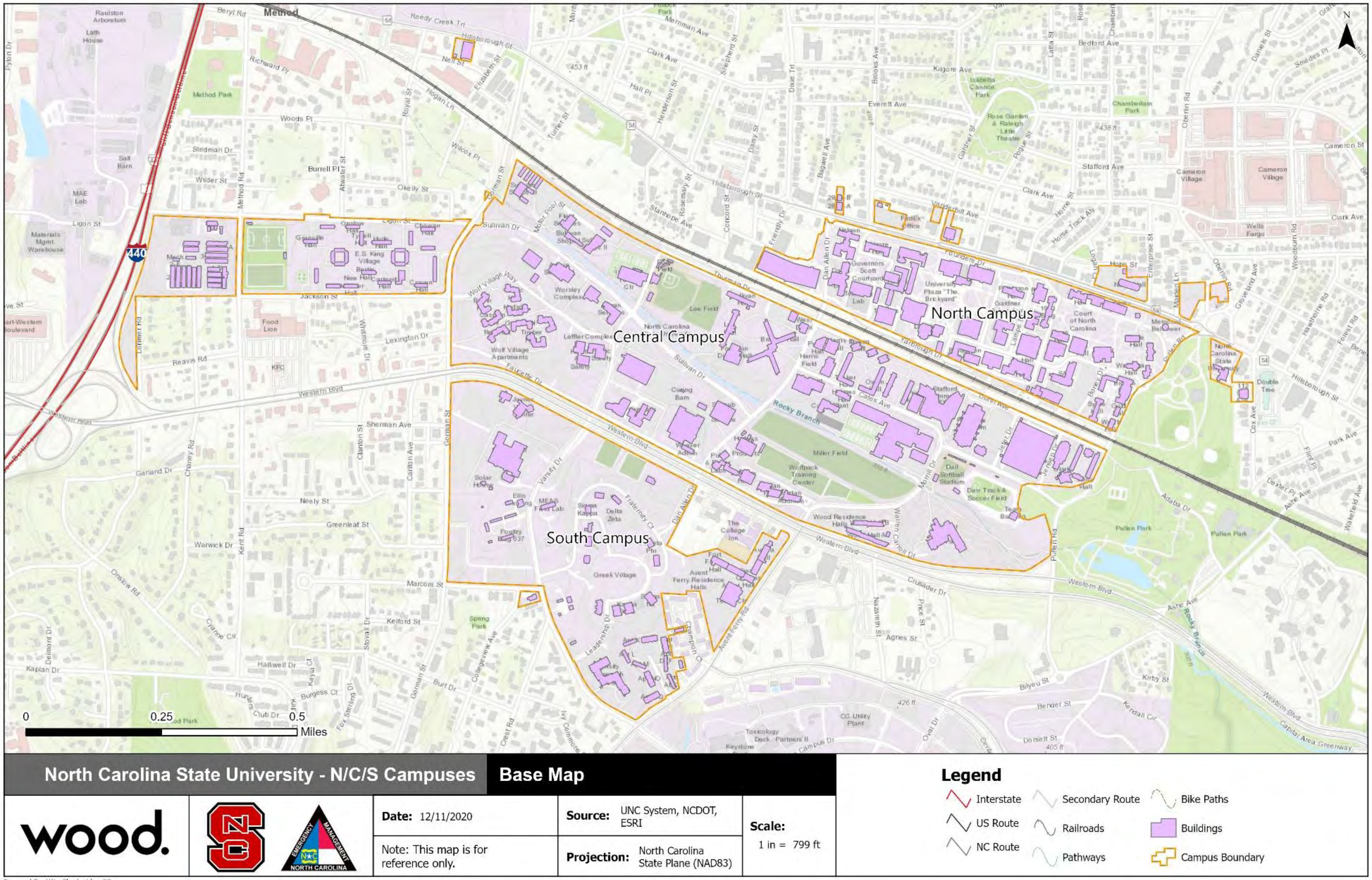
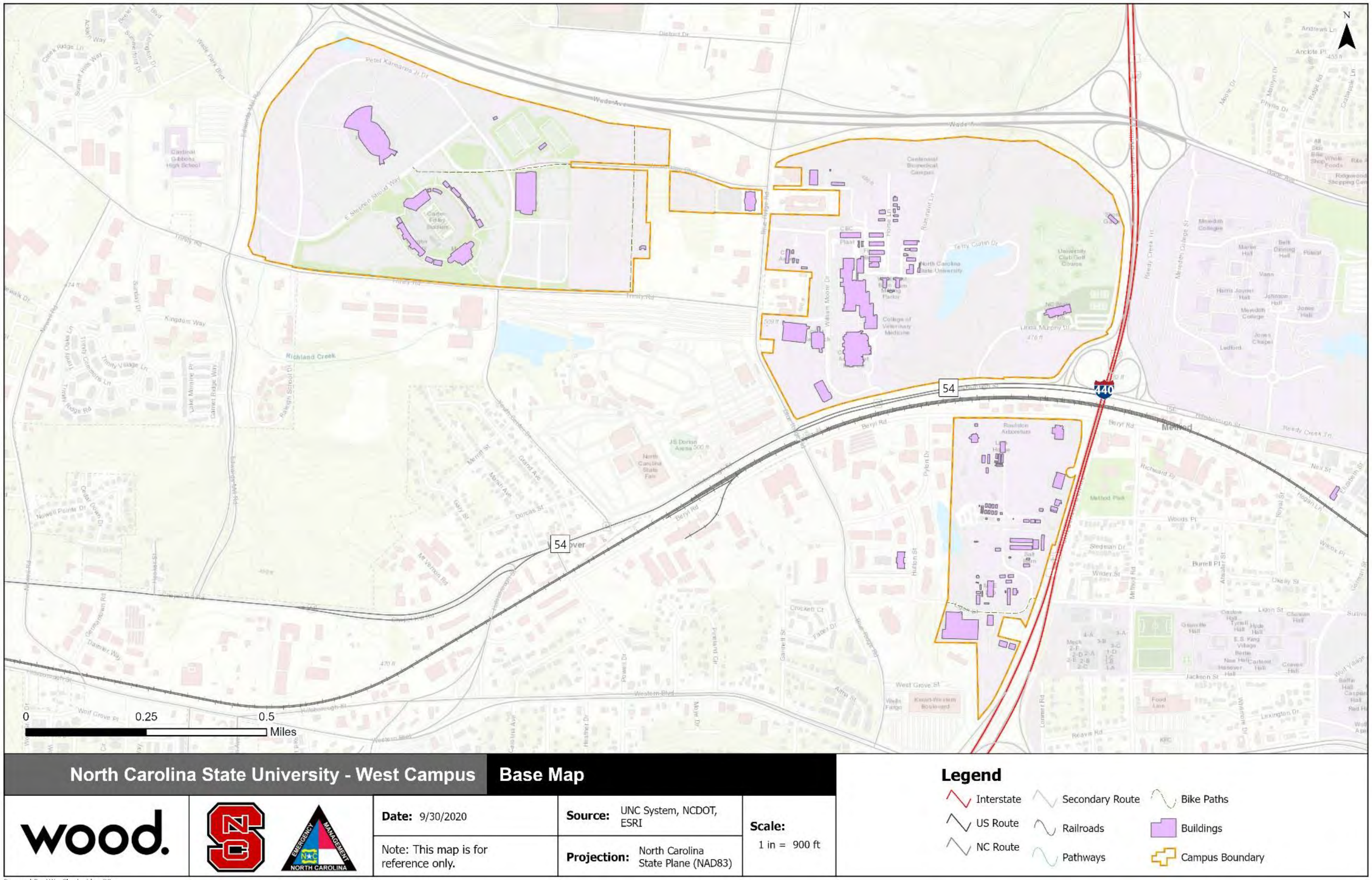


Figure F.3 – NCSU Campus Base Map – West Campus



F.2.2 Geography and Climate

North Carolina State University is in Raleigh, in the eastern part of North Carolina's Piedmont region. NCSU's campus is largely flat with a few rolling hills, which reflects the topography of the Piedmont region. In addition, the central location of Raleigh provides driving access to both the coastal region in the east and to the mountains in the west. Raleigh has a favorable, mild climate with temperatures dropping to 31 degrees Fahrenheit on average in January and climbing to 89 degrees Fahrenheit on average in July. The annual precipitation for the city is approximately 45 inches per year.

F.2.3 History

More than a century after its establishment as a land-grant institution in 1887, North Carolina State University continues to follow the mission upon which it was founded —to provide teaching, research, and extension services to the people of North Carolina in order to strengthen the state and its economy.

Founded in 1887, NC State—then known as the North Carolina College of Agriculture and Mechanic Arts—began classes in the fall of 1889 with 72 students, six faculty, and one building. Today the university has more than 36,000 students, around 9,000 faculty and staff and more than 1,000 buildings.

In the early 1900s, two federal programs sparked a new era in extension and outreach work at the college. An agreement with the U.S. Department of Agriculture in 1909 led to what is now known as the 4-H program. The passage of the Smith-Lever Act in 1914 enabled land-grant colleges to establish state, county, and local extension programs to further support their existing demonstration work, leading North Carolina to establish the Cooperative Agricultural Extension Service at State College.

Although the term "State College" had been in use for years, the broadening of the school's teaching, research, and extension activities led the Board of Trustees to officially adopt the name. By the 1920s, State College was beginning to grow beyond its original agriculture and mechanical focus, adding schools of engineering, science and business, textiles, education, and a graduate school.

The Depression brought on economic challenges for higher education throughout the state, but as the Depression slowly receded, the college renewed its growth in numbers of students and development of programs. The onset of World War II brought with it more changes for the university, namely lower enrollments and reductions in programs.

Despite these difficulties, State College made contributions to the war effort by hosting a number of military detachments and training exercises, and refitting the work of several departments and programs to military and defense purposes. The campus experienced unparalleled growth during the postwar years as the G.I. Bill brought thousands of former servicemen to campus.

In the following decades, the college continued to expand its curricula, creating schools of design, forestry, physical science and mathematics, and humanities and social sciences. During these years of growth, the name was changed again, this time to North Carolina State University at Raleigh.

The university celebrated its 100th anniversary in 1987, which also saw the creation of Centennial Campus, which brings together university and corporate leaders to engage in teaching, research and economic development.

Known as the "People's University," NC State has developed into a vital educational and economic resource, and a wealth of university outreach and extension programs provide services and education to all sectors of the state's economy and its citizens. Consistently ranked a national best value and among the nation's top public universities, NC State is an active and vital part of North Carolina life.

Dr. Randy Woodson is North Carolina State University's 14th chancellor and has been the University's chancellor since April 2010. Woodson leads the largest university in North Carolina, with more than 36,000 students and a $1.5 billion budget. Under his leadership, the university created and implemented The Pathway to the Future strategic plan that has elevated NC State's recognition among the nation's top public research universities.

F.2.4 Cultural and Natural Resources

National Register of Historic Places

There are 142 listings in the National Register of Historic Places for Raleigh. Many places associated with NCSU's School of Design such as the Matsumoto House, Paschal House, Richter House, and Small House are listed as historic places in Raleigh.

Natural Features and Resources

The City of Raleigh is host to a myriad of wetlands, creeks, rivers, lakes, and nature preserves. In 2015, the City owned and was responsible for approximately 12,539 acres of parks and open space. Raleigh strives to provide both larger parks (50+ acres) for active and passive use; neighborhood parks (2-20 acres) within walking and biking distance of most homes; connectors like greenways and bikeways; and unique waterfront parks with public access to waterways whenever possible.

Approximately 218 acres of the land on NC State University's campus are located within a 100-year Special Flood Hazard Area. Of the total 218 acres, 135 acres are in the floodway, 82 acres are designated as Zone AE, and 1 acre is designated as a Zone A. The Zone A is located on the Central Campus, most of the Floodway and Zone AE runs through the Centennial Campus, but a few of acres of the Zone AE and Floodway run through the most western portion of the West Campus. An additional 3 acres of land on NCSU's West campus is located within the 500-year floodplain, and the remaining 1,921 acres throughout all 5 campuses are designated as Unshaded Zone X.

Natural and Beneficial Floodplain Functions

Under natural conditions, a flood causes little or no damage in floodplains. Nature ensures that floodplain flora and fauna can survive the more frequent inundations, and the vegetation stabilizes soils during flooding. Floodplains reduce flood damage by allowing flood waters to spread over a large area. This reduces flood velocities and provides flood storage to reduce peak flows downstream.

Threatened and Endangered Species

The U.S. Fish and Wildlife Service maintains a regular listing of threatened species, endangered species, at-risk species, and candidate species for counties across the United States. Wake County has 11 species that are listed with the U.S. Fish and Wildlife Services. **Table F.3** below shows the 11 species identified as threatened and endangered in Wake County.

Table F.3 – Threatened and Endangered Species in Wake County

Common Name	Scientific Name	Federal Status
Green floater	*Lasmigona subviridis*	Under Review
Neuse River waterdog	*Necturus lewisi*	Proposed Threatened
Carolina madtom	*Noturus furiosus*	Proposed Endangered
Little brown bat	*Myotis lucifugus*	Under Review
Dwarf wedgemussel	*Alasmidonta heterodon*	Endangered
Tar River spinymussel	*Elliptio steinstansana*	Endangered
Michaux's sumac	*Rhus michauxii*	Endangered
Atlantic pigtoe	*Fusconaia masoni*	Proposed Threatened
Red-cockaded woodpecker	*Picoides borealis*	Endangered
Yellow lance	*Elliptio lanceolata*	Threatened

Common Name	Scientific Name	Federal Status
Cape Fear shiner	*Notropis mekistocholas*	Endangered

Source: U.S. Fish & Wildlife Service (https://ecos.fws.gov/ecp/report/species-listings-by-current-range-county?fips=37063)

F.2.5 Land Use

North Carolina State University's 2014 Master Plan includes key projects they have been carrying out including additions and renovations to Broughton, Carmichael, and Dabney Halls within the North, Central, and South Campus precincts, a hotel and conference center along with a Town Center within the Centennial Campus, and a Biomedical Partnership Center on the West Campus. The full list of key projects for each campus can be found below in **Figures 3.1-3.3**. NCSU's Strategic Plan for 2011-2020 also states that the University has developed an online inventory and database of existing facilities, equipment, and instrumentation. On the basis of this inventory, the plan is to develop a high-priority-needs list that will influence future improvement plans regarding facilities and equipment.

Figure F.4 – NCSU North, Central, and South Campus Key Projects, 2014 Master Plan

Figure F.5 – NCSU Centennial Campus Key Projects, 2014 Master Plan

Figure F.6 – NCSU West Campus Key Projects, 2014 Master Plan

F.2.6 Population and Demographics

Table F.4 provides population counts and percent change in population since 2010 for Wake County and the City of Raleigh.

Table F.4 – Population Counts for Surrounding Jurisdictions

Jurisdiction	2010 Census Population	2019 Estimated Population	% Change 2010-2019
Wake County	901,052	1,111,761	23.4
Raleigh	404,068	474,069	17.3

Source: U.S. Census Bureau QuickFacts 2010 vs 2019 (V2019) data

Table F.5 provides population counts for North Carolina State University from Fall 2019, including the number of undergraduate and graduate students, staff, and faculty.

Table F.5 – Population Counts for North Carolina State University, Fall 2019

Group	2019 Population
Students	36,304
Undergraduate Students	25,973
Graduate Students	10,331
Off-Campus	22,871
On-Campus	13,433
Faculty	2,200
Staff	6,500

According to The North Carolina State University's Fall 2019 Fast Facts page, 48% of undergraduate students were female. Among the NCSU student population, the most popular majors were Business Administration and Management, Computer Science, Engineering, and Biological Sciences.

Based on the 2010 Census, the largest number of residents in both Raleigh and Wake County fall in the age range of 5-18, making up 21.7% and 20.4% of the populations, respectively. The racial characteristics of the County, City, and college are presented below in **Table F.6**. White persons make up the majority of the population for the City and County; however, African-Americans make up the majority of the population at North Carolina Central University.

Table F.6 – Demographics of Wake County and North Carolina Central University Students

Jurisdiction	African-American Persons, Percent	American Indian or Alaska Native, Percent	Asian Persons, Percent	Hispanic or Latino Persons, Percent	White Persons, Percent
Wake County[1]	36.9	0.9	5.5	13.7	54
Raleigh [1]	38.7	0.3	5.4	13.8	49.2
North Carolina State University[2]	5.5	0.4	7.1	5.6	67.1

Source: U.S. Census Bureau, 2010

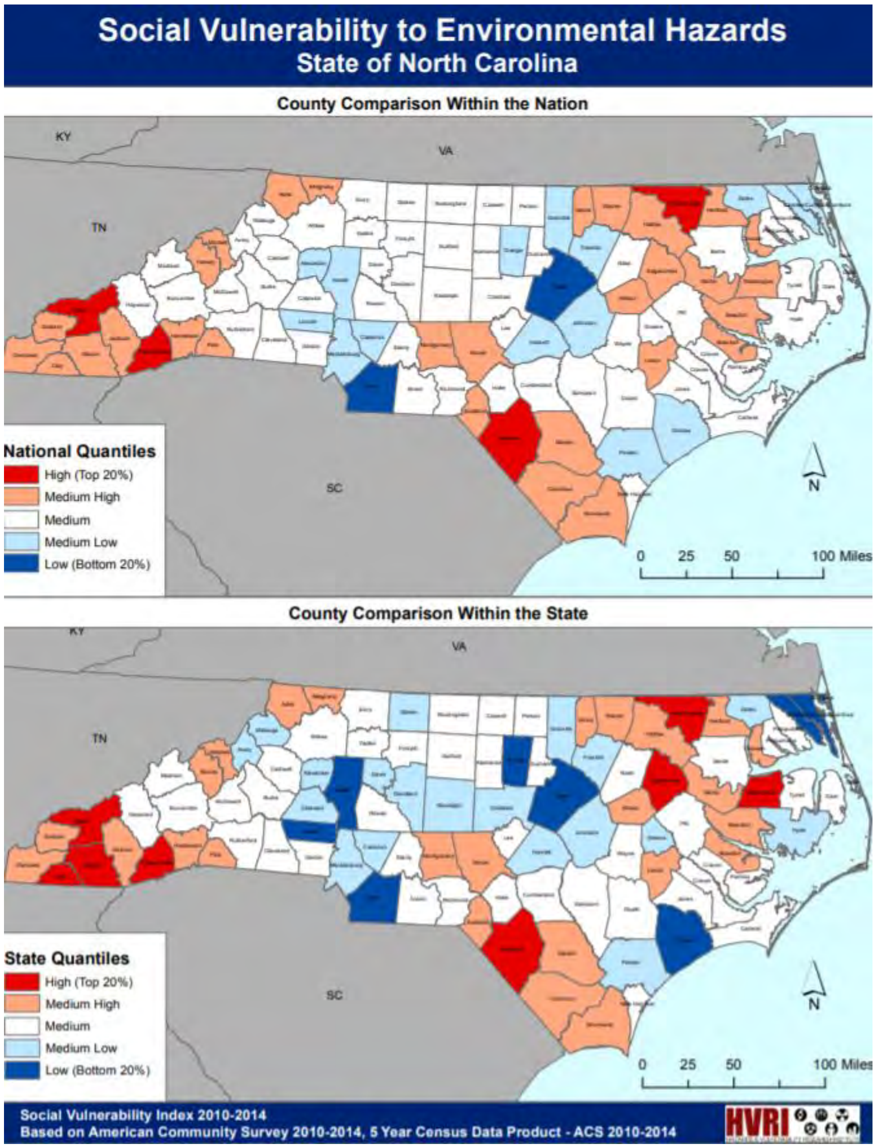
[1]Persons of Hispanic Origin may be of any race, so are also included in applicable race category in Wake County figures.

[2]Source: NC State University Student Enrollment Profile, Spring 2019

F.2.7 Social Vulnerability

The Hazards and Vulnerability Research Institute at the University of South Carolina has created the Social Vulnerability Index (SoVI), to measure comparative social vulnerability to environmental hazards in the U.S. at a county level. SoVI combines 29 socioeconomic variables to determine vulnerability. The seven most significant components for explaining vulnerability are race and class, wealth, elderly residents, Hispanic ethnicity, special needs individuals, Native American ethnicity, and service industry employment. The index also factors in family structure, language barriers, vehicle availability, medical disabilities, and healthcare access, among other variables. **Figure F.7** displays the SoVI index by county with comparisons within the Nation and within the State. In both comparisons, Wake County ranks among the bottom 20% for social vulnerability

Figure F.7 – SoVI Index for North Carolina



F.2.8 Growth and Development Trends

Based on 2010 Census data, Raleigh is the second largest city in North Carolina with an estimated population of 474,069 residents in 2019. The City of Raleigh does not have any public population projections available, but Raleigh's growth rate is one of the highest in the state. Although population projections for the City were unavailable, the North Carolina Office of State Budget and Management (OSBM) have population projections for Wake County. OSBM estimates the population for Wake County as of July 2020 to be 1,109,883 and that the population will be around 1,328,336 in July 2030, which is 19.7% growth.

The estimated population for Raleigh in 2019 was 474,069, which is a 5.5% increase over the 2015 estimated population, and a 16.8% increase from the 2010 Census population. **Table F.7** shows estimated population growth based on the 2010 Census population for the City of Raleigh.

Table F.7 – City of Raleigh Population Growth (2010 – 2019)

Year	Population	Growth	Percent Growth
2010	404,068	--	--
2015	449,546	45,478	11.3
2019	474,069	24,523	5.5

Source: U.S. Census Bureau

F.3 ASSET INVENTORY

An inventory of assets was compiled to identify the total count and value of property exposure on the NCSU campus. This asset inventory serves as the basis for evaluating exposure and vulnerability by hazard. Assets identified for analysis include buildings, critical facilities, and critical infrastructure.

F.3.1 Building Exposure

Table F.8 provides total building exposure for the campus, which was estimated by summarizing building footprints provided by the University of North Carolina System Division of Information Technology and the North Carolina Emergency Management (NCEM) iRisk database and property values provided by the North Carolina Department of Insurance and NCEM iRisk database. All occupancy types were summarized into the following four categories: administration, critical facilities, educational/extracurricular, and housing. Note: estimated content values were not available.

Table F.8 – NCSU Building Exposure by Occupancy

Occupancy	Estimated Building Count	Structure Value
Administration	47	$110,147,099
Critical Facilities	17	$142,507,174
Educational/Extracurricular	316	$2,263,960,825
Housing	82	$342,971,479
Total	**462**	**$2,859,586,577**

Source: UNC Division of Information Technology; NCEM iRisk; NC Department of Insurance

F.3.2 Critical Buildings and Infrastructure Exposure

Of significant concern with respect to any disaster event is the location of critical facilities and infrastructure in the planning area. Critical facilities are those essential services and lifelines that, if damaged during an emergency event, would disrupt campus continuity of operations or result in severe consequences to public health, safety, and welfare.

Critical buildings are a subset of the total building exposure and were identified by NCSU's HMPC representatives. After reviewing the following criteria designed to evaluate all critical buildings in the UNC System Hazard Mitigation Plan, the NCSU HMPC updated the list of critical facilities from the previous PDM plan. Factors considered for this ranking included:

- the building's use for emergency response,
- the building's use for essential campus operations
- the building's use as an emergency shelter or for essential sheltering services,
- the presence of a generator or generator hook-ups,
- the building's use for provision of energy, chilled water or HVAC for sensitive or essential systems,

- the storage of hazardous materials,
- the building's use for sensitive research functions,
- the building's cultural or historical significance, and
- building-specific hazard vulnerabilities

The identified critical facilities for NCSU, as shown in **Figure A.4** through **Figure A.6**, include the following:

Centennial Campus

- Centennial Campus Central Utility Plant
- Centennial Substation
- CMDF - Partners Building I

North/Central/South Campus

- Administrative Services III
- Bragaw Switchyard
- Cates Central Utility Plant
- NMDF - Poe Hall
- Public Safety Building
- SMDF - Main Distribution
- Sullivan Drive Switchstation
- West Chiller Plant
- Yarborough Drive Steam Plant

West Campus

- Centennial Biomedical Campus
- Centennial Biomedical Campus Substation
- WMDF - CVM Research Building

Figure F.8 – NCSU Map of Critical Facilities – Centennial Campus

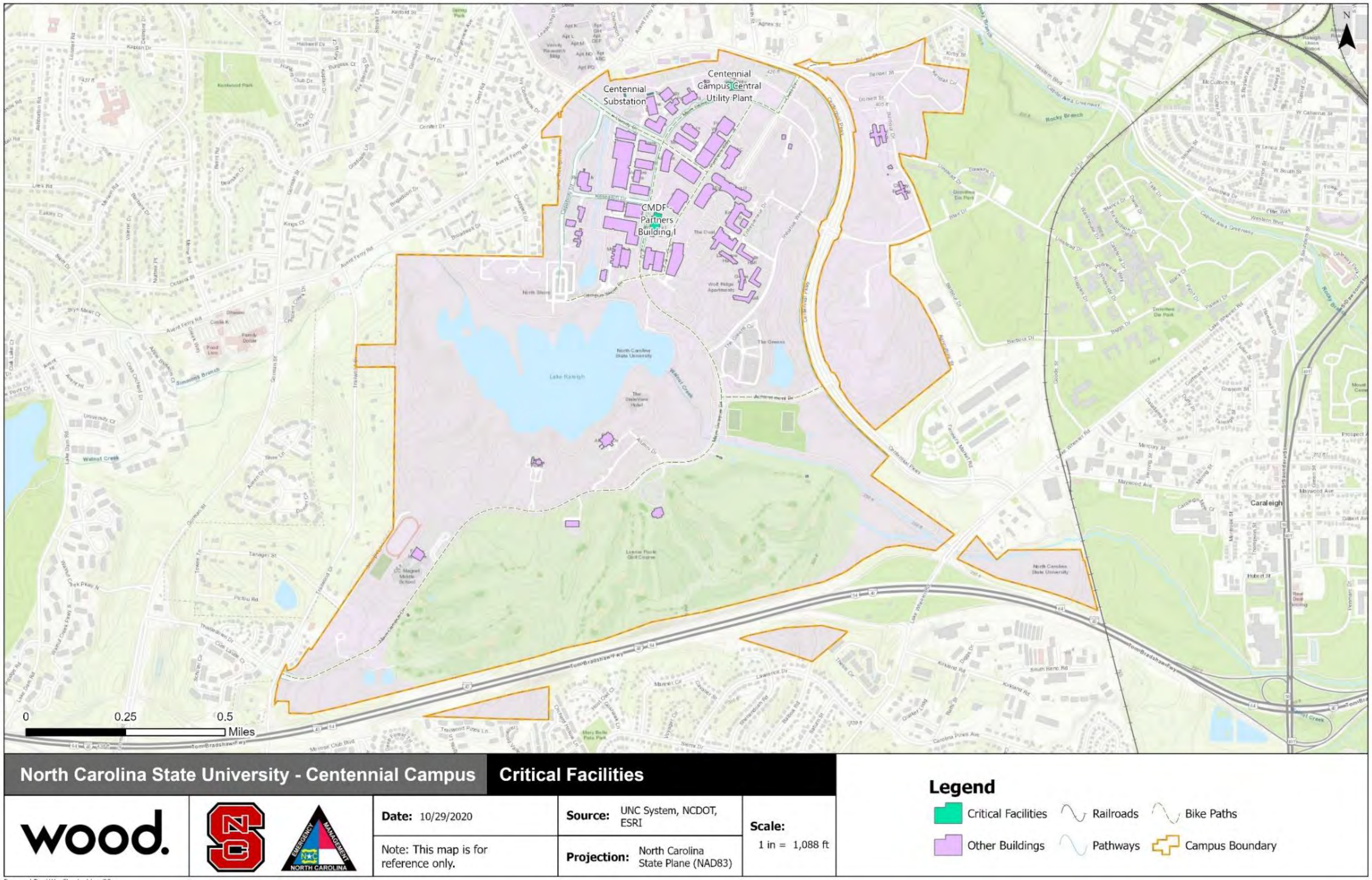


Figure F.9 – NCSU Map of Critical Facilities – North, Central, and South Campus

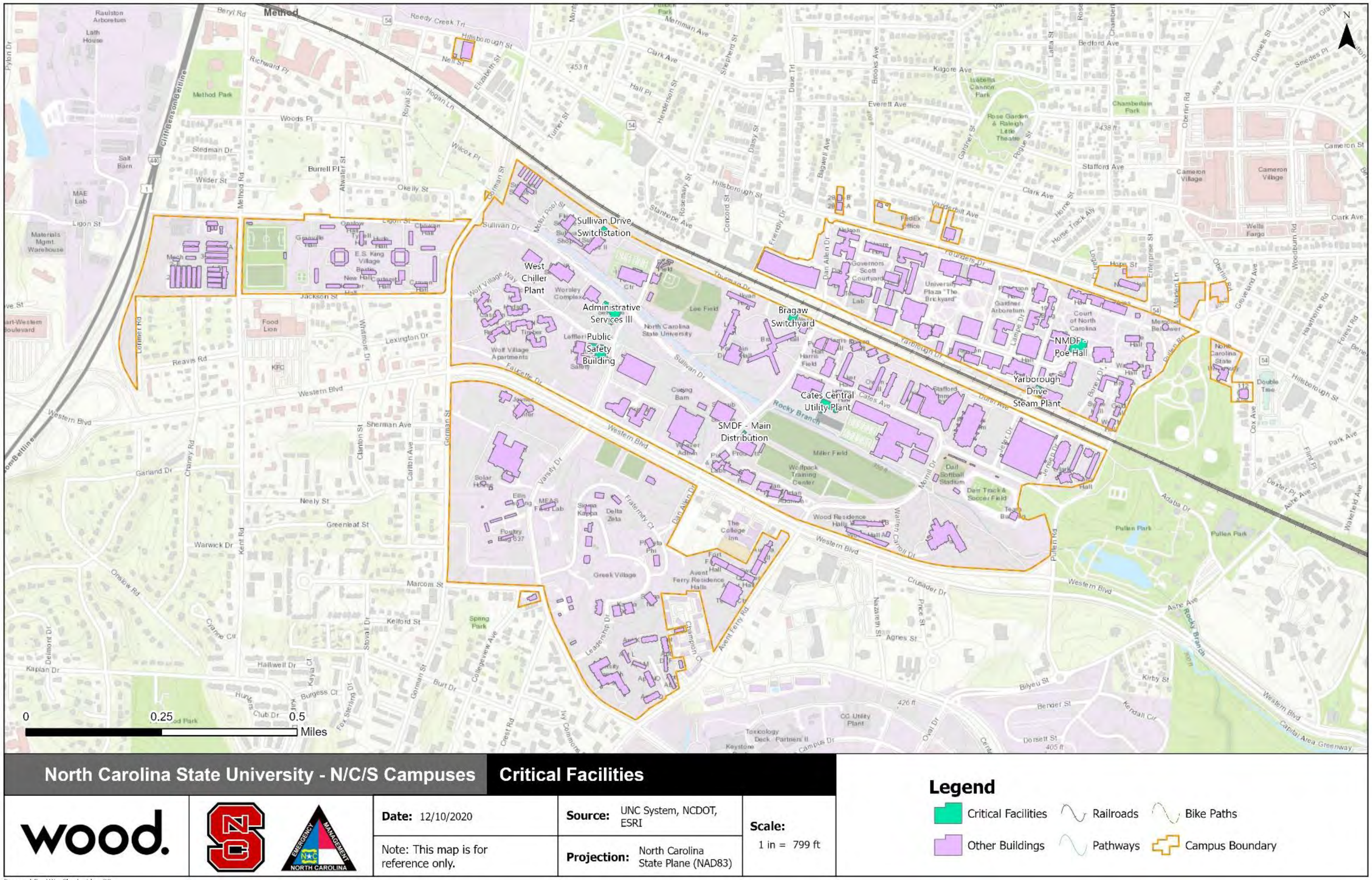
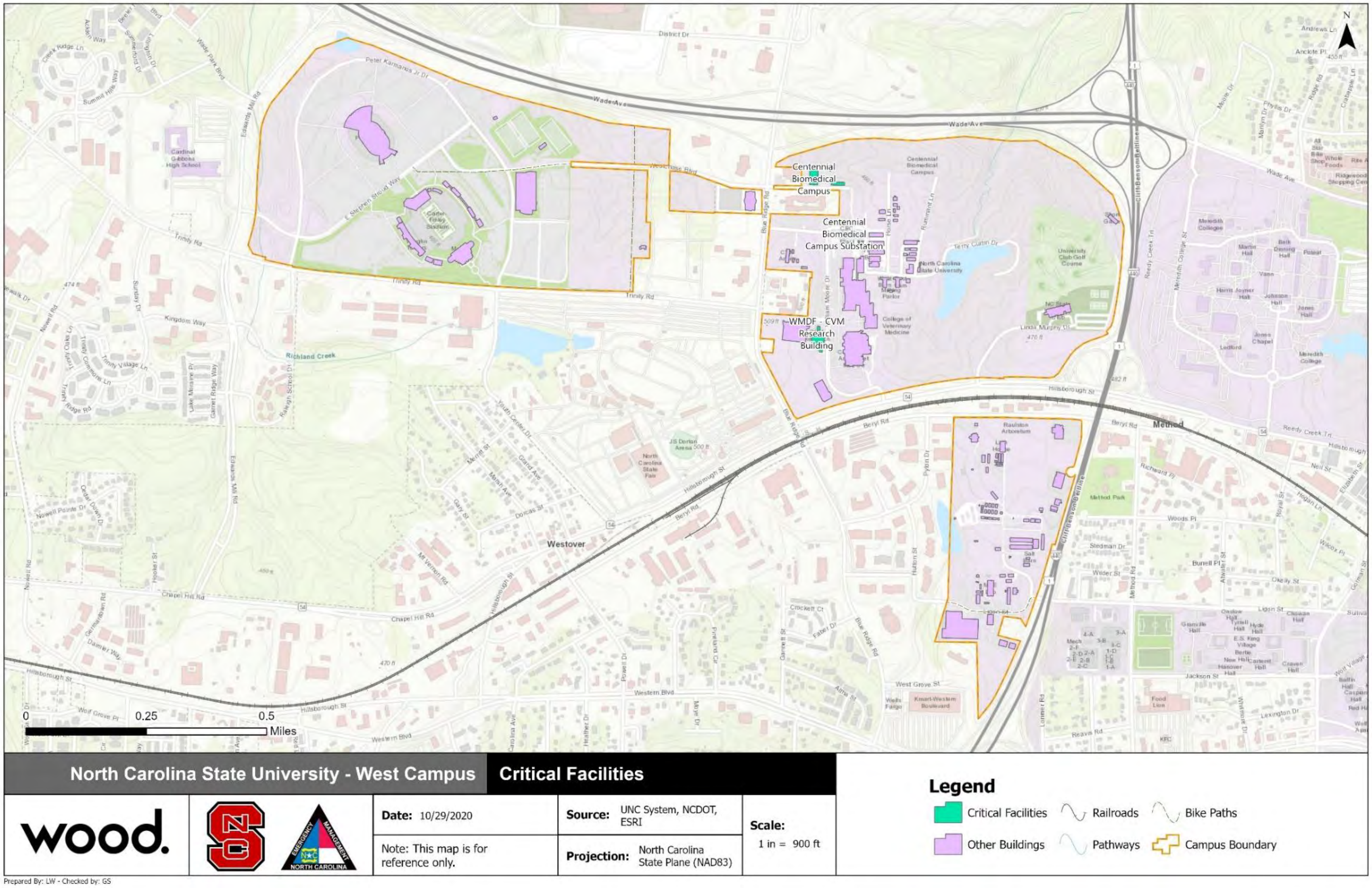


Figure F.10 – NCSU Map of Critical Facilities – West Campus



F.4 HAZARD IDENTIFICATION & RISK ASSESSMENT

F.4.1 Hazard Identification

To identify a full range of hazards relevant to the UNC Eastern Campuses, HMPC representatives from each campus began with a review of the list of hazards identified in the 2018 North Carolina State Hazard Mitigation Plan and the 2010 NCSU Pre-Disaster Mitigation Plan, as summarized in **Table F.9**. This ensured consistency with the state and regional hazard mitigation plans and across each campus' planning efforts.

Table F.9 – Hazards Included in Previous Planning Efforts

Hazard	Included in 2018 State HMP?	Included in 2010 NCSU Pre-Disaster Mitigation Plan?
Flooding	Yes	Yes
Hurricanes and Coastal Hazards	Yes	Yes, as High Wind, Hurricane
Severe Winter Weather	Yes	Yes, as Ice storm and Snow
Extreme Heat	Yes	No
Earthquakes	Yes	Yes
Wildfire	Yes	Yes
Dam Failures	Yes	No
Drought	Yes	No
Tornadoes/Thunderstorms	Yes	Yes
Geological (Landslides, Sinkholes, Coastal Erosion)	Yes	Yes, as Landslide
Hazardous Materials Incidents	Yes	No
Infectious Disease	Yes	No
Radiological Emergency	Yes	No
Terrorism/Mass Casualty	Yes	No
Cyber Threat	Yes	No

NCSU's HMPC representatives evaluated the above list of hazards by considering existing hazard data, past disaster declarations, local knowledge, and information from the 2018 State Plan and the 2010 NCSU Pre-Disaster Mitigation Plan in order to determine whether each hazard was significant enough to assess in this updated Hazard Mitigation Plan. Significance was measured in general terms and focused on key criteria such as frequency, severity, and resulting damage, including deaths and injuries, as well as property and economic damage.

One key resource in this effort was the National Oceanic and Atmospheric Administration's (NOAA) National Center for Environmental Information (NCEI), which has been tracking various types of weather events 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), which compiles their information from a variety of sources, including but 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. While NCEI is not a comprehensive list of past hazard events, it can provide an indication of relevant hazards to the planning area and offers some statistics on injuries, deaths, damages, as well as narrative descriptions of past impacts.

Data for Wake County was used to approximate past events that may have affected the NCSU campus. The NCEI database contains 869 records of storm events that occurred in Wake County in the 20-year period from 2000 through 2019. **Table F.10** summarizes these events.

Table F.10 – NCEI Severe Weather Data for Wake County, 2000 – 2019

Type	# of Events	Property Damage	Crop Damage	Deaths	Injuries
Flash Flood	132	$69,381,500	$0	0	0
Flood	5	$5,000,000	$20,000,000	0	0
Funnel Cloud	2	$0	$0	0	0
Hail	221	$110,000,000	$0	0	0
Heat	1	$0	$0	0	1
Heavy Rain	3	$0	$0	0	0
Heavy Snow	1	$0	$0	0	0
High Wind	3	$135,000	$0	0	0
Hurricane (Typhoon)	1	$890,000	$0	0	0
Lightning	32	$2,382,000	$0	3	1
Strong Wind	14	$978,000	$5,000	1	0
Thunderstorm Wind	387	$3,283,750	$4,000	2	13
Tornado	12	$116,563,000	$25,000	4	68
Tropical Storm	5	$1,221,500	$0	0	1
Wildfire	1	$1,000,000	$0	0	0
Winter Storm	27	$1,000,000	$0	0	0
Winter Weather	22	$40,000	$0	0	0
Grand Total	**869**	**$311,874,750**	**$20,034,000**	**10**	**84**

Source: National Center for Environmental Information Events Database, retrieved October 2020
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 1954. Since then, Wake County has been designated in 19 major disaster declarations, as detailed in **Table F.11**, and 10 emergency declarations, as detailed in **Table F.12**.

Table F.11 – FEMA Major Disaster Declarations, Wake County

Disaster #	Dec. Date	Incident Type	Event Title	Individual Assistance Applications Approved	Total Individual and Households Program Dollars Approved	Total Public Assistance Grant Dollars Obligated
DR-28-NC	17-Oct-54	Hurricane	HURRICANE	N/A	N/A	N/A
DR-37-NC	13-Aug-55	Hurricane	HURRICANES	N/A	N/A	N/A
DR-56-NC	24-Apr-56	Severe Storm(s)	SEVERE STORM	N/A	N/A	N/A
DR-87-NC	01-Oct-58	Hurricane	HURRICANE & SEVERE STORM	N/A	N/A	N/A
DR-107-NC	16-Sep-60	Hurricane	HURRICANE DONNA	N/A	N/A	N/A
DR-130-NC	16-Mar-62	Flood	SEVERE STORM, HIGH TIDES & FLOODING	N/A	N/A	N/A

Disaster #	Dec. Date	Incident Type	Event Title	Individual Assistance Applications Approved	Total Individual and Households Program Dollars Approved	Total Public Assistance Grant Dollars Obligated
DR-179-NC	13-Oct-64	Flood	SEVERE STORMS & FLOODING	N/A	N/A	N/A
DR-234-NC	10-Feb-68	Severe Ice Storm	SEVERE ICE STORM	N/A	N/A	N/A
DR-818-NC	02-Dec-88	Tornado	SEVERE STORMS & TORNADOES	N/A	N/A	N/A
DR-1087-NC	13-Jan-96	Snow	BLIZZARD OF 96	N/A	N/A	N/A
DR-1134-NC	06-Sep-96	Hurricane	HURRICANE FRAN	N/A	N/A	N/A
DR-1211-NC	22-Mar-98	Severe Storm(s)	SEVERE STORMS TORNADOES, AND FLOODING	N/A	N/A	N/A
DR-1292-NC	16-Sep-99	Hurricane	HURRICANE FLOYD MAJOR DISASTER DECLARATIONS	N/A	N/A	$298,105,794
DR-1312-NC	31-Jan-00	Severe Storm(s)	SEVERE WINTER STORM	N/A	N/A	$27,368,108
DR-1448-NC	12-Dec-02	Severe Ice Storm	SEVERE ICE STORM	N/A	N/A	$86,565,180
DR-1490-NC	18-Sep-03	Hurricane	HURRICANE ISABEL	7790	$21,289,504	$18,285,917
DR-1969-NC	20-Apr-11	Severe Storm(s)	SEVERE STORMS, TORNADOES, AND FLOODING	1778	$5,391,278	N/A
DR-4285-NC	10-Oct-16	Hurricane	HURRICANE MATTHEW	28971	$98,842,213	$291,092,954
DR-4487-NC	25-Mar-20	Biological	COVID-19 PANDEMIC	N/A	N/A	$174,898,697

Source: FEMA Disaster Declarations Summary, October 2020

Note: Number of applications approved and all dollar values represent totals for all counties included in disaster declaration.

Table F.12 – FEMA Emergency Declarations, Wake County

Disaster #	Dec. Date	Incident Type	Event Title/Description
EM-3033-NC	02-Mar-77	Snow	DROUGHT & FREEZING
EM-3049-NC	11-Aug-77	Drought	DROUGHT
EM-3110-NC	17-Mar-93	Snow	SEVERE SNOWFALL & WINTER STORM
EM-3146-NC	15-Sep-99	Hurricane	HURRICANE FLOYD EMERGENCY DECLARATIONS
EM-3222-NC	05-Sep-05	Hurricane	HURRICANE KATRINA EVACUATION
EM-3380-NC	07-Oct-16	Hurricane	HURRICANE MATTHEW
EM-3401-NC	11-Sep-18	Hurricane	HURRICANE FLORENCE
EM-3423-NC	04-Sep-19	Hurricane	HURRICANE DORIAN
EM-3471-NC	13-Mar-20	Biological	COVID-19
EM-3534-NC	02-Aug-20	Hurricane	HURRICANE ISAIAS

Source: FEMA Disaster Declarations Summary, October 2020

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. **Table F.13** summaries the determination made for each hazard.

Table F.13 – Hazard Evaluation Results

Hazard	Included in this plan update?	Explanation for Decision
Natural Hazards		
Hurricane	Yes	The 2010 NCSU PDM plan found Hurricane to be a moderate threat hazard. The County has had 10 disaster declarations related to hurricanes wind.
Coastal Hazards	No	The 2010 NCSU PDM plan did not address this hazard.
Tornadoes / Thunderstorms (Wind, Lightning, Hail)	Yes	The 2010 NCSU PDM plan found tornadoes to be a low threat hazard. The County has had no disaster declarations related to tornadoes. The HMPC expressed interest in addressing this hazard in combination with thunderstorms (wind, lightning, hail).
Flood	Yes	The 2010 NCSU PDM plan rated flood a significant threat hazard for the planning area. The County has had 2 disaster declarations related to flooding.
Severe Winter Weather	Yes	The 2010 NCSU PDM plan found ice/snow to be a low threat hazard. The HMPC expressed interest in addressing this hazard as severe winter weather to include cold/wind chill; extreme cold; freezing fog; frost/freeze; heavy snow; ice storm; winter storm; and winter weather.
Drought	No	The 2010 NCSU PDM plan did not address this hazard.
Wildfire	Yes	The 2010 NCSU PDM plan did not assign a threat and/or risk level for this hazard; however, the HMPC expressed interest in addressing this hazard.
Earthquake*	Yes	The 2010 NCSU PDM plan did not assign a threat and/or risk level for this hazard; however, the HMPC expressed interest in addressing this hazard.
Geological Hazards (Sinkhole & Landslide)	No	The 2010 NCSU PDM plan did not assign a threat and/or risk level for this hazard; and the HMPC did not express an interest in addressing this hazard.
Dam Failure	No	The 2010 NCSU PDM plan did not address this hazard.
Extreme Heat	No	The 2010 NCSU PDM plan did not address this hazard.
Technological and Human-Caused Hazards & Threats		
Hazardous Materials Incidents	Yes	The 2010 NCSU PDM plan did not address this hazard; however, there are fixed facility sites and transportation routes with hazardous materials in the planning area and the HMPC expressed interest in addressing this hazard.
Infectious Disease	Yes	The 2010 NCSU PDM plan did not address this hazard; however, due to the COVID-19 pandemic that occurred during this planning process, the HMPC determined infectious disease should be addressed.
Cyber Attack	Yes	The 2010 NCSU PDM plan did not address this hazard; however, the HMPC expressed interest in re-evaluating cyber-attacks in this plan update.
Terrorism	Yes	The 2010 NCSU PDM plan did not address this hazard; however, the HMPC expressed interest in re-evaluating terrorism in this plan update.

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

F.5 HAZARD PROFILES, ANALYSIS, AND VULNERABILITY

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 where it may occur, the severity of potential events, records of past events, the probability of future occurrences, and potential impacts from the hazard. A vulnerability assessment was conducted for each hazard using quantitative and/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.

To account for regional differences in hazard risk across each of the campuses, this risk assessment is divided into two parts:

1) a set of summary hazard profiles describing each hazard and summarizing the risk findings for each campus, presented in Section 3.5; and
2) a campus-specific risk assessment profiling the location, extent, historical occurrences, probability of future occurrence, and vulnerability of each campus, presented in each campus annex.

In the campus-level hazard profiles presented here, each hazard is profiled in the following format:

Location

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

Extent

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

Historical 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. Where possible, this plan uses a consistent 20-year period of record except for hazards with significantly longer average recurrence intervals or where data limitations otherwise restrict the period of record.

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)

Vulnerability Assessment

This section quantifies, to the extent feasible using best available data, assets at risk to natural hazards and potential loss estimates. Details on hazard specific methodologies and assumptions are provided where applicable. People, properties and critical facilities, and environmental assets that are vulnerable to the hazard are identified.

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

- Geographic Information System (GIS) datasets, including County parcel data from 2020, campus building inventory fand values from the University System's Division of Information Technology, NCEM iRisk Database, and property values provided by the NC Department of Insurance, topography, transportation layers, and critical facility and infrastructure locations;
- Hazard layer GIS datasets from state and federal agencies;
- Written descriptions of inventory and risks provided by the 2018 State of North Carolina Hazard Mitigation Plan;
- Written descriptions of inventory and risks provided by the 2019 Wake County Multi-Jurisdictional Hazard Mitigation Plan; and
- Exposure and vulnerability estimates derived using local parcel data.

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. For applicable hazards, the quantitative analysis involved the use of FEMA's Hazus-MH, a nationally applicable standardized set of models for estimating potential losses from earthquakes, floods, and hurricanes. Hazus uses a statistical approach and mathematical modeling of risk to predict a hazard's frequency of occurrence and estimated impacts based on recorded or historic damage information. The Hazus risk assessment methodology is parametric, in that distinct hazard and inventory parameters—such as wind speed and building type—were modeled using the Hazus software to determine the impact on the built environment. The GIS-based risk assessment was completed using data collected from local, regional and national sources that included Wake County, NCEM, and FEMA.

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. Other information can be collected in regard to the hazard area, such as the location of critical facilities and infrastructure, historic resources, 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.

The data collected for the hazard profiles and vulnerability assessment was obtained from multiple sources covering a variety of spatial areas including county-, jurisdictional-, and campus-level information. The table below presents the source data and the associated geographic coverages.

Table F.14 – Summary of Hazard Data Sources and Geographic Coverage

Hazard	Hazard Data Sources	Profile Geographic Area	Vulnerability Methodology	Vulnerability Geographic Area
Earthquake	USGS, NCEI	County	Hazus 4.2	Census Tract
Flood	NCEI, FEMA	Jurisdiction	GIS Spatial Analysis	Campus
Hurricane	NHC	County	Hazus 4.2	Census Tract
Severe Winter Weather	NWS, NCEI	County	Statistical Analysis	County

Hazard	Hazard Data Sources	Profile Geographic Area	Vulnerability Methodology	Vulnerability Geographic Area
Tornado / Thunderstorm	NWS, NCEI	Jurisdiction	Statistical Analysis	Jurisdiction
Wildfire	NCFS, SouthWRAP	County, Campus	GIS Spatial Analysis	Campus
Cyber Attack	Internet Research	County, Higher Education	Qualitative Analysis	Higher Education
Hazardous Materials Incidents	EPA; USDOT	Jurisdiction	GIS Spatial Analysis	Campus
Infections Disease	CDC; WHO	National, Higher Education	Qualitative Analysis	Higher Education
Terrorism	Southern Poverty Law Center	National, Higher Education	Qualitative Analysis	Higher Education

CDC = Centers for Disease Control and Prevention; EPA = United States Environmental Protection Agency; FEMA = Federal Emergency Management Agency; NCEI = National Centers for Environmental Information; NCFS = North Carolina Forest Service; NHC = National Hurricane Center; NWS = National Weather Service; SouthWRAP = Southern Group of State Foresters, Wildfire Risk Assessment Portal; USDOT = United States Department of Transportation; USGS = United States Geological Survey; WHO = World Health Organization

Changes in Development

This section describes how changes in development have impacted vulnerability since the last plan was adopted. 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.

Problem Statements

This section summarizes key mitigation planning concerns related to this hazard.

Priority Risk Index

The conclusions drawn from the hazard profiling and vulnerability assessment process are used to prioritize all potential hazards to the NCSU 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 F.15.**

PRI ratings are provided by category throughout each hazard profile for the planning area as a whole. Ratings specific to each jurisdiction are provided at the end of each hazard profile. The results of the risk assessment and overall PRI scoring are provided in Section 0 Conclusions on Hazard Risk.

The sum of all five risk assessment categories equals the final PRI value, demonstrated in the equation below (the lowest possible PRI value is a 1.0 and 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 campus 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.

Table F.15 – 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**	

F.5.1 Earthquake

Hazard	Probability	Impact	Spatial Extent	Warning Time	Duration	PRI Score
Earthquake	Unlikely	Minor	Large	Less than 6 hours	Less than 6 hours	1.9

Location

The United States Geological Survey (USGS) Quaternary faults database was consulted to determine the sources of potential earthquakes within range of Wake County. Quaternary faults are active faults recognized at the surface which have evidence of movement in the past 2.58 million years. No active faults were noted in Wake County.

Earthquakes are generally felt over a wide area, with impacts occurring hundreds of miles from the epicenter. Therefore, any earthquake that impacts Wake County is likely to be felt across most if not all of the planning area.

Spatial Extent: 4 – Large

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 F.16**. 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 F.17** 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 F.16 – 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 F.17 – 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.

MMI	Richter Scale	Felt Intensity
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.
VIII	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 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.

Impact: 1 – Minor

Historical Occurrences

The USGS Earthquake Hazards Program maintains a database of historical earthquakes of a magnitude 2.5 and greater from 1900 to 2020. Earthquake events that occurred within 100 miles of the NCSU campus are presented in **Table F.18** and **Figure F.11**.

Table F.18 – Historical Earthquakes within 100 Miles of NCSU, 1900-2020

Year	Magnitude	MMI	Location
1978	2.7	II	Virginia-North Carolina border region
1981	2.8	II	North Carolina
1993	2.7	II	Virginia-North Carolina border region
2006	2.6	II	7km S of Winston-Salem, North Carolina
2006	2.5	II	Virginia-North Carolina border region
2015	2.58	II	10km S of Denton, North Carolina
2019	2.5	II	8km E of Archdale, North Carolina

Source: USGS

Figure F.11 – Historical Earthquakes within 100 Miles of NCSU, 1900-2020

Source: USGS

The National Center for Environmental Information (NCEI) maintains a database of the felt intensity of earthquakes from 1638 to 1985 including the maximum intensity for each locality that felt the earthquake. According to this database, in the 100-year period from 1885-1985, there have been 13 earthquakes felt in and around Raleigh with MMI ranging from II in January 1812 to VIII in September 1886.

Probability of Future Occurrence

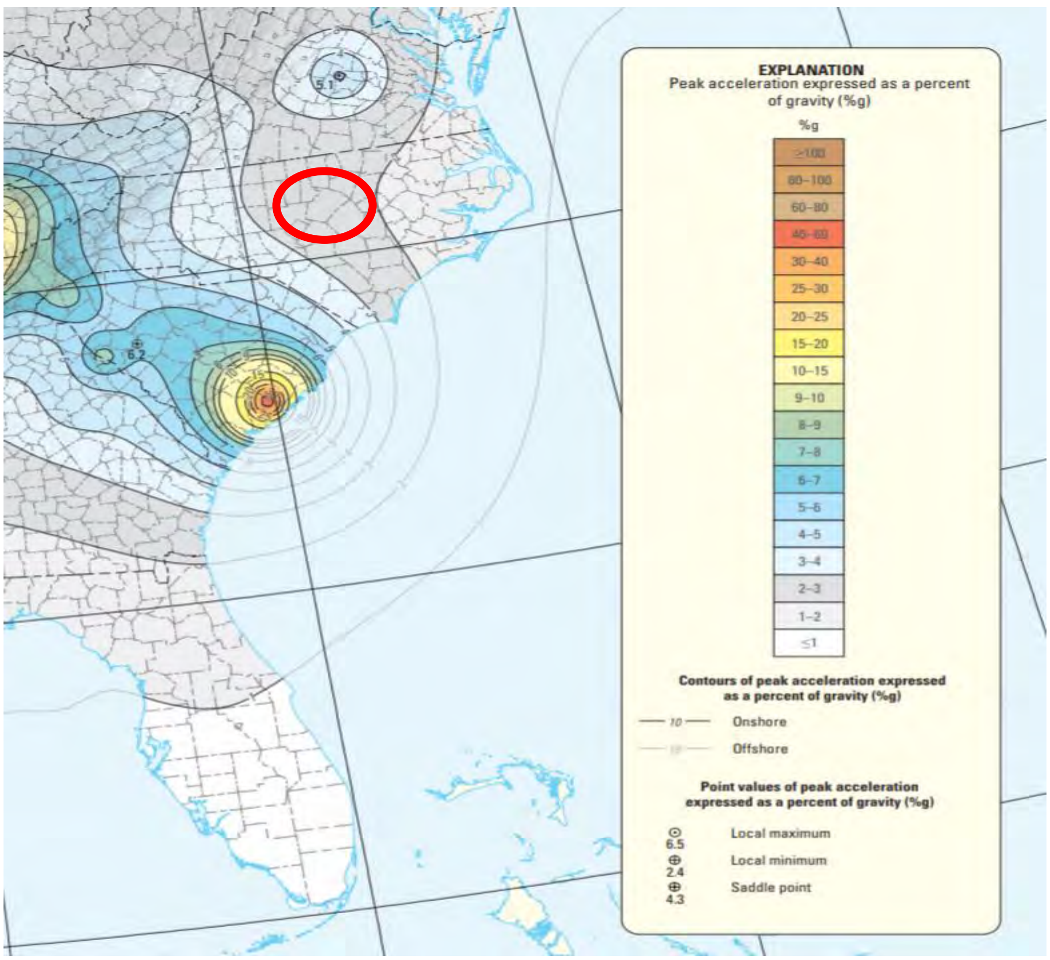
Ground motion is the movement of the earth's surface due to earthquakes or explosions. It is produced by waves generated by a sudden slip on a fault or sudden pressure at the explosive source and travels through the earth and along its surface. Ground motion is amplified when surface waves of unconsolidated 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 that have a common given probability of being exceeded in 50 years.

Figure F.12 on the following page 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 occurrence 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. All of Wake County is located within a zone with peak acceleration of 2-3% g, which indicates low earthquake risk.

In simplified terms, based on the record of past occurrences over a 120-year period from 1900 to 2020 there were no earthquakes that have or could have caused building damage in Raleigh, defined for this purpose as an MMI of VI or greater. All noted earthquakes were located outside Wake County and defined as MMI of II (Felt by persons at rest, on upper floors, or favorably placed). Based on this data, it can be reasonably assumed that an earthquake event affecting Wake County is unlikely.

Probability: 1 – Unlikely

Figure F.12 – Seismic Hazard Information for Cumberland County



Source: USGS Earthquake Hazards Program

Vulnerability Assessment

Methodology & Assumptions

To quantify vulnerability, Wood performed a Level 1 earthquake analysis in Hazus 4.2 utilizing general building stock information based on the 2010 Census. The NCSU campus is located across six census tracts which encompass 11.71 square miles. The earthquake scenario was modeled after an arbitrary earthquake event of magnitude 5.0 with an epicenter in the NCSU campus and depth of 10km.

People

Hazus estimates that the modeled magnitude 5.0 event would result in 363 households requiring temporary shelter. Additionally, Hazus estimates potential injuries and fatalities depending on the time of day of an event. Casualty estimates are shown in **Figure F.13.** Casualties are broken down into the following four levels that describe the extent of injuries:

- Level 1: Injuries will require medical attention, but hospitalization is not needed.
- Level 2: Injuries will require hospitalization but are not considered life-threatening.
- Level 3: Injuries will require hospitalization and can become life threatening if not promptly treated.
- Level 4: Victims are killed by the earthquake.

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. Impacts of earthquakes also include debris clean-up and service disruption. Per the Hazus analysis, a 5.0 magnitude earthquake could produce an estimated 0.10 million tons of debris.

Wake County has not been impacted by an earthquake with more than a low intensity, so major damage to the built environment is unlikely. However, there is potential for impacts to certain masonry buildings, as well as environmental damages with secondary impacts on structures.

Table F.19 details the estimated buildings impacted by a magnitude 5.0 earthquake event, as modeled by Hazus. Note that building value estimates are inherent to Hazus and do not necessarily reflect damages to the asset inventory for the NCSU Campus.

Table F.19 – Estimated Buildings Impacted by 5.0 Magnitude Earthquake Event

Occupancy Type	Estimated Building Damage	Estimated Content Loss	Estimated Total Damage
Residential	$29,990,000	$0	$29,990,000
Commercial	$10,490,000	$0	$10,490,000
Industrial	$1,670,000	$0	$1,670,000
Other	$5,020,000	$0	$5,020,000
Total	**$47,170,000**	**$0**	**$47,170,000**

Source: Hazus

Figure F.13 – Casualty Estimate from a 5.0 Magnitude Earthquake Event

		Level 1	Level 2	Level 3	Level 4
2 AM	Commercial	1	0	0	0
	Commuting	0	0	0	0
	Educational	0	0	0	0
	Hotels	0	0	0	0
	Industrial	1	0	0	0
	Other-Residential	75	17	2	5
	Single Family	12	2	0	0
	Total	**88**	**19**	**3**	**5**
2 PM	Commercial	50	11	1	3
	Commuting	0	0	0	0
	Educational	64	15	2	4
	Hotels	0	0	0	0
	Industrial	6	1	0	0
	Other-Residential	15	4	1	1
	Single Family	2	0	0	0
	Total	**136**	**31**	**4**	**8**
5 PM	Commercial	36	8	1	2
	Commuting	1	2	3	1
	Educational	31	7	1	2
	Hotels	0	0	0	0
	Industrial	4	1	0	0
	Other-Residential	29	7	1	2
	Single Family	5	1	0	0
	Total	**106**	**25**	**6**	**7**

Source: Hazus 4.2

All critical facilities should be considered at risk to minor damage should an earthquake event occur. However, of the essential facilities included in Hazus—which include 13 hospitals, 88 schools, 2 fire stations, 4 police station, and 1 emergency operation facilities— 3 schools were estimated to sustain moderate damages, and all were estimated to maintain at least 50 percent functionality after day one following an event. Additionally, Hazus projected four bridges would sustain moderate damage.

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.

Changes in Development

Building codes substantially reduce the costs of damage to future structures from earthquakes. Future construction on the NCSU campus must follow the applicable requirements of the NC building codes, the State of North Carolina statutes for state owned buildings and zoning for the local jurisdiction.

Development changes at NCSU have not affected the risk characteristics of earthquakes. The probability, impact, spatial extent, warning time, and duration of earthquakes have not changed.

Problem Statement

- While earthquakes are an unlikely hazard event for the NCSU campus, the Hazus model did predict impacts to buildings, 3 schools, and 4 bridges within the six census tracts.

F.5.2 Flood

Hazard	Probability	Impact	Spatial Extent	Warning Time	Duration	PRI Score
Flood	Highly Likely	Limited	Small	6 to 12 hrs	Less than 1 week	2.8

Location

Regulated floodplains are illustrated on inundation maps called Flood Insurance Rate Maps (FIRMs). A FIRM 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 1-percent-annual-chance flood event. Structures located within the SFHA have a 26-percent chance of flooding during the life of a standard 30-year mortgage.

For this risk assessment, flood prone areas were identified within the NCSU Campus using the FIRM dated May 2, 2006. **Figure F.14** through **Figure F.16** reflects the 2006 mapped flood insurance zones.

Table F.20 summarizes the flood insurance zones identified by the Digital FIRM (DFIRM).

Table F.20 – Mapped Flood Insurance Zones

Zone	Description
A	Zone A is the flood insurance rate zone that corresponds to the 1% annual chance floodplains that are determined in the FIS Report by approximate methods. Because detailed hydraulic analyses are not performed for such areas, no Base Flood Elevations or depths are shown within this zone.
AE	Zone AE is the flood insurance rate zone that corresponds to the 1% annual chance floodplains that are determined in the FIS Report by detailed methods. In most instances, whole-foot Base Flood Elevations derived from the detailed hydraulic analyses are shown at selected intervals within this zone.
AH	Zone AH is the flood insurance rate zone that corresponds to the areas of 1% annual chance shallow flooding (usually areas of ponding) where average depths are between 1 and 3 feet. Whole-foot Base Flood Elevations derived from the detailed hydraulic analyses are shown at selected intervals within this zone.
AO	Zone AO is the flood insurance rate zone that corresponds to the areas of 1% annual chance shallow flooding (usually sheet flow on sloping terrain) where average depths are between 1 and 3 feet. Average whole-foot depths derived from the detailed hydraulic analyses are shown within this zone.
VE	Zone VE is the flood insurance rate zone that corresponds to the 1% annual chance coastal floodplains that have additional hazards associated with storm waves. Whole-foot Base Flood Elevations derived from the detailed hydraulic analyses are shown at selected intervals within this zone.
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 0.2-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 10.2 percent of the NCSU Campus falls within the SFHA. **Table F.21** provides a summary of the NCSU Campus' total area by flood zone on the 2006 effective DFIRM.

Figure F.14 – FEMA Flood Hazard Areas in NCSU's Centennial Campus

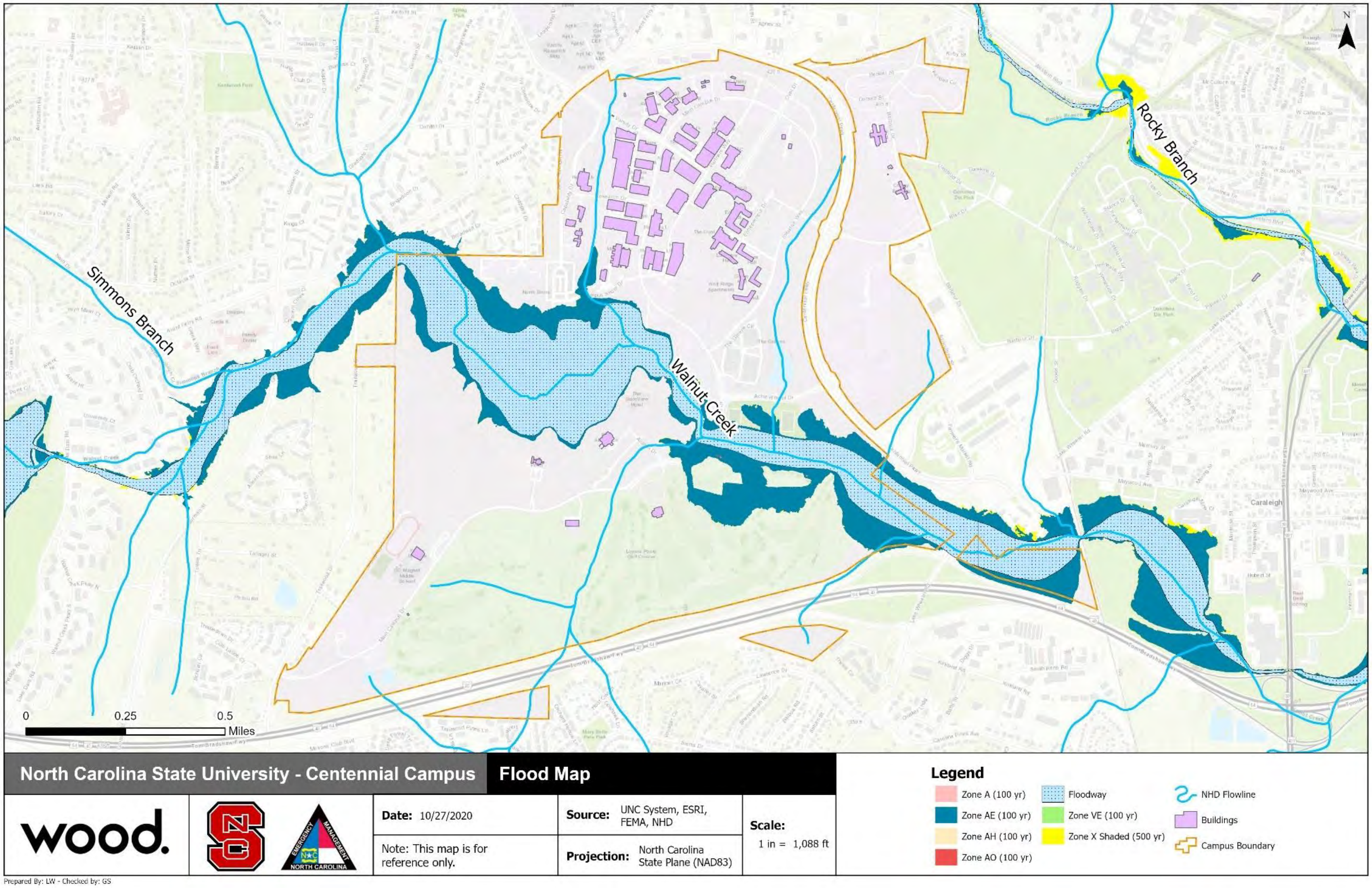


Figure F.15 – FEMA Flood Hazard Areas in NCSU's North, Central, and South Campuses

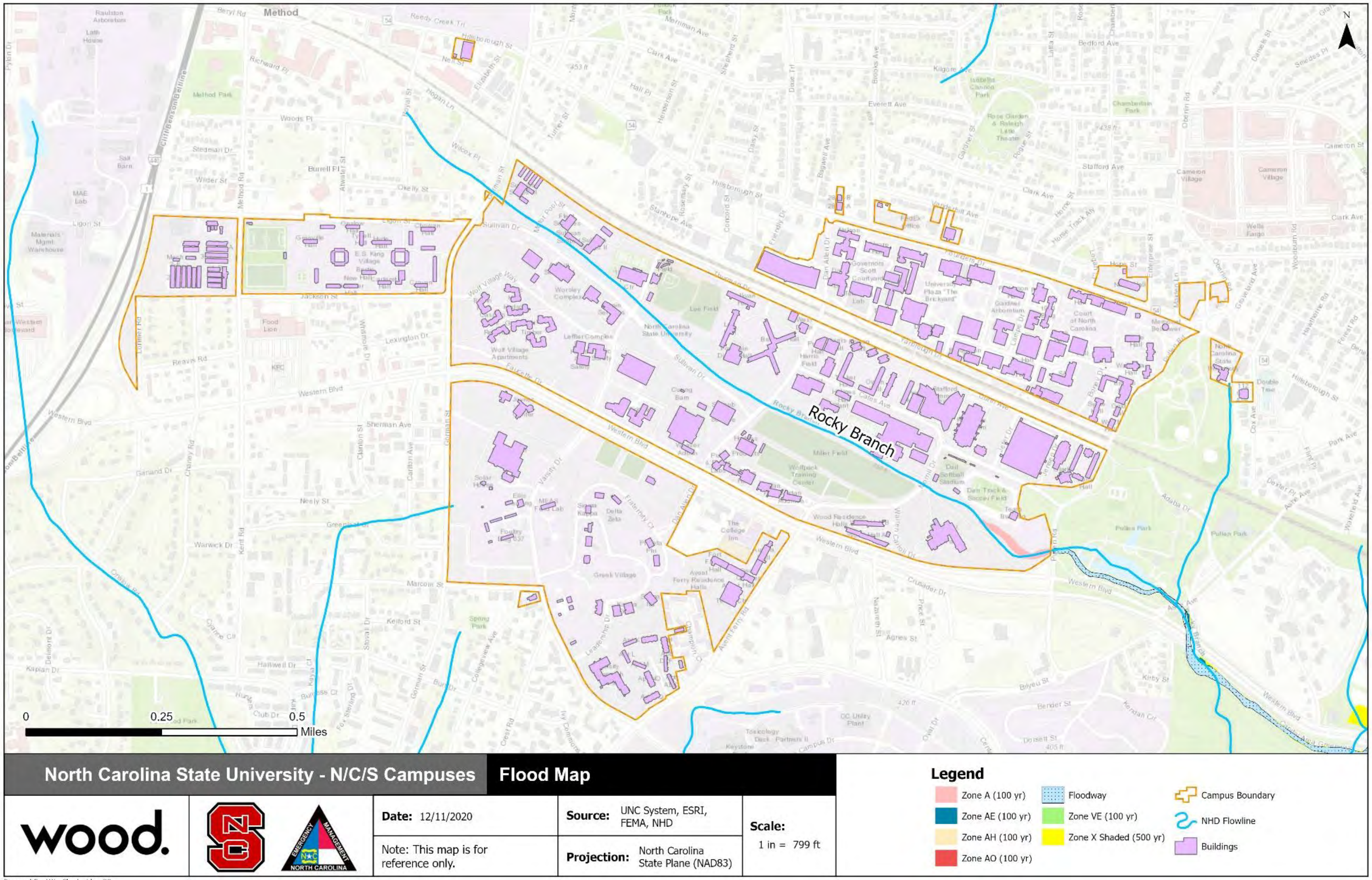


Figure F.16 – FEMA Flood Hazard Areas in NCSU's West Campus

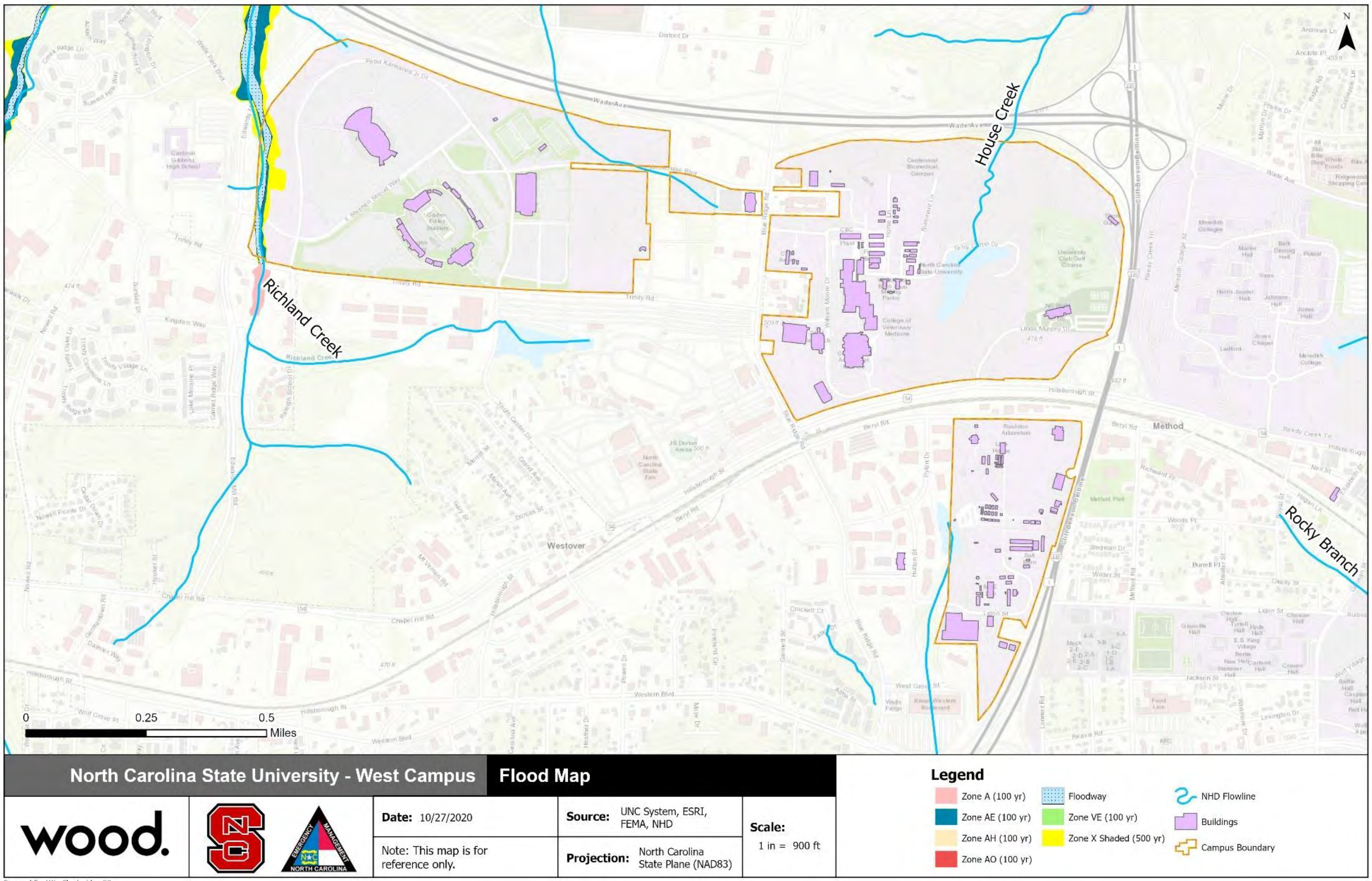


Table F.21 – Flood Zone Acreage on NCSU Campus

Flood Zone	Acreage	Percent of Total (%)
A	1	0.6%
AE	82	37.5%
AH	0	0.0%
AO	0	0.0%
Floodway	135	61.9%
VE	0	0.0%
0.2% Annual Chance Flood Hazard	3	1.4%
Unshaded X	1,921	882.7%
Total	2,141	**--**
SFHA Total	**218**	**10.2%**

Source: FEMA 2006 DFIRM

Spatial Extent: 2 – Small

Although no detailed studies were completed by FEMA for several smaller tributaries that run through campus, it should be noted that these waterways could be a source of flooding.

Additionally, although this assessment focuses on riverine flooding, it is also important to note that localized stormwater flooding can also occur on campus and may affect areas outside the mapped floodplain. Data was not available to evaluate the location or extent of stormwater flooding on campus.

Extent

Flood extent can be defined by the amount of land in the floodplain, detailed above, and the potential magnitude of flooding as measured by flood depth and velocity. **Figure F.17** through **Figure F.19** show the depth of flooding predicted from a 1% annual chance flood. Flood damage is closely related to depth, with greater flood depths generally resulting in more damages.

Impact: 2 – Limited

Figure F.17 – Flood Depth, 1-Percemt-Annual-Chance Flood, NCSU Centennial Campus

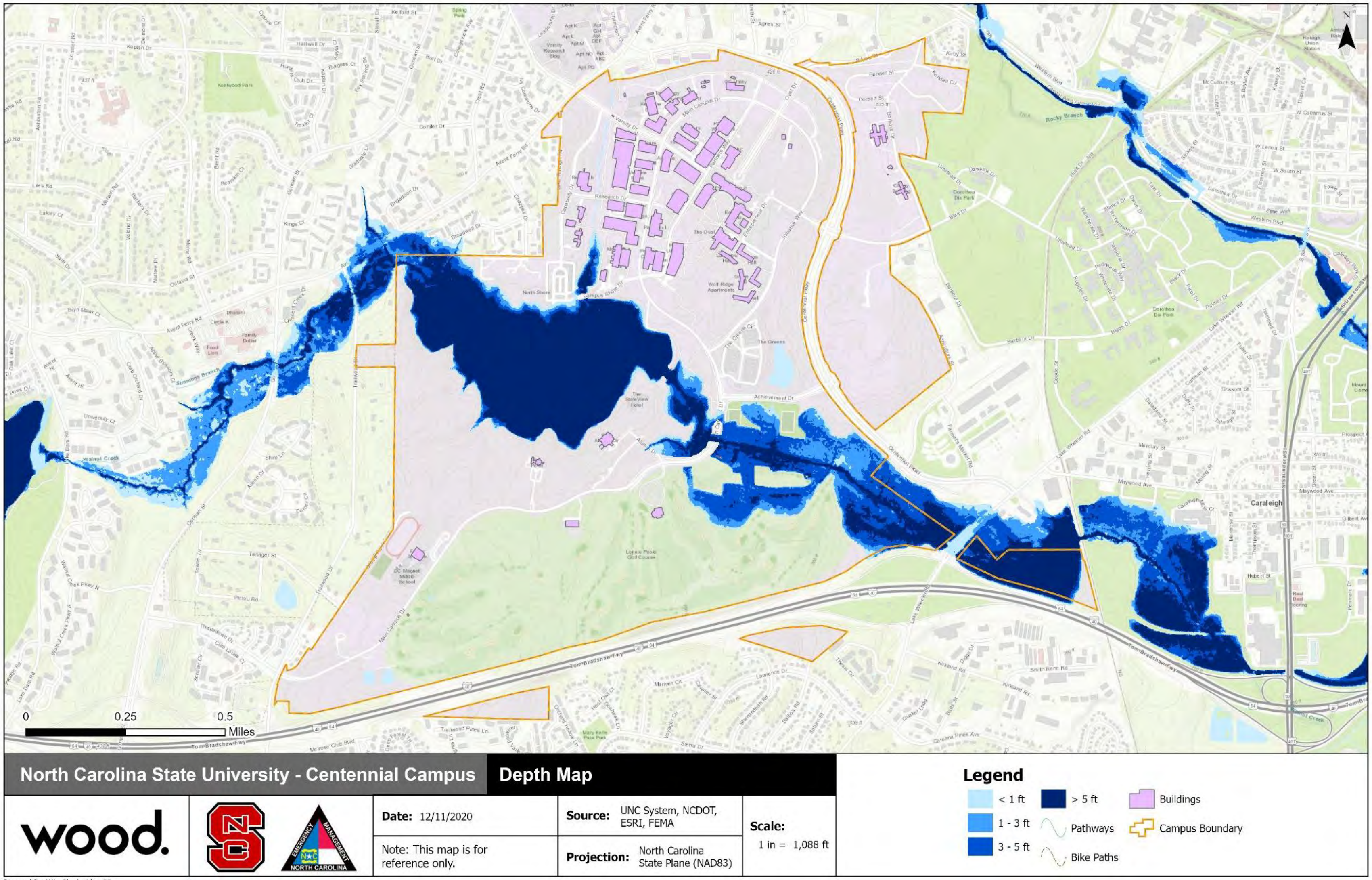


Figure F.18 – Flood Depth, 1-Percemt-Annual-Chance Flood, NCSU North, Central, and South Campuses

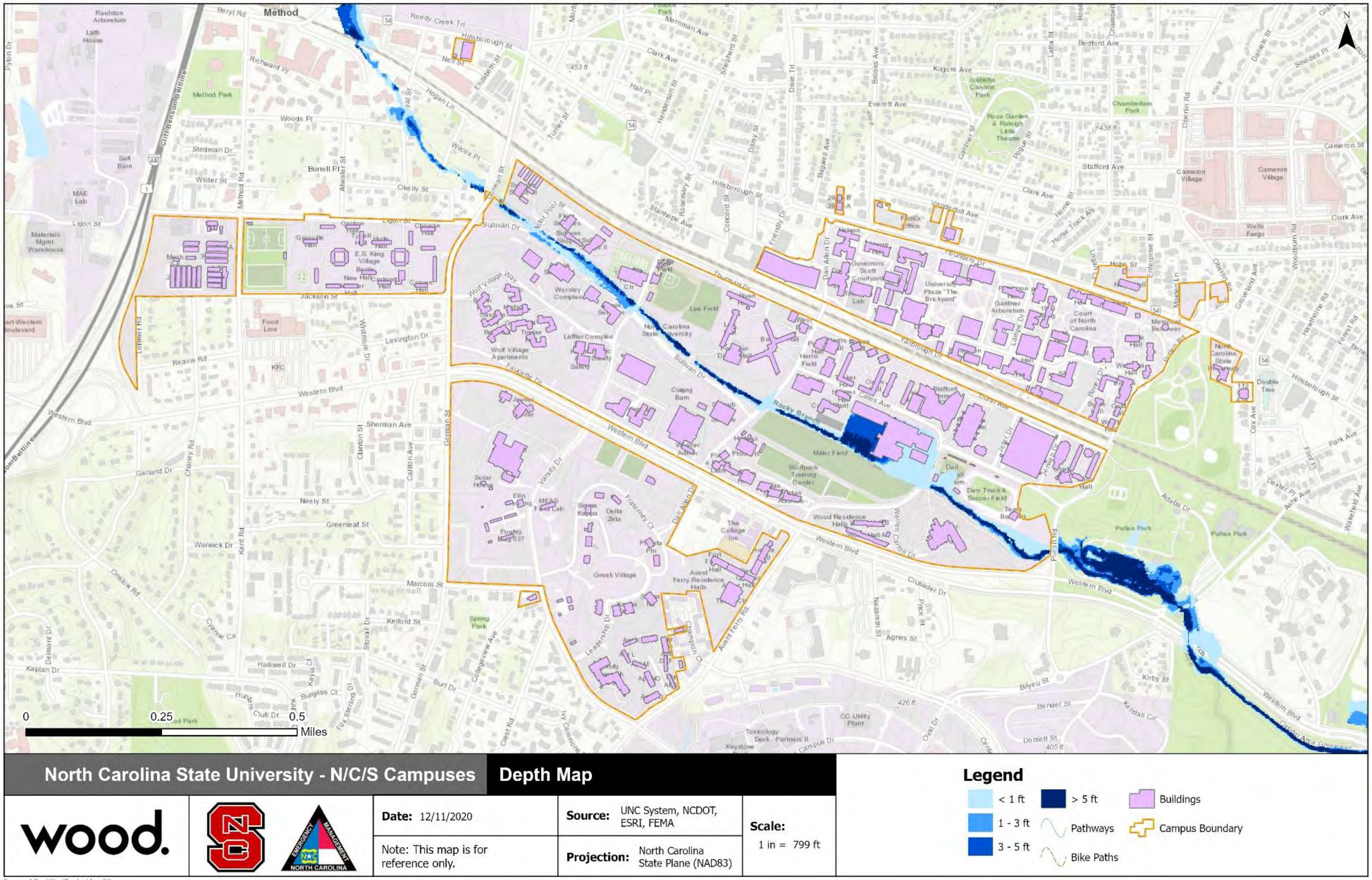
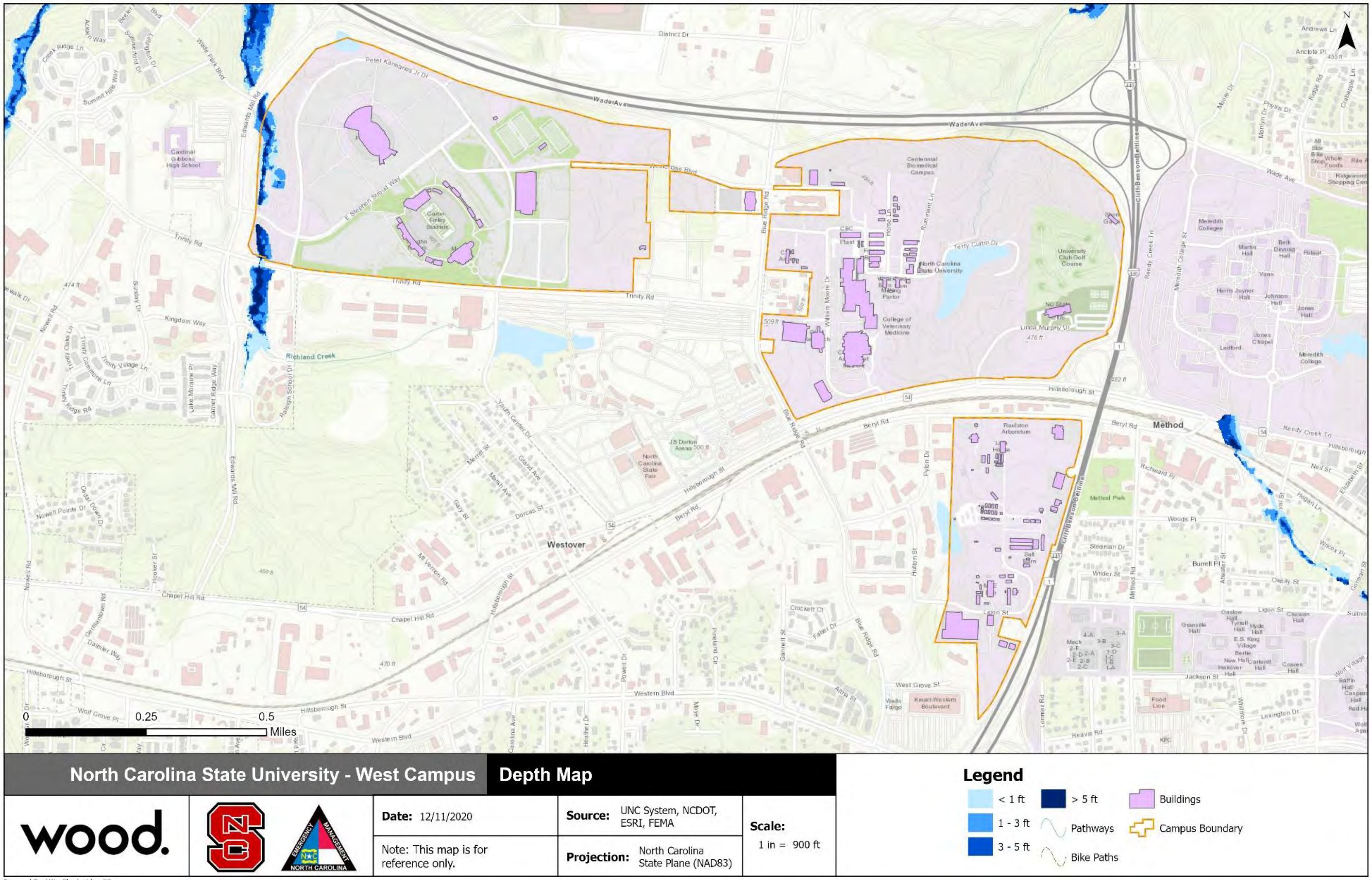


Figure F.19 – Flood Depth, 1-Percemt-Annual-Chance Flood, NCSU West Campus



Historical Occurrences

Table F.22 details the historical occurrences of flooding for Raleigh identified from 2000 through 2019 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 F.22 – NCEI Records of Flooding for the City of Raleigh, 2000-2019

Location	Date	Deaths/Injuries	Reported Property Damage	Reported Crop Damage
Flash Flood				
RALEIGH	7/29/2000	0/0	$0	$0
RALEIGH	8/1/2000	0/0	$0	$0
RALEIGH	8/4/2000	0/0	$0	$0
RALEIGH	9/3/2000	0/0	$0	$0
RALEIGH	9/4/2000	0/0	$0	$0
RALEIGH	9/25/2000	0/0	$0	$0
SOUTH PORTION	7/4/2001	0/0	$0	$0
SOUTH PORTION	7/9/2001	0/0	$0	$0
RALEIGH	3/31/2002	0/0	$0	$0
RALEIGH	6/28/2002	0/0	$0	$0
RALEIGH	8/26/2002	0/0	$0	$0
RALEIGH	10/11/2002	0/0	$0	$0
RALEIGH	6/7/2003	0/0	$0	$0
RALEIGH	7/29/2003	0/0	$0	$0
EAST PORTION	8/1/2003	0/0	$0	$0
CENTRAL PORTION	8/8/2003	0/0	$0	$0
RALEIGH	8/13/2004	0/0	$0	$0
RALEIGH	8/30/2004	0/0	$0	$0
RALEIGH	6/7/2005	0/0	$0	$0
RALEIGH	6/23/2006	0/0	$0	$0
RALEIGH	6/16/2009	0/0	$0	$0
COLLEGE VIEW	12/2/2009	0/0	$0	$0
RALEIGH	1/25/2010	0/0	$0	$0
RALEIGH	9/30/2010	0/0	$0	$0
RALEIGH	8/6/2011	0/0	$0	$0
COLLEGE VIEW	9/21/2011	0/0	$5,000	$0
COLLEGE VIEW	9/8/2012	0/0	$0	$0
RALEIGH	8/12/2014	0/0	$2,500,000	$0
COLLEGE VIEW	6/18/2015	0/0	$0	$0
(RDU)RALEIGH-DURHAM	4/25/2017	0/0	$10,000	$0
(RDU)RALEIGH-DURHAM	6/16/2017	0/0	$0	$0
RALEIGH	7/6/2018	0/0	$0	$0
COLLEGE VIEW	8/19/2018	0/0	$0	$0
RALEIGH	8/20/2018	0/0	$80,000	$0
Flood				
RALEIGH	7/17/2016	0/0	$0	$0
Heavy Rain				

Location	Date	Deaths/Injuries	Reported Property Damage	Reported Crop Damage
RALEIGH	11/22/2006	0/0	$0	$0
	Total	**0/0**	**$2,595,000**	**$0**

Source: NCEI

According to NCEI, 36 recorded flood-related events affected the City of Raleigh from 2000 to 2019 causing an estimated $2,595,000 in property damage, with no injuries, fatalities, or crop damage.

The following event narratives are provided in the NCEI Storm Events Database and illustrate the impacts of flood events on the county:

- **06/16/2009** - Numerous roads closed due to flash flooding in and around Raleigh. Rescuers evacuated 15 to 20 occupants at the Southgate Community Center and surrounding apartments due to high flood waters from Walnut Creek.
- **9/30/2010** - Sullivan Drive on the campus of North Carolina State University was closed due to flash flooding.
- **8/6/2011** - Numerous flooding was reported with flood waters infiltrating several businesses and residences. Eight people were displaced from a house at 320 Hill Street. Another 45 to 50 people at the Milner Hotel were taken to shelter. The lower units of the Capital Inn were also evacuated due to flood waters. Monetary damages were unknown.
- **9/21/2011** - Multiple roads were blocked across Raleigh due to flooding, including Blue Ridge Road at Western Boulevard, Hillsboro Street near the Chapel Hill Road split and Avent Ferry Road at Trailwood Drive. Also, a vehicle stalled in approximately 3 feet of water on Old Wake Forest Road, with another stalled vehicle on Millbrook Road at Hoyle Drive. Monetary damage was estimated.
- **8/12/2014** - Multiple businesses had to be evacuated from the 1600-1800 block of Capital Boulevard. As many as 71 people had to be rescued and evacuated from businesses in this area. In addition, at the nearby intersection of Atlantic Avenue and Old Louisburg Road cars were reported flooded and stuck in the flood waters. Another car was reported stranded in the flood waters nearby at the intersection of Atlantic Avenue and Hodges Street. Monetary damages were estimated to be around 2-3 million dollars.
- **8/20/2018** - Water rescues were conducted as multiple vehicles were submerged in over 4 feet of water on Wake Forest Road near Georgetown Road.

The state of North Carolina has had two FEMA Major Disaster Declarations for severe storms that include elements of flooding in 1962 and 1964 along with four Major Disaster Declarations for Hurricanes in 1954, 1955, 1958, 1960 which may have included damages associated with flooding. Additionally, Wake County has received two Major Disaster Declaration for severe storms including elements of flooding in 1998 and 2011, along with four Major Disaster Declarations for Hurricanes in, 1996, 1999, 2003, 2016 which also may have included damages associated with flooding.

Probability of Future Occurrence

By definition, SFHAs are those areas that will be inundated by the flood event having a 1-percent chance of being equaled or exceeded in any given year. While exposure to flood hazards varies across jurisdictions, all jurisdictions have at least some area of land in FEMA-mapped flood hazard areas. This delineation is a useful way to identify the most at-risk areas, but flooding does not occur in set intervals; any given flood may be more or less severe than the defined 1-percent-annual-chance flood. There is also risk of localized and stormwater flooding in areas outside the SFHA and at different intervals than the 1% annual chance flood.

Floods of varying severity occur regularly in Raleigh and impacts from past flood events have been noted by NCEI. NCEI reports 36 flood-related events in the 20-year period from 2000-2019, in the 20-year period from 2000-2019, which equates to an annual probability greater than 100% for Raleigh. Therefore, the probability of flooding is considered highly likely.

Probability: 4 – Highly Likely

Vulnerability Assessment

Methodology & Assumptions

To quantify vulnerability, Wood performed a GIS spatial analysis of the flood hazard by overlaying the depth raster for the SFHA on the building footprints provided by the UNC Division of Information Technology and NCEM iRisk database. In all, there are 462 buildings on NCSU's campus; of these, 2 are located within the SFHA. These were the parcels analyzed as part of this analysis.

Flood damage is directly related to the depth of flooding by the application of a depth damage curve. In applying the curve, a specific depth of water translates to a specific percentage of damage to the structure, which translates to the same percentage of the structure's replacement value. **Figure F.17** through **Figure F.19** depict the depth of flooding that can be expected within the NCSU campus during the 1-percent-annual-chance flood event. **Table F.23** provides the depth damage factors that were used to calculate flood losses for the planning area. These depth damage factors are based on depth damage curve developed by the USACE Wilmington District for educational structures.

Table F.23 – Depth Damage Percentages

Depth (ft)	Educational Facility Percent Damage
-4	0
-3	0
-2	0
-1	0
0	0
1	5
2	7
3	9
4	9
5	10
6	11
7	13
8	15
9	17
10	20
11	24
12	28
13	33
14	39
15	45
16	52
17	59

Depth (ft)	Educational Facility Percent Damage
-4	0
-3	0
18	64
19	69
20	74
21	79
22	84
23	89
24	94

Source: USACE Wilmington District

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 systems lose 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 high risk when driving through flooded streets. However, NCEI does not contain any records of deaths caused by flood events in Raleigh.

An estimate of population at risk to flooding was developed based on the assessment of residential property at risk. The count of residential buildings at risk, 3,188, was multiplied by 2.43, which is the 2014-2018 American Community Survey (ACS) estimate of average household size for Raleigh. Overall, approximately 7,747 people live in buildings that could be damaged by the 1%-annual-chance flood.

Property

Administration buildings, education and/or extracurricular facilities, housing, as well as critical facilities and infrastructure such as transportation, water, energy, and communication systems may be damaged or destroyed by flood waters.

Table F.24 details the estimated losses for the 1%-annual-chance flood event for the campus. The total damage estimate value is based on damages to the total of building value. Land value is not included in any of the loss estimates as generally land is not subject to loss from floods.

Table F.24 – Estimated Building Damage and Content Loss for 1% Annual Chance Flood

Occupancy Type	Total Buildings with Loss	Total Value	Estimated Building Damage	Loss Ratio
Administration	0	$0	$0	0%
Critical Facilities	0	$0	$0	0%
Education / Extracurricular	2	$78,969,969	$9,150,204	12%
Housing	0	$0	$0	0%
Total	**2**	**$78,969,969**	**$9,150,204**	**12%**

Source: UNC Division of Information Technology; NCEM iRisk; NC Department of Insurance

The loss ratio is the loss estimate divided by the total potential exposure (i.e., total of improved and contents value for all buildings located within the Zone AE) and displayed as a percentage of loss. FEMA considers loss ratios greater than 10% to be significant and an indicator a community may have more difficulties recovering from a flood. The loss ratio for the education/extracurricular buildings is greater than 10%. This means that in the event of a flood with a magnitude of the 1%-annual-chance event or greater, the University would face severe difficulty in recovery.

None of the critical facilities identified for NCSU are located within the 1%-annual-chance floodplain, therefore there are no estimated damages.

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 planning area. According to 2020 NFIP records, there are no repetitive loss properties on the NCSU campus.

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.

Changes in Development

The likelihood of future flood damage can be reduced through appropriate land use planning, building siting and building design. In addition, the NCSU Facilities Services works to maintain compliance with all applicable state and federal regulations regarding water resources, provides a regulatory framework to ensure development has minimal impact on the environment, and manages the stormwater infrastructure.

Problem Statement

- Although there are no critical facilities within the SFHA, two buildings on the NCSU Central campus (Carmichael Gymnasium and Dail Softball Stadium Batting Cage) are impacted by the 1% annual chance floodplain. Along with these buildings, there is potential for many roadways to be impacted as well during these flood events.
- During a flash flood event in September 2010, Sullivan Drive on the campus of North Carolina State University was closed due to water over the roadway.
- Flooding may also occur on the campus when an intense rainfall occurs within the urban area and cannot be carried away by natural or urban drainage systems as fast as it is falling.

F.5.3 Hurricane

Hazard	Probability	Impact	Spatial Extent	Warning Time	Duration	PRI Score
Hurricane	Likely	Critical	Large	More than 24 hrs	Less than 24 hrs	2.9

Location

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

Storm surges, or storm floods, are limited to the coastal counties of North Carolina, therefore NCSU is not exposed to storm surge. However, hurricane winds can impact the entire campus, so the spatial extent was determined to be large.

Spatial Extent: 3 – Large

Extent

Hurricane intensity is classified by the Saffir-Simpson Scale (**Table F.25**), which rates hurricane intensity on a scale of 1 to 5, with 5 being the most intense.

Table F.25 – 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 F.26** 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 F.26 – 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

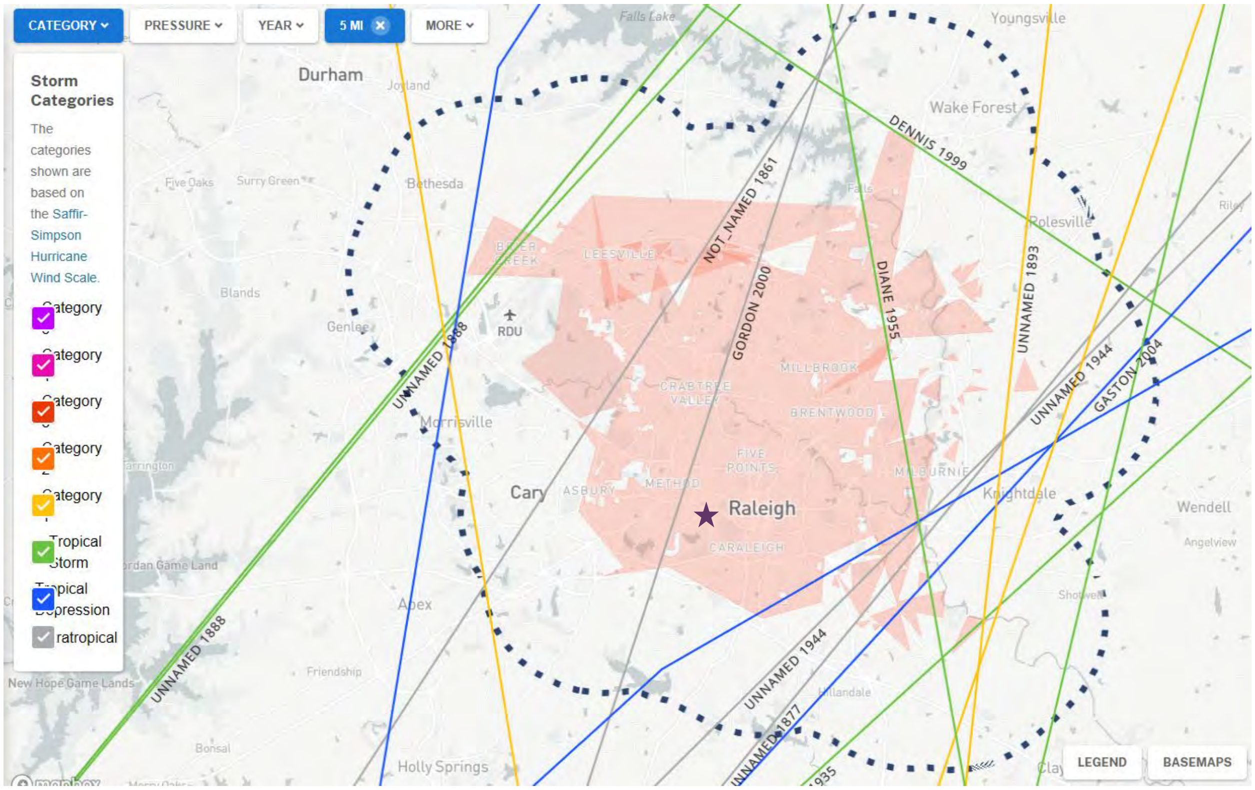
Tropical cyclones weaken relatively quickly after making landfall; therefore, Wake County will not typically experience major hurricane force winds, though these occurrences are possible. Hurricane Fran passed within 5 miles of NCSU's campus as a Category 1 storm with wind speeds around 75 mph in 1996, and Hurricane Gaston passed within 5 miles of the campus as a tropical depression with wind speeds around 29 mph in 2004.

Impact: 3 – Critical

Historical Occurrences

Storm tracks for hurricane-related events that have passed within 5 miles of NCSU's campus were obtained from NOAA 's database and are shown in **Figure F.20**. NCSU's location is noted in the figure by the purple star. The NCEI Storm Events database has recorded three hurricanes and tropical storms that passed through Wake County between 2000 and 2019. **Table F.27** details the historical occurrences.

Figure F.20 – Hurricane and Tropical Storm Tracks within 5 Miles of NCSU



Source: NOAA Office of Coastal Management; image captured directly from website. Black dashed line is 5 mile buffer zone.

Table F.27 – Recorded Hurricane and Tropical Storm Events for Wake County, 2000-2019

Date	Type	Storm	Deaths/ Injuries	Property Damage	Crop Damage
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
9/13/2018	Tropical Storm	Hurricane Florence	0/0	$1,000,000	$0
10/11/2018	Tropical Storm	Tropical Storm Michael	0/1	$200,000	$0
9/5/2019	Tropical Storm	Hurricane Dorian	0/0	$1,500	$0
		Total	**0/1**	**$2,111,500**	**$0**

Source: NCEI

According to NCEI, six recorded hurricane-related events affected Wake County from 2000 to 2019 causing an estimated $2,111,500 in property damage. There were no injuries, fatalities, or crop damage recorded for any of these events.

The following event narratives are provided in the NCEI Storm Events Database and illustrate the impacts of hurricane and tropical storm events on the county:

Hurricane Isabel (2003) – Hurricane Isabel made landfall along the Outer Banks just north of Cape Lookout around 1 pm on September 18, 2003. The eye of the storm tracked northeast passing over eastern Halifax County. Winds gusts to near Hurricane force were recorded over Halifax county. Many locations across the Coastal Plain and even back into the Triangle received wind gusts between 50 to 70 mph late in the afternoon until early evening. Many trees were uprooted falling on vehicles and homes all across the area. One person was killed in Franklin county when their vehicle struck a downed tree. Up to 6 inches of rain fell across Edgecombe, Halifax and Wilson counties resulting in flooding of several roads.

Hurricane Florence (2018) – A ridge of high pressure over eastern North America stalled Florence's forward motion a few miles off the southeast North Carolina coast on September 13th. Hurricane Florence made landfall near Wrightsville Beach early on Saturday, September 15, and weakened further as it moved slowly inland. Despite making landfall as a weakened Category 1 hurricane, Florence still produced 40 to 70 mph wind gusts, enough wind speed to uproot trees and cause widespread power outages throughout the Carolinas. As the storm moved inland, from September 15 to 17, heavy rain of 10 to 25 inches caused widespread inland flooding, inundating cities such as Fayetteville, Smithfield, Goldsboro, Raleigh, and Chapel Hill, and causing major river flooding on main-stem rivers such as the Neuse, Cape Fear, and Little River. Most major roads and highways in the area experienced some flooding, with large stretches of I-40 and I-95 remaining impassable for days after the storm had passed. The storm also spawned tornadoes in several places along its path. There were 3 direct and 6 indirect deaths attributed to the storm with in the WFO RAH CWA.

Tropical Storm Michael (2018) – Tropical storm wind gusts downed numerous trees, caused widespread power outages and produced a variety of damage to homes and structures across the county. At the peak of the storm, the total peak outages were around 20,000 customers. A worker was injured when a tree limb fell on a truck at the State Fairgrounds as Tropical Storm Michael moved through the state Thursday night. Tropical Storm Michael moved through North Carolina on Thursday, October 11th. Michael brought heavy rain and strong damaging winds to central North Carolina. While heavy rainfall of 3 to 6 inches produced minor flash flooding across the area, it was high wind gusts of 40 to 60 mph that caused the biggest problems, knocking down score of trees, leading to blocked roadways and thousands without power.

The state of North Carolina has had four FEMA Major Disaster Declarations for Hurricanes in 1954, 1955, 1958, 1960. Additionally, Wake County has received four Major Disaster Declarations for Hurricanes in 1996, 1999, 2003, 2016.

Probability of Future Occurrence

In the 20-year period from 2000 through 2019, six hurricanes and tropical storms have impacted Wake County, which equates to a 30 percent annual probability of hurricane winds impacting the county. This probability does not account for impacts from hurricane rains, which may also be severe. Overall, the probability of a hurricane or tropical storm impacting the County is likely.

Probability: 3 – Likely

Vulnerability Assessment

Methodologies and Assumptions

To quantify vulnerability, Wood performed a Level 1 hurricane wind analysis in Hazus 4.2 for three scenarios: a historical recreation of Hurricane Fran (1996) and simulated probabilistic wind losses for a 200-year and a 500-year event storm. The analysis utilized general building stock information based on the 2010 Census. The NCSU campus is located across six census tracts which encompass 11.71 square miles. The vulnerability assessment results are for wind-related damages. Hurricanes may also cause substantial damages from heavy rains and subsequent flooding, which is addressed in Section A.5.2. Flood.

People

The very young, the elderly and disabled individuals are more vulnerable to harm from hurricanes, as are those who are unable to evacuate for medical reasons, including 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 or ongoing treatment. For all affected populations, 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.

Table F.28 details the likelihood of building damages by occupancy type from varying magnitudes of hurricane events.

Table F.28 – Likelihood of Buildings Damages Impacted by Hurricane Wind Events

Occupancy	Buildings at Risk	Value at Risk	Likelihood of Damage (%)				
			None	Minor	Moderate	Severe	Destruction
Hurricane Fran (1996)							
Agriculture	19	$21,194,000	95.64%	3.60%	0.56%	0.20%	0.00%
Commercial	465	$443,077,000	95.27%	3.91%	0.80%	0.02%	0.00%
Education	62	$120,131,000	96.88%	2.97%	0.15%	0.00%	0.00%
Government	37	$42,986,000	96.70%	3.13%	0.17%	0.00%	0.00%
Industrial	92	$74,137,000	96.68%	3.10%	0.20%	0.02%	0.00%
Religion	50	$59,962,000	96.78%	3.04%	0.17%	0.01%	0.00%
Residential	4,300	$2,240,667,000	93.68%	5.54%	0.77%	0.00%	0.00%
200-year Hurricane Event							
Agriculture	19	$21,194,000	95.67%	3.58%	0.55%	0.20%	0.00%
Commercial	465	$443,077,000	95.21%	3.96%	0.81%	0.02%	0.00%
Education	62	$120,131,000	96.90%	2.95%	0.14%	0.00%	0.00%
Government	37	$42,986,000	96.70%	3.13%	0.17%	0.00%	0.00%
Industrial	92	$74,137,000	96.61%	3.16%	0.20%	0.02%	0.00%
Religion	50	$59,962,000	96.71%	3.10%	0.17%	0.02%	0.00%
Residential	4,287	$2,240,667,000	93.41%	5.79%	0.80%	0.01%	0.00%
500-year Hurricane Event							
Agriculture	17	$21,194,000	86.69%	9.85%	2.38%	1.00%	0.08%
Commercial	425	$443,077,000	87.19%	9.53%	3.12%	0.17%	0.00%
Education	58	$120,131,000	90.38%	8.18%	1.39%	0.05%	0.00%
Government	34	$42,986,000	90.45%	8.14%	1.36%	0.05%	0.00%
Industrial	86	$74,137,000	90.15%	8.23%	1.46%	0.15%	0.01%
Religion	47	$59,962,000	89.89%	8.86%	1.19%	0.07%	0.00%
Residential	3,830	$2,240,667,000	83.44%	13.70%	2.82%	0.03%	0.01%

Table F.29 details the estimated building and content damages by occupancy type for varying magnitudes of hurricane events.

Table F.29 – Estimated Buildings Impacted by Hurricane Wind Events

Area	Residential	Commercial	Industrial	Others	Total
Hurricane Fran (1996)					
Building	$9,706,920	$533,160	$49,910	$157,060	$10,447,050
Content	$2,504,220	$88,620	$9,850	$14,350	$2,617,040
Inventory	$0	$940	$1,620	$1,040	$3,600
Total	**$12,211,140**	**$622,720**	**$61,380**	**$172,450**	**$13,067,690**
200-year Hurricane Event					
Building	$9,977,000	$528,220	$50,570	$148,610	$10,704,400
Content	$2,581,060	$95,430	$13,510	$18,710	$2,708,710
Inventory	$0	$1,080	$1,990	$1,060	$4,130
Total	**$12,558,060**	**$624,730**	**$66,070**	**$168,380**	**$13,417,240**
500-year Hurricane Event					
Building	$21,488,330	$1,698,520	$185,020	$584,430	$23,956,300
Content	$5,162,540	$392,670	$67,190	$140,770	$5,763,170
Inventory	$0	$6,230	$10,650	$6,680	$23,560
Total	**$26,650,870**	**$2,097,420**	**$262,860**	**$731,880**	**$29,743,030**

The damage estimates for the 500-year hurricane wind event total $29,743,030. These damage estimates account for only wind impacts and actual damages would likely be higher due to flooding.

Environment

Hurricane winds can cause massive damage to the natural environment, uprooting trees and other debris within the storm's path. Animals can either be killed directly by the storm or impacted indirectly through changes in habitat and food availability caused by high winds and intense rainfall. Endangered species can be dramatically impacted. Forests can be completely defoliated by strong winds.

Changes in Development

Future development that occurs in the planning area should consider high wind hazards at the planning, engineering and architectural design stages. The University should consider evacuation planning in the event of a hurricane event.

Problem Statement

- Historical tracks of multiple hurricane events pass within 5-miles of the NCSU Campus.
- For the 20-year period from 2000 through 2019, there have been 3 hurricane wind events causing over $2 million in damage for Wake County.

F.5.4 Severe Winter Weather

Hazard	Probability	Impact	Spatial Extent	Warning Time	Duration	PRI Score
Severe Winter Weather	Highly Likely	Limited	Large	More than 24 hrs	Less than 1 week	3.0

Location

Severe winter weather is usually a countywide or regional hazard, impacting the entire county at the same time. 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, severe winter weather can occur anywhere in the county.

Spatial Extent: 4 – Large

Extent

The National Oceanic and Atmospheric Administration (NOAA) uses the Regional Snowfall Index (RSI), shown in **Table F.30** for the Wake County region, to assess the societal impact of winter storms in the six easternmost regions in the United States. The index makes use of population and regional differences to assess the impact of snowfall. For example, areas which receive very little snowfall on average may be more adversely affected than other regions, resulting in a higher severity. The County may experience any level on the RSI scale. Wake County receives an average of 4 inches of snowfall per year. According to NCEI, the greatest snowfall amounts to impact Wake County have been between 7-11 inches. During the snowstorm of December 24 to December 26, 2010, the county was classified as a Category 1 on the RSI scale. It is possible that more severe events and impacts could be felt in the future.

Table F.30 – Regional Snowfall Index (RSI) Values

Category	RSI Value	Description
1	1-3	Notable
2	3-6	Significant
3	6-10	Major
4	10-18	Crippling
5	18+	Extreme

Source: NOAA

Severe winter weather often involves 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 F.21**, provides a formula for calculating the dangers of winter winds and freezing temperatures. This presents wind chill temperatures which are based on the rate of heat loss from exposed skin caused by wind and cold. As the wind increases, it draws heat from the body, driving down skin temperature and eventually the internal body temperature.

Figure F.21 – NWS Wind Chill Temperature Index

Wind Chill Chart

Wind (mph) \ Temperature (°F) Calm	40	35	30	25	20	15	10	5	0	-5	-10	-15	-20	-25	-30	-35	-40	-45
5	36	31	25	19	13	7	1	-5	-11	-16	-22	-28	-34	-40	-46	-52	-57	-63
10	34	27	21	15	9	3	-4	-10	-16	-22	-28	-35	-41	-47	-53	-59	-66	-72
15	32	25	19	13	6	0	-7	-13	-19	-26	-32	-39	-45	-51	-58	-64	-71	-77
20	30	24	17	11	4	-2	-9	-15	-22	-29	-35	-42	-48	-55	-61	-68	-74	-81
25	29	23	16	9	3	-4	-11	-17	-24	-31	-37	-44	-51	-58	-64	-71	-78	-84
30	28	22	15	8	1	-5	-12	-19	-26	-33	-39	-46	-53	-60	-67	-73	-80	-87
35	28	21	14	7	0	-7	-14	-21	-27	-34	-41	-48	-55	-62	-69	-76	-82	-89
40	27	20	13	6	-1	-8	-15	-22	-29	-36	-43	-50	-57	-64	-71	-78	-84	-91
45	26	19	12	5	-2	-9	-16	-23	-30	-37	-44	-51	-58	-65	-72	-79	-86	-93
50	26	19	12	4	-3	-10	-17	-24	-31	-38	-45	-52	-60	-67	-74	-81	-88	-95
55	25	18	11	4	-3	-11	-18	-25	-32	-39	-46	-54	-61	-68	-75	-82	-89	-97
60	25	17	10	3	-4	-11	-19	-26	-33	-40	-48	-55	-62	-69	-76	-84	-91	-98

Frostbite Times: 30 minutes | 10 minutes | 5 minutes

$$\text{Wind Chill (°F)} = 35.74 + 0.6215T - 35.75(V^{0.16}) + 0.4275T(V^{0.16})$$

Where, T= Air Temperature (°F) V= Wind Speed (mph)

Effective 11/01/01

Source: https://www.weather.gov/safety/cold-wind-chill-chart

The most significant recorded snow depth over the last 20 years took place in January 2018, with recorded depths of up to 12 inches across the county.

Impact: 2 – Limited

Historical Occurrences

To get a full picture of the range of impacts of a severe winter weather, data for the following weather types as defined by the National Weather Service (NWS) 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.

According to the NCEI Storm Events Database, there was one heavy snow event, and 49 combined winter storm/winter weather events in Wake County during the 20-year period from 2000 through 2019. As reported in NCEI, severe winter weather caused $1,040,000 in property damage, but they did not cause any fatalities, injuries, or crop damage, though these types of impacts may not have been reported and are possible in future events. Events in Wake County by incident are recorded in **Table F.31**.

Table F.31 – Recorded Severe Winter Weather Events in Wake County, 2000-2019

Event Type	Event Count	Fatalities	Injuries	Property Damage	Crop Damage
Heavy Snow	1	0	0	$0	$0
Winter Storm	27	0	0	$1,000,000	$0
Winter Weather	22	0	0	$40,000	$0
Total	**50**	**0**	**0**	**$1,040,000**	**$0**

Source: NCEI

Storm impacts from NCEI are summarized below:

January 20, 2009 – Between 5 to 7 inches of snow fell across the county over a 12-hour period. Roads were quickly covered with snow resulting in several traffic accidents and the closing of local schools and businesses. Over 700 automobile accidents were reported in the county along with a few house fires.

January 29, 2010 – Between 4 to 6 inches of snow fell across the county. Hundreds of vehicle accidents and some power outages were reported. Due to the cold temperatures icy road conditions persisted for several days resulting in the closure of schools and businesses.

December 25, 2010 – 7 to 11 inches of snow fell countywide with the highest amounts falling from Raleigh east to Wendell, Zebulon and Garner. Many roads were impassible due to the heavy snow, however, other than a few minor accidents no other problems were reported due to the holiday.

January 26, 2016 – One quarter to one half of an inch of freezing rain accrual was reported across the county. In addition, snowfall/sleet amounts of a trace to 2 inches fell. Icy roads created difficult travel conditions during the morning of the 22nd, with numerous automobile accidents reported across the county.

Wake County received four FEMA Major Disaster Declarations for a blizzard in 1996 and severe ice/winter storms in 1968, 2000 and 2002.

Probability of Future Occurrence

NCEI records 50 severe winter weather related events during the 20-year period from 2000 through 2019, which equates to an annual probability greater than 100%. Therefore, the overall probability of severe winter weather in the county is considered highly likely (near or more than 100% annual probability).

Probability: 4 – Highly Likely

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.

The loss of use estimates provided in **Table F.32** were calculated using FEMA's publication *What is a Benefit?: Guidance on Benefit-Cost Analysis of Hazard Mitigation Project*, June 2009. These figures are used to provide estimated costs associated with the loss of power in relation to the populations served on campus. The loss of use is provided in the heading as the loss of use cost per person per day of loss. The estimated loss of use provided for the campus represents the loss of service of the indicated utility for one day for 10 percent of the population. These figures do not take into account physical damages to utility equipment and infrastructure.

Table F.32 – Loss of Use Estimates for Power Failure Associated with Severe Winter Weather

On-Campus Population (Fall 2020)	Estimated Affected Population (10%)	Electric Loss of Use Estimate ($126 per person per day)
9,200	920	$115,920

Property

The NCEI reported $1,040,000 of property damage in association with any winter weather events between 2000 and 2019 for Wake County. Based on these records, the County experiences an estimated annualized loss of $52,000 in property damage. The average impact from winter weather events per incident in Raleigh is $20,800.

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.

Changes in Development

Future development could potentially increase vulnerability to this hazard by increasing demand on the utilities and increasing the exposure of infrastructure networks. NCSU may wish to consider developing a flexible emergency power network to provide efficient back-up power for vulnerable populations, critical facilities, and research facilities.

Problem Statement

- Severe winter weather events are highly likely for Wake County and the NCSU campus. The events have also resulted in four presidential disaster declarations for the County.

F.5.5 Tornadoes/Thunderstorms

Hazard	Probability	Impact	Spatial Extent	Warning Time	Duration	PRI Score
Tornado/Thunderstorm	Likely	Critical	Large	Less than 6 hrs	Less than 6 hrs	3.1

Location

Thunderstorm wind, lightning, and hail events do not have a defined vulnerability zone. The scope of lightning and hail is generally confined to the footprint of its associated thunderstorm. Although these events occur similarly throughout the planning area, they are more frequently reported in more urbanized areas because damages are more likely to occur where exposure is greater in more densely developed urban areas.

Thunderstorm Winds

The entirety of NCSU's campus can be affected by severe weather hazards. Thunderstorm wind events can span many miles and travel long distances, covering a significant area in one event. Due to the small size of the planning area, any given event will impact the entire planning area, approximately 50% to 100% of the planning area could be impacted by one event.

Spatial Extent: 4 – Large

Lightning

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 NCSU is exposed to lightning.

Spatial Extent: 4 – Large

Hail

Hailstorms frequently accompany thunderstorms, so their locations and spatial extents coincide. However, large-scale hail tends to occur in a more localized area within the storm.

Spatial Extent: 4 – Large

Tornado

Figure F.22 and **Figure F.23** reflect the tracks of past tornados that passed within 10 miles of Wake County from 2000 through 2019 according to data from the NOAA/National Weather Service Storm Prediction Center. No tornadoes have passed through West Campus.

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

Spatial Extent: 4 – Large

Figure F.22 – Tornado Paths within 10 Miles of NCSU Centennial Campus

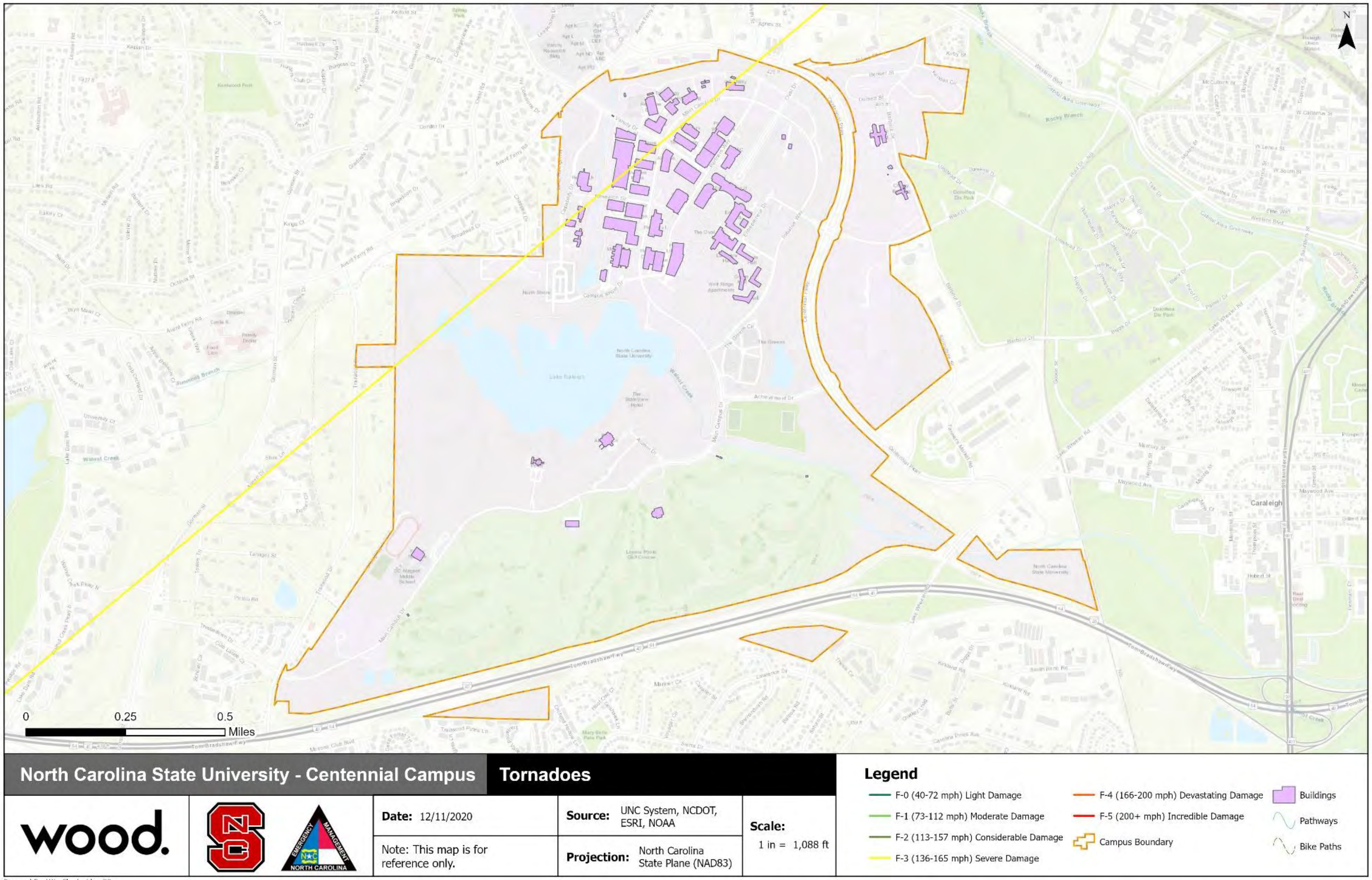
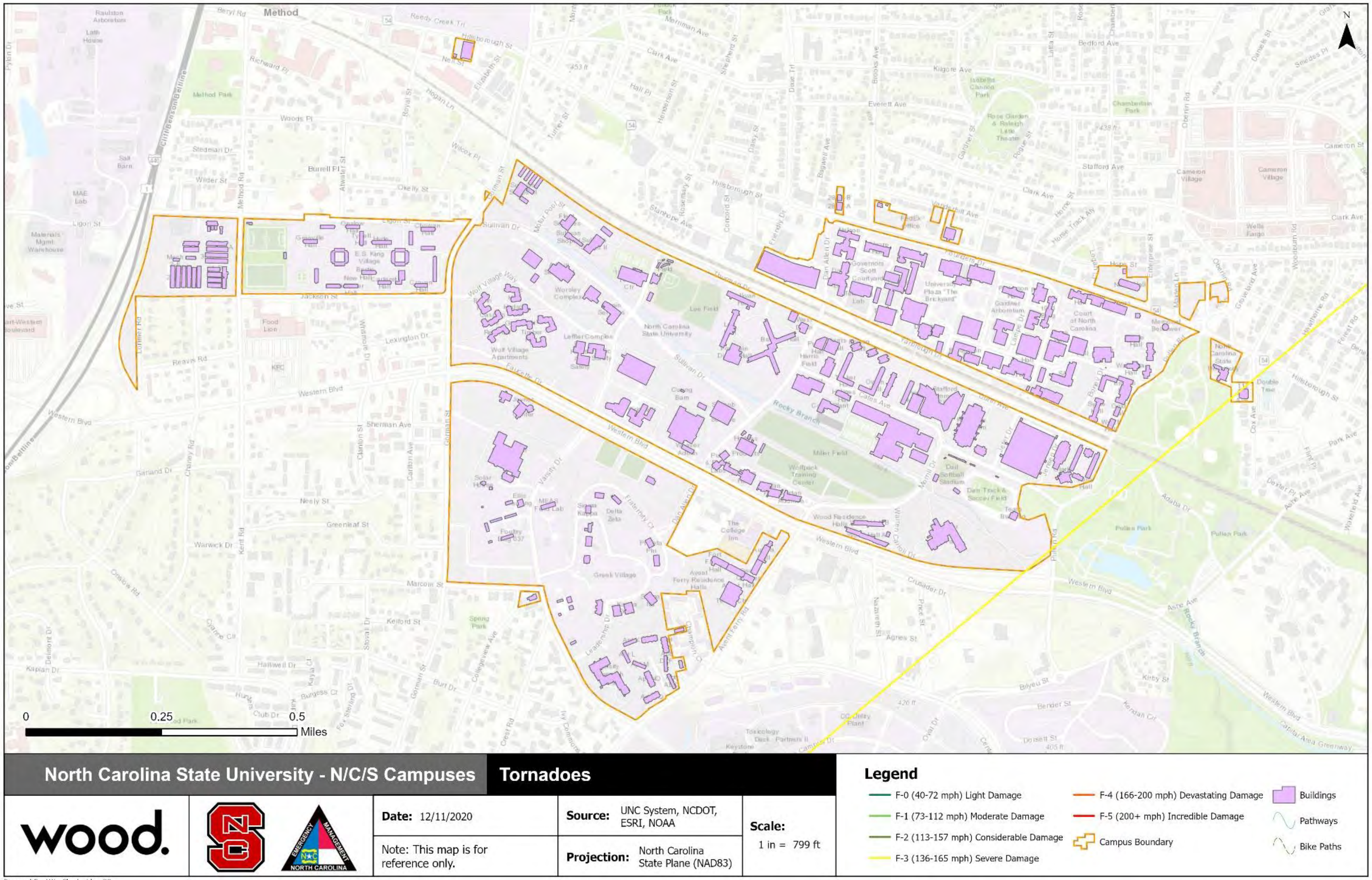


Figure F.23 – Tornado Paths within 10 Miles of NCSU North, Central, and South Campuses



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.

Figure F.24 shows wind zones in the United States. Wake County, indicated by the blue square, is within Wind Zone III, which indicates that speeds of up to 200 mph may occur within the county.

Figure F.24 – Wind Zones in the United States

Source: FEMA 320, Taking Shelter from the Storm, 3rd edition, https://www.fema.gov/pdf/library/ism2_s1.pdf

The strongest recorded thunderstorm wind event for Raleigh occurred on January 11, 2014 with a measured gust of 75 mph. The event reportedly resulted in property damages around $350,000 and no fatalities, injuries, or crop damages.

Impact: 2 – Limited

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, shown in **Table F.33**, is a common parameter that is part of fire weather forecasts nationwide.

Table F.33 – 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

Hail

The National Weather Service classifies hail by diameter size, and corresponding everyday objects to help relay scope and severity to the population. **Table F.34** indicates the hailstone measurements utilized by the National Weather Service.

Table F.34 – 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
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 F.35** describes typical intensity and damage impacts of the various sizes of hail.

Table F.35 – 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 Raleighed
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 2000 and 2019 in Raleigh was a little over 1" in diameter; the largest hailstone recorded was 4 inches, recorded on March 28, 2005.

Impact: 1 – Minor

Tornado

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 and better correlation between damage and wind speed. It is also more precise because it considers the materials affected and the construction of structures damaged by a tornado. **Table F.36** shows the wind speeds associated with the enhanced Fujita scale ratings and the damage that could result at different levels of intensity.

Table F.36 – 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.

EF Number	3 Second Gust (mph)	Damage
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 Raleigh in the past 20 years was an EF3 on April 16, 2011. NCEI reports this event causing around $115,000,000 in property damage, and narratives of the event report 2270 homes were damaged, including 67 homes that were destroyed, with another 184 homes experiencing major damage. There were also 34 businesses damaged.

Impact: 3 – Critical

Historical Occurrences

Thunderstorm Winds

Between January 1, 2000 and December 31, 2019, the NCEI recorded wind speeds for 88 separate incidents of thunderstorm winds, occurring on 63 separate days, for Raleigh. These events caused $581,500 in recorded property damage, 8 injuries, and no fatalities or crop damage. The recorded gusts averaged 51.5 miles per hour, with the highest gusts recorded at 75 mph on January 11, 2014. Of these events, 18 caused property damage. Wind gusts with property damage recorded averaged $32,305 in damage, with the highest reported damage being a total of $350,000 on January 11, 2014. The incidents resulting in property damage or injuries for the City of Raleigh are recorded below in **Table F.37**.

Table F.37 – Recorded Thunderstorm Winds Resulting in Property Damage, Raleigh, 2000-2019

Location	Date	Wind Speed (mph)	Fatalities	Injuries	Property Damage
RALEIGH	8/21/2007*	50	0	8	$0
RALEIGH	7/1/2009	50	0	0	$1,000
RALEIGH	7/4/2012*	50	0	0	$6,000
RALEIGH	7/24/2012*	50	0	0	$10,000
RALEIGH	1/11/2014	75	0	0	$350,000
RALEIGH	6/11/2014	50	0	0	$5,000
RALEIGH	8/20/2014	50	0	0	$25,000
RALEIGH	2/16/2016	50	0	0	$15,000
RALEIGH	6/5/2016	51	0	0	$2,500
RALEIGH	6/29/2016*	50	0	0	$1,500
RALEIGH	6/16/2017	50	0	0	$10,000
RALEIGH	5/10/2018	50	0	0	$5,000
RALEIGH	7/6/2018*	50	0	0	$10,000
RALEIGH	8/3/2018	50	0	0	$1,500

Location	Date	Wind Speed (mph)	Fatalities	Injuries	Property Damage
RALEIGH	4/14/2019	50	0	0	$4,000
EAST RALEIGH	4/15/2019	50	0	0	$5,000
WEST RALEIGH	6/30/2019*	50	0	0	$115,000
WEST RALEIGH	8/19/2019	50	0	0	$5,000
EAST RALEIGH	8/22/2019	50	0	0	$10,000
		Total	**0**	**8**	**$581,500**

Source: NCEI
*Note: Multiple events occurred on these dates. Injuries, fatalities, and property damage are totaled, wind speed is highest reported.

The State of North Carolina received a FEMA Major Disaster Declaration in 1956 for severe storms that included heavy rains and high winds.

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

August 21, 2007 – A spotter reported several trees down at the Walnut Creek Amphitheatre. A roof was also blown off of an outdoor shelter at the amphitheater.

January 11, 2014 – In the Brier Creek area, a condominium complex under construction was damaged by the winds on Bruckhaus Street. Four units that had just been framed were blown over.

June 11, 2014 – Several trees were blown down along a swath from near the Raleigh-Durham International Airport to near Falls Lake. In addition, one of trees fell onto a transformer in north Raleigh.

August 20, 2014 – Severe winds flipped over a super caravan aircraft and blew a large cargo container over an 8-foot fence into a car.

Lightning

According to NCEI data, there was four lightning strikes were reported between 2000 and 2019. These lightning strike events recorded an estimated $210,000 worth of property damage. No crop damage, injuries, fatalities were 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. **Table F.38** details NCEI-recorded lightning strikes from 2000 through 2019 for Raleigh.

Table F.38 – Recorded Lightning Strikes in Raleigh, 2000-2019

Location	Date	Time	Fatalities	Injuries	Property Damage
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
WILDERS GROVE	7/17/2010	1308	0	0	$10,000
		Total	**0**	**0**	**$210,000**

Source: NCEI

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

April 3, 2006 – Lightning destroyed 3 apartment units.

April 22, 2006 – Numerous house fires reported throughout the county. At least 4 homes totally destroyed and 24 apartments in Brier Creek community destroyed

August 15, 2008 – Two homes struck by lightning in Raleigh and caught fire resulting in extensive damage to each home.

July 17, 2010 – Lightning caused a fire to an unoccupied residence on the southeast side of Raleigh. The fire started in the attic and smoldered for a time before igniting.

Hail

NCEI records 29 days with hail incidents between January 1, 2000 and December 31, 2019 in Raleigh. None of these events were reported to have caused death, injury, property damage or crop damage. The largest diameter hail recorded in the City was 4 inches, which occurred on March 28, 2005. The average hail size of all events in the City was just over one inch in diameter. **Table F.39** summarizes hail events for Raleigh. In some cases, hail was reported for multiple locations on the same day.

Table F.39 – Summary of Hail Occurrences in Raleigh

Beginning Location	Date	Hail Diameter
RALEIGH	4/29/2000	1.75
RALEIGH	6/3/2000	1.75
RALEIGH	6/14/2000	0.75
RALEIGH	7/17/2000	1
RALEIGH DURHAM ARPT	5/12/2001	0.75
RALEIGH	3/26/2002	0.75
RALEIGH	3/31/2002	0.88
RALEIGH	7/4/2002	0.88
RALEIGH	3/31/2004	0.88
RALEIGH	7/14/2004	0.88
RALEIGH	3/28/2005*	4
RALEIGH	5/12/2005	0.75
RALEIGH	6/7/2005	1
RALEIGH	4/3/2006	0.75
RALEIGH	4/22/2006*	1.75
RALEIGH	5/14/2006*	1.75
RALEIGH	5/25/2006*	1
RALEIGH	6/11/2006	0.75
RALEIGH	4/15/2007*	0.88
RALEIGH	6/9/2007	0.75
RALEIGH	6/29/2007	0.75
RALEIGH	7/17/2007*	1
(RDU)RALEIGH-DURHAM	7/23/2015	0.75
(RDU)RALEIGH-DURHAM	3/13/2016	0.88
RALEIGH	5/2/2016	1.25
(RDU)RALEIGH-DURHAM	6/29/2016	1.25
WILDERS GROVE	9/30/2016	0.88
WILDERS GROVE	5/13/2019	1
RALEIGH ARPT	5/31/2019	1

Source: NCEI

*Note: Multiple events occurred on these dates. Hail diameter is highest reported for that specific date.

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

April 29, 2000 – Golf ball size hail was reported near Falls Lake at NC 98 and Camp Kanata Road.

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. Hen egg sized hail reported on Lake Wheeler Road. Quarter to half dollar sized hail reported in Fuquay Varina and at Highways 401 and 70 in Garner.

July 17, 2007 – Quarter size hail was reported on the campus of North Carolina State University.

Tornado

NCEI storm reports were reviewed from 2000 through 2019 to assess whether recent trends varied from the longer historical record. According to NCEI, the city of Raleigh has five recorded tornado events between 2000 and 2019. It is likely that there have been several tornados that occurred in Raleigh but went unreported. These tornado events reported $116,163,000 in property damage, 67 injuries, and 4 deaths. **Table F.40** shows historical tornadoes in Raleigh recorded in NCEI between 2000 and 2019.

Table F.40 – Recorded Tornadoes in Raleigh and Surrounding Communities, 2000-2019

Beginning Location	Date	Time	Magnitude	Deaths	Injuries	Property Damage	Crop Damage
BURT	4/16/2011	1427	EF3	4	67	$115,000,000	$0
SOUTH RALEIGH ARPT	3/29/2014	1957	EF0	0	0	$8,000	$0
WILLIAMS XRDS	3/29/2014	2008	EF0	0	0	$5,000	$0
KNIGHTDALE WNDLL ARP	4/15/2018	2135	EF1	0	0	$150,000	$0
KNIGHTDALE WNDLL ARP	5/13/2019	913	EF2	0	0	$1,000,000	$0
			Total	4	67	$116,163,000	$0

Source: NCEI

Wake County received three FEMA Major Disaster Declaration in 1988, 1998, and 2011 for severe storms that included tornadoes.

Narratives from NCEI illustrate that damage occurred 3in many of these incidents even if a monetary value was not recorded. Specific incidents include:

April 16, 2011 – The tornado exited Chatham County and entered southwest Wake County as an EF0. There was multiple tree and roof damage along Avent Ferry Road, southwest of Holly Springs. The tornado intensified to an EF1 with winds of 86 mph as it reached Fire Station Number Two and the Holly Glenn Subdivision before crossing highway 55 and tracking through the Remington subdivision. The tornado continued to track northeastward and caused extensive tree damage and damage to numerous homes, mainly from fallen trees along Pierce Olive, Ten-Ten, Penny Road, and Yates Mill Pond roads, as wind speeds increased to around 100 mph. The tornado crossed Tryon Road, between Lake Wheeler Road and the Raleigh Golf Association Golf Course, before tracking northeast across the entire City of Raleigh, producing EF1 damage in a narrow swath between 50 to 100 yards. It crossed directly over Interstates 40-440, between exits 297 and 298 with damage on both sides of the interstate clearly visible. The tornado continued northeast across South Saunders Street, where 4 businesses were damaged. A body shop was completely destroyed when the roof was ripped off and the side walls collapsed. The tornado continued to snap hardwood trees and powerlines near Mount Hope Cemetery and nearby homes. The tornado weakened as it moved northeast towards Shaw University. Campus dormitories and the university student center had windows blown in with roof damage. The tornado moved northeast along the east side of the major high-rise buildings in downtown Raleigh, downing hundreds of trees, many of which fell on houses. The historic Oakwood to Lion`s Park sections of town, including the historic Oakwood Cemetery were hardest hit. Also, in the path of the tornado was Saint Augustine`s College, which sustained roof damage to every building on campus. The tornado continued to down trees on numerous homes as it crossed North King Charles Road to Yonkers Road, producing EF1 damage to several businesses. The tornado crossed the 440 beltline for a second time, this time on the northeast side of downtown Raleigh near the intersections of Westinghouse and Brentwood roads, again causing damages to several businesses, including the Raleigh Iceplex. The tornado then strengthened to an EF2 with winds greater than 110 mph as it continued northeast producing extensive tree damage in a 100 to 200-yard-wide path from Stony Brook Drive to Buffalo Road. Snapped trees crashed onto and through numerous homes all along the path. Four fatalities occurred when a large tree fell onto a mobile home. Two other mobile homes were thrown 30 to 50 feet when the tie downs snapped from their anchor points with nearly all of the mobile homes in the Stony Brook mobile home park sustained some type of damage. The EF2 tornado continued to move northeast across Buffalo Road, near the Cardinal Grove Subdivision. Several two-story homes were completely destroyed with numerous other homes sustaining moderate to major damage. Damage consistent with an EF2 tornado continued with widespread damage in a 200-yard-wide swath along Forestville road. A couple of mobile homes were destroyed, and several two-story homes suffered extensive roof damage, with continued numerous snapped trees falling on houses. The tornado weakened or lifted as it moved northeast towards Rolesville. Damage became very sporadic and isolated in nature as it neared the Franklin County line. In total, 2270 homes were damaged, including 67 homes that were destroyed, with another 184 homes experiencing major damage. There were also 34 businesses damaged.

May 13, 2019 – The tornado initially touched down just west of Rolesville Road near Tink's Place in eastern Wake County. The tornado initially produced widespread EF-1 damage with sporadic EF-2 damage noted on Weathers Road. Along the path to Weathers Road, numerous trees were either uprooted or snapped and mangled together, consistent with EF-1 damage. At Weathers Road, structural damage was noted as a single-family home had its exterior walls collapsed. Several metal farm buildings were also completely destroyed and strewn about a field. Sheet metal was wrapped around a nearby tree. An RV was flipped over numerous times landing crushed in an open field. In addition, another home had the windows blown out with roof damage. It was in this area that EF-2 damage was determined. The tornado continued tracking east and crossed Edgemont Road just north of HWY 264/64, then crossing HWY 264/64 where numerous trees were downed and snapped. Generally, EF-1 damage was noted here. The tornado then moved east into Zebulon along and near Highway 97 (West Gannon Avenue) where numerous trees snapped and uprooted. It continued east of Zebulon, crossing HWY 264/64 again, and going just north of the Five County Stadium. Generally, EF-0 and EF-1 damage was noted here.

Probability of Future Occurrence

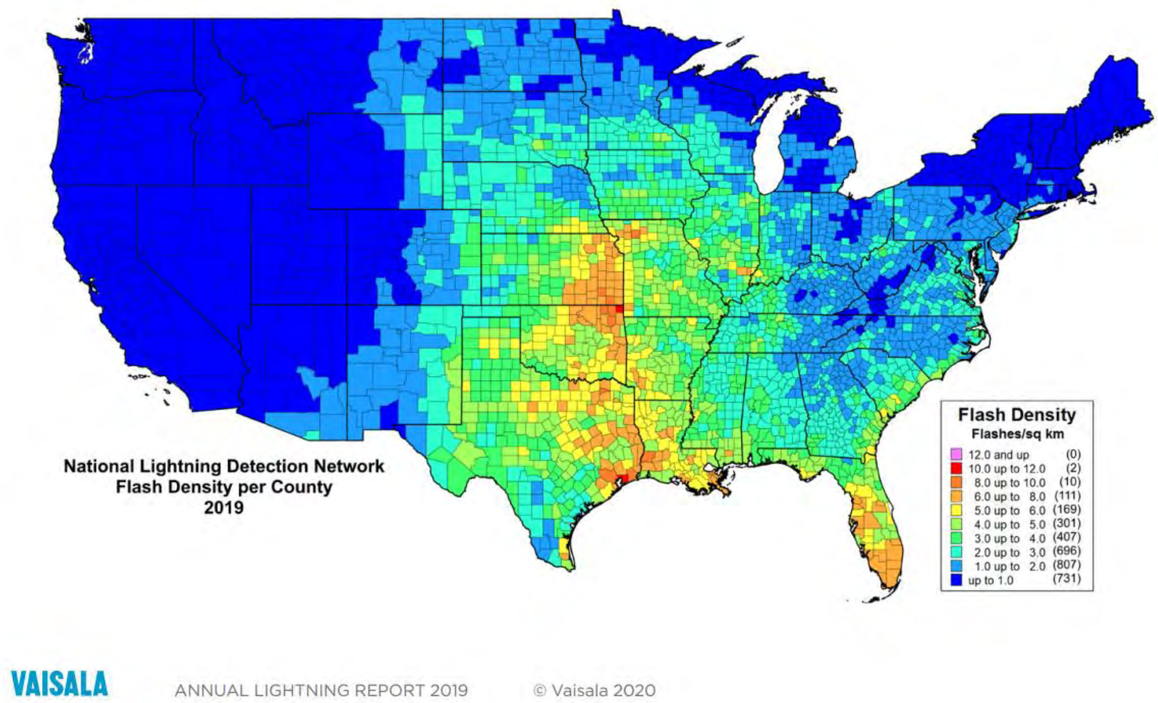
Based on historical occurrences recorded by NCEI for the 20-year period from 2000 through 2019, Raleigh averages 3.15 days with wind events per year. Over this same period, two lightning events were reported as having caused property damage, which equates to an average of 0.1 damaging lightning strikes per year.

The average hailstorm in Raleigh occurs in the evening and has a hail stone with a diameter of just over one inch. Over the 20-year period from 2000 through 2019, Raleigh experienced 29 days with reported hail incidents; this averages to 1.45 days per year with reported incidents somewhere in the City.

Based on the Vaisala 2019 Annual Lightning Report, North Carolina experienced 3,641,417 documented cloud-to-ground lightning flashes. According to Vaisala's flash density map, shown in **Figure F.25**, Wake

County is located in an area that experiences 1 to 2 lightning flashes per square kilometer per year. It should be noted that future lightning occurrences may exceed these figures.

Figure F.25 – Lightning Flash Density per County (2019)



Source: Vaisala

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

In a twenty-year span between 2000 and 2019, Wake County has experienced five separate tornado incidents over four separate days. This correlates to a 25 percent annual probability that the City will experience a tornado somewhere in its boundaries. Two of these past tornado events were a magnitude EF0, one was an EF1, one was an EF2, and the other tornado event was an EF3. Based on two tornado events having a magnitude higher than EF1, the annual probability of a significant tornado event is unlikely with a 10 percent annual chance.

Based on these historical occurrences, there is between a 10% to 100% chance that Raleigh will experience severe weather each year. The probability of a damaging impacts is likely.

Probability: 3 – Likely

Vulnerability Assessment

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.

Similar to the loss of use estimates provided for Severe Winter Weather, the loss of use estimates for a tornadoes/thunderstorms were estimated as $115,920 per person per day, assuming 10-percent of the on-campus population is impacted.

Table F.41 – Loss of Use Estimates for Power Failure Associated with Tornado/Thunderstorm

On-Campus Population (Fall 2020)	Estimated Affected Population (10%)	Electric Loss of Use Estimate ($126 per person per day)
9200	920	$115,920

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 2018 American Community Survey (ACS) 5-Year Estimates, 3,188 occupied housing units (1.6 percent) in Raleigh are classified as "mobile homes or other types of housing." Using the 2018 ACS average persons per household estimate of 2.43, the population at risk due to their housing type was estimated at 7,747 residents within Raleigh.

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. Therefore, the estimated 7,747 residents mentioned above residing in mobile homes in Raleigh are also at a greater risk to tornado damage due to their housing type.

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 Raleigh, the two events with recorded property damage were due to fires ignited by lightning strikes.

NCEI records lightning impacts over 20 years (2000-2019), with $210,000 in property damage recorded during two separate events in 2008 and 2010. Based on these records, the City experiences an annualized loss of $10,500 in property damage. The average impact from lightning per incident in Raleigh is $52,500.

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, 2000 and December 31, 2019 in Raleigh, NCEI did not report any property damage as a direct result of hail.

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 Raleigh, thus the NCEI is still used to form a baseline.

Wind events reported in NCEI for the 20-year period from 2000 through 2019 totaled $581,500 in property damage, which equates to an annualized loss of $29,075 across the City.

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 2000, damaging tornadoes in the City are directly responsible for $116,163,000 worth of damage to property according to NCEI data. This equates to an annualized loss of $5,808,150.

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.

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.

Changes in Development

Future development projects should consider severe thunderstorms hazards and tornado and high wind hazards at the planning, engineering and architectural design stage with the goal of reducing vulnerability. University buildings with high occupancies should consider inclusion of a tornado shelters to accommodate occupants in the event of a tornado. Future development will also affect current stormwater drainage patterns and capacities.

Problem Statement

- Thunderstorms and tornadoes are frequent hazard events in Wake County and the NCSU campus. Reported damages for the 20-year period from 2000-1019 include $581,500 for thunderstorm winds, $210,000 for lightning strikes, and $116,163,000 for tornado events.

F.5.6 Wildfire

Hazard	Probability	Impact	Spatial Extent	Warning Time	Duration	PRI Score
Wildfire	Likely	Limited	Large	More than 24 hrs	More than 1 week	2.8

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 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 F.42** details the WUI on the NCSU campus, and **Figure F.26** through **Figure F.28** below show the WUI areas. On a county level, Wake County is predominately classified as WUI intermix and interface areas and medium to high density housing in the agricultural areas with noted pockets of very low to no housing in Non-WUI vegetated areas.

Table F.42 – Wildland Urban Interface, Population and Acres

	Housing Density	WUI Acres	Percent of WUI Acres
	LT 1hs/40ac	940	43.9%
	1hs/40ac to 1hs/20ac	130	6.1%
	1hs/20ac to 1hs/10ac	108	5.1%
	1hs/10ac to 1hs/5ac	99	4.6%
	1hs/5ac to 1hs/2ac	68	3.2%
	1hs/2ac to 3hs/1ac	137	6.4%
	GT 3hs/1ac	306	14.3%
	Total	353	16.5%

Source: Southern Wildfire Risk Assessment

Spatial Extent: 3 – Large

Figure F.26 – Wildland Urban Interface Areas, NCSU Centennial Campus

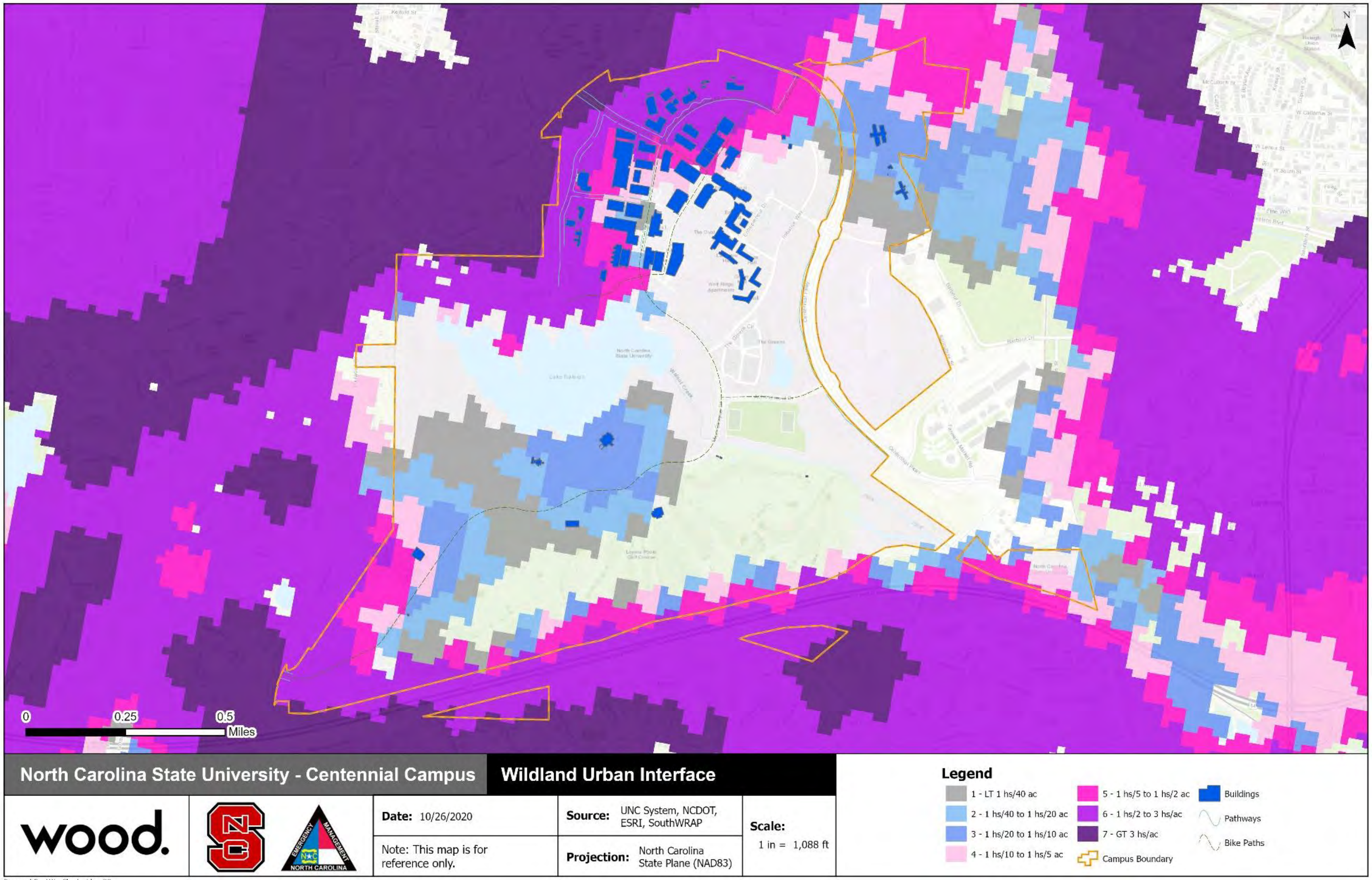


Figure F.27 – Wildland Urban Interface Areas, NCSU North, Central, South Campuses

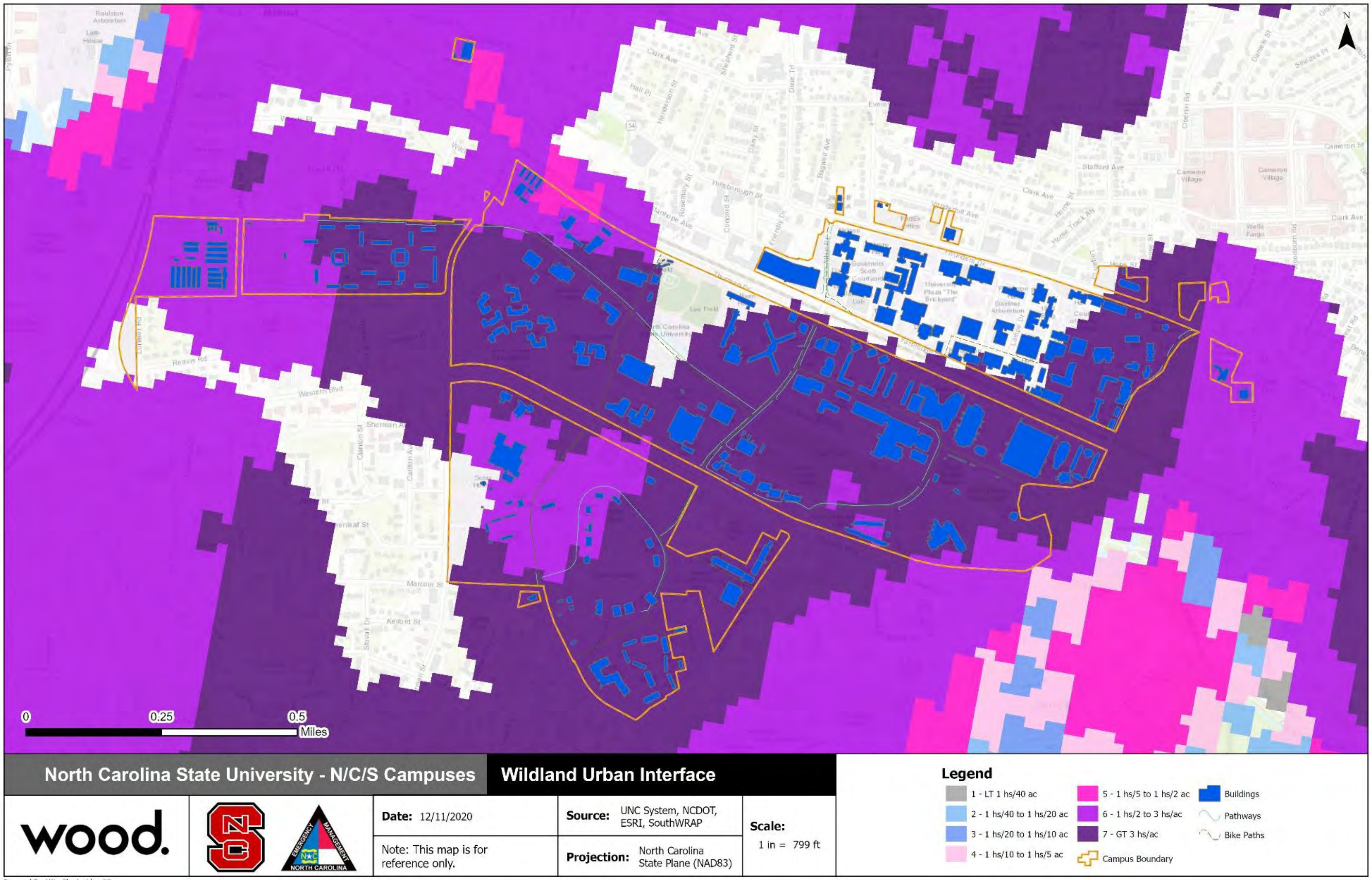
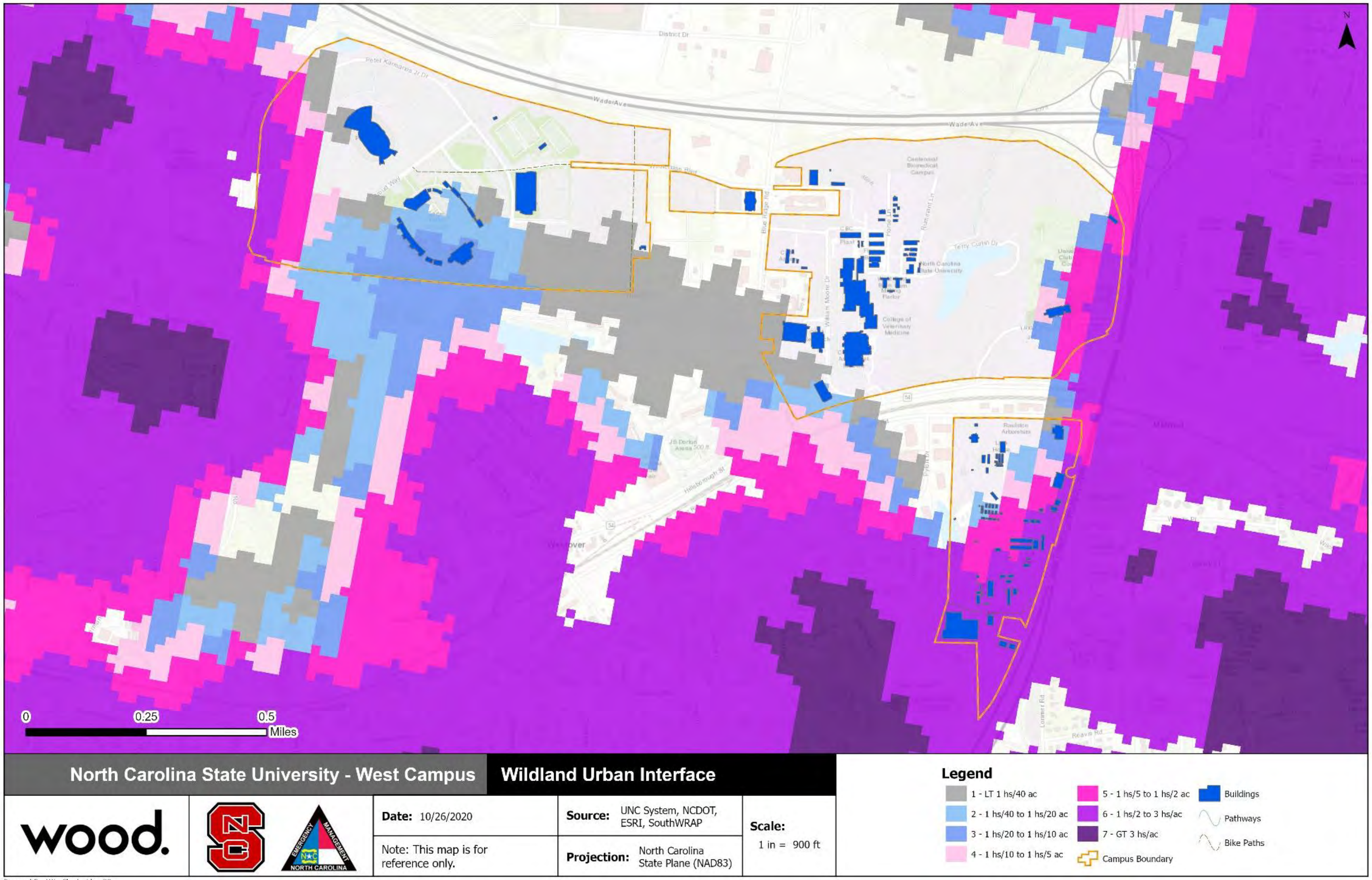


Figure F.28 – Wildland Urban Interface Areas, NCSU West Campus



Extent

The entire state is at risk to a wildfire occurrence. However, several factors such as drought conditions or high levels of fuel on the forest floor may make a wildfire more likely in certain areas. 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, shown in **Table F.43**, consists of five classes, as defined by Southern Wildfire Risk Assessment. **Figure F.29** through **Figure F.31** show the potential fire intensity within the WUI across North Carolina State University.

Table F.43 – 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

Nearly all of the NCSU campus may experience up to a Class 3.5 fire intensity. A significant portion, approximately 41.6 percent, of NCSU's campus, is non-burnable. An additional 43.7 percent would face a Class 1 or Class 2 Fire Intensity, which are easily suppressed. Over 13 percent of the campus may experience Class 3 or Class 3.5 Fire Intensity, which has potential for harm to life and property but is easier to suppress with dozer and plows. The remainder of the planning area (1.4%) may experience a Class 4 fire intensity, which poses significant harm or damage to life and property; these small areas with greatest potential fire intensity are generally outside the WUI.

The WUI Risk Index is used to rate the potential impact of a wildfire on people and their homes. It reflects housing density (per acre) consistent with Federal Register National standards. The WUI Risk Index ranges of values from -1 to -9, with -1 representing the least negative impact and -9 representing the most negative impact. **Figure F.32** through **Figure F.34** map the WUI Risk Index for NC State University (NCSU). The WUI areas within the campus of NCSU range from -5 to -8 on the WUI Risk Index.

Impact: 2 – Limited

Figure F.29 – Characteristic Fire Intensity, NCSU Centennial Campus

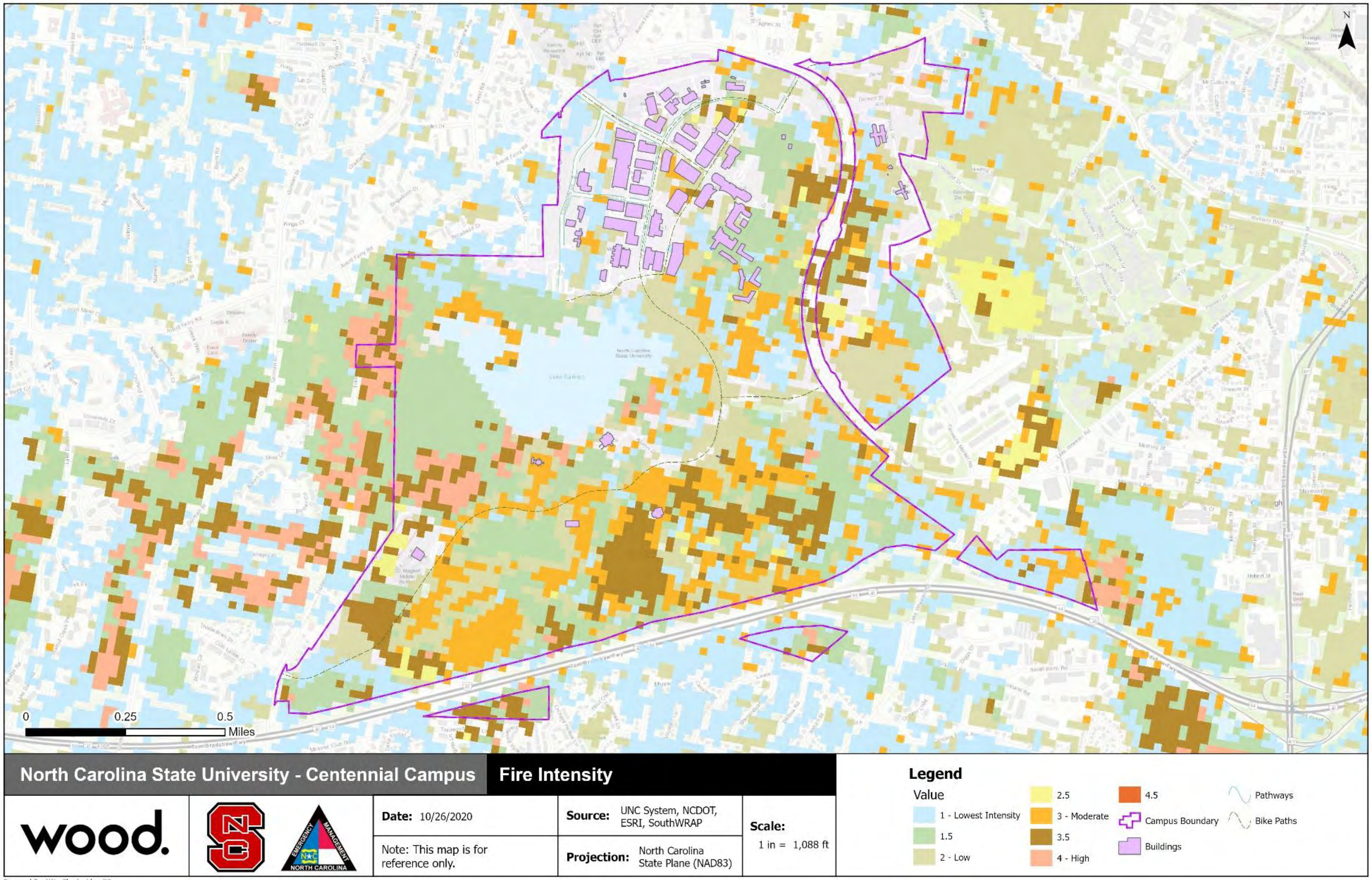


Figure F.30 – Characteristic Fire Intensity, NCSU North, Central, and South Campus

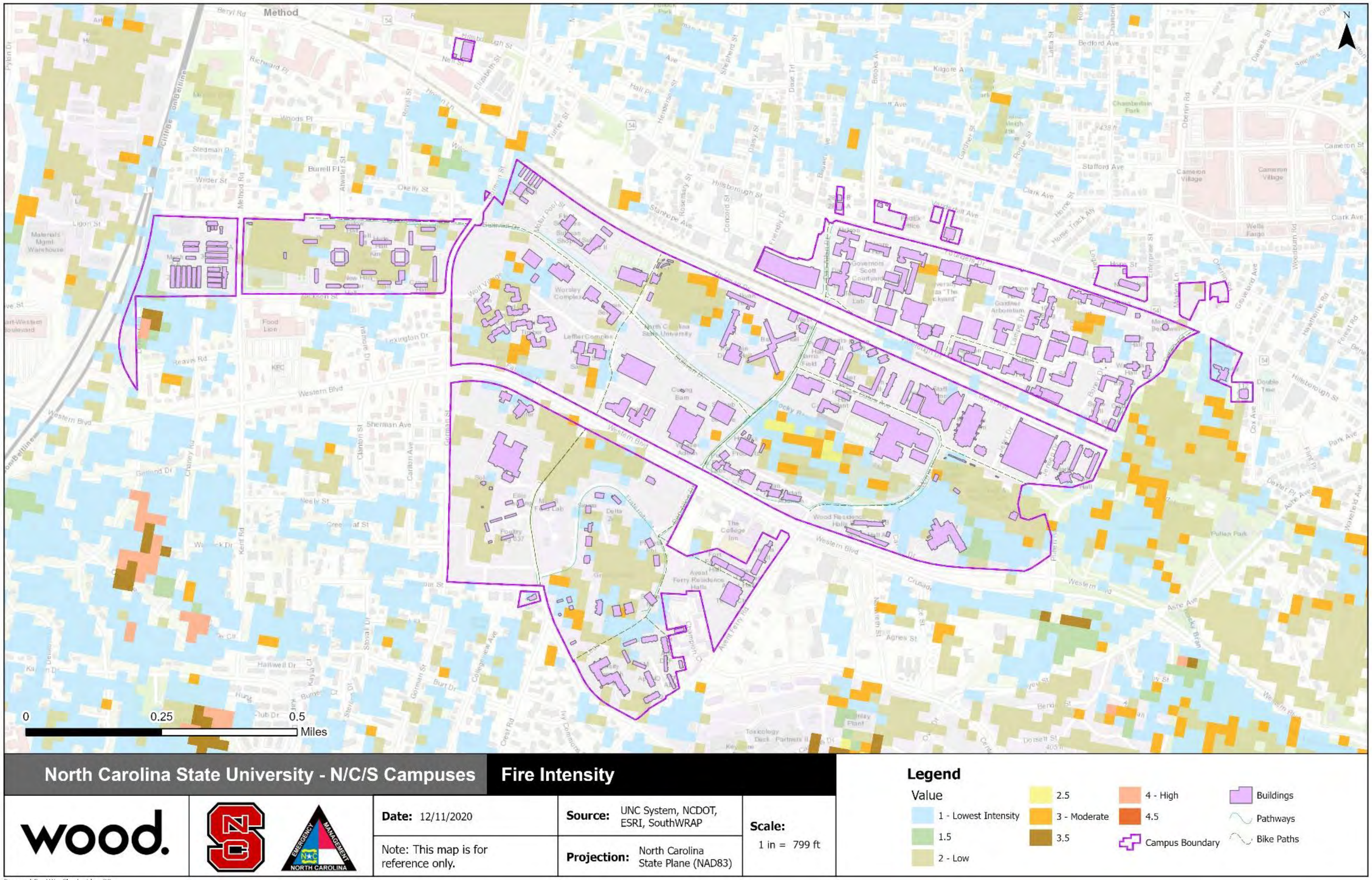


Figure F.31 – Characteristic Fire Intensity, NCSU West Campus

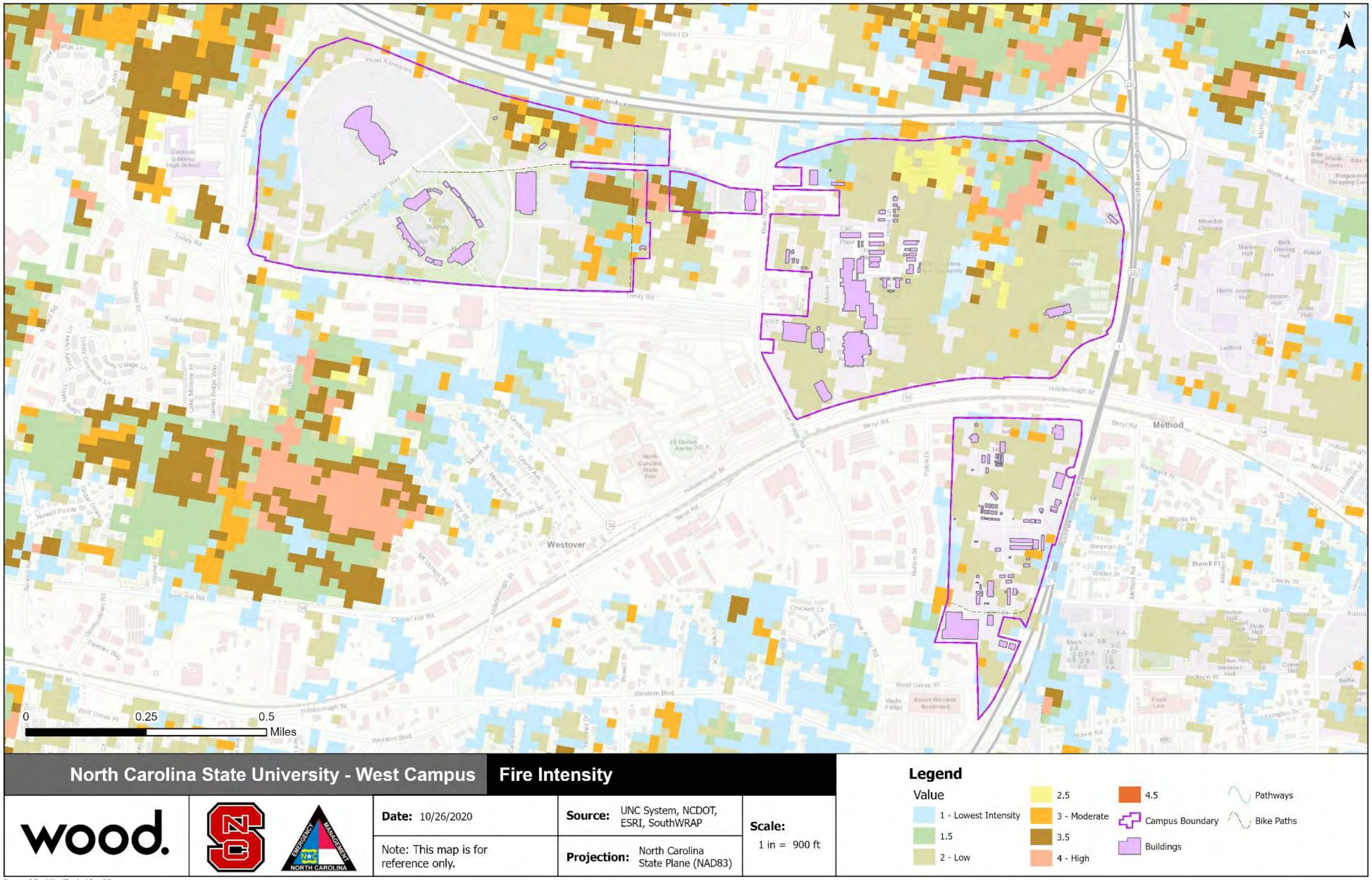


Figure F.32 – WUI Risk Index, NCSU Centennial Campus

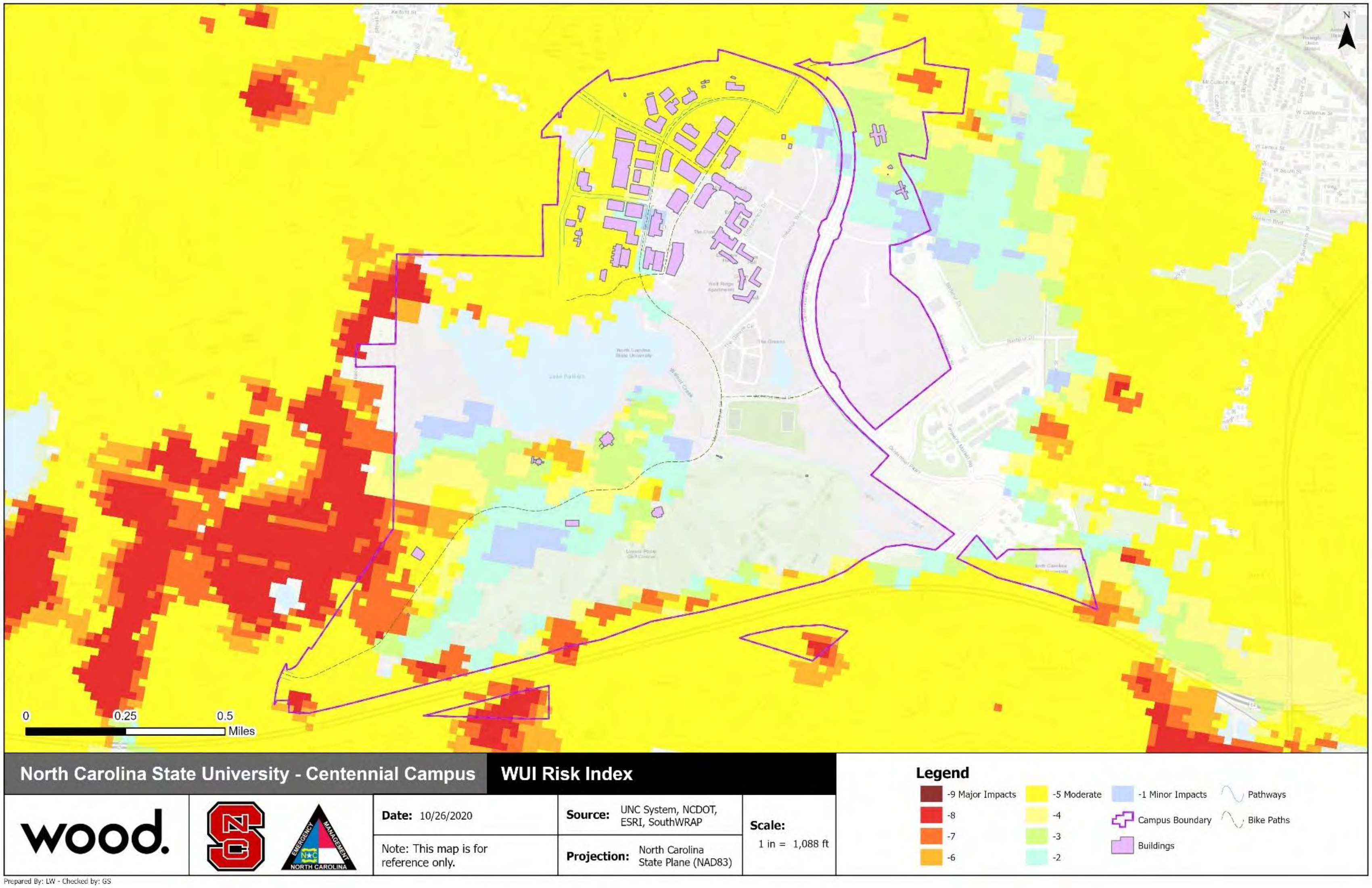


Figure F.33 – WUI Risk Index, NCSU North, Central, and South Campus

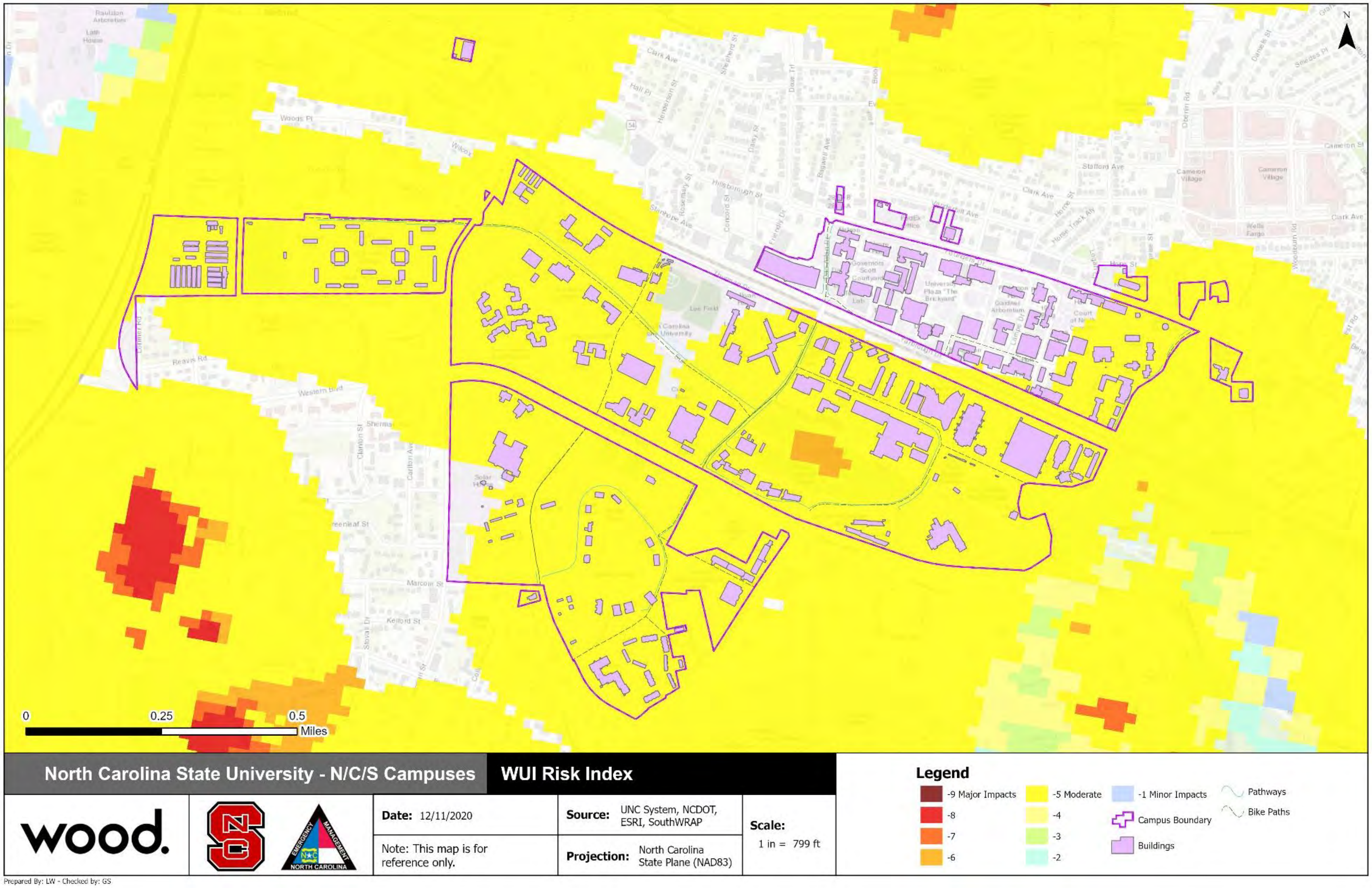
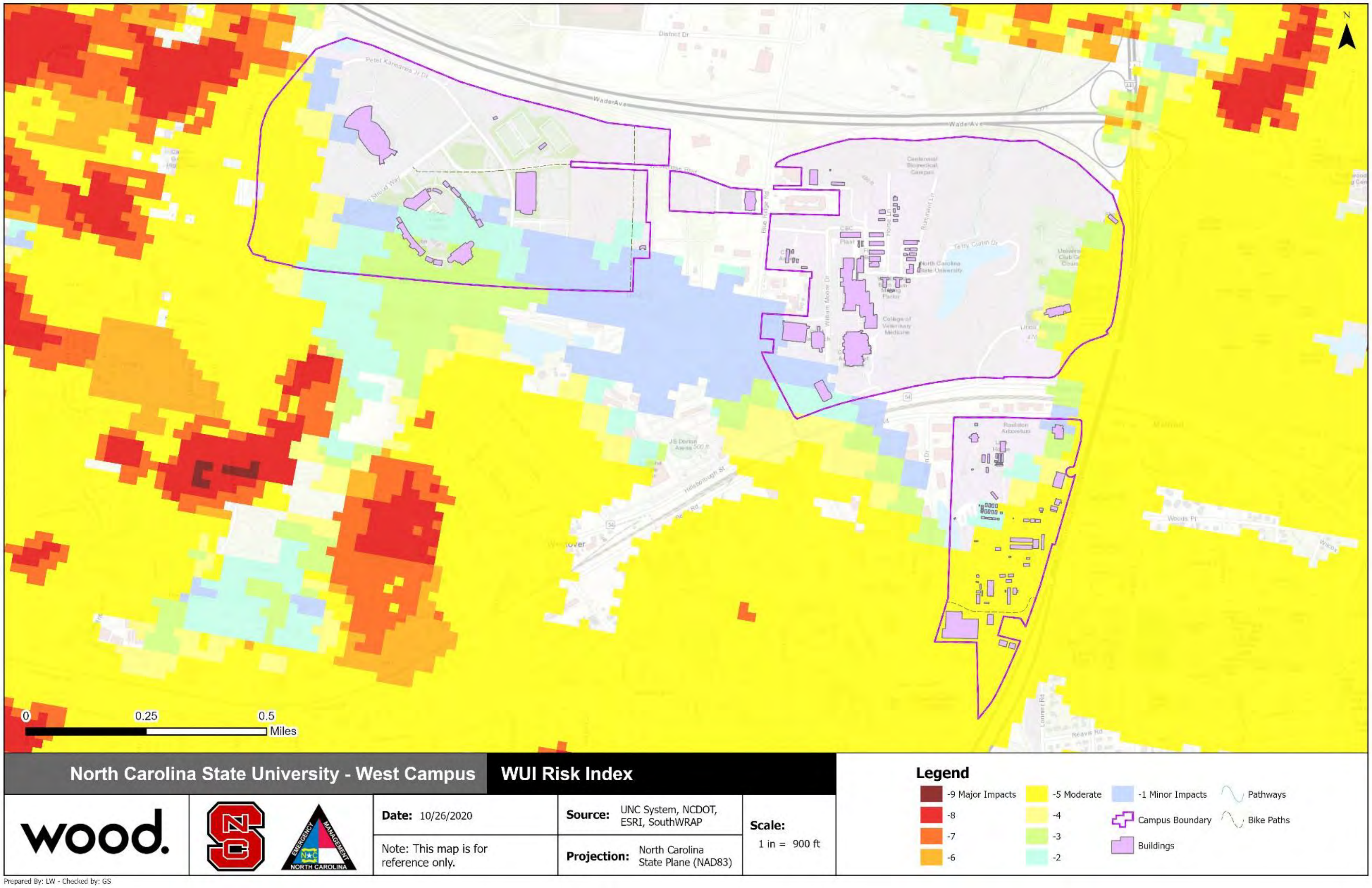


Figure F.34 – WUI Risk Index, NCSU West Campus



Historical Occurrences

According to the North Carolina Forest Service (NCFS), there were 68 noted wildfires within Wake County between 2013 and 2018. The total acreage burned during this period was 303.6 acres. There were no additional data records regarding specific cities or school districts within Wake County. The data is from NCFS records only and may not include data on fires burned within jurisdictional limits that did not require NCFS assistance to suppress. Actual number of fires and acreage burned may be higher than what is reported here.

On average, Wake County experiences 11.3 fires and 50.6 acres burned annually from fires reported by the NCFS. Actual number of fires and acreage burned is likely higher because smaller fires within jurisdictional boundaries are managed by local fire departments. Based on these records, the average wildfire event can be calculated as 4.5 acres. Actual number of fires and acreage burned is likely higher because smaller fires within jurisdictional boundaries are managed by local fire departments. The most known cause was noted as debris.

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 NC State University's Centennial, East, and West Campuses are presented in **Table F.44** and illustrated in **Figure F.35** through **Figure F.37**.

Table F.44 – Burn Probability, NC State University

	Class	Acres	Percent
		1,260	58.8%
	1	150	7.0%
	2	422	19.7%
	3	310	14.5%
	4	0	0.0%
	5	0	0.0%
	6	0	0.0%
	7	0	0.0%
	8	0	0.0%
	9	0	0.0%
	10	0	0.0%
	Total	**2,142**	--

Source: Southern Wildfire Risk Assessment

Approximately 34 percent of NCSU has a burn probability between 2 and 3. The areas of low to moderate burn probability are primarily found on Centennial Campus as well as the northwestern portion of West Campus. The majority of the campus has no burn probability. Overall, the probability of wildfire across the campuses is considered likely, defined as between a 10% and 100% annual chance of occurrence.

Probability: 3 – Likely

Figure F.35 – Burn Probability, NCSU Centennial Campus

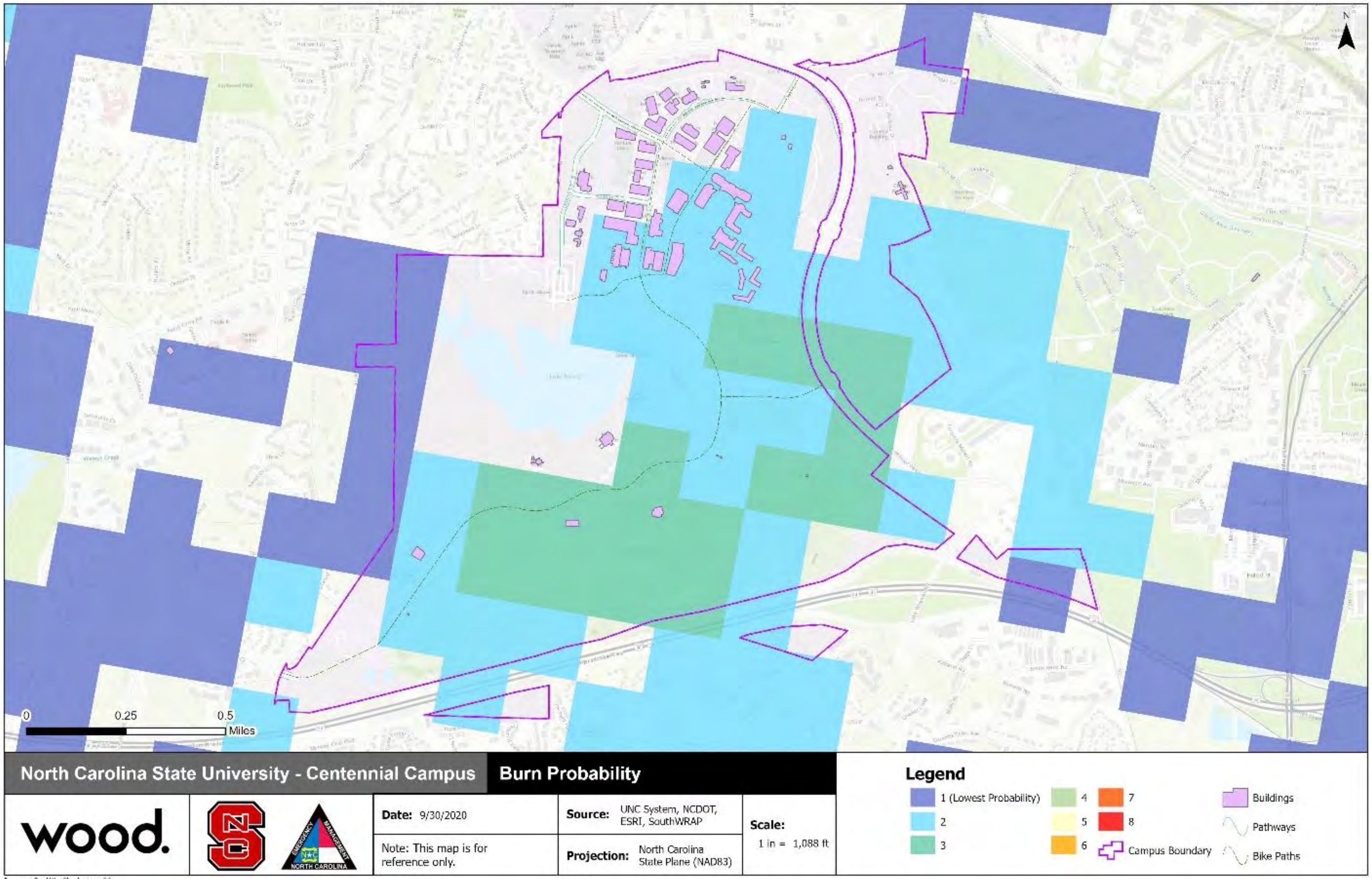


Figure F.36 – Burn Probability, NCSU North, Central, and South Campus

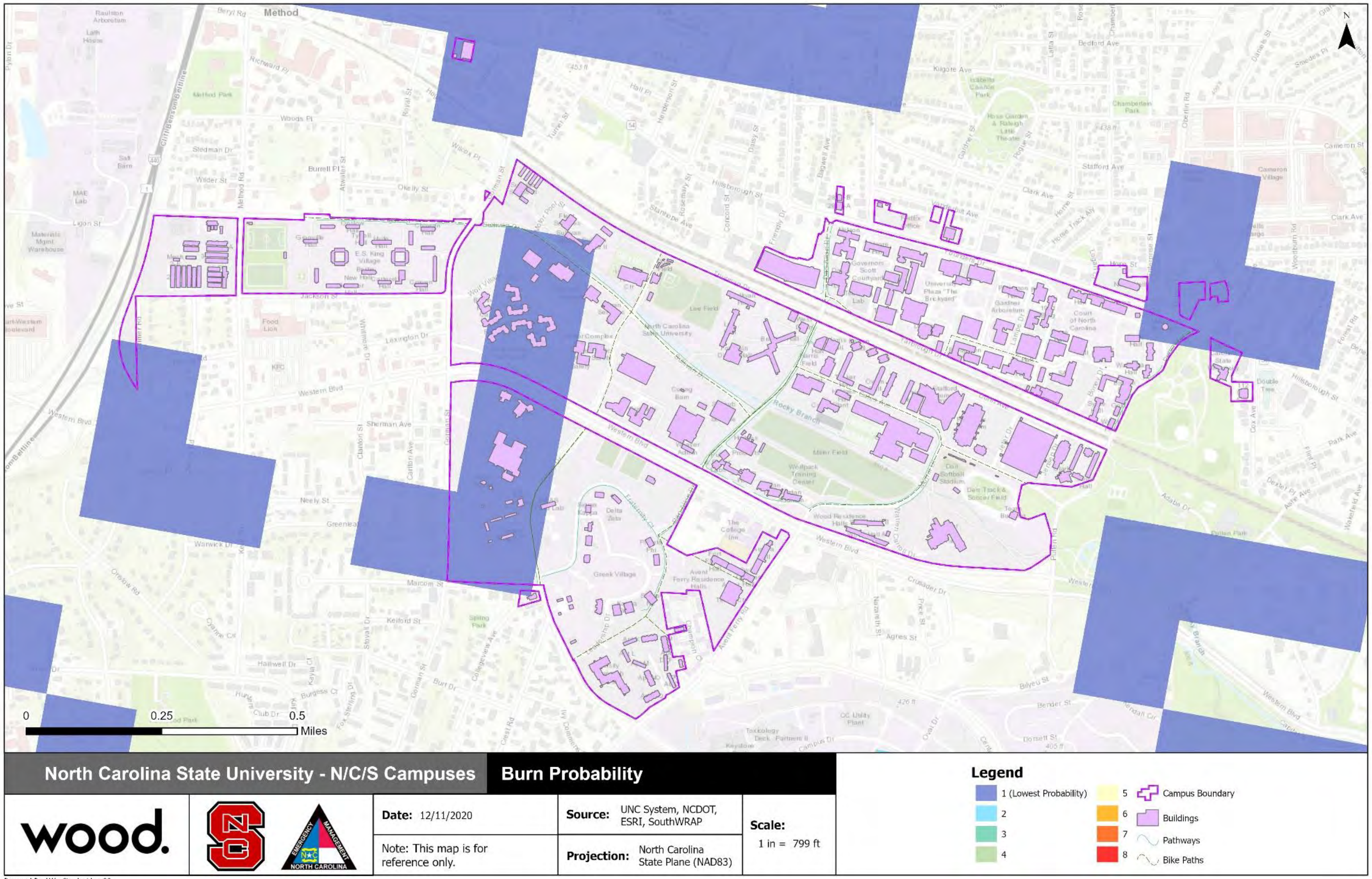
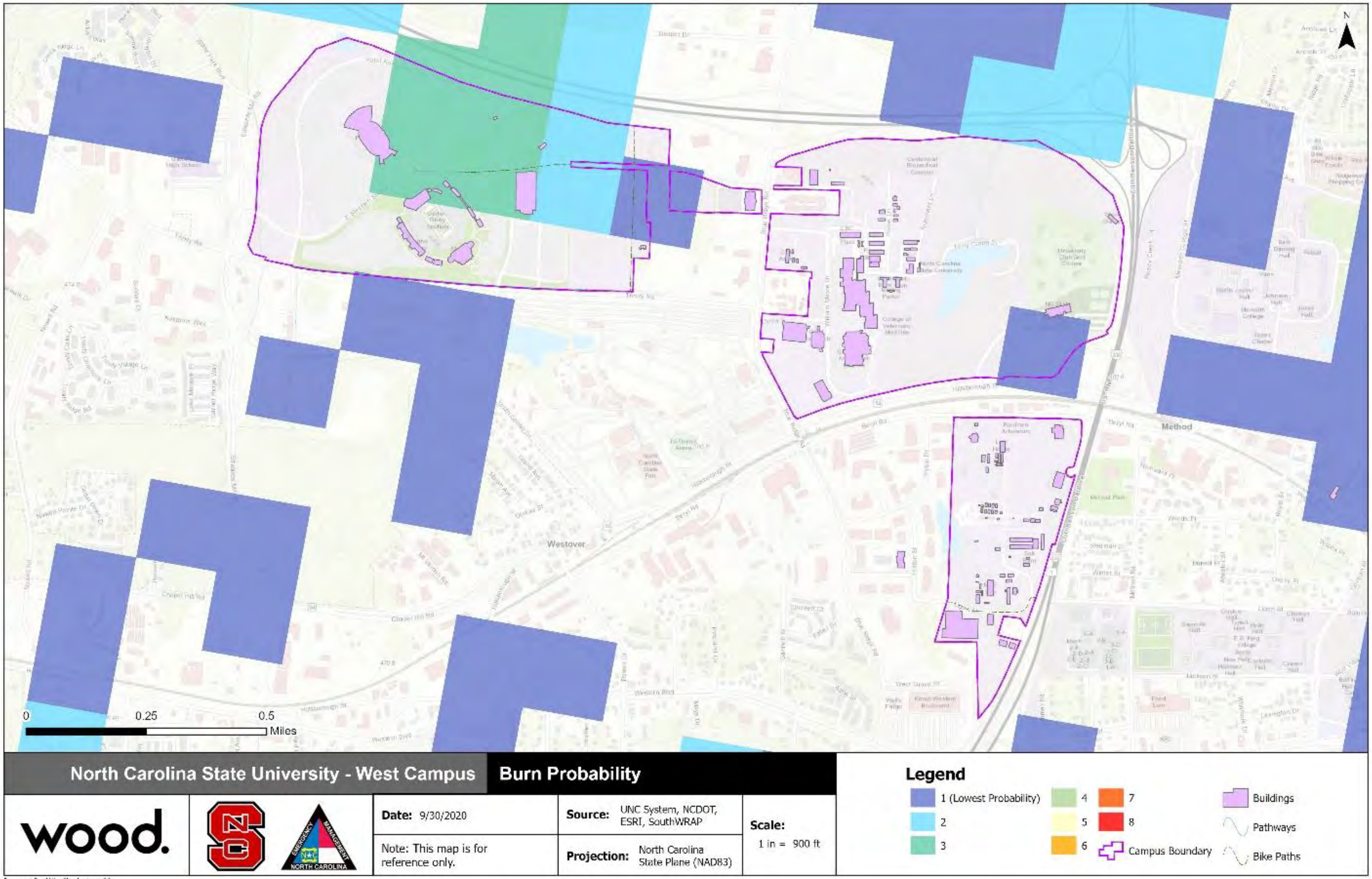


Figure F.37 – Burn Probability, NCSU West Campus



Vulnerability Assessment

People

Wildfire can cause fatalities and human health hazards. Ensuring procedures are in place for rapid warning and evacuation are essential to reducing vulnerability.

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.

Using the Wildland Urban Interface Risk Index (WUIRI) from the Southern Wildfire Risk Assessment, a GIS analysis was used to estimate the exposure of buildings most at risk to loss due to wildfire. The WUIRI shows a rating of the potential impact of wildfire on homes and people. This index ranges from 0 to -9, where lower values are relatively more severe. **Table F.45** summarizes the number of buildings and their total value that fall within areas rated -5 or less on the WUIRI. This table represents potential risks and counts every building within the area rated under -5, actual damages in the event of a wildfire may differ.

Table F.45 – Building Counts and Values within WUIRI under -5

Jurisdiction	Buildings	Building Value
Administration	12	$86,027,456
Critical Facility	4	$103,959,536
Extracurricular/Educational	77	$737,767,233
Housing	47	$286,091,261
Total	**140**	**$1,213,845,486**

Source: GIS Analysis, Southern Wildfire Risk Assessment

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.

Changes in Development

Growth on the NCSU campus within the wildland-urban interface area will increase the vulnerability of people, property, and infrastructure to wildfires. Although a wildfire community protection plan exists for the state of North Carolina, there are no community wildfire protection plans and no wildfire mitigation review requirements or regulations for development in the wildland-urban interface in Wake County.

Problem Statement

- Over 30 percent of all buildings on the NCSU campus fall within areas rated -5 or lower on the WUIRI, including 4 critical facilities (24% of all critical facilities on campus).

F.5.7 Cyber Threat

Hazard	Probability	Impact	Spatial Extent	Warning Time	Duration	PRI Score
Cyber Threat	Possible	Critical	Large	Less than 6 hrs	More than 1 week	3.1

Location

Cyber disruption events can occur and/or impact virtually any location in the state where computing devices are used. Incidents may involve a single location or multiple geographic areas. A disruption can have far-reaching effects beyond the location of the targeted system; disruptions that occur far outside the region can still impact people, businesses, and institutions within the region.

Spatial Extent: 4 – Large

Extent

The extent or magnitude/severity of a cyber disruption event is variable depending on the nature of the event. A disruption affecting a small, isolated system could impact only a few functions/processes. Disruptions of large, integrated systems could impact many functions/processes, as well as many individuals that rely on those systems.

There is no universally accepted scale to quantify the severity of cyber-attacks. The strength of a DDoS attack is sometimes explained in terms of a data transmission rate. One of the largest DDoS disruptions ever, which brought down some of the internet's most popular sites on October 21, 2016, peaked at 1.2 terabytes per second.

Data breaches are often described in terms of the number of records or identities exposed. With the amount of data retained by universities – including student, staff, and faculty personal information as well as research data – a data breach on the NCSU campus could cause significant disruption and impact a large number of records.

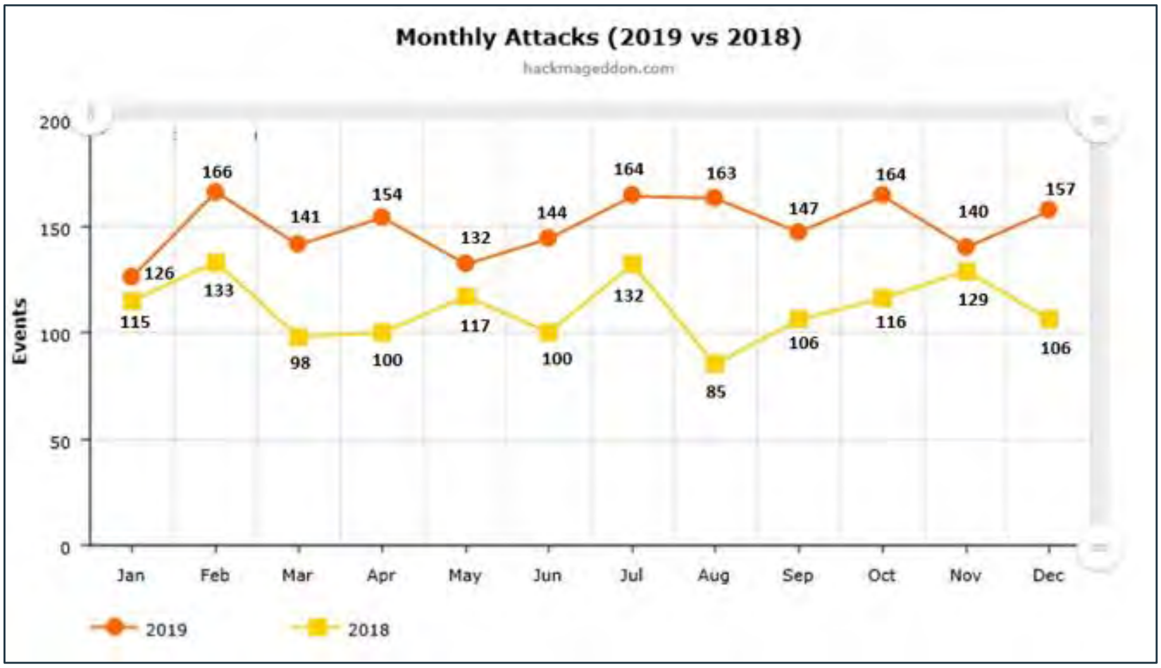
Impact: 3 – Critical

Historical Occurrences

As cyber disruption is an emerging hazard, the reporting and tracking of disruptive events is difficult. In most cases, it is not required to report an event, and when it is reported most of the information is protected due to the sensitive nature of the systems that have been disrupted. However, there currently exists several complex databases that track cyber disruption occurrences. Each system makes use of its own definitions and tracking methods. Hackmageddon is one online source that tracks Cyber Attack Statistics. Hackmageddon was developed by Paolo Passeri, an expert in the computer security industry for more than 15 years and current Principal Sales Engineer at OpenDNS (now part of Cisco). The timelines collect the major cyber events of the related months chosen among events published by open sources (such as blogs or news sites). It should be noted that this database collects cyber-attacks worldwide and this data is provided to show how this hazard is trending in general. During 2019, this database collected reports of a total of 1,802 cyber-attacks.

The graphic in **Figure F.38** provides a comparison of the number of attacks collected during 2018 and 2019. The two following images in **Figure F.39** and **Figure F.40** show the top 10 target distributions for 2018 and 2019. The main finding from the top 10 attack techniques is the percentage of 'other' targeted attacks appearing at 14.1% in 2019. Attacks targeted towards Education slightly increased from 6.4% in 2018 to 7.1% in 2019. Most other target distributions experienced a percentage decrease in 2019. Some of this is probably due to the difference in distribution categories between 2018 and 2019.

Figure F.38 – Comparison of Monthly Attacks Collected by Hackmageddon (2018-2019)



Source: Hackmageddon, https://www.hackmageddon.com/2020/01/23/2019-cyber-attacks-statistics/

Figure F.39 – Top 10 Cyber Attack Target Distributions, 2018

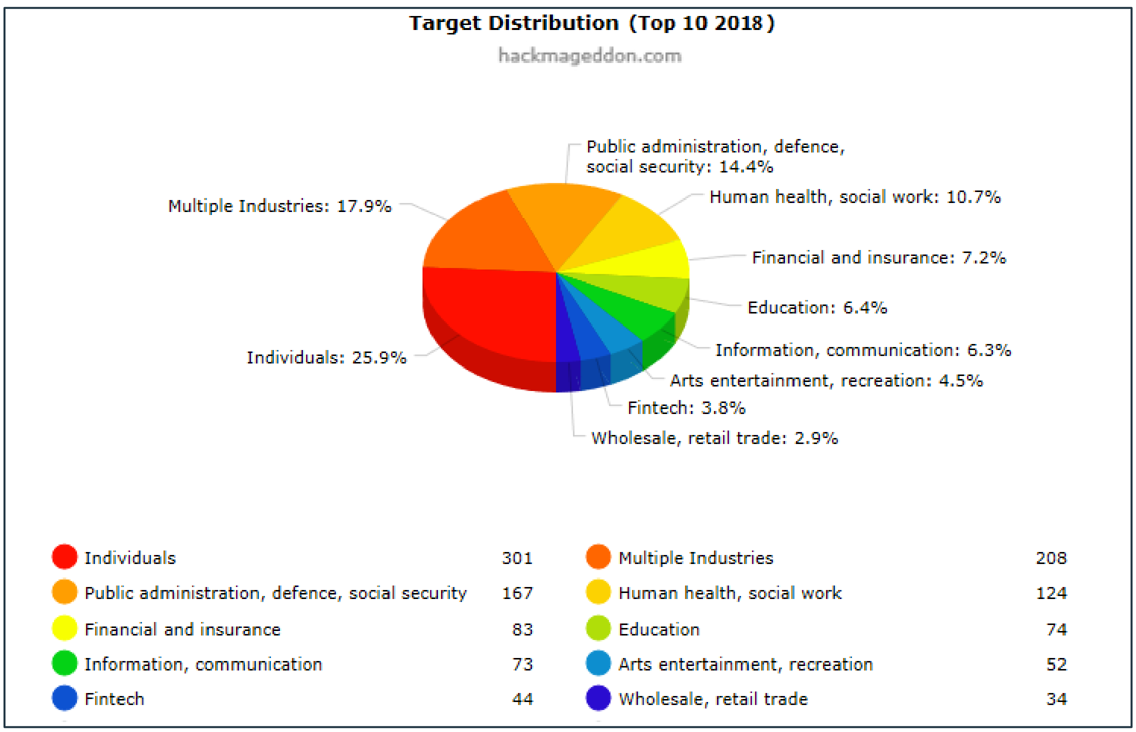
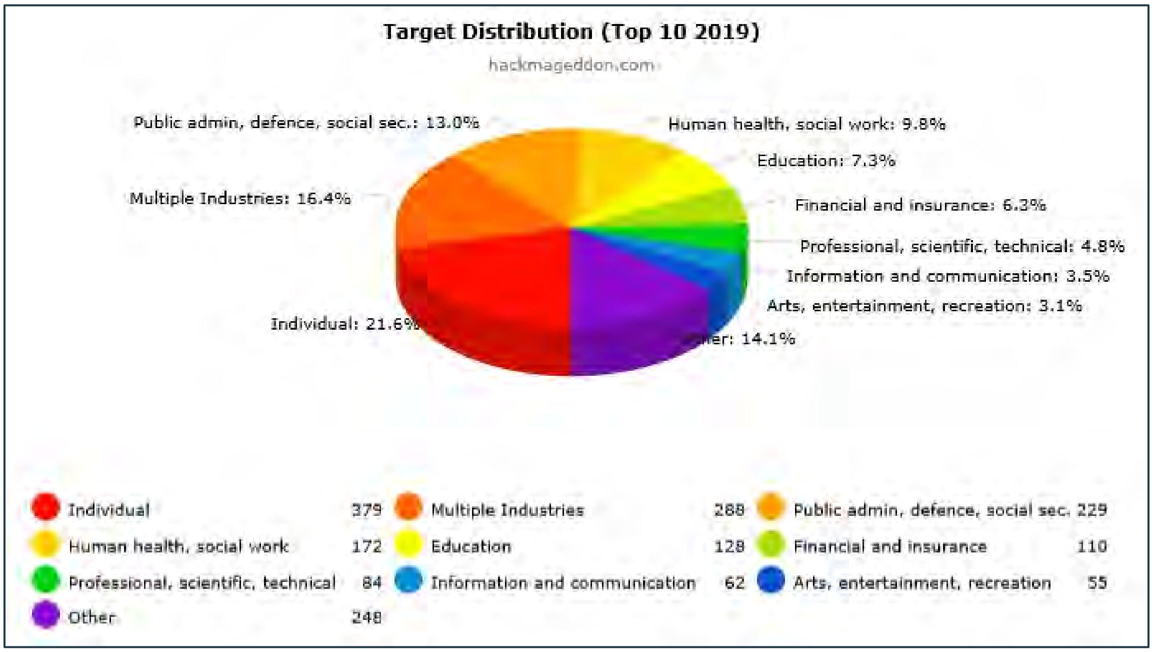


Figure F.40 – Top 10 Cyber Attack Target Distributions, 2019



Source: Hackmageddon

There have been some notable disruption events within the Education target distribution that attained national attention in the last few years:

August 2020, The University of North Carolina Wilmington's Division of University Advancement (DUA) was hacked by a ransomware attack. The data included names, addresses, phone numbers, email addresses, and history of gifts made to UNCW; the University reported that no vulnerable financial or personal information was included. (https://portcitydaily.com/story/2020/08/06/uncw-reports-ransomware-attack-hackers-accessed-personal-details-but-no-financial-info/)

November 2019, The University of North Carolina Chapel Hill School of Medicine reported over 3,500 individuals having private information stolen in phishing cyber-attack, (https://www.databreaches.net/the-university-of-north-carolina-chapel-hill-school-of-medicine-notifying-patients-after-2018-phishing-incident/).

October 2019, Randolph Community College's entire computer network and other devices were compromised following cyberattack. In total, 1,200 devices were affected during the two week attack, (https://www.yourdailyjournal.com/news/89334/report-rcc-cyber-attack-was-first-successful-of-this-scale-at-nc-community-college).

December 2018, The Cape Cod Community College notifies its employees that Hackers stole more than $800,000 when they infiltrated the school's bank accounts, (https://www.databreaches.net/hackers-steal-800000-from-cape-cod-community-college/).

September 2018, The Henderson school district in Texas is hit with a business email compromise (BEC) attack resulting in a $600,000 loss for the district. The attack took place on September, 26th, (https://www.scmagazine.com/home/security-news/bec-attack-scamstexas-school-district-out-of-600000/).

April 2018, Partial social security numbers of more than 1,200 employees at Irvington schools are distributed via email to an unknown number of recipients by an unidentified attacker, (https://www.databreaches.net/hacker-sent-email-with-1200-partial-social-security-numbers-to-school-staff/).

March 2018, Florida Virtual Learning School notifies 368,000 current and former students, after an individual with the moniker $2a$45 uploads information of 35,000 students on a forum. Leon County Schools is among the affected organizations, (https://www.databreaches.net/leon-county-schools-vendors-data-leak-exposed-368000-current-and-former-flvs-students-details-lcs-teacher-data-and-more/).

November 2017, Monticello Central School District warns of a sophisticated e-mail phishing attack occurred on November 1st, 2017. Potentially 2,598 individuals are affected, (https://www.databreaches.net/monticello-central-school-district-notifying-almost-2600-of-phishing-attack-last-year/).

October 2017, The Los Angeles Valley College (LAVC) is forced to pay $28,000 in bitcoin after cybercriminals successfully infected its computer networks, email systems and voicemail lines with ransomware, (https://www.ibtimes.co.uk/la-school-pays-hackers-28000-bitcoin-after-computer-systems-hit-ransomware-1600304).

July 2017, Tax information for dozens of University of Louisville employees is compromised after a hack of the online system the university uses to give employees access to tax documents, (https://www.databreaches.net/tax-information-of-some-university-of-louisville-employees-hacked/).

April 2017, Westminster College in Missouri reveals the details of a breach discovered on March 26 after a phishing scam duped a staffer into sending off W-2 statements, (https://www.scmagazine.com/home/security-news/data-breach/w-2-data-breach-at-westminster-college/).

Probability of Future Occurrence

Cyber-attacks occur daily, but most have negligible impacts at the local or regional level. The possibility of a larger disruption affecting systems within the region is a constant threat, but it is difficult to quantify the exact probability due to such highly variable factors as the type of attack and intent of the attacker. Minor attacks against business and government systems have become a commonplace occurrence but are usually stopped with minimal impact. Similarly, data breaches impacting the information of students and faculty of NCSU are almost certain to happen in coming years. Major attacks or breaches specifically targeting systems at the University are less likely but cannot be ruled out.

Probability: 2 – Possible

Vulnerability Assessment

As discussed above, the impacts from a cyber-attack vary greatly depending on the nature, severity, and success of the attack.

People

Cyber-attacks can have a significant cumulative economic impact. Check Point Research reports that in 2018, cybercrime rates were estimated to have generated around 1.5 trillion dollars. A major cyber-attack has the potential to undermine public confidence and build doubt in their government's ability to protect them from harm. Injuries or fatalities from cyber-attacks would generally only be possible from a major cyber terrorist attack against critical infrastructure.

Property

Short of a major cyber terrorist attacks against critical infrastructure, property damage from cyber-attacks is typically limited to computer systems.

Environment

Short of a major cyber terrorist attacks against critical infrastructure, property damage from cyber-attacks is typically limited to computer systems. A major cyber terrorism attack could potentially impact the environment by triggering a release of a hazardous materials, or by causing an accident involving hazardous materials by disrupting traffic-control devices.

Changes in Development

With enrollment increasing since the last plan, the number of users of campus networks and software has increased. For future development, as the number of users and/or access points to the network and campus software increases, the opportunity for cyber-attacks is also likely to increase.

Problem Statement

- Cyber-attacks occur daily, but most have negligible impacts at the local or regional level. The possibility of a larger disruption affecting systems within the region is a constant threat, but difficult to quantify.
- The University's Office of Information Technology (OIT) addresses cybersecurity through leadership, governance, and collaboration, as well as, cybersecurity services, compliance assurance, policies, regulations and rules (PRRs), and cybersecurity awareness and training.

F.5.8 Hazardous Materials Incidents

Hazard	Probability	Impact	Spatial Extent	Warning Time	Duration	PRI Score
Hazardous Materials Incident	Highly Likely	Minor	Negligible	Less than 6 hrs	More than 1 week	2.3

Location

Hazardous materials releases at fixed sites can cause a range of contamination from very minimal to catastrophic. The releases can go into the air, onto the surface, or into the ground and possibly into groundwater, or a combination of all. Although releases into the air or onto the ground surface can pose a great and immediate risk to human health, they are generally easier to remediate than those releases which enter into the ground or groundwater. Soil and groundwater contamination may take years to remediate causing possible long-term health problems for individuals and rendering land unusable for many years.

The Toxics Release Inventory (TRI) Program run by the 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 10 sites reporting hazardous materials in Raleigh from 2016-2018. These sites are detailed by location and sector in **Table F.46**.

Table F.46 – Toxic Release Inventory Facilities in Raleigh

Facility Name	Sector
Raleigh	
MALLINCKRODT PHARMACEUTICALS	Chemicals
OLDCASTLE PRECAST INC	Nonmetallic Mineral Product
SURTRONICS INC	Fabricated Metals
ARGOS PERSHING RD CONCRETE PLANT	Nonmetallic Mineral Product
CONCRETE SUPPLY CO LLC - DURANT PARK	Nonmetallic Mineral Product
FLOWSERVE - RALEIGH	Fabricated Metals
SAFETY-KLEEN SYSTEMS RALEIGH (RAL)	Hazardous Waste
EAST CAROLINA METAL TREATING INC	Fabricated Metals
AJINOMOTO HEALTH & NUTRITION NA INC	Chemicals
CMC REBAR NC RALEIGH	Fabricated Metals

Source: EPA Toxic Release Inventory

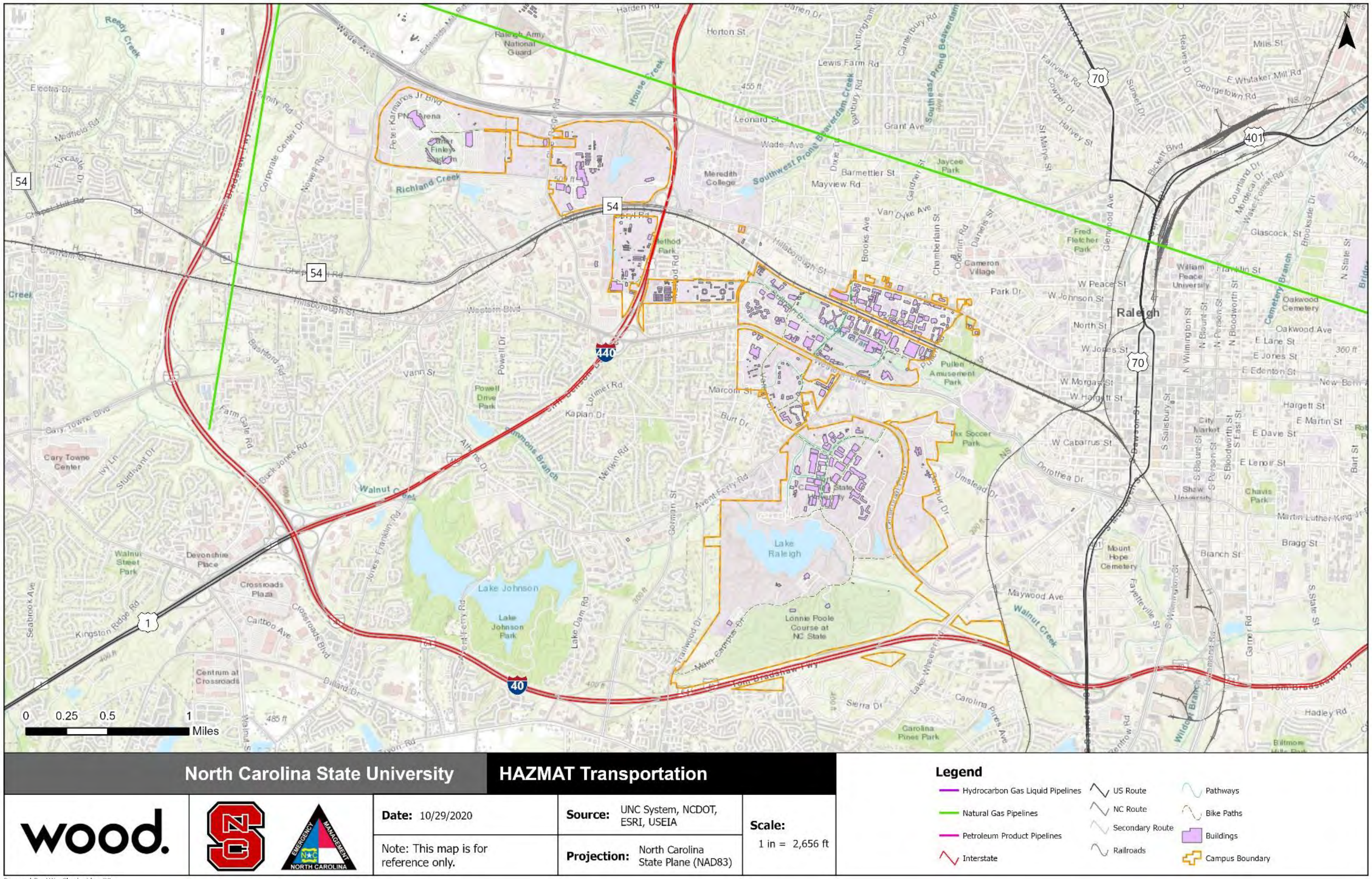
On campus, buildings within the Centennial Biomedical Campus store hazardous materials, as well as, various campus utilities buildings. Storage quantities were not reported for this mitigation planning effort.

Transportation hazardous materials Incidents can occur when hazardous materials are being transported from one location to another in the normal course of business for manufacturing, refining, or other industrial purposes. Additionally, hazardous materials incidents can occur as hazardous waste is transported for final storage and/or disposal. **Figure F.41** shows the routes of transportation for hazardous materials adjacent to or through NCSU's campus.

While a hazardous materials incident could occur in many locations across the campus, any individual hazardous material incident would most likely be highly localized.

Spatial Extent: 1 – Negligible

Figure F.41 – Hazardous Materials Transportation Routes near the NCSU Campus



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.

Prior to 2002, however, a "serious incident" regarding hazardous materials was defined as follows:

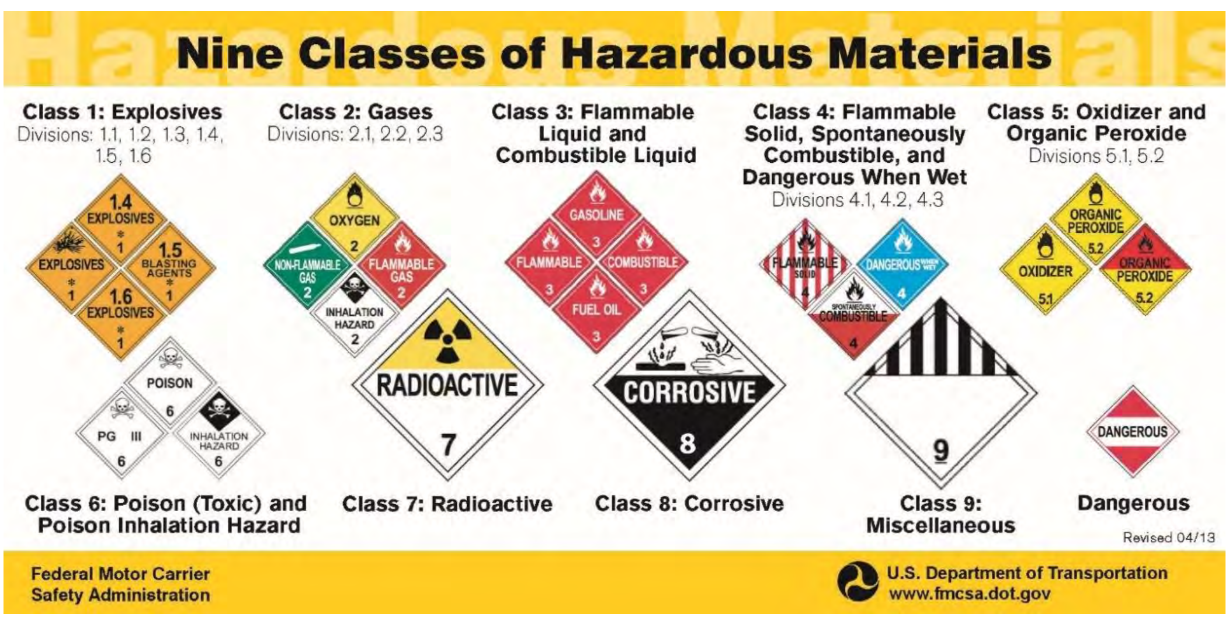
- a fatality or major injury due to a hazardous material
- closure of a major transportation artery or facility or evacuation of six or more persons due to the presence of hazardous material, or
- a vehicle accident or derailment resulting in the release of a hazardous material.

Impact: 1 – Minor

Historical Occurrences

The USDOT's PHMSA maintains a database of reported hazardous materials incidents, which are summarized by location and hazardous material class (see **Figure F.42**). According to PHMSA records, there were 10 recorded releases in Raleigh in 2020. Five of these events were minor Class 3 spills, and the other five incidents were minor class 8 spills.

Figure F.42 – Hazardous Materials Classes



Source: U.S. Department of Transportation

Probability of Future Occurrence

Based on historical occurrences recorded by PHMSA, there have been 384 incidents of hazardous materials release in the 20-year period from 2000 through 2019. Using historical occurrences as an indication of future probability, there is over a 100 percent annual probability of a hazardous materials incident occurring throughout the City of Raleigh.

Probability: 4 – Highly Likely

Vulnerability Assessment

People

Hazardous materials incidents can cause injuries, hospitalizations, and even fatalities to people nearby. People living near hazardous facilities and along transportation routes may be at a higher risk of exposure, particularly those living or working downstream and downwind from such facilities. For example, a toxic spill or a release of an airborne chemical near a populated area can lead to significant evacuations and have a high potential for loss of life. Individuals working with or transporting hazardous materials are also at heightened risk.

In addition to the immediate health impacts of releases, a handful of studies have found long term health impacts such as increased incidence of certain cancers and birth defects among people living near certain chemical facilities. However there has not been sufficient research done on the subject to allow detailed analysis.

The primary economic impact of hazardous material incidents results from lost business, delayed deliveries, property damage, and potential contamination. Large and publicized hazardous material-related events can deter tourists and could potentially discourage residents and businesses. Economic effects from major transportation corridor closures can be significant.

Property

The impact of a fixed hazardous facility, such as a chemical processing facility is typically localized to the property where the incident occurs. The impact of a small spill (i.e. liquid spill) may also be limited to the extent of the spill and remediated if needed. While cleanup costs from major spills can be significant, they do not typically cause significant long-term impacts to property.

Impacts of hazardous material incidents on critical facilities are most often limited to the area or facility where they occurred, such as at a transit station, airport, fire station, hospital, or railroad. However, they can cause long-term traffic delays and road closures resulting in major delays in the movement of goods and services. These impacts can spread beyond the planning area to affect neighboring counties, or vice-versa. While cleanup costs from major spills can be significant, they do not typically cause significant long-term impacts to critical facilities, but there is a chance they may be impacted.

Environment

Hazardous material incidents may affect a small area at a regulated facility or cover a large area outside such a facility. Widespread effects occur when hazards contaminate the groundwater and eventually the municipal water supply, or they migrate to a major waterway or aquifer. Impacts on wildlife and natural resources can also be significant.

Changes in Development

Structures located near fixed facilities, highways and other high traffic roadways are most at risk to a hazardous materials event. Any development that takes place in these areas will place more people and structures in the risk area for hazardous materials events, however since most hazardous material spills are localized to an extremely small area this will not have an effect on the overall risk assessment for this hazard.

Problem Statement

- Transportation and pipeline routes for hazardous materials are located adjacent to the NCSU Campuses.
- The number of reported incidents within Raleigh can be approximated to over 100-percent annual probability

F.5.9 Infectious Disease

Hazard	Probability	Impact	Spatial Extent	Warning Time	Duration	PRI Score
Infectious Disease	Possible	Critical	Large	More than 24 hrs	More than 1 week	2.8

Location

Infectious disease outbreaks can occur anywhere in the planning area, especially where there are groups of people in close quarters.

Spatial Extent: 4 – Large

Extent

When on an epidemic scale, diseases can lead to high infection rates in the population causing isolation, quarantine, and potential mass fatalities. An especially severe influenza pandemic or other major disease outbreak could lead to high levels of illness, death, social disruption, and economic loss. Impacts could range from school and business closings to the interruption of basic services such as public transportation, health care, and the delivery of food and essential medicines.

Table F.47 describes the World Health Organization's six main phases to a pandemic flu as part of their planning guidance.

Table F.47 – World Health Organization's Pandemic Flu Phases

Phase	Description
1	No animal influenza virus circulating among animals have been reported to cause infection in humans.
2	An animal influenza virus circulating in domesticated or wild animals is known to have caused infection in humans and is therefore considered a specific potential pandemic threat.
3	An animal or human-animal influenza reassortant virus has caused sporadic cases or small clusters of disease in people, but has not resulted in human-to-human transmission sufficient to sustain community-level breakouts.
4	Human-to-human transmission of an animal or human-animal influenza reassortant virus able to sustain community-level breakouts has been verified.
5	The same identified virus has caused sustained community-level outbreaks in two or more countries in one WHO region.
6	In addition to the criteria defined in Phase 5, the same virus has caused sustained community-level outbreaks in at least one other country in another WHO region.
Post-Peak Period	Levels of pandemic influenza in most countries with adequate surveillance have dropped below peak levels.
Post-Pandemic Period	Levels of influenza activity have returned to levels seen for seasonal influenza in most countries with adequate surveillance.

Source: World Health Organization

Impact: 3 – Critical

Historical Occurrences

Since the early 1900s, four lethal pandemics have swept the globe: Spanish Flu of 1918-1919; Asian Flu of 1957-1958; Hong Kong Flu of 1968-1969; and Swine Flu of 2009-2010. The Spanish Flu was the most severe pandemic in recent history. The number of deaths was estimated to be 50-100 million worldwide and 675,000 in the United States. Its primary victims were mostly young, healthy adults. The 1957 Asian Flu pandemic killed about 70,000 people in the United States, mostly the elderly and chronically ill. The

1968 Hong Kong Flu pandemic killed 34,000 Americans. The 2009 Swine Flu caused 12,469 deaths in the United States. These historic pandemics are further defined in the following paragraphs along with several "pandemic scares".

Spanish Flu (H1N1 virus) of 1918-1919

In 1918, when World War I was in its fourth year, another threat began that rivaled the war itself as the greatest killer in human history. The Spanish Flu swept the world in three waves during a two-year period, beginning in March 1918 with a relatively mild assault.

The first reported case occurred at Camp Funston (Fort Riley), Kansas, where 60,000 soldiers trained to be deployed overseas. Within four months, the virus traversed the globe, as American soldiers brought the virus to Europe. The first wave sickened thousands of people and caused many deaths (46 died at Camp Funston), but it was considered mild compared to what was to come. The second and deadliest wave struck in the autumn of 1918 and killed millions. At Camp Funston alone, there were 14,000 cases and 861 deaths reported during the first three weeks of October 1918.

Outbreaks caused by a new variant exploded almost simultaneously in many locations including France, Sierra Leone, Boston, and New York City, where more than 20,000 people died that fall. The flu gained its name from Spain, which was one of the hardest hit countries. From there, the flu went through the Middle East and around the world, eventually returning to the United States along with the troops.

Of the 57,000 Americans who died in World War I, 43,000 died because of the Spanish Flu. At one point, more than 10 percent of the American workforce was bedridden. By a conservative estimate, a fifth of the human race suffered the fever and aches of influenza between 1918 and 1919 and 20 million people died. At the height of the flu outbreak during the winter of 1918-1919, at least 20% of North Carolinians were infected by the disease. Ultimately, 10,000 citizens of the state succumbed to this disease.

Asian Flu (H2N2 virus) of 1957-1958

This influenza pandemic was first identified in February 1957 in the Far East. Unlike the Spanish Flu, the 1957 virus was quickly identified, and vaccine production began in May 1957. Several small outbreaks occurred in the United States during the summer of 1957, with infection rates highest among school children, young adults, and pregnant women; however, the elderly had the highest rates of death. A second wave of infections occurred early the following year, which is typical of many pandemics.

Hong Kong Flu (H3N2 virus) of 1968-1969

This influenza pandemic was first detected in early 1968 in Hong Kong. The first cases in the United States were detected in September 1968, although widespread illness did not occur until December. This became the mildest pandemic of the twentieth century, with those over the age of 65 the most likely to die. People infected earlier by the Asian Flu virus may have developed some immunity against the Hong Kong Flu virus. Also, this pandemic peaked during school holidays in December, limiting student-related infections.

Pandemic Flu Threats: Swine Flu of 1976, Russian Flu of 1977, and Avian Flu of 1997 and 1999

Three notable flu scares occurred in the twentieth century. In 1976, a swine-type influenza virus appeared in a U.S. military barracks (Fort Dix, New Jersey). Scientists determined it was an antigenically drifted variant of the feared 1918 virus. Fortunately, a pandemic never materialized, although the news media made a significant argument about the need for a Swine Flu vaccine.

In May 1977, influenza viruses in northern China spread rapidly and caused epidemic disease in children and young adults. By January 1978, the virus, subsequently known as the Russian Flu, had spread around

the world, including the United States. A vaccine was developed for the virus for the 1978–1979 flu season. Because illness occurred primarily in children, this was not considered a true pandemic.

In March 1997, scores of chickens in Hong Kong's rural New Territories began to die—6,800 on three farms alone. The Avian Flu virus was especially virulent and made an unusual jump from chickens to humans. At least 18 people were infected, and six died in the outbreak. Chinese authorities acted quickly to exterminate over one million chickens and successfully prevented further spread of the disease. In 1999, a new avian flu virus appeared. The new virus caused illness in two children in Hong Kong. Neither of these avian flu viruses started pandemics.

Swine Flu (H1N1 virus) of 2009–2010

This influenza pandemic emerged from Mexico in 2009. The first U.S. case of H1N1, or Swine Flu, was diagnosed on April 15, 2009. The U.S. government declared H1N1 a public health emergency on April 26. By June, approximately 18,000 cases of H1N1 had been reported in the United States. A total of 74 countries were affected by the pandemic.

The CDC estimates that 43 million to 89 million people were infected with H1N1 between April 2009 and April 2010. There were an estimated 8,870 to 18,300 H1N1 related deaths. On August 10, 2010, the World Health Organization (WHO) declared an end to the global H1N1 flu pandemic.

Historical occurrences of pandemics other than influenza include the following:

Meningitis, 1996-1997, 2005

During 1996 and 1997, 213,658 cases of meningitis were reported, with 21,830 deaths, in Africa. According to the North Carolina Disease Data Dashboard, there were 28 cases in North Carolina in 2005.

Lyme Disease, 2015

In the United States, Lyme disease is mostly found in the northeastern, mid-Atlantic, and upper north-central regions, and in several counties in northwestern California. In 2015, 95-percent of confirmed Lyme Disease cases were reported from 14 states: Connecticut, Delaware, Maine, Maryland, Massachusetts, Minnesota, New Hampshire, New Jersey, New York, Pennsylvania, Rhode Island, Vermont, Virginia, and Wisconsin. Lyme disease is the most reported vector-borne illness in the United States. In 2015, it was the sixth most common nationally notifiable disease. However this disease does not occur nationwide and is concentrated heavily in the northeast and upper Midwest.

Severe Acute Respiratory Syndrome, 2003

During November 2002-July 2003, a total of 8,098 probable SARS cases were reported to the World Health Organization (WHO) from 29 countries. In the United States, only 8 cases had laboratory evidence of infection. Since July 2003, when SARS transmission was declared contained, active global surveillance for SARS disease has detected no person-to-person transmission. CDC has therefore archived the case report summaries for the 2003 outbreak. Across North Carolina, there was one confirmed SARS case – a man in Orange County tested positive in June 2003.

Zika Virus, 2015

In May 2015, the Pan American Health Organization issued an alert noting the first confirmed case of a Zika virus infection in Brazil. Since that time, Brazil and other Central and South America countries and territories, as well as the Caribbean, Puerto Rico, and the U.S. Virgin Islands have experienced ongoing Zika virus transmission. In August 2016, the Centers for Disease Control and Prevention (CDC) issued guidance for people living in or traveling to a 1-square-mile area Miami, Florida, identified by the Florida Department of Health as having mosquito-borne spread of Zika. In October 2016, the transmission area

was expanded to include a 4.5-square-mile area of Miami Beach and a 1-squre mile area of Miami-Dade County. In addition, all of Miami-Dade County was identified as a cautionary area with an unspecified level of risk. As of the end of 2018, the CDC reported 74 cases of Zika across the United States.

Ebola, 2014-2016

In March 2014, West Africa experienced the largest outbreak of Ebola in history. Widespread transmission was found in Liberia, Sierra Leone, and Guinea with the number of cases totaling 28,616 and the number of deaths totaling 11,310. In the United States, four cases of Ebola were confirmed in 2014 including a medical aid worker returning to New York from Guinea, two healthcare workers at Texas Presbyterian Hospital who provided care for a diagnosed patient, and the diagnosed patient who traveled to Dallas, Texas from Liberia. All three healthcare workers recovered. The diagnosed patient passed away in October 2014.

In March 2016, the WHO terminated the public health emergency for the Ebola outbreak in West Africa.

Coronavirus Disease (COVID-19), 2020

During the update of this plan, the Coronavirus disease 2019, also known as COVID-19, outbreak became a worldwide pandemic. COVID-19 was caused by severe acute respiratory syndrome coronavirus 2 (SARS-Cov-2). First identified in Wuhan, China in December 2019, the virus quickly spread throughout China and then globally. As of October 18, 2020, there were over 39.5 million cases worldwide resulting in over 1.1 million deaths. In the United States, COVID-19 was first identified in late January in Washington State and rapidly spread throughout the Country, with large epicenters on both the east and west coasts.

In order to curb the spread of the virus, Governor Roy Cooper issued a statewide Stay at Home Order on March 27, 2020. According to the North Carolina Department of Health and Human services, as of October 23, 2020, there were over 255,708 confirmed cases and 4,114 deaths across all 100 counties in the State. In Wake County, as of October 23, 2020, there were a total of 20,283 cases and 269 deaths. Case counts are still rising in North Carolina and Wake County at the time of this assessment.

Probability of Future Occurrence

It is impossible to predict when the next pandemic will occur or its impact. The CDC continually monitors and assesses pandemic threats and prepares for an influenza pandemic. Novel influenza A viruses with pandemic potential include Asian lineage avian influenza A (H5N1) and (H7N9) viruses. These viruses have all been evaluated using the Influenza Risk Assessment Tool (IRAT) to assess their potential pandemic risk. Because the CDC cannot predict how severe a future pandemic will be, advance planning is needed at the national, state and local level; this planning is done through public health partnerships at the national, state and local level.

Today, a much larger percentage of the world's population is clustered in cities, making them ideal breeding grounds for epidemics. Additionally, the explosive growth in air travel means the virus could literally be spread around the globe within hours. Under such conditions, there may be very little warning time. Most experts believe we will have just one to six months between the time that a dangerous new influenza strain is identified and the time that outbreaks begin to occur in the United States. Outbreaks are expected to occur simultaneously throughout much of the nation, preventing shifts in human and material resources that normally occur with other natural disasters. These and many other aspects make influenza pandemic unlike any other public health emergency or community disaster.

Probability: 2 – Possible

Vulnerability Assessment

People

Disease spread and mortality is affected by a variety of factors, including virulence, ease of spread, aggressiveness of the virus and its symptoms, resistance to known antibiotics and environmental factors. While every pathogen is different, diseases normally have the highest mortality rate among the very young, the elderly or those with compromised immune systems. As an example, the unusually deadly 1918 H1N1 influenza pandemic had a mortality rate of 20%. If an influenza pandemic does occur, it is likely that many age groups would be seriously affected. The greatest risks of hospitalization and death—as seen during the last two pandemics in 1957 and 1968 as well as during annual outbreaks of influenza—will be to infants, the elderly, and those with underlying health conditions. However, in the 1918 pandemic, most deaths occurred in young adults. Few people, if any, would have immunity to a new virus.

Approximately twenty percent of people exposed to West Nile Virus through a mosquito bite develop symptoms related to the virus; it is not transmissible from one person to another. Preventive steps can be taken to reduce exposure to mosquitos carrying the virus; these include insect repellent, covering exposed skin with clothing and avoiding the outdoors during twilight periods of dawn and dusk, or in the evening when the mosquitos are most active.

Property

For the most part, property itself would not be impacted by a human disease epidemic or pandemic. However, as concerns about contamination increase, property may be quarantined or destroyed as a precaution against spreading illness. Furthermore, staffing shortages could affect the function of critical facilities.

Environment

A widespread pandemic would not have an impact on the natural environment unless the disease was transmissible between humans and animals. However, affected areas could result in denial or delays in the use of some areas, and may require remediation.

Changes in Development

With enrollment increasing since the last plan, the number of students and employees on campus has increased. For future development, as the number of students and employees increase, the opportunity for spread of a pandemic would increase, should in-person educational and/or extracurricular meetings take place.

Problem Statement

- With the current COVID-19 pandemic, it is clear the NCSU campus population is susceptible to the infectious disease pandemic.
- NCSU has a pandemic influenza plan in place to provide a guide for the University to follow in the event of an influenza pandemic in North Carolina.

F.5.10 Terrorism

Hazard	Probability	Impact	Spatial Extent	Warning Time	Duration	PRI Score
Terrorism	Unlikely	Catastrophic	Large	More than 24 hrs	More than 1 week	2.8

Location

Terrorism is defined in the Code of Federal Regulations as "the unlawful use of force and violence against persons or property to intimidate or coerce a government, the civilian population, or any segment thereof, in furtherance of political or social objectives" (28 CFR Section 0.85). The threat of terrorism, both international and domestic, is ever present, and an attack is likely to occur when least expected. A terror threat could occur at any location in the area, but are more likely to target highly populated areas, critical infrastructure, or symbolic locations.

Before the September 11, 2001 attacks in New York and the Pentagon, most terrorist incidents in the United States have been bombing attacks, involving detonated and un-detonated explosive devices, tear gas, and pipe and firebombs. The effects of terrorism can vary significantly from loss of life and injuries to property damage and disruptions in services such as electricity, water supply, public transportation and communications. The U.S. government has attempted to reduce vulnerability to terrorist incidents by developing infrastructure protection programs for critical infrastructure and key resource facilities and increased security at airports.

While we can never predict what target a terrorist will choose, we do know some of the factors they use when selecting a target. Terrorists want to achieve one or more of the following:

- Produce a large number of victims,
- Attack places that have a symbolic value,
- Get the greatest possible media attention, and
- Produce mass panic.

Terrorists also select targets best suited for the type of material being used. For example, some biological agents are not effective in sunlight. Most chemical agents are more effective indoors with limited airflow. A radioactive material will be most effective where large numbers of people will pass close by without detecting it. Terrorists are likely to target heavily populated, enclosed areas like stadiums, government buildings, sporting events, airport terminals, subways, shopping malls and industrial manufacturing facilities. For this reason, it is critical that employers and local government agencies have some type of anti-terrorism plan in place should a terrorist act occur.

A terrorist attack can take several forms, depending on the technological means available to the terrorist, the nature of the political issue motivating the attack, and the points of weakness of the terrorist's target. Bombings have been the most frequently used terrorist method in the United States. Other possibilities include an attack at transportation facilities, an attack against utilities or other public services or an incident involving chemical or biological agents.

Spatial Extent: 4 – Large

Extent

In the United States, most terrorist incidents have involved small extremist groups who use terrorism to achieve a designated objective. Local, state and federal law enforcement officials monitor suspected terrorist groups and try to prevent or protect against a suspected attack. Additionally, the US government works with other countries to limit the sources of support for terrorism.

The Southern Poverty Law Center reports that in 2019, there were 32 active hate groups in North Carolina, as seen in **Table F.48**. Although no major terrorist acts have been attributed to any of these groups, their involvement in violent acts is meant to disrupt governmental functions and cannot be discounted.

Table F.48 – List of Hate Groups in North Carolina, 2019

Name	Type	City
American Christian Dixie Knights of the Ku Klux Klan	Ku Klux Klan	Statewide
American Identity Movement	White Nationalist	Statewide
Americans for Legal Immigration (ALIPAC)	Anti-Immigrant	Raleigh
Asatru Folk Assembly	Neo-Volkisch	Statewide
Blood and Honour Social Club	Racist Skinhead	Statewide
Blood and Honour USA	Racist Skinhead	Statewide
Confederate Hammerskins	Racist Skinhead	Statewide
Crew 38	Racist Skinhead	Statewide
Great Millstone	Black Separatist	Charlotte
Heirs to the Confederacy	Neo-Confederate	Asheboro
Identity Dixie	Neo-Confederate	Statewide
Israel United In Christ	Black Separatist	Concord
Israelite School of Universal Practical Knowledge	Black Separatist	Charlotte
Israelite School of Universal Practical Knowledge	Black Separatist	Durham
Israelite School of Universal Practical Knowledge	Black Separatist	Fayetteville
Israelite School of Universal Practical Knowledge	Black Separatist	Greensboro
Israelite School of Universal Practical Knowledge	Black Separatist	Greenville
Israelite School of Universal Practical Knowledge	Black Separatist	Winston-Salem
Israelites Saints of Christ	Black Separatist	Statewide
Loyal White Knights of the Ku Klux Klan	Ku Klux Klan	Pelham
Masharah Yasharahla - Government of Israel	Black Separatist	Raleigh
Nation of Islam	Black Separatist	Charlotte
Nation of Islam	Black Separatist	Durham
Nation of Islam	Black Separatist	Greensboro
Nation of Islam	Black Separatist	Wilmington
Nation of Islam	Black Separatist	Winston-Salem
New Black Panther Party for Self Defense	Black Separatist	Charlotte
Patriot Front	White Nationalist	Statewide
Proud Boys	General Hate	Statewide
Southern Revivalism	Neo-Confederate	Statewide
The Right Stuff	White Nationalist	Statewide
The United Nuwaupians Worldwide/All Eyes on Egipt	General Hate	Charlotte

Source: Southern Poverty Law, www.splcenter.org

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

Historical Occurrences

There are no reported terrorism incidents for the NCSU campus. However, the following incidents have occurred on other university campuses within the State:

- **May 15, 1954 – UNC Chapel Hill** – Three individuals were shot (one fatally) during a fraternity house carnival at the Phi Delta Theta house at the University of North Carolina.
- **October 3, 2010 – Mid-Atlantic Christian University** - A student at Mid-Atlantic Christian University was shot to death inside Pearl A. Presley Hall, a campus dormitory. Police arrested a 23-year-old male student after the shooting and charged him with first-degree murder. The suspect claimed self-defense, saying the victim came at him with a knife while he was sitting at his computer. The suspect testified he felt he was in danger because he was a gay student at a religious school.
- **November 2, 2013 – North Carolina A&T State University** - One person was shot and wounded at the university. The victim was hospitalized. The university was temporarily locked down that night. No suspects are in custody.
- **April 13, 2015 – Wayne Community College of Goldsboro** – A school employee was fatally shot in the school library. A 20-year-old male suspect was arrested for the killing early the next day.
- **November 1, 2015 – Winston-Salem State University** - One person died, and another person was injured after someone opened fire on campus. A 21-year-old non-student suspect is sought.
- **April 30, 2019 – UNC Charlotte** – A 22-year-old former history undergraduate at UNC Charlotte shot six students and killed two. Probability of Future Occurrence

Probability of Future Occurrence

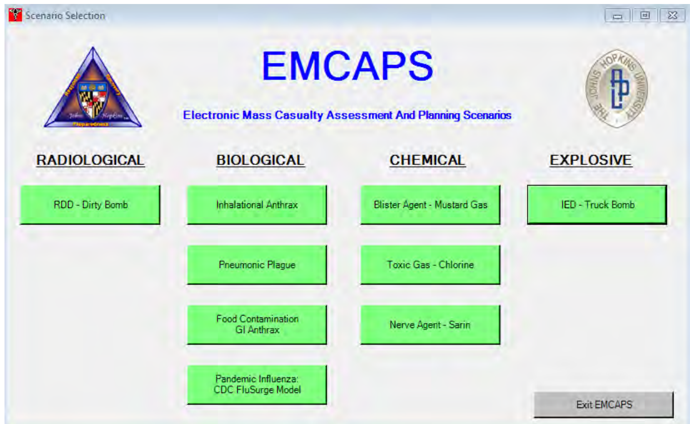
While difficult to estimate when a deliberate act like terrorism may occur, it can be inferred that the probability of a terrorist attack in any one area in the Region is very low at any given time. When identified, credible threats may increase the probability of an incident; these threats are generally tracked by law enforcement.

Probability: 1 – Unlikely

Vulnerability Assessment

Because damage analysis capabilities are still evolving for man-made hazards, such as bombs, a program developed by Johns Hopkins University in 2006 called Electronic Mass Casualty Assessment and Planning Scenarios (EMCAPS) was used to model blast effects and calculate the resulting casualty population. Buildings and other physical structures were not considered in these calculations; it is assumed that the explosion takes place in a relatively open area (e.g. stadium parking lot, park, etc). With the difficult-to-quantify risks of terrorism, the HMPC chose to model worst-case scenarios and estimate losses based on those planning scenarios available within the EMCAPS program, as developed by the Department of Homeland Security.

Figure F.43 – EMCAPS Software



Utilizing the EMCAPS model, scenarios are defined by both bomb size and population density:

- Bomb Size (500, 1000, 2000, 3000, 4000, or 5000 lbs.)
- Population Density (1 person per 25, 50, 100, 225, or 625 square feet).

****THE FOLLOWING HYPOTHETICAL SCENARIOS ARE FOR INSTRUCTIONAL AND ILLUSTRATIVE PURPOSES ONLY****

Explosive Device – Carter-Finley Stadium (NCSU West Campus)

Scenario Overview: A Vehicle-Borne Improvised Explosive Device (VBIED) utilizing an ammonium nitrate/fuel oil (ANFO) mixture is carried in a cargo truck near Carter-Finley Stadium during a highly attended football game and detonated.

Assumptions: (1) The population density outside the stadium prior to an event is high, at least 1 person/50 square feet. (2) The disguised large vehicle bomb contains 4,000 pounds of a readily attainable conventional explosive material such as ammonium nitrate/fuel oil (ANFO) or a commercial high explosive. (3) The estimated lethal air blast range for this vehicle (4,000 pounds of ANFO) is 300 feet.

Table F.49 – EMCAPS Described Losses – Carter-Finley Stadium

Total Dead	695 persons
Total Traumatic Injuries	1,218 persons
Total Urgent Care Injuries	5,967 persons
Injuries not Requiring Hospitalization	2,233 persons
Healthcare Considerations	Triage concerns: many victims will be unconscious; many victims will have hearing loss; psychological distressed but unaffected population reporting to hospitals could be as high as 9 times the actual number of physical injuries.
Additional Considerations	Transportation will be limited/inaccessible in the vicinity of the blast. Services may be unavailable in the vicinity of the blast – water, sewerage, electricity, etc.

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.

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.

Changes in Development

Increase in development and technology has the potential of making the planning area more of a target for a terrorist attack due to larger numbers of victims and more target areas.

Problem Statement

- There are no records of past terrorism incidents for the NCSU Campuses.
- There are active hate groups within North Carolina.
- When identified, credible threats may increase the probability of an incident; these threats are generally tracked by law enforcement.

F.5.11 Conclusions on Hazard Risk

Priority Risk Index

As discussed in Section F.5, 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 F.50 summarizes the degree of risk assigned to each identified hazard using the PRI method.

Table F.50 – Summary of PRI Results

Hazard	Probability	Impact	Spatial Extent	Warning Time	Duration	PRI Score
Earthquake	Unlikely	Minor	Large	Less than 6 hours	Less than 6 hours	1.9
Flood	Highly Likely	Limited	Small	6 to 12 hrs	Less than 1 week	2.8
Hurricane	Likely	Critical	Large	More than 24 hrs	Less than 24 hrs	2.9
Severe Winter Weather	Highly Likely	Limited	Large	More than 24 hrs	Less than 1 week	3.0
Tornado / Thunderstorm	Likely	Critical	Large	Less than 6 hrs	Less than 6 hrs	3.1
Wildfire	Likely	Limited	Large	More than 24 hrs	More than 1 week	2.8
Cyber Threat	Possible	Critical	Large	Less than 6 hrs	More than 1 week	3.1
Hazardous Materials Incidents	Highly Likely	Minor	Negligible	Less than 6 Hrs	Less than 24 Hrs	2.3
Infections Disease	Possible	Critical	Large	More than 24 hrs	More than 1 week	2.8
Terrorism	Unlikely	Catastrophic	Large	More than 24 hrs	More than 1 week	2.8

[1]Note: Severe Weather hazards average to a score of 2.6 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 F.51**:

- **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.
- **Moderate 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 minimal. This is not a priority hazard.

Table F.51 – Summary of Hazard Risk Classification

High Risk **(≥ 3.0)**	Severe Winter Weather Tornado/Thunderstorm Cyber Threat
Moderate Risk **(2.0 – 2.9)**	Flood Hurricane Wildfire Hazardous Materials Infectious Disease Terrorism
Low Risk **(< 2.0)**	Earthquake

F.6 CAPABILITY ASSESSMENT

This section discusses the mitigation capabilities, including planning, programs, policies and land management tools, typically used to implement hazard mitigation activities. It consists of the following subsections:

- F.6.1 Overview of Capability Assessment
- F.6.2 Planning and Regulatory Capability
- F.6.3 Administrative and Technical Capability
- F.6.4 Fiscal Capability

F.6.1 Overview of Capability Assessment

The purpose of conducting a capability assessment is to determine the ability of the college to implement feasible mitigation actions based on an understanding of the capacity of the departments and staff tasked with their implementation. A capability assessment should also identify opportunities for establishing or enhancing specific mitigation policies or programs. The process of conducting a capability assessment includes developing an inventory of relevant plans, policies, or programs already in place; as well as assessing the college's ability to implement existing and/or new policies. Conclusions drawn from the capability assessment should identify any existing gaps or weaknesses in existing programs and policies as well as positive measures already in place which can and should be supported through future mitigation efforts.

F.6.2 Planning and Regulatory Capability

Planning and regulatory capabilities include plans, ordinances, policies and programs that guide development on campus. **Table F.52** lists these local resources currently in place at NCSU.

Table F.52 – Planning and Regulatory Capability

Regulatory Tool (ordinances, codes, plans)	Y/N	Comments
Strategic Plan	Y	NCSU Strategic Plan 2011-2020 2021 planning underway
Zoning code	Y	City of Raleigh Zoning Ordinance
Growth management ordinance	N	
Floodplain ordinance	Y	City of Raleigh Flood Ordinance
Building code	Y	NC building codes; the State of North Carolina statutes for state owned buildings; and zoning for local jurisdiction
Erosion or sediment control program	N	
Stormwater management program	Y	NCSU Annual Stormwater Management Report, 2019
Site plan review requirements	N	
Capital improvements plan	Y	Integrated priority list maintained by Facilities Division
Economic development plan	Y	NCSU Annual Report
Local emergency operations plan	Y	Emergency Operations Plan, v.1.16, 2011
Flood Insurance study or other engineering study for streams	Y	May 2, 2006
Elevation certificates	Y	Campus surveys for building and infrastructure projects

A description of applicable plans, ordinances and programs follows to provide more detail on the relevance of each regulatory tool in examining the capabilities for each community.

Strategic Plan and Physical Master Plan

A Strategic Plan, in broad terms, is a policy statement to guide the future placement and development of campus facilities. The Strategic Plan identifies a future vision, values, principals and goals for the college, determines the projected growth for the college, and identifies policies to plan, direct and accommodate anticipated growth. NC State's Strategic Plan, "Pathway to the Future" operated on a 2011-2020 planning horizon. It was centered around five strategic goals. The University is currently in the planning process for the next Strategic Plan. NCSU also maintains a Physical Master Plan to create a physical environment that supports the Strategic Plan.

Zoning Code

Zoning typically consists of both a zoning map and a written ordinance/code that divides the planning area into zoning districts. The zoning regulations describe what type of land use and specific activities are permitted in each district, and also regulate how buildings, signs, parking, and other construction may be placed on a parcel. The zoning regulations also provide procedures for rezoning and other planning applications. Zoning is handled at the municipal level by the City of Raleigh.

Flood Insurance Study/Floodplain Ordinance

A Flood Insurance Study (FIS) provides information on the existence and severity of flood hazards within a community based on the 100-year flood event. The FIS also includes revised digital Flood Insurance Rate Maps (FIRMs) which reflect updated Special Flood Hazard Areas (SFHAs) and flood zones for the community.

A floodplain ordinance is perhaps the most important flood mitigation tool. 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 will be protected from damage by a 100-year flood event and that new development in the floodplain will not exacerbate existing flood problems or increase damage to other properties. Floodplain Management is handled at the municipal level by the City of Raleigh.

Stormwater Management Program

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. A Stormwater Management Program can prevent flooding problems caused by stormwater runoff by 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) Setting construction standards so buildings are protected from shallow water. A stormwater ordinance provides regulatory authority to implement stormwater management standards. Stormwater Management takes place at the municipal level as well as at the campus level. NCSU issues Annual Stormwater Management Reports (most recently for 2019). Additionally, the Environmental Health & Safety website has a detailed page dedicated to stormwater management information.

Erosion and Sediment Control Program

Surface water runoff can erode soil from development sites, sending sediment into downstream waterways. This can clog storm drains, drain tiles, culverts and ditches and reduce the water transport and storage capacity of channels. The purpose of an erosion, sedimentation and pollution control ordinance is to minimize soil erosion and prevent off-site sedimentation by using soil erosion and sediment control practices designed in accordance with certain standards and specifications.

Site Plan Review

The purpose of the Site Plan Review Process is to review site plans for specific types of development to ensure compliance with all appropriate land development regulations and consistency with the General Plan.

Building Code

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).

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. An Elevation Certificate serves as the official record that shows new buildings and substantial improvements in all identified SFHAs are properly elevated. This elevation information is needed to show compliance with the floodplain ordinance. All buildings on the NCSU campus adhere to North Carolina Building Codes, and State statutes for state owned buildings. Additionally, NCSU facilities maintains Design and Construction guidelines for all new buildings and renovations of existing buildings on campus.

Capital Improvement Plan

A Capital Improvement Plan (CIP) is a planning document that typically provides a five-year outlook for anticipated capital projects designed to facilitate decision makers in the replacement of capital assets. The projects are primarily related to improvement in public service, parks and recreation, public utilities and facilities. The mitigation strategy may include structural projects that could potentially be included in a CIP and funded through a Capital Improvement Program. NCSU Facilities maintains an integrated priority list of Capital Improvements campus-wide.

Emergency Operations Plan

An emergency operations plan outlines responsibilities and the means by which resources are deployed during and following an emergency or disaster. NCSU's emergency operations plan was last updated in 2011.

F.6.3 Administrative and Technical Capability

Administrative and technical capability refers to the college's staff and their skills and tools that can be used for mitigation planning and to implement specific mitigation actions. It also refers to the ability to access and coordinate these resources effectively. The personnel should be considered as well as the level of knowledge and technical expertise of these resources. Resources include engineers, planners, emergency managers, GIS analysts, building inspectors, grant writers, floodplain managers, and more. **Table F.53** provides a summary of the administrative and technical capabilities for NCSU.

Table F.53 – Administrative and Technical Capability

Personnel Resources	Yes/No	Department/Position
Planner/Engineer with knowledge of land development/land management practices	Yes	NCSU Facilities Division
Engineer/Professional trained in construction practices related to buildings and/or infrastructure	Yes	NCSU Facilities Division
Planner/Engineer/Scientist with an understanding of natural hazards	Yes	NCSU Facilities Division
Personnel skilled in GIS	Yes	NCSU Facilities Division
Full time building official	Yes	City of Raleigh; State Construction Office
Floodplain Manager	Yes	City of Raleigh; State Construction Office
Emergency Manager	Yes	Emergency Management and Mission Continuity
Grant Writer	Yes	Academic Departments
Public Information Officer	Yes	University Communications
Student Engagement	Yes	Academic and Student Affairs
Warning Systems	Yes	Wolf Alert - Audible Alert System – 16 sirens Alertus Desktop Notification OnCampus App

Additional resources and departments that may support administrative capabilities include the following:

Environmental Health and Public Safety

The NCSU Division of Environmental Health and Public Safety is dedicated to the reduction of risks within the NCSU community and to the promotion of safety and environmental stewardship as a value in the University culture. The department strives to maximize the use of resources of the University's safety practices and procedures through good practice and partnerships. Environmental Health and Safety, Emergency Management & Mission Continuity, Insurance & Risk Management, Security Applications & Technology, Transportation, University Police, and Risk Assessment all fall within the Environmental Health & Public Safety organization.

Emergency Management and Mission Continuity

The mission of the Department of Emergency Management & Mission Continuity (EM&MC) is to lead and facilitate effective campus disaster preparedness, mitigation, response, and recovery activities to minimize the impacts of emergencies on the NC State community, facilities, and environment. The values of the EM&MC Department are Adaptable, Innovate, Participatory, and Risk-Focused. The department provides resources for the campus as well as facilitates the Pack Planning program. The coordinator of the HMPC for this plan update serves as the Emergency Manager within this department.

Insurance and Risk Management

Insurance & Risk Management (IRM) assists university stakeholders with the management of physical, financial, operational, and reputational risks through early identification and appropriate avoidance, mitigation, and transfer of risk. IRM collaborates with various partners to advance the University's mission of promoting an integrated approach to problem solving. Representatives from IRM served on the HMPC.

Fire and Life Safety

The NCSU Fire and Life Safety Office assists the academic community with recognition of fire hazards and mitigation of fire and medical incidents on University property. The Fire and Life Safety Office strives to reduce incidents on campus through training and education, fire prevention activities, and consultations. The University Fire Marshal served on the HMPC during this plan update.

Campus Police

The NCSU Police department is dedicated to providing the University community with the highest level of service and identifying and preventing crime, but is also dedicated to providing a number of non-criminal services to the community. Other services and programs include: Wolf Guard ID Program, Classes and Seminars, Safety Escort Services, Ride-Along Program, Finding Printing Services, Responsible Behavior Initiative (RBI), Lost and Found Property, Jump starting and unlocking vehicles, Security surveys, and more.

NCSU Facilities Division

The NCSU Facilities Division ensures that the campus physical environment supports the University's mission. The Division is supported by a team of about 800 professionals who plan for current and future needs, build high-impact facilities and maintain campus. The Division prioritizes four strategic goals: Safety, Service, Stewardship, and Staff. Within the division there are 7 additional departments including Capital Project Management, Energy Services, and Facilities Services.

Additional campus resources includes the following:

- Environmental Health and Public Safety offers numerous outreach programs related to campus and personal safety. EMMC offers outreach programs focusing on personal preparedness including household preparedness.
- Fire and Life Safety offers programs to the campus community on fire safety. University Police offer a variety of safety and crime prevention programming for the campus community, including private tenants/private partners on campus.
- The NC State Annual Security and Fire Safety Report provides more information on fire safety outreach on campus and is distributed to the entire campus community.
- The 2019 Annual Stormwater Report provides information on environmental education and responsible water use.
- The University has a Water Management Team with procedures to ensure safe potable water on campus.
- NC State Fire and Life Safety designates shelter in place locations for tornadoes emergencies for all campus buildings. These locations are based on best practices and are not in FEMA accordance with FEMA standards.

F.6.4 Fiscal Capability

Financial capabilities are the resources that an entity has access to or is eligible to use to fund mitigation actions. The costs associated with implementing mitigation activities vary. Some mitigation actions such as building assessment or outreach efforts require little to no costs other than staff time and existing operating budgets. Other actions, such as structural projects, could require a substantial monetary commitment from local, State, and Federal funding sources. **Table F.54** provides a summary of the fiscal resources at NCSU.

Table F.54 – Fiscal Resources

Resource	Ability to Use for Mitigation Projects? Y/N
Community Development Block Grants	N
Capital improvements project funding	Y
In-Kind Services	Y
Tuition & Fees	Y
Federal funding with HMA grants	Y
Revenue Bonds	Y
State Appropriations	Y
Sales & Services	Y
Other Sources (Gifts, Investment Income, Permanent Endowments)	Y

F.7 MITIGATION STRATEGY

F.7.1 Implementation Progress

Progress on the mitigation strategy developed in the previous plan is also documented in this plan update. **Table F.55** details the status of mitigation actions from the previous plan. **Table F.56** on the following pages details all completed and deleted actions from the 2010 plan. More detail on the actions being carried forward is provided in the Mitigation Action Plan.

Table F.55 – Status of Previous Mitigation Actions

Campus	Completed	Deleted	Carried Forward
NCSU	11	10	6

Table F.56 – Completed and Deleted Actions from the NCSU 2010 Plan

Vulnerability	Action	2020 Status	2020 Implementation Status Comments
College of Veterinary Medicine: There is insufficient redundancy for HVAC systems in the adjacent utility plant. The utility plant's generator cannot power the pumps required to support operation of the engine driven chiller. In addition, the engine driven chiller cannot carry the full load of the CVM during summer months.	The utility plant should have wiring and stub-ins in place to allow the rapid connection of large portable generators and chillers to provide cooling to the hospital during a regional power outage or emergency plant outage.	Completed	
College of Veterinary Medicine: Mechanical systems including boilers, chillers, and transformers were observed to have no anchorage to their foundations.	Mechanical systems serving critical spaces or functions should be anchored to their foundations.	Completed	
Dabney and Cox Halls: Drainage along the front of the site appears to be inadequate and there is a history of minor flooding of ground floor laboratories in Dabney. It should be noted that the ground floor contains expensive equipment including NMR magnets, mass spectrometers, servers, etc.	Water diverting features should be installed in front of ground floor entrances to direct water away from the entrance to the building.	Completed	
Dabney and Cox Halls: The building houses low temperature freezers to store irreplaceable biological specimens. There is no alarm system to alert personnel in the event that the emergency generator has failed to start after power failure or in the event that basement flooding causing ATS failure.	Given the value of the biological specimens, low temperature freezers should have monitors that are capable of alerting facility personnel of equipment failure by email, SMS, and/or telephone.	Completed	
Dabney and Cox Halls: The College provides its own data warehousing with no unified data backup. Individuals are responsible for their own backups.	The college should obtain remote, secured servers in the University data centers to facilitate the backup of irreplaceable research and administrative data. Current backup method exposes data to theft and/or loss.	Deleted	No longer a priority
Dabney and Cox Halls: Several mechanical systems were not anchored to their foundations (chiller, fire pump, etc.).	Mechanical systems serving critical facilities/functions should be anchored to their foundations.	Deleted	No longer a priority
DH Hill Library: The perimeter of the building at the rear of the rare books vault is poorly drained. Facility personnel report that leaves will clog site drainage and this has in the past caused minor flooding of the rare books vault.	The drainage at the rear entrance of the rare books area should be improved and water diverting features installed at the entryway to prevent another flooding event.	Deleted	No longer a priority
DH Hill Library: The radio station electronics in the mechanical penthouse were not properly anchored to the structure.	The radio equipment should be properly anchored to the structure to resist seismic forces.	Deleted	No longer a priority
DH Hill Library: There was loose flashing left on the roof that could become airborne debris during high winds.	Loose debris should be cleared from the roof to protect pedestrians and nearby structures during high winds.	Completed	

Vulnerability	Action	2020 Status	2020 Implementation Status Comments
Hillsborough Building, DC#1, and DC#2: Hillsborough Building's utilities are at capacity including the UPS systems and the generator. There is no physical room for expansion. The data center requires that 3 out of 4 CRAC units be operational. There is a history of flooding in the basement electrical room. The transformers in the electrical room are not anchored to their foundations.	In order to facilitate data center growth and provide better systems redundancy (FCAP report notes numerous serious electrical deficiencies in Hillsborough) Data Center #1 should be relocated to a newer building. This will also solve electrical room flooding issues.	Completed	DC1 is no long in this building
Hillsborough Building, DC#1, and DC#2: There is a history of flooding in the basement electrical room. The transformers in the electrical room are not anchored to their foundations. The CRAC unit condensers at Hillsborough are not anchored to their foundations. The emergency generator and transformer at Admin III are not anchored to their foundations. The mechanical systems at the rear of Hillsborough Building are subject to tampering and damage by pedestrians.	All utility systems serving critical functions should be anchored to their foundations.	Deleted	DC1 is no long in this building
Hillsborough Building, DC#1, and DC#2: Data Center #2 has insufficient HVAC redundancy. Loss of any single 30-ton chilled water unit or the chilled water supply would require a partial or complete shutdown of the data center, respectively.	Stub-ins should be added to the chilled water system at Administration III to permit the use of portable air-cooled chillers during emergencies. An additional 30-ton DX CRAC unit should be added to Data Center #2 to provide some level of redundancy in the event of unit failure.	Deleted	DC1 is no long in this building
Main Distribution Frames (MDFs): Although the MDF backbone has a redundant path, most campus buildings have single fiber connections to the MDF backbone. This is particularly true of the CVM and Centennial Campus which both have a single fiber path back to the main campus ring. This means that both voice and data are reliant on a single fiber path. In an outage, neither CVM nor Centennial campus telephones will be able to dial 911.	NCSU should seek to provide redundant fiber paths for Centennial and CVM campuses. This will be more important as phones are switched to VOIP. Loss of these fiber paths would eliminate the ability of personnel on site to dial 911 from in-building phones.	Completed	
Main Distribution Frames (MDFs): VOIP phones will have in-building 1 hour UPS. These systems are not tied to life safety generators.	Where possible, the power supplies for VOIP systems should be tied to life safety generators to extend the period during which building occupants may use the telephone system. This recommendation is contingent on the VOIP system's ability to use PoE.	Deleted	No longer a priority

Vulnerability	Action	2020 Status	2020 Implementation Status Comments
Power Substations and Distribution: Centennial and CVM campuses are each served by a single large, expensive transformer with very long delivery time for a replacement.	Campus facilities on Centennial or CVM campus that must have power or HVAC to support critical operations should have their mechanical and electrical systems configured to permit the use of portable generators and/or chillers in the event of an extended outage. Given the cost of the transformers, maintaining a spare is not economically feasible. This recommendation would especially apply to facilities that maintain biological samples, live animals, computing clusters, or any other high value research work which could not be reasonably relocated during an outage.	Deleted	Part of ongoing building improvements
Public Safety Center: The location designated for the police mobile command center at the football stadium connects via fiber to the CVM and then to Hillsborough. There is no redundancy in the fiber path.	Provide a redundant fiber path between the stadium and/or CVM to the campus fiber backbone.	Completed	
Public Safety Center: The wall mounted plywood used to support telephone circuitry in the ECC did not appear to be well attached to the wall.	The backup support for the telephone circuitry should be securely fastened to the wall.	Completed	
Public Safety Center: There are a number of unreinforced windows in the dispatch area that would be susceptible to damage by windborne debris. The windows also did not appear to have any privacy tinting.	Windows in the dispatch area should be reinforced to reduce the hazard of wind borne debris. The windows should also be tinted for the safety of dispatchers working inside.	Completed	
Yarborough, Cates, West, and Centennial Steam Plants: There is no redundant source of chilled water for Data Center #2 in Administration III in the event that the West Regional chiller plant experiences a failure.	Administration III should have stub-ins added to its chilled water piping to allow the use of a portable chiller in the event of a failure of or damage to the West Regional Plant.	Completed	
Yarborough, Cates, West, and Centennial Steam Plants: Several mechanical systems were observed to have no anchorage to their foundations.	Mechanical and electrical systems deemed life safety or critical to operations should be anchored to resist seismic forces.	Deleted	No longer a priority
Power Substations and Distribution - Personnel report that the electrical cable serving older sections of campus has exceeded its design life and could become a hazard as the wire's insulating coating degrades.	The University should seek to replace aging electrical cable before age-related degradation causes potentially dangerous failures.	Deleted	This property protection measure addresses hazards outside of this plan.

F.7.2 Mitigation Action Plan

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.

The following table comprises the mitigation action plan for NCSU. Each mitigation action recommended for implementation is listed in these tables along with detail on the hazards addressed, the goal and objective addressed, the priority rating, the lead agency responsible for implementation, potential funding sources for the action, a projected implementation timeline, and the 2020 status and progress toward implementation for actions that were carried forward from the 2010 plan.

Table F.57 – Mitigation Action Plan, NCSU

Action #	Action Description	Hazard(s) Addressed	Goal & Objective Addressed	Priority	Mitigation Category	Lead Agency / Department	Estimated Cost	Potential Funding Source	Implementation Timeline	2020 Status	2020 Implementation Status Comments
NCSU1	Campus-Wide – Upgrade back-up power capabilities to critical facilities including, but not limited to: Student Health, University Police, Fuel Polishing, and SCADA.	All Hazards	1.2	M	Structural Projects	Facilities Services	$25,000-$100,000 per site	State/Federal Grants	2021-2026	New	
NCSU2	Campus Wide – Continue to develop outreach projects and campus-wide mitigation training to inform the public about severe winter weather impacts and how to stay safe during winter weather events through emails, flyers, and online training; severe weather week participation; and cyber security awareness.	All Hazards	2.1	Low	Public Education & Awareness	EHS, University Communications and Marketing, Police and Public Safety; and DoIT	< 1,000	Operating Budget	2021-2026	New	
NCSU3	College of Veterinary Medicine - The standing seam metal roof is reported to leak during intense downpours. One leak is located over an electrical panel serving radiology facilities (Photo 1). Other leaks have been observed to occur in operating rooms. The leaks in the standing seam metal roof should be addressed in critical areas to prevent damage to expensive instruments or contamination of surgical areas.	Flood, Hurricane, Tornado/ Thunderstorm	1.2	M	Property Protection	Facilities Department	>$100,000	Operating Budget, State/Federal Grants	2021-2026	Carry Forward	In Progress. Additional funding needed to complete implementation.
NCSU4	College of Veterinary Medicine - During driving rain the façade is reported to leak at locations where brick masonry meets with concrete façade elements and around window frames. Areas of the façade prone to water infiltration should be sealed to prevent water damage and mold growth.	Flood, Hurricane, Tornado/ Thunderstorm	1.1	L	Property Protection	Facilities Department	>$100,000	Operating Budget, State/Federal Grants	2021-2026	Carry Forward	In Progress. Additional funding needed to complete implementation.
NCSU5	Dabney and Cox Halls - The rear of the site is served by one primary drain at the rear of Dabney and Cox. In the past, this drain has failed, causing the HAZMAT bunkers to float off their foundations and the basement mechanical room to flood causing a complete power failure (ATS located in basement). An emergency drain should be added to the rear of the site to reduce the likelihood of significant flooding during intense downpours.	Flood	1.2	H	Structural Projects	Facilities Department	$25,000-$100,000	Operating Budget, State/Federal Grants	2021-2026	Carry Forward	In Progress. Additional funding needed to complete implementation.
NCSU6	DH Hill Library - The gravel ballasted roof of the original low-rise structure is in fair to poor condition and should be replaced. The gravel ballasted roof should be replaced.	Severe Winter Weather, Flood	1.1	L	Property Protection	Facilities Department	>$100,000	Operating Budget, State/Federal Grants	2021-2026	Carry Forward	No progress has been made on this action. Under consideration for future improvement.
NCSU7	Main Distribution Frames (MDFs) - The Dan Allen Drive MDF has several large trees adjacent to the building which could severely damage it if they were to fall. Consider removing the large trees adjacent to the Dan Allen MDF building to prevent damage from falling trees/limbs.	Severe Winter Weather, Hurricane, Tornado/ Thunderstorm	1.1	M	Property Protection	Facilities Department	<$5,000	Operating Budget	2021-2026	Carry Forward	No progress has been made on this action.
NCSU8	Public Safety Center - The EOC is not well configured to provide power and telephone service. Provide more power, voice, and data ports throughout the room to facilitate rapid setup and operation of the EOC.	All Hazards	1.2	H	Emergency Services	Facilities Department	$5,000-$25,000	State/Federal Grants	2021-2026	Carry Forward	In Progress. Ongoing improvements to EOC underway.

THE UNIVERSITY OF NORTH CAROLINA SYSTEM

UNC System Eastern Campuses Regional Hazard Mitigation Plan

Annex G: University of North Carolina at Chapel Hill

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TABLE OF CONTENTS

Annex G University of North Carolina- Chapel Hill

This section provides planning process, campus profile, hazard risk, vulnerability, capability, and mitigation action information specific to University of North Carolina Chapel Hill (UNC-CH). This section contains the following subsections:

- G.1 Planning Process Details
- G.2 Campus Profile
- G.3 Asset Inventory
- G.4 Hazard Identification
- G.5 Hazard Profiles, Analysis, and Vulnerability
- G.6 Capability Assessment
- G.7 Mitigation Strategy

G.1 PLANNING PROCESS DETAILS

The table below lists the HMPC members who represented UNC-CH during the planning process.

Table G.1 – HMPC Members

Representative	Role; Department
Abbas Piran	Director, Facilities Technology; Facilities Services
Cindy Register	Assistant Director Engineering Services & Energy Management; Facilities Services
John Albrechtsen	Facilities Operations; Facilities Services
Ben Poulson	Associated Director, Energy Services; Facilities Services
Rahsheem Holland	Assistant Chief/Patrol; Campus Police
Carly Ann Perin	Executive Director of Finance & Financial Shared Services; SCE Finances
Andrew Fulmer	Capital Projects Accountant; SCE Finances
Cathy Brennan	Executive Director; Environmental Health & Safety
Darrell Jeter	Director; Emergency Management & Planning
Dawn Wedig	Emergency Management Planner; Emergency Management & Planning

Coordination with Other Community Planning Efforts and Hazard Mitigation Activities

The table below lists campus and community resources referenced throughout the planning process and incorporated in the plan development.

Table G.2 – Summary of Existing Studies and Plans Reviewed

Resource Referenced	Use in this Plan
UNC-CH Campus Master Plan	The UNC-CH Campus Master Plan, developed in 2019, was referenced for the Campus Profile in Section G.2 as well as the Capability Assessment in Section G.6
Town of Chapel Hill Comprehensive Plan	The Comprehensive Plan was referenced for the Campus Profile in Section G.2.
Orange County and Incorporated Areas Flood Insurance Study (FIS), Revised 10/19/2018	The FIS report was referenced in the preparation of flood hazard profile in Section G.5.

Resource Referenced	Use in this Plan
UNC Chapel Hill Natural Hazard Mitigation Plan, 2011	The previous UNC-CH Natural Hazard Mitigation Plan was used in preparation of the hazard profiles in Section G.5. The plan was additionally used to track implementation progress and develop the mitigation plan (Section G.7).
Eno-Haw Regional Hazard Mitigation Plan, 2020	The Eno-Haw Regional Hazard Mitigation Plan was referenced in compiling the Hazard Identification and Risk Assessment in Section G.5.

G.2 CAMPUS PROFILE

This section provides a general overview of the University of North Carolina at Chapel Hill (UNCCH) campus and area of concern to be addressed in this plan. It consists of the following subsections:

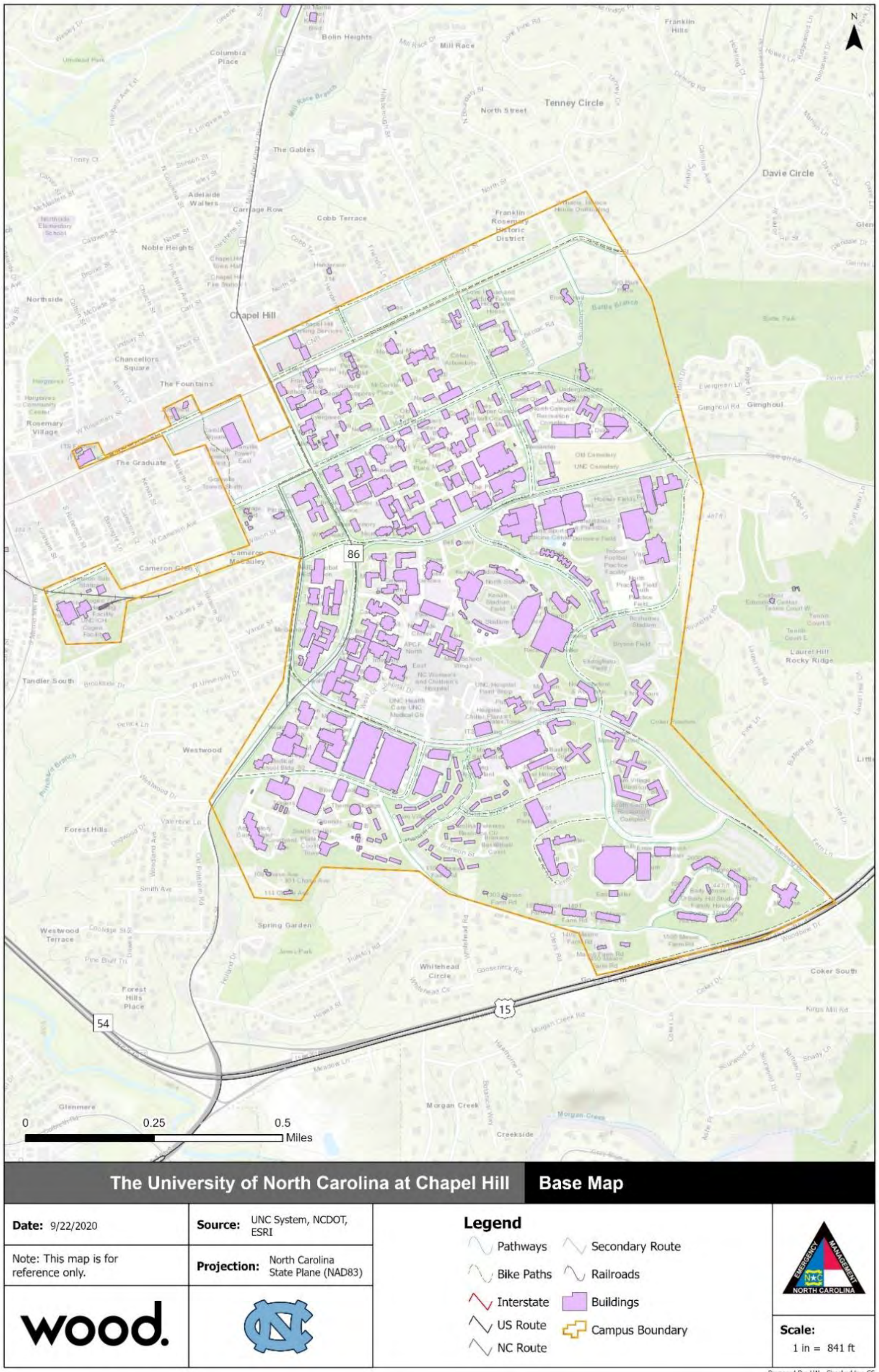
- Location and Setting
- Geography and Climate
- History
- Cultural and Natural Resources
- Land Use
- Population and Demographics
- Social Vulnerability
- Growth and Development Trends

G.2.1 Location and Setting

The University of North Carolina Chapel Hill (UNC-CH) is located primarily within the town of Chapel Hill, a multicultural university town with a resident population of 59,000. The town is located within in Orange, Chatham, and Durham counties. Chapel Hill was originally developed to serve the University. When the University Of North Carolina Board of Trustees chose the area around New Hope Chapel as the site for the first State University in 1793, they also named a committee to lay out a town adjacent to the site.

Figure G.1 provides a base map of the campus. For more details on campus buildings and critical facilities, see Section G.3.

Figure G.1 – UNC-CH Location Map



G.2.2 Geography and Climate

The main campus of UNC-CH, covering approximately 800 acres, is located within the Piedmont region of North Carolina. The campus sits on a ridge and encompasses rolling hills and some areas of steep slope. Several small creeks and streams traverse University property, but there are no major watercourses on campus. The campus has an abundance of trees, many of which are venerable and quite large, and some parts of the campus are heavily wooded.

The climate of the Piedmont region of North Carolina is temperate. Winter daytime temperatures normally range from the upper 30's to the upper 40's and an average low of 29 degrees Fahrenheit in January. Summer daytime temperatures range from the high 70's to the low 90's and an average high of 89 degrees Fahrenheit on average in July. The state has a fairly wet climate with an average precipitation for this area averaging 44-52 inches annually.

G.2.3 History

The University of North Carolina at Chapel Hill (UNC-CH) is one of 17 constituent colleges and universities within the University of North Carolina System. UNC-CH is the oldest of these 17, as well as the largest. Founded in 1793, the University of North Carolina at Chapel Hill is recognized as the first state university in the Nation and is considered the flagship of the North Carolina University system. The University was built by the people of this State, and is funded in large part by the taxpayers, through appropriations from the North Carolina General Assembly. Through its excellent undergraduate programs, the University has provided higher education to ten generations of students, many of whom have become leaders of the State and the Nation. Since the nineteenth century, it has offered distinguished graduate and professional programs. It is vital that the University uphold the long-standing tradition of excellence in teaching and research in order to serve many future generations of students, researchers, and North Carolina citizens in the decades to come.

G.2.4 Cultural and Natural Resources

National Register of Historic Places

There are 16 listings in the National Register of Historic Places for the Town of Chapel Hill. Some of these include the Beta Theta Pi Fraternity House, the Carolina Inn, Old Chapel Hill Cemetery, Old East, and the Playmakers Theater on the Chapel Hill campus. The campus is bordered by the Franklin-Rosemary, Cameron-McCauley, and Gimghoul Historic Districts.

Natural Features and Resources

The Town of Chapel Hill Parks and Recreation Department is responsible for over 730 acres of public spaces, including 9 community parks, 5 public parks, and 17.6 miles of urban greenways and trails. The Chapel Hill Botanical Garden Foundation also maintains many open space and recreational areas including Battle Park, a 93-acre forest with multiple walking trails on the edge of the UNC Chapel Hill Campus as well as the Coker Arboretum located on the campus itself. The university also maintains the Carolina North Forest, which encompasses 750 acres of woodlands located on the University's North campus.

Less than one-half of one percent of the University of North Carolina at Chapel Hill's campus is located within a 100-year Special Flood Hazard Area. The remainder of the Campus is located in the 0.2%-annual-chance or Unshaded X flood zones.

On the UNC-CH campus there are also many innovative Stormwater Best Management Practices to prevent pollution, recharge the water table, and reduce runoff. These interventions include porous pavement in the Estes Drive Extension parking lot, the Park and Ride lot next to the Friday Center, the McCauley Lot, and the Chatham County Park and Ride Lot, vegetated roof systems and roof gardens on the FedEx Global Education Center and Rams Head Plaza, cisterns under Hooker Field and to collect excess runoff at the FedEx Center and Rams Head Plaza, Stormwater Plantings, and Vegetated Swales, among others.

Natural and Beneficial Floodplain Functions

Under natural conditions, a flood causes little or no damage in floodplains. Nature ensures that floodplain flora and fauna can survive the more frequent inundations, and the vegetation stabilizes soils during flooding. Floodplains reduce flood damage by allowing flood waters to spread over a large area. This reduces flood velocities and provides flood storage to reduce peak flows downstream.

Threatened and Endangered Species

The U.S. Fish and Wildlife Service maintains a regular listing of threatened species, endangered species, at-risk species, and candidate species for counties across the United States. Last updated in October 2015, Orange County has 7 species that are listed with the U.S. Fish and Wildlife Services. **Table G.3** below shows the 17 species identified as threatened and endangered in Orange County.

Table G.3 – Threatened and Endangered Species in Orange County

Common Name	Scientific Name	Federal Status
Neuse River waterdog	*Necturus lewisi*	Proposed Threatened
Red-cockaded woodpecker	*Picoides borealis*	Endangered
Green floater	*Lasmigona subviridis*	Under Review
Atlantic pigtoe	*Fusconaia masoni*	Proposed Threatened
Dwarf wedgemussel	*Alasmidonta heterodon*	Endangered
Carolina madtom	*Noturus furiosus*	Proposed Endangered
Cape Fear shiner	*Notropis mekistocholas*	Endangered
Golden sedge	*Carex lutea*	Endangered
Piping Plover	*Charadrius melodus*	Threatened
Seabeach amaranth	*Amaranthus pumilus*	Threatened
Red knot	*Calidris canutus rufa*	Threatened

Source: U.S. Fish & Wildlife Service (https://ecos.fws.gov/ecp/report/species-listings-by-current-range-county?fips=37135

G.2.5 Land Use

The University of North Carolina at Chapel Hill's 2019 Master Plan has recommended various projects to meet current and future space needs and align with the University's Strategic Plan: Carolina Next and the University's Strategic Initiative "Blueprint for Next." **Figure G.2** shows a map of proposed building development and new construction. The Town of Chapel Hill and the University have a long-established relationship regarding land uses on University property. The Master Plan has proposals for New Buildings, Renovation Opportunities, the Campus System, and the Outlying Parcels.

- **New Buildings:** Accounting for the replacement of demolished buildings, the plan identifies 4.1 million gross square feet of net new development; 3.3 million gross square feet of net new development is anticipated within a 15-year time horizon.
- **Renovation Opportunities:** 6.4 million gross square feet (about 30% of campus) is located in buildings rated as worst, severe, or poor condition. The master plan proposes demolition of approximately 1.3 million square feet, factored into the new building development proposals. The plan propose 1.9 million square feet of major renovations to facilities and spaces.
- **Campus System Proposals:** Campus systems proposals include individual projects that advance big ideas. These proposals take into account the Three Zeroes Environmental Initiatives and the importance of understanding that landscapes, utilities, and buildings must work together. These

proposals fall into three categories: Open Space and Environmental Management, Transportation, and Infrastructure.

- **Outlying Parcel Proposals:** The master plan posits that space on main campus is finite, and some uses may be more appropriate for the outlying parcels controlled by the University, particularly the Mason Farm Tract and Carolina North.

Figure G.2 – UNC-CH's Proposed Building Development, 2019 Master Plan

Source: https://facilities.unc.edu/master-plan/2019-master-plan/

G.2.6 Population and Demographics

Table G.4 provides population counts and percent change in population since 2010 for Orange County and the Town of Chapel Hill.

Table G.4 – Population Counts for Participating Jurisdictions

Jurisdiction	2010 Census Population	2019 Estimated Population	% Change 2010-2019
Orange County	133,693	148,476	11.1%
Chapel Hill	57,221	64,051	11.9%

Source: U.S. Census Bureau QuickFacts 2010 vs 2019 (V2019) data

Table G.5 provides population counts for The University of North Carolina at Chapel Hill from Fall 2020, including the number of undergraduate and graduate students, staff, and faculty.

Table G.5 – Population Counts for The University of North Carolina at Chapel Hill, Fall 2020

Group	2020 Population
Students	30,101
Undergraduate Students	19,117
Graduate & Professional Students	10,984
Faculty	3,887
Staff	8,700

Source: https://www.unc.edu/about/by-the-numbers/

According to The University of North Carolina at Chapel Hill's Fall 2020 Fact Sheet, 17% of the Freshman class were from out of state. The students hail from 52 countries, 44 states and Washington, D.C., and 97 of the 100 North Carolina Counties. 36% of all in-state students come from rural counties. Among the UNC-CH student population, the most popular intended majors include Biology, Business, Psychology and Neuroscience, Computer Science, Political Science.

The racial characteristics of the County, Town, and University are presented below in **Table G.6**. These characteristics for the County and Town are based on the 2010 Census Bureau. White persons make up most of the population for the County, Town, and UNC-CH.

Table G.6 – Demographics of Orange County, Town of Chapel Hill and UNC-CH University Students

Jurisdiction	African-American Persons, Percent	American Indian or Alaska Native, Percent	Asian Persons, Percent	Hispanic or Latino Persons, Percent	White Persons, Percent
Orange County[1]	11.8	0.6	8.1	8.6	76.9
Chapel Hill[1]	10.9	0.3	13.0	6.3	71.7
The University of North Carolina at Chapel Hill[2]	11	2	20	11	66

Source: U.S. Census Bureau, 2019 ACS 5-year estimates

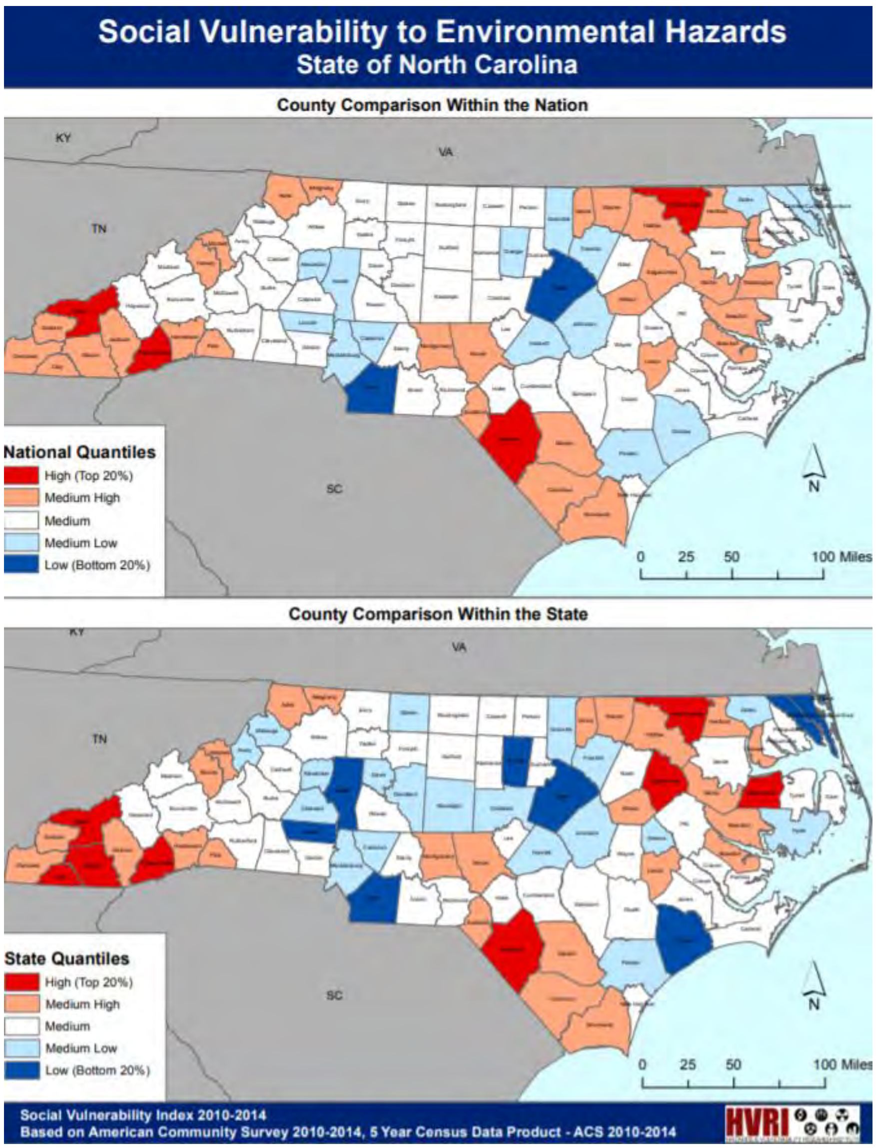
[1]Persons of Hispanic Origin may be of any race, so are also included in applicable race categories.

[2]Source: The University of North Carolina at Chapel Hill, Class Profile 2020 (Numbers based on 2020 incoming class)

G.2.7 Social Vulnerability

The Hazards and Vulnerability Research Institute at the University of South Carolina has created the Social Vulnerability Index (SoVI), to measure comparative social vulnerability to environmental hazards in the U.S. at a county level. SoVI combines 29 socioeconomic variables to determine vulnerability. The seven most significant components for explaining vulnerability are race and class, wealth, elderly residents, Hispanic ethnicity, special needs individuals, Native American ethnicity, and service industry employment. The index also factors in family structure, language barriers, vehicle availability, medical disabilities, and healthcare access, among other variables. **Figure G.3** displays the SoVI index by county with comparisons within the Nation and within the State. Compared with the nation, Orange County's social vulnerability is medium low; within the State, Orange County ranks among the bottom 20% for social vulnerability.

Figure G.3 – SoVI Index for North Carolina



G.2.8 Growth and Development Trends

Growth of the Town of Chapel Hill has been directly related to the expansion of the university as well as annexation. It is anticipated that expansion of the University and University-related health facilities will continue to occur. In turn, the Town will most likely grow in response to this expansion.

Based on 2010 Census data, Wilmington had an estimated population of 64,051 residents in 2019. In the 2018 Orange County & Chapel Hill Data Profile from Carolina Demographics, they provided population projections through 2050 for Orange County and Chapel Hill using three different base periods. A graph of these projections can be found below in **Figure G.4** and **Figure G.5**. The Town of Chapel Hill is estimated to grow in population from 57,324 to between 71,828 and 102,369 by 2050.

Figure G.4 – Population Projections up to 2050 for Orange County

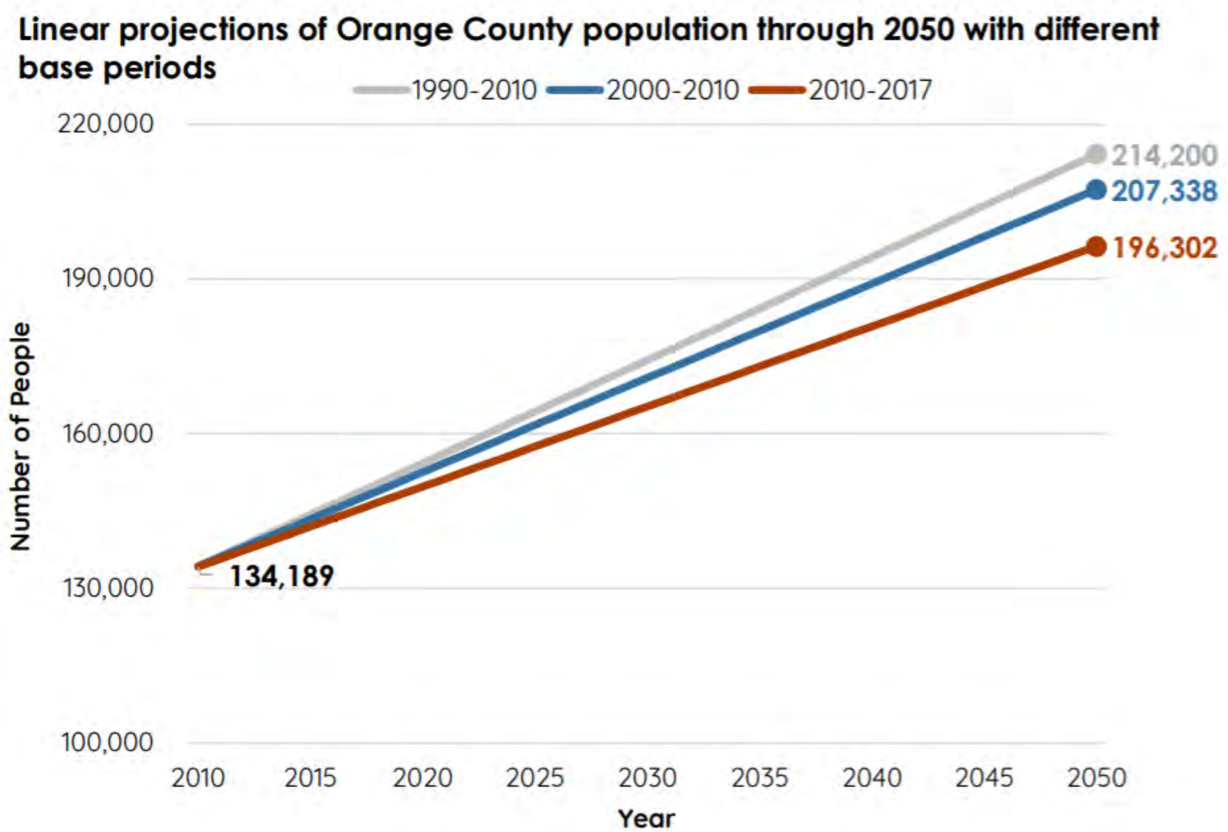
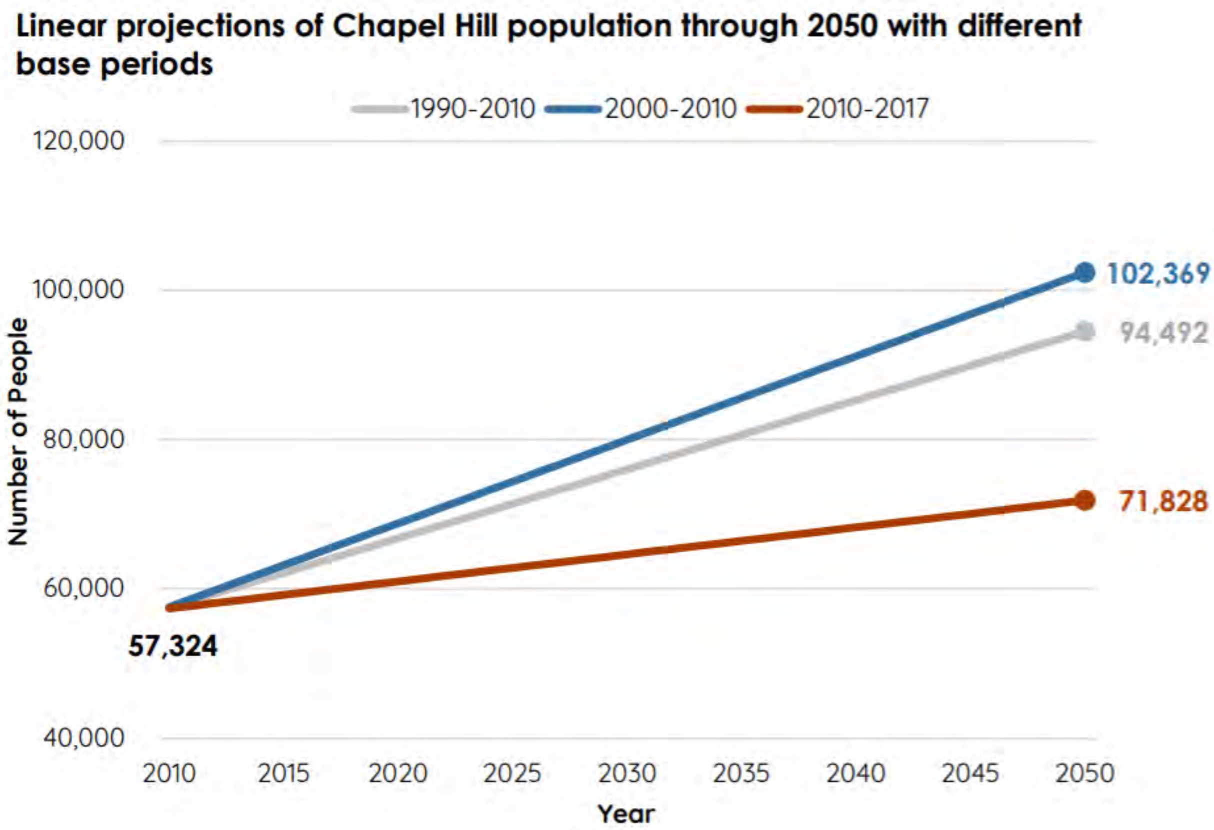


Figure G.5 – Population Projections up to 2050 for Chapel Hill



The estimated population for Chapel Hill in 2019 was 64,051, which is a 11.9% increase from the 2010 estimated population.

G.3 ASSET INVENTORY

An inventory of assets was compiled to identify the total count and value of property exposure on the UNC-CH campus. This asset inventory serves as the basis for evaluating exposure and vulnerability by hazard. Assets identified for analysis include buildings, critical facilities, and critical infrastructure.

G.3.1 Building Exposure

Table G.7 provides total building exposure for the campus, which was estimated by summarizing building footprints provided by the University of North Carolina System Division of Information Technology and the North Carolina Emergency Management (NCEM) iRisk database and property values provided by the North Carolina Department of Insurance and NCEM iRisk database. All occupancy types were summarized into the following four categories: administration, critical facilities, educational/extracurricular, and housing. Note: estimated content values were not available.

Table G.7 – UNC-CH Building Exposure by Occupancy

Occupancy	Estimated Building Count	Structure Value
Administration	20	$181,368,636
Critical Facilities	55	$825,792,941
Educational/Extracurricular	158	$2,004,542,825
Housing	95	$421,644,655

Occupancy	Estimated Building Count	Structure Value
Total	**328**	**$3,433,349,058**

Source: UNC Division of Information Technology; NCEM iRisk; NC Department of Insurance

G.3.2 Critical Buildings and Infrastructure Exposure

Of significant concern with respect to any disaster event is the location of critical facilities and infrastructure in the planning area. Critical facilities are those essential services and lifelines that, if damaged during an emergency event, would disrupt campus continuity of operations or result in severe consequences to public health, safety, and welfare.

Critical buildings are a subset of the total building exposure and were identified by UNC-CH's HMPC representatives. The UNC-CH HMPC updated the list of critical facilities from the previous PDM plan and ranked each facility on a set of standardized criteria designed to evaluate all critical buildings in the UNC System Hazard Mitigation Plan. Factors considered for this ranking included:

- the building's use for emergency response,
- the building's use for essential campus operations
- the building's use as an emergency shelter or for essential sheltering services,
- the presence of a generator or generator hook-ups,
- the building's use for provision of energy, chilled water or HVAC for sensitive or essential systems,
- the storage of hazardous materials,
- the building's use for sensitive research functions,
- the building's cultural or historical significance, and
- building-specific hazard vulnerabilities

Figure G.6 below shows the scoring sheet used to rate critical buildings on campus.

Figure G.6 – Critical Building Scoring Worksheet

Critical Building Scoring Worksheet

Campus:
Facility Name:

		Score
1	Does the facility serve as the campus Emergency Operations Center (EOC)? Yes, Primary EOC = 6 pts Yes, Secondary EOC = 3 pts No = 0 pts	0
2	Does the facility house functions essential to campus operations? Main Telecommunication Center = 3 pts; Maintenance = 1 pt Computer Network Hub = 3 pts; Public Safety = 1 pt Adminstrative Operations = 1 pts	0
3	Is the facility equiped with a generator or hook-ups? Generator = 3 pts Hook-ups = 1 pt Neither = 0 pts	0
4	Does the facility serve as a pre or post disaster shelter? Both pre and post disaster shelter = 6 pts Either pre or post disaster shelter = 3 pts Neither = 0 pts	0
5	Does the facility provide services essential to sheltering? Resident Housing = 1 pt; Food Preperation Facility = 1 pt Assesmbly Space = 1 pt; Shower Facilities = 1 pt	0
6	Does the facility provide chilled water distribution or contain HVAC systems necessary to sensitive or essential systems? Yes = 3 pts No = 0 pts	0
7	Are there hazardous materials on-site? (greater than 25 gallons) Yes = 3 pts No = 0 pts	0
8	Does the facility house research functions that have a low level of tolerance for disruption? Yes = 2 pts No = 0 pts	0
9	Does the facility serve as storage for rare or unique collections (art, artifacts, letters, etc) or is it a historically or culturally significant building? Yes = 2 pts No = 0 pts	0
10	Does the facility have hazard specific vulnerabilities (basement susceptible to flood, etc.) Yes = 3 pts No = 0 pts	0
Notes/ Comments		

Total Score:	0
Total Possible Score:	**42**

The identified critical facilities for UNC-CH, as shown in **Figure G.7**, and summarized in **Table G.8** below.

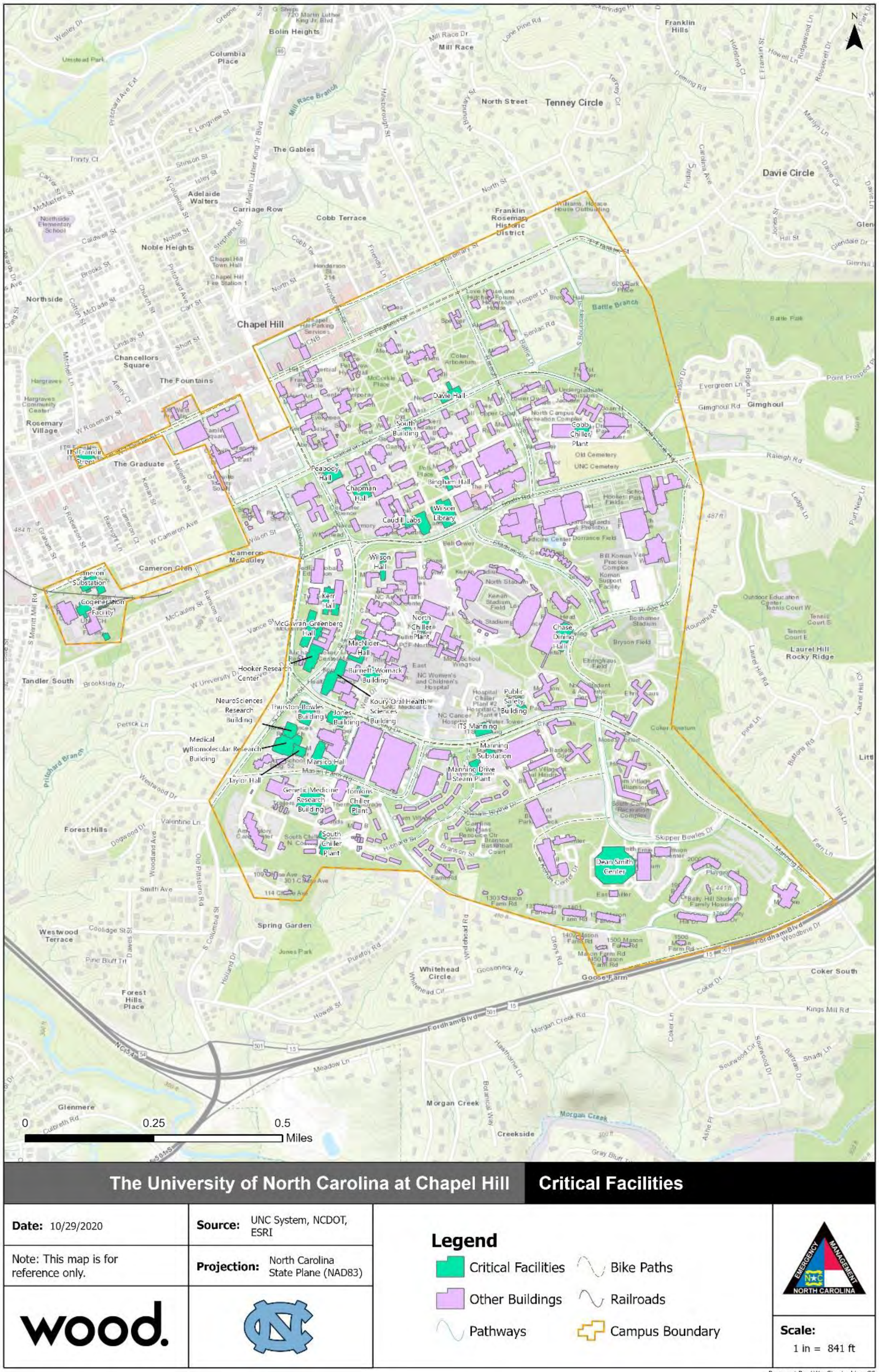
Table G.8 – UNC-CH Critical Facilities

Building	**EOC**	**Essential Operating Functions**	**Generator or Hook-Ups**	**Pre/Post-Disaster Shelter**	**Essential Sheltering Services**	**Chilled Water Distribution/HVAC**	**Hazardous Materials**	**Research Functions**	**Historically Significant/ Rare or Unique Collection**	**Hazard Specific Vulnerabilities**	**Total**
Environment, Health, & Safety Building	6	1	3	0	0	0	0	0	0	3	**13**
Dean Smith Center	0	0	3	6	1	0	0	0	0	0	**10**
Public Safety Building	3	4	3	0	0	0	0	0	0	0	**10**
Bingham Facility A*	0	0	3	0	0	0	3	2	0	0	**8**
Bingham Facility Building #2*	0	0	3	0	0	0	3	2	0	0	**8**
Bingham Facility Building #3*	0	0	3	0	0	0	3	2	0	0	**8**
Burnett-Womack Building	0	0	3	0	0	0	3	2	0	0	**8**
Caudill, W Lowry, & Susan S Labs	0	0	3	0	0	0	3	2	0	0	**8**
Chapman Hall	0	0	3	0	0	0	3	2	0	0	**8**
Davie Hall	0	0	3	0	0	0	3	2	0	0	**8**
Francis Owen Blood Research Lab*	0	0	3	0	0	0	3	2	0	0	**8**
Genetic Medicine Research Lab	0	0	3	0	0	0	3	2	0	0	**8**
Hooker Research Center	0	0	3	0	0	0	3	2	0	0	**8**
Dr. Mary Ellen Jones Building	0	0	3	0	0	0	3	2	0	0	**8**
Koury Oral Health Sciences Building	0	0	3	0	0	0	3	2	0	0	**8**
Marisco Hall	0	0	3	0	0	0	3	2	0	0	**8**
McGavran-Greenberg Hall	0	0	3	0	0	0	3	2	0	0	**8**
Medical Biomolecular Research Building	0	0	3	0	0	0	3	2	0	0	**8**
Neurosciences Research Building	0	0	3	0	0	0	3	2	0	0	**8**
Taylor, Isaac M Hall	0	0	3	0	0	0	3	2	0	0	**8**
Thurston Bowles Building	0	0	3	0	0	0	3	2	0	0	**8**
Cogeneration Facility	0	1	3	0	0	3	0	0	0	0	**7**
Electric Distribution System Operations Center (SOC)	0	1	3	0	0	3	0	0	0	0	**7**
ITS Franklin Street	0	3	3	0	0	0	0	0	0	0	**6**
ITS Manning	0	3	3	0	0	0	0	0	0	0	**6**
Hemophilia Research Lab	0	0	0	0	0	0	3	2	0	0	**5**
Kerr, Banks Dayton Hall	0	0	0	0	0	0	3	2	0	0	**5**
Wilson Hall	0	0	0	0	0	0	3	2	0	0	**5**
Wilson Library	0	0	3	0	0	0	0	0	2	0	**5**
Cameron Substation	0	1	0	0	0	3	0	0	0	0	**4**
Cobb Chilled Water Plant	0	1		0	0	3	0	0	0	0	**4**

Building	EOC	Essential Operating Functions	Generator or Hook-Ups	Pre/Post-Disaster Shelter	Essential Sheltering Services	Chilled Water Distribution/HVAC	Hazardous Materials	Research Functions	Historically Significant/ Rare or Unique Collection	Hazard Specific Vulnerabilities	Total
Chase Dining Hall	0	0	3	0	1	0	0	0	0	0	**4**
Manning Steam Plant	0	1	0	0	0	3	0	0	0	0	**4**
Manning Substation	0	1	0	0	0	3	0	0	0	0	**4**
MacNider Hall	0	3	1	0	0	0	0	0	0	0	**4**
South Chilled Water Plant	0	1	0	0	0	3	0	0	0	0	**4**
South Substataion	0	1	0	0	0	3	0	0	0	0	**4**
Tompkins Chilled Plant	0	1	0	0	0	3	0	0	0	0	**4**
Peabody Hall	0	3	0	0	0	0	0	0	0	0	**3**
South Building	0	1	0	0	0	0	0	0	2	0	**3**

*These buildings are classified as critical facilities but are located outside of the map boundaries.

Figure G.7 – UNC-CH Map of Critical Facilities



G.4 HAZARD IDENTIFICATION & RISK ASSESSMENT

G.4.1 Hazard Identification

To identify a full range of hazards relevant to the UNC Eastern Campuses, HMPC representatives from each campus began with a review of the list of hazards identified in the 2018 North Carolina State Hazard Mitigation Plan and the 2010 UNC-CH Pre-Disaster Mitigation Plan, as summarized in **Table G.9**. This ensured consistency with the state and regional hazard mitigation plans and across each campus' planning efforts.

Table G.9 – Hazards Included in Previous Planning Efforts

Hazard	Included in 2018 State HMP?	Included in 2010 UNC-CH Pre-Disaster Mitigation Plan?
Flooding	Yes	No
Hurricanes and Coastal Hazards	Yes	Yes, as High Wind, Hurricane
Severe Winter Weather	Yes	Yes, as Ice storm and Snow
Extreme Heat	Yes	No
Earthquakes	Yes	Yes
Wildfire	Yes	Yes
Dam Failures	Yes	No
Drought	Yes	Yes
Tornadoes/Thunderstorms	Yes	Yes
Geological (Landslides, Sinkholes, Coastal Erosion)	Yes	Yes, as Landslide
Hazardous Materials Incidents	Yes	No
Infectious Disease	Yes	No
Radiological Emergency	Yes	No
Terrorism/Mass Casualty	Yes	No
Cyber Threat	Yes	No

UNC-CH's HMPC representatives evaluated the above list of hazards by considering existing hazard data, past disaster declarations, local knowledge, and information from the 2018 State Plan and the 2010 UNC-CH Pre-Disaster Mitigation Plan in order to determine whether each hazard was significant enough to assess in this updated DRU plan. Significance was measured in general terms and focused on key criteria such as frequency, severity, and resulting damage, including deaths and injuries, as well as property and economic damage.

One key resource in this effort was the National Oceanic and Atmospheric Administration's (NOAA) National Center for Environmental Information (NCEI), which has been tracking various types of weather events 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), which compiles their information from a variety of sources, including but 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. While NCEI is not a comprehensive list of past hazard events, it can provide an indication of relevant hazards to the planning area and offers some statistics on injuries, deaths, damages, as well as narrative descriptions of past impacts.

Data for Orange County was used to approximate past events that may have affected the UNC-CH campus. The NCEI database contains 324 records of storm events that occurred in Orange County in the 20-year period from 2000 through 2019. **Table G.10** summarizes these events.

Table G.10 – NCEI Severe Weather Data for Orange County, 2000 – 2019

Type	# of Events	Property Damage	Crop Damage	Deaths	Injuries
Flash Flood	29	$10,933,000	$0	0	0
Flood	2	$26,400,000	$5,000,000	0	0
Funnel Cloud	0	$0	$0	0	0
Hail	41	$2,500	$500	0	0
Heavy Rain	1	$0	$0	0	0
Heavy Snow	1	$0	$0	0	0
High Wind	2	$1,000	$0	0	0
Hurricane (Typhoon)	0	$0	$0	0	0
Ice Storm	1	$2,700,000	$0	0	0
Lightning	7	$2,400,000	$0	2	0
Strong Wind	13	$296,500	$6,000	0	2
Thunderstorm Wind	152	$335,750	$2,000	1	3
Tornado	5	$2,250,000	$0	0	0
Tropical Storm	1	$500,000	$0	0	0
Winter Storm	30	$1,000,000	$0	0	0
Winter Weather	29	$30,000	$0	0	0
Total	**314**	**$46,848,750**	**$5,008,500**	**3**	**5**

Source: National Center for Environmental Information Events Database, retrieved October 2020
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 Orange 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 1954. Since then, Orange County has been designated in 17 major disaster declarations, as detailed in **Table G.11,** and 10 emergency declarations, as detailed in **Table G.12.**

Table G.11 – FEMA Major Disaster Declarations, Orange County

Disaster #	Dec. Date	Incident Type	Event Title	Individual Assistance Applications Approved	Total Individual & Households Program Dollars Approved	Total Public Assistance Grant Dollars Obligated
DR-28-NC	17-Oct-54	Hurricane	HURRICANE	N/A	N/A	N/A
DR-37-NC	13-Aug-55	Hurricane	HURRICANES	N/A	N/A	N/A
DR-56-NC	24-Apr-56	Severe Storm(s)	SEVERE STORM	N/A	N/A	N/A
DR-87-NC	01-Oct-58	Hurricane	HURRICANE & SEVERE STORM	N/A	N/A	N/A

Disaster #	Dec. Date	Incident Type	Event Title	Individual Assistance Applications Approved	Total Individual & Households Program Dollars Approved	Total Public Assistance Grant Dollars Obligated
DR-107-NC	16-Sep-60	Hurricane	HURRICANE DONNA	N/A	N/A	N/A
DR-130-NC	16-Mar-62	Flood	SEVERE STORM, HIGH TIDES & FLOODING	N/A	N/A	N/A
DR-179-NC	13-Oct-64	Flood	SEVERE STORMS & FLOODING	N/A	N/A	N/A
DR-1087-NC	13-Jan-96	Snow	BLIZZARD OF 96	N/A	N/A	N/A
DR-1134-NC	06-Sep-96	Hurricane	HURRICANE FRAN	N/A	N/A	N/A
DR-1292-NC	16-Sep-99	Hurricane	HURRICANE FLOYD MAJOR DISASTER DECLARATIONS	N/A	N/A	$298,105,794
DR-1312-NC	31-Jan-00	Severe Storm(s)	SEVERE WINTER STORM	N/A	N/A	$27,368,108
DR-1448-NC	12-Dec-02	Severe Ice Storm	SEVERE ICE STORM	N/A	N/A	$86,565,180
DR-1457-NC	27-Mar-03	Severe Ice Storm	ICE STORM	N/A	N/A	N/A
DR-1490-NC	18-Sep-03	Hurricane	HURRICANE ISABEL	25,950	$45,380,866	$70,854,431
DR-4167-NC	21-Mar-13	Severe Ice Storm	SEVERE WINTER STORM	N/A	N/A	N/A
DR-4393-NC	15-Sep-18	Hurricane	HURRICANE FLORENCE	34,713	$133,948,455	$632,937,402
DR-4487-NC	25-Mar-20	Biological	COVID-19 PANDEMIC	N/A	N/A	$174,898,697

Source: FEMA Disaster Declarations Summary, October 2020

Note: Number of applications approved and all dollar values represent totals for all counties included in disaster declaration.

Table G.12 – FEMA Emergency Declarations, Orange County

Disaster #	Dec. Date	Incident Type	Event Title/Description
EM-3033-NC	02-Mar-77	Snow	DROUGHT & FREEZING
EM-3049-NC	11-Aug-77	Drought	DROUGHT
EM-3110-NC	17-Mar-93	Snow	SEVERE SNOWFALL & WINTER STORM
EM-3146-NC	15-Sep-99	Hurricane	HURRICANE FLOYD EMERGENCY DECLARATIONS
EM-3222-NC	05-Sep-05	Hurricane	HURRICANE KATRINA EVACUATION
EM-3380-NC	07-Oct-16	Hurricane	HURRICANE MATTHEW
EM-3401-NC	11-Sep-18	Hurricane	HURRICANE FLORENCE
EM-3423-NC	04-Sep-19	Hurricane	HURRICANE DORIAN
EM-3471-NC	13-Mar-20	Biological	COVID-19
EM-3534-NC	02-Aug-20	Hurricane	HURRICANE ISAIAS

Source: FEMA Disaster Declarations Summary, October 2020

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.

Table G.13 summaries the determination made for each hazard.

Table G.13 – Hazard Evaluation Results

Hazard	Included in this plan update?	Explanation for Decision
Natural Hazards		
Hurricane	Yes	The 2010 UNC-CH PDM plan found Hurricane to be a high frequency hazard. The County has had 8 disaster declarations related to hurricanes wind.
Coastal Hazards	No	The 2010 UNC-CH PDM plan did not address this hazard.
Tornadoes / Thunderstorms (Wind, Lightning, Hail)	Yes	The 2010 UNC-CH PDM plan found tornadoes to be a low threat. The County has had no disaster declarations related to tornadoes. The HMPC expressed interest in addressing this hazard in combination with thunderstorms (wind, lightning, hail). Thunderstorm wind was considered highly likely.
Flood*	Yes	The 2010 UNC-CH PDM did not assess flood as a hazard that impacts the campus. The County has had 2 disaster declarations related to flooding and the Campus experiences period localized stormwater flooding. The HMPC decided it should be included in this plan update.
Severe Winter Weather	Yes	The 2010 UNC-CH PDM plan found winter storms be a moderate probability hazard. The HMPC expressed interest in addressing this hazard as severe winter weather to include cold/wind chill; extreme cold; freezing fog; frost/freeze; heavy snow; ice storm; winter storm; and winter weather.
Drought	Yes	The 2010 UNC-CH PDM plan did not address this hazard. However, the HMPC decided to include it in this plan update.
Wildfire	Yes	The 2010 UNC-CH PDM plan did not a assign a threat and/or risk level for this hazard; however, the HMPC expressed interest in addressing this hazard.
Earthquake*	Yes	The 2010 UNC-CH PDM plan did not a assign a threat and/or risk level for this hazard; however, the HMPC expressed interest in addressing this hazard.
Geologic Hazards (Sinkhole & Landslide)*	Yes	The 2010 UNC-CH PDM plan did not a assign a threat and/or risk level for this hazard; however the HMPC did expressed an interest in addressing this hazard.
Dam Failure	Yes	The 2010 UNC-CH PDM assigned this hazard a low probability ranking; there are three high hazard dams located in Chapel Hill. The HMPC expressed interest in addressing this hazard.
Extreme Heat	No	The 2010 UNC-CH PDM plan did not address this hazard.
Technological and Human-Caused Hazards & Threats		
Hazardous Materials Incidents	Yes	The 2010 UNC-CH PDM plan did not address this hazard; however, there are fixed facility sites and transportation routes with hazardous materials in the planning area and the HMPC expressed interest in addressing this hazard.
Infectious Disease	No	The 2010 UNC-CH PDM did not address this hazard.
Cyber Attack	No	The 2010 UNC-CH PDM plan did not address this hazard.
Civil Unrest	No	The 2010 UNC-CH PDM plan did not address this hazard.

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

G.5 HAZARD PROFILES, ANALYSIS, AND VULNERABILITY

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 where it may occur, the severity of potential events, records of past events, the probability of future occurrences, and potential impacts from the hazard. A vulnerability assessment was conducted for each hazard using quantitative and/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.

To account for regional differences in hazard risk across each of the campuses, this risk assessment is divided into two parts:

1) a set of summary hazard profiles describing each hazard and summarizing the risk findings for each campus, presented in Section 3.5; and
2) a campus-specific risk assessment profiling the location, extent, historical occurrences, probability of future occurrence, and vulnerability of each campus, presented in each campus annex.

In the campus-level hazard profiles presented here, each hazard is profiled in the following format:

Location

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

Extent

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

Historical Occurrences

This section contains information on historical events, including the location and consequences of all past events on record within or near the Orange County planning area. Where possible, this plan uses a consistent 20-year period of record except for hazards with significantly longer average recurrence intervals or where data limitations otherwise restrict the period of record.

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)

Vulnerability Assessment

This section quantifies, to the extent feasible using best available data, assets at risk to natural hazards and potential loss estimates. Details on hazard specific methodologies and assumptions are provided where applicable. People, properties and critical facilities, and environmental assets that are vulnerable to the hazard are identified.

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

- Geographic Information System (GIS) datasets, including County parcel data from 2020, campus building inventory fand values from the University System's Division of Information Technology, NCEM iRisk Database, and property values provided by the NC Department of Insurance, topography, transportation layers, and critical facility and infrastructure locations;
- Hazard layer GIS datasets from state and federal agencies;
- Written descriptions of inventory and risks provided by the 2018 State of North Carolina Hazard Mitigation Plan;
- Written descriptions of inventory and risks provided by the 2020 Eno-Haw Regional Hazard Mitigation Plan; and
- Exposure and vulnerability estimates derived using local parcel data.

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. For applicable hazards, the quantitative analysis involved the use of FEMA's Hazus-MH, a nationally applicable standardized set of models for estimating potential losses from earthquakes, floods, and hurricanes. Hazus uses a statistical approach and mathematical modeling of risk to predict a hazard's frequency of occurrence and estimated impacts based on recorded or historic damage information. The Hazus risk assessment methodology is parametric, in that distinct hazard and inventory parameters—such as wind speed and building type—were modeled using the Hazus software to determine the impact on the built environment. UNC-CH's GIS-based risk assessment was completed using data collected from local, regional and national sources that included the UNC System, Orange County, NCEM, and FEMA.

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. Other information can be collected in regard to the hazard area, such as the location of critical facilities and infrastructure, historic resources, 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.

The data collected for the hazard profiles and vulnerability assessment was obtained from multiple sources covering a variety of spatial areas including county-, jurisdictional-, and campus-level information. The table below presents the source data and the associated geographic coverages.

Table G.14 – Summary of Hazard Data Sources and Geographic Coverage

Hazard	Hazard Data Sources	Profile Geographic Area	Vulnerability Methodology	Vulnerability Geographic Area
Dam Failure	NC Dam Inventory, NCDEQ	County	Qualitative Analysis	Campus

Hazard	Hazard Data Sources	Profile Geographic Area	Vulnerability Methodology	Vulnerability Geographic Area
Drought	USDM, NDMC, NCEI	County	Qualitative Analysis	Campus
Earthquake	USGS, NCEI	County	Hazus 4.2	Census Tract
Flood	NCEI, FEMA	Jurisdiction	GIS Spatial Analysis	Campus
Hurricane	NHC	County	Hazus 4.2	Census Tract
Landslide	USGS	County	Qualitative Analysis	Campus
Severe Winter Weather	NWS, NCEI	County	Statistical Analysis	County
Tornado / Thunderstorm	NWS, NCEI	Jurisdiction	Statistical Analysis	Jurisdiction
Wildfire	NCFS, SouthWRAP	County, Campus	GIS Spatial Analysis	Campus
Hazardous Materials Incidents	EPA; USDOT	Jurisdiction	GIS Spatial Analysis	Campus

CDC = Centers for Disease Control and Prevention; EPA = United States Environmental Protection Agency; FEMA = Federal Emergency Management Agency; NCDEQ = North Carolina Department of Environmental Quality; NCEI = National Centers for Environmental Information; NCFS = North Carolina Forest Service; NDMC = National Drought Mitigation Center; NHC = National Hurricane Center; NWS = National Weather Service; SouthWRAP = Southern Group of State Foresters, Wildfire Risk Assessment Portal; USDM = United States Drought Monitor; USDOT = United States Department of Transportation; USGS = United States Geological Survey; WHO = World Health Organization

Changes in Development

This section describes how changes in development have impacted vulnerability since the last plan was adopted. 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.

Problem Statements

This section summarizes key mitigation planning concerns related to this hazard.

Priority Risk Index

The conclusions drawn from the hazard profiling and vulnerability assessment process are used to prioritize all potential hazards to the UNC-CH 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 G.15.**

PRI ratings are provided by category throughout each hazard profile for the planning area as a whole. Ratings specific to each jurisdiction are provided at the end of each hazard profile. The results of the risk assessment and overall PRI scoring are provided in Section 0 Conclusions on Hazard Risk.

The sum of all five risk assessment categories equals the final PRI value, demonstrated in the equation below (the lowest possible PRI value is a 1.0 and 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 campus 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.

Table G.15 – 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	

G.5.1 Dam Failure

Hazard	Probability	Impact	Spatial Extent	Warning Time	Duration	PRI Score
Dam Failure	Possible	Critical	Negligible	Less than 6 hours	Less than 1 week	2.4

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 November 2019, there are 55 dams in Orange County; 30 of these dams are rated low hazard, 8 are rated intermediate hazard, and 17 are rated high hazard. Of the 17 high hazard dams in the County, 3 are located in the Town of Chapel Hill. Additionally, Chapel Hill is the nearest downstream location of another high hazard dam.

Figure G.8 shows the location of all dams in Chapel Hill and its proximity. **Table G.16** lists all dams with high hazard potential in the County.

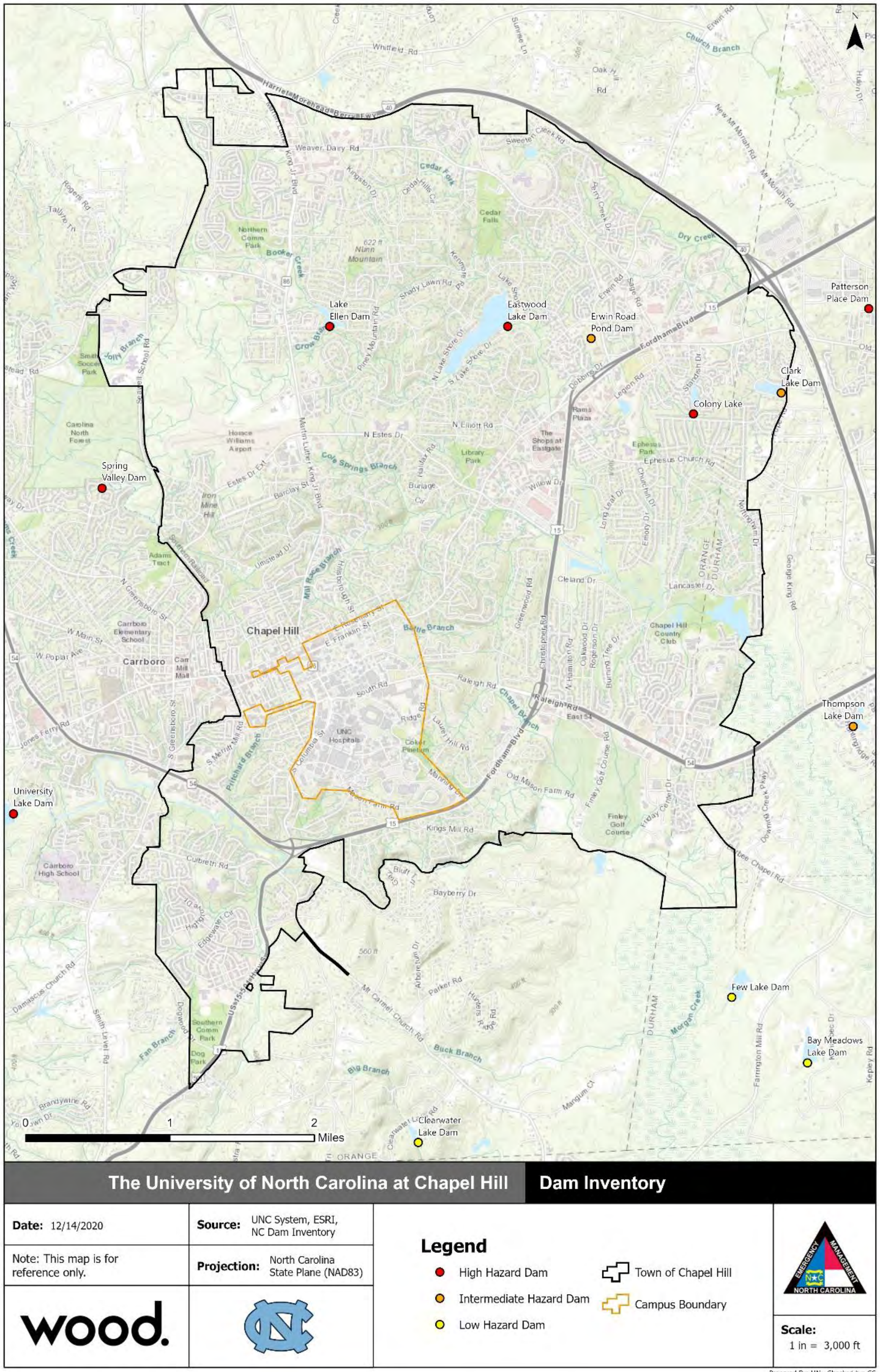
Table G.16 –Dams in and around Chapel Hill

Dam Name	NID ID	Hazard	Max Capacity (Ac-Ft)	River/Stream	Miles to Center of UNC-CH Campus
Spring Valley Dam	NC04994	High	10	Bolin Creek Trail	2.42
University Lake Dam	NC00782	High	4,836	Morgan Creek	2.54
Lake Ellen Dam	NC01537	High	81	Booker Creek	2.71
Eastwood Lake Dam	NC00781	High	330	Booker Creek	2.87
Clearwater Lake Dam	NC01554	Low	90	Big Branch	2.98
Erwin Road Pond Dam	NC06156	Intermediate	--	Unnamed Tributary to Booker Creek	3.04
Colony Lake Dam	NC03671	High	48	Little Creek-Tr	3.08
Few Lake Dam	NC01045	Low	75	New Hope Creek-Tr	3.19
Thompson Lake Dam	NC01047	Intermediate	60	Little Creek-Tr	3.37
Clark Lake Dam	NC01048	Intermediate	50	New Hope Creek-Tr	3.64
Bay Meadows Lake Dam	NC01046	Low	96	Morgan Creek-Tr	3.89
Patterson Place Dam	NC05819	High	82	UT to New Hope Creek	4.48

Source: North Carolina Dam Inventory, November 2019

Spatial Extent: 1 – Negligible

Figure G.8 – Dam Locations in Chapel Hill and Vicinity



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 G.17 – 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

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

Historical Occurrences

According to the current Eno-Haw plan, which includes Orange County, and anecdotal evidence, there are no records of historical dam failures occurrences in or affecting the planning area.

Probability of Future Occurrence

Given the presence of high hazard dams in Orange County, failure of a dam is possible. Dam failure has not occurred in the region, 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

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.

Changes in Development

Increased development downstream from dams generally increases exposure. Such development may necessitate upgrading the rating based on the guidelines in **Table G.17.**

Problem Statement

- While a dam failure has not occurred in the County to date, failure in the future is still possible. There are 3 high hazard dams in Chapel Hill; Chapel Hill is the nearest downstream location of one additional high hazard dam.

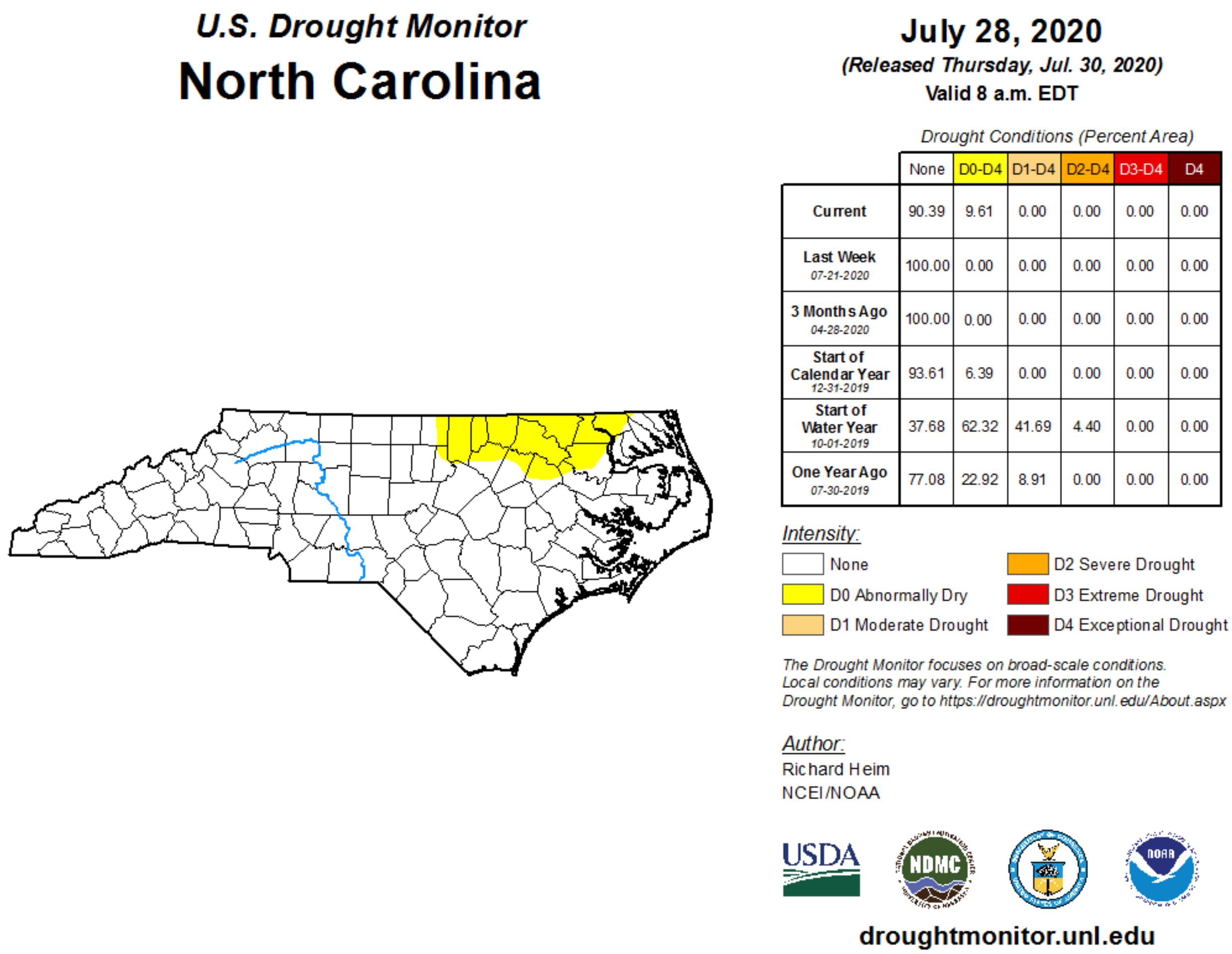
G.5.2 Drought

Hazard	Probability	Impact	Spatial Extent	Warning Time	Duration	PRI Score
Drought	Likely	Minor	Large	More than 24 hrs	More than 1 week	2.5

Location

Drought is a regional hazard that can cover 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 July 28, 2020; as of that date, Orange County was experiencing no impacts of drought, however parts of neighboring Durham County.

Figure G.9 – US Drought Monitor for Week of July 28, 2020



Source: U.S. Drought Monitor

Spatial Extent: 4 – Large

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 G.10** 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 G.10 – 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

From late 2007 through mid-2008, North Carolina experienced the worst drought in state history. During this time, portions of Orange County experienced exceptional drought conditions.

Impact: 1 – Minor

Historical Occurrences

U.S. Drought Monitor records drought intensity weekly throughout the country. The North Carolina Department of Environmental Quality (NCDEQ) Division of Water Resources maintains records of Drought Monitor data for the state as far back as January 2000. **Table G.18** presents the number of weeks that Orange County spent in drought by intensity over the period from 2000 through 2019, for which the Drought Monitor has records for 1,044 weeks.

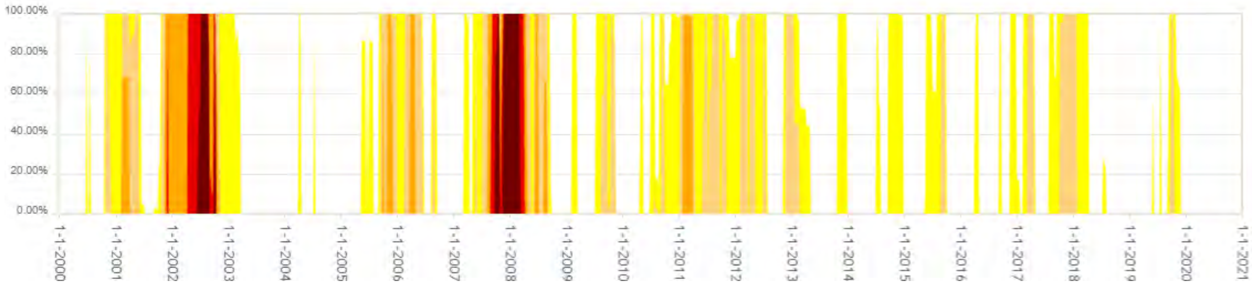
Table G.18 – Weeks in Drought, 2000-2019

	Weeks in Drought						% of time in Severe Drought or Worse
County	Total	D0	D1	D2	D3	D4	
Orange	515	255	143	65	22	30	12.0%

Source: NCDEQ Division of Water Resources, Drought Monitor History

Figure G.11 shows the historical periods where Orange County was considered in some level of drought condition. The color key shown in **Figure G.10** indicates the intensity of the drought.

Figure G.11 – US Drought Monitor Historical Trends – Orange County 2000-2019



Source: U.S. 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 11-year period from January 2009 through December 2019, 289 drought impacts were noted for the State of North Carolina, of which 19 were reported to affect Orange County. **Table G.19** 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 G.19 – Drought Impacts Reported for Orange County, January 2009 through December 2019

Category	Impacts	Years Reported
Agriculture	2	2010, 2012,
Fire	3	2019
Plants & Wildlife	6	2014, 2017,
Relief, Response & Restrictions	9	2010, 2011, 2012, 2017, 2019
Water Supply & Quality	7	2011, 2012, 2014, 2015, 2017

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

Probability of Future Occurrence

Over the 20-year (1044 week) period from 2000 through 2019, Orange County had 515 weeks of drought conditions ranging from abnormally dry to exceptional drought. This equates to a 48 percent chance of drought in any given week. Of this time, 117 weeks were categorized as a severe (D2) drought or greater; which equates to an 11 percent chance of severe drought in any given week.

Probability: 3 – Likely

Vulnerability Assessment

Methodologies and Assumptions

Vulnerability to drought is based on historical occurrences of drought in the planning area and generalized concerns regarding potential drought consequences.

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.

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.

Changes in Development

As new development on campus occurs and population rises, water demand will likely increase, which could lower the threshold for socioeconomic drought in terms of inability of water supply to meet water demand on campus and in the larger Chapel Hill and Orange County community's as a whole.

Following the drought of the late 200s, in 2009, UNC-CH developed a reclaimed water system to provide cooling tower make-up water for the University's chilled water plants, the largest water use on campus, and for athletic field irrigation. Reclaimed water is also used to flush toilet in buildings on campus.

Problem Statement

- The County experienced drought periods of 100 weeks or longer three times between 2000-2019: 100 weeks from August 2010 through July 2012 – 18 weeks at D2 level; 150 weeks from May 2007 through September 2008 – 42 weeks at D2 or higher; and October 2001 through March 2003 – 48 weeks at D2 or higher.
- Critical functions at UNC-CH rely on a chilled water system; UNC-CH has attempted to mitigate impacts to these functions during periods of drought by integrating the use of reclaimed water systems.

G.5.3 Earthquake

Hazard	Probability	Impact	Spatial Extent	Warning Time	Duration	PRI Score
Earthquake	Unlikely	Minor	Large	Less than 6 hours	Less than 6 hours	1.9

Location

The United States Geological Survey (USGS) Quaternary faults database was consulted to determine the sources of potential earthquakes within range of Orange County. Quaternary faults are active faults recognized at the surface which have evidence of movement in the past 2.58 million years. No active faults were noted in Orange County.

Earthquakes are generally felt over a wide area, with impacts occurring hundreds of miles from the epicenter. Therefore, any earthquake that impacts Orange County is likely to be felt across most if not all of the planning area.

Spatial Extent: 4 – Large

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 G.20.** 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 G.21** 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 G.20 – 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 G.21 – 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.

MMI	Richter Scale	Felt Intensity
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.
VIII	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 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.

Impact: 1 – Minor

Historical Occurrences

The USGS Earthquake Hazards Program maintains a database of historical earthquakes of a magnitude 2.5 and greater from 1900 to 2020. Earthquake events that occurred within 100 miles of the UNC-CH campus are presented in **Table G.22** and **Figure G.12.**

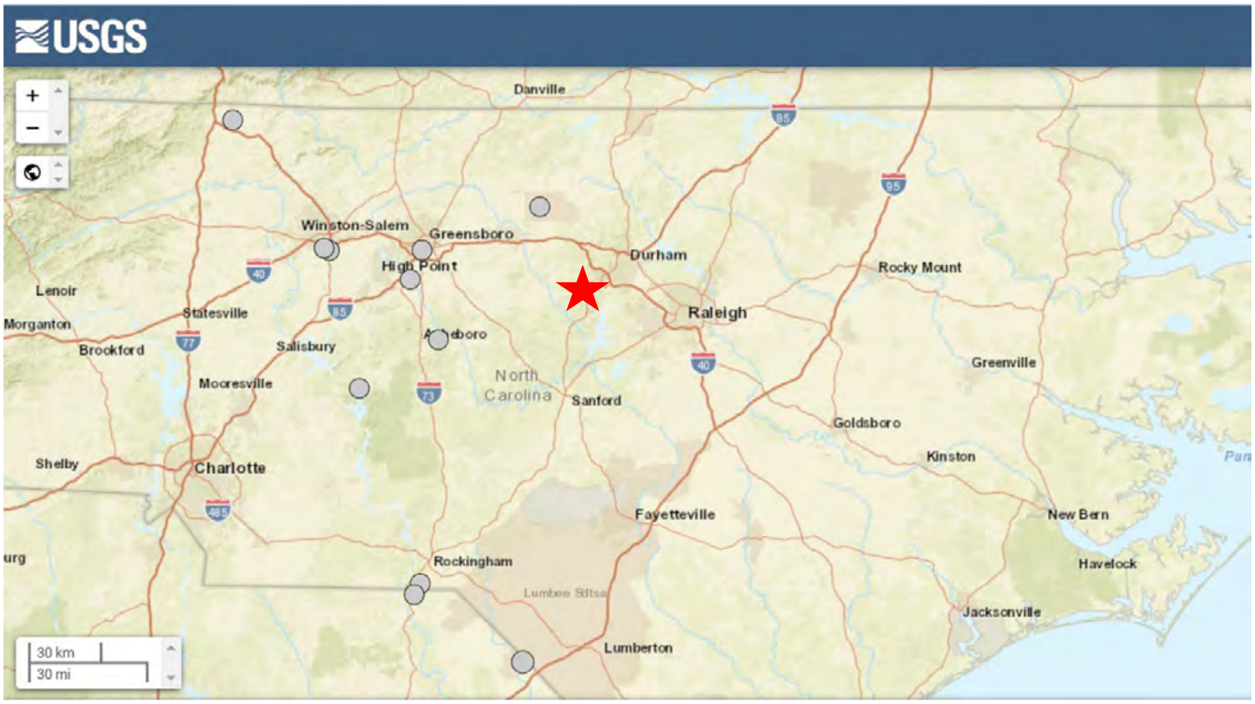
Table G.22 – Historical Earthquakes within 100 Miles of UNC-CH, 1900-2020

Year	Magnitude	MMI	Location
1978	2.7	II	Virginia-North Carolina border region
1980	2.5	II	Virginia-North Carolina border region
1981	2.8	II	North Carolina
1993	2.7	II	Virginia-North Carolina border region
2006	3.7	III	7km W of Rowland, North Carolina
2006	2.5	II	Virginia-North Carolina border region
2006	2.6	II	7km S of Winston-Salem, North Carolina
2011	2.9	II	9km S of Cordova, North Carolina
2012	2.5	II	10km NNE of Cheraw, South Carolina

Year	Magnitude	MMI	Location
2015	2.58	II	10km S of Denton, North Carolina
2019	2.5	II	8km E of Archdale, North Carolina

Source: USGS Earthquake Catalog

Figure G.12 – Historical Earthquakes within 100 Miles of UNC-CH, 1900-2020



Source: USGS Earthquake Catalog

The National Center for Environmental Information (NCEI) maintains a database of the felt intensity of earthquakes from 1638 to 1985 including the maximum intensity for each locality that felt the earthquake. According to this database, in the 100-year period from 1885-1985, there were two earthquakes felt in and around Chapel Hill: on September 1, 1886 with an epicenter approximately 345 miles from Chapel Hill; and on March 3, 1925 a 7 magnitude with an epicenter approximately over 1500 miles from Chapel Hill.

Probability of Future Occurrence

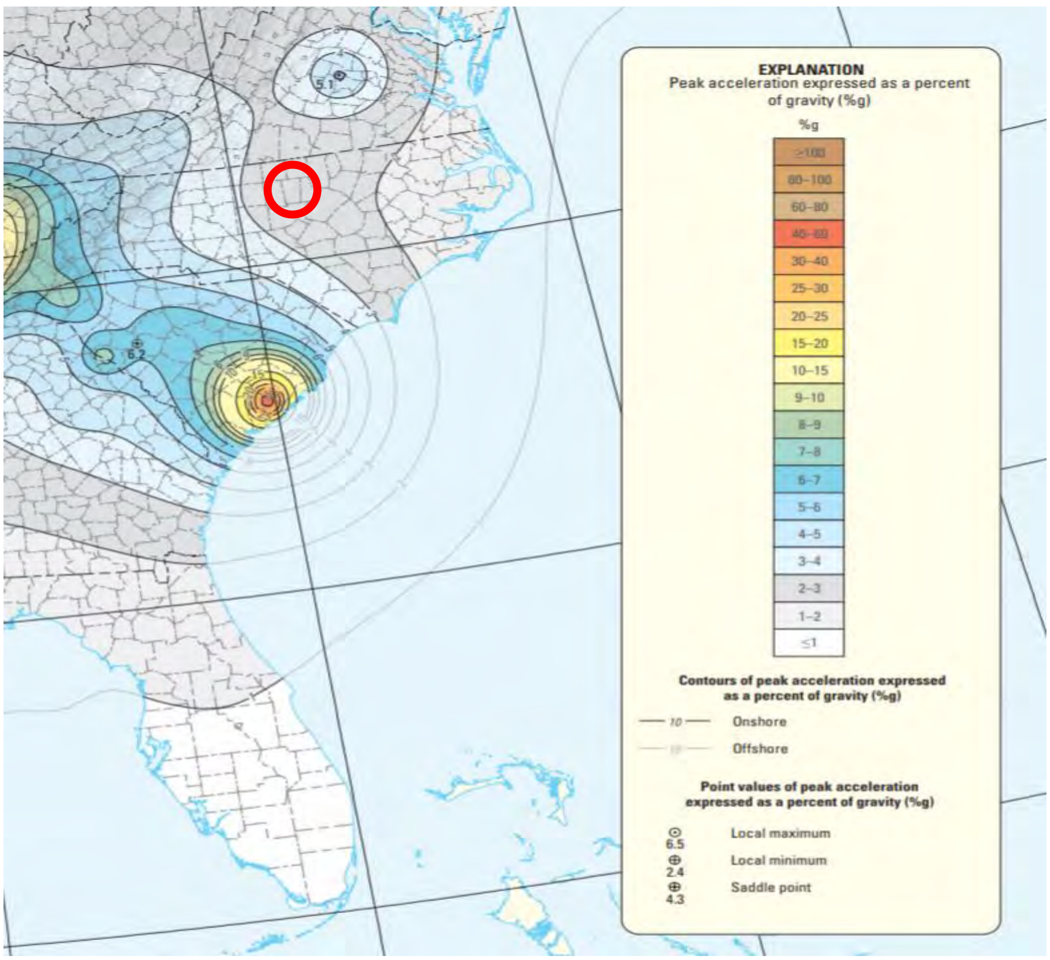
Ground motion is the movement of the earth's surface due to earthquakes or explosions. It is produced by waves generated by a sudden slip on a fault or sudden pressure at the explosive source and travels through the earth and along its surface. Ground motion is amplified when surface waves of unconsolidated 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 that have a common given probability of being exceeded in 50 years.

Figure G.13 on the following page reflects the seismic hazard for Orange 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 occurrence 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. All of Orange County is located within a zone with peak acceleration of 2-3% g, which indicates low earthquake risk.

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

Probability: 1 – Unlikely

Figure G.13 – Seismic Hazard Information for Orange County



Source: USGS Earthquake Hazards Program

Vulnerability Assessment

Methodology & Assumptions

To quantify vulnerability, Wood performed a Level 1 earthquake analysis in Hazus 4.2 utilizing general building stock information based on the 2010 Census. The UNC-CH campus is located within three census tracts encompassing 1.81 square miles. The earthquake scenario was modeled after an arbitrary earthquake event of magnitude 5.0 with an epicenter in the UNC-CH campus and depth of 10km.

People

Hazus estimates that the modeled magnitude 5.0 event would result in 90 households requiring temporary shelter. Additionally, Hazus estimates potential injuries and fatalities depending on the time of day of an event. Casualty estimates are shown in **Figure G.14**. Casualties are broken down into the following four levels that describe the extent of injuries:

- Level 1: Injuries will require medical attention, but hospitalization is not needed.
- Level 2: Injuries will require hospitalization but are not considered life-threatening.
- Level 3: Injuries will require hospitalization and can become life threatening if not promptly treated.
- Level 4: Victims are killed by the earthquake.

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. Impacts of earthquakes also include debris clean-up and service disruption. Per the Hazus analysis, a 5.0 magnitude earthquake could produce 70,000 tons of debris.

Orange County has not been impacted by an earthquake with more than a low intensity, so major damage to the built environment is unlikely. **Table G.23** details the estimated buildings impacted by a magnitude 5.0 earthquake event, as modeled by Hazus. Note that building value estimates are inherent to Hazus and do not necessarily reflect damages to the asset inventory for the UNC-CH Campus.

Table G.23 – Estimated Buildings Impacted by 5.0 Magnitude Earthquake Event

Occupancy Type	Estimated Building Damage	Estimated Content Loss	Estimated Total Damage
Residential	$29,990,000	$0	$29,990,000
Commercial	$10,490,000	$0	$10,490,000
Industrial	$1,670,000	$0	$1,670,000
Other	$5,020,000	$0	$5,020,000
Total	**$47,170,000**	**$0**	**$47,170,000**

Source: Hazus

Figure G.14 – Casualty Estimate from a 5.0 Magnitude Earthquake Event

Table 10: Casualty Estimates

		Level 1	Level 2	Level 3	Level 4
2 AM	Commercial	0	0	0	0
	Commuting	0	0	0	0
	Educational	0	0	0	0
	Hotels	0	0	0	0
	Industrial	0	0	0	0
	Other-Residential	48	11	2	3
	Single Family	3	0	0	0
	Total	51	12	2	3
2 PM	Commercial	15	4	0	1
	Commuting	0	0	0	0
	Educational	48	11	2	3
	Hotels	0	0	0	0
	Industrial	1	0	0	0
	Other-Residential	9	2	0	1
	Single Family	0	0	0	0
	Total	73	17	2	5
5 PM	Commercial	13	3	0	1
	Commuting	0	0	0	0
	Educational	25	6	1	2
	Hotels	0	0	0	0
	Industrial	1	0	0	0
	Other-Residential	19	4	1	1
	Single Family	1	0	0	0
	Total	59	14	2	4

Source: Hazus 4.2

All critical facilities should be considered at risk to minor damage should an earthquake event occur. However, of the essential facilities included in Hazus—which includes 1 hospital, 2 schools, and 2 police station— one schools was estimated to sustain moderate damages, and the remaining school and police station were estimated to maintain at least 50 percent functionality after day one following an event. Additionally, Hazus projected one electrical power facility and one communications facility may sustain at least moderate damage.

Environment

An earthquake is unlikely to cause substantial impacts to the natural environment in Orange 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.

Changes in Development

Building codes substantially reduce the costs of damage to future structures from earthquakes. Future construction on the UNC-CH campus must follow the applicable requirements of the NC building codes, the State of North Carolina statutes for state owned buildings and zoning for the local jurisdiction.

Development changes at UNC-CH have not affected the risk characteristics of earthquakes. The probability, impact, spatial extent, warning time, and duration of earthquakes have not changed.

Problem Statement

- While earthquakes are an unlikely hazard event for the UNC-CH campus, the Hazus model did predict impacts to critical facilities and utility structures within the 1.8 square mile area including and around campus.

G.5.4 Flood

Hazard	Probability	Impact	Spatial Extent	Warning Time	Duration	PRI Score
Flood	Likely	Minor	Negligible	6 to 12 hrs	Less than 6 hours	1.8

Location

Regulated floodplains are illustrated on inundation maps called Flood Insurance Rate Maps (FIRMs). A FIRM 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 1-percent-annual-chance flood event. Structures located within the SFHA have a 26-percent chance of flooding during the life of a standard 30-year mortgage.

For this risk assessment, flood prone areas were identified within the UNC-CH Campus using the FIRM dated October 19, 2018. **Figure G.15** reflects the 2014 mapped flood insurance zones. **Table G.24** summarizes the flood insurance zones identified by the Digital FIRM (DFIRM).

Table G.24 – Mapped Flood Insurance Zones

Zone	Description
A	Zone A is the flood insurance rate zone that corresponds to the 1% annual chance floodplains that are determined in the FIS Report by approximate methods. Because detailed hydraulic analyses are not performed for such areas, no Base Flood Elevations or depths are shown within this zone.
AE	Zone AE is the flood insurance rate zone that corresponds to the 1% annual chance floodplains that are determined in the FIS Report by detailed methods. In most instances, whole-foot Base Flood Elevations derived from the detailed hydraulic analyses are shown at selected intervals within this zone.
AH	Zone AH is the flood insurance rate zone that corresponds to the areas of 1% annual chance shallow flooding (usually areas of ponding) where average depths are between 1 and 3 feet. Whole-foot Base Flood Elevations derived from the detailed hydraulic analyses are shown at selected intervals within this zone.
AO	Zone AO is the flood insurance rate zone that corresponds to the areas of 1% annual chance shallow flooding (usually sheet flow on sloping terrain) where average depths are between 1 and 3 feet. Average whole-foot depths derived from the detailed hydraulic analyses are shown within this zone.
VE	Zone VE is the flood insurance rate zone that corresponds to the 1% annual chance coastal floodplains that have additional hazards associated with storm waves. Whole-foot Base Flood Elevations derived from the detailed hydraulic analyses are shown at selected intervals within this zone.
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 0.2-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 0.3% percent of the UNC-CH Campus falls within the SFHA. **Table G.25** provides a summary of the UNC-CH Campus' total area by flood zone on the 2018 effective DFIRM.

Spatial Extent: 1 – Negligible

Figure G.15 – FEMA Flood Hazard Areas in UNC-CH's Campus Boundary

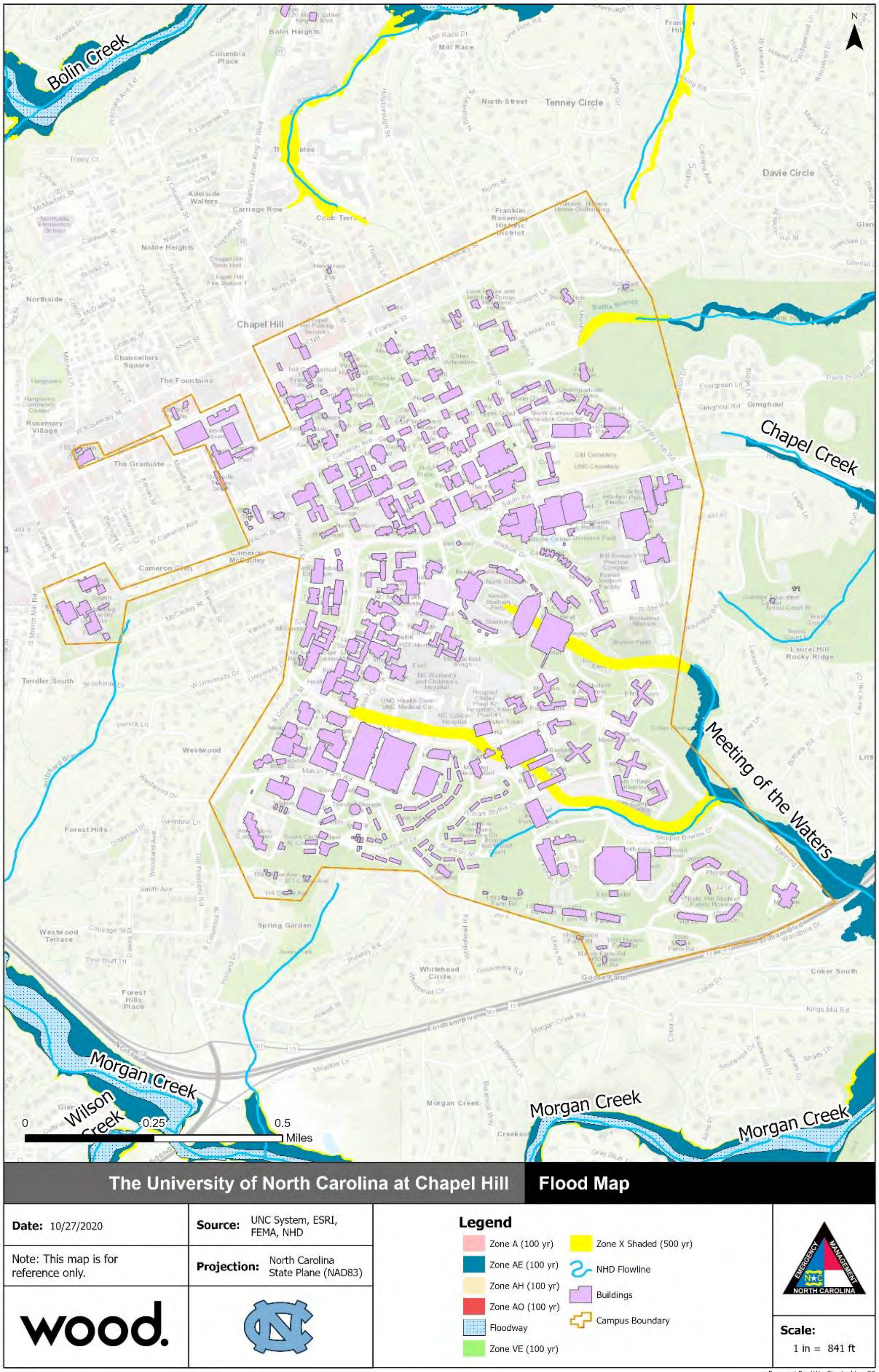


Table G.25 – Flood Zone Acreage on UNC-CH Campus

Flood Zone	Acreage	Percent of Total (%)
A	0	0.0%
AE	2	0.3%
AH	0	0.0%
AO	0	0.0%
Floodway	0	0.0%
VE	0	0.0%
0.2% Annual Chance Flood Hazard	19	2.6%
Unshaded X	713	97.1%
Total	734	**--**
SFHA Total	**2**	**0.3%**

Source: FEMA 2018 DFIRM

Although no detailed studies were completed by FEMA for several smaller tributaries that run through campus, it should be noted that these waterways could be a source of flooding.

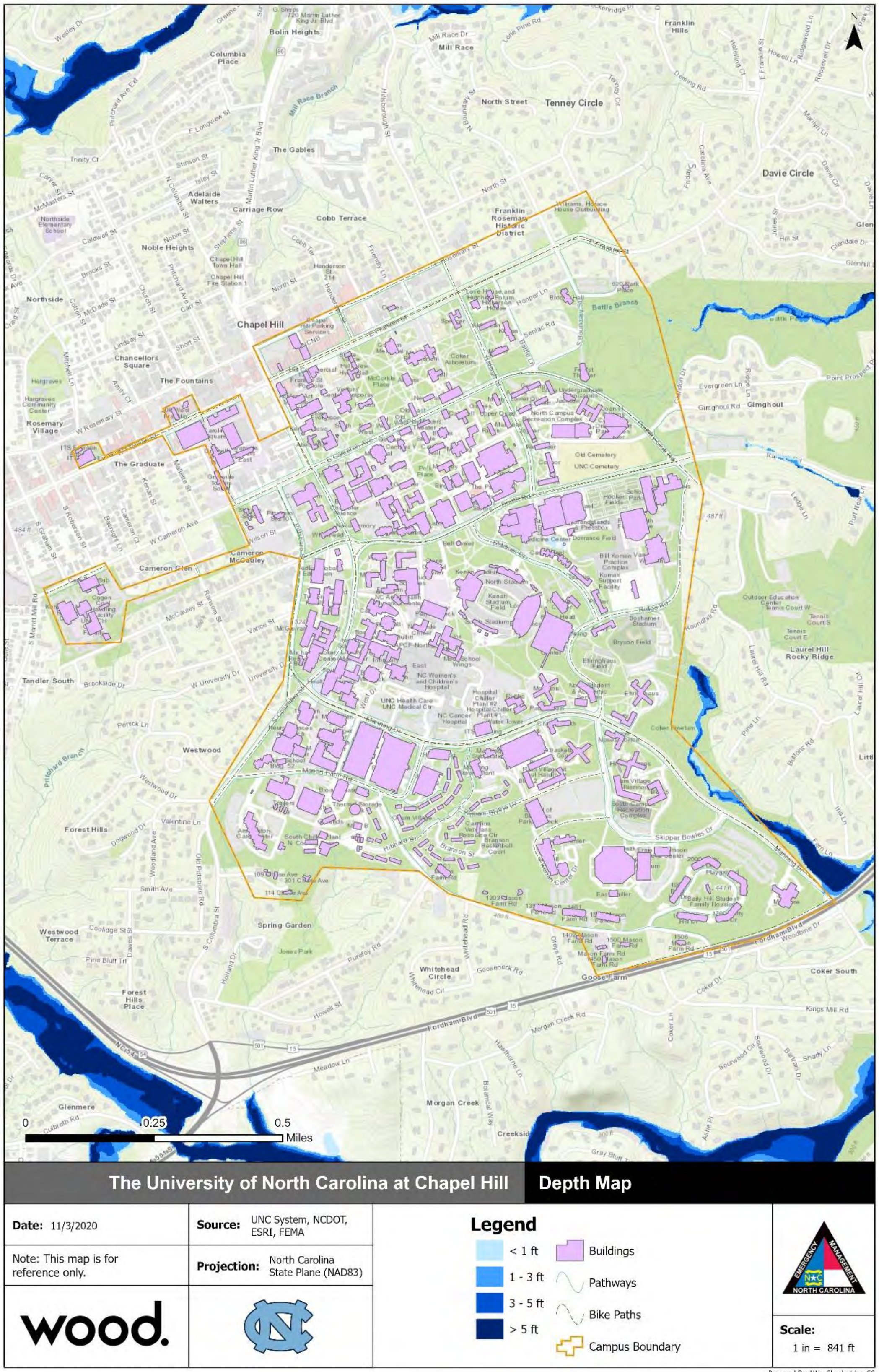
Additionally, although this assessment focuses on riverine flooding, it is also important to note that localized stormwater flooding can also occur on campus and may affect areas outside the mapped floodplain. Data was not available to evaluate the location or extent of stormwater flooding on campus.

Extent

Flood extent can be defined by the amount of land in the floodplain, detailed above, and the potential magnitude of flooding as measured by flood depth and velocity. **Figure G.16** shows the depth of flooding predicted from a 1% annual chance flood. Flood damage is closely related to depth, with greater flood depths generally resulting in more damages.

Impact: 1 – Minor

Figure G.16 – Flood Depth, 1-Percent-Annual-Chance Flood, UNC-CH Campus



Historical Occurrences

Table G.26 details the historical occurrences of flooding for Chapel Hill identified from 2000 through 2019 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. Events in the table include those with a location attributed to Chapel Hill and those where flooding impacts in Chapel Hill are mentioned in the Event Narrative.

Table G.26 – NCEI Records of Flooding for the Town of Chapel Hill, 2000-2019

Location	Date	Deaths/Injuries	Reported Property Damage	Reported Crop Damage
Flash Flood				
CHAPEL HILL	7/23/2000	0/0	$6,400,000	$0
CHAPEL HILL	7/25/2006	0/0	$0	$0
CHAPEL HILL	5/27/2011	0/0	$0	$0
CHAPEL HILL	9/6/2012	0/0	$0	$0
CHAPEL HILL	6/30/2013	0/0	$0	$0
CHAPEL HILL	6/30/2013	0/0	$3,600,000	$0
CHAPEL HILL	6/30/2013	0/0	$500,000	$0
CHAPEL HILL	5/15/2014	0/0	$0	$0
CHAPEL HILL	12/23/2015	0/0	$0	$0
CHAPEL HILL	12/30/2015	0/0	$5,000	$0
ETLAND	10/8/2016	0/0	$250,000	$0
CARR	9/16/2018	0/0	$0	$0
CARRBORO	11/12/2018	0/0	$10,000	$0
Total		**0/0**	**$10,765,000**	**$0**

Source: NCEI

According to NCEI, 13 recorded flood-related events affected the City of Chapel Hill from 2000 to 2019 causing an estimated $10,765,000 in property damage, with no injuries, fatalities, or crop damage.

The following event narratives are provided in the NCEI Storm Events Database and illustrate the impacts of flood events on the county:

- **07/23/2000** – Flooding of streets and buildings was reported countywide, especially in Chapel Hill and Carrboro. The Eastgate Shopping center was damaged, as well as several apartments and homes. A bridge was washed out on Piney Mountain Rd.
- **06/30/2013** – Heavy rain (4-5 inches) resulted in extensive flooding in the city of Chapel Hill. The first floor of the Town Hall flooded. Franklin Street saw widespread flooding, with water above the windows of cars in several locations and some businesses also being impacted. Several buildings on the University of North Carolina had water in them, including the bottom floor of Granville Tower. Another area of the city that experienced flooding was the East Gate Shopping Center, where water entered several businesses and stranded many cars in the parking lot. One hard hit residential areas was along Estes Drive near Highway 15-501, where the Camelot Village Condominiums experienced extensive flooding. In fact, 76 out of 116 units flooded. Another residential area that experienced flooding was the Airport Gardens Public Housing Neighborhood, where 18 out of the 26 units flooded. Due to the flooding, the county qualified for state and federal aid.
- **10/08/2016 –** Heavy rainfall of 4 to 5 inches caused widespread flash flooding across the county, with numerous road closures. Flooding damaged the first floor of 5 buildings in Chapel Hill.

- **11/12/2018** – Heavy rain resulted in flash flooding throughout the city of Chapel Hill. Multiple roads were flooded, including Umstead Road, Estes Drive, Cleland Road and Old Mason Farm Road.

The state of North Carolina has had two FEMA Major Disaster Declarations for severe storms that include elements of flooding in 1962 and 1964 along with four Major Disaster Declarations for Hurricanes in 1954, 1955, 1958, 1960 which may have included damages associated with flooding. Additionally, Orange County has received four Major Disaster Declarations for Hurricanes in, 1996, 1999, 2003, 2018 which also may have included damages associated with flooding.

Probability of Future Occurrence

By definition, SFHAs are those areas that will be inundated by the flood event having a 1-percent chance of being equaled or exceeded in any given year. While exposure to flood hazards varies across jurisdictions, all jurisdictions have at least some area of land in FEMA-mapped flood hazard areas. This delineation is a useful way to identify the most at-risk areas, but flooding does not occur in set intervals; any given flood may be more or less severe than the defined 1-percent-annual-chance flood. There is also risk of localized and stormwater flooding in areas outside the SFHA and at different intervals than the 1% annual chance flood.

Floods of varying severity occur regularly in Orange and impacts from past flood events have been noted by NCEI. NCEI reports 13 flood-related events in the 20-year period from 2000-2019, which equates to an annual probability of 65% for Chapel Hill. Therefore, the probability of flooding is considered likely (between 10% and 100% annual probability).

Probability: 3 –Likely

Vulnerability Assessment

Methodology & Assumptions

To quantify vulnerability, Wood performed a GIS spatial analysis of the flood hazard by overlaying the mapped SFHA on the building footprints provided by the UNC Division of Information Technology and NCEM iRisk database. For the UNC-CH campus, there are no structures located within the SFHA.

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 systems lose 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 high risk when driving through flooded streets. However, NCEI does not contain any records of deaths caused by flood events in Chapel Hill.

An estimate of population at risk to flooding can be developed based on the assessment of housing property at risk. For the UNC-CH campus, there are no housing properties at risk.

Property

Administration buildings, education and/or extracurricular facilities, housing, as well as critical facilities and infrastructure such as transportation, water, energy, and communication systems may be damaged or destroyed by flood waters.

details the estimated losses for the 1%-annual-chance flood event for the campus. The total damage estimate value is based on damages to the total of building value. Land value is not included in any of the loss estimates as generally land is not subject to loss from floods.

Table G.27 – Estimated Building Damage and Content Loss for 1% Annual Chance Flood

Occupancy Type	Total Buildings with Loss	Total Value	Estimated Building Damage	Loss Ratio
Administration	0	$0	$0	0%
Critical Facilities	0	$0	$0	0%
Education/ Extracurricular	0	$0	$0	0%
Housing	0	$0	$0	0%
Total	0	$0	$0	0%

Source: UNC Division of Information Technology; NCEM iRisk; NC Department of Insurance; USACE Wilmington District Depth-Damage Function

The loss ratio is the loss estimate divided by the total potential exposure (i.e., total of improved value for all buildings located within the Zone AE) and displayed as a percentage of loss. FEMA considers loss ratios greater than 10% to be significant and an indicator a community may have more difficulties recovering from a flood. Loss ratios for all occupancy types with identified structures on the UNC-CH campus are 0%, meaning that in the event of a flood with a magnitude of the 1%-annual-chance event or greater, the planning area would be minimally impacted.

None of the critical facilities identified for UNC-CH are located within the 1%-annual-chance floodplain, therefore there are no estimated damages.

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 planning area. According to 2020 NFIP records, there are no repetitive loss properties on the UNC-CH campus.

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.

Changes in Development

The likelihood of future flood damage can be reduced through appropriate land use planning, building siting and building design. In addition, the UNC-CH Facilities Management works to maintain compliance with all applicable state and federal regulations regarding water resources, provides a regulatory framework to ensure development has minimal impact on the environment, and manages the stormwater infrastructure.

Problem Statement

- While the 1% annual chance floodplain only impacts a small portion (0.3%) of the UNC-CH campus, in the southeastern corner, the 0.2% annual chance floodplain (or 500-year floodplain) does extend onto the UNC-CH campus and could potentially impact roadways and buildings within the southern and eastern parts of campus during these flood events.
- In 2013, a flash flood event reportedly impacted several buildings on the UNC Chapel Hill campus.

G.5.5 Geological – Landslide

Hazard	Probability	Impact	Spatial Extent	Warning Time	Duration	PRI Score
Landslide	Possible	Minor	Small	6 to 12 hrs	Less than 6 hrs	1.7

Location

Orange County is located within the Piedmont region of North Carolina. The Piedmont lies between the Coastal Plain and the Blue Ridge Mountains and encompasses approximately 45 percent of the area of the state. The Piedmont is characterized by gently rolling, well-rounded hills and long low ridges with a few hundred feet of elevation difference between the hills and valleys.

The U.S. Geological Survey (USGS) has produced landslide susceptibility and incidence mapping of the U.S., as shown in **Figure G.17**. 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, Orange County faces primarily moderate susceptibility and low incidence of landslides, with some areas of high susceptibility in the southeast corner of the County where UNC-CH is located.

Spatial Extent: 2 – Small

Extent

In low-relief areas, such as the Orange County area, landslides may occur as cut-and fill failures (roadway and building excavations), river bluff failures, lateral spreading landslides, collapse of mine-waste piles (especially coal), and a wide variety of slope failures associated with quarries and open-pit mines. In these instances, impacts are limited to the defined area. Event magnitude is also dependent on topography; landslide risk is higher in areas with steeper slopes. Given the gentle topography the county, the magnitude of any landslides on UNC-CH's campus would be minor.

Impact: 1 – Minor

Historical Occurrences

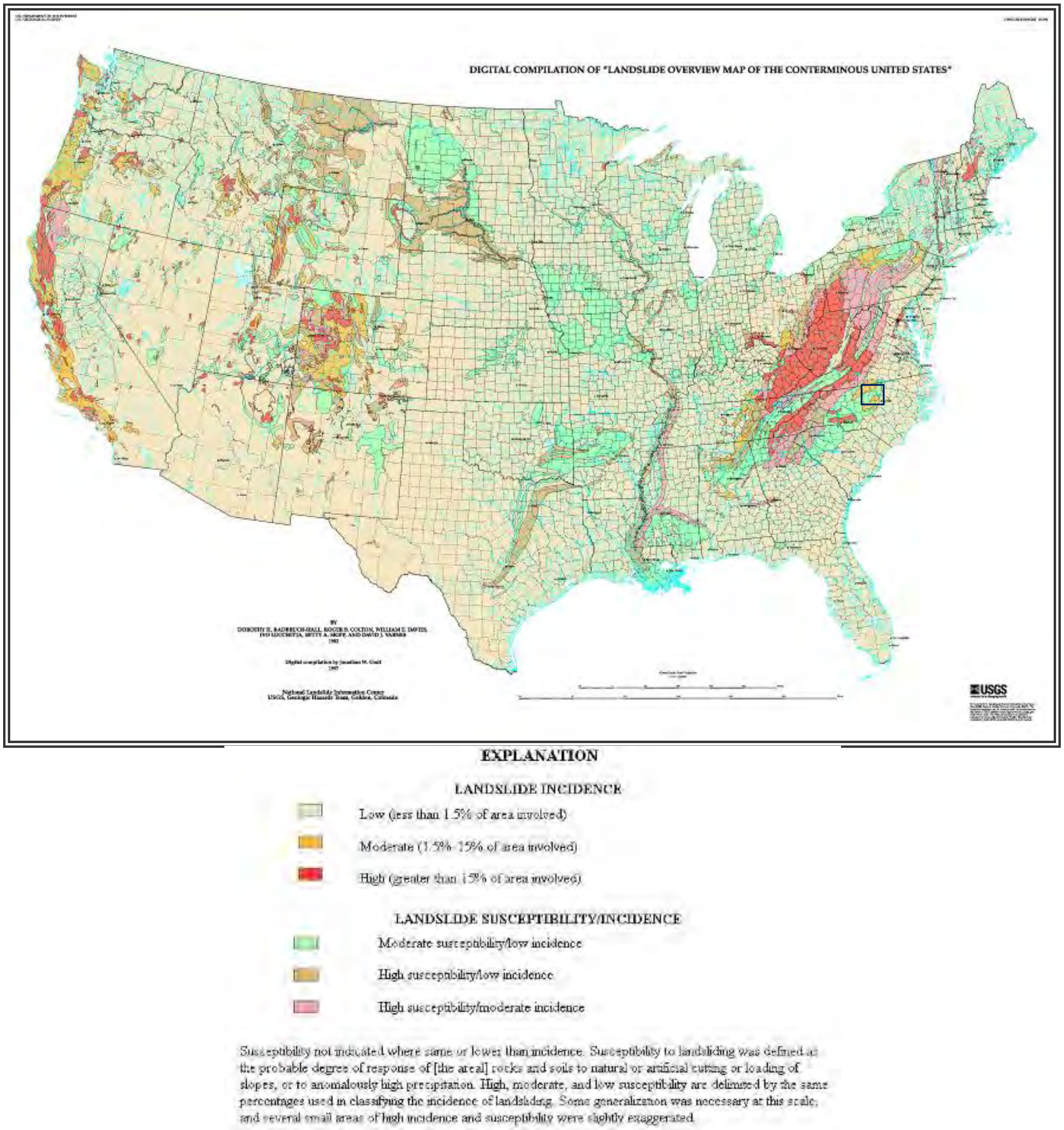
The North Carolina Geologic Survey landslide geodatabase contains records of three landslide occurrences in Orange County between 1990 and 2016. These events occurred in central and western Orange County, and only one event, at Occoneechee Mountain, required an urgent response. Additionally, per information reported by the planning committee for the Eno-Haw Regional Hazard Mitigation Plan, a landslide occurred on September 17, 2018 during Hurricane Florence; an embankment off of East Franklin Street in Chapel Hill spilled significant debris onto the Bolin Creek Trail.

Probability of Future Occurrence

As discussed above, there were four known landslide events occurring in Orange County between 1990 and 2019. Based on these historical occurrences, it is possible to experience a landslide event in the future; however, such an event is unlikely to have a severe impact.

Probability: 2 – Possible

Figure G.17 – Landslide Incidence and Susceptibility



Source: USGS

Vulnerability Assessment

People

People are unlikely to sustain serious physical harm as a result of landslides in Orange 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 Orange 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 Orange County are unlikely to cause any more severe impacts.

G.5.6 Hurricane

Hazard	Probability	Impact	Spatial Extent	Warning Time	Duration	PRI Score
Hurricane	Possible	Limited	Large	More than 24 hrs	Less than 24 hrs	2.3

Location

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

Storm surges, or storm floods, are limited to coastal areas, therefore UNC-CH is not exposed to storm surge. However, hurricane winds can impact the entire campus, so the spatial extent was determined to be large.

Spatial Extent: 4 – Large

Extent

Hurricane intensity is classified by the Saffir-Simpson Scale (**Table G.28**), which rates hurricane intensity on a scale of 1 to 5, with 5 being the most intense.

Table G.28 – 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 G.29** 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 G.29 – 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

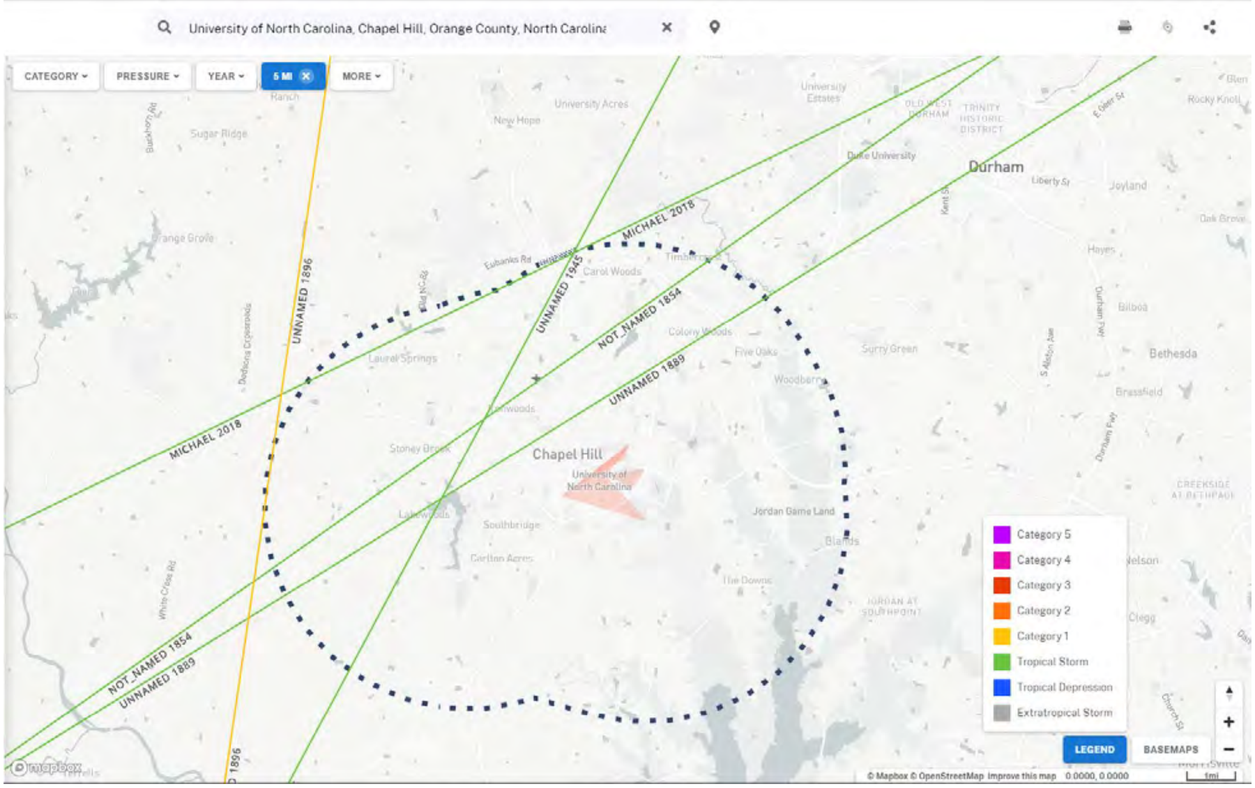
Tropical cyclones weaken relatively quickly after making landfall; therefore, Orange County will not typically experience major hurricane force winds, though these occurrences are possible. Hurricane Michael passed within 10 miles of UNC-CH's campus as a Tropical Storm with wind speeds around 45 mph in 2018.

Impact: 2 – Limited

Historical Occurrences

Storm tracks for hurricane-related events that have passed within 5 miles of UNC-CH's campus were obtained from NOAA's database and are shown in **Figure G.18**. The NCEI Storm Events database has recorded three hurricanes and tropical storms that passed through Orange County between 2000 and 2019. **Table G.30** details the historical occurrences.

Figure G.18 – Hurricane and Tropical Storm Tracks within 5 Miles of UNC-CH



Source: NOAA Office of Coastal Management; image captured directly from website.

Table G.30 – Recorded Hurricane and Tropical Storm Events for Orange County, 2000-2019

Date	Type	Storm	Deaths/ Injuries	Property Damage	Crop Damage
10/11/2018	Tropical Storm	Tropical Storm Michael	0/0	$500,000	$0
		Total	**0/0**	**$500,000**	**$0**

Source: NCEI

According to NCEI, one recorded hurricane-related event affected Orange County from 2000 to 2019 causing an estimated $500,000 in property damage. There was no reported crop damage, and no injuries or fatalities recorded for any of these events.

The following event narrative is provided in the NCEI Storm Events Database and illustrate the impacts of hurricane and tropical storm events on the county:

Tropical Storm Michael (2018) – Tropical Storm Michael moved through North Carolina on Thursday, October 11th. Michael brought heavy rain and strong damaging winds to central North Carolina. While heavy rainfall of 3 to 6 inches produced minor flash flooding across the area, it was high wind gusts of 40 to 60 mph that caused the biggest problems, knocking down score of trees, leading to blocked roadways and thousands without power.

The state of North Carolina has had four FEMA Major Disaster Declarations for Hurricanes in 1954, 1955, 1958, 1960. Additionally, Orange County has received four Major Disaster Declarations for Hurricanes in 1996, 1999, 2003, 2018.

Probability of Future Occurrence

In the 20-year period from 2000 through 2019, one tropical storm has impacted Orange County, which equates to a 5 percent annual probability of hurricane winds impacting the county. This probability does not account for impacts from hurricane rains, which may also be severe. Overall, the probability of a hurricane or tropical storm impacting the County is possible.

Probability: 2 – Possible

Vulnerability Assessment

Methodologies and Assumptions

To quantify vulnerability, Wood performed a Level 1 hurricane wind analysis in Hazus 4.2 for three scenarios: a historical recreation of Hurricane Fran (1996) and simulated probabilistic wind losses for a 200-year and a 500-year event storm. The analysis utilized general building stock information based on the 2010 Census. The UNC-CH campus is located within three census tracts encompassing 1.81 square miles. The vulnerability assessment results are for wind-related damages. Hurricanes may also cause substantial damages from heavy rains and subsequent flooding, which is addressed in Section G.5.4 Flood.

People

The very young, the elderly and disabled individuals are more vulnerable to harm from hurricanes, as are those who are unable to evacuate for medical reasons, including 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 or ongoing treatment. For all affected populations, 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.

Table G.31 details the likelihood of building damages by occupancy type from varying magnitudes of hurricane events.

Table G.31 – Likelihood of Building Damages Impacted by Hurricane Wind Events

Occupancy	Buildings at Risk	Value at Risk	Likelihood of Damage (%)				
			None	Minor	Moderate	Severe	Destruction
Hurricane Fran (1996)							
Agriculture	5	$859,401,000	98.54%	1.31%	0.12%	0.03%	0.00%
Commercial	176	$316,866,000	98.23%	1.62%	0.15%	0.00%	0.00%
Education	46	$264,053,000	98.75%	1.24%	0.01%	0.00%	0.00%
Government	7	$8,410,000	98.76%	1.22%	0.02%	0.00%	0.00%
Industrial	29	$19,420,000	98.65%	1.30%	0.05%	0.01%	0.00%
Religion	25	$29,188,000	98.87%	1.09%	0.04%	0.00%	0.00%
Residential	1,049	$859,401,000	97.93%	1.95%	0.12%	0.00%	0.00%
200-year Hurricane Event							
Agriculture	5	$859,401,000	97.25%	2.36%	0.30%	0.09%	0.00%

Occupancy	Buildings at Risk	Value at Risk	Likelihood of Damage (%)				
			None	Minor	Moderate	Severe	Destruction
Commercial	176	$316,866,000	97.02%	2.62%	0.36%	0.00%	0.00%
Education	46	$264,053,000	97.96%	2.00%	0.05%	0.00%	0.00%
Government	7	$8,410,000	97.95%	1.99%	0.06%	0.00%	0.00%
Industrial	29	$19,420,000	97.71%	2.13%	0.12%	0.03%	0.00%
Religion	25	$29,188,000	97.99%	1.92%	0.08%	1.00%	0.00%
Residential	1,049	$859,401,000	96.10%	3.59%	0.30%	0.00%	0.00%
500-year Hurricane Event							
Agriculture	5	$859,401,000	91.56%	6.57%	1.33%	0.52%	0.03%
Commercial	176	$316,866,000	92.02%	6.48%	1.46%	0.04%	0.00%
Education	46	$264,053,000	94.30%	5.17%	0.52%	0.01%	0.00%
Government	7	$8,410,000	94.24%	5.22%	0.52%	1.00%	0.00%
Industrial	29	$19,420,000	93.52%	5.51%	0.79%	0.18%	0.01%
Religion	25	$29,188,000	93.83%	5.66%	0.48%	0.03%	0.00%
Residential	1,049	$859,401,000	88.77%	9.78%	1.44%	0.01%	0.00%

Table G.32 details the estimated building and content damages by occupancy type for varying magnitudes of hurricane events.

Table G.32 – Estimated Buildings Impacted by Hurricane Wind Events

Area	Residential	Commercial	Industrial	Others	Total
Hurricane Fran (1996)					
Building	$940,120	$100,470	$4,860	$60,900	$1,106,350
Content	$142,130	$7,600	$0	$0	$149,730
Inventory	$0	$0	$0	$0	$0
Total	**$1,082,250**	**$108,070**	**$4,860**	**$60,900**	**$1,256,080**
200-year Hurricane Event					
Building	$1,650,710	$204,830	$11,620	$100,660	$1,967,820
Content	$254,400	$15,200	$2,930	$280	$272,810
Inventory	$0	$0	$610	$30	$640
Total	**$1,905,110**	**$220,030**	**$15,160**	**$100,970**	**$2,241,270**
500-year Hurricane Event					
Building	$4,172,580	$601,410	$43,150	$309,690	$5,126,830
Content	$587,860	$125,210	$21,690	$43,710	$778,470
Inventory	$0	$720	$4,370	$210	$5,300
Total	**$4,760,440**	**$727,340**	**$69,210**	**$353,610**	**$5,910,600**

The damage estimates for the 500-year hurricane wind event total $5,910,600, which equates to a loss ratio of 5.2 percent of the total building exposure. These damage estimates account for only wind impacts and actual damages would likely be higher due to flooding. As noted in Section G.5.4, roadways and buildings in the southern and eastern portions of the campus are located within the 500-year floodplain.

Therefore, the area would likely experience a higher overall loss ratio from the 500-year hurricane event and may face difficulty recovering from such an event.

Environment

Hurricane winds can cause massive damage to the natural environment, uprooting trees and other debris within the storm's path. Animals can either be killed directly by the storm or impacted indirectly through changes in habitat and food availability caused by high winds and intense rainfall. Endangered species can be dramatically impacted. Forests can be completely defoliated by strong winds.

Changes in Development

Future development that occurs in the planning area should consider high wind hazards at the planning, engineering and architectural design stages. The University should consider evacuation planning in the event of a hurricane event.

Problem Statement

- Historical tracks of multiple hurricane events have passed within 5-miles of the UNC-CH Campus.
- For the 20-year period from 2000 through 2019, there was one hurricane wind event that caused $500,000 in damage for Orange County.

G.5.7 Severe Winter Weather

Hazard	Probability	Impact	Spatial Extent	Warning Time	Duration	PRI Score
Severe Winter Weather	Highly Likely	Limited	Large	More than 24 hrs	Less than 1 week	2.0

Location

Severe winter weather is usually a countywide or regional hazard, impacting the entire county at the same time. 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. Orange 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, severe winter weather can occur anywhere in the county.

Spatial Extent: 4 – Large

Extent

The National Oceanic and Atmospheric Administration (NOAA) uses the Regional Snowfall Index (RSI), shown in **Table G.33** for the Orange County region, to assess the societal impact of winter storms in the six easternmost regions in the United States. The index makes use of population and regional differences to assess the impact of snowfall. For example, areas which receive very little snowfall on average may be more adversely affected than other regions, resulting in a higher severity. The County may experience any level on the RSI scale. Orange County receives an average of 1 to 4 inches of snowfall per year. According to NCEI, the greatest snowfall amounts to impact Orange County have been between 7-12 inches. During the snowstorm of January 25, 2000, 11.8 inches of snow were recorded in Chapel Hill, the third greatest one-day snowfall in the County. It is possible that more severe events and impacts could be felt in the future.

Table G.33 – Regional Snowfall Index (RSI) Values

Category	RSI Value	Description
1	1-3	Notable
2	3-6	Significant
3	6-10	Major
4	10-18	Crippling
5	18+	Extreme

Source: NOAA

Severe winter weather often involves 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 G.19**, provides a formula for calculating the dangers of winter winds and freezing temperatures. This presents wind chill temperatures which are based on the rate of heat loss from exposed skin caused by wind and cold. As the wind increases, it draws heat from the body, driving down skin temperature and eventually the internal body temperature.

Figure G.19 – NWS Wind Chill Temperature Index

Wind Chill Chart

Wind (mph)	Temperature (ºF)																	
Calm	40	35	30	25	20	15	10	5	0	-5	-10	-15	-20	-25	-30	-35	-40	-45
5	36	31	25	19	13	7	1	-5	-11	-16	-22	-28	-34	-40	-46	-52	-57	-63
10	34	27	21	15	9	3	-4	-10	-16	-22	-28	-35	-41	-47	-53	-59	-66	-72
15	32	25	19	13	6	0	-7	-13	-19	-26	-32	-39	-45	-51	-58	-64	-71	-77
20	30	24	17	11	4	-2	-9	-15	-22	-29	-35	-42	-48	-55	-61	-68	-74	-81
25	29	23	16	9	3	-4	-11	-17	-24	-31	-37	-44	-51	-58	-64	-71	-78	-84
30	28	22	15	8	1	-5	-12	-19	-26	-33	-39	-46	-53	-60	-67	-73	-80	-87
35	28	21	14	7	0	-7	-14	-21	-27	-34	-41	-48	-55	-62	-69	-76	-82	-89
40	27	20	13	6	-1	-8	-15	-22	-29	-36	-43	-50	-57	-64	-71	-78	-84	-91
45	26	19	12	5	-2	-9	-16	-23	-30	-37	-44	-51	-58	-65	-72	-79	-86	-93
50	26	19	12	4	-3	-10	-17	-24	-31	-38	-45	-52	-60	-67	-74	-81	-88	-95
55	25	18	11	4	-3	-11	-18	-25	-32	-39	-46	-54	-61	-68	-75	-82	-89	-97
60	25	17	10	3	-4	-11	-19	-26	-33	-40	-48	-55	-62	-69	-76	-84	-91	-98

Frostbite Times: 30 minutes, 10 minutes, 5 minutes

$$\text{Wind Chill (ºF)} = 35.74 + 0.6215T - 35.75(V^{0.16}) + 0.4275T(V^{0.16})$$

Where, T= Air Temperature (ºF) V= Wind Speed (mph)

Effective 11/01/01

Source: https://www.weather.gov/safety/cold-wind-chill-chart

The most significant recorded snow depth over the last 20 years took place on January 25, 2000, with recorded depths of 11.8 inches.

Impact: 2 – Limited

Historical Occurrences

To get a full picture of the range of impacts of a severe winter weather, data for the following weather types as defined by the National Weather Service (NWS) 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.

According to the NCEI Storm Events Database, there was one heavy snow event, one ice storm, and 59 combined winter storm/winter weather events in Orange County during the 20-year period from 2000 through 2019. As reported in NCEI, severe winter weather caused $3,730,000 in property damage, but they did not cause any fatalities, injuries, or crop damage, though these types of impacts may not have been reported and are possible in future events. Events in Orange County by incident are recorded in **Table G.34**.

Table G.34 – Recorded Severe Winter Weather Events in Orange County, 2000-2019

Event Type	Event Count	Fatalities	Injuries	Property Damage	Crop Damage
Heavy Snow	1	0	0	$0	$0
Ice Storm	1	0	0	$2,700,000	$0
Winter Storm	30	0	0	$1,000,000	$0
Winter Weather	29	0	0	$30,000	$0
Total	**61**	**0**	**0**	**$3,730,000**	**$0**

Source: NCEI

Storm impacts from NCEI are summarized below:

December 7, 2007 – A brief period of light freezing rain fell across Central North Carolina from the Triad east to portions of the Triangle and over the Coastal Plain. Most of the freezing rain accumulation of up to sixteenth of an inch occurred from southern Wake county east to Smithfield and north to Wilson, Rocky 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. In Orange County, Light freezing rain during the early morning hours just prior to sunrise resulted in several automobile accidents from black ice on numerous bridges.

March 6, 2014 – One quarter of an inch of ice from freezing rain resulted in widespread downed trees and powerlines. Additionally, 1 to 1.5 inches of snow fell across the county. A strong surface low deepening off the Carolina coast brought a wintry mix of snow, sleet, and freezing rain to the northern-northwestern Piedmont counties. Snowfall amounts of 4 to 7 inches fell Forsyth, Person and Guilford counties. Just to the south and east of this area, a corridor of mainly sleet mixed with freezing rain produced significant icing of a quarter to half inch. This icing produced widespread downed trees and power outages over the northwest Piedmont. At the peak of the storm, over 400,000 customers were without power. A natural disaster was declared in 7 counties across the Raleigh CWA that were impacted by this storm.

February 25, 2015 – As a low-pressure system tracked along the southeast coast, wintry precipitation spread into Central North Carolina. A winter storm warning was issued for the majority of the area, with the exception of a few counties in the extreme southeast where a winter weather advisory was needed. Snowfall/sleet amounts of 5 to 8 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 7,000 customers were without power in the county.

December 9, 2018 – Strong Cold Air Damming and a Miller-A storm track from the northern Gulf of Mexico to off the NC coast brought record early heavy snowfall to parts of central NC on December 9th and 10th. There was also a narrow swath of 0.1 to 0.2 inches of freezing rain across portions of the western Piedmont counties. In Orange County, snowfall amounts ranged from 7 inches across southern portions of the county to 11 inches across northern portions of the county. A thin glaze of ice from freezing rain was also reported.

Durham County received three FEMA Major Disaster Declarations for a blizzard in 1996 and severe winter storms or ice storms in 2000, 2002, 2003, and 2013.

Probability of Future Occurrence

NCEI records 61 severe winter weather related events during the 20-year period from 2000 through 2019, which equates to an annual probability greater than 100%. Therefore, the overall probability of severe winter weather in the county is considered highly likely (near or more than 100% annual probability).

Probability: 4 – Highly Likely

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.

The loss of use estimates provided in **Table G.35** were calculated using FEMA's publication *What is a Benefit?: Guidance on Benefit-Cost Analysis of Hazard Mitigation Project*, June 2009. These figures are used to provide estimated costs associated with the loss of power in relation to the populations served on campus. The loss of use is provided in the heading as the loss of use cost per person per day of loss. The estimated loss of use provided for the campus represents the loss of service of the indicated utility for one day for 10 percent of the population. These figures do not take into account physical damages to utility equipment and infrastructure. The estimated on-campus population used in the table below was determined by taking 25% of the current enrollment for UNC-CH, which is 30,101 students.

Table G.35 – Loss of Use Estimates for Power Failure Associated with Severe Winter Weather

On-Campus Population (Fall 2020)	Estimated Affected Population (10%)	Electric Loss of Use Estimate ($126 per person per day)
7,525	753	$94,878

Property

The NCEI reported $3,730,000 of property damage in association with any winter weather events between 2000 and 2019 for Orange County. Based on these records, the County experiences an estimated annualized loss of $186,500 in property damage. The average impact from winter weather events per incident in Orange County is $61,148.

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.

Changes in Development

Future development could potentially increase vulnerability to this hazard by increasing demand on the utilities and increasing the exposure of infrastructure networks. UNC-CH may wish to consider developing a flexible emergency power network to provide efficient back-up power for vulnerable populations, critical facilities, and research facilities.

Problem Statement

- Severe winter weather events are highly likely for Orange County and the UNC-CH campus. The events have also resulted in four presidential disaster declarations for the County.

G.5.8 Tornadoes/Thunderstorms

Hazard	Probability	Impact	Spatial Extent	Warning Time	Duration	PRI Score
Tornado/Thunderstorm	Likely	Critical	Large	Less than 6 hrs	Less than 6 hrs	3.1

Location

Thunderstorm wind, lightning, and hail events do not have a defined vulnerability zone. The scope of lightning and hail is generally confined to the footprint of its associated thunderstorm. Although these events occur similarly throughout the planning area, they are more frequently reported in more urbanized areas because damages are more likely to occur where exposure is greater in more densely developed urban areas.

Thunderstorm Winds

The entirety of UNC-CH's campus can be affected by severe weather hazards. Thunderstorm wind events can span many miles and travel long distances, covering a significant area in one event. Due to the small size of the planning area, any given event will impact the entire planning area, approximately 50% to 100% of the planning area could be impacted by one event.

Spatial Extent: 4 – Large

Lightning

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 UNC-CH is exposed to lightning.

Spatial Extent: 4 – Large

Hail

Hailstorms frequently accompany thunderstorms, so their locations and spatial extents coincide. However, large-scale hail tends to occur in a more localized area within the storm.

Spatial Extent: 4 – Large

Tornado

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

Spatial Extent: 4 – Large

Extent

Thunderstorm Winds

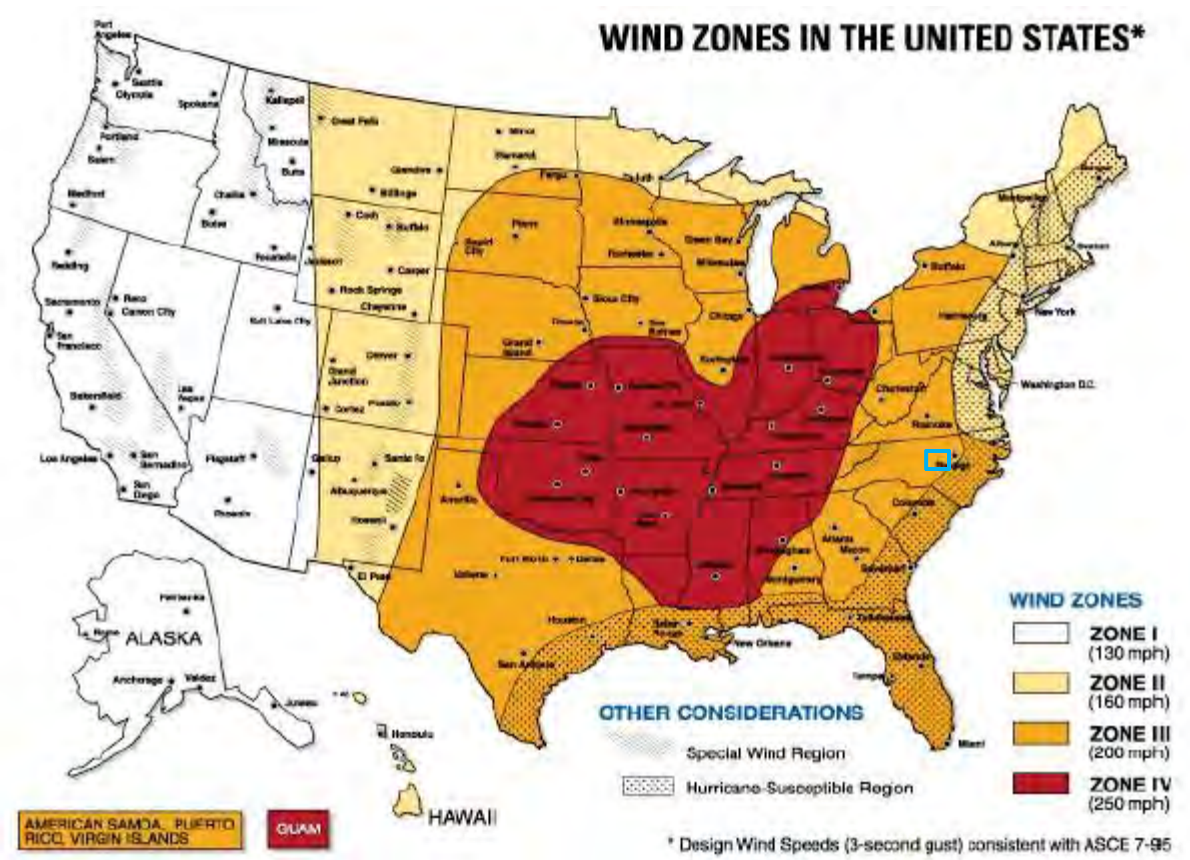
The magnitude of a thunderstorm event can be defined by the storm's maximum wind speed and its impacts. NCEI divides wind events into several types including High Wind, Strong Wind, Thunderstorm Wind, Tornado and Hurricane. For this severe weather risk assessment, High Wind, Strong Wind and Thunderstorm 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.

Figure G.20 shows wind zones in the United States. Orange County, indicated by the blue square, is within Wind Zone III, which indicates that speeds of up to 200 mph may occur within the county.

Figure G.20 – Wind Zones in the United States



Source: FEMA 320, Taking Shelter from the Storm, 3rd edition, https://www.fema.gov/pdf/library/ism2_s1.pdf

The strongest recorded thunderstorm wind event for Orange County in NCEI's recorded history occurred on April 26, 1986 with a gust of 69 mph. The event reportedly resulted in no fatalities, injuries, property damages or crop damages. In the past 20 years, the strongest recorded thunderstorm wind event occurred on June 13, 2013 with a recorded wind gust of 61 mph; the event caused on injury and $3,000 in property damage.

Impact: 2 – Limited

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, shown in **Table G.36**, is a common parameter that is part of fire weather forecasts nationwide.

Table G.36 – 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

Hail

The National Weather Service classifies hail by diameter size, and corresponding everyday objects to help relay scope and severity to the population. **Table G.37** indicates the hailstone measurements utilized by the National Weather Service.

Table G.37 – 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
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 G.38** describes typical intensity and damage impacts of the various sizes of hail.

Table G.38 – 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

Intensity Category	Diameter (mm)	Diameter (inches)	Size Description	Typical Damage Impacts
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 Durhamed
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 2000 and 2019 in Durham was a little over 1" in diameter; the largest hailstone recorded was 1.75", recorded on March 8, 2005, April 8, 2006, June 4, 2007, May 9, 2008, June 25, 2015 and April 28, 2016. The largest hailstone recorded in NCEI's full records was 2.75" on May 14, 1967.

Impact: 1 – Minor

Tornado

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 and better correlation between damage and wind speed. It is also more precise because it considers the materials affected and the construction of structures damaged by a tornado. **Table G.39** shows the wind speeds associated with the enhanced Fujita scale ratings and the damage that could result at different levels of intensity.

Table G.39 – 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.

EF Number	3 Second Gust (mph)	Damage
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 Orange County in the past 20 years was an EF2 on April 19, 2019. NCEI reports this event causing $2 million in property damage, and narratives of the event approximated severe thunderstorms produced 8 tornadoes. At least one home's roof and exterior walls were completely destroyed. The tornado was 12 miles long and 600 yards wide.

Impact: 3 – Critical

Historical Occurrences

Thunderstorm Winds

Between January 1, 2000 and December 31, 2019, the NCEI recorded wind speeds for 45 separate incidents of thunderstorm winds, occurring on 37 separate days, for Chapel Hill. These events caused $110,500 in recorded property damage, 2 injuries, and one fatality. The recorded gusts averaged 50.5 miles per hour, with the highest gusts recorded at 60 mph on May 25, 2000. Of these events, 16 caused property damage. Wind gusts with property damage recorded averaged $6,906 in damage, with the highest reported damage being a total $34,000 across three events on July 24, 2012. These incidents are aggregated by the date the events occurred and are recorded in **Table G.40**. These records specifically note Thunderstorm Wind impacts for Chapel Hill.

Table G.40 – Recorded Thunderstorm Winds, Chapel Hill, 2000-2019

Location	Date	Wind Speed (mph)	Fatalities	Injuries	Property Damage
COUNTYWIDE	5/20/2000	50	0	0	$0
CHAPEL HILL	5/25/2000	60	0	2	$0
CHAPEL HILL	8/18/2000	50	0	0	$0
CHAPEL HILL	2/22/2003	50	0	0	$0
CHAPEL HILL	7/22/2003	50	0	0	$0
CHAPEL HILL	10/14/2003	50	0	0	$0
CHAPEL HILL	7/28/2005	50	0	0	$0
CHAPEL HILL	4/3/2006	50	0	0	$0
CHAPEL HILL WLLMS AR	3/4/2008	55	0	0	$0
CHAPEL HILL WLLMS AR	5/9/2008	52	0	0	$0
CHAPEL HILL	7/4/2008	50	0	0	$0
CHAPEL HILL	5/9/2009*	50	0	0	$0
CHAPEL HILL WLLMS AR	9/28/2009	50	0	0	$0
CHAPEL HILL	7/17/2010	50	0	0	$0
CHAPEL HILL	7/18/2010	50	0	0	$0
CHAPEL HILL WLLMS AR	5/27/2011	50	0	0	$0

Location	Date	Wind Speed (mph)	Fatalities	Injuries	Property Damage
CHAPEL HILL WLLMS AR	6/18/2011	50	0	0	$0
CHAPEL HILL	8/14/2011	50	0	0	$0
CHAPEL HILL	5/9/2012*	50	0	0	$2,500
CHAPEL HILL	7/19/2012	50	0	0	$0
CHAPEL HILL	7/24/2012*	50	0	0	$34,000
CHAPEL HILL	6/13/2013	50	1	0	$3,000
CHAPEL HILL	6/30/2013	50	0	0	$5,000
CHAPEL HILL WLLMS AR	1/11/2014	50	0	0	$1,000
CHAPEL HILL	6/18/2015	50	0	0	$0
CHAPEL HILL	6/26/2015	50	0	0	$2,000
CHAPEL HILL WLLMS AR	7/21/2015	50	0	0	$5,000
CHAPEL HILL WLLMS AR	2/24/2016*	50	0	0	$3,000
CHAPEL HILL WLLMS AR	6/16/2017	50	0	0	$0
CHAPEL HILL	7/23/2017	50	0	0	$3,000
CHAPEL HILL	4/15/2018	50	0	0	$1,000
CHAPEL HILL	5/21/2018	50	0	0	$2,000
CHAPEL HILL	6/10/2018	50	0	0	$25,000
CHAPEL HILL	7/4/2018*	50	0	0	$1,500
CHAPEL HILL	4/12/2019*	50	0	0	$6,000
CHAPEL HILL	6/20/2019*	50	0	0	$15,000
CHAPEL HILL	8/21/2019	50	0	0	$1,500
		Total	**1**	**2**	**$110,500**

Source: NCEI
*Note: Multiple events occurred on these dates. Injuries, fatalities, and property damage are totaled, wind speed is highest reported.

The State of North Carolina received a FEMA Major Disaster Declaration in 1956 for severe storms that included heavy rains and high winds.

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

April 25, 2000 – A Piper Cherokee crashed while trying to land at the Horace Williams Airport due to strong winds.

March 4, 2008 – Numerous tress were blown down from Chapel Hill east to the Durham County line.

May 27, 2011 – Several power-lines were blown down across Chapel Hill.

May 9, 2012 – A cold front moved into central North Carolina and interacted with an unstable air mass to produce scattered showers and thunderstorms .Some of these storms became strong to severe across portions of the Piedmont and Coastal Plain of Central North Carolina. Several trees were reported down in Chapel Hill; one 4-inch diameter tree was snapped in half and partially blocking Manning Drive.

July 24, 2012 – A very unstable airmass and deep dry sub cloud layer coupled with a disturbance which moved across the area during peak heating caused scattered to numerous showers and thunderstorms to develop in the afternoon into the evening. Many of these storms became severe and produced damaging wind events. More than a dozen trees and power lines were reported down across the Town of Chapel Hill; one tree was blow down onto a car on South Columbia Street at the UNC-CH campus. One adult and two high school students were inside the car at the time, but escaped without injuries.

June 13, 2013 – A ferocious line of strong to severe thunderstorms raced through central North Carolina during the afternoon and into the early evening, uprooting trees and snapping power lines with straight-line wind gusts up to 80 mph. Damage was widespread with numerous trees falling on homes throughout the County warning area. A large tree was blown down on the 300 Block of East Franklin Street killing a 20 year old UNC-CH student.

June 30, 2013 – The forecast area remained sandwiched between an unseasonably deep trough aloft to the west and a ridge to the east. This resulted in a persistent very moist air mass and with soils already saturated., two rounds of heavy rain resulting in flash flooding, first in the early morning hours across Durham and Orange counties and later in the day across the same area. Chapel Hill and Carrboro experienced the most significant flooding, with substantial property damage occurring. As afternoon destabilization occurred, a couple of storms became severe and produced some isolated wind damage. A tree was blown down on the UNC-CH campus, damaging a couple of cars.

Lightning

According to NCEI data, there were 2 lightning strike reported between 2000 and 2019 in Chapel Hill and one in neighboring Carrboro. These lightning strike events recorded an estimated $2,385,000 worth of property damage. No crop damage, injuries, fatalities were reportedly caused by these strikes; however, two fatalities were recorded due to lightning strikes elsewhere in Orange County. 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. **Table G.41** details NCEI-recorded lightning strikes from 2000 through 2019 for Chapel Hill.

Table G.41 – Recorded Lightning Strikes in Chapel Hill, 2000-2019

Location	Date	Time	Fatalities	Injuries	Property Damage
CHAPEL HILL	7/2/2002	1515	0	0	$880,000
CHAPEL HILL	12/11/2008	1205	0	0	$1,500,000
CARRBORO	8/21/2019	1804	0	0	$5,000
		Total	**0**	**0**	**$2,385,000**

Source: NCEI

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

July 2, 2002 – Lightning started at least three house fires around Chapel Hill. The worst damage was sustained at a condominium complex on Copperline Drive.

December 11, 2008 – A powerful upper level disturbance with associated cold front pushed across the region the afternoon and evening of December 11. Over 2 inches of rain fell in many locations with several reports of minor urban flooding. Lightning struck a home in Chapel Hill and it caught fire; the house burned to the ground when the lightning got into the gas lines of the home.

August 21, 2019 – Scattered afternoon showers and thunderstorms developed in the North Carolina and Virginia mountains and moved southeastward and developed into a line and moved into the northwest Piedmont of central North Carolina. The line of storms produced multiple reports of wind damage across the northwest Piedmont. Lightning struck a traffic light box at the intersection of Homestead Road and Seawell School Road.

Hail

NCEI records 8 hail incidents across 7 days between January 1, 2000 and December 31, 2019 in Chapel Hill. None of these events were reported to have caused death, injury, property damage or crop damage. The largest diameter hail recorded in the City was 1.75 inches, which occurred on three different occasions in 2005, 2008, and 2015. The average hail size of all events in Chapel Hill was approximately 1.2 inches in diameter. **Table G.42** summarizes hail events for Chapel Hill. In some cases, hail was reported for multiple locations on the same day.

Table G.42 – Summary of Hail Occurrences in Chapel Hill

Beginning Location	Date	Hail Diameter
CHAPEL HILL	3/8/2005	1.75
CHAPEL HILL	5/25/2006	1
CHAPEL HILL WLLMS AR	5/9/2008	0.75
CHAPEL HILL	5/9/2008	1.75
CHAPEL HILL WLLMS AR	5/27/2011	1
CHAPEL HILL WLLMS AR	4/25/2014	1
CHAPEL HILL WLLMS AR	6/25/2015	1.75
CHAPEL HILL	5/21/2018	0.75

Source: NCEI

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

May 9, 2008 – Penny sized hail was reported at the intersection of Allard and Lyon Roads.

June 25, 2015 – Golf ball sized hail was reported near Fordham Boulevard and East Franklin Street.

May 21, 2018 – Sime sized hail reported at UNC Chapel Hill Medical Center.

Tornado

NCEI storm reports were reviewed from 2000 through 2019 to assess whether recent trends varied from the longer historical record. According to NCEI, Chapel Hill does not have any recorded tornado incidents between 2000 and 2019. It is likely that there have been tornados that occurred in Chapel Hill but went unreported. However, neighboring communities surrounding Durham have three reported tornado incidents between 2000 and 2019, causing $350,000 in property damage and no injuries or deaths. **Table G.43** shows historical tornadoes in Durham along with its surrounding communities during this time.

Table G.43 – Recorded Tornadoes in Orange County, 2000-2019

Beginning Location	Date	Time	Magnitude	Deaths/ Injuries	Property Damage	Crop Damage
CARRBORO	6/19/2000	1305	F0	0/0	$0	$0
CARRBORO	9/8/2004	1145	F0	0/0	$0	$0
SCHLEY	1/14/2005	445	F0	0/0	$0	$0
CARR	10/27/2010	1630	EF1	0/0	$250,000	$0
TEER	04/19/2019	1500	EF2	0/0	$2,000,000	$0

Source: NCEI

Narratives from NCEI illustrate that damage occurred in many of these incidents even if a monetary value was not recorded. Specific incidents include:

January 14, 2005 – A tornado touched down in northeast Hillsborough along St. Mary's Road and damaged two properties. The east wall of a home was almost completely blown out, and on an adjacent property a metal equipment shed was destroyed with some of the debris carried into nearby trees. A small outbuilding was pushed a short distance off its foundation wall, as well.

October 27, 2010 – A supercell thunderstorm produced a series of tornadoes across portions of Orange, Granville, and Vance counties in central North Carolina. The first tornado produced EF-1 damage with winds between 90 to 95 mph along Carr Store Road near Allie Mae Road in northern Orange County. At this location a church sustained significant damage, with two walls made of cinder blocks blown down. Numerous hard and soft wood trees were also snapped off and uprooted at this location. The tornado continued to track east northeast and damaged two homes along Pentecost Road. Both homes sustained roof damage, including a partially collapsed chimney. Two individuals were home at the time of the tornado and were not injured. Numerous trees where snapped off and uprooted at this location as well. Winds were estimated to range from 86 to 90 mph. The tornado weakened as it continued to track east north-east across Mcdade Store Road and Efland-Cedar Grove Road before lifting. Numerous trees were either damaged or downed during this area.

April 19, 2019 – A tornado initially touched down in the White Cross area and Leslie Drive area of southwest Orange County. Considerable tree damage occurred in this area, including the snapping and splitting of healthy large-trunk trees. Subsequent damage to vehicles and homes occurred as the trees fell. Given the magnitude and nature of the damage, wind speeds were estimated at 110 mph. The tornado then tracked north-northeast eventually crossing Dodsons Cross Road, Dairyland Road, Arthur Minnis Road, and Borland Roads, all while producing similar tree damage. The tornado finally began to lift and/or dissipate near Hillsborough just north of I-40 near exit 261, but not before producing considerable damage to several homes just south of exit 261. The roof and several exterior walls of one home were completely destroyed. Damage at this location was estimated at 115 mph, making this tornado a low-end EF-2 on the EF scale.

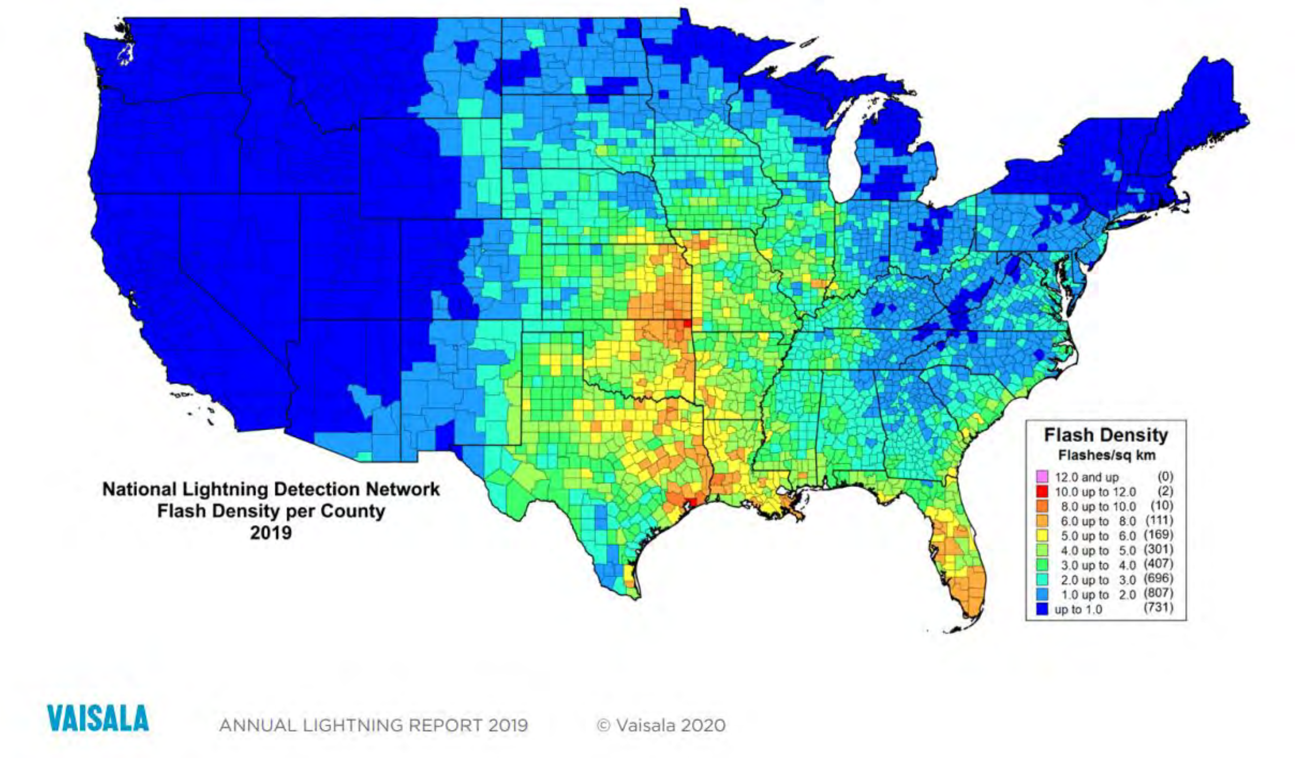
Probability of Future Occurrence

Based on historical occurrences recorded by NCEI for the 20-year period from 2000 through 2019, Chapel Hill averages 2.25 days with thunderstorm wind events per year. Over this same period, three lightning event was reported as having caused property damage, which equates to an average of 0.15 damaging lightning strikes per year.

The average hail storm in Chapel Hill occurs in the afternoon or evening and has a hail stone with a diameter of around 1.2 inches. Over the 20-year period from 2000 through 2019, Chapel Hill experienced 8 days with reported hail incidents; this averages to 0.4 days per year with reported incidents somewhere in the City.

Based on the Vaisala 2019 Annual Lightning Report, North Carolina experienced 3,641,417 documented cloud-to-ground lightning flashes. According to Vaisala's flash density map, shown in **Figure G.21**, Orange County is located in an area that experiences 1 to 2 lightning flashes per square kilometer per year. It should be noted that future lightning occurrences may exceed these figures.

Figure G.21 – Lightning Flash Density per County (2019)



Source: Vaisala

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

In a twenty-year span between 2000 and 2019, Orange County has experienced five separate tornado incidents over five separate days. This correlates to a 25 percent annual probability that the County will experience a tornado somewhere in its boundaries. Three of these past tornado events were magnitude F0, one was a magnitude EF1 and the other was a magnitude EF2; therefore, the annual probability of a significant tornado event is highly unlikely.

Based on these historical occurrences, there is between a 10% to 100% chance that Chapel Hill will experience severe weather each year. The probability of a damaging impacts is likely.

Probability: 3 –Likely

Vulnerability Assessment

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.

Similar to the loss of use estimates provided for Severe Winter Weather, the loss of use estimates for a tornadoes/thunderstorms were estimated as $94,878 per day, assuming 10-percent of the on-campus population is impacted.

Table G.33 – Loss of Use Estimates for Power Failure Associated with Tornado/Thunderstorms

On-Campus Population (Fall 2020)	Estimated Affected Population (10%)	Electric Loss of Use Estimate ($126 per person per day)
7,525	753	$94,878

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.

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.

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 Chapel Hill, most property damage caused by lightning was due to structural fires.

NCEI records lightning impacts over 20 years (2000-2019), with $2,385,000 in property damage recorded during three events. Based on these records, the planning area experiences an annualized loss of $119,250 in property damage. The average impact from lightning per incident in Chapel Hill is nearly $800,000.

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, 2000 and December 31, 2019 in Chapel Hill, NCEI did not report any property damage as a direct result of hail.

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 Chapel Hill, thus the NCEI is still used to form a baseline.

Wind events reported in NCEI for the 20-year period from 2000 through 2019 totaled $110,500 in property damage, which equates to an annualized loss of $5,525 across Chapel Hill.

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 2000, damaging tornadoes in Orange County are directly responsible for $2,250,000 worth of damage to property according to NCEI data. This equates to an annualized loss of $112,500.

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.

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.

Changes in Development

Future development projects should consider severe thunderstorms hazards and tornado and high wind hazards at the planning, engineering and architectural design stage with the goal of reducing vulnerability. University buildings with high occupancies should consider inclusion of a tornado shelters to accommodate occupants in the event of a tornado. Future development will also affect current stormwater drainage patterns and capacities.

Problem Statement

- Thunderstorms and tornadoes are frequent hazard events in Orange County and around the UNC-CH campus. Reported damages for the 20-year period from 2000-2019 include $110,500 for thunderstorm winds, $2,385,000 for lightning strikes, and $2,250,000 for tornado events.
- One Chapel Hill student died due to injuries sustained from a downed tree during a thunderstorm wind event.

G.5.9 Wildfire

Hazard	Probability	Impact	Spatial Extent	Warning Time	Duration	PRI Score
Wildfire	Possible	Limited	Large	More than 24 hrs	More than 1 week	2.5

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 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 G.44** details the extent of the WUI on the UNC-CH campus and **Figure G.22** below shows the WUI areas on the UNC-CH Campus.

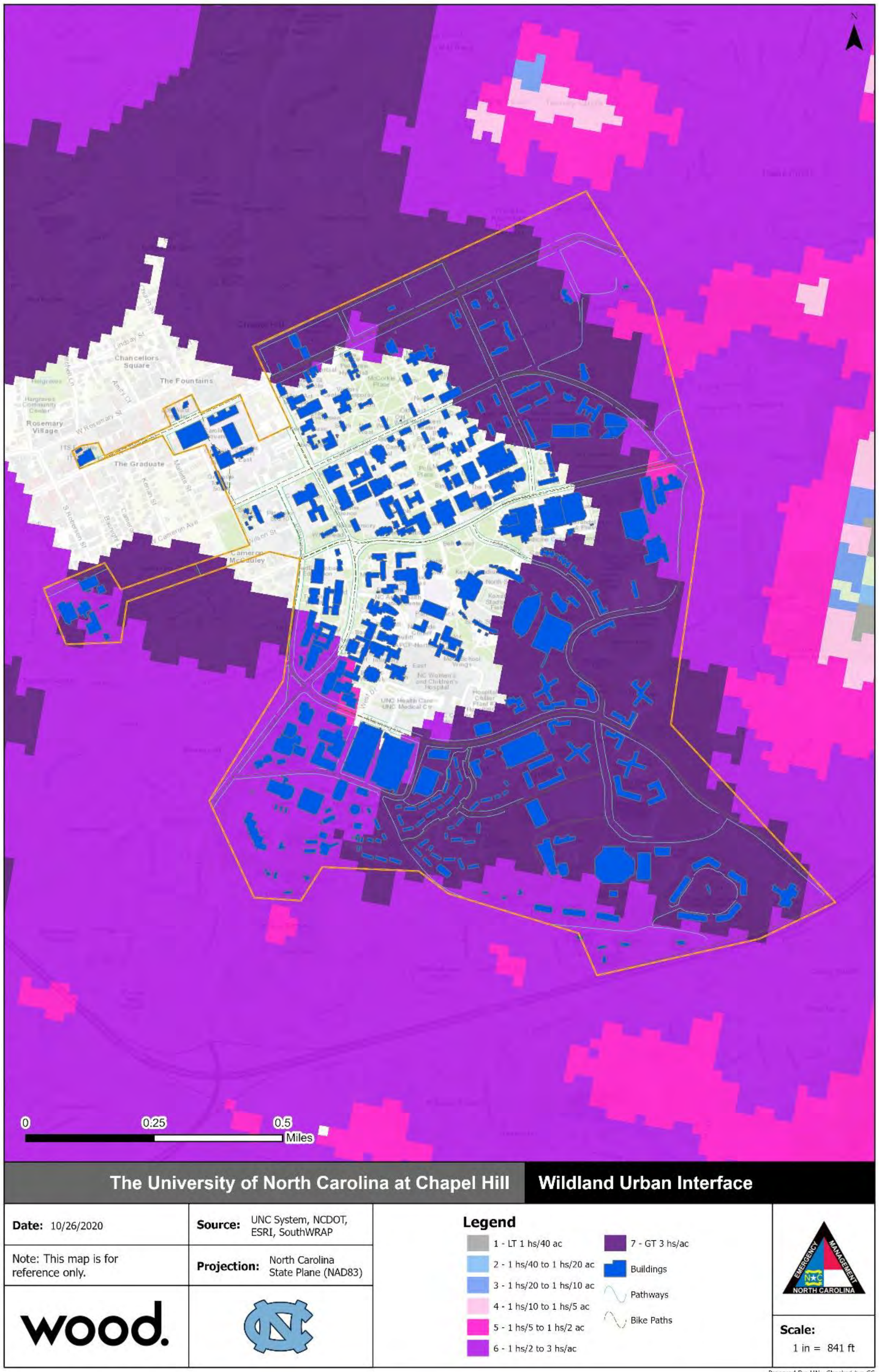
Table G.44 – Wildland Urban Interface Acres, UNC-CH

Housing Density	WUI Acres	Percent of WUI Acres
Not in WUI	212	28.8%
LT 1hs/40ac	0	0.0%
1hs/40ac to 1hs/20ac	0	0.0%
1hs/20ac to 1hs/10ac	0	0.0%
1hs/10ac to 1hs/5ac	0	0.0%
1hs/5ac to 1hs/2ac	8	1.1%
1hs/2ac to 3hs/1ac	167	22.8%
GT 3hs/1ac	348	47.3%
Total	**735**	--

Source: Southern Wildfire Risk Assessment

Spatial Extent: 4 – Large

Figure G.22 – WUI Areas, UNC-CH



Source: Southern Wildfire Risk Assessment

Extent

The entire state is at risk to a wildfire occurrence. However, several factors such as drought conditions or high levels of fuel on the forest floor may make a wildfire more likely in certain areas. 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, shown in **Table G.45**, consists of five classes, as defined by Southern Wildfire Risk Assessment. **Figure G.23** shows the potential fire intensity within the WUI across the UNC-CH Campus.

Table G.45 – 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

The majority of UNC-CH's campus area (75.7%) is identified as Class 0 or non-burnable. Approximately 21.2% of the campus area is identified as Class 1 or Class 2 Fire Intensity, which are easily suppressed. Only 3.1% of the campus area is identified as Class 3 Fire Intensity or higher which would have the potential for harm to life and property.

The WUI Risk Index is used to rate the potential impact of a wildfire on people and their homes. It reflects housing density (per acre) consistent with Federal Register National standards. The WUI Risk Index ranges of values from -1 to -9, with -1 representing the least negative impact and -9 representing the most negative impact**. Figure G.24** maps the WUI Risk Index for UNC-CH. The WUI areas within the UNC-CH campus have a value of -5 on the WUI Risk Index.

Impact: 2 – Limited

Figure G.23 – WUI Characteristic Fire Intensity, UNC-CH

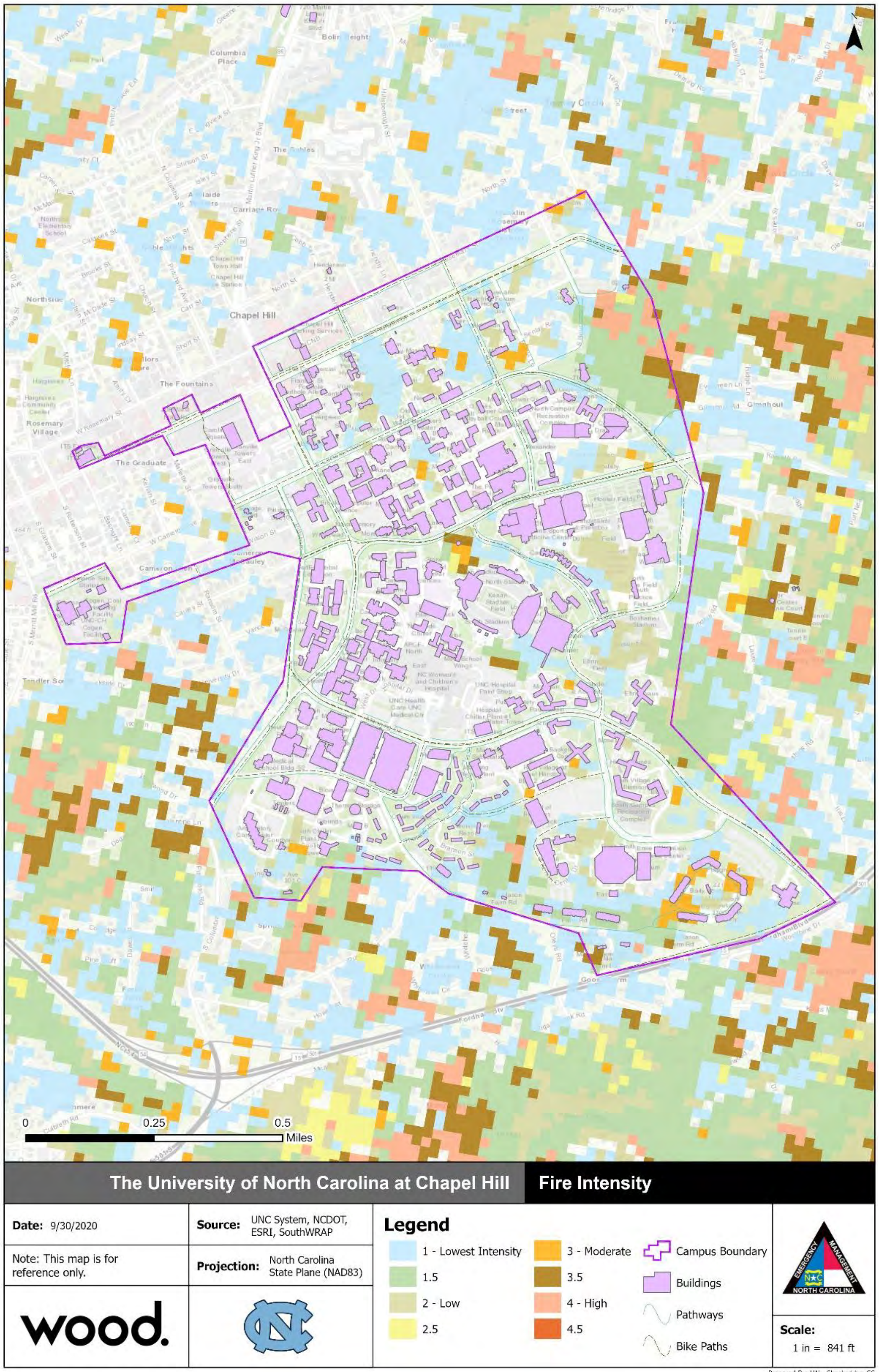
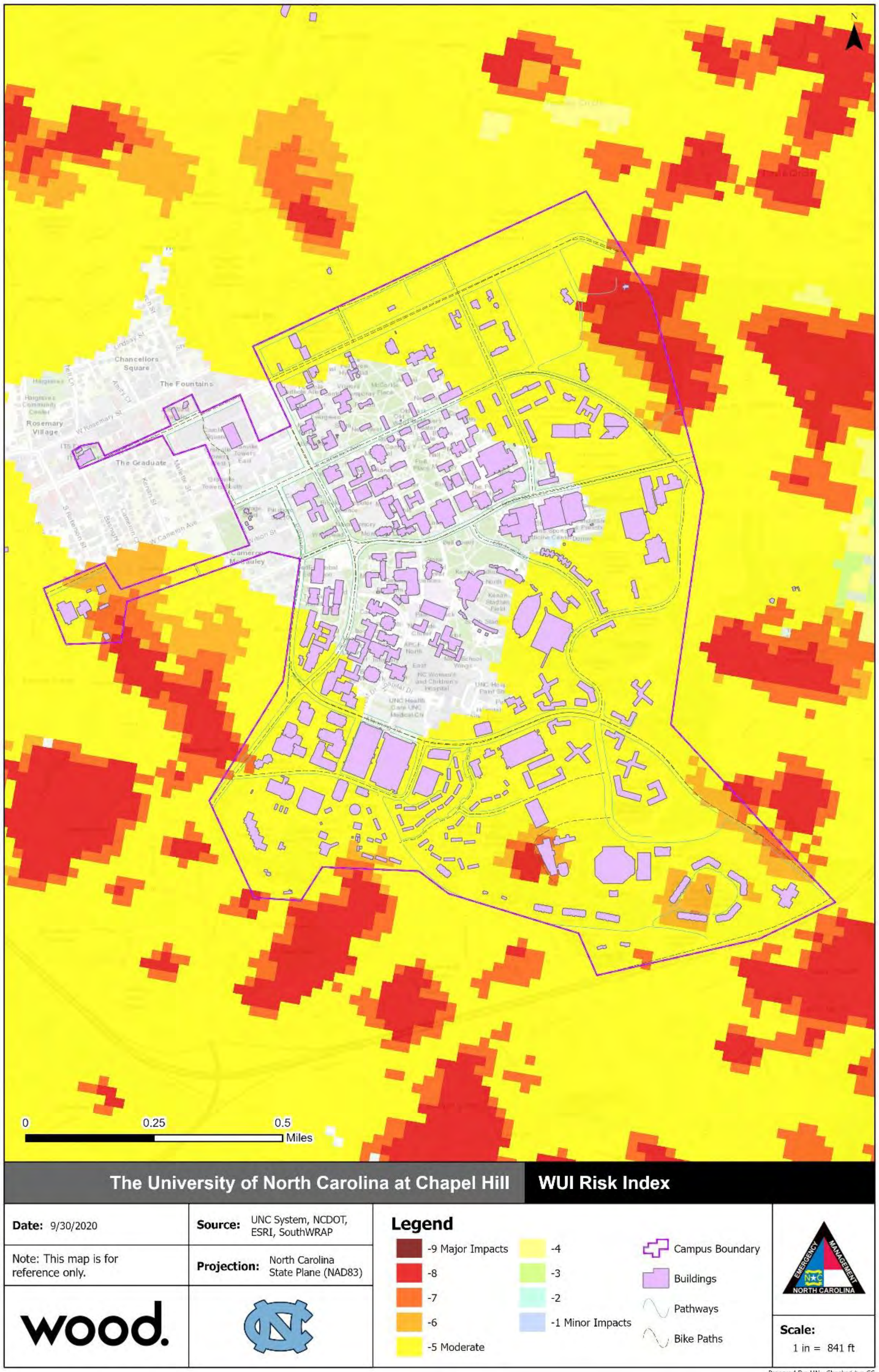


Figure G.24 – WUI Risk Index, UNC Chapel Hill



Historical Occurrences

According to the North Carolina Forest Service (NCFS) there were 854 noted wildfires within Orange County between January 2000 and May 2019. The total acreage burned during this period was 1233.8 acres. There were no additional data records regarding specific cities or school districts within Orange County. The data is from NCFS records only and may not include data on fires burned within jurisdictional limits that did not require NCFS assistance to suppress. Actual number of fires and acreage burned may be higher than what is reported here.

On average, Orange County experiences 42.7 fires and 61.7 acres burned annually from fires reported by the NCFS. Actual number of fires and acreage burned is likely higher because smaller fires within jurisdictional boundaries are managed by local fire departments. Based on these records, the average wildfire event can be calculated as 1.4 acres. Actual number of fires and acreage burned is likely higher because smaller fires within jurisdictional boundaries are managed by local fire departments. The most known cause was noted as debris.

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 UNC-CH is presented in **Table G.46** and illustrated in **Figure G.25**.

Table G.46 – Burn Probability, UNC-CH

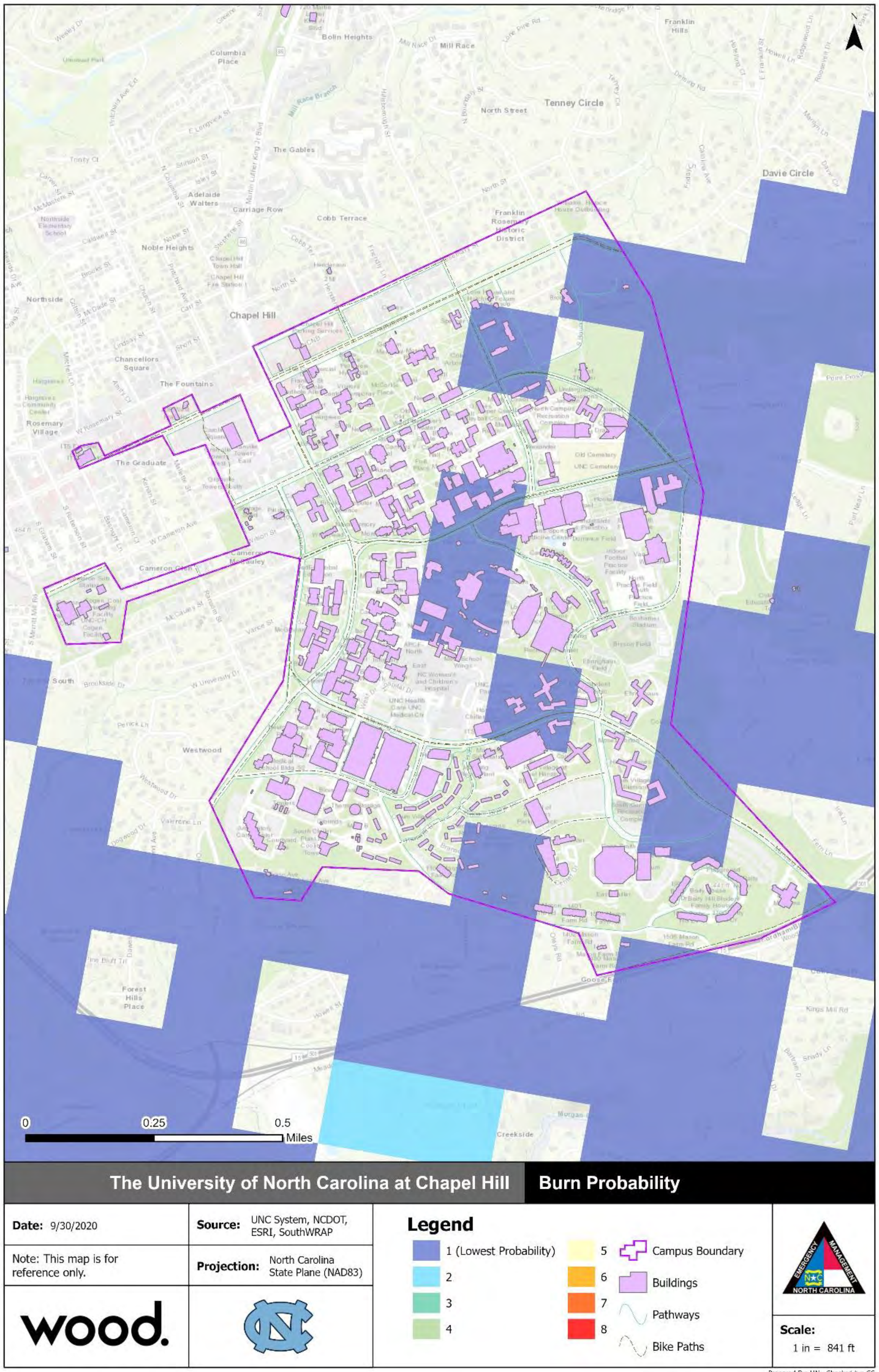
	Class	Acres	Percent
	No probability	*573*	*78.0%*
	1	162	22.0%
	2	0	0.0%
	3	0	0.0%
	4	0	0.0%
	5	0	0.0%
	6	0	0.0%
	7	0	0.0%
	8	0	0.0%
	9	0	0.0%
	10	0	0.0%
	Total	**735**	**--**

Source: Southern Wildfire Risk Assessment

The UNC-CH campus was predominantly determined has having no probability (78%). The remainder of the campus was determined to be Class 1 (22%) having the lowest probability.

Probability: 2 – Possible

Figure G.25 – Burn Probability, UNC-CH



Source: Southern Wildfire Risk Assessment

Vulnerability Assessment

People

Wildfire can cause fatalities and human health hazards. Ensuring procedures are in place for rapid warning and evacuation are essential to reducing vulnerability.

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.

Using the Wildland Urban Interface Risk Index (WUIRI) from the Southern Wildfire Risk Assessment, a GIS analysis was used to estimate the exposure of buildings most at risk to loss due to wildfire. The WUIRI shows a rating of the potential impact of wildfire on homes and people. This index ranges from 0 to -9, where lower values are relatively more severe. **Table G.47** summarizes the number of buildings and their total value that fall within areas rated -5 or less on the WUIRI. This table represents potential risks and counts every building within the area rated under -5, actual damages in the event of a wildfire may differ.

Table G.47 – Building Counts and Values within WUIRI under -5

Occupancy Type	Buildings	Building Value
Administration	20	$181,368,636
Critical Facility	32	$405,538,363
Extracurricular/Educational	80	$897,330,028
Housing	86	$262,631,817
Total	**218**	**$1,746,868,844**

Source: GIS Analysis, Southern Wildfire Risk Assessment

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.

Changes in Development

Growth on the UNC-CH campus within the wildland-urban interface area will increase the vulnerability of people, property, and infrastructure to wildfires. To reduce wildfire impacts, the University can work with the City and/or County to coordinate fuel reduction efforts, educate residents and campus population, train firefighters, and establish local wildfire management plans.

Problem Statement

- Approximately 71% of the UNC-CH campus is located within an identified WUI area.
- Orange County experiences wildfires on an annual basis with 42.7 fires and 61.7 acres burned annually, as reported by the NCFS. The actual number of fires and acreage burned is likely higher because smaller fires within jurisdictional boundaries are managed by local fire department.
- Coordination with the City/County is recommended to reduce fuel efforts and establish a local wildfire management plan.

G.5.10 Hazardous Materials Incidents

Hazard	Probability	Impact	Spatial Extent	Warning Time	Duration	PRI Score
Hazardous Materials Incident	Likely	Minor	Negligible	Less than 6 Hrs	Less than 24 Hrs	2.0

Location

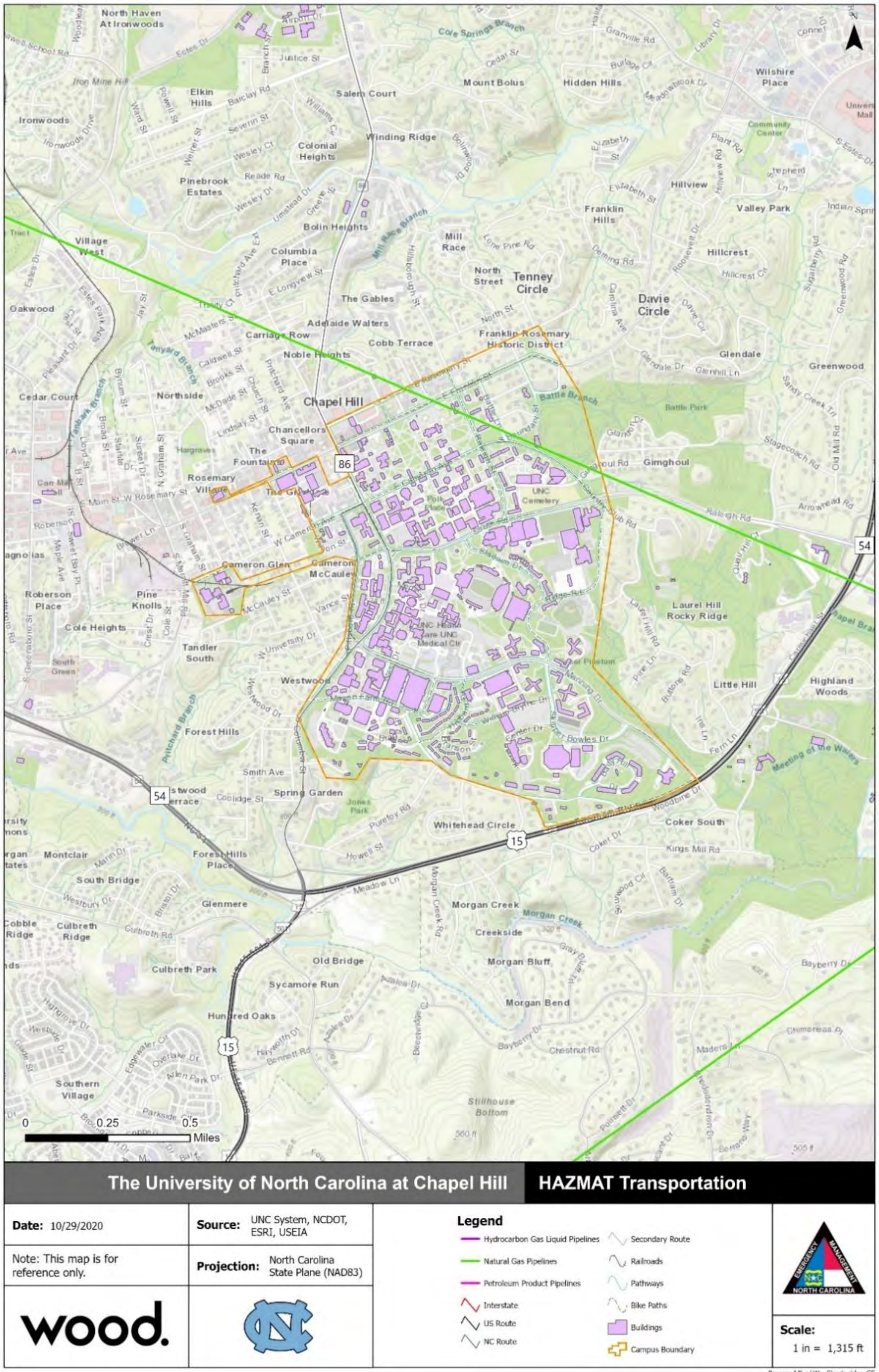
Hazardous materials releases at fixed sites can cause a range of contamination from very minimal to catastrophic. The releases can go into the air, onto the surface, or into the ground and possibly into groundwater, or a combination of all. Although releases into the air or onto the ground surface can pose a great and immediate risk to human health, they are generally easier to remediate than those releases which enter the ground or groundwater. Soil and groundwater contamination may take years to remediate causing possible long-term health problems for individuals and rendering land unusable for many years.

The Toxics Release Inventory (TRI) Program run by the 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 one site reporting hazardous materials releases in Carrboro or Chapel Hill between 2007-2019. This site is the Argos Chapel Hill Concrete Plan which is in the Nonmetallic Mineral Product sector. Additionally, the HMPC identified the following critical facilities on UNC-CH's campus with hazardous materials stored on site:

- Bingham Facility A
- Bingham Facility Building #2
- Bingham Facility Building #3
- Burnett-Womack Building
- Caudill, W Lowry, and Susan S Labs
- Chapman Hall
- Davie Hall
- Francis Owen Blood Research Lab
- Genetic Medicine Research Lab
- Hemophilia Research Lab
- Hooker, Michael Research Center
- Jones Building, Dr. Mary Ellen
- Kerr, Banks Dayton Hall
- Koury Oral Health Sciences Building
- Marsico Hall
- McGavran-Greenberg Hall
- Medical Biomolecular Research Building
- Neurosciences Research Building
- Taylor, Isaac M Hall
- Thurston Bowles Building
- Wilson Hall

Transportation hazardous materials incidents can occur when hazardous materials are being transported from one location to another in the normal course of business for manufacturing, refining, or other industrial purposes. Additionally, hazardous materials incidents can occur as hazardous waste is transported for final storage and/or disposal. **Figure G.26** below shows the modes of transportation for hazardous materials adjacent to or through UNC-CH's campus.

Figure G.26 – HAZMAT Transportation Map, UNC-CH



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.

Prior to 2002, however, a "serious incident" regarding hazardous materials was defined as follows:

- a fatality or major injury due to a hazardous material
- closure of a major transportation artery or facility or evacuation of six or more persons due to the presence of hazardous material, or
- a vehicle accident or derailment resulting in the release of a hazardous material.

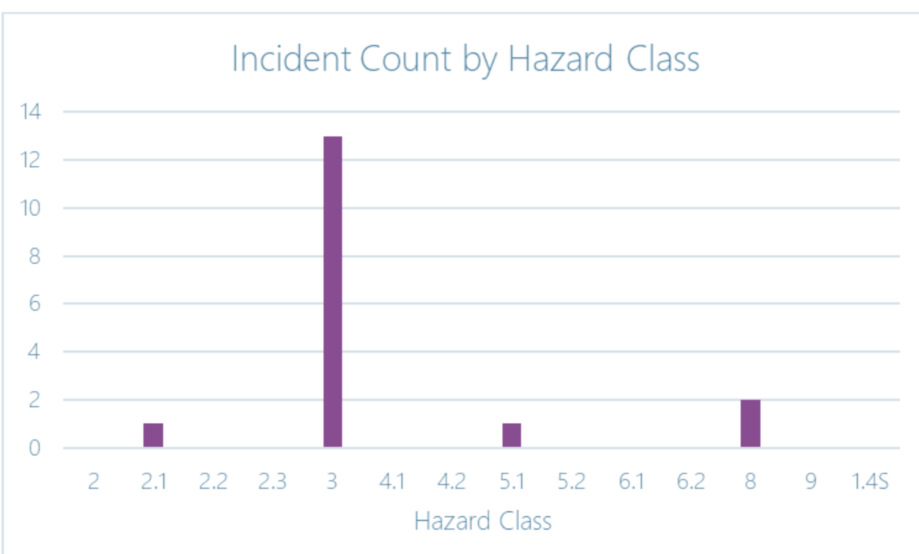
Impact: 1 – Minor

Spatial Extent: 1 – Negligible

Historical Occurrences

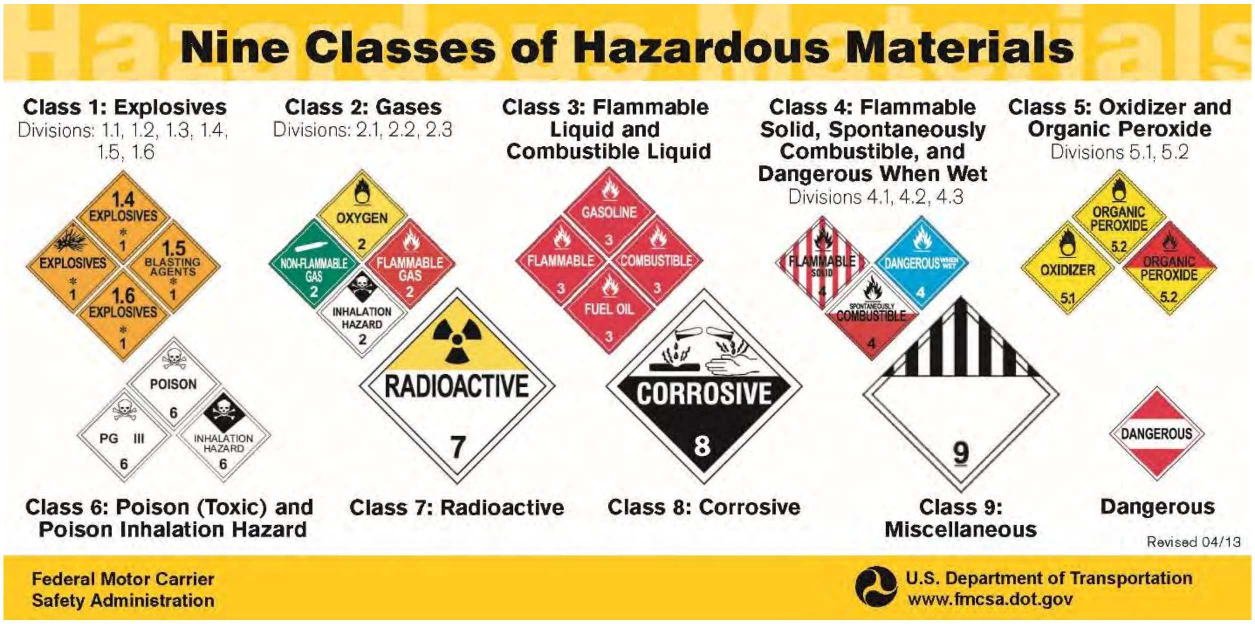
The USDOT's PHMSA maintains a database of reported hazardous materials incidents by location and hazardous material class. According to PHMSA records, there were 17 recorded releases in Chapel Hill from 2000 through 2019. **Figure G.27** categorizes these incidents by hazardous material class. The most common materials spilled in the City were Class 3 (Flammable and Combustible Liquids). **Figure G.28** describes all nine hazard classes.

Figure G.27 – Incidents by Hazardous Materials Class, 2000-2019



Source: PHMSA Hazmat Incident Database

Figure G.28 – Hazardous Materials Classes



Source: U.S. Department of Transportation

Probability of Future Occurrence

Based on historical occurrences recorded by PHMSA, there have been 17 incidents of hazardous materials release in the 20-year period from 2000 through 2019. Using historical occurrences as an indication of future probability, there is an 85 percent annual probability of a hazardous materials incident occurring throughout the Town of Chapel Hill.

Probability: 3 – Likely

Vulnerability Assessment

People

Hazardous materials incidents can cause injuries, hospitalizations, and even fatalities to people nearby. People living near hazardous facilities and along transportation routes may be at a higher risk of exposure, particularly those living or working downstream and downwind from such facilities. For example, a toxic spill or a release of an airborne chemical near a populated area can lead to significant evacuations and have a high potential for loss of life. Individuals working with or transporting hazardous materials are also at heightened risk.

In addition to the immediate health impacts of releases, a handful of studies have found long term health impacts such as increased incidence of certain cancers and birth defects among people living near certain chemical facilities. However, there has not been sufficient research done on the subject to allow detailed analysis.

The primary economic impact of hazardous material incidents results from lost business, delayed deliveries, property damage, and potential contamination. Large and publicized hazardous material-related events can deter tourists and could potentially discourage residents and businesses. Economic effects from major transportation corridor closures can be significant.

Property

The impact of a fixed hazardous facility, such as a chemical processing facility is typically localized to the property where the incident occurs. The impact of a small spill (i.e. liquid spill) may also be limited to the extent of the spill and remediated if needed. While cleanup costs from major spills can be significant, they do not typically cause significant long-term impacts to property.

Hazardous materials spills reported by PHMSA for the 20-year period from 2000 through 2019 totaled $7,935 in damage, which equates to an annualized loss of $397 across the Town of Chapel Hill.

Impacts of hazardous material incidents on critical facilities are most often limited to the area or facility where they occurred, such as at a transit station, airport, fire station, hospital, or railroad. However, they can cause long-term traffic delays and road closures resulting in major delays in the movement of goods and services. These impacts can spread beyond the planning area to affect neighboring counties, or vice-versa. While cleanup costs from major spills can be significant, they do not typically cause significant long-term impacts to critical facilities, but there is a chance they may be impacted.

Environment

Hazardous material incidents may affect a small area at a regulated facility or cover a large area outside such a facility. Widespread effects occur when hazards contaminate the groundwater and eventually the municipal water supply, or they migrate to a major waterway or aquifer. Impacts on wildlife and natural resources can also be significant.

Changes in Development

Structures located near fixed facilities, highways and other high traffic roadways are most at risk to a hazardous materials event. Any development that takes place in these areas will place more people and structures in the risk area for hazardous materials events, however since most hazardous material spills are localized to an extremely small area this will not have an effect on the overall risk assessment for this hazard.

Problem Statement

- Transportation routes for hazardous materials are located adjacent to the UNC-CH campus.
- The number of reported incidents within Chapel Hill can be approximated to 85 percent annual probability.

G.5.11 Conclusions on Hazard Risk

Priority Risk Index

As discussed in **Section G.5**, 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 G.48 summarizes the degree of risk assigned to each identified hazard using the PRI method.

Table G.48 – Summary of PRI Results

Hazard	Probability	Impact	Spatial Extent	Warning Time	Duration	PRI Score
Dam Failure	Possible	Critical	Negligible	Less than 6 hours	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 hours	Less than 6 hours	1.9
Flood	Likely	Minor	Negligible	6 to 12 hours	Less than 6 hours	1.8
Geological – Landslide	Possible	Minor	Small	6 to 12 hours	Less than 6 hours	1.7
Hurricane	Possible	Limited	Large	More than 24 hrs	Less than 24 hrs	2.3
Severe Winter Weather	Highly Likely	Limited	Large	More than 24 hrs	More than 1 week	3.1
Tornado / Thunderstorm	Likely	Critical	Large	Less than 6 hours	Less than 6 hours	3.1
Wildfire	Possible	Limited	Large	More than 24 hrs	More than 1 week	2.5
Hazardous Materials Incidents	Likely	Minor	Negligible	Less than 6 hours	Less than 24 hrs	2.0

[1]Note: Severe Weather hazards average to a score of 2.6 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 G.49**:

- **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.
- **Moderate 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 minimal. This is not a priority hazard.

Table G.49 – Summary of Hazard Risk Classification

High Risk (≥ 3.0)	Severe Winter Weather Tornado / Thunderstorm
Moderate Risk (2.0 – 2.9)	Dam Failure Drought Hazardous Materials Wildfire
Low Risk (< 2.0)	Earthquake Flood Hurricane Geological – Landslide

G.6 CAPABILITY ASSESSMENT

This section discusses the mitigation capabilities, including planning, programs, policies and land management tools, typically used to implement hazard mitigation activities. It consists of the following subsections:

- G.6.1 Overview of Capability Assessment
- G.6.2 Planning and Regulatory Capability
- G.6.3 Administrative and Technical Capability
- G.6.4 Fiscal Capability

G.6.1 Overview of Capability Assessment

The purpose of conducting a capability assessment is to determine the ability of the college to implement feasible mitigation actions based on an understanding of the capacity of the departments and staff tasked with their implementation. A capability assessment should also identify opportunities for establishing or enhancing specific mitigation policies or programs. The process of conducting a capability assessment includes developing an inventory of relevant plans, policies, or programs already in place; as well as assessing the college's ability to implement existing and/or new policies. Conclusions drawn from the capability assessment should identify any existing gaps or weaknesses in existing programs and policies as well as positive measures already in place which can and should be supported through future mitigation efforts.

G.6.2 Planning and Regulatory Capability

Planning and regulatory capabilities include plans, ordinances, policies and programs that guide development on campus. **Table G.50** lists local plans, ordinances, policies and programs currently in place at UNC-CH.

Table G.50 – Planning and Regulatory Capability

Regulatory Tool (ordinances, codes, plans)	Y/N	Comments
Master Plan	Y	UNC-CH Master Plan, 2019
Zoning code	Y	Town of Chapel Hill Zoning Ordinance
Growth management ordinance	N	
Floodplain ordinance	Y	Town of Chapel Hill Flood Ordinance
Building code	Y	NC building codes; the State of North Carolina statutes for state owned buildings; and zoning for local jurisdiction
Erosion or sediment control program	N	
Stormwater management program	Y	Energy Services
Site plan review requirements	Y	Design Review and Checking System (DrChecks)
Capital improvements plan	Y	Facilities Planning and Design; 6yr Capital Plan
Economic development plan	Y	UNC-CH Annual Report
Local emergency operations plan	Y	Emergency Operations Plan 2014
Flood Insurance study or other engineering study for streams	Y	November 17, 2017
Elevation certificates	Y	Town of Chapel Hill

A description of applicable plans, ordinances and programs follows to provide more detail on the relevance of each regulatory tool in examining capability.

Master Plan

A Master Plan, in broad terms, is a policy statement to guide the future placement and development of campus facilities. The Master Plan identifies a future vision, values, principles and goals for the college, determines the projected growth for the college, and identifies policies to plan, direct and accommodate anticipated growth. UNC-CH maintains a Master Plan that incorporates a strong sense of environmental responsibility. Additionally, the campus also has the UNC Development Plan, which outlines plans for buildings and infrastructure on campus and is submitted to the Town of Chapel Hill to enable a comprehensive, joint approach to planning by the Town and university.

Zoning Code

Zoning typically consists of both a zoning map and a written ordinance/code that divides the planning area into zoning districts. The zoning regulations describe what type of land use and specific activities are permitted in each district, and also regulate how buildings, signs, parking, and other construction may be placed on a parcel. The zoning regulations also provide procedures for rezoning and other planning applications. Zoning is undertaken by the Town of Chapel Hill.

Flood Insurance Study/Floodplain Ordinance

A Flood Insurance Study (FIS) provides information on the existence and severity of flood hazards within a community based on the 100-year flood event. The FIS also includes revised digital Flood Insurance Rate Maps (FIRMs) which reflect updated Special Flood Hazard Areas (SFHAs) and flood zones for the community. FIS Reports and FIRMs are prepared and provided by FEMA.

A floodplain ordinance is perhaps the most important flood mitigation tool for the flood hazard. 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 will be protected from damage by a 100-year flood event and that new development in the floodplain will not exacerbate existing flood problems or increase damage to other properties. Floodplain management is carried out by the Town of Chapel Hill.

Stormwater Management Program

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. A Stormwater Management Program can prevent flooding problems caused by stormwater runoff by 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) Setting construction standards so buildings are protected from shallow water. A stormwater ordinance provides regulatory authority to implement stormwater management standards.

UNC-CH maintains a Stormwater Management Plan and operates its own stormwater system under the EPA's National Pollutant Discharge Elimination System (NPDES) Phase II Program. This system is comprised of thousands of catch basins and inlets, miles of piping, dozens of structural best management practices (BMPs), and outfalls that discharge storm water into nearby creeks. UNC's storm water program has been recognized as a model for University Campuses and has been profiled several times in trade journals.

Erosion and Sediment Control Program

Surface water runoff can erode soil from development sites, sending sediment into downstream waterways. This can clog storm drains, drain tiles, culverts and ditches and reduce the water transport and storage capacity of channels. The purpose of an erosion, sedimentation and pollution control ordinance is to minimize soil erosion and prevent off-site sedimentation by using soil erosion and sediment control practices designed in accordance with certain standards and specifications. UNC-CH maintains a soil erosion and sediment control plan.

Site Plan Review

The purpose of the Site Plan Review Process is to review site plans for specific types of development to ensure compliance with all appropriate land development regulations and consistency with the General Plan. The Campus has extended the Town a courtesy review of most development activities conducted on campus.

Building Code

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).

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. An Elevation Certificate serves as the official record that shows new buildings and substantial improvements in all identified SFHAs are properly elevated. This elevation information is needed to show compliance with the floodplain ordinance.

In addition to local building code enforcement, UNC-CH maintains building standards and design and construction guidelines.

Capital Improvement Plan

A Capital Improvement Plan (CIP) is a planning document that typically provides a five-year outlook for anticipated capital projects designed to facilitate decision makers in the replacement of capital assets. The projects are primarily related to improvement in public service, parks and recreation, public utilities and facilities. The mitigation strategy may include structural projects that could potentially be included in a CIP and funded through a Capital Improvement Program.

Emergency Operations Plan

An emergency operations plan outlines responsibilities and the means by which resources are deployed during and following an emergency or disaster. The University maintains several plans, administrated through the Department of Public Safety, that provide guidance for the full range of emergency management services on campus. These plans are coordinated with other Orange County emergency response agencies and have been tested in joint training drills that included UNC Hospitals.

The University updated a campus-wide Emergency Plan in 2014. The purpose of the Plan is to outline an organizational structure and to assign responsibilities for coping with emergencies affecting the safety and well-being of people and/or facilities on campus. The Plan is intended as guidance in the management of any unusual occurrence on campus. UNC-CH also has an Emergency Warning and Crisis Communications Plan, a Pandemic Influenza Plan, a Departmental Business Continuity Plan, and Museum and Library Disaster Plans.

G.6.3 Administrative and Technical Capability

Administrative and technical capability refers to the college's staff and their skills and tools that can be used for mitigation planning and to implement specific mitigation actions. It also refers to the ability to access and coordinate these resources effectively. The personnel should be considered as well as the level of knowledge and technical expertise of these resources. Resources include engineers, planners, emergency managers, GIS analysts, building inspectors, grant writers, floodplain managers, and more. **Table G.51** provides a summary of the administrative and technical capabilities for UNC-CH.

Table G.51 – Administrative and Technical Capability

Personnel Resources	Yes/No	Department/Position
Planner/Engineer with knowledge of land development/land management practices	Yes	Facilities Planning and Design
Engineer/Professional trained in construction practices related to buildings and/or infrastructure	Yes	Engineering Services, Energy Services, Facilities Planning and Design
Planner/Engineer/Scientist with an understanding of natural hazards	Yes	Energy Services, Facilities Technology Group, Engineering Services
Personnel skilled in GIS	Yes	Facilities Technology Group
Full time building official	Yes	Town of Chapel Hill
Floodplain Manager	Yes	Town of Chapel Hill, Energy Services
Emergency Manager	Yes	Emergency Management and Planning
Grant Writer	Yes	Various Faculty
Public Information Officer	Yes	Communications Department
Student Engagement	Yes	Division of Student Affairs
Warning Systems	Yes	Campus Outdoor Alert System and Electronic Communications

The following support services, as described in the 2011 PDM plan, are key campus resources that may provide administrative or technical support for mitigation activities.

Emergency Management and Planning

The Department of Emergency Management and Planning is housed under the Campus Safety umbrella. The department plans for emergencies such as pandemics, natural hazards, and other threats to the health and safety of the University. The department hosts Carolina Ready to help students, faculty, and staff be informed about and prepared for emergencies and take action when they occur. The department also utilizes Alert Carolina, an emergency notification system that pushes out messages in multiple ways in the event of an emergency or dangerous situation. The Department of Emergency Management and Planning lead this hazard mitigation planning process for UNC-CH; the HMPC coordinator for this update is the Director of the department.

Facilities Services

The Office of Facilities Services within the Division of Finance and Administration is responsible for maintaining all facilities located on the campus of UNC-CH. The Office administers the University's Facilities Condition Assessment Program (FCAP). As part of this program, the UNC Facilities Conditions

Assessment Team proactively examines all facilities on campus to identify any architectural and engineering systems deficiencies, and plans for any correction to bring facilities up to current standards. The FCAP also tries to anticipate when building systems will require replacement or repair so that the University may plan for capital expenditures accordingly.

An extensive database containing information on all UNC-CH facilities is maintained as part of the FCAP by the Office of Engineering Information Services (EIS). The database includes data on the conditions of systems housed in each building, such as fire/life safety systems; ADA accessibility; exterior elements; HVAC systems; plumbing systems; electrical systems; and health factors (e.g., presence of asbestos, mold, etc.). The database also includes information such as square footage, year constructed, useful life expectancies, facility replacement costs, and a facilities conditions needs index. Among the project funding and needs categories for work to be performed on each facility is an identification of mitigation needs to withstand high probability hazardous events.

Energy Services

The Energy Services section is in charge of all power generation and distribution on campus, as well as water, wastewater and storm water services. The Power Services Office plans for redundancies and power allocation during shortages or outages. The Energy Services section also develops a Capital Improvement Program for all campus facilities that generate and distribute electric power on campus. For water and wastewater needs, UNC-CH relies on the local water utility, Orange Water and Sewer Authority (OWASA), to provide potable water to all structures and facilities on campus; the University represents 30 percent of the customer base for OWASA. During periods of drought, the University has worked with officials at OWASA to institute successful programs aimed at reducing water consumption campus wide. Wastewater disposal service is also provided to campus by OWASA, which treats university wastewater in its municipal treatment facilities.

In 2004 the University initiated a joint project with OWASA to develop a reclaimed water system that diverts highly treated effluent from OWASA's Mason Farm Sewage Treatment Plant for reuse on campus. This system now pumps grey water to campus for use in flushing toilets and for grounds maintenance.

Facilities Planning and Construction

The Facilities Planning and Construction Division was created to assure that the University gives appropriate, sustained attention to all aspects of its ongoing expansion initiated with the approval of the UNC Development Plan. The Division is overseen by the Facilities Planning Committee, an advisory board made up of senior administration officials; the Facilities Planning Work Group is made up of mid-level management and administrators and advises the Committee on University practice and policy regarding development on campus.

Facilities Planning also provides land use planning services and coordinates project development with open space and infrastructure planning to ensure consistency with the Campus Master Plan.

Grounds Service and Maintenance

University groundskeepers are in charge of maintaining all university acreage, including planting, pruning, watering and routine maintenance. The Grounds Services Division is also responsible for snow and ice removal, as well as debris removal following a hazard event. After Hurricane Fran, tons of debris, primarily downed trees and limbs, littered campus. Grounds crews were assisted by dozens of campus and community volunteers to remove the debris. Policies for prioritization of debris and snow removal have been instituted, with first priority granted to removing obstacles to hospital access.

UNC-CH has a strong tree maintenance program with a high level of in-house staffing devoted to maintaining the health of trees on campus. UNC Forest Management conducts routine inspections of the hundreds of trees on campus, removing any limbs or trees that are vulnerable to toppling in high winds or otherwise appear fragile, making trees healthier and more resilient to ice damage, high winds and heavy snows. Heightened attention to maintenance around the hospital ensures access at all times remains unimpeded by downed trees. This proactive approach ensures that tree damage will cause minimal disruption to power distribution as well.

UNC Property Office

The UNC Property Office manages the real property of the University including endowment properties and properties owned by the University or University's foundation. It also acts as the leasing agent for the University departments requiring rental space. An in-depth study of leased property was outside the scope of this hazard mitigation planning process. Understanding the location of leased properties can ensure the university minimizes operations in hazard prone areas and ensure policies and practices of property owners place high priority on life safety and protection of assets.

Information Technologies Services

Information Technologies Services (ITS) is the central organization providing all members of the UNC-CH community with telecommunications, computer support, networking, applications development, and other computing services for academic and administrative endeavors. Organized under the Office of the Vice Chancellor for Information Technologies and incorporating nine divisions, each reflecting a core skill and services set, ITS works with campus organizations, student, faculty, and staff to provide robust, flexible, and secure technologies that support the institutional goals of the University.

ITS works with the Office of Facilities Services and the Office of Facilities Planning and Construction to construct and maintain its databases of all existing facilities on campus, as well as new construction projects. ITS maintains a robust cyber security system that incorporates several mitigative and redundancy provisions to minimize potential disruption in IT and communications due to power failure or other events.

Risk Management Services

Risk Management Services is a division of Finance, overseen by the Vice Chancellor for Finance and Administration. The University engages in Enterprise Risk Management, defined as a coordinated approach to assessing and responding to all risks that affect the achievement of the University's strategic and financial objectives, including both upside and downside risks. UNC-CH Risk Management Services were consulted for this plan update. Risk Management Services plays a role in a wider campus effort to reduce risks and liabilities of the university to all types of hazards.

Carolina established the Enterprise Risk Management Advisory Committee in 2003, which is represented by leadership from a broad area of the University. The Committee collaborates on a holistic approach to identifying and managing the full range of risks the University faces and reports to the Vice Chancellor of Finance and Administration on proposed strategies. The committee champions these strategies and is charged with communicating them to each member's respective areas so that all stakeholders take ownership.

Risk Management Services is in charge of all insurance policies for University property. Most of the University's real and personal property is insured through the State Property Fire Insurance Fund, a division of the NC Department of Insurance. The Fund offers three tiers of coverage, as well as several stand-alone coverage options, for insuring the University's buildings and contents. The most basic tier covers fire and lightning losses. Departments may opt for the second tier, which adds extended coverage to the first tier, and includes windstorms or hail among other perils. The third tier is "all-risk insurance," covering all perils unless specifically excluded. Miscellaneous property coverage offered by the Fund that may be purchased by departments includes flood, sprinkler leakage, and business interruption and extra expenses.

The office of Risk Management Services also supports Mission Continuity program to ensure the University can recover its mission critical functions. The program focuses on the three key elements of recovery: human resources continuity, work area recovery, and resumption of information technology/utility services.

UNC Safety and Security Committee

The University has a robust committee structure for the planning of health, safety, and emergency activities. The University Safety and Security Committee is the most senior level committee reviewing emergency plans for campus. This committee is composed of senior administrators and executives and the chairs of several working committees, including the Occupational Health and Clinical Safety Committee; Hazards Management Committee; Laboratory and Chemical Safety Committee; Radiation Safety Committee; Institutional Biosafety Committee; and the Emergency Operations Planning Committee.

Department of Public Safety

The UNC Department of Public Safety is a nationally accredited police force consisting of XX sworn officers. It includes a detective team, special bike patrols, a larceny reduction unit, a traffic and pedestrian safety unit, a specially trained bomb-sniffing dog, a full-service 911 response center, a fully-equipped emergency operations center, a silent witness program to encourage the reporting of suspicious activities and extensive mutual aid agreements with area municipal and county agencies.

University Public Safety Officers serve as first responders to any emergency situation on campus which requires recognition and initial assessment of potential hazards in order to activate the UNC-CH Emergency Response Plan. Police officers establish the initial Incident Command pending arrival of the police supervisor who assumes command until relieved by senior police personnel or the Chapel Hill Fire Department. Public Safety personnel are responsible for establishing and securing a "clear zone" around the emergency area, providing traffic control escort for emergency responders and coordination with other law enforcement agencies.

Emergency management activities on campus are overseen by an Emergency Management Coordinator, who reports directly to the Chief of UNC Public Safety. This position is in charge of developing and maintaining campus emergency response plans.

The University Staff has the capability and resources to manage many emergencies, but relies on the Chapel Hill Fire Department, South Orange County Emergency Medical Services, and Orange County Emergency Management Department for services for events that present significant risk to life and/or property. IN the even of large-scale incidents or disaster, State and federal agencies also may play a significant role in responding to emergencies. The University's emergency operations work in coordination with these emergency response organizations to mitigation and resolve emergency situations.

The department has been through extensive trainings and evaluations as a result of events that have occurred on campus and schools across the country and have made impacts nationwide including reevaluating security measures following the Virginia Tech mass murder incident in April 2007 and active shooter drills following the 1999 Columbine High School shootings.

Emergency Coordinators

The University has designated an Emergency Coordinator(s) for all of its occupied buildings. Each Emergency Coordinator is responsible for assisting in the safe and orderly emergency evacuation of employees. In preparation for an emergency, they complete information cards and place them in door hanger pockets provided by Environmental Health and Safety. In an emergency, each Emergency Coordinator is responsible for carrying out procedures in accordance with the University Emergency Plan.

Environmental Health and Safety

The mission of the Department of Environmental Health and Safety (EHS) is to maintain a safe environment on campus, ensure regulatory compliance for all campus activities, recognize and control health and safety hazards on campus, and provide education through training and consultation. Sections within EHS include Environmental Affairs, Biological Safety, Fire and Life Safety, Industrial Hygiene, Laboratory Safety, Radiation Safety, Workers' Compensation, and Workplace Safety.

The University's Health and Safety Management Information System (HASMIS) is an extensive database that is constructed and maintained pursuant to federal regulations promulgated by OSHA, which includes chemical lists, chemical hygiene plans, location of radioactive materials, etc.

The director of EHS was a member of the UNC-CH HMP and was involved throughout the planning process.

G.6.4 Fiscal Capability

Financial capabilities are the resources that an entity has access to or is eligible to use to fund mitigation actions. The costs associated with implementing mitigation activities vary. Some mitigation actions such as building assessment or outreach efforts require little to no costs other than staff time and existing operating budgets. Other actions, such as structural projects, could require a substantial monetary commitment from local, State, and Federal funding sources. **Table G.52** provides a summary of the fiscal resources at UNC-CH.

Table G.52 – Fiscal Resources

Resource	Ability to Use for Mitigation Projects? Y/N
Community Development Block Grants	N
Capital improvements project funding	Y
In-Kind Services	Y
Tuition & Fees	Y
Federal funding with HMA grants	Y
Revenue Bonds	Y
State Appropriations	Y
Sales & Services	Y
Other Sources (Gifts, Investment Income, Permanent Endowments)	Y; UNC-CH receives funding from Contracts and Grants, and other income from Interest and Fees

G.7 MITIGATION STRATEGY

G.7.1 Implementation Progress

Progress on the mitigation strategy developed in the previous plan is also documented in this plan update. **Table G.53** details the status of mitigation actions from the previous plan. **Table G.54** on the following pages details all completed and deleted actions from the 2011 plan. More detail on the actions being carried forward is provided in the Mitigation Action Plan.

Table G.53 – Status of Previous Mitigation Actions

Campus	Completed	Deleted	Carried Forward and/or Combined
UNC-CH	56	1	74

Table G.54 – Completed and Deleted Actions from the UNC-CH 2011 Plan

Item #	Vulnerability	Action	2020 Status	2020 Implementation Status Comments
RV4	CoGen: Proactive inspection, maintenance, repair, and replacement are required.	Schedule regular inspection, maintenance, and timely replacement of roof systems.	Completed	
SV1	CoGen: High winds may drive unsecured items stored at the site and miscellaneous debris into building exits or vehicle lanes, blocking them.	Inspect site for loose debris or unsecured stored items; haul off debris and tie down stored materials.	Completed	
SV2	CoGen: Vehicle access is currently limited to two narrow routes from Cameron at the northwest, and one very narrow route across the south of the site. Windstorms or other events could readily block vehicle access to the east half of the site.	As construction project is completed at northeast part of site, complete the vehicle entry drives onto the site from the east side.	Completed	
RV2	CoGen: The age and condition of the interlocking pavers and thermoplastic membrane roof system make these roof sections vulnerable to tear-off in high winds.	Replace the roof systems.	Completed	
RV3	CoGen: The age and condition of the interlocking pavers make these roof sections vulnerable to tear-off in high winds.	Replace the paver system.	Completed	
RV1	CoGen: The age and condition of these roofs make them vulnerable to tear-off in high winds.	Replace the roof systems.	Completed	
RV1	Lenoir: Roof is vulnerable to wind damage at isolated areas of damage: Cracked, loose, and broken slate and damaged repair straps.	Replace broken slate, re-secure loose slate, and replace or rework repair straps.	Completed	
RV3	Lenoir: Proactive inspection, maintenance, repair, and replacement program will make roofs less vulnerable to wind damage.	Perform regular roof inspections and maintenance, and replace roof on schedule.	Completed	
RV5	Lenoir: Both blower and duct have insufficient attachment to the roof, and are vulnerable to becoming detached during high winds.	Install new, larger fasteners at base of blower and duct to upgrade their attachment to their curbs.	Completed	
CV2	Lenoir: Metal tables at north end and wooden tables with umbrellas at south end may be driven into building by high winds, breaking windows.	Secure wooden tables to plaza pavers.	Completed	
SV1	Lenoir: Unsecured dining tables outside of hotdog restaurant may be blown into doorway, blocking exit.	Secure wooden tables to plaza pavers.	Deleted	Repeat of CV2
RV7	Lenoir: HVAC condenser units have no connection to roof, and are vulnerable to sliding off their base during high winds.	Install attachment hardware to tie units to their curbs.	Completed	
RV10	Lenoir: Rear (southern) 10' of unit has no connection to roof. Very high winds may shift the unit off its curbs.	Install new attachment hardware between unit base and roof deck.	Completed	

Item #	Vulnerability	Action	2020 Status	2020 Implementation Status Comments
CV1	Lenoir: High winds may break tree branches or topple trees that are directly adjacent to Lenoir's large windows.	Trim tree branches that are within striking distance of windows.	Completed	
SV2	Lenoir: Tree branches or fallen trees may block exits during high winds.	Trim trees near exits.	Completed	
CV1	Mary Ellen Jones Bldg: Structural supports for panels have been weakened by corrosion damage at steel connections and cracked concrete at column stubs. Over time, supports will fail during high winds and a panel will fall off the building. Structural repairs are required to mitigate this threat.	Repair damaged concrete at column stubs. Install new steel support brackets and anchor bolts. Protect connections from future corrosion.	Completed	Building was renovated in 2018.
RV1	Mary Ellen Jones Bldg: Corrosion damage at support posts & connections, missing bolts, insufficient panel screws. Prone to failure in high wind. Will damage roof and nearby equipment.	Repair corrosion damage & upgrade connections. Provide protection against future corrosion.	Completed	Building was renovated in 2018.
RV6	Mary Ellen Jones Bldg: Inadequate, corroded, or missing fasteners at base. Improper and corroded guy wires. Units will overturn in high wind, damaging unit, roof, and utility connections to unit.	Install roof curb with structural connection to deck. Secure unit to curb. Upgrade guy wires and anchors.	Completed	Building was renovated in 2018.
RV2	Mary Ellen Jones Bldg: Mounting stanchions too small, inadequate to resist high wind loads on duct. Base of duct corroded at connection with unit. Duct will break away in high wind, damaging unit and nearby equipment.	Upgrade supports for ducts, repair corrosion damage. Provide protection against future corrosion.	Completed	Building was renovated in 2018.
RV7	Mary Ellen Jones Bldg: Need for proactive inspection, maintenance, repair, and replacement program	Perform regular roof inspection, maintenance, and replace roof on time.	Completed	Building was renovated in 2018.
RV3	Mary Ellen Jones Bldg: Severely corroded connection between blower and pedestal. Blowers will overturn in high winds, damaging blowers, ductwork, utilities, and roof.	Replace attachment hardware at blowers.	Completed	Building was renovated in 2018.
RV4	Mary Ellen Jones Bldg: Inadequate fasteners to base. Hood may detach in high wind, damaging unit and endangering pedestrians on ground.	Install new fasteners at hood mount.	Completed	Building was renovated in 2018.
RV8	Mary Ellen Jones Bldg: Inadequate and/or corroded mounts. Aerials will break free during high winds, damaging roof.	Upgrade all aerial mounts.	Completed	Building was renovated in 2018.
RV5	Mary Ellen Jones Bldg: No securement to plastic pad set on roof surface, can be moved by hand. Overturning in high wind could damage MEP connections and roof	Install roof curb with structural connection to deck. Secure unit to curb.	Completed	Building was renovated in 2018.

Item #	Vulnerability	Action	2020 Status	2020 Implementation Status Comments
SV1	Mary Ellen Jones Bldg: The fuel pipe is elevated and exposed for a short distance, between the fuel tank and the building. This section is vulnerable to breakage from flying debris during high winds. The hazard can be mitigated by re-routing the pipe, or by installing a protective guard.	Install protective guard around exposed portion of fuel pipe.	Completed	Building was renovated in 2018.
CV2	Mary Ellen Jones Bldg: Trees close to the building face will thrash about during high winds and upper branches will break windows. Mitigate by trimming tree branches.	Trim tree branches near building face.	Completed	Building was renovated in 2018.
CV4	Mary Ellen Jones Bldg: Louvers protect mechanical systems and are subject to high wind loads due to their size. Mitigate hazard by inspecting connections between panels and building frame.	Inspect panel mounts for corrosion or other damage.	Completed	Building was renovated in 2018.
CV3	Mary Ellen Jones Bldg: Nearby buildings have roof systems that include loose gravel. During very high winds, gravel may impact the Jones Building, breaking windows. Mitigation depends on overall University roofing strategy.	Consider this hazard in long-term planning for campus roofing program.	Completed	Building was renovated in 2018.
CV5	Mary Ellen Jones Bldg: Possible water entry at spalls during high winds. Mitigate by repairing spalls.	Repair panel spalls and reseal adjacent joints.	Completed	Building was renovated in 2018.
RV7	Smith Arena: Need for proactive inspection, maintenance, repair, and replacement program.	Perform regular inspection and maintenance, and replace roof on time.	Completed	
CV2	Smith Arena: High winds will propel loose site items into windows. Loose site items include tree branches, decayed landscape timbers, and unsecured tables at east side of arena.	Trim tree branches near windows. Replace decayed timbers at eight landscaped slopes near exit ports. Secure metal tables along arena's east side.	Completed	
SV1	Smith Arena: During severe winds, damage to smaller trees along walkways will partially block escape routes. Tall trees over ramp access road may topple into ramp and block access.	Trim tree branches along walkways. Remove tall trees over southeast ramp approach.	Completed	
RV5	Smith Arena: Small aerials with rusted or inadequate mounts are vulnerable to damage during high winds.	Upgrade aerial mounts and replace corroded fasteners.	Completed	
RV1	Woolen Gym: Age and condition of recovery roof system makes roof vulnerable to damage and blow-off during high wind leading to water entry and damage. Lack of secondary drainage allow for build-up of water along the perimeters and increases risk of water entry and structural overloading.	Replace roof system at main gym. Install secondary drainage at main gym roof.	Completed	

Item #	Vulnerability	Action	2020 Status	2020 Implementation Status Comments
RV11	Woolen Gym: Need for proactive inspection, maintenance, repair, and replacement program.	-n/a -	Completed	
RV5	Woolen Gym: Loose and broken slate and deteriorated perimeter flashing and gutters are vulnerable to additional damage from high winds that may cause damage to adjacent roofs and buildings, endanger pedestrians, or cause damage and water entry into the building.	Replace gutters and flashing, repairs to slate roofing.	Completed	
RV8	Woolen Gym: Condenser units are set on steel frames mounted to the masonry parapet wall. Units are not secured to the steel frame platforms and could come loose causing damage to the platforms and adjacent roof. Platforms are corroded and are poorly attached to the distressed masonry wall and may detach during high winds.	Construct proper platforms mounted to roof structure.	Completed	
RV9	Woolen Gym: Exhaust fan hoods have inadequate securement to the roof curbs. These hoods could be blown off by high winds causing damage to the roof system, or to buildings and pedestrians below.	Construct new curbs and make proper connection to base of fan units.	Completed	
RV10	Woolen Gym: Wall mounts for aerials are either inadequate or corroded and could detach during high winds. Damage to the roof system or pedestrians and vehicles below is possible.	Remove or replace aerials.	Completed	
SV3	Woolen Gym: Trees directly adjacent to rear driveway may topple during windstorm, blocking vehicle access to main gym and Women's gym at south side of site.	Trim tree branches.	Completed	
SV4	Woolen Gym: Wood poles supporting light arrays, east of Carmichael auditorium, may topple during wind storm, blocking vehicle access to main gym and Women's gym at south side of site.	Inspect soundness of wood utility poles.	Completed	
RV1	Kenan Labs Building: No secondary drainage system provided. Windstorms commonly come with heavy rains. Clogged or overwhelmed internal drains will lead to roof flooding, with water entry at flashings and excessive load on roof structure.	Design and install secondary roof drains.	Completed	
RV2	Kenan Labs Building: Loose items on roof, including lumber, furniture, steel parts. High winds will tumble debris, damaging roof membrane and greenhouse.	Remove debris from roof.	Completed	
RV3	Kenan Labs Building Proactive inspection, maintenance, repair, and replacement program will make roofs less vulnerable to wind damage.	Perform regular roof inspections and maintenance, and replace roof on time.	Completed	

Item #	Vulnerability	Action	2020 Status	2020 Implementation Status Comments
RV6	Kenan Labs Building: 500 sf greenhouse is in poor repair and its frame is poorly mounted to the roof. High winds will blow out additional panes and may dislodge entire frame. Wreckage will damage roof and parts may blow off the roof.	Dismantle and remove greenhouse. Repair roof and flashings at greenhouse footprint.	Completed	
RV8	Kenan Labs Building: Lightweight metal and plywood platform, apparently for weather instruments, is mounted to parapet wall. High winds will tear platform off wall, possibly damaging roof or going over the side to fall to the ground below.	Remove platform from roof.	Completed	
RV5	Kenan Labs Building: Existing stacks and mounts may be under-designed and incapable of resisting Code-level winds. Mounts or stack barrels may be overwhelmed and fail, toppling stacks and damaging the roof.	Analyze wind loads on stacks and capacity of existing stacks and mounts to resist the Code wind event. Replace corroded bolts. If indicated by analysis, install more robust mounts or add guys at 48 stacks.	Completed	
RV7	Kenan Labs Building: Large blower unit has corroded and undersized mounting bolts at support rail. High winds may dislodge the blower, damaging the unit and the roof.	Replace support legs at pitch pockets, replace support rail, install new isolators.	Completed	
RV9	Kenan Labs Building: HVAC units have rusty and inadequate attachment hardware and could be dismounted by high winds, damaging the units and the roof.	Remove existing corroded mounting brackets and install new, more robust brackets and fasteners.	Completed	
SV2	Thurston-Bowles Bldg: Trees above retaining wall, over driveway at west side of building, could topple in high winds and temporarily block driveway. Mitigate by trimming or cutting trees.	Cut back trees - remove large branches.	Completed	
CV1	Thurston-Bowles Bldg: Nearby buildings have roof systems that include loose stone ballast. During very high winds, ballast stone from MBR, NSRC or Tarrson may impact Thurston-Bowles, breaking windows. Mitigation depends on long-term University policy on reroofing options.	University to consider re-roofing policy regarding the use of stone-ballasted roofing systems.	Completed	

Item #	Vulnerability	Action	2020 Status	2020 Implementation Status Comments
CV1	Carmichael Residence Hall: Skylights are vulnerable to breakage by wind-driven roof gravel, creating a large opening for water entry into building.	1. Next Reroof: Non-gravel system $0. 2. Remove (16) trees closest to building, plus aggressive trimming at (10) others. $63,000. 3. Architectural Study: Replace building glass with impact- resistant glass. Study cost $25,000. Construction cost not estimated at this time.	Completed	
RV7	Carmichael Residence Hall: Need for proactive inspection, maintenance, repair, and replacement program.	Perform regular roof inspection and maintenance, and replace roof on time.	Completed	
RV4	Carmichael Residence Hall: Estimate 10% of coping sections have excessive spacing of fasteners and some missing fasteners. High winds can tear off loose coping sections, exposing wall assemblies to water entry and damage. Detached coping can damage other building parts.	Check all coping for proper attachment. Install new fasteners where missing or broken.	Completed	
RV1	Carmichael Residence Hall: Top hat of pipe vent can detach in high winds, damaging vent. Loose piece can damage other building parts.	Replace top hat at small pipe vents.	Completed	
RV3	Carmichael Residence Hall: Inadequate mount to penthouse. Aerial can detach in high wind, damaging aerial and its wiring, roof, or other building parts.	Aerial is reportedly no longer needed. Remove aerial and mounting hardware.	Completed	
RV2	Carmichael Residence Hall: Inadequate mount to roof. Condenser unit can topple over in high winds, damaging unit, mechanical lines, and roof.	Upgrade attachment hardware between unit and roof curb.	Completed	

G.7.2 Mitigation Action Plan

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.

Table G.55 comprises the mitigation action plan for UNCH-CH. Each mitigation action recommended for implementation is listed in these tables along with detail on the hazards addressed, the goal and objective addressed, the priority rating, the lead agency responsible for implementation, potential funding sources for the action, a projected implementation timeline, and the 2020 status and progress toward implementation for actions that were carried forward from the 2010 plan.

Table G.55 – Mitigation Action Plan, UNC-CH

Action #	Action Description	Hazard(s) Addressed	Goal & Objective Addressed	Priority	Mitigation Category	Lead Agency / Department	Estimated Cost	Potential Funding Source	Implementation Timeline	2020 Status	2020 Implementation Status Comments
UNC1	Campus-Wide – Major mechanical systems (HVAC equipment, heat pumps, chillers, generators, fuel tanks, gas cylinders, and boilers) should be anchored to their foundations. This includes, but is not limited to, the following campus buildings: CoGen; Lenoir; Woollen Gym; Kenan Labs Building; Thurston-Bowles Bldg; and MBR Bldg.	All Hazards	1.1	H	Property Protection	Facilities Department	$1,000-$65,000 per site	Operating Budget	2021-2026	Carry Forward	No progress has been made on this action. Pending further review and funding consideration
UNC2	Campus-Wide – Upgrade back-up power capabilities to critical facilities including, but not limited to: Woollen Gym.	All Hazards	1.2	M	Property Protection	Facilities Department	$25,000 per site	State/Federal Grants	2021-2026	Carry Forward	No progress has been made on this action. Inadequate Repair and Renovation funding.
UNC3	Campus-Wide – For critical facilities with a roof that is at or near the end of its service life, replace roof with one that has a continuous load path and provides increased resistance to wind and driving rain.	Hurricane, Tornado/ Thunderstorm	1.1	H	Structural Projects	Facilities Department	$480,000 per site	State/Federal Grants	2021-2026	Carry Forward	No progress has been made on this action. Inadequate Repair and Renovation funding.
UNC3	CoGen - Five aerials and two small monitoring units are mounted to the roof-edge handrails with inadequate or corroded mounts. High winds will detach this equipment. Upgrade mounts at aerials and small equipment that is mounted to rails.	Hurricane, Tornado/ Thunderstorm	1.1	H	Property Protection	Facilities Department	$2,000	Operating Budget	2021-2026	Carry Forward	No progress has been made on this action. Pending further review and funding consideration
UNC4	CoGen - The guyed stack is missing a guy wire on the west side, making it vulnerable to high winds from the west. Install an additional guy wire and guy anchor at west side of stack. Installation will require new framing for guy anchor.	Hurricane, Tornado/ Thunderstorm	1.1	H	Property Protection	Facilities Department	$7,000	Operating Budget	2021-2026	Carry Forward	No progress has been made on this action. Pending further review and funding consideration
UNC5	CoGen - Tall square ducts can be rocked by hand, and have under-deck mounts that are not rigid. They are vulnerable to being toppled by high winds. Rework and upgrade base attachments, or add guy wires to support upper part of vent stack.	Hurricane, Tornado/ Thunderstorm	1.1	H	Property Protection	Facilities Department	$12,000	Operating Budget	2021-2026	Carry Forward	No progress has been made on this action. Pending further review and funding consideration
UNC6	CoGen - The curtain walls are well-built and in good condition, but were designed under a more lenient Code. Due to the vast extent of glass on these large buildings, it is prudent to check their resistance to blow-out in high winds. Study Only: Engineering or architectural study to wind load capacity of existing glass and aluminum panels, compare to current Code requirements, estimate cost of upgraded panels, and determine cost/ benefit of upgrading panels.	Hurricane, Tornado/ Thunderstorm	1.1	H	Structural Projects	Facilities Department	$45,000	Operating Budget, State/ Federal Grants	2021-2026	Carry Forward	No progress has been made on this action. Pending further review and funding consideration
UNC7	CoGen - The loose roof ballast at the Boiler 8 building may be blown off during very high winds and break glass curtain wall panels at the new Boiler and Turbine buildings. During next re-roof, use roof system that does not require loose ballast rock.	Hurricane, Tornado/ Thunderstorm	1.1	H	Property Protection	Facilities Department	n/a	Operating Budget	2021-2026	Carry Forward	No progress has been made on this action. Pending further review and funding consideration
UNC8	CoGen - The white metal wall panels at penthouse and at south addition have insufficient fasteners attaching the panels to the girts. Many girts have been weakened by notch cuts to accommodate the cross- bracing. The wall panels are vulnerable to tear-off in high winds. Repair existing notched girts and add additional girts and fasteners at metal wall panel assemblies.	Hurricane, Tornado/ Thunderstorm	1.1	M	Property Protection	Facilities Department	$28,000	Operating Budget	2021-2026	Carry Forward	No progress has been made on this action. Pending further review and funding consideration
UNC9	Lenoir - Gaps between slate and coping at gable details make perimeter slate vulnerable to water infiltration and loss of slates during high winds. Rework perimeter detail to include flashing under edge slates.	Hurricane, Tornado/ Thunderstorm	1.1	H	Property Protection	Facilities Department	$12,000	Operating Budget	2021-2026	Carry Forward	No progress has been made on this action. Inadequate Repair and Renovation funding.
UNC10	Smith Arena - Loose and corroded fasteners at metal roof eaves, swege laps, and transition flashings reduce security of roof panels, making them vulnerable to leaks and tear-off during high winds. Walk every screw-fastened seam. Tighten loose screws, replace rusty or missing screws.	Hurricane, Tornado/ Thunderstorm	1.1	H	Property Protection	Facilities Department	$12,000	Operating Budget	2021-2026	Carry Forward	No progress has been made on this action. Inadequate Repair and Renovation funding.

Action #	Action Description	Hazard(s) Addressed	Goal & Objective Addressed	Priority	Mitigation Category	Lead Agency / Department	Estimated Cost	Potential Funding Source	Implementation Timeline	2020 Status	2020 Implementation Status Comments
UNC11	Smith Arena - Connections at lower chords of pipe arches are improperly built and have less strength and stability than intended by the design. Design upgrade to existing sleeve connections. Fabricate and install new connection parts at eight lower-chord supports for pipe arches.	Flood	1.1	H	Structural Projects	Facilities Department	$52,000	Operating Budget, Federal/ State Grants	2021-2026	Carry Forward	No progress has been made on this action. Inadequate Repair and Renovation funding.
UNC12	Smith Arena - Fabric panel edges are tied to steel cables with thousands of plastic wire ties. Wire ties are not reliable over the long term and increase the vulnerability of the fabric roof to wind damage. Procure and install proper connection ties between fabric panel grommets and adjacent catenary cables.	Hurricane, Tornado/ Thunderstorm	1.1	H	Property Protection	Facilities Department	$9,000	Operating Budget	2021-2026	Carry Forward	No progress has been made on this action. Inadequate Repair and Renovation funding.
UNC13	Smith Arena - Due to the age of the fabric roof, the system requires specialty inspection to ensure that the fabric, seams, and detailing remain in adequate condition to resist high wind loads. Degradation of the fabric roof components will result in vulnerability to failure during high winds. Specialty inspection of fabric roof panels, sleeves, seams, and grommets for material degradation by age and sunlight.	Hurricane, Tornado/ Thunderstorm	1.1	H	Property Protection	Facilities Department	$9,000	Operating Budget	2021-2026	Carry Forward	No progress has been made on this action. Inadequate Repair and Renovation funding.
UNC14	Smith Arena - No secondary drains. If primary drains are blocked or overwhelmed, water will back up in gutters and leak into the building at the parapet flashings. Water damage will reduce the uplift resistance of the single-ply. Install secondary drain system or scuppers at parapet walls.	Flood, Hurricane, Tornado/ Thunderstorm	1.1	M	Structural Projects	Facilities Department	$190,000	Operating Budget, Federal/ State Grants	2021-2026	Carry Forward	No progress has been made on this action. Inadequate Repair and Renovation funding.
UNC15	Smith Arena - 12'-3" by 4'-5" windows of 5/16" plate glass likely do not meet current Code requirements for wind loading, and may blow out during a Code wind event. Progressive loss of windows is a possibility. Study: Perform engineering study on wind loading capacity for existing windows. Determine failure windspeed. Compile costs for window upgrade options. Determine cost/benefit for installing stronger window assemblies.	Hurricane, Tornado/ Thunderstorm	1.1	M	Structural Projects	Facilities Department	$14,000	Operating Budget	2021-2026	Carry Forward	No progress has been made on this action. Inadequate Repair and Renovation funding.
UNC16	Smith Arena - Steel fuel lines are elevated above tank and are exposed to damage by wind-driven debris. Install protective guard around exposed section of fuel line.	Hurricane, Tornado/ Thunderstorm	1.1	M	Property Protection	Facilities Department	$4,000	Operating Budget	2021-2026	Carry Forward	No progress has been made on this action. Inadequate Repair and Renovation funding.
UNC17	Woollen Gym - Trusses have slender members and long spans with minimal bracing and may fail under high wind loads. Structural analysis of barrel roof trusses, to determine factor of safety under Code-mandated wind loads. Design of structural upgrades for trusses.	Hurricane, Tornado/ Thunderstorm	1.1	H	Structural Projects	Facilities Department	$65,000	Operating Budget, Federal/ State Grants	2021-2026	Carry Forward	No progress has been made on this action. Inadequate Repair and Renovation funding.
UNC18	Woollen Gym - Age and condition of metal roof panels and deck makes roof vulnerable to damage and blow-off during high wind leading to water entry, damage, and possible ceiling collapse. Replace roof system at main gym high-house and natatorium high- house.	Hurricane, Tornado/ Thunderstorm	1.1	H	Structural Projects	Facilities Department	$450,000	Federal/State Grants	2021-2026	Carry Forward	No progress has been made on this action. Inadequate Repair and Renovation funding.
UNC19	Woollen Gym - Large expanse of glass is vulnerable to wind blown debris from adjacent roofs and buildings during high winds and exposes the building interior to water entry and damage. Architectural study for upgrading or replacing glass roof skylight at natatorium.	Hurricane, Tornado/ Thunderstorm	1.1	H	Property Protection	Facilities Department	$50,000	Operating Budget, State/ Federal Grants	2021-2026	Carry Forward	No progress has been made on this action. Inadequate Repair and Renovation funding.
UNC20	Woollen Gym - Unreinforced, 71-year-old brick masonry wall with unbraced vertical span of 31'. Vulnerable to blow- in from wind pressure during severe windstorm. Structural analysis of masonry wall to determine factor of safety under Code wind level. Design of repairs or upgrades as required.	Hurricane, Tornado/ Thunderstorm	1.1	H	Property Protection	Facilities Department	$25,000	Operating Budget	2021-2026	Carry Forward	No progress has been made on this action. Inadequate Repair and Renovation funding.
UNC21	Woollen Gym - Unreinforced, 66-year-old brick masonry wall with unbraced vertical span of 24'. Vulnerable to blow- in from wind pressure during severe windstorm. Structural analysis of masonry wall to determine factor of safety under Code wind level. Design of repairs or upgrades as required.	Hurricane, Tornado/ Thunderstorm	1.1	H	Property Protection	Facilities Department	$25,000	Operating Budget	2021-2026	Carry Forward	No progress has been made on this action. Inadequate Repair and Renovation funding.

Action #	Action Description	Hazard(s) Addressed	Goal & Objective Addressed	Priority	Mitigation Category	Lead Agency / Department	Estimated Cost	Potential Funding Source	Implementation Timeline	2020 Status	2020 Implementation Status Comments
UNC22	Woollen Gym - Large satellite dish has undersized and corroded mounts. Failure of the mounts during high winds would cause damage to both the roof system and the dish. Install new dish mounts.	Hurricane, Tornado/ Thunderstorm	1.1	M	Property Protection	Facilities Department	$3,000	Operating Budget	2021-2026	Carry Forward	No progress has been made on this action. Inadequate Repair and Renovation funding.
UNC23	Woollen Gym - Unreinforced, 71-year-old brick masonry wall with no bracing. Mortar deteriorated on both sides. Vulnerable to push-over in severe windstorm. Failure of parapet could lead to failure of south wall and hole in barrel roof. Repair face brick and repoint mortar. Install parapet bracing.	Hurricane, Tornado/ Thunderstorm	1.1	M	Property Protection	Facilities Department	$22,000	Operating Budget	2021-2026	Carry Forward	No progress has been made on this action. Inadequate Repair and Renovation funding.
UNC24	Woollen Gym - Large fragile 54-pane frames with swing-sashes. Vulnerable to breakage by flying slate from Women's Gym, glass panes from pool roof, and roof gravel from Fetzer. Vulnerable to blow-in from wind pressure during severe windstorm. Architectural study for replacing window frames and glazing.	Hurricane, Tornado/ Thunderstorm	1.1	M	Property Protection	Facilities Department	$40,000	Operating Budget, State/ Federal Grants	2021-2026	Carry Forward	No progress has been made on this action. Inadequate Repair and Renovation funding.
UNC25	Woollen Gym - Large 9-pane frames positioned just above grade. Vulnerable to breakage by debris blowing across ground. Architectural study for replacing window frames and glazing.	Hurricane, Tornado/ Thunderstorm	1.1	M	Property Protection	Facilities Department	$40,000	Operating Budget, State/ Federal Grants	2021-2026	Carry Forward	No progress has been made on this action. Inadequate Repair and Renovation funding.
UNC26	Woollen Gym - Large fragile 48-pane frames positioned just above grade. Vulnerable to breakage by debris blowing across parking lot. Architectural study for replacing window frames and glazing.	Hurricane, Tornado/ Thunderstorm	1.1	M	Property Protection	Facilities Department	$40,000	Operating Budget, State/ Federal Grants	2021-2026	Carry Forward	No progress has been made on this action. Inadequate Repair and Renovation funding.
UNC27	Woollen Gym - Several windows within range of tree branches. Vulnerable to breakage by tree damage during high winds. Architectural study for replacing window frames and glazing.	Hurricane, Tornado/ Thunderstorm	1.1	M	Property Protection	Facilities Department	$40,000	Operating Budget, State/ Federal Grants	2021-2026	Carry Forward	No progress has been made on this action. Inadequate Repair and Renovation funding.
UNC28	Woollen Gym - West wall of main gym includes 12 large, fragile windows assemblies, each with 54 panes. Broken glass during severe windstorm will hamper use of exits at this wall. Architectural study for replacing window frames and glazing.	Hurricane, Tornado/ Thunderstorm	1.1	M	Property Protection	Facilities Department	$30,000	Operating Budget, State/ Federal Grants	2021-2026	Carry Forward	No progress has been made on this action. Inadequate Repair and Renovation funding.
UNC29	Woollen Gym - Six exits from main gym empty into narrow alley. Exit path is below large windows at main gym's west wall, and adjacent to glass roof and ridge monitor at natatorium. Alley may be strewn with broken glass during a severe windstorm and be impassable, blocking exit and emergency access for main gym. Architectural study for proving overhead protection for alley.	Hurricane, Tornado/ Thunderstorm	1.1	M	Property Protection	Facilities Department	$30,000	Operating Budget, State/ Federal Grants	2021-2026	Carry Forward	No progress has been made on this action. Inadequate Repair and Renovation funding.
UNC30	Kenan Labs Building - Pedestrian escape routes away from Kenan are difficult, especially those at the east. These include exterior elevated walkways with stairs, and require entry into other buildings through exterior doors. Evacuation drills and building signage would improve site evacuation after a windstorm or other natural disaster. Install signage along exterior escape routes. Improve signage inside of Kenan. At lockable door at Caudill ground floor, install alarm/ panic entry on Kenan side. Encourage department to hold evacuation drills.	All Hazards	1.2	H	Emergency Services	Facilities Department	$12,000	Operating Budget	2021-2026	Carry Forward	No progress has been made on this action. Inadequate Repair and Renovation funding.
UNC31	Kenan Labs Building - Emergency crews will have difficult vehicle access to Kenan due to limited routes and constricted access lanes. Site training by responders would improve emergency access after a windstorm or other natural disaster. Coordinate with local responders and encourage preplanning and vehicle access and rescue drills, to make responders more familiar with Kenan's site layout.	All Hazards	1.2	H	Emergency Services	Facilities Department	n/a	Operating Budget	2021-2026	Carry Forward	No progress has been made on this action. Inadequate Repair and Renovation funding.
UNC32	Kenan Labs Building - At courtyard north of Towers B & C, landscaping gravel could be driven by high winds to break glass at ground floor windows and doors. Install concrete pavers at graveled area.	Hurricane, Tornado/ Thunderstorm	1.1	M	Property Protection	Facilities Department	$24,000	Operating Budget	2021-2026	Carry Forward	No progress has been made on this action. Inadequate Repair and Renovation funding.

Action #	Action Description	Hazard(s) Addressed	Goal & Objective Addressed	Priority	Mitigation Category	Lead Agency / Department	Estimated Cost	Potential Funding Source	Implementation Timeline	2020 Status	2020 Implementation Status Comments
UNC33	Thurston-Bowles Bldg - Unanchored metal tables could shift and topple in high winds, blocking exit routes along the east side of the building. Mitigate by anchoring tables to plaza. As described for UNC50	Hurricane, Tornado/ Thunderstorm	1.1	H	Property Protection	Facilities Department	n/a	Operating Budget	2021-2026	Carry Forward	No progress has been made on this action. Inadequate Repair and Renovation funding.
UNC34	Thurston-Bowles Bldg - Inadequate bolts at base. Crane is corroded and in poor condition. Unit and/or crane could blow off during high winds damaging unit, roof, and penthouse. Remove crane and discard. Install additional mounting fasteners and hardware to secure blower to penthouse roof.	Hurricane, Tornado/ Thunderstorm	1.1	H	Property Protection	Facilities Department	$1,000	Operating Budget	2021-2026	Carry Forward	No progress has been made on this action. Inadequate Repair and Renovation funding.
UNC35	Thurston-Bowles Bldg - Loose and missing fasteners at inside face of coping. Coping could blow off allowing water entry into masonry wall. Install additional fasteners.	Hurricane, Tornado/ Thunderstorm	1.1	H	Property Protection	Facilities Department	$750	Operating Budget	2021-2026	Carry Forward	No progress has been made on this action. Inadequate Repair and Renovation funding.
UNC36	Thurston-Bowles Bldg - Damaged counterflashing and fastener spacing at termination bar and counterflashing in excess of 8". Flashings could blow off causing water entry and damage to roof system. Replace damaged counterflashing and add fasteners where spacing exceeds 8".	Hurricane, Tornado/ Thunderstorm	1.1	H	Property Protection	Facilities Department	$7,500	Operating Budget	2021-2026	Carry Forward	No progress has been made on this action. Inadequate Repair and Renovation funding.
UNC37	Thurston-Bowles Bldg - Raised edge detail is canted inward increasing vulnerability of detail to wind loads and water entry. Refasten and seal canted edge.	Hurricane, Tornado/ Thunderstorm	1.1	H	Property Protection	Facilities Department	$3,000	Operating budget	2021-2026	Carry Forward	No progress has been made on this action. Inadequate Repair and Renovation funding.
UNC38	Thurston-Bowles Bldg - Metal tables with rigid umbrellas are unanchored, and high winds could drive the tables into the storefront windows and doors at the cafeteria. Anchoring the tables would mitigate this hazard. Secure metal tables to plaza deck. Replace metal umbrellas with lighter, foldable fabric umbrellas.	Hurricane, Tornado/ Thunderstorm	1.1	H	Property Protection	Facilities Department	$10,000	Operating Budget	2021-2026	Carry Forward	No progress has been made on this action. Inadequate Repair and Renovation funding.
UNC39	Thurston-Bowles Bldg - Corroded cabinet and mounting screws. Cabinets could overturn or come loose during high winds, damaging the cabinet, roof, and electrical connections within. Clean and coat corroded steel panels. Install additional fasteners at base.	Hurricane, Tornado/ Thunderstorm	1.1	H	Property Protection	Facilities Department	$14,000	Operating Budget	2021-2026	Carry Forward	No progress has been made on this action. Inadequate Repair and Renovation funding.
UNC40	Thurston-Bowles Bldg - Corroded isolators and fasteners at mounts. Units could become dismounted during high winds, damaging the units, roof, and support frames. Clean and coat mounting frames. Replace isolators. Replace all fasteners with stainless.	Hurricane, Tornado/ Thunderstorm	1.1	H	Property Protection	Facilities Department	$110,000	Operating Budget, State/ Federal Grants	2021-2026	Carry Forward	No progress has been made on this action. Inadequate Repair and Renovation funding.
UNC41	Thurston-Bowles Bldg - Fuel lines near tank are exposed to damage from flying debris during high winds. Mitigate by re- routing or protecting the lines. Install shields for fuel lines near tank.	Hurricane, Tornado/ Thunderstorm	1.1	M	Structural Projects	Facilities Department	$4,000	Operating Budget	2021-2026	Carry Forward	No progress has been made on this action. Inadequate Repair and Renovation funding.
UNC42	Thurston-Bowles Bldg - Old-style roll-up metal door are notorious for failing during high winds. Inspect the door and determine its wind rating (if any). Inspect door for wind rating. Inspect anchorage of door frame. Possibly replace with door of modern wind rating.	Hurricane, Tornado/ Thunderstorm	1.1	M	Property Protection	Facilities Department	$1,000	Operating Budget	2021-2026	Carry Forward	No progress has been made on this action. Inadequate Repair and Renovation funding.
UNC43	MBR Bldg - The MBR roof system includes large ballast stone and a very low parapet. During very high winds, stone could be blown off the roof and impact and break windows. Mitigation depends on overall University roofing strategy. Same as for UNC58.	Hurricane, Tornado/ Thunderstorm	1.1	H	Property Protection	Facilities Department	n/a	Operating Budget	2021-2026	Carry Forward	No progress has been made on this action. Inadequate Repair and Renovation funding.
UNC44	MBR Bldg - Ballast in-place may not be adequate to resist required code wind loads with the current materials, building height, and parapet conditions (SPRI/ ANSI standard). High winds could cause scour of ballast, displacement of insulation, or blow-off of ballast and protective components from the roof system. ENGINEERING STUDY prior to replacement of ballast stone: Make a detailed analysis of wind uplift forces near edges, corners, and field. Determine if existing stone ballast is adequate, and to what windspeed.	Hurricane, Tornado/ Thunderstorm	1.1	H	Property Protection	Facilities Department	$25,000	Operating Budget, State/ Federal Grants	2021-2026	Carry Forward	No progress has been made on this action. Inadequate Repair and Renovation funding.

Action #	Action Description	Hazard(s) Addressed	Goal & Objective Addressed	Priority	Mitigation Category	Lead Agency / Department	Estimated Cost	Potential Funding Source	Implementation Timeline	2020 Status	2020 Implementation Status Comments
UNC45	MBR Bldg - Areas of main roof show wind scour of ballast, reducing wind uplift resistance, exposing geotextile fabric to UV, and allowing displacement of protective insulation. Redistribute existing ballast over bare areas.	Hurricane, Tornado/ Thunderstorm	1.1	H	Property Protection	Facilities Department	$500	Operating Budget	2021-2026	Carry Forward	No progress has been made on this action. Inadequate Repair and Renovation funding.
UNC46	MBR Bldg - Infill stud walls are not reliably attached to steel framing at penthouse. Stud walls are vulnerable to blow-in during high winds, with resulting equipment and water damage within penthouse. Add fasteners between bottom plate of stud wall and support curb, and between top plate and spandrel beam.	Hurricane, Tornado/ Thunderstorm	1.1	H	Property Protection	Facilities Department	$13,000	Operating Budget	2021-2026	Carry Forward	No progress has been made on this action. Inadequate Repair and Renovation funding.
UNC47	MBR Bldg - Need for proactive inspection, maintenance, repair, and replacement program. Perform regular roof inspection and maintenance, and replace roof on schedule.	Hurricane, Tornado/ Thunderstorm	1.1	H	Property Protection	Facilities Department	n/a	Operating Budget	2021-2026	Carry Forward	No progress has been made on this action. Inadequate Repair and Renovation funding.
UNC48	MBR Bldg - Operable decorative metal grille panels provide emergency firefighter access at stair landings. Panels are poorly mounted and have inadequate pin latches. High winds could open grille or dislodge its frame, creating hazard for people using the stairs. Install additional and more robust mounting bolts between panel frame and masonry wall. Install additional quick-release pin latches at exterior for firefighter use.	Hurricane, Tornado/ Thunderstorm	1.1	H	Property Protection	Facilities Department	$34,000	Operating Budget, State/ Federal Grants	2021-2026	Carry Forward	No progress has been made on this action. Inadequate Repair and Renovation funding.
UNC49	MBR Bldg - Lightning protection cable has detached from metal panels at multiple locations and may affect proper performance of the system, or cause damage during high wind events. Repair broken cable mounts.	Hurricane, Tornado/ Thunderstorm	1.1	M	Property Protection	Facilities Department	$2,500	Operating Budget	2021-2026	Carry Forward	No progress has been made on this action. Inadequate Repair and Renovation funding.
UNC50	MBR Bldg - Downspouts are minimally secured to the adjacent penthouse walls and could come loose in high wind events causing damage to adjacent roof system and pedestrians below. Install additional downspout mounts.	Hurricane, Tornado/ Thunderstorm	1.1	M	Property Protection	Facilities Department	$1,000	Operating Budget	2021-2026	Carry Forward	No progress has been made on this action. Inadequate Repair and Renovation funding.
UNC51	MBR Bldg - Wood fins and metal parts could be dislodged by high winds, producing wind-blown debris at main exit area. The pergola and its parts should be inspected for proper connections and sound parts. Inspect decorative hardware at top of pergola. Improve connections as required to make parts secure.	Hurricane, Tornado/ Thunderstorm	1.1	L	Property Protection	Facilities Department	$4,700	Operating Budget	2021-2026	Carry Forward	No progress has been made on this action. Inadequate Repair and Renovation funding.
UNC52	MBR Bldg - Fuel lines, conduits, and utility equipment at fuel tank are exposed to damage from wind-blown debris. Re-routing or protective guards would mitigate these hazards. Install protective guards around fuel lines, conduits, and electrical boxes at and near fuel tank	Hurricane, Tornado/ Thunderstorm	1.1	L	Property Protection	Facilities Department	$8,000	Operating Budget	2021-2026	Carry Forward	No progress has been made on this action. Inadequate Repair and Renovation funding.
UNC53	Carmichael Residence Hall - Window walls at stairs are vulnerable to wind-driven roof gravel and tree parts, and to falling trees. Broken glass walls will hamper egress down stairs and cause interior water damage. 1. Next Reroof: Non-gravel system $0. 2. Remove (16) trees closest to building, plus aggressive trimming at (10) others. $63,000. 3. Architectural Study: Replace building glass with impact- resistant glass. Study cost $25,000. Construction cost not estimated at this time.	Hurricane, Tornado/ Thunderstorm	1.1	H	Property Protection	Facilities Department	$88,000	Operating Budget, Federal/ State Grants	2021-2026	Carry Forward	No progress has been made on this action. Inadequate Repair and Renovation funding.
UNC54	Carmichael Residence Hall - Large expanse of glass is within fall shadows of tall oaks. During high winds, the window wall is likely to be broken by wind-driven tree parts or falling trees. Will hamper building egress and cause interior water damage. 1. Next Reroof: Non-gravel system $0. 2. Remove (16) trees closest to building, plus aggressive trimming at (10) others. $63,000. 3. Architectural Study: Replace building glass with impact- resistant glass. Study cost $25,000. Construction cost not estimated at this time.	Hurricane, Tornado/ Thunderstorm	1.1	H	Property Protection	Facilities Department	$88,000	Operating Budget, Federal/ State Grants	2021-2026	Carry Forward	No progress has been made on this action. Inadequate Repair and Renovation funding.

Action #	Action Description	Hazard(s) Addressed	Goal & Objective Addressed	Priority	Mitigation Category	Lead Agency / Department	Estimated Cost	Potential Funding Source	Implementation Timeline	2020 Status	2020 Implementation Status Comments
UNC55	Carmichael Residence Hall - Exhaust pipe makes a horizontal run from building, supported by a single stanchion. Pipe is exposed to damage from falling tress and wind-driven debris. Re-route exhaust pipe or construct protective guard.	Hurricane, Tornado/ Thunderstorm	1.1	H	Property Protection	Facilities Department	$18,000	Operating Budget	2021-2026	Carry Forward	No progress has been made on this action. Inadequate Repair and Renovation funding.
UNC56	Carmichael Residence Hall - Rear building exits lead to difficult escape route. Rear site is narrow, with steep grade and many trees. Fences limit escape options. Entire area likely to be impassable after a severe wind storm, making the four rear exits at building ineffective. Landscape Architectural Study/ Design/ Costing: Design exit routing for north side of site, and rework stairs and ramp at south	All Hazards	1.1	H	Emergency Services	Facilities Department	$65,000	Operating Budget, State/ Federal Grants	2021-2026	Carry Forward	No progress has been made on this action. Inadequate Repair and Renovation funding.
UNC57	Carmichael Residence Hall - Front exit/access routes are an exterior stair and a narrow ramp. No vehicle access for emergency and repair equipment. Both will likely be blocked by fallen trees after a severe windstorm, hampering pedestrian escape routes. side for better emergency routing for pedestrians and vehicles. Study/ Design cost $65,000. Construction cost not estimated at this time.	All Hazards	1.1	H	Emergency Services	Facilities Department	$65,000	Operating Budget, State/ Federal Grants	2021-2026	Carry Forward	No progress has been made on this action. Inadequate Repair and Renovation funding.
UNC58	Carmichael Residence Hall - Isolated fascia/edge metal sections are loose. High winds can tear off loose flashing, precipitate a failure of the adjacent roof system, and expose roof and wall assemblies to water entry and damage. Check all fascia and edge metal for coping for proper attachment. Install new fasteners where missing or broken.	Hurricane, Tornado/ Thunderstorm	1.1	M	Emergency Services	Facilities Department	$1,700	Operating Budget, State/ Federal Grants	2021-2026	Carry Forward	No progress has been made on this action. Inadequate Repair and Renovation funding.
UNC59	Carmichael Residence Hall - Face width of single-piece metal fascia exceeds 8" making it vulnerable to wind damage. Fascia sections that tear off in high winds can precipitate a failure in the adjacent roof system, and expose roof and wall assemblies to water entry and damage. Cut metal fascia to 8" width or less.	Hurricane, Tornado/ Thunderstorm	1.1	L	Property Protection	Facilities Department	$2,100	Operating Budget	2021-2026	Carry Forward	No progress has been made on this action. Inadequate Repair and Renovation funding.
UNC60	Assess auxiliary power and water intrusion prevention capacity and conditions for critical campus infrastructure and building, and where necessary, retrofit critical facilities with emergency generators, generator hook-ups, and/or leak detectors for improved resilience to all hazards.	All Hazards	1.1	H	Property Protection	Facilities Department	To be determined	Operating Budget, State/ Federal Grants	2021-2026	New	
UNC61	Implement actions to establish and/or enhance public information and education activities and programs that promote community awareness of natural hazards and mitigation techniques available for them to employ to minimize the impact of such hazards on people, property, and the environment.	All Hazards	2.1	H	Public Education & Awareness	Facilities Department	To be determined	Operating Budget	2021-2026	New	
UNC62	Identify and implement systems and measures to improve drainage throughout campus to avoid nuisance flooding in older campus buildings, roads, and parking lots. This includes improved building drainage and roofing systems.	All Hazards	1.1	H	Structural Projects	Facilities Department	To be determined	Operating Budget, State/ Federal Grants	2021-2026	New	

THE UNIVERSITY OF NORTH CAROLINA SYSTEM

UNC System Eastern Campuses Regional Hazard Mitigation Plan

Annex H: University of North Carolina at Pembroke

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Annex H University of North Carolina - Pembroke

This section provides planning process, campus profile, hazard risk, vulnerability, capability, and mitigation action information specific to University of North Carolina at Pembroke (UNC-P). This section contains the following subsections:

- H.1 Planning Process Details
- H.2 Campus Profile
- H.3 Asset Inventory
- H.4 Hazard Identification
- H.5 Hazard Profiles, Analysis, and Vulnerability
- H.6 Capability Assessment
- H.7 Mitigation Strategy

H.1 PLANNING PROCESS DETAILS

The table below lists the HMPC members who represented UNC-P during the planning process.

Table H.1 – HMPC Members

Representative	Role; Department
Travis Bryant	Associate Vice Chancellor for Campus Safety & Emergency Operations; Student Affairs
McDuffie Cummings	Chief/Director; Police and Public Safety
Michael Bullard	Environmental Health and Safety Professional; Environmental Health & Safety
Cora Bullard	Director, Student Health Services
Annie Angueira	Assistant Vice Chancellor for Facilities; Facilities Management
Dr. Scott Billingsley	Associated Provost; Academic Affairs
Paul O'Neil	Senior Associate Director; Athletics
Katina Blue	Associate Vice Chancellor for Information Resources, Chief Information Officer; Division of Information Technology
Paul Posener	Director; Housing and Residence Life
Mark Vesely	Director of Operations and Maintenance; Facilities Management
Charles Chavis	Environmental Health and Safety Professional; Environmental Health and Safety

Coordination with Other Community Planning Efforts and Hazard Mitigation Activities

The table below lists campus and community resources referenced throughout the planning process and used in the plan development.

Table H.2 – Summary of Existing Studies and Plans Reviewed

Resource Referenced	Use in this Plan
UNC-P Campus Master Plan	The UNC-P Campus Master Plan, developed in 2011, was referenced for the Campus Profile in Section H.2 as well as the Capability Assessment in Section H.6
Town of Pembroke Comprehensive Plan	The Comprehensive Plan developed by the Pembroke Planning and Zoning Department was referenced for the Campus Profile in Section H.2.
Robeson County and Incorporated Areas Flood Insurance Study (FIS), Revised 12/06/2019	The FIS report was referenced in the preparation of flood hazard profile in Section H.5.

Resource Referenced	Use in this Plan
UNC Pembroke Pre-Disaster Mitigation Plan, 2011	The previous UNC-P Pre-Disaster Mitigation Plan was used in preparation of the hazard profiles in Section H.5. The plan was additionally used to track implementation progress (Section 2) and develop the mitigation plan (Section 7).
Robeson County Multi-Jurisdictional Hazard Mitigation Plan, January 2017	The Robeson County Multi-Jurisdictional Hazard Mitigation Plan was referenced in compiling the Hazard Identification and Risk Assessment in Section H.5.

H.2 CAMPUS PROFILE

This section provides a general overview of the University of North Carolina at Pembroke (UNC-P) campus and area of concern to be addressed in this plan. It consists of the following subsections:

- Location and Setting
- Geography and Climate
- History
- Cultural and Natural Resources
- Land Use
- Population and Demographics
- Social Vulnerability
- Growth and Development Trends

H.2.1 Location and Setting

The University of North Carolina at Pembroke is in Pembroke, North Carolina. Pembroke is the historic home of UNCP and the Lumbee Tribe of North Carolina. Along with having a rich American Indian history, it is also one of the safest campuses in the University of North Carolina (UNC) System. The Town of Pembroke is convenient to most metro areas in North Carolina and nearby states, coastal beaches in the East, mountains in the West, and the famous golf courses of Pinehurst.

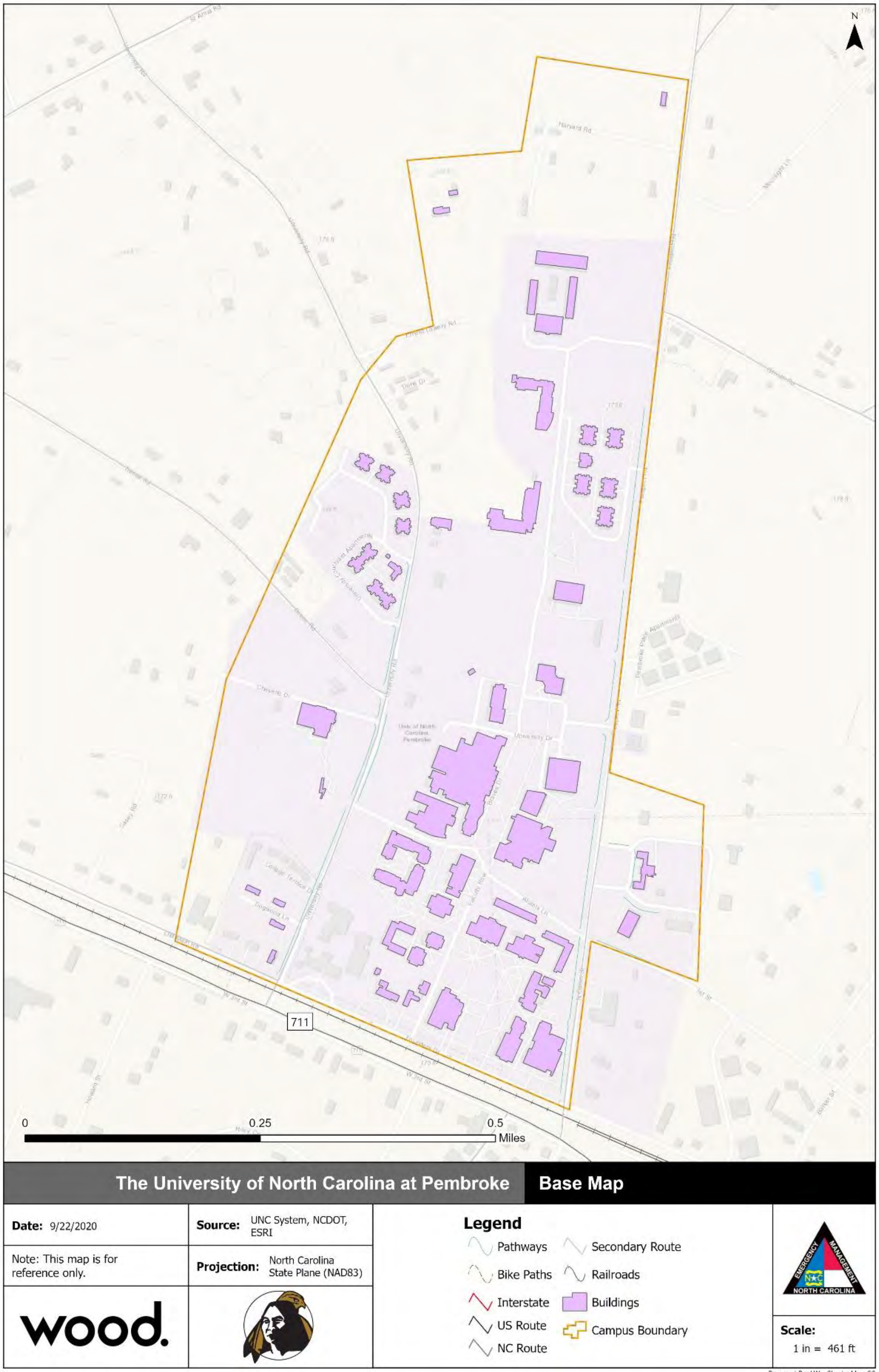
UNCP has a campus size of 281 acres and consists of more than 49 buildings. It has grown significantly over the last decade and offers 41 undergraduate degrees and 18 graduate degree programs throughout 26 different departments. UNCP also has more than 100 student organizations, along with 35 intramural and club sports programs and 13 Division II varsity teams, which help cater to any area of interest a student may have, whether it be political, athletic, professional, social, ethnic, or academic. UNCP is known for small classes, close interaction with faculty, community involvement, and diversity.

The Office for Community and Civic Engagement coordinates volunteer and service-learning opportunities for students. During the 2019-2020 academic year, UNC Pembroke students dedicated approximately 29,620 service hours through service-learning and co-curricular volunteering. This has an in-kind value estimated at more than $753,236 in the community.

The University is located approximately 10 miles from the intersection of Interstate 95 and US Highway 74 in Lumberton. UNCP has a partnership with South East Area Transit System (SEATS) to provide transportation to and from campus along with key locations in Pembroke for students, faculty, and staff. Other modes of transportation offered on campus include a shuttle service and bicycle rental program. The campus even has car charging stations for Plug-In Electric Vehicles (PEV).

Figure H.1 provides a base map of the campus. For more details on campus buildings and critical facilities, see Section H.3.

Figure H.1 – UNC-P Campus Base Map



H.2.2 Geography and Climate

The University of North Carolina at Pembroke is in Pembroke, in the southern part of North Carolina's Inner Coastal Plain region. Pembroke has an elevation of 171 feet above sea level and UNCP’s campus is largely flat with a few rolling hills. Pembroke has a moderate climate with temperatures dropping to 32 degrees Fahrenheit on average in January and climbing to 90 degrees Fahrenheit on average in July. The annual precipitation for the Town is approximately 46 inches per year.

H.2.3 History

On March 7, 1887, the General Assembly of North Carolina enacted legislation, sponsored by Representative Hamilton McMillan of Robeson County, to create the Croatan Normal School. The law, which was in response to a petition from the Indian people of the area, established a Board of Trustees and appropriated $500 to be used only for salaries. Local people constructed a building at a site approximately one mile west of the present location.

The school opened with 15 students and one teacher in the fall of 1887. The normal school was founded to train American Indian public-school teachers. For many years, the instruction was at the elementary and secondary levels, and the first diploma was awarded in 1905.

The school moved to its present location in Pembroke, the center of the Indian community, in 1909. The General Assembly changed the name of the institution in 1911 to the Indian Normal School of Robeson County, and again in 1913 to the Cherokee Indian Normal School of Robeson County. In 1926 the Board of Trustees added a two-year normal program beyond high school and phased out elementary instruction. The first 10 diplomas were awarded in 1928 when the state accredited the school as a "standard normal school."

Additional college classes were offered beginning in 1931, and, in 1939, a fourth year was added with the first degrees conferred in 1940. In recognition of its new status, the General Assembly changed the name of the school in 1941 to Pembroke State College for Indians. Until 1953 it was the only state-supported four-year college for Indians in the nation. The scope of the institution was widened in 1942 when non-teaching baccalaureate degrees were added, and in 1945 when enrollment, previously limited to the Indians of Robeson County, was opened to people from all federally recognized Indian groups. A few years later in 1949 the General Assembly shortened the name to Pembroke State College.

The Board of Trustees approved the admission of white students up to 40 percent of the total enrollment in 1953 and, following the Supreme Court's school desegregation decision, opened the college to all qualified applicants without regard to race in 1954. Growth of more than 500 percent followed during the next eight years. In 1969 the General Assembly changed the name again to Pembroke State University and made the institution a regional university. Such universities were authorized "to provide undergraduate and graduate instruction in liberal arts, fine arts, and science, and in the learned professions, including teaching" and to "provide other graduate and undergraduate programs of instruction as are deemed necessary to meet the needs of their constituencies and of the state."

Three years later in 1972 the General Assembly established the 17-campus University of North Carolina with Pembroke State University as one of the constituent institutions. The Board of Governors approved the implementation of master's programs in professional education at Pembroke State University in 1978 as well as several new undergraduate programs. Since that time, additional baccalaureate programs have been added, including nursing. Master's level programs have been implemented in business administration, public administration, and school and service agency counseling.

The University of North Carolina at Pembroke celebrated its centennial in 1987. On July 1, 1996, Pembroke State University officially became The University of North Carolina at Pembroke.

In 2000 a major in applied physics and four new Master of Arts programs were added. An office of International Programs and the Esther G. Maynor Honors College were also instituted to enhance scholarship. Since then, the University has added new baccalaureate programs, including Spanish and environmental science, as well as new graduate degrees, including the Master of School Administration (M.S.A.) and the Master of Arts in Teaching (M.A.T.). Many classes at the undergraduate and graduate levels are available through distance learning, including the Internet.

On July 5, 2005, North Carolina Gov. Mike Easley signed into law Session Law 2005-153, which declared The University of North Carolina at Pembroke as "North Carolina's Historically American Indian University."

Between March 2012 and May 2013, the university celebrated the 125th anniversary of its founding.

Robin Gary Cummings, M.D., took office as the sixth Chancellor of The University of North Carolina at Pembroke in July 2015 after being elected by the Board of Governors of the 17-campus University of North Carolina System. Over the past five years, UNCP has increased access to a high-quality education through the NC Promise Tuition Plan, expanded academic opportunities through institutional partnerships, enhanced the university's role in regional economic development and set records for philanthropic giving.

H.2.4 Cultural and Natural Resources

National Register of Historic Places

There are two listings in the National Register of Historic Places for Pembroke. These listings are the Old Main building on UNCP's campus and the former Pembroke High School.

Natural Features and Resources

The Town of Pembroke is responsible for approximately 45 acres of parks and open space. UNCP's campus even includes a water feature comprised of 1 acre of water and an amphitheater. Pembroke strives to provide for active and passive use within walking and biking distance of most homes.

There are not any areas located within a 100-year Special Flood Hazard Area on The University of North Carolina at Pembroke's campus. The entire campus is located within an Unshaded Zone X.

Natural and Beneficial Floodplain Functions

Under natural conditions, a flood causes little or no damage in floodplains. Nature ensures that floodplain flora and fauna can survive the more frequent inundations, and the vegetation stabilizes soils during flooding. Floodplains reduce flood damage by allowing flood waters to spread over a large area. This reduces flood velocities and provides flood storage to reduce peak flows downstream. Although there are no floodplains on the UNCP's campus, protecting natural and beneficial floodplain functions throughout the watershed can still benefit the campus and protect it from flood risk.

Threatened and Endangered Species

The U.S. Fish and Wildlife Service maintains a regular listing of threatened species, endangered species, at-risk species, and candidate species for counties across the United States. Robeson County has four species that are listed with the U.S. Fish and Wildlife Services. Table H.3 below shows the four species identified as threatened and endangered in Robeson County.

Table H.3 – Threatened and Endangered Species in Robeson County

Common Name	Scientific Name	Federal Status
Wood stork	*Mycteria americana*	Threatened
Michaux's sumac	*Rhus michauxii*	Endangered

Common Name	Scientific Name	Federal Status
American alligator	*Alligator mississippiensis*	Threatened
Red-cockaded woodpecker	*Picoides borealis*	Endangered

Source: U.S. Fish & Wildlife Service (https://ecos.fws.gov/ecp/report/species-listings-by-current-range-county?fips=37155)

H.2.5 Land Use

The University of North Carolina at Pembroke has a Planning, Design, and Construction (PDC) program within the Facilities Management Department that provides professional administration for design and construction of capital improvement projects on campus. PDC is dedicated to improving and expanding all physical facilities in support of the teaching, research, and service missions of UNCP. There are many projects on campus currently undergoing construction, including the renovations of West Hall and Hickory Hall North, and a dance floor replacement in the Jones Center. A full list of current projects in store for the University, to include a new School of Business, can be found on UNCP's website at the following link: https://www.uncp.edu/resources/facilities-management/facilities-planning-design-and-construction/current-project-status-and-workload.

H.2.6 Population and Demographics

Table H.4 provides population counts and percent change in population since 2010 for Robeson County and the Town of Pembroke.

Table H.4 – Population Counts for Surrounding Jurisdictions

Jurisdiction	2010 Census Population	2019 Estimated Population	% Change 2010-2019
Robeson County	134,229	130,625	-2.7
Pembroke	2,973	2,951	-0.74

Source: U.S. Census Bureau QuickFacts 2010 vs 2019 (V2019) data

Table H.5 provides population counts for The University of North Carolina at Pembroke from Fall 2020, including the number of undergraduate and graduate students, staff, and faculty.

Table H.5 – Population Counts for The University of North Carolina at Pembroke, Fall 2020

Group	2020 Population
Students	8,262
Undergraduate Students	6,436
Graduate Students	1,826
Full-time Students	5,528
In-state Students	7,775
Faculty	309
Staff	597

According to The University of North Carolina at Pembroke's Fall 2020 Campus Profile, 63.8% of students were female. Among the UNCP student population, the most popular majors include Biological and Biomedical Sciences, Business Administration and Management, Social Sciences, Homeland Security, Law Enforcement, and Firefighting and Related Protective Services.

The racial characteristics of the County, Town, and college are presented below in **Table H.6**. These characteristics for the County and Town are based on the 2010 Census Bureau. American Indian or Alaska Native persons make up most of the population for the County and Town; however, White persons make up most of the population at UNCP.

Table H.6 – Demographics of Robeson County, Town of Pembroke and UNCP University Students

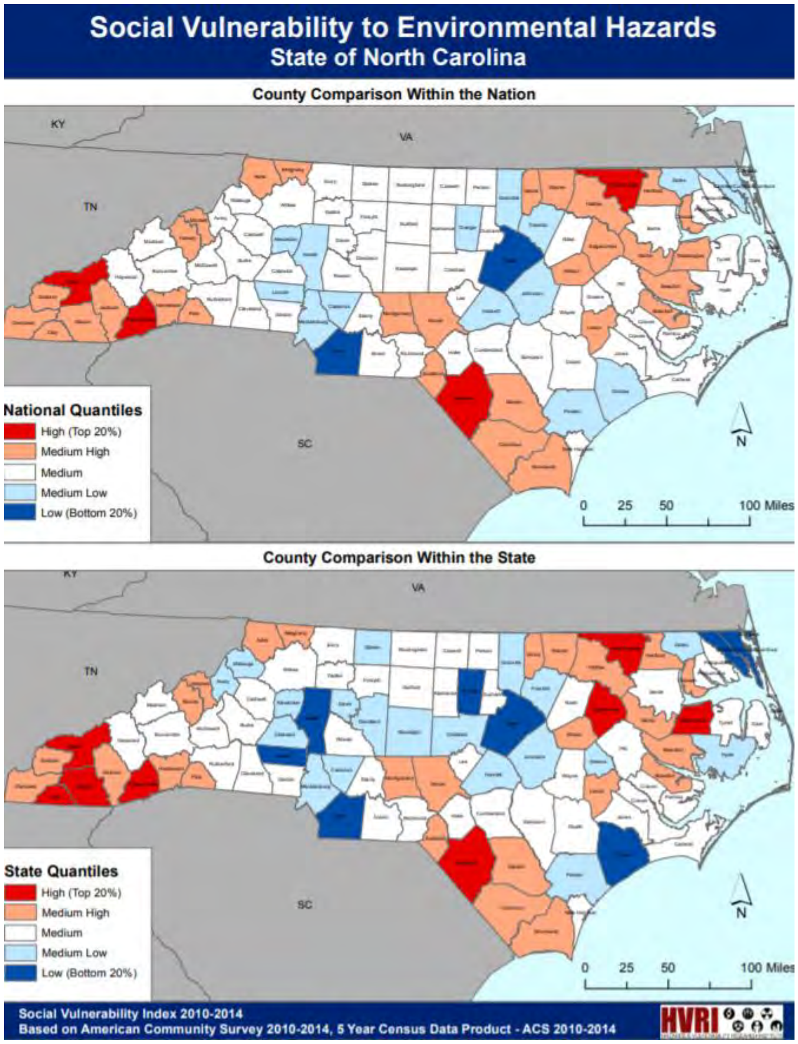
Jurisdiction	African-American Persons, Percent	American Indian or Alaska Native, Percent	Asian Persons, Percent	Hispanic or Latino Persons, Percent	White Persons, Percent
Robeson County[1]	23.6	42.3	0.7	9.2	30.6
Pembroke [1]	12.3	66.4	0.6	2.19	18.5
The University of North Carolina at Pembroke[2]	31	13	2	8	39

Source: U.S. Census Bureau, 2010
[1]Persons of Hispanic Origin may be of any race, so are also included in applicable race category in Robeson County figures.
[2]Source: The University of North Carolina at Pembroke Quick Facts, Fall 2020

H.2.7 Social Vulnerability

The Hazards and Vulnerability Research Institute at the University of South Carolina has created the Social Vulnerability Index (SoVI), to measure comparative social vulnerability to environmental hazards in the U.S. at a county level. SoVI combines 29 socioeconomic variables to determine vulnerability. The seven most significant components for explaining vulnerability are race and class, wealth, elderly residents, Hispanic ethnicity, special needs individuals, Native American ethnicity, and service industry employment. The index also factors in family structure, language barriers, vehicle availability, medical disabilities, and healthcare access, among other variables. **Figure H.2** displays the SoVI index by county with comparisons within the Nation and within the State. In both comparisons, Robeson County ranks among the top 20% for social vulnerability.

Figure H.2 – SoVI Index for North Carolina



H.2.8 Growth and Development Trends

Based on 2010 Census data, Pembroke had an estimated population of 2,951 residents in 2019. The Town of Pembroke does not have any public population projections available, but Pembroke's growth rate has been in the negatives for several years. Although population projections for the Town were unavailable, the North Carolina Office of State Budget and Management (OSBM) has population projections for Robeson County. OSBM estimates the population for Robeson County as of July 2020 to be 130,529 and that the population will be around 125,259 in July 2030, which is a 4% decline in population.

The estimated population for Pembroke in 2019 was 2,951, which is a 3.4% decrease from the 2015 estimated population, and a 0.7% decrease from the 2010 Census population. **Table H.7** shows estimated population growth based on the 2010 Census population for the Town of Pembroke.

Table H.7 – Town of Pembroke Population Growth (2010 – 2019)

Year	Population	Growth	Percent Growth
2010	2,973	--	--

Year	Population	Growth	Percent Growth
2015	3,056	83	2.8
2019	2,951	24,523	-3.4

Source: U.S. Census Bureau

H.3 ASSET INVENTORY

An inventory of assets was compiled to identify the total count and value of property exposure on the UNC-P campus. This asset inventory serves as the basis for evaluating exposure and vulnerability by hazard. Assets identified for analysis include buildings, critical facilities, and critical infrastructure.

H.3.1 Building Exposure

Table H.8 provides total building exposure for the campus, which was estimated by summarizing building footprints provided by the University of North Carolina System Division of Information Technology and the North Carolina Emergency Management (NCEM) iRisk database and property values provided by the North Carolina Department of Insurance and NCEM iRisk database. All occupancy types were summarized into the following four categories: administration, critical facilities, educational/extracurricular, and housing. Note: estimated content values were not available.

Table H.8 – UNC-P Building Exposure by Occupancy

Occupancy	Estimated Building Count	Structure Value
Administration	2	$4,678,579
Critical Facilities	33	$106,725,390
Educational/Extracurricular	26	$29,807,779
Housing	4	$6,461,840
Total	**65**	**$147,673,588**

Source: UNC Division of Information Technology; NCEM iRisk; NC Department of Insurance

H.3.2 Critical Buildings and Infrastructure Exposure

Of significant concern with respect to any disaster event is the location of critical facilities and infrastructure in the planning area. Critical facilities are those essential services and lifelines that, if damaged during an emergency event, would disrupt campus continuity of operations or result in severe consequences to public health, safety, and welfare.

Critical buildings are a subset of the total building exposure and were identified by UNC-P's HMPC representatives. The UNC-P HMPC updated the list of critical facilities from the previous PDM plan and ranked each facility on a set of standardized criteria designed to evaluate all critical buildings in the UNC System Hazard Mitigation Plan. Factors considered for this ranking included:

- the building's use for emergency response,
- the building's use for essential campus operations
- the building's use as an emergency shelter or for essential sheltering services,
- the presence of a generator or generator hook-ups,
- the building's use for provision of energy, chilled water or HVAC for sensitive or essential systems,
- the storage of hazardous materials,
- the building's use for sensitive research functions,
- the building's cultural or historical significance, and
- building-specific hazard vulnerabilities

Figure H.3 below shows the scoring sheet used to rate critical buildings on campus.

Figure H.3 – Critical Building Scoring Worksheet

Critical Building Scoring Worksheet

Campus:
Facility Name:

			Score
1	Does the facility serve as the campus Emergency Operations Center (EOC)? Yes, Primary EOC = 6 pts Yes, Secondary EOC = 3 pts No = 0 pts		0
2	Does the facility house functions essential to campus operations? Main Telecommunication Center = 3 pts Computer Network Hub = 3 pts Adminstrative Operations = 1 pts	Maintenance = 1 pt Public Safety = 1 pt	0
3	Is the facility equiped with a generator or hook-ups? Generator = 3 pts Hook-ups = 1 pt Neither = 0 pts		0
4	Does the facility serve as a pre or post disaster shelter? Both pre and post disaster shelter = 6 pts Either pre or post disaster shelter = 3 pts Neither = 0 pts		0
5	Does the facility provide services essential to sheltering? Resident Housing = 1 pt Assesmbly Space = 1 pt	Food Preperation Facility = 1 pt Shower Facilities = 1 pt	0
6	Does the facility provide chilled water distribution or contain HVAC systems necessary to sensitive or essential systems? Yes = 3 pts No = 0 pts		0
7	Are there hazardous materials on-site? (greater than 25 gallons) Yes = 3 pts No = 0 pts		0
8	Does the facility house research functions that have a low level of tolerance for disruption? Yes = 2 pts No = 0 pts		0
9	Does the facility serve as storage for rare or unique collections (art, artifacts, letters, etc) or is it a historically or culturally significant building? Yes = 2 pts No = 0 pts		0
10	Does the facility have hazard specific vulnerabilities (basement susceptible to flood, etc.) Yes = 3 pts No = 0 pts		0
Notes/ Comments			

Total Score:	0
Total Possible Score:	**42**

The identified critical facilities for UNC-P, as shown in **Figure H.4**, are listed below along with their respective scores:

- Pinchbeck Maintenance Complex (15)
- Lumbee Hall (13)
- Jones Athletic Center (12)
- Weinstein Health Sciences Building (12)
- Oxendine Science Building (11)
- Livermore Library (10)
- Campus Police and Business Services (9)
- Oak Hall (7)
- Pine Residence Hall (7)
- Chavis University Center (6)
- Brave Health Center (5)
- Cypress Hall (5)
- Old Main (5)
- New School of Business (5)
- Courtyard Apartments (1)
- Village Apartments (1)

Lumbee Hall serves as the primary Emergency Operations Center for campus. Pinchbeck Maintenance Complex serves as a secondary Emergency Operations Center and provides functions essential to campus operations and sheltering.

The Chavis University Center, Mary Livermore Library, Campus Police and Business Services Building, Oxendine Science Building, Lumbee Hall, Cypress Hall, Village Apartments, Courtyard Apartments, Weinstein Health Services, Braves Health, and New School of Business provide services essential for campus operations and/or sheltering. Additionally, Oak Hall and Pine Hall are critical for continuous utility service on campus and support sheltering needs.

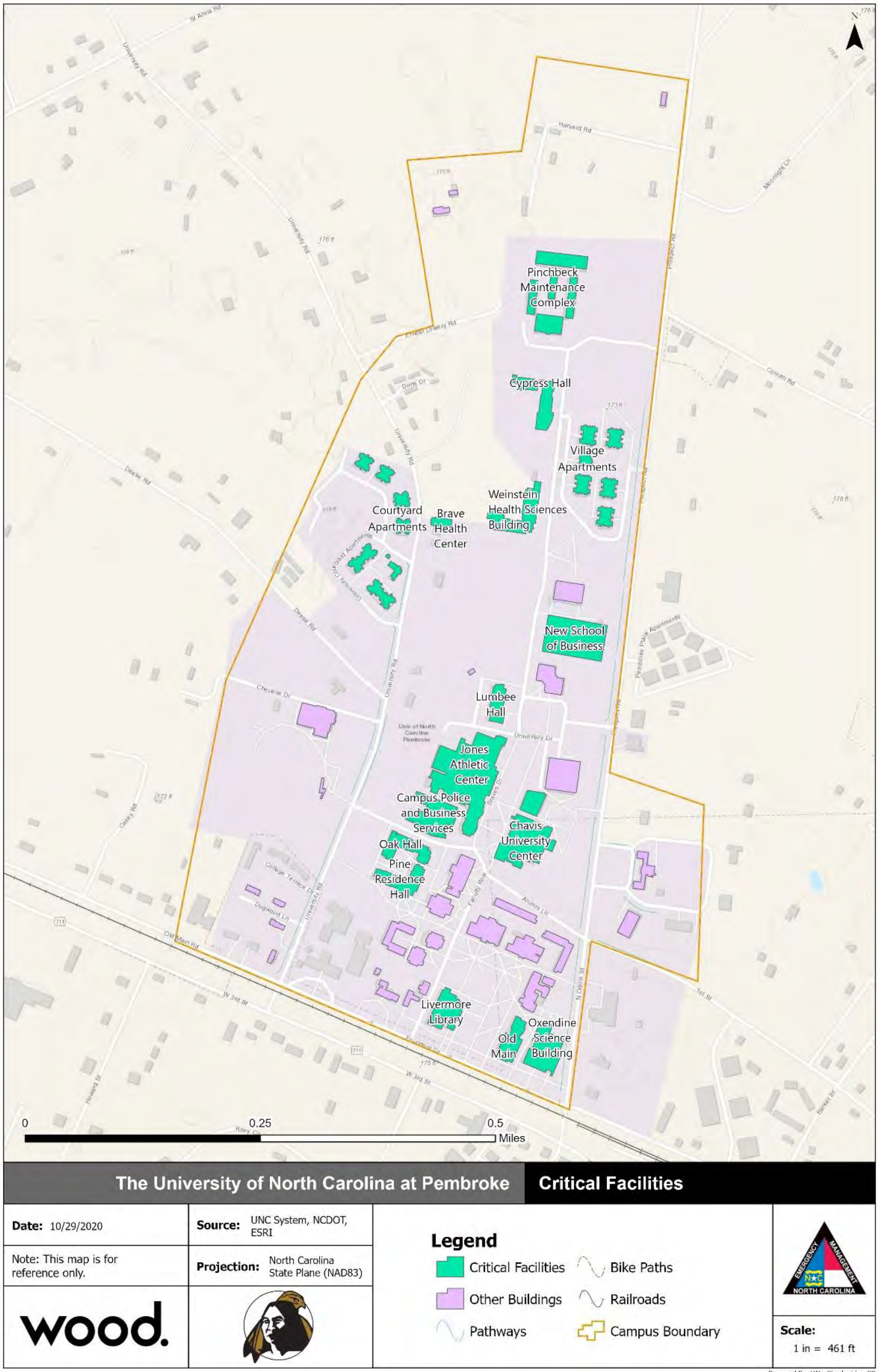
Jones Athletic Center serves as a pre- and post-disaster shelter.

Livermore Library and Old Main are historically significant and/or store important documents and artifacts.

Research functions with low levels of tolerance for disruption are housed in Oxendine Science Building and Weinstein Health Services Building.

Although it is not attached to UNC-P's main campus, the HMPC also identified the off-campus Biotechnology Center as a critical campus building. It houses sensitive research functions and provides services essential to sheltering.

Figure H.4 – UNC-P Map of Critical Facilities



H.4 HAZARD IDENTIFICATION & RISK ASSESSMENT

H.4.1 Hazard Identification

To identify a full range of hazards relevant to the UNC Eastern Campuses, HMPC representatives from each campus began with a review of the list of hazards identified in the 2018 North Carolina State Hazard Mitigation Plan and the 2011 UNC-P Pre-Disaster Mitigation Plan, as summarized in **Table H.9**. This ensured consistency with the state and regional hazard mitigation plans and across each campus' planning efforts.

Table H.9 – Hazards Included in Previous Planning Efforts

Hazard	Included in 2018 State HMP?	Included in 2011 UNC-P Pre-Disaster Mitigation Plan?
Flooding	Yes	Yes
Hurricanes and Coastal Hazards	Yes	Yes, as High Wind, Hurricane
Severe Winter Weather	Yes	Yes, as Ice storm and Snow
Extreme Heat	Yes	No
Earthquakes	Yes	Yes
Wildfire	Yes	Yes
Dam Failures	Yes	No
Drought	Yes	No
Tornadoes/Thunderstorms	Yes	Yes
Geological (Landslides, Sinkholes, Coastal Erosion)	Yes	Yes, as Landslide
Hazardous Materials Incidents	Yes	No
Infectious Disease	Yes	No
Radiological Emergency	Yes	No
Terrorism/Mass Casualty	Yes	No
Cyber Threat	Yes	No

UNC-P's HMPC representatives evaluated the above list of hazards by considering existing hazard data, past disaster declarations, local knowledge, and information from the 2018 State Plan and the 2011 UNC-P Pre-Disaster Mitigation Plan in order to determine whether each hazard was significant enough to assess in this updated Hazard Mitigation Plan. Significance was measured in general terms and focused on key criteria such as frequency, severity, and resulting damage, including deaths and injuries, as well as property and economic damage.

One key resource in this effort was the National Oceanic and Atmospheric Administration's (NOAA) National Center for Environmental Information (NCEI), which has been tracking various types of weather events 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), which compiles their information from a variety of sources, including but 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. While NCEI is not a comprehensive list of past hazard events, it can provide an indication of relevant hazards to the planning area and offers some statistics on injuries, deaths, damages, as well as narrative descriptions of past impacts.

Data for Robeson County was used to approximate past events that may have affected the UNC-P campus. The NCEI database contains 460 records of storm events that occurred in Robeson County in the 20-year period from 2000 through 2019. **Table H.10** summarizes these events.

Table H.10 – NCEI Severe Weather Data for Robeson County, 2000 – 2019

Type	# of Events	Property Damage	Crop Damage	Deaths	Injuries
Drought	11	$0	$0	0	0
Flash Flood	17	$4,910,000	$0	2	0
Flood	9	$7,000	$0	0	0
Frost/Freeze	3	$0	$0	0	0
Funnel Cloud	3	$0	$0	0	0
Hail	109	$117,150	$50,000	0	0
Heat	4	$0	$0	0	0
Heavy Rain	6	$0	$0	0	0
Heavy Snow	5	$0	$0	0	1
High Wind	3	$0	$0	0	0
Ice Storm	5	$4,500,000	$0	0	0
Lightning	7	$506,500	$0	0	2
Strong Wind	10	$26,000	$0	0	0
Thunderstorm Wind	229	$3,594,750	$4,000	0	4
Tornado	17	$5,018,000	$0	0	1
Tropical Storm	6	$71,000	$0	0	0
Wildfire	2	$0	$0	0	0
Winter Storm	9	$20,000	$0	0	0
Winter Weather	5	$30,000	$0	0	0
Grand Total	**460**	**$18,800,400**	**$54,000**	**2**	**8**

Source: National Center for Environmental Information Events Database, retrieved October 2020
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 Robeson 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 1954. Since then, Robeson County has been designated in 19 major disaster declarations, as detailed in **Table H.11**, and seven emergency declarations, as detailed in **Table H.12**.

Table H.11 – FEMA Major Disaster Declarations, Robeson County

Disaster #	Dec. Date	Incident Type	Event Title	Individual Assistance Applications Approved	Total Individual and Households Program Dollars Approved	Total Public Assistance Grant Dollars Obligated
DR-28-NC	17-Oct-54	Hurricane	HURRICANE	N/A	N/A	N/A
DR-37-NC	13-Aug-55	Hurricane	HURRICANES	N/A	N/A	N/A
DR-56-NC	24-Apr-56	Severe Storm(s)	SEVERE STORM	N/A	N/A	N/A

Disaster #	Dec. Date	Incident Type	Event Title	Individual Assistance Applications Approved	Total Individual and Households Program Dollars Approved	Total Public Assistance Grant Dollars Obligated
DR-87-NC	01-Oct-58	Hurricane	HURRICANE & SEVERE STORM	N/A	N/A	N/A
DR-107-NC	16-Sep-60	Hurricane	HURRICANE DONNA	N/A	N/A	N/A
DR-130-NC	16-Mar-62	Flood	SEVERE STORM, HIGH TIDES & FLOODING	N/A	N/A	N/A
DR-179-NC	13-Oct-64	Flood	SEVERE STORMS & FLOODING	N/A	N/A	N/A
DR-699-NC	30-Mar-84	Tornado	SEVERE STORMS & TORNADOES	N/A	N/A	N/A
DR-1134-NC	06-Sep-96	Hurricane	HURRICANE FRAN	N/A	N/A	N/A
DR-1200-NC	15-Jan-98	Severe Storm(s)	SEVERE STORMS AND FLOODING	N/A	N/A	N/A
DR-1240-NC	27-Aug-98	Hurricane	HURRICANE BONNIE	N/A	N/A	N/A
DR-1292-NC	16-Sep-99	Hurricane	HURRICANE FLOYD MAJOR DISASTER DECLARATIONS	N/A	N/A	$298,105,794
DR-1490-NC	18-Sep-03	Hurricane	HURRICANE ISABEL	7790	$21,289,504	$18,285,917
DR-1546-NC	10-Sep-04	Hurricane	TROPICAL STORM FRANCES	25950	$45,380,867	$70,854,432
DR-1969-NC	20-Apr-11	Severe Storm(s)	SEVERE STORMS, TORNADOES, AND FLOODING	1778	$5,391,278	N/A
DR-4285-NC	10-Oct-16	Hurricane	HURRICANE MATTHEW	28971	$98,842,213	$291,092,954
DR-4393-NC	15-Sep-18	Hurricane	HURRICANE FLORENCE	34713	$133,948,455	$632,937,402
DR-4465-NC	04-Oct-19	Hurricane	HURRICANE DORIAN	N/A	N/A	$28,138,271
DR-4487-NC	25-Mar-20	Biological	COVID-19 PANDEMIC	N/A	N/A	$174,898,697

Source: FEMA Disaster Declarations Summary, October 2020

Note: Number of applications approved, and all dollar values represent totals for all counties included in disaster declaration.

Table H.12 – FEMA Emergency Declarations, Robeson County

Disaster #	Dec. Date	Incident Type	Event Title/Description
EM-3146-NC	15-Sep-99	Hurricane	HURRICANE FLOYD EMERGENCY DECLARATIONS
EM-3222-NC	5-Sep-05	Hurricane	HURRICANE KATRINA EVACUATION
EM-3254-NC	15-Sep-05	Hurricane	HURRICANE OPHELIA
EM-3314-NC	2-Sep-10	Hurricane	HURRICANE EARL
EM-3327-NC	25-Aug-11	Hurricane	HURRICANE IRENE
EM-3380-NC	7-Oct-16	Hurricane	HURRICANE MATTHEW
EM-3401-NC	11-Sep-18	Hurricane	HURRICANE FLORENCE
EM-3423-NC	4-Sep-19	Hurricane	HURRICANE DORIAN
EM-3471-NC	13-Mar-20	Biological	COVID-19
EM-3534-NC	2-Aug-20	Hurricane	HURRICANE ISAIAS

Source: FEMA Disaster Declarations Summary, October 2020

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. **Table H.13** summaries the determination made for each hazard.

Table H.13 – Hazard Evaluation Results

Hazard	Included in this plan update?	Explanation for Decision
Natural Hazards		
Hurricane	Yes	The 2011 UNC-P PDM plan found Hurricane to be a moderate threat hazard. The County has had 10 disaster declarations related to hurricanes wind.
Coastal Hazards	No	The 2011 UNC-P PDM plan did not address this hazard.
Tornadoes / Thunderstorms (Wind, Lightning, Hail)	Yes	The 2011 UNC-P PDM plan found tornadoes to be a low threat hazard. The County has had no disaster declarations related to tornadoes. The HMPC expressed interest in addressing this hazard in combination with thunderstorms (wind, lightning, hail).
Flood	Yes	The 2011 UNC-P PDM plan rated flood a significant threat hazard for the planning area. The County has had 2 disaster declarations related to flooding.
Severe Winter Weather	Yes	The 2011 UNC-P PDM plan found ice/snow to be a low threat hazard. The HMPC expressed interest in addressing this hazard as severe winter weather to include cold/wind chill; extreme cold; freezing fog; frost/freeze; heavy snow; ice storm; winter storm; and winter weather.
Drought	No	The 2011 UNC-P PDM plan did not address this hazard.
Wildfire	Yes	The 2011 UNC-P PDM plan did not assign a threat and/or risk level for this hazard; however, the HMPC expressed interest in addressing this hazard.
Earthquake*	Yes	The 2011 UNC-P PDM plan did not assign a threat and/or risk level for this hazard; however, the HMPC expressed interest in addressing this hazard.
Geological Hazards (Sinkhole & Landslide)*	Yes	The 2011 UNC-P PDM plan did not assign a threat and/or risk level for this hazard; however, the HMPC expressed an interest in addressing this hazard.
Dam Failure	No	The 2011 UNC-P PDM plan did not address this hazard.
Extreme Heat	Yes	The 2011 UNC-P PDM plan did not address this hazard; however, the HMPC expressed an interest in addressing this hazard.
Technological and Human-Caused Hazards & Threats		
Hazardous Materials Incidents*	Yes	The 2011 UNC-P PDM plan did not address this hazard; however, there are fixed facility sites and transportation routes with hazardous materials in the planning area and the HMPC expressed interest in addressing this hazard.
Infectious Disease	Yes	The 2011 UNC-P PDM plan did not address this hazard; however, due to the COVID-19 pandemic that occurred during this planning process, the HMPC determined infectious disease should be addressed.
Cyber Attack	Yes	The 2011 UNC-P PDM plan did not address this hazard; however, the HMPC expressed interest in re-evaluating cyber-attacks in this plan update.
Civil Unrest	No	The 2011 UNC-P PDM plan did not address this hazard and the HMPC did not express interest in re-evaluating civil unrest in this plan update.

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

H.5 HAZARD PROFILES, ANALYSIS, AND VULNERABILITY

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 where it may occur, the severity of potential events, records of past events, the probability of future occurrences, and potential impacts from the hazard. A vulnerability assessment was conducted for each hazard using quantitative and/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.

To account for regional differences in hazard risk across each of the campuses, this risk assessment is divided into two parts:

1) a set of summary hazard profiles describing each hazard and summarizing the risk findings for each campus, presented in Section 3.5; and
2) a campus-specific risk assessment profiling the location, extent, historical occurrences, probability of future occurrence, and vulnerability of each campus, presented in each campus annex.

In the campus-level hazard profiles presented here, each hazard is profiled in the following format:

Location

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

Extent

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

Historical Occurrences

This section contains information on historical events, including the location and consequences of all past events on record within or near the Robeson County planning area. Where possible, this plan uses a consistent 20-year period of record except for hazards with significantly longer average recurrence intervals or where data limitations otherwise restrict the period of record.

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)

Vulnerability Assessment

This section quantifies, to the extent feasible using best available data, assets at risk to natural hazards and potential loss estimates. Details on hazard specific methodologies and assumptions are provided where applicable. People, properties and critical facilities, and environmental assets that are vulnerable to the hazard are identified.

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

- Geographic Information System (GIS) datasets, including County parcel data from 2020, campus building inventory fand values from the University System's Division of Information Technology, NCEM iRisk Database, and property values provided by the NC Department of Insurance, topography, transportation layers, and critical facility and infrastructure locations;
- Hazard layer GIS datasets from state and federal agencies;
- Written descriptions of inventory and risks provided by the 2018 State of North Carolina Hazard Mitigation Plan;
- Written descriptions of inventory and risks provided by the 2017 Robeson County Multi-Jurisdictional Hazard Mitigation Plan; and
- Exposure and vulnerability estimates derived using local parcel data.

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. For applicable hazards, the quantitative analysis involved the use of FEMA's Hazus-MH, a nationally applicable standardized set of models for estimating potential losses from earthquakes, floods, and hurricanes. Hazus uses a statistical approach and mathematical modeling of risk to predict a hazard's frequency of occurrence and estimated impacts based on recorded or historic damage information. The Hazus risk assessment methodology is parametric, in that distinct hazard and inventory parameters—such as wind speed and building type—were modeled using the Hazus software to determine the impact on the built environment. Robeson County's GIS-based risk assessment was completed using data collected from local, regional, and national sources that included Robeson County, GEMA, and FEMA.

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. Other information can be collected in regard to the hazard area, such as the location of critical facilities and infrastructure, historic resources, 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.

The data collected for the hazard profiles and vulnerability assessment was obtained from multiple sources covering a variety of spatial areas including county-, jurisdictional-, and campus-level information. The table below presents the source data and the associated geographic coverages.

Table H.14 – Summary of Hazard Data Sources and Geographic Coverage

Hazard	Hazard Data Sources	Profile Geographic Area	Vulnerability Methodology	Vulnerability Geographic Area
Earthquake	USGS, NCEI	County	Hazus 4.2	Census Tract

Hazard	Hazard Data Sources	Profile Geographic Area	Vulnerability Methodology	Vulnerability Geographic Area
Extreme Heat	NCEI	County	Qualitative Analysis	Campus
Flood	NCEI, FEMA	County	GIS Spatial Analysis	Campus
Hurricane	NHC	County	Hazus 4.2	Census Tract
Landslide	USGS	County	Qualitative Analysis	County
Severe Winter Weather	NWS, NCEI	County	Statistical Analysis	County
Tornado / Thunderstorm	NWS, NCEI	County	Statistical Analysis	County
Wildfire	NCFS, SouthWRAP	County, Campus	GIS Spatial Analysis	Campus
Cyber Threat	Internet Research	County, Higher Education	Qualitative Analysis	Higher Education
Hazardous Materials Incidents	EPA; USDOT	Jurisdiction	GIS Spatial Analysis	Campus
Infections Disease	CDC; WHO	National, Higher Education	Qualitative Analysis	Higher Education

CDC = Centers for Disease Control and Prevention; EPA = United States Environmental Protection Agency; FEMA = Federal Emergency Management Agency; NCEI = National Centers for Environmental Information; NCFS = North Carolina Forest Service; NHC = National Hurricane Center; NWS = National Weather Service; SouthWRAP = Southern Group of State Foresters, Wildfire Risk Assessment Portal; USDOT = United States Department of Transportation; USGS = United States Geological Survey; WHO = World Health Organization

Changes in Development

This section describes how changes in development have impacted vulnerability since the last plan was adopted. 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.

Problem Statements

This section summarizes key mitigation planning concerns related to this hazard.

Priority Risk Index

The conclusions drawn from the hazard profiling and vulnerability assessment process are used to prioritize all potential hazards to the UNC-P 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 H.15**.

PRI ratings are provided by category throughout each hazard profile for the planning area as a whole. Ratings specific to each jurisdiction are provided at the end of each hazard profile. The results of the risk assessment and overall PRI scoring are provided in Section H.5.13 Conclusions on Hazard Risk.

The sum of all five risk assessment categories equals the final PRI value, demonstrated in the equation below (the lowest possible PRI value is a 1.0 and 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 campus 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.

Table H.15 – 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	

H.5.2 Earthquake

Hazard	Probability	Impact	Spatial Extent	Warning Time	Duration	PRI Score
Earthquake	Unlikely	Minor	Large	Less than 6 hours	Less than 6 hours	1.9

Location

The United States Geological Survey (USGS) Quaternary faults database was consulted to determine the sources of potential earthquakes within range of Robeson County. Quaternary faults are active faults recognized at the surface which have evidence of movement in the past 2.58 million years. No active faults were noted in Robeson County.

Earthquakes are generally felt over a wide area, with impacts occurring hundreds of miles from the epicenter. Therefore, any earthquake that impacts Robeson County is likely to be felt across most if not all of the planning area.

Spatial Extent: 4 – Large

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 H.16**. 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 H.17** 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 H.16 – 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 H.17 – 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.

MMI	Richter Scale	Felt Intensity
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.
VIII	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 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.

Impact: 1 – Minor

Historical Occurrences

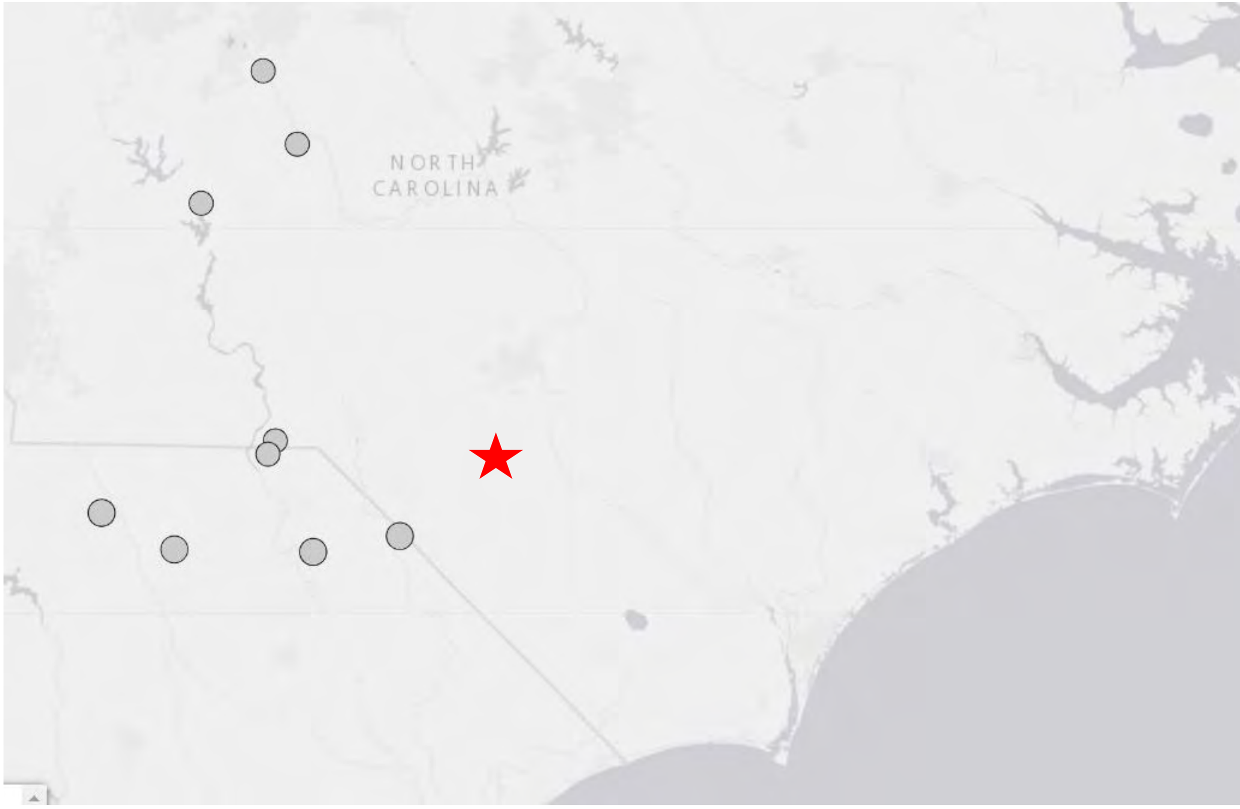
The USGS Earthquake Hazards Program maintains a database of historical earthquakes of a magnitude 2.5 and greater from 1900 to 2020. Earthquake events that occurred within 100 miles of the UNC-P campus are presented in **Table H.18** and **Figure H.5**.

Table H.18 – Historical Earthquakes within 100 Miles of UNC-P, 1900-2020

Year	Magnitude	MMI	Location
1959	3.9	III	South Carolina
1981	2.8	II	North Carolina
1998	3.5	III	South Carolina
2006	3.4	III	13km S of Bennettsville, South Carolina
2006	3.7	III	7km W of Rowland, North Carolina
2011	2.9	II	9km S of Cordova, North Carolina
2012	2.5	II	10km NNE of Cheraw, South Carolina
2015	2.58	II	10km S of Denton, North Carolina
2019	2.5	II	8km E of Archdale, North Carolina

Source: USGS

Figure H.5 – Historical Earthquakes within 100 Miles of UNC-P, 1900-2020



Source: USGS

The National Center for Environmental Information (NCEI) maintains a database of the felt intensity of earthquakes from 1638 to 1985 including the maximum intensity for each locality that felt the earthquake. According to this database, in the 100-year period from 1885-1985, there were no earthquakes felt in or around Pembroke.

Probability of Future Occurrence

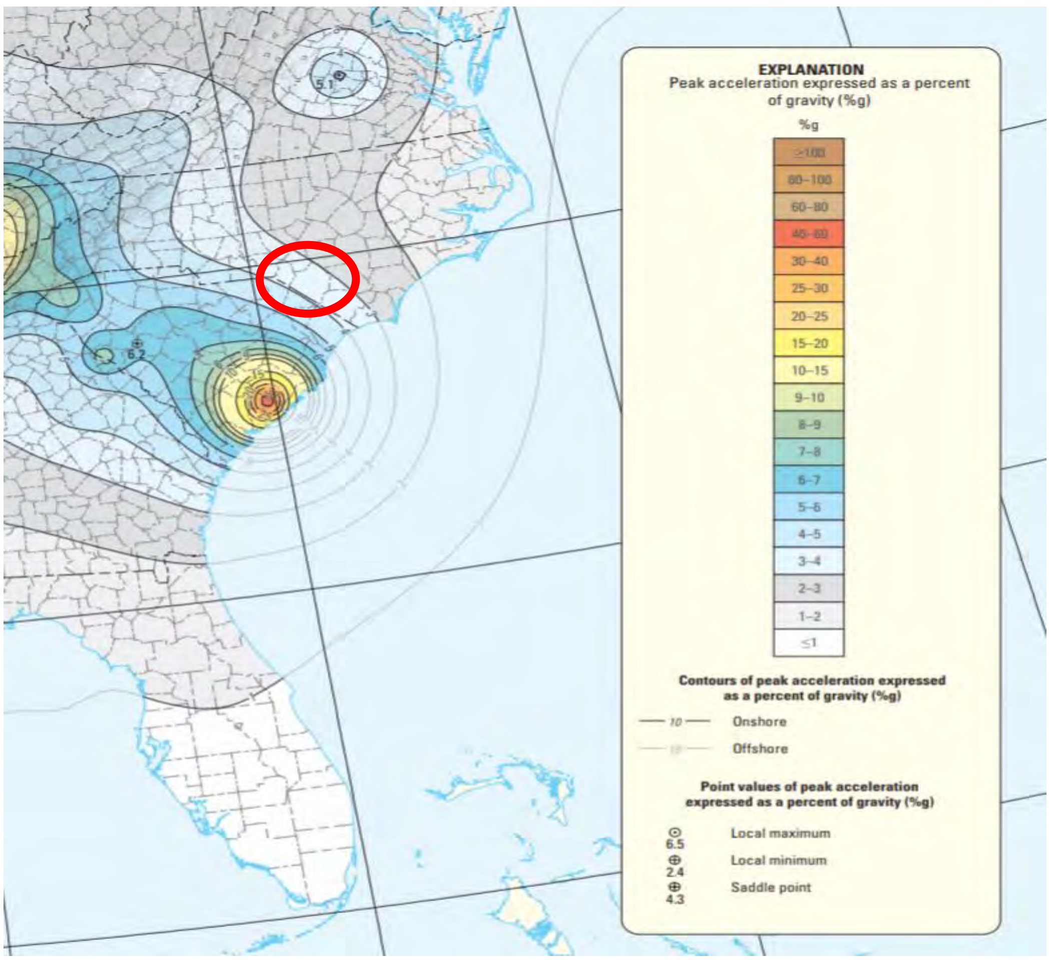
Ground motion is the movement of the earth's surface due to earthquakes or explosions. It is produced by waves generated by a sudden slip on a fault or sudden pressure at the explosive source and travels through the earth and along its surface. Ground motion is amplified when surface waves of unconsolidated 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 that have a common given probability of being exceeded in 50 years.

Figure H.6 on the following page reflects the seismic hazard for Robeson 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 occurrence 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. All of Robeson County is located within a zone with peak acceleration of 3-4% g, which indicates low earthquake risk.

In simplified terms, based on the record of past occurrences over a 120-year period from 1900 to 2020 there were no earthquakes that have or could have caused building damage in Pembroke, defined for this purpose as an MMI of VI or greater. All noted earthquakes were located outside Robeson County and defined as MMI of III (Felt indoors. Hanging objects swing. Vibration like passing of light trucks. Duration estimated. May not be recognized as an earthquake.), or an MMI of II (Felt by persons at rest, on upper floors, or favorably placed). Based on this data, it can be reasonably assumed that an earthquake event affecting Robeson County is unlikely.

Probability: 1 – Unlikely

Figure H.6 – Seismic Hazard Information for Robeson County



Source: USGS Earthquake Hazards Program

Vulnerability Assessment

Methodology & Assumptions

To quantify vulnerability, Wood performed a Level 1 earthquake analysis in Hazus 4.2 utilizing general building stock information based on the 2010 Census. The UNC-P campus is located within one census tracts which encompass 6.66 square miles. The earthquake scenario was modeled after an arbitrary earthquake event of magnitude 5.0 with an epicenter in the UNC-P campus and depth of 10km.

People

Hazus estimates that the modeled magnitude 5.0 event would result in 59 households requiring temporary shelter. Additionally, Hazus estimates potential injuries and fatalities depending on the time of day of an event. Casualty estimates are shown in **Figure H.7.** Casualties are broken down into the following four levels that describe the extent of injuries:

- Level 1: Injuries will require medical attention but hospitalization is not needed.
- Level 2: Injuries will require hospitalization but are not considered life-threatening.
- Level 3: Injuries will require hospitalization and can become life threatening if not promptly treated.
- Level 4: Victims are killed by the earthquake.

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. Impacts of earthquakes also include debris clean-up and service disruption. Per the Hazus analysis, a 5.0 magnitude earthquake could produce an estimated 20,000 tons of debris.

Robeson County has not been impacted by an earthquake with more than a low intensity, so major damage to the built environment is unlikely. However, there is potential for impacts to certain masonry buildings, as well as environmental damages with secondary impacts on structures.

Table H.19 details the estimated buildings impacted by a magnitude 5.0 earthquake event, as modeled by Hazus. Note that building value estimates are inherent to Hazus and do not necessarily reflect damages to the asset inventory for the UNC-P Campus.

Table H.19 – Estimated Buildings Impacted by 5.0 Magnitude Earthquake Event

Occupancy Type	Estimated Building Damage	Estimated Content Loss	Estimated Total Damage
Residential	$5,430,000	$0	$5,430,000
Commercial	$1,720,000	$0	$1,720,000
Industrial	$270,000	$0	$270,000
Other	$970,000	$0	$970,000
Total	**$8,390,000**	**$0**	**$8,390,000**

Source: Hazus

Figure H.7 – Casualty Estimate from a 5.0 Magnitude Earthquake Event

		Level 1	Level 2	Level 3	Level 4
2 AM	Commercial	0	0	0	0
	Commuting	0	0	0	0
	Educational	0	0	0	0
	Hotels	0	0	0	0
	Industrial	0	0	0	0
	Other-Residential	13	3	0	1
	Single Family	4	1	0	0
	Total	16	3	0	1
2 PM	Commercial	7	1	0	0
	Commuting	0	0	0	0
	Educational	9	2	0	1
	Hotels	0	0	0	0
	Industrial	1	0	0	0
	Other-Residential	3	1	0	0
	Single Family	1	0	0	0
	Total	20	5	1	1
5 PM	Commercial	5	1	0	0
	Commuting	0	0	0	0
	Educational	3	1	0	0
	Hotels	0	0	0	0
	Industrial	1	0	0	0
	Other-Residential	5	1	0	0
	Single Family	1	0	0	0
	Total	15	3	0	1

Source: Hazus 4.2

All critical facilities should be considered at risk to minor damage should an earthquake event occur. However, none of the essential facilities included in Hazus—which include 4 schools, 1 fire stations, and 2 police stations—were estimated to sustain moderate damages, and all were estimated to maintain at least 50 percent functionality after day one following an event. Additionally, Hazus did not project any impacts to utility system facilities or pipelines.

Environment

An earthquake is unlikely to cause substantial impacts to the natural environment in Robeson 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.

Changes in Development

Building codes substantially reduce the costs of damage to future structures from earthquakes. Future construction on the UNC-P campus must follow the applicable requirements of the NC building codes, the State of North Carolina statutes for state owned buildings and zoning for the local jurisdiction.

Development changes at UNC-P have not affected the risk characteristics of earthquakes. The probability, impact, spatial extent, warning time, and duration of earthquakes have not changed.

Problem Statement

- While earthquakes are an unlikely hazard event for the UNC-P campus, the Hazus model did predict impacts to buildings within the census tract.

H.5.3 Extreme Heat

Hazard	Probability	Impact	Spatial Extent	Warning Time	Duration	PRI Score
Extreme Heat	Highly Likely	Limited	Large	12 to 24 hrs	Less than 1 week	3.1

Location

Extreme heat is a dangerous and deadly occurrence in all of North Carolina. According to the National Weather Service, heat is one of the leading weather-related causes of loss of life in the United States. The State of North Carolina Hazard Mitigation Plan states that the Centers for Disease Control and Prevention indicates that 618 people in the United States are killed by extreme heat every year. The CDC defines extreme heat as "summertime temperatures that are much hotter and/or humid than average." The National Weather Service defines a heat wave as "a period of abnormally and uncomfortably hot and unusually humid weather, typically lasting two or more days." Extreme heat can have an impact in any location throughout the state as temperatures in all parts of the state have been high enough historically to cause heat disorders in the population; therefore, the entire planning area is susceptible to high temperatures and incidents of extreme heat.

Spatial Extent: 4 – Large

Extent

Temperatures that remain 10 degrees or more above the average high temperature for the region and last for several weeks are defined as extreme heat by FEMA. Humid or muggy conditions, which add to the discomfort of high temperatures, occur when high atmospheric pressure traps damp air near the ground.

In an effort to alert the public to the hazards of prolonged heat and humidity episodes, the National Weather Service devised the "heat index". The heat index is an accurate measure of how hot it feels to an individual when the effects of humidity are added to high temperature. **Table H.20** presents heat index values and their potential physical effects.

Table H.20 – Heat Index Values and Effects

Classification	Heat Index	Effect on the body
Caution	80°F - 90°F	Fatigue possible with prolonged exposure and/or physical activity
Extreme Caution	90°F - 103°F	Heat stroke, heat cramps, or heat exhaustion possible with prolonged exposure and/or physical activity
Danger	103°F - 124°F	Heat cramps or heat exhaustion likely, and heat stroke possible with prolonged exposure and/or physical activity
Extreme Danger	125°F or higher	Heat stroke highly likely

Source: National Weather Service, Heat Index Chart, http://www.srh.noaa.gov/ama/?n=heatindex

The National Weather Service will issue a *Heat Advisory* for Robeson County when daytime heat indices are at or above 105°F and nighttime heat indices are at or above 80°F. An *Excessive Heat Warning* is issued when the heat index equals or exceeds 115°F for three hours or longer with a minimum heat index of at least 80°F during a 24-hour period. An excessive heat advisory is also issued when heat advisory conditions persist for at least 3 days. In either of these scenarios, the heat becomes dangerous for a large portion of the population.

The extent of extreme heat can be defined by the maximum apparent temperature reached. NCEI reports 3 extreme heat events reporting heat indices around 110 degrees in 2011 and 2012.

Impact: 2 – Limited

Historical Occurrences

NCEI records four incidents of heat for Robeson County between 2000-2019. The highest recorded heat index was near 120 degrees on June 29, 2012. There were no recorded fatalities or injuries nor was any property or crop damage reported. The following are a selection of narrative descriptions recorded in NCEI:

July 21, 2011 – Excessive heat advisories and warnings were issued for the region for several days toward the end of July. The heat and humidity combined to push heat indices near 110 degrees at times during the afternoon.

June 29, 2012 – Northwest flow aloft and southwest flow at the surface produced excessive heat at the end of June. The heat index went over 110 degrees beginning the afternoon of June 29th, continuing through the next day. The highest heat index noted was near 120 degrees. There were no reports of heat related illnesses or fatalities.

July 26, 2012 – Directional flow at the surface and aloft were both from the west southwest. This contributed to heat indices above 110 degrees for several hours on both the 26th and 27th of July. There were no reports of heat related injuries.

June 19, 2015 – A prolonged period of unseasonably high heat indices blanketed most of the southeastern US. Afternoon temperatures mainly between 95 and 100 combined with dewpoints in the mid-70s produced heat index values in the 105 to 110 range. The heat wave finally broke on Jun 26th with cloud cover and precipitation.

Heat index records indicate that the Robeson County area regularly experiences heat index temperatures above 100°F. **Table H.21** provides counts of heat index values by threshold recorded from 2000-2019 at the Fayetteville Airport weather station (KFAY), used as an indicator for Pembroke and Robeson County overall. Counts are provided as the number of hours in a given year where the heat index reached or exceeded 100°F. According to this data, Robeson County averages approximately 91 hours per year with heat index values above 100°F.

Table H.21 – Historical Heat Index Counts Fayetteville Airport (KFAY), 2000-2019

Year	Heat Index Value				Total
	100-104°F	105-109°F	110-114°F	≥115°F	
2000	44	9	1	0	54
2001	38	11	0	0	49
2002	84	6	0	0	90
2003	55	7	0	0	62
2004	27	2	0	0	29
2005	92	34	6	0	132
2006	75	31	6	0	112
2007	76	17	12	0	105
2008	95	4	0	0	99
2009	54	2	0	0	56
2010	147	55	9	0	211
2011	118	47	16	0	181

Year	Heat Index Value				Total
	100-104°F	105-109°F	110-114°F	≥115°F	
2012	83	38	8	2	131
2013	50	9	0	0	59
2014	62	1	0	0	63
2015	135	19	0	0	154
2016	181	62	2	0	245
2017	122	61	16	8	207
2018	87	7	0	0	94
2019	188	65	1	0	254
Sum	**1,813**	**487**	**77**	**10**	**2,387**
Average	**91**	**24**	**4**	**1**	**119**

Source: North Carolina Climate Office, Heat Index Climatology Tool

Probability of Future Occurrence

Data was gathered on historical heat index values using the Hartsfield Atlanta Airport weather station as an approximation for Robeson County. Based on 20 years of available data, the county averages 91 hours per year with heat index temperatures above 100°F. Heat index temperatures surpassed 100°F in all 20 years, which equates to a 100 percent annual chance of heat index values exceeding 100°F in any given year.

Probability: 4 – Highly Likely

Vulnerability Assessment

People

Those at greatest risk for heat-related illness include infants and children up to four years of age, people 65 years of age and older, people who are overweight, and people who are ill or on certain medications. However, even young and healthy individuals are susceptible if they participate in strenuous physical activities during hot weather.

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.

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.

Changes in Development

Increases in impervious surface area can exacerbate heat conditions through the urban heat island effect, whereby the concentration of structures, infrastructure, and human activity, traps and stores heat resulting in localized "heat islands." Information is not available on the extent to which impervious surface coverage has changed since the adoption of the previous hazard mitigation plan, but it is possible that as greenfield development has occurred, this process has and may continue to exacerbate heat hazards in some areas of the county.

Problem Statement

- UNC-P is located within Robeson County which currently averages 91 hours per year with heat index temperatures above 100°F and there is a 100% annual chance of heat index values exceeding 100°F in any given year.

H.5.4 Flood

Hazard	Probability	Impact	Spatial Extent	Warning Time	Duration	PRI Score
Flood	Highly Likely	Minor	Negligible	6 to 12 hrs	Less than 6 hours	2.1

Location

Regulated floodplains are illustrated on inundation maps called Flood Insurance Rate Maps (FIRMs). A FIRM 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 1-percent-annual-chance flood event. Structures located within the SFHA have a 26-percent chance of flooding during the life of a standard 30-year mortgage.

For this risk assessment, flood prone areas were identified within the UNC-P Campus using the FIRM dated December 6, 2019. **Figure H.8** reflects the 2019 mapped flood insurance zones that are summarized in **Table H.22**.

Table H.22 – Mapped Flood Insurance Zones

Zone	Description
A	Zone A is the flood insurance rate zone that corresponds to the 1% annual chance floodplains that are determined in the FIS Report by approximate methods. Because detailed hydraulic analyses are not performed for such areas, no Base Flood Elevations or depths are shown within this zone.
AE	Zone AE is the flood insurance rate zone that corresponds to the 1% annual chance floodplains that are determined in the FIS Report by detailed methods. In most instances, whole-foot Base Flood Elevations derived from the detailed hydraulic analyses are shown at selected intervals within this zone.
AH	Zone AH is the flood insurance rate zone that corresponds to the areas of 1% annual chance shallow flooding (usually areas of ponding) where average depths are between 1 and 3 feet. Whole-foot Base Flood Elevations derived from the detailed hydraulic analyses are shown at selected intervals within this zone.
AO	Zone AO is the flood insurance rate zone that corresponds to the areas of 1% annual chance shallow flooding (usually sheet flow on sloping terrain) where average depths are between 1 and 3 feet. Average whole-foot depths derived from the detailed hydraulic analyses are shown within this zone.
VE	Zone VE is the flood insurance rate zone that corresponds to the 1% annual chance coastal floodplains that have additional hazards associated with storm waves. Whole-foot Base Flood Elevations derived from the detailed hydraulic analyses are shown at selected intervals within this zone.
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 0.2-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.

Source: FEMA

None of the UNC-P Campus falls within the SFHA. **Table H.23** provides a summary of the UNC-P Campus' total area by flood zone on the 2019 effective DFIRM.

Figure H.8 – FEMA Flood Hazard Areas in UNC-P's Campus Boundary

Table H.23 – Flood Zone Acreage on UNC-P Campus

Flood Zone	Acreage	Percent of Total (%)
A	0	0.0%
AE	0	0.0%
AH	0	0.0%
AO	0	0.0%
Floodway	0	0.0%
VE	0	0.0%
0.2% Annual Chance Flood Hazard		0.0%
Unshaded X	241	100.0%
Total	241	--
SFHA Total	**0**	**0.0%**

Source: FEMA 2019 DFIRM

Spatial Extent: 1 – Negligible

Although this assessment focuses on riverine flooding, it is also important to note that localized stormwater flooding can also occur on campus and may affect areas outside the mapped floodplain. Data was not available to evaluate the location or extent of stormwater flooding on campus.

Extent

Flood extent can be defined by the amount of land in the floodplain, detailed above, and the potential magnitude of flooding as measured by flood depth and velocity. As shown in **Figure H.8** the SFHA does not intersect with the UNC-P campus. However, flooding may also occur on the campus when an intense rainfall occurs within the urban area and cannot be carried away by natural or urban drainage systems as fast as it is falling.

Impact: 1 – Minor

Historical Occurrences

Table H.24 details the historical occurrences of flooding for Robeson County identified from 2000 through 2019 by NCEI Storm Events database. According to NCEI, 29 recorded flood-related events affected Robeson County from 2000 to 2019 causing an estimated $4,910,000 in property damage, with two fatalities and no injuries or crop damage. 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 H.24 – NCEI Records of Flooding for Robeson County, 2000-2019

Location	Date	Deaths/Injuries	Reported Property Damage	Reported Crop Damage
Flash Flood				
ST PAULS	6/15/2001	0/0	$0	$0
LUMBERTON	6/16/2001	0/0	$0	$0
ELROD	10/8/2016	0/0	$2,000,000	$0
SMITHS	10/8/2016	0/0	$500,000	$0
POWERS	10/8/2016	0/0	$2,000,000	$0
NORTH LUMBERTON	10/8/2016	0/0	$250,000	$0
LUMBERTON	9/15/2018	2/0	$50,000	$0
RAYNHAM	9/15/2018	0/0	$10,000	$0
RED SPGS	9/15/2018	0/0	$10,000	$0

Location	Date	Deaths/Injuries	Reported Property Damage	Reported Crop Damage
ROZIERS	9/15/2018	0/0	$10,000	$0
SMITHS	9/15/2018	0/0	$20,000	$0
OAKLAND	9/15/2018	0/0	$10,000	$0
LUMBERTON MUNI ARPT	9/16/2018	0/0	$20,000	$0
BUIE	9/16/2018	0/0	$30,000	$0
Flood				
LUMBERTON	9/9/2008	0/0	$0	$0
ROZIERS	5/16/2010	0/0	$5,000	$0
MOSS NECK	8/19/2011	0/0	$2,000	$0
LUMBERTON MUNI ARPT	7/11/2012	0/0	$0	$0
ST PAULS	6/27/2013	0/0	$0	$0
RENNERT	7/1/2013	0/0	$0	$0
RED SPGS	7/1/2013	0/0	$0	$0
NORTH LUMBERTON	6/26/2015	0/0	$0	$0
POWERS	6/26/2015	0/0	$0	$0
Heavy Rain				
LUMBERTON	7/13/2003	0/0	$0	$0
FAIRMONT	10/6/2005	0/0	$0	$0
FAIRMONT	6/5/2009	0/0	$0	$0
ST PAULS	8/14/2009	0/0	$0	$0
LUMBERTON	7/27/2010	0/0	$0	$0
LUMBERTON	6/3/2013	0/0	$0	$0
	Total	**2/0**	**$4,910,000**	**$0**

Source: NCEI

The following event narratives are provided in the NCEI Storm Events Database and illustrate the impacts of flood events on the county:

- **10/8/2016** - Flooding was reported throughout Pembroke. Flood waters were reportedly entering structures to include homes. Several roads were under water and impassable. Smith Mill Road was washed out due to flooding. Adjacent roadways and structures were impacted by the flood waters. Kahn Drive was flooded with water entering the first floor of the Econo Lodge Inn and Suites. Major Hurricane Matthew moved up the southeast coast and slowly weakened to a category 1 storm as it moved up along the South Carolina coast and then eastward near the North Carolina coast. The hurricane brought 6 to 12 inches of rain and up to 18 inches to some areas of southeast North Carolina, with the bulk of the rainfall occurring within a 12 hour period. The result was historic flooding; widespread flash flooding, and an extended period of major to record river flooding. Matthew's flooding rains, surge and wind brought loss of life, displaced tens of thousands of people, and caused hundreds of millions of dollars in structural damage as homes and businesses were devastated or totally destroyed. Major infrastructure will have to be repaired or rebuilt.
- **9/15/2008** - Route 1588 was closed and impassable. Flooding as also reported on Pine Log Road and Hwy 711. Flooding was also reported on Briarcliff Lane. A male drove into a sinkhole and died. Davis Road near Hwy 301 was impassable due to flooding. The Swiftwater Rescue Team was called to Tartan Road with waist deep water. A female drove into a road that was washed out and drowned. Shaw Mill road was impassable near Dean Road due to flooding.

- **9/16/2008** - Interstate 95 North was closed at the overpass for US-74. Snipes road was completely washed out near McQueen Road.

The state of North Carolina has had two FEMA Major Disaster Declarations for severe storms that include elements of flooding in 1962 and 1964 along with four Major Disaster Declarations for Hurricanes in 1954, 1955, 1958, 1960 which may have included damages associated with flooding. Additionally, Robeson County has received two Major Disaster Declaration for severe storms including elements of flooding in 1998 and 2011, along with eight Major Disaster Declarations for Hurricanes in 1996, 1998, 1999, 2003, 2004, 2016, 2018, and 2019 which also may have included damages associated with flooding.

Probability of Future Occurrence

By definition, SFHAs are those areas that will be inundated by the flood event having a 1-percent chance of being equaled or exceeded in any given year. While exposure to flood hazards varies across jurisdictions, all jurisdictions have at least some area of land in FEMA-mapped flood hazard areas. This delineation is a useful way to identify the most at-risk areas, but flooding does not occur in set intervals; any given flood may be more or less severe than the defined 1-percent-annual-chance flood. There is also risk of localized and stormwater flooding in areas outside the SFHA and at different intervals than the 1% annual chance flood.

Floods of varying severity occur regularly in Pembroke and impacts from past flood events have been noted by NCEI. NCEI reports 29 flood-related events in the 20-year period from 2000-2019, which equates to an annual probability greater than 100% for Robeson County. Therefore, the probability of flooding is considered highly likely.

Probability: 4 – Highly Likely

Vulnerability Assessment

Methodology & Assumptions

To quantify vulnerability, Wood performed a GIS spatial analysis of the flood hazard by overlaying the mapped SFHA on the building footprints provided by the UNC Division of Information Technology and NCEM iRisk database. For the UNC-P campus, there are no structures located within the SFHA.

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 systems lose 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 high risk when driving through flooded streets. NCEI records reported two deaths caused by flood events in Robeson County.

An estimate of population at risk to flooding was developed based on the assessment of residential property at risk. The count of residential buildings at risk, 76, was multiplied by 2.61, which is the 2014-2018 American Community Survey (ACS) estimate of average household size for Pembroke. Overall, approximately 199 people live in buildings that could be damaged by the 1%-annual-chance flood.

Property

Administration buildings, education and/or extracurricular facilities, housing, as well as critical facilities and infrastructure such as transportation, water, energy, and communication systems may be damaged or destroyed by flood waters.

Table H.25 details the estimated losses for the 1%-annual-chance flood event for the campus. The total damage estimate value is based on damages to the total of building value. Land value is not included in any of the loss estimates as generally land is not subject to loss from floods.

Table H.25 – Estimated Building Damage and Content Loss for 1% Annual Chance Flood

Occupancy Type	Total Buildings with Loss	Total Value	Estimated Building Damage	Loss Ratio
Administration	0	$0	$0	0%
Critical Facilities	0	$0	$0	0%
Education/ Extracurricular	0	$0	$0	0%
Housing	0	$0	$0	0%
Total	**0**	**$0**	**$0**	**0%**

Source: UNC Division of Information Technology; NCEM iRisk; NC Department of Insurance; USACE Wilmington District Depth-Damage Function

The loss ratio is the loss estimate divided by the total potential exposure (i.e., total of improved value for all buildings located within the Zone AE) and displayed as a percentage of loss. FEMA considers loss ratios greater than 10% to be significant and an indicator a community may have more difficulties recovering from a flood. Loss ratios for all occupancy types with identified structures on the UNC-P campus are 0%, meaning that in the event of a flood with a magnitude of the 1%-annual-chance event or greater, the planning area would be minimally impacted.

None of the critical facilities identified for UNC-P are located within the 1%-annual-chance floodplain, therefore there are no estimated damages.

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 planning area. According to 2020 NFIP records, there are no repetitive loss properties on the UNC-P campus.

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.

Changes in Development

The likelihood of future flood damage can be reduced through appropriate land use planning, building siting and building design. In addition, the UNC-P Facilities Management works to maintain compliance with all applicable state and federal regulations regarding water resources, provides a regulatory framework to ensure development has minimal impact on the environment, and manages the stormwater infrastructure.

Problem Statement

- While the 1% annual chance floodplain does not impact the UNC-P campus, flooding may also occur on the campus when an intense rainfall occurs within the urban area and cannot be carried away by natural or urban drainage systems as fast as it is falling.

H.5.5 Geological – Landslide

Hazard	Probability	Impact	Spatial Extent	Warning Time	Duration	PRI Score
Landslide	Unlikely	Minor	Negligible	6 to 12 hours	Less than 6 hrs	1.2

Location

Robeson County is located within the Coastal Plain physiographic province of North Carolina. The Coastal Plain province encompasses approximately 45 percent of the land area of the state. The Coastal Plain province is characterized by flat land to gently rolling hills and valleys. Elevations range from sea level near the coast to roughly 600 feet in the southern Inner Coastal Plain.

The U.S. Geological Survey (USGS) has produced landslide susceptibility and incidence mapping of the U.S., as shown in **Figure H.9** 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, Robeson County faces low susceptibility and incidence of landslides.

Spatial Extent: 1 – Small

Extent

In low-relief areas, such as the Robeson County area, landslides may occur as cut-and fill failures (roadway and building excavations), river bluff failures, lateral spreading landslides, collapse of mine-waste piles (especially coal), and a wide variety of slope failures associated with quarries and open-pit mines. In these instances, impacts are limited to the defined area. Event magnitude is also dependent on topography; landslide risk is higher in areas with steeper slopes. Given the gentle topography the county, the magnitude of any landslides on UNC-P's campus would be minor.

Impact: 1 – Minor

Historical Occurrences

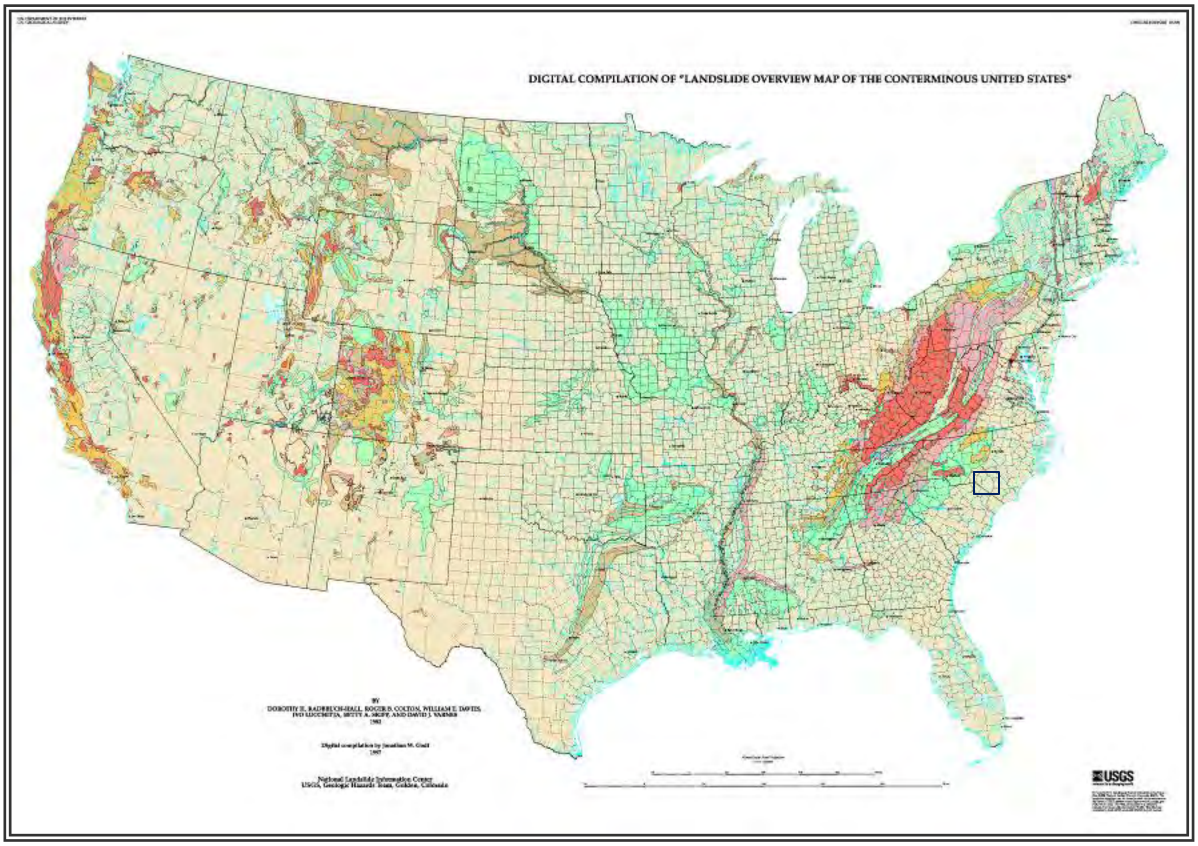
There were no available records of past landslide events for Robeson County. When looking at **Figure H.9**, it is shown that all of Robeson County is in an area with low susceptibility incidence to landslides.

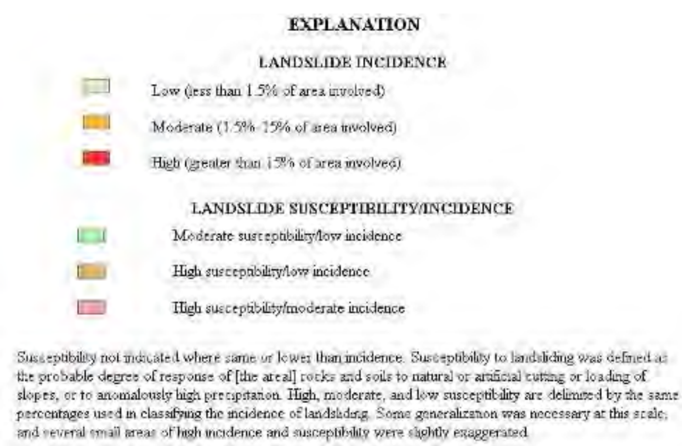
Probability of Future Occurrence

There were no records found for any landslide events occurring in Robeson County between 2000 and 2019. Since this area does not have any historical occurrences, it is 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

Figure H.9 – Landslide Incidence and Susceptibility





Source: USGS

Vulnerability Assessment

People

People are unlikely to sustain serious physical harm as a result of landslides in Robeson 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 Robeson 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 Robeson County are unlikely to cause any more severe impacts.

H.5.6 Hurricane

Hazard	Probability	Impact	Spatial Extent	Warning Time	Duration	PRI Score
Hurricane	Likely	Critical	Large	More than 24 hrs	Less than 24 hrs	2.9

Location

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

Storm surges, or storm floods, are limited to the coastal counties of North Carolina, therefore UNC-P is not exposed to storm surge. However, hurricane winds can impact the entire campus, so the spatial extent was determined to be large

Spatial Extent: 4 – Large

Extent

Hurricane intensity is classified by the Saffir-Simpson Scale (**Table H.26**), which rates hurricane intensity on a scale of 1 to 5, with 5 being the most intense.

Table H.26 – 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 H.27** 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 H.27 – 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

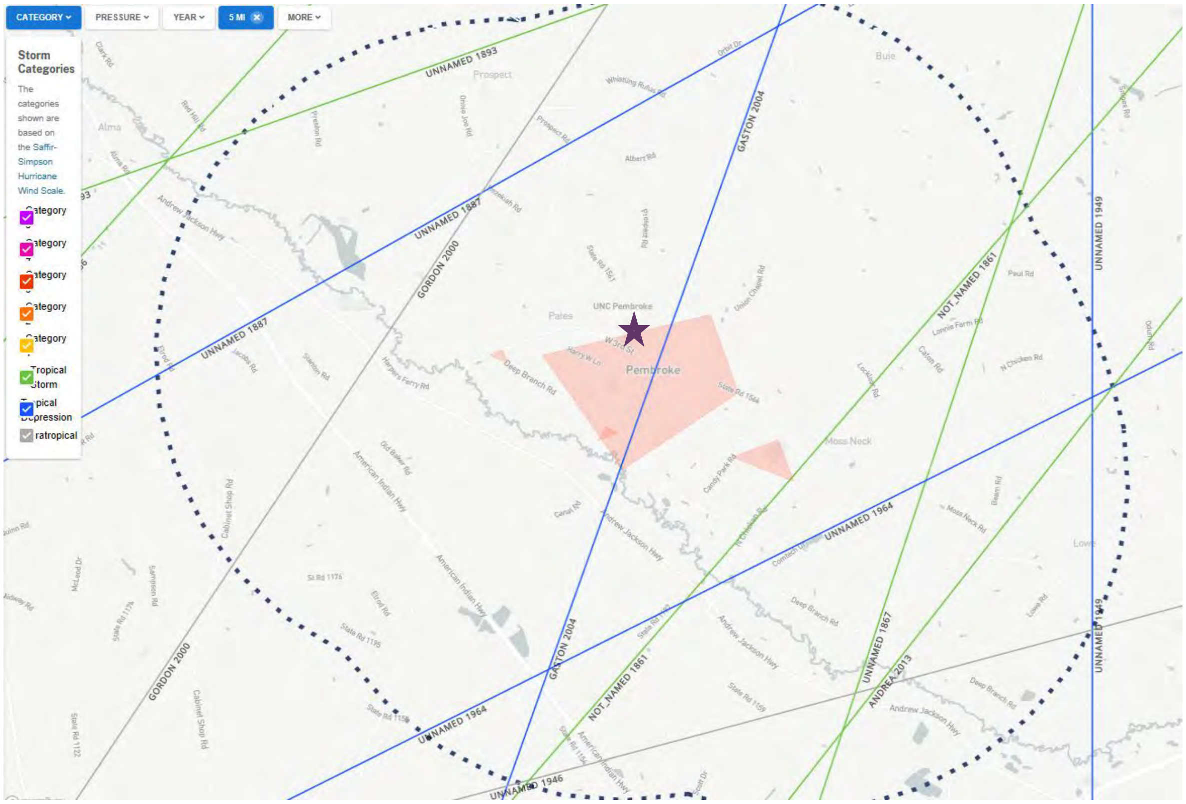
Tropical cyclones weaken relatively quickly after making landfall; therefore, Robeson County will not typically experience major hurricane force winds, though these occurrences are possible. Hurricane Gaston passed within 5 miles of the campus as a tropical depression with wind speeds around 35 mph in 2004. Hurricane Fran also passed within 5 miles of UNC-P's campus as a tropical storm with wind speeds around 46 mph in 2013.

Impact: 3 – Critical

Historical Occurrences

Storm tracks for hurricane-related events that have passed within 5 miles of UNC-P's campus were obtained from NOAA 's database and are shown in **Figure H.10**. UNC-P's location is noted in the figure by the purple star. The NCEI Storm Events database has recorded four tropical storms that passed through Robeson County between 2000 and 2019. **Table H.28** details the historical occurrences.

Figure H.10 – Hurricane and Tropical Storm Tracks within 5 Miles of UNC-P



Source: NOAA Office of Coastal Management; image captured directly from website. Black dashed line is 5 mile buffer zone.

Table H.28 – Recorded Hurricane and Tropical Storm Events for Robeson County, 2000-2019

Date	Type	Storm	Deaths/ Injuries	Property Damage	Crop Damage
8/29/2004	Tropical Storm	Hurricane Gaston	0/0	$0	$0
9/2/2016	Tropical Storm	Hurricane Hermine	0/0	$11,000	$0
10/8/2016	Tropical Storm	Hurricane Matthew	0/0	$0	$0
9/15/2018	Tropical Storm	Hurricane Florence	0/0	$60,000	$0
		Total	**0/0**	**$71,000**	**$0**

Source: NCEI

According to NCEI, four recorded hurricane-related events affected Robeson County from 2000 to 2019 causing an estimated $71,000 in property damage. There were no injuries, fatalities, or crop damage recorded for any of these events.

The following event narratives are provided in the NCEI Storm Events Database and illustrate the impacts of hurricane and tropical storm events on the county:

Hurricane Hermine (2016) – Hurricane Hermine made landfall as a minimal category 1 hurricane near the Florida Panhandle the night of September 1st. The hurricane weakened to a tropical storm as it moved up the eastern seaboard. The storm entered southeast NC the morning of September 2nd, and moved rapidly northeast. The storm produced very heavy rainfall with flash flooding, as well as some scattered reports of wind damage. Rainfall amounts averaged around six inches, with isolated amounts around ten inches. The highest wind gusts were around 65 mph.

Hurricane Matthew (2016) – Hurricane Matthew moved up the eastern seaboard, bringing very heavy rain and strong winds. Rainfall amounts over 12 inches occurred in multiple areas of the county. Wind gusts were surprisingly high, with a gust to 67 mph at the Lumberton Airport. Tropical storm force winds and flooded ground caused widespread tree and power line damage. The river gauge at the Lumber River at Lumberton failed, however the high watermark data from the U.S. Geological Survey indicated the water level may have reached over 25 feet. This exceeded the previous record by over 4 feet. This level bypassed the levee that protects parts of Lumberton from the river due to water passing under I-95 via VFR road. One elderly male died in his home on West Fifth Street on 10/9. The man had a heart condition and when power was lost, he was without oxygen. The family believes he may have died of a heart attack and then fell into flood waters which had overtaken his home from the Lumber River. The Lumber River also exceeded record levels at Boardman by about 2.5 feet. This resulted in the closure of U. S. Route 74, the main route between Wilmington and Lumberton. Numerous water rescues were required along and near the Lumber River. Many homes were flooded in Pembroke. This was one of the hardest hit counties due to the historic river flooding. The offices of the Robesonian Newspaper were flooded.

Hurricane Florence (2018) – Hurricane Florence began its long Atlantic trek from the Cape Verde Islands in early September. It made landfall near Wrightsville Beach during the morning of September 14th. The barometric pressure at landfall was 959 millibars, or 28.32 inches. The strongest winds were recorded at 106 mph at Cape Lookout, as well as 105 mph measured at the Wilmington International Airport. In addition to the strong storm surge, there was historic rainfall totals of 20 to 25 inches, with isolated totals of 35 inches in parts of Bladen and Robeson counties. Flash Flooding was severe and widespread, with many communities experiencing flooding for the first time. River flooding was epic, with dozens of main highways impassible. Significant flooding occurred for weeks after the storm had departed. The hurricane spawned 19 tornadoes, one causing significant damage to 8 structures in the Sydney community in Columbus county. The community at Lake Waccamaw experienced more damage than Hurricane Floyd in 1999, the previous benchmark for the area. In Pender County, over 6000 structures had damage, with 2800 structures suffered major damage or were destroyed altogether. Damage estimates from wind and water are in the tens of billions of dollars, making it one of the costliest hurricanes ever.

The state of North Carolina has had four FEMA Major Disaster Declarations for Hurricanes in 1954, 1955, 1958, 1960. Additionally, Robeson County has received eight Major Disaster Declarations for Hurricanes in 1996, 1998, 1999, 2003, 2004, 2016, 2018, and 2019.

Probability of Future Occurrence

In the 20-year period from 2000 through 2019, four hurricanes and tropical storms have impacted Robeson County, which equates to a 20 percent annual probability of hurricane winds impacting the county. This probability does not account for impacts from hurricane rains, which may also be severe. Overall, the probability of a hurricane or tropical storm impacting the County is likely.

Probability: 3 – Likely

Vulnerability Assessment

Methodologies and Assumptions

To quantify vulnerability, Wood performed a Level 1 hurricane wind analysis in Hazus 4.2 for three scenarios: a historical recreation of Hurricane Fran (1996) and simulated probabilistic wind losses for a 200-year and a 500-year event storm. The analysis utilized general building stock information based on the 2010 Census. The UNC-P campus is located within a single census tract encompassing 6.66 square miles. The vulnerability assessment results are for wind-related damages. Hurricanes may also cause substantial damages from heavy rains and subsequent flooding, which is addressed in Section A.5.2. Flood.

People

The very young, the elderly and disabled individuals are more vulnerable to harm from hurricanes, as are those who are unable to evacuate for medical reasons, including 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 or ongoing treatment. For all affected populations, 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.

Table H.29 details the likelihood of building damages by occupancy type from varying magnitudes of hurricane events.

Table H.29 – Likelihood of Buildings Damages Impacted by Hurricane Wind Events

Occupancy	Buildings at Risk	Value at Risk	Likelihood of Damage (%)				
			None	Minor	Moderate	Severe	Destruction
Hurricane Fran (1996)							
Agriculture	7	$1,968,000	99.52%	0.47%	0.01%	0.00%	0.00%
Commercial	110	$67,896,000	99.42%	0.57%	0.01%	0.00%	0.00%
Education	21	$29,850,000	99.40%	0.60%	0.00%	0.00%	0.00%
Government	3	$735,000	99.39%	0.61%	0.00%	0.00%	0.00%
Industrial	19	$11,791,000	99.32%	0.67%	0.01%	0.00%	0.00%
Religion	17	$15,192,000	99.56%	0.44%	0.00%	0.00%	0.00%
Residential	1,355	$373,260,000	99.44%	0.54%	0.02%	0.00%	0.00%
200-year Hurricane Event							
Agriculture	5	$1,968,000	74.13%	17.23%	5.75%	2.59%	0.30%
Commercial	86	$67,896,000	77.23%	15.61%	6.26%	0.88%	0.02%
Education	16	$29,850,000	77.59%	15.68%	6.00%	0.73%	0.00%
Government	2	$735,000	77.52%	15.62%	6.11%	0.75%	0.00%
Industrial	14	$11,791,000	74.88%	15.44%	7.22%	2.25%	0.21%
Religion	13	$15,192,000	77.93%	16.88%	4.68%	0.51%	0.00%
Residential	990	$373,260,000	77.62%	20.69%	6.39%	0.20%	0.10%
500-year Hurricane Event							
Agriculture	4	$1,968,000	52.63%	26.84%	12.69%	6.73%	1.11%
Commercial	63	$67,896,000	56.52%	23.30%	15.88%	4.18%	0.12%
Education	12	$29,850,000	56.54%	23.25%	16.00%	4.21%	0.00%
Government	2	$735,000	56.46%	23.01%	16.21%	4.32%	0.00%
Industrial	10	$11,791,000	53.41%	21.77%	16.78%	7.62%	0.78%

Occupancy	Buildings at Risk	Value at Risk	Likelihood of Damage (%)				
			None	Minor	Moderate	Severe	Destruction
Religion	10	$15,192,000	56.97%	26.93%	13.14%	2.96%	50.00%
Residential	702	$373,260,000	51.52%	30.46%	16.41%	1.15%	0.46%

Table H.30 details the estimated building and content damages by occupancy type for varying magnitudes of hurricane events.

Table H.30 – Estimated Buildings Impacted by Hurricane Wind Events

Area	Residential	Commercial	Industrial	Others	Total
Hurricane Fran (1996)					
Building	$313,570	$9,060	$1,180	$4,770	$328,580
Content	$57,680	$0	$0	$0	$57,680
Inventory	$0	$0	$0	$0	$0
Total	**$371,250**	**$9,060**	**$1,180**	**$4,770**	**$386,260**
200-year Hurricane Event					
Building	$6,869,640	$584,160	$135,440	$304,310	$7,893,550
Content	$1,343,750	$242,470	$92,760	$131,620	$1,810,600
Inventory	$0	$7,610	$17,960	$1,230	$26,800
Total	**$8,213,390**	**$834,240**	**$246,160**	**$437,160**	**$9,730,950**
500-year Hurricane Event					
Building	$15,010,810	$1,798,300	$401,270	$1,006,800	$18,217,180
Content	$3,685,660	$940,120	$311,680	$548,850	$5,486,310
Inventory	$0	$29,320	$59,240	$3,750	$92,310
Total	**$18,696,470**	**$2,767,740**	**$772,190**	**$1,559,400**	**$23,795,800**

The damage estimates for the 500-year hurricane wind event total $23,795,800, which equates to a loss ratio of 16.1 percent of the total building exposure. These damage estimates account for only wind impacts and actual damages would likely be higher due to flooding.

Environment

Hurricane winds can cause massive damage to the natural environment, uprooting trees and other debris within the storm's path. Animals can either be killed directly by the storm or impacted indirectly through changes in habitat and food availability caused by high winds and intense rainfall. Endangered species can be dramatically impacted. Forests can be completely defoliated by strong winds.

Changes in Development

Future development that occurs in the planning area should consider high wind hazards at the planning, engineering and architectural design stages. The University should consider evacuation planning in the event of a hurricane event.

Problem Statement

- Historical tracks of multiple hurricane events pass within 5-miles of the UNC-P Campus.

- For the 20-year period from 2000 through 2019, there have been 4 hurricane wind events causing around $71,000 in damage for Robeson County.

H.5.8 Severe Winter Weather

Hazard	Probability	Impact	Spatial Extent	Warning Time	Duration	PRI Score
Severe Winter Weather	Highly Likely	Limited	Large	More than 24 hrs	Less than 1 week	3.0

Location

Severe winter weather is usually a countywide or regional hazard, impacting the entire county at the same time. 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. Robeson 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, severe winter weather can occur anywhere in the county.

Extent

The National Oceanic and Atmospheric Administration (NOAA) uses the Regional Snowfall Index (RSI), shown in **Table H.31** for the Robeson County region, to assess the societal impact of winter storms in the six easternmost regions in the United States. The index makes use of population and regional differences to assess the impact of snowfall. For example, areas which receive very little snowfall on average may be more adversely affected than other regions, resulting in a higher severity. The County may experience any level on the RSI scale. Robeson County receives an average of 1 inch of snowfall per year. According to NCEI, the greatest snowfall amounts to impact Robeson County have been around 10 inches. During the snowstorm of December 24 to December 26, 2010, the county was classified as a Category 1 on the RSI scale. It is possible that more severe events and impacts could be felt in the future.

Table H.31 – Regional Snowfall Index (RSI) Values

Category	RSI Value	Description
1	1-3	Notable
2	3-6	Significant
3	6-10	Major
4	10-18	Crippling
5	18+	Extreme

Source: NOAA

Severe winter weather often involves 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 H.11**, provides a formula for calculating the dangers of winter winds and freezing temperatures. This presents wind chill temperatures which are based on the rate of heat loss from exposed skin caused by wind and cold. As the wind increases, it draws heat from the body, driving down skin temperature and eventually the internal body temperature.

Figure H.11 – NWS Wind Chill Temperature Index

Wind Chill Chart

Wind (mph) \ Temperature (ºF) Calm	40	35	30	25	20	15	10	5	0	-5	-10	-15	-20	-25	-30	-35	-40	-45
5	36	31	25	19	13	7	1	-5	-11	-16	-22	-28	-34	-40	-46	-52	-57	-63
10	34	27	21	15	9	3	-4	-10	-16	-22	-28	-35	-41	-47	-53	-59	-66	-72
15	32	25	19	13	6	0	-7	-13	-19	-26	-32	-39	-45	-51	-58	-64	-71	-77
20	30	24	17	11	4	-2	-9	-15	-22	-29	-35	-42	-48	-55	-61	-68	-74	-81
25	29	23	16	9	3	-4	-11	-17	-24	-31	-37	-44	-51	-58	-64	-71	-78	-84
30	28	22	15	8	1	-5	-12	-19	-26	-33	-39	-46	-53	-60	-67	-73	-80	-87
35	28	21	14	7	0	-7	-14	-21	-27	-34	-41	-48	-55	-62	-69	-76	-82	-89
40	27	20	13	6	-1	-8	-15	-22	-29	-36	-43	-50	-57	-64	-71	-78	-84	-91
45	26	19	12	5	-2	-9	-16	-23	-30	-37	-44	-51	-58	-65	-72	-79	-86	-93
50	26	19	12	4	-3	-10	-17	-24	-31	-38	-45	-52	-60	-67	-74	-81	-88	-95
55	25	18	11	4	-3	-11	-18	-25	-32	-39	-46	-54	-61	-68	-75	-82	-89	-97
60	25	17	10	3	-4	-11	-19	-26	-33	-40	-48	-55	-62	-69	-76	-84	-91	-98

Frostbite Times: 30 minutes; 10 minutes; 5 minutes

$$\text{Wind Chill (ºF)} = 35.74 + 0.6215T - 35.75(V^{0.16}) + 0.4275T(V^{0.16})$$

Where, T= Air Temperature (ºF) V= Wind Speed (mph)

Effective 11/01/01

Source: https://www.weather.gov/safety/cold-wind-chill-chart

The most significant recorded snow depth over the last 20 years took place in January 2018, with recorded depths of up to 12 inches across the county.

Impact: 2 – Limited

Spatial Extent: 4 – Large

Historical Occurrences

To get a full picture of the range of impacts of a severe winter weather, data for the following weather types as defined by the National Weather Service (NWS) 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 Pembroke 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.

According to the NCEI Storm Events Database, there were three frost/freeze events, five heavy snow events, five ice storm events, and 14 combined winter storm/winter weather events in Robeson County during the 20-year period from 2000 through 2019. As reported in NCEI, severe winter weather caused $1,040,000 in property damage and one injury, but they did not cause any fatalities, or crop damage. It should be noted though that these types of impacts may not have been reported and are possible in future events. Events in Robeson County by incident are recorded in **Table H.32**.

Table H.32 – Recorded Severe Winter Weather Events in Robeson County, 2000-2019

Event Type	Event Count	Fatalities	Injuries	Property Damage	Crop Damage
Frost/Freeze	3	0	0	$0	$0
Heavy Snow	5	0	1	$0	$0
Ice Storm	5	0	0	$4,500,000	$0
Winter Storm	9	0	0	$20,000	$0
Winter Weather	5	0	0	$30,000	$0
Total	**27**	**0**	**1**	**$4,550,000**	**$0**

Source: NCEI

Storm impacts from NCEI are summarized below:

December 3, 2000 – Low pressure moving up the coast of the Carolinas combined with cold air and an upper level disturbance moving in from the Midwest to create a winter weather scenario. Snowfall measured up to around 10 inches in parts of east central North Carolina, while less fell further south in southeast NC and northeast SC. A trained spotter in Robeson county reported 3 inches, and 1 to 2 inches fell in Bladen and Florence counties. Dillon county received around an inch. The rest of the area reported some snow and sleet, but no accumulations. The wintery mix was directly responsible for numerous traffic accidents, reported by 911 and law enforcement.

December 4, 2002 – Between a tenth and a quarter inch of ice was recorded. The ice caused branches to snap on many trees, causing power outages for 9000 residences. No major traffic accidents were noted. Strong high pressure over the mid-Atlantic fed a shallow layer of cold air across interior portions of the state. Low pressure formed over the Gulf coast, spreading moisture over the Carolinas. The result was freezing rain.

January 30, 2010 – A winter mix of sleet and ice fell over much of the county. Based on reports, up to a quarter inch of ice accumulated, with a half inch of ice and sleet combined accumulation over the northern portion of the county. Numerous power outages were reported.

December 26, 2010 – Between five and seven inch of snow fell across the county. There were sporadic power outages, and one motorist was injured when their car skidded off the road on Hwy 211. A limb 12 inches in diameter and 20 feet in length fell from the weight of the snow.

Probability of Future Occurrence

NCEI records 27 severe winter weather related events during the 20-year period from 2000 through 2019, which equates to an annual probability greater than 100%. Therefore, the overall probability of severe winter weather in the county is considered highly likely (near or more than 100% annual probability).

Probability: 4 – Highly Likely

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.

The loss of use estimates provided in **Table H.33** were calculated using FEMA's publication *What is a Benefit?: Guidance on Benefit-Cost Analysis of Hazard Mitigation Project*, June 2009. These figures are used to provide estimated costs associated with the loss of power in relation to the populations served on campus. The loss of use is provided in the heading as the loss of use cost per person per day of loss. The estimated loss of use provided for the campus represents the loss of service of the indicated utility for one day for 10 percent of the population. These figures do not take into account physical damages to utility equipment and infrastructure. The estimated on-campus population used in the table below was determined by taking 25% of the current enrollment for UNC-P, which is 8,262 students.

Table H.33 – Loss of Use Estimates for Power Failure Associated with Severe Winter Weather

On-Campus Population (Fall 2020)	Estimated Affected Population (10%)	Electric Loss of Use Estimate ($126 per person per day)
2,066	207	$26,082

Property

The NCEI reported $4,550,000 of property damage in association with any winter weather events between 2000 and 2019 for Robeson County. Based on these records, the County experiences an estimated annualized loss of $227,500 in property damage. The average impact from winter weather events per incident in the County is $168,518.

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.

Changes in Development

Future development could potentially increase vulnerability to this hazard by increasing demand on the utilities and increasing the exposure of infrastructure networks. UNC-P may wish to consider developing a flexible emergency power network to provide efficient back-up power for vulnerable populations, critical facilities, and research facilities.

Problem Statement

- Severe winter weather events are highly likely for Robeson County and the UNC-P campus.

H.5.9 Tornadoes/Thunderstorms

Hazard	Probability	Impact	Spatial Extent	Warning Time	Duration	PRI Score
Tornado/Thunderstorm	Likely	Critical	Large	Less than 6 hrs	Less than 6 hrs	3.1

Location

Thunderstorm wind, lightning, and hail events do not have a defined vulnerability zone. The scope of lightning and hail is generally confined to the footprint of its associated thunderstorm. Although these events occur similarly throughout the planning area, they are more frequently reported in more urbanized areas because damages are more likely to occur where exposure is greater in more densely developed urban areas.

Thunderstorm Winds

The entirety of UNC-P's campus can be affected by severe weather hazards. Thunderstorm wind events can span many miles and travel long distances, covering a significant area in one event. Due to the small size of the planning area, any given event will impact the entire planning area, approximately 50% to 100% of the planning area could be impacted by one event.

Spatial Extent: 4 – Large

Lightning

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 UNC-P is exposed to lightning.

Spatial Extent: 4 – Large

Hail

Hailstorms frequently accompany thunderstorms, so their locations and spatial extents coincide. However, large-scale hail tends to occur in a more localized area within the storm.

Spatial Extent: 4 – Large

Tornado

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

Spatial Extent: 4 – Large

Extent

Thunderstorm Winds

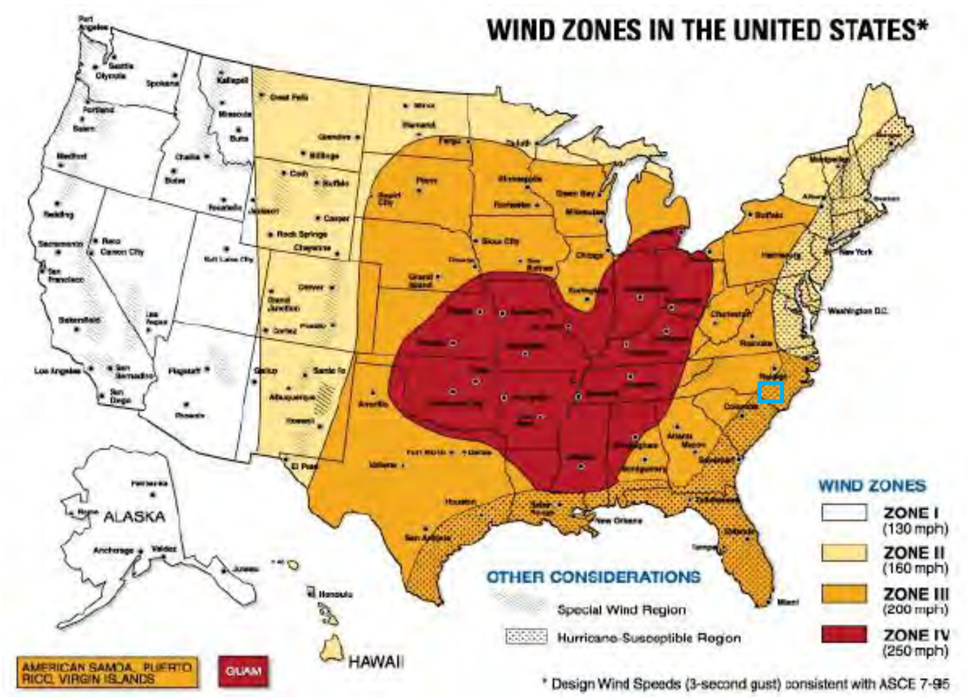
The magnitude of a thunderstorm event can be defined by the storm's maximum wind speed and its impacts. NCEI divides wind events into several types including High Wind, Strong Wind, Thunderstorm Wind, Tornado and Hurricane. For this severe weather risk assessment, High Wind, Strong Wind and Thunderstorm 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.

Figure H.12 shows wind zones in the United States. Robeson County, indicated by the blue square, is within Wind Zone III, which indicates that speeds of up to 200 mph may occur within the county.

Figure H.12 – Wind Zones in the United States



Source: FEMA 320, Taking Shelter from the Storm, 3rd edition, https://www.fema.gov/pdf/library/ism2_s1.pdf

The strongest recorded thunderstorm wind event for Robeson County occurred on May 11, 2014 with a measured gust of 109 mph. The event reportedly resulted in property damages around $878,000 with one injury and no fatalities or crop damages.

Impact: 2 – Limited

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, shown in **Table H.34**, is a common parameter that is part of fire weather forecasts nationwide.

Table H.34 – 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

Lightning Activity Level Scale	
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

Hail

The National Weather Service classifies hail by diameter size, and corresponding everyday objects to help relay scope and severity to the population. **Table H.35** indicates the hailstone measurements utilized by the National Weather Service.

Table H.35 – 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
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 H.36** describes typical intensity and damage impacts of the various sizes of hail.

Table H.36 – 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

Intensity Category	Diameter (mm)	Diameter (inches)	Size Description	Typical Damage Impacts
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 2000 and 2019 in Robeson County was a little over 1" in diameter; the largest diameter hail recorded in the County was 3", which occurred on February 24, 2016.

Impact: 1 – Minor

Tornado

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 and better correlation between damage and wind speed. It is also more precise because it considers the materials affected and the construction of structures damaged by a tornado. **Table H.37** shows the wind speeds associated with the enhanced Fujita scale ratings and the damage that could result at different levels of intensity.

Table H.37 – 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 Robeson County in the past 20 years was an EF2 on March 27, 2009. NCEI reports this event causing around $35,000 in property damage and one injury. The tornado was 2.02 miles long and 50 yards wide.

Impact: 3 – Critical

Historical Occurrences

Thunderstorm Winds

Between January 1, 2000 and December 31, 2019, the NCEI recorded wind speeds for 229 separate incidents of thunderstorm winds, occurring on 111 separate days, for Robeson County. These events caused $3,594,750 in recorded property damage, four injuries, $4,000 in crop damage and no fatalities. The recorded gusts averaged 55.3 miles per hour, with the highest gusts recorded at 109 mph on May 11, 2009. Of these events, 77 caused property damage. Wind gusts with property damage recorded averaged $47,326 in damage, with the highest reported damage being a total of $878,000 on May 11, 2009. The incidents resulting in property damage for Robeson County are recorded below in **Table H.38**.

Table H.38 – Recorded Thunderstorm Winds Resulting in Property Damage, 2000-2019

Location	Date	Wind Speed (mph)	Fatalities	Injuries	Property Damage
ROWLAND	5/27/2000	65	0	0	$100,000
RED SPGS	4/1/2001	78	0	0	$300,000
RED SPGS	5/12/2001	60	0	0	$5,000
BARNESVILLE	6/1/2001	61	0	0	$25,000
LUMBERTON	6/16/2001	70	0	0	$50,000
MAXTON	3/16/2002	90	0	1	$750,000
FAIRMONT	6/14/2002	70	0	0	$100,000
PEMBROKE	5/2/2003	70	0	0	$30,000
MAXTON	5/25/2003	70	0	0	$60,000
PEMBROKE	5/31/2003*	70	0	0	$290,000
MAXTON	8/12/2004	60	0	0	$20,000
LUMBERTON	3/8/2005	65	0	0	$40,000
PEMBROKE	6/11/2006	65	0	0	$15,000
LUMBERTON	8/29/2007	60	0	0	$50,000
ALLENTON	5/11/2009*	109	0	1	$878,000
FAIRMONT	7/16/2009	50	0	0	$1,000
RENNERT	5/16/2010*	52	0	0	$12,000
FAIRMONT	5/23/2010*	52	0	0	$30,000
PHILDELPHUS	5/28/2010*	52	0	0	$4,000
EAST LUMBERTON	6/14/2010	52	0	0	$5,000
ORRUM	6/29/2010*	52	0	0	$45,500
SHANNON	7/25/2010	50	0	0	$1,000
EAST LUMBERTON	7/27/2010	56	0	0	$11,000
ROZIERS	11/17/2010	52	0	0	$8,000
RAYNHAM	4/5/2011*	56	0	0	$16,000
ROWLAND	4/16/2011*	65	0	0	$54,000
PROCTORVILLE	5/14/2011	50	0	0	$1,000
LUMBER BRIDGE	5/22/2011	52	0	0	$7,000
ALMA	6/12/2011*	52	0	0	$16,000
WAKULLA	6/18/2011*	50	0	0	$34,500
MAXTON	6/23/2011*	65	0	0	$32,000
ALLENTON	6/24/2011*	50	0	0	$5,000
RED SPGS	6/28/2011	56	0	0	$9,000
RENNERT	7/13/2011	56	0	0	$3,000
PROCTORVILLE	8/19/2011	50	0	0	$2,000
POWERS	8/21/2011*	52	0	0	$5,500

Location	Date	Wind Speed (mph)	Fatalities	Injuries	Property Damage
PARKTON	8/29/2011*	50	0	0	$3,000
PROCTORVILLE	11/16/2011*	50	0	0	$4,000
ROWLAND	7/5/2012*	52	0	0	$5,500
PARKTON	7/10/2012*	50	0	0	$7,000
ELROD	7/21/2012*	52	0	0	$9,000
FAIRMONT	1/30/2013*	50	0	0	$6,000
TOLARSVILLE	1/31/2013	50	0	0	$3,000
OAKLAND	4/19/2013*	50	0	0	$5,000
RAEMON	6/9/2013	52	0	0	$5,000
MC MILLAN	6/13/2013	52	0	0	$1,000
RENNERT	6/26/2013*	54	0	0	$56,000
BUIE	2/21/2014*	52	0	0	$18,000
PEMBROKE	5/29/2014	50	0	0	$1,000
BLOOMINGDALE	6/5/2014	61	0	0	$25,000
RED SPGS CNFDRTE ARP	6/17/2014	54	0	0	$4,000
FAIRMONT	6/19/2014*	52	0	0	$5,000
MC MILLAN	8/23/2014*	50	0	0	$8,000
PARKTON	9/3/2014*	50	0	0	$ 1, 500
FAIRMONT	6/18/2015	52	0	0	$10,000
MAXTON	6/19/2015*	52	0	0	$6,000
RENNERT	6/26/2015*	50	0	0	$2,000
RAYNHAM	6/27/2015*	56	0	0	$20,000
PEMBROKE	2/24/2016*	65	0	2	$88,000
PATES	5/2/2016*	52	0	0	$7,000
PURVIS	7/4/2016	56	0	0	$12,000
SMITHS	7/5/2016	50	0	0	$1,000
MAXTON	7/11/2016*	56	0	0	$40,000
POWERS	7/19/2016*	56	0	0	$12,250
ALMA	3/18/2017	50	0	0	$3,000
RED SPGS	6/24/2017	50	0	0	$2,000
PARKTON	7/10/2017*	50	0	0	$2,000
FAIRMONT	7/23/2017	50	0	0	$3,000
FAIRMONT	8/23/2017	52	0	0	$5,000
MC DONALDS	3/1/2018	50	0	0	$3,000
PATES	6/11/2018	60	0	0	$50,000
LUMBERTON	6/18/2018*	55	0	0	$10,500
SMITHS	6/24/2018*	55	0	0	$2,000
ROWLAND	4/19/2019*	56	0	0	$7,000
PARKTON	5/30/2019*	61	0	0	$100,000
FAIRMONT	6/22/2019	61	0	0	$20,000
MAXTON	7/19/2019	52	0	0	$10,000
		Total	**0**	**4**	**$3,594,750**

Source: NCEI
*Note: Multiple events occurred on these dates. Injuries, fatalities, and property damage are totaled, wind speed is highest reported.

The State of North Carolina received a FEMA Major Disaster Declaration in 1956 for severe storms that included heavy rains and high winds.

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

May 27, 2000 – Emergency manager reported trees and power lines down...8 buildings were damaged. Nickle-size hail was also reported.

April 1, 2001 – Damage occurred to 8 homes, with several sustaining significant damage. One roof was blown completely off. Many trees were down, all as a result of straight-line winds. The estimated peak wind for the event was 90 mph.

March 16, 2002 – A NWS Storm survey determined that straight line thunderstorm winds produce extensive damage to a trailer park in the northern part of Robeson county. 18 structures in all were damaged. 8 mobile homes were completely destroyed with one double wide trailer moved 10 feet off its foundation. A large metal electrical tower in the area was also blown down. A woman was injured in her mobile home during the event, dislocating her elbow. Large hail was also produced from the strong thunderstorm, with 2.5 hail reported in the area.

May 31, 2003 – Thunderstorm winds overturned a mobile home on Roberts Ave. Seven or eight homes were damaged in The Oaks subdivision. Car windows were blown out at a dealership. A sign was blown down at Rt 301 and Ten Mile Rd.

May 11, 2009 – A super-cell thunderstorm with damaging winds accelerated as it moved across Robeson County. Numerous trees and power lines were down and there was considerable structural damage. A National Weather Service Storm Survey concluded that a wet microburst produced a swath of damaging straight-line winds up to 125 mph. The microburst damage began near the intersection of Wilton Drive and Gem Road. Several trees were uprooted or snapped off and minor to moderate damage was observed to roof shingles and to siding. Significant damage was observed to the east of NC Highway 72. Numerous large trees were snapped off or uprooted along NC Highway 72 and significant structural damage occurred to approximately 8 homes on Sadie Drive. One of these homes was completely destroyed and another lost its entire roof. Several sheds and outbuildings were destroyed in this area. One adult woman suffered broken bones. The damage had a maximum path width of 350 yards and a path length of 2.25 miles. The Robeson County Emergency Manager estimated the damage at $813,000.00.

Lightning

According to NCEI data, there were seven lightning strikes reported between 2000 and 2019. These lightning strike events recorded two injuries and an estimated $506,500 worth of property damage. No crop damage or fatalities were 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. **Table H.39** details NCEI-recorded lightning strikes from 2000 through 2019 for Robeson County.

Table H.39 – Recorded Lightning Strikes in Pembroke, 2000-2019

Location	Date	Time	Fatalities	Injuries	Property Damage
ST PAULS	5/27/2001	900	0	0	$40,000
RED SPGS	8/18/2001	1400	0	0	$0
LUMBERTON	8/28/2001	1430	0	1	$300,000
ST PAULS	5/26/2006	1520	0	0	$15,000
ORRUM	6/16/2010	510	0	0	$1,500
LUMBERTON	6/12/2011	2128	0	1	$0
FAIRMONT	6/19/2014	2130	0	0	$150,000
		Total	**0**	**2**	**$506,500**

Source: NCEI

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

May 27, 2001 – Lightning started a fire that destroyed a storage unit at the Barker Mobile Home Park.

August 28, 2001 – Lightning struck a business (body shop) on 1205 Roberts Ave. The resulting fire destroyed the building, as well as caused second degree burns to the owner.

June 12, 2011 – A man was injured when lightning struck as he was unplugging a pool pump.

June 19, 2014 – Lightning struck the Lumber River Electric Company building at the corner of Main and Red Cross Streets. The resulting fire destroyed the interior of the structure.

Hail

NCEI records 63 days with hail incidents between January 1, 2000 and December 31, 2019 in Robeson County. These events were reported to have caused $120,400 in property damages, $50,000 in crop damages, and no deaths or injuries. The largest diameter hail recorded in the County was 3 inches, which occurred on February 24, 2016. The average hail size of all events in the County was just over one inch in diameter. **Table H.40** summarizes hail events for Robeson County. In some cases, hail was reported for multiple locations on the same day.

Table H.40 – Summary of Hail Occurrences in Robeson County

Beginning Location	Date	Hail Diameter
FAIRMONT	4/17/2000*	1
FAIRMONT	4/28/2000*	0.75
BARNESVILLE	6/3/2000*	1.75
PEMBROKE	6/14/2000*	1.75
PEMBROKE	6/22/2000*	0.75
ST PAULS	7/16/2000*	1.75
LUMBER BRIDGE	8/18/2000	0.75
ORRUM	4/1/2001	0.75
LUMBERTON	6/22/2001	0.75
BARNESVILLE	8/28/2001	0.88
LUMBERTON	3/31/2002*	1.75
RENNERT	7/31/2002	1.25
ORRUM	3/6/2003	0.75
PEMBROKE	5/3/2003*	1.75
FAIRMONT	5/25/2003	0.75
PEMBROKE	5/31/2003*	0.88
LUMBERTON	4/11/2004*	0.88
TOLARSVILLE	5/8/2004	0.75
LUMBERTON	5/23/2004	0.75
MARIETTA	4/3/2006	0.75
LUMBERTON	5/5/2006	0.88
PEMBROKE	5/20/2006	0.75
LUMBERTON	5/26/2006*	0.88
LUMBERTON	6/8/2006	0.88
MARIETTA	6/12/2007*	0.88
LUMBERTON	6/13/2007*	1
ORRUM	3/15/2008*	1.75
ALLENTON	5/11/2008	1

Beginning Location	Date	Hail Diameter
POWERS	6/9/2008*	0.88
FAIRMONT	6/17/2008	0.75
RAYNHAM	6/20/2008	1
SMITHS	7/31/2008	0.75
PEMBROKE	10/1/2008	0.75
LUMBERTON MUNI ARPT	5/11/2009	0.75
FAIRMONT	5/29/2009*	1.13
LUMBERTON	4/27/2010*	0.88
LOWE	5/23/2010*	1
RED SPGS	5/28/2010	0.75
ALLENTON	6/29/2010	0.75
EAST LUMBERTON	7/27/2010	0.88
LUMBERTON	2/28/2011	0.75
PEMBROKE	4/16/2011*	1.75
EAST LUMBERTON	4/28/2011	1.75
MC DONALDS	5/10/2011*	1.5
POWERS	5/14/2011	1
LUMBER BRIDGE	5/22/2011*	1.25
PLAINVIEW	5/27/2011*	1.75
ALLENTON	6/16/2011	1
LUMBERTON MUNI ARPT	3/25/2012	1
FAIRMONT	4/26/2012	1
ALLENTON	5/15/2012	1
MC MILLAN	5/22/2012	1
EAST LUMBERTON	5/23/2012	1
PARKTON	7/1/2012*	1.75
ELROD	7/21/2012	1
ALFORDS	9/3/2013	0.88
RED SPGS	4/28/2014	1
RED BANKS	5/29/2014*	0.88
PARKTON	4/9/2015	1.25
SMITHS	6/26/2015	0.88
PEMBROKE	2/24/2016*	3
TOLARSVILLE	5/3/2016*	1.25
ROZIERS	4/6/2017	0.75

Source: NCEI

*Note: Multiple events occurred on these dates. Hail diameter is highest reported for that specific date.

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

July 16, 2000 – Robeson 911 center reported golf ball size hail and large garbage dumpsters blown over.

April 16, 2011 – Hail to the size of golf balls was reported near the University of North Carolina at Pembroke. The hail lasted for about 15 minutes.

February 24, 2016 – Hail up to around 3 inches or greater was measured.

Tornado

NCEI storm reports were reviewed from 2000 through 2019 to assess whether recent trends varied from the longer historical record. According to NCEI, Robeson County has 17 recorded tornado events between

2000 and 2019, these events occurred on 10 different days. It is likely that there have been several tornados that occurred but went unreported. These tornado events reported $5,018,000 in property damage, 1 injury, and no deaths or crop damage. **Table H.41** shows historical tornadoes in Robeson County recorded in NCEI between 2000 and 2019.

Table H.41 – Recorded Tornadoes in Robeson County, 2000-2019

Beginning Location	Date	Time	Magnitude	Deaths	Injuries	Property Damage	Crop Damage
FAIRMONT	8/18/2001	1345	F0	0	0	$25,000	$0
ORRUM	9/7/2004	1305	F0	0	0	$0	$0
LUMBERTON	9/7/2004	1347	F0	0	0	$0	$0
MARIETTA	9/7/2004	1453	F1	0	0	$200,000	$0
MARIETTA	9/7/2004	1710	F0	0	0	$3,000	$0
ST PAULS	11/15/2008	0135	EF0	0	0	$50,000	$0
ALLENTON	3/27/2009	1532	EF0	0	0	$5,000	$0
MC MILLAN	3/27/2009	1602	EF2	0	1	$35,000	$0
ROWLAND	4/16/2011	1433	EF1	0	0	$1,500,000	$0
POWERS	4/16/2011	1447	EF1	0	0	$3,000,000	$0
RENNERT	9/6/2011	1841	EF0	0	0	$20,000	$0
RED BANKS	2/21/2014	1215	EF0	0	0	$9,000	$0
ROZIERS	2/21/2014	1238	EF0	0	0	$11,000	$0
RAYNHAM	6/27/2015	1923	EF1	0	0	$40,000	$0
ALLENTON	6/27/2015	1945	EF1	0	0	$20,000	$0
LUMBER BRIDGE	5/23/2017	1438	EF0	0	0	$100,000	$0
PURVIS	9/16/2018	1529	EF0	0	0	$0	$0
			Total:	**0**	**1**	**$5,018,000**	**$0**

Source: NCEI

Robeson County received two FEMA Major Disaster Declaration in 1984 and 2011 for severe storms that included tornadoes.

Narratives from NCEI illustrate that damage occurred in many of these incidents even if a monetary value was not recorded. Specific incidents include:

March 27, 2009 – A National Weather Service Storm Survey confirmed an EF-2 Tornado touched down about 3 miles east of Parkton, North Carolina. The tornado first touched down along W Parkton Tobermory Road, halfway between Highway 301 and Interstate 95, with no significant damage. The tornado tracked north-northeast and intensified to EF-2 with winds to 130 mph as it impacted structures along E Everette Road. One mobile home was completely destroyed and an adult female was thrown by the tornado. The woman suffered minor injuries. Also at this location, the tornado destroyed a two story home that was empty at the time. The tornado continued to track to the north-northeast and eventually lifted across a wooded area.

June 27, 2015 – A survey was conducted by the National Weather Service. The team found damage supportive of a brief EF-1 tornado with winds up to 90 mph. The tornado touched down in the Allentown community, just east of Highway 211. The tornado uprooted a healthy 100 year old three foot diameter pecan tree. The pecan tree fell across a house and punctured its roof, causing significant damage. Four smaller oak trees were also uprooted. This tornado was spawned from the same supercell that produced a tornado 14 miles to the west, 22 minutes prior.

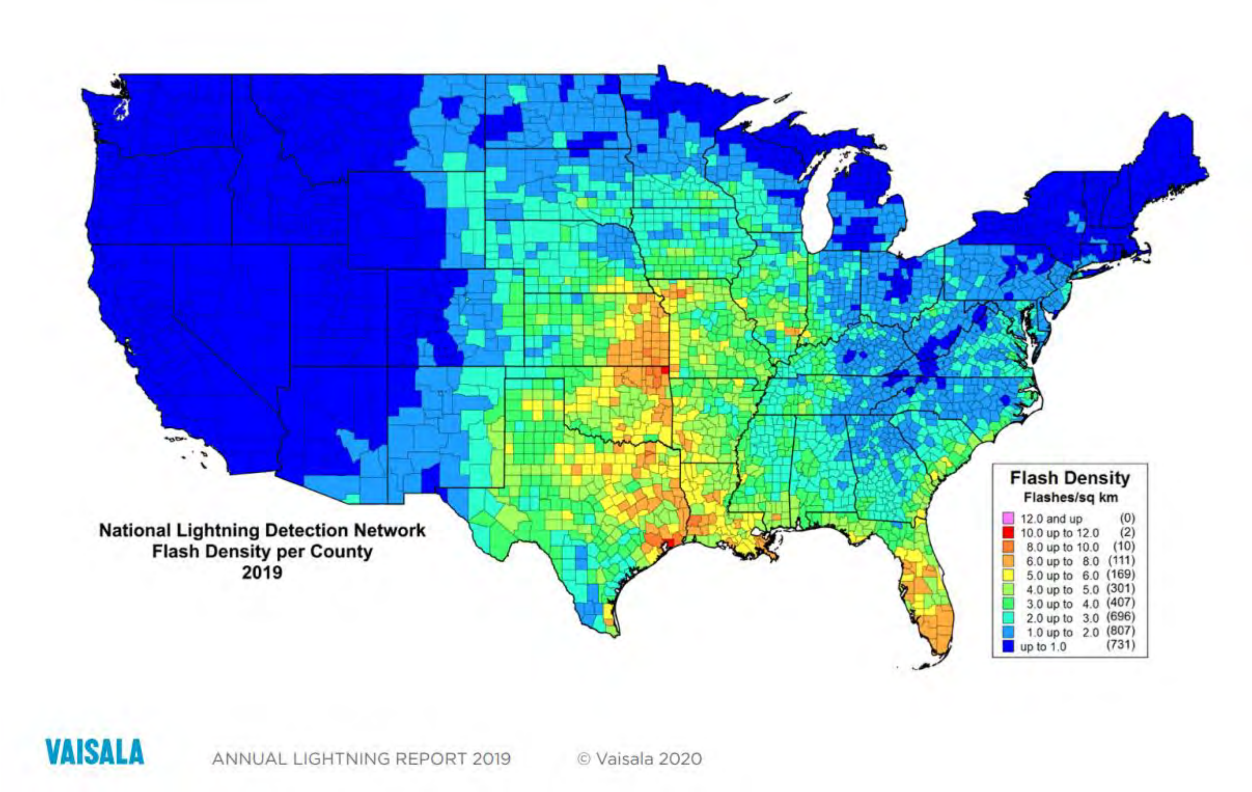
Probability of Future Occurrence

Based on historical occurrences recorded by NCEI for the 20-year period from 2000 through 2019, Robeson County averages 5.55 days with wind events per year. Over this same period, five lightning events were reported as having caused property damage, which equates to an average of 0.25 damaging lightning strikes per year.

The average hail storm in Robeson County occurs in the evening and has a hail stone with a diameter of just over one inch. Over the 20-year period from 2000 through 2019, Robeson County experienced 63 days with reported hail incidents; this averages to 3.15 days per year with reported incidents somewhere in the County.

Based on the Vaisala 2019 Annual Lightning Report, North Carolina experienced 3,641,417 documented cloud-to-ground lightning flashes. According to Vaisala's flash density map, shown in **Figure H.13**, Robeson County is located in an area that experiences 1 to 2 lightning flashes per square kilometer per year. It should be noted that future lightning occurrences may exceed these figures.

Figure H.13 – Lightning Flash Density per County (2019)



Source: Vaisala

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

In a 20-year span between 2000 and 2019, Robeson County has experienced 17 separate tornado incidents over 10 separate days. This correlates to a 50 percent annual probability that the County will experience a tornado somewhere in its boundaries. Of these past tornado events, 11 were a magnitude EF0/F0, five were an EF1/F1, and one was an EF2. Based on one tornado event having a magnitude higher than EF1, the annual probability of a significant tornado event is unlikely with a 5 percent annual chance.

Based on these historical occurrences, there is between a 10% to 100% chance that Robeson County will experience severe weather each year. The probability of a damaging impacts is likely.

Probability: 3 –Likely

Vulnerability Assessment

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.

Similar to the loss of use estimates provided for Severe Winter Weather, **Table H.42** shows the loss of use estimates for a tornadoes/thunderstorms were estimated as $26,082 per day, assuming 10-percent of the on-campus population is impacted.

Table H.42 – Loss of Use Estimates for Power Failure Associated with Tornadoes/Thunderstorms

On-Campus Population (Fall 2020)	Estimated Affected Population (10%)	Electric Loss of Use Estimate ($126 per person per day)
2,066	207	$26,082

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 2018 American Community Survey (ACS) 5-Year Estimates, 76 occupied housing units (7.2 percent) in Pembroke are classified as “mobile homes or other types of housing.” Using the 2018 ACS average persons per household estimate of 2.61, the population at risk due to their housing type was estimated at 199 residents within Pembroke.

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. Therefore, the estimated 199 residents mentioned above residing in mobile homes in Pembroke are also at a greater risk to tornado damage due to their housing type.

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 Pembroke, the two events with recorded property damage were due to fires ignited by lightning strikes.

NCEI records lightning impacts over 20 years (2000-2019), with $506,500 in property damage recorded during five separate events. Based on these records, the County experiences an annualized loss of $25,325 in property damage. The average impact from lightning per incident in Robeson County is $72,357.

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, 2000 and December 31, 2019 in Robeson County, NCEI reported $120,400 in property damages and $50,000 in crop damages caused by hail events. This equates to an estimated annualized loss of $8,520 due to hail related events across the County.

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 Robeson County, thus the NCEI is still used to form a baseline.

Wind events reported in NCEI for the 20-year period from 2000 through 2019 totaled $3,594,750 in property damage and $4,000 in crop damage, which equates to an annualized loss of $179,938 across the County.

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 2000, damaging tornadoes in the County are directly responsible for $5,018,000 worth of damage to property according to NCEI data. This equates to an annualized loss of $250,900.

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.

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.

Changes in Development

Future development projects should consider severe thunderstorms hazards and tornado and high wind hazards at the planning, engineering and architectural design stage with the goal of reducing vulnerability. University buildings with high occupancies should consider inclusion of a tornado shelters to accommodate occupants in the event of a tornado. Future development will also affect current stormwater drainage patterns and capacities.

Problem Statement

- Thunderstorms and tornadoes are frequent hazard events in Robeson County and the UNC-P campus. Reported damages for the 20-year period from 2000-1019 include $3,598,750 for thunderstorm winds, $506,500 for lightning strikes, $170,400 for hail, and $5,018,000 for tornado events.

H.5.10 Wildfire

Hazard	Probability	Impact	Spatial Extent	Warning Time	Duration	PRI Score
Wildfire	Likely	Limited	Large	More than 24 hrs	More than 1 week	2.8

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 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 H.43** details the extent of the WUI on the UNC-P campus, and **Figure H.14** below shows the WUI areas. Only 1.4% of the campus is not in the WUI. Most of the campus is classified as high to moderate housing density. At the county level, the southern perimeter of Robeson County is predominately classified as non-WUI vegetated with very little to no housing density. Central and northern Robeson County is classified as non-vegetated or agriculture with large pockets of WUI interface and intermix areas and medium to high density housing in the agricultural areas.

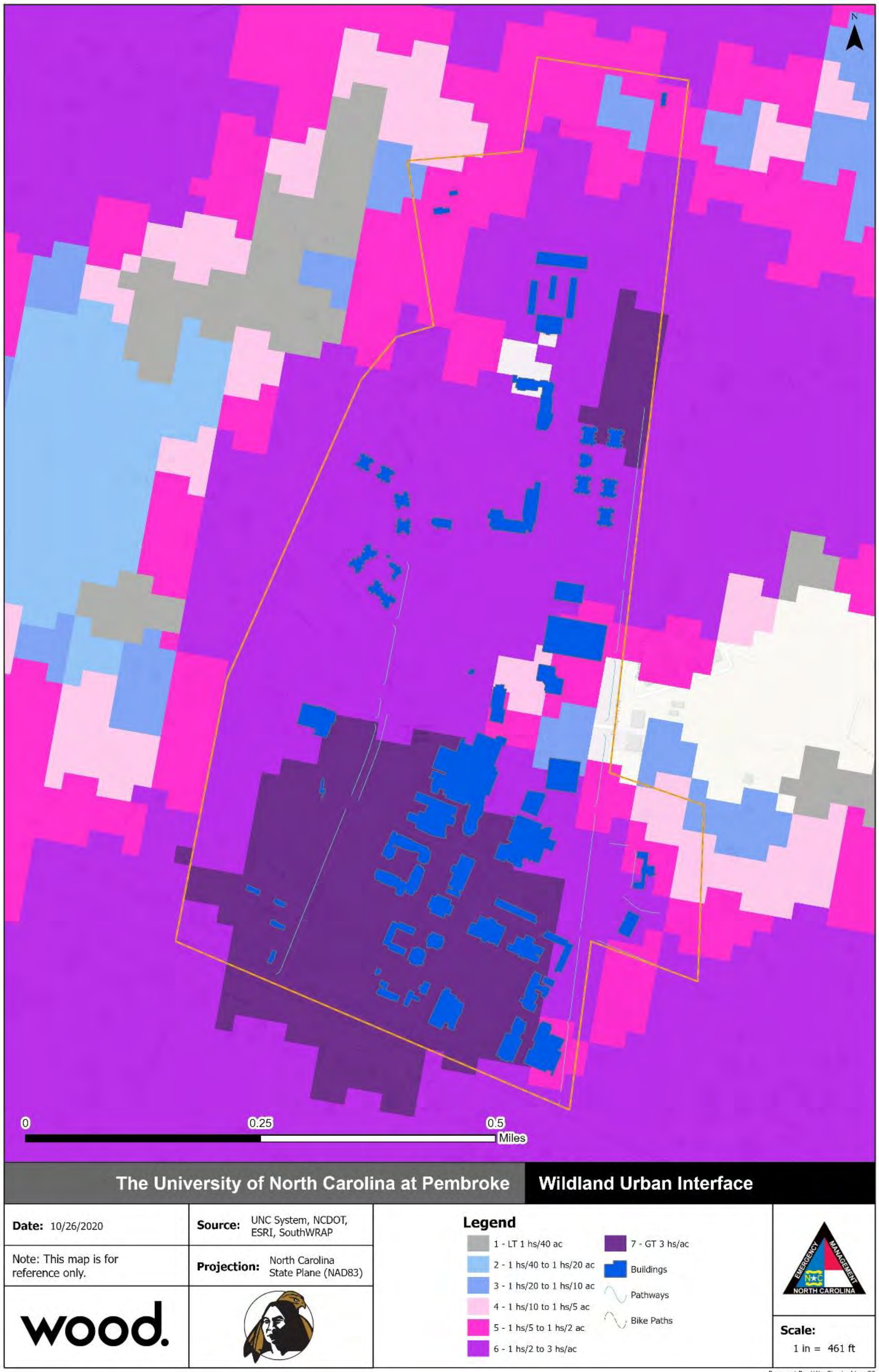
Table H.43 – Wildland Urban Interface, Population and Acres

	Housing Density	WUI Acres	Percent of WUI Acres
	Not in WUI	*3*	*1.4%*
	LT 1hs/40ac	0	0.0%
	1hs/40ac to 1hs/20ac	0	0.0%
	1hs/20ac to 1hs/10ac	5	2.1%
	1hs/10ac to 1hs/5ac	5	2.3%
	1hs/5ac to 1hs/2ac	32	13.4%
	1hs/2ac to 3hs/1ac	129	53.6%
	GT 3hs/1ac	66	27.2%
	Total	**241**	**--**

Source: Southern Wildfire Risk Assessment

Spatial Extent: 4 – Large

Figure H.14 – Wildland Urban Interface Areas, UNC-P



Extent

The entire state is at risk to a wildfire occurrence. However, several factors such as drought conditions or high levels of fuel on the forest floor may make a wildfire more likely in certain areas. 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, shown in **Table H.44**, consists of five classes, as defined by Southern Wildfire Risk Assessment. **Figure H.15** shows the potential fire intensity within the WUI across University of North Carolina at Pembroke.

Table H.44 – 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

The majority of UNC-P's campus area (55.2%) is identified as Class 0 or non-burnable. Approximately 28.2% of the campus area is identified as Class 1 or Class 2 Fire Intensity, which are easily suppressed. The remaining 16.6% of the campus area is identified as Class 3 Fire Intensity or higher which would have the potential for harm to life and property.

The WUI Risk Index is used to rate the potential impact of a wildfire on people and their homes. It reflects housing density (per acre) consistent with Federal Register National standards. The WUI Risk Index ranges of values from -1 to -9, with -1 representing the least negative impact and -9 representing the most negative impact. **Figure H.16** maps the WUI Risk Index for University of North Carolina at Pembroke (UNC-P). The WUI areas within the campus of UNC-P range from -3 to -9 on the WUI Risk Index.

Impact: 2 – Limited

Figure H.15 – Characteristic Fire Intensity, UNC-P

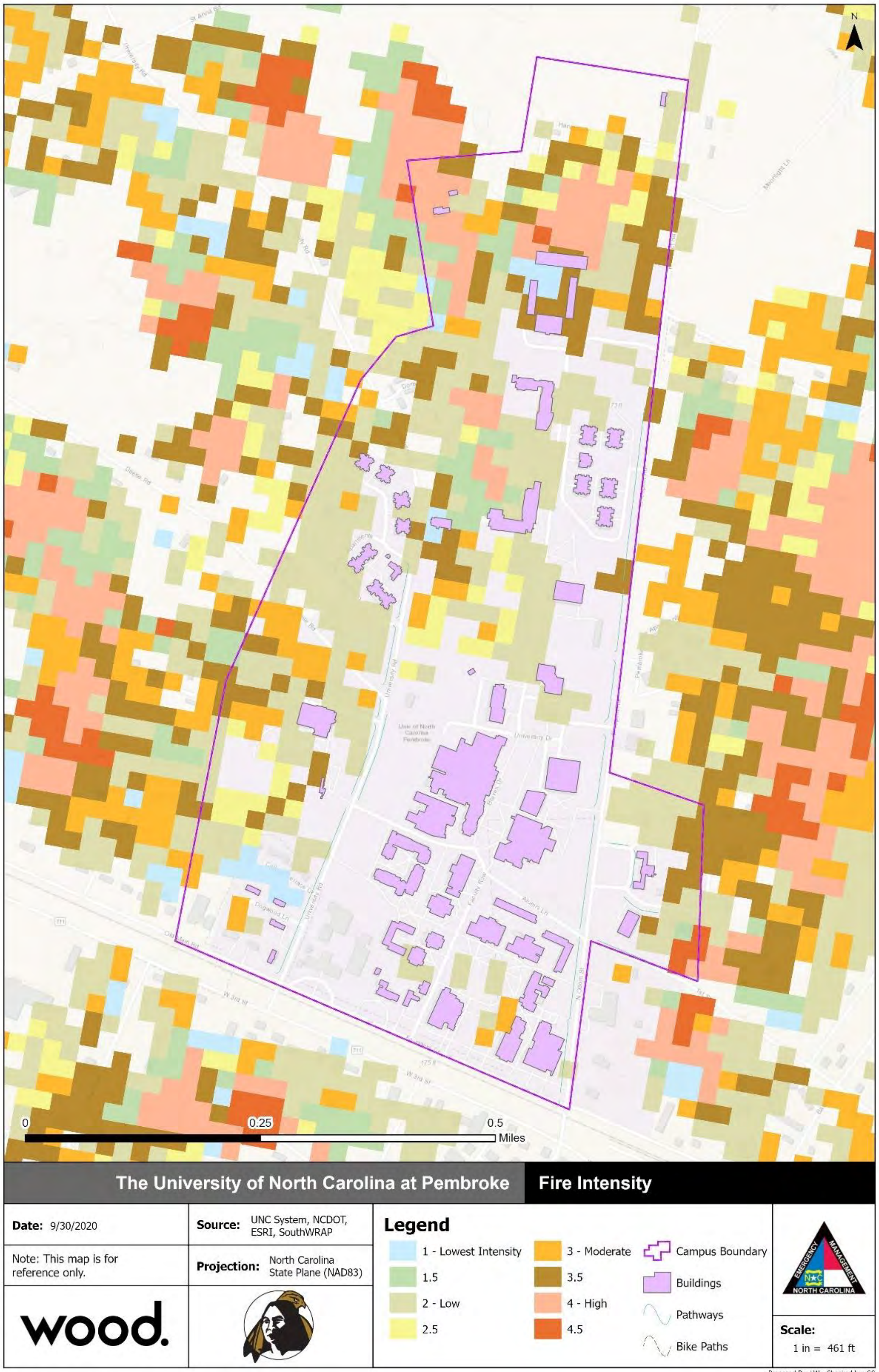
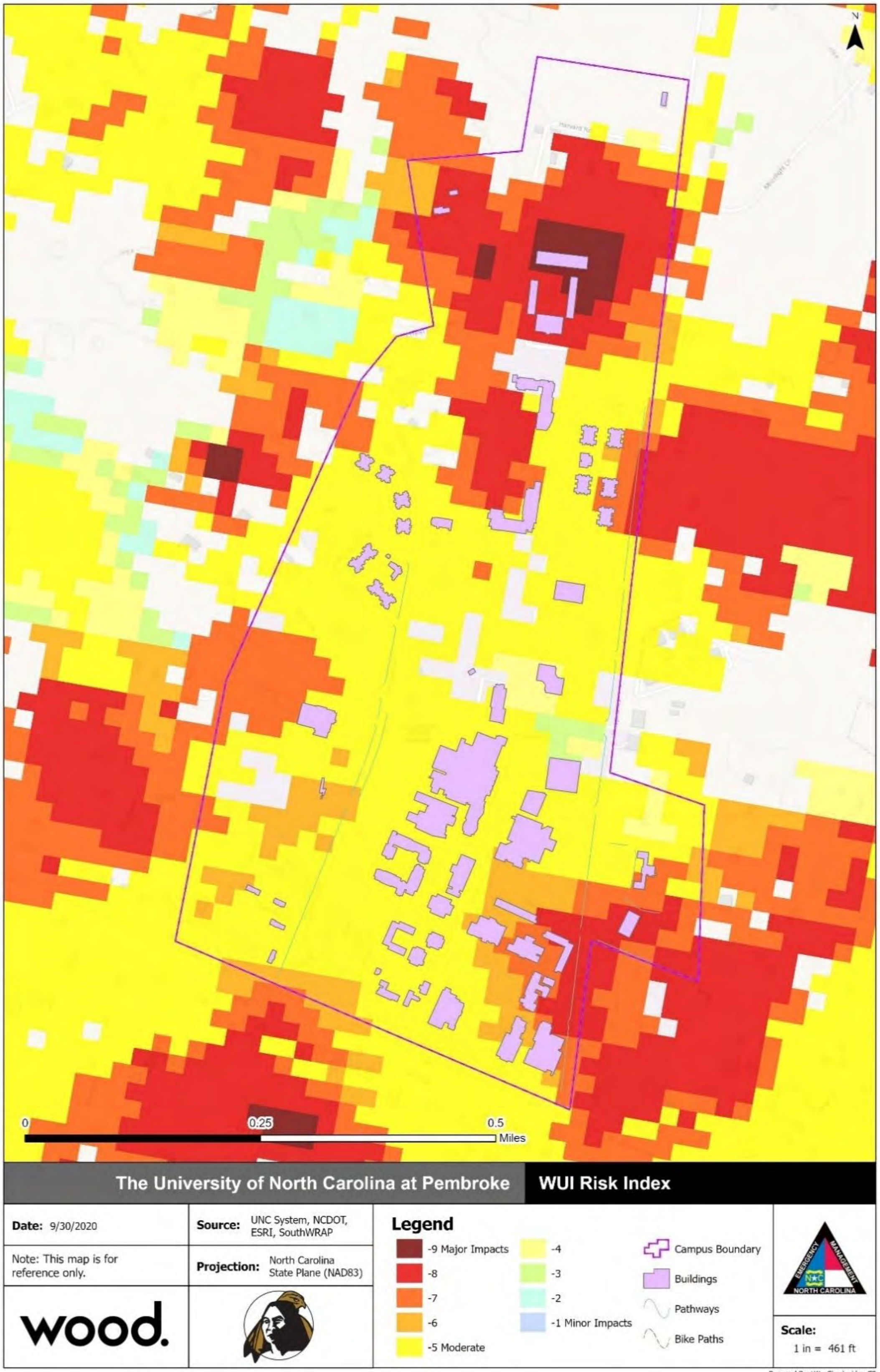


Figure H.16 – WUI Risk Index, UNC-P



Historical Occurrences

Wildfire data on a county level is no longer publicly available for Robeson County, but wildfire data for the state is provided by the North Carolina Forest Service (NCFS) and is reported annually from 1970 to 2018. Below in **Figure H.17** is the number of documented wildfires in North Carolina from 1999-2018 including the acreage burned and different causes. Debris burning appears to continue to be the largest cause of fires in the state.

Figure H.17 – North Carolina Wildfires by Cause, 2009-2018

Year	Fires	Acres	Lightning	Camping	Smoking	Debris Burning	Incendaiary	Machine Use	Railroad	Children	MISC.
2018	3,597	10,994	43	29	35	1,601	191	364	22	140	1,172
2017	5,153	20,479	60	40	79	2,413	322	485	36	159	1,559
2016	4,195	77,741	48	65	78	1,566	402	438	18	175	1,405
2015	3,886	10,588	77	32	82	1,671	444	416	4	223	937
2014	4,593	13,327	53	41	90	2,237	706	460	30	210	766
2013	3,374	9,451	20	37	102	1,492	580	344	14	200	583
2012	3,550	11,992	129	46	91	1,221	715	384	36	228	668
2011	5,265	63,547	200	28	216	2,102	1,012	522	40	298	803
2010	4,053	14,703	71	36	166	1,642	801	435	24	268	602
2009	3,291	12,328	56	38	186	1,309	618	283	26	246	528
2008	4,378	49,929	197	36	246	1,565	758	384	58	332	802
2007	7,260	36,850	215	105	503	2,461	1,476	614	98	614	1,174
2006	5,767	23,364	98	60	360	2,414	1,031	489	53	452	810
2005	4,078	14,981	49	47	278	1,697	764	347	45	311	540
2004	4,406	14,221	29	49	255	2,046	693	337	36	335	626
2003	2,041	31,843	10	21	121	864	355	187	15	154	314
2002	5,655	27,678	261	73	369	2,250	975	397	65	501	764
2001	8,240	28,576	82	110	708	3,227	1,593	635	121	749	1,015
2000	5,039	24,660	57	60	358	2,049	956	372	118	443	626
1999	6,341	27,389	110	75	439	2,629	1,195	412	107	598	776

Source: https://www.ncforestservice.gov/fire_control/fc_statisticsCause.htm

With 94,162 wildfires noted within North Carolina between 1999 and 2018, the likelihood of occurrence can be calculated to be 4,708 wildfire events throughout the state per year. With the total acreage burned during this same period as 524,641 acres, the annual average acreage burned can be calculated as 26,232 acres burned per year and the average event can be calculated as 5.6 acres.

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 University of North Carolina at Pembroke is presented in **Table H.45** and illustrated in **Figure H.18**.

Table H.45 – Burn Probability, UNC-P

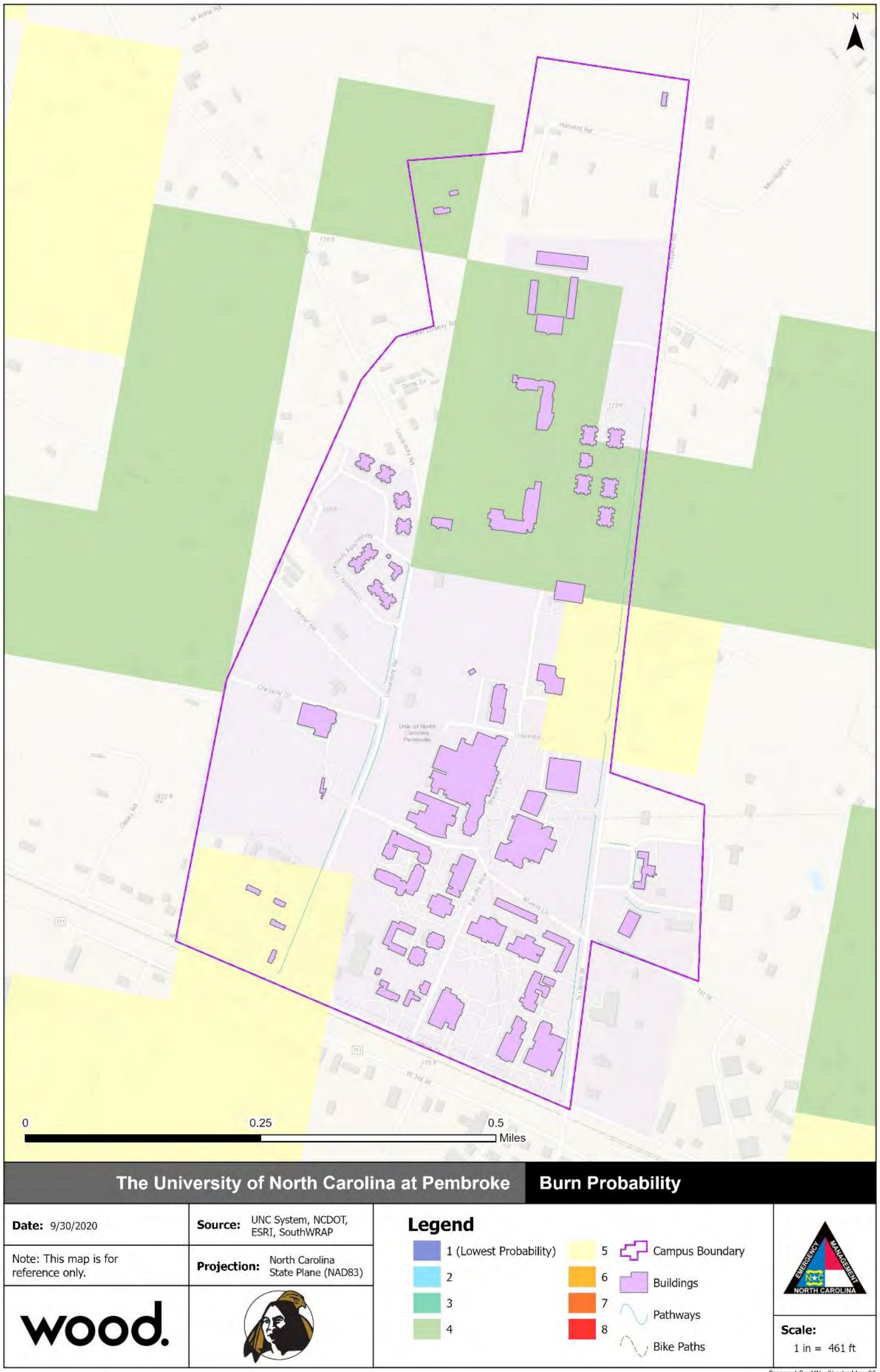
	Class	Acres	Percent
	No probability	*173*	*71.7%*
	1	0	0.0%
	2	0	0.0%
	3	0	0.0%
	4	47	19.5%
	5	21	8.8%
	6	0	0.0%
	7	0	0.0%
	8	0	0.0%
	9	0	0.0%
	10	0	0.0%
	Total	**241**	--

Source: Southern Wildfire Risk Assessment

A portion of the campus (28.3%) is located within areas defined as Class 4 and Class 5, having moderate probability. Located within these moderate burn probability areas are Dial Humanities Building, Dogwood Building, Global Engagement, Magnolia House, Pine Cottage, Sampson Academic Building, and the critical facilities Brave Health Center, Cypress Residence Hall, Pinchbeck Maintenance Complex, University Village Apartments and Weinstein Health Science Building.

Probability: 3 – Likely

Figure H.18 – Burn Probability, UNC-P



Vulnerability Assessment

People

Wildfire can cause fatalities and human health hazards. Ensuring procedures are in place for rapid warning and evacuation are essential to reducing vulnerability.

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.

Using the Wildland Urban Interface Risk Index (WUIRI) from the Southern Wildfire Risk Assessment, a GIS analysis was used to estimate the exposure of buildings most at risk to loss due to wildfire. The WUIRI shows a rating of the potential impact of wildfire on homes and people. This index ranges from 0 to -9, where lower values are relatively more severe. **Table H.46** summarizes the number of buildings and their total value that fall within areas rated -5 or less on the WUIRI. This table represents potential risks and counts every building within the area rated under -5, actual damages in the event of a wildfire may differ.

Table H.46 – Building Counts and Values within WUIRI under -5

Occupancy Type	Buildings	Building Value
Administration	3	$4,678,579
Critical Facility	30	$106,725,390
Extracurricular/Educational	20	$28,356,854
Housing	4	$6,461,840
Total	**57**	**$146,222,663**

Source: GIS Analysis, Southern Wildfire Risk Assessment

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.

Changes in Development

Growth on the UNC-P campus within the wildland-urban interface area will increase the vulnerability of people, property, and infrastructure to wildfires. To reduce wildfire impacts, the University can work with the City and/or Robeson County to coordinate fuel reduction efforts, educate residents and campus population, train firefighters, and establish local wildfire management plans.

Problem Statement

- Approximately 98% of the UNC-P campus is located within an identified WUI area.
- A portion of the UNC-P campus (28.3%) is located within Burn Probability areas defined as Class 4 and Class 5, having moderate probability.
- Coordination with the City of Pembroke and/or Robeson County is recommended to reduce fuel efforts and establish a local wildfire management plan.

H.5.11 Cyber Threat

Hazard	Probability	Impact	Spatial Extent	Warning Time	Duration	PRI Score
Cyber Threat	Possible	Critical	Large	Less than 6 hrs	More than 1 week	3.1

Location

Cyber disruption events can occur and/or impact virtually any location in the state where computing devices are used. Incidents may involve a single location or multiple geographic areas. A disruption can have far-reaching effects beyond the location of the targeted system; disruptions that occur far outside the region can still impact people, businesses, and institutions within the region.

On the UNC-P campus, the Division of Information Technology (DoIT) provides integrated technology support for administrative computing, client services, IT infrastructure systems, and IT security. The University's critical applications require passwords for access. Modifications of the application software are protected from abuse by an electronic software control procedure. Information security is managed and controlled in accordance with the university's Information Security Policy.

Spatial Extent: 4 – Large

Extent

The extent or magnitude/severity of a cyber disruption event is variable depending on the nature of the event. A disruption affecting a small, isolated system could impact only a few functions/processes. Disruptions of large, integrated systems could impact many functions/processes, as well as many individuals that rely on those systems.

There is no universally accepted scale to quantify the severity of cyber-attacks. The strength of a DDoS attack is sometimes explained in terms of a data transmission rate. One of the largest DDoS disruptions ever, which brought down some of the internet's most popular sites on October 21, 2016, peaked at 1.2 terabytes per second.

Data breaches are often described in terms of the number of records or identities exposed. With the amount of data retained by universities – including student, staff, and faculty personal information as well as research data – a data breach on the UNC-P campus could cause significant disruption and impact a large number of records.

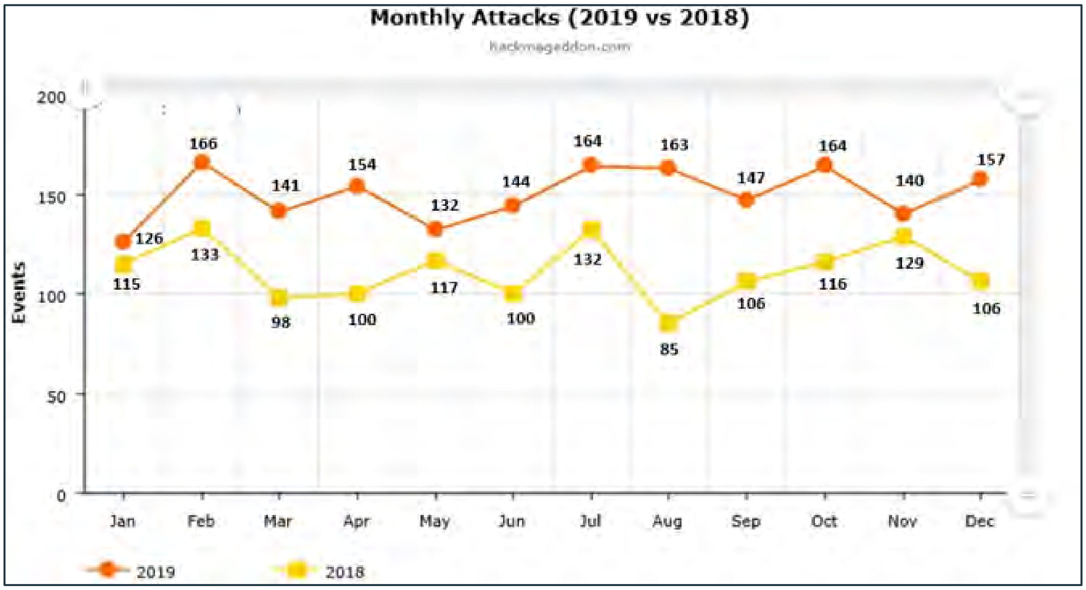
Impact: 2 – Limited

Historical Occurrences

As cyber disruption is an emerging hazard, the reporting and tracking of disruptive events is difficult. In most cases, it is not required to report an event, and when it is reported most of the information is protected due to the sensitive nature of the systems that have been disrupted. However, there currently exists several complex databases that track cyber disruption occurrences. Each system makes use of its own definitions and tracking methods. Hackmageddon is one online source that tracks Cyber Attack Statistics. Hackmageddon was developed by Paolo Passeri, an expert in the computer security industry for more than 15 years and current Principal Sales Engineer at OpenDNS (now part of Cisco). The timelines collect the major cyber events of the related months chosen among events published by open sources (such as blogs or news sites). It should be noted that this database collects cyber-attacks worldwide and this data is provided to show how this hazard is trending in general. During 2019, this database collected reports of a total of 1,802 cyber-attacks.

The graphic in **Figure H.19** provides a comparison of the number of attacks collected during 2018 and 2019. The two following images in **Figure H.20** and **Figure H.21** show the top 10 target distributions for 2018 and 2019. The main finding from the top 10 attack techniques is the percentage of 'other' targeted attacks appearing at 14.1% in 2019. Attacks targeted towards Education slightly increased from 6.4% in 2018 to 7.1% in 2019. Most other target distributions experienced a percentage decrease in 2019. Some of this is probably due to the difference in distribution categories between 2018 and 2019.

Figure H.19 – Comparison of Monthly Attacks Collected by Hackmageddon (2018-2019)



Source: Hackmageddon, https://www.hackmageddon.com/2020/01/23/2019-cyber-attacks-statistics/

Figure H.20 – Top 10 Cyber Attack Target Distributions, 2018

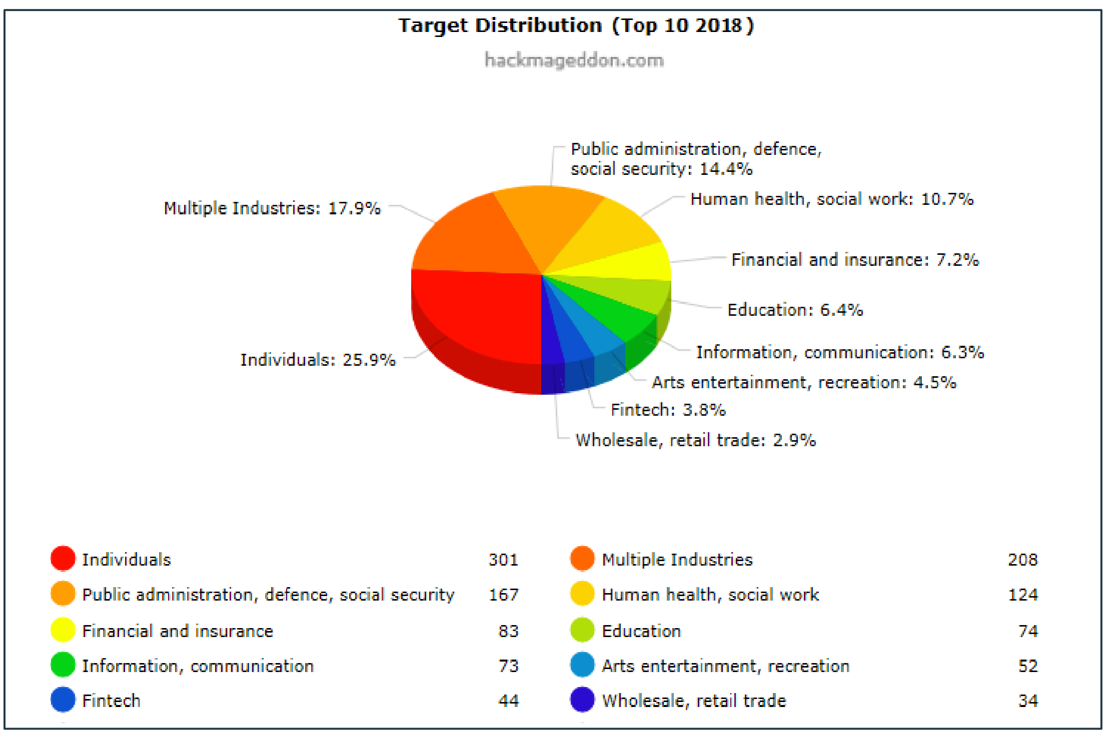
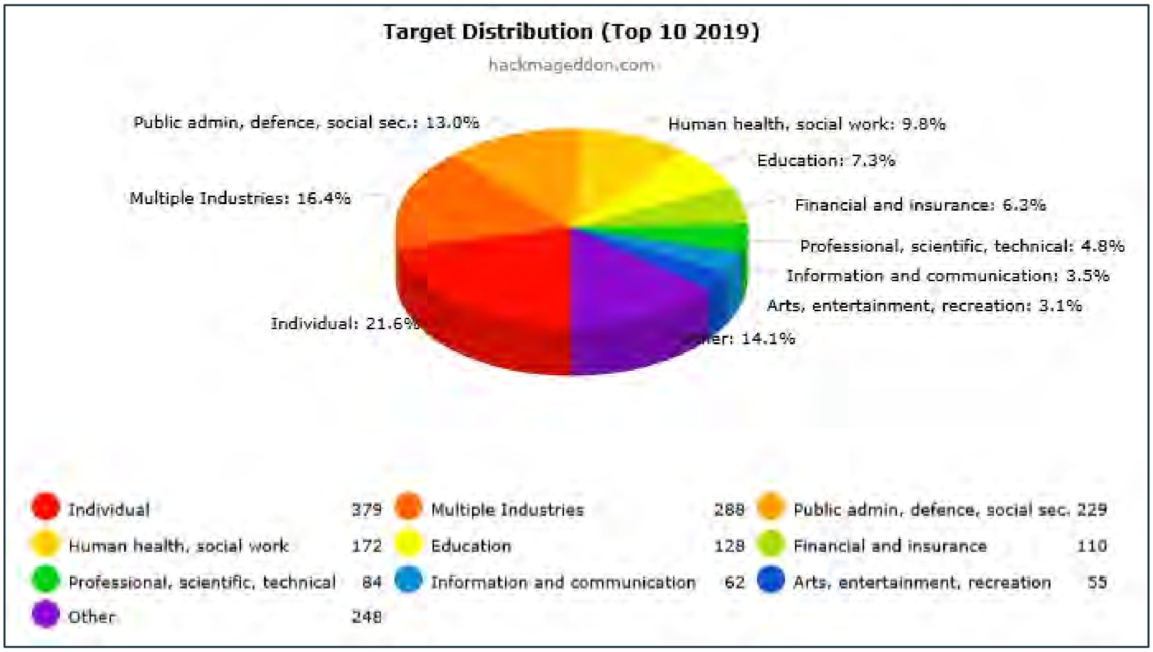


Figure H.21 – Top 10 Cyber Attack Target Distributions, 2019



There have been some notable disruption events within the Education target distribution that attained national attention in the last few years:

August 2020, The University of North Carolina Wilmington's Division of University Advancement (DUA) was hacked by a ransomware attack. The data included names, addresses, phone numbers, email addresses, and history of gifts made to UNCW; the University reported that no vulnerable financial or personal information was included. (https://portcitydaily.com/story/2020/08/06/uncw-reports-ransomware-attack-hackers-accessed-personal-details-but-no-financial-info/)

November 2019, The University of North Carolina Chapel Hill School of Medicine reported over 3,500 individuals having private information stolen in phishing cyber-attack, (https://www.databreaches.net/the-university-of-north-carolina-chapel-hill-school-of-medicine-notifying-patients-after-2018-phishing-incident/).

October 2019, Randolph Community College's entire computer network and other devices were compromised following cyberattack. In total, 1,200 devices were affected during the two week attack, (https://www.yourdailyjournal.com/news/89334/report-rcc-cyber-attack-was-first-successful-of-this-scale-at-nc-community-college).

December 2018, The Cape Cod Community College notifies its employees that Hackers stole more than $800,000 when they infiltrated the school's bank accounts, (https://www.databreaches.net/hackers-steal-800000-from-cape-cod-community-college/).

September 2018, The Henderson school district in Texas is hit with a business email compromise (BEC) attack resulting in a $600,000 loss for the district. The attack took place on September, 26th, (https://www.scmagazine.com/home/security-news/bec-attack-scamstexas-school-district-out-of-600000/).

April 2018, Partial social security numbers of more than 1,200 employees at Irvington schools are distributed via email to an unknown number of recipients by an unidentified attacker, (https://www.databreaches.net/hacker-sent-email-with-1200-partial-social-security-numbers-to-school-staff/).

March 2018, Florida Virtual Learning School notifies 368,000 current and former students, after an individual with the moniker $2a$45 uploads information of 35,000 students on a forum. Leon County Schools is among the affected organizations, (https://www.databreaches.net/leon-county-schools-vendors-data-leak-exposed-368000-current-and-former-flvs-students-details-lcs-teacher-data-and-more/).

November 2017, Monticello Central School District warns of a sophisticated e-mail phishing attack occurred on November 1st, 2017. Potentially 2,598 individuals are affected, (https://www.databreaches.net/monticello-central-school-district-notifying-almost-2600-of-phishing-attack-last-year/).

October 2017, The Los Angeles Valley College (LAVC) is forced to pay $28,000 in bitcoin after cybercriminals successfully infected its computer networks, email systems and voicemail lines with ransomware, (https://www.ibtimes.co.uk/la-school-pays-hackers-28000-bitcoin-after-computer-systems-hit-ransomware-1600304).

July 2017, Tax information for dozens of University of Louisville employees is compromised after a hack of the online system the university uses to give employees access to tax documents, (https://www.databreaches.net/tax-information-of-some-university-of-louisville-employees-hacked/).

April 2017, Westminster College in Missouri reveals the details of a breach discovered on March 26 after a phishing scam duped a staffer into sending off W-2 statements, (https://www.scmagazine.com/home/security-news/data-breach/w-2-data-breach-at-westminster-college/).

Probability of Future Occurrence

Cyber attacks occur daily, but most have negligible impacts at the local or regional level. The possibility of a larger disruption affecting systems within the region is a constant threat, but it is difficult to quantify the exact probability due to such highly variable factors as the type of attack and intent of the attacker. Minor attacks against business and government systems have become a commonplace occurrence but are usually stopped with minimal impact. Similarly, data breaches impacting the information of students and faculty of UNC-P are almost certain to happen in coming years. Major attacks or breaches specifically targeting systems at the University are less likely but cannot be ruled out.

Probability: 2 – Possible

Vulnerability Assessment

As discussed above, the impacts from a cyber attack vary greatly depending on the nature, severity, and success of the attack.

People

Cyber-attacks can have a significant cumulative economic impact. Check Point Research reports that in 2018, cybercrime rates were estimated to have generated around 1.5 trillion dollars. A major cyber-attack has the potential to undermine public confidence and build doubt in their government's ability to protect them from harm. Injuries or fatalities from cyber attacks would generally only be possible from a major cyber terrorist attack against critical infrastructure.

Property

Short of a major cyber terrorist attacks against critical infrastructure, property damage from cyber attacks is typically limited to computer systems.

Environment

Short of a major cyber terrorist attacks against critical infrastructure, property damage from cyber attacks is typically limited to computer systems. A major cyber terrorism attack could potentially impact the environment by triggering a release of a hazardous materials, or by causing an accident involving hazardous materials by disrupting traffic-control devices.

Changes in Development

With enrollment decreasing since the last plan, the number of users of campus networks and software has decreased. Additionally, with fewer buildings located on campus, the number of network access points has decreased.

For future development, as the number of users and/or access points to the network and campus software increases, the opportunity for cyber-attacks is also likely to increase.

Problem Statement

- Cyber-attacks occur daily, but most have negligible impacts at the local or regional level. The possibility of a larger disruption affecting systems within the region is a constant threat, but difficult to quantify.
- The University's Division of Information Technology (DoIT) addresses IT security through policies addressing users, physical security, system security, password administration, communications, wireless devices, computer viruses, disaster recovery, and compliance with law and policy.

H.5.12 Hazardous Materials Incidents

Hazard	Probability	Impact	Spatial Extent	Warning Time	Duration	PRI Score
Hazardous Materials Incident	Possible	Limited	Small	Less than 6 Hrs	Less than 24 Hrs	2.2

Location

Hazardous materials releases at fixed sites can cause a range of contamination from very minimal to catastrophic. The releases can go into the air, onto the surface, or into the ground and possibly into groundwater, or a combination of all. Although releases into the air or onto the ground surface can pose a great and immediate risk to human health, they are generally easier to remediate than those releases which enter into the ground or groundwater. Soil and groundwater contamination may take years to remediate causing possible long-term health problems for individuals and rendering land unusable for many years.

The Toxics Release Inventory (TRI) Program run by the 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 did not include any sites reporting hazardous materials in Pembroke from 2016-2018.

The HMPC identified the following critical buildings on UNC-P's campus with hazardous materials stored on site:

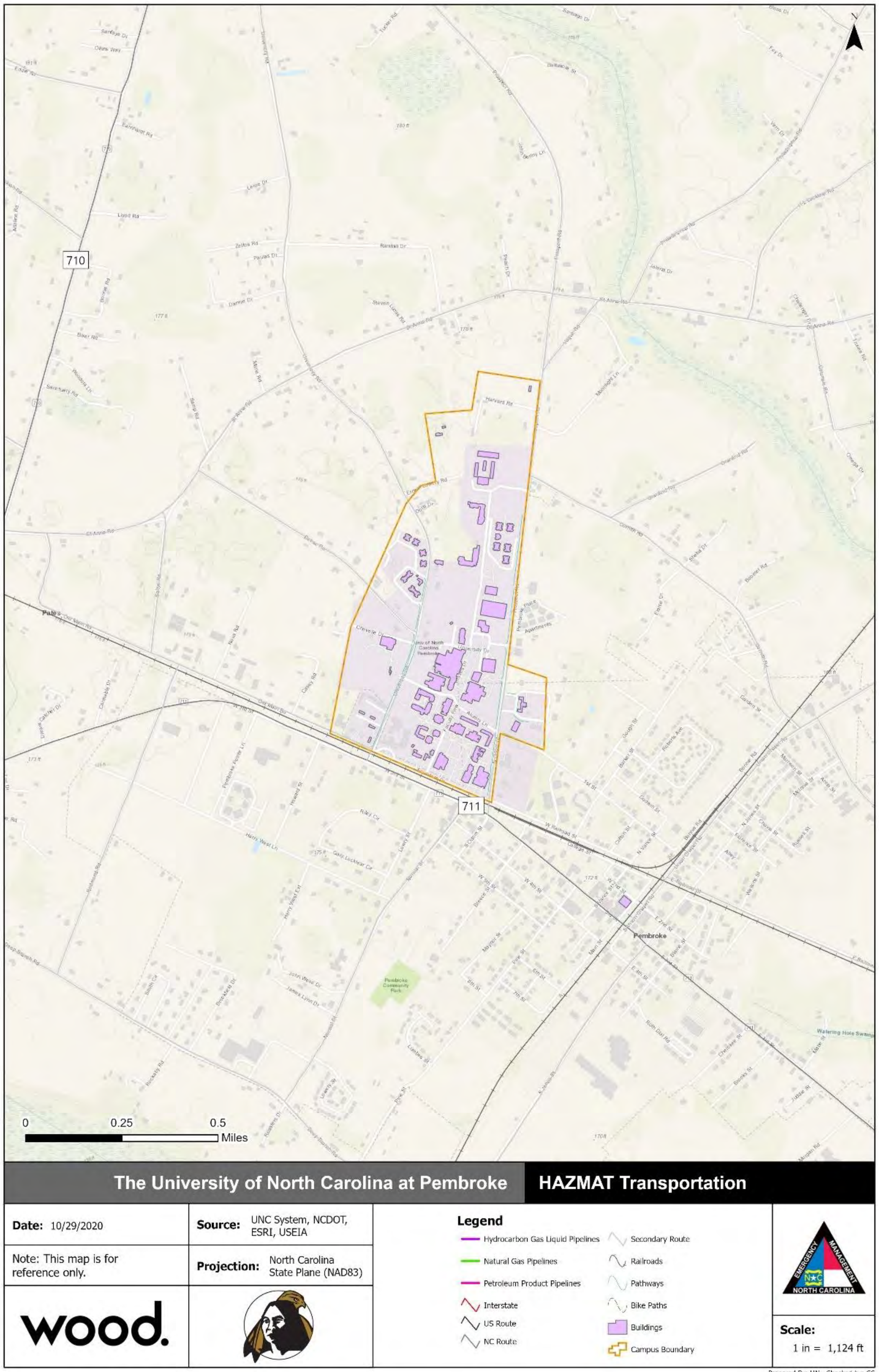
- Pinchbeck Maintenance Complex
- Oxendine Science Building
- Weinstein Health Services

Transportation hazardous materials Incidents can occur when hazardous materials are being transported from one location to another in the normal course of business for manufacturing, refining, or other industrial purposes. Additionally, hazardous materials incidents can occur as hazardous waste is transported for final storage and/or disposal. **Figure H.22** shows the modes of transportation for hazardous materials adjacent to or through UNC-P's campus.

The campus sits along a CSX Transportation freight route, which exposes the campus to risks associated with rail transport of hazardous materials.

Spatial Extent: 2 – Small

Figure H.22 – HAZMAT Transportation Map, UNC-P



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.

Prior to 2002, however, a "serious incident" regarding hazardous materials was defined as follows:

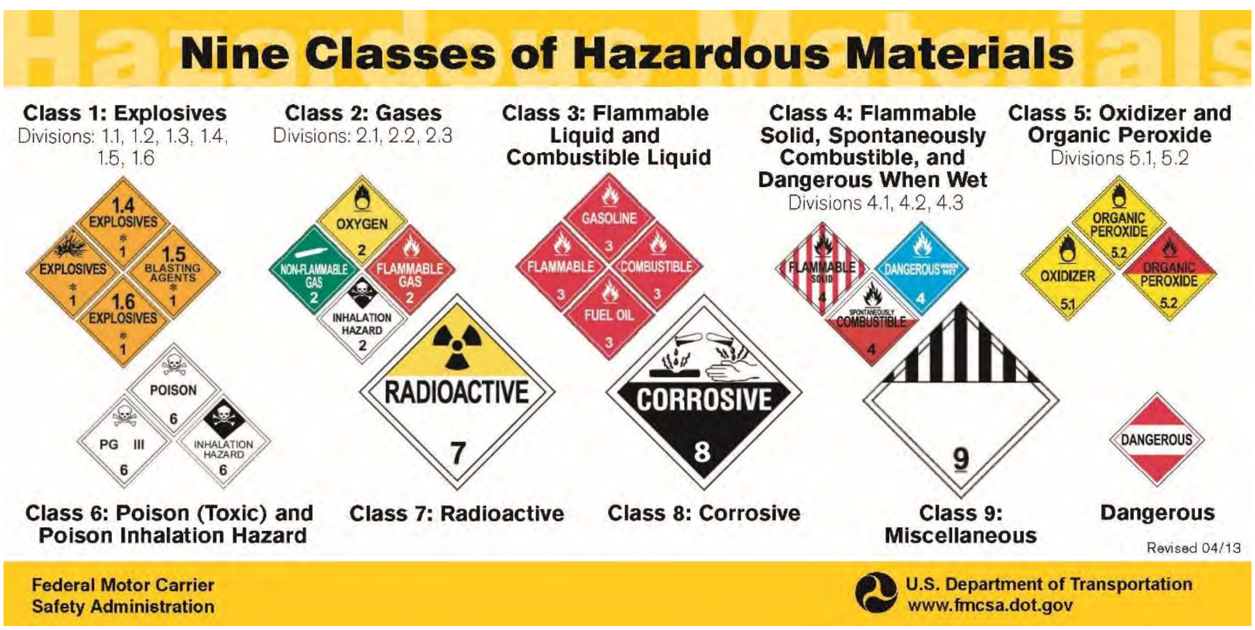
- a fatality or major injury due to a hazardous material
- closure of a major transportation artery or facility or evacuation of six or more persons due to the presence of hazardous material, or
- a vehicle accident or derailment resulting in the release of a hazardous material.

Impact: 2 – Limited

Historical Occurrences

The USDOT's PHMSA maintains a database of reported hazardous materials incidents by location and hazardous material class. According to PHMSA records, there have not been any recorded releases in Pembroke from 2000 through 2019. **Figure H.23** describes all nine hazard classes.

Figure H.23 – Hazardous Materials Classes



Source: U.S. Department of Transportation

Probability of Future Occurrence

Based on historical occurrences recorded by PHMSA, there have not been any serious incidents of hazardous materials release in the 20-year period from 2000 through 2019. However, given the proximity of the campus to a freight rail line, the HMPC considered there to be between 1% and 10% annual probability of occurrence.

Probability: 2 – Possible

Vulnerability Assessment

People

Hazardous materials incidents can cause injuries, hospitalizations, and even fatalities to people nearby. People living near hazardous facilities and along transportation routes may be at a higher risk of exposure, particularly those living or working downstream and downwind from such facilities. For example, a toxic spill or a release of an airborne chemical near a populated area can lead to significant evacuations and have a high potential for loss of life. Individuals working with or transporting hazardous materials are also at heightened risk.

In addition to the immediate health impacts of releases, a handful of studies have found long term health impacts such as increased incidence of certain cancers and birth defects among people living near certain chemical facilities. However there has not been sufficient research done on the subject to allow detailed analysis.

The primary economic impact of hazardous material incidents results from lost business, delayed deliveries, property damage, and potential contamination. Large and publicized hazardous material-related events can deter tourists and could potentially discourage residents and businesses. Economic effects from major transportation corridor closures can be significant.

Property

The impact of a fixed hazardous facility, such as a chemical processing facility is typically localized to the property where the incident occurs. The impact of a small spill (i.e. liquid spill) may also be limited to the extent of the spill and remediated if needed. While cleanup costs from major spills can be significant, they do not typically cause significant long-term impacts to property.

Impacts of hazardous material incidents on critical facilities are most often limited to the area or facility where they occurred, such as at a transit station, airport, fire station, hospital, or railroad. However, they can cause long-term traffic delays and road closures resulting in major delays in the movement of goods and services. These impacts can spread beyond the planning area to affect neighboring counties, or vice-versa. While cleanup costs from major spills can be significant, they do not typically cause significant long-term impacts to critical facilities, but there is a chance they may be impacted.

Environment

Hazardous material incidents may affect a small area at a regulated facility or cover a large area outside such a facility. Widespread effects occur when hazards contaminate the groundwater and eventually the municipal water supply, or they migrate to a major waterway or aquifer. Impacts on wildlife and natural resources can also be significant.

Changes in Development

Structures located near fixed facilities, highways and other high traffic roadways are most at risk to a hazardous materials event. Any development that takes place in these areas will place more people and structures in the risk area for hazardous materials events, however since most hazardous material spills are localized to an extremely small area this will not have an effect on the overall risk assessment for this hazard.

Problem Statement

- Transportation routes for hazardous materials are located adjacent to the UNC-P campus.
- According to PHMSA, there have not been any reported incidents within Pembroke between January 2000 and December 2019.

H.5.14 Infectious Disease

Hazard	Probability	Impact	Spatial Extent	Warning Time	Duration	PRI Score
Infectious Disease	Possible	Critical	Large	More than 24 hrs	More than 1 week	2.8

Location

Infectious disease outbreaks can occur anywhere in the planning area, especially where there are groups of people in close quarters.

Spatial Extent: 4 – Large

Extent

When on an epidemic scale, diseases can lead to high infection rates in the population causing isolation, quarantine, and potential mass fatalities. An especially severe influenza pandemic or other major disease outbreak could lead to high levels of illness, death, social disruption, and economic loss. Impacts could range from school and business closings to the interruption of basic services such as public transportation, health care, and the delivery of food and essential medicines.

Table H.47 describes the World Health Organization's six main phases to a pandemic flu as part of their planning guidance.

Table H.47 – World Health Organization's Pandemic Flu Phases

Phase	Description
1	No animal influenza virus circulating among animals have been reported to cause infection in humans.
2	An animal influenza virus circulating in domesticated or wild animals is known to have caused infection in humans and is therefore considered a specific potential pandemic threat.
3	An animal or human-animal influenza reassortant virus has caused sporadic cases or small clusters of disease in people, but has not resulted in human-to-human transmission sufficient to sustain community-level breakouts.
4	Human-to-human transmission of an animal or human-animal influenza reassortant virus able to sustain community-level breakouts has been verified.
5	The same identified virus has caused sustained community-level outbreaks in two or more countries in one WHO region.
6	In addition to the criteria defined in Phase 5, the same virus has caused sustained community-level outbreaks in at least one other country in another WHO region.
Post-Peak Period	Levels of pandemic influenza in most countries with adequate surveillance have dropped below peak levels.
Post-Pandemic Period	Levels of influenza activity have returned to levels seen for seasonal influenza in most countries with adequate surveillance.

Source: World Health Organization

Impact: 3 – Critical

Historical Occurrences

Public Health Emergencies – Influenza Pandemics

Since the early 1900s, four lethal pandemics have swept the globe: Spanish Flu of 1918-1919; Asian Flu of 1957-1958; Hong Kong Flu of 1968-1969; and Swine Flu of 2009-2010. The Spanish Flu was the most severe pandemic in recent history. The number of deaths was estimated to be 50-100 million worldwide and 675,000 in the United States. Its primary victims were mostly young, healthy adults. The 1957 Asian

Flu pandemic killed about 70,000 people in the United States, mostly the elderly and chronically ill. The 1968 Hong Kong Flu pandemic killed 34,000 Americans. The 2009 Swine Flu caused 12,469 deaths in the United States. These historic pandemics are further defined in the following paragraphs along with several "pandemic scares".

Spanish Flu (H1N1 virus) of 1918-1919

In 1918, when World War I was in its fourth year, another threat began that rivaled the war itself as the greatest killer in human history. The Spanish Flu swept the world in three waves during a two-year period, beginning in March 1918 with a relatively mild assault.

The first reported case occurred at Camp Funston (Fort Riley), Kansas, where 60,000 soldiers trained to be deployed overseas. Within four months, the virus traversed the globe, as American soldiers brought the virus to Europe. The first wave sickened thousands of people and caused many deaths (46 died at Camp Funston), but it was considered mild compared to what was to come. The second and deadliest wave struck in the autumn of 1918 and killed millions. At Camp Funston alone, there were 14,000 cases and 861 deaths reported during the first three weeks of October 1918.

Outbreaks caused by a new variant exploded almost simultaneously in many locations including France, Sierra Leone, Boston, and New York City, where more than 20,000 people died that fall. The flu gained its name from Spain, which was one of the hardest hit countries. From there, the flu went through the Middle East and around the world, eventually returning to the United States along with the troops.

Of the 57,000 Americans who died in World War I, 43,000 died because of the Spanish Flu. At one point, more than 10 percent of the American workforce was bedridden. By a conservative estimate, a fifth of the human race suffered the fever and aches of influenza between 1918 and 1919 and 20 million people died. At the height of the flu outbreak during the winter of 1918-1919, at least 20% of North Carolinians were infected by the disease. Ultimately, 10,000 citizens of the state succumbed to this disease.

Asian Flu (H2N2 virus) of 1957-1958

This influenza pandemic was first identified in February 1957 in the Far East. Unlike the Spanish Flu, the 1957 virus was quickly identified, and vaccine production began in May 1957. Several small outbreaks occurred in the United States during the summer of 1957, with infection rates highest among school children, young adults, and pregnant women; however, the elderly had the highest rates of death. A second wave of infections occurred early the following year, which is typical of many pandemics.

Hong Kong Flu (H3N2 virus) of 1968-1969

This influenza pandemic was first detected in early 1968 in Hong Kong. The first cases in the United States were detected in September 1968, although widespread illness did not occur until December. This became the mildest pandemic of the twentieth century, with those over the age of 65 the most likely to die. People infected earlier by the Asian Flu virus may have developed some immunity against the Hong Kong Flu virus. Also, this pandemic peaked during school holidays in December, limiting student-related infections.

Pandemic Flu Threats: Swine Flu of 1976, Russian Flu of 1977, and Avian Flu of 1997 and 1999

Three notable flu scares occurred in the twentieth century. In 1976, a swine-type influenza virus appeared in a U.S. military barracks (Fort Dix, New Jersey). Scientists determined it was an antigenically drifted variant of the feared 1918 virus. Fortunately, a pandemic never materialized, although the news media made a significant argument about the need for a Swine Flu vaccine.

In May 1977, influenza viruses in northern China spread rapidly and caused epidemic disease in children and young adults. By January 1978, the virus, subsequently known as the Russian Flu, had spread around

the world, including the United States. A vaccine was developed for the virus for the 1978–1979 flu season. Because illness occurred primarily in children, this was not considered a true pandemic.

In March 1997, scores of chickens in Hong Kong's rural New Territories began to die—6,800 on three farms alone. The Avian Flu virus was especially virulent and made an unusual jump from chickens to humans. At least 18 people were infected, and six died in the outbreak. Chinese authorities acted quickly to exterminate over one million chickens and successfully prevented further spread of the disease. In 1999, a new avian flu virus appeared. The new virus caused illness in two children in Hong Kong. Neither of these avian flu viruses started pandemics.

Swine Flu (H1N1 virus) of 2009–2010

This influenza pandemic emerged from Mexico in 2009. The first U.S. case of H1N1, or Swine Flu, was diagnosed on April 15, 2009. The U.S. government declared H1N1 a public health emergency on April 26. By June, approximately 18,000 cases of H1N1 had been reported in the United States. A total of 74 countries were affected by the pandemic.

The CDC estimates that 43 million to 89 million people were infected with H1N1 between April 2009 and April 2010. There were an estimated 8,870 to 18,300 H1N1 related deaths. On August 10, 2010, the World Health Organization (WHO) declared an end to the global H1N1 flu pandemic.

Public Health Emergencies – Other Pandemics

Meningitis, 1996-1997, 2005

During 1996 and 1997, 213,658 cases of meningitis were reported, with 21,830 deaths, in Africa. According to the North Carolina Disease Data Dashboard, there were 28 cases in North Carolina in 2005.

Lyme Disease, 2015

In the United States, Lyme disease is mostly found in the northeastern, mid-Atlantic, and upper north-central regions, and in several counties in northwestern California. In 2015, 95-percent of confirmed Lyme Disease cases were reported from 14 states: Connecticut, Delaware, Maine, Maryland, Massachusetts, Minnesota, New Hampshire, New Jersey, New York, Pennsylvania, Rhode Island, Vermont, Virginia, and Wisconsin. Lyme disease is the most reported vector-borne illness in the United States. In 2015, it was the sixth most common nationally notifiable disease. However this disease does not occur nationwide and is concentrated heavily in the northeast and upper Midwest.

Severe Acute Respiratory Syndrome, 2003

During November 2002-July 2003, a total of 8,098 probable SARS cases were reported to the World Health Organization (WHO) from 29 countries. In the United States, only 8 cases had laboratory evidence of infection. Since July 2003, when SARS transmission was declared contained, active global surveillance for SARS disease has detected no person-to-person transmission. CDC has therefore archived the case report summaries for the 2003 outbreak. Across North Carolina, there was one confirmed SARS case – a man in Orange County tested positive in June 2003.

Zika Virus, 2015

In May 2015, the Pan American Health Organization issued an alert noting the first confirmed case of a Zika virus infection in Brazil. Since that time, Brazil and other Central and South America countries and territories, as well as the Caribbean, Puerto Rico, and the U.S. Virgin Islands have experienced ongoing Zika virus transmission. In August 2016, the Centers for Disease Control and Prevention (CDC) issued guidance for people living in or traveling to a 1-square-mile area Miami, Florida, identified by the Florida Department of Health as having mosquito-borne spread of Zika. In October 2016, the transmission area

was expanded to include a 4.5-square-mile area of Miami Beach and a 1-squre mile area of Miami-Dade County. In addition, all of Miami-Dade County was identified as a cautionary area with an unspecified level of risk. As of the end of 2018, the CDC reported 74 cases of Zika across the United States.

Ebola, 2014-2016

In March 2014, West Africa experienced the largest outbreak of Ebola in history. Widespread transmission was found in Liberia, Sierra Leone, and Guinea with the number of cases totaling 28,616 and the number of deaths totaling 11,310. In the United States, four cases of Ebola were confirmed in 2014 including a medical aid worker returning to New York from Guinea, two healthcare workers at Texas Presbyterian Hospital who provided care for a diagnosed patient, and the diagnosed patient who traveled to Dallas, Texas from Liberia. All three healthcare workers recovered. The diagnosed patient passed away in October 2014.

In March 2016, the WHO terminated the public health emergency for the Ebola outbreak in West Africa.

Coronavirus Disease (COVID-19), 2020

During the update of this plan, the Coronavirus disease 2019, also known as COVID-19, outbreak became a worldwide pandemic. COVID-19 was caused by severe acute respiratory syndrome coronavirus 2 (SARS-Cov-2). First identified in Wuhan, China in December 2019, the virus quickly spread throughout China and then globally. As of October 18, 2020, there were over 39.5 million cases worldwide resulting in over 1.1 million deaths. In the United States, COVID-19 was first identified in late January in Washington State and rapidly spread throughout the Country, with large epicenters on both the east and west coasts.

In order to curb the spread of the virus, Governor Roy Cooper issued a statewide Stay at Home Order on March 27, 2020. According to the North Carolina Department of Health and Human services, as of October 23, 2020, there were over 255,708 confirmed cases and 4,114 deaths across all 100 counties in the State. In Robeson County, as of October 23, 2020, there were a total of 5,792 cases and 91 deaths. Case counts are still rising in North Carolina and Robeson County at the time of this assessment.

Probability of Future Occurrence

It is impossible to predict when the next pandemic will occur or its impact. The CDC continually monitors and assesses pandemic threats and prepares for an influenza pandemic. Novel influenza A viruses with pandemic potential include Asian lineage avian influenza A (H5N1) and (H7N9) viruses. These viruses have all been evaluated using the Influenza Risk Assessment Tool (IRAT) to assess their potential pandemic risk. Because the CDC cannot predict how severe a future pandemic will be, advance planning is needed at the national, state and local level; this planning is done through public health partnerships at the national, state and local level.

Today, a much larger percentage of the world's population is clustered in cities, making them ideal breeding grounds for epidemics. Additionally, the explosive growth in air travel means the virus could literally be spread around the globe within hours. Under such conditions, there may be very little warning time. Most experts believe we will have just one to six months between the time that a dangerous new influenza strain is identified and the time that outbreaks begin to occur in the United States. Outbreaks are expected to occur simultaneously throughout much of the nation, preventing shifts in human and material resources that normally occur with other natural disasters. These and many other aspects make influenza pandemic unlike any other public health emergency or community disaster.

Probability: 2 – Possible

Vulnerability Assessment

People

Disease spread and mortality is affected by a variety of factors, including virulence, ease of spread, aggressiveness of the virus and its symptoms, resistance to known antibiotics and environmental factors. While every pathogen is different, diseases normally have the highest mortality rate among the very young, the elderly or those with compromised immune systems. As an example, the unusually deadly 1918 H1N1 influenza pandemic had a mortality rate of 20%. If an influenza pandemic does occur, it is likely that many age groups would be seriously affected. The greatest risks of hospitalization and death—as seen during the last two pandemics in 1957 and 1968 as well as during annual outbreaks of influenza—will be to infants, the elderly, and those with underlying health conditions. However, in the 1918 pandemic, most deaths occurred in young adults. Few people, if any, would have immunity to a new virus.

Approximately twenty percent of people exposed to West Nile Virus through a mosquito bite develop symptoms related to the virus; it is not transmissible from one person to another. Preventive steps can be taken to reduce exposure to mosquitos carrying the virus; these include insect repellent, covering exposed skin with clothing and avoiding the outdoors during twilight periods of dawn and dusk, or in the evening when the mosquitos are most active.

Property

For the most part, property itself would not be impacted by a human disease epidemic or pandemic. However, as concerns about contamination increase, property may be quarantined or destroyed as a precaution against spreading illness. Furthermore, staffing shortages could affect the function of critical facilities.

Environment

A widespread pandemic would not have an impact on the natural environment unless the disease was transmissible between humans and animals. However, affected areas could result in denial or delays in the use of some areas, and may require remediation.

Changes in Development

With enrollment decreasing since the last plan, the number of students and employees on campus has decreased. Additionally, with fewer buildings located on campus, the number of indoor meeting locations has decreased.

For future development, as the number of students and employees increase, the opportunity for spread of a pandemic would increase, should in-person educational and/or extracurricular meetings take place.

Problem Statement

- With the current COVID-19 pandemic, it is clear the UNC-P campus population is susceptible to the infectious disease pandemic.
- UNC-P has a pandemic influenza plan in place to provide a guide for the University to follow in the event of an influenza pandemic in North Carolina.

H.5.16 Conclusions on Hazard Risk

Priority Risk Index

As discussed in **Section H.5**, 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 H.48 summarizes the degree of risk assigned to each identified hazard using the PRI method.

Table H.48 – Summary of PRI Results

Hazard	Probability	Impact	Spatial Extent	Warning Time	Duration	PRI Score
Earthquake	Unlikely	Minor	Large	Less than 6 hours	Less than 6 hours	1.9
Extreme Heat	Highly Likely	Limited	Large	12 to 24 hours	Less than 1 week	3.1
Flood	Highly Likely	Minor	Negligible	6 to 12 hours	Less than 6 hours	2.1
Geological – Landslide	Unlikely	Minor	Negligible	6 to 12 hours	Less than 6 hours	1.2
Hurricane	Likely	Critical	Large	More than 24 hrs	Less than 24 hrs	2.9
Severe Winter Weather	Highly Likely	Limited	Large	More than 24 hrs	Less than 1 week	3.0
Tornado / Thunderstorm	Likely	Critical	Large	Less than 6 hrs	Less than 6 hours	3.1
Wildfire	Likely	Limited	Large	More than 24 hrs	More than 1 week	2.8
Cyber Threat	Possible	Critical	Large	Less than 6 hours	More than 1 week	3.1
Hazardous Materials Incidents	Possible	Limited	Small	Less than 6 hours	Less than 24 hrs	2.2
Infectious Disease	Possible	Critical	Large	More than 24 hrs	More than 1 week	2.8

[1]Note: Severe Weather hazards average to a score of 2.6 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 H.49**:

- **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.
- **Moderate 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 minimal. This is not a priority hazard.

Table H.49 – Summary of Hazard Risk Classification

High Risk (≥ 3.0)	Severe Winter Weather Tornado / Thunderstorm Extreme Heat
Moderate Risk (2.0 – 2.9)	Flood Hurricane Wildfire Cyber Threat Infectious Disease
Low Risk (< 2.0)	Earthquake Hazardous Materials Geological – Landslide

H.6 CAPABILITY ASSESSMENT

This section discusses the mitigation capabilities, including planning, programs, policies and land management tools, typically used to implement hazard mitigation activities. It consists of the following subsections:

- H.6.1 Overview of Capability Assessment
- H.6.2 Planning and Regulatory Capability
- H.6.3 Administrative and Technical Capability
- H.6.4 Fiscal Capability

H.6.1 Overview of Capability Assessment

The purpose of conducting a capability assessment is to determine the ability of the college to implement feasible mitigation actions based on an understanding of the capacity of the departments and staff tasked with their implementation. A capability assessment should also identify opportunities for establishing or enhancing specific mitigation policies or programs. The process of conducting a capability assessment includes developing an inventory of relevant plans, policies, or programs already in place; as well as assessing the college's ability to implement existing and/or new policies. Conclusions drawn from the capability assessment should identify any existing gaps or weaknesses in existing programs and policies as well as positive measures already in place which can and should be supported through future mitigation efforts.

H.6.2 Planning and Regulatory Capability

Planning and regulatory capabilities include plans, ordinances, policies and programs that guide development on campus. **Table H.50** lists these local resources currently in place at UNC-P.

Table H.50 – Planning and Regulatory Capability

Regulatory Tool (ordinances, codes, plans)	Y/N	Comments
Master Plan	Y	UNC-P Master Plan, 2011
Zoning code	Y	Town of Pembroke Zoning Ordinance
Growth management ordinance	N	
Floodplain ordinance	Y	Town of Pembroke Flood Ordinance
Building code	Y	NC building codes; the State of North Carolina statutes for state owned buildings; and zoning for local jurisdiction
Erosion or sediment control program	Y	Robeson County, NRCS
Stormwater management program	Y	Town of Pembroke Stormwater Regulations
Site plan review requirements	Y	Town of Pembroke Site Development Plans Review
Capital improvements plan	Y	UNC-P Capital Improvements Plan, 6-yr UNC-P Repair and Renovations Plan, 6-yr
Economic development plan	Y	UNC-P Annual Report
Local emergency operations plan	Y	Emergency Operations Plan, revised 2013
Flood Insurance study or other engineering study for streams	Y	December 6, 2019
Elevation certificates	Y	Town of Pembroke

A description of applicable plans, ordinances and programs follows to provide more detail on the relevance of each regulatory tool in examining the capabilities for each community.

Master and Strategic Plans

A Master Plan, in broad terms, is a policy statement to guide the future placement and development of campus facilities. The Strategic Plan identifies a future vision, values, principals and goals for the college, determines the projected growth for the college, and identifies policies to plan, direct and accommodate anticipated growth. UNC-P most recently updated their Master Plan in 2011. The plan addresses the campus landscape, districts, mobility, and infrastructure.

A Strategic Plan sets the overarching mission and vision for a University based on campus values. It also sets goals and objectives for institutional growth. The UNC-P Strategic Plan was most recently updated in 2012 but is currently being updated.

Zoning Code

Zoning typically consists of both a zoning map and a written ordinance/code that divides the planning area into zoning districts. The zoning regulations describe what type of land use and specific activities are permitted in each district, and also regulate how buildings, signs, parking, and other construction may be placed on a parcel. The zoning regulations also provide procedures for rezoning and other planning applications. Zoning is managed at the municipal and county level by the Town of Pembroke and

Flood Insurance Study/Floodplain Ordinance

A Flood Insurance Study (FIS) provides information on the existence and severity of flood hazards within a community based on the 100-year flood event. The FIS also includes revised digital Flood Insurance Rate Maps (FIRMs) which reflect updated Special Flood Hazard Areas (SFHAs) and flood zones for the community.

A floodplain ordinance is perhaps the most important flood mitigation tool. 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 will be protected from damage by a 100-year flood event and that new development in the floodplain will not exacerbate existing flood problems or increase damage to other properties. Floodplain management is handled at the County and municipal level, however UNC-P does have information on flood risk on the Environmental Health and Safety website.

Stormwater Management Program

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. A Stormwater Management Program can prevent flooding problems caused by stormwater runoff by 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) Setting construction standards so buildings are protected from shallow water. A stormwater ordinance provides regulatory authority to implement stormwater management standards. UNC-P adheres to Town of Pembroke Stormwater Management Regulations.

Erosion and Sediment Control Program

Surface water runoff can erode soil from development sites, sending sediment into downstream waterways. This can clog storm drains, drain tiles, culverts and ditches and reduce the water transport and storage capacity of channels. The purpose of an erosion, sedimentation and pollution control ordinance is to minimize soil erosion and prevent off-site sedimentation by using soil erosion and sediment control practices designed in accordance with certain standards and specifications. Erosion and Sedimentation Control is managed by Robeson County and addresses such issues on the UNC-P campus.

Site Plan Review

The purpose of the Site Plan Review Process is to review site plans for specific types of development to ensure compliance with all appropriate land development regulations and consistency with the General Plan. Site Plan Review for development on the UNC-P campus is run through the Town of Pembroke.

Building Code

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).

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. An Elevation Certificate serves as the official record that shows new buildings and substantial improvements in all identified SFHAs are properly elevated. This elevation information is needed to show compliance with the floodplain ordinance. Development on the UNC-P campus must adhere to state and local building codes. Additionally, the UNC-P Facilities Planning, Design, and Construction department maintains Campus Design and Construction Guidelines.

Capital Improvement Plan

A Capital Improvement Plan (CIP) is a planning document that typically provides a five-year outlook for anticipated capital projects designed to facilitate decision makers in the replacement of capital assets. The projects are primarily related to improvement in public service, parks and recreation, public utilities and facilities. The mitigation strategy may include structural projects that could potentially be included in a CIP and funded through a Capital Improvement Program. UNC-P Facilities Planning, Design, and Construction department maintains and manages both the UNC-P 6-year Capital Appropriate Plan and UNC-P 6-year Repair and Renovations Plan. The department’s website also provides updates on current project status.

Emergency Operations Plan

An emergency operations plan outlines responsibilities and the means by which resources are deployed during and following an emergency or disaster. The University’s emergency operations plan was most recently updated in 2013.

H.6.3 Administrative and Technical Capability

Administrative and technical capability refers to the college’s staff and their skills and tools that can be used for mitigation planning and to implement specific mitigation actions. It also refers to the ability to access and coordinate these resources effectively. The personnel should be considered as well as the level of knowledge and technical expertise of these resources. Resources include engineers, planners, emergency managers, GIS analysts, building inspectors, grant writers, floodplain managers, and more. **Table H.51** provides a summary of the administrative and technical capabilities for UNC-P.

Table H.51 – Administrative and Technical Capability

Personnel Resources	Yes/No	Department/Position
Planner/Engineer with knowledge of land development/land management practices	Yes	Holland Consulting Planners
Engineer/Professional trained in construction practices related to buildings and/or infrastructure	Yes	Facilities Management; AVC
Planner/Engineer/Scientist with an understanding of natural hazards	Yes	Holland Consulting Planners
Personnel skilled in GIS	Yes	Facilities Planning Design and Construction; CAD Tech
Full time building official	Yes	Town of Pembroke
Floodplain Manager	Yes	Town of Pembroke
Emergency Manager	Yes	Student Affairs; AVC Campus; Safety and Emergency Operations
Grant Writer	Yes	Sponsored Research
Public Information Officer	Yes	University Communications and Marketing
Student Engagement	Yes	Division of Student Affairs
Warning Systems	Yes	Campus Police RAVE; Code Red; LiveSafe; Blue Light 2 Outdoor sirens

Additional resources include the following:

- Students, faculty, and staff may have access and functional needs. For example, many may be unable to drive; therefore, unique evacuation plans may need to be created for them. They may also have hearing or vision impairments that could make receiving emergency instructions difficult. Both older and younger populations have higher risks of contracting certain diseases.
- As with older students, faculty, and staff, many first- and second-year students, along with transfer students, may face more significant challenges. They are less likely to be familiar with the area, and many may not have access to a car while on campus.
- Brave Alert; If it becomes necessary to notify the campus community of a serious threat, University Communications and Marketing has the ability to send immediate notifications via telephone, text, and email by using Brave Alert, a computerized campus notification system. A person must voluntarily sign-up for Brave Alert to receive text messages in the event of an emergency.

Additional resources and departments that may support administrative capabilities include the following:

Facilities Operations and Housekeeping Services

The mission of the University of North Carolina at Pembroke's Facilities Operations (composed of Administration, Carpentry/Locksmith, Electrical, Grounds, Housekeeping, HVAC/Plumbing, Motor Pool, Painting and Setups/Labor) is to provide support services to the University community. The ultimate goal of Facilities Operations is to condition UNCP facilities through inspection and audit programs, to design new and renovated facilities for low cost life-cycle maintenance, to assign the highest priorities to the most serious conditions, and to utilize all funding sources as good stewards.

Facilities Planning and Construction

The missions of Facilities Planning and Construction (FPC) is to provide professional administration for design and construction of capital improvement projects. FPC is dedicated to improving and expanding all physical facilities in support of the teaching, research, and service missions of UNC-P. FPC also seeks to accomplish this by providing timely and efficient professional services in a fiscally sound manner throughout all phases of project development. Also, FPC further strives to ensure that each design for a new or renovated facility provides a safe and accessible environment for the public while complying with state and federal codes and regulations.

Police and Public Safety

The Police and Public Safety Department at UNC-P is a full-service law enforcement agency. The departments primary responsibility is the protection of life and property on the University campus. The department offers many crime prevention and awareness programs designed to ensure a continued safe and secure campus. The department received the Association of Campus Law Enforcement Administrators (IACLEA) Award for Valor for their tremendous efforts to serve the campus and community during Hurricane Florence.

Environmental Health and Safety

The UNC-P Environmental Health and Safety (EH&S) Office is dedicated to protecting both human life and the campus environment. The department understands and acknowledges the interconnectedness between the environment, work, and human health and safety. The EH&S Department works to prevent the loss of human potential caused by fatalities, injuries, illness, and disabilities on the job and in the campus community. The department provides high-quality and informative training, comprehensive workplace evaluations, emergency response, and guidance on proper hazardous materials and hazardous waste management; EH&S promulgates regulatory guidance across Campus. Campus Emergency Management is handled under the EH&S umbrella. The Emergency Management team at UNC-P works to increase campus preparedness and disaster readiness. The HMPC coordinator for UNC-P is part of the EH&S department.

Division of Information Technology

The UNC-P Division of Information Technology (DoIT) provides support and service to the campus community to ensure successful use of technology. The department strives to be proactive in our development and delivery of services and support options.

H.6.4 Fiscal Capability

Financial capabilities are the resources that an entity has access to or is eligible to use to fund mitigation actions. The costs associated with implementing mitigation activities vary. Some mitigation actions such as building assessment or outreach efforts require little to no costs other than staff time and existing operating budgets. Other actions, such as structural projects, could require a substantial monetary commitment from local, State, and Federal funding sources. **Table H.52** provides a summary of the fiscal resources at UNC-P.

Table H.52 – Fiscal Resources

Resource	Ability to Use for Mitigation Projects? Y/N
Community Development Block Grants	Y; Need a partnership, UNC-P has worked with the Town of Pembroke for storm drain management in the past.
Capital improvements project funding	Y
In-Kind Services	Y; Education enrichment programs
Tuition & Fees	Y
Federal funding with HMA grants	Y

Resource	Ability to Use for Mitigation Projects? Y/N
Revenue Bonds	Y
State Appropriations	Y
Sales & Services	Y
Other Sources (Gifts, Investment Income, Permanent Endowments)	Y; UNC-P has worked with NCDOT on stormwater and roadway improvements.

H.7 MITIGATION STRATEGY

H.7.1 Implementation Progress

Progress on the mitigation strategy developed in the previous plan is also documented in this plan update. **Table H.53** details the status of mitigation actions from the previous plan. **Table H.54** on the following pages details all completed and deleted actions from the 2011 plan. More detail on the actions being carried forward is provided in the Mitigation Action Plan.

Table H.53 – Status of Previous Mitigation Actions

Campus	Completed	Deleted	Carried Forward and/or Combined
UNC-P	21	10	14

Table H.54 – Completed and Deleted Actions from the UNC-P 2011 Plan

Vulnerability	Action	2020 Status	2020 Implementation Status Comments
Chavis University Center and UC Annex: The UC is the primary dining facility for campus; there is no source of standby power to maintain continuity of dining services, or prevent frozen/refrigerated food from spoiling in the event of a prolonged power outage.	A generator capable of powering refrigerators/freezers, cooking, cleaning, and serving equipment should be installed to maintain continuity of dining services in the event of a prolonged power outage.	Completed	Action was completed
Chavis University Center and UC Annex: Some of the brick masonry is crumbling over the loading dock at the UC.	The crumbling of the brick masonry should be monitored; it could be damage over time from large/heavy items bumping into the building while being loaded/unloaded.	Completed	Repaired
Jones Athletic Center: The east wing of Jones has a history of flooding during intense storms; significant repairs have been made three times to date. Recent upgrades to drainage infrastructure have yet to be tested.	The modifications made to site drainage are only a partial repair. The root cause of flooding in this area is located to the east of campus where drain lines servicing the campus go through a diameter reduction, decreasing available capacity and leading to rapid and uncontrolled flooding in areas served upstream of the diameter reduction. The University should work to increase the capacity of drainage infrastructure in this area to prevent backups.	Completed	Stormwater system was updated
Jones Athletic Center: There is debris stacked up in the mechanical rooms near the pool.	The mechanical rooms and pool area should not be used to store debris; areas with clutter should have the clutter removed.	Completed	Room was cleared
Lumbee Hall: The northwest and southwest corners of the building have masonry bulges at the 4th floor diaphragm.	The bulges in the brick masonry façade should be inspected at closer range to determine if in fact damage is occurring at these locations. The cause of ongoing damage should be identified and repaired.	Deleted	Maintenance Issue
Lumbee Hall: The secondary data center does not have adequately redundant HVAC, is at generator capacity, and has no physical space to expand.	Given the importance of the secondary data center and the limited space and support infrastructure in Lumbee, we recommend moving the data center to an alternate location—the new nursing building is reported to have adequate space and infrastructure to house this data center.	Completed	Action was completed

Vulnerability	Action	2020 Status	2020 Implementation Status Comments
Lumbee Hall: The executive EOC, located in the chancellor's board room does not have adequate emergency power or telephone infrastructure to support the functions of the EOC.	The secondary data center should be relocated to an alternate location. The excess generator capacity and the existing data center HVAC system should be repurposed to the Chancellor's board room to support the executive EOC. The University should maintain a telecom crash-cart with switches and phones to provision the EOC during emergencies.	Completed	Room renovated
Mary Livermore Library: There is an exterior soffit with water damage.	The cause of water infiltration should be identified and remedied to prevent further damage to the structure and/or its contents.	Completed	Repaired
Mary Livermore Library: The special collections room is in an area that uses water-based sprinklers.	The water based sprinkler system should be replaced with a fire suppression system that is inert with respect to the documents in the room.	Deleted	Building Design
Oak Hall: Some of the roof scuppers are several inches above the roof deck. If roof drains become clogged roof ponding will occur.	During the next roof remodel, have scuppers lowered to within one inch of the roof deck.	Deleted	Building Design
Oak Hall: The building telephone system relies on VOIP switches powered by local UPS devices with limited battery life.	Place VOIP switches on standby power to facilitate communications during power outages.	Completed	Action was completed
Old Main: The museum has a water based fire suppression system.	If water-based sprinklers would damage museum artifacts, they should be replaced with a non-water based fire suppression system.	Deleted	Building Design
Old Main: Building is exposed to several large pine trees; should one of the trees fall on the building it would cause significant damage.	The large pine trees should be monitored by an arborist to ensure their health. If they are deemed to pose a significant threat to the building due to their size and condition, they should be removed.	Completed	Some trees were removed.
Old Main: Several caulk joints on the parapet wall cap stone are deteriorating.	The caulk joints on the parapet wall cap stone should be replaced to mitigate the negative effects of water intrusion.	Completed	Repaired
Oxendine Science Building: North Odem Street is a 5-lane highway east of Oxendine; numerous students cross the street throughout the day without signals or a crosswalk. The area of the structure housing the data center could be struck by a vehicle that jumps the curb.	Installation of a crosswalk and/or pedestrian signal system will reduce the exposure of pedestrians to vehicle-pedestrian accidents. Consider installation of site vegetation or bollards in front of data center that would slow or stop a vehicle that jumps the curb.	Completed	Prospect Road Update

Vulnerability	Action	2020 Status	2020 Implementation Status Comments
Oxendine Science Building: The fiber network that links communication systems across campus is nearing the end of its design life and lacks significant redundancy.	Planning should begin to replace the primary segments of the aging fiber optic network. As the fiber network is replaced, redundancies should be added into the system to make the campus communications system more resilient. This is vital as mobile phone service is spotty and the VOIP network is the primary mode of emergency communication.	Completed	Fiber has been updated
Oxendine Science Building: A sewage lift station serves Oxendine and some of the surrounding buildings; it is not clear if the lift station is on generator power.	Ensure the sewage lift station is on generator power; if it is not, it should be placed on generator power.	Completed	Electrician advised the lift station is on generator power
Oxendine Science Building: There were sprinklers in the data center; it is not clear if they are deactivated.	Ensure the sprinkler heads in the data center are deactivated; if they are not, they should be deactivated.	Deleted	They are deactivated
Pinchbeck Maintenance Complex: Personnel pointed out areas of the roof with a history of leaks.	Areas with water leaks should be identified and repaired to prevent damage to contents or further deterioration of the roof.	Deleted	Ongoing Maintenance Issue
Pinchbeck Maintenance Complex: Numerous storage areas (records, equipment, and surplus) are improperly maintained; they are cluttered and/or have items stacked/stored in an unsafe manner.	Items stored on racks should be correctly palletized and their weight should not exceed safe load limits of the racking system; items on shelves should be secured, and items that must be stacked on the floor should be stacked safely.	Completed	Warehouses have been reorganized
Pinchbeck Maintenance Complex: Gas cylinders in the HVAC bay were not properly secured.	All gas cylinders in the complex should be properly restrained from tipping.	Completed	Gas cylinders are properly secured
Pine Hall: The south façade has a history of water penetration during intense storm events.	The cause of the water penetration of the south façade should be identified and remedied.	Deleted	Maintenance Issue
Pine Hall: Some roof scuppers are located several inches above the level of the roof deck.	During the next re-roofing project, scuppers should be lowered to within one inch of the roof deck.	Deleted	Building Design
Pine Hall: The building telephone system relies on VOIP switches powered by local UPS devices with limited battery life.	Place VOIP switches on standby power to facilitate communications during power outages.	Completed	
Student Health Services Building: Several caulk joints around windows are deteriorating.	The single-pane windows should be replaced or at minimum recaulked.	Completed	Building Renovated: Hickory Hall North
Student Health Services Building: Evidence of water intrusion through the CMU wall in the network closet was observed.	The cause of the water intrusion through the CMU wall in the network closet should be identified and remedied.	Completed	Building Renovated: Hickory Hall North

Vulnerability	Action	2020 Status	2020 Implementation Status Comments
Student Health Services Building: There is a large tree adjacent to the generator courtyard which could fall onto the generator or wall surrounding the generator.	The large tree adjacent to the generator courtyard should be considered for removal. If it is desired to keep the tree, it should be periodically checked by an arborist to ensure it remains healthy.	Completed	Building Renovated: Hickory Hall North
Student Health Services Building: The building telephone system relies on VOIP switches powered by local UPS devices with limited battery life. The campus infirmary would be vital to any coordinated disaster response.	Place VOIP switches on standby power to facilitate communications during power outages.	Completed	Building Renovated: Hickory Hall North
Chavis University Center and UC Annex: The UC is the primary dining facility for campus; there is no source of standby power to maintain continuity of dining services, or prevent frozen/refrigerated food from spoiling in the event of a prolonged power outage.	A generator capable of powering refrigerators/freezers, cooking, cleaning, and serving equipment should be installed to maintain continuity of dining services in the event of a prolonged power outage.	Completed	Action was completed
Chavis University Center and UC Annex: Some of the brick masonry is crumbling over the loading dock at the UC.	The crumbling of the brick masonry should be monitored; it could be damage over time from large/heavy items bumping into the building while being loaded/unloaded.	Completed	Repaired
Jones Athletic Center: The east wing of Jones has a history of flooding during intense storms; significant repairs have been made three times to date. Recent upgrades to drainage infrastructure have yet to be tested.	The modifications made to site drainage are only a partial repair. The root cause of flooding in this area is located to the east of campus where drain lines servicing the campus go through a diameter reduction, decreasing available capacity and leading to rapid and uncontrolled flooding in areas served upstream of the diameter reduction. The University should work to increase the capacity of drainage infrastructure in this area to prevent backups.	Completed	Stormwater system was updated
Jones Athletic Center: There is debris stacked up in the mechanical rooms near the pool.	The mechanical rooms and pool area should not be used to store debris; areas with clutter should have the clutter removed.	Completed	Room was cleared
Lumbee Hall: The northwest and southwest corners of the building have masonry bulges at the 4th floor diaphragm.	The bulges in the brick masonry façade should be inspected at closer range to determine if in fact damage is occurring at these locations. The cause of ongoing damage should be identified and repaired.	Deleted	Maintenance Issue

Vulnerability	Action	2020 Status	2020 Implementation Status Comments
Lumbee Hall: The secondary data center does not have adequately redundant HVAC, is at generator capacity, and has no physical space to expand.	Given the importance of the secondary data center and the limited space and support infrastructure in Lumbee, we recommend moving the data center to an alternate location—the new nursing building is reported to have adequate space and infrastructure to house this data center.	Completed	Action was completed
Lumbee Hall: The executive EOC, located in the chancellor's board room does not have adequate emergency power or telephone infrastructure to support the functions of the EOC.	The secondary data center should be relocated to an alternate location. The excess generator capacity and the existing data center HVAC system should be repurposed to the Chancellor's board room to support the executive EOC. The University should maintain a telecom crash-cart with switches and phones to provision the EOC during emergencies.	Completed	Room renovated
Lumbee Hall - Facility personnel described minor flooding history at the west side entrance where driving rain penetrates under the door, resulting in water intrusion in the lobby area.	The entrance should be sloped away from the building and a catch-basin installed to divert storm water away from the building.	Completed	The door threshold weather stripping was replaced. A canopy was installed over door Summer 2020.
Mary Livermore Library: There is an exterior soffit with water damage.	The cause of water infiltration should be identified and remedied to prevent further damage to the structure and/or its contents.	Completed	Repaired
Mary Livermore Library: The special collections room is in an area that uses water-based sprinklers.	The water based sprinkler system should be replaced with a fire suppression system that is inert with respect to the documents in the room.	Deleted	Building Design
Oak Hall: Some of the roof scuppers are several inches above the roof deck. If roof drains become clogged roof ponding will occur.	During the next roof remodel, have scuppers lowered to within one inch of the roof deck.	Deleted	Building Design
Oak Hall: The building telephone system relies on VOIP switches powered by local UPS devices with limited battery life.	Place VOIP switches on standby power to facilitate communications during power outages.	Completed	Action was completed
Old Main: The museum has a water based fire suppression system.	If water-based sprinklers would damage museum artifacts, they should be replaced with a non-water based fire suppression system.	Deleted	Building Design

Vulnerability	Action	2020 Status	2020 Implementation Status Comments
Old Main: Building is exposed to several large pine trees; should one of the trees fall on the building it would cause significant damage.	The large pine trees should be monitored by an arborist to ensure their health. If they are deemed to pose a significant threat to the building due to their size and condition, they should be removed.	Completed	Some trees were removed.
Old Main: Several caulk joints on the parapet wall cap stone are deteriorating.	The caulk joints on the parapet wall cap stone should be replaced to mitigate the negative effects of water intrusion.	Completed	Repaired
Oxendine Science Building: North Odem Street is a 5-lane highway east of Oxendine; numerous students cross the street throughout the day without signals or a crosswalk. The area of the structure housing the data center could be struck by a vehicle that jumps the curb.	Installation of a crosswalk and/or pedestrian signal system will reduce the exposure of pedestrians to vehicle-pedestrian accidents. Consider installation of site vegetation or bollards in front of data center that would slow or stop a vehicle that jumps the curb.	Completed	Prospect Road Update
Oxendine Science Building: The fiber network that links communication systems across campus is nearing the end of its design life and lacks significant redundancy.	Planning should begin to replace the primary segments of the aging fiber optic network. As the fiber network is replaced, redundancies should be added into the system to make the campus communications system more resilient. This is vital as mobile phone service is spotty and the VOIP network is the primary mode of emergency communication.	Completed	Fiber has been updated
Oxendine Science Building: A sewage lift station serves Oxendine and some of the surrounding buildings; it is not clear if the lift station is on generator power.	Ensure the sewage lift station is on generator power; if it is not, it should be placed on generator power.	Completed	Electrician advised the lift station is on generator power
Pinchbeck Maintenance Complex - While the entire complex has a sprinkler system, in many of the shops the sprinkler heads were outside the shops under the awning, rather than in the shops, as per the plans. The layout of the sprinkler system might not satisfy building code requirements.	All bays should be sprinklered. Verify with engineer of record that system was correctly installed.	Deleted	Plans did not call for the areas to be sprinkled. Fire Marshal was ok with the current setup.
Pinchbeck Maintenance Complex - Facilities Several shops had an entrance/exit on one side of the building; if a fire broke out in these bays, workers could become trapped in the bays.	Each bay should have a redundant egress route opposite the primary entrance/exit.	Deleted	Egress requirements are determined by occupancy.

H.7.2 Mitigation Action Plan

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.

The following table comprises the mitigation action plan for UNC-P. Each mitigation action recommended for implementation is listed in these tables along with detail on the hazards addressed, the goal and objective addressed, the priority rating, the lead agency responsible for implementation, potential funding sources for the action, a projected implementation timeline, and the 2020 status and progress toward implementation for actions that were carried forward from the 2011 plan.

Table H.55 – Mitigation Action Plan, UNC-P

Action #	Action Description	Hazard(s) Addressed	Goal & Objective Addressed	Priority	Mitigation Category	Lead Agency / Department	Estimated Cost	Potential Funding Source	Implementation Timeline	2020 Status	2020 Implementation Status Comments
UNCP1	Campus-Wide – Major mechanical systems (HVAC equipment, heat pumps, chillers, generators, fuel tanks, gas cylinders, and boilers) should be anchored to their foundations. This includes, but is not limited to, the following campus buildings: Chavis University Center and UC Annex; Jones Athletic Center; Lumbee Hall; Mary Livermore Library; Oak Hall; Old Main; Oxendine Science Building; Pinchbeck Maintenance Complex; Pine Hall; and Student Health Services Building.	All Hazards	1.1	Moderate	Property Protection	Facilities Operations & Maintenance	$5,000-$25,000 per site	Operating Budget	2021-2026	Carry Forward	No progress has been made on this action. Need to get clarification on the anchoring of equipment from construction perspective. Pembroke does not fall within the Wind map zone that requires anchoring.
UNCP2	Campus-Wide – Upgrade back-up power capabilities to critical facilities including, but not limited to: Old Main; UC dining services; Pinchbeck Facilities; and Lumbee Hall.	All Hazards	1.2	High	Structural Project	Facilities Operations & Maintenance	>$100,000 per site	State/Federal Grants	2021-2026	Carry Forward	No progress has been made on this action. Pending further review and funding consideration.
UNCP3	Campus Wide – Develop and/or provide campus-wide outreach and mitigation training to inform the public about severe winter weather impacts and how to stay safe during winter weather events through emails, flyers, and online training; severe weather week participation; and cyber security awareness.	All Hazards	2.1	Low	Public Education & Awareness	EHS, University Communications and Marketing, Police and Public Safety; and DoIT	< 1,000	Operating Budget	2021-2026	New	
UNCP4	Mary Livermore Library - There is no redundant source of climate control for the special collections. In the event of a prolonged power outage or failure of the main HVAC system, materials would be exposed to environmental conditions which encourage mold growth and accelerate deterioration of documents. Provide a redundant source of climate control for the special collections which is capable of operating during power outages.	All Hazards	1.2	High	Property Protection	Facilities Operations & Maintenance	$25,000-$100,000	Federal/State Grants	2021-2026	Carry Forward	FM has procured a 250kw, portable generator for this facility specifically for limited cooling during extended power outages. A project has been created for the installation of a permanent facility generator but no funding at this time.
UNCP5	Mary Livermore Library - Several large pine trees are adjacent to the building and mechanical equipment areas. The health of the large pine trees should be monitored to reduce the exposure of the building to impacts from the large trees falling on the facility and its utilities.	Hurricane, Tornado/ Thunderstorm, Severe Winter Weather	1.1	Moderate	Property Protection	Facilities Operations & Maintenance	<$5,000	Operating Budget	2021-2026	Carry Forward	Ongoing assessment.
UNCP6	Oak Hall - The adjacent parking lot for the football stadium has a history of flooding during intense rains which leads to vehicle damage. Facility personnel reported flooding on Faculty Row due to insufficient drainage along the road. Additional drainage should be added to Faculty Row. The bottleneck in the main drainage lines to the east of campus should be corrected to prevent system backup.	Flood	1.1	High	Structural Projects	Facilities Operations & Maintenance	>$100,000	State/Federal Grants	2021-2026	Carry Forward	No progress has been made on this action. There is serious drainage flow constriction on the west side of Pembroke which impacts drainage movement off the west side of campus.
UNCP7	Increasing tree plantings around buildings to shade parking lots and along public rights-of-ways.	Extreme Heat	1.3	Low	Property Protection	Facilities Operations & Maintenance	>$12,000	Operating Budget	2021-2026	New	Ongoing project
UNCP8	Educate the campus community regarding the dangers of extreme heat and cold and the steps they can take to protect themselves when extreme temperatures occur through flyers and online training.	Extreme Heat	2.1	Low	Public Education & Awareness	Facilities Operations & Maintenance, EHS, University Communications and Marketing	<$1,000	Operating Budget	2021-2026	New	

Action #	Action Description	Hazard(s) Addressed	Goal & Objective Addressed	Priority	Mitigation Category	Lead Agency / Department	Estimated Cost	Potential Funding Source	Implementation Timeline	2020 Status	2020 Implementation Status Comments
UNCP9	Installing, re-routing, or increasing the capacity of a storm drainage system in flood prone areas.	Flood, Hurricane	1.1	High	Structural Project	Facilities Operations & Maintenance, Facilities Planning, Design and Construction	>$20,000	Operating Budget, Federal/State Grants	2021-2026	New	Ongoing project as funding is available.
UNCP10	Stormwater Awareness campaign: a stormwater awareness campaign can provide information to the university community on the necessity of keeping the stormwater system clean and the role they can play.	Flood	2.1	Low	Public Education & Awareness	Facilities Management, EHS, University Communications and Marketing	<$1,000	Operating Budget	2021-2026	New	
UNCP11	Install flood panels around flood-prone areas such as mechanical room entrances. Belk & North Hall exterior mechanical rooms. DF Lowry boiler room, Chancellors Guest House, water tower pump house (highest criticality).	Flood, Hurricane	1.2	Moderate	Structural Project	Facilities Operations & Maintenance	$30,000 - $50,000	Operating Budget, Federal/State Grants	2021-2026	New	Ongoing project as funding is available.
UNCP12	Raise electrical components of transformers above base flood elevation in flood-prone areas. Belk & North Hall transformers & generator, Primary Electric Switch 12.	Flood, Hurricane	1.1	Moderate	Structural Project	Facilities Operations & Maintenance	$20,000 - $40,000	Operating Budget, Federal/State Grants	2021	New	Reevaluating electrical infrastructure for possible transfer to local utilities provider.
UNCP13	During retrofitting or new building development raise utilities or other mechanical devices if in a flood zone area.	Flood, Hurricane	1.1	High	Structural Project	Facilities Operations & Maintenance, Facilities Planning, Design and Construction	$20,000 - $40,000	Operating Budget	2021-2026	New	Ongoing as new construction and/or renovation projects are established.
UNCP14	Identifying saferoom locations in campus buildings where the university community can gather during severe weather.	Hurricane, Tornado/ Thunderstorm	2.3	Moderate	Emergency Services	EHS, Police and Public Safety	<$1,000	Operating Budget	2022	New	Pending further review and funding consideration.
UNCP15	Protecting propane tanks or other external fuel sources, by installing bollards to protect the storage areas.	Wildfire, Hazardous Materials	1.1	Moderate	Property Protection	Facilities Operations & Maintenance	<$2,000	Operating Budget	2021	New	Project initiated
UNCP16	Establish safe areas within the facilities for people to assemble and seek refuge during a crisis.	Terrorism	2.3	Moderate	Emergency Services	EHS, Police and Public Safety	<$1,500	Operating Budget	2022	New	Pending further review and funding consideration.
UNCP17	Institute security access controls to limit access to the campus' critical infrastructure.	Terrorism	1.1	High	Prevention	IT, Facilities Operations & Maintenance, Police & Public Safety	>$500,000	Operating Budget, Federal/State Grants	2021-2026	New	Meetings have been held with the major stakeholders. Pending further review and funding consideration.
UNCP18	Install secure locks and protection on all internal/external doors, with quick-release capability. During a active threat internal doors could be secured with some type of locking device to protect those inside.	Terrorism	1.1	High	Prevention	Facilities Operations & Maintenance, Police & Public Safety	>$500,000	Operating Budget, Federal/State Grants	2021-2026	New	Demos from vendors have been conducted. Pending further review and funding consideration.
UNCP19	Training and exercise development to prepare for multiple hazards.	All-Hazards	3.2	Moderate	Emergency Services	Campus Stakeholders	<$10,000	Federal/State Grants	2021-2026	New	Dependent upon funding
UNCP20	Auxiliary Services Building - The UNCP Police and Public Safety Department was inaccessible during recent hurricanes due to rising floodwaters; this critical department needs to be relocated to a more accessible location to avoid a scenario were it would be impossible to access the Police and Public Safety Department. See line item 12	All-Hazards	1.2	High	Structural Project	Facilities Operations & Maintenance, Facilities Planning, Design and Construction, Space Allocation Committee	To be determined	Federal/State Grants	2021-2026	New	Pending further review and funding consideration.

Action #	Action Description	Hazard(s) Addressed	Goal & Objective Addressed	Priority	Mitigation Category	Lead Agency / Department	Estimated Cost	Potential Funding Source	Implementation Timeline	2020 Status	2020 Implementation Status Comments
UNCP21	UNCP Jones Athletic building served as a hub for first responders during past disasters; need to strengthen this facility to function as a shelter for first responders and government organizations (NC EM) during/after disasters. A standalone generator capable of handling the potential large load due to acting as a hub is needed. UNCP does not currently house a standalone EOC; now, we utilize conference rooms to convene the EOC when needed. A dedicated EOC space is necessary for the group to complete its duties effectively. Jones PE Center is the space recommended to house the primary EOC. It would need power, voice, and data ports throughout the room to facilitate rapid setup and operation of the EOC	All-Hazards	1.2	High	Structural Project	Facilities Operations & Maintenance, Facilities Planning, Design and Construction	$1,000,000	Federal/State Grants	2021-2026	New	Facilities installed a manual transfer switch to accept portable generator. Two portable generators have been staged at this facility.
UNCP22	On the south end of campus, we have a railroad the runs east to west. Several buildings are near the rail line, Oxendine Science, Old Main, Livermore Library, Hickory Hall, Hickory Hall North, and Chancellor's Residence. An internal warning system is needed to warn occupants of any significant issues from the rail line.	All-Hazards	2.2	Moderate	Emergency Services	Facilities Operations & Maintenance, Facilities Planning, Design and Construction	$50,000	Federal/State Grants	2021-2026	New	Met with (1) vendor that offered an indoor alarm solution. Pending further review and funding consideration.
UNCP23	Some chemical storage cabinets located at Oxendine, Comtec and Weinstein Health Science are not vented. Some chemicals contain hazardous fumes and must be stored respectively. A vented chemical storage cabinet is necessary for protecting the rest of the laboratory environment from these noxious fumes.	Hazardous Materials	1.1	Moderate	Structural Project	Facilities Operations & Maintenance, Facilities Planning, Design and Construction	$80,000-$100,000	Operating Budget	2021-2026	New	Design required.
UNCP24	A Spill Prevention, Control, and Countermeasure (SPCC) Plan is needed. The purpose of the Spill Prevention, Control, and Countermeasure (SPCC) rule is to help facilities prevent a discharge of oil into navigable waters or adjoining shorelines. The SPCC rule requires facilities to develop, maintain, and implement an oil spill prevention plan, called an SPCC Plan. These Plans help facilities prevent oil spill, as well as control a spill should one occur.	Hazardous Materials	3.2	High	Prevention	Facilities Operations & Maintenance, Facilities Planning, Design and Construction	$8,000-$12,000	Operating Budget	2021-2026	New	Pending further review and funding consideration.

THE UNIVERSITY OF NORTH CAROLINA SYSTEM

UNC System Eastern Campuses Regional Hazard Mitigation Plan

Annex I: University of North Carolina at Wilmington

wood.

TABLE OF CONTENTS

Annex I University of North Carolina - Wilmington

This section provides planning process, campus profile, hazard risk, vulnerability, capability, and mitigation action information specific to the University of North Carolina – Wilmington (UNC-W). This section contains the following subsections:

- I.1 Planning Process Details
- I.2 Campus Profile
- I.3 Asset Inventory
- I.4 Hazard Identification
- I.5 Hazard Profiles, Analysis, and Vulnerability
- I.5 Capability Assessment
- I.6 Mitigation Strategy

I.1 PLANNING PROCESS DETAILS

The table below lists the HMPC members who represented UNC-W during the planning process.

Table I.1 – HMPC Members

Representative	Agency/Department
Eric Griffin	Assistant Director, Emergency Management; Environmental Health and Safety
Jeff Campbell	Director; Environmental Health and Safety
Jodie Ruskin	Business Continuity Planner; Environmental Health and Safety
Stuart Borrett	Associate Provost; Research and Innovation
Carey Gibson	Executive Director for Infrastructure Operations; ITS
Wesley Merrill	Director of Facilities and Event Management; Athletics
Paul Townend	Associate Vice Chancellor & Dean; Undergraduate Studies
Larry Wray	Executive Director; Campus Life
Andrew Mauk	Associate Provost; Institutional Research and Planning
Peter Groenendyk	Director; Housing & Residence Life
Laura McBrayer	Senior Associate Director; Library Information Technology & Scholarly Research
Kristy Burnette	Institutional Risk Management Coordinator; Enterprise Risk Management
Mark Morgan	Associate Vice Chancellor; Facilities
Steven Still	Emergency Management Director; New Hanover County Emergency Management

Coordination with Other Community Planning Efforts and Hazard Mitigation Activities

The table below lists campus and community resources referenced throughout the planning process and used in the plan development.

Table I.2 – Summary of Existing Studies and Plans Reviewed

Resource Referenced	Use in this Plan
UNC-W Campus Master Plan	The UNC-W Campus Master Plan, developed in 2017, was referenced for the Campus Profile in Section I.2 as well as the Capability Assessment in Section I.6
City of Wilmington Comprehensive Plan	The Comprehensive Plan developed by the Wilmington Planning, Development, and Transportation Department was referenced for the Campus Profile in Section I.2.

Resource Referenced	Use in this Plan
New Hanover County and Incorporated Areas Flood Insurance Study (FIS), Revised 12/06/2019	The FIS report was referenced in the preparation of flood hazard profile in Section I.5.
UNC Wilmington Hazard Mitigation Plan, 2008; UNC Wilmington THIRA, 2016	The UNC-W previous Hazard Mitigation Plan and the campus' existing THIRA were used in preparation of the hazard profiles in Section I.5. The HMP was additionally used to track implementation progress (Section 2) and develop the mitigation plan (Section 7).
Southeaster NC Regional Hazard Mitigation Plan, April/June 2016	The Southeast NC Regional Hazard Mitigation Plan, which includes New Hanover County & Wilmington, was referenced in compiling the Hazard Identification and Risk Assessment in Section I.5.

I.2 CAMPUS PROFILE

This section provides a general overview of the University of North Carolina at Wilmington (UNC-W) campus and area of concern to be addressed in this plan. It consists of the following subsections:

- Location and Setting
- Geography and Climate
- History
- Cultural and Natural Resources
- Land Use
- Population and Demographics
- Social Vulnerability
- Growth and Development Trends

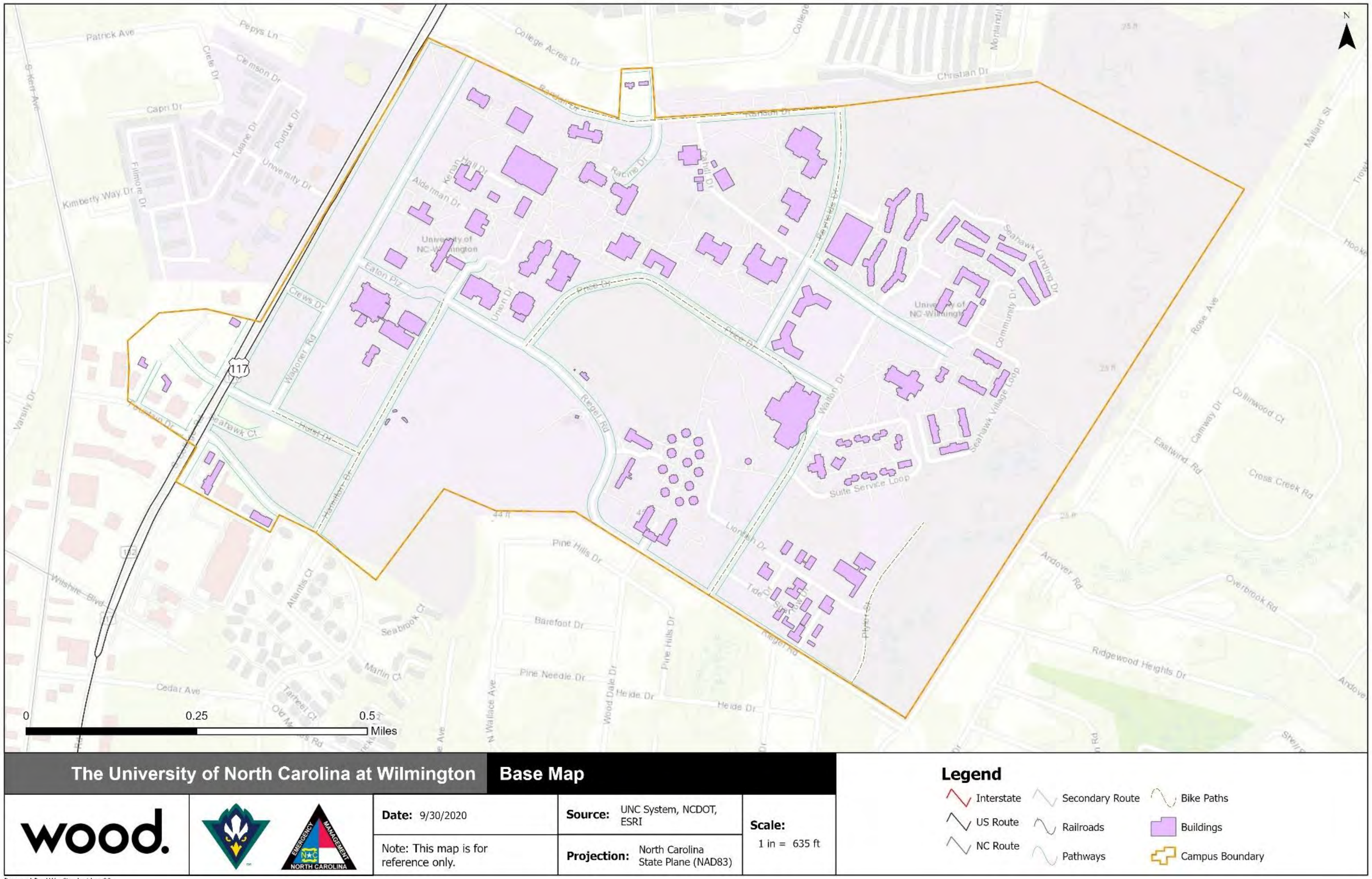
I.2.1 Location and Setting

The University of North Carolina at Wilmington is in the historic port city of Wilmington, North Carolina, which is located on the Cape Fear River. The UNCW campus is located about 5 miles from the historic downtown riverfront to the west and the Atlantic Ocean and Wrightsville Beach about 5 miles to the east. The University is situated on 661 acres and consists of more than 49 buildings. It has grown significantly over the last decade and offers 56 different majors, 36 Master's degrees and 4 Doctoral degree programs. UNCW also has more than 250 student organizations which help cater to any area of interest a student may have and promote a sense of belonging. UNCW is known for small classes with custom designed courses tailored to student need and is dedicated to the integration of teaching, mentoring, research, and service.

United States Highways 17 and 117 make UNCW easily accessible by automobile. The University provides shuttle services on and around campus, a bicycle rental program, and they maintain bicycle, skateboard, and pedestrian amenities.

Figure I.1 provides a base map of the campus. For more information on campus buildings and critical facilities, see Section I.3.

Figure I.1 – UNC-W Campus Base Map



I.2.2 Geography and Climate

The University of North Carolina at Wilmington is in Wilmington, which is in the Tidewater portion of North Carolina's Inner Coastal Plain region. Wilmington has an elevation of 36 feet above sea level and UNCW's campus is largely flat with a few rolling hills. Wilmington has a moderate climate with temperatures dropping to 33 degrees Fahrenheit on average in January and climbing to 90 degrees Fahrenheit on average in July. The annual precipitation for the City is approximately 58 inches per year.

I.2.3 History

In 1946, a college center was established under the direction of the North Carolina College Conference and under the administration of the Directorate of Extension of the University of North Carolina at Chapel Hill. It offered courses at the freshman level to 238 students during the 1946-47 academic year.

A tax levy was approved by the citizens of New Hanover County, and Wilmington College was brought into existence as a county institution under the control of the New Hanover County Board of Education. In 1948 Wilmington College was officially accredited by the North Carolina College Conference and became a member of the American Association of Junior Colleges.

New Hanover County voted to place the college under the Community College Act of the state of North Carolina in 1958, making it a part of the state system of higher education. Control passed from the New Hanover County Board of Education to a board of 12 trustees, eight of whom were appointed locally and four of whom were appointed by the governor of the state. Requirements for admission and graduation and the general academic standards of the college came under the supervision of the North Carolina Board of Higher Education, and the college began to receive an appropriation from the state for operating expenses in addition to the local tax.

In 1963 the General Assembly of North Carolina declared Wilmington College eligible to become a senior college with a four-year curriculum, authorized to offer the bachelor's degree. By vote of the Board of Trustees of the University of North Carolina, with subsequent approval by the North Carolina Board of Higher Education, and by an act of the General Assembly of North Carolina, Wilmington College became the University of North Carolina at Wilmington by 1969.

The Board of Governors of the University of North Carolina authorized the University of North Carolina at Wilmington to offer its first graduate programs at the master's level in 1977.

In 1979, the university reorganized into the College of Arts and Sciences, the School of Business Administration, and the School of Education. The business school was later renamed the Cameron School of Business; the School of Education later became the Watson College of Education. The University then opened the Graduate School in 1980.

In 1984, the first history of UNCW, From These Beginnings: Wilmington College 1946-1969, was published. It was written by J. Marshall Crews, one of Wilmington College's early instructors. One year later, The Board of Governors elevated the University of North Carolina at Wilmington to a Comprehensive Level I University. Less than a decade later, UNCW received its first patent, for a streamlined bacterial test developed by biology and marine biology professor Ronald Sizemore and Jerra Caldwell '86.

The UNCW Onslow Extension Site, now known as UNCW@Onslow, was established as a partnership involving UNCW, Coastal Carolina Community College, Marine Corps Base Camp Lejeune and the Onslow County Public School System in 1995. UNCW@Onslow is a unique distance education site that has provided access for nontraditional students – active-duty military, veterans, military dependents, working professionals and others – to earn degrees without commuting to Wilmington. That same year, the Upperman African American Cultural Center opened in the Fisher University Union. It was named for the late Dr. Leroy Upperman, a Wilmington physician in honor of his “love of education and dedication to the provision of opportunities for African American students.”

In 2000, the Center for Marine Science building opened at the Myrtle Grove Campus, giving UNCW’s marine-related programs direct access to coastal waters and space for laboratories and classrooms. Planning for the facility began in 1990. Two years later, UNCW established its first doctoral program: Marine Biology. Since then, UNCW has added doctoral degrees in Educational Leadership, Nursing Practice and Psychology. The first Ph.D. in marine biology was awarded in 2006.

In 2005, Centro Hispano opened to serve UNCW’s growing Latino and Hispanic student population.

Five years later, The College of Health and Human Services opened in what is now McNeill Hall. CHHS now includes the School of Nursing, the School of Health and Applied Human Sciences and the School of Social Work.

The 69,000-square-foot interdisciplinary MARBIONC research facility opened its doors at UNCW’s Myrtle Grove campus in 2013. The building brought academic research and business startups in the field of marine biotechnology together under one roof to advance new discoveries and develop new products from the oceans.

In 2016, North Carolina voters supported the $2 billion NC Connect bond issue, which included $66 million for a new allied health building at UNCW, to be named Veterans Hall. Scheduled for completion in 2020, it will house UNCW’s growing health and human services programs; College of Arts and Sciences programs, including some chemistry courses and pharmaceutical science; and enhanced services to support military-affiliated students.

The University celebrated its 70th anniversary year in 2017, and in conjunction with the anniversary, the university published an updated history, Giving Flight to Imagination: 70 Years of Excellence, 1947-2017, researched and written by UNCW history lecturer Thomas R. Hart. As it enters its next 70 years, UNCW continues to plan new academic programs that prepare students for advanced degrees and careers in the global market and encourage them to pursue lifelong learning.

Hurricane Florence came ashore at Wrightsville Beach on Sept. 14, 2018, causing widespread damage in southeastern North Carolina, including extensive damage to the UNCW campus. UNCW was closed for nearly a month as university and emergency management officials worked to restore the campus, and faculty, staff and students worked together to save the semester. That same year though, UNCW was elevated to the category “Doctoral Universities: High Research Activity” in the Carnegie Classification of Institutions of Higher Education.

Dr. Jose V. Sartarelli is the sixth chancellor and ninth leader of the University North Carolina Wilmington. He brings more than 35 years of professional leadership experience to UNCW. He is committed to attracting the best students, faculty and staff to UNCW by supporting the university's success in teaching, research and service.

I.2.4 Cultural and Natural Resources

National Register of Historic Places

There are 21 listings in the National Register of Historic Places for Wilmington and Wilmington Beach. Some of these include City Hall, the Federal Building and Courthouse, Fort Fisher, Gabriel’s Landing, and the James Walker Hospital Nursing School Quarters.

Natural Features and Resources

The City of Wilmington is responsible for 41 parks and 16 athletic facilities totaling 744 acres. The City received a Parks Bond in 2016 which gave the approval to begin $38 million in parks projects. Wilmington strives to provide both larger parks (50+ acres) for active and passive use; neighborhood parks (2-20 acres) within walking and biking distance of most homes; connectors like greenways and bikeways; and unique waterfront parks with public access to waterways whenever possible. Work is underway on the city's North Waterfront Park which is scheduled to be completed in June 2021.

There are not any areas located within a 100-year Special Flood Hazard Area on The University of North Carolina at Wilmington's campus. The entire campus is located within an Unshaded Zone X.

Natural and Beneficial Floodplain Functions

Under natural conditions, a flood causes little or no damage in floodplains. Nature ensures that floodplain flora and fauna can survive the more frequent inundations, and the vegetation stabilizes soils during flooding. Floodplains reduce flood damage by allowing flood waters to spread over a large area. This reduces flood velocities and provides flood storage to reduce peak flows downstream. While there are no mapped floodplain areas on the campus, protection of natural floodplain functions within the watershed may still benefit the campus and reduce flood risk.

Threatened and Endangered Species

The U.S. Fish and Wildlife Service maintains a regular listing of threatened species, endangered species, at-risk species, and candidate species for counties across the United States. Last updated in October 2015, New Hanover County has 17 species that are listed with the U.S. Fish and Wildlife Services. **Table I.3** below shows the 17 species identified as threatened and endangered in New Hanover County.

Table I.3 – Threatened and Endangered Species in New Hanover County

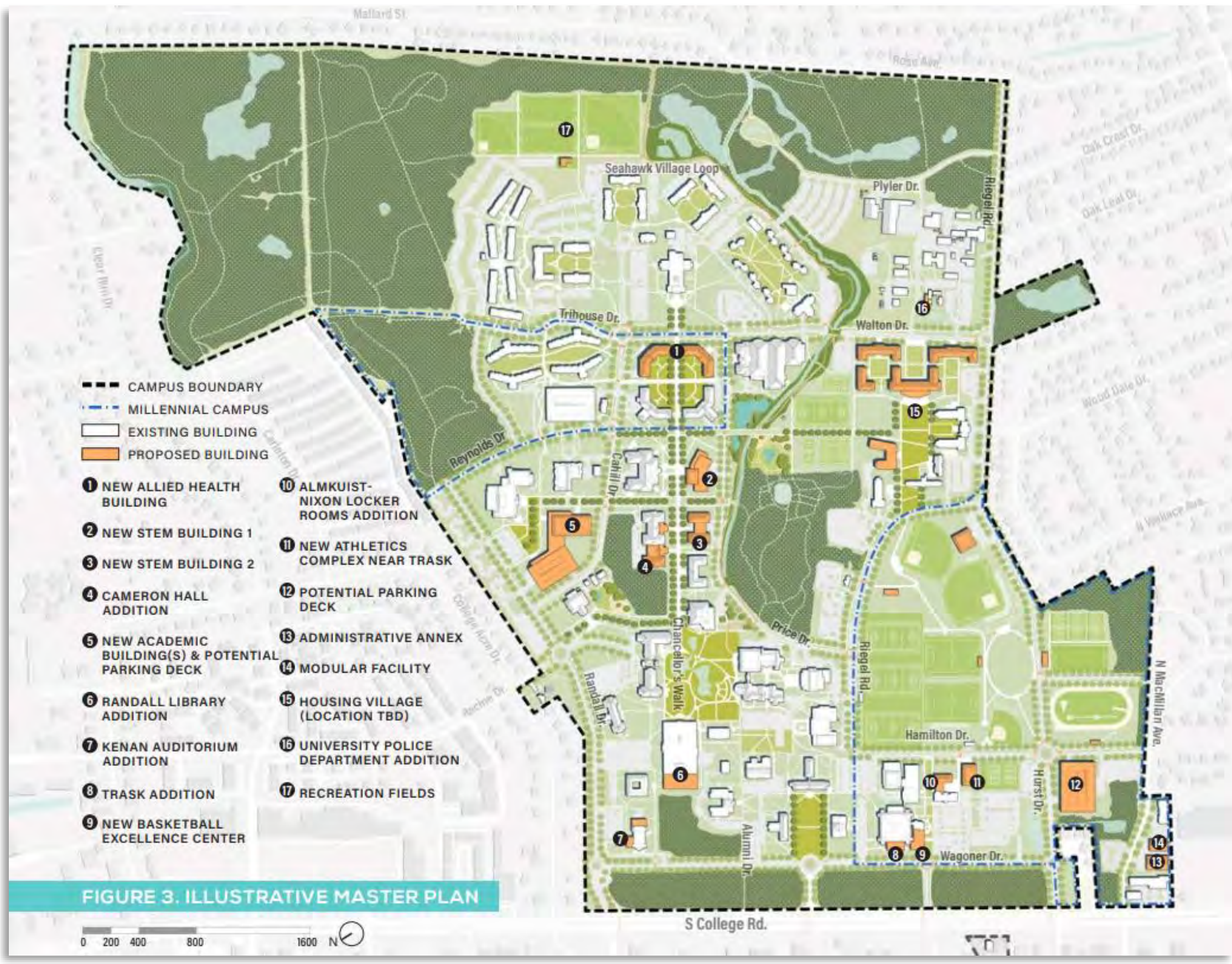
Common Name	Scientific Name	Federal Status
Hawksbill sea turtle	*Eretmochelys imbricata*	Endangered
Green sea turtle	*Chelonia mydas*	Threatened
Leatherback sea turtle	*Dermochelys coriacea*	Endangered
Loggerhead sea turtle	*Caretta*	Threatened
American alligator	*Alligator mississippiensis*	Threatened
Red-cockaded woodpecker	*Picoides borealis*	Endangered
Eastern Black rail	*Laterallus jamaicensis ssp. jamaicensis*	Threatened
Black Rail	*Laterallus jamaicensis*	Species of Concern
Cooley's meadowrue	*Thalictrum cooleyi*	Endangered
Rough-leaved loosestrife	*Lysimachia asperulaefolia*	Endangered
Northern Long-Eared Bat	*Myotis septentrionalis*	Threatened
Magnificent ramshorn	*Planorbella magnifica*	Candidate
West Indian Manatee	*Trichechus manatus*	Threatened
Golden sedge	*Carex lutea*	Endangered
Piping Plover	*Charadrius melodus*	Threatened
Seabeach amaranth	*Amaranthus pumilus*	Threatened
Red knot	*Calidris canutus rufa*	Threatened

Source: U.S. Fish & Wildlife Service (https://ecos.fws.gov/ecp/report/species-listings-by-current-range-county?fips=37129)

I.2.5 Land Use

The University of North Carolina at Wilmington's 2017 Master Plan has recommended various projects to meet current and future space needs and align with the University's 2016-2021 Strategic Plan. The Master Plan has proposed 495,000 gross square feet of new academic and research facilities across three distinct phases, an approximately 48,000 gross square foot addition to the west side of Randall Library, new administrative and academic support spaces to support current and future increases in student enrollment, and an additional indoor and outdoor athletic and recreational facilities that meet current and future needs. **Figure I.2** below shows a map of the proposed building development aligned with UNCW's 2016-2021 Strategic Plan.

Figure I.2 – UNCW's Proposed Building Development, 2017 Master Plan



I.2.6 Population and Demographics

Table I.4 provides population counts and percent change in population since 2010 for New Hanover County and the City of Wilmington.

Table I.4 – Population Counts for Surrounding Jurisdictions

Jurisdiction	2010 Census Population	2019 Estimated Population	% Change 2010-2019
New Hanover County	202,683	234,473	15.7
Wilmington	106,456	123,744	16.2

Source: U.S. Census Bureau QuickFacts 2010 vs 2019 (V2019) data

Table I.5 provides population counts for The University of North Carolina at Wilmington from Fall 2020, including the number of undergraduate and graduate students, staff, and faculty.

Table I.5 – Population Counts for The University of North Carolina at Wilmington, Fall 2020

Group	2020 Population
Students	17,915
Undergraduate Students	14,650
Graduate Students	3,265
Faculty	1,055
Staff	1,424

According to The University of North Carolina at Wilmington's Fall 2020 Fact Sheet, 14 % of the Freshman class were from out of state, and 63% of Freshman were female. Among the UNCW student population, the most popular majors include Business, MBA, Education, Nursing, and Marine Biology.

The racial characteristics of the County, City, and University are presented below in **Table I.6**. These characteristics for the County and City are based on the 2010 Census Bureau. White persons make up most of the population for the County, City, and UNCW.

Table I.6 – Demographics of New Hanover County, City of Wilmington and UNCW University Students

Jurisdiction	African-American Persons, Percent	American Indian or Alaska Native, Percent	Asian Persons, Percent	Hispanic or Latino Persons, Percent	White Persons, Percent
New Hanover County[1]	13.4	0.6	1.6	5.8	77.4
Wilmington [1]	18.4	0.3	1.3	6.3	71.7
The University of North Carolina at Wilmington[2]	6	1	2	7	77

Source: U.S. Census Bureau, 2010

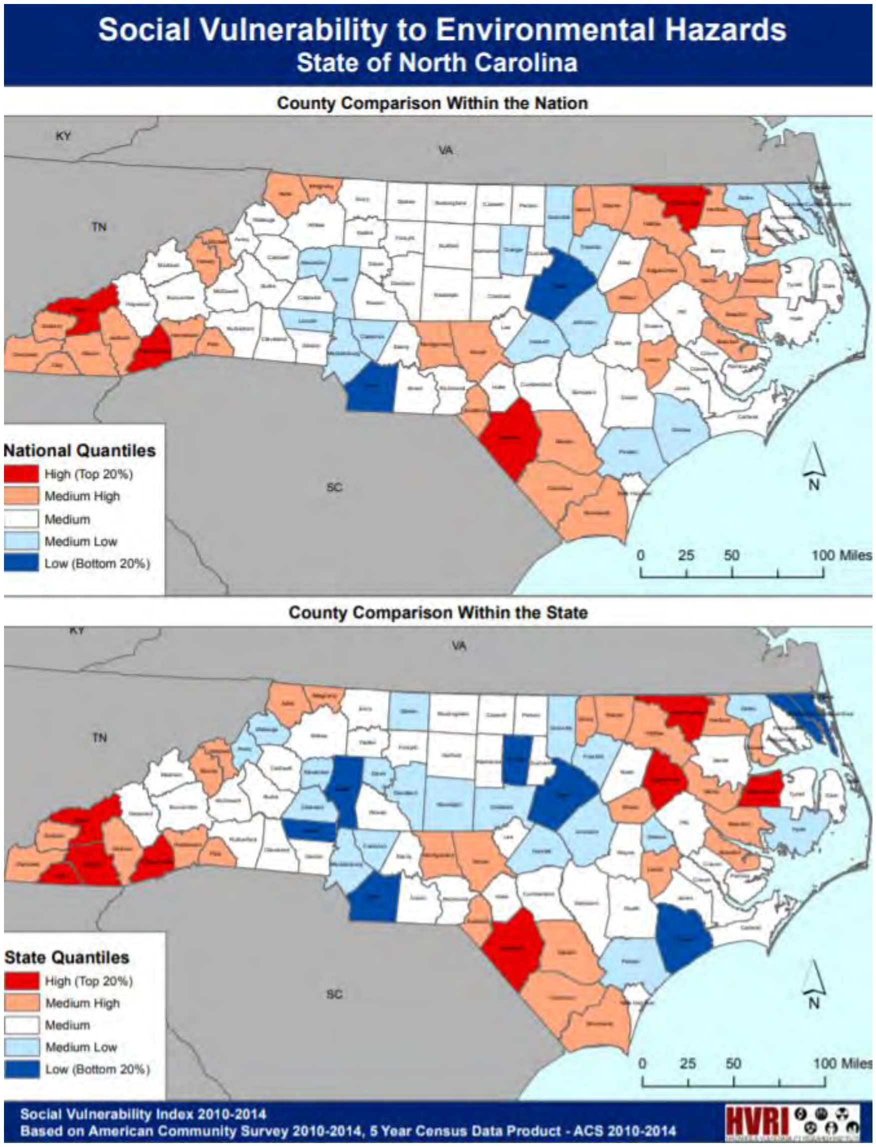
[1]Persons of Hispanic Origin may be of any race, so are also included in applicable race category in New Hanover County figures.

[2]Source: The University of North Carolina at Wilmington Quick Facts, Fall 2020

I.2.7 Social Vulnerability

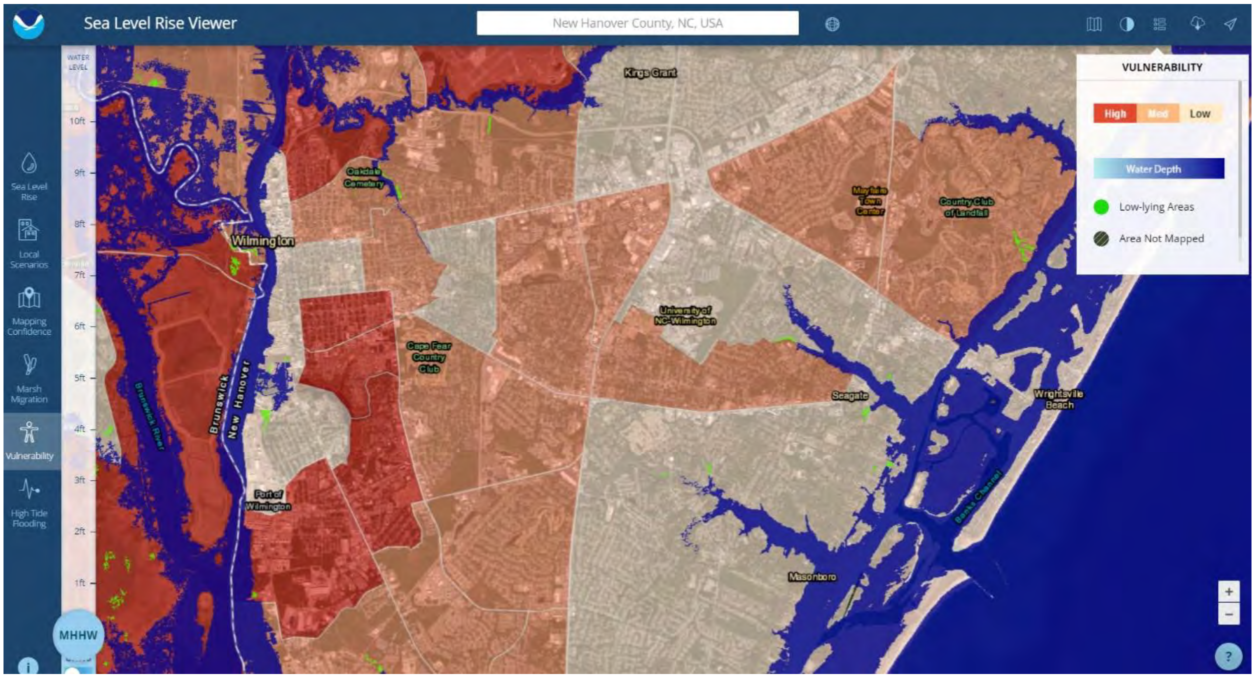
The Hazards and Vulnerability Research Institute at the University of South Carolina has created the Social Vulnerability Index (SoVI), to measure comparative social vulnerability to environmental hazards in the U.S. at a county level. SoVI combines 29 socioeconomic variables to determine vulnerability. The seven most significant components for explaining vulnerability are race and class, wealth, elderly residents, Hispanic ethnicity, special needs individuals, Native American ethnicity, and service industry employment. The index also factors in family structure, language barriers, vehicle availability, medical disabilities, and healthcare access, among other variables. **Figure I.3** displays the SoVI index by county with comparisons within the Nation and within the State. In both comparisons, New Hanover County ranks among the medium quantiles for social vulnerability.

Figure I.3 – SoVI Index for North Carolina



Using data from SoVI, NOAA created a social vulnerability viewer by census tract for their Digital Coast Sea Level Rise Viewer, which gives a much more detailed picture of variations in social vulnerability by location. **Figure I.4** displays social vulnerability at and around Wilmington and the UNC-W campus, with darker shades corresponding to higher levels of vulnerability. Based on New Hanover County's medium vulnerability rating from SoVI and Wilmington's low level of vulnerability according to the NOAA viewer, UNC-W can be assumed to have an overall medium-low level of social vulnerability to environmental hazards.

Figure I.4 – Social Vulnerability at and around UNC-W

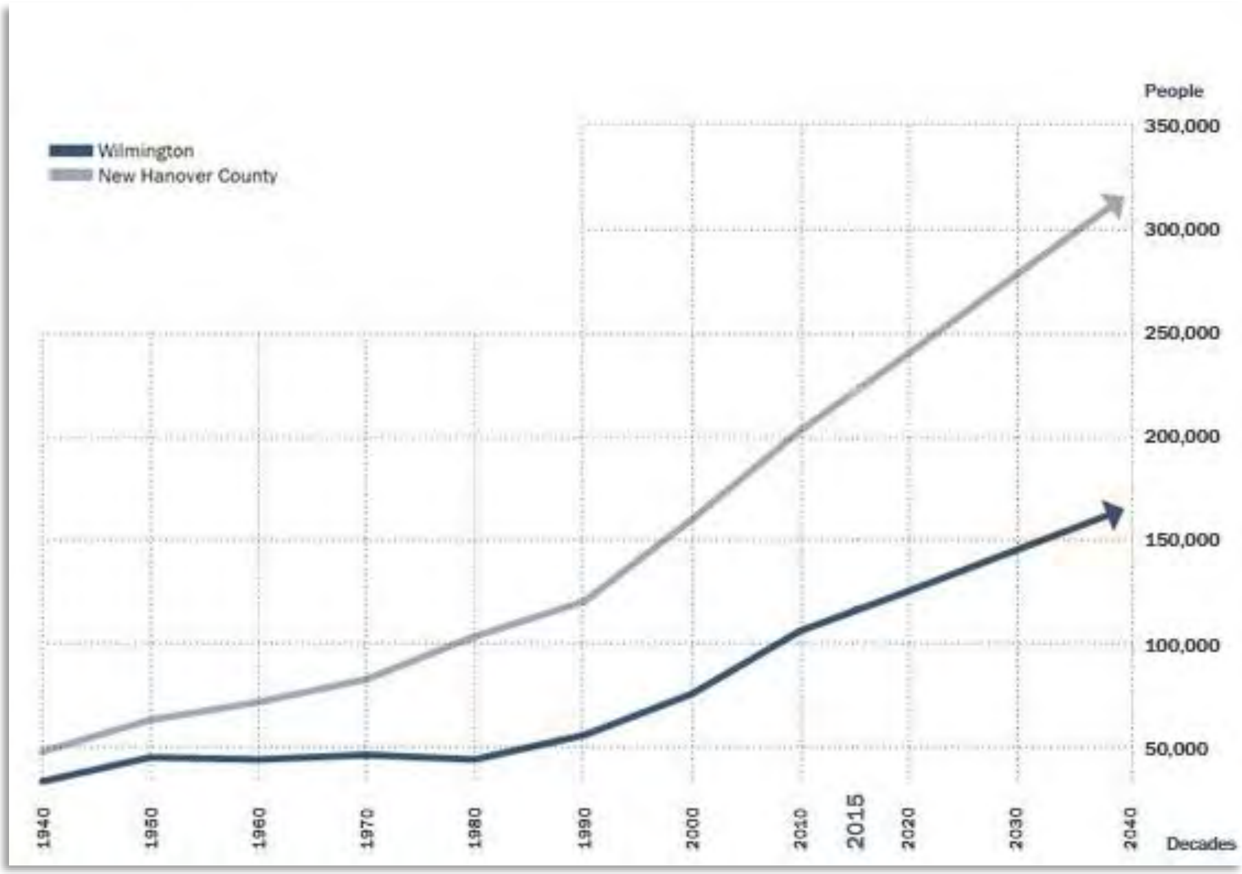


Source: NOAA Office for Coastal Management, Digital Coast, July 2016

I.2.8 Growth and Development Trends

Based on 2010 Census data, Wilmington had an estimated population of 123,744 residents in 2019. In the City of Wilmington's 2015 Comprehensive Plan, they provided population projections up to 2040 for the City and County. A graph of these projections can be found below in **Figure I.5**. The City of Wilmington currently has an annual growth rate of around 0.91% and is projected to grow to an estimated population of 166,000 by 2040, based on the City's projections. Wilmington's population has more than tripled since 1940; the biggest increase was seen after the completion of Interstate 40 in 1990 and following two major annexations in 1995 and 1998.

Figure I.5 – Population Projections up to 2040 for Wilmington and New Hanover County



The estimated population for Wilmington in 2019 was 123,744, which is a 7.6% increase from the 2015 estimated population, and a 16.2% increase from the 2010 Census population. **Table I.7** shows estimated population growth based on the 2010 Census population for the City of Wilmington.

Table I.7 – City of Wilmington Population Growth (2010 – 2019)

Year	Population	Growth	Percent Growth
2010	106,456	--	--
2015	115,050	8,594	8.1
2019	123,744	8,694	7.6

Source: U.S. Census Bureau

I.3 ASSET INVENTORY

An inventory of assets was compiled to identify the total count and value of property exposure on the UNC-W campus. This asset inventory serves as the basis for evaluating exposure and vulnerability by hazard. Assets identified for analysis include buildings, critical facilities, and critical infrastructure.

I.3.1 Building Exposure

Table I.8 provides total building exposure for the campus, which was estimated by summarizing building footprints provided by the University of North Carolina System Division of Information Technology and the North Carolina Emergency Management (NCEM) iRisk database and property values provided by the North Carolina Department of Insurance and NCEM iRisk database. All occupancy types were summarized into the following four categories: administration, critical facilities, educational/extracurricular, and housing. Note: estimated content values were not available.

Table I.8 – UNC-W Building Exposure by Occupancy

Occupancy	Estimated Building Count	Structure Value
Administration	2	$2,265,747
Critical Facilities	10	$24,126,888
Educational/Extracurricular	36	$41,848,457
Housing	10	$13,698,369
Total	**58**	**$81,939,461**

Source: UNC Division of Information Technology; NCEM iRisk; NC Department of Insurance

I.3.2 Critical Buildings and Infrastructure Exposure

Of significant concern with respect to any disaster event is the location of critical facilities and infrastructure in the planning area. Critical facilities are those essential services and lifelines that, if damaged during an emergency event, would disrupt campus continuity of operations or result in severe consequences to public health, safety, and welfare.

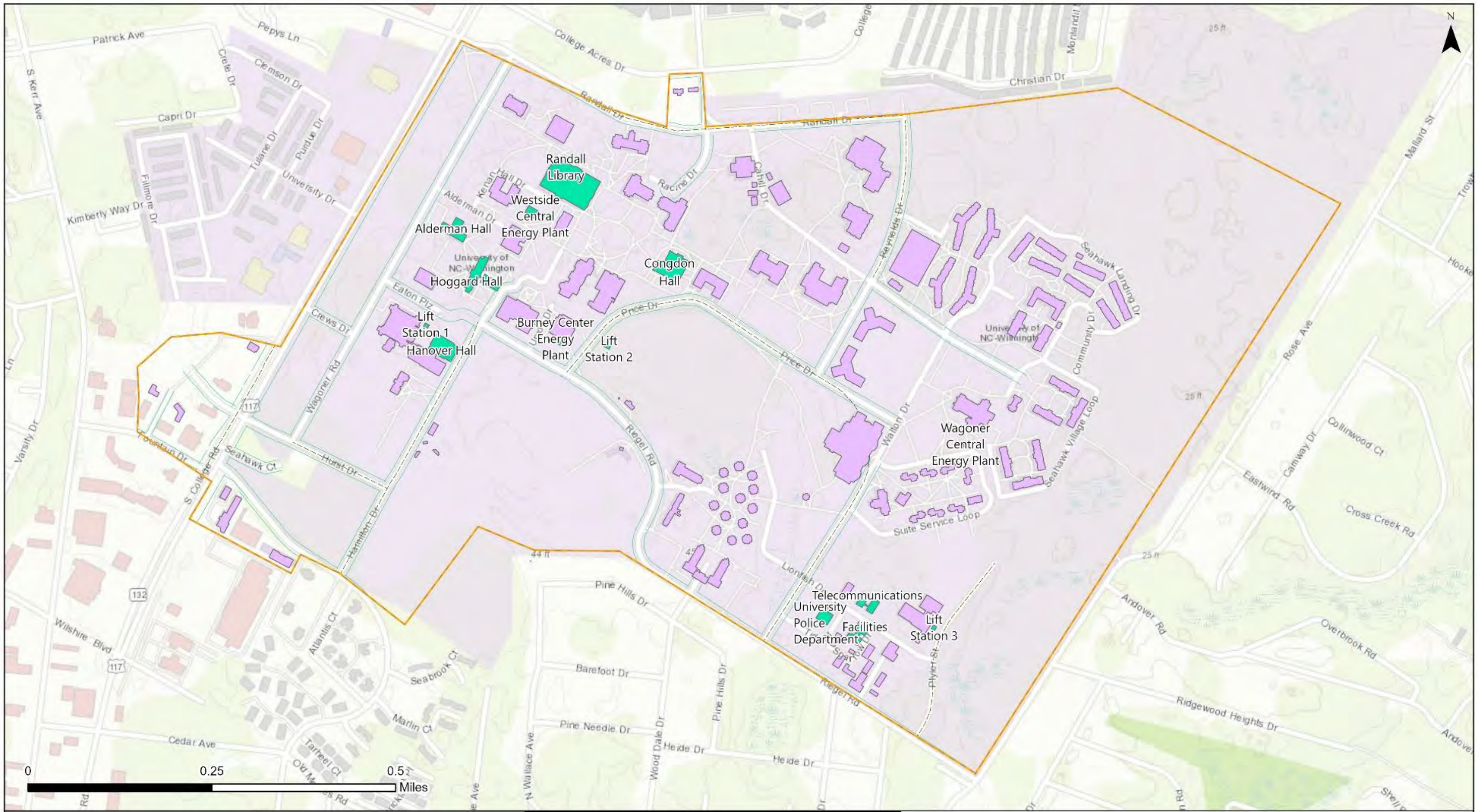
Critical buildings are a subset of the total building exposure and were identified by UNC-W's HMPC representatives. After reviewing the following criteria designed to evaluate all critical buildings in the UNC System Hazard Mitigation Plan, the UNC-W HMPC updated the list of critical facilities from the previous PDM plan. Factors considered for this ranking included:

- the building's use for emergency response,
- the building's use for essential campus operations
- the building's use as an emergency shelter or for essential sheltering services,
- the presence of a generator or generator hook-ups,
- the building's use for provision of energy, chilled water or HVAC for sensitive or essential systems,
- the storage of hazardous materials,
- the building's use for sensitive research functions,
- the building's cultural or historical significance, and
- building-specific hazard vulnerabilities

The identified critical facilities for UNC-W, as shown in **Figure I.6**, include the following:

- Alderman Hall
- Burney Center Energy Plant
- Center for Marine Science and Technology (CMAST)
- Congdon Hall
- Facilities
- Hanover Hall
- Hoggard Hall
- Lift Station 1
- Lift Station 2
- Lift Station 3
- Randall Library
- Telecommunications
- University Police Department
- Wagoner Central Energy Plant
- Westside Central Energy Plant

Figure I.6 – UNC-W Map of Critical Facilities



The University of North Carolina at Wilmington	Critical Facilities	
Date: 10/30/2020	Source: UNC System, NCDOT, ESRI	Scale: 1 in = 635 ft
Note: This map is for reference only.	Projection: North Carolina State Plane (NAD83)	

Legend: Critical Facilities, Other Buildings, Railroads, Pathways, Bike Paths, Campus Boundary

Prepared By: LW - Checked by: GS

I.4 HAZARD IDENTIFICATION & RISK ASSESSMENT

I.4.1 Hazard Identification

To identify a full range of hazards relevant to the UNC Eastern Campuses, HMPC representatives from each campus began with a review of the list of hazards identified in the 2018 North Carolina State Hazard Mitigation Plan and the 2008 UNC-W Pre-Disaster Mitigation Plan, as summarized in **Table I.9.** This ensured consistency with the state and regional hazard mitigation plans and across each campus' planning efforts.

Table I.9 – Hazards Included in Previous Planning Efforts

Hazard	Included in 2018 State HMP?	Included in 2008 UNC-W Pre-Disaster Mitigation Plan?
Flooding	Yes	Yes
Hurricanes and Coastal Hazards	Yes	Yes, as High Wind, Hurricane
Severe Winter Weather	Yes	Yes, as Ice storm and Snow
Extreme Heat	Yes	No
Earthquakes	Yes	Yes
Wildfire	Yes	Yes
Dam Failures	Yes	No
Drought	Yes	No
Tornadoes/Thunderstorms	Yes	Yes
Geological (Landslides, Sinkholes, Coastal Erosion)	Yes	Yes, as Landslide
Hazardous Materials Incidents	Yes	No
Infectious Disease	Yes	No
Radiological Emergency	Yes	No
Terrorism/Mass Casualty	Yes	No
Cyber Threat	Yes	No

UNC-W's HMPC representatives evaluated the above list of hazards by considering existing hazard data, past disaster declarations, local knowledge, and information from the 2018 State Plan and the 2008 UNC-W Pre-Disaster Mitigation Plan in order to determine whether each hazard was significant enough to assess in this updated Hazard Mitigation Plan. Significance was measured in general terms and focused on key criteria such as frequency, severity, and resulting damage, including deaths and injuries, as well as property and economic damage.

One key resource in this effort was the National Oceanic and Atmospheric Administration's (NOAA) National Center for Environmental Information (NCEI), which has been tracking various types of weather events 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), which compiles their information from a variety of sources, including but 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. While NCEI is not a comprehensive list of past hazard events, it can provide an indication of relevant hazards to the planning area and offers some statistics on injuries, deaths, damages, as well as narrative descriptions of past impacts.

Data for New Hanover County was used to approximate past events that may have affected the UNC-W campus. The NCEI database contains 431 records of storm events that occurred in New Hanover County in the 20-year period from 2000 through 2019. **Table I.10** summarizes these events.

Table I.10 – NCEI Severe Weather Data for New Hanover County, 2000 – 2019

Type	# of Events	Property Damage	Crop Damage	Deaths	Injuries
Coastal Flood	6	$0	$0	0	0
Drought	4	$0	$0	0	0
Flash Flood	69	$7,397,000	$0	0	0
Flood	59	$27,000	$0	0	2
Frost/Freeze	2	$0	$0	0	0
Funnel Cloud	9	$0	$0	0	0
Hail	57	$15,450	$0	0	0
Heat	7	$0	$0	0	0
Heavy Rain	44	$1,663,000	$0	0	2
High Wind	6	$10,000	$0	0	0
Hurricane (Typhoon)	2	$0	$0	0	0
Ice Storm	2	$0	$0	0	0
Lightning	31	$1,086,000	$0	2	15
Rip Current	27	$0	$0	11	3
Strong Wind	2	$17,000	$0	0	0
Thunderstorm Wind	61	$1,576,500	$0	0	1
Tornado	16	$1,678,000	$0	0	3
Tropical Storm	18	$3,028,000	$0	0	0
Waterspout	2	$0	$0	0	0
Wildfire	1	$2,500	$0	0	0
Winter Storm	6	$0	$0	0	0
Grand Total	**431**	**$16,500,450**	**$0**	**13**	**26**

Source: National Center for Environmental Information Events Database, retrieved October 2020
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 New Hanover 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 1954. Since then, New Hanover County has been designated in 12 emergency declarations, as detailed in **Table I.11**; and 21 major disaster declarations, as detailed in **Table I.12**.

Table I.11 – FEMA Emergency Declarations, New Hanover County

Disaster #	Dec. Date	Incident Type	Event Title/Description
EM-3110-NC	17-Mar-93	Snow	SEVERE SNOWFALL & WINTER STORM
EM-3141-NC	01-Sep-99	Hurricane	HURRICANE DENNIS
EM-3146-NC	15-Sep-99	Hurricane	HURRICANE FLOYD EMERGENCY DECLARATIONS
EM-3222-NC	05-Sep-05	Hurricane	HURRICANE KATRINA EVACUATION
EM-3254-NC	15-Sep-05	Hurricane	HURRICANE OPHELIA
EM-3314-NC	02-Sep-10	Hurricane	HURRICANE EARL

Disaster #	Dec. Date	Incident Type	Event Title/Description
EM-3327-NC	25-Aug-11	Hurricane	HURRICANE IRENE
EM-3380-NC	07-Oct-16	Hurricane	HURRICANE MATTHEW
EM-3401-NC	11-Sep-18	Hurricane	HURRICANE FLORENCE
EM-3423-NC	04-Sep-19	Hurricane	HURRICANE DORIAN
EM-3471-NC	13-Mar-20	Biological	COVID-19
EM-3534-NC	02-Aug-20	Hurricane	HURRICANE ISAIAS

Source: FEMA Disaster Declarations Summary, October 2020

Table I.12 – FEMA Major Disaster Declarations, New Hanover County

Disaster #	Dec. Date	Incident Type	Event Title	Individual Assistance Applications Approved	Total Individual and Households Program Dollars Approved	Total Public Assistance Grant Dollars Obligated
DR-28-NC	17-Oct-54	Hurricane	HURRICANE	N/A	N/A	N/A
DR-37-NC	13-Aug-55	Hurricane	HURRICANES	N/A	N/A	N/A
DR-56-NC	24-Apr-56	Severe Storm(s)	SEVERE STORM	N/A	N/A	N/A
DR-87-NC	01-Oct-58	Hurricane	HURRICANE & SEVERE STORM	N/A	N/A	N/A
DR-107-NC	16-Sep-60	Hurricane	HURRICANE DONNA	N/A	N/A	N/A
DR-130-NC	16-Mar-62	Flood	SEVERE STORM, HIGH TIDES & FLOODING	N/A	N/A	N/A
DR-179-NC	13-Oct-64	Flood	SEVERE STORMS & FLOODING	N/A	N/A	N/A
DR-724-NC	21-Sep-84	Hurricane	HURRICANE DIANA	N/A	N/A	N/A
DR-1127-NC	18-Jul-96	Hurricane	HURRICANE BERTHA	N/A	N/A	N/A
DR-1134-NC	06-Sep-96	Hurricane	HURRICANE FRAN	N/A	N/A	N/A
DR-1240-NC	27-Aug-98	Hurricane	HURRICANE BONNIE	N/A	N/A	N/A
DR-1292-NC	16-Sep-99	Hurricane	HURRICANE FLOYD MAJOR DISASTER DECLARATIONS	N/A	N/A	$298,105,794
DR-1490-NC	18-Sep-03	Hurricane	HURRICANE ISABEL	7790	$21,289,504	$18,285,917
DR-1608-NC	07-Oct-05	Hurricane	HURRICANE OPHELIA	N/A	N/A	$16,887,659
DR-1801-NC	08-Oct-08	Severe Storm(s)	TROPICAL STORM HANNA	N/A	N/A	$4,657,982
DR-1942-NC	14-Oct-10	Severe Storm(s)	SEVERE STORMS, FLOODING, AND STRAIGHT-LINE WINDS	2037	$8,587,054	$19,065,881
DR-4019-NC	31-Aug-11	Hurricane	HURRICANE IRENE	10270	$37,238,655	$88,847,065
DR-4285-NC	10-Oct-16	Hurricane	HURRICANE MATTHEW	28971	$98,842,213	$291,092,954
DR-4393-NC	15-Sep-18	Hurricane	HURRICANE FLORENCE	34713	$133,948,455	$632,937,402
DR-4465-NC	04-Oct-19	Hurricane	HURRICANE DORIAN	N/A	N/A	$28,138,271
DR-4487-NC	25-Mar-20	Biological	COVID-19 PANDEMIC	N/A	N/A	$174,898,697

Source: FEMA Disaster Declarations Summary, October 2020
Note: Number of applications approved and all dollar values represent totals for all counties included in disaster declaration.

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. **Table I.13** summaries the determination made for each hazard.

Table I.13 – Hazard Evaluation Results

Hazard	Included in this plan update?	Explanation for Decision
Natural Hazards		
Hurricane	Yes	The 2008 UNC-W PDM plan found Hurricane to be a moderate threat hazard. The County has had 10 disaster declarations related to hurricanes wind.
Coastal Hazards	No	The 2008 UNC-W PDM plan did not address this hazard.
Tornadoes / Thunderstorms (Wind, Lightning, Hail)	Yes	The 2008 UNC-W PDM plan found tornadoes to be a low threat hazard. The County has had no disaster declarations related to tornadoes. The HMPC expressed interest in addressing this hazard in combination with thunderstorms (wind, lightning, hail).
Flood	Yes	The 2008 UNC-W PDM plan rated flood a significant threat hazard for the planning area. The County has had 2 disaster declarations related to flooding.
Severe Winter Weather	No	The 2008 UNC-W PDM plan found ice/snow to be a low threat hazard. The HMPC was not interested in re-evaluating severe winter weather in this plan update.
Drought	No	The 2008 UNC-W PDM plan did not address this hazard.
Wildfire	Yes	The 2008 UNC-W PDM plan did not assign a threat and/or risk level for this hazard; however, the HMPC expressed interest in addressing this hazard.
Earthquake*	Yes	The 2008 UNC-W PDM plan did not assign a threat and/or risk level for this hazard; however, the HMPC expressed interest in addressing this hazard.
Geologic Hazards (Sinkhole & Landslide)*	Yes	The 2008 UNC-W PDM plan did not assign a threat and/or risk level for this hazard; however the HMPC expressed an interest in addressing this hazard for sinkholes.
Dam Failure	No	The 2008 UNC-W PDM plan did not address this hazard.
Extreme Heat	No	The 2008 UNC-W PDM plan did not address this hazard.
Technological and Human-Caused Hazards & Threats		
Hazardous Materials Incidents	Yes	The 2008 UNC-W PDM plan did not address this hazard; however, there are fixed facility sites and transportation routes with hazardous materials in the planning area and the HMPC expressed interest in addressing this hazard.
Infectious Disease	Yes	The 2008 UNC-W PDM plan did not address this hazard; however, due to the COVID-19 pandemic that occurred during this planning process, the HMPC determined infectious disease should be addressed.
Cyber Attack	Yes	The 2008 UNC-W PDM plan did not address this hazard; however, the HMPC expressed interest in re-evaluating cyber attacks in this plan update.
Terrorism	Yes	The 2008 UNC-W PDM plan did not address this hazard; however, the HMPC expressed interest in re-evaluating terrorism in this plan update.

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

I.5 HAZARD PROFILES, ANALYSIS, AND VULNERABILITY

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 where it may occur, the severity of potential events, records of past events, the probability of future occurrences, and potential impacts from the hazard. A vulnerability assessment was conducted for each hazard using quantitative and/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.

To account for regional differences in hazard risk across each of the campuses, this risk assessment is divided into two parts:

1) a set of summary hazard profiles describing each hazard and summarizing the risk findings for each campus, presented in Section 3.5; and
2) a campus-specific risk assessment profiling the location, extent, historical occurrences, probability of future occurrence, and vulnerability of each campus, presented in each campus annex.

In the campus-level hazard profiles presented here, each hazard is profiled in the following format:

Location

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

Extent

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

Historical Occurrences

This section contains information on historical events, including the location and consequences of all past events on record within or near the New Hanover County planning area. Where possible, this plan uses a consistent 20-year period of record except for hazards with significantly longer average recurrence intervals or where data limitations otherwise restrict the period of record.

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)

Vulnerability Assessment

This section quantifies, to the extent feasible using best available data, assets at risk to natural hazards and potential loss estimates. Details on hazard specific methodologies and assumptions are provided where applicable. People, properties and critical facilities, and environmental assets that are vulnerable to the hazard are identified.

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

- Geographic Information System (GIS) datasets, including County parcel data from 2020, campus building inventory fand values from the University System's Division of Information Technology, NCEM iRisk Database, and property values provided by the NC Department of Insurance, topography, transportation layers, and critical facility and infrastructure locations;
- Hazard layer GIS datasets from state and federal agencies;
- Written descriptions of inventory and risks provided by the 2018 State of North Carolina Hazard Mitigation Plan;
- Written descriptions of inventory and risks provided by the 2016 Southeastern NC Regional Hazard Mitigation Plan; and
- Exposure and vulnerability estimates derived using local parcel data.

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. For applicable hazards, the quantitative analysis involved the use of FEMA's Hazus-MH, a nationally applicable standardized set of models for estimating potential losses from earthquakes, floods, and hurricanes. Hazus uses a statistical approach and mathematical modeling of risk to predict a hazard's frequency of occurrence and estimated impacts based on recorded or historic damage information. The Hazus risk assessment methodology is parametric, in that distinct hazard and inventory parameters—such as wind speed and building type—were modeled using the Hazus software to determine the impact on the built environment. The GIS-based risk assessment was completed using data collected from local, regional and national sources that included New Hanover County, GEMA, and FEMA.

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. Other information can be collected in regard to the hazard area, such as the location of critical facilities and infrastructure, historic resources, 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.

The data collected for the hazard profiles and vulnerability assessment was obtained from multiple sources covering a variety of spatial areas including county-, jurisdictional-, and campus-level information. The table below presents the source data and the associated geographic coverages.

Table I.7 – Summary of Hazard Data Sources and Geographic Coverage

Hazard	Hazard Data Sources	Profile Geographic Area	Vulnerability Methodology	Vulnerability Geographic Area
Earthquake	USGS, NCEI	County	Hazus 4.2	Census Tract

Hazard	Hazard Data Sources	Profile Geographic Area	Vulnerability Methodology	Vulnerability Geographic Area
Flood	NCEI, FEMA	Jurisdiction	GIS Spatial Analysis	Campus
Hurricane	NHC	County	Hazus 4.2	Census Tract
Tornado / Thunderstorm	NWS, NCEI	Jurisdiction	Statistical Analysis	Jurisdiction
Sinkholes	USGS	County	Qualitative Analysis	County
Wildfire	NCFS, SouthWRAP	County, Campus	GIS Spatial Analysis	Campus
Cyber Threat	Internet Research	County, Higher Education	Qualitative Analysis	Higher Education
Hazardous Materials Incidents	EPA; USDOT	Jurisdiction	GIS Spatial Analysis	Campus
Infections Disease	CDC; WHO	National, Higher Education	Qualitative Analysis	Higher Education
Terrorism	Southern Poverty Law Center	National, Higher Education	Qualitative Analysis	Higher Education

CDC = Centers for Disease Control and Prevention; EPA = United States Environmental Protection Agency; FEMA = Federal Emergency Management Agency; NCEI = National Centers for Environmental Information; NCFS = North Carolina Forest Service; NHC = National Hurricane Center; NWS = National Weather Service; SouthWRAP = Southern Group of State Foresters, Wildfire Risk Assessment Portal; USDOT = United States Department of Transportation; USGS = United States Geological Survey; WHO = World Health Organization

Changes in Development

This section describes how changes in development have impacted vulnerability since the last plan was adopted. 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.

Problem Statements

This section summarizes key mitigation planning concerns related to this hazard.

Priority Risk Index

The conclusions drawn from the hazard profiling and vulnerability assessment process are used to prioritize all potential hazards to the UNC-W 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 I.8**

PRI ratings are provided by category throughout each hazard profile for the planning area as a whole. Ratings specific to each jurisdiction are provided at the end of each hazard profile. The results of the risk assessment and overall PRI scoring are provided in Section 0 Conclusions on Hazard Risk.

The sum of all five risk assessment categories equals the final PRI value, demonstrated in the equation below (the lowest possible PRI value is a 1.0 and 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 campus 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.

Table I.8 – 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	

I.5.1 Earthquake

Hazard	Probability	Impact	Spatial Extent	Warning Time	Duration	PRI Score
Earthquake	Unlikely	Minor	Large	Less than 6 hours	Less than 6 hours	1.9

Location

The United States Geological Survey (USGS) Quaternary faults database was consulted to determine the sources of potential earthquakes within range of New Hanover County. Quaternary faults are active faults recognized at the surface which have evidence of movement in the past 2.58 million years. The Charleston liquefaction features extend into New Hanover County. The liquefaction was recognized as being caused by strong ground motion and the strong motions are presumed to be caused by slip on one or more preexisting faults. However, the causative fault or faults have not been identified, and the locations and sizes of the liquefaction features provide poor constraints on the exact location, dimension, and orientation of the source or sources of the shaking.

Earthquakes are generally felt over a wide area, with impacts occurring hundreds of miles from the epicenter. Therefore, any earthquake that impacts New Hanover County is likely to be felt across most if not all of the planning area.

Spatial Extent: 4 – Large

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 I.14**. 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 I.15** 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 I.14 – 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 I.15 – 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.

MMI	Richter Scale	Felt Intensity
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.
VIII	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 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.

Impact: 1 – Minor

Historical Occurrences

The USGS Earthquake Hazards Program maintains a database of historical earthquakes of a magnitude 2.5 and greater from 1900 to 2020. Earthquake events that occurred within 100 miles of the UNC-W campus are presented in **Table I.16** and **Figure I.7**.

Table I.16 – Historical Earthquakes within 100 Miles of UNC-W, 1900-2020

Year	Magnitude	MMI	Location
1994	3.8	III	North Carolina
2006	3.7	III	7km W of Rowland, North Carolina

Source: USGS

Figure I.7 – Historical Earthquakes within 100 Miles of UNC-W, 1900-2020

Source: USGS

The National Center for Environmental Information (NCEI) maintains a database of the felt intensity of earthquakes from 1638 to 1985 including the maximum intensity for each locality that felt the earthquake. According to this database, in the 100-year period from 1885-1985, there have been 17 earthquakes felt in and around Wilmington with MMI ranging from II in November 1928 to VIII in September 1886.

Probability of Future Occurrence

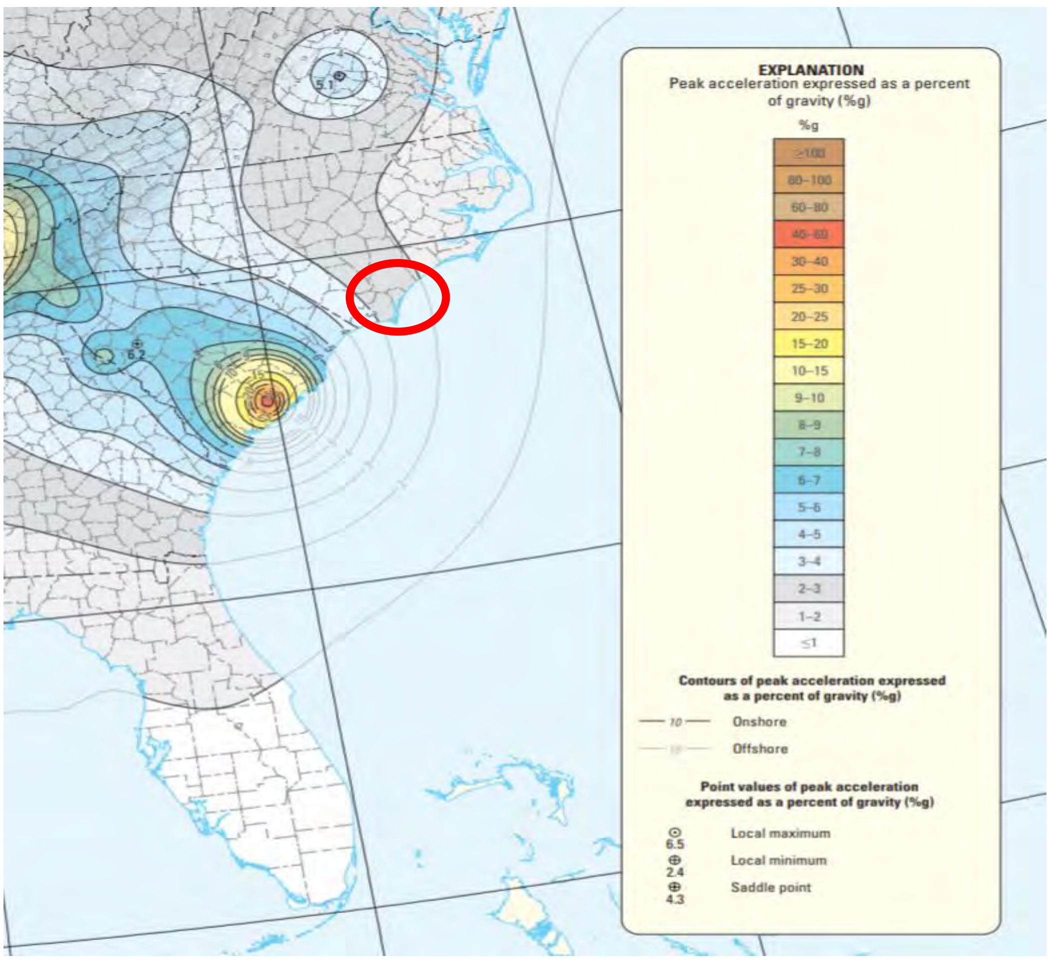
Ground motion is the movement of the earth's surface due to earthquakes or explosions. It is produced by waves generated by a sudden slip on a fault or sudden pressure at the explosive source and travels through the earth and along its surface. Ground motion is amplified when surface waves of unconsolidated 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 that have a common given probability of being exceeded in 50 years.

Figure I.8 on the following page reflects the seismic hazard for New Hanover 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 occurrence 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. All of New Hanover County is located within a zone with peak acceleration of 2-3% g, which indicates low earthquake risk.

In simplified terms, based on the record of past occurrences over a 120-year period from 1900 to 2020 there were no earthquakes that have or could have caused building damage in Wilmington, defined for this purpose as an MMI of VI or greater. All noted earthquakes were located outside New Hanover County and defined as MMI of III (Felt indoors. Hanging objects swing. Vibration like passing of light trucks. Duration estimated. May not be recognized as an earthquake.). Based on this data, it can be reasonably assumed that an earthquake event affecting New Hanover County is unlikely.

Probability: 1 – Unlikely

Figure I.8 – Seismic Hazard Information for New Hanover County



Source: USGS Earthquake Hazards Program

Vulnerability Assessment

Methodology & Assumptions

To quantify vulnerability, Wood performed a Level 1 earthquake analysis in Hazus 4.2 utilizing general building stock information based on the 2010 Census. The UNC-W campus is located within one census tracts which encompass 2.29 square miles. The earthquake scenario was modeled after an arbitrary earthquake event of magnitude 5.0 with an epicenter in the UNC-W campus and depth of 10km.

People

Hazus estimates that the modeled magnitude 5.0 event would result in 112 households requiring temporary shelter. Additionally, Hazus estimates potential injuries and fatalities depending on the time of day of an event. Casualty estimates are shown in **Figure I.9.** Casualties are broken down into the following four levels that describe the extent of injuries:

- Level 1: Injuries will require medical attention but hospitalization is not needed.
- Level 2: Injuries will require hospitalization but are not considered life-threatening.
- Level 3: Injuries will require hospitalization and can become life threatening if not promptly treated.
- Level 4: Victims are killed by the earthquake.

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. Impacts of earthquakes also include debris clean-up and service disruption. Per the Hazus analysis, a 5.0 magnitude earthquake could produce an estimated 30,000 tons of debris.

New Hanover County has not been impacted by an earthquake with more than a low intensity, so major damage to the built environment is unlikely. However, there is potential for impacts to certain masonry buildings, as well as environmental damages with secondary impacts on structures.

Table I.17 details the estimated buildings impacted by a magnitude 5.0 earthquake event, as modeled by Hazus. Note that building value estimates are inherent to Hazus and do not necessarily reflect damages to the asset inventory for the UNC-W Campus.

Table I.17 – Estimated Buildings Impacted by 5.0 Magnitude Earthquake Event

Occupancy Type	Estimated Building Damage	Estimated Content Loss	Estimated Total Damage
Residential	$400,000	$0	$400,000
Commercial	$3,250,000	$0	$3,250,000
Industrial	$40,000	$0	$40,000
Other	$90,000	$0	$90,000
Total	**$3,780,000**	**$0**	**$3,780,000**

Source: Hazus

Figure I.9 – Casualty Estimate from a 5.0 Magnitude Earthquake Event

		Level 1	Level 2	Level 3	Level 4
2 AM	Commercial	0	0	0	0
	Commuting	0	0	0	0
	Educational	0	0	0	0
	Hotels	0	0	0	0
	Industrial	0	0	0	0
	Other-Residential	20	5	1	1
	Single Family	4	1	0	0
	Total	**25**	**5**	**1**	**1**
2 PM	Commercial	16	4	0	1
	Commuting	0	0	0	0
	Educational	17	4	1	1
	Hotels	0	0	0	0
	Industrial	1	0	0	0
	Other-Residential	3	1	0	0
	Single Family	1	0	0	0
	Total	**38**	**9**	**1**	**2**
5 PM	Commercial	12	3	0	1
	Commuting	1	1	1	0
	Educational	9	2	0	1
	Hotels	0	0	0	0
	Industrial	1	0	0	0
	Other-Residential	8	2	0	1
	Single Family	2	0	0	0
	Total	**32**	**8**	**2**	**2**

Source: Hazus 4.2

All critical facilities should be considered at risk to minor damage should an earthquake event occur. However, none of the essential facilities included in Hazus—which include 2 schools, 1 police station, and 1 emergency operation facility—were estimated to sustain moderate damages, and all were estimated to maintain at least 50 percent functionality after day one following an event. Additionally, Hazus projected one highway bridge and one bus facility to sustain moderate damage.

Environment

An earthquake is unlikely to cause substantial impacts to the natural environment in New Hanover 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.

Changes in Development

Building codes substantially reduce the costs of damage to future structures from earthquakes. Future construction on the UNC-W campus must follow the applicable requirements of the NC building codes, the State of North Carolina statutes for state owned buildings and zoning for the local jurisdiction.

Development changes at UNC-W have not affected the risk characteristics of earthquakes. The probability, impact, spatial extent, warning time, and duration of earthquakes have not changed.

Problem Statement

- While earthquakes are an unlikely hazard event for the UNC-W campus, the Hazus model did predict impacts to buildings, one highway bridge, and one bus facility within the census tract.

I.5.2 Flood

Hazard	Probability	Impact	Spatial Extent	Warning Time	Duration	PRI Score
Flood	Highly Likely	Minor	Negligible	6 to 12 hrs	Less than 1 week	2.3

Location

Regulated floodplains are illustrated on inundation maps called Flood Insurance Rate Maps (FIRMs). A FIRM 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 1-percent-annual-chance flood event. Structures located within the SFHA have a 26-percent chance of flooding during the life of a standard 30-year mortgage.

For this risk assessment, flood prone areas were identified within the UNC-W Campus using the FIRM dated August 28, 2018. **Figure I.10** reflects the 2018 mapped flood insurance zones that are summarized in **Table I.18**.

Table I.18 – Mapped Flood Insurance Zones in New Hanover County

Zone	Description
A	Zone A is the flood insurance rate zone that corresponds to the 1% annual chance floodplains that are determined in the FIS Report by approximate methods. Because detailed hydraulic analyses are not performed for such areas, no Base Flood Elevations or depths are shown within this zone.
AE	Zone AE is the flood insurance rate zone that corresponds to the 1% annual chance floodplains that are determined in the FIS Report by detailed methods. In most instances, whole-foot Base Flood Elevations derived from the detailed hydraulic analyses are shown at selected intervals within this zone.
AH	Zone AH is the flood insurance rate zone that corresponds to the areas of 1% annual chance shallow flooding (usually areas of ponding) where average depths are between 1 and 3 feet. Whole-foot Base Flood Elevations derived from the detailed hydraulic analyses are shown at selected intervals within this zone.
AO	Zone AO is the flood insurance rate zone that corresponds to the areas of 1% annual chance shallow flooding (usually sheet flow on sloping terrain) where average depths are between 1 and 3 feet. Average whole-foot depths derived from the detailed hydraulic analyses are shown within this zone.
VE	Zone VE is the flood insurance rate zone that corresponds to the 1% annual chance coastal floodplains that have additional hazards associated with storm waves. Whole-foot Base Flood Elevations derived from the detailed hydraulic analyses are shown at selected intervals within this zone.
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 0.2-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.

None of the UNC-W Campus falls within the SFHA. **Table I.19** provides a summary of the UNC-W Campus' total area by flood zone on the 2018 effective DFIRM.

Figure I.10 – FEMA Flood Hazard Areas in UNC-W's Campus Boundary

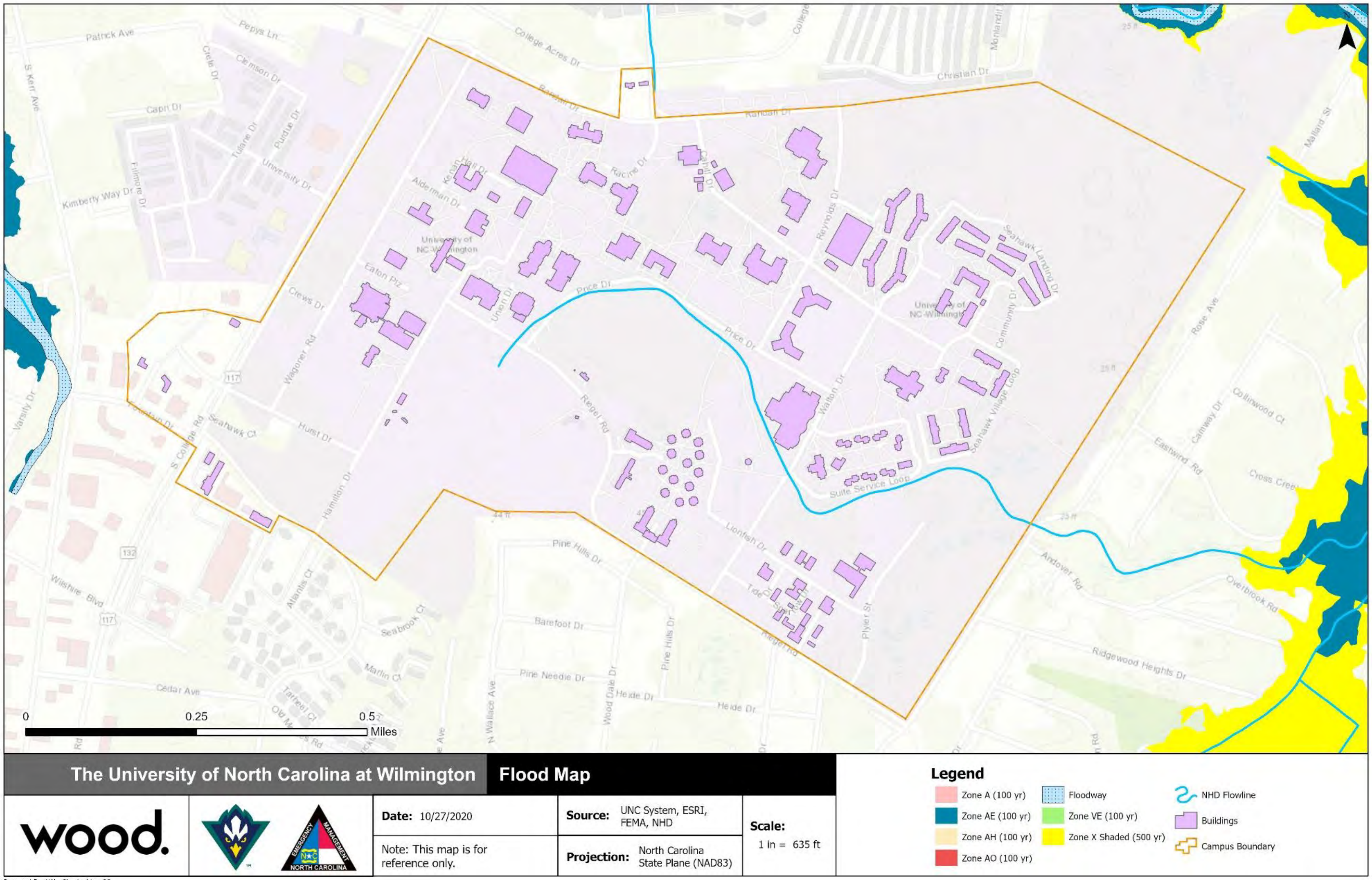


Table I.19 – Flood Zone Acreage on UNC-W Campus

Flood Zone	Acreage	Percent of Total (%)
A	0	0.0%
AE	0	0.0%
Floodway	0	0.0%
0.2% Annual Chance Flood Hazard	0	0.0%
Unshaded X	587	100.0%
Total	587	--
SFHA Total	**0**	**0.0%**

Source: FEMA 2018 DFIRM

Spatial Extent: 1 – Negligible

Extent

Flood extent can be defined by the amount of land in the floodplain, detailed above, and the potential magnitude of flooding as measured by flood depth and velocity. Flood damage is closely related to depth, with greater flood depths generally resulting in more damages. Since UNC-W's campus is not affected by the 1% annual chance flood, the depth of this flooding will not pose any threat to the campus. However, flooding may also occur on the campus when an intense rainfall occurs within the urban area and cannot be carried away by natural or urban drainage systems as fast as it is falling.

Impact: 1 – Minor

Historical Occurrences

Table I.20 details the historical occurrences of flooding for Wilmington identified from 2000 through 2019 by NCEI Storm Events database. According to NCEI, 54 recorded flood-related events affected the City of Wilmington from 2000 to 2019 causing an estimated $3,014,000 in property damage, with three injuries and no fatalities or crop damage. 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 I.20 – NCEI Records of Flooding, 2000-2019

Location	Date	Deaths/Injuries	Reported Property Damage	Reported Crop Damage
Heavy Rain				
WILMINGTON	9/18/2000	0/2	$5,000	$0
WILMINGTON	7/15/2002	0/0	$0	$0
WILMINGTON	8/29/2002	0/0	$0	$0
WILMINGTON	8/30/2002	0/0	$0	$0
WILMINGTON	8/31/2002	0/0	$0	$0
WILMINGTON	7/29/2004	0/0	$0	$0
WILMINGTON	8/15/2004	0/0	$0	$0
WILMINGTON	9/1/2004	0/0	$0	$0
WILMINGTON	9/10/2004	0/0	$0	$0
WILMINGTON	9/14/2004	0/0	$0	$0
WILMINGTON	7/13/2005	0/0	$0	$0
WILMINGTON	8/23/2005	0/0	$0	$0
WILMINGTON	10/7/2005	0/0	$1,500,000	$0
WILMINGTON	11/21/2005	0/0	$1,000	$0
WILMINGTON	8/27/2007	0/0	$0	$0

Location	Date	Deaths/Injuries	Reported Property Damage	Reported Crop Damage
WILMINGTON	5/11/2008	0/0	$0	$0
WILMINGTON	6/22/2008	0/0	$0	$0
WILMINGTON	9/25/2008	0/0	$0	$0
WILMINGTON	9/22/2009	0/0	$5,000	$0
WILMINGTON	12/2/2009	0/0	$0	$0
WILMINGTON	9/27/2010	0/0	$150,000	$0
WILMINGTON	8/1/2012	0/0	$0	$0
WILMINGTON	4/12/2013	0/0	$0	$0
WILMINGTON	8/22/2013	0/0	$2,000	$0
Flood				
WILMINGTON	7/2/2001	0/1	$0	$0
WILMINGTON	9/1/2002	0/0	$0	$0
WILMINGTON	9/15/2002	0/0	$0	$0
WILMINGTON	8/19/2010	0/0	$1,000	$0
WILMINGTON	9/30/2010	0/0	$0	$0
EAST WILMINGTON	6/29/2011	0/0	$0	$0
WILMINGTON	9/26/2011	0/0	$0	$0
WILMINGTON	6/27/2013	0/0	$0	$0
SOUTH WILMINGTON	7/12/2013	0/0	$0	$0
WILMINGTON	9/12/2014	0/0	$0	$0
WILMINGTON	12/24/2014	0/0	$0	$0
WILMINGTON	6/9/2015	0/0	$0	$0
WILMINGTON	7/23/2015	0/0	$0	$0
EAST WILMINGTON	7/31/2015	0/0	$0	$0
EAST WILMINGTON	8/25/2015	0/0	$0	$0
(ILM)WILMINGTON ARPT	10/2/2015	0/0	$0	$0
EAST WILMINGTON	5/19/2018	0/0	$0	$0
Flash Flood				
WILMINGTON	3/20/2001	0/0	$50,000	$0
WILMINGTON	8/14/2001	0/0	$0	$0
WILMINGTON	8/31/2006	0/0	$0	$0
WILMINGTON	7/6/2009	0/0	$0	$0
EAST WILMINGTON	9/27/2010	0/0	$250,000	$0
EAST WILMINGTON	9/29/2010	0/0	$300,000	$0
WILMINGTON	9/29/2010	0/0	$400,000	$0
EAST WILMINGTON	10/5/2015	0/0	$0	$0
WILMINGTON	9/2/2016	0/0	$0	$0
WILMINGTON	10/8/2016	0/0	$50,000	$0
WILMINGTON	9/14/2018	0/0	$250,000	$0
WILMINGTON	7/3/2019	0/0	$0	$0
EAST WILMINGTON	9/6/2019	0/0	$0	$0
	Total	**0/3**	**$3,014,000**	**$0**

Source: NCEI

The following event narratives are provided in the NCEI Storm Events Database and illustrate the impacts of flood events on the county:

- **09/18/2000** - Two accidents occurred due to the heavy rain on the Cape Fear Memorial Bridge. Minor injuries were reported.
- **9/27/2010** - A nearly stationary upper low over northern Alabama, combined with a plume of tropical moisture, produced record rainfall over portions of Brunswick and New Hanover Counties. The Wilmington NC airport (ILM) received 10.33 inches of rainfall on the 27th, the second highest daily precipitation total since recordings began back in 1871. Brunswick County declared a state of emergency, with many roads impassable.
- **9/29/2010** - A nearly continuous feed of tropical moisture, combined with a series of upper level low pressure systems, produced record rainfall over the region. Many areas received over 20 inches of rainfall over a four-day period. Rainfall accumulations led to significant flooding that included the closure of dozens of roadways. Many low-lying bridges were overtopped and swift waters led to numerous road scours and closings. The impacts of the rain were greatest in the Cape Fear region. In New Hanover county, there were 137 homes impacted, and 34 buildings at the University of North Carolina at Wilmington sustained water damage.
- **9/14/2018** - Flash flooding occurred in the area of Oleander Dr and S College Rd. Flooding on New Center Drive. NWS employee reported significant flooding on Kerr Ave. Flooding was reported on Gordon Rd at the I-40 overpass. There was a road failure on Shire Lane. High water was reported on Castle Hayne Road.

The state of North Carolina has had two FEMA Major Disaster Declarations for severe storms that include elements of flooding in 1962 and 1964 along with four Major Disaster Declarations for Hurricanes in 1954, 1955, 1958, 1960 which may have included damages associated with flooding. Additionally, New Hanover County has received one FEMA Major Disaster Declaration for a severe storm that included elements of flooding in 2010 along with 11 Major Disaster Declarations for Hurricanes in 1984, 1996, 1998, 1999, 2003, 2005, 2011, 2016, 2018 and 2019, which also may have included damages associated with flooding.

Probability of Future Occurrence

By definition, SFHAs are those areas that will be inundated by the flood event having a 1-percent chance of being equaled or exceeded in any given year. While exposure to flood hazards varies across jurisdictions, all jurisdictions have at least some area of land in FEMA-mapped flood hazard areas. This delineation is a useful way to identify the most at-risk areas, but flooding does not occur in set intervals; any given flood may be more or less severe than the defined 1-percent-annual-chance flood. There is also risk of localized and stormwater flooding in areas outside the SFHA and at different intervals than the 1% annual chance flood.

Floods of varying severity occur regularly in Wilmington, and impacts from past flood events have been noted by NCEI. NCEI reports 54 flood-related events in the 20-year period from 2000-2019, which equates to an annual probability greater than 100% for Wilmington alone. Therefore, the overall probability of flooding is considered highly likely (near or more than 100% annual probability).

Probability: 4 – Highly Likely

Vulnerability Assessment

Methodology & Assumptions

To quantify vulnerability, Wood performed a GIS spatial analysis of the flood hazard by overlaying the mapped SFHA on the building footprints provided by the UNC Division of Information Technology and NCEM iRisk database. For the UNC-W campus, there are no structures located within the SFHA.

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 systems lose 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 high risk when driving through flooded streets. However, NCEI does not contain any records of deaths in the City of Wilmington caused by flood events.

An estimate of population at risk to flooding was developed based on the assessment of residential property at risk. The count of residential buildings in Wilmington at risk, 1,453, was multiplied by 2.20, which is the 2014-2018 American Community Survey estimate of average household size. Overall, approximately 3,197 people live in buildings that could be damaged by the 1%-annual-chance flood.

Property

Administration buildings, education and/or extracurricular facilities, housing, as well as critical facilities and infrastructure such as transportation, water, energy, and communication systems may be damaged or destroyed by flood waters.

Table I.21 details the estimated losses for the 1%-annual-chance flood event for the campus. The total damage estimate value is based on damages to the total of building value. Land value is not included in any of the loss estimates as generally land is not subject to loss from floods.

Table I.21 – Estimated Building Damage and Content Loss for 1% Annual Chance Flood

Occupancy Type	Total Buildings with Loss	Total Value	Estimated Building Damage	Loss Ratio
Administration	0	$0	$0	0%
Critical Facilities	0	$0	$0	0%
Education/ Extracurricular	0	$0	$0	0%
Housing	0	$0	$0	0%
Total	0	$0	$0	0%

Source: UNC Division of Information Technology; NCEM iRisk; NC Department of Insurance; USACE Wilmington District Depth-Damage Function

The loss ratio is the loss estimate divided by the total potential exposure (i.e., total of improved value for all buildings located within the Zone AE) and displayed as a percentage of loss. FEMA considers loss ratios greater than 10% to be significant and an indicator a community may have more difficulties recovering from a flood. Loss ratios for all occupancy types with identified structures on the UNC-W campus are 0%, meaning that in the event of a flood with a magnitude of the 1%-annual-chance event or greater, the planning area would be minimally impacted.

None of the critical facilities identified for UNC-W are located within the 1%-annual-chance floodplain, therefore there are no estimated damages.

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 planning area. According to 2020 NFIP records, there are no repetitive loss properties on the UNC-W campus.

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.

Changes in Development

The likelihood of future flood damage can be reduced through appropriate land use planning, building siting and building design. In addition, the UNC-W Facilities Management works to maintain compliance with all applicable state and federal regulations regarding water resources, provides a regulatory framework to ensure development has minimal impact on the environment, and manages the stormwater infrastructure.

Problem Statement

- None of the UNC-W Campus falls within the SFHA. However, flooding may also occur on the campus when an intense rainfall occurs within the urban area and cannot be carried away by natural or urban drainage systems as fast as it is falling.

I.5.3 Geological – Sinkhole

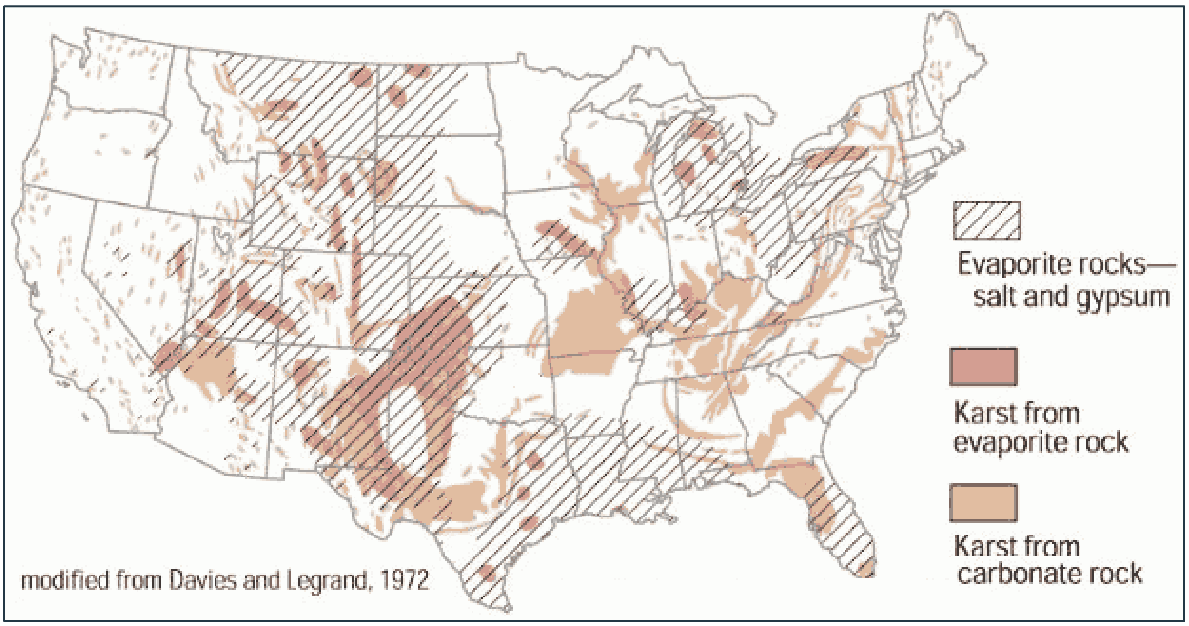
Hazard	Probability	Impact	Spatial Extent	Warning Time	Duration	PRI Score
Landslide	Possible	Limited	Negligible	Less than 6 hours	Less than 6 hours	1.9

Location

New Hanover County is located within the Coastal Plain physiographic province of North Carolina. The Coastal Plain province encompasses approximately 45 percent of the land area of the state. The Coastal Plain province is characterized by flat land to gently rolling hills and valleys. Elevations range from sea level near the coast to roughly 600 feet in the southern Inner Coastal Plain. According to the North Carolina Department of Environmental Quality (NC DEQ), in North Carolina sinkholes mainly occur in the coastal plain.

Figure I.11 shows the locations of rock formations susceptible to the formation of sinkholes.

Figure I.11 – Rock Formations in the United States



Per the 2016 Southeastern NC Regional Hazard Mitigation Plan, areas of sinkhole activity underly the majority of eastern New Hanover County, including much of the City of Wilmington. However, while susceptibility may be widespread, any individual sinkhole only affects a highly localized area.

Spatial Extent: 1 – Negligible

Extent

Sinkholes are relatively unpredictable, causing greater impacts when they do occur. They can range dramatically in size, from a few feet wide to hundreds of acres wide and from less than 1 foot to more than 100 feet deep. Sinkholes can also vary in shape. Some are shaped like shallow bowls or saucers while others have vertical walls. In North Carolina, sinkholes sometimes hold water and form natural ponds. There is no formal scale for measuring the extent of sinkholes.

Sinkholes can have dramatic effects if they occur in urban settings, particularly when infrastructure, such as roads, or buildings are on top of the cavity, causing catastrophic damage. They can also contaminate water resources and have been known to swallow up vehicles, swimming pools, parts of roadways, and even buildings.

Impact: 2 – Limited

Historical Occurrences

The 2016 Southeastern NC Regional Hazard Mitigation Plan notes sinkhole events that have occurred in New Hanover County near Snow's Cut and Carolina Beach State Park. No detailed data was available on past events.

Probability of Future Occurrence

Given the past occurrences of sinkholes in New Hanover County, future sinkholes are considered possible, defined as between a 1% and 10% annual chance of occurrence.

Probability: 2 – Possible

Vulnerability Assessment

People

A person's vulnerability to sinkhole is directly related to the speed in which the sinkhole opens and the person being above the sinkhole. Deaths and injuries may occur if a sinkhole opens directly beneath an occupied building or may result from motor vehicle incidents if drivers cannot avoid driving into the sinkhole before protective barriers were in place. However, there were no records found of such severe events on or near the UNC-W campus. Minor sinkholes have been reported following severe storms and rain events in the City of Wilmington.

Property

Similar to people, property's vulnerability to a sinkhole is dependent on a variety of factors including the speed at which the sinkhole develops. Property above a large sinkhole that suddenly collapses can suffer catastrophic damages ranging from cracked foundations to damaged roadways and totaled vehicles.

Environment

Sinkholes are unlikely to cause substantial impacts to the natural environment. Natural areas that are damaged will recover quickly.

Changes in Development

Increases in development could potentially be a contributing factor in causing sinkholes. Development increases water usage, alters drainage pathways, overloads the ground surface, and redistributes soil. Sinkholes may occur if infrastructure is not graded correctly, or if poorly planned alteration of drainage patterns is implemented.

Problem Statement

- Sinkhole risks on UNC-W campus are likely to be associated with infrastructure and drainage issues. Such events are typically minor, therefore UNC-W is unlikely to experience a severe sinkhole event.

I.5.4 Hurricane

Hazard	Probability	Impact	Spatial Extent	Warning Time	Duration	PRI Score
Hurricane	Likely	Catastrophic	Large	More than 24 hrs	Less than 24 hrs	3.2

Location

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

Storm surges, or storm floods, are limited to the coastal counties of North Carolina. UNC-W is located close to the coast and is directly impacted by the storm surges of a Category 5 hurricane. **Figure I.12** through **Figure I.16** below show the different storm surge extents for hurricane categories 1-5 at UNC-W. Between 10 to 50% of the campus is inundated during a Category 5 storm surge event. Additionally, hurricane winds can impact the entire campus, so the spatial extent was determined to be large.

Spatial Extent: 4 – Large

Extent

Hurricane intensity is classified by the Saffir-Simpson Scale (**Table I.22**), which rates hurricane intensity on a scale of 1 to 5, with 5 being the most intense.

Table I.22 – 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

Figure I.12 – Category 1 Storm Surge Inundation Areas, UNC-W

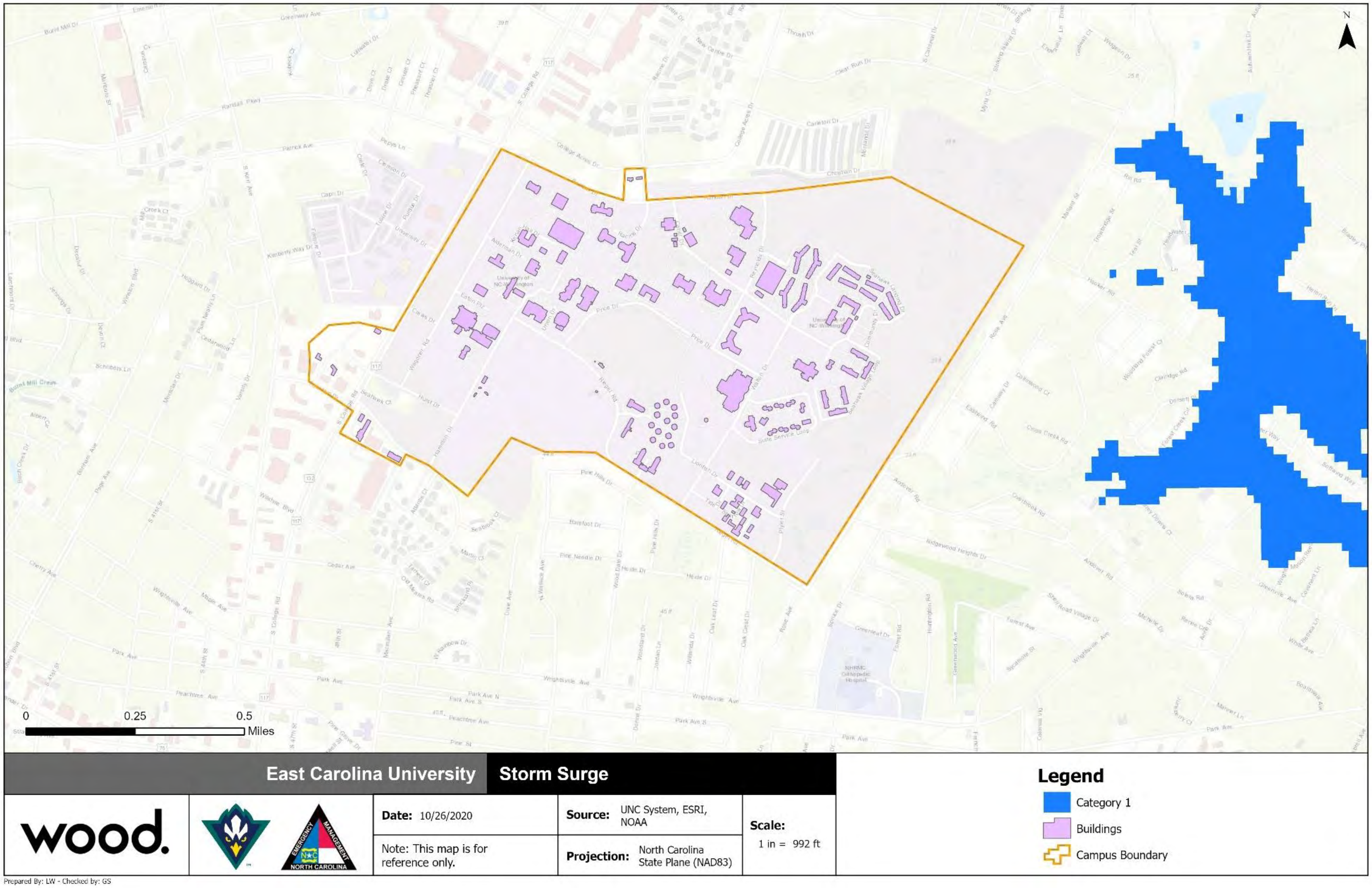


Figure I.13 – Category 2 Storm Surge Inundation Areas, UNC-W

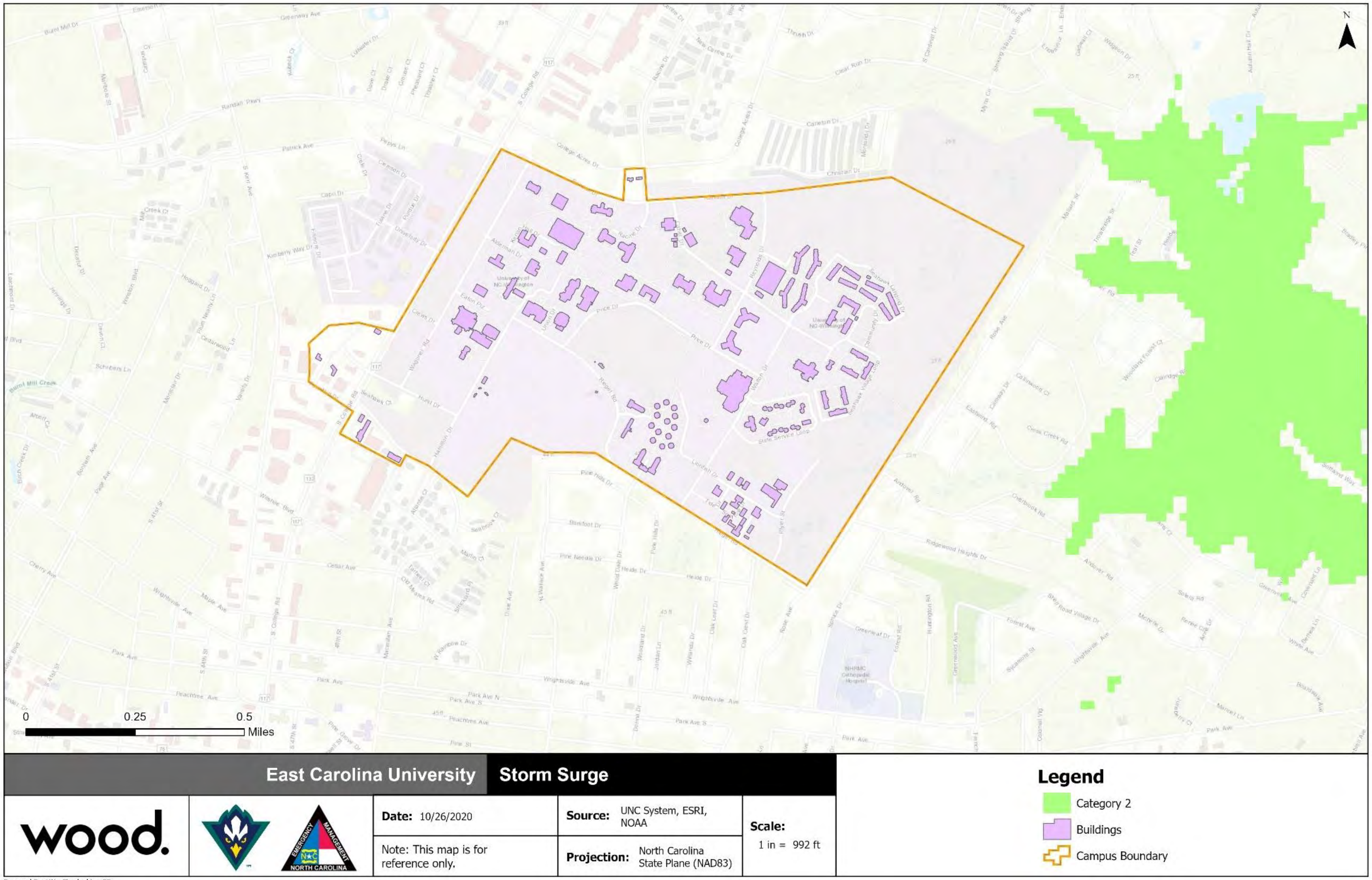


Figure I.14 – Category 3 Storm Surge Inundation Areas, UNC-W

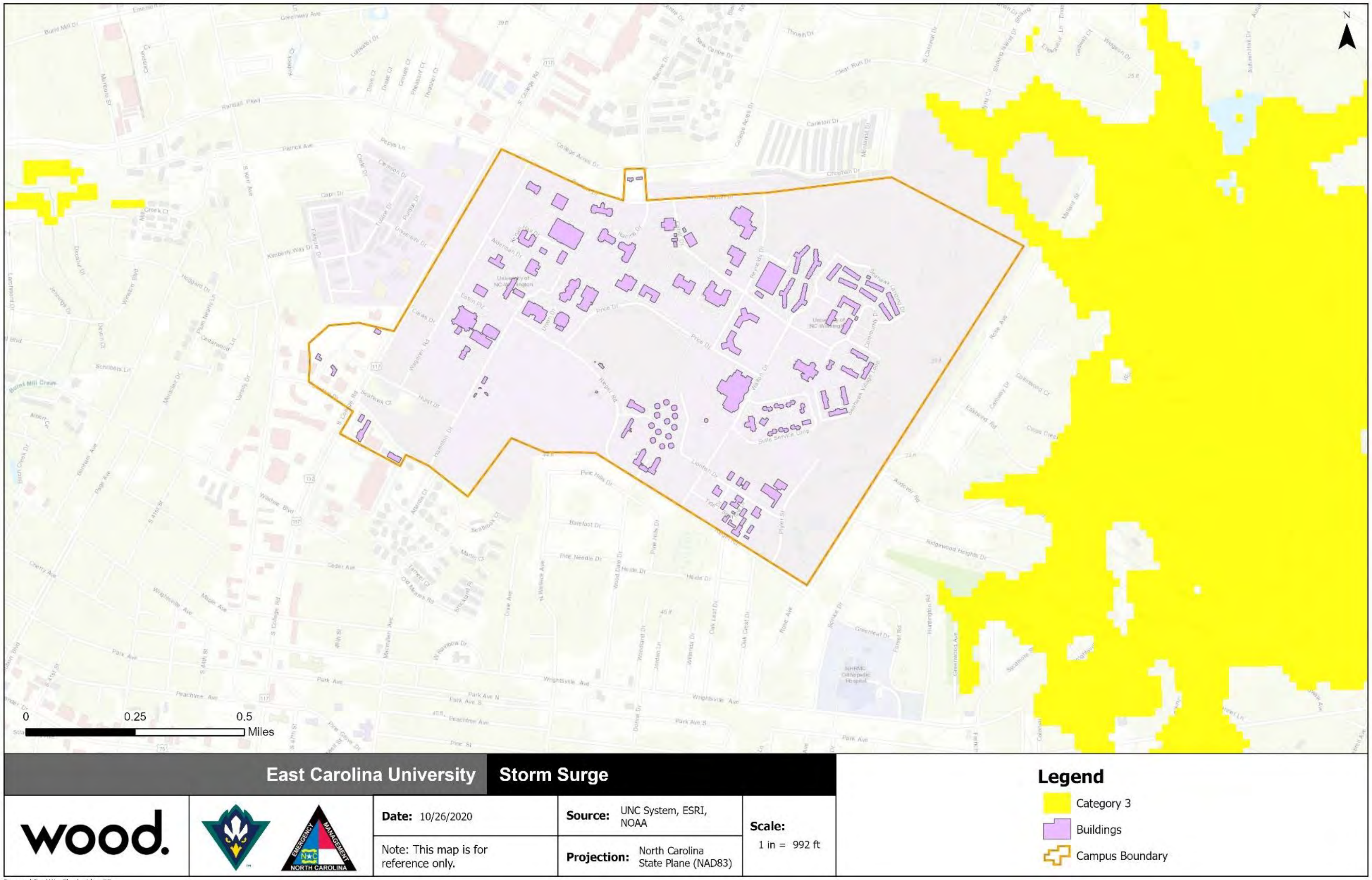


Figure I.15 – Category 4 Storm Surge Inundation Areas, UNC-W

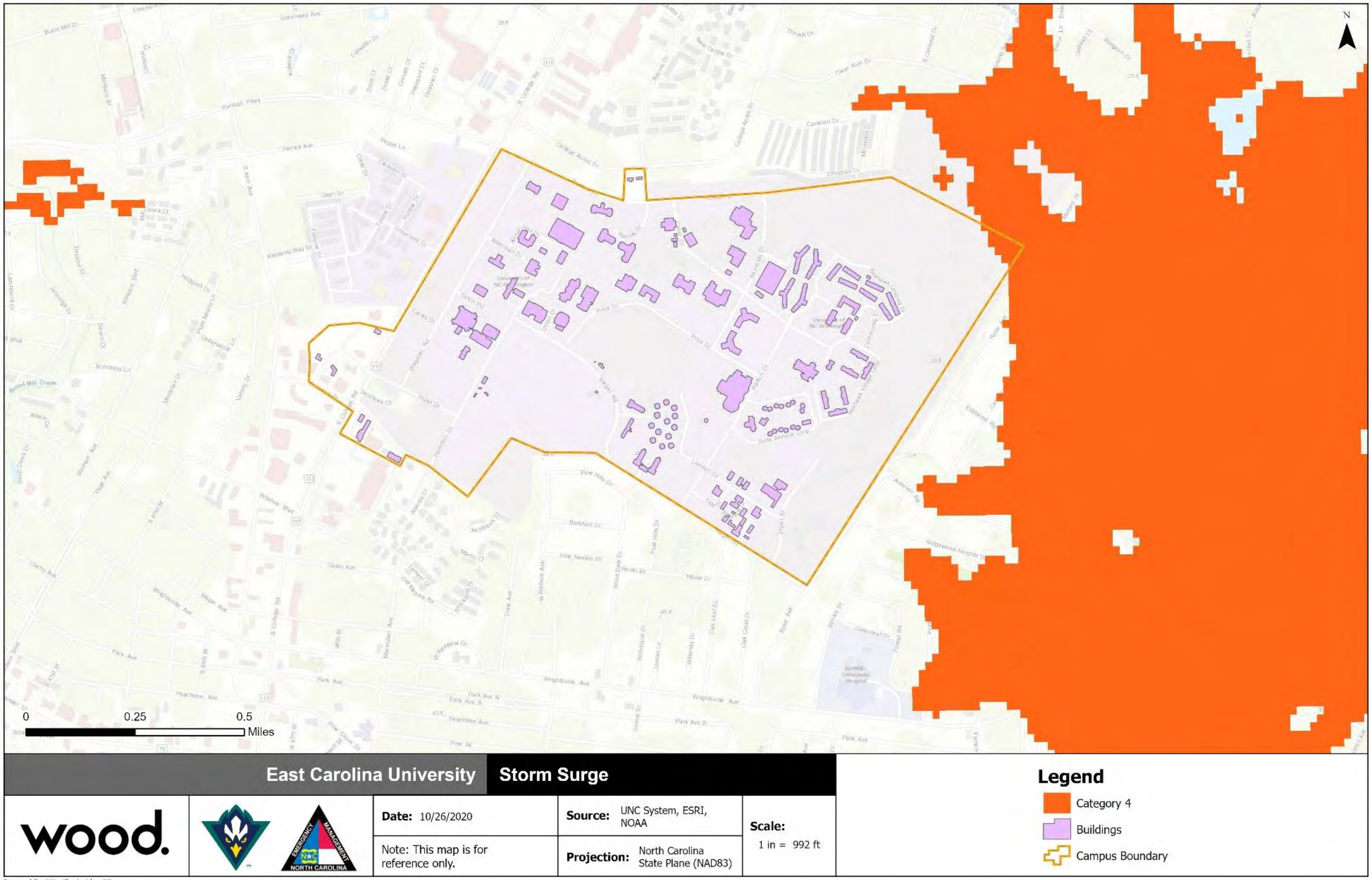
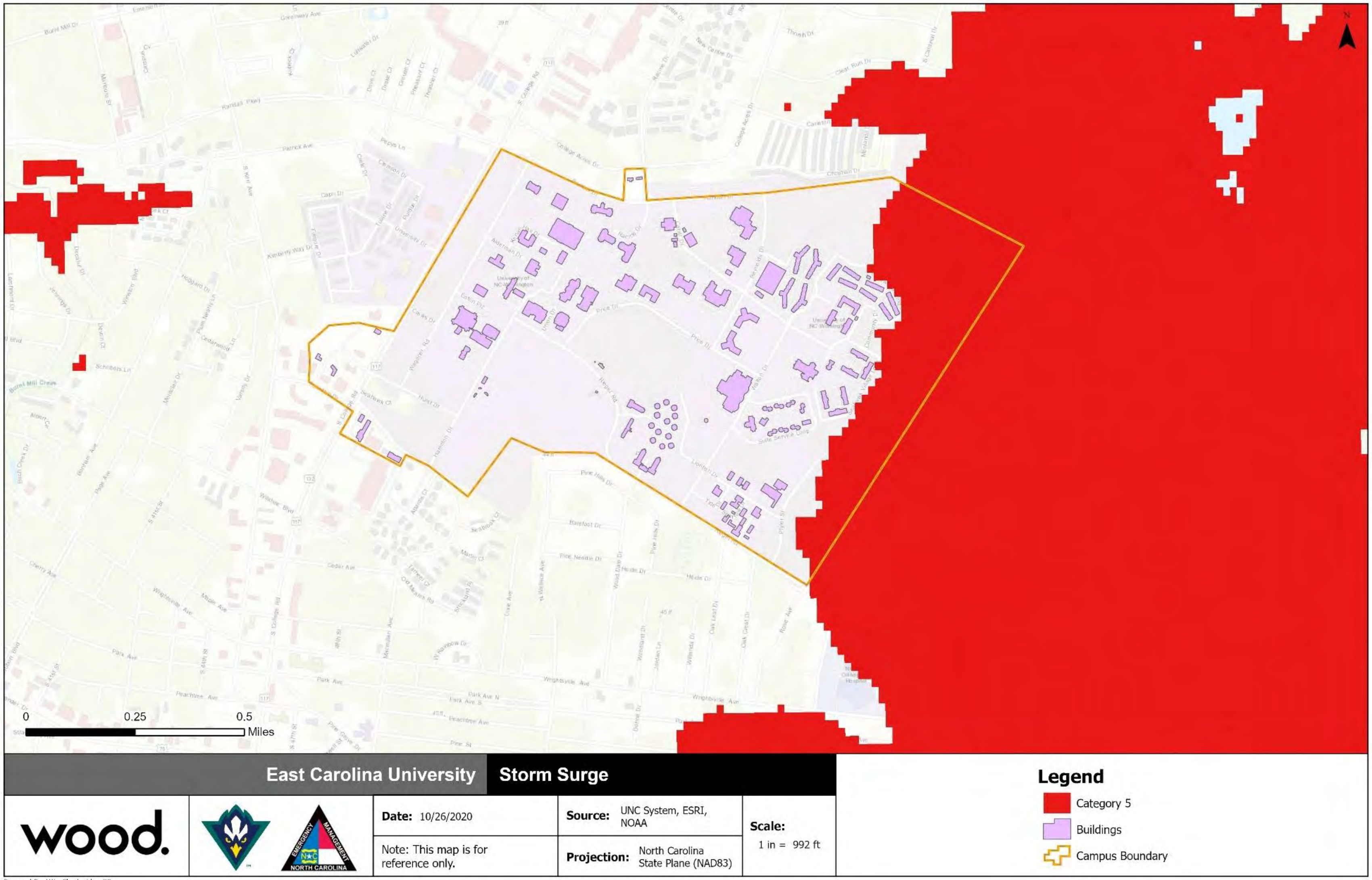


Figure I.16 – Category 5 Storm Surge Inundation Areas, UNC-W



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 I.23** 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 I.23 – 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

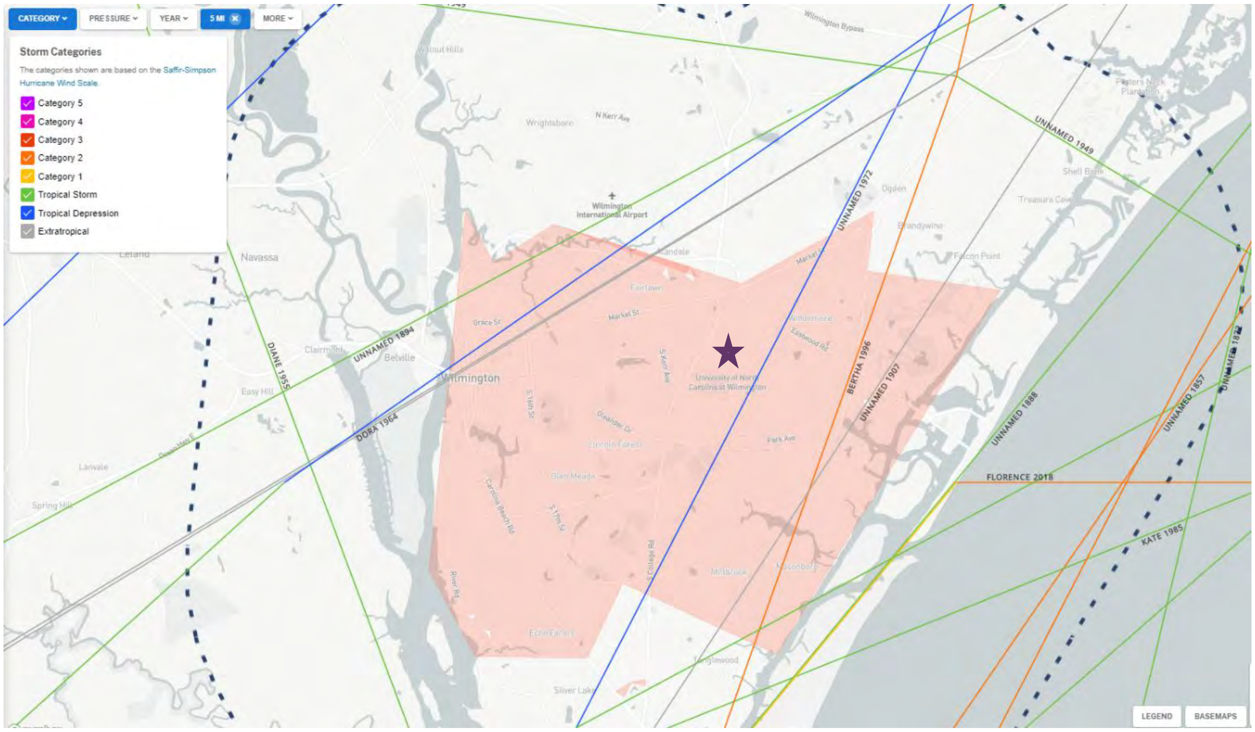
New Hanover County may experience any category of hurricane force winds. Hurricane Bertha passed within 5 miles of UNC-W's campus as a Category 2 storm with wind speeds around 104 mph in 1996. Hurricane Florence also passed within 5 miles of UNC-W's campus as a Category 1 storm with wind speeds around 92 mph in 2018.

Impact: 4 – Catastrophic

Historical Occurrences

Storm tracks for hurricane-related events that have passed within 5 miles of UNC-W's campus were obtained from NOAA 's database and are shown in **Figure I.17**. UNC-W's location is noted in the figure by the purple star. The NCEI Storm Events database has recorded eight hurricanes and tropical storms that passed through inland and coastal New Hanover County between 2000 and 2019. **Table I.24** details the historical occurrences.

Figure I.17 – Hurricane and Tropical Storm Tracks within 5 Miles of UNC-W



Source: NOAA Office of Coastal Management; image captured directly from website. Black dashed line is 5 mile buffer zone.

Table I.24 – Recorded Hurricane and Tropical Storm Events for Inland and Coastal New Hanover County, 2000-2019

Date	Type	Storm	Deaths/ Injuries	Property Damage	Crop Damage
8/26/2011	Tropical Storm	Hurricane Irene	0/0	$1,500,000	$0
10/27/2012	Tropical Storm	Hurricane Sandy	0/0	$3,000	$0
6/7/2013	Tropical Storm	Tropical Storm Andrea	0/0	$0	$0
7/3/2014	Tropical Storm	Hurricane Arthur	0/0	$0	$0
5/9/2015	Tropical Storm	Tropical Storm Ana	0/0	$0	$0
9/2/2016	Tropical Storm	Hurricane Hermine	0/0	$25,000	$0
10/8/2016	Hurricane (Typhoon)	Hurricane Matthew	0/0	$0	$0
9/14/2018	Hurricane	Hurricane Florence	0/1	$1,000,000,000	$0
		Total	**0/1**	**$1,003,028,000**	**$0**

Source: NCEI

According to NCEI, eight recorded hurricane-related events affected New Hanover County from 2000 to 2019 causing an estimated $1,003,028,000 in property damage and one injury. There were no fatalities or crop damage recorded for any of these events. Note that NCEI records may be incomplete due to limitations in reporting.

According to the university's records, UNC-W sustained $23,187.82 in damages from Hurricane Matthew.

The following event narratives are provided in the NCEI Storm Events Database and illustrate the impacts of hurricane and tropical storm events on the county:

Hurricane Irene (2011) – Even though the center of Hurricane Irene passed over 100 miles east of the coast of southeastern North Carolina, its large wind field produced tropical storm force winds for nearly 24 hours as it made its landfall near Cape Lookout. The highest recorded wind gust at the Wilmington International Airport was 57 kts on the backside of the storm the morning of the August 27th. A 61 kt gust was recorded at the Johnny Mercer Pier in Wrightsville Beach. Rainfall amounts across the county ranged from six to seven inches, with moderate street flooding reported. Numerous trees and power lines were blown down, leading to 62,000 homes without power. Storm surge ranged from three to four feet above normal, with moderate beach erosion. North Lumina Avenue was covered with water and impassible due to the storm surge. The lowest pressure recorded at the Wilmington Airport was 979.5 millibars, about 28.90 inches.

Hurricane Matthew (2016) – Hurricane Matthew moved up the eastern seaboard, bringing very heavy rain and strong winds. Rainfall amounts ranged from three to six inches. A peak wind of 70 mph was reported at the Wilmington airport, with a suspect report of 82 mph recorded at Federal Point. Wind gusts to hurricane strength and saturated ground caused damage to numerous trees. Many roads became flooded due to the heavy rain. The downtown Wilmington gauge along the lower Cape Fear River peaked at 8.21 feet, eclipsing the old record of 8.15 feet set in 1954 by Hurricane Hazel. These levels led to flooding in portions of Carolina Beach. Moderate ocean over wash was observed along the immediate coast due to the storm surge.

Hurricane Florence (2018) – Hurricane Florence began its long Atlantic trek from the Cape Verde Islands in early September. It made landfall near Wrightsville Beach during the morning of September 14th. The barometric pressure at landfall was 959 millibars, or 28.32 inches. The strongest winds were recorded at 106 mph at Cape Lookout, as well as 105 mph measured at the Wilmington International Airport. In addition to the strong storm surge, there was historic rainfall totals of 20 to 25 inches, with isolated totals of 35 inches in parts of Bladen and Robeson counties. Flash Flooding was severe and widespread, with many communities experiencing flooding for the first time. River flooding was epic, with dozens of main highways impassible. Significant flooding occurred for weeks after the storm had departed. The hurricane spawned 19 tornadoes. Damage estimates from wind and water are in the tens of billions of dollars, making it one of the costliest hurricanes ever. A large tree fell through the roof of a home at Nantucket Pointe. There was significant damage to the house. Multiple large trees in the road in Murrayville, with power lines down as well. A Scotchman gas station on 23rd had a pump station knocked down with awning damage. Multiple trees down on Independence Rd and River Rd. A garage was blown in on S Kerr Ave. Large trees were reported down throughout the town of Wilmington and Hampstead. A 105 mph was recorded at the Wilmington International Airport. A structural fire due to storm damage on Bay Blossom Rd. An injury occurred when a tree fell on a house on Mercer Ave.

The state of North Carolina has had four FEMA Major Disaster Declarations for Hurricanes in 1954, 1955, 1958, 1960. Additionally, New Hanover County has received 11 Major Disaster Declarations for Hurricanes in 1984, 1996, 1998, 1999, 2003, 2005, 2011, 2016, 2018, and 2019.

Probability of Future Occurrence

In the 20-year period from 2000 through 2019, eight hurricanes and tropical storms have impacted the New Hanover County, which equates to a 40 percent annual probability of hurricane winds impacting the county. This probability does not account for impacts from hurricane rains, which may also be severe. Overall, the probability of a hurricane or tropical storm impacting the County is likely.

Probability: 3 – Likely

Vulnerability Assessment

Methodologies and Assumptions

To quantify vulnerability, Wood performed a Level 1 hurricane wind analysis in Hazus 4.2 for three scenarios: a historical recreation of Hurricane Fran (1996) and simulated probabilistic wind losses for a 200-year and a 500-year event storm. The analysis utilized general building stock information based on the 2010 Census. The UNC-W campus is located within a single census tract encompassing 2.29 square miles. The vulnerability assessment results are for wind-related damages. Hurricanes may also cause substantial damages from heavy rains and subsequent flooding, which is addressed in Section A.5.2. Flood.

People

The very young, the elderly and disabled individuals are more vulnerable to harm from hurricanes, as are those who are unable to evacuate for medical reasons, including 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 or ongoing treatment. For all affected populations, 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.

Table I.25 details the likelihood of building damages by occupancy type from varying magnitudes of hurricane events.

Table I.25 – Likelihood of Buildings Damages Impacted by Hurricane Wind Events

Occupancy	Buildings at Risk	Value at Risk	Likelihood of Damage (%)				
			None	Minor	Moderate	Severe	Destruction
Hurricane Fran (1996)							
Agriculture	2	$546,000	81.04%	13.56%	3.66%	1.59%	0.15%
Commercial	131	$121,947,000	82.74%	12.71%	4.26%	0.29%	0.01%
Education	9	$10,167,000	85.00%	12.03%	2.84%	0.13%	0.00%
Government	1	$148,000	84.99%	11.98%	2.89%	0.14%	0.00%
Industrial	29	$12,211,000	84.53%	12.09%	3.05%	0.32%	0.02%
Religion	11	$8,524,000	84.88%	12.79%	2.23%	0.10%	0.00%
Residential	1,032	$820,785,000	75.95%	18.23%	5.72%	0.08%	0.02%
200-year Hurricane Event							
Agriculture	1	$546,000	31.51%	31.83%	20.85%	12.83%	2.98%
Commercial	54	$121,947,000	34.32%	25.16%	28.08%	12.07%	0.37%
Education	4	$10,167,000	35.65%	24.87%	25.80%	13.68%	0.00%
Government	-	$148,000	35.63%	24.33%	26.01%	14.03%	0.00%
Industrial	12	$12,211,000	35.18%	24.54%	25.68%	14.25%	0.35%
Religion	5	$8,524,000	35.32%	31.45%	23.31%	9.92%	0.00%
Residential	365	$820,785,000	26.88%	32.25%	34.94%	4.97%	0.96%
500-year Hurricane Event							

Occupancy	Buildings at Risk	Value at Risk	Likelihood of Damage (%)				
			None	Minor	Moderate	Severe	Destruction
Agriculture	-	$546,000	15.15%	29.05%	28.47%	20.97%	6.36%
Commercial	29	$121,947,000	18.22%	21.02%	34.14%	25.55%	1.06%
Education	2	$10,167,000	18.93%	20.21%	31.26%	29.58%	0.02%
Government	-	$148,000	18.99%	19.56%	31.21%	30.23%	0.01%
Industrial	6	$12,211,000	18.64%	19.88%	30.88%	29.85%	0.75%
Religion	2	$8,524,000	17.96%	28.03%	31.56%	22.38%	0.07%
Residential	174	$820,785,000	12.79%	26.93%	43.80%	13.66%	2.83%

Table I.26 details the estimated building and content damages by occupancy type for varying magnitudes of hurricane events.

Table I.26 – Estimated Buildings Impacted by Hurricane Wind Events

Area	Residential	Commercial	Industrial	Others	Total
Hurricane Fran (1996)					
Building	$12,829,170	$700,760	$47,380	$63,110	$13,640,420
Content	$1,965,020	$202,180	$18,010	$15,760	$2,200,970
Inventory	$0	$5,520	$2,780	$190	$8,490
Total	**$14,794,190**	**$908,460**	**$68,170**	**$79,060**	**$15,849,880**
200-year Hurricane Event					
Building	$70,598,550	$8,261,900	$797,010	$1,048,830	$80,706,290
Content	$19,760,690	$4,572,520	$544,720	$604,870	$25,482,800
Inventory	$0	$128,140	$72,880	$2,480	$203,500
Total	**$90,359,240**	**$12,962,560**	**$1,414,610**	**$1,656,180**	**$106,392,590**
500-year Hurricane Event					
Building	$132,230,910	$17,057,930	$1,699,710	$2,256,750	$153,245,300
Content	$44,877,100	$10,582,960	$1,276,220	$1,454,000	$58,190,280
Inventory	$0	$280,170	$168,120	$5,150	$453,440
Total	**$177,108,010**	**$27,921,060**	**$3,144,050**	**$3,715,900**	**$211,889,020**

The damage estimates for the 500-year hurricane wind event total $211,889,020, which equates to a loss ratio of 98.3 percent of the total building exposure. These damage estimates account for only wind impacts and actual damages would likely be higher due to flooding.

Environment

Hurricane winds can cause massive damage to the natural environment, uprooting trees and other debris within the storm's path. Animals can either be killed directly by the storm or impacted indirectly through changes in habitat and food availability caused by high winds and intense rainfall. Endangered species can be dramatically impacted. Forests can be completely defoliated by strong winds.

Changes in Development

Future development that occurs in the planning area should consider high wind hazards at the planning, engineering and architectural design stages. The University should consider evacuation planning in the event of a hurricane event.

Problem Statement

- Historical tracks of multiple hurricane events pass within 5-miles of the UNC-W Campus.
- For the 20-year period from 2000 through 2019, there have been 4 hurricane wind events causing over $1 billion in damage for New Hanover County.

I.5.5 Tornadoes/Thunderstorms

Hazard	Probability	Impact	Spatial Extent	Warning Time	Duration	PRI Score
Tornado/Thunderstorm	Likely	Critical	Large	Less than 6 hrs	Less than 6 hrs	3.1

Location

Thunderstorm wind, lightning, and hail events do not have a defined vulnerability zone. The scope of lightning and hail is generally confined to the footprint of its associated thunderstorm. Although these events occur similarly throughout the planning area, they are more frequently reported in more urbanized areas because damages are more likely to occur where exposure is greater in more densely developed urban areas.

Thunderstorm Winds

The entirety of UNC-W's campus can be affected by severe weather hazards. Thunderstorm wind events can span many miles and travel long distances, covering a significant area in one event. Due to the small size of the planning area, any given event will impact the entire planning area, approximately 50% to 100% of the planning area could be impacted by one event.

Spatial Extent: 4 – Large

Lightning

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 UNC-W is exposed to lightning.

Spatial Extent: 4 – Large

Hail

Hailstorms frequently accompany thunderstorms, so their locations and spatial extents coincide. However, large-scale hail tends to occur in a more localized area within the storm.

Spatial Extent: 4 – Large

Tornado

Tornados can occur anywhere on UNC-W's campus. 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 campus versus another. All of UNC-W is exposed to this hazard.

Spatial Extent: 4 – Large

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.

Figure I.18 shows wind zones in the United States. New Hanover County, indicated by the blue square, is within Wind Zone III, which indicates that speeds of up to 200 mph may occur within the county.

Figure I.18 – Wind Zones in the United States

Source: FEMA 320, Taking Shelter from the Storm, 3rd edition, https://www.fema.gov/pdf/library/ism2_s1.pdf

The strongest recorded thunderstorm wind event for Wilmington occurred on May 31, 2003 with a measured gust of 87 mph. The event reportedly caused $750,000 in property damages and resulted in no fatalities, injuries, or crop damages.

Impact: 2 – Limited

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, shown in **Table I.27**, is a common parameter that is part of fire weather forecasts nationwide.

Table I.27 – 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

Lightning Activity Level Scale	
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

Hail

The National Weather Service classifies hail by diameter size, and corresponding everyday objects to help relay scope and severity to the population. **Table I.28** indicates the hailstone measurements utilized by the National Weather Service.

Table I.28 – 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
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 I.29** describes typical intensity and damage impacts of the various sizes of hail.

Table I.29 – 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

Intensity Category	Diameter (mm)	Diameter (inches)	Size Description	Typical Damage Impacts
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 2000 and 2019 in Wilmington was a little under 1" in diameter; the largest hailstone recorded was 1.75", recorded on June 8, 2006.

Impact: 1 – Minor

Tornado

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 and better correlation between damage and wind speed. It is also more precise because it considers the materials affected and the construction of structures damaged by a tornado. **Table I.30** shows the wind speeds associated with the enhanced Fujita scale ratings and the damage that could result at different levels of intensity.

Table I.30 – 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 Wilmington in the past 20 years was an EF1 on September 15, 2018. NCEI reports this event causing around $50,000 in property damage, and narratives of the event approximate damage to the Forest Hills community. The tornado was 2.92 miles long and 50 yards wide.

Impact: 3 – Critical

Historical Occurrences

Thunderstorm Winds

From January 2000 through December 2019, NCEI recorded wind speeds for 31 separate incidents of thunderstorm winds, occurring on 27 separate days, for Wilmington. These events caused $1,237,000 in recorded property damage, one injury, and no fatalities. The recorded gusts averaged 58 miles per hour, with the highest gusts recorded at 87 mph on May 31, 2003. Of these events, 14 caused property damage. Wind gusts with property damage recorded averaged $88,357 in damage, with the highest reported damage being a total of $750,000 on May 31, 2003. These incidents are aggregated by the date the events occurred and are recorded in **Table I.31**. These records specifically note thunderstorm wind impacts for Wilmington. In some cases, strong winds were reported for multiple locations on the same day.

Table I.31 – Recorded Thunderstorm Winds, Wilmington, 2000-2019

Location	Date	Wind Speed (mph)	Fatalities	Injuries	Property Damage
WILMINGTON	2/14/2000	54	0	0	$-
WILMINGTON	8/24/2000	50	0	0	$30,000
WILMINGTON ARPT	6/7/2001*	62	0	0	$-
WILMINGTON	5/10/2002	53	0	0	$-
WILMINGTON	6/14/2002*	78	0	0	$265,000
WILMINGTON	7/20/2002	55	0	0	$5,000
WILMINGTON	3/20/2003	51	0	0	$-
WILMINGTON ARPT	5/8/2003	62	0	0	$-
WILMINGTON	5/31/2003	87	0	0	$750,000
WILMINGTON	3/5/2005	51	0	0	$-
WILMINGTON	3/8/2005	77	0	1	$150,000
WILMINGTON	4/3/2006	60	0	0	$-
WILMINGTON	7/15/2006*	60	0	0	$-
WILMINGTON	8/8/2006	60	0	0	$-
SOUTH WILMINGTON	7/10/2008	50	0	0	$-
WILMINGTON	4/11/2009	52	0	0	$8,000
(ILM)WILMINGTON ARPT	6/23/2011	65	0	0	$1,000
SOUTH WILMINGTON	6/29/2011*	62	0	0	$4,000
WILMINGTON	7/1/2012	61	0	0	$-
WILMINGTON	1/31/2013	50	0	0	$3,000
(ILM)WILMINGTON ARPT	6/18/2015	54	0	0	$-
SOUTH WILMINGTON	6/17/2016	50	0	0	$5,000
(ILM)WILMINGTON ARPT	7/8/2016	50	0	0	$-
WILMINGTON	7/23/2018	52	0	0	$1,000
WILMINGTON	12/20/2018	52	0	0	$4,000
EAST WILMINGTON	7/3/2019	52	0	0	$1,000
WILMINGTON	9/9/2019	56	0	0	$10,000
		Total	**0**	**1**	**$1,237,000**

Source: NCEI

*Note: Multiple events occurred on these dates. Injuries, fatalities, and property damage are totaled, wind speed is highest reported.

The State of North Carolina received a FEMA Major Disaster Declaration in 1956 for severe storms that included heavy rains and high winds. Additionally, New Hanover County received a FEMA Major Disaster Declaration in 2010 for a severe storm including straight-line winds.

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

May 10, 2002 – Television station reported trees down. A wind gust of 62 mph was recorded at State Port. The strong winds and lightning caused power outages for approximately 4600 residents in the county.

June 14, 2002 – National Weather Service storm survey concluded a microburst with estimated 80-90 mph winds caused widespread damage along a path approximately 1/2 mile long with a maximum width of 50 to 100 yards. Wrightsboro Elementary School sustained three broken windows. Portions of school's metal roof were peeled back or were torn off and blown 50 yards from the building. One trailer was blown off its concrete blocks. Seventeen houses sustained damage along Long Leaf Drive. Damage included shingles blown off roofs, siding torn off houses or significant damage to porches. An 18 inch diameter tree was snapped off about 20 feet above ground level, with numerous other trees uprooted. Fallen trees and limbs damaged power lines and at least 4 cars. No injuries were reported.

May 31, 2003 – A NWS storm survey concluded a microburst produced estimated 100 mph wind gusts, causing extensive damage to many homes in the Brittany Woods subdivision. Nearly 100 homes sustained at least some damage. The more serious damage occurred to half a dozen homes when their garage doors were blown in, allowing the wind to blow portions of walls and/or roofs away. One home sustained extensive damage when a fence was demolished, with the projectiles blown through the house's walls. A large travel trailer and an RV motor home were overturned, and an SUV and an attached trailer were turned around. The storm continued east southeast, with numerous trees and power lines reported down. The thunderstorm dropped penny to nickel size hail 3 miles northeast of Wilmington and 7 miles north of Wilmington, as well as 3 miles east of Murraysville. More penny size hail was reported in Wrightsville Beach, as the storm finally moved offshore.

March 8, 2005 –The Wilmington ASOS measured an 89 mph wind gust. A private hangar at the airport was damaged, and a man in Wilmington was injured. In downtown Wilmington, a section of the roof of city hall was damaged, and an historic home, built in 1738, was moderately damaged when a chimney collapsed. The Oceanic pier also measured a 69 mph wind gust.

Lightning

According to NCEI data, there were 11 lightning strikes reported between 2000 and 2019. These events caused an estimated total property damage of $377,000 and one injury. No crop damage or fatalities were 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. **Table I.32** details NCEI-recorded lightning strikes from 2000 through 2019 for Wilmington.

Table I.32 – Recorded Lightning Strikes in Wilmington, 2000-2019

Location	Date	Time	Fatalities	Injuries	Property Damage
WILMINGTON	8/11/2000	1500	0	0	$106,000
WILMINGTON	6/16/2001	1530	0	0	$15,000
WILMINGTON	7/20/2002	1345	0	1	$0
WILMINGTON	3/5/2005	1600	0	0	$20,000
WILMINGTON	7/28/2007	1414	0	0	$50,000
WILMINGTON	7/28/2007	1430	0	0	$30,000
WILMINGTON	6/26/2009	1530	0	0	$20,000

Location	Date	Time	Fatalities	Injuries	Property Damage
WILMINGTON	6/27/2009	1745	0	0	$15,000
EAST WILMINGTON	8/19/2010	1445	0	0	$100,000
WILMINGTON	7/10/2012	1950	0	0	$1,000
WILMINGTON	7/12/2018	1500	0	0	$20,000
		Total	**0**	**1**	**$377,000**

Source: NCEI

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

August 11, 2000 – Lightning stuck a home on Avenshire Circle, setting it ablaze. A fire captain estimated the damage at $100,000. Lightning also struck a shed behind a private home on Meares Street, causing approximately $6000 in fire damage.

June 16, 2001 – Lightning struck an apartment unit, starting a fire.

July 20, 2002 – A women was injured when struck by lightning and was sent to the hospital.

August 19, 2010 – Lightning struck a house at 5119 Somersett Lane, causing significant damage.

Hail

NCEI records 17 separate days with hail incidents between January 1, 2000 and December 31, 2019 in Wilmington. None of these events were reported to have caused death, injury, property damage or crop damage. The largest diameter hail recorded in the City was 1.75 inches, which occurred on June 8, 2006. The average hail size of all events in the City was just under one inch in diameter. **Table I.33** summarizes hail events for Wilmington. In some cases, hail was reported for multiple locations on the same day.

Table I.33 – Summary of Hail Occurrences in Wilmington

Beginning Location	Date	Hail Diameter
WILMINGTON	4/18/2000	0.75
WILMINGTON	5/22/2000	0.75
WILMINGTON	4/1/2001	0.88
WILMINGTON	5/28/2001	1
WILMINGTON	4/3/2002	0.75
WILMINGTON	7/31/2002	0.75
WILMINGTON	3/11/2003*	1.25
WILMINGTON	5/31/2003	1
WILMINGTON	8/23/2003	1
WILMINGTON	7/13/2005	0.75
WILMINGTON	1/2/2006	0.75
WILMINGTON	4/3/2006	0.75
WILMINGTON	6/6/2006*	0.88
WILMINGTON	6/8/2006*	1.75
WILMINGTON	6/25/2007	0.75
WILMINGTON	3/15/2008	1
WILMINGTON	6/22/2008*	0.88

Source: NCEI

*Note: Multiple events occurred on these dates. Hail diameter is highest reported for that specific date.

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

March 11, 2003 – Spotter reported half dollar size hail. The police also reported dime size hail at Wrightsville Beach.

May 31, 2003 – Widespread hail was reported in and around the city of Wilmington, ranging from penny to quarter size.

August 23, 2003 – New Hanover 911 reported quarter size hail in Wrightsboro.

Tornado

NCEI storm reports were reviewed from 2000 through 2019 to assess whether recent trends varied from the longer historical record. According to NCEI, Wilmington experienced 4 tornado incidents between 2000 and 2019, causing $110,000 in property damage and no injuries, fatalities, or crop damage. It is likely that there have been several tornados that occurred but went unreported. **Table I.34** shows historical tornadoes in Wilmington during this time.

Table I.34 – Recorded Tornadoes in Wilmington, 2000-2019

Beginning Location	Date	Time	Magnitude	Deaths	Injuries	Property Damage	Crop Damage
EAST WILMINGTON	9/15/2018	2342	EF1	0	0	$50,000	$0
SOUTH WILMINGTON	9/16/2018	510	EF0	0	0	$5,000	$0
EAST WILMINGTON	9/5/2019	517	EF0	0	0	$5,000	$0
(ILM)WILMINGTON ARPT	9/5/2019	539	EF0	0	0	$50,000	$0
			Total:	**0**	**0**	**$110,000**	**$0**

Source: NCEI

Narratives from NCEI illustrate that damage occurred in many of these incidents even if a monetary value was not recorded. Specific incidents include:

May 9, 2008 – A tornado touched down near the intersection of Floral Parkway and Park Avenue, causing minor tree damage as it moved quickly northwest. Damage became more severe as it passed east and north of Empie Park where a few pine trees up to 18 inches in diameter were snapped, and numerous large limbs broken. A nearly continuous path of tree damage was observed as the tornado continued northwest across the Forest Hills community and 23rd Street between Market Street and Princess Place Drive. This area also received significant tree damage during the landfall of Hurricane Florence, however the path of the tornado was discernible by observing damage limited primarily to broken and twisted limbs amongst treetops. The heavy damage to large oak trees in Forest Hills and on 23rd Street was apparently a result of the hurricane and not the tornado. The tornado moved northwest, crossing Princess Place Drive and snapping several trees up to 10 inches in diameter, along with numerous limbs along 21st Street and the intersection with Klein Road. The tornado broke large limbs from a few trees along Wynnwood Street in the Love Grove community before lifting.

April 25, 2014 – A weak tornado with winds generally 55 to 65 mph caused mainly minor tree damage from near Wrightsville Ave around Eisenhower Rd into the Burnt Mill Creek area. The tornado quickly moved toward the northwest and completely lifted near the west end of Klein Rd.

Another short-lived tornado impacted the Brookfield Community near Gordon Rd in the Wilmington area. The tornado formed just south of Stones Edge Loop causing some damage to trees. The tornado moved across Northbrook Rd and knocked large limbs down. It also caused the walls to buckle at a home along Northbrook Rd., destroyed a nearby shed, and knocked several large limbs out of a large tree. The tornado moved northwest causing damage to an old shed on the south side of Briercrest Dr. The tornado then crossed Briercrest Dr. causing minor damage to a home and knocking large limbs out of trees. The tornado lifted in the vicinity of Gordon Rd. east of North Kerr Ave.

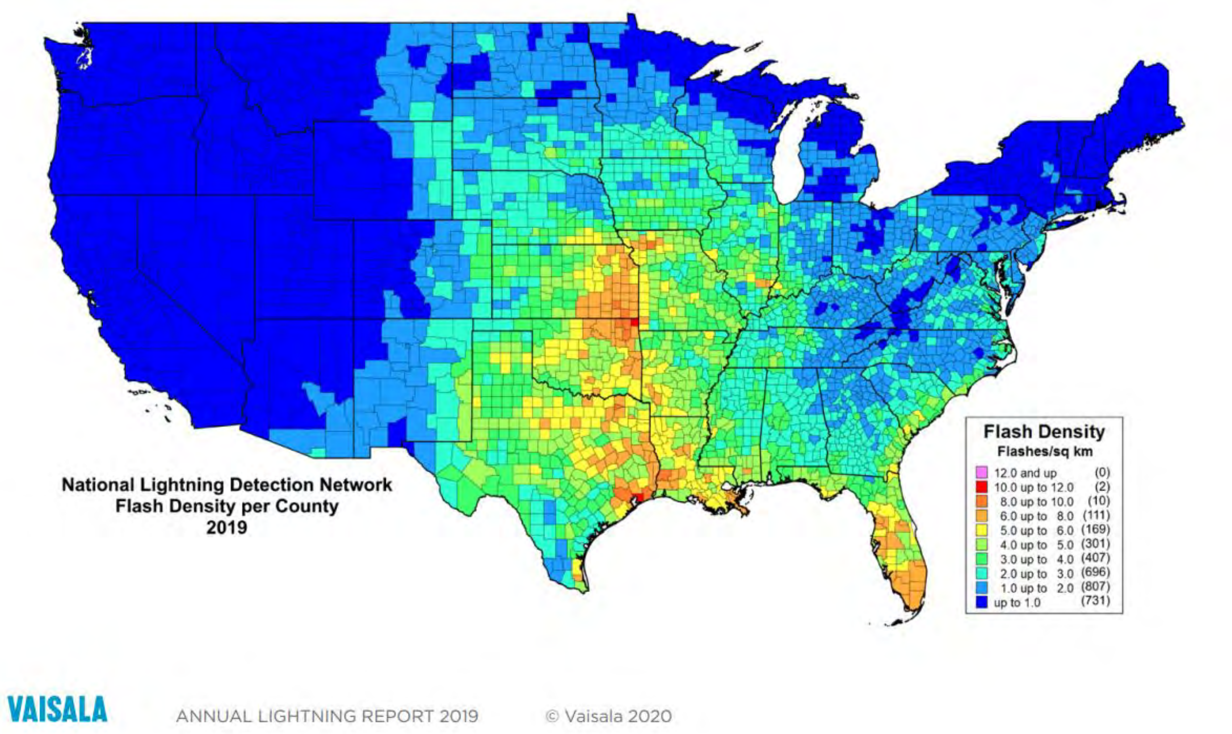
Probability of Future Occurrence

Based on historical occurrences recorded by NCEI for the 20-year period from 2000 through 2019, Wilmington averages 1.4 days with wind events per year. Over this same period, 11 lightning events were reported as having caused death, injury, or property damage, which equates to an average of 0.55 damaging lightning strikes per year.

The average hailstorm in Wilmington occurs in the afternoon and has a hail stone with a diameter of just under one inch. Over the 20-year period from 2000 through 2019, Wilmington experienced 17 days with reported hail incidents; this averages to 0.85 days per year with reported incidents somewhere in the planning area.

Based on the Vaisala 2019 Annual Lightning Report, North Carolina experienced 3,641,417 documented cloud-to-ground lightning flashes. According to Vaisala's flash density map, shown in **Figure I.19**, New Hanover County is located in an area that experiences 3 to 4 lightning flashes per square kilometer per year. It should be noted that future lightning occurrences may exceed these figures.

Figure I.19 – Lightning Flash Density per County (2019)



Source: Vaisala

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

In a twenty-year span between 2000 and 2019, Wilmington experienced 4 separate tornado incidents over 3 separate days. This correlates to a 15 percent annual probability that the City will experience a tornado somewhere in its boundaries. Three of these past tornado events were a magnitude EF0, and one event was a magnitude EF1; therefore, the annual probability of a significant tornado event is highly unlikely.

Based on these historical occurrences, there is between a 10% to 100% chance that Wilmington will experience severe weather each year. The probability of a damaging impacts is likely.

Probability: 3 – Likely

Vulnerability Assessment

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. Since 2000, NCEI records report 1 injury attributed to lightning strikes in Wilmington.

The loss of use estimates provided in **Table I.35** were calculated using FEMA's publication *What is a Benefit?: Guidance on Benefit-Cost Analysis of Hazard Mitigation Project*, June 2009. These figures are used to provide estimated costs associated with the loss of power in relation to the populations served on campus. The loss of use is provided in the heading as the loss of use cost per person per day of loss. The estimated loss of use provided for the campus represents the loss of service of the indicated utility for one day for 10 percent of the population. These figures do not take into account physical damages to utility equipment and infrastructure. The estimated on-campus population used in the table below was determined by taking 25% of the current enrollment for UNC-W, which is 17,915 students.

Table I.35 – Loss of Use Estimates for Power Failure Associated with Tornadoes/Thunderstorms

On-Campus Population (Fall 2020)	Estimated Affected Population (10%)	Electric Loss of Use Estimate ($126 per person per day)
4,479	448	$56,448

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 2018 American Community Survey (ACS) 5-Year Estimates, 1,453 occupied housing units (2.5 percent) in Wilmington are classified as "mobile homes or other types of housing." Using the 2018 ACS average persons per household estimate of 2.20, the population at risk due to their housing type was estimated at 3,197 residents within Wilmington. Individuals who work outdoors may also face increased risk.

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. Therefore, the estimated 3,197 residents mentioned above residing in mobile homes in Wilmington are also at a greater risk to tornado damage due to their housing type.

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 Wilmington, the 10 events with recorded property damage were due to lightning strikes resulting in fires.

NCEI records lightning impacts over 20 years (2000-2019), with $377,000 in property damage recorded during 10 separate events. Based on these records, the planning area experiences an annualized loss of $18,850 in property damage. The average impact from lightning per incident in Wilmington is $34,272.

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, 2000 and December 31, 2019 in Wilmington, NCEI did not report any property damage as a direct result of hail.

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 Wilmington, thus the NCEI is still used to form a baseline.

Wind events reported in NCEI for the 20-year period from 2000 through 2019 totaled $1,237,000 in property damage, which equates to an annualized loss of $61,850 across the City.

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 2000, damaging tornadoes in the City are directly responsible for $110,000 worth of damage to property according to NCEI data. This equates to an annualized loss of $5,500.

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.

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.

Changes in Development

Future development projects should consider severe thunderstorms hazards and tornado and high wind hazards at the planning, engineering and architectural design stage with the goal of reducing vulnerability. University buildings with high occupancies should consider inclusion of a tornado shelters to accommodate occupants in the event of a tornado. Future development will also affect current stormwater drainage patterns and capacities.

Problem Statement

- Thunderstorms and tornadoes are frequent hazard events in Wilmington and the UNC-W campus. Reported damages for the 20-year period from 2000-1019 include $1,237,000 for thunderstorm winds, $377,000 for lightning strikes, and $110,000 for tornado events.

I.5.6 Wildfire

Hazard	Probability	Impact	Spatial Extent	Warning Time	Duration	PRI Score
Wildfire	Likely	Critical	Large	More than 24 hrs	More than 1 week	3.1

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 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 I.36** details the WUI on the UNC-W campus and **Figure I.20** shows the WUI areas. The majority of the campus is classified as high and moderate housing density.

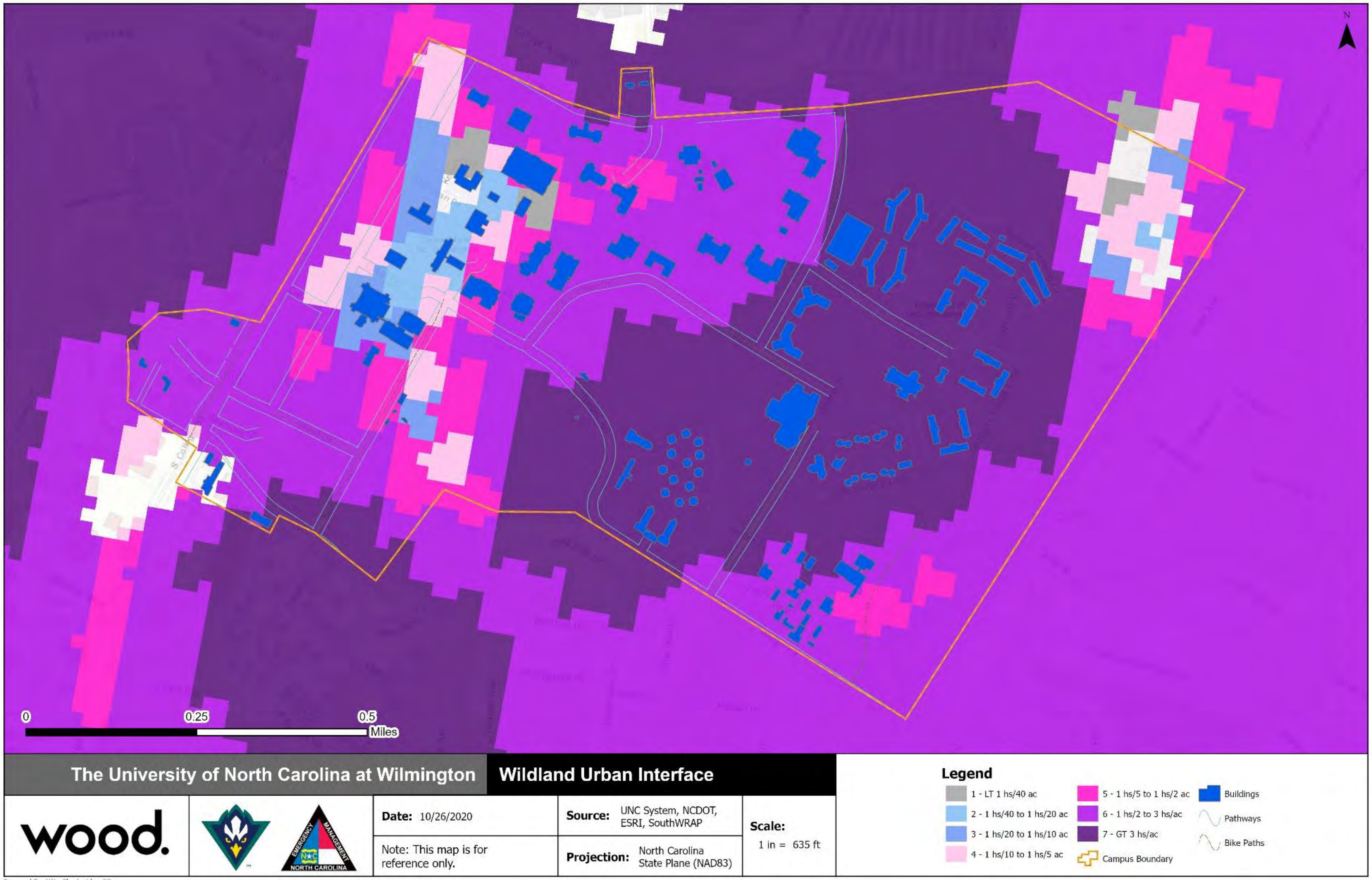
Table I.36 – Wildland Urban Interface, Population and Acres

	Housing Density	WUI Acres	Percent of WUI Acres
	Not in WUI	9	1.6%
	LT 1hs/40ac	6	1.0%
	1hs/40ac to 1hs/20ac	11	1.9%
	1hs/20ac to 1hs/10ac	17	2.9%
	1hs/10ac to 1hs/5ac	28	4.7%
	1hs/5ac to 1hs/2ac	50	8.5%
	1hs/2ac to 3hs/1ac	228	38.9%
	GT 3hs/1ac	237	40.4%
	Total	**587**	**--**

Source: Southern Wildfire Risk Assessment

Spatial Extent: 4 – Large

Figure I.20 – Wildland Urban Interface Areas, UNC-W



Source: Southern Wildfire Risk Assessment

Extent

The entire state is at risk to a wildfire occurrence. However, several factors such as drought conditions or high levels of fuel on the forest floor may make a wildfire more likely in certain areas. 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, shown in **Table I.37**, consists of five classes, as defined by Southern Wildfire Risk Assessment. **Figure I.21** shows the potential fire intensity within the WUI across University of North Carolina at Wilmington.

Table I.37 – 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

The largest portion UNC-W's campus area (49.9%) is identified as Class 0 or non-burnable. Approximately 17.8% of the campus area is identified as Class 1 or Class 2 Fire Intensity, which are easily suppressed. The remaining 32.3% of the campus area is identified as Class 3 Fire Intensity or higher which would have the potential for harm to life and property.

The WUI Risk Index is used to rate the potential impact of a wildfire on people and their homes. It reflects housing density (per acre) consistent with Federal Register National standards. The WUI Risk Index ranges of values from -1 to -9, with -1 representing the least negative impact and -9 representing the most negative impact. **Figure I.22** maps the WUI Risk Index for UNC-W. The WUI areas within the campus of UNC-W range from -1 to -9 on the WUI Risk Index.

Impact: 3 – Critical

Figure I.21 – WUI Characteristic Fire Intensity, UNC-W

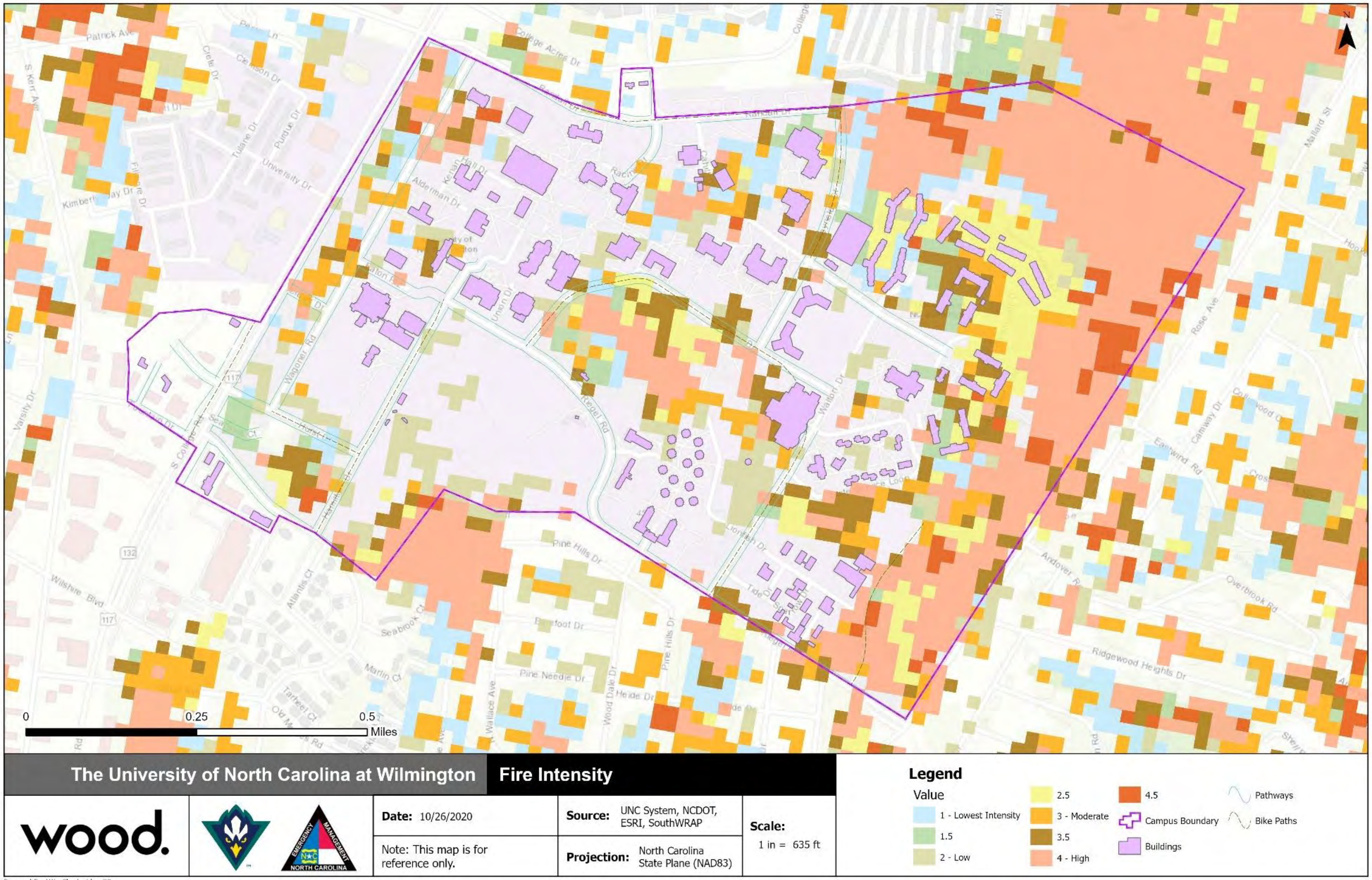
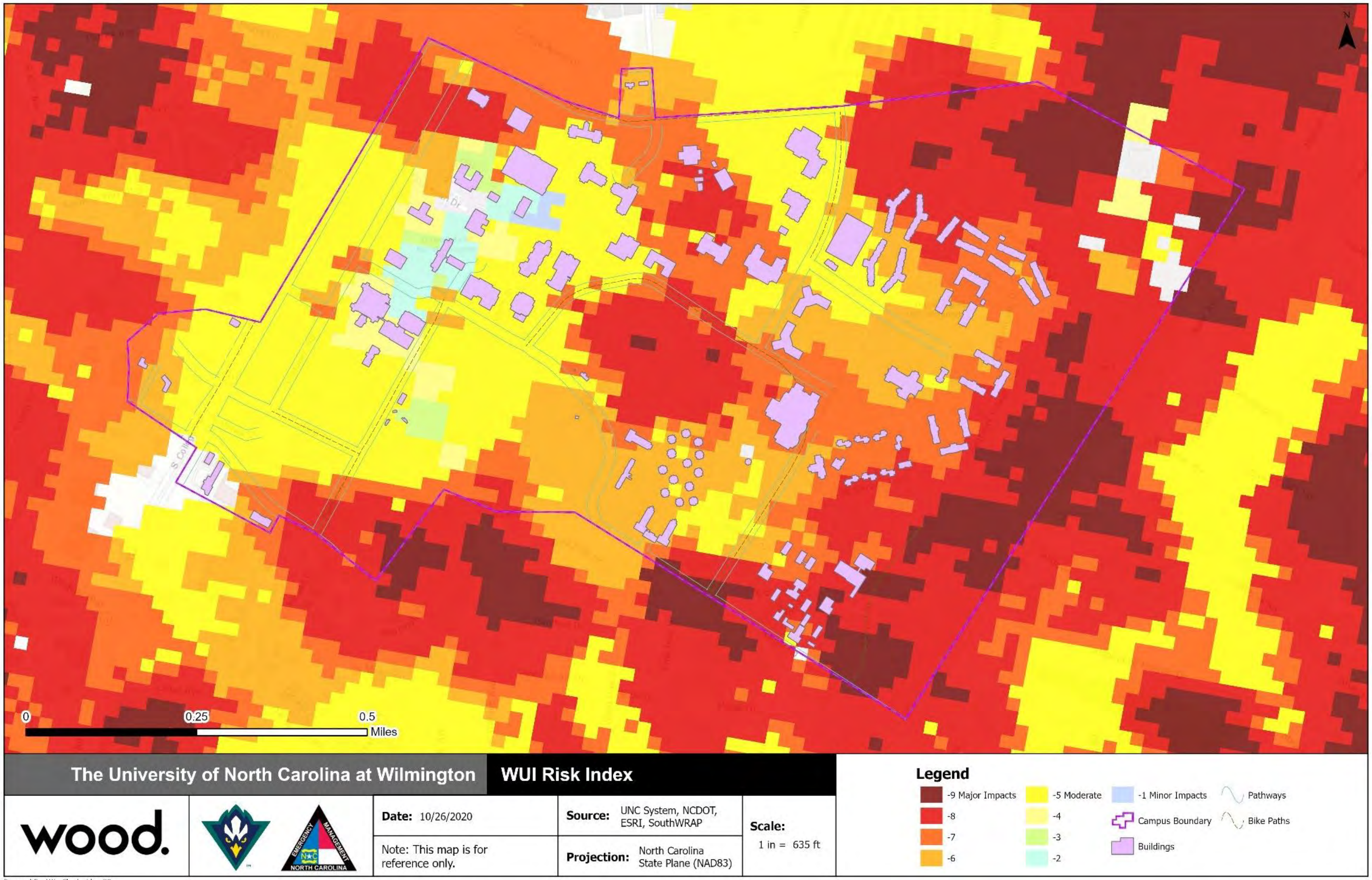


Figure I.22 – WUI Risk Index, UNC-W



Historical Occurrences

Wildfire data on a county level is no longer publicly available for New Hanover County, but wildfire data for the state is provided by the North Carolina Forest Service (NCFS) and is reported annually from 1970 to 2018. Below in **Figure I.23** is the number of documented wildfires in North Carolina from 1999-2018 including the acreage burned and different causes. Debris burning appears to continue to be the largest cause of fires in the state.

Figure I.23 – North Carolina Wildfires by Cause, 2009-2018

Year	Fires	Acres	Lightning	Camping	Smoking	Debris Burning	Incendaiary	Machine Use	Railroad	Children	MISC.
2018	3,597	10,994	43	29	35	1,601	191	364	22	140	1,172
2017	5,153	20,479	60	40	79	2,413	322	485	36	159	1,559
2016	4,195	77,741	48	65	78	1,566	402	438	18	175	1,405
2015	3,886	10,588	77	32	82	1,671	444	416	4	223	937
2014	4,593	13,327	53	41	90	2,237	706	460	30	210	766
2013	3,374	9,451	20	37	102	1,492	580	344	14	200	583
2012	3,550	11,992	129	46	91	1,221	715	384	36	228	668
2011	5,265	63,547	200	28	216	2,102	1,012	522	40	298	803
2010	4,053	14,703	71	36	166	1,642	801	435	24	268	602
2009	3,291	12,328	56	38	186	1,309	618	283	26	246	528
2008	4,378	49,929	197	36	246	1,565	758	384	58	332	802
2007	7,260	36,850	215	105	503	2,461	1,476	614	98	614	1,174
2006	5,767	23,364	98	60	360	2,414	1,031	489	53	452	810
2005	4,078	14,981	49	47	278	1,697	764	347	45	311	540
2004	4,406	14,221	29	49	255	2,046	693	337	36	335	626
2003	2,041	31,843	10	21	121	864	355	187	15	154	314
2002	5,655	27,678	261	73	369	2,250	975	397	65	501	764
2001	8,240	28,576	82	110	708	3,227	1,593	635	121	749	1,015
2000	5,039	24,660	57	60	358	2,049	956	372	118	443	626
1999	6,341	27,389	110	75	439	2,629	1,195	412	107	598	776

Source: https://www.ncforestservice.gov/fire_control/fc_statisticsCause.htm

With 94,162 wildfires noted within North Carolina between 1999 and 2018, the likelihood of occurrence can be calculated to be 4,708 wildfire events throughout the state per year. With the total acreage burned during this same period as 524,641 acres, the annual average acreage burned can be calculated as 26,232 acres burned per year and the average event can be calculated as 5.6 acres.

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 UNC-W is presented in **Table I.38** and illustrated in **Figure I.24**.

Table I.38 – Burn Probability, UNC-W

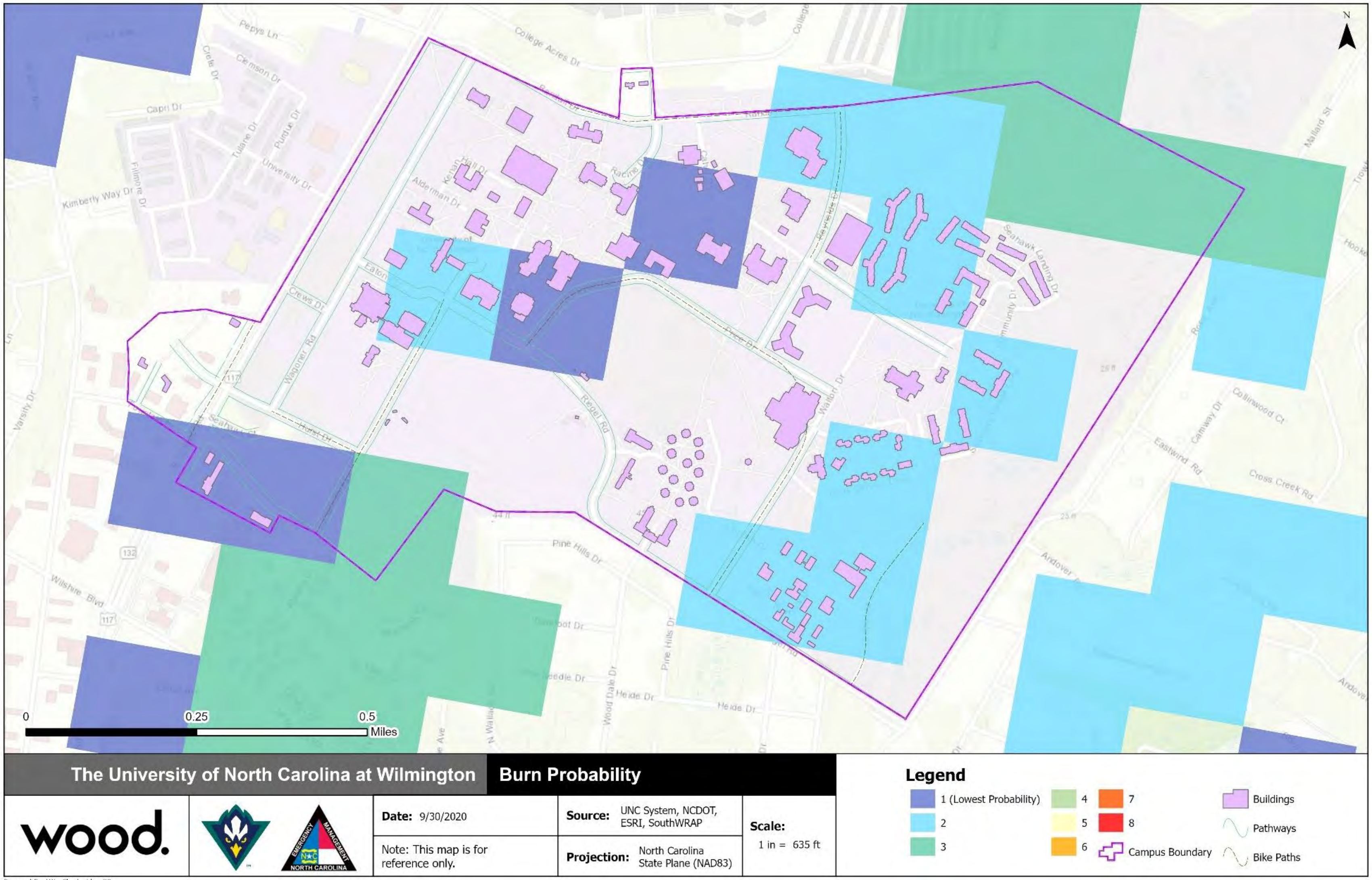
Class	Acres	Percent
No Probability	346	59.0%
1	55	9.4%
2	135	23.0%
3	50	8.5%
4	0	0.0%
5	0	0.0%
6	0	0.0%
7	0	0.0%
8	0	0.0%
9	0	0.0%
10	0	0.0%
Total	**587**	--

Source: Southern Wildfire Risk Assessment

The UNC-W campus was predominantly determined has having no probability (59%). The remainder of the campus was determined to be Class 1, 2, or 3 (41%) having a low probability. Located within these burn probability areas are the Academic Support Center, Cameron Hall, Center for Innovation and Entrepreneurship, Computer Information Systems Building, Cultural Arts Building, Cornerstone Hall, Environmental Health and Safety building and Warehouse, Fisher Buildings, Friday Annex, Honors House, Innovations House, Isaac Bear Early College High School, James Hall, Kresge Greenhouse, Natatorium, Network and Communications Building, Oriole Burevitch Laboratory, Osprey Hall, Printing Services Building, Purchasing Services Building, Schwartz Hall, Seahawk Crossing, Seahawk Landing, Seahawk Village, University Suites, Warwick Center. Additionally, the critical facilities Burney Center Energy Plant, Facilities Building, Hanover Hall, Hoggard Hall, and the University Police Department are located within these burn probability areas as well.

Probability: 3 – Likely

Figure I.24 – Burn Probability, UNC-W



Vulnerability Assessment

People

Wildfire can cause fatalities and human health hazards. Ensuring procedures are in place for rapid warning and evacuation are essential to reducing vulnerability.

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.

Using the Wildland Urban Interface Risk Index (WUIRI) from the Southern Wildfire Risk Assessment, a GIS analysis was used to estimate the exposure of buildings most at risk to loss due to wildfire. The WUIRI shows a rating of the potential impact of wildfire on homes and people. This index ranges from 0 to -9, where lower values are relatively more severe. **Table I.39** summarizes the number of buildings and their total value that fall within areas rated -5 or less on the WUIRI. This table represents potential risks and counts every building within the area rated under -5, actual damages in the event of a wildfire may differ.

Table I.39 – Building Counts and Values within WUIRI under -5

Occupancy Type	Buildings	Building Value
Administration	4	$14,856,840
Critical Facility	2	$36,019,986
Extracurricular/Educational	15	$143,696,857
Housing	6	$40,602,817
Total	**27**	**$235,176,500**

Source: GIS Analysis, Southern Wildfire Risk Assessment

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.

Changes in Development

Growth on the UNC-W campus within the wildland-urban interface area will increase the vulnerability of people, property, and infrastructure to wildfires. To reduce wildfire impacts, the University can work with the City and/or New Hanover County to coordinate fuel reduction efforts, educate residents and campus population, train firefighters, and establish local wildfire management plans.

Problem Statement

- Approximately 98% of the UNC-W campus is located within an identified WUI area.
- Approximately 32.3% of the campus area is identified as Class 3 Fire Intensity or higher which would have the potential for harm to life and property.
- A portion of the UNC-W campus (41%) is located within areas with defined Burn Probability Classes 1, 2, and 3 having lower probability.
- Coordination with the City of Wilmington and/or New Hanover County is recommended to reduce fuel efforts and establish a local wildfire management plan.

I.5.7 Cyber Threat

Hazard	Probability	Impact	Spatial Extent	Warning Time	Duration	PRI Score
Cyber Threat	Possible	Critical	Large	Less than 6 hrs	More than 1 week	3.1

Location

Cyber disruption events can occur and/or impact virtually any location in the state where computing devices are used. Incidents may involve a single location or multiple geographic areas. A disruption can have far-reaching effects beyond the location of the targeted system; disruptions that occur far outside the region can still impact people, businesses, and institutions within the region.

On the UNC-W campus, the Information Security division of Information Technology Services (ITS) is responsible for safeguarding the confidentiality, integrity, and availability of all information processed, stored or transmitted using university electronic resources while also taking proactive measures to counter threats, vulnerabilities and cyber-attacks. The University's critical applications require passwords for access. Modifications of the application software are protected from abuse by an electronic software control procedure. Information security is managed and controlled in accordance with the university's Information Security Policy.

Spatial Extent: 4 – Large

Extent

The extent or magnitude/severity of a cyber disruption event is variable depending on the nature of the event. A disruption affecting a small, isolated system could impact only a few functions/processes. Disruptions of large, integrated systems could impact many functions/processes, as well as many individuals that rely on those systems.

There is no universally accepted scale to quantify the severity of cyber-attacks. The strength of a DDoS attack is sometimes explained in terms of a data transmission rate. One of the largest DDoS disruptions ever, which brought down some of the internet's most popular sites on October 21, 2016, peaked at 1.2 terabytes per second.

Data breaches are often described in terms of the number of records or identities exposed. With the amount of data retained by universities – including student, staff, and faculty personal information as well as research data – a data breach on the UNC-W campus could cause significant disruption and impact a large number of records.

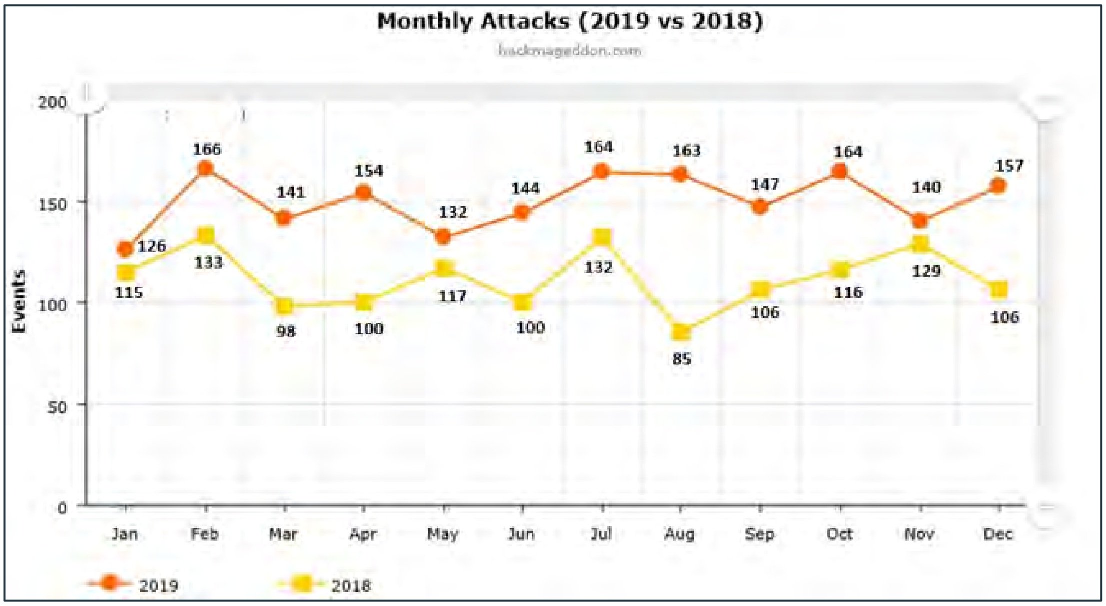
Impact: 3 – Critical

Historical Occurrences

As cyber disruption is an emerging hazard, the reporting and tracking of disruptive events is difficult. In most cases, it is not required to report an event, and when it is reported most of the information is protected due to the sensitive nature of the systems that have been disrupted. However, there currently exists several complex databases that track cyber disruption occurrences. Each system makes use of its own definitions and tracking methods. Hackmageddon is one online source that tracks Cyber Attack Statistics. Hackmageddon was developed by Paolo Passeri, an expert in the computer security industry for more than 15 years and current Principal Sales Engineer at OpenDNS (now part of Cisco). The timelines collect the major cyber events of the related months chosen among events published by open sources (such as blogs or news sites). It should be noted that this database collects cyber-attacks worldwide and this data is provided to show how this hazard is trending in general. During 2019, this database collected reports of a total of 1,802 cyber-attacks.

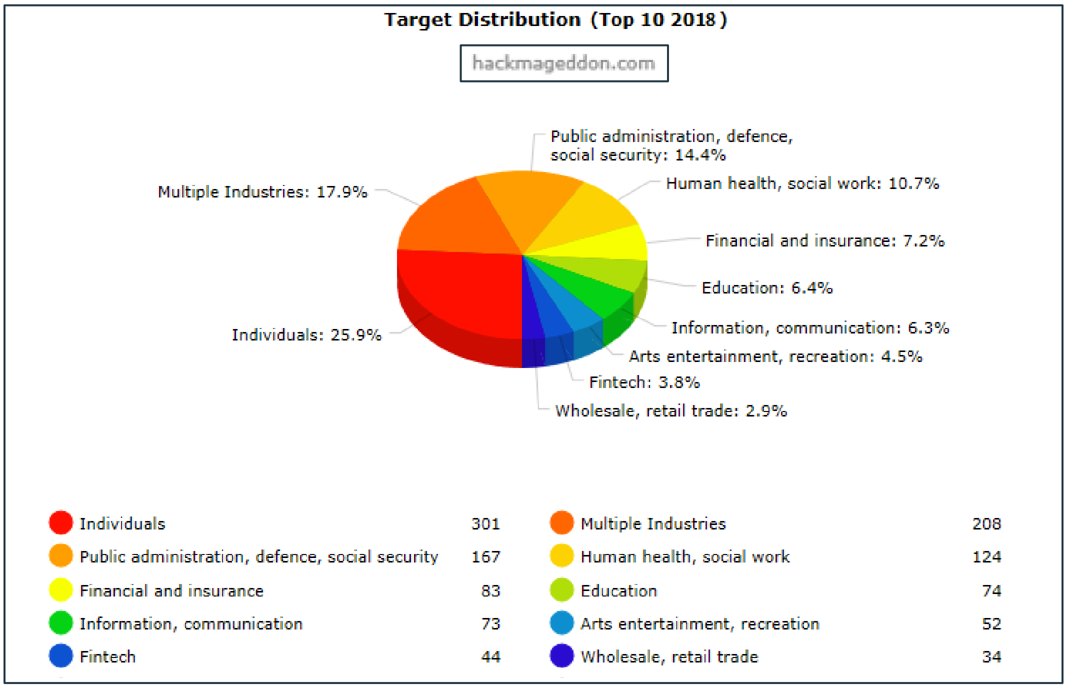
The graphic in **Figure I.25** provides a comparison of the number of attacks collected during 2018 and 2019. The two following images in **Figure I.26** and **Figure I.27** shows the top 10 target distributions for 2018 and 2019. The main finding from the top 10 attack techniques is the percentage of 'other' targeted attacks appearing at 14.1% in 2019. Attacks targeted towards Education slightly increased from 6.4% in 2018 to 7.1% in 2019. Most other target distributions experienced a percentage decrease in 2019. Some of this is probably due to the difference in distribution categories between 2018 and 2019.

Figure I.25– Comparison of Monthly Attacks Collected by Hackmageddon (2018-2019)



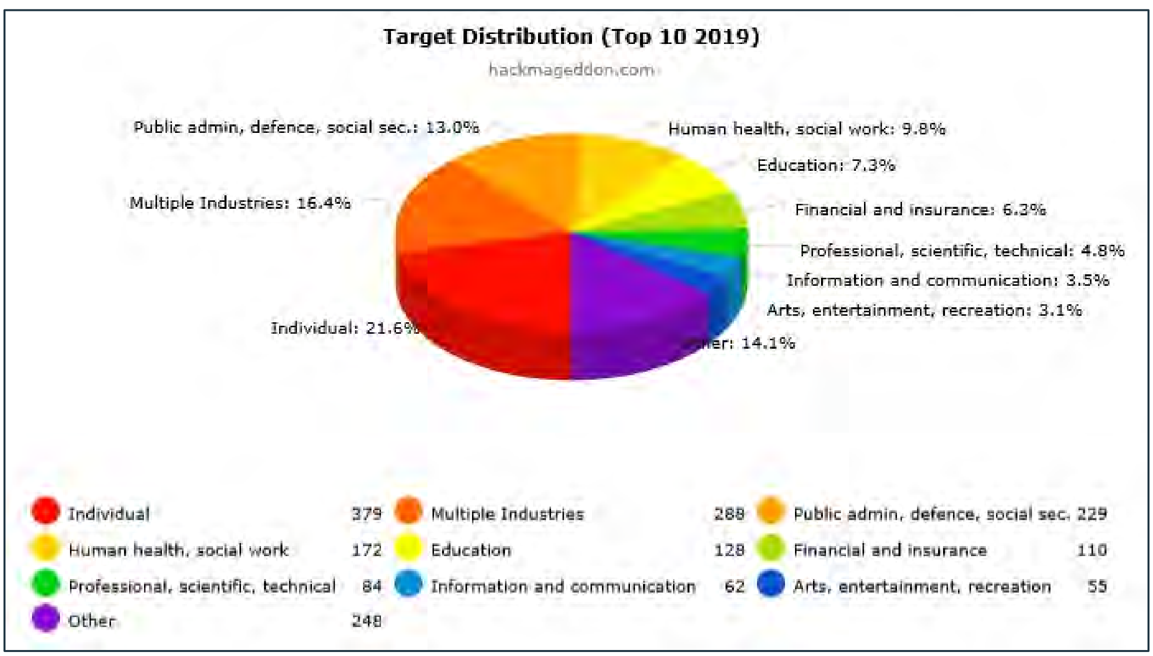
Source: Hackmageddon, https://www.hackmageddon.com/2020/01/23/2019-cyber-attacks-statistics/

Figure I.26 – Top 10 Cyber Attack Target Distributions, 2018



Source: Hackmageddon

Figure I.27 – Top 10 Cyber Attack Target Distributions, 2019



Source: Hackmageddon

There have been some notable disruption events within the Education target distribution that attained national attention in the last few years:

August 2020, The University of North Carolina Wilmington's Division of University Advancement (DUA) was hacked by a ransomware attack. The data included names, addresses, phone numbers, email addresses, and history of gifts made to UNCW; the University reported that no vulnerable financial or personal information was included. (https://portcitydaily.com/story/2020/08/06/uncw-reports-ransomware-attack-hackers-accessed-personal-details-but-no-financial-info/)

November 2019, The University of North Carolina Chapel Hill School of Medicine reported over 3,500 individuals having private information stolen in phishing cyber-attack, (https://www.databreaches.net/the-university-of-north-carolina-chapel-hill-school-of-medicine-notifying-patients-after-2018-phishing-incident/).

October 2019, Randolph Community College's entire computer network and other devices were compromised following cyberattack. In total, 1,200 devices were affected during the two week attack, (https://www.yourdailyjournal.com/news/89334/report-rcc-cyber-attack-was-first-successful-of-this-scale-at-nc-community-college).

December 2018, The Cape Cod Community College notifies its employees that Hackers stole more than $800,000 when they infiltrated the school's bank accounts, (https://www.databreaches.net/hackers-steal-800000-from-cape-cod-community-college/).

September 2018, The Henderson school district in Texas is hit with a business email compromise (BEC) attack resulting in a $600,000 loss for the district. The attack took place on September, 26th, (https://www.scmagazine.com/home/security-news/bec-attack-scamstexas-school-district-out-of-600000/).

April 2018, Partial social security numbers of more than 1,200 employees at Irvington schools are distributed via email to an unknown number of recipients by an unidentified attacker, (https://www.databreaches.net/hacker-sent-email-with-1200-partial-social-security-numbers-to-school-staff/).

March 2018, Florida Virtual Learning School notifies 368,000 current and former students, after an individual with the moniker $2a$45 uploads information of 35,000 students on a forum. Leon County Schools is among the affected organizations, (https://www.databreaches.net/leon-county-schools-vendors-data-leak-exposed-368000-current-and-former-flvs-students-details-lcs-teacher-data-and-more/).

November 2017, Monticello Central School District warns of a sophisticated e-mail phishing attack occurred on November 1st, 2017. Potentially 2,598 individuals are affected, (https://www.databreaches.net/monticello-central-school-district-notifying-almost-2600-of-phishing-attack-last-year/).

October 2017, The Los Angeles Valley College (LAVC) is forced to pay $28,000 in bitcoin after cybercriminals successfully infected its computer networks, email systems and voicemail lines with ransomware, (https://www.ibtimes.co.uk/la-school-pays-hackers-28000-bitcoin-after-computer-systems-hit-ransomware-1600304).

July 2017, Tax information for dozens of University of Louisville employees is compromised after a hack of the online system the university uses to give employees access to tax documents, (https://www.databreaches.net/tax-information-of-some-university-of-louisville-employees-hacked/).

April 2017, Westminster College in Missouri reveals the details of a breach discovered on March 26 after a phishing scam duped a staffer into sending off W-2 statements, (https://www.scmagazine.com/home/security-news/data-breach/w-2-data-breach-at-westminster-college/).

Probability of Future Occurrence

Cyber attacks occur daily, but most have negligible impacts at the local or regional level. The possibility of a larger disruption affecting systems within the region is a constant threat, but it is difficult to quantify the exact probability due to such highly variable factors as the type of attack and intent of the attacker. Minor attacks against business and government systems have become a commonplace occurrence but are usually stopped with minimal impact. Similarly, data breaches impacting the information of students and faculty of UNC-W are almost certain to happen in coming years. Major attacks or breaches specifically targeting systems at the University are less likely but cannot be ruled out.

Probability: 2 – Possible

Vulnerability Assessment

As discussed above, the impacts from a cyber attack vary greatly depending on the nature, severity, and success of the attack.

People

Cyber-attacks can have a significant cumulative economic impact. Check Point Research reports that in 2018, cybercrime rates were estimated to have generated around 1.5 trillion dollars. A major cyber-attack has the potential to undermine public confidence and build doubt in their government's ability to protect them from harm. Injuries or fatalities from cyber attacks would generally only be possible from a major cyber terrorist attack against critical infrastructure.

Property

Short of a major cyber terrorist attacks against critical infrastructure, property damage from cyber attacks is typically limited to computer systems.

Environment

Short of a major cyber terrorist attacks against critical infrastructure, property damage from cyber attacks is typically limited to computer systems. A major cyber terrorism attack could potentially impact the environment by triggering a release of a hazardous materials, or by causing an accident involving hazardous materials by disrupting traffic-control devices.

Changes in Development

With enrollment increasing since the last plan, the number of users of campus networks and software have significantly increased. Additionally, with fewer buildings located on campus, the number of network access points have decreased.

For future development, as the number of users and/or access points to the network and campus software increases, the opportunity for cyber-attacks is also likely to increase.

Problem Statement

- Cyber-attacks occur daily, but most have negligible impacts at the local or regional level. The possibility of a larger disruption affecting systems within the region is a constant threat, but difficult to quantify.
- The University's Information Security division addresses IT security through policies addressing users, physical security, system security, password administration, communications, wireless devices, computer viruses, disaster recovery, and compliance with law and policy.

I.5.8 Hazardous Materials Incidents

Hazard	Probability	Impact	Spatial Extent	Warning Time	Duration	PRI Score
Hazardous Materials Incident	Highly Likely	Minor	Negligible	Less than 6 Hrs	Less than 24 Hrs	2.3

Location

Hazardous materials releases at fixed sites can cause a range of contamination from very minimal to catastrophic. The releases can go into the air, onto the surface, or into the ground and possibly into groundwater, or a combination of all. Although releases into the air or onto the ground surface can pose a great and immediate risk to human health, they are generally easier to remediate than those releases which enter into the ground or groundwater. Soil and groundwater contamination may take years to remediate causing possible long-term health problems for individuals and rendering land unusable for many years.

The Toxics Release Inventory (TRI) Program run by the 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 11 sites reporting hazardous materials in Wilmington from 2016-2018. These sites are detailed by location and sector in **Table I.40**.

Table I.40 – Toxic Release Inventory Facilities in Wilmington

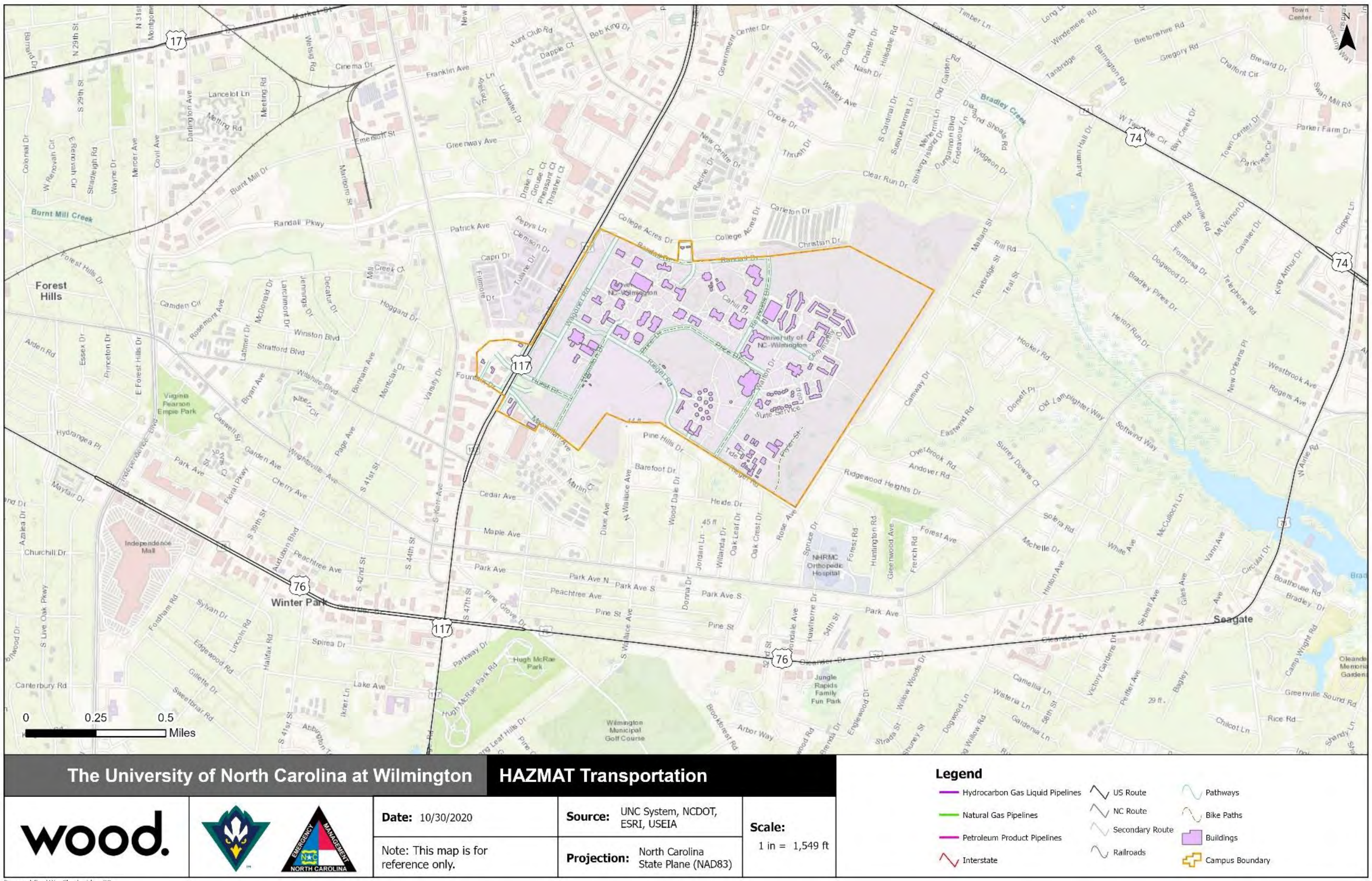
Facility Name	Sector
Wilmington	
ARGOS SUNNYVALE CONCRETE PLANT	Nonmetallic Mineral Product
CORNING INC	Nonmetallic Mineral Product
S&W WILMINGTON PLANT	Nonmetallic Mineral Product
STURDY CORP	Transportation Equipment
WILBARA LLC	Chemicals
GE CO	Chemicals
ARGOS READY MIX SCOTTS HILL CONCRETE PLANT	Nonmetallic Mineral Product
SOUTH ATLANTIC SERVICES INC	Chemicals
FORTRON INDUSTRIES LLC	Chemicals
INVISTA SA RL-WILMINGTON	Chemicals
ARGOS HWY 421 CONCRETE PLANT	Nonmetallic Mineral Product

Source: EPA Toxic Release Inventory

Transportation hazardous materials Incidents can occur when hazardous materials are being transported from one location to another in the normal course of business for manufacturing, refining, or other industrial purposes. Additionally, hazardous materials incidents can occur as hazardous waste is transported for final storage and/or disposal. **Figure I.28** shows the routes of transportation for hazardous materials adjacent to or through UNC-W's campus. According to data collected by the UNC System, one pipeline intersects the critical facility, Steam Plant, on campus.

Spatial Extent: 1 – Negligible

Figure I.28 – Hazardous Materials Transportation Routes near the UNC-W Campus



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.

Prior to 2002, however, a "serious incident" regarding hazardous materials was defined as follows:

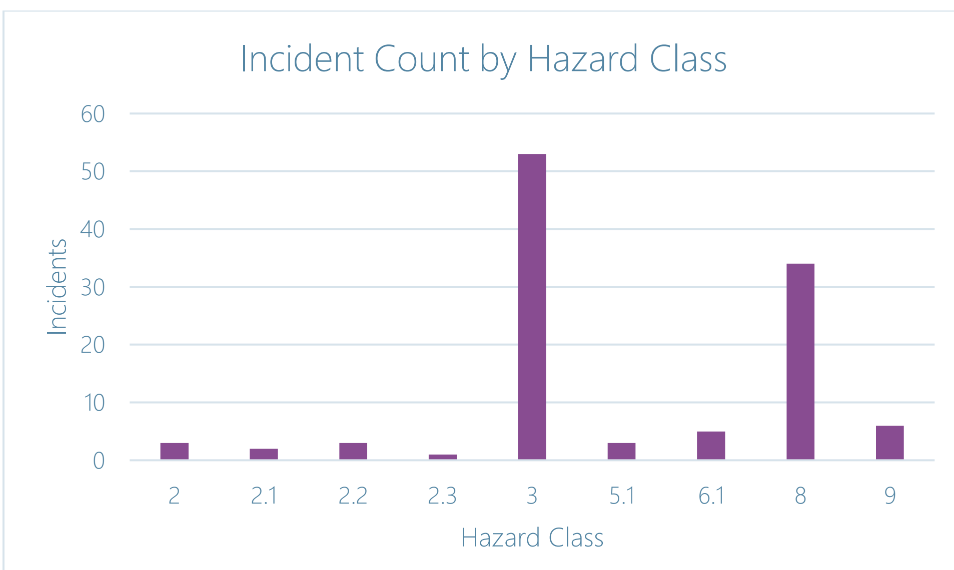
- a fatality or major injury due to a hazardous material
- closure of a major transportation artery or facility or evacuation of six or more persons due to the presence of hazardous material, or
- a vehicle accident or derailment resulting in the release of a hazardous material.

Impact: 1 – Minor

Historical Occurrences

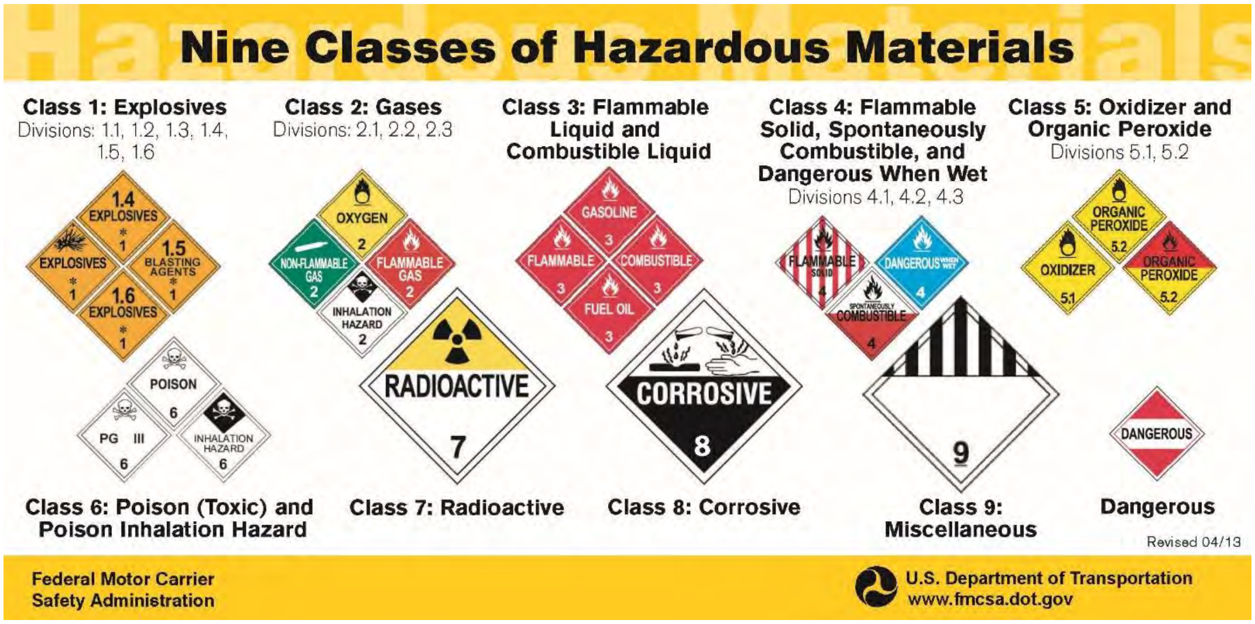
The USDOT's PHMSA maintains a database of reported hazardous materials incidents by location and hazardous material class. According to PHMSA records, there were 110 recorded releases in Wilmington from 2000 through 2019. **Figure I.29** categorizes these incidents by hazardous material class. The most common materials spilled in the City were Class 3 (Flammable and Combustible Liquids) and Class 8 (Corrosives). **Figure I.30** describes all nine hazard classes.

Figure I.29 – Count of Hazardous Materials Release Incidents by Hazard Class, 2000-2019



Source: PHMSA Incident Reports, Office of Hazardous Materials Safety, Incident Reports Database Search.

Figure I.30 – Hazardous Materials Classes



Source: U.S. Department of Transportation

Probability of Future Occurrence

Based on historical occurrences recorded by PHMSA, there have been 110 serious incidents of hazardous materials release in the 20-year period from 2000 through 2019. Using historical occurrences as an indication of future probability, there is over a 100 percent annual probability of a hazardous materials incident occurring throughout the City of Wilmington.

Probability: 4 – Highly Likely

Vulnerability Assessment

People

Hazardous materials incidents can cause injuries, hospitalizations, and even fatalities to people nearby. People living near hazardous facilities and along transportation routes may be at a higher risk of exposure, particularly those living or working downstream and downwind from such facilities. For example, a toxic spill or a release of an airborne chemical near a populated area can lead to significant evacuations and have a high potential for loss of life. Individuals working with or transporting hazardous materials are also at heightened risk.

In addition to the immediate health impacts of releases, a handful of studies have found long term health impacts such as increased incidence of certain cancers and birth defects among people living near certain chemical facilities. However there has not been sufficient research done on the subject to allow detailed analysis.

The primary economic impact of hazardous material incidents results from lost business, delayed deliveries, property damage, and potential contamination. Large and publicized hazardous material-related events can deter tourists and could potentially discourage residents and businesses. Economic effects from major transportation corridor closures can be significant.

Property

The impact of a fixed hazardous facility, such as a chemical processing facility is typically localized to the property where the incident occurs. The impact of a small spill (i.e. liquid spill) may also be limited to the extent of the spill and remediated if needed. While cleanup costs from major spills can be significant, they do not typically cause significant long-term impacts to property.

Hazardous materials spills reported by PHMSA for the 20-year period from 2000 through 2019 totaled $491,862 in damage, which equates to an annualized loss of $24,593 across the City of Wilmington.

Impacts of hazardous material incidents on critical facilities are most often limited to the area or facility where they occurred, such as at a transit station, airport, fire station, hospital, or railroad. However, they can cause long-term traffic delays and road closures resulting in major delays in the movement of goods and services. These impacts can spread beyond the planning area to affect neighboring counties, or vice-versa. While cleanup costs from major spills can be significant, they do not typically cause significant long-term impacts to critical facilities, but there is a chance they may be impacted.

Environment

Hazardous material incidents may affect a small area at a regulated facility or cover a large area outside such a facility. Widespread effects occur when hazards contaminate the groundwater and eventually the municipal water supply, or they migrate to a major waterway or aquifer. Impacts on wildlife and natural resources can also be significant.

Changes in Development

Structures located near fixed facilities, highways and other high traffic roadways are most at risk to a hazardous materials event. Any development that takes place in these areas will place more people and structures in the risk area for hazardous materials events, however since most hazardous material spills are localized to an extremely small area this will not have an effect on the overall risk assessment for this hazard.

Problem Statement

- Transportation routes for hazardous materials are located adjacent to the UNC-W campus.
- The number of reported incidents within Wilmington can be approximated to over a 100 percent annual probability.

I.5.9 Infectious Disease

Hazard	Probability	Impact	Spatial Extent	Warning Time	Duration	PRI Score
Infectious Disease	Possible	Critical	Large	More than 24 hrs	More than 1 week	2.8

Location

Infectious disease outbreaks can occur anywhere in the planning area, especially where there are groups of people in close quarters.

Spatial Extent: 4 – Large

Extent

When on an epidemic scale, diseases can lead to high infection rates in the population causing isolation, quarantine, and potential mass fatalities. An especially severe influenza pandemic or other major disease outbreak could lead to high levels of illness, death, social disruption, and economic loss. Impacts could range from school and business closings to the interruption of basic services such as public transportation, health care, and the delivery of food and essential medicines.

Table I.41 describes the World Health Organization's six main phases to a pandemic flu as part of their planning guidance.

Table I.41 – World Health Organization's Pandemic Flu Phases

Phase	Description
1	No animal influenza virus circulating among animals have been reported to cause infection in humans.
2	An animal influenza virus circulating in domesticated or wild animals is known to have caused infection in humans and is therefore considered a specific potential pandemic threat.
3	An animal or human-animal influenza reassortant virus has caused sporadic cases or small clusters of disease in people, but has not resulted in human-to-human transmission sufficient to sustain community-level breakouts.
4	Human-to-human transmission of an animal or human-animal influenza reassortant virus able to sustain community-level breakouts has been verified.
5	The same identified virus has caused sustained community-level outbreaks in two or more countries in one WHO region.
6	In addition to the criteria defined in Phase 5, the same virus has caused sustained community-level outbreaks in at least one other country in another WHO region.
Post-Peak Period	Levels of pandemic influenza in most countries with adequate surveillance have dropped below peak levels.
Post-Pandemic Period	Levels of influenza activity have returned to levels seen for seasonal influenza in most countries with adequate surveillance.

Source: World Health Organization

Impact: 3 – Critical

Historical Occurrences

Public Health Emergencies – Influenza Pandemics

Since the early 1900s, four lethal pandemics have swept the globe: Spanish Flu of 1918-1919; Asian Flu of 1957-1958; Hong Kong Flu of 1968-1969; and Swine Flu of 2009-2010. The Spanish Flu was the most severe pandemic in recent history. The number of deaths was estimated to be 50-100 million worldwide and 675,000 in the United States. Its primary victims were mostly young, healthy adults. The 1957 Asian

Flu pandemic killed about 70,000 people in the United States, mostly the elderly and chronically ill. The 1968 Hong Kong Flu pandemic killed 34,000 Americans. The 2009 Swine Flu caused 12,469 deaths in the United States. These historic pandemics are further defined in the following paragraphs along with several "pandemic scares".

Spanish Flu (H1N1 virus) of 1918-1919

In 1918, when World War I was in its fourth year, another threat began that rivaled the war itself as the greatest killer in human history. The Spanish Flu swept the world in three waves during a two-year period, beginning in March 1918 with a relatively mild assault.

The first reported case occurred at Camp Funston (Fort Riley), Kansas, where 60,000 soldiers trained to be deployed overseas. Within four months, the virus traversed the globe, as American soldiers brought the virus to Europe. The first wave sickened thousands of people and caused many deaths (46 died at Camp Funston), but it was considered mild compared to what was to come. The second and deadliest wave struck in the autumn of 1918 and killed millions. At Camp Funston alone, there were 14,000 cases and 861 deaths reported during the first three weeks of October 1918.

Outbreaks caused by a new variant exploded almost simultaneously in many locations including France, Sierra Leone, Boston, and New York City, where more than 20,000 people died that fall. The flu gained its name from Spain, which was one of the hardest hit countries. From there, the flu went through the Middle East and around the world, eventually returning to the United States along with the troops.

Of the 57,000 Americans who died in World War I, 43,000 died because of the Spanish Flu. At one point, more than 10 percent of the American workforce was bedridden. By a conservative estimate, a fifth of the human race suffered the fever and aches of influenza between 1918 and 1919 and 20 million people died. At the height of the flu outbreak during the winter of 1918-1919, at least 20% of North Carolinians were infected by the disease. Ultimately, 10,000 citizens of the state succumbed to this disease.

Asian Flu (H2N2 virus) of 1957-1958

This influenza pandemic was first identified in February 1957 in the Far East. Unlike the Spanish Flu, the 1957 virus was quickly identified, and vaccine production began in May 1957. Several small outbreaks occurred in the United States during the summer of 1957, with infection rates highest among school children, young adults, and pregnant women; however, the elderly had the highest rates of death. A second wave of infections occurred early the following year, which is typical of many pandemics.

Hong Kong Flu (H3N2 virus) of 1968-1969

This influenza pandemic was first detected in early 1968 in Hong Kong. The first cases in the United States were detected in September 1968, although widespread illness did not occur until December. This became the mildest pandemic of the twentieth century, with those over the age of 65 the most likely to die. People infected earlier by the Asian Flu virus may have developed some immunity against the Hong Kong Flu virus. Also, this pandemic peaked during school holidays in December, limiting student-related infections.

Pandemic Flu Threats: Swine Flu of 1976, Russian Flu of 1977, and Avian Flu of 1997 and 1999

Three notable flu scares occurred in the twentieth century. In 1976, a swine-type influenza virus appeared in a U.S. military barracks (Fort Dix, New Jersey). Scientists determined it was an antigenically drifted variant of the feared 1918 virus. Fortunately, a pandemic never materialized, although the news media made a significant argument about the need for a Swine Flu vaccine.

In May 1977, influenza viruses in northern China spread rapidly and caused epidemic disease in children and young adults. By January 1978, the virus, subsequently known as the Russian Flu, had spread around

the world, including the United States. A vaccine was developed for the virus for the 1978–1979 flu season. Because illness occurred primarily in children, this was not considered a true pandemic.

In March 1997, scores of chickens in Hong Kong's rural New Territories began to die—6,800 on three farms alone. The Avian Flu virus was especially virulent and made an unusual jump from chickens to humans. At least 18 people were infected, and six died in the outbreak. Chinese authorities acted quickly to exterminate over one million chickens and successfully prevented further spread of the disease. In 1999, a new avian flu virus appeared. The new virus caused illness in two children in Hong Kong. Neither of these avian flu viruses started pandemics.

Swine Flu (H1N1 virus) of 2009–2010

This influenza pandemic emerged from Mexico in 2009. The first U.S. case of H1N1, or Swine Flu, was diagnosed on April 15, 2009. The U.S. government declared H1N1 a public health emergency on April 26. By June, approximately 18,000 cases of H1N1 had been reported in the United States. A total of 74 countries were affected by the pandemic.

The CDC estimates that 43 million to 89 million people were infected with H1N1 between April 2009 and April 2010. There were an estimated 8,870 to 18,300 H1N1 related deaths. On August 10, 2010, the World Health Organization (WHO) declared an end to the global H1N1 flu pandemic.

Public Health Emergencies – Other Pandemics

Meningitis, 1996-1997, 2005

During 1996 and 1997, 213,658 cases of meningitis were reported, with 21,830 deaths, in Africa. According to the North Carolina Disease Data Dashboard, there were 28 cases in North Carolina in 2005.

Lyme Disease, 2015

In the United States, Lyme disease is mostly found in the northeastern, mid-Atlantic, and upper north-central regions, and in several counties in northwestern California. In 2015, 95-percent of confirmed Lyme Disease cases were reported from 14 states: Connecticut, Delaware, Maine, Maryland, Massachusetts, Minnesota, New Hampshire, New Jersey, New York, Pennsylvania, Rhode Island, Vermont, Virginia, and Wisconsin. Lyme disease is the most reported vector-borne illness in the United States. In 2015, it was the sixth most common nationally notifiable disease. However this disease does not occur nationwide and is concentrated heavily in the northeast and upper Midwest.

Severe Acute Respiratory Syndrome, 2003

During November 2002-July 2003, a total of 8,098 probable SARS cases were reported to the World Health Organization (WHO) from 29 countries. In the United States, only 8 cases had laboratory evidence of infection. Since July 2003, when SARS transmission was declared contained, active global surveillance for SARS disease has detected no person-to-person transmission. CDC has therefore archived the case report summaries for the 2003 outbreak. Across North Carolina, there was one confirmed SARS case – a man in Orange County tested positive in June 2003.

Zika Virus, 2015

In May 2015, the Pan American Health Organization issued an alert noting the first confirmed case of a Zika virus infection in Brazil. Since that time, Brazil and other Central and South America countries and territories, as well as the Caribbean, Puerto Rico, and the U.S. Virgin Islands have experienced ongoing Zika virus transmission. In August 2016, the Centers for Disease Control and Prevention (CDC) issued guidance for people living in or traveling to a 1-square-mile area Miami, Florida, identified by the Florida Department of Health as having mosquito-borne spread of Zika. In October 2016, the transmission area

was expanded to include a 4.5-square-mile area of Miami Beach and a 1-squre mile area of Miami-Dade County. In addition, all of Miami-Dade County was identified as a cautionary area with an unspecified level of risk. As of the end of 2018, the CDC reported 74 cases of Zika across the United States.

Ebola, 2014-2016

In March 2014, West Africa experienced the largest outbreak of Ebola in history. Widespread transmission was found in Liberia, Sierra Leone, and Guinea with the number of cases totaling 28,616 and the number of deaths totaling 11,310. In the United States, four cases of Ebola were confirmed in 2014 including a medical aid worker returning to New York from Guinea, two healthcare workers at Texas Presbyterian Hospital who provided care for a diagnosed patient, and the diagnosed patient who traveled to Dallas, Texas from Liberia. All three healthcare workers recovered. The diagnosed patient passed away in October 2014.

In March 2016, the WHO terminated the public health emergency for the Ebola outbreak in West Africa.

Coronavirus Disease (COVID-19), 2020

During the update of this plan, the Coronavirus disease 2019, also known as COVID-19, outbreak became a worldwide pandemic. COVID-19 was caused by severe acute respiratory syndrome coronavirus 2 (SARS-Cov-2). First identified in Wuhan, China in December 2019, the virus quickly spread throughout China and then globally. As of October 18, 2020, there were over 39.5 million cases worldwide resulting in over 1.1 million deaths. In the United States, COVID-19 was first identified in late January in Washington State and rapidly spread throughout the Country, with large epicenters on both the east and west coasts.

In order to curb the spread of the virus, Governor Roy Cooper issued a statewide Stay at Home Order on March 27, 2020. According to the North Carolina Department of Health and Human services, as of October 23, 2020, there were over 255,708 confirmed cases and 4,114 deaths across all 100 counties in the State. In New Hanover County, as of October 23, 2020, there were a total of 5,099 cases and 37 deaths. Case counts are still rising in North Carolina and New Hanover County at the time of this assessment.

Probability of Future Occurrence

It is impossible to predict when the next pandemic will occur or its impact. The CDC continually monitors and assesses pandemic threats and prepares for an influenza pandemic. Novel influenza A viruses with pandemic potential include Asian lineage avian influenza A (H5N1) and (H7N9) viruses. These viruses have all been evaluated using the Influenza Risk Assessment Tool (IRAT) to assess their potential pandemic risk. Because the CDC cannot predict how severe a future pandemic will be, advance planning is needed at the national, state and local level; this planning is done through public health partnerships at the national, state and local level.

Today, a much larger percentage of the world's population is clustered in cities, making them ideal breeding grounds for epidemics. Additionally, the explosive growth in air travel means the virus could literally be spread around the globe within hours. Under such conditions, there may be very little warning time. Most experts believe we will have just one to six months between the time that a dangerous new influenza strain is identified and the time that outbreaks begin to occur in the United States. Outbreaks are expected to occur simultaneously throughout much of the nation, preventing shifts in human and material resources that normally occur with other natural disasters. These and many other aspects make influenza pandemic unlike any other public health emergency or community disaster.

Probability: 2 – Possible

Vulnerability Assessment

People

Disease spread and mortality is affected by a variety of factors, including virulence, ease of spread, aggressiveness of the virus and its symptoms, resistance to known antibiotics and environmental factors. While every pathogen is different, diseases normally have the highest mortality rate among the very young, the elderly or those with compromised immune systems. As an example, the unusually deadly 1918 H1N1 influenza pandemic had a mortality rate of 20%. If an influenza pandemic does occur, it is likely that many age groups would be seriously affected. The greatest risks of hospitalization and death—as seen during the last two pandemics in 1957 and 1968 as well as during annual outbreaks of influenza—will be to infants, the elderly, and those with underlying health conditions. However, in the 1918 pandemic, most deaths occurred in young adults. Few people, if any, would have immunity to a new virus.

Approximately twenty percent of people exposed to West Nile Virus through a mosquito bite develop symptoms related to the virus; it is not transmissible from one person to another. Preventive steps can be taken to reduce exposure to mosquitos carrying the virus; these include insect repellent, covering exposed skin with clothing and avoiding the outdoors during twilight periods of dawn and dusk, or in the evening when the mosquitos are most active.

Property

For the most part, property itself would not be impacted by a human disease epidemic or pandemic. However, as concerns about contamination increase, property may be quarantined or destroyed as a precaution against spreading illness. Furthermore, staffing shortages could affect the function of critical facilities.

Environment

A widespread pandemic would not have an impact on the natural environment unless the disease was transmissible between humans and animals. However, affected areas could result in denial or delays in the use of some areas, and may require remediation.

Changes in Development

With enrollment decreasing since the last plan, the number of students and employees on campus has decreased. Additionally, with fewer buildings located on campus, the number of indoor meeting locations has decreased.

For future development, as the number of students and employees increase, the opportunity for spread of a pandemic would increase, should in-person educational and/or extracurricular meetings take place.

Problem Statement

- With the current COVID-19 pandemic, it is clear the UNC-W campus population is susceptible to the infectious disease pandemic.
- UNC-W has a pandemic influenza plan in place to provide a guide for the University to follow in the event of an influenza pandemic in North Carolina.

I.5.10 Terrorism

Hazard	Probability	Impact	Spatial Extent	Warning Time	Duration	PRI Score
Terrorism	Unlikely	Catastrophic	Large	More than 24 hrs	More than 1 week	2.8

Location

Terrorism is defined in the Code of Federal Regulations as "the unlawful use of force and violence against persons or property to intimidate or coerce a government, the civilian population, or any segment thereof, in furtherance of political or social objectives" (28 CFR Section 0.85). The threat of terrorism, both international and domestic, is ever present, and an attack is likely to occur when least expected. A terror threat could occur at any location in the area, but are more likely to target highly populated areas, critical infrastructure, or symbolic locations.

Before the September 11, 2001 attacks in New York and the Pentagon, most terrorist incidents in the United States have been bombing attacks, involving detonated and un-detonated explosive devices, tear gas, and pipe and firebombs. The effects of terrorism can vary significantly from loss of life and injuries to property damage and disruptions in services such as electricity, water supply, public transportation and communications. The U.S. government has attempted to reduce vulnerability to terrorist incidents by developing infrastructure protection programs for critical infrastructure and key resource facilities and increased security at airports.

While we can never predict what target a terrorist will choose, we do know some of the factors they use when selecting a target. Terrorists want to achieve one or more of the following:

- Produce a large number of victims,
- Attack places that have a symbolic value,
- Get the greatest possible media attention, and
- Produce mass panic.

Terrorists also select targets best suited for the type of material being used. For example, some biological agents are not effective in sunlight. Most chemical agents are more effective indoors with limited airflow. A radioactive material will be most effective where large numbers of people will pass close by without detecting it. Terrorists are likely to target heavily populated, enclosed areas like stadiums, government buildings, sporting events, airport terminals, subways, shopping malls and industrial manufacturing facilities. For this reason, it is critical that employers and local government agencies have some type of anti-terrorism plan in place should a terrorist act occur.

A terrorist attack can take several forms, depending on the technological means available to the terrorist, the nature of the political issue motivating the attack, and the points of weakness of the terrorist's target. Bombings have been the most frequently used terrorist method in the United States. Other possibilities include an attack at transportation facilities, an attack against utilities or other public services or an incident involving chemical or biological agents.

Facilities on the UNC-W campus could be potential terrorism targets include, but are not limited to:

- Burney Center Energy Plant
- Congdon Hall
- Hanover Hall

Extent

In the United States, most terrorist incidents have involved small extremist groups who use terrorism to achieve a designated objective. Local, state and federal law enforcement officials monitor suspected terrorist groups and try to prevent or protect against a suspected attack. Additionally, the US government works with other countries to limit the sources of support for terrorism.

The Southern Poverty Law Center reports that in 2019, there were 32 active hate groups in North Carolina, as seen in **Table I.42**. Although no major terrorist acts have been attributed to any of these groups, their involvement in violent acts is meant to disrupt governmental functions and cannot be discounted.

Table I.42 – List of Hate Groups in North Carolina, 2019

Name	Type	City
American Christian Dixie Knights of the Ku Klux Klan	Ku Klux Klan	Statewide
American Identity Movement	White Nationalist	Statewide
Americans for Legal Immigration (ALIPAC)	Anti-Immigrant	Raleigh
Asatru Folk Assembly	Neo-Volkisch	Statewide
Blood and Honour Social Club	Racist Skinhead	Statewide
Blood and Honour USA	Racist Skinhead	Statewide
Confederate Hammerskins	Racist Skinhead	Statewide
Crew 38	Racist Skinhead	Statewide
Great Millstone	Black Separatist	Charlotte
Heirs to the Confederacy	Neo-Confederate	Asheboro
Identity Dixie	Neo-Confederate	Statewide
Israel United In Christ	Black Separatist	Concord
Israelite School of Universal Practical Knowledge	Black Separatist	Charlotte
Israelite School of Universal Practical Knowledge	Black Separatist	Durham
Israelite School of Universal Practical Knowledge	Black Separatist	Fayetteville
Israelite School of Universal Practical Knowledge	Black Separatist	Greensboro
Israelite School of Universal Practical Knowledge	Black Separatist	Greenville
Israelite School of Universal Practical Knowledge	Black Separatist	Winston-Salem
Israelites Saints of Christ	Black Separatist	Statewide
Loyal White Knights of the Ku Klux Klan	Ku Klux Klan	Pelham
Masharah Yasharahla - Government of Israel	Black Separatist	Raleigh
Nation of Islam	Black Separatist	Charlotte
Nation of Islam	Black Separatist	Durham
Nation of Islam	Black Separatist	Greensboro
Nation of Islam	Black Separatist	Wilmington
Nation of Islam	Black Separatist	Winston-Salem
New Black Panther Party for Self Defense	Black Separatist	Charlotte
Patriot Front	White Nationalist	Statewide
Proud Boys	General Hate	Statewide
Southern Revivalism	Neo-Confederate	Statewide
The Right Stuff	White Nationalist	Statewide
The United Nuwaupians Worldwide/All Eyes on Egipt	General Hate	Charlotte

Source: Southern Poverty Law, www.splcenter.org

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: 4 – Large

Historical Occurrences

There are no reported terrorism incidents for the UNC-W campus. However, the following incidents have occurred on other university campuses within the State:

- **May 15, 1954 – UNC Chapel Hill** – Three individuals were shot (one fatally) during a fraternity house carnival at the Phi Delta Theta house at the University of North Carolina.
- **October 3, 2010 – Mid-Atlantic Christian University** - A student at Mid-Atlantic Christian University was shot to death inside Pearl A. Presley Hall, a campus dormitory. Police arrested a 23-year-old male student after the shooting and charged him with first-degree murder. The suspect claimed self-defense, saying the victim came at him with a knife while he was sitting at his computer. The suspect testified he felt he was in danger because he was a gay student at a religious school.
- **November 2, 2013 – North Carolina A&T State University** - One person was shot and wounded at the university. The victim was hospitalized. The university was temporarily locked down that night. No suspects are in custody.
- **April 13, 2015 – Wayne Community College of Goldsboro** – A school employee was fatally shot in the school library. A 20-year-old male suspect was arrested for the killing early the next day.
- **November 1, 2015 – Winston-Salem State University** - One person died, and another person was injured after someone opened fire on campus. A 21-year-old non-student suspect is sought.
- **April 30, 2019 – UNC Charlotte** – A 22-year-old former history undergraduate at UNC Charlotte shot six students and killed two. Probability of Future Occurrence

Probability of Future Occurrence

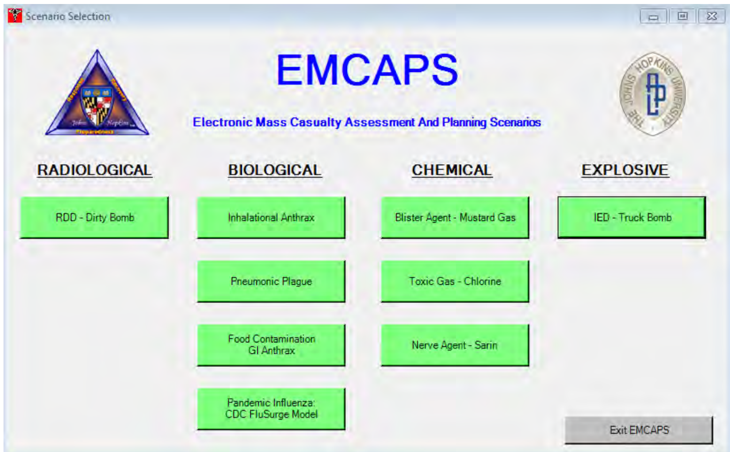
While difficult to estimate when a deliberate act like terrorism may occur, it can be inferred that the probability of a terrorist attack in any one area in the Region is very low at any given time. When identified, credible threats may increase the probability of an incident; these threats are generally tracked by law enforcement.

Probability: 1 – Unlikely

Vulnerability Assessment

Because damage analysis capabilities are still evolving for man-made hazards, such as bombs, a program developed by Johns Hopkins University in 2006 called Electronic Mass Casualty Assessment and Planning Scenarios (EMCAPS) was used to model blast effects and calculate the resulting casualty population. Buildings and other physical structures were not considered in these calculations; it is assumed that the explosion takes place in a relatively open area (e.g. stadium parking lot, park, etc). With the difficult-to-quantify risks of terrorism, the HMPC chose to model worst-case scenarios and estimate losses based on those planning scenarios available within the EMCAPS program, as developed by the Department of Homeland Security.

Figure I.31 – EMCPS Software



Utilizing the EMCAPS model, scenarios are defined by both bomb size and population density:

- Bomb Size (500, 1000, 2000, 3000, 4000, or 5000 lbs)
- Population Density (1 person per 25, 50, 100, 225, or 625 square feet).

****THE FOLLOWING HYPOTHETICAL SCENARIOS ARE FOR INSTRUCTIONAL AND ILLUSTRATIVE PURPOSES ONLY****

Explosive Device – Trask Coliseum

Scenario Overview: A Vehicle-Borne Improvised Explosive Device (VBIED) utilizing an ammonium nitrate/fuel oil (ANFO) mixture is carried in a cargo truck near Trask Coliseum during a highly attended basketball game and detonated.

Assumptions: (1) The population density outside Trask Coliseum prior to an event is high, at least 1 person/50 square feet. (2) The disguised large vehicle bomb contains 4,000 pounds of a readily attainable conventional explosive material such as ammonium nitrate/fuel oil (ANFO) or a commercial high explosive. (3) The estimated lethal air blast range for this vehicle (4,000 pounds of ANFO) is 300 feet.

Table I.43 – EMCAPS Described Losses – Trask Coliseum

Total Dead	695 persons
Total Traumatic Injuries	1,218 persons
Total Urgent Care Injuries	5,967 persons
Injuries not Requiring Hospitalization	2,233 persons
Healthcare Considerations	Triage concerns: many victims will be unconscious; many victims will have hearing loss; psychological distressed but unaffected population reporting to hospitals could be as high as 9 times the actual number of physical injuries.
Additional Considerations	Transportation will be limited/inaccessible in the vicinity of the blast. Services may be unavailable in the vicinity of the blast – water, sewerage, electricity, etc.

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.

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.

Changes in Development

Increase in development and technology has the potential of making the planning area more of a target for a terrorist attack due to larger numbers of victims and more target areas.

Problem Statement

- There are no records of past terrorism incidents for the UNC-W campus.
- There are active hate groups within North Carolina.
- When identified, credible threats may increase the probability of an incident; these threats are generally tracked by law enforcement.

I.5.11 Conclusions on Hazard Risk

Priority Risk Index

As discussed in **Section I.5**, 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 I.44 summarizes the degree of risk assigned to each identified hazard using the PRI method.

Table I.44 – Summary of PRI Results

Hazard	Probability	Impact	Spatial Extent	Warning Time	Duration	PRI Score
Earthquake	Unlikely	Minor	Large	Less than 6 hours	Less than 6 hours	1.9
Flood	Highly Likely	Minor	Negligible	6 to 12 hrs	Less than 1 week	2.3
Hurricane	Likely	Catastrophic	Large	More than 24 hrs	Less than 24 hrs	3.2
Geological – Sinkhole	Possible	Limited	Negligible	Less than 6 hours	Less than 6 hours	1.9
Tornado / Thunderstorm	Likely	Critical	Large	Less than 6 hrs	Less than 6 hrs	3.1
Wildfire	Likely	Critical	Large	More than 24 hrs	More than 1 week	3.1
Cyber Threat	Possible	Critical	Large	Less than 6 hrs	More than 1 week	3.1
Hazardous Materials	Highly Likely	Minor	Negligible	Less than 6 Hrs	Less than 24 Hrs	2.3
Infectious Disease	Possible	Critical	Large	More than 24 hrs	More than 1 week	2.8
Terrorism	Unlikely	Catastrophic	Large	More than 24 hrs	More than 1 week	2.8

[1]Note: Severe Weather hazards average to a score of 2.6 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 I.45**:

- **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.
- **Moderate 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 minimal. This is not a priority hazard.

Table I.45 – Summary of Hazard Risk Classification

High Risk (≥ 3.0)	Hurricane Tornado/Thunderstorm Wildfire Cyber Threat
Moderate Risk (2.0 – 2.9)	Flood Wildfire Hazardous Materials Infectious Disease Terrorism
Low Risk (< 2.0)	Earthquake Geological – Sinkhole

I.6 CAPABILITY ASSESSMENT

This section discusses the mitigation capabilities, including planning, programs, policies and land management tools, typically used to implement hazard mitigation activities. It consists of the following subsections:

I.6.1 Overview of Capability Assessment

The purpose of conducting a capability assessment is to determine the ability of the college to implement feasible mitigation actions based on an understanding of the capacity of the departments and staff tasked with their implementation. A capability assessment should also identify opportunities for establishing or enhancing specific mitigation policies or programs. The process of conducting a capability assessment includes developing an inventory of relevant plans, policies, or programs already in place; as well as assessing the college's ability to implement existing and/or new policies. Conclusions drawn from the capability assessment should identify any existing gaps or weaknesses in existing programs and policies as well as positive measures already in place which can and should be supported through future mitigation efforts.

I.6.2 Planning and Regulatory Capability

Planning and regulatory capabilities include plans, ordinances, policies and programs that guide development on campus. **Table I.46** lists these local resources currently in place at UNC-W.

Table I.46 – Planning and Regulatory Capability

Regulatory Tool (ordinances, codes, plans)	Y/N	Comments
Master Plan	Y	UNC-W Master Plan, 2017
Zoning code	Y	City of Wilmington Zoning Ordinance
Growth management ordinance	N	
Floodplain ordinance	Y	City of Wilmington Flood Ordinance
Building code	Y	NC building codes; the State of North Carolina statutes for state owned buildings; and zoning for local jurisdiction
Erosion or sediment control program	N	
Stormwater management program	N	
Site plan review requirements	N	
Capital improvements plan	Y	Office of Facilities; Capital Projects
Economic development plan	Y	UNC-W Annual Report
Local emergency operations plan	Y	Emergency Operations Plan, no date available
Flood Insurance study or other engineering study for streams	Y	August 28, 2018
Elevation certificates	Y	City of Wilmington

A description of applicable plans, ordinances and programs follows to provide more detail on the relevance of each regulatory tool in examining the capabilities for each community.

Master Plan

A Master Plan, in broad terms, is a policy statement to guide the future placement and development of campus facilities. The Master Plan identifies a future vision, values, principals and goals for the college, determines the projected growth for the college, and identifies policies to plan, direct and accommodate anticipated growth. UNC-W maintains a Master Plan that was most recently updated in 2017. It is inspired by, and based in, the University's 2016-2021 Strategic Plan. Along with aligning with the Strategic Plan, the Master Plan's three additional goals include addressing space needs and online education, integrating all completed and ongoing studies, and recommending space management systems.

Zoning Code

Zoning typically consists of both a zoning map and a written ordinance/code that divides the planning area into zoning districts. The zoning regulations describe what type of land use and specific activities are permitted in each district, and also regulate how buildings, signs, parking, and other construction may be placed on a parcel. The zoning regulations also provide procedures for rezoning and other planning applications. Zoning is undertaken by the City of Wilmington.

Flood Insurance Study/Floodplain Ordinance

A Flood Insurance Study (FIS) provides information on the existence and severity of flood hazards within a community based on the 100-year flood event. The FIS also includes revised digital Flood Insurance Rate Maps (FIRMs) which reflect updated Special Flood Hazard Areas (SFHAs) and flood zones for the community.

A floodplain ordinance is perhaps the most important flood mitigation tool. 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 will be protected from damage by a 100-year flood event and that new development in the floodplain will not exacerbate existing flood problems or increase damage to other properties. Floodplain management is carried out by the City of Wilmington.

Stormwater Management Program

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. A Stormwater Management Program can prevent flooding problems caused by stormwater runoff by 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) Setting construction standards so buildings are protected from shallow water. A stormwater ordinance provides regulatory authority to implement stormwater management standards. The City of Wilmington's Stormwater Services provide comprehensive management of stormwater systems in Wilmington, including regulations across various ordinances. The UNC-W Master Plan (2017) notes the need for a campus-wide stormwater management plan to address flooding.

Erosion and Sediment Control Program

Surface water runoff can erode soil from development sites, sending sediment into downstream waterways. This can clog storm drains, drain tiles, culverts and ditches and reduce the water transport and storage capacity of channels. The purpose of an erosion, sedimentation and pollution control ordinance is to minimize soil erosion and prevent off-site sedimentation by using soil erosion and sediment control practices designed in accordance with certain standards and specifications. Erosion and Sediment Control is managed by the New Hanover County Engineering Department within the unincorporated county and the City of Wilmington.

Site Plan Review

The purpose of the Site Plan Review Process is to review site plans for specific types of development to ensure compliance with all appropriate land development regulations and consistency with the General Plan.

Building Code

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).

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. An Elevation Certificate serves as the official record that shows new buildings and substantial improvements in all identified SFHAs are properly elevated. This elevation information is needed to show compliance with the floodplain ordinance.

Building Codes are maintained and enforced by the City of Wilmington. In addition to such codes, UNC-W has extensive Campus Design Guidelines maintained and updated regularly by the Architecture and Construction Services department.

Capital Improvement Plan

A Capital Improvement Plan (CIP) is a planning document that typically provides a five-year outlook for anticipated capital projects designed to facilitate decision makers in the replacement of capital assets. The projects are primarily related to improvement in public service, parks and recreation, public utilities and facilities. The mitigation strategy may include structural projects that could potentially be included in a CIP and funded through a Capital Improvement Program. UNC-W maintains a Capital Improvement Plan through the Office of Facilities and the Architecture and Construction Services Department.

Emergency Operations Plan

An emergency operations plan outlines responsibilities and the means by which resources are deployed during and following an emergency or disaster. UNC-W maintains an Emergency Operations Plan which includes a Threat and Hazard Identification and Risk Assessment (2016).

I.6.3 Administrative and Technical Capability

Administrative and technical capability refers to the college's staff and their skills and tools that can be used for mitigation planning and to implement specific mitigation actions. It also refers to the ability to access and coordinate these resources effectively. The personnel should be considered as well as the level of knowledge and technical expertise of these resources. Resources include engineers, planners, emergency managers, GIS analysts, building inspectors, grant writers, floodplain managers, and more. **Table I.47** provides a summary of the administrative and technical capabilities for UNC-W.

Table I.47 – Administrative and Technical Capability

Personnel Resources	Yes/No	Department/Position
Planner/Engineer with knowledge of land development/land management practices	Yes	Office of Facilities

Personnel Resources	Yes/No	Department/Position
Engineer/Professional trained in construction practices related to buildings and/or infrastructure	Yes	Office of Facilities
Planner/Engineer/Scientist with an understanding of natural hazards	Yes	Office of Facilities
Personnel skilled in GIS	Yes	Office of Facilities
Full time building official	Yes	City of Wilmington
Floodplain Manager	Yes	City of Wilmington
Emergency Manager	Yes	Environmental Health & Safety
Grant Writer	No	
Public Information Officer	Yes	Office of University Relations
Student Engagement	Yes	Division of Student Affairs
Warning Systems	Yes	University Police 5 Outdoor sirens

Additional resources include the following:

- UNC-W utilizes text, telephone, social media to reach all students who are automatically registered. Faculty and staff have to register themselves.
- UNC-W has an automatic alert pop up software on university computers.
- UNC-W has an indoor notification system in our satellite campus called the CREST Research Park located in Myrtle Grove, North Carolina.
- UNC-W has designated locations inside campus buildings, but no official tornado safe rooms nor are they constructed to FEMA standards

From the 2008 UNC-W, the following tables highlight university departments that have staff and faculty with expertise to assist in implementing this hazard mitigation plan.

Table I.48 – UNC-W Offices Relevant to Hazard Mitigation Plan Implementation

Office	Key Responsibilities
Budget Office	Maintains and monitors budget.
Information Technology System Division*	Provides information technology support across campus including disaster recovery services for information technology
Telecommunications	Provides and maintains telephone communications for the campus
Environmental Health and Safety*	Provides leadership in maintaining a safe and healthy environment; conducts facility and equipment inspections; coordinates university management activities. Emergency Management and Institutional Risk Management are both offices under the Environmental Health & Safety umbrella. The Emergency Management Assistant Director coordinated the HMPC and this plan update process.
General Counsel	Provides professional legal services that minimize risk, reduce litigation, and identify and respond to legal issues affecting the university
Human Resources	Provides comprehensive human resources services including salary and benefits administration, staff training and development, and employee relations
Institutional Research and Planning	Collects data to support university decision-making and planning
Office of Facilities, Design and Construction*	Provides planning and project management for major capital projects; ensures that proposed architectural and engineering projects are planned and designed to seamlessly blend with and enhance the natural and build environments of the campus while meeting the programmatic needs of the users; coordinates projects detailed in the UNCW Master Plan

Office	Key Responsibilities
Office of Facilities, Project Management*	Provides effective and efficient service in the design and implementation of facility construction, renovation, and minor improvement projects; preserves the facility record archives of the university and the space data system
Office of University Planning*	Manages and facilitates the university-wide strategic planning process
UNCW Police	Establishes and maintains a safe campus atmosphere; enforces all laws of the State and all rules and regulations set forth by UNC-W

*Members from these departments took part in the Hazard Mitigation Planning Committee

Table I.49 – UNC-W Academic Departments Relevant to Hazard Mitigation Plan Implementation

College	Department	Expertise
College of Arts & Sciences	Communication Studies	Applied communications including media production and messaging development. (i.e., Public Service Announcements)
	Geography and Geology	Coastal and Estuarine Processes, GIS and Remote Sensing, Subsurface and Surface Hydrology
	Environmental Studies	Interdisciplinary approach to solving environmental problems; systematic study of human interaction with their environment
	Physics and Physical Oceanography	Coastal Ocean Research and Monitoring Program explores effects of hurricanes on the coastal ocean
	Political Science	Expertise in policy analysis and implementation
Cameron School of Business	Economics	Expertise in economic impact analysis following disasters.

I.6.4 Fiscal Capability

Financial capabilities are the resources that an entity has access to or is eligible to use to fund mitigation actions. The costs associated with implementing mitigation activities vary. Some mitigation actions such as building assessment or outreach efforts require little to no costs other than staff time and existing operating budgets. Other actions, such as structural projects, could require a substantial monetary commitment from local, State, and Federal funding sources. **Table I.50** provides a summary of the fiscal resources at UNC-W.

Table I.50 – Fiscal Resources

Resource	Ability to Use for Mitigation Projects? Y/N
Community Development Block Grants	N
Capital improvements project funding	Y
In-Kind Services	Y
Tuition & Fees	Y
Federal funding with HMA grants	Y
Revenue Bonds	Y
State Appropriations	Y
Sales & Services	Y
Other Sources (Gifts, Investment Income, Permanent Endowments)	Y

I.7 MITIGATION STRATEGY

I.7.1 Implementation Progress

Progress on the mitigation strategy developed in the previous plan is also documented in this plan update. **Table I.51** details the status of mitigation actions from the previous plan. **Table I.52** on the following pages details all completed and deleted actions from the 2008 plan. More detail on the actions being carried forward is provided in the Mitigation Action Plan.

Table I.51 – Status of Previous Mitigation Actions

Campus	Completed	Deleted	Carried Forward and/or Combined
UNC-W	19	4	40

Table I.52 – Completed and Deleted Actions from the UNC-W 2008 Plan

Vulnerability	Action	2020 Status	2020 Implementation Status Comments
Belk Residence Hall: The primary identified vulnerability to Belk Hall was the lack of adequate anchoring for rooftop equipment. Failure or movement of rooftop equipment can lead to progressive failure of roof system or lead to significant interior water damage. During inspection, it was observed that some standard connectors were missing or unattached.	Anchor rooftop equipment.	Completed	2018 Renovations
Dobo Hall: has an air-handling system that is designed to reclaim heat from discharged air before it exits the building. The vent for this system includes a set of louvers that run the full height of the building. Historically, wind-driven rain has entered the system through the louvers causing minor to moderate water damage. In addition, wind-driven rain water raises the humidity level in the buildings and, depending on the nature of the re- search ongoing at the time of the event, could jeopardize research material. Wind-driven rain has also entered the building at other vents around the building.	Either upgrade louvers or install shields to protect from infiltration of wind-driven rain. Install hoods on vents where historic wind-driven rain damage has occurred.	Completed	Completed during post Hurricane Florence renovations in 2019-2020
Dobo Hall: Major rooftop equipment on Dobo Hall was adequately anchored; however, smaller units such as fan and vent covers were not anchored and could create a windborne debris hazard. Failure of rooftop equipment can lead to progressive failure of roof system or lead to significant interior water damage.	Anchor all un-secured rooftop equipment. Institute periodic building envelope inspection program with emphasis on rooftop mechanical equipment, roof flashing, and roof coping.	Completed	Completed during post Hurricane Florence renovations in 2019-2020
Dobo Hall: Windows/doors are not fitted with impact-resistant glass or other protection. Potential for damage during hurricane events could lead to substantial internal water damage.	Upgrade windows to utilize safety glass or other impact-resistant material.	Completed	Completed during post Hurricane Florence renovations in 2019-2020
Hoggard Hall: A large glass atrium has been constructed as part of the recent new addition to the building. Design specifications were not available to determine the protection offered by the glazing. Therefore, the potential for damage from windborne debris exists during moderate to severe wind events.	Determine level of protection offered by glazing in atrium. If no protection is offered, consider installing impact- resistance film or install doors/barrier to protect building contents should atrium fail.	Completed	Completed in 2011
Hoggard Hall: There are a number of trees directly adjacent to the portion of the building housing the computing center. Trees close to windows could fall into the building causing damage to the computing center.	Routinely inspect trees adjacent to computing center and remove/trim any in sub par condition.	Completed	Completed 2015-2020

Vulnerability	Action	2020 Status	2020 Implementation Status Comments
Leutze Hall: Roof access was not available for this building, therefore, the level of anchoring to rooftop equipment and other roofing material could not be assessed. Failure of rooftop equipment can create windborne debris and lead to progressive failure of roof system or significant interior water damage.	Anchor rooftop equipment if required.	Completed	Completed during post Hurricane Florence renovations in 2019-2020
Randall Library: Portions of Randall Library contain rare and valuable collections. Portions of these areas are protected by interior plywood shutters or additional plexiglass protection. A mitigation project is underway to install impact-resistant glass on all windows in these areas. Additional windows/doors, including those as part of a large skylight located in the center of the library, are not fitted with impact-resistant glass or other protection. Damage during hurricane events could lead to substantial internal water damage to library contents.	Install impact-resistant film on skylight over center portion of library. Upgrade windows to utilize safety glass or other impact-resistant material. Develop a campus shelter plan to provide direction to students, faculty, and staff in the event of a high-wind event. Avoid the use of large assembly areas in favor of smaller, interior areas.	Completed	Completed in 2020
The Social & Behavioral Sciences Building (S&BS) contains animal quarters where a variety of research projects are undertaken. The S&BS building does not have a backup power source, and, historically, following power losses, portable air conditioning units have been used to provide cooling to animals and avoid research losses. However, these portable units do not always provide adequate power, and installation can take from 4 to 5 hours and require university staff that is already in high demand immediately following a power outage.	Install permanent generator for animal quarters and other critical research areas to ensure essential services and to avoid potential loss of research.	Deleted	Building has been reprogrammed
S&BS: Some older windows have historically received minor damage due to wind-driven rain. Damages have been mi- nor and localized, but the potential for more significant damages exists.	Inspect all windows and upgrade weather stripping and sealants around existing windows.	Completed	Completed during 2018 renovations
S&BS: Windows/doors are not fitted with impact-resistant glass or other protection. Potential for damage during hurricane events could lead to substantial internal water damage.	Upgrade windows to safety glass or other impact-resistant material.	Completed	Completed during 2018 renovations
S&BS: Building is not located in a flood zone or hurricane surge zone. The potential of flooding to the building is low.	Institute periodic building envelope inspection program with emphasis on rooftop mechanical equipment, roof flashing, and roof coping.	Completed	Completed during 2018 renovations
Trask Coliseum: The primary identified vulnerability to Trask Coliseum is the lack of adequate anchoring for rooftop equipment. Failure of rooftop equipment can lead to progressive failure of roof system or significant interior water damage.	Anchor rooftop equipment.	Completed	Completed during post Hurricane Florence renovations in 2019-2020

Vulnerability	Action	2020 Status	2020 Implementation Status Comments
Trask Coliseum: Contrary to common opinion, large assembly areas with large span roofs are not ideal shelter locations during a high wind event. Although these areas can accommodate large numbers of people, large span roofs are more vulnerable to uplift forces during a high wind event, and, therefore, more vulnerable to collapse. Although the roof design on Trask Coliseum is less vulnerable to substantial damage than the similar large span roof at the Warwick Center, alternative shelter locations should be used.	Develop a campus shelter plan to provide direction to students, faculty, and staff in the event of a high wind event. Avoid the use of large assembly area in Trask Coliseum in favor of smaller, interior areas.	Completed	Shelter plan has been created
University Apartments: Windows/doors are not fitted with impact-resistant glass or other protection. Potential for damage during hurricane events could lead to substantial internal water damage.	Upgrade windows to safety glass or other impact-resistant material.	Deleted	Demolished in 2018
University Apartments: The roofing system on the University Apartments has fared well in historic wind events with only sporadic shingle loss in a few events. The potential exists for more substantial loss of shingles and roof coverings in more severe wind events, which could lead to more severe structural roof damage.	Institute periodic building envelope inspection program with emphasis on shingle connections, roof flashing, and gutters.	Deleted	Demolished in 2018
University Apartments: The University Apartments are part of a small portion of the campus served by overhead power lines. Downed trees or limbs could cause loss of power to these structures in moderate high wind events.	Trim and maintain tree load around overhead power lines.	Deleted	Demolished in 2018
University Police Building: is located within the Category 5 hurricane surge zone. Although the probability of an event of this magnitude occurring is low, the potential for damages exists. In the event the building is inundated with floodwaters, extensive damage is possible. Due to the low probability of impact, substantial mitigation measures may not be cost effective.	Develop a plan to relocate contents and transfer essential functions in advance of forecasted moderate to severe hurricanes. Begin to elevate sensitive contents above the first floor when possible.	Completed	
University Police: The existing windows in the University Police Building have not been protected by impact-resistant windows. Because the police dispatch center is used up to a Category 3 hurricane, additional protection is required.	Upgrade windows to safety glass or other impact-resistant glass (effort on-going).	Completed	Partial completion in new communications center construction in 2019
Warwick Center: Large assembly areas with large span roofs are not ideal shelter locations during a high wind event. Although these areas can accommodate large numbers of people, large span roofs are more vulnerable to uplift forces during a high wind event, and, therefore, more vulnerable to collapse.	Develop a campus shelter plan to provide direction to students, faculty, and staff in the event of a high wind event. Avoid the use of large assembly area in Warwick Center in favor of smaller, interior areas.	Completed	Shelter plan has been created

Vulnerability	Action	2020 Status	2020 Implementation Status Comments
Westside Hall: The primary identified vulnerability to Westside Hall was the lack of adequate anchoring for rooftop equipment. Some standard connectors were missing or unattached. Failure of rooftop equipment can lead to progressive failure of roof system or significant interior water damage.	Anchor rooftop equipment if required.	Completed	Westside now renamed to DePaolo Hall
N/A	Install a campus-wide warning system and develop education plan addressing how the community should respond to the warning.	Completed	
N/A	Update Emergency Plans to reflect current conditions and ensure compliance with National Incident Management System standards.	Completed	

I.7.2 Mitigation Action Plan

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.

The following table comprises the mitigation action plan for UNC-W. Each mitigation action recommended for implementation is listed in these tables along with detail on the hazards addressed, the goal and objective addressed, the priority rating, the lead agency responsible for implementation, potential funding sources for the action, a projected implementation timeline, and the 2020 status and progress toward implementation for actions that were carried forward from the 2008 plan.

Table I.53 – Mitigation Action Plan, UNC-W

Action #	Action Description	Hazard(s) Addressed	Goal & Objective Addressed	Priority	Mitigation Category	Lead Agency / Department	Estimated Cost	Potential Funding Source	Implementation Timeline	2020 Status	2020 Implementation Status Comments
UNCW1	Campus-Wide – Major mechanical systems (HVAC equipment, heat pumps, chillers, generators, fuel tanks, gas cylinders, and boilers) should be anchored to their foundations. This includes, but is not limited to, the following campus buildings: Cornerstone Hall; Galloway Residence Hall; Randall Library; and Warwick Center.	All Hazards	1.1	L	Property Protection	Associate Vice Chancellor for Business Affairs - Facilities;	To be determined for each site	Operating Budget	2021-2026	Carry Forward	No progress has been made on this action.
UNCW2	Campus-Wide – Upgrade back-up power capabilities to critical facilities including, but not limited to: Congdon Hall; Telecommunications; Westside energy plant; Facilities building; Lift Stations; Hanover Gymnasium; and Randall library.	All Hazards	1.2	H	Emergency Services	Associate Vice Chancellor for Business Affairs - Facilities; Environmental Health & Safety	To be determined for each site	Operating Budget	2021-2026	Carry Forward	Revised: CIS building now called Condgon Hall No progress has been made on this action.
UNCW3	Belk Residence Hall - The potential exists for clogged roof drains leading to increased loads on roof and potential for failure. Roof drains should be maintained and inspected regularly, especially prior to forecasted heavy rain events to prevent clogging. Ensure consistent inspection and maintenance of roof drains.	Hurricane, Tornado/ Thunderstorm	1.1	L	Property Protection	Associate Vice Chancellor for Business Affairs - Facilities;	To be determined	Operating Budget	2021-2026	Carry Forward	No progress has been made on this action.
UNCW4	Belk Residence Hall - Windows/doors are not fitted with impact-resistant glass or other protection. Potential for damage during hurricane events could lead to substantial internal water damage. Upgrade windows to utilize safety glass or other impact-resistant material.	Hurricane, Tornado/ Thunderstorm	1.1	L	Property Protection	Associate Vice Chancellor for Business Affairs - Facilities;	To be determined	Operating Budget	2021-2026	Carry Forward	No progress has been made on this action.
UNCW5	Belk Residence Hall - Building is not located in a flood zone or hurricane surge zone. The potential of flooding to the building is low. Institute periodic building envelope inspection program with emphasis on rooftop mechanical equipment, roof flashing, and roof coping.	Flood, Hurricane	1.1	L	Property Protection	Associate Vice Chancellor for Business Affairs - Facilities;	To be determined	Operating Budget	2021-2026	Carry Forward	No progress has been made on this action.
UNCW6	Center for Marine Science (Myrtle Grove) - A noise reduction screen-wall was erected around mechanical equipment. Design plans for this addition were not available. It is unclear if this screen-wall could withstand high winds associated with a major hurricane. Failure of the screen wall could lead to progressive roof failure or become wind-borne debris causing damage to other portions of the building. Evaluate screen-wall to ensure ability to withstand hurricane forces winds. Retrofit if needed.	Hurricane, Tornado/ Thunderstorm	1.1	M	Property Protection	Associate Vice Chancellor for Business Affairs - Facilities;	To be determined	Operating Budget	2021-2026	Carry Forward	No progress has been made on this action.
UNCW7	Center for Marine Science (Myrtle Grove) - The primary function of the CMS building is as a marine research facility. Portions of the research conducted at this facility require fresh seawater, which is pumped from the Intercoastal Waterway via an above-ground piping system. Because it is above ground, this system has the potential to be damaged, which could cause a loss of research. Upgrade seawater piping system to higher quality insulated piping system and install bollards or other protective measures in areas of high vehicular traffic.	Hurricane, Tornado/ Thunderstorm	1.2	L	Structural Projects	Associate Vice Chancellor for Business Affairs - Facilities;	To be determined	State/Federal Grants	2021-2026	Carry Forward	No progress has been made on this action.
UNCW8	Cornerstone Hall - Located within the Category 5 Hurricane Surge Zone. Although the probability of an event of this magnitude occurring is low, the potential for damages does exist. In the event the building is inundated with floodwaters, extensive damage is possible. Due to the low probability of impact, substantial mitigation measures may not be cost effective. Develop a plan for active mitigation measures including sand bagging and temporary flood barriers to be instituted immediately prior to impact of a major hurricane event.	Flood, Hurricane	1.1	L	Property Protection	Associate Vice Chancellor for Business Affairs - Facilities;	To be determined	State/Federal Grants	2021-2026	Carry Forward	No progress has been made on this action.

Action #	Action Description	Hazard(s) Addressed	Goal & Objective Addressed	Priority	Mitigation Category	Lead Agency / Department	Estimated Cost	Potential Funding Source	Implementation Timeline	2020 Status	2020 Implementation Status Comments
UNCW9	Cornerstone Hall - Windows/doors are not fitted with impact-resistant glass or other protection. Potential for damage during hurricane events could lead to substantial internal water damage. Upgrade windows to utilize safety glass or other impact-resistant material.	Hurricane, Tornado/ Thunderstorm	1.1	L	Property Protection	Associate Vice Chancellor for Business Affairs - Facilities;	To be determined	Operating Budget	2021-2026	Carry Forward	No progress has been made on this action.
UNCW10	Galloway Residence Hall - The potential exists for clogged roof drains leading to increased loads on roof and potential for failure. Roof drains should be maintained and inspected regularly, especially prior to forecasted heavy rain events to prevent clogging. Ensure consistent inspection and maintenance of roof drains	Hurricane, Tornado/ Thunderstorm	1.1	L	Property Protection	Associate Vice Chancellor for Business Affairs - Facilities;	To be determined	Operating Budget	2021-2026	Carry Forward	No progress has been made on this action.
UNCW11	Galloway Residence Hall - Windows/doors are not fitted with impact-resistant glass or other protection. Potential for damage during hurricane events could lead to substantial internal water damage. Upgrade windows to utilize safety glass or other impact-resistant material.	Hurricane, Tornado/ Thunderstorm	1.1	L	Property Protection	Associate Vice Chancellor for Business Affairs - Facilities;	To be determined	Operating Budget	2021-2026	Carry Forward	No progress has been made on this action.
UNCW12	Galloway Residence Hall - Building is not located in a flood zone or hurricane surge zone. The potential of flooding to the building is low. Institute periodic building envelope inspection program with emphasis on rooftop mechanical equipment, roof flashing, and roof coping.	Flood, Hurricane	1.1	L	Property Protection	Associate Vice Chancellor for Business Affairs - Facilities;	To be determined	Operating Budget	2021-2026	Carry Forward	No progress has been made on this action.
UNCW13	Hoggard Hall - Building is not located in a flood zone or hurricane surge zone. The potential of flooding to the building is low. Institute periodic building envelope inspection program with emphasis on rooftop mechanical equipment, roof flashing, and roof coping.	Flood, Hurricane	1.1	L	Property Protection	Associate Vice Chancellor for Business Affairs - Facilities;	To be determined	Operating Budget	2021-2026	Carry Forward	No progress has been made on this action.
UNCW14	Leutze Hall - Windows/doors are not fitted with impact–resistant glass or other protection. Potential for damage during hurricane events could lead to substantial internal water damage. Upgrade windows to utilize safety glass or other impact-resistant material.	Hurricane, Tornado/ Thunderstorm	1.1	L	Property Protection	Associate Vice Chancellor for Business Affairs - Facilities;	To be determined	Operating Budget	2021-2026	Carry Forward	No progress has been made on this action.
UNCW15	Leutze Hall - Building is not located in a flood zone or hurricane surge zone. The potential of flooding to the building is low. Institute periodic building envelope inspection program with emphasis on rooftop mechanical equipment, roof flashing, and roof coping.	Flood, Hurricane	1.1	L	Property Protection	Associate Vice Chancellor for Business Affairs - Facilities;	To be determined	Operating Budget	2021-2026	Carry Forward	No progress has been made on this action.
UNCW16	Psychopharmacology Lab - Pre-engineered metal buildings of this type often fail when exposed to wind speeds greater than the design wind speed. Based on general building type, this building has the highest risk to potential structural damages during severe wind events. The dense tree load around the building may offer some protection from wind forces, but also increases the potential of building damage as a result of adjacent tree failure. Retrofit existing building to increase wind resistance by adding additional bracing and connectors for roofing system.	Hurricane, Tornado/ Thunderstorm	1.1	M	Property Protection	Associate Vice Chancellor for Business Affairs - Facilities;	To be determined	Operating Budget, Federal/State Grants	2021-2026	Carry Forward	No progress has been made on this action.
UNCW17	Psychopharmacology Lab - At the time of the site inspections, this building was not in use. Typically, the building houses ongoing research activities, which are usually funded through some form of grant funding. If the building is used for this purpose in the future, the potential for substantial loss of research exists. If building is used again for research purposes, develop a plan to relocate critical research components to another facility prior to a moderate or severe wind event.	Hurricane, Tornado/ Thunderstorm, Flood, Wildfire	1.2	M	Property Protection	Associate Vice Chancellor for Business Affairs - Facilities;	To be determined	Operating Budget	2021-2026	Carry Forward	No progress has been made on this action.
UNCW18	Psychopharmacology Lab - Building is not located in a flood zone or hurricane surge zone. The potential of flooding to the building is low. Institute periodic building envelope inspection program with emphasis on rooftop mechanical equipment, roof flashing, and roof coping.	Flood, Hurricane	1.1	L	Property Protection	Associate Vice Chancellor for Business Affairs - Facilities;	To be determined	Operating Budget	2021-2026	Carry Forward	No progress has been made on this action.

Action #	Action Description	Hazard(s) Addressed	Goal & Objective Addressed	Priority	Mitigation Category	Lead Agency / Department	Estimated Cost	Potential Funding Source	Implementation Timeline	2020 Status	2020 Implementation Status Comments
UNCW19	Randall Library - The potential exists for clogged roof drains leading to increased loads on roof and potential for failure. Roof drains should be maintained and inspected regularly, especially prior to forecasted heavy rain events to prevent clogging. Institute periodic building envelope inspection program with emphasis on rooftop mechanical equipment, roof flashing, and roof coping.	Hurricane, Tornado/ Thunderstorm	1.1	L	Property Protection	Associate Vice Chancellor for Business Affairs - Facilities;	To be determined	Operating Budget	2021-2026	Carry Forward	No progress has been made on this action.
UNCW20	Randall Library - Building is not located in a flood zone or hurricane surge zone. The potential of flooding to the building is low. Institute periodic building envelope inspection program with emphasis on rooftop mechanical equipment, roof flashing, and roof coping.	Flood, Hurricane	1.1	L	Property Protection	Associate Vice Chancellor for Business Affairs - Facilities;	To be determined	Operating Budget	2021-2026	Carry Forward	No progress has been made on this action.
UNCW21	Telecommunications - Pre-engineered metal buildings of this type often fail when exposed to wind speeds greater than the design wind speed. Based on general building type, this building has the highest risk to potential structural damages during severe wind events. Retrofit building to increase wind resistance by adding additional bracing and connectors for roofing system.	Hurricane, Tornado/ Thunderstorm	1.1	M	Property Protection	Associate Vice Chancellor for Business Affairs - Facilities;	To be determined	Operating Budget, Federal/State Grants	2021-2026	Carry Forward	No progress has been made on this action.
UNCW22	Telecommunications - This building houses the critical communications equipment for the campus. A loss of this building would currently result in a full loss of communication ability for the campus. There is an on-going project to install a redundant server in Hoggard Hall to allow for continuation of service should this building be damaged. However, the potential for damages to valuable contents of this building still exists. Look for opportunities during overall campus expansion to relocate Telecommunication Services out of pre- engineered metal building.	All Hazards	1.2	H	Structural Projects, Property Protection	Associate Vice Chancellor for Business Affairs - Facilities;	To be determined	State/Federal Grants	2021-2026	Carry Forward	No progress has been made on this action.
UNCW23	Telecommunications - Telecommunications building is located within the Category 5 hurricane surge zone. Although the probability of an event of this magnitude occurring is low, the potential for damages exists. In the event the building is inundated with floodwaters, extensive damage is possible. Due to the low probability of impact, substantial mitigation measures may not be cost effective; however, best practices such as protecting contents is recommended. Develop a plan to relocate contents and transfer communication functions in advance of forecasted moderate to severe hurricanes. Begin to elevate sensitive contents above the first floor when possible.	Hurricane	1.2	H	Property Protection	Associate Vice Chancellor for Business Affairs - Facilities;	To be determined	Operating Budget	2021-2026	Carry Forward	No progress has been made on this action.
UNCW24	Telecommunications - Building should be periodically inspected. Institute periodic building envelope inspection program with emphasis on rooftop mechanical equipment, roof flashing, and roof coping.	Hurricane, Tornado/ Thunderstorm	1.1	L	Property Protection	Associate Vice Chancellor for Business Affairs - Facilities;	To be determined	Operating Budget	2021-2026	Carry Forward	No progress has been made on this action.
UNCW25	Trask Coliseum - The potential exists for clogged roof drains leading to increased loads on roof and potential for failure. Roof drains should be inspected regularly, especially prior to forecasted heavy rain events to prevent clogging. Institute periodic building envelope inspection program with emphasis on rooftop mechanical equipment, roof flashing, and roof coping.	Hurricane, Tornado/ Thunderstorm	1.1	L	Property Protection	Associate Vice Chancellor for Business Affairs - Facilities;	To be determined	Operating Budget	2021-2026	Carry Forward	No progress has been made on this action.
UNCW26	Trask Coliseum - Windows/doors are not fitted with impact-resistant glass or other protection. Potential for damage during hurricane events could lead to substantial internal water damage. Upgrade windows to safety glass or other impact-resistant material.	Hurricane, Tornado/ Thunderstorm	1.1	L	Property Protection	Associate Vice Chancellor for Business Affairs - Facilities;	To be determined	Operating Budget	2021-2026	Carry Forward	No progress has been made on this action.

Action #	Action Description	Hazard(s) Addressed	Goal & Objective Addressed	Priority	Mitigation Category	Lead Agency / Department	Estimated Cost	Potential Funding Source	Implementation Timeline	2020 Status	2020 Implementation Status Comments
UNCW27	University Police - The University Police Building is made up of three separate buildings, two of which are manufactured buildings or trailers. Buildings of this type often fail when exposed to wind speeds greater than the design wind speed. Based on general building type, this building has the highest risk to potential structural damages during severe wind events. Look for opportunities during overall campus expansion to relocate University Police out of manufactured buildings and out of the Category 5 surge zone.	Hurricane, Tornado/ Thunderstorm	1.2	M	Property Protection	Associate Vice Chancellor for Business Affairs - Facilities;	To be determined	Operating Budget, Federal/State Grants	2021-2026	Carry Forward	No progress has been made on this action.
UNCW28	Warwick Center - The potential exists for clogged roof drains leading to increased loads on roof and potential for failure. Roof drains should be inspected regularly, especially prior to forecasted heavy rain events to prevent clogging. Institute periodic building envelope inspection program with emphasis on rooftop mechanical equipment, roof flashing, and roof coping.	Hurricane, Tornado/ Thunderstorm	1.1	L	Property Protection	Associate Vice Chancellor for Business Affairs - Facilities;	To be determined	Operating Budget	2021-2026	Carry Forward	No progress has been made on this action.
UNCW29	Warwick Center - Windows/doors are not fitted with impact-resistant glass or other protection. Potential for damage during hurricane events could lead to substantial internal water damage. Upgrade windows to safety glass or other impact-resistant material.	Hurricane, Tornado/ Thunderstorm	1.1	L	Property Protection	Associate Vice Chancellor for Business Affairs - Facilities;	To be determined	Operating Budget	2021-2026	Carry Forward	No progress has been made on this action.
UNCW30	Westside Hall - The potential exists for clogged roof drains leading to increased loads on roof and potential for failure. Roof drains should be inspected and maintained regularly, especially prior to forecasted heavy rain events to prevent clogging. Institute periodic building envelope inspection program with emphasis on rooftop mechanical equipment, roof flashing, and roof coping.	Hurricane, Tornado/ Thunderstorm	1.1	L	Property Protection	Associate Vice Chancellor for Business Affairs - Facilities;	To be determined	Operating Budget	2021-2026	Carry Forward	Revised: Westside now renamed to DePaolo Hall No progress has been made on this action.
UNCW31	Westside Hall - Windows/doors are not fitted with impact-resistant glass or other protection. Potential for damage during hurricane events could lead to substantial internal water damage. Upgrade windows to safety glass or other impact-resistant material.	Hurricane, Tornado/ Thunderstorm	1.1	L	Property Protection	Associate Vice Chancellor for Business Affairs - Facilities;	To be determined	Operating Budget	2021-2026	Carry Forward	Revised: Westside now renamed to DePaolo Hall No progress has been made on this action.
UNCW32	Westside Hall - The Student Health Center is located on the second floor of Westside Hall. The windows in this area are not protected by impact-resistant glass. The higher than typical contents value in this area, as well as the presence of medical records, would result in greater losses should window damage occur. Protect medical records and equipment.	Hurricane, Tornado/ Thunderstorm	1.2	M	Property Protection	Associate Vice Chancellor for Business Affairs - Facilities;	To be determined	Operating Budget	2021-2026	Carry Forward	Revised: Westside now renamed to DePaolo Hall No progress has been made on this action.
UNCW33	Develop a process for identifying and cataloging the research undertaken at the university to better understand the support needs	All Hazards	1.2	M	Emergency Services	Office of Research Services and Sponsored Programs; Environmental Health & Safety	Staff Time	Operating Budget	2021-2026	Carry Forward	In progress
UNCW34	For buildings with critical contents or functions, install emergency generators and/or generator hook-ups and consider the portability of these generators. Needs would, in part, be based on information gathered in Action B. Generators would be purchased through phased approach.	All Hazards	1.2	H	Property Protection	Associate Vice Chancellor for Business Affairs - Facilities; Environmental Health & Safety	~$90,000-$250,000 per generators	Operating Budget, Federal/State Grants	2021-2026	Carry Forward	Revised to remove Social and Behavioral science building from example as it is no longer a research building. No progress has been made on this action.
UNCW35	Develop continuity of operations plan	All Hazards	3.2	H	Preventive	Vice Chancellor for Business Affairs, Environmental Health & Safety	Staff Time, $100,000	Operating Budget, Federal/State Grants	2021-2026	Carry Forward	In progress. Efforts have increased since October of 2018

Action #	Action Description	Hazard(s) Addressed	Goal & Objective Addressed	Priority	Mitigation Category	Lead Agency / Department	Estimated Cost	Potential Funding Source	Implementation Timeline	2020 Status	2020 Implementation Status Comments
UNCW36	Develop a Stormwater Master Plan	Flood	3.1	H	Preventive	Associate Vice Chancellor for Business Affairs - Facilities	$100,000	Operating Budget, Federal/State Grants	2021-2026	Carry Forward	No progress has been made on this action.
UNCW37	Build hardened facilities to house critical university functions such as police and emergency response operations, telecommunications, electrical substation, etc. as well as an Emergency Operations Center (EOC) in times of disaster	All Hazards	1.1	H	Property Protection	Associate Vice Chancellor for Business Affairs-Facilities, University Police, Vice Chancellor for IT	$200/sq. ft.	Federal/State Grants	2021-2026	Carry Forward	No progress has been made on this action.
UNCW38	Hoggard - Emergency operations space is woefully inadequate for housing staff and provide for coordination efforts. Reassess operating space. Identify larger space and upgrade	All Hazards	1.2	M	Emergency Services	Associate Vice Chancellor for Business Affairs - Facilities	To be determined	Federal/State Grants	2021-2026	New	
UNCW39	Telecommunications - Other data centers on campus have a secondary roof called a "rain shield." This data center does not. Install a "rain shield"	Flood, Hurricane, Tornado/ Thunderstorm	1.2	L	Property Protection	Associate Vice Chancellor for Business Affairs - Facilities;	To be determined	Operating Budget, Federal/State Grants	2021-2026	New	
UNCW40	Congdon Hall - Other data centers on campus have a secondary roof called a "rain shield." This data center does not. Install a "rain shield"	Flood, Hurricane, Tornado/ Thunderstorm	1.1	L	Property Protection	Associate Vice Chancellor for Business Affairs - Facilities;	To be determined	Operating Budget, Federal/State Grants	2021-2026	New	
UNCW41	Congdon Hall - Air conditioner system for critical infrastructure has no redundancy. Assess options for ceiling mount air conditioning system on a separate circuit	All Hazards	1.1	M	Property Protection	Associate Vice Chancellor for Business Affairs - Facilities;	To be determined	Operating Budget	2021-2026	New	
UNCW42	Energy Plant (each) - Energy plants do not have capability for rapid backup generator connections. Install generator quick connects at each energy plant	All Hazards	1.2	H	Property Protection	Associate Vice Chancellor for Business Affairs - Facilities;	To be determined	Federal/State Grants	2021-2026	New	
UNCW43	Alderman Hall - The current windows in Alderman Hall are vulnerable to high winds and water intrusion and can cause the loss of the building envelope if not replaced. Replace windows in Alderman Hall with a higher wind rating	Hurricane, Tornado/ Thunderstorm	1.1	L	Property Protection	Associate Vice Chancellor for Business Affairs - Facilities;	To be determined	Operating Budget	2021-2026	New	
UNCW44	Hanover Gymnasium - This facility serves as a coordination location for disaster recovery. It does not have impact resistant windows. Install impact resistant windows for upper levels	Hurricane, Tornado/ Thunderstorm	1.2	L	Property Protection	Associate Vice Chancellor for Business Affairs - Facilities;	To be determined	Operating Budget, Federal/State Grants	2021-2026	New	
UNCW45	UNCW Police non-dispatch area - The entire University Police building is not hardened. Harden remaining areas of the University Police Facility	Hurricane, Tornado/ Thunderstorm	1.2	M	Property Protection	Associate Vice Chancellor for Business Affairs - Facilities;	To be determined	Operating Budget	2021-2026	New	
UNCW46	Randall library - The library is reliant on continuous HVAC operations to prevent mold growth on vulnerable items. Install quick connect for chilled water	All Hazards	1.2	M	Property Protection	Associate Vice Chancellor for Business Affairs - Facilities;	To be determined	Operating Budget, Federal/State Grants	2021-2026	New	
UNCW47	Center for Marine Science Main Building - The outside air intake is vulnerable to flooding. Relocate air intake	Flood	1.1	H	Property Protection	Associate Vice Chancellor for Business Affairs - Facilities;	To be determined	Operating Budget	2021-2026	New	
UNCW48	Center for Marine Science Main Building - The current backup generator is old and underpowered. Install appropriately sized generator	All Hazards	1.1	M	Property Protection	Associate Vice Chancellor for Business Affairs - Facilities;	To be determined	Federal/State Grants	2021-2026	New	

Action #	Action Description	Hazard(s) Addressed	Goal & Objective Addressed	Priority	Mitigation Category	Lead Agency / Department	Estimated Cost	Potential Funding Source	Implementation Timeline	2020 Status	2020 Implementation Status Comments
UNCW49	Center for Marine Science Main Building - The current cooling tower is on top of the building and is vulnerable to high winds. Relocate cooling tower apparatus	Hurricane, Tornado/ Thunderstorm	1.1	M	Property Protection	Associate Vice Chancellor for Business Affairs - Facilities;	To be determined	Operating Budget	2021-2026	New	
UNCW50	Center for Marine Science Main Building - The current roof of the main building needs replacement and upgrades to a higher wind rating. Fortify the roof structure and replace roofing materials	Hurricane, Tornado/ Thunderstorm	1.1	L	Property Protection	Associate Vice Chancellor for Business Affairs - Facilities;	To be determined	Operating Budget	2021-2026	New	
UNCW51	Center for Marine Science Main Building - The current windows are vulnerable to breakage from flying objects and high wind. Install impact resistant windows	Hurricane, Tornado/ Thunderstorm	1.1	L	Property Protection	Associate Vice Chancellor for Business Affairs - Facilities;	To be determined	Operating Budget	2021-2026	New	
UNCW52	Campus wide power grid - Currently power supply comes from three locations into campus but if city wide power is out backup power is provided by generators. Subscribe to backup generation service provided by Duke/Progress energy	All Hazards	1.1	H	Emergency Services	Associate Vice Chancellor for Business Affairs - Facilities;	To be determined	Operating Budget, Federal/State Grants	2021-2026	New	
UNCW53	Campus wide power grid - Currently backup power is provided by generators that must be hard wired into the target building. Install power taps on all key structures on campus	All Hazards	1.1	H	Property Protection	Associate Vice Chancellor for Business Affairs - Facilities;	To be determined	Operating Budget, Federal/State Grants	2021-2026	New	

THE UNIVERSITY OF NORTH CAROLINA SYSTEM

UNC System Eastern Campuses Regional Hazard Mitigation Plan

Appendices

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Appendix A Plan Review Tool

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APPENDIX A:
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*.

Jurisdiction: **University of North Carolina System Eastern Campuses**	**Title of Plan:** **UNC Eastern Campuses Hazard Mitigation Plan**	**Date of Plan:** **February 2021**
Local Point of Contact: **David Stroud**	**Address:** **4021 Stirrup Creek Drive, Suite 100** **Durham, NC 27703**	
Title: **Hazard Mitigation Planning & Emergency Lead**		
Agency:		
Phone Number: **919-765-9986**	**E-Mail:** **david.stroud@woodplc.com**	

State Reviewer: **Carl Baker**	**Title:** **Hazard Mitigation Planner**	**Date:** **Feb. 25, 2021** **Mar. 18, 2021**

FEMA Reviewer: **Edwardine S. Marrone** **Carl Mickalonis**	**Title:** **NC-FIT-Mitigation Planner** **HM Planning Lead**	**Date:** **06/02/21** **7/15/21**
Date Received in FEMA Region IV	**03/19/21**	
Plan Not Approved		
Plan Approvable Pending Adoption		
Plan Approved	**07/16/21**	

✓ Denotes FEMA Reviewer concurs with State Reviewers notations.

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.4-15) a. Pg. 4-13 b. University plan c. Pg. 9-11 d. Pg. 11 e. Pg. 7-8	X	
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. 14), Appendix B a.-c. Pg. 13-15	X	
A3. Does the Plan document how the public was involved in the planning process during the drafting stage? (Requirement §201.6(b)(1)) **QC concurs**	Section 2 (p. 13-14), Appendix B✓	X	
A4. Does the Plan describe the review and incorporation of existing plans, studies, reports, and technical information? (Requirement §201.6(b)(3))	Annexes Section 1✓ Annexes Section 1 & 6 Appendix C	X	
A5. Is there discussion of how the community(ies) will continue public participation in the plan maintenance process? (Requirement §201.6(c)(4)(iii)) **QC concurs**	Section 5 (p.79-80)✓	X	
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 5 (p. 77-80)✓	X	

1. REGULATION CHECKLIST **Regulation** (44 CFR 201.6 Local Mitigation Plans)	Location in Plan (section and/or page number)	Met	Not Met
ELEMENT A: REQUIRED REVISIONS NCEM 1st Review: A1: No revision required. See also Appendix B. A2: No revision required. A3: No revision required. A4: No revision required. A5: No revision required. A6: No revision required. **NCEM 2nd Review: No revisions required.**			
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)) **QC concurs**	Section 3 (p.20-72), Annexes Section 5✓ Location & Extent Sub-section	X	
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))	Annexes Section 5, ✓ Historical & Probability Sub-section	X	
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))	Annexes Section 5 ✓ Vulnerability Sub-section	X	
B4. Does the Plan address NFIP insured structures within the jurisdiction that have been repetitively damaged by floods? (Requirement §201.6(c)(2)(ii)) **QC concurs**	Section 3.4.5 (p. 34)✓	X	
ELEMENT B: REQUIRED REVISIONS NCEM 1st Review: B1: Table 3.1 and Section 3.4.4 identify "Excessive Heat" as a hazard, while the text of the section defines and discusses "Extreme Heat". Updated all to Extreme Heat, per FEMA Local Planning Handbook. Only references remaining for 'excessive heat' are in regards to NWS definitions. Updated all annexes as well. B2: East Carolina University, Annex A: Page A-37 references Figure A.10, which is not shown until page A-39. Page A-38 also references a map of Pitt County named Figure A.10. Removed page breaks. Figure A.10 is a large graphic and needs a full page. The reference number and reference county are correct. North Carolina State University, Annex F: Page F-105, Probability of future occurrences not labeled. Heading added. University of North Carolina-Wilmington, Annex I: Page I-69, reference to UNC-CH campus in last paragraph. Corrected to UNC-W. B3: No revision required. B4: No revision required. **NCEM 2nd Review: No revisions required.**			
ELEMENT C. MITIGATION STRATEGY			

1. REGULATION CHECKLIST **Regulation** (44 CFR 201.6 Local Mitigation Plans)	**Location in Plan** (section and/or page number)	**Met**	**Not Met**
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))	Annexes Section 6 Section 5; Annexes Section 1 & 6	X	
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))	N/A	N/A	N/A
C3. Does the Plan include goals to reduce/avoid long-term vulnerabilities to the identified hazards? (Requirement §201.6(c)(3)(i)) **QC concurs**	Section 4 (p.73-74)✓	X	
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)) **QC concurs**	Section 4 (p.74-76) **Annexes Section 7**✓		
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))	Annexes Section 7 P. 75-76	X	
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 5 (p.77-79)✓	X	

ELEMENT C: REQUIRED REVISIONS

NCEM 1st Review:

C1: No revision required.

C2: Floodplain managers are identified in Annexes Section 6. Add statement: Individual campuses are not required to maintain NFIP Flood Insurance as North Carolina is a self-insuring state. All state owned facilities are covered by the NC General Assembly. (Section 3.4.5 , Page 34) Statement added to flood hazard profile in Main Document, beneath Figure 3.3 in paragraph discussing insurance.

C3: No revision required.

C4: North Carolina State University requires additional All Hazard mitigation actions.

See addendum for further Element C4 required revisions. Response comments included in addendum.

NCEM 1st Review:

Element C4: Notes:

1. Consider making specific building actions a campus wide consideration. (e.g. securing HVAC equipment.) Recommend changing to an **All Hazards** action.
2. Actions regarding sprinklers and firefighting apparatus are listed as Wildfire actions.
3. Consider amending generator/back-up power actions to one campus wide for critical facilities.
4. Consider expanding this action to include a mitigation measure such as creating or improving a continuous load path, or increasing the resistance to wind driver rain.
5. Mitigation efforts of the sidewalk replacement could include considerations such as non-skid, ice-resistance, or heating elements.

School	*Action #*	*Description*	*Hazard(s) Addressed*	*Comment*
East Carolina University				All re-numbered after deletions and combines. Tables A.52 and A.53 updated to note additional deleted/completed.
	ECU2	Action describes protection against wind-borne debris.	Flood	Change Hazards Addressed to wind events. Updated to Tornado/Thun/Hurr.
	ECU6	The installation of vehicle barriers (bollards) to prevent damage from vehicles.	Tornado / Thunderstorm	This is not a mitigation action. Though related to property protection, the hazards addressed are not appropriate. Removed.
	ECU7	Installation of HVAC chiller.	All Hazards	This is listed as a completed action on Page A-98. Removed.
	ECU8	Installation of smokeheads and temperature sensors in electrical closets.	Wildfire	This action does not address a natural hazard. Updated hazard to Human-Caused hazard.

	ECU9	Sealing of building exterior façade.	Flood	Change Hazards Addressed to wind events. Updated to Tornado/Thun/Hurr
	ECU10	Installation/changing types of fire suppression system.	Wildfire	This action does not address a natural hazard. Updated hazard to Human-Caused hazard.
	ECU11	Anchoring of HVAC equipment.	Tornado / Thunderstorm, Hurricane	See Note 1. Updated to All Hazards Updated ECU1 to incorporate all anchoring actions (ECU11, 12, 16, 19, 20, 23, 25, 26, 29, 34, 39) Updated cost with "per site"
	ECU12	Securing gas cylinder storage.	Tornado / Thunderstorm, Hurricane	Change to All Hazard. Updated.
	ECU14	Installation of HVAC chiller.	All Hazards	This is listed as a completed action on Page A-98. Removed.
	ECU16 ECU19 ECU23 ECU25 ECU26 ECU29 ECU39	Anchoring of HVAC equipment.	Tornado / Thunderstorm, Hurricane	See Note 1. Incorporated into ECU1.
	ECU17	Tree pruning.	Tornado / Thunderstorm, Hurricane, Severe Winter Weather	As noted in the 2020 Implementation Status, this is maintenance, not a mitigation action. Removed.
	ECU18	Installation of fire suppression system.	Wildfire	This action does not address a natural hazard. Updated hazard to Human-Caused hazard.
	ECU24	Suspended pipes in electronic equipment rooms.	Flood	This action does not address a natural hazard. Updated hazard to Human-Caused hazard.
	ECU28	Emergency power Leo W. Jenkins Center	All Hazards	See Note 3. Updated ECU2 to incorporate all

				backup power actions (ECU28, 30,31) Updated cost with "per site"
	ECU31	Generator and Chiller	All Hazards	See Note 3. Incorporated into ECU2.
	ECU34	Anchoring HVAC equipment and generator. As noted in the action description this should be required for all mechanical systems.	Tornado / Thunderstorm	Change to All Hazard. Updated. See note 1. Incorporated into ECU1.
	ECU38	The installation of vehicle barriers (bollards) to prevent damage from vehicles.	Tornado / Thunderstorm, Hurricane	This is not a mitigation action. Though related to property protection, the hazards addressed are not appropriate. Removed.
Elizabeth City State University				All re-numbered after deletions and combines. Tables B.51 and B.52 updated to note additional deleted/completed.
	ECSU1 ECSU3 ECSU11 ECSU14 ECSU17 ECSU21 ECSU26 ECSU33 ECSU37 ECSU38	Anchoring of HVAC/Mechanical equipment.	Tornado / Thunderstorm, Hurricane	Change to All Hazard. See Note 1. Updated to All Hazards; Updated ECSU1 to incorporate all anchoring actions; Updated cost with "per site"
	ECSU2	Suspended pipes in electric/electronic equipment rooms.	Flood	This action does not address a natural hazard. Updated hazard to Human-Caused hazard.
	ECSU7	Back-up generator.	Tornado / Thunderstorm	Change to All Hazard. See Note 3. Updated to new ECU2 to incorporate all backup power actions (ECSU7, 20, 24) Updated cost with "per site"

	ECSU9	Roof leaks.	Flood	This is not a mitigation action. Though related to property protection, the hazards addressed are not appropriate. Removed.
	ECSU13	Roof slopping, remediation.	Flood	This is not a mitigation action. Though related to property protection, the hazards addressed are not appropriate. See Note 4. Updated to Tornado/Thun/Hurr. Added notation for increased resistance to wind and driving rain.
	ECSU18	Clogged roof drain.	Flood	Change to wind/rain events. Updated to Tornado/Thun/Hurr.
	ECSU20	Emergency power for shelter.	All Hazards	See Note 3. Incorporated into ECSU2.
	ECSU23	Replace roof on Marion D. Thorpe building.	All Hazards	Though related to property protection, this is not a mitigation action. See Note 4. Updated to Tornado/Thun/Hurr. Added notation for increased resistance to wind and driving rain.
	ECSU24	Emergency power for Marion D. Thorpe building, designated EOC.	All Hazards	See Note 3. Incorporated into ECSU2.
	ECSU28	Installing a pedestrian sidewalk.	Severe Winter Weather	As described this is a safety item and will not count as a mitigation action. See Note 5. Updated to note non-skid, ice resistant sidewalk.
	ECSU31	Emergency power for Robert L. Vaughn Center	All Hazards	See Note 3. Incorporated into ECSU2.

	ECSU35	The installation of vehicle barriers (bollards) to prevent damage from vehicles.	Tornado / Thunderstorm, Hurricane	This is not a mitigation action. Though related to property protection, the hazards addressed are not appropriate. Removed.
	ECSU36	Repair roof on Thomas Jenkins building.	All Hazards	Though related to property protection, this is not a mitigation action. See Note 4. Updated to Tornado/Thun/Hurr. Added notation for increased resistance to wind and driving rain.
Fayetteville State University				All re-numbered after deletions and combines. Tables C.50 and C.51 updated to note additional deleted/completed.
	FSU2 FSU5 FSU14 FSU17 FSU24 FSU26 FSU32 FSU33 FSU40	Anchoring of HVAC/Mechanical equipment.	Tornado / Thunderstorm, Hurricane	Change to All Hazard. See Note 1. Updated to All Hazards; Updated to new FSU1 to incorporate all anchoring actions; Updated cost with "per site"
	FSU3	Emergency power for Bronco Hall.	All Hazards	See Note 3. Updated to new FSU2 to incorporate all backup power actions (FSSU7, 20, 24) Updated cost with "per site"
	FSU6 FSU12 FSU16 FSU22 FSU37	Installation of fire suppression system.	Wildfire	This action does not address a natural hazard. Updated to FSU3, campus wide, and Human-Caused hazard.
	FSU7	Emergency power for C.J. Barber Administration Building	All Hazards	See Note 3. Incorporated into FSU2.

	FSU8	Emergency/back-up power for Capel Arena.	All Hazards	See Note 3. Incorporated into FSU2.
	FSU15 FSU27	The installation of vehicle barriers (bollards) to prevent damage from vehicles.	Tornado / Thunderstorm	This is not a mitigation action. Though related to property protection, the hazards addressed are not appropriate. Removed.
	FSU18 FSU19	Emergency power for sump pumps in Lily Gym and Lyons Science Annex.	Flood	See Note 3. Incorporated into FSU2.
	FSU21	Emergency/back-up power for Lyons Science Annex.	Wildfire	Change to All Hazards. See Note 3. Incorporated into FSU2.
	FSU23	Emergency/back-up power for Lyons Science Building.	Wildfire, Tornado / Thunderstorm, Hurricane	Change to All Hazards. See Note 3. Incorporated into FSU2.
	FSU25	Emergency/back-up power for Mitchell Building.	All Hazards	See Note 3. Incorporated into FSU2.
	FSU30	Inspection and repair of retaining wall and installation of bollards.	Drought	While a vital project, the hazard addressed is not appropriate. Removed.
	FSU34	Deterioration of building façade.	Drought	While a vital project, the hazard addressed is not appropriate. Removed.
	FSU35	Relocation of network cable rack.	Flood	While a vital project, the hazard addressed is not appropriate. Removed.
	FSU36	Installation of window locks.	Flood	While a vital project, the hazard addressed is not appropriate. Removed.
	FSU38	Roof repair to William R. Collins Administration building	Flood	Though related to property protection, this is not a mitigation action. See Note 4. Updated to Tornado/Thun/Hurr. Added notation for increased resistance

				to wind and driving rain.
	FSU39	Walkway repair.	Drought	Though related to property protection, this is not a mitigation action. Removed.
North Carolina Central University				All re-numbered after deletions and combines. Tables D.52 and D.53 updated to note additional deleted/completed.
	NCCU1	Emergency/back-up power for Brite Mary Townes building.	All Hazards	See Note 3. Updated to new NCCU2 to incorporate all backup power actions (NCCU1, 6) Updated cost with "per site"
	NCCU2 NCCU5 NCCU7 NCCU11 NCCU14 NCCU15 NCCU19 NCCU21	Anchoring of HVAC/Mechanical equipment.	Tornado / Thunderstorm, Hurricane	Change to All Hazard. See Note 1. Updated to All Hazards; Updated to new NCCU1 to incorporate all anchoring actions; Updated cost with "per site"
	NCCU3	Unlocked roof access.	Tornado / Thunderstorm, Hurricane	This is a safety issue, not a hazard mitigation action. Removed.
	NCCU4 NCCU20	Deterioration of building façade.	Drought	While a vital project, the hazard addressed is not appropriate. Removed.
	NCCU6	Pearson cafeteria back-up power.	All Hazards	See Note 3. Incorporated into NCCU2.
	NCCU8 NCCU17	Action description discusses securing items during a seismic event.	Tornado / Thunderstorm, Hurricane	Hazards addressed does not match action description. Updated to earthquake.
	NCCU22	Action description discusses overhead HVAC piping and condensation.	Flood	Hazards addressed does not match action description.

				Removed, Extreme Heat not addressed in this plan.
North Carolina School of Science and Mathematics				All re-numbered after deletions and combines. Tables E.51 and E.52 updated to note additional deleted/completed.
	NCSSM3	Emergency/back-up power for Bryan Center and Bean Hall.	All Hazards.	See Note 3. Updated to new NCSSM2 to incorporate all backup power actions. Updated cost with "per site"
	NCSSM4	Deterioration of building masonry.	Drought	While a vital project, the hazard addressed is not appropriate. Removed.
	NCSSM9	Emergency/generator power for sump pumps.	Flood	See Note 3. Incorporated into NCSSM2.
	NCSSM11	Emergency generator power for Hill House.	All Hazards	See Note 3. Incorporated into NCSSM2.
	NCSSM14	Emergency generator power for the Physical Education Center	All Hazards	See Note 3. Incorporated into NCSSM2.
	NCSSM16	Anchoring of HVAC/Mechanical equipment.	Tornado / Thunderstorm, Hurricane	Change to All Hazard. See Note 1. Updated to All Hazards; Updated to new NCSSM1. Updated cost with "per site"
	NCSSM17	Emergency generator power for Plant Facilities.	All Hazards	See Note 3. Incorporated into NCSSM2.
	NCSSM18	The installation of vehicle barriers (bollards) to prevent damage from vehicles.	Severe Winter Weather	Though related to property protection, this is not a mitigation action. Removed.
	NCSSM21	Upgrade to ITS server room HVAC systems.	All Hazards	This action does not address a natural hazard. Removed.

	NCSSM24	Offsite ITS data back-up.	All Hazards	This action does not address a natural hazard. Removed.
	NCSSM27	Cooling for IT equipment with generator back-up power.	All Hazards	See Note 3. Incorporated into NCSSM2.
	NCSSM29	Back-up power for Royall Center EOC.	All Hazards	See Note 3. Incorporated into NCSSM2.
North Carolina State University				All re-numbered after deletion. Tables F.55 and F.56 updated to note additional deleted.
	NCSU6	Replacement of aging electrical distribution system and cables.	All Hazards	Though a vital project, this is not related to natural hazard mitigation. Removed.
	NCSU7	Increase power, voice, and data service to EOC/Public Safety Center.	All Hazards	As described this is more an Emergency Services action. Updated Mitigation Category to Emergency Services.
	NEW			Added new NCSU1 action for addressing backup power.
	NEW			Added new NCSU2 action for outreach projects.
University of North Carolina, Chapel Hill				All re-numbered after combinations.
	UNC3 UNC7 UNC8 UNC11 UNC12 UNC13 UNC14 UNC15 UNC16 UNC26 UNC41 UNC44 UNC49 UNC53 UNC65	Anchoring of HVAC/Mechanical equipment, and exterior ductwork.	Tornado / Thunderstorm, Hurricane	Change to All Hazard. See Note 1. Updated to All Hazards; Updated to new UNC1 to incorporate all anchoring actions; Updated cost with "per site"
	UNC32	Emergency power for Woollen buildings.	All Hazards	See Note 3.

				Updated to new UNC2 to incorporate all backup power actions. Updated cost with "per site"
	UNC54	Roof replacement to Thurston-Bowles Administration building. Stated that roof system is at or near its end of service life.	Hurricane, Tornado / Thunderstorm	Though related to property protection, this is not a mitigation action. See Note 4. Updated to Campus Wide – moved to new UNC3 Added notation for improved load path and increased resistance to wind and driving rain.
University of North Carolina, Pembroke				All re-numbered after combinations.
	UNCP1 UNCP2 UNCP3 UNCP5 UNCP7 UNCP9 UNCP11 UNCP12 UNCP13 UNCP14	Anchoring of HVAC/Mechanical/Utility equipment.	Tornado / Thunderstorm, Hurricane	Change to All Hazard. See Note 1. Updated to All Hazards; Updated to new UNCP1 to incorporate all anchoring actions; Updated cost with "per site"
	UNCP10	Installation of generator at Old Main building.	All Hazards	See Note 3. Updated to new UNCP2 to incorporate all backup power actions. Updated cost with "per site"
	UNCP32 UNCP33 UNCP34 UNCP35	Install generator.	All Hazards	See Note 3. Incorporated into UNCP2.
	UNCP22 UNCP24 UNCP39	Action descriptions cover hazard specific information dissemination.	Severe Winter Weather, Hurricane, Tornado /	Combine these public education measure and awareness to general mitigation training to add one

			Thunderstorm, Cyber Threat	more All Hazard mitigation action. Updated to new UNCP3 for public education.
University of North Carolina, Wilmington				All re-numbered after combinations.
	UNCW1 UNCW10 UNCW19 UNCW26 UNCW30 UNCW32	Action description addresses the potential for damage from clogged roof drains.	Flood	The action description does not match the hazard addressed. Change to wind/rain events. All actions updated to note Hurr/Tor/Thund.
	UNCW8 UNCW9 UNCW20 UNCW29	Anchoring of HVAC/Mechanical equipment.	Tornado / Thunderstorm, Hurricane	Change to All Hazard. See Note 1. Updated to All Hazards; Updated to new UNCW1 to incorporate all anchoring actions; Updated cost with "per site"
	UNCW36	Install emergency generator for Congdon Hall.	Hurricane, Severe Winter Weather, Tornado / Thunderstorm	Change to All Hazards and Property Protection category. See Note 3. Updated to new UNCW2 to incorporate all backup power actions. Updated cost with "per site"
	UNCW42	Install generator for Telecommunications.	All Hazards	See Note 3. Incorporated into UNCW2.
	UNCW47	Back-up generator for Westside energy plant.	All Hazards	See Note 3. Incorporated into UNCW2.
	UNCW48	Back-up generator for Facilities building.	All Hazards	See Note 3. Incorporated into UNCW2.
	UNCW50	Back-up generator for sewer lift stations.	All Hazards	See Note 3. Incorporated into UNCW2.

1. REGULATION CHECKLIST **Regulation** (44 CFR 201.6 Local Mitigation Plans)	**Location in Plan** (section and/or page number)	**Met**	**Not Met**

	UNCW51	Back-up generator for Hanover Gymnasium.	All Hazards	See Note 3. Incorporated into UNCW2.
	UNCW55	Back-up generator for Randall Library.	All Hazards	See Note 3. Incorporated into UNCW2.

C5: No revision required.
C6: No revision required.
NCEM 2nd Review: No revisions required.

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))	Annexes Sections 2, 3, 5✓ P. A-26, G-28, Annexes Under the Environment Sub-section.	X	
D2. Was the plan revised to reflect progress in local mitigation efforts? (Requirement §201.6(d)(3)) **QC concurs**	Annexes Section 7✓	X	
D3. Was the plan revised to reflect changes in priorities? (Requirement §201.6(d)(3)) **QC concurs**	Section 4 (p.74-76), Annexes Section 7	X	

ELEMENT D: REQUIRED REVISIONS
NCEM 1st Review:
D1: No revision required.
D2: No revision required.
D3: No revision required.
NCEM 2nd Review: No revisions required.

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)) **QC concurs**	Plan will be adopted pending NCEM approval; Adoption resolutions will be added to Section 6	X	
E2. For multi-jurisdictional plans, has each jurisdiction requesting approval of the plan documented formal plan adoption? (Requirement §201.6(c)(5)) **QC concurs**	Plan will be adopted pending NCEM approval; Adoption resolutions will be added to Section 6	X	

1. REGULATION CHECKLIST Regulation (44 CFR 201.6 Local Mitigation Plans)	Location in Plan (section and/or page number)	Met	Not Met
ELEMENT E: REQUIRED REVISIONS Prior to review completion adoption documentation was provided by all participating campuses.			
ELEMENT F. ADDITIONAL STATE REQUIREMENTS (OPTIONAL FOR STATE REVIEWERS ONLY; NOT TO BE COMPLETED BY FEMA)			
F1.			
F2.			
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

The plan consists of the main document which provides a broad view of the hazards and a focused view of the planning process and plan implementation, monitoring and updating process. Each campus has a dedicated Annex which primarily focuses on the Hazard Identification and Risk Assessment and the Mitigation Strategies. Each campus will utilize the Annex document to monitor and update the plan, as needed.

Subsequent plan updates considering these efforts will ensure continued development of a campus focused hazard mitigation plan with the intent of decreasing vulnerability and increasing resiliency and sustainability for the participating campuses.

Element B: Hazard Identification and Risk Assessment

The risk assessment is the groundwork for the development of mitigation measures. The plan draws from each of the campus capabilities to document the campus sustained efforts to incorporate hazard mitigation principles and practices into routine government activities and functions thus establishing a successful and sustainable local hazard mitigation program.

Element C: Mitigation Strategy

The Annexes provide status of the Mitigation Strategies completed, deleted or moved forward, along with identified new mitigation strategies the campus intends on pursuing.

Element D: Plan Update, Evaluation, and Implementation (*Plan Updates Only*)

Each campus will utilize the Annex document to monitor and update the plan, as needed.

B. Resources for Implementing Your Approved Plan

- **Local Mitigation Planning Handbook**
  This Handbook provides guidance to local governments on developing or updating hazard mitigation plans to meet the requirements under the Code of Federal Regulations (CFR) Title 44 – Emergency Management and Assistance §201.6.
  Use the Local Plan Guide and Handbook in tandem to understand technical requirements
  http://www.fema.gov/library/viewRecord.do?fromSearch=fromsearch&id=7209
- **Integrating Mitigation Strategies with Local Planning**
  This resource provides practical guidance on how to incorporate risk reduction strategies into existing local plans, policies, codes, and programs that guide community development or redevelopment patterns.
  http://www.fema.gov/library/viewRecord.do?id=7130
- **Mitigation Ideas**
  Communities can use this resource to identify and evaluate a range of potential mitigation actions for reducing risk to natural hazards and disasters.
  http://www.fema.gov/media-library/assets/documents/30627?id=6938

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	East Carolina University	School					Y	Y	Y	Y	Y	
2	Elizabeth City State University	School					Y	Y	Y	Y	Y	
3	Fayetteville State University	School					Y	Y	Y	Y	Y	
4	North Carolina Central University	School					Y	Y	Y	Y	Y	
5	North Carolina School of Science and Math	School					Y	Y	Y	Y	Y	
6	North Carolina State University	School					Y	Y	Y	Y	Y	
7	University of North Carolina at Chapel Hill	School					Y	Y	Y	Y	Y	

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
8	University of North Carolina at Pembroke	School					Y	Y	Y	Y	Y	
9	University of North Carolina at Wilmington	School					Y	Y	Y	Y	Y	

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
Meeting #1 - Kickoff			
NCCU HMPC	1) Introduction to DMA, CRS, and FMA requirements and the planning process 2) Review of HMPC responsibilities and the project schedule 3) Preliminary hazard identification 4) Complete data collection guide	March 31, 2020	Zoom Video Conference Call
UNC-CH HMPC		April 7, 2020	Zoom Video Conference Call
UNC-P HMPC		April 16, 2020	Zoom Video Conference Call
FSU HMPC		April 21, 2020	Zoom Video Conference Call
ECU HMPC		April 30, 2020	Zoom Video Conference Call
UNC-W HMPC		May 5, 2020	Zoom Video Conference Call
NCSSM HMPC		May 7, 2020	Zoom Video Conference Call
ECSU HMPC		May 12, 2020	Zoom Video Conference Call
NCSU HMPC		July 10, 2020	Zoom Video Conference Call
Meeting #2			
All-Campuses HMPC	1) Review and update plan goals 2) Report on status of previous mitigation actions	August 20, 2020	Zoom Video Conference Call
Meeting #3			
All-Campuses HMPC	1) Review Draft Hazard Identification & Risk Assessment (HIRA) 2) Draft Mitigation Action Plans	December 15, 2020	Zoom Video Conference Call
Meeting #4			
All-Campuses HMPC	1) Review the Draft Hazard Mitigation Plan 2) Solicit comments and feedback	January 19, 2021	Zoom Video Conference Call

Note: All HMPC Meetings were open to the public.

HMPC Meeting Agendas, Minutes, and Sign-in Sheets

HMPC Kickoff: NCCU – March 31, 2020

North Carolina Central University
UNC Eastern Campuses Hazard Mitigation Plan

Meeting 1: Hazard Mitigation Planning Committee Project Kick-Off Meeting
Time & Date: Tuesday, March 31, 2020, 1:00-2:00 p.m., Webex Video Conference Call

Attendance

The following members of the HMPC were in attendance for the call:

- Atty. Fenita Morrish-Shepard – General Counsel
- Joel Faison – Director of Network Services and Telecommunications
- Dr. Kristin Long – Director of Environmental Health and Safety
- Ondin Mihalcescu – Director of Design, Planning, and Construction
- Tim Williams – Chief Architect
- Dr. Undi Hoffler – Director, Research Compliance and Technology Transfer
- Thomas Verrault – Emergency Management Coordinator

Additionally, Jacazza Jones from North Carolina Emergency Management was in attendance.

Introductions

David Stroud and Abby Moore, consultants from Wood, presented the meeting slides per the agenda shown below:

1. HMPC Introductions
2. Introduction to Hazard Mitigation Planning
    a. What is Mitigation? What is Mitigation Planning?
    b. Why Plan?
3. Requirements of Mitigation Planning
    a. Disaster Mitigation Act of 2000
        i. Planning Requirements
        ii. Planning Process Review
4. Scope of Work
5. Project Schedule
6. Next Steps
    a. Complete Data Collection Guide
    b. Review Existing Mitigation Projects
7. Questions

Discussion

The following comments and topics were discussed throughout and after the meeting.

- Coordination - In reviewing phase one of the planning process, David discussed the need for the HMPC to identify stakeholders that can contribute their input to the plan's development. Jacazza Jones noted that the HMPC should consider student groups that could be stakeholders as a resource in this planning process.
- Hazard Identification - The HMPC discussed the list of hazards that are included in the 2018 State Hazard Mitigation Plan and the previous campus hazard mitigation plan. In addition to the hazards that were included in the previous plan, the HMPC decided to add Hazardous Substances, Cyber Threat, and Infectious Disease.
- Data Collection Guide – The HMPC was asked to complete a Data Collection Guide together in order to provide information on the school's capabilities and vulnerabilities.
- Action Reporting – The HMPC was asked to provide a status update on all projects from the previous HMP.

NCCU – UNC Eastern Campuses Hazard Mitigation Plan Page **1** of **2**
HMPC Meeting 1

- Plan Website – The website www.NCeastcampusHMP.com has been created to support coordination among the HMPC and the contractors and to support public outreach. The site contains upcoming meetings announcements, meeting agendas and minutes, draft documents of the plan update, information on the identified hazards, and opportunities to provide feedback including the public survey. The HMPC was asked to place a link to this website on their school's website and/or social media to encourage more public involvement.

Next Steps

Abby and David requested the HMPC complete the Data Collection Guide by April 14th and the mitigation action status updates by April 28th. The Data Collection Guide and an excel spreadsheet of the existing actions will be emailed to the HMPC. The Data Collection Guide and a PDF of existing actions are also posted on the plan website. Representatives should come to the next meeting prepared to discuss updates to the plan goals and objectives.

HMPC Kickoff: UNC-CH – April 7, 2020

University of North Carolina Chapel Hill
UNC Eastern Campuses Hazard Mitigation Plan

Meeting 1: Hazard Mitigation Planning Committee Project Kick-Off Meeting
Time & Date: Tuesday, April 7, 2020, 1:00-2:00 p.m., Zoom Video Conference Call

Darrell Jeter of UNC-CH Emergency Management kicked off the meeting with a brief introduction and had all attendees introduce themselves.

Attendance

The following members of the HMPC were in attendance for the call:

- Darrell Jeter – Emergency Management
- Carly Perin – SCE Finance
- Rahsheem Holland – Campus Police
- Cynthia Register – Facilities Engineering
- Doug Fleming – Facilities
- Abbas Piran – Facilities Technology
- Andrew Fulmer – SCE Finance

Additionally, Jacazza Jones from North Carolina Emergency Management was in attendance.

Introductions

David Stroud and Abby Moore, consultants from Wood, presented the meeting slides per the agenda shown below:

1. HMPC Introductions
2. Introduction to Hazard Mitigation Planning
   a. What is Mitigation? What is Mitigation Planning?
   b. Why Plan?
3. Requirements of Mitigation Planning
   a. Disaster Mitigation Act of 2000
      i. Planning Requirements
      ii. Planning Process Review
4. Scope of Work
5. Project Schedule
6. Next Steps
   a. Complete Data Collection Guide
   b. Review Existing Mitigation Projects
7. Questions

Discussion

The following comments and topics were discussed throughout the meeting.

- Coordination - In reviewing phase one of the planning process, David discussed the need for the HMPC to identify stakeholders that can contribute their input to the plan's development. It was noted that when identifying stakeholders to involve, the HMPC should also consider student groups that could be a resource in this planning process.
- Hazard Identification - The HMPC discussed the list of hazards that are included in the 2018 State Hazard Mitigation Plan and the previous campus hazard mitigation plan. In addition to the hazards that were included in the previous plan, the HMPC decided to add Flooding and Hazardous Substances. The HMPC also discussed Infectious Disease in light of the ongoing Covid-19 pandemic. The threat of Utility Infrastructure Failure was also brought up, given water utility emergencies that have occurred in recent years and affected the campus. David and Abby advised the HMPC that the focus for FEMA's requirements

UNC-CH – UNC Eastern Campuses Hazard Mitigation Plan Page **1** of **2**
HMPC Meeting 1

is to address natural hazards but that the HMPC should include any technological or human-caused hazards that pose a risk to the campus if they think there is sufficient data to profile the hazard and if the hazard can be mitigated. It was noted that if a hazard is already addressed through emergency operations preparedness and response planning, it may not need to be addressed in this plan. The HMPC did not yet decide whether Infectious Disease and/or Utility Infrastructure Failure should be added to the plan.

- Data Collection Guide – The HMPC was asked to complete a Data Collection Guide together in order to provide information on the school's capabilities and vulnerabilities.
- Action Reporting – The HMPC was asked to provide a status update on all projects from the previous HMP by identifying each project as Completed, Delete, or Carry Forward and providing any available details on progress.
- Plan Website – The website www.NCeastcampusHMP.com has been created to support coordination among the HMPC and the contractors and to support public outreach. The site contains upcoming meetings announcements, meeting agendas and minutes, draft documents of the plan update, information on the identified hazards, and opportunities to provide feedback including the public survey. The HMPC was asked to place a link to this website on their school's website and/or social media to encourage more public involvement.

Next Steps

Abby and David requested the HMPC complete the Data Collection Guide by April 21st and the mitigation action status updates by May 5th. The Data Collection Guide and an excel spreadsheet of the existing actions will be emailed to the HMPC. The Data Collection Guide and a PDF of existing actions are also posted on the plan website. Representatives should come to the next meeting prepared to discuss updates to the plan goals and objectives.

HMPC Kickoff: UNC-P – April 16, 2020

University of North Carolina Pembroke
UNC Eastern Campuses Hazard Mitigation Plan

Meeting 1: Hazard Mitigation Planning Committee Project Kick-Off Meeting
Time & Date: Thursday, April 16, 2020, 10:00-11:00 am., Zoom Video Conference Call

Travis Bryant, Associate Vice Chancellor for Student Affairs, kicked off the meeting with a brief introduction and had attendees introduce themselves.

Attendance
The following members of the HMPC were in attendance for the call:

- Travis Bryant – Campus Safety and Emergency Operations
- Cora Bullard – Student Health Services
- Paul Posener – Housing and Residence Life
- Mike Bullard – Environmental Health and Safety
- Ray Buehne – IT
- Robert Hughes – IT

Additionally, Jacazza Jones from North Carolina Emergency Management was in attendance.

Introductions
David Stroud and Abby Moore, consultants from Wood, presented the meeting slides per the agenda shown below:

1. HMPC Introductions
2. Introduction to Hazard Mitigation Planning
    a. What is Mitigation? What is Mitigation Planning?
    b. Why Plan?
3. Requirements of Mitigation Planning
    a. Disaster Mitigation Act of 2000
        i. Planning Requirements
        ii. Planning Process Review
4. Scope of Work
5. Project Schedule
6. Next Steps
    a. Complete Data Collection Guide
    b. Review Existing Mitigation Projects
7. Questions

Discussion
The following comments and topics were discussed throughout the meeting.

- Coordination - In reviewing phase one of the planning process, David discussed the need for the HMPC to identify stakeholders that can contribute their input to the plan's development. It was noted that when identifying stakeholders to involve, the HMPC should also consider student groups that could be a resource in this planning process.
- Hazard Identification - The HMPC discussed the list of hazards that are included in the 2018 State Hazard Mitigation Plan and the previous campus hazard mitigation plan. In addition to the hazards that were included in the previous plan, the HMPC decided to add the following hazards:
    - Excessive Heat – this a concern for both energy systems as well as human health
    - Hazardous Substances – risk from the railroad track running right by campus should be evaluated
    - Cyber Threat
    - Infectious Disease

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HMPC Meeting 1

- Data Collection Guide – The HMPC was asked to complete a Data Collection Guide together in order to provide information on the school's capabilities and vulnerabilities.
- Action Reporting – The HMPC was asked to provide a status update on all projects from the previous HMP by identifying each project as Completed, Delete, or Carry Forward and providing any available details on progress.
- Plan Website – The website www.NCeastcampusHMP.com has been created to support coordination among the HMPC and the contractors and to support public outreach. The site contains upcoming meetings announcements, meeting agendas and minutes, draft documents of the plan update, information on the identified hazards, and opportunities to provide feedback including the public survey. The HMPC was asked to place a link to this website on their school's website and/or social media to encourage more public involvement.

Next Steps

Abby and David requested the HMPC complete the Data Collection Guide by April 30th and the mitigation action status updates by May 14th. The Data Collection Guide and an excel spreadsheet of the existing actions will be emailed to the HMPC. The Data Collection Guide and a PDF of existing actions are also posted on the plan website. Representatives should come to the next meeting prepared to discuss updates to the plan goals and objectives.

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HMPC Meeting 1

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HMPC Kickoff: FSU – April 21, 2020

Fayetteville State University
UNC Eastern Campuses Hazard Mitigation Plan

Meeting 1: Hazard Mitigation Planning Committee Project Kick-Off Meeting
Time & Date: Tuesday, April 21, 2020, 1:00-2:00 p.m., Zoom Video Conference Call

Attendance

The following members of the HMPC were in attendance for the call:

- Melvin Lewis, Emergency Management Director
- Gregory Moyd, Assistant Vice Chancellor of Student Affairs
- Donald Pearsall, Director of Business Services
- Conroy Campbell, Database Administrator, Information Technology
- Terri Tibbs, Associate VC Human Resources
- Benita Powell, Assistant General Counsel

Additionally, Jacazza Jones from North Carolina Emergency Management was in attendance.

Introductions

David Stroud and Abby Moore, consultants from Wood, presented the meeting slides per the agenda shown below:

1. HMPC Introductions
2. Introduction to Hazard Mitigation Planning
    a. What is Mitigation? What is Mitigation Planning?
    b. Why Plan?
3. Requirements of Mitigation Planning
    a. Disaster Mitigation Act of 2000
        i. Planning Requirements
        ii. Planning Process Review
4. Scope of Work
5. Project Schedule
6. Next Steps
    a. Complete Data Collection Guide
    b. Review Existing Mitigation Projects
7. Questions

Discussion

The following comments and topics were discussed throughout and after the meeting.

- Coordination - In reviewing phase one of the planning process, David discussed the need for the HMPC to identify stakeholders that can contribute their input to the plan's development. Jacazza Jones noted that the HMPC should consider student groups that could be stakeholders as a resource in this planning process.
- Hazard Identification - The HMPC discussed the list of hazards that are included in the 2018 State Hazard Mitigation Plan and the previous campus hazard mitigation plan. In addition to the hazards that were included in the previous plan, the HMPC discussed adding Terrorism with an emphasis on threats of violence on campus. David also suggested the HMPC consider Hazardous Substances if they are stored or transported on or near campus.
- Data Collection Guide – The HMPC was asked to complete a Data Collection Guide together in order to provide information on the school's capabilities and vulnerabilities.
- Action Reporting – The HMPC was asked to provide a status update on all projects from the previous HMP.

FSU – UNC Eastern Campuses Hazard Mitigation Plan
HMPC Meeting 1
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- Plan Website – The website www.NCeastcampusHMP.com has been created to support coordination among the HMPC and the contractors and to support public outreach. The site contains upcoming meetings announcements, meeting agendas and minutes, draft documents of the plan update, information on the identified hazards, and opportunities to provide feedback including the public survey. The HMPC was asked to place a link to this website on their school's website and/or social media to encourage more public involvement.

Next Steps

Abby and David requested the HMPC complete the Data Collection Guide by May 5th and the mitigation action status updates by May 19th. The Data Collection Guide and an excel spreadsheet of the existing actions will be emailed to the HMPC. The Data Collection Guide and a PDF of existing actions are also posted on the plan website. Representatives should come to the next meeting prepared to discuss updates to the plan goals and objectives.

HMPC Kickoff: ECU – April 30, 2020

East Carolina University
UNC Eastern Campuses Hazard Mitigation Plan

Meeting 1: Hazard Mitigation Planning Committee Project Kick-Off Meeting
Time & Date: Thursday, April 30, 2020, 1:00-2:00 p.m., Zoom Video Conference Call

Attendance

The following members of the HMPC were in attendance for the call:

- Phil Lewis, Environmental Health and Safety
- Chris Sutton, ECU Police
- Curtis Hayes, ECU Police
- William Bagnell, Campus Operations
- Aaron Lucier, Housing
- Blake Halsey, Environmental Health and Safety
- Cathy Delk, Emergency Manager
- Merrill Flood, Research, Economic Development and Engagement
- Mike O'Driscoll, Department of Coastal Studies
- Ricky Hill, Facilities Services

Introductions

David Stroud and Abby Moore, consultants from Wood, presented the meeting slides per the agenda shown below:

1. HMPC Introductions
2. Introduction to Hazard Mitigation Planning
    a. What is Mitigation? What is Mitigation Planning?
    b. Why Plan?
3. Requirements of Mitigation Planning
    a. Disaster Mitigation Act of 2000
        i. Planning Requirements
        ii. Planning Process Review
4. Scope of Work
5. Project Schedule
6. Next Steps
    a. Complete Data Collection Guide
    b. Review Existing Mitigation Projects
7. Questions

Discussion

The following comments and topics were discussed throughout and after the meeting.

- Coordination - In reviewing phase one of the planning process, David discussed the need for the HMPC to identify stakeholders that can contribute their input to the plan's development.
- Hazard Identification - The HMPC discussed the list of hazards that are included in the 2018 State Hazard Mitigation Plan and the previous campus hazard mitigation plan. In addition to the hazards that were included in the previous plan, the HMPC decided to add Hazardous Substances, with a particular focus on the risks associated with a railroad derailment or incident. Additionally, the HMPC discussed Infectious Disease and decided to include this as a hazard given the recent COVID-19 pandemic. The HMPC also discussed Excessive Heat but decided that the hazard is already well mitigated and additional analysis and action are not necessary.

ECU – UNC Eastern Campuses Hazard Mitigation Plan
HMPC Meeting 1
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- Data Collection Guide – The HMPC was asked to complete a Data Collection Guide together in order to provide information on the school's capabilities and vulnerabilities.
- Action Reporting – The HMPC was asked to provide a status update on all projects from the previous HMP.
- Plan Website – The website www.NCeastcampusHMP.com has been created to support coordination among the HMPC and the contractors and to support public outreach. The site contains upcoming meetings announcements, meeting agendas and minutes, draft documents of the plan update, information on the identified hazards, and opportunities to provide feedback including the public survey. The HMPC was asked to place a link to this website on their school's website and/or social media to encourage more public involvement.

Next Steps

Abby and David requested the HMPC complete the Data Collection Guide by May 14th and the mitigation action status updates by May 28th. The Data Collection Guide and an excel spreadsheet of the existing actions will be emailed to the HMPC. The Data Collection Guide and a PDF of existing actions are also posted on the plan website. Representatives should come to the next meeting prepared to discuss updates to the plan goals and objectives.

HMPC Kickoff: UNC-W – May 5, 2020

University of North Carolina Wilmington
UNC Eastern Campuses Hazard Mitigation Plan

Meeting 1: Hazard Mitigation Planning Committee Project Kick-Off Meeting
Time & Date: Tuesday, May 5, 2020, 10:00-11:00 am., Zoom Video Conference Call

Eric Griffin, Emergency Manager, kicked off the meeting with a brief introduction and had attendees introduce themselves.

Attendance

The following members of the HMPC were in attendance for the call:

- Eric Griffin, Emergency Manager
- Andy Mauk, Associate Provost for Institutional Research and Planning
- Laura McBrayer, Senior Associate Director of Randall Library
- Kristy Burnette, Director of Enterprise Risk Management
- Wes Merrill, Director of Facilities & Event Management
- Jeff Campbell, Director of Environmental Health & Safety
- Paul Townend, Dean of Undergraduate Studies and Associate Vice Chancellor
- Stuart Borrett, Associate Provost for Research
- Carey Gibson, Director of Infrastructure & Operations Services
- Mark Morgan, Associate Vice Chancellor of Facilities

Additionally, Jacazza Jones from North Carolina Emergency Management was in attendance.

Introductions

David Stroud and Abby Moore, consultants from Wood, presented the meeting slides per the agenda shown below:

1. HMPC Introductions
2. Introduction to Hazard Mitigation Planning
    a. What is Mitigation? What is Mitigation Planning?
    b. Why Plan?
3. Requirements of Mitigation Planning
    a. Disaster Mitigation Act of 2000
        i. Planning Requirements
        ii. Planning Process Review
4. Scope of Work
5. Project Schedule
6. Next Steps
    a. Complete Data Collection Guide
    b. Review Existing Mitigation Projects
7. Questions

Discussion

The following comments and topics were discussed throughout the meeting.

- Coordination - In reviewing phase one of the planning process, David discussed the need for the HMPC to identify stakeholders that can contribute their input to the plan's development. Jacazza recommended that when identifying stakeholders to involve, the HMPC should also consider student groups that could be a resource in this planning process. The Sustainability Office was mentioned as a possible resource for encouraging student involvement in the plan.

UNC-W – UNC Eastern Campuses Hazard Mitigation Plan
HMPC Meeting 1
Page **1** of **2**

- Hazard Identification - The HMPC discussed the list of hazards that are included in the 2018 State Hazard Mitigation Plan and the previous campus hazard mitigation plan. In addition to the hazards that were included in the previous plan, the HMPC decided to add the following hazards:
  - Infectious Disease
  - Cyber Threat
  - Sinkhole – it was noted that sinkhole occurrences are related to stormwater issues. This hazard may be profiled on its own or addressed as an impact of flooding.
- Data Collection Guide – The HMPC was asked to complete a Data Collection Guide together in order to provide information on the school's capabilities and vulnerabilities. Eric Griffin will coordinate the gathering of HMPC input into one completed response.
- Action Reporting – The HMPC was asked to provide a status update on all projects from the previous HMP by identifying each project as Completed, Delete, or Carry Forward and providing any available details on progress. Wood will check with NCEM to confirm we have the most updated list of projects.
- Plan Website – The website www.NCeastcampusHMP.com has been created to support coordination among the HMPC and the contractors and to support public outreach. The site contains upcoming meetings announcements, meeting agendas and minutes, draft documents of the plan update, information on the identified hazards, and opportunities to provide feedback including the public survey. The HMPC was asked to place a link to this website on their school's website and/or social media to encourage more public involvement.

Next Steps

David and Abby requested the HMPC complete the Data Collection Guide by May 19th and the mitigation action status updates by June 2nd. The Data Collection Guide will be emailed to the HMPC. Once Wood confirms the list of current mitigation actions, a spreadsheet with those actions will also be emailed to the HMPC. The Data Collection Guide and a PDF of existing actions are also posted on the plan website. Representatives should come to the next meeting prepared to discuss updates to the plan goals and objectives.

HMPC Kickoff: NCSSM – May 7, 2020

North Carolina School of Science and Math
UNC Eastern Campuses Hazard Mitigation Plan

Meeting 1: Hazard Mitigation Planning Committee Project Kick-Off Meeting
Time & Date: Thursday, May 7, 2020, 10:00-11:00 am., Zoom Video Conference Call

Attendance

The following members of the HMPC were in attendance for the call:

- Rick Hess, Director of Safety and Security
- Gary Covington, Director of Plan Facilities
- Paul Menchini, IT Security Director
- Joyce Boni, Internal Auditor

Additionally, Jacazza Jones from North Carolina Emergency Management was in attendance.

Introductions

David Stroud and Abby Moore, consultants from Wood, presented the meeting slides per the agenda shown below:

1. HMPC Introductions
2. Introduction to Hazard Mitigation Planning
    a. What is Mitigation? What is Mitigation Planning?
    b. Why Plan?
3. Requirements of Mitigation Planning
    a. Disaster Mitigation Act of 2000
        i. Planning Requirements
        ii. Planning Process Review
4. Scope of Work
5. Project Schedule
6. Next Steps
    a. Complete Data Collection Guide
    b. Review Existing Mitigation Projects
7. Questions

Discussion

The following comments and topics were discussed throughout the meeting.

- Coordination - In reviewing phase one of the planning process, David discussed the need for the HMPC to identify stakeholders that can contribute their input to the plan's development.
- Hazard Identification - The HMPC discussed the list of hazards that are included in the 2018 State Hazard Mitigation Plan and the previous campus hazard mitigation plan. In addition to the hazards that were included in the previous plan, the HMPC decided to add the following hazards:
    - Hazardous Substances – two issues were discussed: the potential for a spill related to the transportation of hazardous materials (a recent incident occurred in Orange County), and the gas leak explosion that occurred last year in Durham.
    - Vandalism/Threat – this was not included in the State HMP but was noted as a specific concern to campuses especially while schools are currently closed.
- Data Collection Guide – The HMPC was asked to complete a Data Collection Guide together in order to provide information on the school's capabilities and vulnerabilities. Rick Hess will coordinate the gathering of HMPC input into one completed response.

NCSSM – UNC Eastern Campuses Hazard Mitigation Plan
HMPC Meeting 1
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- Action Reporting – The HMPC was asked to provide a status update on all projects from the previous HMP by identifying each project as Completed, Delete, or Carry Forward and providing any available details on progress.
- Plan Website – The website www.NCeastcampusHMP.com has been created to support coordination among the HMPC and the contractors and to support public outreach. The site contains upcoming meetings announcements, meeting agendas and minutes, draft documents of the plan update, information on the identified hazards, and opportunities to provide feedback including the public survey. The HMPC was asked to place a link to this website on their school's website and/or social media to encourage more public involvement.

Next Steps

David and Abby requested the HMPC complete the Data Collection Guide by May 21st and the mitigation action status updates by June 4th. The Data Collection Guide and a spreadsheet with the existing mitigation actions will be emailed to the HMPC. The Data Collection Guide and a PDF of existing actions are also posted on the plan website. HMPC representatives should come to the next meeting prepared to discuss updates to the plan goals and objectives.

HMPC Kickoff: ECSU – May 12, 2020

Elizabeth City State University
UNC Eastern Campuses Hazard Mitigation Plan

Meeting 1: Hazard Mitigation Planning Committee Project Kick-Off Meeting
Time & Date: Tuesday, May 12, 2020, 1:00-2:00 p.m., Zoom Video Conference Call

Attendance

The following members of the HMPC were in attendance for the call:

- Rickey Freeman, EM/EHS Coordinator
- Derrick Wilkins, Chief of Staff
- John Manley, Chief of Police
- Kevin Wade, AVC Student Affairs
- Kevin Kupietz, Aviation/Emergency Management
- Sabrina Williams, Director Residence Life

Jacazza Jones from North Carolina Emergency Management was also in attendance.

Introductions

David Stroud and Abby Moore, consultants from Wood, presented the meeting slides per the agenda shown below:

1. HMPC Introductions
2. Introduction to Hazard Mitigation Planning
    a. What is Mitigation? What is Mitigation Planning?
    b. Why Plan?
3. Requirements of Mitigation Planning
    a. Disaster Mitigation Act of 2000
        i. Planning Requirements
        ii. Planning Process Review
4. Scope of Work
5. Project Schedule
6. Next Steps
    a. Complete Data Collection Guide
    b. Review Existing Mitigation Projects
7. Questions

Discussion

The following comments and topics were discussed throughout and after the meeting.

- Coordination - In reviewing phase one of the planning process, David discussed the need for the HMPC to identify stakeholders that can contribute their input to the plan's development. Jacazza encouraged the HMPC to consider student groups on campus and school departments that could support the planning process and public outreach efforts.
- Hazard Identification - The HMPC discussed the list of hazards that are included in the 2018 State Hazard Mitigation Plan and the previous campus hazard mitigation plan. In addition to the hazards that were included in the previous plan, the HMPC decided to add Infectious Disease, Cyber, and Hazardous Substances. The HMPC also discussed Geological hazards and decided that the hazard is not significant to the campus and does not need to be included in the plan.
- Data Collection Guide – The HMPC was asked to complete a Data Collection Guide together in order to provide information on the school's capabilities and vulnerabilities.
- Action Reporting – The HMPC was asked to provide a status update on all projects from the previous HMP.

ECSU – UNC Eastern Campuses Hazard Mitigation Plan
HMPC Meeting 1
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- Plan Website – The website www.NCeastcampusHMP.com has been created to support coordination among the HMPC and the contractors and to support public outreach. The site contains upcoming meetings announcements, meeting agendas and minutes, draft documents of the plan update, information on the identified hazards, and opportunities to provide feedback including the public survey. The HMPC was asked to place a link to this website on their school's website and/or social media to encourage more public involvement.

Next Steps

Abby and David requested the HMPC complete the Data Collection Guide by May 26th and the mitigation action status updates by June 9th. The Data Collection Guide and an excel spreadsheet of the existing actions will be emailed to the HMPC. The Data Collection Guide and a PDF of existing actions are also posted on the plan website. Representatives should come to the next meeting prepared to discuss updates to the plan goals and objectives.

HMPC Kickoff: NCSU – July 10, 2020

North Carolina State University
UNC Eastern Campuses Hazard Mitigation Plan

Meeting 1: Hazard Mitigation Planning Committee Project Kick-Off Meeting
Time & Date: Friday, July 10, 2020, 11:30 a.m.-12:00 p.m., Zoom Video Conference Call

Todd Becker of NCSU Emergency Management kicked off the meeting with a brief introduction and had all attendees introduce themselves.

Attendance
The following members of the HMPC were in attendance for the call:

- Todd Becker – Emergency Management
- Dave Rainer – Associate Vice Chancellor for Environmental Health & Public Safety
- Jon Brann – Fire Marshall
- Steve Olmstead – Director of Insurance and Risk Management
- Greg Sparks – Assistant Vice Chancellor for IT
- Doug Morton – Associate Vice Chancellor for Facilities
- Amy Orders – Emergency Management

Additionally, Jacazza Jones and Chris Crew from North Carolina Emergency Management were in attendance.

Introductions
David Stroud and Abby Moore, consultants from Wood, presented the meeting slides per the agenda shown below:

1. HMPC Introductions
2. Introduction to Hazard Mitigation Planning
    a. What is Mitigation? What is Mitigation Planning?
    b. Why Plan?
3. Requirements of Mitigation Planning
    a. Disaster Mitigation Act of 2000
        i. Planning Requirements
        ii. Planning Process Review
4. Scope of Work
5. Project Schedule
6. Next Steps
    a. Complete Data Collection Guide
    b. Review Existing Mitigation Projects
7. Questions

Discussion
The following comments and topics were discussed throughout the meeting.

- Coordination - In reviewing phase one of the planning process, David discussed the need for the HMPC to identify stakeholders that can contribute their input to the plan's development. It was noted that when identifying stakeholders to involve, the HMPC should also consider student groups that could be a resource in this planning process. David also asked the HMPC to consider non-profit organizations and the surrounding business community.
- Hazard Identification - The HMPC discussed the list of hazards that are included in the 2018 State Hazard Mitigation Plan and the previous campus hazard mitigation plan. In addition to the hazards that were included in the previous plan, David recommended the addition of Excessive Heat, Cyber Threat, and Infection Disease, in light of the Covid-19 Pandemic. The HMPC decided to add Cyber Threat and Infectious Disease. Doug Morton mentioned the Loss of Utility having significant impact; Chris Crew (NCEM)

NCSU – UNC Eastern Campuses Hazard Mitigation Plan Page **1** of **2**
HMPC Meeting 1

suggested considering this as a consequence of hazards rather than a standalone hazard. Todd Becker noted that the university has worked with various groups to complete a risk assessment (Pack Planning); he will provide that information to David.

- *Scope of Work:* Amy Orders (NCSU EM) noted that much of what was shared has been done in campus planning efforts to date; she asked how this process would benefit NCSU. Chris Crew noted that the biggest benefit was in the planning process itself: the funding made available would help reduce risks to hazards on campus. Wood noted that because the previous plan is expired, they will work from it as a base. Amy also asked about the inclusion of stakeholders (as this was above the Scope the university understood prior to the meeting). Chris noted that these stakeholders solely need to be identified and invited to participate, not necessarily have an impact. Additionally, the inclusion of identified mitigation actions in the plan does not constitute a requirement to accomplish those actions.
- Data Collection Guide – The HMPC was asked to complete a Data Collection Guide together in order to provide information on the school's capabilities and vulnerabilities.
- Action Reporting – The HMPC was asked to provide a status update on all projects from the previous HMP by identifying each project as Completed, Delete, or Carry Forward and providing any available details on progress.
- Plan Website – The website www.NCeastcampusHMP.com has been created to support coordination among the HMPC and the contractors and to support public outreach. The site contains upcoming meetings announcements, meeting agendas and minutes, draft documents of the plan update, information on the identified hazards, and opportunities to provide feedback including the public survey. The HMPC was asked to place a link to this website on their school's website and/or social media to encourage more public involvement. Further, Abby requested the HMPC share screenshots of the posted website to be included in the plan.

Next Steps

Abby and David requested the HMPC complete the Data Collection Guide by July 31st and the mitigation action status updates by August 7th. The Data Collection Guide and an excel spreadsheet of the existing actions will be emailed to the HMPC. The Data Collection Guide and a PDF of existing actions are also posted on the plan website. Representatives should come to the next meeting prepared to discuss updates to the plan goals and objectives.

HMPC Meeting 2: August 20, 2020

UNC Eastern Campuses Hazard Mitigation Plan

Meeting 2: Hazard Mitigation Planning Committee Meeting

Time & Date: Thursday, August 20, 2020, 1:30-2:30 p.m., Zoom Video Conference Call

Introductions and Agenda

Approximately 61 people were in attendance at the Hazard Mitigation Planning (HMP) Committee Meeting #2 which took place at 2:00pm on Wednesday, August. 12th.

David Stroud and Abby Moore (Wood) presented the briefing slides per the meeting agenda shown below.

1. Updates: Where we are in the planning process
2. Project Schedule Update
3. Review & Update Mitigation Goals and Objectives
4. Review Mitigation Ideas for New Actions
5. Discuss Critical Building Identification/Rankings
6. Reminders & Next Steps:
    a. Hold a Public Meeting
    b. Finalize Goals & Objectives
    c. Submit Data Collection Guides
7. Questions

Planning Process

David updated the HMPC on where the consultants are in the 10-step Planning Process. Wood is currently working through Steps 4 and 5: Assessing the Hazard and Assessing the problem, the results of this assessment will be presented to the HMPC at the next meeting. At this particular meeting the objectives were to address Steps 6 and 7: Set Goals and Review Possible Activities

Survey and Public Outreach

David noted that only 6 UNC East Campus community members had responded to the community survey so far. The survey is an important tool that gives the community the opportunity to share their input on the planning process and risks the individuals campuses face as well as for the planners committee members to form a more in depth understanding of community needs. David asked that the committee members continue to publicize the survey to garner more response. The survey can be found at http://www.nceastcampushmp.com/survey.html.

David also reminded the committee members to share the full website (www.NCeastcampusHMP.com) on websites, social media, and through emails to staff, faculty, and students. The website contains everything the public needs to know about the plan.

Project Schedule

Given the delays caused by COVID-19, the plan is as on schedule as possible. The Wood consultants presented the schedule, aiming to have goals finalized by mid-September. Wood is also aiming to have a public kick-off meeting in September. The campuses would need to assist in publicizing this meeting to garner as much public involvement as possible. Wood anticipated being in draft plan stage by the end of December.

Review and Update Mitigation Goals

David reviewed the five goals from the 2010 UNC Eastern Campuses Pre-Disaster Mitigation Plan. It was noted that with exception of goal 1 and parts of goal 4, most of the existing goals address inherent pieces of the planning process itself, and are not addressing mitigation itself.

The original goals are as follows:

#1	Reduce the impact of natural hazards on campus
#2	Develop a natural hazards mitigation plan that meets planning criteria outlined in 44 CFR, Part 201

#3	Develop a model PDM planning process for a multi-campus university system
#4	Develop an innovate approach based on ASCE/Building Security Council National Standards
#5	Provide a mechanism to obtain FEMA Mitigation Project Grant funding for facility improvements.

Due to the large size of the meeting, rather than presenting recommended revisions and asking for input, Wood presented the joint HMPCs with the following set of concepts that will be considered in reformulating the goals. Wood intends to develop four strong goals with associated objectives that will guide the committee and campuses in selecting mitigation projects to include in their mitigation action plans. The list of concepts is as follows:

- Prevent property damage;
- Protect critical facilities;
- Improve public awareness of risk and mitigation;
- Build capacity to implement mitigation;
- Develop funding sources to support mitigation; and
- Plan for resilient future development.

Committee members discussed further potential goal-setting concepts using the Zoom chat feature. The main ideas brought up were as follows:

- Creating a culture of preparedness;
- Protecting people, not just property;
- Speedy return to campus function as part of resilience;
- Continuity of operations;
- Training of campus personnel, including full scale vs. table top exercises; and
- Protection of critical research.

Once Wood has drafted the goals, they will be shared with the HMPC for review and comment.

Review Mitigation Action Ideas

Abby reviewed a selection of mitigation action ideas from the FEMA "Mitigation Ideas" publication. She encouraged the HMPC to review the full document, which is available on the plan website, to find ideas for new mitigation actions. Each campus will need two actions per high and moderate priority hazard – the campuses may utilize mitigation strategies that address all, or multiple, hazards. Hazard Strategies include: Alter, Avert, Adapt to, and Avoid the Hazard. Mitigation Categories include: Prevention, Property Protection, Emergency Services, Structural Projects, Natural Floodplain Functions, and Education and Outreach Programs.

Critical Building Review and Ranking

Abby asked that representatives from all campuses review their existing list of critical facilities from the 2010 Campus plan. Campuses are welcome to add new buildings to the list and are asked to provide justification if they chose to remove a building from the list. Wood will provide the Campuses with a 10 question rating worksheet to use to rank the buildings, however if a campus has already ranked their buildings using their own criteria, they are welcome to provide that instead. The results of this exercise will be incorporated into the vulnerability assessments and will be used to formulate mitigation action plans.

A member of the HMPC asked if this worksheet account for high dollar equipment that would be difficult to replace and is critical to educational operations. Such equipment may be accounted for under Question 8 or Question 10; campuses are also encouraged to use the notes and comments section to provide additional pertinent information about individual buildings.

Next Steps

Campuses that have yet to do so are asked to complete and return their data collection guides ASAP.

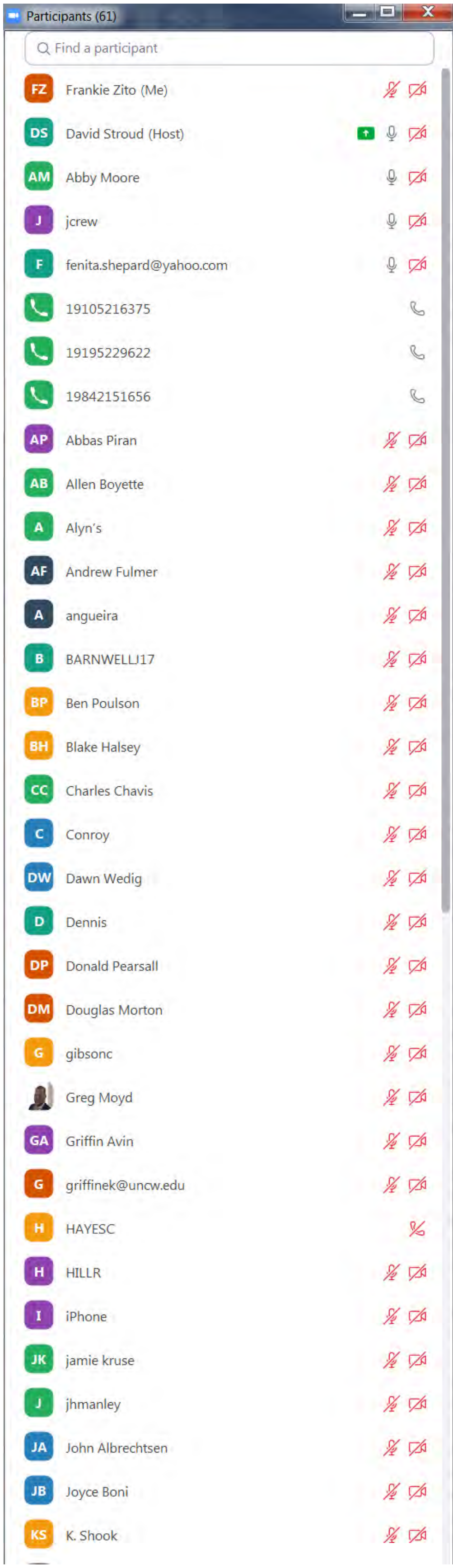
The first public meeting will be scheduled for the month of September and will be held over zoom. It is understood that COVID may create roadblocks in planning meetings as some universities may be pivoting to remote learning.

Wood and the HMPC are prepared to be flexible given the circumstances. The meeting will likely be in the evening, and Wood will provide the Campuses with language they can use on their websites, social media channels, and in emails to their communities. The campuses should also continue outreach to share the plan website and promote the community survey.

HMPC members were asked to continue working on their mitigation action reporting. All campuses should submit action statuses for all actions to Abby at abigail.moore@woodplc.com by **Friday, August 28th.** Critical building rankings must be returned by **Friday, September 11th,** and feedback on the soon to be distributed goals and objectives must be received by **Friday, October 2nd, 2020.**

The next meeting will be scheduled soon for the consultants to review the findings of the Hazard Identification

Meeting Adjourned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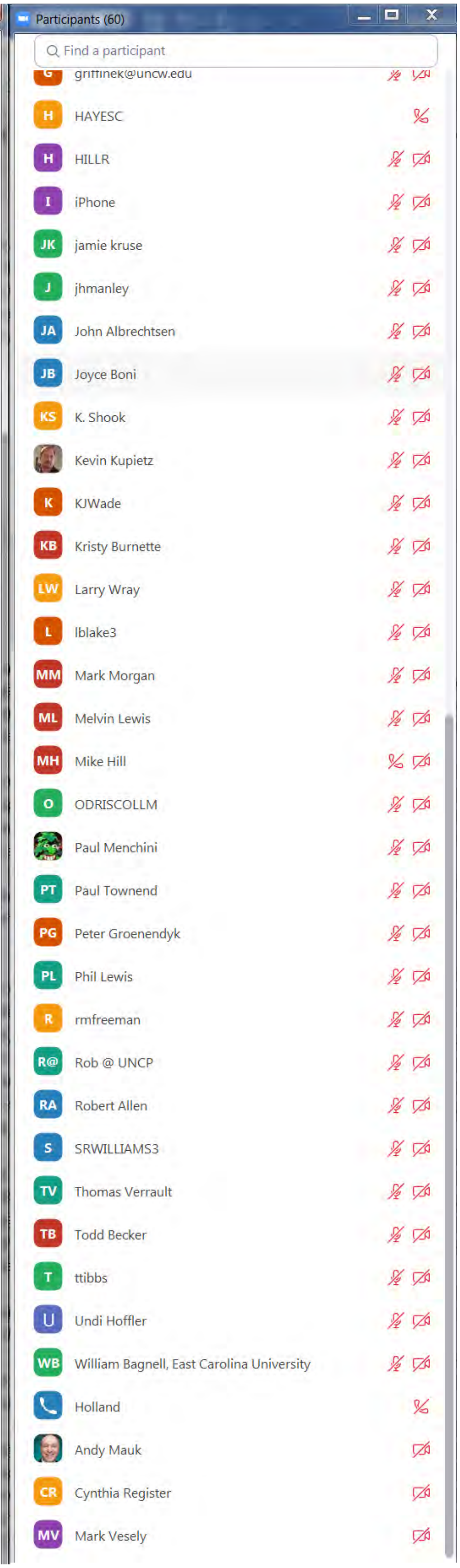
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Mike Hill
ODRISCOLLM
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Paul Townend
Peter Groenendyk
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Robert Allen
SRWILLIAMS3
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Todd Becker
ttibbs
Undi Hoffler
William Bagnell, East Carolina University
Holland
Andy Mauk
Cynthia Register
Mark Vesely

HMPC Meeting 3: December 15, 2020

UNC Eastern Campuses Hazard Mitigation Plan

Meeting 3: Hazard Mitigation Planning Committee Meeting

Time & Date: Tuesday, December 15th, 2020, 11:00 - 12:30 a.m., Zoom Video Conference Call

Introductions and Agenda

Approximately 49 people were in attendance at the Hazard Mitigation Planning Committee (HMPC) Meeting #3 which took place at 11:00am on Tuesday, December 15th.

David Stroud, Frankie Zito, Abby Moore (Wood) presented the briefing slides per the meeting agenda shown below.

1. Grant Match Reminder
2. Where we are in the planning process
3. HIRA Review:
    a. Organization in the plan: main document and campus annexes
    b. Hazard Identification
    c. Methodology
    d. Asset Inventory: Building Exposure & Critical Facilities
    e. Hazard Profile Summary
4. Mitigation Action Plan Requirements
5. Goals & Objectives Review
6. Next Steps & Questions

Grant Match Reminder

David reminded that campus representatives of the Grant Match requirements for NCEM. Each campus must provide a grant match letter to confirm "in-kind" work on this plan update (25% match); this equates to at least $9,259.26 per campus. Campuses can either estimate their grant match through the entire planning process or include only time up through now; may also use a blended hourly rate for all member of the planning committee. David can provide a sample letter for campuses to use. Chris Crew (NCEM) requested these letters be addressed to Steve McGugan, Assistant Director, NCEM.

Planning Process

David updated the HMPC on where the consultants are in the 10-step Planning Process. Steps 2 & 3 (Involve the Public and Coordinate) are ongoing throughout the duration of the planning process. Wood has completed Steps 4 and 5: Assessing the Hazard and Assessing the problem, the results of which were presented at this meeting. Step 6, Set Goals, was completed at Meeting 2 and the resulting goals were reviewed again during this meeting and affirmed; Step 7: Review Possible Activities was also covered in HMPC Meeting 2. Step 8: Draft an Action Plan is the next big step in the process.

HIRA Review

Organization in the Plan:

The HIRA will be contained in two parts of the plan, the Main Document and the individual Campus Annexes; this will reduce repetition of information between the main plan and annexes. The organization can be found in the draft documents on the plan website (http://www.nceastcampushmp.com/) and in the meeting presentation slides.

UNC Eastern Campuses Hazard Mitigation Plan
HMPC Meeting 3 – Systemwide
Page **1** of **3**

Hazard Identification

Hazards were identified for initial review based on the list of hazards included in the 2018 State of North Carolina Hazard Mitigation Plan, the previous campus PDM plans (2008/2010/2011), major disaster declarations for associated counties, NCEI storm events data, and HMPC input. Hazards profiled varied by campus and are summarized in the following table:

Hazard	ECU	ECSU	FSU	NCCU	NCSSM	NCSU	UNC-CH	UNC-P	UNC-W
Hurricane	X	X	X	X	X	X	X	X	X
Severe Winter Weather	X	X	X	X	X	X	X	X	
Earthquake	X	X	X	X	X	X	X	X	X
Wildfire	X	X	X	X	X	X	X	X	X
Tornado/Thunderstorm	X	X	X	X	X	X	X	X	X
Geological	X		X	X	X		X	X	X
Flooding	X	X	X	X	X	X	X	X	X
Hazardous Substances	X	X		X	X	X	X	X	X
Dam Failures							X		
Drought							X		
Infectious Disease	X	X		X		X		X	X
Cyber Threat		X		X		X		X	X
Excessive Heat								X	
Terrorism						X			X
Vandalism/Threat					X				

Methodology

David reviewed the different data sources, geographic scales, and assessment methodologies used to complete the HIRA. The table (available in the presentation) is explained in more detail in each campus annex. David also reviewed the Priority Risk Index, a weighted-sum scale used to compare hazards like-for-like and determine which hazards (high and moderate risk) to prioritize for mitigation activities.

Asset Inventory

The asset inventory details what exists in the planning area that may be impacted by the various hazards profiled. Assets include buildings and critical facilities on each campus. Details can be found in the PDF presentation posted on the plan website.

Hazard Profiles

The Hazard Profiles, presented by Frankie and Abby, summarized the results of the risk and vulnerability analyses of each of the hazards listed above. These profiles were created using qualitative and quantitative data gathered from national, state, and local sources. Where applicable, Wood used FEMA's Hazus program to approximate the potential risk/loss the County might face in the event of the hazards; Wood also employed GIS overlay analysis where Hazus analysis was unavailable. The summary information that was presented on each hazard can be found in the PDF of the presentation posted on the plan website.

The following questions and comments were posed throughout the presentation:

- **Hurricanes:** Multiple participants questioned Hurricane's PRI rating of moderate, especially for the easternmost campuses in North Carolina. Particularly, where spatial extent was rated as small, noting that all buildings on campus are impacted by hurricane winds, and where impact was rated as critical and might be considered catastrophic. The consultants acknowledged these concerns and will update the annexes accordingly. Additional concerns were raised around the associated challenges of rainfall and flooding during a hurricane event. Wood will ensure this interaction of hazards is appropriately addressed in the final annexes and HIRA.

- **Climate Change:** Wes Merrill (UNC-W) asked how climate change gets accounted for in these hazard profiles (particularly hurricane, tornado, etc.) where it increases frequency? Abby noted that a discussion of climate change and how it impacts the frequency and intensity of each hazard is addressed in the main body of the plan. However, NCEM/FEMA require using historical events to assess probability of future occurrence, as is done here.
- **Tornado/Severe Storm:** It was noted that tornado and severe storms have different impacts/spatial extents and the PRI results would vary; although this detail was not displayed in the presentation, the PRI ratings are varied by sub-hazard in the text to address these differences.
- **Severe Winter Weather:** Eric Griffin (UNC-W) noted that severe winter weather is relative – across many of the campuses, any winter weather is considered severe because of a limited capacity to respond and recover. This will be noted in the hazard profile text.
- **Cyber Attacks:** A few questions were raised about cyber attacks, including whether the probability should be higher than "possible" given the historic attempts at cyber attacks to government and other institutions; additionally, with the amount of data retained by universities from research, consequences of a breach could be higher. David noted that we will consider these comments and address them as necessary.
- **Terrorism:** A few committee members also noted that terrorism threat might be higher based on a rural setting, the historic context of a university, a university's values, or its visibility.

The consultants will consider all these comments and address them in future drafts of the HIRA and Annexes.

Mitigation Action Plan Requirements

To close out the meeting, Abby presented the requirements for creating the Mitigation Action Plan, the final big step in preparing the HMP for adoption. She noted that there must be two actions for every high and moderate priority (natural) hazard. For FEMA requirements, communities must have at least one structural or property protection project; emergency services projects do not count toward the FEMA requirements.

Next Steps

There were no additional questions from the attendees. If any questions come up, please reach out to the Wood team.

The next steps are as follows:

- Review the draft HIRA and your campus Annex, posted on www.NCeastcampusHMP.com. Comments should be submitted to Abby (abigail.moore@woodplc.com) by **Monday January 11th.**
- Develop new mitigation actions. These should be submitted to Abby by COB **Tuesday January 19th.**

The final meeting will be scheduled for mid-January. *Please respond to the forthcoming Doodle poll with your availability.* A public meeting will follow in the evening; once the meeting date is set, Wood will ask the campuses to advertise to their campus communities.

Meeting Adjourned

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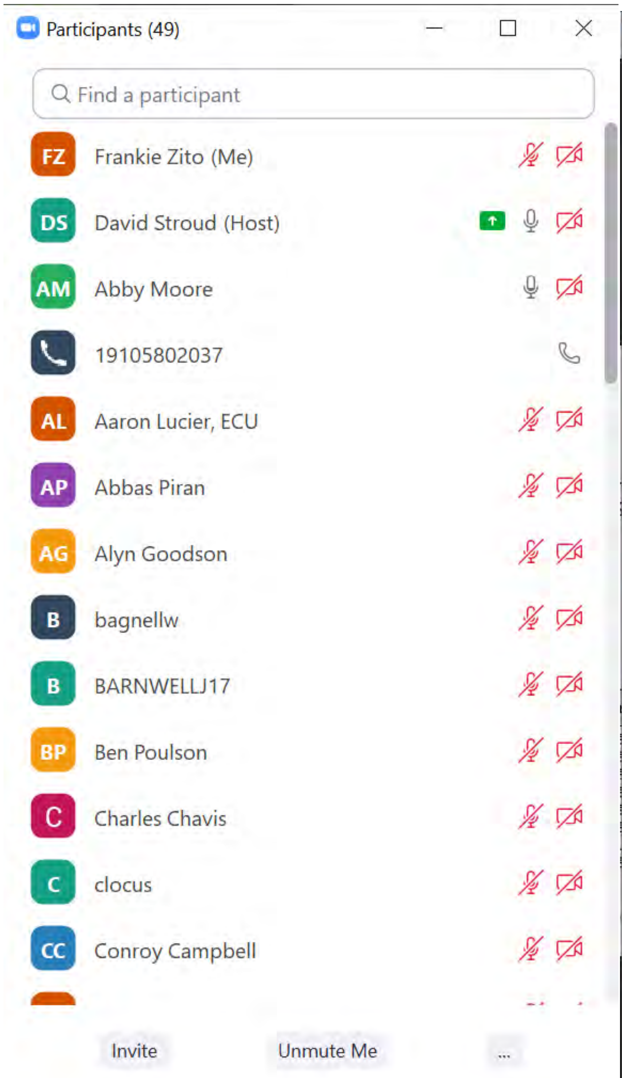
HMPC Meeting 3 – Systemwide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Frankie Zito (Me)
David Stroud (Host)
Abby Moore
19105802037
Aaron Lucier, ECU
Abbas Piran
Alyn Goodson
bagnellw
BARNWELLJ17
Ben Poulson
Charles Chavis
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Conroy Campbell
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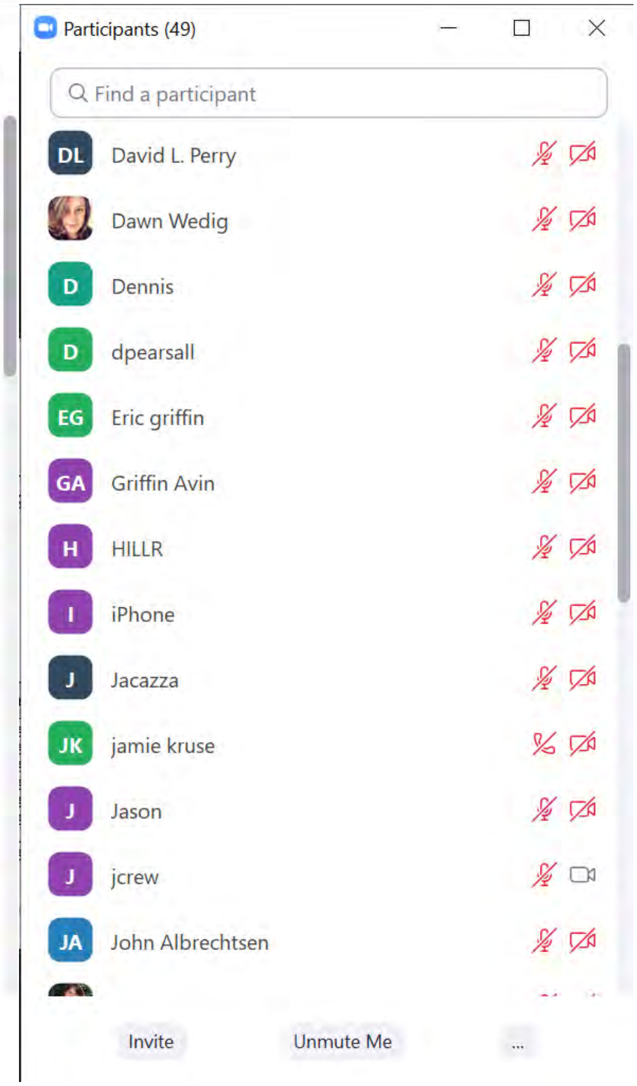
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David L. Perry
Dawn Wedig
Dennis
dpearsall
Eric griffin
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jamie kruse
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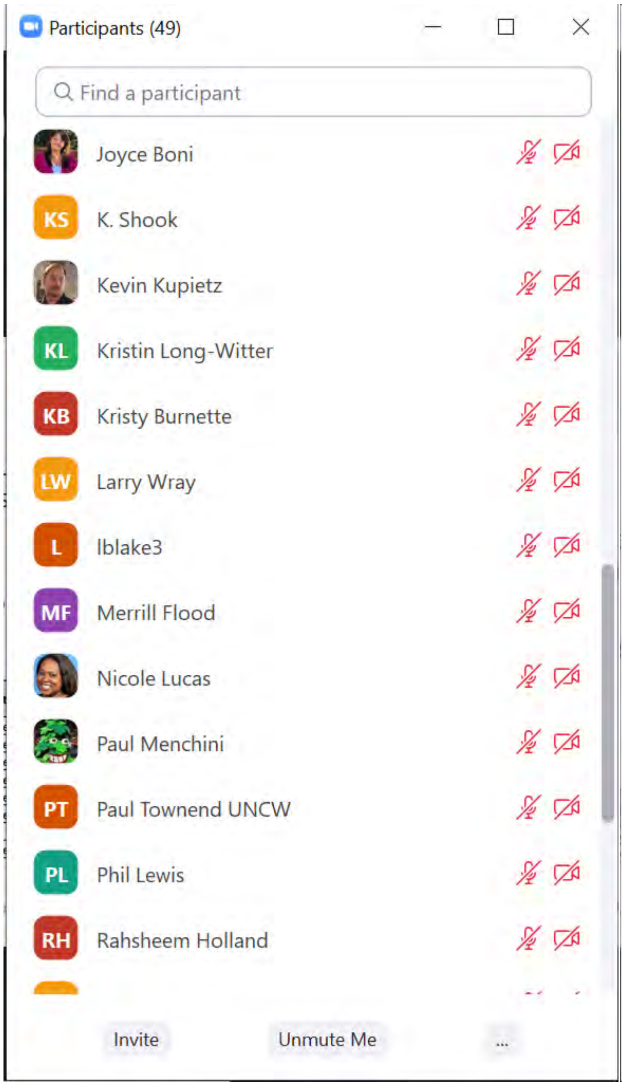
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Joyce Boni
KS K. Shook
Kevin Kupietz
KL Kristin Long-Witter
KB Kristy Burnette
LW Larry Wray
L lblake3
MF Merrill Flood
Nicole Lucas
Paul Menchini
PT Paul Townend UNCW
PL Phil Lewis
RH Rahsheem Holland
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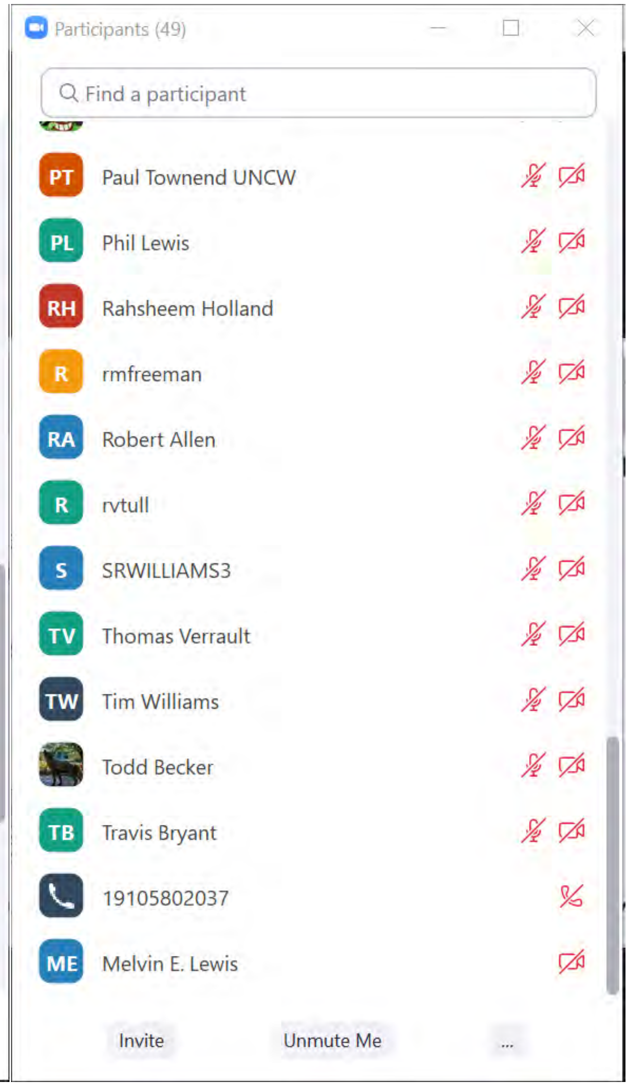
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PT Paul Townend UNCW
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R rmfreeman
RA Robert Allen
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TV Thomas Verrault
TW Tim Williams
Todd Becker
TB Travis Bryant
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HMPC Meeting 4: January 19, 2021

UNC Eastern Campuses Hazard Mitigation Plan

Meeting 4: Hazard Mitigation Planning Committee Meeting

Time & Date: Tuesday, January 19th, 2021, 2:00 - 3:00 p.m., Zoom Video Conference Call

Introductions and Agenda

Approximately 40 people were in attendance at the Hazard Mitigation Planning (HMP) Committee Meeting #4 which took place at 2:00pm on Tuesday January 19, 2021.

David Stroud, Frankie Zito, and Abby Moore (Wood) presented the briefing slides the meeting agenda shown below.

1. Grant Match Reminder
2. Where we are in the planning process
3. Structure of the Plan
4. Review of Key Plan Components
    a. Hazards & Priority Risk Index
    b. Goals & Objectives Review
    c. Mitigation Actions
5. Plan Implementation & Maintenance
    a. Responsibilities of the HMPC
    b. Integration with Other Plans
6. Completing the Planning Process
7. Next Steps and Questions

Meeting Presentation

David started the meeting by reminding the HMPC about the necessity of the Grant Match letter to confirm "in kind" work on this plan update as the required 25% match. This equals at least $9,259.26 per campus. David has sent out a template for this letter, which should be addressed to Steve McGugan.

David then reviewed the joint DMA and CRS planning process used to update the UNC Eastern Campuses Hazard Mitigation Plans. Wood is currently completing the planning process (Steps 8 & 9: Draft an Action Plan and Adopt the Plan). The draft plan has been uploaded to the plan website and is ready for HMPC and public review.

Frankie then overviewed the structure of the plan by section and highlighted some of the most important pieces. She presented the timeline of meetings – both HMPC and Public – and explained more of the outreach efforts untaken by the HMPC. She then broke down in more detail the various sections of the plan and went through what is included in each Campus annex.

Abby continued by reviewing the key plan components and what the HMPC should look for as they review.

Hazard Identification and Risk Assessment: Abby reminded the HMPC which hazards were profiled for each university, went through the Priority Risk Index (PRI) scoring, and reviewed which hazards fell into the High, Moderate, and Low priority categories.

Mitigation Strategy: Abby reviewed the Goals and Objectives agreed upon by the HMPC in the second meeting and then previewed a portion of the Mitigation Action Plan. Abby reminded the Committee that it is required by FEMA to report on existing actions. In instances where Wood did not receive reporting (two campuses), the action was considered Carried Forward. She asked that the HMPC take extra care in reviewing the Mitigation Action Plan and update any highlighted sections.

Finally, Abby finished the meeting by going over the plan implementation and maintenance procedures.

Plan Adoption: The plan will need to be formally adopted by each campus. Wood will provide an adoption resolution template. Campuses should prepare to adopt the plan following NCEM approval, which is anticipated in March.

UNC Eastern Campuses Hazard Mitigation Plan Update   Page **1** of **2**
HMPC Meeting 4

Implementation and Maintenance: Wood suggested the HMPCs report annually on the status of plan implementation and recommended plan revisions. These reviews can be a zoom meeting. This is a good opportunity for the HMPC to discuss integration of the HMP into other planning mechanisms. The HMPC should also continue to monitor funding opportunities and include the wider campus community in the implementation and maintenance process.

Integration with Other Plans: Abby explained that integration of the HMP into other planning mechanisms is an important and easy way to implement it. She asked the HMPC for ways the previous plan was integrated into plans around their campuses or plans for future integration. There were no comments regarding integration.

Finally, Abby described the steps for completing the planning process. The HMPC and the public will have two full weeks to review the plan and send in any updates or revisions to the Wood team. Wood will then implement any revisions and submit the plan to NCEM. Once NCEM approves the plan, likely in March, Wood will reach out and provide next steps for the campuses to adopt the plan as soon as possible. Once all campuses adopt the plan, documentation of the adoption will be added to the plan along with the final FEMA approval letter and the full, completed plan will be issued.

Questions and Comments:

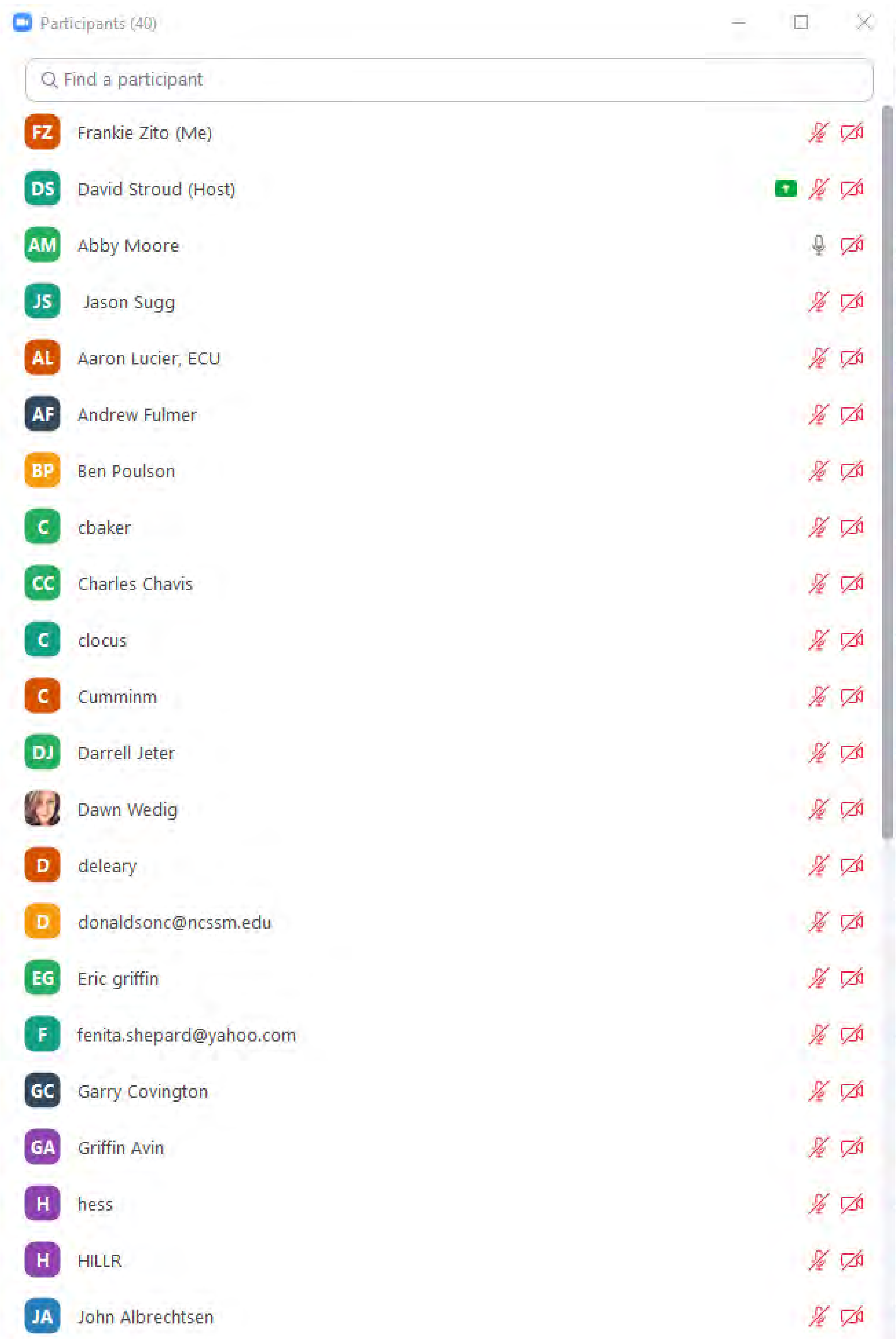
1) **Why is Cyber not considered some level of risk for all universities?** The hazards included for each university were based on what was decided at each Campus HMCP Meeting 1. If a campus wants it to be included now, it is relatively easy to integrate, but they need to let the consultants know ASAP.
2) **Are mitigation funds only allowed to be used towards hazard identified?** More specifically, funds are directed only towards projects identified in the plan. These individual projects are where HMGP, BRIC, and FMA funds are directed to. These funding sources only support mitigation action of natural hazards impacts. Carl Baker, from NCEM, noted that each university needs two actions per natural hazard or all hazards actions; actions for technological and man-made hazards may be listed but will not be counted toward the required total. He went on to mention that when applying for a grant, FEMA calls NCEM and they will compare the grant application to the most recent plan. If it is not in the mitigation action plan, it will not continue on in the grant process. Two good all hazard mitigation actions to consider including are generator backups for all critical facilities and some form of public education action.

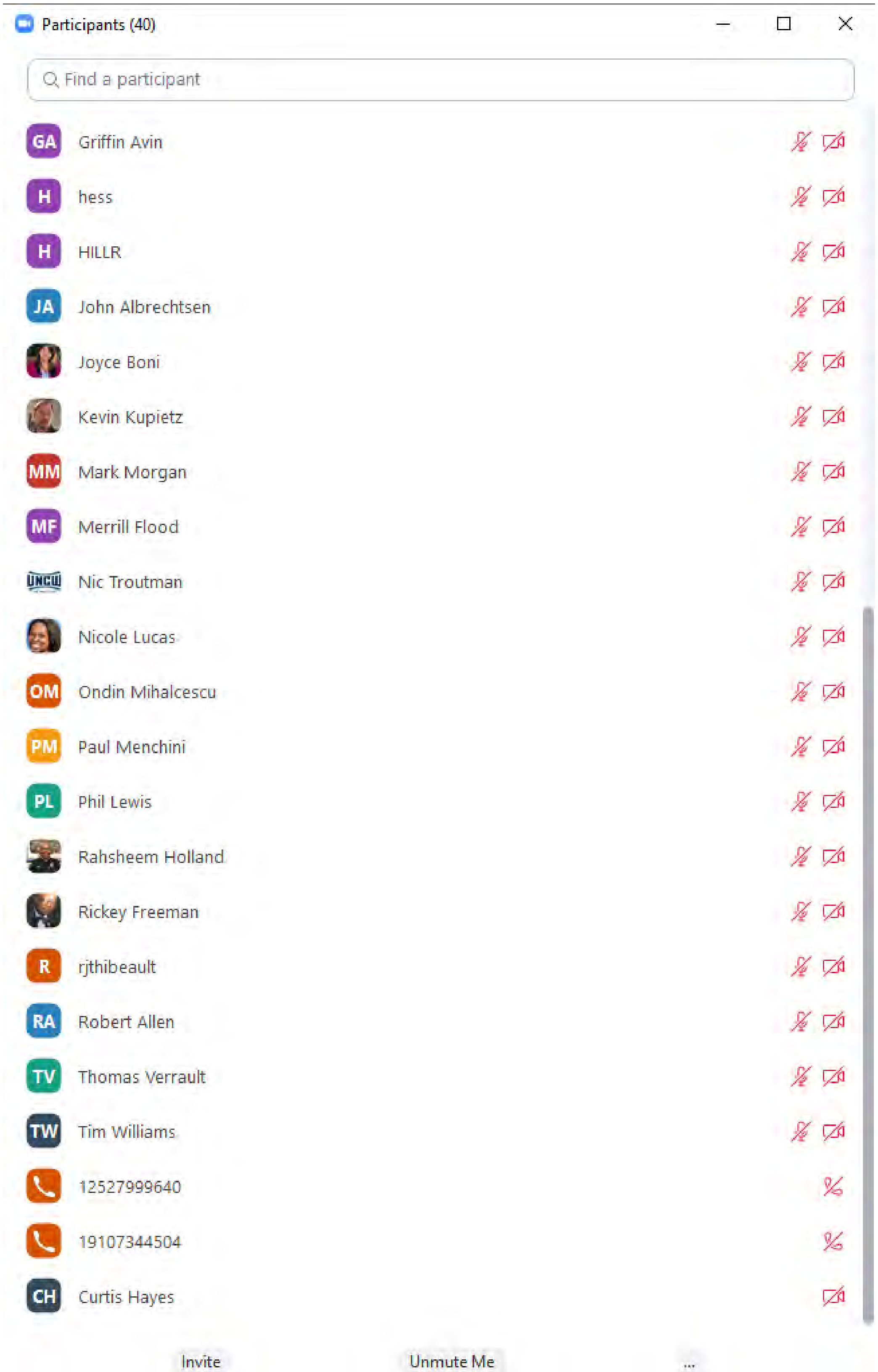
Next Steps:

Review Mitigation Action Plan: It is critical that we get feedback on the mitigation action as soon as possible to accurately report on the progress of the prior plan. Please be sure to fill out any missing pieces that are highlighted. The mitigation action spreadsheet will be sent out to each campus representative. Return all comments by **January 26th.**

Review the Draft Plan: Review the full draft plan, available on the plan website, and provide feedback to Abby Moore (abigail.moore@woodplc.com) by **Wednesday, February 3rd.**

Meeting Adjourned.


Participants (40)
Find a participant
FZ Frankie Zito (Me)
DS David Stroud (Host)
AM Abby Moore
JS Jason Sugg
AL Aaron Lucier, ECU
AF Andrew Fulmer
BP Ben Poulson
C cbaker
CC Charles Chavis
C clocus
C Cumminm
DJ Darrell Jeter
Dawn Wedig
D deleary
D donaldsonc@ncssm.edu
EG Eric griffin
F fenita.shepard@yahoo.com
GC Garry Covington
GA Griffin Avin
H hess
H HILLR
JA John Albrechtsen


Participants (40)
Find a participant
Griffin Avin
hess
HILLR
John Albrechtsen
Joyce Boni
Kevin Kupietz
Mark Morgan
Merrill Flood
Nic Troutman
Nicole Lucas
Ondin Mihalcescu
Paul Menchini
Phil Lewis
Rahsheem Holland
Rickey Freeman
rjthibeault
Robert Allen
Thomas Verrault
Tim Williams
12527999640
19107344504
Curtis Hayes
Invite
Unmute Me
...

PLANNING STEP 2: INVOLVE THE PUBLIC

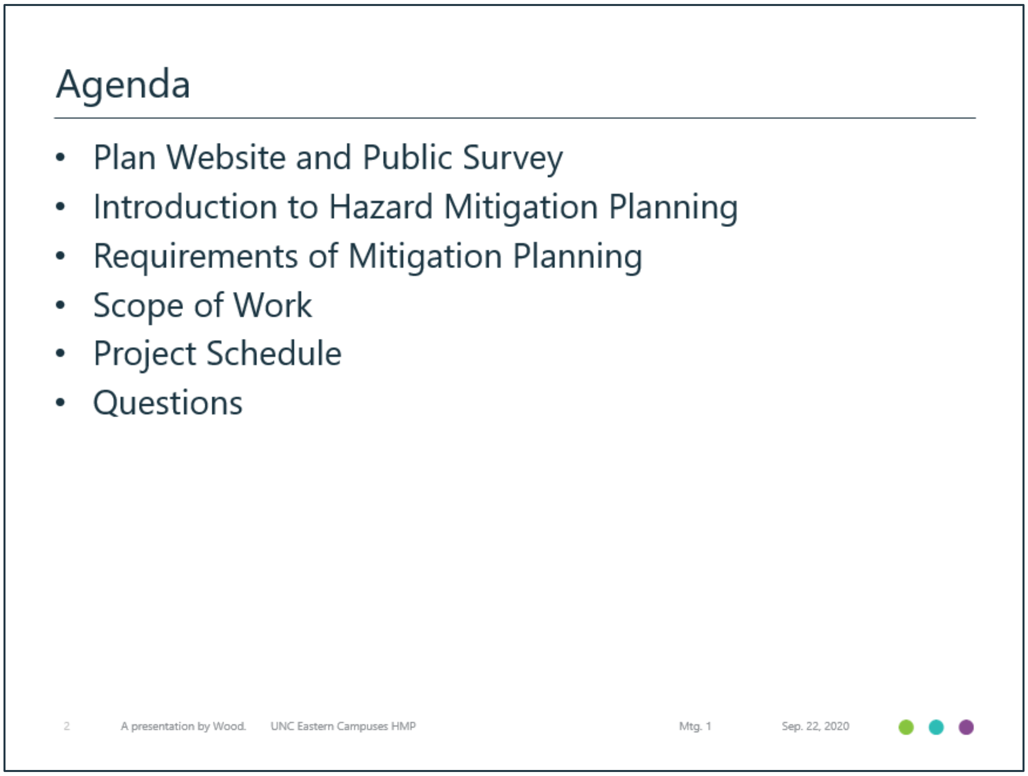
Table B.2 – Public Meeting Topics, Dates, Locations

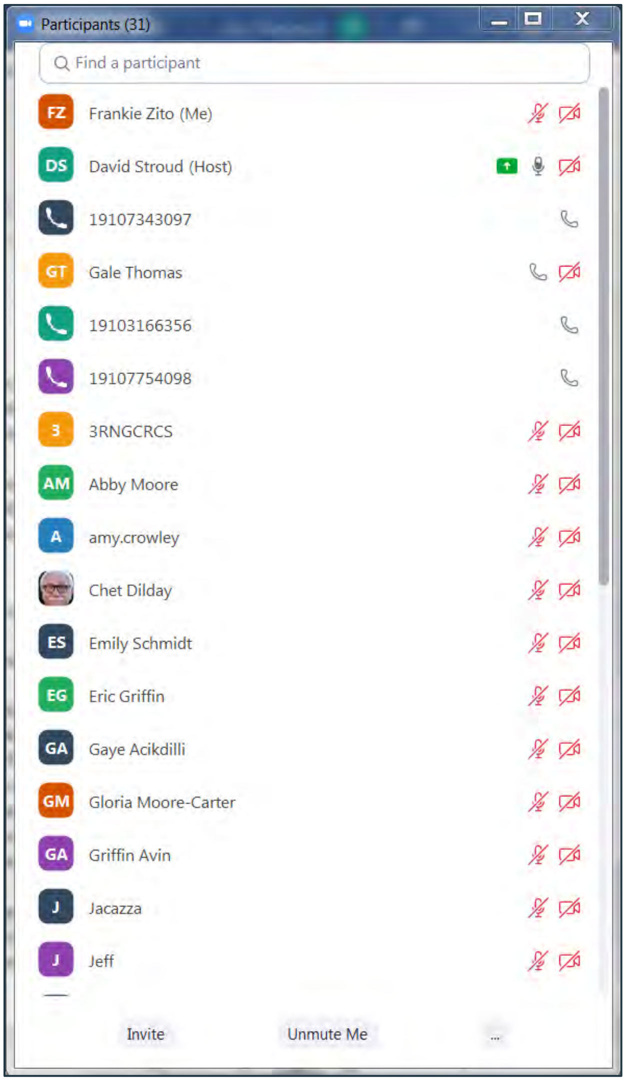
Meeting Title	Meeting Topic	Meeting Date	Meeting Location
Public Meeting #1	1) Introduction to DMA, CRS, and FMA requirements and the planning process 2) Review of planning process, hazards identified, public survey and website, and the project schedule.	September 22, 2020 5:30 p.m.	Zoom Video Conference Call
Public Meeting #2	1) Review "Draft" Hazard Mitigation Plan 2) Solicit comments and feedback	January 19, 2021 5:00 p.m.	Zoom Video Conference Call

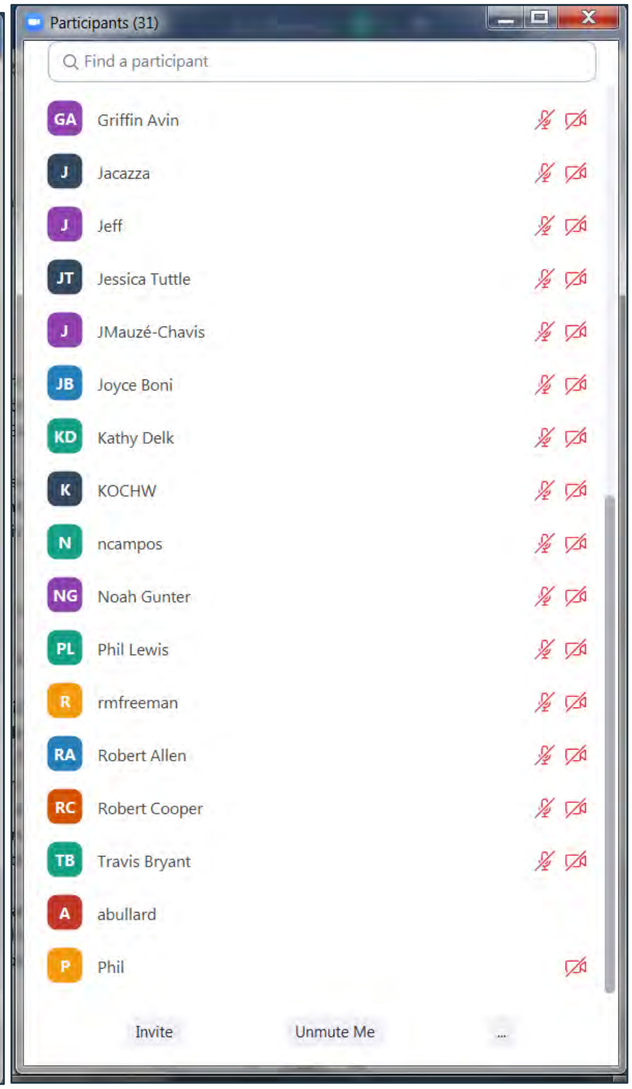
PLANNING STEP 2: INVOLVE THE PUBLIC

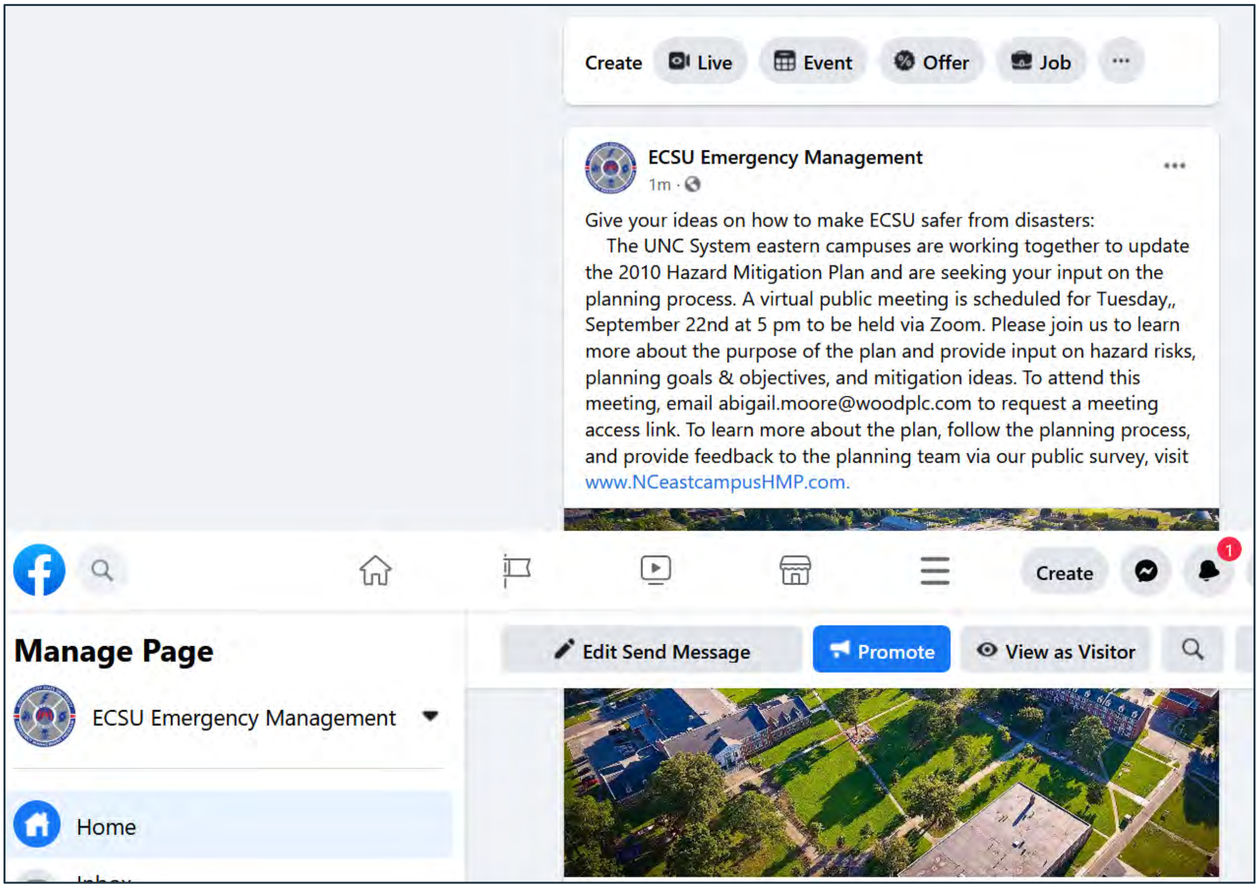
Public Meeting Agendas, Minutes, Sign-in Sheets, and Announcements

Public Meeting 1: September 22, 2020

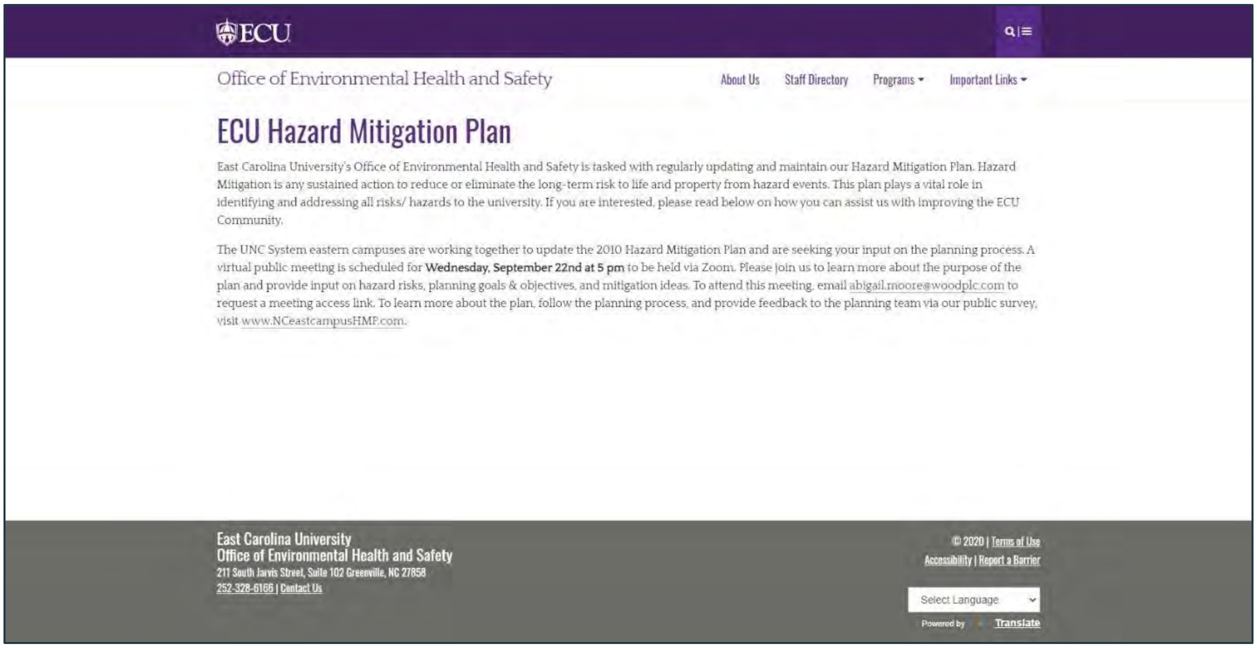

Agenda
• Plan Website and Public Survey
• Introduction to Hazard Mitigation Planning
• Requirements of Mitigation Planning
• Scope of Work
• Project Schedule
• Questions
2
A presentation by Wood.
UNC Eastern Campuses HMP
Mtg. 1
Sep. 22, 2020

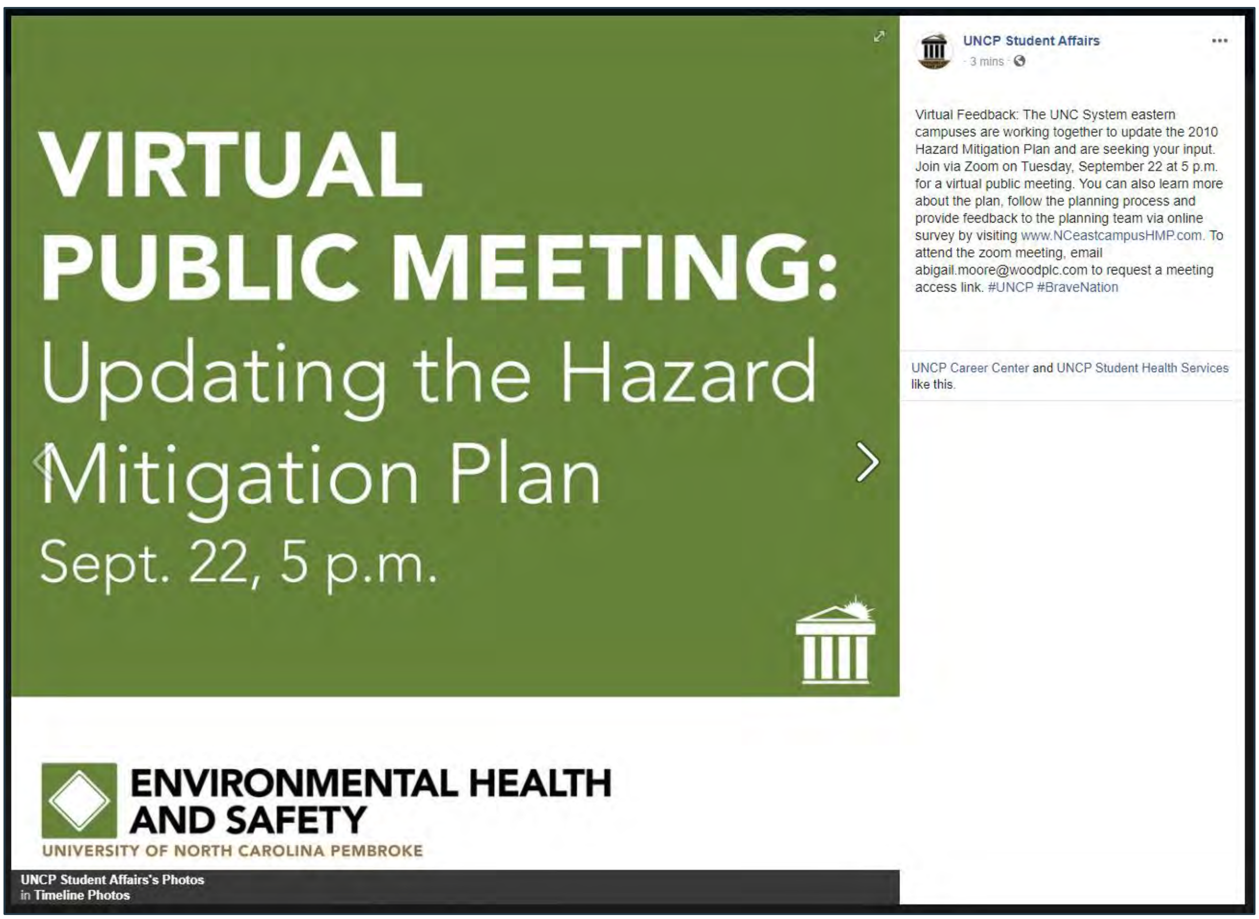

Participants (31)
Find a participant
Frankie Zito (Me)
David Stroud (Host)
19107343097
Gale Thomas
19103166356
19107754098
3RNGCRCS
Abby Moore
amy.crowley
Chet Dilday
Emily Schmidt
Eric Griffin
Gaye Acikdilli
Gloria Moore-Carter
Griffin Avin
Jacazza
Jeff
Invite
Unmute Me


Participants (31)
Find a participant
Griffin Avin
Jacazza
Jeff
Jessica Tuttle
JMauzé-Chavis
Joyce Boni
Kathy Delk
KOCHW
ncampos
Noah Gunter
Phil Lewis
rmfreeman
Robert Allen
Robert Cooper
Travis Bryant
abullard
Phil
Invite
Unmute Me


Create
Live
Event
Offer
Job
ECSU Emergency Management
1m
Give your ideas on how to make ECSU safer from disasters:
The UNC System eastern campuses are working together to update the 2010 Hazard Mitigation Plan and are seeking your input on the planning process. A virtual public meeting is scheduled for Tuesday,, September 22nd at 5 pm to be held via Zoom. Please join us to learn more about the purpose of the plan and provide input on hazard risks, planning goals & objectives, and mitigation ideas. To attend this meeting, email abigail.moore@woodplc.com to request a meeting access link. To learn more about the plan, follow the planning process, and provide feedback to the planning team via our public survey, visit www.NCeastcampusHMP.com.
Create
Manage Page
ECSU Emergency Management
Home
Edit Send Message
Promote
View as Visitor


Explore
Settings
Tweet
ECU News
is working with the @UNC_System eastern campuses to update the 2010 Hazard Mitigation Plan and wants YOUR input.
Meeting details:
Wednesday, Sept. 22
5 p.m.
RSVP to abigail.moore@woodplc.com
go.ecu.edu/HazardPlan
OFFICE OF ENVIRONMENTAL HEALTH AND SAFETY
Hazard Mitigation Plan
oehs.ecu.edu | go.ecu.edu/hazardplan
More Tweets
ECU Professor
So basically all the Greek orgs have clusters.
Additional COVID-19 clusters identified on campus.
New to Twitter?
Sign up
Relevant people
ECU News
Follow
ECU
Follow
UNC System
Follow
What's happening
Don't miss what's happening
People on Twitter are the first to know.
Log in
Sign up


ECU
Office of Environmental Health and Safety
About Us
Staff Directory
Programs
Important Links
ECU Hazard Mitigation Plan
East Carolina University's Office of Environmental Health and Safety is tasked with regularly updating and maintain our Hazard Mitigation Plan. Hazard Mitigation is any sustained action to reduce or eliminate the long-term risk to life and property from hazard events. This plan plays a vital role in identifying and addressing all risks/ hazards to the university. If you are interested, please read below on how you can assist us with improving the ECU Community.
The UNC System eastern campuses are working together to update the 2010 Hazard Mitigation Plan and are seeking your input on the planning process. A virtual public meeting is scheduled for Wednesday, September 22nd at 5 pm to be held via Zoom. Please join us to learn more about the purpose of the plan and provide input on hazard risks, planning goals & objectives, and mitigation ideas. To attend this meeting, email abigail.moore@woodplc.com to request a meeting access link. To learn more about the plan, follow the planning process, and provide feedback to the planning team via our public survey, visit www.NCeastcampusHMP.com.
East Carolina University
Office of Environmental Health and Safety
211 South Jarvis Street, Suite 102 Greenville, NC 27858
252-328-6166 | Contact Us
© 2020 | Terms of Use
Accessibility | Report a Barrier
Select Language
Powered by Translate


VIRTUAL PUBLIC MEETING:
Updating the Hazard Mitigation Plan
Sept. 22, 5 p.m.
ENVIRONMENTAL HEALTH AND SAFETY
UNIVERSITY OF NORTH CAROLINA PEMBROKE
UNCP Student Affairs's Photos in Timeline Photos
UNCP Student Affairs
3 mins
Virtual Feedback: The UNC System eastern campuses are working together to update the 2010 Hazard Mitigation Plan and are seeking your input. Join via Zoom on Tuesday, September 22 at 5 p.m. for a virtual public meeting. You can also learn more about the plan, follow the planning process and provide feedback to the planning team via online survey by visiting www.NCeastcampusHMP.com. To attend the zoom meeting, email abigail.moore@woodplc.com to request a meeting access link. #UNCP #BraveNation
UNCP Career Center and UNCP Student Health Services like this.

From: Devan Britt
To: campus.news.events
Subject: [Campus News] Zoom to Join: UNC System Hazard Mitigation Plan Update
Date: Monday, September 14, 2020 10:14:13 AM

BraveNation,

The UNC System eastern campuses are working together to update the 2010 Hazard Mitigation Plan and are seeking your input on the planning process.

Join us via Zoom on Tuesday, September 22 at 5 p.m. for a virtual public meeting. You can also learn more about the plan, follow the planning process and provide feedback to the planning team via online survey by visiting www.NCeastcampusHMP.com.

To attend the zoom meeting, email abigail.moore@woodplc.com to request a meeting access link.

We look forward to hearing from you throughout the process.

Thanks,

Charles E. Chavis 03'
Environmental, Health, and Safety Professional
Campus Safety and Emergency Operations
128 A Facilities Drive I P.O. Box 1510 I Pembroke, NC 28372
O: 910.775.4772 I C: 910-316-6356 I uncp.edu I charles.chavis@uncp.edu

From: FSU News <fsunews@uncfsu.edu>
Sent: Wednesday, September 9, 2020 9:59 AM
To: FSU Campus Faculty and Staff <allcamp@uncfsu.edu>
Subject: Hazard Mitigation Plan Update

Dear FSU Family:

The UNC System eastern campuses are working together to update the 2010 Hazard Mitigation Plan and are seeking your input on the planning process. A virtual public meeting is scheduled for Wednesday, September 22nd, at 5 pm to be held via Zoom. Please join us to learn more about the purpose of the plan and provide input on hazard risks, planning goals & objectives, and mitigation ideas. To attend this meeting, email abigail.moore@woodplc.com to request a meeting access link. To learn more about the plan, follow the planning process, and provide feedback to the planning team via our public survey, visit www.NCeastcampusHMP.com.

SWOOP

Faculty & Staff Newsletter

Faculty Honors

Though it was done virtually this year, UNCW honored the dedication and talents of its faculty at the annual fall faculty meeting on Sept. 10.

ACADEMIC AFFAIRS | HUMAN RESOURCES | STAFF SENATE

Take Action

- NEW: Save-the-Date: Employee Appreciation Week Begins Sept. 28
- NEW: Sign up for Upperman Center's "The Sit-In: A Black Cultural Competency Module" Virtual Session Oct. 13
- NEW: Join a Virtual Community on Teams to Share Resources, Ideas and Support with Fellow Seahawks
- REMINDER: Complete Mandatory Return to Campus Online Safety Training

Announcements

- NEW: UNCW One of Three UNC System Schools Ranked Among the Top 100 Public National Universities by U.S. News & World Report
- NEW: College of Health and Human Services to Launch Respiratory Therapy Program
- NEW: Registration Open for Interdisciplinary Research Seminar Series Exploring Digital Networks and Scholarship
- NEW: Randall Library Hosting Virtual Events "She Rocks the Vote" and "Barriers to the Ballot"
- NEW: UNC System Hazard Mitigation Plan Virtual Public Meeting Sept. 22

Submit items for the next edition of SWOOP by noon Friday.

In the News

Events

The coronavirus has had significant impacts on university events and programming. Please check the websites of your events of interest for current scheduling information.

(more)

SWOOP Archive

From: ECSUNews <ecsunews@ecsu.edu>
Sent: Friday, September 18, 2020 9:16 AM
To: ECSUNews <ecsunews@ecsu.edu>
Subject: ECSU Campus Community Asked to Participate in Hazard Mitigation Planning Public Meeting and Survey

ECSU
ELIZABETH CITY STATE UNIVERSITY
FOUNDED 1891

ECSU Campus Community Asked to Participate in Hazard Mitigation Planning Public Meeting and Survey

Elizabeth City State University is in the process of updating the university's Hazard Mitigation Plan. Students, faculty and staff are asked to complete a brief survey to provide input for this process.

What is mitigation planning? A process for the UNC System Eastern Campuses to:

– Identify the natural and human-caused hazards to which they are at risk;
– Assess the potential impacts of those hazards;
– Develop goals, objectives, and actions to reduce impacts;
– Prioritize and implement mitigation actions.

The following link will give you access to more information about the plan, the planning process and the public survey:

www.NCeastcampusHMP.com

A virtual public meeting is scheduled for **Tuesday Sept. 22, at 5 p.m. to be held via Zoom.** You can join the meeting to learn more about the purpose of the plan and provide input on hazard risks, planning goals and objectives, and mitigation ideas.

To attend this meeting, email abigail.moore@woodplc.com to request a meeting access link.

See the Hazard Mitigation Survey Here.

From the Office of Communications and Marketing

#CHOOSEECSU
www.ecsu.edu

Communications and Marketing
1704 Weeksville Road, Elizabeth City, NC 27909
252-335-3594 | ecsunews@ecsu.edu

BRAVE EXPERIENCE

LEARNING ▶BELONGING ▶COMMUNITY ▶WELLBEING

Choose to be engaged, build your brave experience!

Discover more about expanding your Brave Experience here: https://www.uncp.edu/campus-life/student-affairs/things-do/brave-experience

Explore BraveConnect: Student organization and campus events: Click Here

#BraveNation athletics: Click Here

Get the #BraveNation app - more than just athletics:

iTunes: Click Here

Google Play: Click Here

Student Affairs 'Things to Do': Click Here

Campus master calendar: Click Here

Academic calendars: Click Here

Corq App: Click Here

****ACADEMIC AFFAIRS****

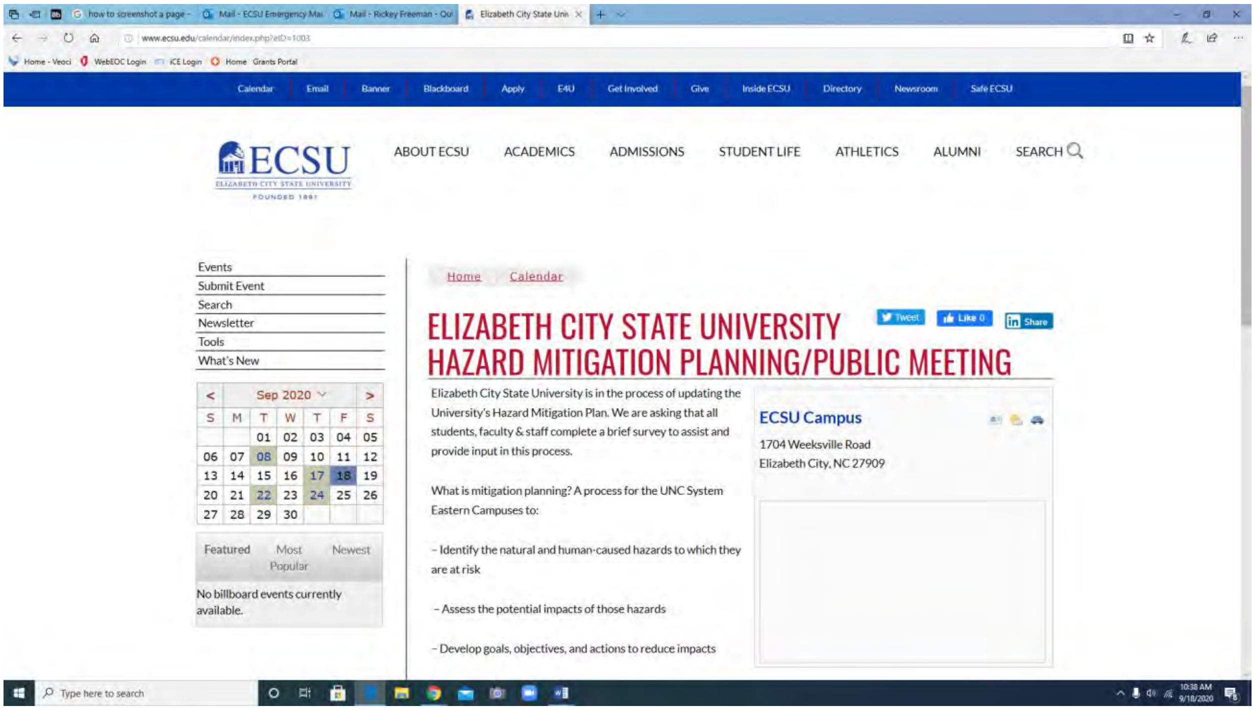
-

****STUDENT AFFAIRS****

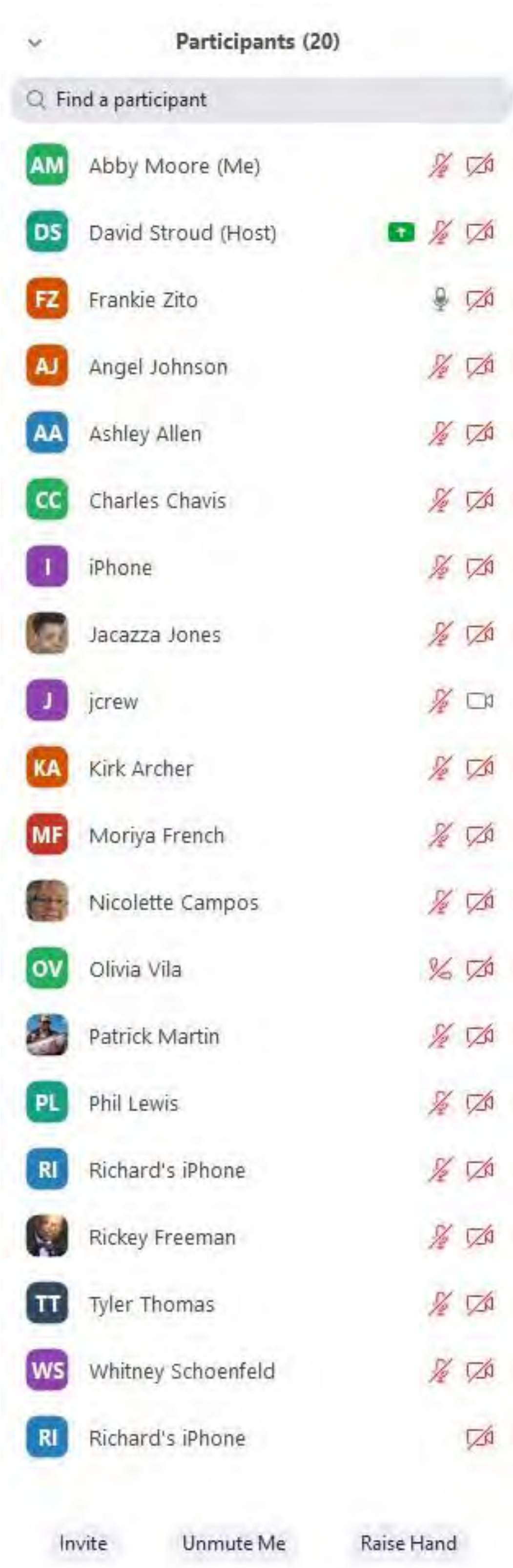
Virtual Public Meeting: Updating the Hazard Mitigation Plan

Tuesday, September 22 at 5:00 p.m.

To attend the Zoom meeting, email abigail.moore@woodplc.com to request a meeting access link.


Calendar
Email
Banner
Blackboard
Apply
E4U
Get Involved
Give
Inside ECSU
Directory
Newsroom
Safe ECSU
ECSU
ABOUT ECSU
ACADEMICS
ADMISSIONS
STUDENT LIFE
ATHLETICS
ALUMNI
SEARCH
Events
Submit Event
Search
Newsletter
Tools
What's New
Sep 2020
Featured
Most Popular
Newest
No billboard events currently available.
Home
Calendar
ELIZABETH CITY STATE UNIVERSITY HAZARD MITIGATION PLANNING/PUBLIC MEETING
Elizabeth City State University is in the process of updating the University's Hazard Mitigation Plan. We are asking that all students, faculty & staff complete a brief survey to assist and provide input in this process.
What is mitigation planning? A process for the UNC System Eastern Campuses to:
- Identify the natural and human-caused hazards to which they are at risk
- Assess the potential impacts of those hazards
- Develop goals, objectives, and actions to reduce impacts
ECSU Campus
1704 Weeksville Road
Elizabeth City, NC 27909
Type here to search

Public Meeting 2: January 19, 2021



From: ECSU Emergency Management <emergencymgmt@ecsu.edu>
Sent: Friday, January 15, 2021 8:27 PM
To: Employees; students
Cc: Moore, Abigail
Subject: Hazard Mitigation Plan Public Meeting

CAUTION: External email. Please do not click on links/attachments unless you know the content is genuine and safe.

ECSU Office of Emergency Management
Hazard Mitigation Plan Public Meeting

Elizabeth City State University and the other UNC System Eastern Campuses have completed a Regional Hazard Mitigation Plan and would like your input on the draft plan. A public meeting to review the plan will be held on Tuesday, January 19th at 5pm via Zoom. Email abigail.moore@woodplc.com for a link to attend the meeting. To learn more and view the draft plan, visit www.NCeastcampusHMP.com.

RICKEY M. FREEMAN B.A.
Environmental Health & Safety/Emergency Management Coordinator
University Police
Elizabeth City State University
1704 Weeksville Rd. | Elizabeth City, NC 27909
Phone: 252-335-3877 | **Fax:** 252-335-3502
Email: rmfreeman@ecsu.edu emergencymgnt@ecsu.edu

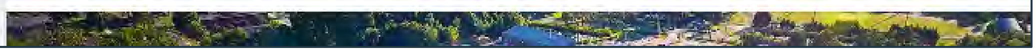
ECSU
ELIZABETH CITY STATE UNIVERSITY
FOUNDED 1891

ECSU Emergency Management

2h ·

This is a project that the EM 480 Hazards class helped with this past fall semester. Pass the word and see the students hard work put towards making a safer campus for everyone.

ECSU Office of Emergency Management
Hazard Mitigation Plan Public Meeting
Elizabeth City State University and the other UNC System Eastern Campuses have completed a Regional Hazard Mitigation Plan and want your input on the draft plan. A public meeting to review the plan will be held on Tuesday, January 19th at 5pm via Zoom. Email abigail.moore@woodplc.com for a link to attend the meeting. To learn more and view the draft plan, visit www.NCeastcampusHMP.com.
http://www.nceastcampushmp.com/



[Student_Campus News] [Campus News] UNC HMP Final Public Meeting

DB Devan Britt <devan.britt@uncp.edu>
To student_campus.news.events@listserv.uncp.edu
Cc campus.news.events
Thu 1/14

Follow up.

ENVIRONMENTAL HEALTH AND SAFETY
UNIVERSITY OF NORTH CAROLINA PEMBROKE

UNC Pembroke and other UNC System campuses have completed a Regional Hazard Mitigation Plan and want your input on the draft plan. A public meeting to review the plan will be held on Tuesday, January 19 at 5 p.m. via Zoom. Email abigail.moore@woodplc.com for a link to attend the meeting. To learn more and view the draft plan, visit www.NCeastcampusHMP.com.

Thanks,

Charles E. Chavis 03'
Environmental, Health, and Safety Professional
Campus Safety and Emergency Operations
128 A Facilities Drive I P.O. Box 1510 I Pembroke, NC 28372
O: 910.775.4772 I C: 910-316-6356 I uncp.edu I charles.chavis@uncp.edu

UNC HMP Final Public Meeting [January 19th]

Charles E. Chavis <charles.chavis@uncp.edu>
To stephanie.chavis@co.robeson.nc.us
Cc Travis Bryant

Wed 1/13

Good morning,

I am sharing the below information for the final public meeting for the UNC Eastern Campuses Hazard Mitigation Plan to be held on Tuesday, January 19th at 5 pm via Zoom. We would value the input of the county/community for this process. Can you assist with publicizing this meeting to the residents of the county, through social media, website, and other resources?

"UNC - Pembroke and the other UNC System Eastern Campuses have completed a Regional Hazard Mitigation Plan and want your input on the draft plan. A public meeting to review the plan will be held on Tuesday, January 19th, at 5 pm via Zoom. Email abigail.moore@woodplc.com for a link to attend the meeting. To learn more and view the draft plan, visit www.NCeastcampusHMP.com."

Thanks,

Charles E. Chavis 03'
Environmental, Health, and Safety Professional
Campus Safety and Emergency Operations
128 A Facilities Drive I P.O. Box 1510 I Pembroke, NC 28372
O: 910.775.4772 I C: 910-316-6356 I uncp.edu I charles.chavis@uncp.edu

ENVIRONMENTAL HEALTH AND SAFETY
UNIVERSITY OF NORTH CAROLINA PEMBROKE

IH Industrial Hygiene MESH
Manager of Environmental Safety and Health Programs

Email correspondence to and from this address may be subject to the North Carolina Public Records Law and may be disclosed to third parties by an authorized state official.

Environmental Health and Safety

The University of North Carolina at Pembroke Office of Environmental Health and Safety (EH&S) is dedicated to the protection of human life and our campus environment. EH&S acknowledges the close relationship between the environment, work, and human health and safety.

We are committed to preventing the loss of human potential caused by fatalities, injuries, illness, and disabilities on the job and in the campus community.

> UNCP Environmental Health and Safety Office believes that the health and safety of the university community are of the greatest importance
> — EHS OFFICE

Environmental Affairs

Fire Safety and Emergency Response

Laboratory and Research Safety

Occupational Health and Safety

EHS Handbook

pdf

Announcements

News from the Environmental Health & Safety Office

1/13/2021

UNC Hazard Mitigation Plan Public Final Meeting

"UNC - Pembroke and the other UNC System Eastern Campuses have completed a Regional Hazard Mitigation Plan and want your input on the draft plan. A public meeting to review the plan will be held on Tuesday, January 19th at 5 pm via Zoom. Email abigail.moore@woodplc.com for a link to attend the meeting. To learn more and view the draft plan, visit www.NCeastcampusHMP.com."

Environmental Health and Safety

- COVID-19 Resources
- Accident Reporting
- EHS Mission
- EHS Safety Programs
- EHS Safety Resources
- EHS Safety Training
- Flag The Hazard
- LiveSafe Mobile App
- Safety and Health Committee
- UNCP Emergency Procedure Poster
- Emergency Management
- WeatherSTEM
- Contact Us
- FAQs

Environmental Health and Safety

Pinchbeck Maintenance Building 138
PO Box 1510 Pembroke, NC 28372
Phone: 910.521.6792
Fax: 910.521.6554
safety@uncp.edu

BRAVECONNECT

SIGN IN

HOME EVENTS ORGANIZATIONS NEWS FORMS

Hazard Mitigation Feedback Meeting

Date and Time
Tuesday, January 19 2021 at 5:00 PM EST to
Tuesday, January 19 2021 at 6:30 PM EST
Add To Google Calendar | iCal/Outlook

Location
Online

Online Location

Online Location Instructions

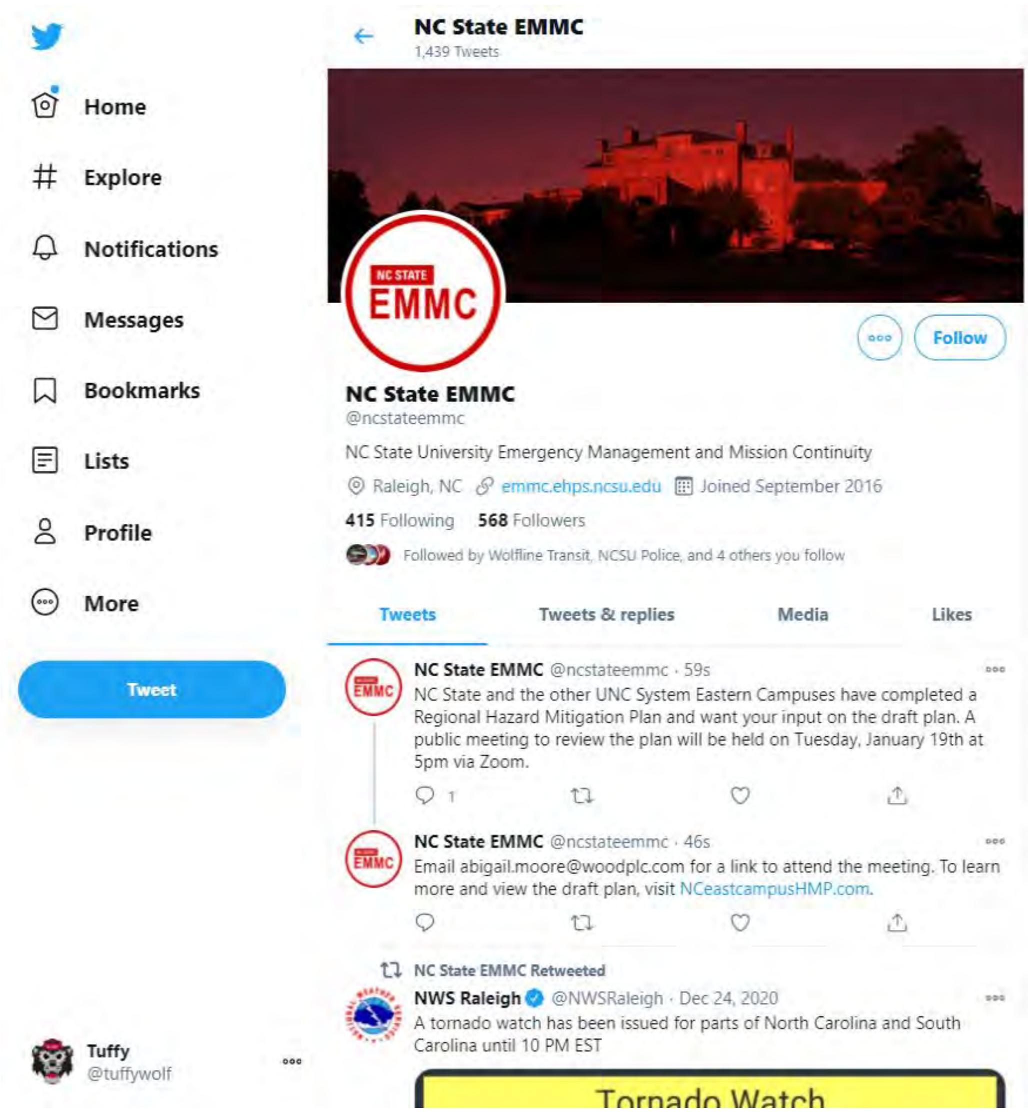
Link will be emailed

RSVP to Event

SIGN IN TO RSVP

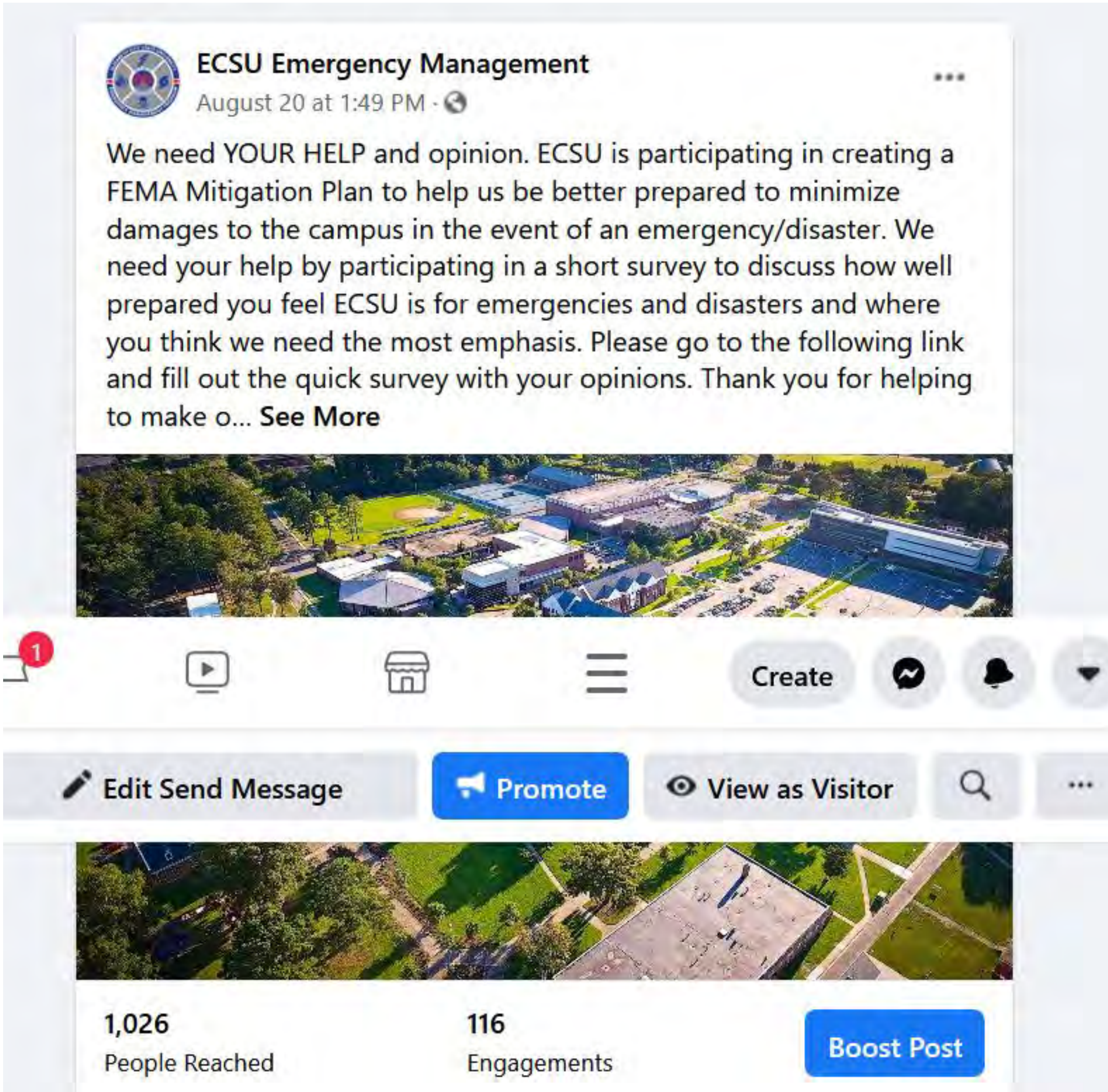
Description

"UNC - Pembroke and the other UNC System Eastern Campuses have completed a Regional Hazard Mitigation Plan and want your input on the draft plan. A public meeting to review the plan will be held on Tuesday, January 19th, at 5 pm via Zoom. Email abigail.moore@woodplc.com for a link to attend the meeting. To learn more and view the draft plan, visit www.NCeastcampusHMP.com."


Home
Explore
Notifications
Messages
Bookmarks
Lists
Profile
More
Tweet
Tuffy
@tuffywolf
NC State EMMC
1,439 Tweets
NC STATE
EMMC
Follow
NC State EMMC
@ncstateemmc
NC State University Emergency Management and Mission Continuity
Raleigh, NC emmc.ehps.ncsu.edu Joined September 2016
415 Following 568 Followers
Followed by Wolfline Transit, NCSU Police, and 4 others you follow
Tweets
Tweets & replies
Media
Likes
NC State EMMC @ncstateemmc · 59s
NC State and the other UNC System Eastern Campuses have completed a Regional Hazard Mitigation Plan and want your input on the draft plan. A public meeting to review the plan will be held on Tuesday, January 19th at 5pm via Zoom.
NC State EMMC @ncstateemmc · 46s
Email abigail.moore@woodplc.com for a link to attend the meeting. To learn more and view the draft plan, visit NCeastcampusHMP.com.
NC State EMMC Retweeted
NWS Raleigh @NWSRaleigh · Dec 24, 2020
A tornado watch has been issued for parts of North Carolina and South Carolina until 10 PM EST
Tornado Watch

Additional Public Outreach

Plan Website Outreach



Public Survey

The UNC Eastern Campuses 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 hazard events. The survey was announced at the first public meeting, provided via a link on campus web and social media accounts, and made available online on the plan website.

UNC Eastern Campuses HMP Survey

1. What school/campus are you associated with?

- East Carolina University
- Elizabeth City State University
- Fayetteville State University
- North Carolina Central University
- North Carolina School of Math and Science
- North Carolina State University
- UNC Chapel Hill
- UNC Pembroke
- UNC Wilmington

2. How prepared do you feel for a hazard event impacting your school/campus?

- Very prepared
- Somewhat prepared
- Somewhat unprepared
- Very unprepared

3. Do you know where storm shelters are located at your school/campus?

- Yes
- No

4. Do you know where/how to get more information on hazard risk and preparedness?

- Yes
- No

5. The hazards considered for this Hazard Mitigation Plan are listed below. For each hazard, indicate whether you feel it has a low, moderate, or high significance for the school/campus.

	Low Significance	Moderate Significance	High Significance
Flooding	○	○	○
Hurricane	○	○	○
Severe Winter Weather	○	○	○
Earthquake	○	○	○
Wildfire	○	○	○
Tornado/Thunderstorm	○	○	○
Geological Hazards (Landslide, Sinkhole)	○	○	○
Dam Failure	○	○	○
Drought	○	○	○
Extreme Heat	○	○	○
Infectious Disease	○	○	○
Hazardous Materials Incident	○	○	○
Cyber Threat	○	○	○

6. Describe any specific hazard issues/problem areas that you would like the planning committee to consider

Enter your answer

7. Share any specific buildings/locations on campus that may be at heightened risk or should be prioritized for mitigation.

Enter your answer

8. Which categories of mitigation actions do you feel would be most effective?

- [ ] Prevention (e.g. planning, building codes and design standards)
- [ ] Property protection (e.g. retrofitting, insurance)
- [ ] Natural resource protection (e.g. wetlands or open space protection, erosion control)
- [ ] Emergency services (e.g. hazard warning systems, electronic notification systems)
- [ ] Structural projects (e.g. storm drain improvements, hazardous tree removal)
- [ ] Public Information & Outreach (e.g. public education, signage)

9. What is the best way to disseminate hazard information to students, faculty, and staff?

- [ ] Text message
- [ ] Email
- [ ] School website
- [ ] School social media
- [ ] Print media
- [ ] Other

Submit

The UNC Eastern Campuses received 119 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.

- The majority of responses came from individuals associated with ECSU, followed by UNC-P and NCSSM. All campuses had at least one associated response to the survey.
- Most respondents (62%) feel somewhat prepared for a hazard impacting their campus, but approximately 22% of respondents feel somewhat to very unprepared, while 16% feel very prepared.
- 48% of respondents do not know where storm shelters are located on their campus.
- 28% of respondents do not know where to get more information on hazard risk and preparedness. More outreach may be needed and it may be beneficial to pursue new methods of outreach.
- Hurricane was rated the most significant hazard, followed by infectious disease, flooding, tornado/thunderstorm, and cyber threat. Earthquake, dam failure, wildfire, geological hazards, and drought were rated the least significant hazards. Severe winter weather, extreme heat, and hazardous materials incidents received moderate risk ratings.
- Many respondents noted concerns related to flooding, including stormwater flooding issues and ice and freeze issues during the winter in floodprone areas. Cyber threat concerns were mentioned frequently, including the need for improved preparation and protection as well as communication to campus staff and students. Hurricane preparedness was also a common concern, as was the current COVID-19 pandemic. In both cases, respondents noted issues with sheltering in place, evacuation issues, and communication issues.
- Respondents favored prevention activities for mitigation; the least favored option was natural resource protection.
- Text message and email were the most preferred methods of communication for information on hazard events.

Figure B.1 – Survey Response, Campus Affiliation

1. What school/campus are you associated with?

More Details

East Carolina University	3
Elizabeth City State University	58
Fayetteville State University	6
North Carolina Central Univer...	2
North Carolina School of Mat...	19
North Carolina State University	2
UNC Chapel Hill	1
UNC Pembroke	24
UNC Wilmington	4

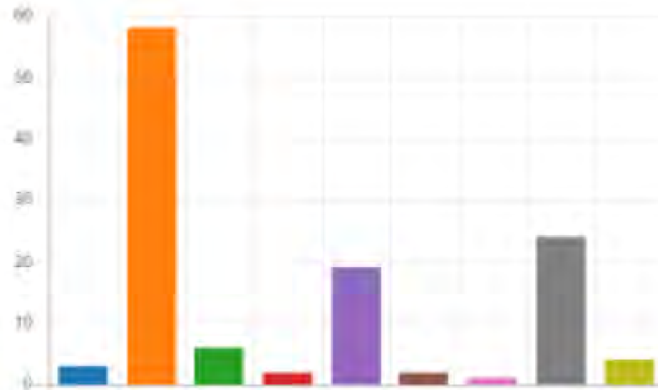


Figure B.2 – Survey Response, Preparedness

2. How prepared do you feel for a hazard event impacting your school/campus?

More Details

Very prepared	19
Somewhat prepared	73
Somewhat unprepared	16
Very unprepared	10

Figure B.3 – Survey Response, Evacuation Center/Shelter Awareness

3. Do you know where storm shelters are located at your school/campus?

More Details Insights

Yes	61
No	56

Figure B.4 – Survey Response, Knowledge of Where to Find Hazard Information

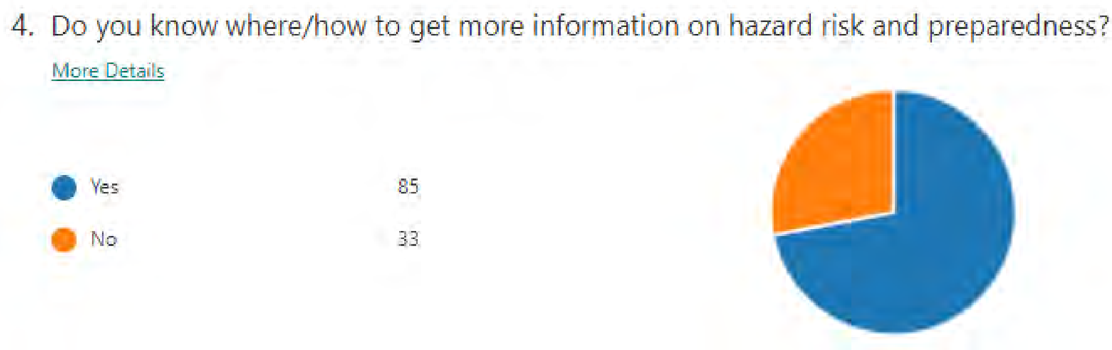


Figure B.5 – Survey Response, Hazard Significance Ratings

5. The hazards considered for this Hazard Mitigation Plan are listed below. For each hazard, indicate whether you feel it has a low, moderate, or high significance for the school/campus.

More Details

Figure B.6 – Survey Response, Key Hazard Issues/Concerns

6. Describe any specific hazard issues/problem areas that you would like the planning committee to consider

49 Responses

ID↑	Name	Responses
1	anonymous	Power failure and backup generation
2	anonymous	Special needs populations, preparedness, high dollar equipment protection, alternative learning methods for disasters
3	anonymous	Ground Bryan Telecom Room flooding; Lack of emergency power to ETC; Campus needs rekeying, as students have master keys; our telecom rooms are not always secure and access to them are not logged
4	anonymous	Shelter in place issues
5	anonymous	N/A
6	anonymous	Storm drain improvement; Tree pruning schedules; and Education and Awareness.
7	anonymous	The campus floods when it rains, sometimes even with small amounts of rain. Some of the drains aren't very effective and the certain areas in the road are underwater quickly.
8	anonymous	I would like for the planning committee to discuss the flooding issues on Campus. There are several roads that flood easily after any storm. During the winter, it rains often and the flood waters freeze and can create black ice. The planning team will need to identify these areas and make the neccesary corrections to solve these problems.
9	anonymous	None
10	anonymous	A plan to exit the general area in case of an emergency. Everyone should be told if they're in the vicinity of a certain building, they are required to exit out of certain gates of the campus.
11	anonymous	The windows in Viking towers cannot be opened, this is a major safety issue. If a fire was to break out and the residents couldn't get downstairs we would be stuck in the building.
12	anonymous	The current pandemic. We should not be in physical classes, especially classes with as many as 50 people.
13	anonymous	The impact of a hurricane compounded by COVID and social distancing regulations. What is the plan?
14	anonymous	communication strategies; logistic efficiency;
15	anonymous	N/a

16	anonymous	Due to the current pandemic, what are you doing to prepare for hazards as well promote social distancing measures? Can you effectively do both?
17	anonymous	Flooding
18	anonymous	N/A
19	anonymous	Flooding in entrances of buildings during rain and thunderstorms
20	anonymous	Pandemic and flood
21	anonymous	I do not live on campus and have not been down to visit the campus.
22	anonymous	A way to be able to keep student on campus that don't have anywhere to go instead of making everybody evacuate. We all don't have money, or the access to go back home whenever we choose to. Some of us all we have for food, shelter is school.
23	anonymous	None that I can think of.
24	anonymous	Old windows, gutters, and roofing are a serious threat for storm damage.
25	anonymous	Financial mitigation. The University was not prepared for the negative financial impact of the combination of a few years of poor athletic performance followed by a pandemic.
26	anonymous	Flooding and infectious disease
27	anonymous	Protests/mobs on campus Shelter in place during weather hazards - i.e., food issues, medication needs
28	anonymous	Mass exodus of population due to disaster such as toxic plume, sudden sea level rise, etc., including heavy traffic along Interstate escape routes.
29	anonymous	n/a
30	anonymous	Tornado and Hurricane
31	anonymous	Active Shooter Incident
32	anonymous	Today, cyber threats and infectious diseases are more prevalent uncommon threats that need to be explored more.
33	anonymous	Significant number or sick employees
34	anonymous	Mold in buildings affecting employees.

35	anonymous	Well considering we are under a cyber attack right now, I'd say they should have been better prepared for that. As of right now, we have no organized way of turning in work or doing online classwork. This is especially bad since we are in a current climate that most of the classes have moved online. We are in a hurricane prone area, yet I have not heard anything about hurricane preparedness from our campus. I don't live on campus so its not that big of a deal to me, but students who live on campus should readily know where to go in the event of sudden high winds and shelter on campus.
36	anonymous	Better Covid case tracking please...
37	anonymous	ECSU has had a recent Cyber incident this month that has not been clearly explained to employees. Therefore I think it is important to better prepare our campus leadership for how to be clear to employees about what is happening and to make sure that skilled an educated IT staff and proper technology are in place to protect our campus technology before something like this happens again.
38	anonymous	more info on tornado safety. one incident many people gathered around large windows.
39	anonymous	Our campus does not have appropriate buildings for the number of students
40	anonymous	N/A
41	anonymous	Covid 19 and Cyber attacks to Blackboard
42	anonymous	Cyber Threat, the key risks and mitigation (clear response and recovery plan)
43	anonymous	Infectious Disease. For example, we have been asked to have students and teachers on campus, and just yesterday the CDC updated COVID-19 guidelines to state that the virus is airborne through aerosol, even while breathing, and that it travels more than 6 feet.
44	anonymous	The flooding areas/zones throughout the campus and buildings on the campus. There are parking lots that flood when it rains and it causes a problem when parking. There are some buildings that need new roofs so that it doesn't leak when it rains.
45	anonymous	Covered above
46	anonymous	Wetlands and low lying areas
47	anonymous	The structural integrity of the facilities seems a hazard - rain comes into my office on occasion from the ceiling and lands on my desk, causing it to warp. The roof tiles in some places (and gutters) appeared to be falling down in places last year. Some of the plaster walls and ceilings are crumbling.
48	anonymous	More planning and sharing of those plans
49	anonymous	Flooding and water damage.

Figure B.7 – Survey Response, Personal Actions Taken for Mitigation

7. Share any specific buildings/locations on campus that may be at heightened risk or should be prioritized for mitigation.

45 Responses

ID↑	Name	Responses
1	anonymous	Cross Creek near Bryant Hall.
2	anonymous	1. Emergency Operations Center 2. Facilities Bldg.
3	anonymous	The Myrtle Grove campus (with CMS, Shellfish Hatchery, and MARBIONC) due to its proximity to the water. Also, the fin fish hatchery on Harbor Island.
4	anonymous	Smith Hall, butler building, Helen t chick building
5	anonymous	STEM due to high dollar equipment on first floor, air craft on airfield
6	anonymous	Bryan, ETC
7	anonymous	Williams Hall,
8	anonymous	Research Facilities, data centers, critical facilities
9	anonymous	N/A
10	anonymous	Locklear Hall: Flooding Auxiliary Services: Flooding Weinstein Health Science: Data Center, Research Oxendine Science: Data Center, Research Regional Center: Research Future Building West Hall: Cyber Security
11	anonymous	RESEARCH OR CLINICAL
12	anonymous	The road between Johnson Hall and Moore Hall, including the two buildings (there's a bad smell of mold in Johnson Hall, and the heating/air conditioning system does not work as it should). There's other areas prone to flooding like the walkways between Johnson Hall, and Lester and the Administrative building at the entrance of the campus by the police department. There could be other areas but I can't remember at this very moment.
13	anonymous	None
14	anonymous	That bottleneck road by the gym/tennis courts needs to be widen in case if a mass evacuation were mandated. Cars going in both directions could cause that cars behind each other to be potentially trapped.
15	anonymous	All residence halls
16	anonymous	Oxendine, Weinstein, Art, Old Main, ComTech

17	anonymous	Hazardous waste disposal storage site Chemical and biological safety research laboratories Licensed radiation spaces Animal Care Facility
18	anonymous	N/a
19	anonymous	Unknown at this time.
20	anonymous	West Hall
21	anonymous	Dorms
22	anonymous	NA
23	anonymous	I do not live on campus and have not been down to visit the campus.
24	anonymous	Library
25	anonymous	All freshman dorms.
26	anonymous	PEC, Hunt, ETC
27	anonymous	Watts building is the oldest building on campus and currently has some deferred maintenance that is critical to maintain the safety of those working and learning there.
28	anonymous	Ground Watts, Ground Reynolds
29	anonymous	Tornado combined with a pandemic would not be good, it would be impossible to social distance within the currently available shelter locations.
30	anonymous	Lumbee Hall is the main building for campus administration & student processes. I believe that makes this building a high priority for possible active shooter & protests.
31	anonymous	N/A
32	anonymous	Vaughan Center if used for an emergency shelter KE White if used for an emergency shelter Cafeteria and Information Technology buildings for continued operations through an emergency
33	anonymous	n/a
34	anonymous	Any of the dorm buildings
35	anonymous	All residence halls
36	anonymous	Information Technology Center and any other buildings with servers or technology that could cause a major negative impact to our campus if those systems were impacted again by a cyber threat.
37	anonymous	Vaughn center, Jenkins Science, STEM

38	anonymous	N/A
39	anonymous	Any spaces that tend to leak and may have a increase risk to community health
40	anonymous	Our classrooms and dorms are in the same buildings, and most of our campus is one giant building, so infectious disease can spread fairly quickly on most of our campus.
41	anonymous	McLendon Hall - because the building needs a new roof. It leaks in the offices when it rains. This can cause excessive damage to the property.
42	anonymous	It's an old campus and needs thorough renovation, especially Watts and BBR.
43	anonymous	A lot of buildings are old and leak every time it rains and there is occasional flooding.
44	anonymous	Reynolds Building Roofs are falling apart. The Ground Reynolds tunnel leaks and floods very easily as well. The library also has unfixed broken windows.
45	anonymous	Butler Bldg., Barber Bldg., Cook Bldg. Smith Hall, Joyner Hall, and Harris Hall

Figure B.8 – Survey Response, Preferred Mitigation Categories

8. Which categories of mitigation actions do you feel would be most effective?

More Details

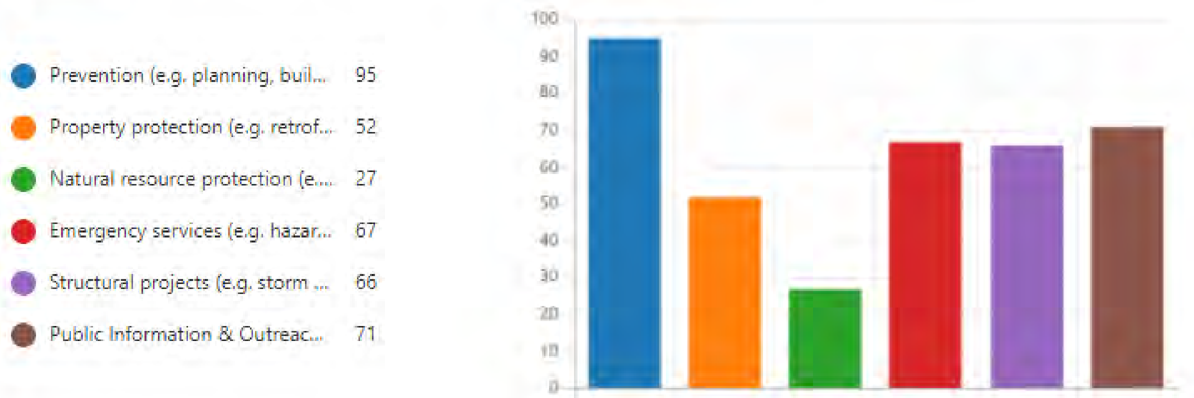
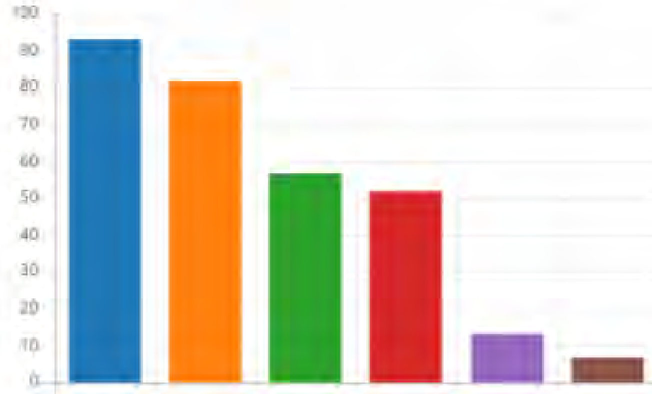


Figure B.9 – Survey Response, Preferred Public Outreach Methods

9. What is the best way to disseminate hazard information to students, faculty, and staff?

More Details

Text message	93
Email	82
School website	57
School social media	52
Print media	13
Other	7



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.

Table B.3 – Stakeholder List

First Name	Last Name	Organization, Title
Student Organizations		
Emmanuel	Butts	SGA President, ECSU
Abbey	Friday	Point of Contact for Student Planners Action Network
Tucker	Robbins	Student Body President, ECU SGA
Tiaquan	Pleasant	Student Body Point of Contact, FSU
Christopher	Paul	Advisor, International City/Council Management Association; Director MPA Program, NCCU
Brandon	Hedgebeth	Student Body President, NCCU
Megan	Mou	NCSSM Student Body President
Olivia	Vila	HazNerds President, NCSU
Melanie	Flowers	Student President, NCSU Student Government
Reeves	Moseley	Student Body President, UNC
Kerina	Patel	President, Carolina Urbanists
Cortrayia	Hardison	SGA President, UNCP
Matt	Talone	Student Body President, UNCW
Surrounding Municipalities		
Rebekah	Roth	Interim Planning Director, New Hanover County
Glenn	Harbeck	Director, Wilmington Planning, Development, and Transportation Department
Steven	Still	Director, New Hanover County Emergency Management
Vence	Harris	Coordinator, Town of Chapel Hill Emergency Management
Kirby	Saunders	EM Coordinator, Orange County
Jim	Groves	Director, Durham City Emergency Management
Leslie	O'Connor	Chief Emergency Manager, Durham County Emergency Management
Scott	Bullard	Coordinator, Fayetteville Emergency Management
Hendrix	Valenzuela	Coordinator, Cumberland County Emergency Management
Joshua	Creighton	Wake County Emergency Management Deputy Director
Kellen	Long	Planner II, Elizabeth City
Brian	Parnell	Coordinator, Pasquotank-Camden-Elizabeth City Emergency Management
Randy	Gentry	Emergency Manager, Pitt County
Chantae	Gooby	Chief Planner, City of Greenville
Whitney	Schoenfeld	Planning Supervisor, Raleigh Emergency Management
Tyler	Thomas	Town Manager, Planning Lead, Pembroke, NC
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		
Steve	Garrett	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
Hannah	Thompson-Welch	NC Forest Service, Wildfire Mitigation Specialist

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