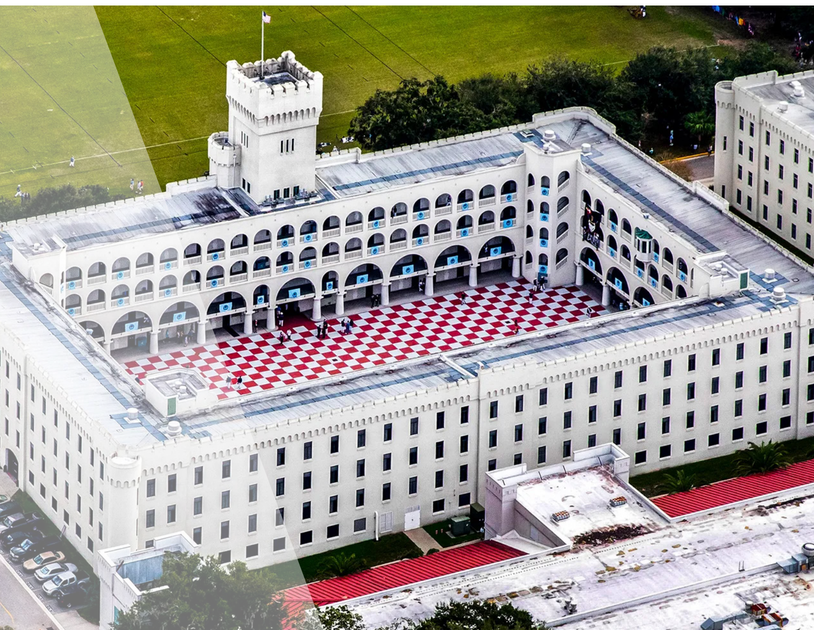
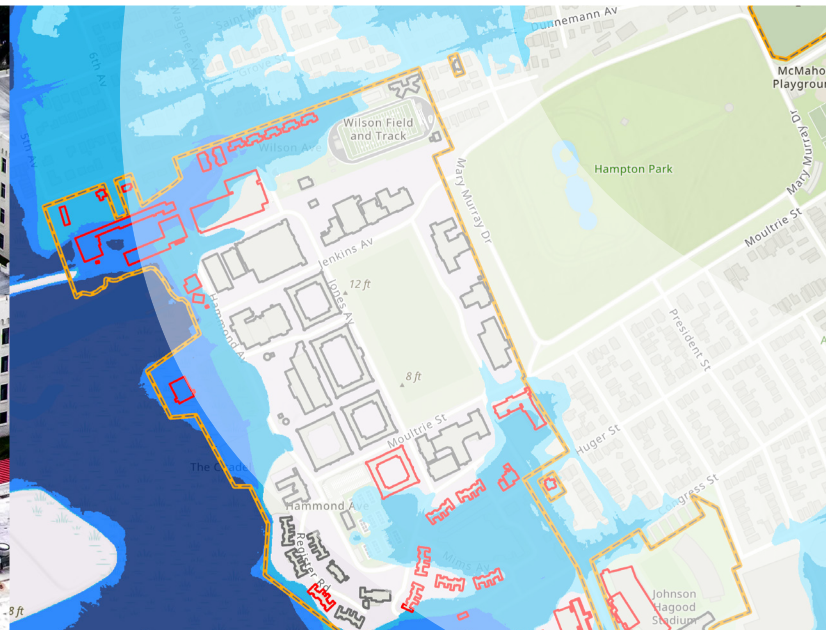
THE CITADEL

THE MILITARY COLLEGE OF SOUTH CAROLINA

The Citadel
Multi-Hazard Mitigation Plan





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EXECUTIVE SUMMARY

Background & Methodology

This document comprises a Multi-Hazard Mitigation Plan for The Citadel, The Military College of South Carolina, encompassing The Citadel's main campus and facilities.

As defined by FEMA, "hazard mitigation" means any sustained action taken to reduce or eliminate the long-term risk to life and property from a hazard event. Hazard mitigation planning is the process through which a community identifies hazard risk, determines likely impacts, and sets mitigation goals with actions to reduce vulnerability and exposure to those impacts.

The Disaster Mitigation Act of 2000 (DMA 2000) makes the development of a hazard mitigation plan a specific eligibility requirement for any local government applying for federal mitigation grant funds. In 2003, FEMA piloted its Disaster Resistant University (DRU) program to encourage higher education institutions to prepare and implement their own hazard mitigation plans and become eligible for FEMA funding similar to states and localities. This plan was prepared in coordination with FEMA Region 4, South Carolina Office of Resilience, and the South Carolina Emergency Management Division (SCEMD) and meets the requirements of both DMA 2000 and the DRU program.

Chapter 1 provides further information on the context, purpose, scope, and organization of this plan.

Planning Process

This plan was developed through a 10-step process aligned with the four phases of the DMA planning process: (1) Planning Process, (2) Risk Assessment, (3) Mitigation Strategy, and (4) Plan Maintenance. A Hazard Mitigation Planning Committee (HMPC) comprising members of strategic administrative and academic departments at The Citadel guided the planning process. The HMPC met four times to organize the planning process, review risk and capability assessment findings, develop mitigation goals and actions, and review the final draft plan. The planning process also involved gathering public input and coordinating with other related planning efforts.

Chapter 2 details the planning process with a description of each step in the process, a list of HMPC participants and their participation and expertise, and an explanation of how the public and additional stakeholders were involved.

Chapter 3 provides a profile of The Citadel campus including its geography, climate, history, resources, land use, demographics, and development trends. This profile provides the foundation upon which The Citadel's hazard risk and vulnerability assessment was prepared.

Risk Assessment Findings

The Hazard Identification and Risk Assessment (HIRA) is presented in Chapter 4. This chapter explains the hazard identification process, provides the asset inventory of campus exposure, and presents detailed profiles of all hazards identified as potential risks to The Citadel. Each hazard profile describes the hazard, approximates its spatial extent, reviews past occurrences, estimates the probability of future occurrences, analyzes potential consequences, and evaluates the vulnerability of campus assets through quantitative, qualitative, and spatial assessments, presenting loss estimates where possible.

The hazard profiles rank the priority of all potential hazards to The Citadel by calculating a Priority Risk Index (PRI), which rates varying degrees of risk for each hazard in five categories (probability, impact, spatial extent, warning time, and duration) and provides a standardized numerical value so that hazards can be compared against one another (the higher the PRI value, the greater the hazard risk).

The hazards profiled in this plan and their PRI ratings and resulting priorities are listed below. Hazards with a PRI score less than 2 are considered low priority, 2.0 to 2.9 are medium priority, and 3.0 or higher are high priority.

Hazard	Probability	Impact	Spatial Extent	Warning Time	Duration	PRI Score
Dam Failure	Unlikely	Limited	Moderate	>24 hours	<1 week	1.9
Drought	Highly Likely	Minor	Large	>24 hours	>1 week	2.8
Earthquake	Possible	Critical	Large	<6 hours	>1 week	3.1
Extreme Heat	Likely	Minor	Large	>24 hours	<1 week	2.4
Flood	Highly Likely	Critical	Large	6 to 12 hours	<1 week	3.5
Hurricane/Tropical Storm	Highly Likely	Critical	Large	>24 hours	<1 week	3.3
Sea Level Rise	Highly Likely	Limited	Small	>24 hours	>1 week	2.7
Severe Weather	Highly Likely	Minor	Large	6 to 12 hours	<6 hours	2.7
Sinkhole	Unlikely	Limited	Negligible	<6 hours	<6 hours	1.6
Tornado	Likely	Limited	Moderate	<6 hours	<6 hours	2.6
Tsunami	Unlikely	Critical	Large	<6 hours	<24 hours	2.6
Wildfire	Possible	Limited	Moderate	<6 hours	<1 week	2.5
Winter Weather	Likely	Limited	Large	12 to 24 hours	<1 week	2.7
Active Shooter	Possible	Catastrophic	Small	<6 hours	<6 hours	2.7
Civil Disturbance	Possible	Limited	Small	<6 hours	<1 week	2.3
Cyber Disruption	Possible	Critical	Large	<6 hours	<1 week	3.0
Hazardous Materials	Possible	Limited	Small	<6 hours	<1 week	2.2

Mitigation Strategy & Action Plan

Chapter 5 provides a detailed capability assessment, which determines 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. The capability assessment includes planning and regulatory capability, administrative and technical capability, as well as fiscal capability. The review contains an inventory of relevant plans, policies, or programs already in place; as well as an assessment of The Citadel's ability to implement existing and/or new policies. The capability assessment provides a foundation for identifying feasible, implementable mitigation actions.

Chapter 6 presents the mitigation strategy for The Citadel Multi-Hazard Mitigation Plan, including plan goals, the evaluation of mitigation alternatives, and prioritization criteria. The following goals were developed by the HMPC for this plan:

Goal 1: Reduce the vulnerability of the people and property of the College from the effects of natural and man-made hazards.

Goal 2: Safeguard the College's mission of education, outreach and engagement against natural or man-made hazards.

Goal 3: Preserve and strengthen protection of critical facilities and infrastructure through the implementation of mitigation actions to create a safer, more sustainable College.

Goal 4: Enhance campus education programs to raise awareness of and preparedness for hazard events.

Goal 5: Improve and coordinate mitigation activities with surrounding communities, non-profits and private businesses.

Chapter 7 presents the resulting Mitigation Action Plan developed based on the process and information outlined in the mitigation strategy.

Plan Adoption & Implementation

Chapter 8 contains the adoption resolution for the plan. The purpose of formally adopting this plan is to secure buy-in, raise awareness of the plan, and formalize the plan's implementation.

Implementation and maintenance of the plan is critical to the overall success of hazard mitigation planning. Chapter 9 describes the procedures for implementation and maintenance. The HMPC identified in Chapter 2 will convene annually and following a hazard event to review the plan, discuss progress toward implementation, and consider whether any revisions are needed. The HMPC will be responsible for facilitating, coordinating, and scheduling reviews and maintenance of the plan. The criteria recommended in 44 CFR 201 and 206 will be utilized in reviewing and updating the plan.

The HMPC will submit a five-year written update to SCEMD and FEMA Region 4, unless disaster or other circumstances (e.g., changing regulations) require a change to this schedule. With this plan update anticipated to be fully approved and adopted in 2023, the next plan update will occur in 2028.

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 develop a plan for public involvement and will be responsible for disseminating information through a variety of media channels detailing the plan update process.

1 INTRODUCTION

Chapter 1 provides a general introduction to hazard mitigation and an introduction to The Citadel Disaster Resistant University Multi-Hazard Mitigation Plan. This chapter consists of the following subsections:

- **1.1 Background**
- **1.2 Purpose and Need**
- **1.3 Scope**
- **1.4 Authority and References**
- **1.5 Organization of the Plan**

1.1 Background

Each year in the United States, natural disasters 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 disasters are predictable, and much of the damage caused by these events can be reduced or even eliminated.

In an effort to reduce the Nation's mounting natural disaster losses, the U.S. Congress passed the Disaster Mitigation Act of 2000 (DMA 2000) to invoke new and revitalized approaches to mitigation planning. Section 322 of DMA 2000 emphasizes the need for state and local government entities to closely coordinate on mitigation planning activities and makes the development of a hazard mitigation plan a specific eligibility requirement for any local government applying for federal mitigation grant funds. These funds include the Hazard Mitigation Grant Program (HMGP), the Pre-Disaster Mitigation (PDM) program, and the Flood Mitigation Assistance (FMA) Program, all of which are administered by the Federal Emergency Management Agency (FEMA) under the Department of Homeland Security. Communities with an adopted and federally approved hazard mitigation plan thereby become pre-positioned and more apt to receive available mitigation funds before and after the next disaster strikes. In 2003, FEMA piloted its Disaster Resistant University (DRU) program to encourage higher education institutions to prepare and implement their own hazard mitigation plans and become eligible for FEMA funding similar to states and localities.

This Plan was prepared in coordination with FEMA Region 4, the South Carolina Emergency Management Division (SCEMD), and the South Carolina Office of Resilience (SCOR) to ensure that it meets all applicable DMA 2000 planning requirements. A Local Mitigation Plan Crosswalk, found in Appendix A, provides a summary of FEMA's current minimum standards of acceptability and notes the location within the Plan where each planning requirement is met.

1.2 Purpose and Need

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

The purpose of this plan is to identify, assess and mitigate risk in order to better protect the people and property of The Citadel from the effects of natural and man-made hazards. This plan documents the hazard mitigation planning process and identifies relevant hazards and strategies the college will use to decrease vulnerability and increase resiliency and sustainability. This plan demonstrates The Citadel's commitment to reducing risks from identified hazards and serves as a tool to help decision-makers direct mitigation activities and resources. This Plan will ensure The Citadel's continued eligibility for federal disaster assistance, including the HMGP, PDM and FMA programs.

1.3 Scope

This document comprises a Multi-Hazard Mitigation Plan for The Citadel, The Military College of South Carolina. This is an update to the original hazard mitigation plan for The Citadel, which was approved by FEMA on October 6, 2017.

Due to the small geographic scope of The Citadel and the larger regional extent of many hazard events, many of the hazard profiles use county level data. This was done to ensure an accurate estimation of risk for The Citadel. The vulnerability assessment and mitigation actions are specific to The Citadel.

1.4 Authority and References

This plan was developed in accordance with current state and federal rules and regulations governing local hazard mitigation plans. The plan shall be reviewed annually and updated on a routine basis to maintain compliance with the following legislation:

- Section 322, Mitigation Planning, of the Robert T. Stafford Disaster Relief and Emergency Assistance Act, as enacted by Section 104 of the Disaster Mitigation Act of 2000 (P.L. 106-390); and
- FEMA's Interim Final Rule published in the Federal Register on February 26, 2002, at 44 CFR Part 201.

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. 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.
- FEMA. Local Mitigation Planning Policy Guide. Effective April 19, 2023.

1.5 Organization of the Plan

The Citadel Disaster Resistant University Multi-Hazard Mitigation Plan is organized as follows:

- Executive Summary
- Chapter 1 – Introduction
- Chapter 2 – Planning Process
- Chapter 3 – Campus Profile
- Chapter 4 – Hazard Identification and Risk Assessment
- Chapter 5 – Capability Assessment
- Chapter 6 – Mitigation Strategy
- Chapter 7 – Mitigation Action Plan
- Chapter 8 – Plan Adoption
- Chapter 9 – Plan Implementation and Maintenance
- Appendix A – Local Mitigation Plan Review Tool
- Appendix B – Planning Process Documentation
- Appendix C – Public Outreach Strategy
- Appendix D – Campus Building Occupancy Types
- Appendix E – References

2 PLANNING PROCESS

Chapter 2 provides an overview of the planning process used to develop The Citadel Multi-Hazard Mitigation Plan. It consists of the following subsections:

- **2.1 Participation**
- **2.2 The 10-Step Planning Process**

Requirement §201.6(b): An open public involvement process is essential to the development of an effective plan. In order 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 Disaster Resistant University Multi-Hazard Mitigation Plan was developed under the guidance of a Hazard Mitigation Planning Committee (HMPC). Information in this plan will be used to help guide and coordinate mitigation activities and decisions for campus growth and development in the future. Proactive mitigation planning will help reduce the cost of disaster response and recovery to The Citadel, its cadets, students, faculty and staff, and the surrounding community by protecting campus facilities, reducing liability exposure, and minimizing overall impacts and disruptions.

2.1 Participation

The DMA planning regulations and guidance stress that each entity 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 Citadel HMPC, “participation” meant the following:

- Providing facilities for meetings;
- Attending and participating in the HMPC meetings;
- Collecting and providing requested data (as available);
- 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 The Citadel.

The HMPC met all of the above participation requirements. The Committee included representatives of key Citadel administrative and academic departments. Table 2.1 details the HMPC members, departments represented, meeting dates, and individual meeting attendance records. A more detailed summary of HMPC meeting dates including topics discussed and meeting locations follows in Table 2.4. During the planning process, the HMPC members communicated through face-to-face meetings, email and telephone conversations. Draft documents were posted in a central location so that the HMPC members could easily access and review them. Although all HMPC members could not be present at every meeting, coordination was ongoing throughout the entire planning process.

TABLE 2.1 – HMPC MEETING ATTENDANCE RECORD

Member Name	Title	Department	Meeting Date			
			10/11/22	12/8/22	2/8/23	3/28/23
Abigail Hatch	Senior Accountant	Financial Services	✓	✓		
Amy Orr	Director of Auxiliaries	Auxiliary Services	✓	✓		✓
David Orr	Director of EHS/Emergency Management	Department of Public Safety	✓	✓	✓	✓
Glenn Easterby	Assistant VP of F&E	Facilities and Engineering		✓		
Jeff Well	Manager of IT Security	Information Technology				
Kevin Bower	Assistant Provost of Academics	Office of the Provost	✓	✓	✓	✓
Leah Schonfeld	Assistant VP of Human Resources	Human Resources		✓	✓	✓
Michael Turner	Director of Public Safety/Police Chief	Department of Public Safety	✓	✓	✓	✓
Preethi Saint	Associate VP for Finance	Finance	✓			
William Leggett	VP of OCM	Office of Communications and Marketing				
William Lind	Chief of Staff	Office of the President	✓	✓	✓	✓

Based on the area of expertise of each representative participating on the HMPC, Table 2.2 demonstrates each member's expertise in the six mitigation categories: Prevention, Property Protection, Natural Resource Protection, Emergency Services, Structural Flood Control Projects and Public Information.

TABLE 2.2 – STAFF CAPABILITY WITH SIX MITIGATION CATEGORIES

Community Department/Office	Prevention	Property Protection	Natural Resource Protection	Emergency Services	Structural Flood Control Projects	Public Information
Communications & Marketing						✓
Facilities & Engineering	✓	✓	✓		✓	
Public Safety				✓		

Appendix B provides additional documentation of the planning process that was implemented during the development of this HMP.

2.2 The 10-Step Planning Process

The planning process for preparing The Citadel Multi-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 Citadel chose to integrate a more detailed 10-step planning process based on FEMA's Community Rating System (CRS) program. Table 2.3 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 2.3 – 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

2.2.1 Phase I – Planning Process

2.2.1.1 Planning Step 1: Organize to Prepare the Plan

In alignment with the commitment to participate in the DMA and CRS planning processes, community officials worked to establish the framework and organization for development of the plan. A kick-off meeting was held with key Citadel representatives to discuss the organizational aspects of the plan development process and formation of the HMPC.

The formal HMPC meetings followed the 10 CRS Planning Steps. Meeting agendas and sign-in sheets for the HMPC meetings are included in Appendix B – Planning Process Documentation. The meeting dates and topics discussed are summarized below in Table 2.4.

TABLE 2.4 – SUMMARY OF HMPC MEETING DATES

Meeting Type	Meeting Topic	Meeting Date/Time	Meeting Location
HMPC #1	1) Introduction to DMA and CRS planning process 2) Organize resources: the role of the HMPC, planning for public involvement, and coordinating with other agencies and stakeholders	October 11, 2022 1:00pm – 2:00pm	Bond Hall, Rm. 514 Citadel Campus
HMPC #2	1) Review/discussion of Hazard Risk Assessment 2) Review/discussion of Vulnerability Assessment 3) Review and discussion of the capability assessment	December 8, 2022 11:00am – 12:00pm	Microsoft Teams
HMPC #3	1) Review and update the mitigation goals and existing mitigation actions 2) Discuss new mitigation action alternatives	February 8, 2023 11:00am – 12:00pm	Microsoft Teams
HMPC #4	1) Review “Draft” Hazard Mitigation Plan 2) Solicit comments and feedback from the HMPC	March 28, 2023 2:00 – 3:00pm	Bond Hall, Rm. 514 Citadel Campus

2.2.1.2 Planning Step 2: Involve the Public

Early in the planning process, the HMPC established a public outreach strategy to encourage public input and engagement in the plan update process. The HMPC agreed to an approach using established public information mechanisms and resources within the college. Public involvement activities for this plan update included press releases, stakeholder and public meetings, the collection of public and stakeholder comments on the draft plan, and a public questionnaire that was made available online to gather public input on the hazards of concern, areas of mitigation interest, and related preparedness. Nine responses to the public survey were received and are summarized in Appendix B.

The public meeting dates and topics discussed are summarized below in Table 2.5. As documented in Appendix B, a public notice was posted on The Citadel website and social media accounts prior to each public meeting inviting members of the public to attend.

TABLE 2.5 – SUMMARY OF PUBLIC MEETING DATES

Meeting Type	Meeting Topic	Meeting Date/Time	Meeting Location
Public Meeting #1	1) Introduction to DMA, CRS, DRU, and the planning process 2) Introduction to hazard identification	November 16, 2022 5:00 – 6:00PM	Microsoft Teams
Public Meeting #2	1) Review complete draft Hazard Mitigation Plan 2) Solicit comments and feedback from the public	March 28, 2023 5:00 – 6:00PM	Bond Hall, Rm. 514 Citadel Campus

Public feedback was presented to the HMPC for review and consideration. Specifically, public input from the survey informed development of the hazard identification and risk assessment. Public comments received via the survey and the second public meeting also informed the update of existing mitigation actions and the identification of new mitigation actions. See Appendix B for meeting minutes and a summary of the public survey, which detail input received from the public throughout the planning process.

2.2.1.3 Planning Step 3: Coordinate

Early in the planning process, the HMPC determined that the risk assessment and mitigation strategy development would be greatly enhanced by inviting other local, state and federal agencies and organizations to participate in the process. Coordination involved sending these stakeholders coordination letters asking for their assistance and input and telling them how to become involved in the plan development process. The list of stakeholders and an example coordination letter is provided in Appendix B.

Coordination with Other Planning Efforts and Hazard Mitigation Activities

The HMPC understood that coordination with other college/university and surrounding community planning efforts was also paramount to the success of this plan. Mitigation planning involves identifying existing policies, tools, and actions that will reduce risk and vulnerability to hazards. Integrating existing planning efforts and mitigation policies and action strategies into this plan establishes a credible and comprehensive plan that ties into and supports other university and community programs. The development of this plan incorporated information from the following existing plans, studies, reports, and initiatives as well as other relevant data from neighboring communities and other jurisdictions.

Resource Referenced	Use in this Plan
South Carolina Hazard Mitigation Plan, October 2018 Update	Used in Section 4 to identify relevant hazards
Charleston Regional Hazard Mitigation Plan, 2022 Update	Used in Section 4 to identify relevant hazards
Charleston All Hazards Vulnerability and Risk Assessment, 2020	Used in Section 5 to evaluate capability
The Citadel Master Plan, 2021	Used in Section 5 to evaluate capability
The Citadel Emergency Response Plan, December 2016	Used in Section 5 to evaluate capability
The Charleston City Plan (Comprehensive Plan), 2021	Used in Section 3 to identify land use trends
Flood Insurance Study Report: Charleston County, South Carolina and Incorporated Areas. January 29, 2021.	Used in Section 4 to evaluate flood risk and vulnerability and Section 5 to assess capability

These and other documents were reviewed and considered, as appropriate, during the collection of data to support Planning Steps 4 and 5, which include the hazard identification, vulnerability assessment, and capability assessment. Data from these plans was incorporated into the risk assessment and hazard vulnerability sections of the plan as appropriate. The data was also used in determining the capability of the college in being able to implement certain mitigation strategies. The Capability Assessment can be found in Chapter 5 – Capability Assessment.

2.2.2 Phase II – Risk Assessment

2.2.2.1 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. Various datasets were used to aid in determining hazards and vulnerabilities and where the risk varies across the planning area. Geographic information systems (GIS) were used to display, analyze, and quantify hazards and vulnerabilities.

The HMPC also conducted a capability assessment to review and document the college's current capabilities to mitigate risk from and vulnerability to hazards. By collecting information about existing programs, policies, regulations, and emergency plans, the HMPC could assess those activities and measures already in place that contribute to mitigating some of the risks and vulnerabilities identified. A more detailed description of the risk assessment process and the results are included in Chapter 4 – Hazard Identification and Risk Assessment. A more detailed description of the capability assessment process and the results is included in Chapter 5 – Capability Assessment.

2.2.3 Phase III – Mitigation Strategy

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

The intent of Goal Setting is to identify areas where improvements to existing capabilities (policies and programs) can be made so that vulnerability is reduced. Goals are also necessary to guide the review of possible mitigation measures. WSP facilitated brainstorming and discussion sessions with the HMPC that described the purpose and process of developing planning goals, 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 Chapter 6 - Mitigation Strategy.

2.2.3.2 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 complete draft was provided to the HMPC for review and comment. HMPC comments were integrated into the final draft for FEMA Region 4 to review and approve, contingent upon final adoption by The Citadel.

2.2.4 Phase IV – Plan Maintenance

2.2.4.1 Planning Step 9: Adopt the Plan

In order to secure buy-in and officially implement the plan, the plan was reviewed and adopted by The Citadel on the date included in the corresponding resolution included in Chapter 8 - Plan Adoption.

2.2.4.2 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, HMPC efforts have been directed at researching data, coordinating input from participating entities, and developing appropriate mitigation actions. Chapter 9 - Plan Maintenance provides an overview of the overall strategy for plan implementation and maintenance and outlines the method and schedule for monitoring, updating, and evaluating the plan. Chapter 9 also discusses incorporating the plan into existing planning mechanisms and how to address continued public involvement.

3 CAMPUS PROFILE

Chapter 3 provides a general overview of The Citadel campus and area of concern to be addressed in this plan. It consists of the following subsections:

- **3.1 Location and Setting**
- **3.2 Geography and Climate**
- **3.3 History**
- **3.4 Cultural and Natural Resources**
- **3.5 Land Use**
- **3.6 Population and Demographics**
- **3.7 Growth and Development Trends**

3.1 Location and Setting

The Citadel is located in Charleston, South Carolina, northwest of downtown Charleston on the peninsula between the Ashley and Cooper Rivers. The 300-acre campus sits on the bank of the Ashley River and is bordered to the east by Hampton Park and the Hampton Park Terrace neighborhood, to the north by the Wagener Terrace neighborhood, and to the south by the Westside neighborhood.

The Citadel campus is situated around Summerall Field. The western edge of Summerall Field, along Jones Avenue, is lined by the Murray, Padgett-Thomas, and Law Barracks, with the Watts and Stevens Barracks adjacent to the west and south of the Law Barracks. Behind the barracks are the infirmary, soccer field, and marksmanship center. Departmental and administrative buildings line Lee Street on the southern edge of Summerall Field, on the next block south on Richardson Street, and Jenkins Ave at the northern edge of Summerall Field. Behind these buildings, further north, are several practice fields and a gym facility. To the northwest corner of the field are the Field House, and the boating center, which has access to the Ashley River via a small dug channel through narrow marshland. The Citadel Bookstore, Summerall Chapel, and Daniel Library line the Avenue of Remembrance on the eastern edge of Summerall Field along with several campus landmarks including the Thomas Dry Howie Memorial Carillon and Tower, General Mark W. Clark's grave, and the Seraph Monument. Mary Murray Drive, parallel to the Avenue of Remembrance, separates The Citadel from neighboring Hampton Park. Holliday Alumni Center and the sport facilities at Johnson Hagood Stadium, Harmon Field Park, Stoney Park, and Joseph P. Riley Jr. Park are all further south along Fishburne Street. A base map for The Citadel campus is shown on the following page in Figure 3.1.

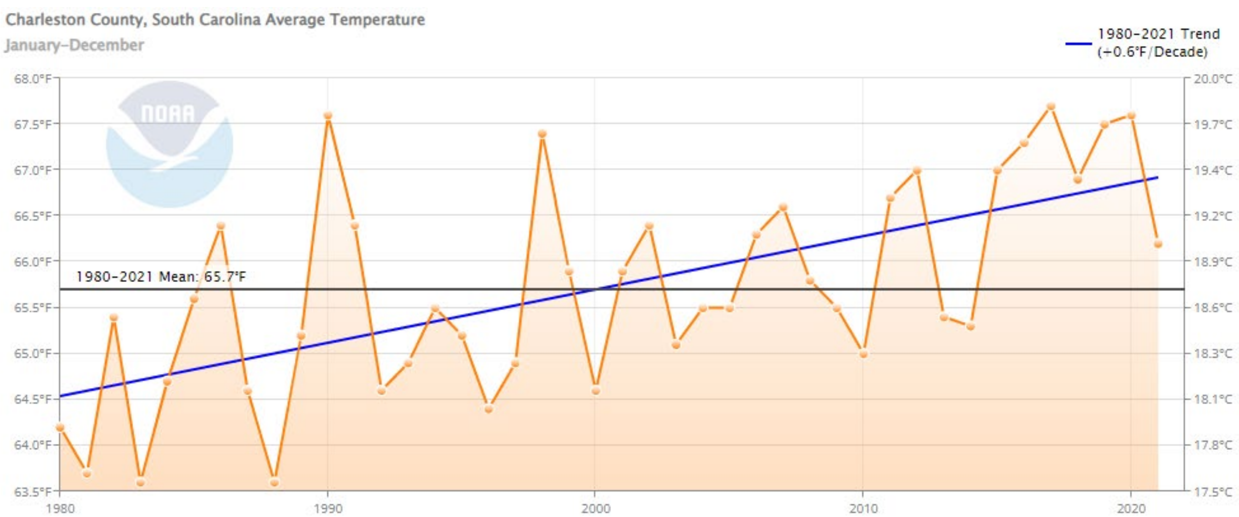
FIGURE 3.1 – CITADEL CAMPUS BASE MAP

3.2 Geography and Climate

The Charleston County region has a humid climate, the annual average temperature is 65.7 degrees. The mean high temperature is 75.8 and mean minimum temperature is 55.7. The annual precipitation for the county is approximately 51 inches per year.

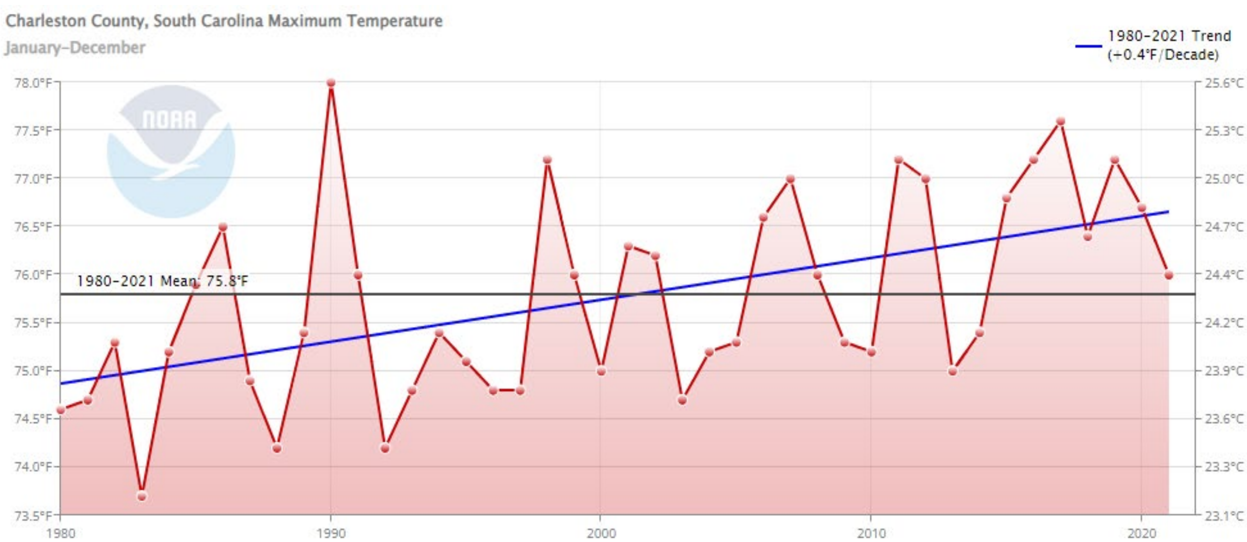
The following charts from the National Oceanic and Atmospheric Administration (NOAA) show the annual average temperature, average precipitation, average maximum temperature, and average minimum temperature for Charleston County from 1980 to 2021.

FIGURE 3.2 – AVERAGE TEMPERATURE TRENDS FOR CHARLESTON COUNTY, 1980-2021



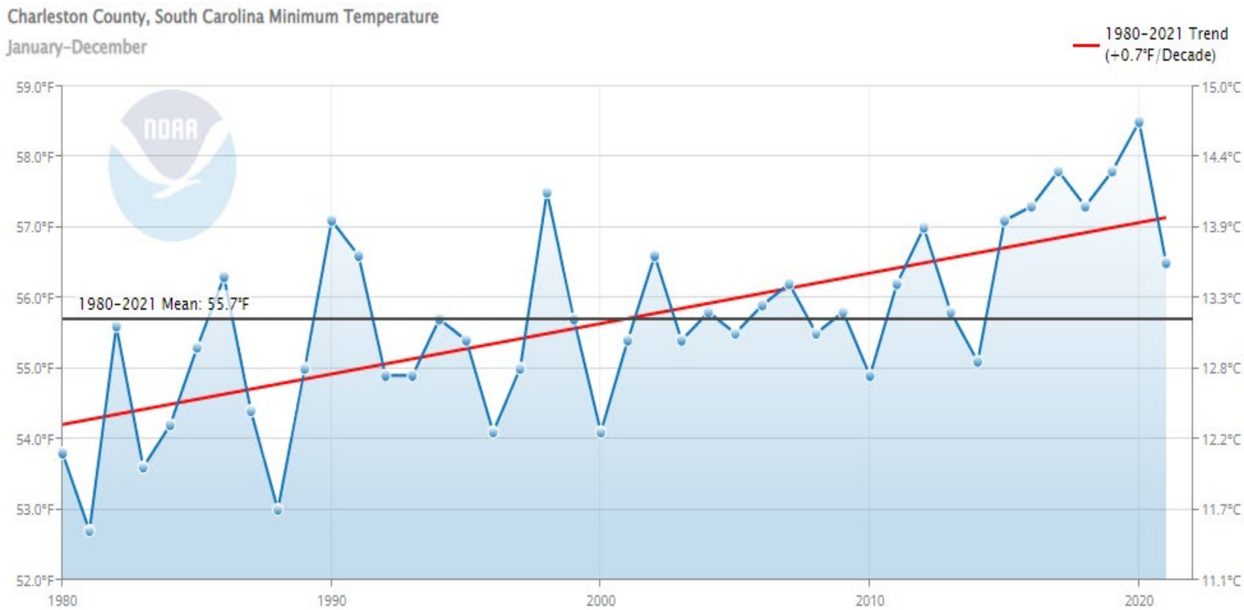
Source: Source: NOAA National Centers for Environmental information, Climate at a Glance: County Time Series, published August 2022, retrieved on August 15, 2022 from https://www.ncdc.noaa.gov/cag/

FIGURE 3.3 – MAXIMUM TEMPERATURE TRENDS FOR CHARLESTON COUNTY, 1980-2021



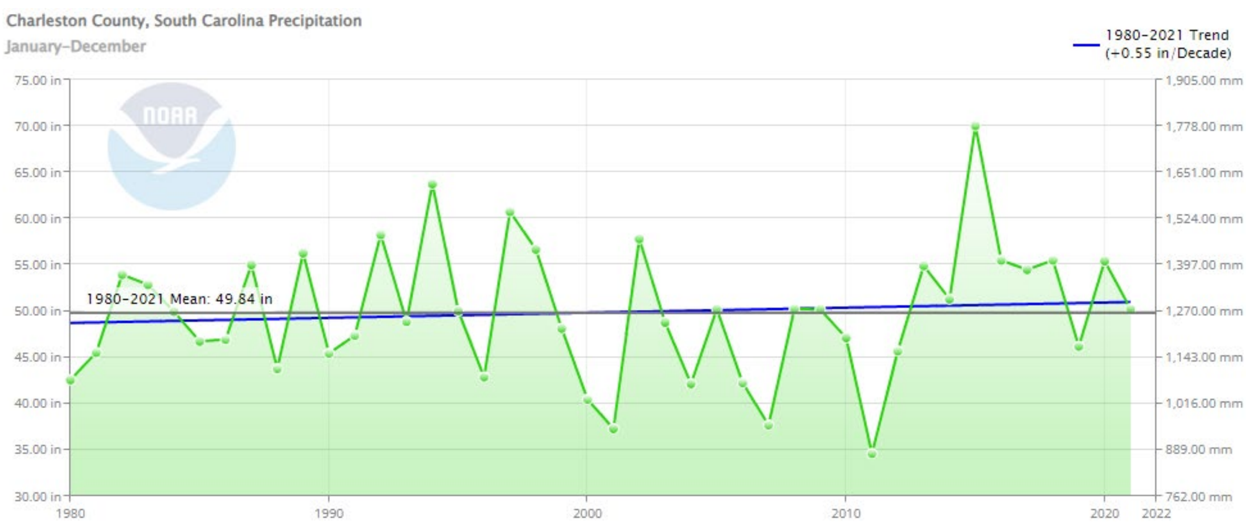
Source: Source: NOAA National Centers for Environmental information, Climate at a Glance: County Time Series, published August 2022, retrieved on August 15, 2022 from https://www.ncdc.noaa.gov/cag/

FIGURE 3.4 – MINIMUM TEMPERATURE TRENDS FOR CHARLESTON COUNTY, 1980-2021



Source: Source: NOAA National Centers for Environmental information, Climate at a Glance: County Time Series, published August 2022, retrieved on August 15, 2022 from https://www.ncdc.noaa.gov/cag/

FIGURE 3.5 – PRECIPITATION TRENDS FOR CHARLESTON COUNTY, 1980-2021



Source: Source: NOAA National Centers for Environmental information, Climate at a Glance: County Time Series, published August 2022, retrieved on August 15, 2022 from https://www.ncdc.noaa.gov/cag/

The Charleston County region is part of the low-lying Coastal Plain of South 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 Charleston is relatively flat and sits approximately 20 feet above sea level. The Ashley and Cooper Rivers meet at the Charleston Harbor, forming the peninsula where downtown Charleston is located. The Ashley River averages approximately 8.6 feet in elevation near North Charleston. The Cooper River averages an elevation of 6.4 feet.

3.3 History

Founded in 1842, The Citadel is a landmark military college in Charleston, South Carolina and the nation, noted for its educational reputation as well as its rich history. Originally located in downtown Charleston on Marion Square, by 1918, enrollment had outgrown the college's capacity. The City of Charleston offered the tract of land on the Ashley River adjacent to Hampton Park and a new campus was soon constructed. The Citadel officially moved to its Ashley River Campus in 1922 and there expanded both its enrollment and its academic programs. The Citadel established the undergraduate Evening College in 1966, and the Graduate School in 1968. The first African American Cadet enrolled at The Citadel in 1966 and the first women entered the South Carolina Corps of Cadets in 1996.

As a higher education institution, The Citadel's mission is to educate and develop its students to become principled leaders in all walks of life by instilling the core values of The Citadel in a disciplined and intellectually challenging environment. The Citadel is best known nationally for its Corps of Cadets which draws students from 42 states and a dozen countries. The men and women in the Corps live and study under a classical military system that makes leadership and character training an essential part of the educational experience. About one-third of the graduating classes accept military commissions.

The Citadel has an undergraduate student body of about 2,300 students who make up the South Carolina Corps of Cadets. Another 1,000 students attend The Citadel Graduate College, a civilian evening program that offers 25 graduate degrees with 15 concentrations, 25 graduate certificate programs, and 12 college transfer programs. Of the students outside the Corps of Cadets, a small percentage are veteran students who attend day classes with cadets.

The Citadel is divided into five academic schools: Business, Education, Engineering, Humanities & Social Sciences, and Science & Mathematics. The Citadel's main focus on higher education, its core values and leadership principles, and its prestigious reputation for a successful and high graduation rate supported by its strong Citadel Alumni support, have earned the #1 Public College in the South ranking in the Annual U.S. News & World Report college ranks.

3.4 Cultural, Historic, and Natural Resources

National Register of Historic Places

The City of Charleston has 108 listing on the National Register of Historic Places. Listing on the National Register signifies that these structures and districts have been determined to be worthy of preservation for their historical values. Historic places include several historic sites, buildings, and districts such as Ashley River Road and the Hampton Park Terrace Historic District, neighboring The Citadel campus.

Parks, Preserves, and Conservation

The City of Charleston is host to a myriad of islands, wetlands, creeks, rivers and harbors. The City currently owns and is responsible for 120 parks, including approximately 1,500 acres of parks and open space. Charleston 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 natural resources map can be found on the following page in Figure 3.2.

Waterbodies and Floodplains

The Citadel campus is on a peninsula of Charleston and sits on the coast of the Ashley River. Some vegetative open space borders the campus creating a small barrier between the buildings the river.

According to the Effective FIRMS, approximately 54 acres of the land on The Citadel campus is located within the special flood hazard area. Approximately 45.8 acres are designated as Zone AE, and 9 acres are designated as Unshaded Zone X.

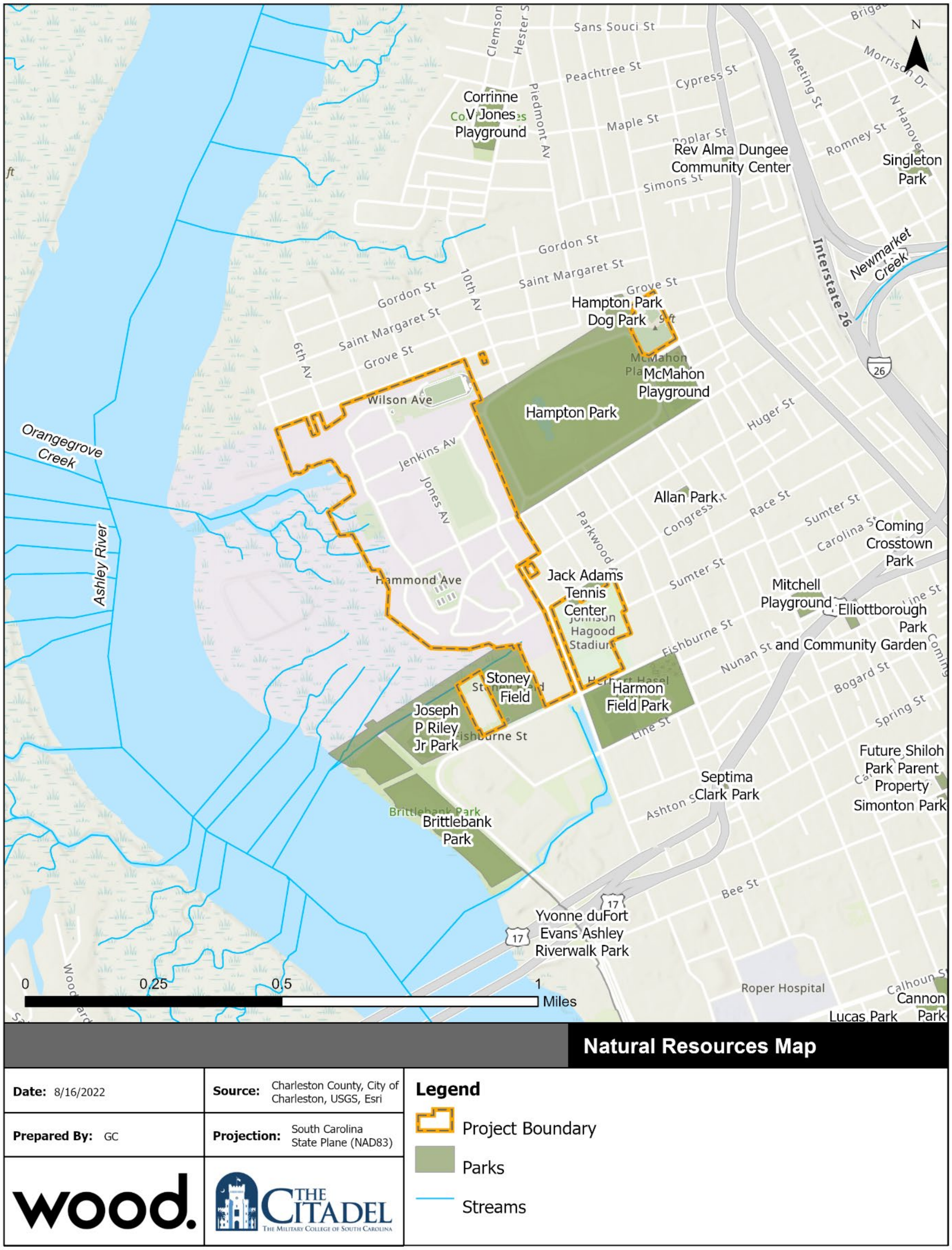
Natural and Beneficial Floodplain Functions: Under natural conditions, a flood causes little or no damage in floodplains. Nature ensures that floodplain flora and fauna can survive the more frequent inundations, and the vegetation stabilizes soils during flooding. Floodplains reduce flood damage by allowing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

Wetlands

Wetlands in Charleston generally follow the major hydrology and are found within areas that are deemed flood hazard areas which provide additional regulations that make these areas difficult to develop. According to the National Land Cover Database, the Citadel campus only contains a little over an acre of wetlands.

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.

FIGURE 3.6 – CITY OF CHARLESTON NATURAL RESOURCES



Threatened and Endangered Species

The U.S. Fish and Wildlife Service maintains a regular listing of threatened species, endangered species, species of concern, and candidate species for counties across the United States. Charleston County has 37 species that are listed with the U.S. Fish and Wildlife Services. Table 3.1 below shows the species identified as threatened, endangered, species of concern, or other classification for Charleston County.

TABLE 3.1 – THREATENED AND ENDANGERED SPECIES IN CHARLESTON COUNTY

Common Name	Scientific Name	Group	Federal Status
American chaffseed	*Schwalbea americana*	Flowering Plants	Endangered
Bachman's warbler	*Vermivora bachmanii*	Birds	Endangered
Bald eagle	*Haliaeetus leucocephalus*	Birds	Recovery
Black-capped petrel	*Pterodroma hasitata*	Birds	Proposed Threatened
Boykin's lobelia	*Lobelia boykinii*	Flowering Plants	Under Review
Canby's dropwort	*Oxypolis canbyi*	Flowering Plants	Endangered
Ciliate-leaf tickseed	*Coreopsis integrifolia*	Flowering Plants	Under Review
Eastern Black rail	*Laterallus jamaicensis ssp. jamaicensis*	Birds	Threatened
Eastern diamondback rattlesnake	*Crotalus adamanteus*	Reptiles	Under Review
American chaffseed	*Callophrys irus irus, C. i. hadros, C. i. arsace*	Insects	Status Undefined
Frosted Elfin	*Ambystoma cingulatum*	Amphibians	Threatened
Frosted Flatwoods salamander	*Carex lutea*	Flowering Plants	Endangered
Golden sedge	*Vermivora chrysoptera*	Birds	Under Review
Golden-winged warbler	*Lithobates capito*	Amphibians	Under Review
Gopher Frog	*Chelonia mydas*	Reptiles	Threatened
Green sea turtle	*Lepidochelys kempii*	Reptiles	Endangered
Kemp's ridley sea turtle	*Setophaga kirtlandii*	Birds	Recovery
Kirtland's Warbler	*Dermochelys coriacea*	Reptiles	Endangered
Leatherback sea turtle	*Myotis lucifugus*	Mammals	Under Review
Little brown bat	*Callophrys irus irus, C. i. hadros, C. i. arsace*	Reptiles	Threatened
Loggerhead sea turtle	*Caretta caretta*	Flowering Plants	Status Undefined
Long Beach seedbox	*Ludwigia brevipes*	Birds	Resolved Taxon
MacGillivray's Seaside sparrow	*Ammodramus maritimus macgillivraii*	Insects	Candidate
Monarch butterfly	*Danaus plexippus*	Mammals	Threatened
Northern Long-Eared Bat	*Myotis septentrionalis*	Birds	Threatened
Piping Plover	*Charadrius melodus*	Flowering Plants	Endangered
Pondberry	*Lindera melissifolia*	Mammals	Species of Concern
Rafinesque's big-eared bat	*Plecotus rafinesquii*	Birds	Threatened
Red knot	*Calidris canutus rufa*	Birds	Endangered
Red-cockaded woodpecker	*Picoides borealis*	Birds	Species of Concern
Saltmarsh Sparrow	*Ammospiza caudacuta*	Flowering Plants	Threatened
Seabeach amaranth	*Amaranthus pumilus*	Reptiles	Resolved Taxon
Southern hognose snake	*Heterodon simus*	Reptiles	Under Review
Spotted turtle	*Clemmys guttata*	Mammals	Under Review
Tricolored bat	*Perimyotis subflavus*	Mammals	Threatened
West Indian Manatee	*Trichechus manatus*	Birds	Threatened
Wood stork	*Mycteria americana*	Flowering Plants	Endangered

Source: U.S. Fish & Wildlife Service, August 2022 (https://ecos.fws.gov/ecp/report/species-listings-by-current-range-county?fips=45019)

3.5 Land Use

The Citadel campus is located within an area of the City of Charleston known as the Peninsula. The Peninsula is the urban center of Charleston (both the city and region) and contains the widest diversity of land uses and highest residential densities of anywhere in the city. According to the City of Charleston's comprehensive plan, institutional and industrial uses, combined, make up the majority (66%) of developed land area. Residential makes up around 33%.

The comprehensive plan notes that elevation analysis reveals that the highest parts of the Peninsula tend to be the areas already containing the highest intensity of uses. However other areas with higher elevation may experience an increase in density and mixed use. Areas with expected growth include the planned Magnolia development on the Ashley River, the blocks along the proposed Lowcountry Rapid Transit Route (LCRT), and others. The future bus rapid transit system will have planned hubs on the Peninsula and these areas can expect higher residential density infill and redevelopment.

However, 42% of the future land use in the Peninsula is planned to stay undeveloped or protected. Based on the City's future land use map, 3% of the land is designated for parks, 3% for low impact/conserved land, and 21% for natural space and wetlands. A future land use map for the Peninsula is shown on the following page in Figure 3.7.

FIGURE 3.7 – CITY OF CHARLESTON (PENINSULA) FUTURE LAND USE

Source: The City Plan, City of Charleston Comprehensive Plan 2021

3.6 Population and Demographics

Table 3.2 provides population counts and percent change in population since 2010 for Charleston County and City of Charleston.

TABLE 3.2 – POPULATION COUNTS FOR PARTICIPATING JURISDICTIONS

Jurisdiction	2010 Census Population	2020 Estimated Population	% Change 2010-2020
Charleston County	350,209	407,543	16.4
City of Charleston	120,083	137,041	14.1

Source: U.S. Census Bureau: 2010 Census & 2020 American Community Survey 5-Year Estimates

Table 3.3 provides population counts for The Citadel, including the number of full-time, part-time, and off-campus students, cadets, faculty, and staff.

TABLE 3.3 – POPULATION COUNTS FOR THE CITADEL, 2021

Group	2021 Population
Cadets	2,252
Graduate Students	975
College Transfer Students	265
Fifth Year Day Students	54
Active Duty Students	42
Off-Campus	13
Veteran Students (60)	60
Transient Students	32
Faculty	318
Staff	473
Student Total	**4,484**

Source: The Citadel Student Enrollment Profile, Fall 2021

Based on the 2020 ACS data, the median age of residents in the City of Charleston is 35.3. The racial characteristics of the County, City, and college are presented below in Table 3.4. White persons make up the majority of the population in each group. However, there is a much larger black and African-American population in Charleston County and the City of Charleston than at The Citadel.

TABLE 3.4 – DEMOGRAPHICS OF CHARLESTON COUNTY AND CITADEL STUDENTS

Jurisdiction	White	Black or African American	American Indian/Alaska Native	Asian	Hispanic or Latino	Two or More Races	Some Other Race/Unknown
Charleston County[1]	64.7%	26.0%	0.1%	1.6%	5.2%	2.0%	0.2%
City of Charleston[1]	71.4%	20.7%	0.1%	2.1%	3.6%	1.7%	0.3%
The Citadel[2]	76.1%	7.7%	0.3%	1.7%	6.6%	4.5%	1.8%
Cadets	77.4%	6.4%	0.22%	1.5%	7.3%	5.0%	0.22%
Graduate Students	77.4%	10.7%	0.21%	1.4%	4.1%	3.8%	1.4%

Source: U.S. Census Bureau, 2020 American Community Survey 5-Year Estimates

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

[2]Source: The Citadel Student Enrollment Profile, Fall 2021

According to The Citadel's Fall 2021 Student Enrollment Profile, 31.7 percent of students are from out of State. Around 76.8% of students are male, and a gender difference is most prominent in Cadet enrollment, where over 88% of Cadets are male. Conversely, 49.9% of graduate students are female. Data was not available on income levels and whether any of the campus population could be considered Low-to-Moderate Income.

Among the South Carolina Corps of Cadets, the most popular majors by enrollment are Business Administration with 13% of Cadets, Mechanical Engineering with 10%, and Criminal Justice with 6.8% of Cadets. The most popular graduate degree majors by enrollment are Business Administration (25.6%), and Clinical Psychology (8.2%).

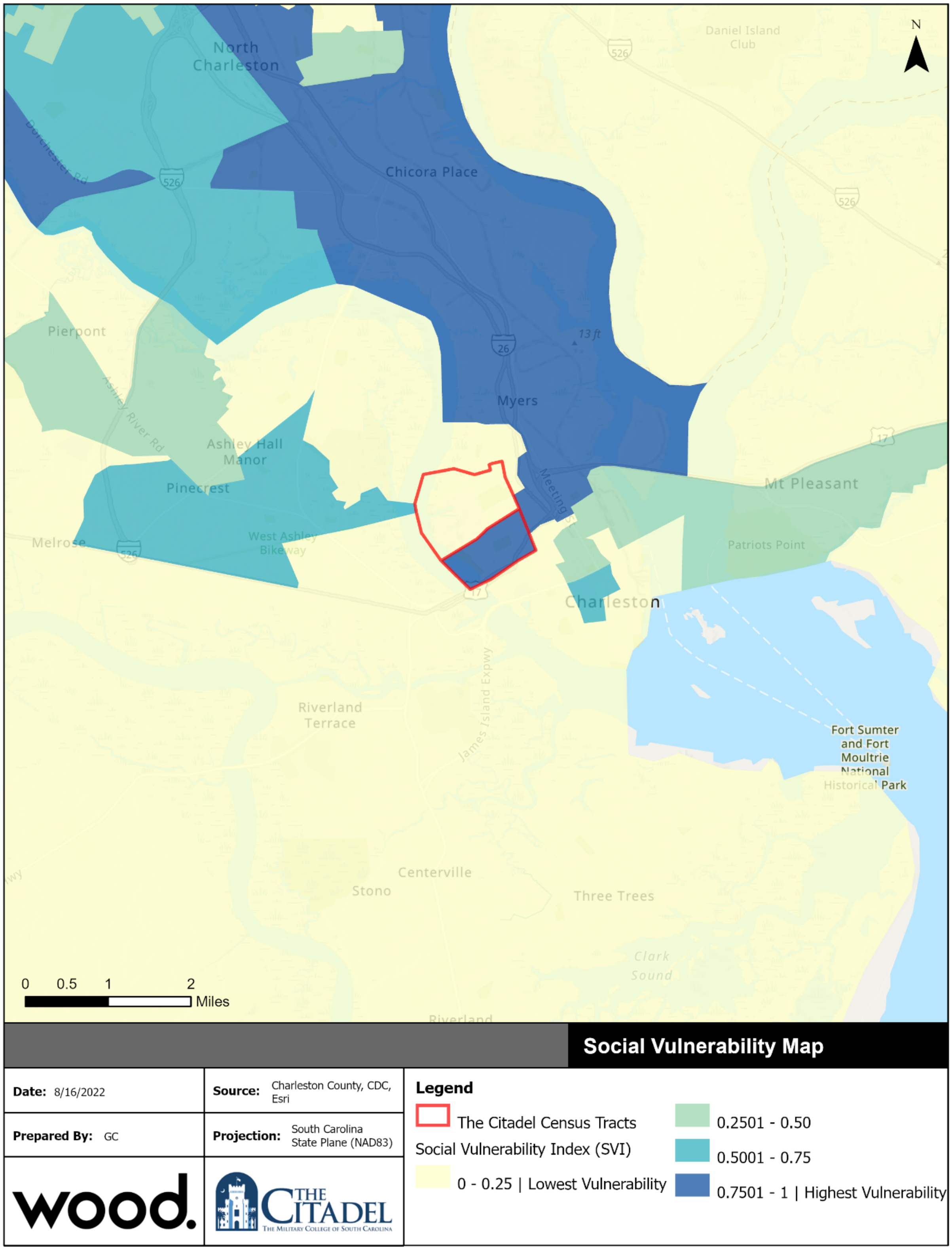
Social Vulnerability

Social vulnerability refers to the factors that may weaken a community's capacity to prepare for and respond to hazard events. Understanding where social vulnerability is higher and what factors are contributing to it can enable the community to mitigate that vulnerability and improve local resilience.

The Center for Disease Control and Prevention (CDC) has developed a social vulnerability index (SVI) to measure the resilience of communities when confronted by external stresses such as natural hazards. The SVI indicates the relative vulnerability within Census tracts based on 15 social factors: poverty, unemployment, income, education, age, disability, household composition, minority status, language, housing type, and transportation access. These factors are summarized into four themes: socioeconomic status, household composition/disability, race/ethnicity/language, and housing type/transportation. Using this SVI information can help the Village to prioritize pre-disaster aid, allocate emergency preparedness and response resources, and plan for the provision of recovery support.

Figure 3.8 shows the relative social vulnerability for the Census tracts around The Citadel campus according to SVI data. Per the CDC SVI information, social vulnerability is relatively low in Charleston County. Based, on the map below, vulnerability is highest in the northern portion of the County closer to North Charleston. The Citadel campus is split between the lowest vulnerability scores and highest, showing a stark contrast in vulnerability across the campus. While SVI is useful for assessing vulnerability for communities, the context and demographics of a college campus is significantly different.

FIGURE 3.8 – SOCIAL VULNERABILITY INDEX FOR SOUTH CAROLINA



3.7 Growth and Development Trends

According to the City of Charleston's Comprehensive Plan, the City of Charleston is the urban and geographic center of the Lowcountry region and is gaining in significance for the state and nation as it grows in population, and economic and cultural influence. The city has more than 7 million visitors annually and has recently become a destination for immigrants from all over the United States, but especially from the South and within the state itself.

The City of Charleston's population has increased consistently since 1980, with the greatest increase occurring in the last decade. According to US Census Population Estimates, since 2010, the city increased in population by approximately 14% overall and about 1.55% per year. However, this growth is not as rapid as most of the surrounding towns and cities.

Population density in the City of Charleston has remained relatively stable in recent decades. This is largely due to the city boundaries growing at a similar rate as the population. Between 1990 and 2000, about half the city's population growth was the result of annexation. In contrast, today most of the growth is occurring as a result of migration to the city. Table 3.5 shows historic population growth.

TABLE 3.5 – CITY OF CHARLESTON POPULATION GROWTH, 1990-2020

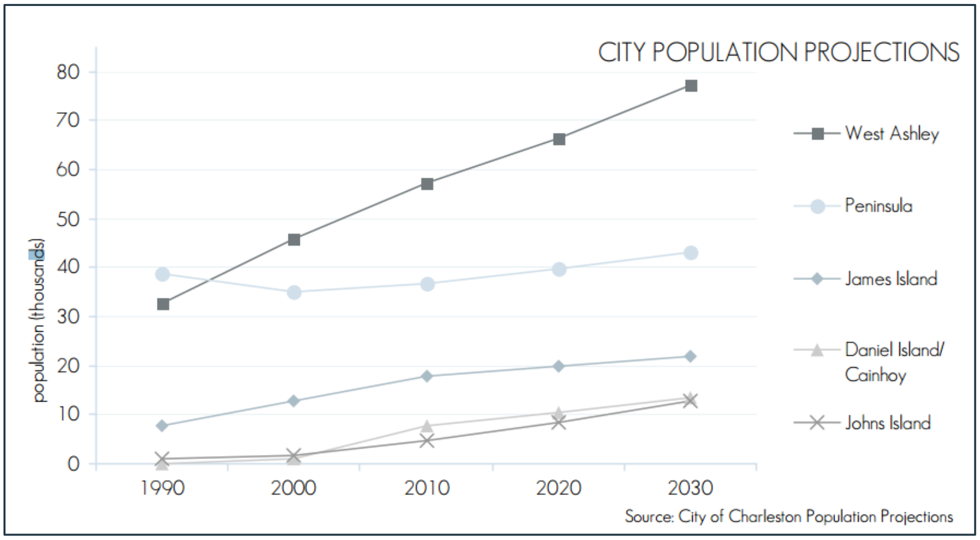
Year	Population	Growth	Percent Growth
1990	90,295	--	--
2000	96,650	6,355	7.0
2010	120,083	23,433	24.2
2015	127,694	7,611	6.3
2016	129,888	2,194	1.7
2017	131,204	1,316	1.0
2018	133,762	2,558	1.9
2019	135,257	1,495	1.1
2020	137,041	1,784	1.3

Source: U.S. Census Bureau

The Charleston peninsula, historically the population center of the city and the region, is the second-most populated land body in the city with an estimated 40,000 residents. Both the total number and percentage of population on the peninsula declined significantly after 1940 and was on a downward trend until 2000 when it began to tick back up and has recently seen a resurgence. The Peninsula gained the largest number of new residents between 2010 and 2020. Population density is the highest in the Peninsula at 4,735 per square mile. Figure 3.9 shows estimated population projections from the previous comprehensive plan for the Peninsula and other cities in Charleston.

Based on the City's comprehensive plan, the population of the peninsula will continue its upward trend. Additionally, the plan states that projections indicate most of the population will live outside the city center but will not extend significantly beyond existing urban and suburbanized areas. The plan predicts that infill development, more compact development patterns, changing housing markets, and City planning, and growth management policies may drive this trend.

FIGURE 3.9 – CITY OF CHARLESTON PROJECTED POPULATION GROWTH, 1990-2030



Source: Century V, City of Charleston Comprehensive Plan Update 2010

4 HAZARD IDENTIFICATION AND RISK ASSESSMENT

Chapter 4 identifies hazards that may affect The Citadel. This chapter also describes the Risk Assessment process for the development of The Citadel Hazard Mitigation Plan. It describes how the HMPC met the requirements of Planning Step 4: Assess the Hazard and Planning Step 5: Assess the Problem from the 10-step planning process. Data collected through this process has been incorporated into the following chapters of this plan:

- **4.1 Hazard Identification** identifies the natural and man-made hazards that threaten the planning area.
- **4.2 Risk Assessment Methodology** describes the approach to evaluating risk and vulnerability and outlines the format of each hazard profile.
- **4.3 Asset Inventory** identifies critical facilities and campus properties potentially at risk
- **4.4 Hazard Profiles, Analysis, and Vulnerability** discusses the threat to the planning area, describes previous occurrences of hazard events and the likelihood of future occurrences, and assess the planning area's vulnerability to the hazards.
- **4.5 Risk and Vulnerability Conclusions** summarizes the planning area's general vulnerability and provides an overall risk rating.

4.1 Hazard Identification

44 CFR Subsection D §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.

4.1.1 Overview

The Citadel is vulnerable to a wide range of natural and human-caused hazards. FEMA regulations and guidance under the Disaster Mitigation Act of 2000 (DMA 2000) require, at a minimum, an evaluation of a full range of natural hazards, but evaluation of human-caused hazards is not required for plan approval. However, The Citadel HMPC decided to include human-caused hazards in this plan to develop a comprehensive evaluation of risk and mitigation opportunities.

To identify hazards that may affect the campus, the HMPC began by reviewing the list of hazards that were included in the 2017 plan. This list was compared the state plan and other local plans relevant to The Citadel campus to develop a full range of hazards for consideration. Past hazard occurrences, disaster declarations, and information from the previous plan were reviewed to evaluate the significance of each hazard. With this information, a final determination was made on which hazards to include in the plan.

4.1.2 Full Range of Hazards Considered

To identify hazards relevant to the planning area, the HMPC began with a review of the list of hazards identified in the 2017 plan. This list was compared to the 2019 Charleston Regional Hazard Mitigation Plan and the 2018 South Carolina Hazard Mitigation Plan, as summarized in Table 4.1. The HMPC used these lists to identify a full range of hazards for potential inclusion in this plan update and to ensure consistency across these planning efforts. All hazards on the below list were evaluated for inclusion in this plan update.

TABLE 4.1 – FULL RANGE OF HAZARDS ADDRESSED

Hazard	Included in The Citadel 2017 HMP?	Included in 2019 Charleston Regional HMP?	Included in 2018 South Carolina HMP?
Coastal Hazards (Flooding & Sea Level Rise)	Yes	Yes	Yes
Dam Failure	Yes	Yes	Yes (with Floods)
Drought	Yes	No	Yes
Earthquake	Yes	Yes	Yes
Extreme Heat	Yes	No	Yes
Hurricane/Tropical Storm	Yes	Yes	Yes
Landslides	No	No	Yes
Severe Weather (Thunderstorm, Lighting, & Hail)	Yes	No	Yes
Tornado	Yes	Yes	Yes
Tsunami	Yes	Yes	Yes
Sinkhole	Yes	No	Yes
Wildfire	Yes	Yes	Yes
Winter Weather	Yes	No	Yes
Active Shooter	Yes	No	No
Civil Disturbance	Yes	No	No
Cyber Disturbance	No	No	Yes (with Terrorism)
Hazardous Materials	Yes	No	Yes
Terrorist Incident	No	Yes	Yes
Nuclear Facilities	No	No	Yes
Pandemic and Disease Outbreak	No	No	Yes

4.1.3 Past Occurrences and Disaster Declarations

The HMPC conducted a hazard identification study to determine the natural and human-caused hazards that threaten The Citadel campus. Existing hazard data from SCEMD, FEMA, University of South Carolina, National Oceanic and Atmospheric Administration (NOAA), and other sources were examined to assess 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.

To identify known hazards for this plan, the HMPC researched past severe weather reports that impacted the planning area. NOAA's National Centers for Environmental Information (NCEI) has been tracking severe weather since 1950. For some hazard types, records have been maintained since 1996. NCEI's Storm Events Database contains an archive of destructive storm or weather data and information which includes local, intense and damaging events. NCEI receives storm data from the National Weather Service (NWS). The NWS receives their information from a variety of sources, which include but are not limited to county, state and federal emergency management officials, local law enforcement officials, SkyWarn spotters, NWS damage surveys, newspaper clipping services, the insurance industry and the general public. This database contains 1,619 severe weather events that occurred in Charleston County between January 1950 and August 2022. Table 4.2 below summarizes these events.

TABLE 4.2 – CHARLESTON COUNTY NCEI STORM EVENTS, JANUARY 1950-AUGUST 2022

Type	# of Events	Property Damage	Crop Damage	Deaths (Direct)	Injuries (Direct)
Coastal Flood	204	$395,000	$0	0	0
Cold/Wind Chill	1	$0	$0	1	0
Excessive Heat	15	$0	$0	0	0
Flash Flood	220	$19,985,250	$0	0	3

Type	# of Events	Property Damage	Crop Damage	Deaths (Direct)	Injuries (Direct)
Flood	8	$22,500	$0	0	0
Frost/Freeze	1	$0	$0	0	0
Drought	20	$0	$0	0	0
Hail	291	$40,500	$0	0	0
Heat	9	$0	$0	7	5
Heavy Rain	5	$10,500	$0	0	0
Heavy Snow	19	$73,000	$0	0	0
High Surf	16	$204,000	$0	1	0
High Wind	14	$23,000	$0	0	0
Hurricane (Typhoon)	7	$0	$0	0	0
Ice Storm	7	$160,000	$0	0	0
Lightning	37	$1,230,000	$0	2	11
Storm Surge/Tide	6	$0	0	0	0
Strong Wind	48	$88,250	$1,000	3	3
Thunderstorm Wind	563	$950,100	$2,000	0	3
Tornado	50	$5,956,340	$0	0	17
Tropical Depression	7	$7,500	$0	0	0
Tropical Storm	64	$16,656,250	$0	0	2
Wildfire	3	$2,000,000	$0	0	0
Winter Storm	1	$0	$0	0	0
Winter Weather	3	$0	$0	0	0
Total:	**1,619**	**$47,802,190**	**$3,000**	**14**	**44**

Source: National Climatic Data Center Storm Events Database, August 2022

Table 4.3 presents a list of all major disaster declarations that have occurred in Charleston County since 1953. Disaster declarations provide a foundation for identifying which hazards pose the greatest risk to the region. Table 4.4 shows a list of emergency declarations.

TABLE 4.3 – FEMA MAJOR DISASTER DECLARATIONS, CHARLESTON COUNTY, 1953-2020

Disaster #	Dec. Date	Incident Type	Event Title
28	10/17/1954	Hurricane	Hurricane Hazel
44	08/20/1955	Hurricane	Hurricane
843	09/22/1989	Hurricane	Hurricane Hugo
1299	09/21/1999	Hurricane	Hurricane Floyd
1313	01/31/2000	Severe Storms	Winter Storms
1547	09/15/2004	Severe Storms	Tropical Storm Gaston
1566	10/07/2004	Hurricane	Tropical Storm Frances
4241	10/05/2015	Flood	Severe Storms, Flooding
4286	20/22/2016	Hurricane	Hurricane Matthew
4346	10/16/2017	Hurricane	Hurricane Irma
4394	09/16/2018	Hurricane	Hurricane Florence
4464	09/30/2019	Hurricane	Hurricane Dorian
4492	03/27/2020	Biological	Covid-19

Source: FEMA

TABLE 4.4 – FEMA EMERGENCY DECLARATIONS, CHARLESTON COUNTY

Disaster #	Dec. Date	Incident Type	Event Title/ Description
EM-3047	08/04/1977	Drought	Drought
EM- 3145	09/15/1999	Hurricane	Hurricane Floyd Emergency Declarations
EM-3233	09/10/2005	Hurricane	Hurricane Katrina Evacuation
EM-3369	02/12/2014	Severe Ice Storm	Severe Winter Storm
EM-3373	10/03/2015	Severe Storm	Severe Storms and Flooding
EM-3378	10/06/2016	Hurricane	Hurricane Matthew
EM-3386	09/07/2017	Hurricane	Hurricane Irma
EM-3400	09/10/2018	Hurricane	Hurricane Florence
EM-3421	01/09/2019	Hurricane	Hurricane Dorian
EM-3470	03/13/2020	Biological	Covid-19

Source: FEMA

4.1.4 Hazard Evaluation

Using the above information and additional discussion, the HMPC evaluated each hazard's significance to the planning area to decide which hazards to include in this plan update. Table 4.5 summarizes how and why the determination for each hazard was made.

TABLE 4.5 – SUMMARY OF HAZARD EVALUATION

Hazard	Included in this Plan Update?	How and why was determination made?
Coastal Hazards (Flooding and Sea Level Rise)	Yes	Flooding and Sea Level Rise were evaluated as separate hazards for this plan update. Both hazards are identified in the County and State plans and spatial data shows risk areas impacting The Citadel campus.
Dam/Levee Failure	Yes	Dam breach analysis from the previous HMP showed potential for impacts to The Citadel campus.
Drought	Yes	The previous plan rated dam failure as a moderate risk for The Citadel.
Earthquake	Yes	The previous plan rated earthquake as a high risk for The Citadel. The Charleston fault could generate a significant earthquake that would have major impacts on the entire region.
Extreme Heat	Yes	NCEI data indicates that extreme heat events have caused multiple deaths and injuries in Charleston County.
Hurricane/Tropical Storm	Yes	Several past disaster declarations for Charleston County have been related to hurricane events. The campus is at risk of wind and storm surge impacts.
Landslides	No	There is virtually no risk of landslides impacting the campus.
Severe Weather (Thunderstorm, Lighting, & Hail)	Yes	Charleston County has received disaster declarations in the past for severe storms. NCEI data reports numerous past severe weather related events in the planning area.
Tornado	Yes	NCEI data reports numerous past tornado events in Charleston County.
Tsunami	Yes	This hazard is included in the County and State plans and is carried forward despite very low probability.
Sinkhole	Yes	This hazard is included in the previous plan and the State plan as is carried forward despite low probability.
Wildfire	Yes	Southern Wildfire Risk Assessment data shows areas of risk and vulnerability on and near The Citadel campus

Hazard	Included in this Plan Update?	How and why was determination made?
Winter Weather	Yes	Charleston County has received a disaster declaration in the past for winter weather and ice.
Active Shooter	Yes	This threat was evaluated in the previous plan and was carried forward despite limited data available to assess risk.
Civil Disturbance	Yes	This threat was evaluated in the previous plan and was carried forward despite limited data available to assess risk.
Cyber Disruption	Yes	This hazard is briefly discussed in the State plan and vulnerability and risk facing colleges is increasing.
Hazardous Materials	Yes	Risk of this hazard remains, as hazardous materials are stored on campus and transported near the campus.

4.1.5 Hazard Identification Results

Below is the final list of hazards selected by the HMPC for inclusion in this plan:

Natural Hazards

- Dam Failure
- Drought
- Earthquake
- Extreme Heat
- Flood
- Hurricane/Tropical Storm
- Sea Level Rise
- Severe Weather (Thunderstorm, Lighting, & Hail)
- Sinkhole
- Tornado
- Tsunami
- Wildfire
- Winter Weather

Technical and Human Caused Hazards

- Active Shooter
- Civil Disturbance
- Cyber Disruption
- Hazardous Materials

4.2 Risk Assessment Methodology

> **44 CFR Subsection D §201.6(c)(2)(i):** [The risk assessment shall include a] description of the type, 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.

Chapter 4.2 through Chapter 4.5 describe and document how The Citadel met Step 4: Assess the Hazard, and Step 5: Assess the Problem from the 10-step planning process. Section 4.4 includes detailed hazard profiles with risk and vulnerability assessment data for each of the hazards identified in Section 4.1. The hazards identified in Chapter 4.1 - Hazard Identification, are profiled individually in this chapter.

- 4.4.1 Dam Failure
- 4.4.2 Drought
- 4.4.3 Earthquake
- 4.4.4 Extreme Heat
- 4.4.5 Flood
- 4.4.6 Hurricane & Tropical Storm (Storm Surge & Wind)
- 4.4.7 Sea Level Rise
- 4.4.8 Severe Weather (Thunderstorm Wind, Lightning, & Hail)
- 4.4.9 Sinkhole
- 4.4.10 Tornado
- 4.4.11 Tsunami
- 4.4.12 Wildfire
- 4.4.13 Winter Weather
- 4.4.14 Active Shooter
- 4.4.15 Civil Disturbance
- 4.4.16 Cyber Disruption
- 4.4.17 Hazardous Materials

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 following section presents detailed hazard profiles for each of the hazards identified in Section 4.1 as significant enough to warrant further evaluation. Each hazard profile includes a general description of the hazard, its location, extent, past occurrences, and the probability of future occurrences as well as a detailed vulnerability assessment identifying the assets at risk and potential loss estimates. Each profile also includes specific items noted by members of the HMPC as they relate to unique historical or anecdotal hazard information for the planning area.

The hazard risk assessment covers the geographical area of The Citadel campus but also includes data for Charleston County and the City of Charleston. The risk assessment process identifies and profiles relevant hazards and assesses the exposure of lives, property, infrastructure, and other assets to these hazards. The process allows for a better understanding of the potential risks natural hazards pose to The Citadel 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:

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 losses to life or property. A consequence analysis was also completed for each hazard. Each hazard is profiled in the following format:

Hazard Description

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

Location

This section includes information on the hazard physical extent, describing where the hazard can occur with mapped boundaries where applicable.

The Citadel is located northwest of downtown Charleston, within the Charleston city limits. Because of the large geographical extent of hazard events, it is generally assumed that hazard risks are similar across the County, and that therefore the County is a reasonable level of analysis for understanding The Citadel's risks. The following hazard profiles and risk assessments are frequently based on data for past hazard events in Charleston County. In some cases, analysis is based on data for the City of Charleston alone. When analyzing the potential consequences of these hazards, the focus is returned to The Citadel planning area. In many cases, the discussion also includes widespread impacts such as those on the economy or the surrounding built environment, as they may have secondary impacts on The Citadel.

Extent

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

Past Occurrences

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

Probability of Future Occurrence

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

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

Climate Change and Future Conditions

For profiles of natural hazards, this section provides a summary of how climate change may be expected to alter the hazard based on current available research. This section also addresses potential for other future conditions, such as changes in population and development, to affect the hazard.

Regional Climate Change Projections

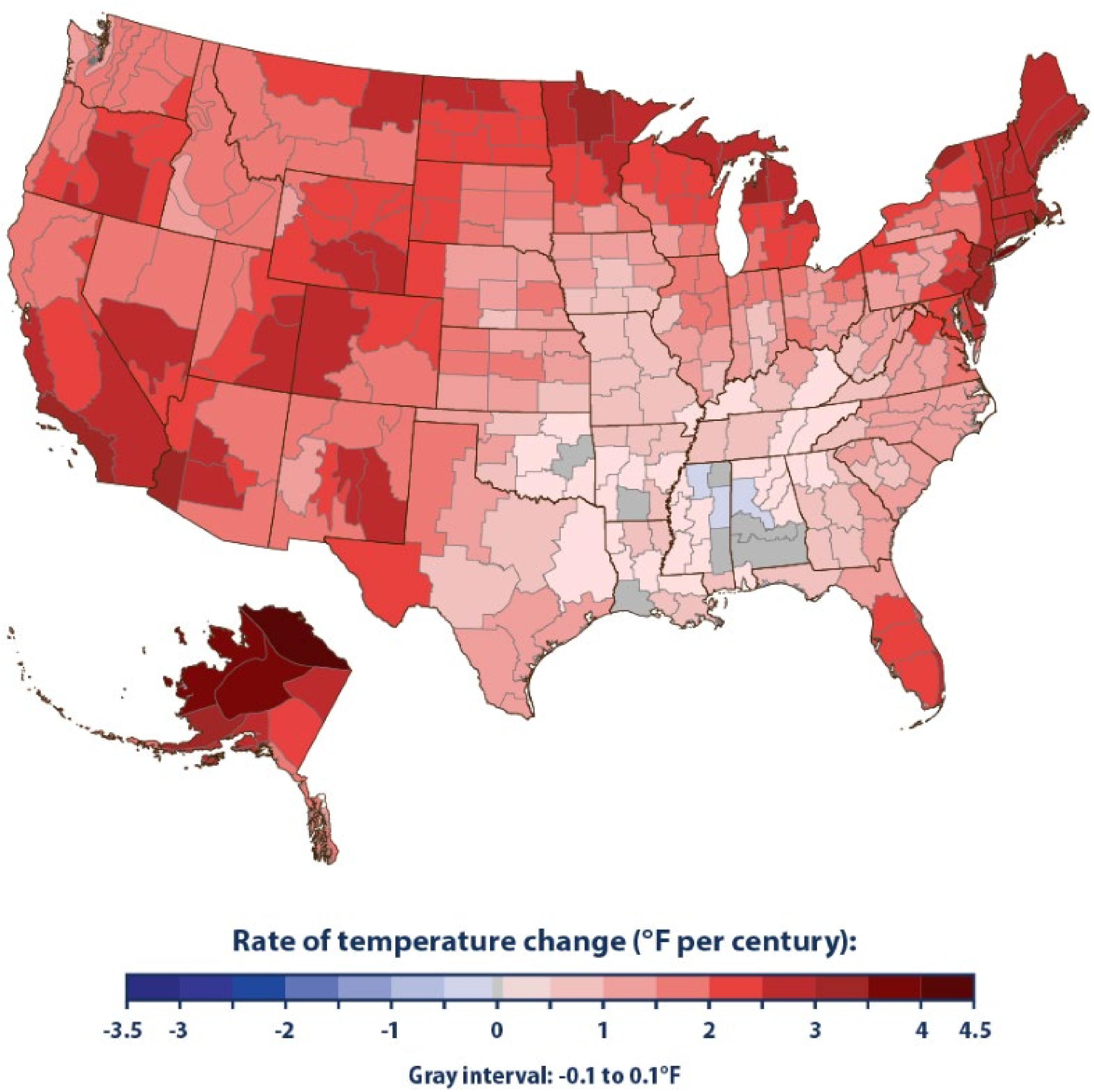
Climate change refers to long-term shifts in temperature and weather patterns. Climate change can be due to natural internal processes or external forces such as modulations of the solar cycles, volcanic eruptions, and persistent anthropogenic changes in the composition of the atmosphere or in land use (IPCC, 2014). However, the recent and rapid warming of the earth that has been observed over the past century has been cause for concern, as this warming is due to the accumulation of human-caused greenhouse gases, such as CO2, in the atmosphere (IPCC, 2007). Global average temperature is estimated to have increased by about 1 degree Celsius since the pre-industrial period, and it is currently increasing by about 0.2 degrees Celsius per decade. This global increase in temperatures is having broad range of effects on global, regional and local climates.

Since 1901, the average surface temperature across the contiguous 48 states has risen at an average rate of 0.17°F per decade. Average temperatures have risen more quickly since the late 1970s (0.32 to 0.55°F per decade since 1979). Nine of the top 10 warmest years on record for the contiguous 48 states have occurred since 1998, and six of the warmest years on record have all occurred since 2012. As of January 2022, the average contiguous U.S. temperature was 54.5°F, 2.5 degrees above the 20th-century average and 2021 ranked as the fourth-warmest year in the 127-year period of record. (NOAA NCEI, 2022).

According to the Fourth National Climate Assessment, the Southeast region experienced high annual average temperatures in the 1920s and 1930s, followed by cooler temperatures until the 1970s. Since then, annual average temperatures have warmed to levels above the 1930s. The decade of the 2010s through 2017 has been warmer in the Southeast than any previous decade both for average daily maximum and average daily minimum temperature.

Figure 4.1, based on data from NOAA and prepared by the EPA, shows how annual average air temperatures have changed in different parts of the United States since 1901.

FIGURE 4.1 – RATE OF TEMPERATURE CHANGE, 1901-2021



Alaska data start in 1925.

Data source: NOAA (National Oceanic and Atmospheric Administration). 2022. Climate at a glance. Accessed February 2022. www.ncdc.noaa.gov/cag.

For more information, visit U.S. EPA's "Climate Change Indicators in the United States" at www.epa.gov/climate-indicators.

Source: NOAA, Climate at a Glance, 2022; https://www.ncdc.noaa.gov/cag

According to the IPCC, the extent of climate change effects on individual regions will vary over time and with the ability of different societal and environmental systems to mitigate or adapt to change. The Fourth

National Climate Assessment explains that "throughout the southeastern United States, the impacts of sea level rise, increasing temperatures, extreme heat events, heavy precipitation, and decreased water availability continue to have numerous consequences for human health, the built environment, and the natural world." It can reasonably be assumed that the following climate risks could impact The Citadel planning area: 1) increasing temperatures; 2) increasing frequency and strength of severe weather events; 3) more heavy rain/flooding; and 4) more frequent and prolonged drought. A discussion of the effect of these climate risks on the individual hazards profiled in this plan has been included in the Probability of Future Occurrence section for each hazard as applicable.

Consequence Analysis

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

Hazard significance was determined by frequency of the hazard and resulting damage, including deaths/injuries and property and economic damage. Hazards occurring infrequently or having little to no impact on the planning area were determined to be of low significance and not considered a priority hazard in need of further evaluation. Those hazards determined to have a higher likelihood of future occurrence or likely to result in significant damage were characterized as priority hazards that required further evaluation in the vulnerability assessment. These criteria allowed the HMPC to prioritize hazards of greatest significance and focus resources where they are most needed. See Section 4.5.1 for the Hazard Profile Summary.

Vulnerability Assessment

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.

The Disaster Mitigation Act regulations require that the HMPC evaluate the risks associated with each of the hazards identified in the planning process. This section summarizes the possible impacts and quantifies The Citadel's vulnerability to each hazard.

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

The HMPC conducted a vulnerability assessment of the hazards identified as a priority in order to assess the impact that each hazard would have on the region. The vulnerability assessment quantifies, to the extent feasible using best available data, assets at risk to natural hazards and estimates potential losses.

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

- Campus Geographic Information System (GIS) datasets, including building footprints, topography, aerial photography, and transportation layers;
- Hazard layer GIS datasets from state and federal agencies;
- Written descriptions of inventory and risks provided by the State Hazard Mitigation Plan; and
- Written descriptions of inventory and risks provided by the County Hazard Mitigation Plan.

Two distinct risk assessment methodologies were used in the formation of this vulnerability assessment. The first consists of a ***quantitative*** analysis that relies upon best available data and technology, while the second approach consists of a somewhat ***qualitative*** analysis that relies on local knowledge and rational decision making. The quantitative analysis involved the use of the most recent version of Hazards U.S. Multi-Hazard (Hazus) software, a nationally applicable standardized set of models available from FEMA 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.

Problem Statements

This section summarizes key mitigation planning concerns related to each hazard. Where possible, statements of specific problems and issues that could be addressed through mitigation are provided.

Priority Risk Index

The conclusions drawn from the hazard risk and vulnerability assessment process can be used to prioritize all potential hazards to The Citadel planning area.

The findings from the above sections of the hazard profiles are summarized using the Priority Risk Index (PRI) to score and rank each hazard's significance to the planning area. The PRI 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 in five categories (probability, impact, spatial extent, warning time, and duration). Each degree of risk is assigned a value (1 to 4) and a weighting factor as summarized in Table 4.6.

TABLE 4.6 – 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 flood hazards as high, moderate, or low risk. This process allowed the HMPC to focus on the hazards of greatest significance and to prioritize mitigation actions appropriately, allowing The Citadel to focus resources where they are most needed.

PRI ratings are provided by category throughout each hazard profile, and a summary of each hazard's PRI score is provided at the beginning of each hazard profile. The results of the risk assessment and overall PRI scoring are provided in Section 4.5.

4.3 Asset Inventory

An inventory of assets was compiled to identify those structures potentially to risk from the identified hazards. The asset inventory includes primary campus buildings as well as critical facilities and infrastructure. By understanding the type and number of assets that exist and where they are located in relation to known hazard areas, the relative risk and vulnerability for such assets can be assessed.

4.3.1 Properties at Risk

The property inventory was compiled using building footprints and parcel data from Charleston County and property insurance assessment data from the South Carolina Insurance Reserve Fund. Charleston County data included 104 buildings within The Citadel campus boundary, of which 82 were primary buildings with associated insurance assessment information. The remaining 22 footprints were for smaller structures and outbuildings and where therefore not included in the property inventory. This information is summarized in Table 4.7 in terms of the number of buildings by occupancy type and the total assessed value of improvements that may be exposed to the identified hazards. The 82 primary buildings were classified into FEMA occupancy types to support Hazus risk analysis. The building footprint data was used to provide an accurate assessment of building locations relative to hazard areas. A detailed inventory of campus buildings and their insurance assessment information is provided in Appendix D.

TABLE 4.7 – CITADEL PROPERTIES AT RISK

Occupancy Type	Total Number of Buildings	Total Building Value	Estimated Content Value	Total Value
Agricultural	1	$56,500	$2,600	$59,100
Commercial	16	$67,131,500	$4,433,060	$71,564,560
Education	23	$214,947,500	$50,108,350	$265,055,850
Government	0	$0	$0	$0
Industrial	12	$7,920,300	$3,114,050	$11,034,350
Religious	2	$8,861,440	$466,830	$9,328,270
Residential	28	$108,807,400	$7,197,500	$116,004,900
Total	**82**	**$407,724,640**	**$65,322,390**	**$473,047,030**

Source: The Citadel, 2022

Note: Cost and contents value were obtained from each building's insurance assessment data, so content values were not calculated using the HAZUS standard methodology of multipliers by occupancy code.

4.3.2 Critical Facilities at Risk

Of significant concern with respect to any disaster event is the location of critical facilities in the planning area. Critical facilities are often defined as those essential services and facilities in a major emergency which, if damaged, would result in severe consequences to public health and safety or a facility which, if unusable or unreachable because of a major emergency, would seriously and adversely affect the health, safety, and welfare of the public. Critical facilities are summarized by type and total structure value in Table 4.8. A full inventory of identified critical facilities and infrastructure is provided in Table 4.9 and their locations are shown Figure 4.2.

TABLE 4.8 – CITADEL CAMPUS CRITICAL FACILITIES

Facility Type	Count	Structure Value
Medical/Infirmary	1	$3,393,500
Police Station	1	$1,175,200
Utilities	8	$3,505,200
Total	**10**	**$8,073,900**

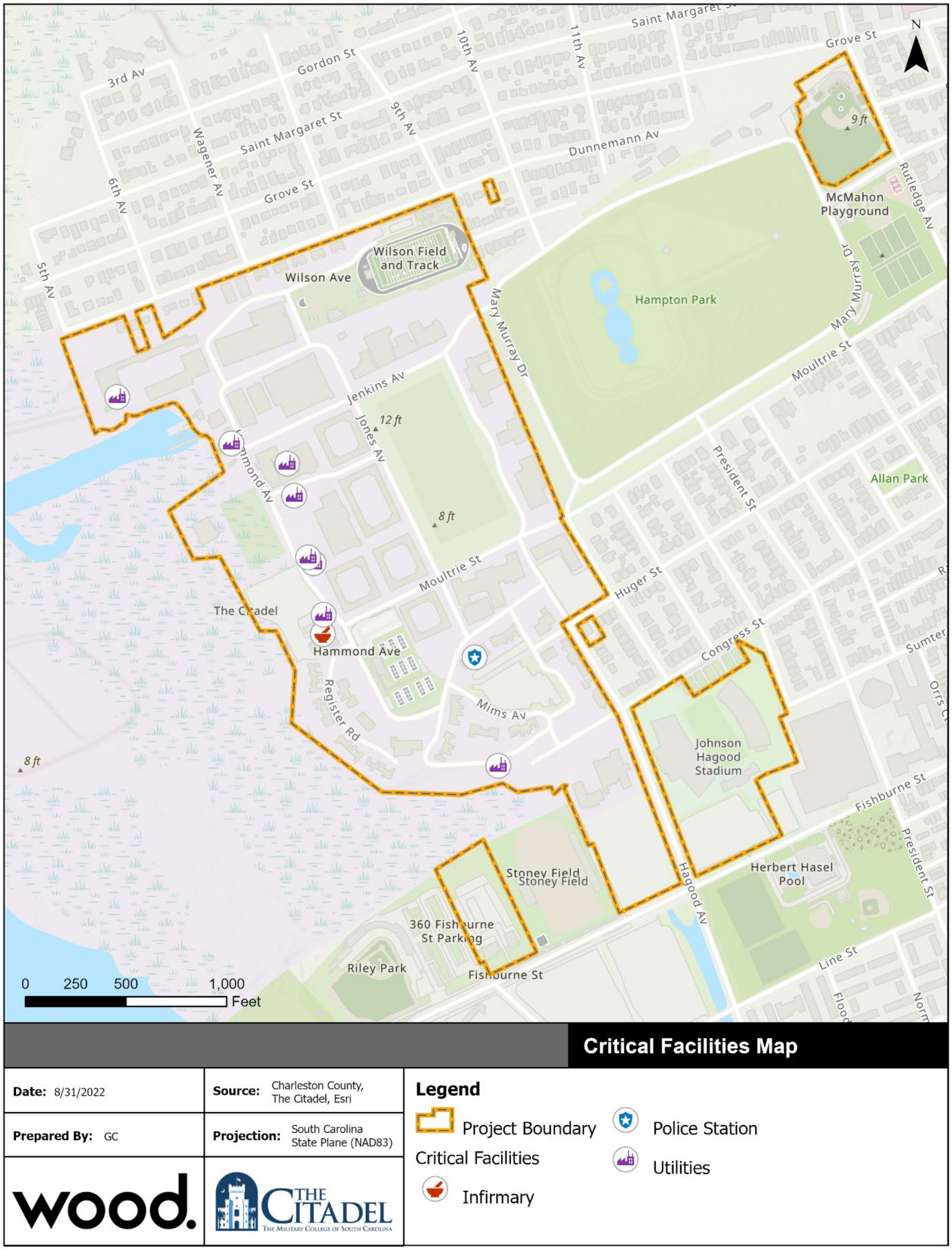
Source: The Citadel, 2022

TABLE 4.9 – INVENTORY OF CRITICAL FACILITIES AND INFRASTRUCTURE

Facility Name	Facility Type	Structure Value
Mary Murray Infirmary & Generator	Infirmary	$3,393,500
Police Station (Apts 205-208 Richardson Ave)	Police Station	$1,175,200
Pplt Lift Station Wilson Ave	Utilities	$29,700
Cadet Services Building	Utilities	$2,138,000
Boat Center Lift Station	Utilities	$52,800
Elevated Water Tank St/Eq 75000 Gallon	Utilities	$702,600
Infirmary Generator Hammond Ave	Utilities	$153,000
Water Tank St/F Indian Hill	Utilities	$305,400
Fire Sys Pump Sta St/Eq Indian Hill	Utilities	$69,100
Housing Lift Station Mims Ave	Utilities	$54,600

Source: The Citadel, 2022

FIGURE 4.2 – CITADEL CAMPUS CRITICAL FACILITIES



4.4 Hazard Profiles, Analysis, and Vulnerability

4.4.1 Dam Failure

Hazard	Probability	Impact	Spatial Extent	Warning Time	Duration	PRI Score
Dam Failure	Unlikely	Limited	Moderate	>24 hours	<1 week	1.9

Hazard Description

A dam is a barrier constructed across a watercourse that stores, controls, or diverts water. Dams are usually constructed of earth, rock, or concrete. 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, human-caused events, or a combination. Due to the lack of advance warning, failures resulting from natural events, such as hurricanes, earthquakes, or landslides, may be particularly severe. Prolonged rainfall and subsequent flooding is 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 cause a full structural breach, a high-velocity, debris-laden wall of water is released and rushes downstream, damaging or destroying anything in its path. Overtopping is the primary cause of earthen dam failure in the United States.

Dam failures can result from 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
- Poor operation or 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
- 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. 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 flash flooding within a few hours or even minutes of the beginning of heavy rainfall, and dam failure may occur within hours of the first signs of breaching. Actual warning time depends on the distance of the planning area from the point of failure;

in the case of The Citadel, there would be more than 24 hours of warning time for a major event from an upstream high hazard dam. 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. The duration of the flood will vary but may last as long as a week.

The National Inventory of Dams (NID) is a database of dams in the United States which was developed and is maintained by the USACE. Congress authorized the USACE to inventory dams as part of the 1972 National Dam Inspection Act. Several subsequent acts have authorized maintenance of the NID and provided funding. The USACE collaborates with FEMA and state regulatory offices to collect data on dams.

Warning Time: 1 – More than 24 hours

Duration: 3 – Less than 1 week

Location

Information on the location of dams in the planning area was retrieved from the National Inventory of Dams and South Carolina Department of Health and Environmental Control (SC DHEC), which provides an inventory of all State controlled dams. South Carolina DHEC has records of two dams, and the NID reports an additional two dams. Locations of the four Charleston County dams are shown in Figure 4.3. All four dams within the county are located downstream, or in areas that would have no impact on the Citadel if breached. However, the Citadel is at risk from failure of two upstream dams. The Santee dam and Pinopolis dam, both lie outside of the Charleston County, and if breached could impact The Citadel. The Santee dam is located at Lake Marion and Pinopolis dam is located at Lake Moultrie. Table 4.10 has details on the four Charleston County dams and the two Berkley County dams. Locations of the two upstream dams is shown in Figure 4.4.

TABLE 4.10 – DAM INVENTORY FOR CHARLESTON COUNTY, SC AND POTENTIAL IMPACT DAMS

Dam Name	NIDID	County	Height (ft)	NID Storage (acre-feet)	Year Built	Purpose	Hazard Potential
Santee Dam	SC00732	Berkeley, Clarendon	68	1,450,000	1942	Flood Risk Reduction, Hydroelectric, Navigation, Water Supply, Recreation	High
Cooper Dev - Pinopolis Dam System	SC01076	Berkeley	138	1,110,000	1942	Flood Risk Reduction, Hydroelectric, Recreation, Water Supply, Navigation	High
Kiawah Island Bass Pond	SC01650	Charleston	10	228	No Data	No Data	Undetermined
Lake Wackendaw Dam	SC01027	Charleston	9	112	1954	Irrigation Recreation	Undetermined
Margaret Meyer Dam	SC01025	Charleston	13	461	1969	Recreation	Low
West Virginia Company Dam	SC01033	Charleston	12	224	1968	Recreation	Low

Source: National Inventory of Dams, August 2022

FIGURE 4.3 – CHARLESTON COUNTY DAM INVENTORY

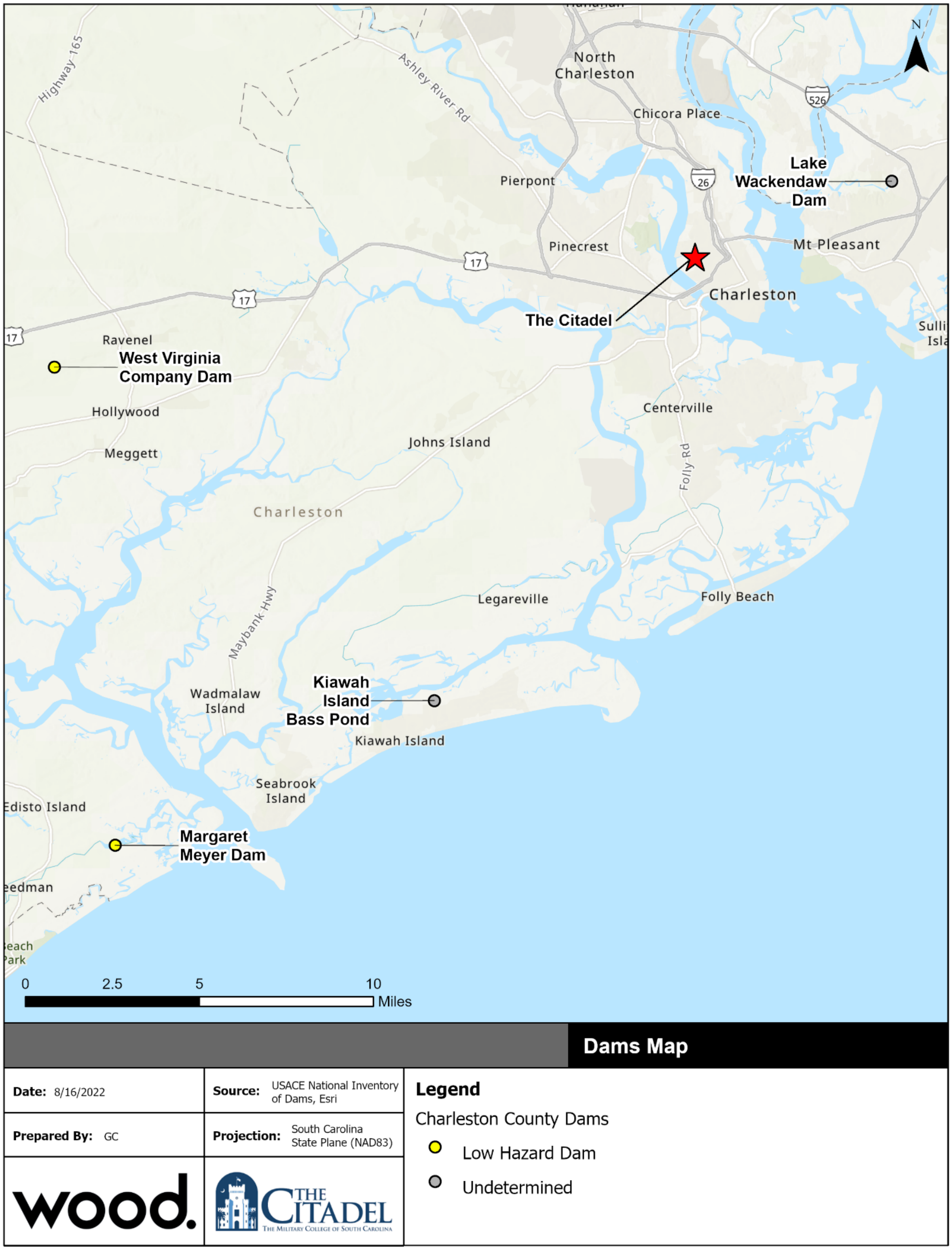
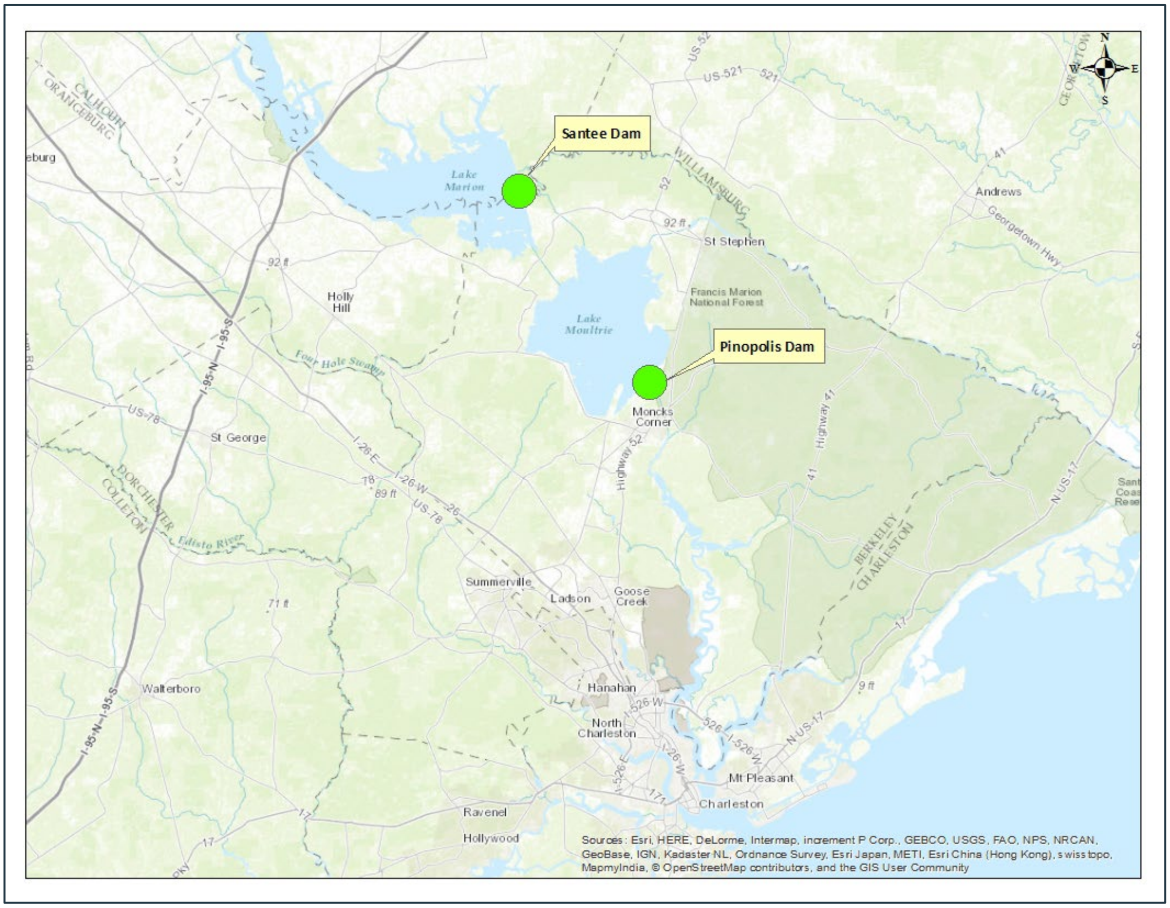


FIGURE 4.4 – HIGH HAZARD DAM LOCATIONS



Source: National Inventory of Dams, September 2022

Spatial Extent: 2 – Moderate

Extent

Each state has definitions and methods to determine the hazard potential of a dam. In South Carolina, unless exempted by law, dams regulated by DHEC are classified based on size and hazards and must meet one of the following criteria: 25 feet in height; impounds 50 acre-feet or more of water; or classified as a high-hazard dam, regardless of size.

DHEC only regulates two dams in Charleston County, Margaret Meyer Dam, and West Virginia Company Dam, neither of which present any risk to the Citadel and are both classified as low-hazard dams.

The dam hazard potential classification system, as shown Table 4.11, was developed by the Interagency Committee on Dam Safety (ICODS) as part of the National Dam Safety Program. The system provides a common way to understand and talk about the possible negative impacts to people and property downstream in the case a dam fails or is mis-operated.

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:

1. **Low Hazard:** Dams where failure or mis-operation results in no probable loss of human life and low economic and/or environmental losses. Losses are principally limited to the owner's property.

2. **Significant Hazard:** Includes dams where failure or mis-operation results in no probable loss of human life but can cause economic loss, environment damage, disruption of lifeline facilities, or impact other concerns. Significant hazard dams are often located in rural or agricultural areas but could be located in areas with population and significant infrastructure.
3. **High Hazard:** Includes dams where failure will likely cause loss of life.

TABLE 4.11 – DAM HAZARDS CLASSIFICATION

Hazard Classification	Loss of Human Life	Economic, Environmental, Lifeline Losses
Low	None Expected	Low and generally limited to owner
Significant	None Expected	Yes
High	Probable. One or more expected	Yes

Source: FEMA Guidelines for Dam Safety

According to the NID, both the Santee and Cooper Dev-Pinopolis dams are classified as high hazard dams. This high hazard rating indicates that dam failure would probably cause loss of life.

Extent: 2 – Limited

Past Occurrences

There have been no known failures on either the Pinopolis Dam System or the Santee Dam. There are two recorded incidents on the Pinopolis West Dike, listed in the National Performance of Dams Program database, but neither incident resulted in dam failure. There are no recorded failures for any of the other lower hazard dams in the area. The flooding across the state in 2015 resulted in 36 dam breaches, including one intentional release, but none of these breaches occurred in Berkeley or Charleston County. The closest breaches occurred in Orangeburg and Clarendon Counties.

TABLE 4.12 – KNOWN DAM INCIDENTS IN CHARLESTON AREA

Location	County	Date of Occurrence	Result of Failure	Deaths/ Injuries	Property Damage	Details
Pinopolis West Dike	Berkeley	07/06/1983	NR	NR	NR	Failure of timber bulkhead at entrance to unused 6-foot-diameter conduit through concrete non-overflow section
Pinopolis West Dike	Berkeley	09/21/1989	NR	NR	NR	Hurricane-generated waves caused slumping of riprap on upstream face of 16,000 feet of west dike

Source: National Performance of Dams Program database (npdp.standord.edu).

Probability of Future Occurrence

Based on historical occurrence information of no failures and only two incidents in the area, it can reasonably be assumed that there is a less than 1 percent probability of a high hazard dam near Charleston County experiencing any incident or failure.

Probability: 1 – Unlikely

Climate and Future Conditions

Future development may increase the overall risk of dam failure by increasing downstream exposure of people and property. Regular inspection and evaluation of dam hazard potential can ensure appropriate safety precautions, such as the preparation of an Emergency Action Plan and the establishment of procedures for warning and evacuation of all at-risk structures should a failure occur.

Dam failure is already tied to flooding and the increased pressure that flooding places on dams. Climate change impacts on dam failure will most likely be those related to changes in precipitation and flood probability. The Fourth National Climate Assessment indicates that heavy precipitation events are already becoming more frequent and intense and that this trend is likely to continue. This change may increase risk of flooding, putting stress on dams and increasing likelihood of dam failure. A recent study evaluated the safety of dams for the future climate based on an evaluation of changes in design floods and the freeboard available to accommodate an increase in flood levels. The study results indicated that the design floods and 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. The study 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 (Chernet, 2013).

Consequence Analysis

Category	Consequences
Public	Localized impact expected to be severe for inundation area and moderate to light for other adversely affected areas. While impacts will mirror those of a flood event, residents who might be impacted by a dam/levee failure may believe themselves to be protected from flood events and may not anticipate the event.
Responders	First responders will be impacted similarly to other events that have advance warning. For dams that fail without prior warning, the impact is rapid and severe, requiring rapid response to the impacts. Although the response is generally restricted to the stream below the dam, the location of impact moves rapidly downstream requiring multiple response locations.
Continuity of Operations (including Continued Delivery of Services)	Unless critical infrastructure or facilities essential to the campus operations are located in the impact area of the inundation area downstream of the dam, continuity of operations will likely not be disrupted. Emergency response, emergency management and law enforcement officials may have resources stretched or overwhelmed in the failure of a large dam.
Property, Facilities and Infrastructure	Localized impact to facilities and infrastructure in the inundation area of the incident may occur. Potentially catastrophic damages to roads and builds are possible. Localized power outages could occur. Natural gas distribution networks may be damaged. Phone and internet systems could be impacted on a local scale.
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. Ecosystems and habitats in the affected river/stream/lake could be destroyed.
Economic Condition	Economic impact from small dams is generally small and impact is often limited to the dam owner and the cost of first responder activities. Large failures can disrupt the economy through displacement of workers, damage to commercial employment facilities or destruction of infrastructure that impacts commercial activities or access to other economic drivers.

Vulnerability Assessment

Given the current dam inventory and historic data, a dam breach of a high hazard dam is unlikely (<1 percent annual probability) in the future. However, regular monitoring can help mitigate or prevent failures if appropriate actions are taken when it is determined a failure may be likely.

As noted above, there are two high hazard dams in Berkeley and Clarendon Counties and an additional four dams in Charleston County that are not classified as high hazard. The only two dams considered potentially hazardous to Charleston County in the event of a failure are the Pinopolis Dam System and the

Santee Dam, capable of producing more than $1 billion in damage to structures and infrastructure. Only the Pinopolis Dam System is considered potentially hazardous to The Citadel in the event of a failure.

In 2002, Santee Cooper implemented the Pinopolis East Dam Seismic Mitigation Project to retrofit the dam for earthquake resiliency. The project included the placement of stone columns and downstream berm material designed to meet current earthquake standards and protect the downstream floodplain, which includes portions of Charleston. The project ensures the dam can withstand seismic activity equivalent to the 1886 Charleston Earthquake, a 7.3 magnitude earthquake that would cause peak ground acceleration of 0.42g at the East Dam.

The owner of the Pinopolis Dam, the South Carolina Public Service Authority (also known as Santee Cooper), completed an Emergency Action Plan in 2000, including maps of potentially damaged areas in the event of a dam breach. The study indicated flooding would reach Charleston County within one day of failure and the floodwaters would take up to 12 days to recede. The 2019 Charleston Regional Hazard Mitigation Plan reported an estimated 19,896 buildings in the City of Charleston would be inundated.

Using data from the South Carolina Public Service Authority's Pinopolis Dam Emergency Action Plan, the 2019 Charleston Regional Hazard Mitigation Plan estimates the flooding elevation in the peninsula near the Ashley and Cooper Rivers, including areas bordering the Ashley River, to be 9.8 feet within 96 hours after the breach. The number and characteristics of buildings on The Citadel campus that could potentially be impacted by this flood elevation are shown in Table 4.13. Figure 4.5 reflects the inundation area at 9.8 ft. <u>Note: the extent of inundation presented in Table 4.13 and Figure 4.5 is estimated based on the reported flood elevation noted above. A dam inundation study including a hydrologic and hydraulic analysis was not performed.</u>

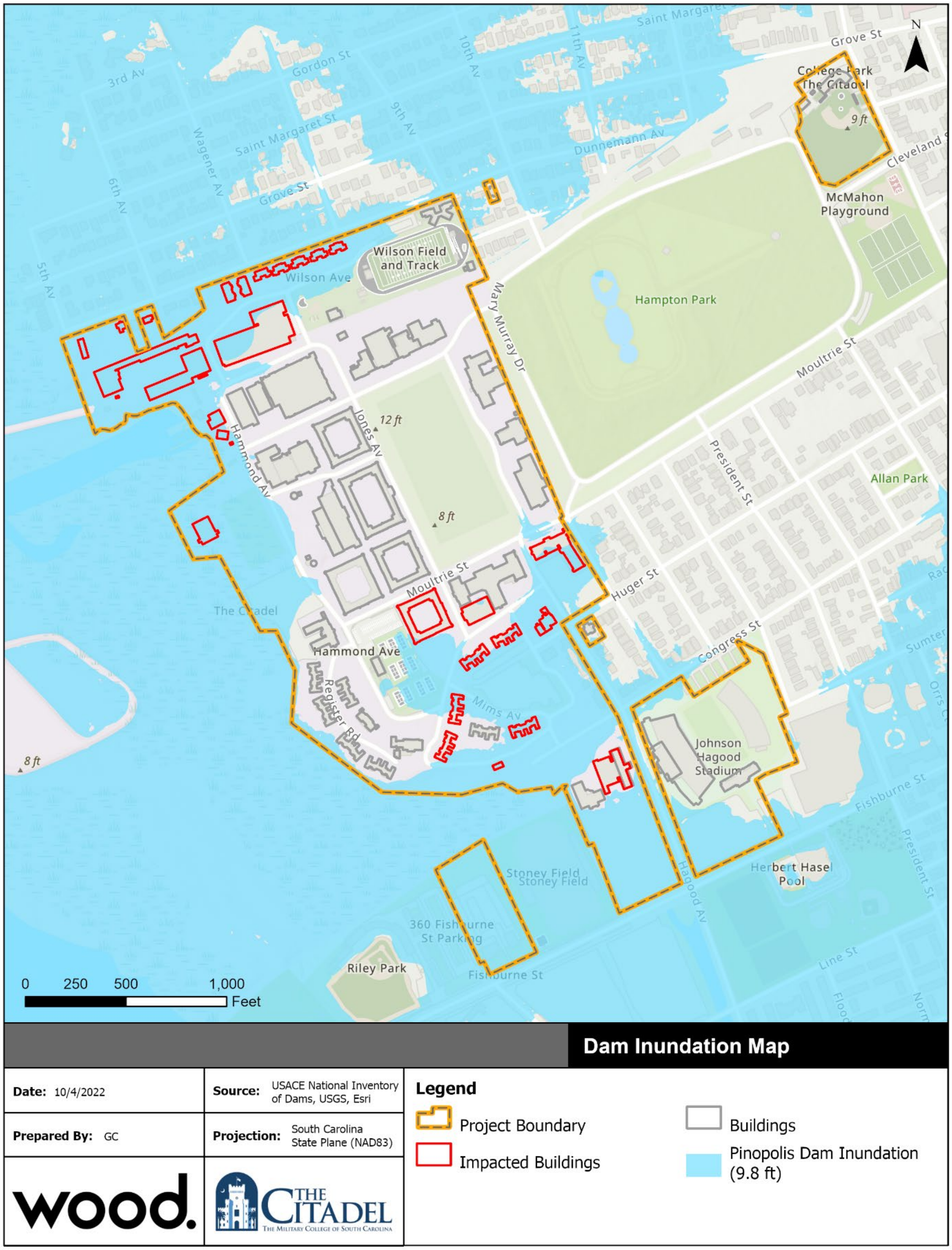
TABLE 4.13 – PROPERTIES POTENTIALLY AT RISK TO DAM FAILURE

Occupancy Type	Total Number of Buildings in Estimated Inundation Area	Total Building Value	Total Contents Value	Total Value
Agriculture	1	$56,500	$2,600	$59,100
Commercial	3	$1,385,700	$381,400	$1,767,100
Education	5	$44,378,700	$6,232,250	$50,610,950
Government	0	-	-	$0
Industrial	7	$6,384,800	$1,564,100	$7,948,900
Religious	0	-	-	$0
Residential	14	$22,098,700	$1,727,100	$23,825,800
Total	**30**	**$74,304,400**	**$9,907,450**	**$84,211,850**

Problem Statement

- Failure of the Pinopolis Dam could result in widespread inundation of The Citadel campus, affecting 30 buildings with a total building and contents exposure of over $84 million.
- There would be about 96 hours of warning time before failure of the Pinopolis dam would result in peak flooding in the Ashley River near The Citadel. Prompt response and evacuation could avoid major losses.

FIGURE 4.5 – PINOPOLIS DAM FAILURE IMPACT



4.4.2 Drought

Hazard	Probability	Impact	Spatial Extent	Warning Time	Duration	PRI Score
Drought	Highly Likely	Minor	Large	>24 hours	>1 week	2.8

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 4.14.

TABLE 4.14 – 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

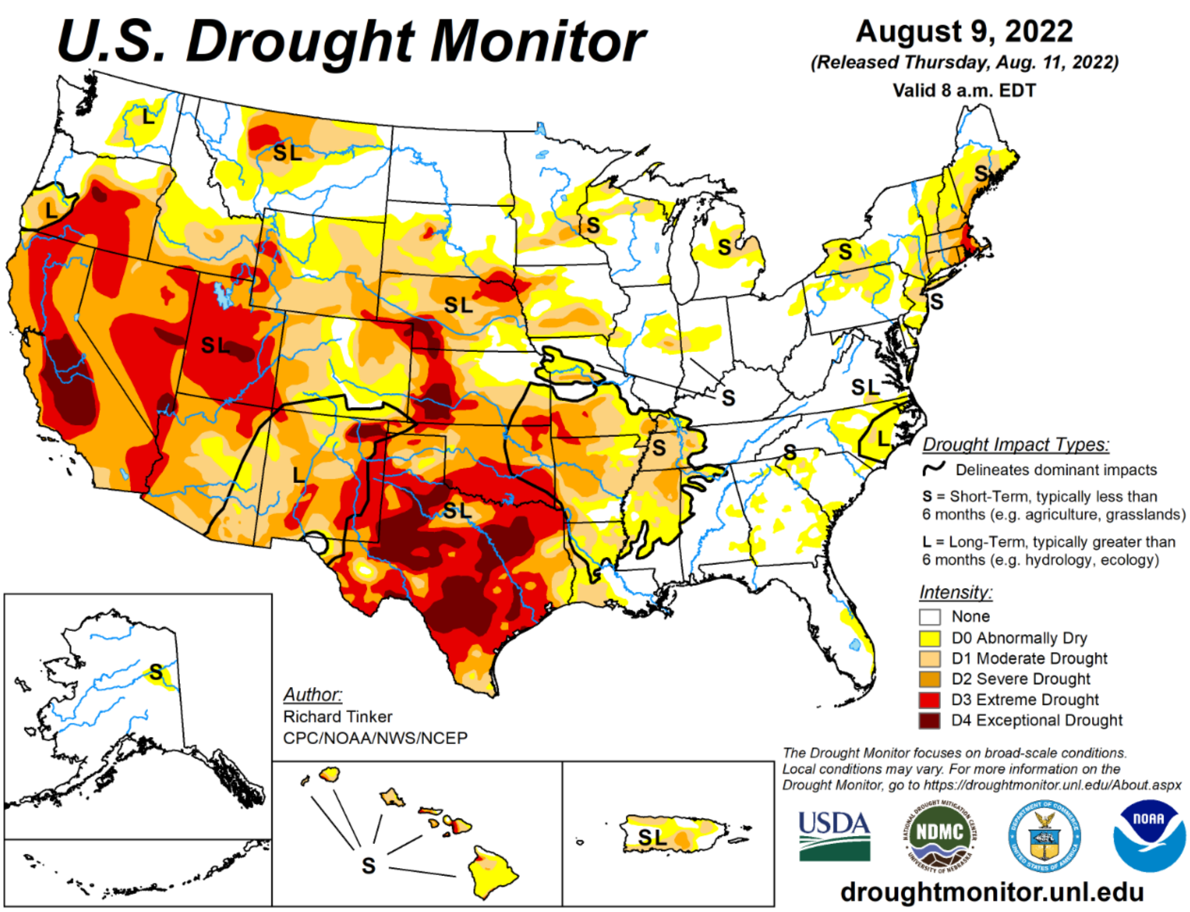
Duration: 4 – More than one week

The State of South Carolina adopted a Drought Response Plan specifies response strategies to varying levels of drought. These plan outlines state-level actions to assist and respond to drought.

Location

Drought is a regional hazard that can cover the entire planning area, and in some cases the entire state. The U.S. Drought Monitor map shown in Figure 4.6 below, depicts the current week's (August 8, 2022) drought conditions. According to the map, coastal South Carolina is not currently experiencing drought. However, drought conditions can change quickly and are not confined to geographic or political boundaries. As a result, some areas may experience more severe drought events than what is shown on the map, and the map does not serve as a predictor of future conditions.

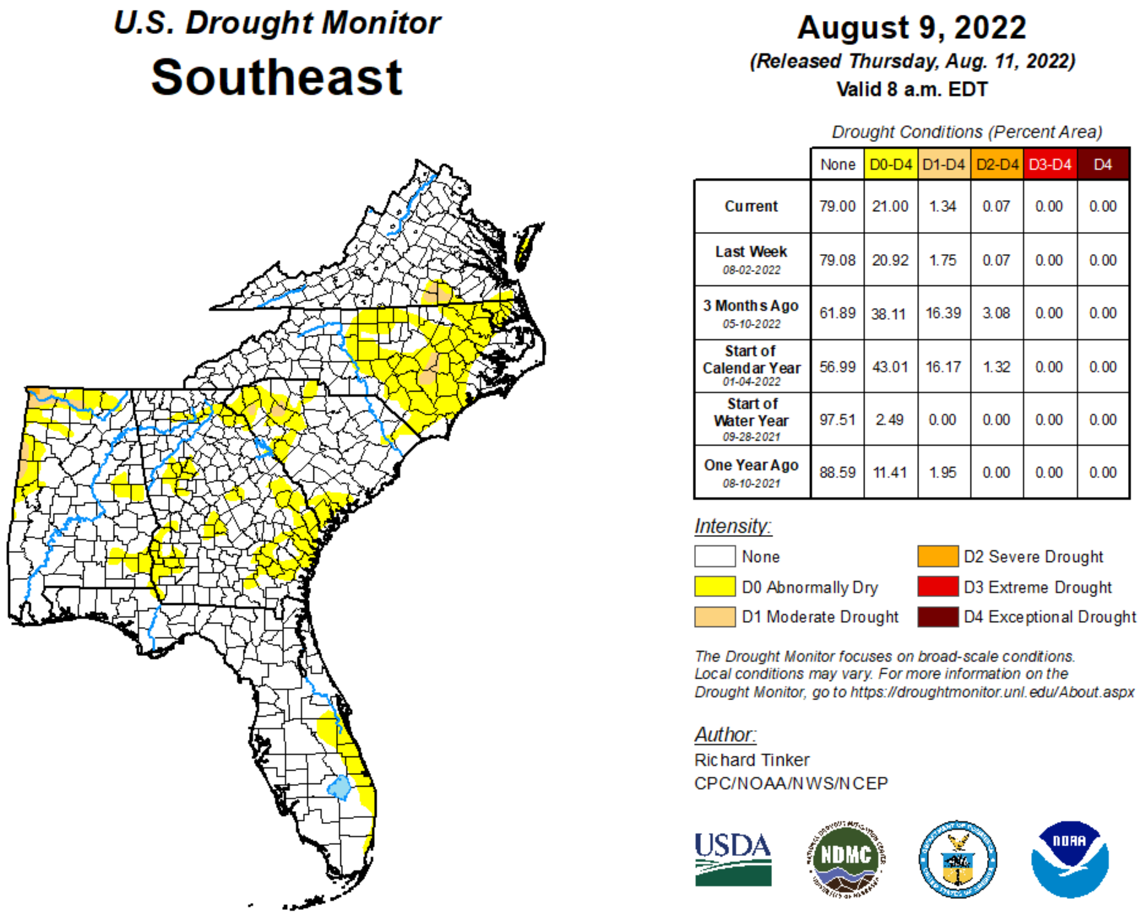
FIGURE 4.6 – U.S. DROUGHT MONITOR NATIONAL CONDITIONS, WEEK OF AUGUST 8, 2022



Source: NOAA National Weather Service, August 2022

Figure 4.7 provides the U.S. Drought Monitor's drought ratings for the southeast as of August 8, 2022; as of that date, only 8.25% of Charleston County was experiencing abnormally dry conditions. The figure illustrates the large-scale, regional nature of drought.

FIGURE 4.7 – U.S. DROUGHT MONITOR SOUTHEAST CONDITIONS, WEEK OF AUGUST 8, 2022



	None	D0-D4	D1-D4	D2-D4	D3-D4	D4
Current	79.00	21.00	1.34	0.07	0.00	0.00
Last Week 08-02-2022	79.08	20.92	1.75	0.07	0.00	0.00
3 Months Ago 05-10-2022	61.89	38.11	16.39	3.08	0.00	0.00
Start of Calendar Year 01-04-2022	56.99	43.01	16.17	1.32	0.00	0.00
Start of Water Year 09-28-2021	97.51	2.49	0.00	0.00	0.00	0.00
One Year Ago 08-10-2021	88.59	11.41	1.95	0.00	0.00	0.00

Source: NOAA National Weather Service, August 2022

Spatial Extent: 4 – Large

Extent

Drought extent can be defined using the U.S. Drought Monitor scale. The Drought Monitor Scale measures drought episodes with input from the Palmer Drought Severity Index, the Standardized Precipitation Index, the Keetch-Byram Drought Index, soil moisture indicators, and other inputs as well as information on how drought is affecting people. Figure 4.8 details the classifications used by the U.S. Drought Monitor and Figure 4.9 details impacts from past droughts in South Carolina and highlight expected impacts. A category of D2 (severe) on the U.S. Drought Monitor Scale can typically result in crop and livestock impacts, water conservation requirements, low river levels and dried up streams, and tree mortality.

FIGURE 4.8 – U.S. DROUGHT MONITOR CLASSIFICATION

			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: U.S. Drought Monitor

FIGURE 4.9 – POSSIBLE IMPACTS BY U.S. DROUGHT MONITOR CATEGORY IN SOUTH CAROLINA

Category	Historically observed impacts
D0	Row crop growth is stunted, irrigation begins early
	Brush fires increase
D1	Peach size is reduced; non-irrigated corn shows severe stress
	Fire risk increases; tree pests increase
	Water use is high; creeks, streams, and lakes are low
	Voluntary conservation of water and energy is requested
D2	Cattle are lighter, producers are selling calves early and feeding cattle earlier
	Number of fires increases, and fires are more intense
	Fisheries are impacted; duck hunting areas close
	Boating recreation is compromised
	River and lake levels are low; saltwater intrusion occurs; hydroelectric power production is reduced
D3	Hay is scarce and expense; owners are giving away horses
	Soil moisture is low, winter crops are slow to germinate
	Burn bans begin
	Small aquatic species are stressed
	Mandatory water restrictions are implemented, violators are fined; lake outflow is low
D4	Producers are hauling water for cattle; auctions see record number of cattle
	Trees are stressed; fish are dying
	Daily life is compromised
	Wells are contaminated or running dry; lakes are extremely low with hazards exposed

Source: U.S. Drought Monitor

The longest duration of drought to South Carolina in the past 22 years occurred when the state spent 156 weeks from January 2000 to December 2002 in moderate to exception drought. The most intense drought period occurred the week of August 20th, 2002, where D4 affected 50.71% of South Carolina.

Impact: 2 – Minor

Past Occurrences

According to the National Drought Monitor, Charleston County has experienced drought conditions every year since 2000. Charleston County was in some level of drought for 391 weeks between January 2000 and November 2022. Table 4.15 shows the most severe classification for each year.

TABLE 4.15 – HISTORICAL DROUGHT OCCURRENCES IN CHARLESTON COUNTY

Year	Drought Classification
2000	Severe Drought
2001	Severe Drought
2002	Extreme Drought
2003	Abnormally Dry
2004	Moderate Drought
2005	Abnormally Dry
2006	Abnormally Dry
2007	Severe Drought
2008	Severe Drought

Year	Drought Classification
2009	Moderate Drought
2010	Abnormally Dry
2011	Extreme Drought
2012	Exceptional Drought
2013	Severe Drought
2014	Abnormally Dry
2015	Abnormally Dry
2016	Abnormally Dry
2017	Moderate Drought
2018	Severe Drought
2019	Severe Drought
2020	Abnormally Dry
2021	Moderate Drought
2022	Moderate Drought

Source: U.S. Drought Monitor, August 2022

Furthermore, there are 20 records of drought for Charleston County recorded by NCEI. The following provides a typical narrative for the types of flooding events recorded in the NCEI database:

May/June 2000 - S.C. Department of Natural Resources declared the first stage of drought. Rainfall was 4 to 6 inches below normal for the year and temperatures were at or above normal. Many places had not received any measurable rain for nearly three weeks. Drought conditions continued into June. Most counties were still running a deficit of near 6 inches.

October 2001 - Moderate to severe drought conditions continued over south coastal South Carolina. Rainfall for the month was less than three quarters of an inch at most places.

May 2002 - Moderate to severe drought conditions continued over south coastal South Carolina through the month of May. Rainfall for the month was 2.39 inches which was 1.28 inches below the normal for the month. This continued the trend of deficit rain fall.

Probability of Future Occurrence

Based on historical occurrence information (20 records in 26 years), it can reasonably be assumed that Charleston County has a 77% chance of this type of event occurring each year.

Probability: 4 – Highly Likely

Climate Change and Future Conditions

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 between rainfall events. 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.

Drought has been a recurrent issue in the Southeast affecting agriculture, forestry, and water resources. With rapid growth in population and overall demand, drought is increasingly a concern for water resource management sectors such as cities, ecosystems, and energy production.

Consequence Analysis

Category	Consequences
Public	Drought can affect people's health and safety. Examples of drought impacts on people include fewer recreational activities, higher incidents of heat stroke, and even loss of human

Category	Consequences
	life. Drought can also affect availability and quality of drinking water supply.
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 operations. In the event of drought affecting water supply, The Citadel may need to consider alternative drinking water options for faculty, staff and students.
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. Irrigation and outdoor landscaping would be affected, as would recreational uses.
Environment	Environmental impacts include strain on local plant and wildlife; increased probability of wildfire; and decreased water quality. Drought can also impact water quality, as shrinking surface water bodies experience higher pollutant and algal concentrations but have less capacity to attenuate those pollutants due to decreased volume.
Economic Condition	Examples of economic impacts include farmers who lose money because drought destroyed their crops or who may have to spend more money to feed and water their animals. Food prices may increase as a result of shortages which could have a direct effect on The Citadel's operating budget.

Vulnerability Assessment

Although the State of South Carolina is vulnerable to drought, estimated potential losses are inherently difficult to calculate because drought tends to cause little damage to the built environment. Therefore, it is assumed that while all buildings and facilities in the planning area would technically be exposed to the drought hazard, there is no significant vulnerability to these buildings on a structural level.

Given the Charleston region's steady growth, there is concern that continued population growth in the region, or in upstream cities that depend on the same water supply, could compound the felt impacts of any droughts that occur as an increased number of users pull from the available water supply within the region. In fact, the South Carolina coastal plain has experienced increasing groundwater withdrawals in recent decades, leading to substantial declines in groundwater levels. In 2002, the Charleston area was designated a capacity-use area (CUA) to regulate groundwater withdrawals in response to 225-foot drawdowns in the Middendorf aquifer following a four year drought.[39] Despite the creation of the CUA, the Middendorf aquifer has not recovered to levels observed prior to the 1998-2002 drought; levels have declined by approximately 55 feet since the 1990s.[39] Although the City of Charleston now gets its water from surface water sources, declining groundwater levels are a concern for the whole region. Restricted groundwater resources may shift users to surface water and place additional strain on surface water resources.

Surface water supply is also at risk to a decrease in precipitation, which is required to recharge supply. This puts The Citadel as risk given that it uses the Charleston Water System, which relies solely on surface water supplies. The Citadel does benefit from reduced vulnerability to drought by using the Charleston Water System, which is able to monitor and regulate water usage on a large scale, if necessary, to more effectively manage water resources during times of drought. The Citadel also benefits from the Charleston Water System's Drought Management Plan, which increases preparedness for drought by outlining a plan of action and allowable regulations based on drought severity.

Another concern during a drought is that contaminants such as pesticides and fertilizers may concentrate in the soil as precipitation wanes and then enter waterways during heavy rains and flooding. Given its proximity to the Ashley River, any increase in contaminant load of the river could adversely affect health and safety at The Citadel.

Problem Statement

- The primary concerns associated with drought are water supply limitations and use restrictions on campus loss as well as loss of access to and use of the river.

4.4.3 Earthquake

Hazard	Probability	Impact	Spatial Extent	Warning Time	Duration	PRI Score
Earthquake	Possible[1]	Critical	Large	<6 hours	>1 week[2]	3.1

[1]While the probability of a small-scale earthquake is *likely*, this vulnerability assessment is analyzing a large scale earthquake which has a lower recurrence interval of *possible*.
[2]Duration is considering the potential for aftershocks.

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 can affect hundreds of thousands of square miles and can cause major damage to property and loss of life or injury in the affected area. Most property damage and deaths are caused by the failure and collapse of structures due to ground shaking. The level of damage depends upon the amplitude and duration of the shaking, which are directly related to the earthquake size, distance from the fault, site, and regional geology.

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 – More than 1 week

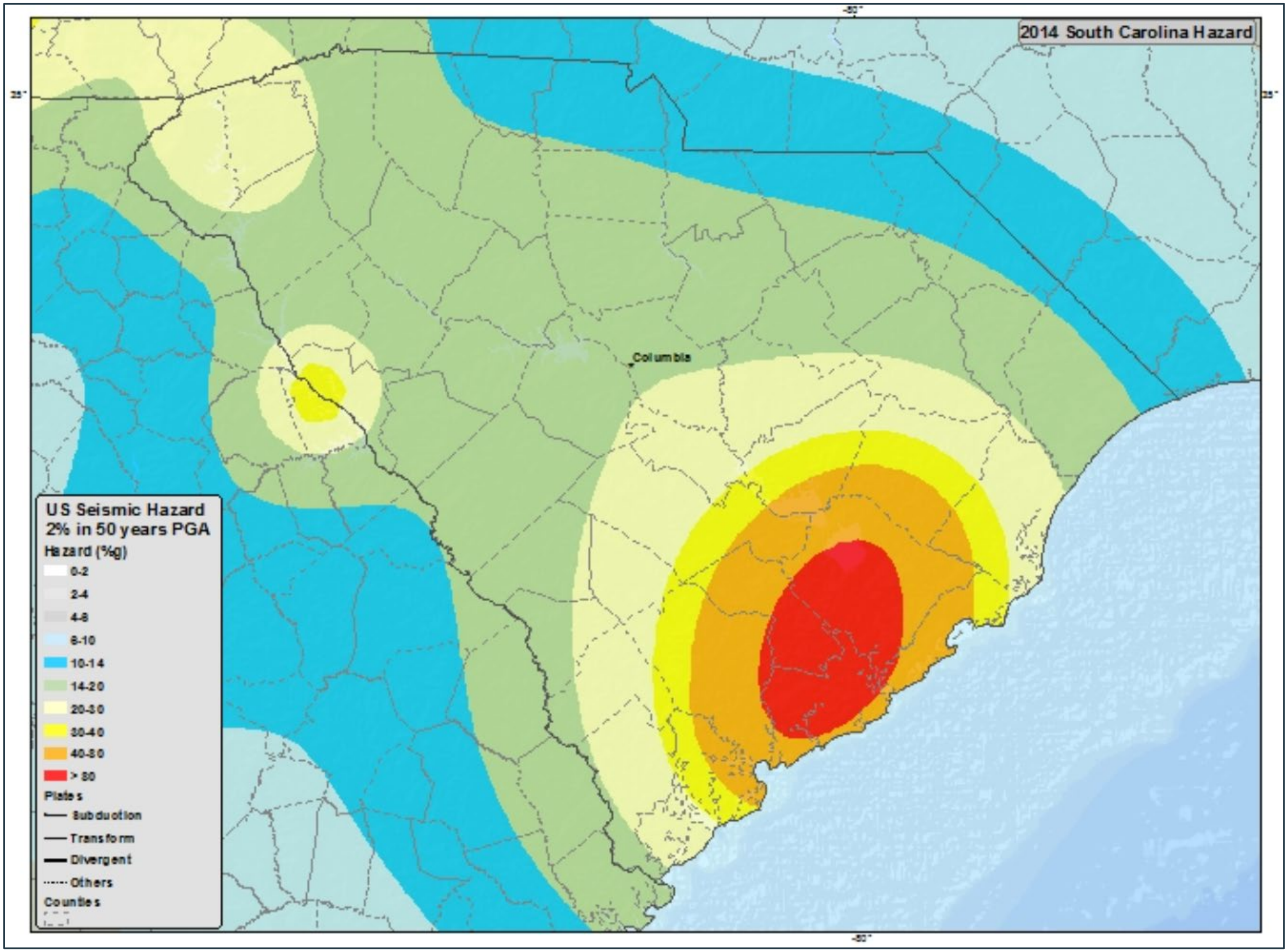
Location

All of South Carolina is subject to earthquakes, with the coastal region most vulnerable to a very damaging earthquake. The state is affected by both the Charleston Fault in South Carolina and New Madrid Fault in Tennessee. Both of these faults have generated earthquakes measuring greater than 8.0 on the Richter Scale during the last 200 years. In addition, there are several smaller fault lines throughout South Carolina. According to South Carolina Emergency Management, about 70 percent of South Carolina earthquakes are located in the Middleton Place-Summerville Seismic Zone, just outside Charleston County.

Figure 4.10 on the following page depicts the earthquake intensity level for South Carolina based on the national USGS map of peak ground acceleration (PGA) with 2 percent probability of exceedance in 50 years. This is the probability that ground motion will reach a certain level during an earthquake. The data shows PGA (the fastest measured change in speed for a particle at ground level that is moving horizontally due to an earthquake) with a 2 percent probability of exceedance in 50 years. According to this map, The Citadel lies within an approximate zone with risk of PGA above 80 percent gravity. This indicates that the region as a whole exists within an area at risk of high seismic activity.

Spatial Extent: 4 – Large

FIGURE 4.10 – SEISMIC HAZARD INFORMATION FOR SOUTH CAROLINA



Source: USGS 2014 Seismic Hazard Map – South Carolina

Extent

Earthquakes are measured in terms of their magnitude and intensity. Magnitude is measured using the Richter Scale, an open-ended logarithmic scale that describes the energy release of an earthquake through a measure of shock wave amplitude. A detailed description of the Richter Scale is given in Table 4.16.

TABLE 4.16 – 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

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 the Modified Mercalli Intensity (MMI) scale. The MMI scale is an arbitrary ranking based on observed effects. It describes the intensity of an earthquake at a particular location. Lower numbers of the MMI scale generally deal with the manner in which the earthquake is felt by people, while higher numbers are generally based on observed structural damage. Figure 4.11 shows descriptions for levels of earthquake intensity on the MMI scale.

FIGURE 4.11 – MODIFIED MERCALLI INTENSITY (MMI) SCALE FELT INTENSITIES

CIIM Intensity	People's Reaction	Furnishings	Built Environment	Natural Environment
I	Not felt			Changes in level and clarity of well water are occasionally associated with great earthquakes at distances beyond which the earthquakes felt by people.
II	Felt by a few.	Delicately suspended objects may swing.		
III	Felt by several; vibration like passing of truck.	Hanging objects may swing appreciably.		
IV	Felt by many; sensation like heavy body striking building.	Dishes rattle.	Walls creak; window rattle.	
V	Felt by nearly all; frightens a few.	Pictures swing out of place; small objects move; a few objects fall from shelves within the community.	A few instances of cracked plaster and cracked windows with the community.	Trees and bushes shaken noticeably.
VI	Frightens many; people move unsteadily.	Many objects fall from shelves.	A few instances of fallen plaster, broken windows, and damaged chimneys within the community.	Some fall of tree limbs and tops, isolated rockfalls and landslides, and isolated liquefaction.
VII	Frightens most; some lose balance.	Heavy furniture overturned.	Damage negligible in buildings of good design and construction, but considerable in some poorly built or badly designed structures; weak chimneys broken at roof line, fall of unbraced parapets.	Tree damage, rockfalls, landslides, and liquefaction are more severe and widespread wiht increasing intensity.
VIII	Many find it difficult to stand.	Very heavy furniture moves conspicuously.	Damage slight in buildings designed to be earthquake resistant, but severe in some poorly built structures. Widespread fall of chimneys and monuments.	
IX	Some forcibly thrown to the ground.		Damage considerable in some buildings designed to be earthquake resistant; buildings shift off foundations if not bolted to them.	
X			Most ordinary masonry structures collapse; damage moderate to severe in many buildings designed to be earthquake resistant.	

Source: USGS

Table 4.17 approximates the Richter Scale magnitudes that would correspond with certain intensities on the MMI scale.

TABLE 4.17 – COMPARISON OF MODIFIED MERCALLI SCALE AND RICHTER SCALE

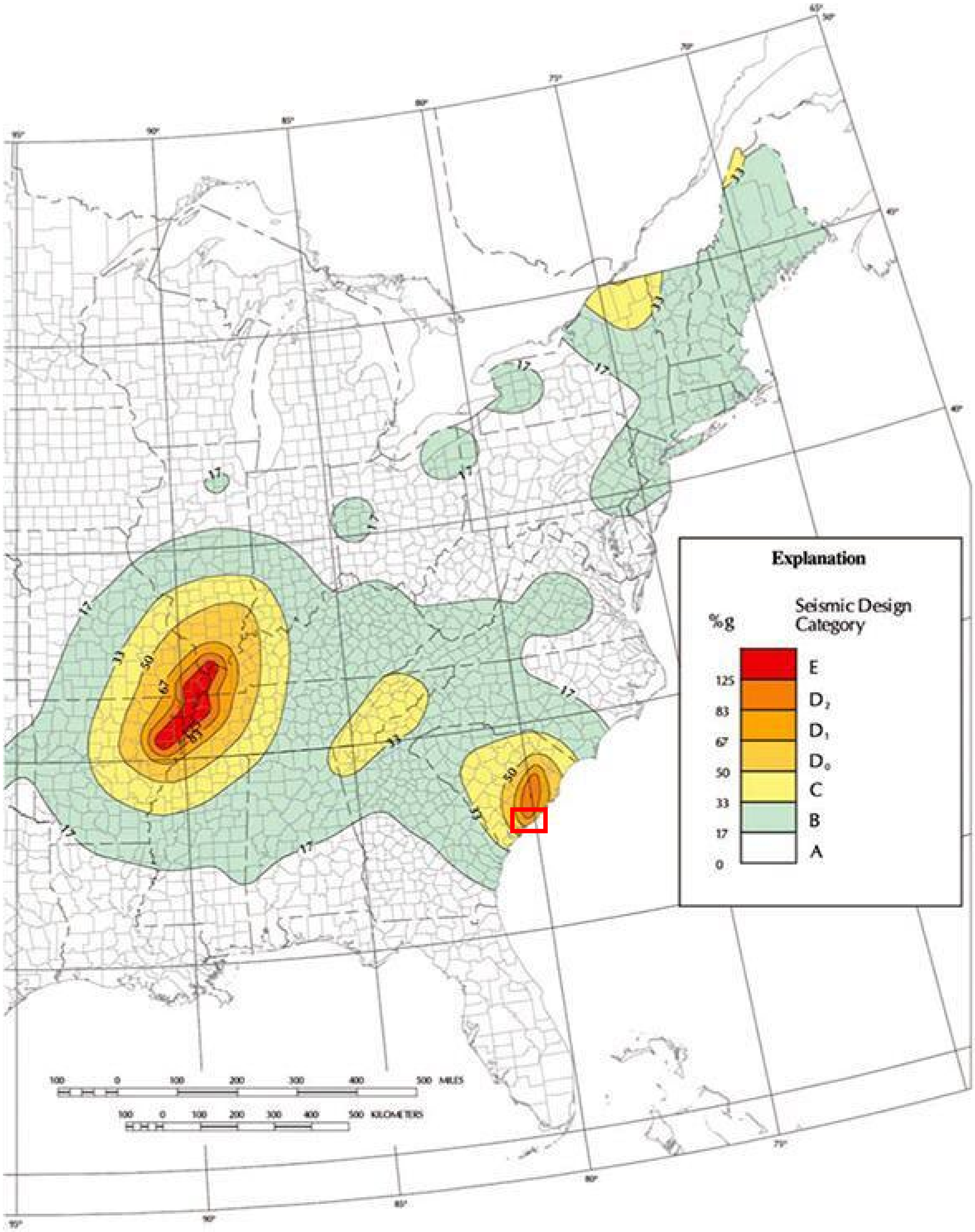
MMI Scale	Corresponding Richter Scale Magnitude
I	-
II	<4.2
III	-
IV	-
V	<4.8
VI	<5.4
VII	<6.1
VIII	-
IX	<6.9
X	<7.3
XI	<8.1
XII	>8.1

Source: FEMA

According to South Carolina Emergency Management, the two most significant historical earthquakes to occur in South Carolina were the 1886 Charleston/Summerville earthquake and the 1913 Union County earthquake. The 1886 earthquake in Charleston was the most damaging earthquake to ever occur in the eastern United States. In terms of lives lost, human suffering and devastation, this was the most destructive United States earthquake in the 19th century. According to FEMA's Seismic Design Category (SDC) mapping shown in Figure 4.12, Charleston County (shown in the red rectangle) falls within SDC "D" Categories, which indicates potential for very strong shaking with slight damage in specially designed structures but considerable damage in ordinary substantial buildings.

Impact: 3 – Critical

FIGURE 4.12 – SEISMIC DESIGN CATEGORY MAPPING FOR THE EASTERN U.S.



Source: FEMA
Notes: Charleston County indicated by red rectangle

Past Occurrences

A list of earthquakes that have affected South Carolina from 1886 to 1971 is presented below in Table 4.18. This information is based on the USGS earthquake history for South Carolina and is not an exhaustive list of all seismic activity affecting the State. Where available, magnitude based on the Richter Scale is listed, otherwise intensity based on the Modified Mercalli scale is listed for the identified location.

TABLE 4.18 – MAJOR EARTHQUAKES AFFECTING SOUTH CAROLINA

Date	Location	Magnitude/Intensity
08/31/1886	Charleston, SC	7.3
01/23/1903	Charleston, SC	IV
04/19/1907	Charleston, SC	V
06/12/1912	Charleston, SC	VI
01/01/1913	Union County, SC	VII
09/22/1914	Charleston	IV
10/20/1924	Pickens County, SC	V
07/26/1945	Lake Murray, SC	V
11/19/1952	Charleston, SC	---
10/20/1958	Anderson, SC	V
08/03/1959	Charleston, SC	VI
10/26/1959	Chesterfield, SC	V
03/12/1960	off South Carolina coast	---
07/23/1960	Charleston, SC	---
04/20/1964	Gaston, SC	V
10/23/1967	Charleston, SC	---
05/19/1971	Orangeburg, SC	3.4
07/13/1971	Newry, SC	VI

Source: USGS South Carolina Earthquake History

Table 4.19 lists earthquakes that have occurred within the Charleston region since 1971. This is not an exhaustive list of earthquakes affecting the region either, because many quakes outside the region may have been strong enough to affect Charleston during this time. Nonetheless, this list does illustrate the recent activity of the fault lines in the region. According to South Carolina Emergency Management, approximately 10 to 15 earthquakes are recorded annually in South Carolina with 3 to 5 of them felt or noticed by people.

TABLE 4.19 – EARTHQUAKE OCCURRENCES IN THE CHARLESTON REGION SINCE 1971

Date	Location	Magnitude/Intensity
11/22/1974	Dorchester County	4.7
01/18/1977	Berkeley County	3.0
12/15/1977	Dorchester County	2.5
12/15/1977	Dorchester County	3.0
09/07/1978	Dorchester County	2.7
12/07/1979	Charleston County	2.9
09/01/1980	Dorchester County	2.7
03/19/1981	Dorchester County	2.5
03/01/1982	Dorchester County	3.0
11/06/1983	Dorchester County	3.3
09/17/1986	Dorchester County	2.6
01/23/1988	Dorchester County	3.3
01/02/1989	Dorchester County	2.6
02/07/1990	Dorchester County	2.7

Date	Location	Magnitude/Intensity
05/11/1990	Dorchester County	2.6
11/13/1990	Dorchester County	3.2
08/21/1992	Berkeley County	4.1
04/17/1995	Charleston County	3.9
03/29/1999	Dorchester County	2.9
11/08/2002	off South Carolina coast	3.5
11/11/2002	off South Carolina coast	4.0
02/28/2003	Dorchester County	2.6
03/02/2003	Dorchester County	2.9
05/05/2003	Berkeley County	3.1
06/12/2003	Dorchester County	2.6
07/19/2003	Dorchester County	2.5
10/14/2003	Dorchester County	2.5
12/22/2003	Dorchester County	3.0
05/01/2004	Berkeley County	2.7
07/20/2004	Dorchester County	3.1
08/18/2004	Berkeley County	2.5
11/25/2004	Berkeley County	2.7
11/19/2005	Dorchester County	2.6
12/16/2008	Berkeley County	3.6
01/29/2009	Dorchester County	2.5
05/06/2009	Berkeley County	2.5
08/29/2009	Berkeley County	3.2
05/12/2010	Dorchester County	2.8
10/15/2011	Dorchester County	2.5
12/21/2011	Dorchester County	2.6
01/04/2012	Dorchester County	2.6
07/31/2012	Dorchester County	2.8
09/19/2013	Dorchester County	2.5
03/19/2014	Dorchester County	3.0
08/24/2015	Dorchester County	2.1
02/08/2016	Dorchester County	1.9
08/25/2017	Dorchester County	2.4
03/02/2018	Dorchester County	2.4
03/16/2020	Dorchester County	2.4
11/14/2020	Berkeley County	2.0
09/27/2021	Berkeley County	2.8
09/27/2021	Dorchester County	3.3
04/09/2022	Dorchester County	1.6

Source: USGS Earthquakes Map: https://www.usgs.gov/programs/earthquake-hazards/earthquakes

Probability of Future Occurrence

Based on historical occurrences, the probability of a significant earthquake event affecting Charleston County is likely. There are a total of 71 records in South Carolina over the past 136 years. Therefore, the annual probability level for the county is estimated to be 52 percent. The probability of a larger magnitude event is less likely but still possible.

Probability: 2 – Possible

Climate Change and Future Conditions

According to NASA's Global Climate Change Program, scientists are beginning to believe there may be a connection between climate change and earthquakes. Changing ice caps and sea-level redistribute weight over fault lines, which could potentially have an influence on earthquake occurrences. However, currently no studies quantify the relationship to a high level of detail, so recent earthquakes should not be linked with climate change. Additionally, it's possible that increased groundwater pumping as a result of climate change-driven increases in drought could add to stress buildup in tectonic plates and hasten the occurrence of earthquakes. Again, this relationship is hypothetical and not yet well studied. While not conclusive, early research suggest that more intense earthquakes may eventually be added to the adverse consequences that are caused by climate change.

Consequence Analysis

Category	Consequences
Public	The public may experience some shaking in these events and the greatest threat to health and well-being is often from objects falling from shelves.
Responders	Minimal expected impact on responders given only moderate events. If a more severe incident occurs, responders may need to enter compromised structures or infrastructure.
Continuity of Operations (including Continued Delivery of Services)	There would likely be little disruption to services or operations due to a moderate earthquake.
Property, Facilities, and Infrastructure	A moderate earthquake is unlikely to damage infrastructure such as roads, bridges, or gas/power/water lines. However, if severe enough, fires can be started by broken gas lines and power lines. 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.
Environment	No severe impacts expected, but damage to key infrastructure, utility systems, or facilities that house hazardous materials could harm the surrounding environment and may require remediation.
Economic Condition	Economic losses associated with an earthquake include property damage, business interruption costs, and costs to repair damaged utilities and infrastructure.

Vulnerability Assessment

An earthquake has the potential to impact all existing and future buildings, facilities, and populations on The Citadel campus. Impacts of earthquakes include debris clean-up, service disruption and, in severe cases, fatalities due to building collapse.

Earthquakes in the Charleston County region generally are low impact events that do not cause injury or death. The public may experience some shaking – the greatest threat to health and well-being is often from objects falling from shelves. Despite most earthquakes in the region being low magnitude, the Charleston earthquake of 1886 was a 7.3 magnitude earthquake that caused approximately $5-6 million in property damage and killed 60 people. This event set a precedent that severe earthquakes are possible in the region, however an earthquake of this magnitude remains unlikely.

Buildings can be damaged by shaking from the earthquake or by the ground beneath properties settling to a different level than it was before (subsidence). This type of damage is unlikely to occur from a low magnitude event. Any damage of campus buildings or disruption to critical resources may interrupt regular campus activities.

Table 4.20 provides an estimate of the number and value of buildings that would experience damage based on the past 7.3 magnitude Charleston earthquake of 1886. This analysis was produced using Hazus and provides a general estimate of the count of buildings by occupancy type that would experience slight, moderate, extensive, and complete damage. Loss ratio estimates by occupancy type from the Level 2 Hazus run produced with Hazus 3.1 in 2016 were applied to the updated building inventory to estimate total damages. Figure 4.13 on the following page depicts the epicenter of the modeled 1886 event.

TABLE 4.20 – ESTIMATED BUILDING DAMAGE AND CONTENT LOSS FOR 1886 EARTHQUAKE EVENT

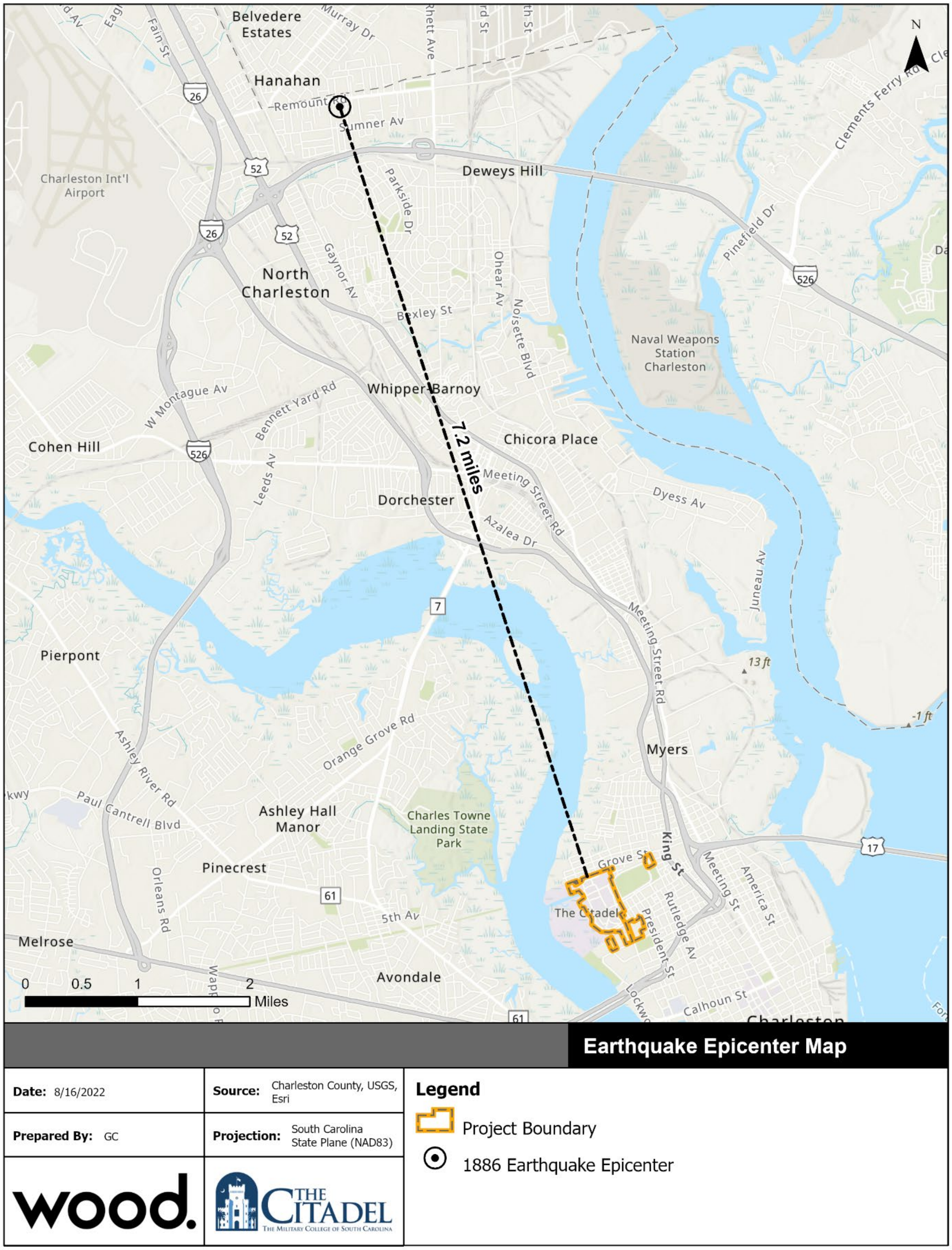
Occupancy Type	Total Value (Building & Contents	Loss Ratio	Estimated Total Damage	Total Number of Buildings			
				Slight	Moderate	Extensive	Complete
Agriculture	$59,100	0.49	$28,959	0.00	0.00	0.00	0.95
Commercial	$71,564,560	0.47	$33,635,343	0.00	0.15	0.93	10.91
Education	$265,055,850	0.40	$106,022,340	0.38	0.59	1.34	17.53
Government	$0	0.00	$0	0.00	0.00	0.46	0.00
Industrial	$10,288,500	0.39	$4,012,515	0.00	0.00	0.00	9.45
Religious	$9,328,270	0.54	$5,037,266	0.00	0.00	0.10	1.89
Residential	$115,177,250	0.55	$63,347,488	8.00	8.72	2.13	5.03
Total	**$471,473,530**	**0.45**	**$212,163,089**	**8**	**10**	**5**	**46**

Source: Hazus, v5

Problem Statement

- An earthquake on the magnitude of the 1886 Charleston earthquake could cause major damages to The Citadel campus, including complete destruction of 46 campus buildings. An estimated $212 million in building damages could result.
- While sever are unlikely to occur, any damage to campus barracks or mess hall would greatly impact campus life and operations.

FIGURE 4.13 – 1886 EARTHQUAKE EPICENTER



4.4.4 Extreme Heat

Hazard	Probability	Impact	Spatial Extent	Warning Time	Duration	PRI Score
Extreme Heat	Likely	Minor	Large	>24 hours	<1 week	2.4

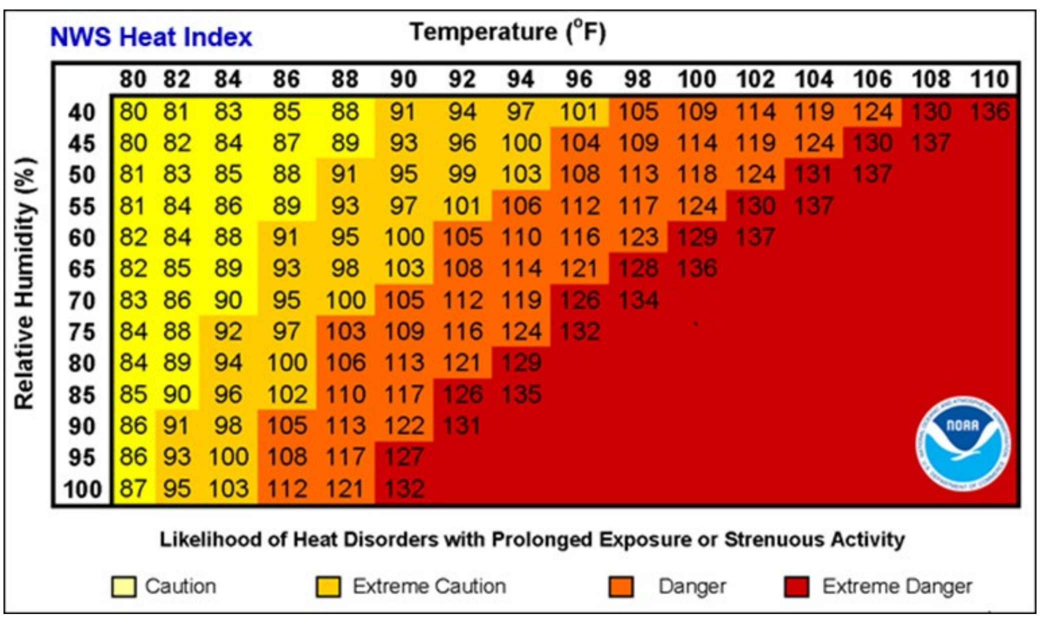
Hazard Description

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. However, the 2019 Georgia Mitigation Strategy notes that extreme heat is relative; it can also be defined as an event at least three days long where temperatures are 10 degrees greater than the normal temperature for the affected area. Extreme heat is often referred to as a "heat wave."

According to the National Oceanic and Atmospheric Administration (NOAA), heat is one of the leading weather-related killers in the United States. Under extreme heat conditions, the human body has difficulties cooling through the normal method of the evaporation of perspiration and must work harder to maintain a normal temperature. 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. Per the National Weather Service (NWS), certain populations are more vulnerable to heat, including young children and infants, older adults, people with chronic medical conditions, and pregnant women. People who are socially isolated are also at heightened risk, as are individuals who work outside under direct sun exposure. Even young and healthy individuals are susceptible to heat-related disorders if they participate in strenuous physical activities during hot weather or are not acclimated to hot weather.

Ambient air temperature and relative humidity determine the relative intensity of heat conditions. The relationship of these factors creates what is known as the apparent temperature. The Heat Index Chart, shown in Figure 4.14, uses temperature and humidity to produce a guide for the apparent temperature, to better inform the public of heat dangers.

FIGURE 4.14 – HEAT INDEX CHART



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

The Heat Index Chart was devised for shady locations. Exposure to direct sun can increase Heat Index values by as much as 15°F.

Table 4.21 lists typical symptoms and health impacts of heat exposure according to the severity classifications shown in the heat index chart.

TABLE 4.21 – TYPICAL HEALTH IMPACTS OF EXTREME HEAT

Classification	Heat Index	Effects on the Body
Caution	80-90°F	Fatigue possible with prolonged exposure and/or physical activity
Extreme Caution	90-103°F	Heat stroke, heat cramps, and heat exhaustion possible with prolonged exposure and/or physical activity
Danger	103-124°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, https://www.weather.gov/ama/heatindex

Extreme heat events are one of the leading weather-related causes of death in the United States—from 1999 through 2009, extreme heat exposure caused more than 7,800 deaths [36]. Sun exposure, wind conditions, age, and physical condition influence susceptibility to heat disorder.

Hotter than average days in the summer increase illness and death by compromising the body's ability to regulate its temperature. This loss of temperature control can result in a cascade of illnesses, including heat cramps, heat exhaustion, heatstroke, and hyperthermia. Temperature extremes can also worsen chronic conditions, including cardiovascular, respiratory, and cerebrovascular disease and diabetes-related conditions [34].

Impacts of extreme heat are not only focused on human health; 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.

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

Warning Time: 1 – More than 24 hours

Duration: 3 – Less than one week

Location

Summers in North America are hot, with the southern US experiencing heat waves periodically each summer. Extreme heat typically occurs over large areas impacting multiple counties at one time. All of Charleston County, including The Citadel planning area, is vulnerable to extreme heat.

Areas that lack shade or have a high concentration of buildings, roads, and other infrastructure may experience higher temperatures. These materials absorb and re-emit the sun's heat more than natural areas like vegetation and water.

Spatial Extent: 4 – Large

Extent

The heat index chart, shown in Figure 4.14, provides a measure of the severity of extreme heat. Per the NWS, heat index values above 90°F can cause heat-related disorders affecting public health and safety.

The extent of extreme heat in the planning area can be defined by the historical maximum temperature reached. The Northeast Regional Climate Center's Climate Information for Management and Operational Decisions (CLIMOD 2) tool was used to compile data on historical maximum temperatures in the planning area. Table 4.22 provides the monthly highest maximum temperature on record for the Downtown Charleston weather station.

TABLE 4.22 – MONTHLY HIGHEST MAX TEMP., DOWNTOWN CHARLESTON WEATHER STATION, 2000-2022

Year	Jan	Feb	Mar	Apr	May	Jun	Jul	Aug	Sep	Oct	Nov	Dec	Annual
2000	73	73	79	80	M	89	100	95	92	91	80	75	M
2001	72	82	81	89	93	96	100	96	90	86	76	77	100
2002	74	73	81	92	87	94	96	93	89	90	78	66	96
2003	68	67	79	79	89	89	95	88	86	81	84	68	95
2004	73	77	79	77	92	93	96	91	88	83	80	72	96
2005	73	76	82	78	88	93	95	94	94	84	79	68	95
2006	72	71	79	90	93	91	94	95	88	87	77	73	95
2007	75	76	81	85	82	90	94	96	89	86	77	77	96
2008	73	73	76	77	88	95	95	95	91	85	76	78	95
2009	75	75	83	78	89	96	92	91	87	87	76	75	96
2010	69	65	73	82	91	93	98	93	93	84	78	72	98
2011	70	77	87	87	91	100	96	98	87	83	78	74	100
2012	74	78	85	90	91	93	94	92	90	83	79	74	94
2013	74	75	76	79	84	94	90	94	90	82	81	77	94
2014	69	74	77	84	93	92	94	98	M	88	79	72	M
2015	72	72	84	88	90	95	96	90	90	81	82	78	96
2016	69	72	84	84	89	95	96	94	90	84	82	76	96
2017	77	74	80	80	92	88	94	97	93	85	79	76	97
2018	73	77	75	83	86	96	91	93	91	92	78	71	96
2019	75	79	76	84	100	95	95	95	90	86	75	76	100
2020	76	74	84	88	89	95	93	92	96	86	80	74	96
2021	74	78	81	86	92	96	93	95	92	87	75	77	96
2022	71	75	80	78	91	94	91	M	M	M	M	M	M
Mean	**73**	**74**	**80**	**83**	**90**	**94**	**95**	**94**	**90**	**86**	**79**	**74**	**96**
Max *(Year)*	**77** *2017*	**82** *2001*	**87** *2011*	**92** *2002*	**100** *2019*	**100** *2011*	**100** *2001*	**98** *2014*	**96** *2020*	**92** *2018*	**84** *2003*	**78** *2015*	**100** *2019*
Min *(Year)*	**68** *2003*	**65** *2010*	**73** *2010*	**77** *2008*	**82** *2007*	**88** *2017*	**90** *2013*	**88** *2003*	**86** *2003*	**81** *2015*	**75** *2021*	**66** *2002*	**94** *2013*

Source: Northeast Regional Climate Center CLIMOD 2 (http://climod2.nrcc.cornell.edu/)

Per this historical temperature data, the highest temperature on record for the planning area during the last 23 years was 100°F, recorded in May 2019, June 2011, and July 2001. Given the NWS classification of danger for heat cramps, heat exhaustion, and heat stroke at this temperature, the magnitude of heat in the Charleston County planning area is considered critical.

Impact: 1 – Minor

Past Occurrences

According to the NCEI, Charleston County experienced 9 "Heat" events and 15 "Excessive Heat" events since 1996 (earliest NCEI records available for extreme heat), reported in Table 4.23. Per the SC State Climatology Office, the highest temperature on record in Charleston County was 105° in 1952.

TABLE 4.23 – HEAT AND EXTREME HEAT EVENTS IN CHARLESTON COUNTY SINCE 1996

Date	Type of Event	Deaths/Injuries	Property Damage	Crop Damage
6/1/1996	Heat	0/0	$0	$0
6/1/1998	Heat	1/0	$0	$0
8/1/1999	Heat	6/0	$0	$0
6/15/2005	Heat	0/5	$0	$0
7/27/2005	Heat	0/0	$0	$0
8/1/2006	Heat	0/0	$0	$0
8/2/2006	Heat	0/0	$0	$0
8/3/2006	Heat	0/0	$0	$0
8/10/2007	Excessive Heat	0/0	$0	$0
7/22/2010	Excessive Heat	0/0	$0	$0
7/25/2010	Excessive Heat	0/0	$0	$0
7/26/2010	Excessive Heat	0/0	$0	$0
7/26/2010	Excessive Heat	0/0	$0	$0
7/26/2010	Excessive Heat	0/0	$0	$0
7/29/2010	Excessive Heat	0/0	$0	$0
7/30/2010	Excessive Heat	0/0	$0	$0
7/31/2011	Excessive Heat	0/0	$0	$0
8/3/2011	Excessive Heat	0/0	$0	$0
8/4/2011	Excessive Heat	0/0	$0	$0
8/4/2011	Excessive Heat	0/0	$0	$0
8/4/2011	Excessive Heat	0/0	$0	$0
8/4/2011	Excessive Heat	0/0	$0	$0
8/16/2017	Heat	0/0	$0	$0
7/30/2021	Excessive Heat	0/0	$0	$0
Total		**7/5**	**$0**	**$0**

Source: NCEI, August 2022

Heat and excessive heat event types are distinguished by locally or regionally designated thresholds for heat advisory and excessive heat warning. According to the National Weather Service documentation criteria, heat events are reported whenever heat index values meet or exceed heat advisory thresholds, and excessive heat events are reported whenever heat index values meet or exceed excessive heat warning thresholds. In some cases, heat or excessive heat thresholds were passed multiple times in a day. In total, these events caused 7 direct deaths and 5 direct injuries, but no reports of property or crop damage were recorded by NCEI.

Data from the Southeast Regional Climate Center indicates that over of the period of record from January 1893 through November 2018, Charleston has averaged 30 days per year with temperatures at or above 90°F. This data is summarized in Table 4.24.

TABLE 4.24 – AVERAGE DAYS WITH MAXIMUM TEMPERATURE ≥ 90˚F, 1893-2018

Station	Jan	Feb	Mar	Apr	May	Jun	Jul	Aug	Sep	Oct	Nov	Dec	Annual
13782 Charleston	0	0	n/a	n/a	2	6	10	9	3	n/a	0	0	**30**

Source: Southeast Regional Climate Center, NCEI Comparative Climate Data

Heat index records indicate that the Charleston County area regularly experiences heat index temperatures above 100°F. Table 4.25 provides counts of heat index values by threshold recorded from 2000 through 2022 at the Charleston Airport weather station (KCHS), 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, Charleston County averages approximately 156 hours per year with heat index values above 100°F.

TABLE 4.25 – HISTORICAL HEAT INDEX COUNTS, CHARLESTON AIRPORT (KCHS), 2000-2022

Year	Heat Index Value				Total
	100-104°F	105-109°F	110-114°F	≥115°F	
2000	118	50	5	0	173
2001	95	41	12	0	148
2002	96	39	0	0	135
2003	61	7	0	0	68
2004	87	19	0	0	106
2005	170	52	26	1	249
2006	67	28	3	0	98
2007	87	30	13	8	138
2008	49	18	1	0	68
2009	58	12	0	0	70
2010	198	95	18	3	314
2011	169	86	21	5	281
2012	79	41	11	0	131
2013	70	10	0	0	80
2014	142	29	5	0	176
2015	132	54	1	0	187
2016	203	90	4	0	297
2017	112	34	2	0	148
2018	174	48	2	0	224
2019	127	21	2	0	150
2020	136	41	1	0	178
2021	40	16	2	0	58
2022	88	23	3	0	114
Sum	**2,558**	**884**	**132**	**17**	**3,591**
Average	**111**	**38**	**6**	**1**	**156**

Source: North Carolina Climate Office, Heat Index Climatology Tool (https://legacy.climate.ncsu.edu/climate/heat_index_climatology)

Probability of Future Occurrence

According to maximum temperature data for the Downtown Charleston Weather Station, shown in Table 4.22 above, Charleston County has experienced a max temperature above 90°F during all of the last 23 years and a max temperature at or above 100°F during 5 of the last 23 years. The effects of humidity further compound heat conditions at these temperatures, as evidenced by the heat index climatology summarized in Table 4.25. Heat index values surpassed 100°F in all of the last 23 years, which equates to a 100 percent annual chance of heat index values exceeding 100°F in any given year. Based on historical occurrence information from NCEI (24 records in 27 years), it can reasonably be assumed that an extreme heat event has an 89% chance of occurring each year in Charleston County.

Probability: 4 – Highly Likely

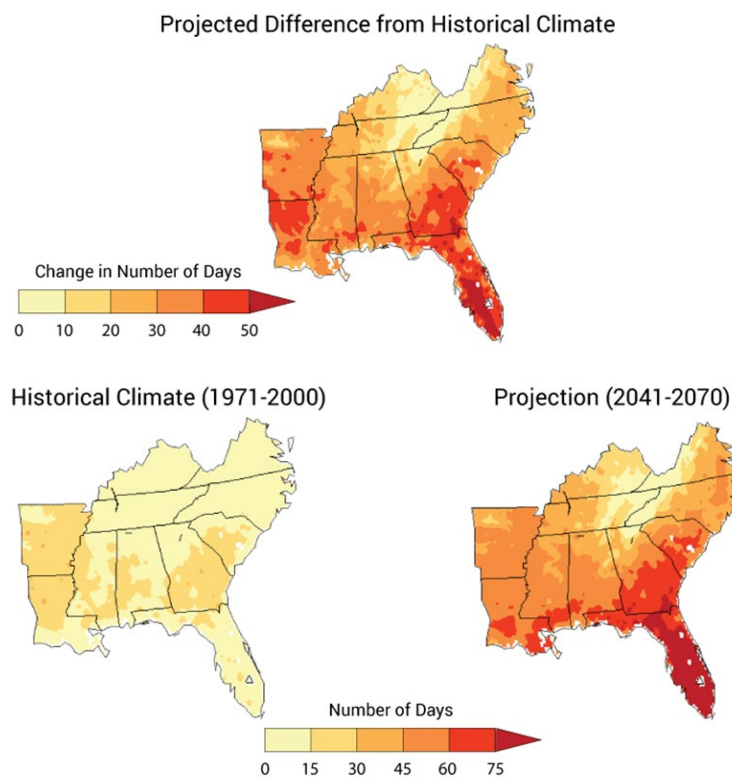
Climate Change and Future Conditions

Research shows that temperatures will continue to rise in the Southeast United States and globally, directly affecting the Charleston County region in South Carolina. Based on NOAA NCEI data, the decade from 2010–2020 was the warmest on record for the Southeast, and the region is now experiencing a higher percentage of intensifying heat waves than any other part of the country. Climate Central estimates that by 2050, the typical number of heat wave days in South Carolina is projected to quadruple from 15 to nearly 60 days a year.

Per the Fourth National Climate Assessment, "extreme temperatures are projected to increase even more than average temperatures. Cold waves are projected to become less intense and heat waves more intense." The number of days over 95°F is expected to increase by between 30 and 40 days annually, as shown in Figure 4.15.

However, daily minimum temperatures (overnight lows) have increased at a faster rate than maximum temperatures (afternoon highs). The number of days with high minimum temperatures (nighttime temperatures that stay above 75ºF) has been increasing across the Southeast, and this trend is projected to intensify, with some areas experiencing more than 100 additional warm nights per year by the end of the century. Exposure to high nighttime minimum temperatures reduces the ability of some people to recover from high daytime temperatures, resulting in heat-related illness and death.

FIGURE 4.15 – PROJECTED CHANGE IN NUMBER OF DAYS OVER 95°F



Source: NOAA NCDC from 2014 National Climate Assessment

Consequence Analysis

Category	Consequences
Public	Extreme heat may cause illness and/or death. Children, older adults, individuals with chronic conditions, are particularly vulnerable. Additionally, athletes and people working or recreating outdoors with minimal shade are at risk of increased exposure to extreme heat.
Responders	Consequences may be greater for responders if their work requires physical exertion, sun exposure, and/or wearing heavy protective gear.
Continuity of Operations (including Continued Delivery of Services)	Extreme heat would have minimal impacts on continuity of operations. 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, rail lines, and power lines as well as increased strain on power generation and water systems infrastructure.
Environment	Environmental impacts include strain on local plant and wildlife, including potential for illness or death. Crops and livestock may be affected.
Economic Condition	Short term impacts could include reduced local spending if individuals are encouraged to stay inside. Crop yields can be significantly reduced by extreme heat, particularly when extreme heat occurs during drought conditions, which may affect food prices.

Vulnerability Assessment

Extreme heat is more common and occurs more frequently than the events recorded by the National Weather Service and has a greater impact on the community than can be analyzed by weather reports or dollar losses. As mentioned above, temperatures will continue to rise in the Southeast United States directly affecting the Charleston County region in South Carolina.

Extreme heat primarily poses a threat to human health and can cause heat stroke and even loss of life. NCEI reports seven deaths and five injuries due to heat, however, injuries from heat illness are likely much higher. Older adults, very young children, and persons with respiratory disabilities, may be at increased risk to experience health problems during extreme heat events. Citadel cadets and campus staff face increased exposure to the dangers of extreme heat when participating in physical training or outside for extended periods of time. Intense physical training in extreme heat can lead to dehydration, heat stroke, heat cramps, and heat exhaustion.

Extreme heat is unlikely to cause significant damages to the built environment at The Citadel. However, road surfaces can be damaged as asphalt softens, and concrete sections may buckle under expansion caused by heat. 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. Systems in older buildings may fail as a result of excessive heat build-up due to inadequate ventilation or insulation.

Problem Statement

- Charleston County averages 30 days per year with temperatures above 90°F. The number of days with temperatures above 95°F is expected to increase by 20-30 days per year by 2041-2070.
- Cadets and campus staff are vulnerable to extreme heat if they face prolonged exposed to temperatures above 90°F or are participating in physical training in high temperatures. Intense physical training in extreme heat can lead to dehydration, heat stroke, heat cramps, and heat exhaustion.

4.4.5 Flood

Hazard	Probability	Impact	Spatial Extent	Warning Time	Duration	PRI Score
Flood	Highly Likely	Critical	Large	6 to 12 hours	<1 week	3.5

Hazard Description

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

Flooding is the most frequent and costly of all natural hazards in the United States. Ninety percent of all natural disasters in the U.S. involve flooding.

Flooding on The Citadel campus can be attributed to two sources: 1) localized stormwater flooding resulting from heavy rainfall that overburdens the drainage system; and 2) coastal flooding resulting from abnormally high tides, storm surge and heavy rains in combination with tropical storms and hurricanes.

Sources and Types of Flooding

Coastal and Tidal Flooding: Coastal flooding usually occurs as a result of abnormally high tides or tidal waves, storm surge, and heavy rains in combination with high tides, tropical storms and hurricanes.

The term "King Tide" is a non-scientific term used to describe the highest seasonal tides that occur each year. For example, in Charleston, the average high tide range is about 5.5 ft., whereas during a King Tide event the high tide range may reach 7 ft. or higher. These tides occur naturally and are typically caused when a spring tide (when the sun, moon, and earth align during a new and full moon, increasing tide ranges) takes place when the moon is closest to Earth during the 28-day elliptical orbit (known as perigee).

The effect of individual King Tides may vary considerably. In some cases, they may barely even be noticed. In other cases, a King Tide may cause coastal erosion, flooding of low-lying areas and disruption to normal daily routines. This is particularly true when a King Tide event coincides with significant precipitation because water drainage and runoff is impeded. Over time, the frequency and effect of King Tide events may increase due to gradual mean sea level rise.

Flash Flooding: A flash flood occurs when water levels rise at an extremely fast rate as a result of intense rainfall over a brief period, possibly from severe thunderstorms, hurricanes, or tropical storms, and sometimes combined with saturated soil or impermeable surfaces. Flash flooding can also result from dam failures, which are discussed in Section 4.4.1, or from a sudden release of water held by a retention basin or other stormwater control facility.

Flash flooding can happen anywhere, in or out of floodplains. Flash flood hazards caused by surface water runoff are common in urbanized areas, where greater impervious surface (e.g., pavement and buildings) 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. The 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 occurs when heavy, localized rainfall and an accumulation of stormwater runoff overburden the stormwater drainage system. The cause of localized stormwater flooding on The Citadel campus can be attributed to a number of factors, including its relatively flat terrain, close proximity to the coast, and the large amount of developed and impervious land, which limits ground absorption and increases surface water runoff. Localized flooding may also be caused by the following maintenance related issues:

- **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 which may cause flooding near the structure. Debris within the basin itself may also reduce the efficacy 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.

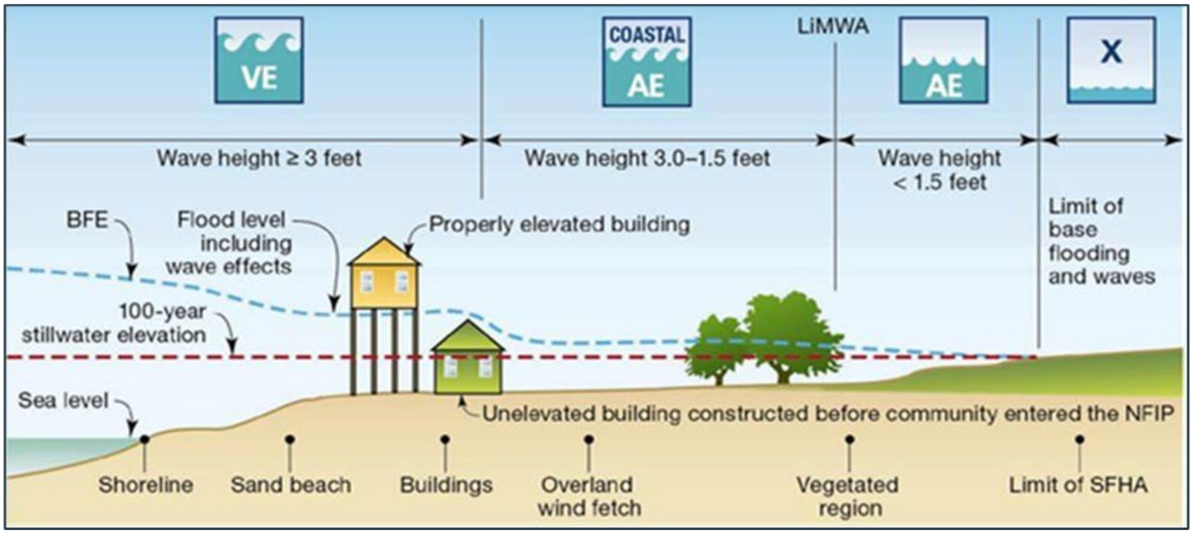
While localized flooding may not be as destructive as coastal flooding, it is a chronic problem. The repetitive damage caused by such flooding can add up. Sewers may back up, and mechanical systems can be damaged when buildings and vehicles are flooded. These impacts, and other localized flooding impacts, 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.

Riverine Flooding: The Citadel has a few small creeks and streams running throughout the coast of the campus, along the Ashley River that are susceptible to overflowing their banks during and following excessive precipitation events. Riverine flooding is mapped and evaluated based on the floodplain, which is the area adjacent to rivers and streams that is expected to experience periodic flooding. Floodplains are discussed further under "Flooding and Floodplains" below.

Flooding and Floodplains

In coastal areas, flooding occurs due to high tides, tidal waves, storm surge, or heavy rains in combination with these other sources. In these areas, flood hazards typically include the added risk of wave action delineated by the VE Zone and Coastal A Zone. Wave height and intensity decreases as floodwaters move inland. Figure 4.16 shows the typical coastal floodplain and the breakdown of flood zones in these settings. These flood zones are discussed further in Table 4.26.

FIGURE 4.16 – CHARACTERISTICS OF A COASTAL FLOODPLAIN



Source: FEMA.gov

In its common usage, the floodplain most often refers to that area that is inundated by the "100-year flood," which is the flood that has a 1-percent chance in any given year of being equaled or exceeded. The 500-year flood is the flood that has a 0.2-percent chance of being equaled or exceeded in any given year. The potential for flooding can change and increase through various land use changes and changes to land surface, which result in a change to the floodplain. A change in environment can create localized flooding problems inside and outside of natural floodplains by altering or confining natural drainage channels. These changes are 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 NFIP as the standard for floodplain management and to determine the need for flood insurance. Participation in the NFIP requires adoption and enforcement of a local floodplain management ordinance which is intended to prevent unsafe development in the floodplain, thereby reducing future flood damages. Participation in the NFIP allows for the federal government to make flood insurance available within the community as a financial protection against flood losses. Since floods have an annual probability of occurrence, have a known magnitude, depth, and velocity for each event, and in most cases, have a map indicating where they will occur, they are in many ways the most predictable and manageable hazard.

Warning Time: 3 – 6 to 12 hours

Duration: 3 – Less than 1 week

Location

Regulated floodplains are illustrated on inundation maps called Flood Insurance Rate Maps (FIRMs). It is the official map for a community on which FEMA has delineated both the SFHAs and the risk premium zones applicable to the community. SFHAs represent the areas subject to inundation by the 100-year flood event. Structures located within the SFHA have a 26-percent chance of flooding during the life of a standard 30-year mortgage.

Charleston County floodplains have been studied and mapped by FEMA. Flood prone areas were identified within the Citadel using Effective FIRMs. The most recent Flood Insurance Study for Charleston County is dated January 29, 2021. Table 4.26 summarizes the flood insurance zones identified by the current FIRMs.

TABLE 4.26 – MAPPED FLOOD INSURANCE ZONES

Zone	Description
VE	Also known as the coastal high hazard areas. They are areas subject to high velocity water including waves; they are defined by the 1% annual chance (base) flood limits (also known as the 100-year flood) and wave effects 3 feet or greater. The hazard zone is mapped with base flood elevations (BFEs) that reflect the combined influence of stillwater flood elevations, primary frontal dunes, and wave effects 3 feet or greater.
AE	AE Zones, also within the 100-year flood limits, are defined with BFEs that reflect the combined influence of stillwater flood elevations and wave effects less than 3 feet. The AE Zone generally extends from the landward VE zone limit to the limits of the 100-year flood from coastal sources, or until it reaches the confluence with riverine flood sources. The AE Zones also depict the SFHA due to riverine flood sources, but instead of being subdivided into separate zones of differing BFEs with possible wave effects added, they represent the flood profile determined by hydrologic and hydraulic investigations and have no wave effects. The Coastal AE Zone is differentiated from the AE Zone by the Limit of Moderate Wave Action (LiMWA), and includes areas susceptible to wave action between 1.5 to 3 feet.
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

All lands bordering the coast are prone to tidal flooding. Coastal land such as sand bars, barrier islands and deltas provide a buffer zone to help protect human life and property relative to the sea much as flood plains provide a buffer zone along rivers and other bodies of water. Coastal floods usually occur as a result of abnormally high tides or tidal waves, storm surge and heavy rains in combination with high tides, tropical storms and hurricanes. While The Citadel campus is not located along an immediate shoreline, it is located along the Ashley River in an area that is vulnerable to tidal flooding and storm surge inundation.

FIGURE 4.17 – FEMA FLOOD HAZARD ZONES

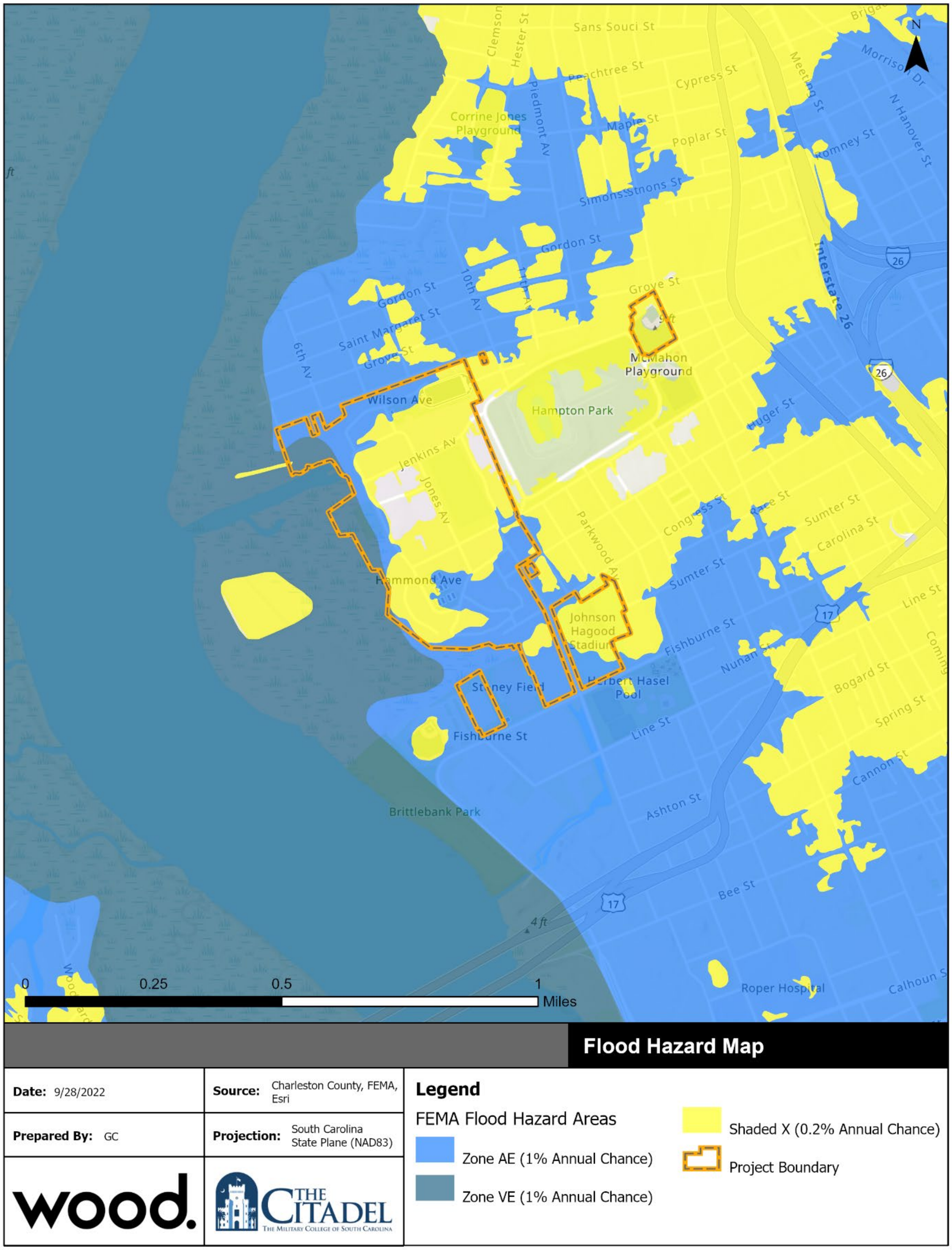
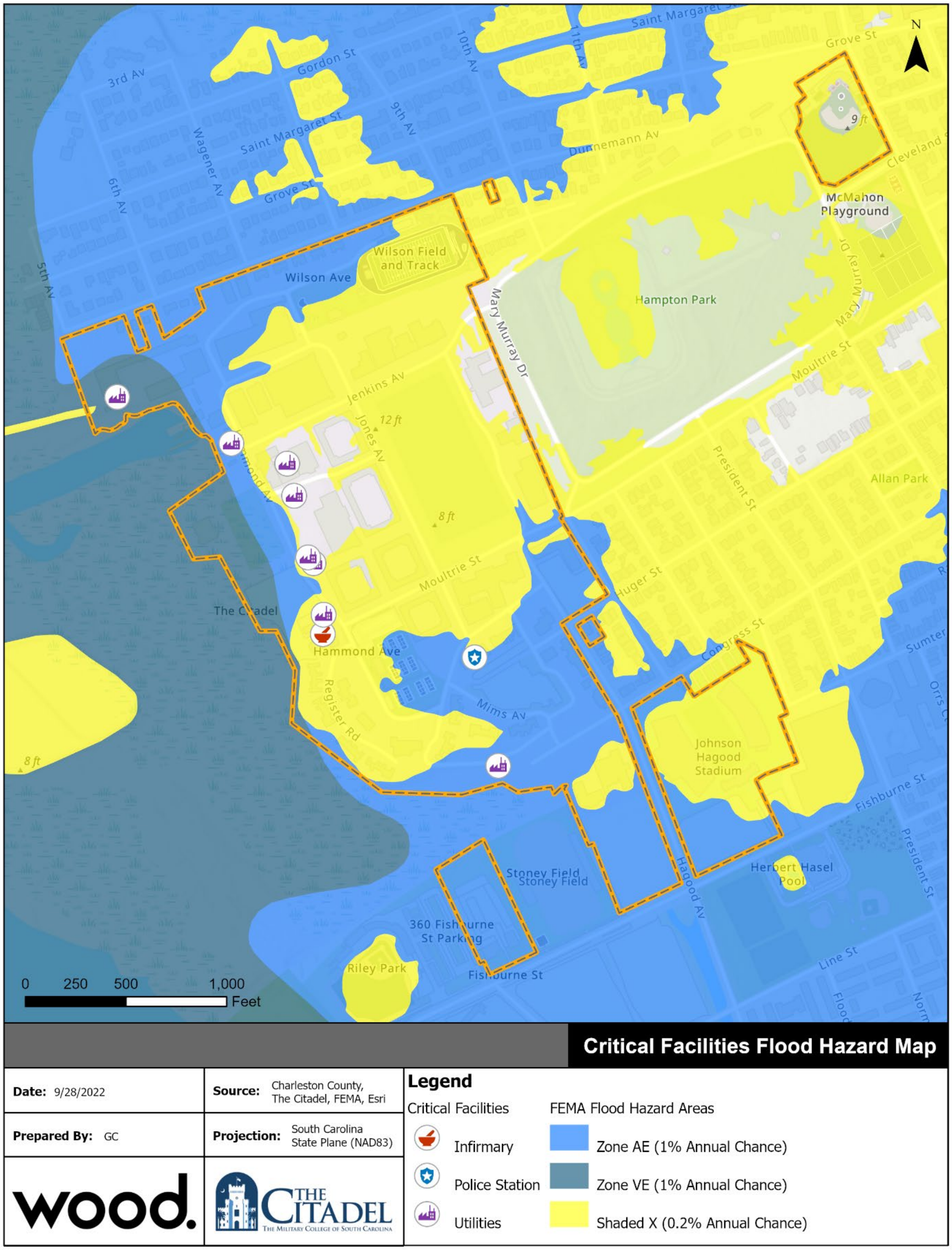


FIGURE 4.18 – CRITICAL FACILITIES & FLOOD HAZARD AREAS



Flood prone areas on The Citadel campus were identified using the most current FIRMs developed by FEMA. Figure 4.17 on the previous page reflects the FEMA mapped flood insurance zones for The Citadel campus, and Figure 4.18 shows critical facilities on campus in relation to flood hazard areas. Table 4.27 below provides a summary of acreage by flood zone. Approximately 41% of the campus falls within the SFHA in the Effective FIRM.

TABLE 4.27 – SUMMARY OF FLOOD ZONE ACREAGE

Zone	Acreage	Percent of Total
Zone VE	7.9	6.0%
Zone AE	45.8	34.9%
Zone Shaded X	68.3	52.1%
Zone X Unshaded	9.1	6.9%
Total:	**131.0**	**100.0%**
SFHA Total	**53.7**	**41.0%**

Source: Charleston County 2021 Effective FIRM

Table 4.28 shows what flood zones the campus' critical facilities are located in. The police station and the lift stations on Wilson Ave, Mims Ave, and the boat center are all within the SFHA.

TABLE 4.28 – CRITICAL FACILITIES & FLOOD HAZARD AREAS

Facility Type	Facility Name	Flood Zone
Infirmary	Mary Murray Infirmary & Generator	Shaded X
Police Station	Apts 205-208 Richardson Ave / Police Station	AE
Utilities	Pplt Lift Station Wilson Ave	VE
Utilities	Cadet Services Building	Shaded X
Utilities	Boat Center Lift Station	AE
Utilities	Elevated Water Tank St/Eq 75000 Gallon	Shaded X
Utilities	Infirmary Generator Hammond Ave	Shaded X
Utilities	Water Tank St/F Indian Hill	Shaded X
Utilities	Fire Sys Pump Sta St/Eq Indian Hill	Shaded X
Utilities	Housing Lift Station Mims Ave	AE

There are no repetitive loss properties on the Citadel campus. The Citadel does not participate in the NFIP; however, the City of Charleston does participate in the NFIP and The Citadel complies with the City of Charleston Flood Damage Prevention Ordinance for new development.

Spatial Extent: 4 – Large

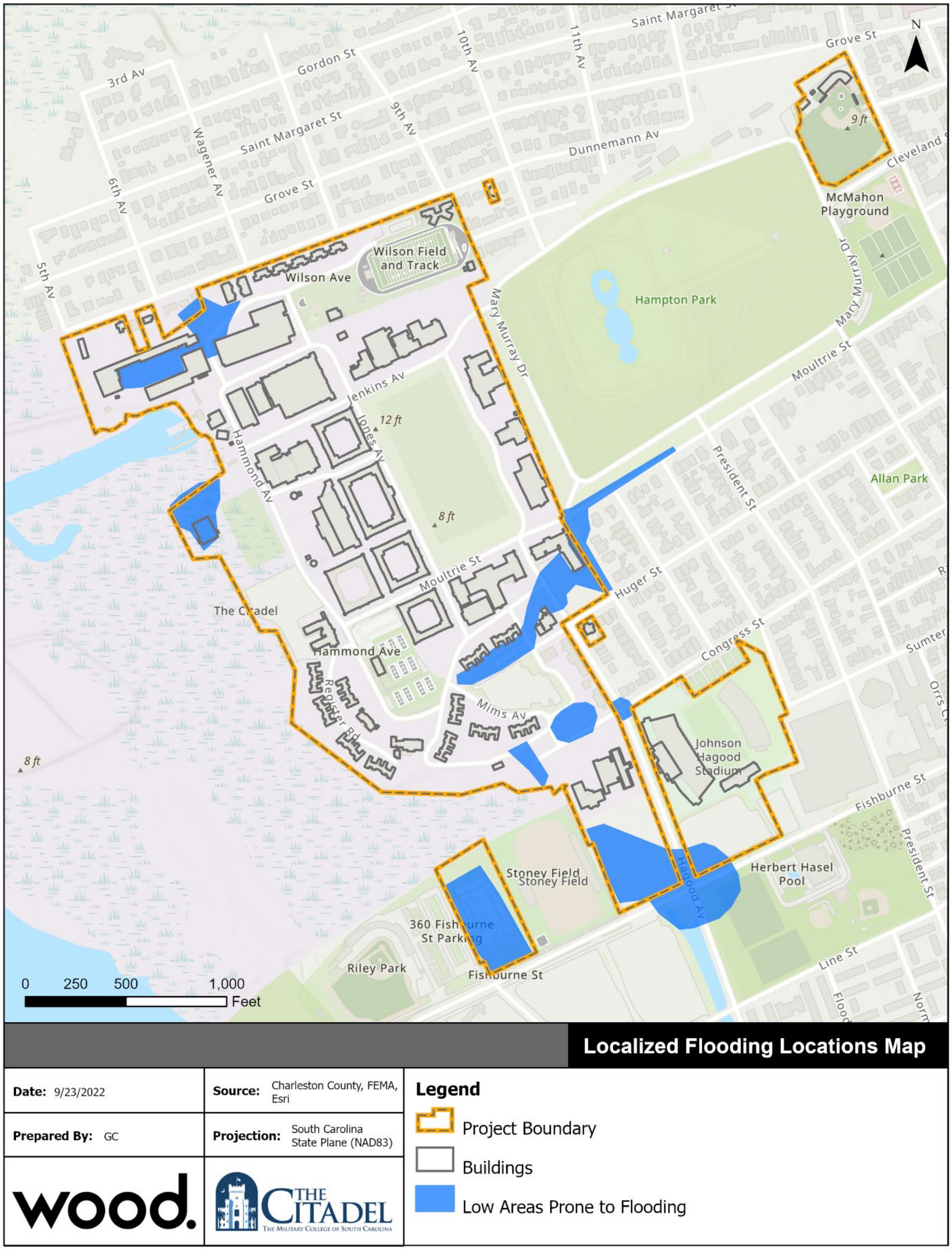
Figure 4.19 depicts the areas of localized stormwater flooding identified by the HMPC. The areas of localized stormwater flooding include:

TABLE 4.29 – STORMWATER FLOODING HOTSPOT LOCATIONS

Location	Cause of Flooding
SCNG Vehicle Maintenance Facility	King Tides, Heavy Rainfall
Intersection of Fishburne Street and Hagood Avenue	King Tides, Heavy Rainfall
Intersection of Hagood Avenue and Congress Street	King Tides, Heavy Rainfall
Hagood Avenue west of Congress Street (including cadet parking area)	King Tides, Heavy Rainfall
Moultrie Street between Parkwood Avenue and Elmwood Avenue	King Tides, Heavy Rainfall
Elmwood Avenue between Moultrie Street and Huger Street	King Tides, Heavy Rainfall
Parking areas behind Capers Hall and Alumni House	King Tides, Heavy Rainfall
Cadet parking at Kovats Field	King Tides, Heavy Rainfall

Location	Cause of Flooding
Rifle Range and adjacent parking area	King Tides, Heavy Rainfall
Wilson Avenue adjacent to Deas Hall	King Tides, Heavy Rainfall
Motor Pool	King Tides, Heavy Rainfall
Print Shop	King Tides, Heavy Rainfall
Physical Plant	King Tides, Heavy Rainfall

FIGURE 4.19 – AREAS OF LOCALIZED STORMWATER FLOODING



Extent

Flood extent can be defined by the amount of land in the floodplain, detailed above in Table 4.27.

The severity of a flood can also be measured by its depth and velocity. The depth of flooding that impacts a property is correlated with the property damages that result, where greater depths cause more substantial damages. Figure 4.20 shows the flood depths throughout The Citadel for the 1-percent-annual-chance flood event, as defined by the Effective FIRMs for the County.

Impact: 3 – Critical

Past Occurrences

Table 4.30 shows detail for flooding events reported by the NCEI since 1996 for Charleston County. There have been 437 recorded events causing over $20 million in property damage.

TABLE 4.30 – FLOODING EVENTS IN CHARLESTON COUNTY

Event Type	# of Events	Deaths/Injuries	Property Damage	Crop Damage
Coastal Flood	204	0/0	$395,000	$0
Flood	8	0/0	$22,500	$0
Flash Flood	220	0/3	$19,985,259	$0
Heavy Rain	5	0/3	$10,500	$0
Total:	**437**	**0/6**	**$20,413,259**	**$0**

Source: NCEI, August 2022

The following provides a typical narrative for the types of flooding events recorded in the NCEI database:

June 2009 - Anomalously high Perigean Spring Tides resulted in significant coastal flooding along the South Carolina coast. A National Weather Service employee reported high water entering homes near the intersection of America Street and South Street in downtown Charleston, South Carolina. The flooding was due to anomalously high tides.

December 2009 – Heavy onshore winds, rainfall, and strong thunderstorms coupled with a high tide led to flooding throughout the Charleston area, and resulted in multiple road closures around The Citadel, including at King and Huger Streets, Fishburne and Coming Streets, Fishburne and President Streets, and the Crosstown Expressway.

September 2010 – Deep southerly flow overspread the region allowing tropical moisture originating in the Caribbean Sea to stream into southern South Carolina. A developing area of low pressure over the nearby Atlantic Coastal Waters and a deepening upper level low west of the region, resulted in numerous showers and thunderstorms which produced heavy rainfall and isolated flash flooding across the area.

August 2012 – A line of thunderstorms developed late in the day and produced very heavy rainfall across much of the Downtown Charleston area. The rain fell in an area that had already seen extremely heavy rainfall amounts from the previous day. Flash flooding occurred in similar areas with many roads closed.

March 2014 - A strong northeast wind developed along the southeast coast as a wedge of high pressure built inland. This led to elevated astronomical tide levels and shallow coastal flooding just a few days out of perigee during a new moon. Law enforcement reported portions of Fishburne Street and Hagood Avenue as well as the intersection of Horizon Street and Line Street blocked off due to saltwater on the roadway. A maximum tide level of 7.47 MLLW was observed at the Charleston Harbor tide gage.

October 2015 – Precipitated by a low pressure system over the Southeast and winds from Hurricane Joaquin offshore, South Carolina experienced record 4-day rainfall of 15-20 inches, exceeding the threshold for a 1,000-year event. Flash flooding occurred for several days, prolonged by historic high tides and strong winds. The flooding caused substantial damage to buildings and infrastructure, totaling over $18M for Charleston County alone and resulting in a presidential Disaster Declaration.

January 2016 - A deepening area of low pressure moved across central South Carolina and deep layer forcing helped to produce a large swath of moderate to heavy rain with a few embedded thunderstorms. The rainfall occurred across the Charleston peninsula leading up to and right around the time of high tide in Charleston Harbor. The high tide was abnormally high due to the lunar perigee and the lingering effects of a new moon cycle. The combination of the rainfall and the high tide produced street flooding in downtown Charleston.

September 2017 - A combination of recent full moon, approaching perigee, and elevated northeast winds ahead of approaching Tropical Cyclone Irma produced elevated high tides and coastal flooding along the southeast South Carolina coast. Numerous roads closed across Downtown Charleston due to tidal flooding. A high tide gage in Charleston Harbor peaked at 7.38 ft MLLW.

November 2020 - Major coastal flooding impacted portions of the southeast South Carolina coast as astronomical high tides were elevated due to the perigee and a new moon cycle. Tides were driven higher due to the presence of favorable onshore winds as the region was under the influence of strong high pressure to the north and northeast. Major flooding typically begins along the southeast South Carolina coast when tide levels at the Charleston Harbor tide gauge reach or exceed 8.0 feet above MLLW, or 2.24 feet above MHHW.

November 2021 - Astronomical and meteorological factors combined to produce a significant multi-day coastal flood event along portions of the southeast South Carolina coast. Significant coastal flooding occurred, and the Charleston Harbor tide gauge measured 3 of the top 15 peak tides on record (dating back to 1922).

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, and the Shaded X Zone is the area that will be inundated by the flood event having a 0.2-percent chance of being equaled or exceeded in any given year. This delineation is a useful way to identify the most at-risk areas. However, 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 stormwater flooding in areas outside the SFHA and at different intervals than the 1-percent-annual-chance flood.

Based on the historical record of 212 flood and coastal flood events over the 26-year period from 1996 through August 2022, Charleston County experiences an average of 8.2 flood events per year. Some of these events may not have affected The Citadel, but many were the result of area-wide storms. Overall, flood events remain a threat in Charleston County, and the probability of future occurrences remains highly likely. Flood events will continue to occur with varying magnitudes and probabilities.

Probability: 4 – Highly Likely

Climate Change and Future Conditions

According to the Fourth National Climate Assessment, the frequency and intensity of heavy precipitation events is expected to increase across the country. More specifically, there is a 90-100% probability that by the late 21st century most areas of the U.S. will exhibit an increase of at least 5% in the maximum 5-day precipitation. Overall increases in precipitation totals are also expected in the Southeast. The mean change in the annual number of days with rainfall over 1 inch for the Southeastern U.S. 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 and localized stormwater flooding. Increased flooding may also result from more intense tropical cyclones; 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. The effects of climate change on hurricanes and tropical storms are discussed further in Section 4.4.6.

Consequence Analysis

Category	Consequences
Public	People may become stranded in their homes or vehicles. Flooding may cause injuries or loss of life. Certain health hazards are common to flood events. 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. Stagnant pools can become breeding grounds for mosquitoes, and wet areas of a building that have not been properly cleaned breed mold and mildew.
Responders	First responders are at risk when attempting to rescue people from flooded buildings. They are subject to the same health hazards as the public mentioned above. 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.
Continuity of Operations (including Continued Delivery of Services)	Floods can severely disrupt normal operations, especially when there is a loss of power or when flooding blocks access to facilities or travel routes. Damage to facilities in the affected area may require temporary relocation of some operations. Localized disruption of roads, facilities, and/or utilities 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	During a flood event, chemicals and other hazardous substances may end up contaminating local water bodies. Tidal flooding can result in saltwater contamination of fresh water supplies. Shallow flooding could also create breeding grounds for mosquitos and increase exposure to mosquito-borne diseases. Snakes may also make their way to the flooded areas.
Economic Condition	Campus buildings located in flooded areas will incur direct property damage costs. Severe flooding may impact access to campus buildings and class schedules, possibly resulting in tuition reimbursements in a worst-case scenario. Indirectly, tidal flooding can affect commerce by interrupting normal transportation systems, forcing closure of key infrastructure, and requiring traffic diversions.

Vulnerability Assessment

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 4.20 on the following page depicts the depth of flooding that can be expected within The Citadel planning area during a 1% annual chance flood event. Properties outlined in red are those impacted by the various flood depths. Figure 4.21 depicts critical facilities on The Citadel campus in relation to the 1% annual chance flood depth.

FIGURE 4.20 – 1% ANNUAL CHANCE FLOOD DEPTH

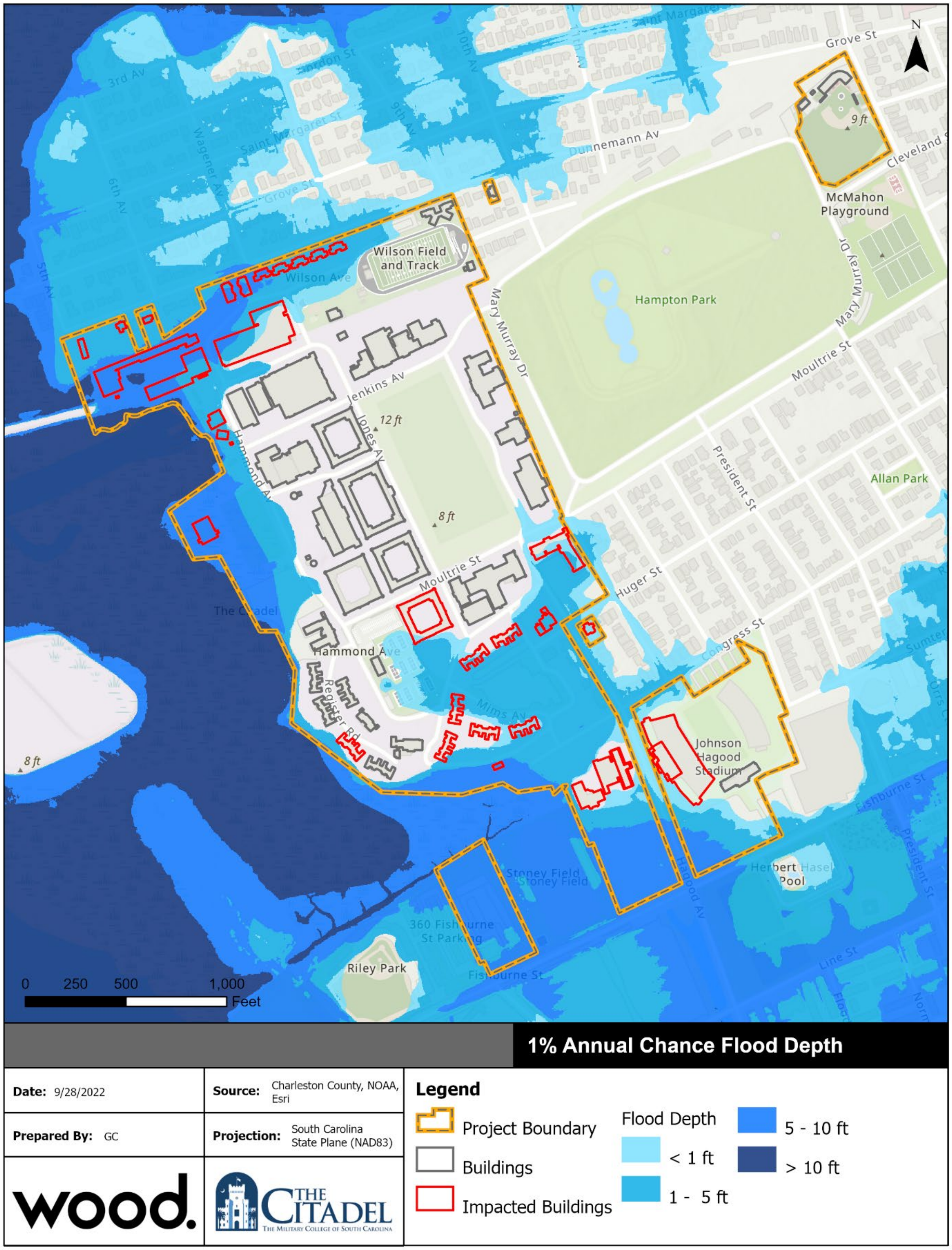


FIGURE 4.21 – CRITICAL FACILITIES AND 1% ANNUAL CHANCE FLOOD DEPTH

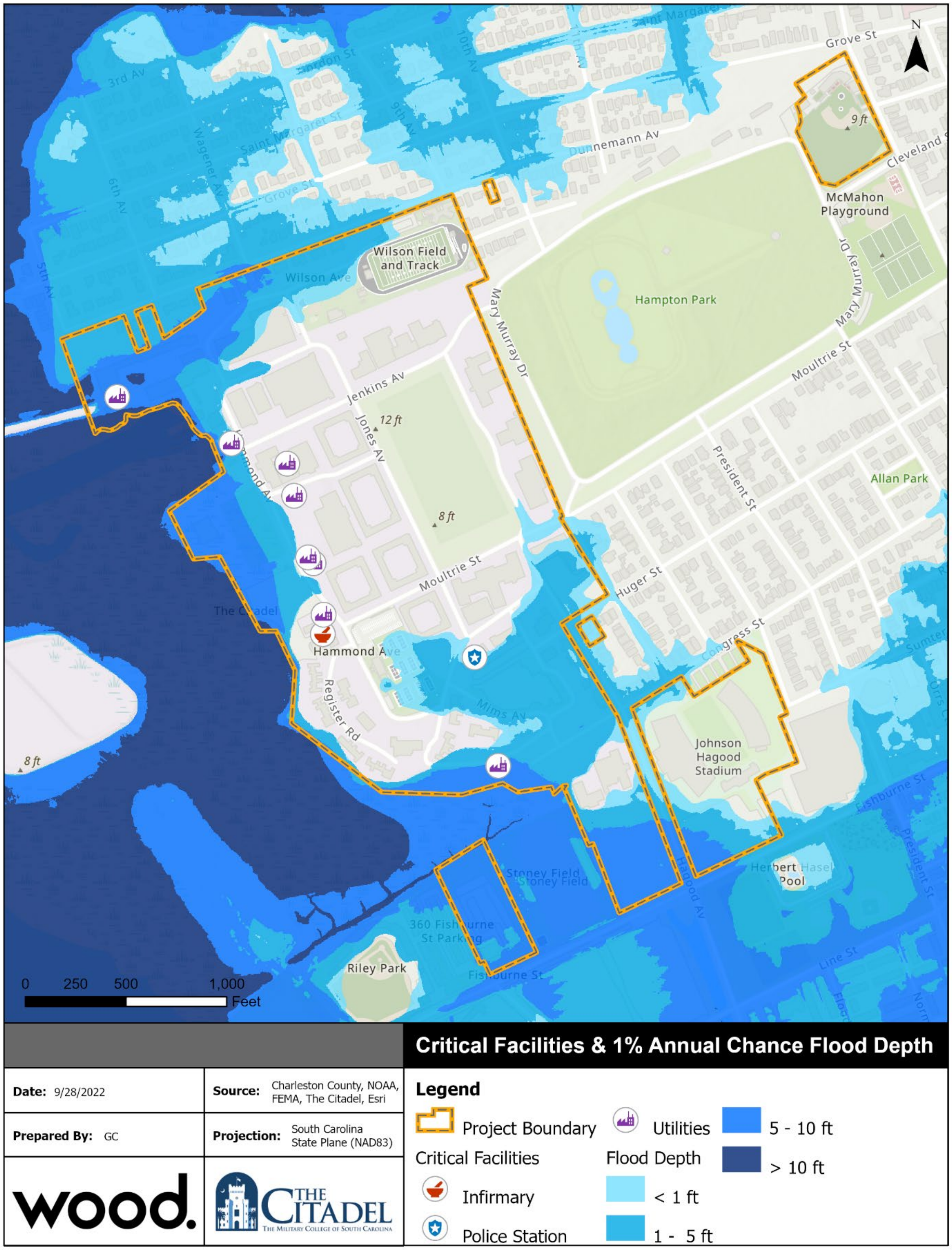


Table 4.31 provides the depth damage factors that were used to calculate coastal flood losses for The Citadel. These depth damage factors are based on the default depth damage curve in Hazus.

TABLE 4.31 – DEPTH DAMAGE PERCENTAGES

Percent Damaged (%)							
Depth (ft)	**Agricultural**	**Commercial**	**Education**	**Government**	**Industrial**	**Religious**	**Residential**
0	0	1	0	0	1	0	18
1	6	9	5	5	10	10	22
2	11	14	7	8	12	11	25
3	15	16	9	13	15	11	28
4	19	18	9	14	19	12	30
5	25	20	10	14	22	12	31
6	30	23	11	15	26	13	40
7	35	26	13	17	30	14	43
8	41	30	15	19	35	14	43
9	46	34	17	22	29	15	45
10	51	38	20	26	42	17	46
11	57	42	24	31	48	19	47
12	63	47	28	37	50	24	47
13	70	51	33	44	51	30	49
14	75	55	39	51	53	38	50
15	79	58	45	59	54	45	50
16	82	61	52	65	55	52	50
17	84	64	59	70	55	58	51
18	87	67	64	74	56	64	51
19	89	69	69	79	56	69	52
20	90	71	74	83	57	74	52
21	92	74	79	87	57	78	53
22	93	76	84	91	57	82	53
23	95	78	89	95	58	85	54
24	96	80	94	98	58	88	54

Table 4.32 details the estimated losses for a 1% annual chance flood event, calculated using Hazus.

The following assumptions were made as part of this analysis:

- Floor height and foundation type were provided or assumed based on the photos provided by The Citadel
- Building value and content cost was provided by The Citadel. Where content cost was $0, a multiplier of 0.5 was used to estimate content cost.

Table 4.32 shows the building count, total value, estimated damages and loss ratio for buildings that fall within the 1-percent-annual-chance floodplain of the Effective FIRM by flood zone and land use type.

The loss estimate for flood is based on the total of improved building value and contents value. Land value is not included in any of the loss estimates as generally the land is not subject to loss from floods.

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 1% annual chance floodplain) 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.

TABLE 4.32 – ESTIMATED BUILDING DAMAGE AND CONTENT LOSS FOR 100-YEAR COASTAL FLOOD

Occupancy Type	Total Number of Buildings with Loss	Total Value (Building & Contents)	Estimated Building Damage	Estimated Content Loss	Estimated Total Damage	Loss Ratio
Agricultural	1	$59,100	$6,298	$1,132	$7,431	12.57%
Commercial	16	$71,564,560	$142,474	$98,570	$241,045	0.34%
Education	23	$265,055,850	$349,796	$57,768	$407,564	0.15%
Government	0	$0	$0	$0	$0	0.00%
Industrial	12	$10,288,500	$1,639,742	$760,774	$2,400,516	23.33%
Religious	2	$9,328,270	$0	$0	$0	0.00%
Residential	28	$115,177,250	$1,074,778	$342,024	$1,416,802	1.23%
Total	**82**	**$471,473,530**	**$3,213,088**	**$1,260,269**	**$4,473,357**	**0.95%**

Table 4.33 details the campus critical facilities that are at risk to the 1% annual chance flood event. Based on this table and Figure 4.21, above, there are four critical facilities that would be exposed to potential flooding during a 1% annual chance flood at various flood depths.

TABLE 4.33 – CITADEL CAMPUS CRITICAL FACILITIES AT RISK 1% ANNUAL CHANCE FLOOD

Facility Type	Facility Name	1% Annual Chance Flood Depth (ft)
Police Station	Apts 205-208 Richardson Ave / Police Station	0.90
Utilities	Pplt Lift Station Wilson Ave	0.65
Utilities	Boat Center Lift Station	2.31
Utilities	Housing Lift Station Mims Ave	7.45

Problem Statement

- The 1%-annual-chance flood event could cause an estimated $4.47 million in property damage on campus. Including impacts to residential, commercial, industrial, and educational buildings. Any damage to campus barracks or the mess hall could greatly impact campus life and operations.
- Four campus critical facilities are vulnerable to impacts from the 1% annual chance flood, including three lift stations.

4.4.6 Hurricane & Tropical Storm (Storm Surge & Wind)

Hazard	Probability	Impact	Spatial Extent	Warning Time	Duration	PRI Score
Hurricane & Tropical Storm	Highly Likely	Critical	Large	>24 hours	<1 week	3.3

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

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

While hurricanes pose the greatest threat to life and property, tropical storms and depressions also can be devastating. A tropical disturbance can grow to a more intense stage through an increase in sustained wind speeds. The progression of a tropical disturbance is described below.

- **Tropical Depression:** A tropical cyclone with maximum sustained winds of 38 mph (33 knots) or less.
- **Tropical Storm:** A tropical cyclone with maximum sustained winds of 39 to 73 mph (34 to 63 knots).
- **Hurricane:** A tropical cyclone with maximum sustained winds of 74 mph (64 knots) or higher. In the western North Pacific, hurricanes are called typhoons; similar storms in the Indian Ocean and South Pacific Ocean are called cyclones.
- **Major Hurricane:** A tropical cyclone with maximum sustained winds of 111 mph (96 knots) or higher, corresponding to a Category 3, 4 or 5 on the Saffir-Simpson Hurricane Wind Scale.

Damage during hurricanes may also result from inland flooding from associated heavy rainfall.

Warning Time: 1 – More than 24 hours

Duration: 3 – Less than 1 week

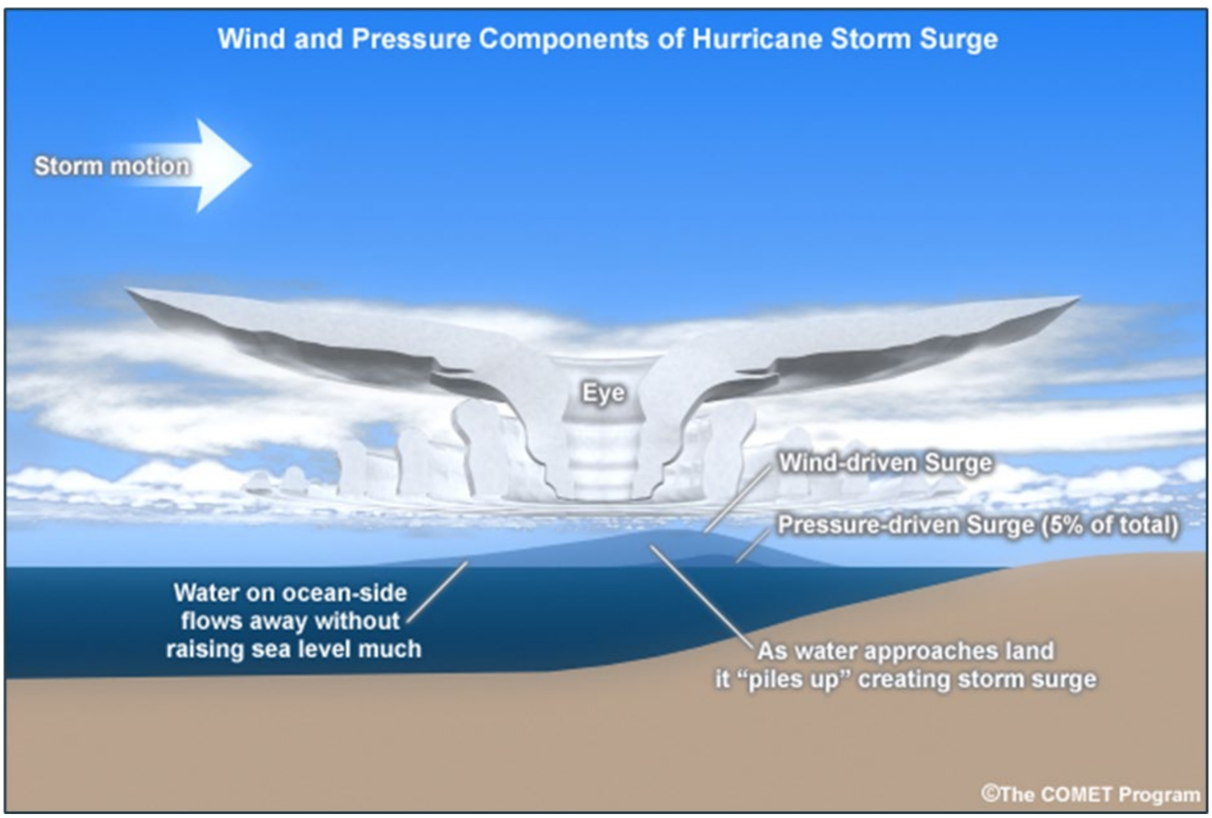
Storm Surge

In addition to high winds, hurricanes can also generate elevated water levels called storm surge, which can cause flooding and carry destructive debris. Storm surge is water that is pushed toward the shore by the force of the winds swirling around the storm as shown in Figure 4.22. This advancing surge combines with the normal tides to create the hurricane storm tide, which can increase the mean water level to heights impacting roads, homes and other critical infrastructure. In addition, wind driven waves are superimposed on the storm tide. This rise in water level can cause severe flooding in coastal areas, particularly when the storm tide coincides with the normal high tides. Because much of the densely populated Atlantic coastline lies less than 10 feet above mean sea level, the danger from storm tides is tremendous.

Although storm surge is often predicted based on a hurricane's rating on the Saffir-Simpson Scale (described below), it is also determined by hurricane size and other factors. The maximum potential storm surge for a particular location depends on a number of different factors. Storm surge is a very complex phenomenon because it is sensitive to the slightest changes in storm intensity, forward speed, size (radius of maximum winds-RMW), angle of approach to the coast, central pressure (minimal contribution in comparison to the wind), and the shape and characteristics of coastal features such as bays and estuaries. Other factors which can impact storm surge are the width and slope of the continental shelf. A shallow slope will potentially produce a greater storm surge than a steep shelf. For example, a Category 4 storm hitting the Louisiana coastline, which has a very wide and shallow continental shelf, may produce a 20-foot storm surge, while the same hurricane in Miami Beach, Florida, where the continental shelf drops off very quickly, might see an 8 or 9-foot surge.

The descriptions below of potential hurricane damage based on wind speed, hurricane damage cannot be predicted based on category rating alone because storm surge can also cause significant damage. The greatest potential for loss of life related to a hurricane is from the storm surge. Hurricane Katrina and Superstorm Sandy were both evidence of the catastrophic storm surge damages that can occur even from low category storms.

FIGURE 4.22 – COMPONENTS OF HURRICANE STORM SURGE



Source: NOAA/The COMET Program

Location

Located near the coast of South Carolina and along the Ashley River, The Citadel planning area is very susceptible to hurricane winds and flooding from storm surge. Heavy and prolonged rains from hurricanes and tropical storms can produce extensive urban and riverine flooding, especially if the storm systems are large and slow moving. Winds from these storms located offshore can drive ocean water up the mouth of a river or canal, compounding the severity of inland overbank flooding. Additionally, hurricanes and tropical storms can create storm surges along the coast and cause extensive damage. Given The Citadels coastal location and low elevation, it is very vulnerable to storm surge flooding. The entire planning area can be impacted by hurricanes and tropical storms.

The Sea, Lake and Overland Surges from Hurricanes (SLOSH) model is a computerized numerical model developed by the National Weather Service to estimate storm surge heights resulting from historical, hypothetical, or predicted hurricanes by taking into account the atmospheric pressure, size, forward speed, and track data. These parameters are used to create a model of the wind field which drives the storm surge. The SLOSH model consists of a set of physics equations which are applied to a specific locale's shoreline, incorporating the unique bay and river configurations, water depths, bridges, roads, levees and other physical features. The model creates outputs for all different storm simulations from all points of the compass. Each direction has a MEOW (maximum envelope of water) for each category of storm (1-5), and all directions combined result in a MOMs (maximum of maximums) set of data.

Anticipated SLOSH model surge elevations for Category 1 through Category 5 hurricanes are shown for The Citadel in Figure 4.23 through Figure 4.27 on the following pages.

Location: 4 – Large

FIGURE 4.23 – SLOSH STORM SURGE MODEL FOR A CATEGORY 1 STORM

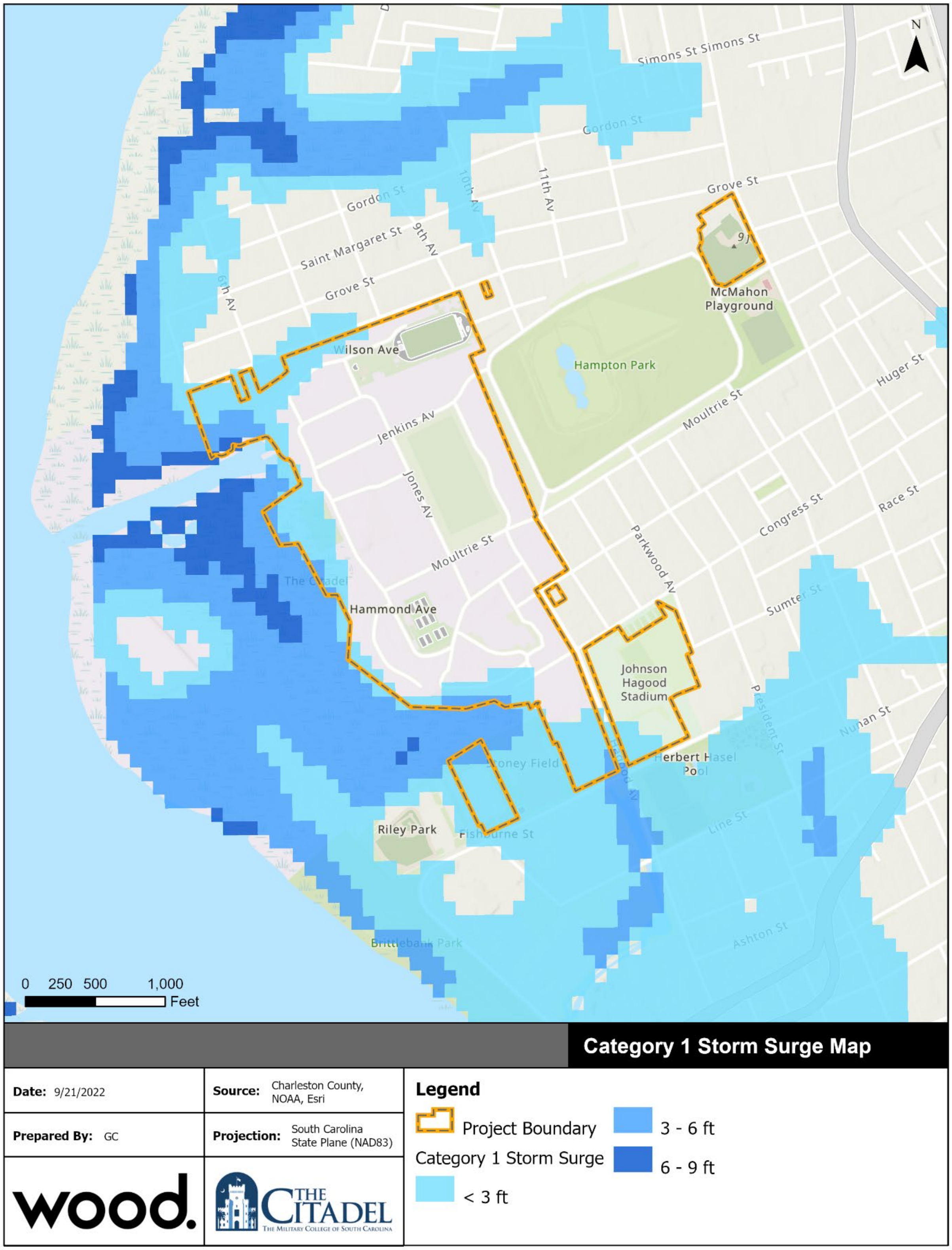


FIGURE 4.24 – SLOSH STORM SURGE MODEL FOR A CATEGORY 2 STORM

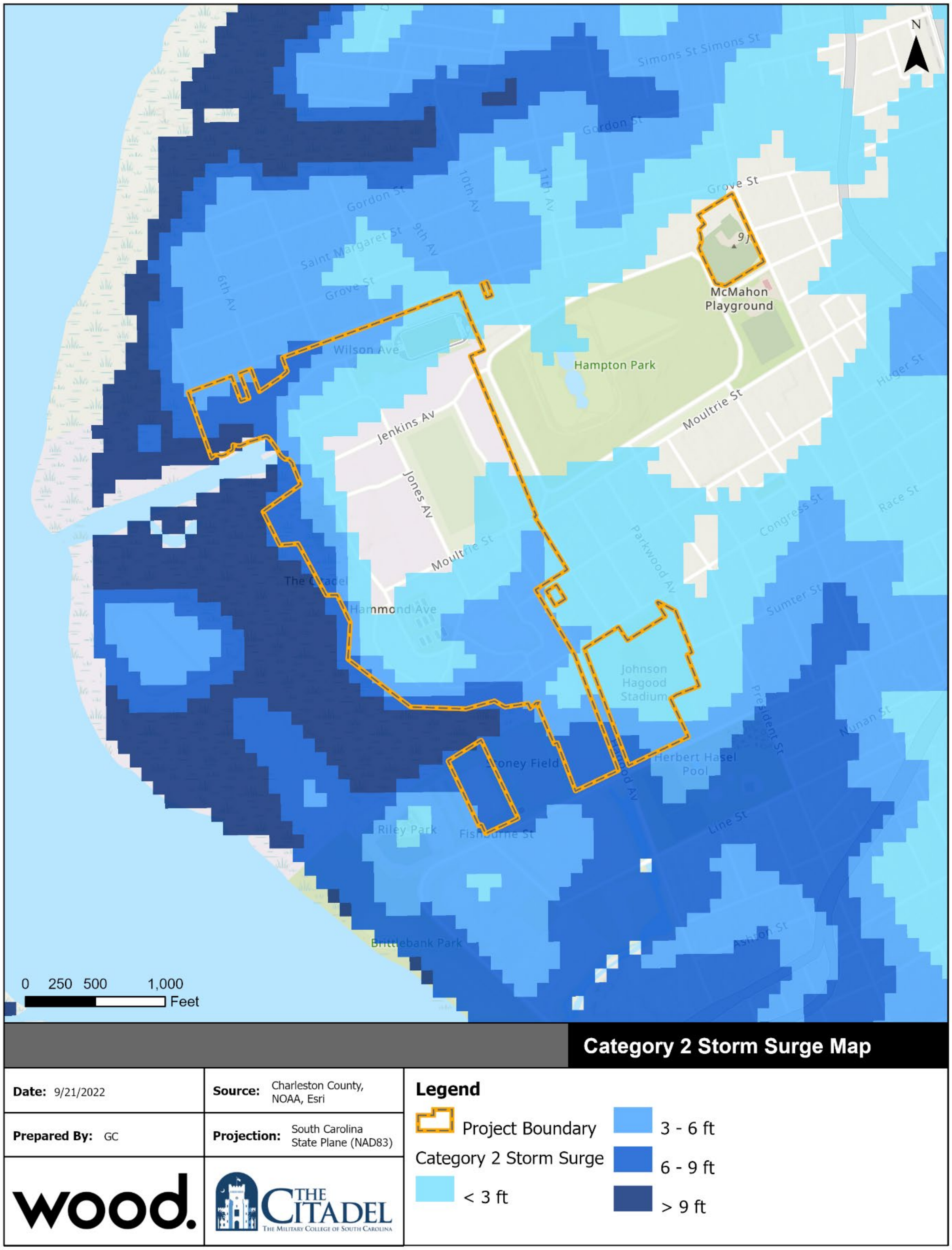


FIGURE 4.25 – SLOSH STORM SURGE MODEL FOR A CATEGORY 3 STORM

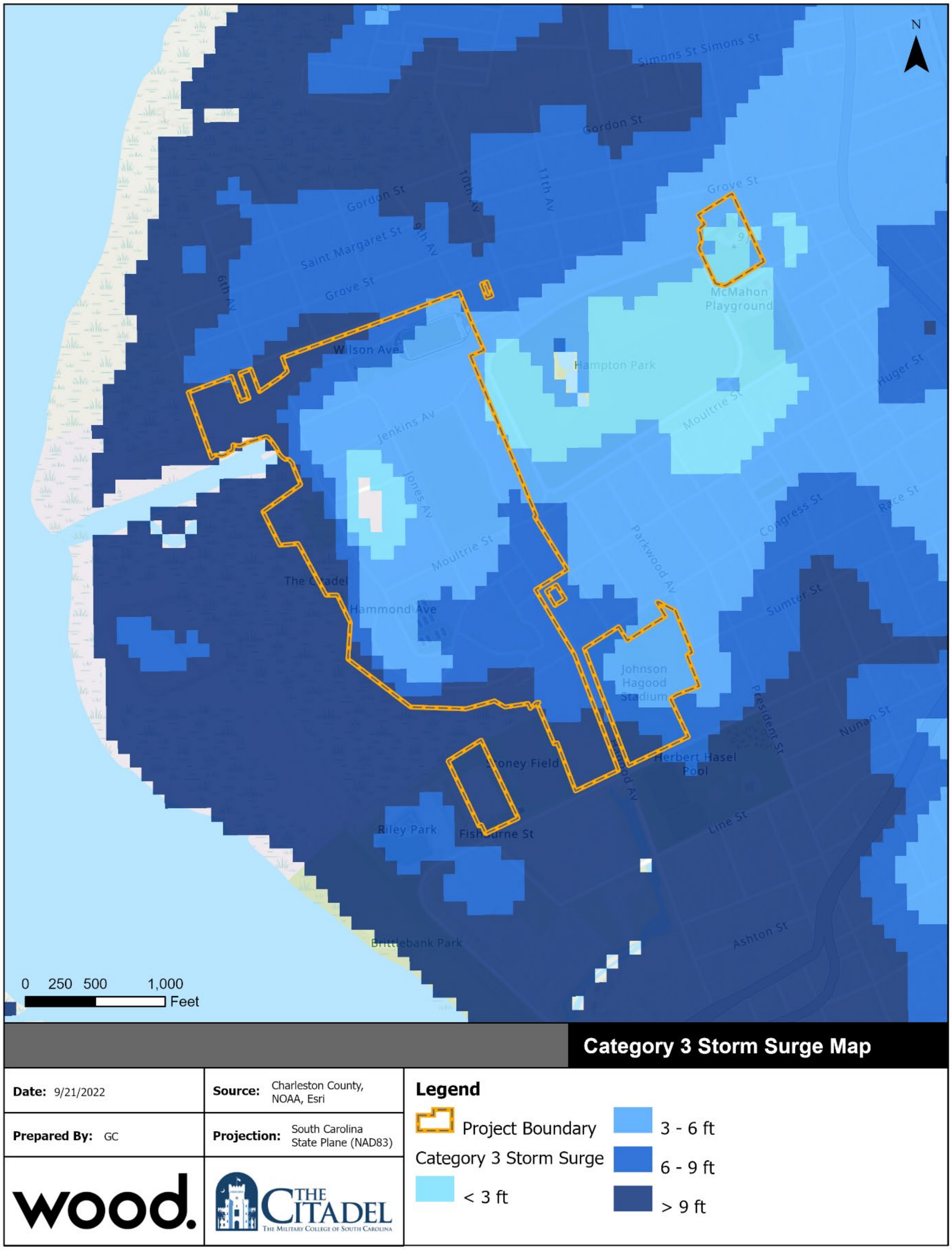


FIGURE 4.26 – SLOSH STORM SURGE MODEL FOR A CATEGORY 4 STORM

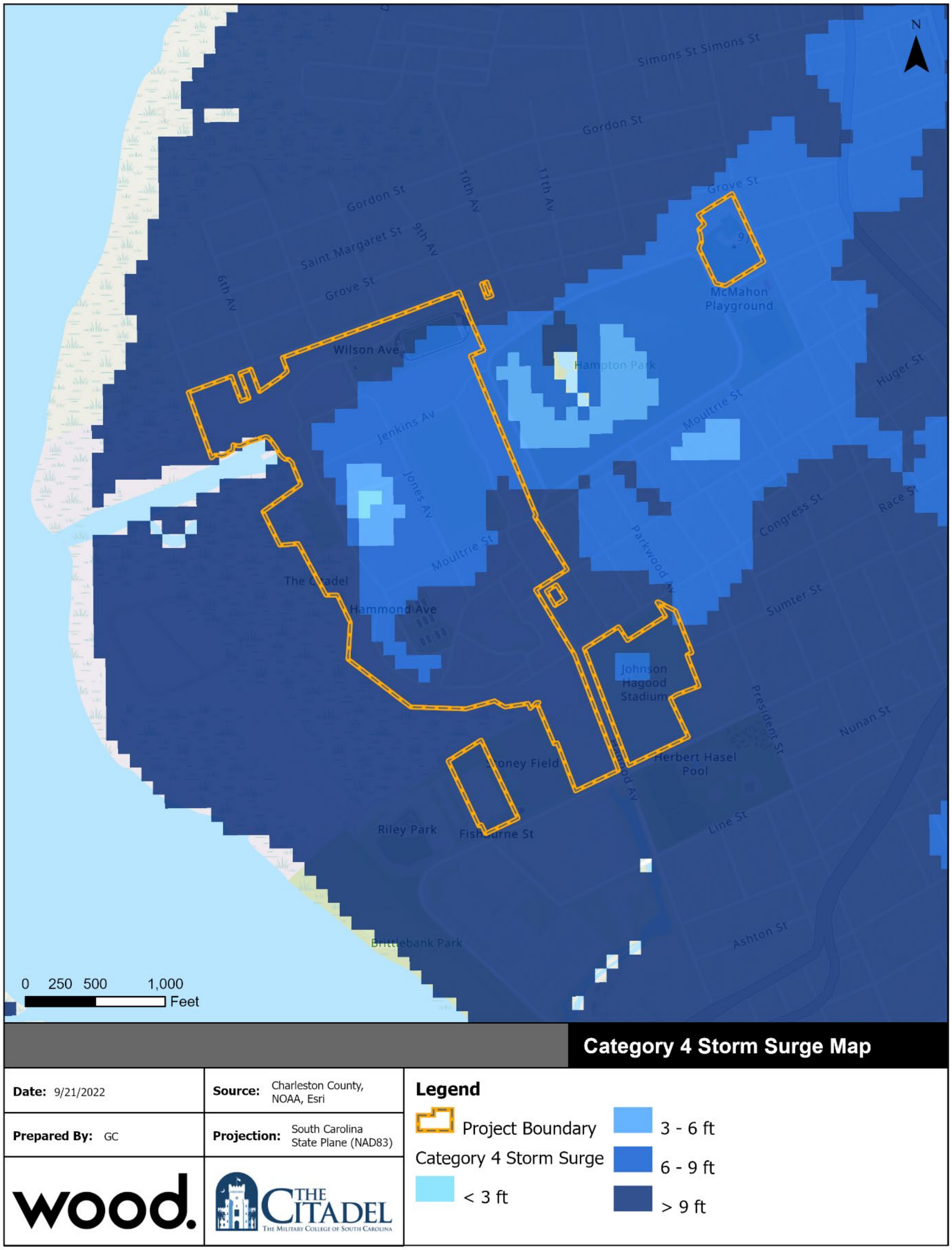
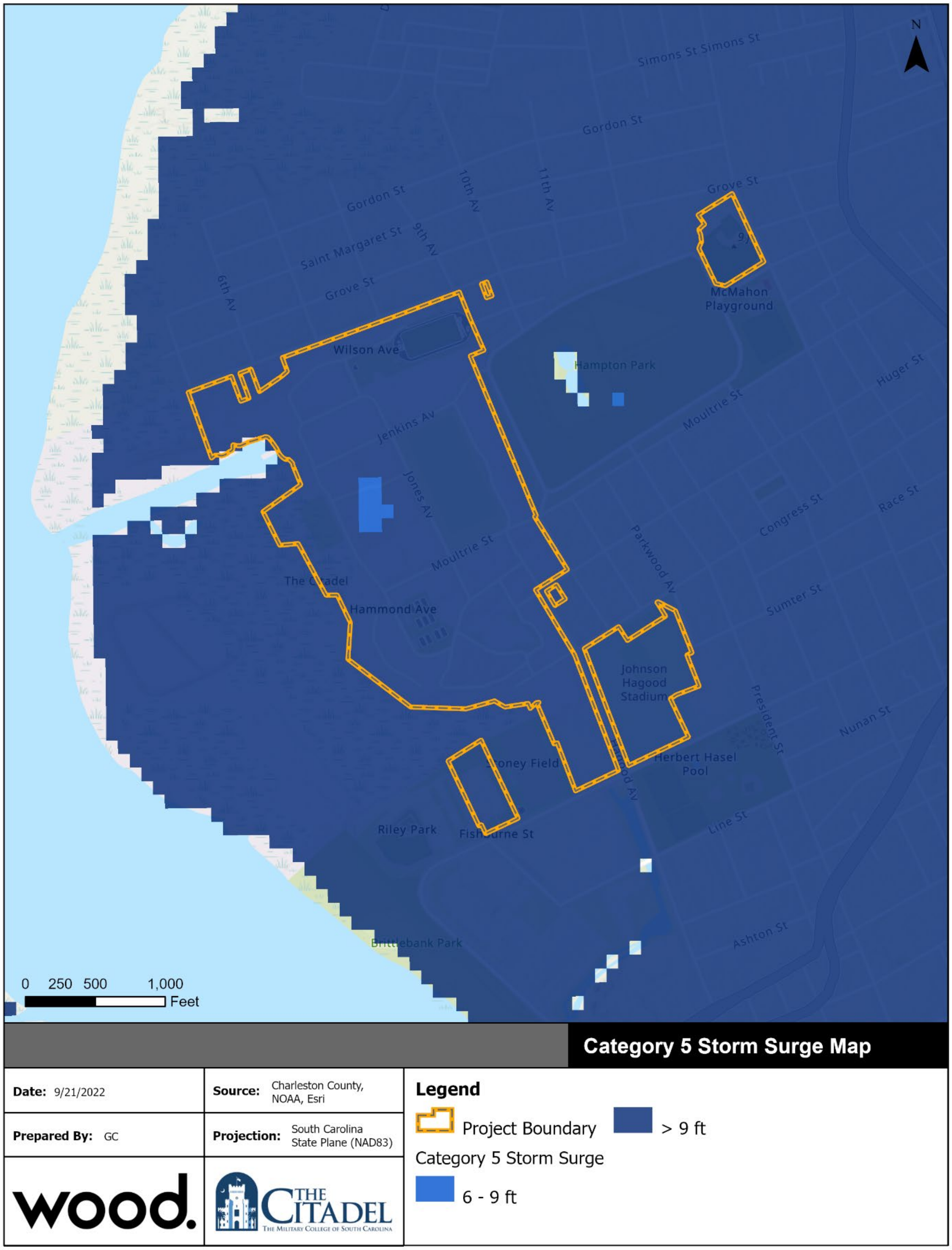


FIGURE 4.27 – SLOSH STORM SURGE MODEL FOR A CATEGORY 5 STORM



Extent

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. Hurricane intensity is further classified by the Saffir-Simpson Scale (Table 4.34), which rates hurricane intensity on a scale of 1 to 5, with 5 being the most intense. This scale estimates potential property damage.

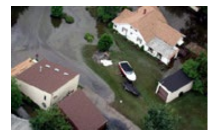
TABLE 4.34 – SAFFIR-SIMPSON SCALE

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/NOAA

Hurricanes reaching Category 3 and higher are considered major hurricanes because of their potential for significant loss of life and damage. While major hurricanes comprise only 20 percent of total tropical cyclone landfalls, they account for over 70 percent of the damage in the United States. Table 4.35 describes the damage that could be expected for each category of hurricane. Damage during hurricanes may also result from spawned tornadoes and inland flooding associated with heavy rainfall that usually accompanies these storms. Category 1 and 2 storms are still dangerous, however, and require preventative measures.

TABLE 4.35 – 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

Storm surge is also significant to a hurricane and tropical storm's magnitude, and storm surge projections are often tied to a storm's category on the Saffir-Simpson scale, however, storm surge values are highly dependent on the slope of the continental shelf, the shape of the coastline in the landfall region, and the storm's path.

Storm surge can raise the sea level as high as 25 feet or more in the strongest hurricanes. As a hurricane approaches the coast, its winds drive water toward the shore. Once the edge of the storm reaches the shallow waters of the continental shelf, the water begins to pile up. Winds of hurricane strength eventually force the water onto the shore. At first, the water level climbs slowly, but as the eye of the storm approaches, water rises rapidly. Storm surge can also cause extensive damage on the backside of a hurricane as storm surge waters are sucked back out to sea. The estimated depth and spatial extent of storm surge by storm category is shown in Figure 4.23 through Figure 4.27 above based on the SLOSH model. Note that actual storm surge levels can vary substantially from these estimates.

Impact: 3 – Critical

Past Occurrences

Table 4.36 provides hurricane and tropical storm data reported by NCEI since 1950 for Charleston County (Charleston County records start at 1996). According to NCEI data, there have been 64 tropical storms and seven hurricanes that have been reported in Charleston County. Major disaster declarations for hurricanes and tropical storms can be found in Table 4.2 and Table 4.3.

TABLE 4.36 – HURRICANE AND TROPICAL STORM EVENTS FOR CHARLESTON COUNTY

Event Type	# of Events	Deaths/ Injuries	Property Damage	Crop Damage
High Surf	16	1/0	$204,000	$0
Hurricane (Typhoon)	7	0/0	$0	$0
Storm Surge/Tide	6	0/0	$0	$0
Tropical Depression	7	0/0	$7,500	$0
Tropical Storm	64	0/2	$16,656,250	$0
Total	**100**	**1/2**	**$16,867,750**	**$0**

Source: NCEI, August 2022

Note: Costs estimates do not include debris cleanup costs, economic losses from impacts on tourism or other industry, etc.

The following provides details on hurricane events recorded in the NCEI database and in NOAA's summary of major historical hurricanes:

September 1989 – Hurricane Hugo is not recorded in NCEI, yet it produced substantial inundation and damage in the Charleston area. Hugo made landfall just north of Charleston as a Category 4 storm, with sustained winds of 120 mph. Maximum storm tides of 20 feet registered in the Cape Romain area.

July 1996 – Hurricane Bertha came close to the south coastal counties of South Carolina, but did not cause any significant damage. The maximum sustained winds (36kts) and peak gust (50kts) both occurred at the Charleston City Office on 7/12/96. Bertha's most significant impact was on tourism where the estimated loss revenue approached $20,000,000. Near eleven (11) million dollars of that was in Beaufort/Hilton Head area. A few places along the Charleston coast experienced moderate beach erosion.

September 1996 – On the 5th Hurricane Fran brushed the county warning area of Charleston. The highest peak wind gust was observed at Lake Marion in Berkeley County where a tree struck a car in the Cainhoy area and the porch of a Bonneau home was ripped off. Sporadic power outages were reported across northern Charleston and Berkeley counties as well. Economic losses were estimated at 20 million dollars.

August 1998 – Several trees down in the Mt. Pleasant area of Charleston County as Hurricane Bonnie passed east of the area headed for the North Carolina coast.

September 1999 – Hurricane Floyd produced 3 to 5 inches of rain in the Charleston area. Tides increased to 3.5 feet above normal levels, with a maximum tide height of 10.6 feet in downtown Charleston. Sustained wind speed reached 50 mph with maximum gusts in Charleston of 85 mph. Businesses and homes in the Charleston area suffered major damage totaling $10.5 million. Over a thousand trees were downed, leaving over 200,000 people in the region without power.

October 1999 – Three to five inches of rain fell across the tri-county area during the morning and early afternoon of October 17, associated with the rainbands from Hurricane Irene. Minor street flooding was reported by emergency management personnel across Charleston, Dorchester, and Berkeley counties. The highest wind gust, 48 mph, occurred in downtown Charleston on October 17 at 154 am. Minor beach erosion occurred along the Charleston county coast line, and isolated trees down and sporadic power outages occurred across Charleston and Berkeley counties.

August 2004 – Hurricane Gaston made landfall at Bulls Bay with sustained winds of 70 mph. Gusts reached 48 mph in downtown Charleston, and the maximum storm surge reached 4.5 feet at Bulls Bay. Most damage was associated with high winds, including downed trees and substantial structural damages.

August 2004 – The center of Hurricane Charley brushed the northern Charleston county coastline before making landfall just north of Myrtle Beach. The strongest winds were in northern Charleston County and eastern Berkeley county. The highest wind gusts were 63 mph at the Isle of Palms, 58 mph at Folly Beach, and 51 mph in downtown Charleston. Numerous trees and large limbs were knocked down in northern Charleston County and eastern Berkeley County. Storm surge was estimated at 4 to 6 feet over northern Charleston County from Oyster Landing to the Cape Romain Wildlife Refuge.

May 2012 - Beryl developed as a Subtropical Storm over the Atlantic Ocean well east of the South Coastal South Carolina area. The cyclone eventually became a Tropical Storm and slowly moved to the southwest and finally made landfall along the northeast Florida coast. The system then weakened to a Tropical Depression and meandered about before slowly moving back to the northeast across coastal portions of Georgia and South Carolina. The system produced tropical storm force winds, rip currents, and areas of heavy rainfall across the region.

August 2012 – Torrential heavy rainfall developed in the late morning hours within the broad circulation and deep tropical moisture around Tropical Cyclone Isaac. The heavy rainfall producing thunderstorms produced widespread flash flooding in and around Downtown Charleston.

October 2016 – Hurricane Matthew brought high winds and significant storm surge to Charleston County. Wind damage produced widespread power outages and damage to homes and other structures throughout the area. The most extensive damage came with storm surge during Matthew. Southeast South Carolina coast was impacted by storm surge generally ranging between 2 to 5 ft with some locations as high as 6 to 8 ft. The Charleston Harbor tide gauge recorded a peak tide of 9.29 ft MLLW which was the 3rd highest all storm tide on record at this location.

September 2017 - Charleston County Emergency Management reported numerous trees and power lines down across the county due to strong winds associated with Tropical Storm Irma. The National Weather Service official observation site near Waterfront Park in Downtown Charleston measured peak sustained winds of 40 mph and a peak wind gust of 52 mph. This storm surge produced numerous reports of 4 to 6 feet of inundation above ground level, mainly along the southeast South Carolina coast. A peak surge of 4.87 feet occurred at the Charleston Harbor tide gauge. Inundation due to storm surge and heavy rainfall became so widespread that the Charleston Police Department closed the peninsula to travel during the event. Significant beach erosion occurred at area beaches with widespread damage to docks and piers all along the coast, as well as numerous reports of inundated roadways.

September 2019 – Hurricane Dorian brought peak windspeeds of 69 mph to the Charleston County area. The peak storm surge from Dorian was 3-4 ft, but this occurred at low tide which greatly reduced the threat of damaging and life-threatening storm surge inundation. Charleston County Emergency Management reported numerous trees and power lines down across the entire county due to strong winds. Scattered to widespread power outages occurred, and some areas were without power for multiple days. Several trees fell onto homes and structures causing extensive damage as well as 2 minor injuries. Numerous roads were closed in Downtown Charleston and other coastal areas due to a combination of heavy rainfall and high tide flooding.

July 2021 - A tropical depression fell over southeast Charleston in early July. The primary impacts to southeast South Carolina included heavy rainfall, a few tornadoes, and gusty winds. Rainfall amounts peaked in the 6–8-inch range across portions of Charleston County. The heavy rainfall did produce some street flooding, causing some roadways to become impassable in and around Charleston. Multiple trees and powerlines were reported down across Charleston County.

According to the NOAA Historical Hurricane Tracks dataset, 106 hurricanes or tropical storms, including 88 extratropical storms passed within 50 miles of the City of Charleston since 1850. In the past 41 years

(1980-2021) 26 hurricanes and tropical storms have come within 50 miles of The Citadel. This is the most current spatial data available. The past occurrences and average frequency of hurricane events are summarized by category in Table 4.37 and a list of all hurricanes and tropical storms that have come within 50 miles of The Citadel since 1980 is provided on the following pages in Table 4.38.

TABLE 4.37 – HURRICANE TYPE & FREQUENCY

Storm Intensity	Number of Occurrences	Rate of Occurrence
Extratropical Storm	4	1 in 10.3 years
Tropical Depression	5	1 in 8.2 years
Tropical Storm	13	1 in 3.2 years
CAT I Hurricane	2	1 in 20.5 years
CAT II Hurricane	1	1 in 41 years
CAT III Hurricane	0	No occurrence
CAT IV Hurricane	1	1 in 41 years
CAT V Hurricane	0	No occurrence
Total	26	1 in 1.6

Source: NOAA Historical Hurricane Tracks, August 2022

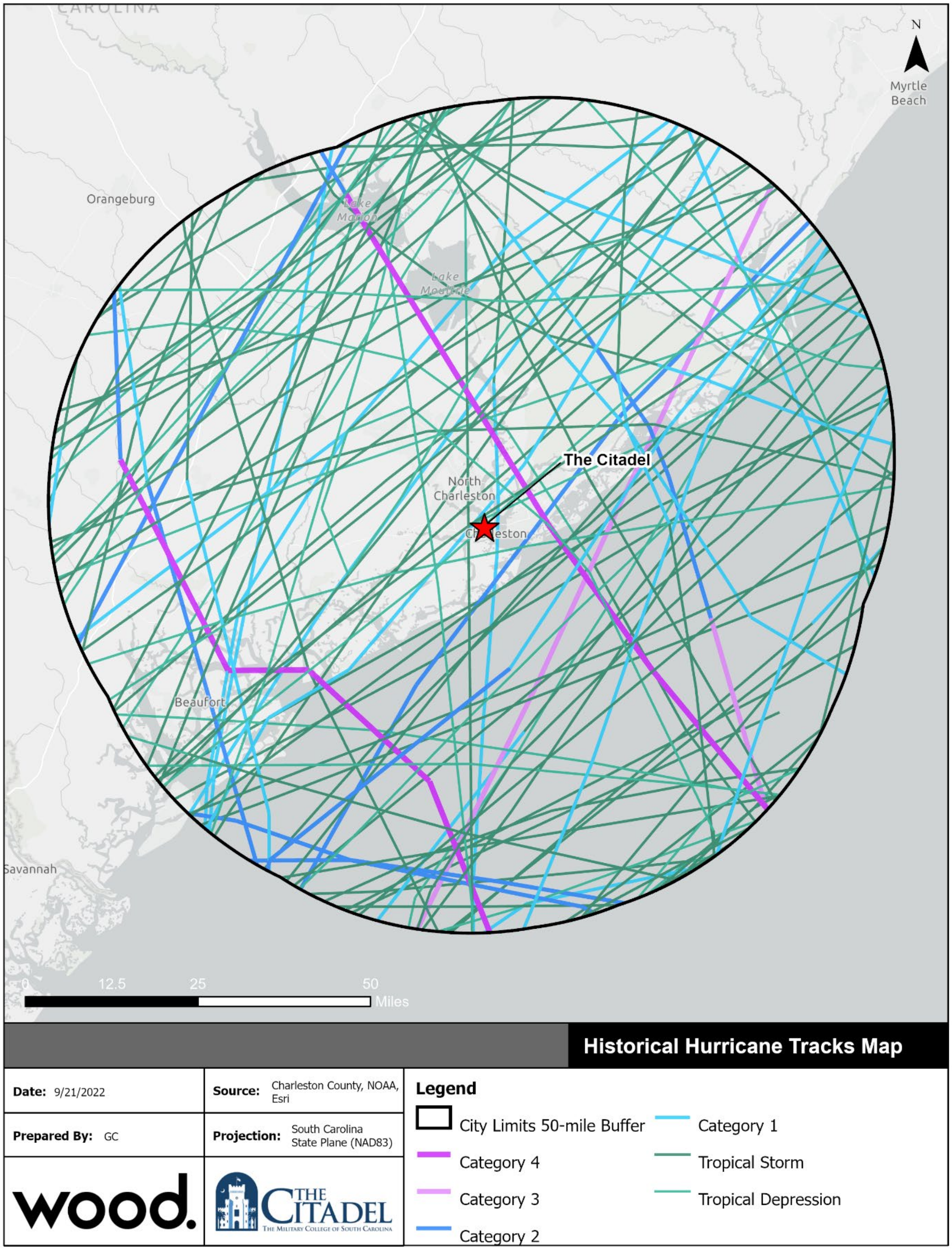
Figure 4.28 on the following page illustrates past hurricane strike data for land falling major hurricanes over The Citadel as provided by the NOAA National Hurricane Center.

TABLE 4.38 – HISTORICAL HURRICANE TRACKS NEAR THE CITADEL

Storm Name	Date	Category
DANNY	6/28/2021	Tropical Storm
ETA	11/13/2020	Tropical Storm
ISAIAS	8/3/2020	Category 1
BERTHA	5/27/2020	Tropical Storm
FLORENCE	9/15/2018	Tropical Storm
MATTHEW	10/8/2016	Category 2
HERMINE	9/2/2016	Tropical Storm
COLIN	6/7/2016	Tropical Storm
ANDREA	6/7/2013	Tropical Storm
BERYL	5/30/2012	Tropical Depression
HANNA	9/6/2008	Tropical Storm
CRISTOBAL	7/19/2008	Tropical Depression
BARRY	6/3/2007	Extratropical
GASTON	8/29/2004	Tropical Storm
BONNIE	8/13/2004	Tropical Depression
KYLE	10/11/2002	Tropical Storm
EARL	9/3/1998	Extratropical
JOSEPHINE	10/8/1996	Extratropical
ALLISON	6/6/1995	Extratropical
GORDON	11/21/1994	Tropical Depression
HUGO	9/22/1989	Category 4
CHARLEY	8/15/1986	Tropical Depression
KATE	11/22/1985	Tropical Storm
BOB	7/25/1985	Category 1
ISIDORE	9/29/1984	Tropical Storm
DENNIS	8/19/1981	Tropical Storm

Source: NOAA Historical Hurricane Tracks

FIGURE 4.28 – NOAA HISTORICAL HURRICANE TRACKS SINCE 1900

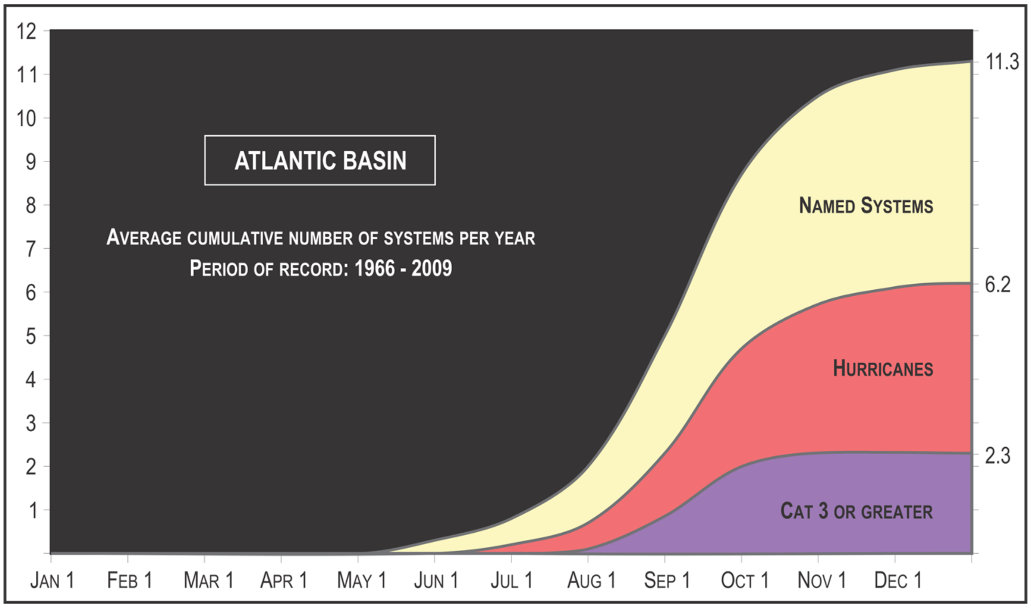


Source: NOAA/National Hurricane Center, August 2022

Probability of Future Occurrences

The Atlantic basin hurricane season runs from June 1st to November 30th. The Atlantic basin includes the Atlantic Ocean, Caribbean Sea, and Gulf of Mexico. Figure 4.29 shows the progress of a typical hurricane season in terms of the total number of tropical systems and hurricanes produced throughout the year in the Atlantic basin. The curves represent the average cumulative production of all named tropical systems, all hurricanes, and those hurricanes which were Category 3 or stronger in those basins. Hurricanes are certain to continue occurring in the Atlantic Basin.

FIGURE 4.29 – AVERAGE NUMBER OF TROPICAL STORMS PER YEAR (ATLANTIC BASIN)



Source: NOAA/National Hurricane Center

Given the 100 hurricane, tropical storm, and storm surge occurrences recorded in NCEI over a period of 27 years (1996-2022), Charleston County averages 3.7 hurricane, tropical storm, or storm surge related events annually. Therefore, it can be reasonably assumed that hurricane or tropical storm related events have a 100% chance of occurring in Charleston in each year.

Probability: 4 – Highly Likely

Climate Change and Future Conditions

One of the primary factors contributing to the origin and growth of tropical storm and hurricanes systems is water temperature. Sea surface temperature may increase significantly in the main hurricane development region of the North Atlantic during the next century as well as in the Gulf of Mexico. NOAA models predict that while there may be less frequent, low-category storm events (Tropical Storms, Category 1 Hurricanes), there will be more, high-category storm events (Category 4 and 5 Hurricanes) in the future. This means that there may be fewer hurricanes overall in any given year, but when hurricanes do form, it is more likely that they will become large storms that can create massive damage. Per the Fourth National Climate Assessment, studies suggest that there will be an increase in the number of very intense tropical cyclones. The total number of storms may remain consistent, but very intense storms are expected to become more frequent and the amount of rainfall from these storms is projected to increase. Additionally, research suggests that hurricane precipitation is likely to increase by about 20 percent in warmer climates.

Hurricanes and other coastal storms may result in increased flooding, injuries, deaths, and extreme property loss. According to the US Government Accountability Office, national storm losses from changing frequency and intensity of storms is projected to increase anywhere from $4-6 billion soon.

Sea level change will be particularly important in influencing storm surge flooding in the Charleston area, since the area is already subject to flooding from above normal tides, surge and rainfall events from hurricanes and less powerful tropical storms. As a result of sea-level rise, flooding from just high tide events is becoming more common.

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 may 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	Impacts on responders could be severe, including potential for death or injury during response operations. Downed trees and flooding may block roads. Response time may be reduced due to the large geographic scale of likely impacts and the high potential number of incidents requiring response.
Continuity of Operations (including Continued Delivery of Services)	Damage to facilities and/or personnel, power outages, road blockages, and other impacts from flooding or wind may require temporary relocation of some operations and may disrupt operations. Disruption or damage of roads and/or utilities may postpone delivery of some services. The County's EOP may mitigate some potential issues.
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. Flood damages may also impact buildings and infrastructure. Regulatory waivers may be needed locally.
Environment	Hurricanes can devastate wooded ecosystems and remove foliage from forest canopies, and they can change habitats, affecting indigenous animal populations 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	Local economy and finances can be adversely affected, possibly for an extended period of time, depending on damages. Intangible impacts are also likely, including business interruption and additional living expenses.

Vulnerability Assessment

Hurricanes can have immediate and long-term impacts on people and property. Hurricanes may affect human beings in a number of ways including death and injury, outbreak of diseases, and mental trauma. Additionally, water can become polluted making it undrinkable, and if consumed, diseases and infection can be easily spread. During a hurricane, residential, commercial, and public buildings, as well as critical infrastructure such as transportation, water, energy, and communication systems may be damaged or destroyed by several of the impacts associated with hurricanes. Transportation disruptions and damage may limit students' ability evacuate or access resources off campus. Power outages and flooding are likely to displace people from their homes. Any displacement may cause challenges for professors and other campus staff that go to the campus regularly for employment.

Due to the variability in flooding and other impacts associated with hurricanes, it is difficult to estimate losses for a hurricane event. This vulnerability assessment presents a spatial analysis of property exposure to SLOSH modeled storm surge inundation areas. Hurricane flooding will also be affected by rainfall, which is not accounted for in these storm surge estimates.

It should be noted that SLOSH models do not predict storm surge, and actual storm surge heights may exceed the estimates shown. Additionally, these storm surge models do not incorporate other hurricane impacts that may exacerbate flooding, including hurricane strength winds and rain. Therefore, these models should be interpreted as a minimum impact scenario.

A vulnerability assessment was completed for hurricane wind using parameters based on the 1989 Hurricane Hugo event. On September 22, 1989, Hurricane Hugo roared ashore just north of Charleston, S.C. as a massive Category 4 storm with winds near 140 mph and a storm tide around 20 feet. The hurricane leveled beachfront properties and toppled trees, leaving much of the coastal areas in absolute ruin. Figure 4.30 on the following page depicts the path of Hurricane Hugo.

Table 4.39 displays damage results for the modeled 1989 Hurricane Hugo event categorized by minor, moderate, severe and complete damage. The categories are defined as follows:

Minor Damage

A building has sustained between 2% - 15% roof cover damage and at least one window, door or garage door failure. Roof cover losses can be mitigated by covering the damage to prevent water intrusion. Wall dents or marks can be patched or painted.

Moderate Damage

Between 15% - 50% roof cover damage resulting in the loss of at least 1-3 roof panels. Some interior damage from water. At least 20% of windows have failed. Building walls have sustained between 5-10 debris impacts.

Severe Damage

>50% of roof cover loss resulting in major damage to the roofing structure. Extensive interior damage due to water. Up to 25% of roofing panels are impacted. Between 20% - 50% of windows have failed. Building walls have sustained between 10-20 debris impacts.

Complete Damage

Complete roof and/or wall structure failure. Greater than 50% of roof missing or damaged. Greater than 50% of windows have failed. Building walls have sustained > 20 debris impacts and may be structurally compromised.

TABLE 4.39 – ESTIMATED BUILDING DAMAGE AND CONTENT LOSS – HURRICANE HUGO EVENT (CATEGORY 4)

Occupancy Type	Total Value (Building & Contents)	Total Number of Buildings			
		Minor	Moderate	Severe	Complete
Agriculture	$59,100	0.22	0.28	0.17	0.00
Commercial	$71,564,560	2.58	4.46	1.64	0.00
Education	$265,055,850	4.39	8.95	2.12	0.00
Government	$0	0.00	0.00	0.00	0.00
Industrial	$10,288,500	2.13	3.39	1.55	0.00
Religious	$9,328,270	0.38	1.16	0.17	0.00
Residential	$115,177,250	11.09	6.98	0.83	0.00
Total	**$471,473,530**	**21**	**25**	**6**	**0**

Source: Hazus, v5

FIGURE 4.30 – HURRICANE HUGO PATH

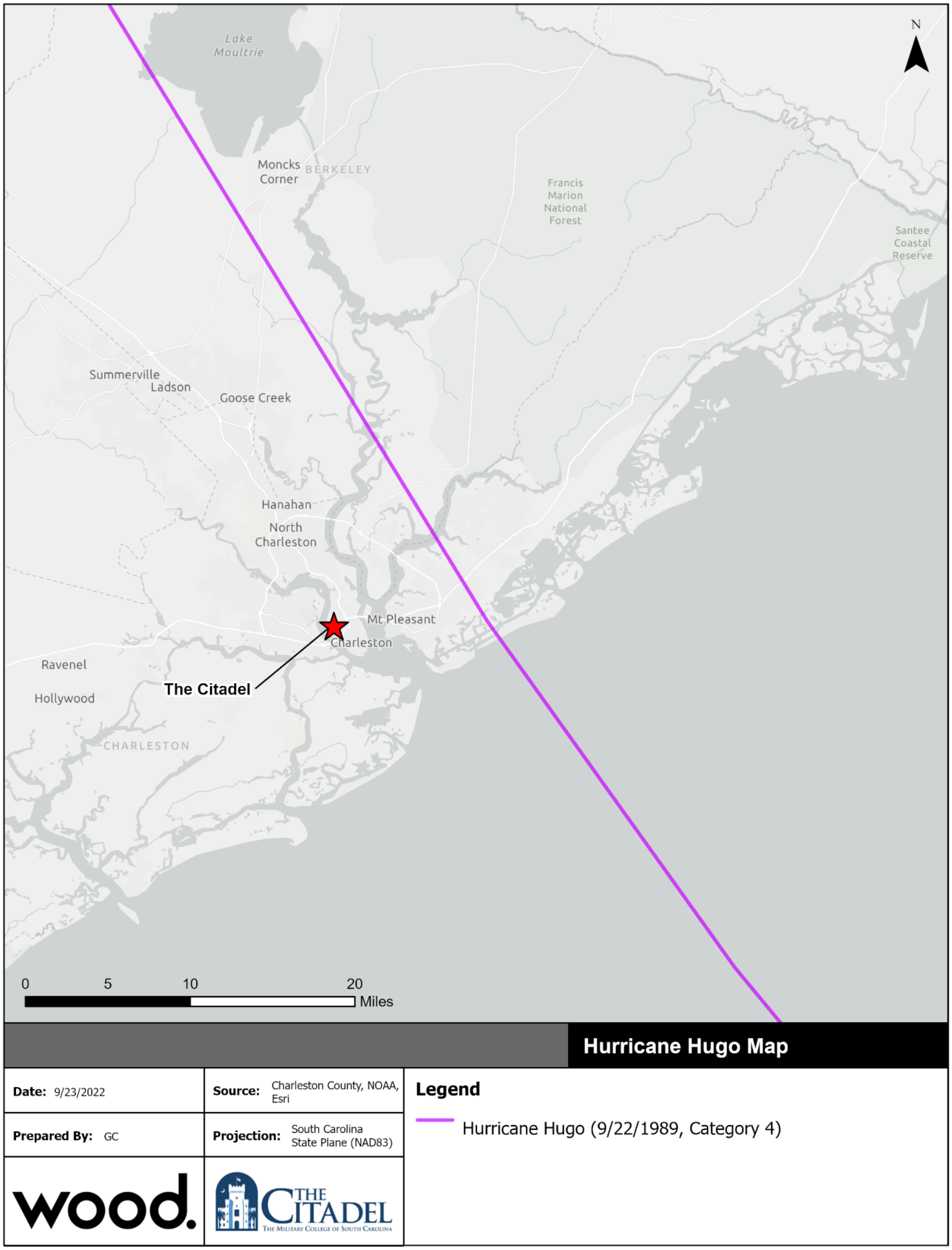


Table 4.40 through Table 4.42 provides a summary of estimated assets at risk to hurricane storm surge for each hurricane category. The assets at risk estimate for each hurricane category is based on the total of improved and contents value. The value of land is not included in the loss estimates as generally the land is not subject to loss from hurricane and tropical storm damage. Figure 4.31 through Figure 4.36 on the following pages depict storm surge inundation area and property exposure by category. Note that these are storm surge estimates.

Areas inundated by storm surge are also those that are more likely to experience some degree of velocity wave action, which can exacerbate the damage caused by a typical flood.

The entire Citadel campus would be inundated by a Category 3 or a more severe hurricane, therefore, Category 4 and Category 5 losses are not shown.

TABLE 4.40 – PROPERTIES AT RISK TO CATEGORY 1 STORM SURGE

Occupancy Type	Building Count	Total Building Value	Estimated Content Value	Total Value (Building and Contents)
Agriculture	1	$56,500	$2,600	$59,100
Commercial	0	0	0	$0
Education	3	$30,946,300	$11,810,700	$42,757,000
Government	0	0	0	$0
Industrial	4	$5,976,200	$1,445,750	$7,421,950
Religious	0	$0	$0	$0
Residential	14	$10,346,800	$830,900	$11,177,700
Total	**22**	**$47,325,800**	**$14,089,950**	**$61,415,750**

TABLE 4.41 – ADDITIONAL PROPERTIES AT RISK TO CATEGORY 2 STORM SURGE

Occupancy Type	Building Count	Total Building Value	Estimated Content Value	Total Value (Building and Contents)
Agriculture	0	$0	$0	$0
Commercial	9	$50,786,400	$2,821,060	$53,607,460
Education	16	$148,035,600	$29,050,900	$177,086,500
Government	0	$0	$0	$0
Industrial	5	$630,700	$265,750	$896,450
Religious	1	$7,152,400	$204,330	$7,356,730
Residential	10	$24,298,000	$1,062,250	$25,360,250
Total	**41**	**$230,903,100**	**$33,404,290**	**$264,307,390**

TABLE 4.42 – ADDITIONAL PROPERTIES AT RISK TO CATEGORY 3 STORM SURGE

Occupancy Type	Building Count	Total Building Value	Estimated Content Value	Total Value (Building and Contents)
Agriculture	0	$0	$0	$0
Commercial	7	$16,345,100	$1,612,000	$17,957,100
Education	4	$35,965,600	$9,246,750	$45,212,350
Government	0	$0	$0	$0
Industrial	3	$1,313,400	$656,700	$1,970,100
Religious	1	$1,709,040	$262,500	$1,971,540
Residential	4	$74,162,600	$4,476,700	$78,639,300
Total	**19**	**$129,495,740**	**$16,254,650**	**$145,750,390**

FIGURE 4.31 – OVERVIEW OF STORM SURGE EXTENT

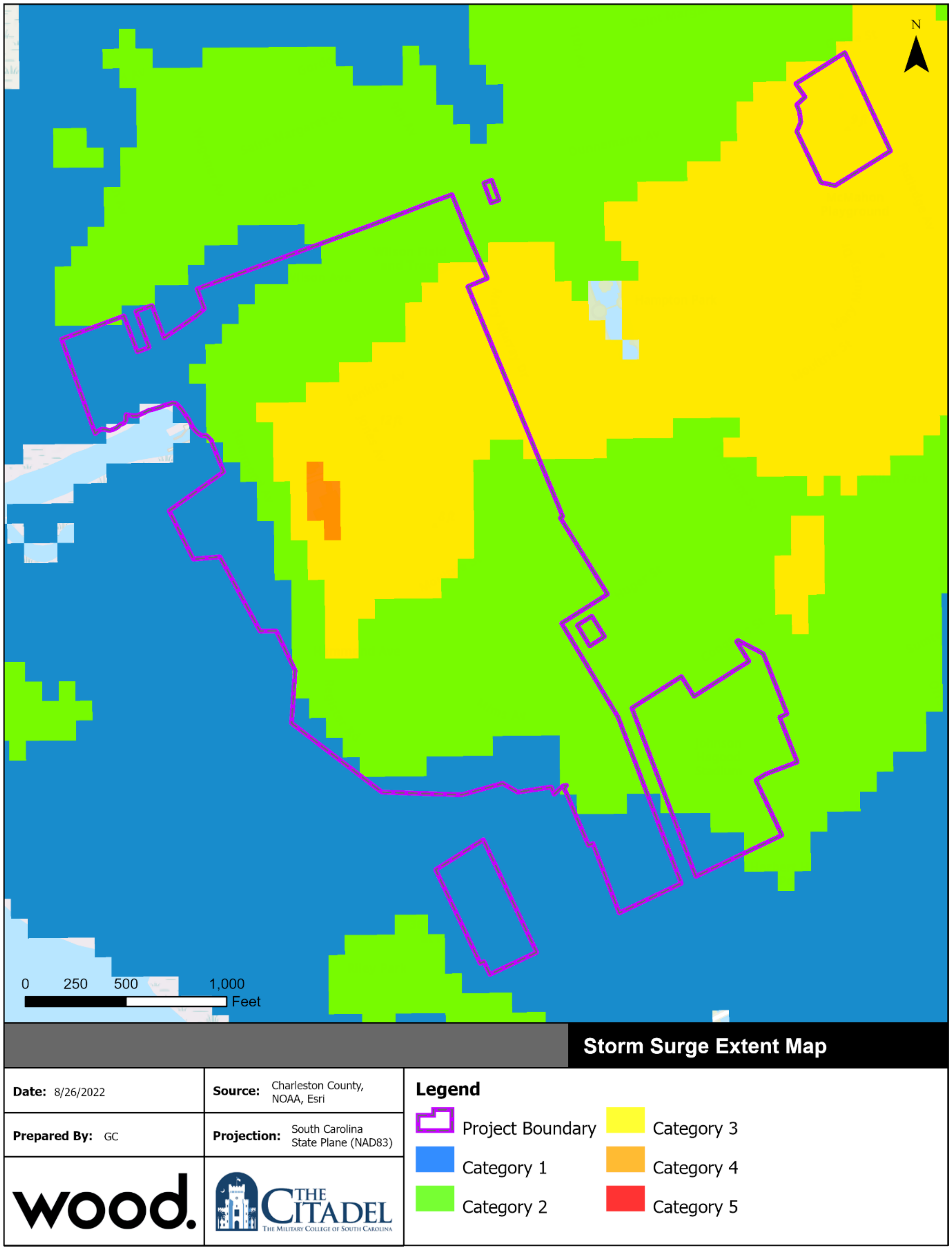


FIGURE 4.32 – ESTIMATED PROPERTY EXPOSURE TO CATEGORY 1 STORM SURGE

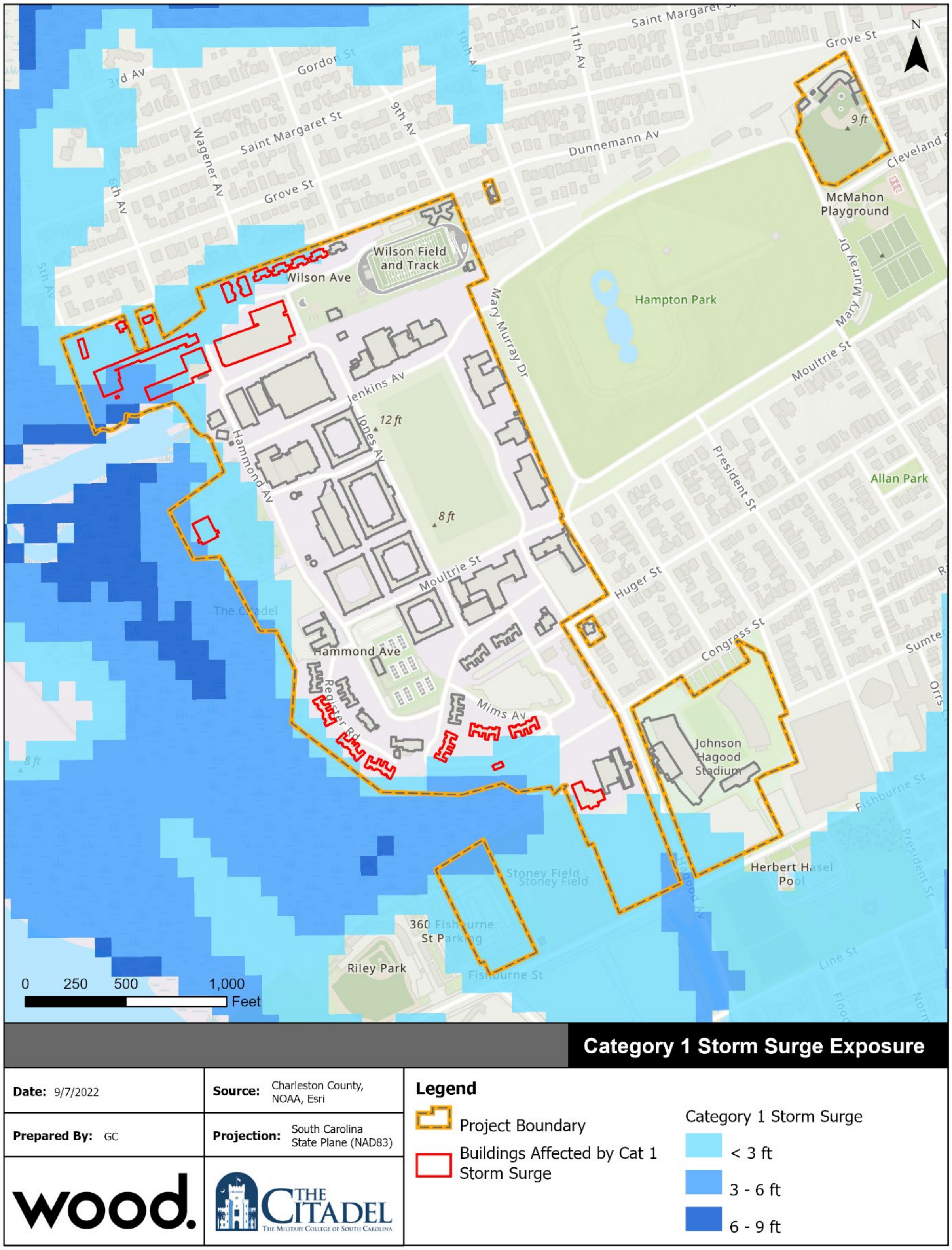


FIGURE 4.33 – ESTIMATED PROPERTY EXPOSURE TO CATEGORY 2 STORM SURGE

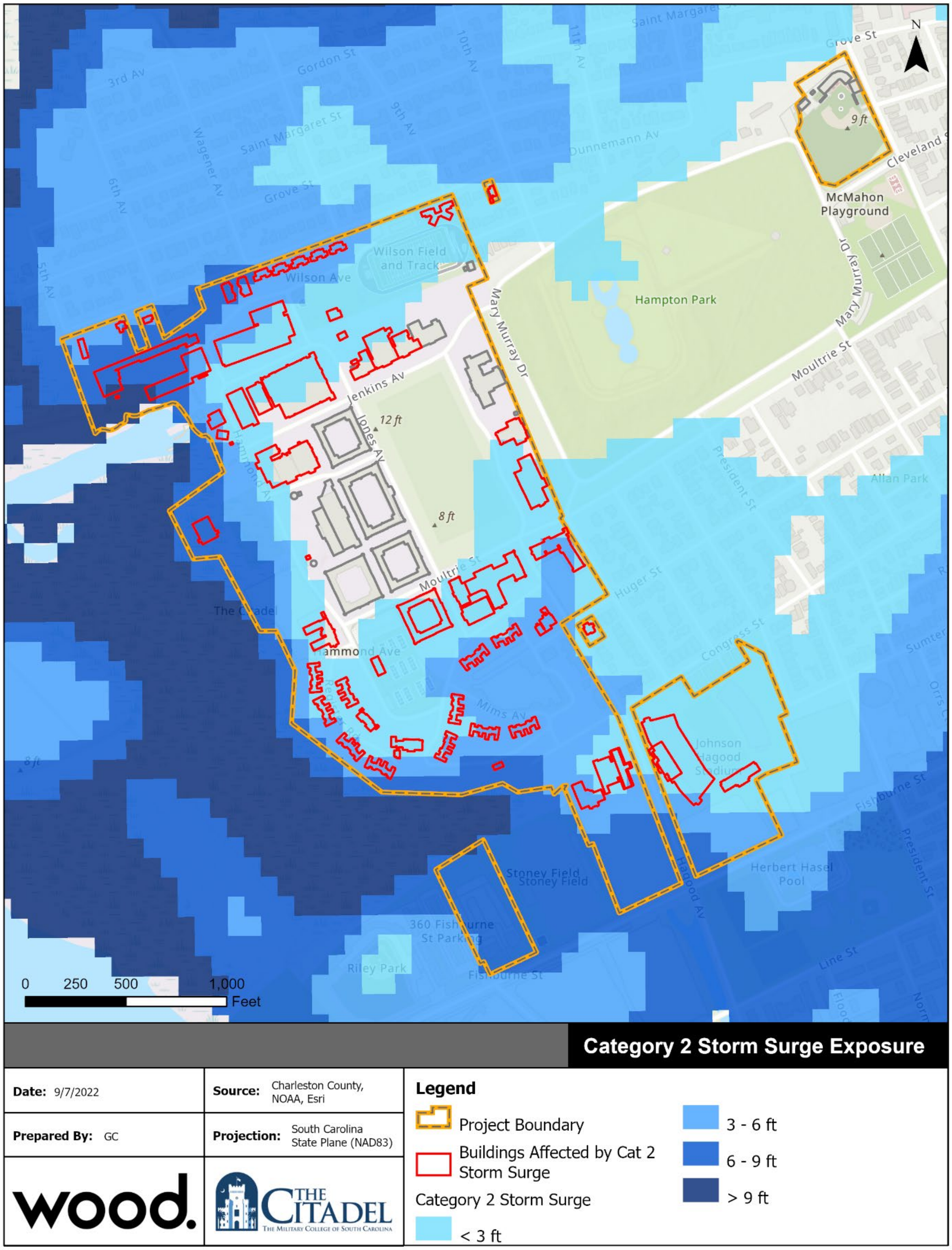


FIGURE 4.34 – ESTIMATED PROPERTY EXPOSURE TO CATEGORY 3 STORM SURGE

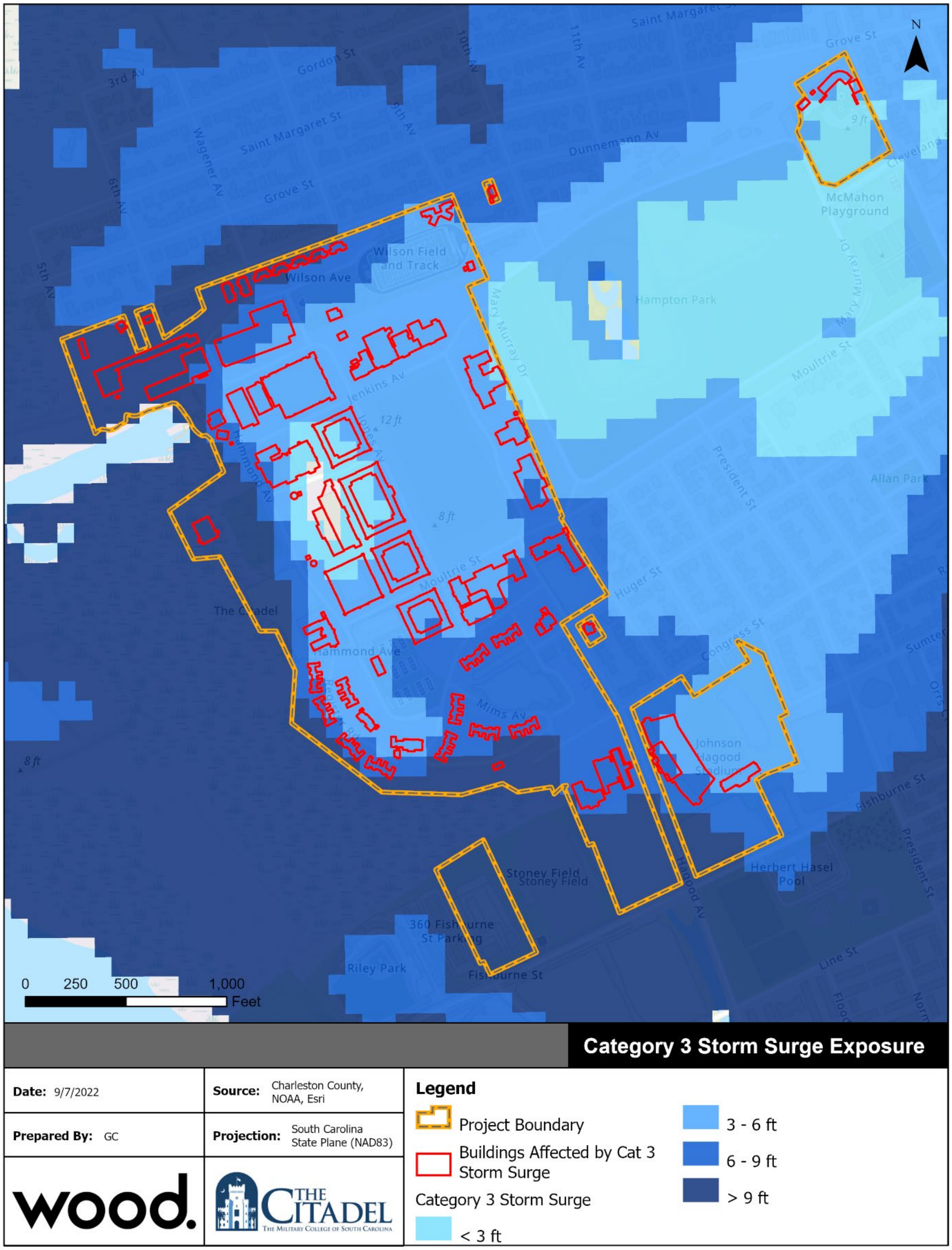


FIGURE 4.35 – ESTIMATED PROPERTY EXPOSURE TO CATEGORY 4 STORM SURGE

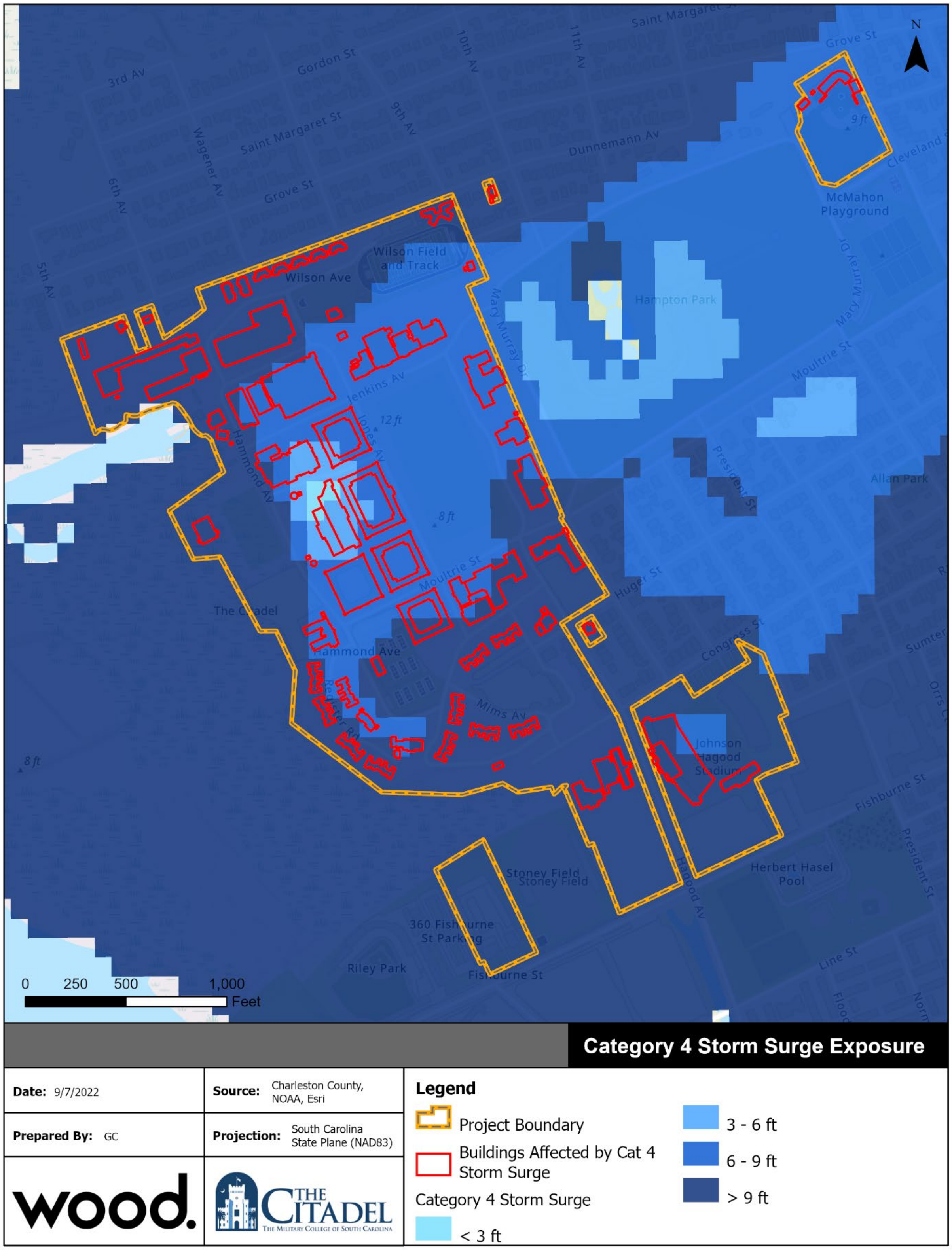
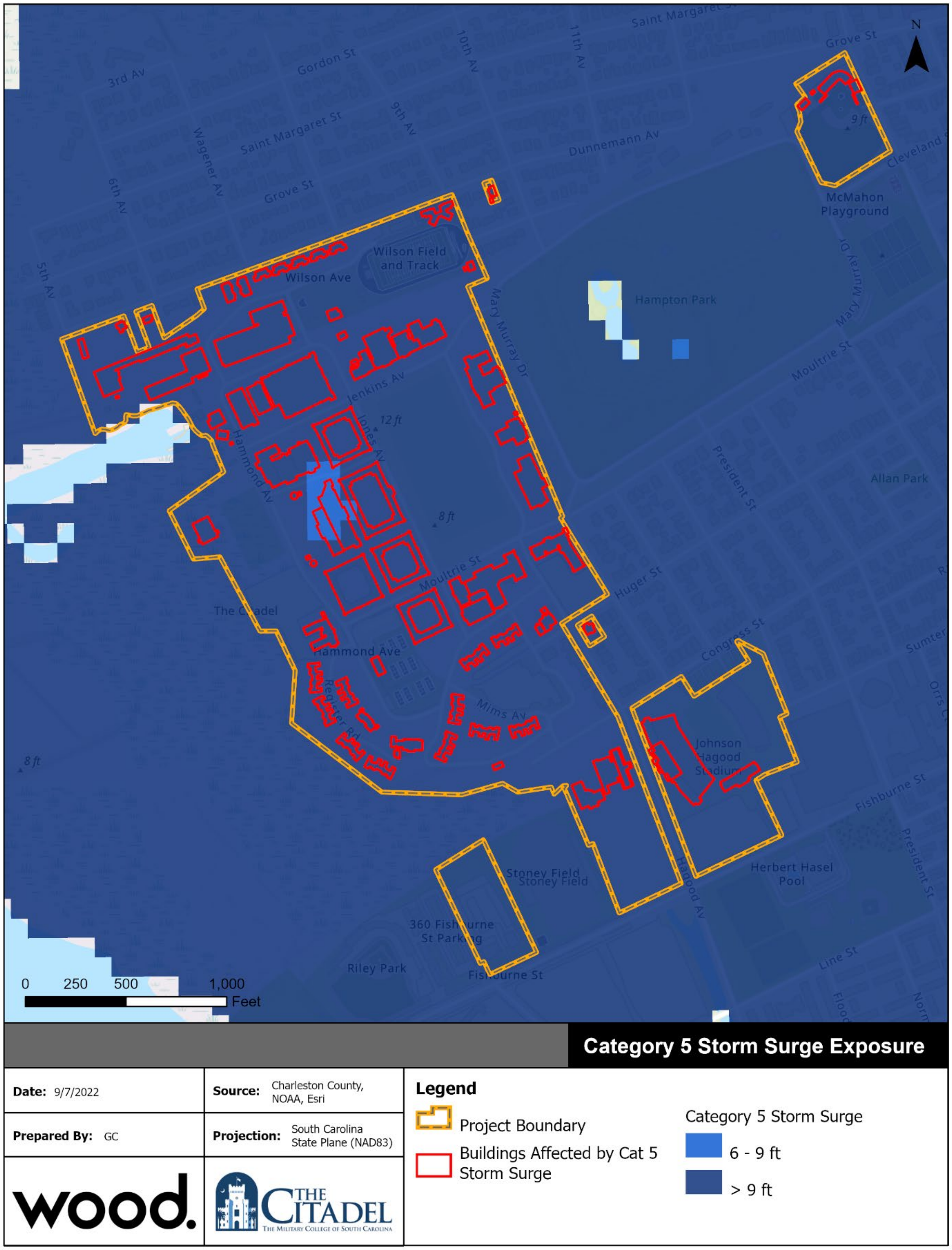


FIGURE 4.36 – ESTIMATED PROPERTY EXPOSURE TO CATEGORY 5 STORM SURGE



Problem Statement

- A category 4 hurricane wind event could cause minor to moderate damage to over half of the buildings on campus. These impacts could include roof damage, some interior damage from water, failure of windows, and debris impacts to building walls.
- Based on average storm surge inundation levels estimated by the SLOSH model, the entire Citadel campus could be inundated by a Category 3 or stronger hurricane. Actual storm impacts are highly variable, but the campus is particularly vulnerable to storm surge given its location on the Ashley River.

4.4.7 Sea Level Rise

Hazard	Probability	Impact	Spatial Extent	Warning Time	Duration	PRI Score
Sea Level Rise	Highly Likely	Limited	Small	>24 hours	>1 week	2.7

Hazard Description

Sea level rise is the increase in sea levels as a result of atmospheric and oceanic warming which causes water expansion as well as ice melt from ice sheets and glaciers. Sea level rise is a result of global climate change, and there are generally two separate mechanics involved in global sea level rise. The first is directly attributed to global temperature increases, which warm the oceans waters and cause them to expand. The second is attributed to the melting of ice over land which simply adds water to the oceans. Global sea level rise is likely caused by a combination of these two mechanics and can be exasperated on the local level by factors such as erosion and subsidence. The rate of sea level rise has varied throughout geologic history, and studies have shown that global temperature and sea level are strongly correlated.

Due to sea-level rise projected throughout the 21st century and beyond, coastal systems and low-lying areas will increasingly experience adverse impacts such as submergence, coastal flooding, and coastal erosion. Higher sea levels will also cause the storm surges from tropical storms to travel farther inland than in the past, impacting more coastal properties. The population and assets projected to be exposed to coastal risks as well as human pressures on coastal ecosystems will increase significantly in the coming decades due to population growth, economic development, and urbanization (IPCC, 2014). The City of Charleston is particularly vulnerable to the effects of climate change and sea level rise, due to its coastal location, subtropical environment and low topography. In 2019 the City of Charleston updated its Sea Level Rise Strategy that plans for 50 years out based on moderate sea level rise scenarios and that reinvests in infrastructure, develops a response plan, and increases readiness.

Warning Time: 1 – More than 24 hours

Duration: 4 – More than 1 week

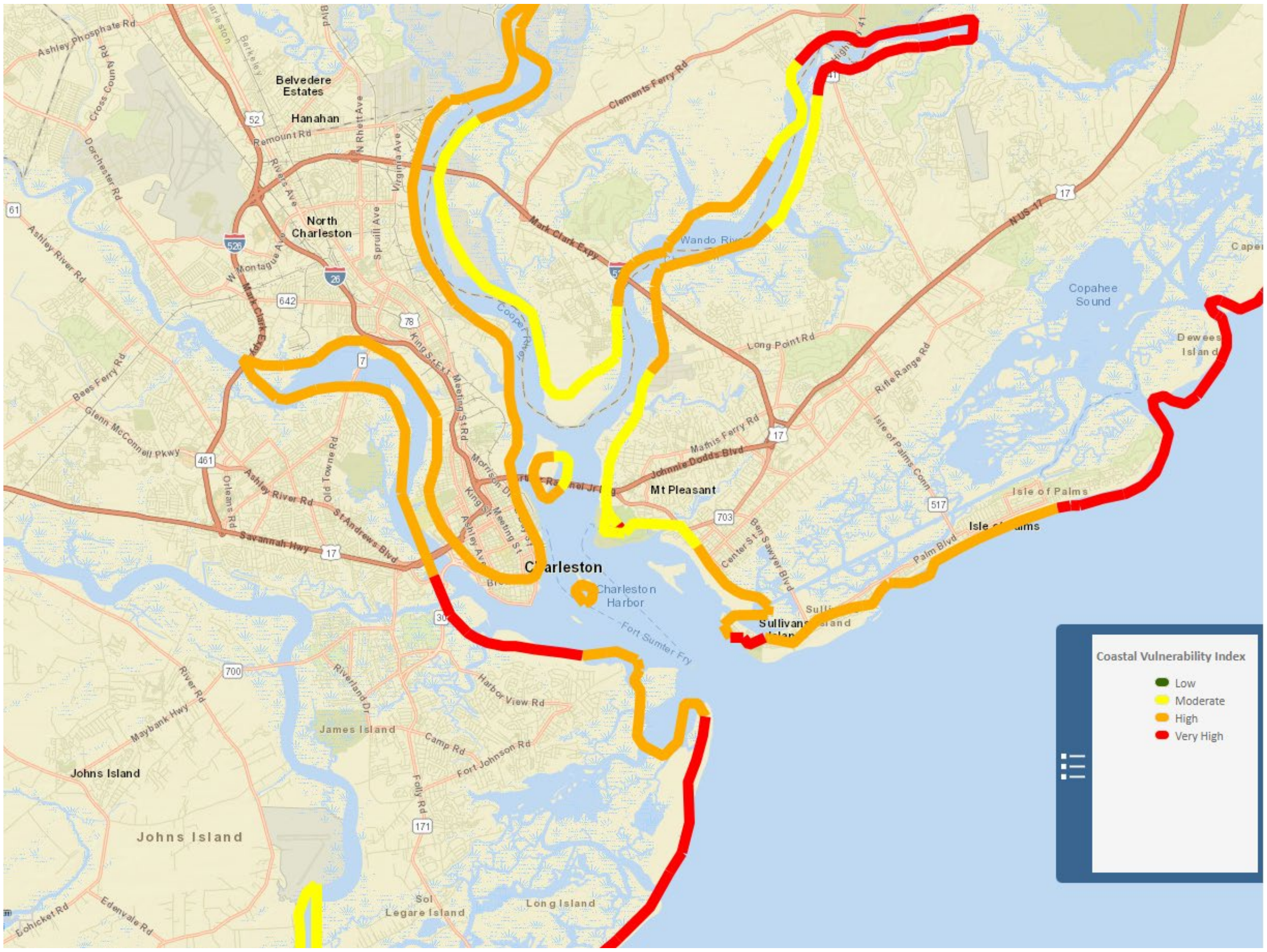
Location

Sea level rise can occur anywhere along the coast of Charleston and the Citadel Campus – particularly the portion of campus that sits along the Ashley River. The United States Geological Survey's (USGS) Coastal Vulnerability Index (CVI) provides a preliminary overview of the relative susceptibility of the United States coast to sea level rise. The CVI is based on geomorphology, regional coastal slope, tide range, wave height, relative sea level rise, and shoreline erosion and acceleration rates. For each study area, each variable is scored on a 1-5 scale based on defined parameters, where "1" indicates low contribution to coastal vulnerability and "5" indicates high contribution to vulnerability. These scores are then aggregated into a single index through a mathematical formula. The resulting index gives an overview of where physical changes may occur due to sea-level rise.

Figure 4.37 shows the CVI for the City of Charleston. The majority of the Charleston area, including the Citadel, has a CVI rating of high.

Spatial Extent: 2 – Small

FIGURE 4.37 – COASTAL VULNERABILITY INDEX, CHARLESTON, SC

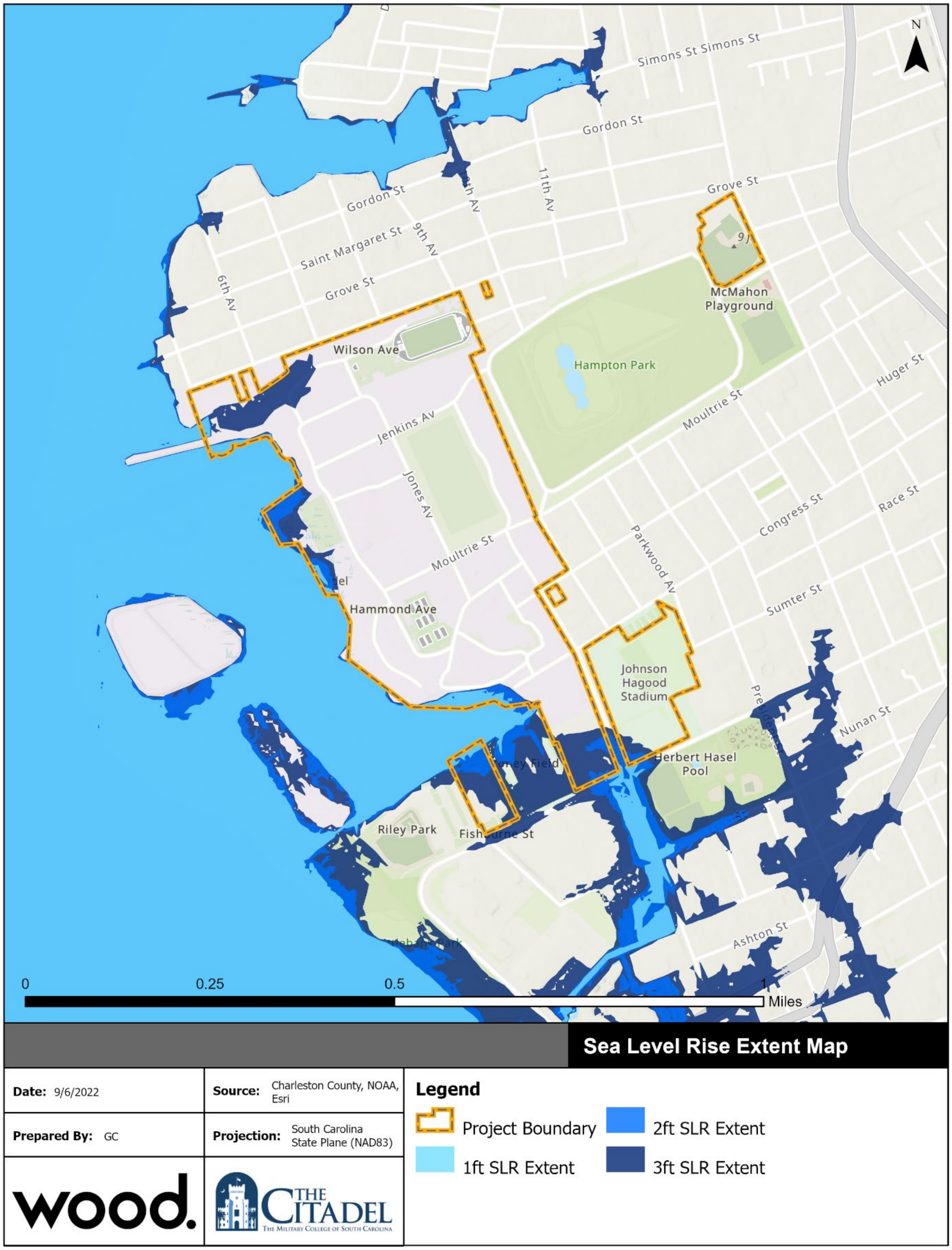


Source: USGS Coastal Change Hazards Portal, Coastal Vulnerability Index, https://marine.usgs.gov/coastalchangehazardsportal/

Extent

The effects of climate change, such as changes in the frequency and intensity of extreme precipitation events, will affect the entire planning area. Sea level rise can occur anywhere along the coast of Charleston and may have direct localized impacts, such as inundation of land and property, as well as broader indirect impacts, such as interruption of transportation networks or other infrastructure. Sea level rise is generally measured by the number of feet of relative rise and the areas that such rise would inundate. The estimated impacts of 1-foot, 2-foot, and 3-foot, sea level rise are shown in Figure 4.38 according to data from the NOAA Sea Level Rise viewer. This map of estimated sea level rise shows inundation above mean higher high water (the average of each day's higher high tide line). Sea level rise will likely affect coastal marsh lands as well as land along rivers, canals, and their tributaries. In addition to inundation of low-lying lands, sea level rise will likely increase future risk of flooding from the other flood hazards discussed later in this plan, as more land will have a lower elevation relative to sea level.

FIGURE 4.38 – EXTENT OF SEA LEVEL RISE



Sea level rise is a slow onset hazard, and because the full extent of anticipated sea level rise has not yet been realized, the effects of sea level rise have not yet been fully felt. However, sea level rise has already begun to cause "clear sky" or "nuisance" flooding, which is brought on by high tidewaters rather than storm or rain events. Tidal flooding causes temporary inundation of low-lying areas during high-tide events. While tidal flooding is not caused by sea level rise itself, a 2015 tidal flooding report published by NOAA notes that tidal flood rates are steadily increasing, and daily highest tides surpass fixed elevations increasingly frequently, due in part to sea level rise. According to NOAA, annual occurrences of high tide flooding have increased 5- to 10-fold since the 1960s.

In 2015, several Southeast coastal cities experienced all-time records of coastal flooding occurrences, including Charleston which sustained 38 days of flooding. These flooding occurrences increased more than 50% in 2015 compared to 2014. In 2016, records were broken when Charleston sustained its record high of 50 days of flooding. By 2045, Charleston is projected to experience up to 180 high tide flood events a year. This increase in high tide flooding frequency is directly tied to sea level rise.

As sea level continues to rise, tidal flooding will continue to occur more frequently and over a greater inland area. Figure 4.39 shows areas in Charleston that are susceptible to high tide flooding as defined by NOAA based on derived national flood thresholds from [NOAA Technical Report NOS CO-OPS 086: Patterns and Projections of High Tide Flooding along the U.S. Coastline Using a Common Impact Threshold.]

The black rectangle highlights the area surrounding the Citadel. A good portion of the campus is susceptible to tidal flooding.

Impact: 2 – Limited

FIGURE 4.39 – AREAS SUSCEPTIBLE TO HIGH TIDE FLOODING, CHARLESTON SC

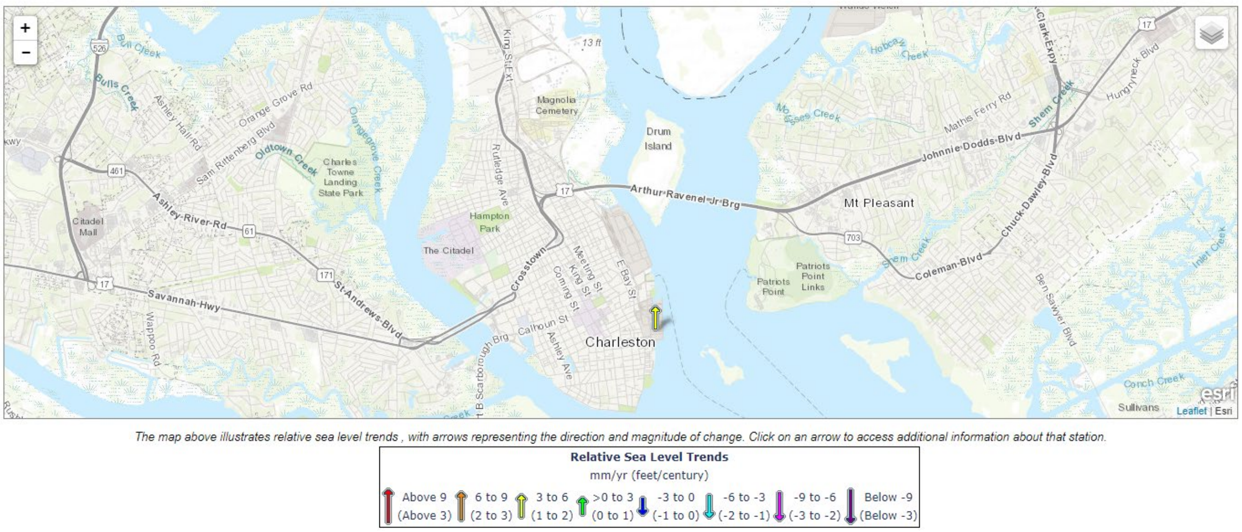
Source: NOAA Coastal Flood Exposure Mapper, https://coast.noaa.gov/digitalcoast/tools/flood-exposure.html

Past Occurrences

The rate of sea level rise has varied throughout geologic history, and studies have shown that global temperature and sea level are strongly correlated. Historic trends in local mean sea level (MSL) are best determined from tide gauge records. The Center for Operational Oceanographic Products and Services (CO-OPS) has been measuring sea level for over 150 years, with tide stations operating on all U.S. coasts. Changes in MSL, either a sea level rise or sea level fall, have been computed at 128 long-term water level stations using a minimum span of 30 years of observations at each location. These measurements have been averaged by month to remove the effect of higher frequency phenomena (e.g. storm surge) in order to compute an accurate linear sea level trend.

Figure 4.40 illustrates regional trends in sea level from NOAA. At the Charleston, SC station (indicated by the yellow arrow), the relative sea level trend is 3.39 mm/year with a 95% confidence interval of +/- 0.19 mm/year based on monthly mean sea level data from 1901 to 2021 which is equivalent to a change of 1.11 feet in 100 years.

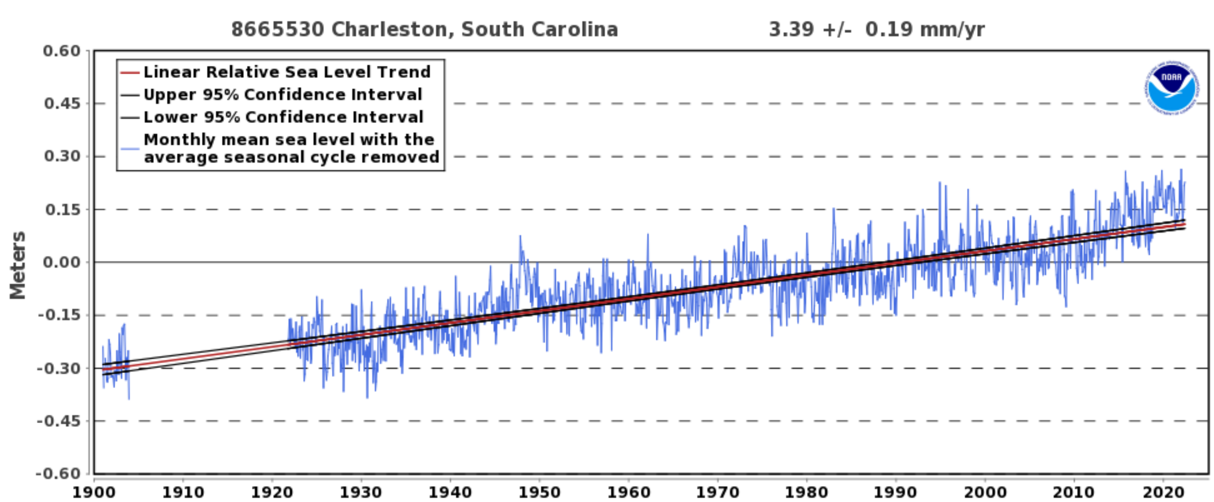
FIGURE 4.40 – SEA LEVEL TRENDS, CHARLESTON, SC



Source: https://tidesandcurrents.noaa.gov/sltrends/sltrends.html

Figure 4.41 shows the monthly mean sea level at NOAA's Charleston, SC station without the regular seasonal fluctuations due to coastal ocean temperatures, salinities, winds, atmospheric pressures, and ocean currents. The long-term linear trend is also shown, including its 95% confidence interval. The plotted values are relative to the most recent [Mean Sea Level datum established by CO-OPS](#).

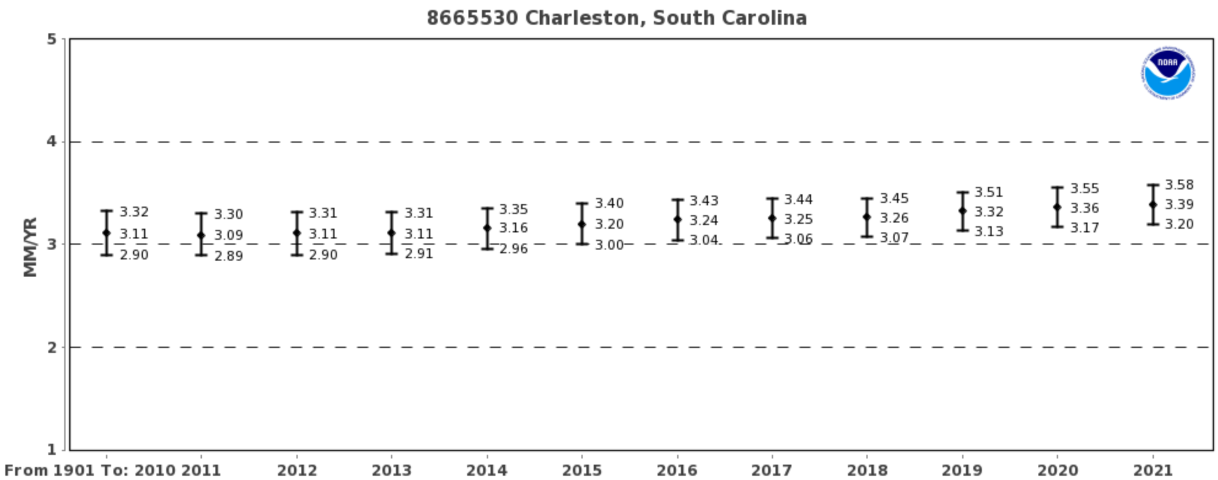
FIGURE 4.41 – MEAN SEA LEVEL TREND



Source: NOAA Tides & Currents, 2022 (https://tidesandcurrents.noaa.gov/sltrends/sltrends_station.shtml?id=8665530)

Figure 4.42 shows this trend compared with previous mean sea level trends. The values indicate the trend of the entire data period up to the given year. As such, each year's trend estimate is more precise than previous years' estimates. The sea level trend through 2021 at the Charleston tide gauge is 3.39 mm/year with a 95% confidence interval of 3.20 mm/yr to 3.58 mm/yr.

FIGURE 4.42 – PREVIOUS MEAN SEA LEVEL TRENDS



Source: NOAA Tides & Currents, 2022 (https://tidesandcurrents.noaa.gov/sltrends/sltrends_station.shtml?id=8665530)

Probability of Future Occurrences

Average global sea level (or global mean sea level; GMSL) has risen about 8–9 inches since 1880, with about 3 inches of that rise occurring since 1990. This recent increase in the rate of rise is projected to accelerate in the future due to continuing temperature increases and additional melting of land ice. Under higher emissions scenarios (RCP8.5), global sea level rise exceeding 8 feet (and even higher in the Southeast) by 2100 cannot be ruled out.

The Earth's changing climate will continue to drive nonlinear trends in sea level that deviate from historic trends. This is especially pertinent in the coastal communities of South Carolina on the frontlines of climate change and sea level rise.

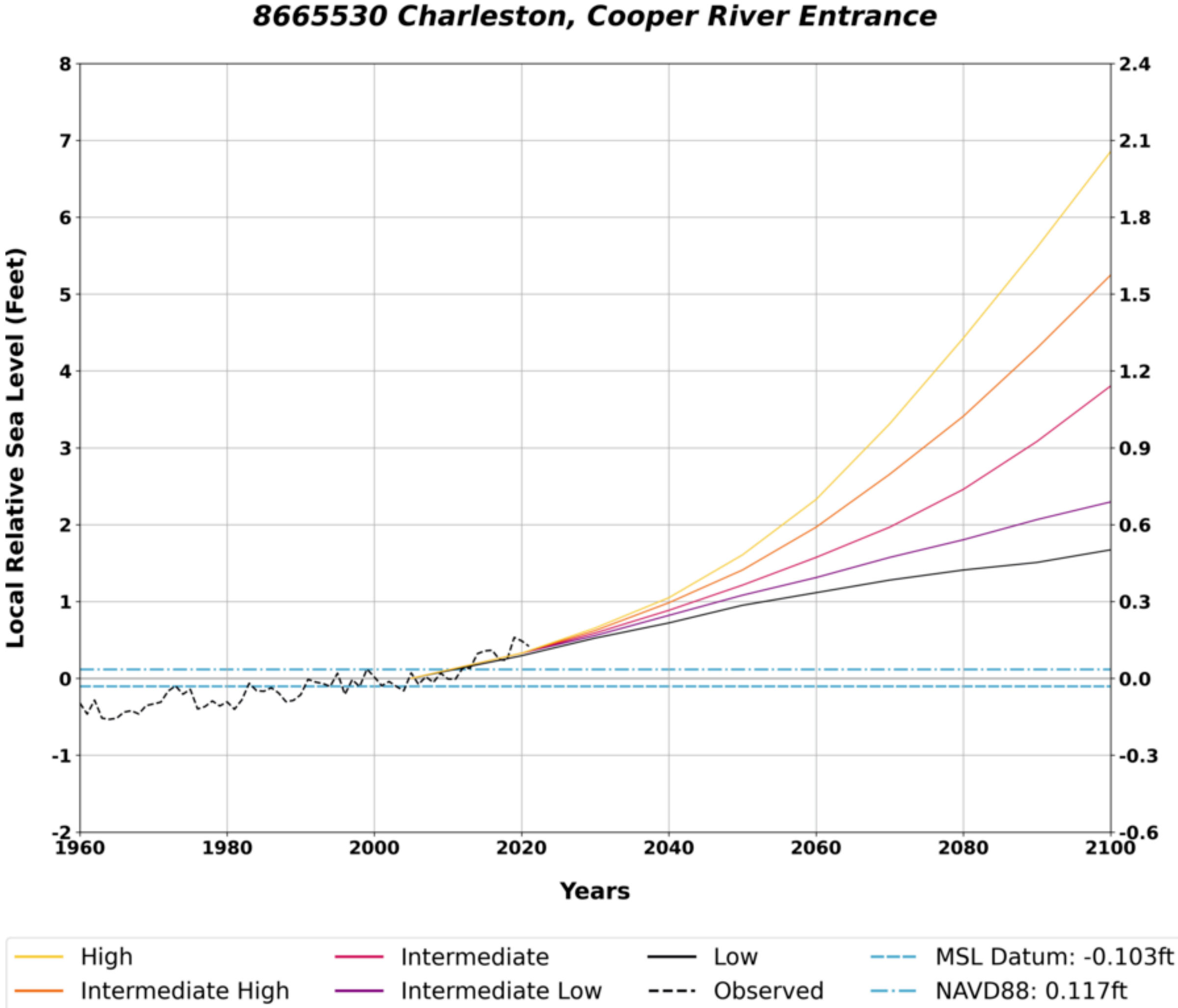
Figure 4.43 shows regionalized sea level rise scenarios for the Charleston, SC tide station, indicating the range in sea level rise that may occur. The figure shows the station's annual mean sea level since 1960 and five regionalized sea level rise scenarios plotted relative to a 1996-2014 baseline period, with the year 2005 as the 'zero' for the figure. The projections were released in 2022 by a U.S. interagency task force in preparation for the Fifth National Climate Assessment. Using the intermediate scenario, projects for the Charleston area are as follow:

- **Short term:** by 2040, sea level in the region is projected to rise almost 0.99 feet (11.93 inches)
- **Medium term:** by 2070 sea level in the region is projected to rise almost 2 feet (24 inches)
- **Long term:** by 2100 sea level in the region is projected to rise almost 3.8 feet (45.6 inches)

While the degree of future rise is uncertain, sea level has already risen and it is important to understand that sea level rise is not a singular event but an ongoing trend. Some amount of continued sea level rise is highly likely.

Probability: 4 – Highly Likely

FIGURE 4.43 – REGIONAL SEA LEVEL RISE AT CHARLESTON, SC STATION



Source: NOAA Tides & Currents, August 2022 (https://tidesandcurrents.noaa.gov/sltrends/sltrends_station.shtml?id=8665530)

Climate Change and Future Conditions

Sea level rise is a direct result of global climate change. Estimates for sea level rise are based on projected greenhouse gas emission levels and their associated impacts on global temperature change. As such, these projections contain substantial variability but are nonetheless important to consider when planning for coastal areas because they indicate where flooding can be expected should actual sea level rise meet estimated levels.

Climate change and sea level rise are expected to make other types of coastal flooding more frequent and extreme. Per the Fourth National Climate Assessment, many Southeast cities are projected to experience more than 30 days of high tide flooding by 2050, regardless of the emissions scenario that occurs. Higher emissions scenarios are associated with greater amounts of sea level rise.

Consequence Analysis

Category	Consequences
Public	Sea Level Rise may cause increased flooding which may lead to illness, injury, or death. Additionally, sea level rise may cause psychological stress from loss of

Category	Consequences
	home, economy, and culture.
Responders	Impacts on responders are likely minimal as sea level rise is a gradual hazard. Flooded roads from hightide may cause delays or disruptions and increased need for services as people and property are increasingly impacted by rising water levels.
Continuity of Operations (including Continued Delivery of Services)	As sea levels rise and cause more regular, chronic flooding, continuity of operations, such as delivery of services may be interrupted due to localized disruption of roads, facilities, and/or utilities.
Property, Facilities and Infrastructure	Sea level rise can cause damage to property as flooding becomes more regular in the short term and as sea levels continue to rise in the long term. Sea Level Rise can also compromise infrastructure such as drainage systems and roads.
Environment	Sea level rise can lead to increased erosion, saltwater intrusion, and inundation of wetlands and previous dry land.
Economic Condition	Sea level rise can severely disrupt the economy, particularly in a areas that rely on tourism. Relocation of infrastructure or floodproofing may be costly.

Vulnerability Analysis

Given the IPCC projections and USACE estimations, sea level rise is highly likely to occur. Sea level rise will increase the frequency and exacerbate the impacts of coastal flooding and storm surge as well as localized stormwater flooding, by reducing the threshold for flooding and putting additional stress on the already limited capacity of the City's stormwater system. To determine the specific variation in loss estimates based on flood severity and sea level rise, impacts of compounding flood hazard were assessed using Hazus. Figure 4.44 on the following page depicts the impact of a 1% annual chance flood on The Citadel campus with one foot of sea level rise (0.99ft expected by 2040). Figure 4.45 depicts critical facilities on The Citadel campus exposed to the 1% annual chance flood with one foot of sea level rise.

FIGURE 4.44 – PROPERTIES AT RISK OF 1 FT OF SEA LEVEL RISE & 1% CHANCE ANNUAL FLOOD DEPTH

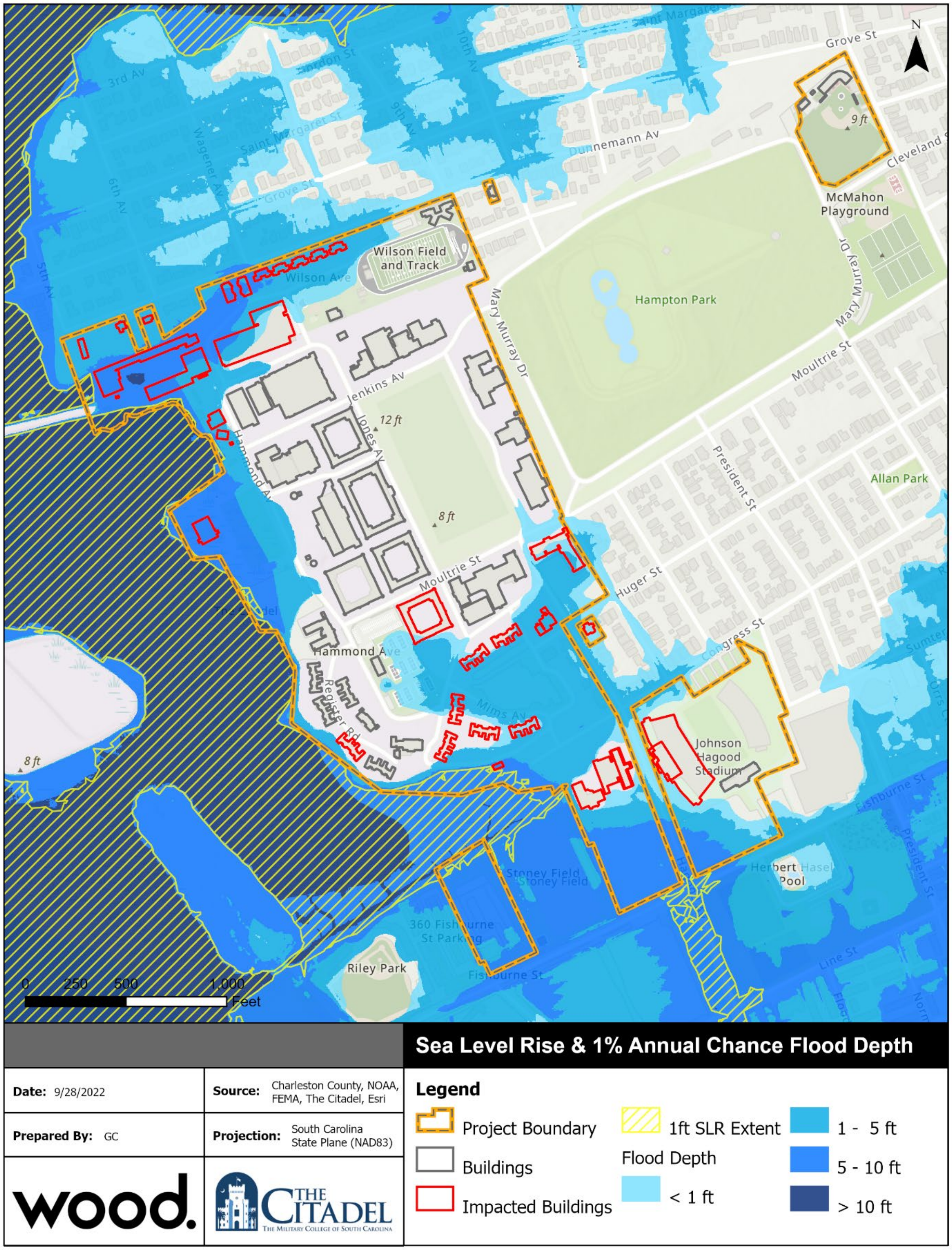


FIGURE 4.45 – CAMPUS CRITICAL FACILITIES EXPOSED TO 1 FOOT OF SEA LEVEL RISE

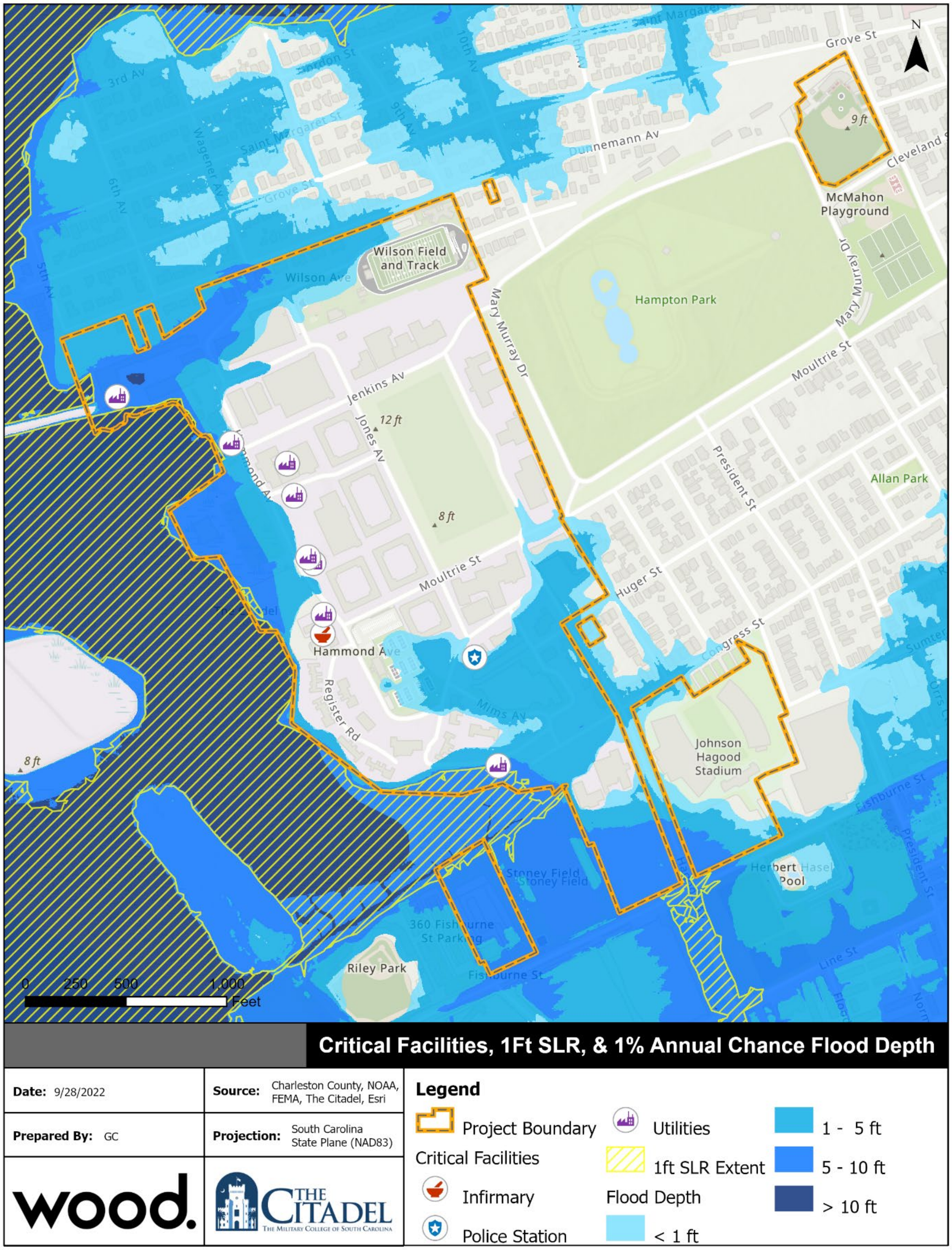


Table 4.43 details the campus critical facilities that are at risk of a 1% annual chance flood event with one foot of sea level rise.

TABLE 4.43 – CRITICAL FACILITIES AT RISK OF 1% ANNUAL CHANCE FLOOD WITH 1 FOOT OF SEA LEVEL RISE

Facility Type	Facility Name
Police Station	Apts 205-208 Richardson Ave / Police Station
Utilities	Pplt Lift Station Wilson Ave
Utilities	Boat Center Lift Station
Utilities	Housing Lift Station Mims Ave

Table 4.44 details the estimated property exposure to 2 feet and 3 feet of sea level rise (expected by 2070 and 2090 respectively). The exposure value includes improved building value and contents value. Land value is not included in any of the exposure estimates as generally land is not subject to loss from floods.

TABLE 4.44 – PROPERTY EXPOSURE TO SEA LEVEL RISE

Occupancy Type	Buildings with Loss	Building Value	Content Value	Total Value
2 Foot Sea Level Rise	**1**	**$54,600**	**$18,700**	**$73,300**
Agricultural	0	$0	$0	$0
Commercial	0	$0	$0	$0
Education	0	$0	$0	$0
Government	0	$0	$0	$0
Industrial	1	$54,600	$18,700	$73,300
Religious	0	$0	$0	$0
Residential	0	$0	$0	$0
3 Foot Sea Level Rise	**6**	**$32,574,600**	**$3,257,300**	**$35,831,900**
Agricultural	0	$0	$0	$0
Commercial	0	$0	$0	$0
Education	2	$25,540,300	$1,269,000	$26,809,300
Government	0	$0	$0	$0
Industrial	2	$5,891,900	$1,417,100	$7,309,000
Religious	0	$0	$0	$0
Residential	2	$1,142,400	$571,200	$1,713,600

Note: Estimates in this table are for sea level rise alone, not compounded with a flood event.

One property on The Citadel campus, an industrial building, is the only property exposed to two feet of sea level rise. This property along with 5 other buildings with a total value of $1.7 million would be exposed to three feet of sea level rise.

In addition to a projected increase in the 1% annual chance flood depths, smaller scale nuisance flooding is occurring at a greater rate as a result of sea level rise. Though not as extreme or extensive as a 1% annual chance flood event, nuisance flooding can still cause road closures, threaten infrastructure, and overwhelm the stormwater system. Charleston experienced a record number of nuisance flooding days in 2015 and according to the Fourth National Climate Assessment, is one of five cities projected to experience the highest frequency of nuisance flooding. Nuisance flooding is often attributed to "king tides," the highest seasonal tides that occur each year; however, king tide events are growing more frequent as the term is used to describe other high tide events made more extreme by sea level rise.

Problem Statement

- One lift station is vulnerable to a 2-foot sea level rise, and six buildings are vulnerable to a 3-foot rise.
- A 1% annual chance flood event on top of one foot of sea level rise could cause widespread inundation on campus, including impacts on the campus police station and three lift stations.

4.4.8 Severe Weather (Thunderstorm Wind, Lightning & Hail)

Hazard	Probability	Impact	Spatial Extent	Warning Time	Duration	PRI Score
Severe Weather	Highly Likely	Minor	Large	6 to 12 hours	<6 hours	2.7

Hazard Description

Thunderstorms 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: 3 – 6 to 12 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. A lightning flash is composed of a series of strokes with an average of about four. The length and duration of each lightning stroke vary, but typically average about 30 microseconds.

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.

Hail falls when it becomes heavy enough to overcome the strength of the updraft and is pulled by gravity towards 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.

Hailstones are usually less than two inches in diameter and can fall at speeds of 120 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 South 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

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. 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. 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.

The entirety of Charleston County including all assets located within the County can be considered at risk to severe weather events. This includes the entire population of The Citadel and all critical facilities, buildings, and infrastructure.

Spatial Extent: 4 – Large

Extent

Thunderstorm Wind

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 the purpose of this severe weather risk assessment, the wind hazard will include data from High Wind, Strong Wind and Thunderstorm Wind. Hurricane Wind and Tornadoes are addressed as separate, individual hazards. The following definitions come from the NCEI Storm Data Preparation document.

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

The highest thunderstorm wind gust on record in Charleston County was 96 mph in 2022.

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 4.45, is a common parameter that is part of fire weather forecasts nationwide.

TABLE 4.45 – 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 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 5 minute period.
LAL 4	Scattered thunderstorms. Moderate rain is commonly produced Lightning is frequent, 11 to 15 cloud to ground strikes in a 5 minute period.
LAL 5	Numerous thunderstorms. Rainfall is moderate to heavy. Lightning is frequent and intense, greater then 15 cloud to ground strikes in a 5 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

Lightning is one of the more dangerous weather hazards in the United States. Each year, lightning is responsible for deaths, injuries, and millions of dollars in property damage, including damage to buildings, communications systems, power lines, and electrical systems. Lightning also causes forest and brush fires. According to the National Lightning Safety Institute, lightning causes more than 26,000 fires in the United States each year. The institute estimates property damage, increased operating costs, production delays, and lost revenue from lightning and secondary effects to be in excess of $6 billion per year. Impacts can be direct or indirect. People or objects can be directly struck, or damage can occur indirectly when the current passes through or near it.

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 4.46 indicates the hailstone measurements utilized by the National Weather Service.

TABLE 4.46 – 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	Softball
4.5 inch	Grapefruit

Source: National Weather Service

The Tornado and Storm Research Organization (TORRO) has further described hail sizes by their typical damage impacts. Table 4.47 describes typical intensity and damage impacts of the various sizes of hail.

TABLE 4.47 – TORNADO AND STORM RESEARCH ORGANIZATION HAILSTORM INTENSITY SCALE

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

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

The average hailstone size recorded between 1950 and 2022 in Charleston County was a little over 1.06" in diameter; the largest hail on record in Charleston County was 2.75" in 2011.

Impact: 1 – Minor

Past Occurrences

Table 4.48 shows detail for severe weather events reported by the NCEI since 1950 for Charleston County. There have been over 900 recorded events causing 17 injuries, 5 deaths and close to $2.3M in property damage.

TABLE 4.48 – NCEI SEVERE WEATHER EVENTS IN CHARLESTON COUNTY

Event Type	# of Events	Deaths/ Injuries	Property Damage	Crop Damage
Hail	291	0/0	$40,500	$0
High Wind	14	0/0	$23,000	$0
Lighting	37	2/11	$1,230,000	$0
Strong Wind	48	3/3	$88,250	$1,000
Thunderstorm Wind	563	0/3	$950,100	$2,000
Total	**953**	**5/17**	**$2,331,850**	**$3,000**

Source: NCEI, August 2022

The following provides details on select storm events recorded in the NCEI database:

July 1983 – Scattered thunderstorms brought wind gusts up to 80 kts (92 mph), lightning struck several homes, and power was disrupted to 25,000 homes.

June 1995 – Thunderstorm winds caused power outages to over 2,500 homes and brought heavy rain.

April 2000 – Lightning struck and destroyed a house in Mount Pleasant and did considerable damage to two other homes nearby.

March 2008 – A large and intense area of low pressure lifted northward through the central Appalachians, dragging a strong cold front toward southern South Carolina and southeast Georgia. The combination of the approaching cold front along with strong dynamic forcing and plenty of instability resulted in a widespread organized severe weather outbreak across the region.

June 2008 – Golf ball sized hail was reported at The Citadel Mall in West Ashley.

August 2010 – A backdoor cold front moved in from the north over portions of southeast South Carolina. This provided enhanced lift in a very moist and unstable atmosphere over the forecast area. As thunderstorms developed they became clustered and pulsed to produce isolated severe winds. Heavy rains fell in and around the Charleston metro near high tide, thus enhancing flooding to prone locations.

April 2011 – A cold front in combination with an upper level disturbance and a warm unstable air mass, resulted in scattered strong to severe thunderstorms across southern South Carolina.

September 2013 – Lightning set fire to a house in Drayton.

July 2015 – A stationary cold front was positioned to the north with a weak area of low pressure along it. Scattered to numerous thunderstorms developed in the mid to late afternoon hours within a very unstable air mass. The thunderstorms were aided by the presence of a shortwave trough aloft and 15-20 knots of bulk shear. The thunderstorms produced numerous reports of damaging wind gusts across southeast South Carolina.

August 2015 – An inland trough of low pressure and a destabilizing atmosphere in wake of earlier convection led to additional showers and thunderstorms that shifted into parts of southeast South Carolina. Several of these thunderstorms became strong to severe with damaging winds.

July 2016 – Isolated thunderstorms developed along the southeast South Carolina coast in the midafternoon hours. The thunderstorms initiated along the diurnal sea breeze and produced damaging wind gusts and large hail. A report of quarter sized hail was received via social media.

July 2018 – Scattered thunderstorms developed across portions of southeast South Carolina ahead of a nearby stationary front. A few of these storms produced large hail and cloud-to-ground lightning strikes. Hail up to the size of quarters was reported in the area.

May 2020 – Under the influence of a large and anomalous upper low a large cluster of thunderstorms developed in the morning hours and impacted portions of southeast South Carolina. One storm developed near a stationary surface front and produced a short-lived tornado, damaging straight-line wind gusts, and large hail.

April 2022 – Strong surface heating ahead of an arriving cold front led to a few thunderstorms capable of producing small hail across southeast South Carolina. Reports of pea to nickel size hail was recorded in downtown Charleston.

Probability of Future Occurrences

Given the high number of previous events (953 records in 67 years), it is certain that severe weather events, including thunderstorm wind, lightning and hail, will occur in the future. This results in a probability level of highly likely for future severe weather events for the entire planning area.

The average hailstorm in Charleston County occurs in the afternoon and has a hail stone with a diameter of just under one inch. Over the 22-year period from 2000 to 2022, Charleston County experienced 246 reported hail incidents, which averages to about 11.2 hail incidents per year.

Based on historical occurrences recorded by NCEI for the 22-year period, 28 lightning events were reported as having caused death, injury, or property damage, which equates to an average of about 1.3 damaging lightning strikes per year. However, the lightning events recorded by the NCEI are only those that are reported to have caused damage or injuries; it is certain that additional non-damaging lightning incidents will occur in Charleston County.

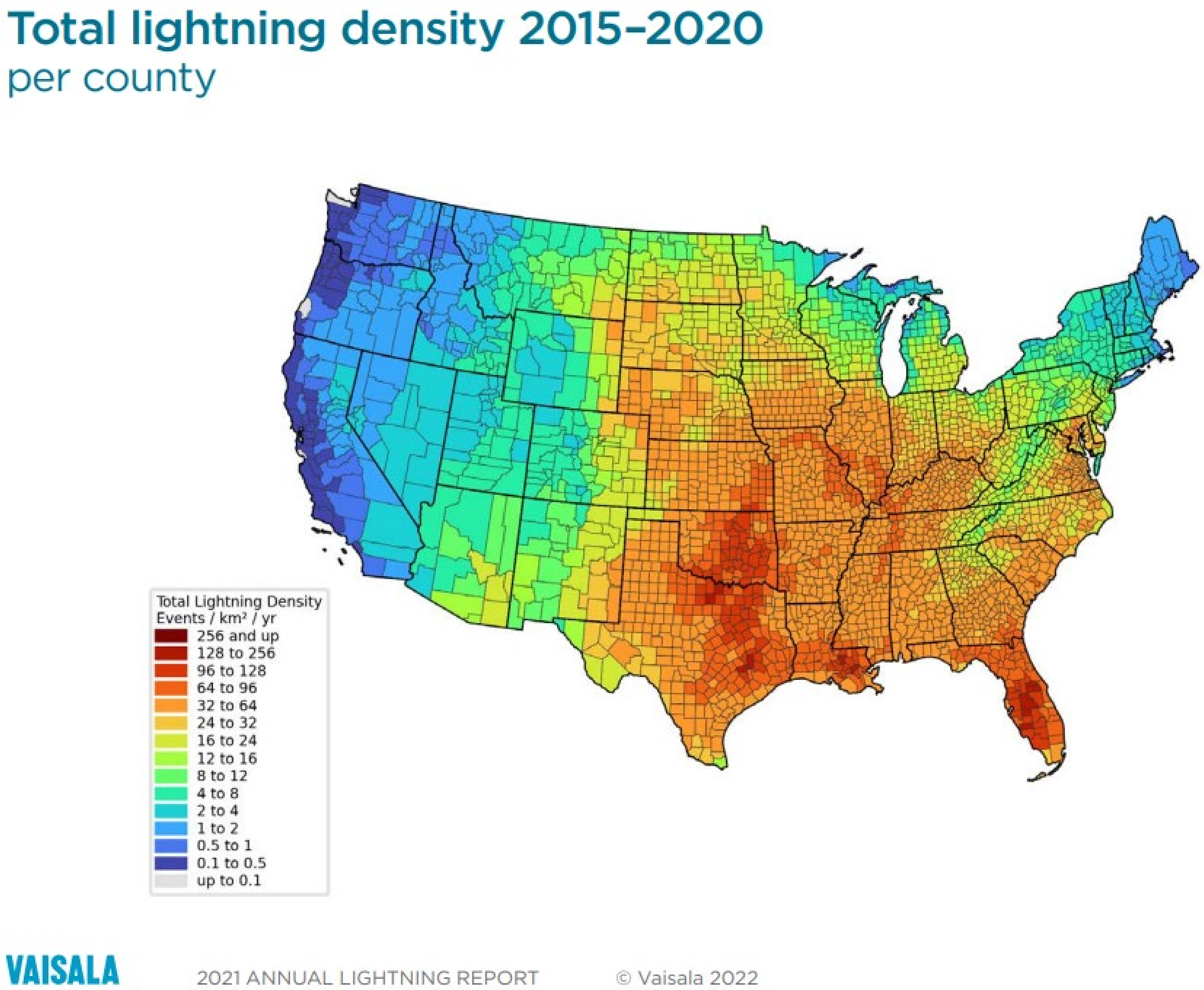
According to the total lighting density map in Vaisala 2021 Annual Lightning Report, shown in Figure 4.46, the majority of Charleston County is located in an area that experiences 32 to 64 lightning events per square kilometer per year. Vaisala reported that Charleston County experiences exactly 33.8 lightning events per square kilometer per year in 2021.

It should be noted that future lightning occurrences may exceed these figures.

Based on past occurrences, there is a 100% annual chance that Charleston will experience severe weather.

Probability: 4 – Highly Likely

FIGURE 4.46 – LIGHTNING DENSITY, 2015-2020



Source: Vaisala

Climate Change and Future Conditions

Higher temperatures and humidity may increase atmospheric variability associated with the origination of severe thunderstorms and tornadoes, and early research suggests that continued climate change and greenhouse forcing are likely to increase severe thunderstorm occurrence (Diffenbaugh, et al. 2013). Decreases in vertical wind shear can result in fewer or weaker severe thunderstorms and tornadoes. However, this decrease is most likely to occur when convective available potential energy is high in spring and summer, which could result in more frequent severe storms. There has been a surge in the number of severe storms reported over the past 50 years, but this increase could at least be partially attributed to technological developments that allow for better identification and reporting of such storms. More specifically, the frequency and intensity of individual rainfall events associated with thunderstorms is likely to increase which can overwhelm local stormwater drainage systems, leading to street flooding and ponded water.

Consequence Analysis

Category	Consequences
Public	Impacts from lightning and hail can result in injuries and fatalities if a person is struck. High

Category	Consequences
	wind can cause trees to fall and potentially result in injuries, death, or damage. Fatalities and injuries most often occur when a person is exposed and in outdoor conditions during a storm. Exposure to water and open areas also increases the likelihood that a person will be struck by lightning.
Responders	First responders can be impacted in the same way as the general public. Downed trees, power lines and flood waters may prevent access to areas in need which prolongs response time.
Continuity of Operations (including Continued Delivery of Services)	Thunderstorm events can result in a loss of power which may impact operations. Downed trees, power lines and flash flooding may prevent access to critical facilities and/or emergency equipment.
Property, Facilities and Infrastructure	Thunderstorms can cause damage to buildings due to strong winds, lightning strikes and hail, especially windows, cars, and siding. Heavy rains associated with thunderstorm events may also lead to flash flooding which can damage roads and bridges.
Environment	Lightning can cause sparks to flare up in surrounding forests or immense shrubs. This is often the cause of bush fires, which then spread quickly due to the fast winds that accompany the storm.
Economic Condition	Damages to power-related infrastructure could cause economic strain to return the system to full capacity. Damages to property can lead to costly recovery efforts like business interruption and additional living/operation expenses.

Vulnerability Assessment

Given the high number of previous events (953 NECI records in 72 years), it is certain that severe weather events, including wind, lightning and hail, will occur in the future. This results in a probability level of highly likely (100 percent annual probability) for future severe weather events to impact Charleston County and The Citadel Campus.

Because the location of future severe thunderstorm, lightning or hail events cannot be predicted, it is not possible to map geographic boundaries for these hazards. However, we can conclude that severe weather events including thunderstorm wind, lightning and hail have the potential to impact all existing and future buildings, facilities, and populations at The Citadel. Impacts of severe weather events include wind damage, debris clean-up, hail damage, and potential fatalities damage due to lightning strikes and associated fires. Risk of being struck by lightning is greater in open areas, at higher elevations, and on the water. NCEI reported 17 injuries and 5 deaths as a result of lightning and strong winds. These storms have also resulted in close to $2.3M in property damage in Charleston County. That's almost $32,000 in annualized losses.

Severe weather can also cause cascading hazards, including power loss, which could critically impact those relying on energy service, including those that need powered medical devices and students and staff that require electricity to complete their work.

In 2011, The Citadel became the first college in South Carolina to be designated a "Storm Ready University," a title earned by preparing an Emergency Response Plan for severe weather. The Storm Ready Program is a nationwide program supported by the National Weather Service and NOAA that helps communities better protect their people and property during severe weather events. To qualify for the program, The Citadel established a 24-hour warning point, implemented a system to monitor and receive severe weather warnings, developed a formal weather response plan, and regularly promotes readiness through training and exercises. These activities have increased severe weather preparedness on campus and decreased vulnerability to severe weather events.

Problem Statement

- There is a 100% probability of severe weather occurring in the Charleston area in any given year. Reported impacts across the county total nearly $32,000 annually.
- Power outages from severe weather could disrupt campus operations.
- The Citadel is a Storm Ready University, which means preparedness and response systems and procedures are in place to reduce vulnerability to severe weather on campus.

4.4.9 Sinkhole

Hazard	Probability	Impact	Spatial Extent	Warning Time	Duration	PRI Score
Sinkhole	Likely	Minor	Negligible	<6 hours	<6 hours	1.9

Hazard Description

As defined by USGS, a sinkhole is an area of the ground "that has no natural external surface drainage – when it rains, water stays inside the sinkhole." Sinkholes are common where the rock below the land surface is limestone, carbonate rock, salt beds, or rocks that can naturally be dissolved by groundwater circulating through them. As the water dissolves the rock, spaces and caverns develop underground. The land usually stays intact for a while until the underground space becomes too big. If there is not enough support for the land above the spaces, then a sudden collapse of the land surface can occur.

Typically, sinkholes form so slowly that little change is noticeable, but they can form suddenly when a collapse occurs. Such a collapse can have a significant effect if it occurs in an urban setting.

There are three types of sinkholes, subsidence, dissolution, and collapse. Sinkholes can also be related to human activities. The types of sinkholes are detailed below:

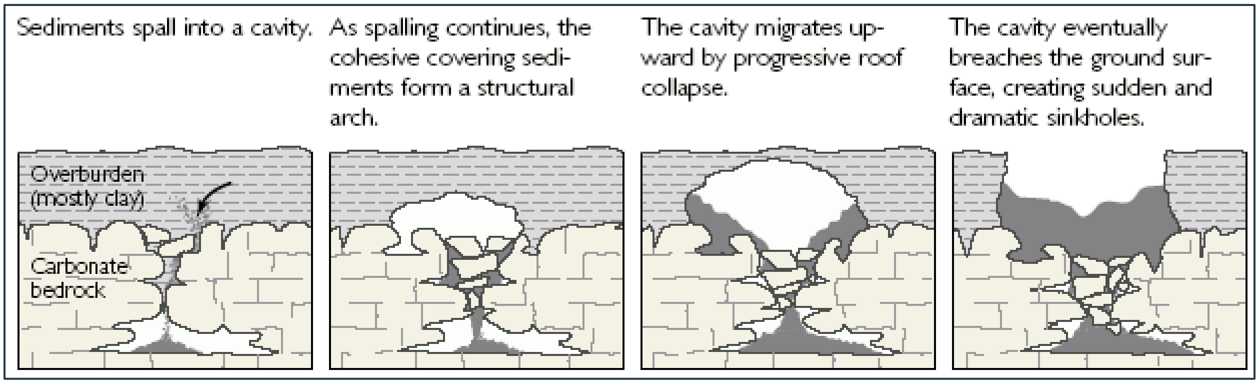
- **Subsidence:** Tend to develop gradually where the covering sediments are permeable and contain sand. In areas where cover material is thicker, or sediments contain more clay, cover-subsidence sinkholes are relatively uncommon, are smaller, and may go undetected for long periods.
- **Dissolution:** Rainfall and surface water percolate through joints in limestone or dolomite. Dissolved carbonate rock is carried away from the surface and a small depression gradually forms. On exposed carbonate surfaces, a depression may focus surface drainage, accelerating the dissolution process
- **Collapse:** These are the quickest to develop and may cause the greatest damages. The cover layer contains a lot of clay sediment, and over time surface drainage, erosion, and deposition of sediment transform the steep-walled sinkhole into a shallower bowl-shaped depression.
- **Human Induced:** New sinkholes have been correlated to land-use practices, especially from groundwater pumping and from construction and development practices. Sinkholes can also form when natural water-drainage patterns are changed, and new water-diversion systems are developed. If water pumping results in a lowering of groundwater levels, then underground structural failure, and thus, sinkholes, can occur.

Warning Time: 4 – Less than six hours

Duration: 1 – Less than six hours

Figure 4.47 illustrates how a cover-collapse sinkhole forms.

FIGURE 4.47 – COVER-COLLAPSE SINKHOLE FORMATION



Source: water.usgs.gov/edu/sinkholes

Location

Sinkholes are most common in what geologists call, "karst terrain." These are regions where the types of rock below the land surface can naturally be dissolved by groundwater circulating through them. Soluble rocks include salt beds and domes, gypsum, limestone and other carbonate rock.

Figure 4.48, from USGS, shows areas of rock types that are susceptible to dissolution in water. These rocks are either evaporites (salt, gypsum, and anhydrite) or carbonates (limestone and dolomite). Evaporite rocks underlie 35 - 40 percent of the United Sates, although in many areas the rock is at considerable depths. The most damage from sinkholes tends to occur in Florida, Texas, Alabama, Missouri, Kentucky, Tennessee, and Pennsylvania. The figure indicates that there are no karst regions or evaporite rocks occurring in the Charleston County area.

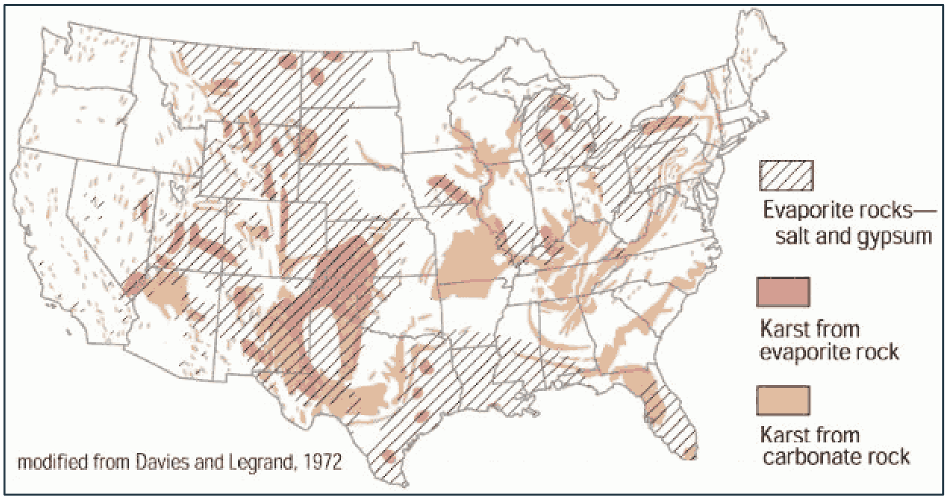
Data from USGS suggest that Charleston County is not underlain by rock formations susceptible to dissolution and is therefore at low risk of experiencing naturally occurring sinkholes.

However, The Citadel campus has sustained small human induced sinkholes on roadways and parking lots due to the increase of fill over time and utilities. Below is a list of locations where sinkholes have occurred on campus:

- Roadway just north of the boiler plant between the boiler plant and Seignious Hall
- Infirmary parking lot in multiple places
- Executive parking lot just behind (south) of Bond Hall
- Swain Boating Center – just to the south of the pavilion

Spatial Extent: 1 – Negligible

FIGURE 4.48 – ROCK FORMATIONS IN THE UNITED STATES



Source: water.usgs.org/edu/sinkholes

Extent

Sinkholes can vary from a few feet to hundreds of acres and from less than one to more than 100 feet deep. Some are shaped like shallow bowls or saucers whereas others have vertical walls; some hold water and form natural ponds.

Sinkholes rarely happen, but when they strike, tragedy can occur if they happen where a house or a road is on top.

According to USGS, sinkhole damages over the last 15 years cost on average at least $300 million per year. Since there is no national tracking of sinkhole damage costs, this estimate is probably much lower than the actual cost.

Impact: 2 – Limited

Past Occurrences

The SC State Hazard Mitigation Plan provides no data on sinkholes, and the Charleston County Regional HMP does not address sinkholes. A search of sinkholes in the Charleston area turns up few results, though there are some instances of sinkholes opening up under roadways. The picture below shows a small sinkhole in downtown Charleston. Reports exist of a larger sinkhole in Dorchester County; however, these cases are most likely attributable to failure of man-made features. College of Charleston geology professor Norman Levine explains that in Charleston, the sinkholes that typically occur are infrastructure-related sinkholes. In downtown Charleston, the pre-Civil War drainage tunnels the major storm drains across the city. As materials are deteriorate through the tunnels, the pressure and support holding the bricks in place shifts and the brick work collapses causing a large void in the subsurface that pulls the material away and the roads sink (get the low broad potholes) or collapse.

Citadel Staff have reported that over the past few years, sinkholes have become increasingly common on campus in roadways and parking lots. There have been three occurrences in 2022, and staff estimates the campus has one pothole every four to five months. Reports have estimated that holes are about the size of dinner plate and the causes have been attributed to soil type, utilities, and increases of fill over time.

Probability of Future Occurrences

Based on past occurrence information reported by Citadel Staff, it can be reasonably be assumed that it is likely that the campus will have a small sinkhole event each year.

Probability: 1 – Likely

Climate Change and Future Conditions

Direct effects from global warming and climate change such as an increase in droughts, floods and hurricanes could contribute to an increase in sinkholes. Climate change raises 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 hurricane following a period of drought can trigger a sinkhole due to low levels of groundwater combined with a heavy influx of rain. As discussed in Section 4.4.6, research shows that the increasing trend in strength, frequency and duration of hurricanes will continue. Therefore, an increase in the occurrence of sinkholes in the future is possible.

Consequence Analysis

Category	Consequences
Public	Injuries or deaths may occur when sinkholes open under people, cars, or buildings.
Responders	Sinkholes may result in road closures which could affect the speed of response. If people are injured this may require increased attention from first responders.
Continuity of Operations (including Continued Delivery of Services)	Records exist for deaths associated with sinkholes opening beneath homes while occupants were present or from motor vehicle deaths when drivers could not avoid driving into the sinkhole before protective barriers were in place.
First Responders	The overall effect on first responders would be relatively limited. Sinkholes may result in road closures which could affect the speed of response. Depending on the type and severity, responders may have difficulty reaching injured people.
Property, Facilities and Infrastructure	Damage tends to be localized, however, 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 collapse into the sinkhole. Water infrastructure and road may be damaged.
Environment	Most sinkholes are a natural occurring process. Many naturally occurring sinkholes fill with rainwater creating new aquatic habitat. Rain water may pick up polluted runoff and can contaminate water source or new habitats.
Economic Condition	Remediation costs can be high due to costly foundation shoring, replacement of infrastructure, or cost of stabilization of the sinkhole itself.

Vulnerability Assessment

Charleston County has had very few historical occurrences of sinkholes and the County's geological make up is not vulnerable to sinkholes. As a result, there is very little probability that The Citadel will experience naturally occurring sinkholes, and thus faces minimal risk.

The Citadel is likely to sustain human induced sinkholes that are small and likely have minimal impact on campus activities.

Problem Statement

- Sinkholes on campus are generally small and have not caused building damages or injuries but are a nuisance hazard that require response and repair operations.

4.4.10 Tornado

Hazard	Probability	Impact	Spatial Extent	Warning Time	Duration	PRI Score
Tornado	Likely*	Limited*	Moderate	<6 hours	<6 hours	2.6

*Based on an EF1 scenario.

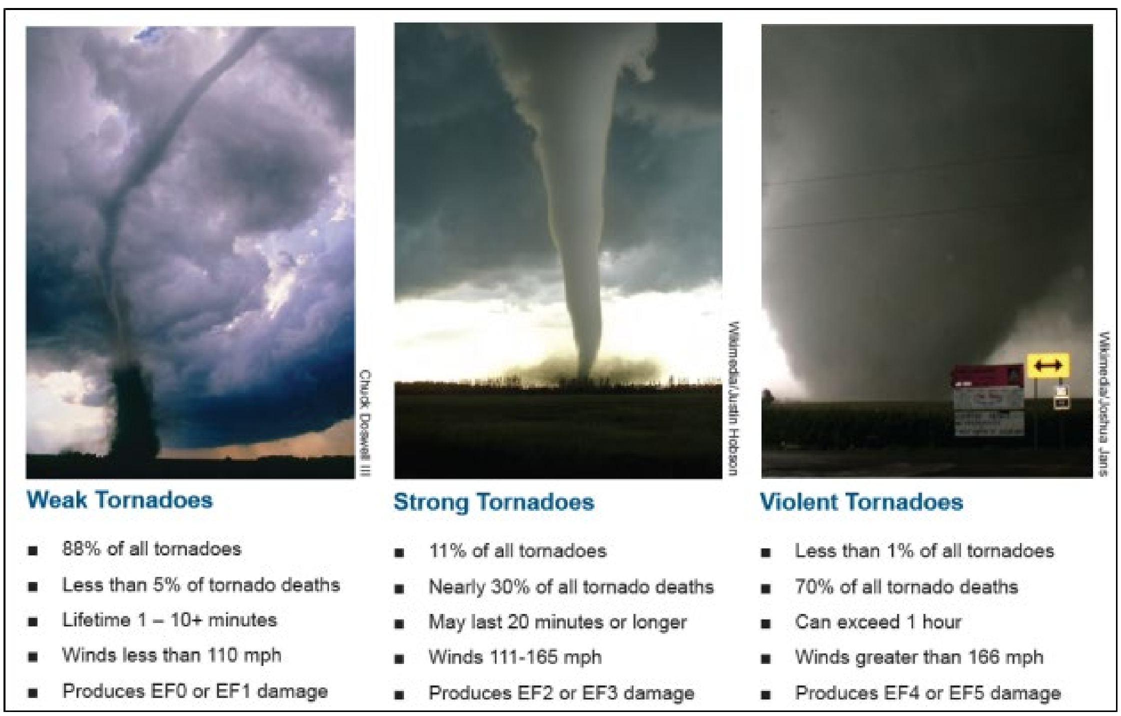
Hazard Description

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. The damage caused by a tornado is a result of the high wind velocity and wind-blown debris, sometimes accompanied by lightning or large hail.

NOAA records estimate that an average of 1,253 tornadoes occur in the United States each year. Most tornadoes are related to thunderstorms, which gain most of their energy from solar heating and latent heat released by the condensation of water vapor; therefore, tornadoes most often occur in the afternoon and evening hours, when temperatures are higher. Similarly, the months in which tornadoes are most likely correspond to the times of year with increased solar heating and strong frontal systems. In the Southeast, tornadoes are more likely in the early spring. However, tornadoes can occur at any time of day or year, with little warning.

The severity of tornadoes can vary significantly. According to the National Weather Service, tornado wind speeds normally range from 40 miles per hour to more than 300 miles per hour. The most violent tornadoes have rotating winds of 250 miles per hour or more and are capable of causing extreme destruction and turning normally harmless objects into deadly missiles. A tornado's path might vary from only a few dozen yards wide to over a mile wide. Figure 4.49 summarizes the average breakdown of tornadoes and their impacts by their magnitude.

FIGURE 4.49 – SUMMARY OF TORNADO OCCURRENCES AND IMPACTS BY MAGNITUDE



Source: NOAA National Weather Service

Warning Time: 4 – Less than 6 hours

Duration: 1 – Less than 6 hours

Location

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"), tornadoes can and do occur throughout the central and eastern U.S., as shown in Figure 4.50 , which depicts tornado activity based on the number of recorded tornadoes per 1,000 square miles. Charleston County is in an area that averages 1-5 tornadoes per 1,000 square miles.

FIGURE 4.50 – TORNADO ACTIVITY IN THE UNITED STATES

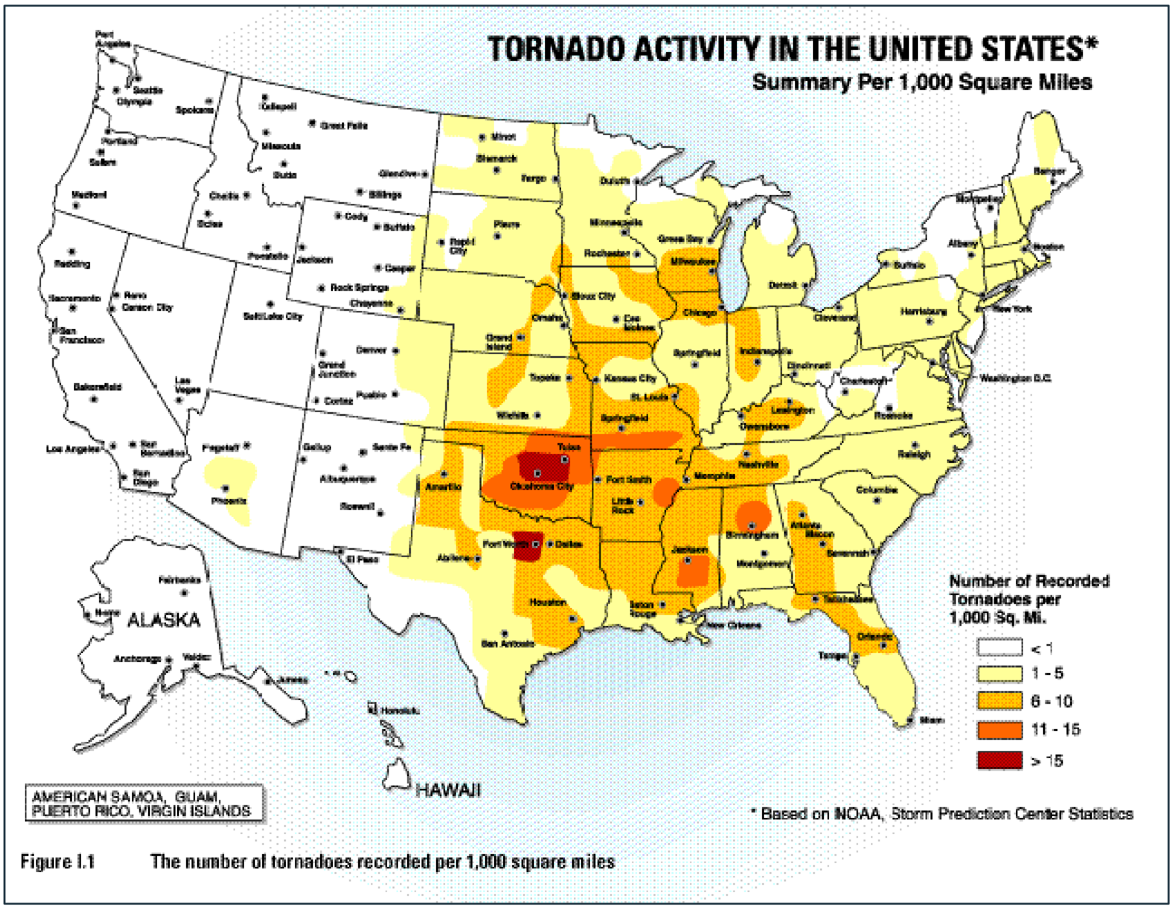


Figure I.1 The number of tornadoes recorded per 1,000 square miles

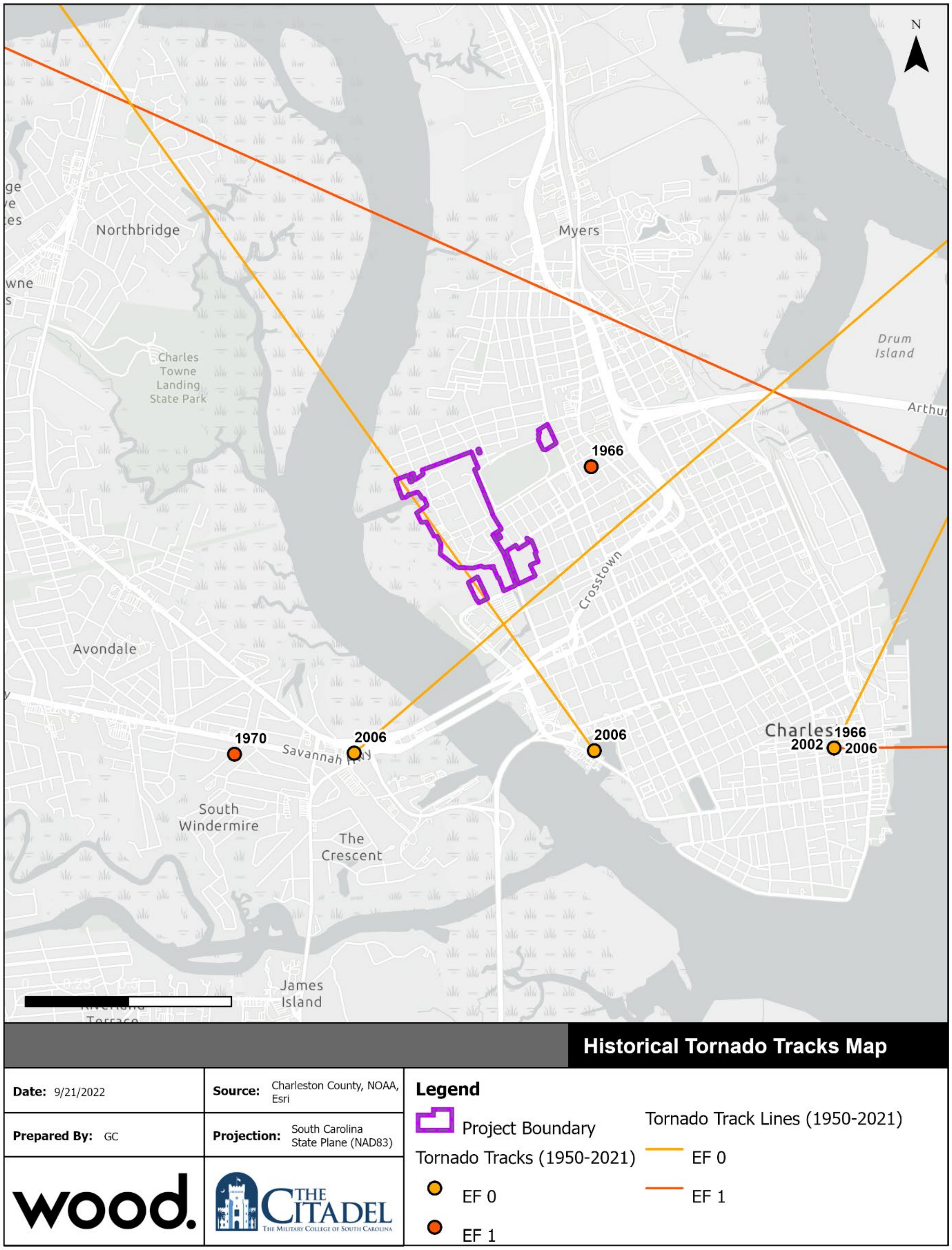
Source: FEMA

Figure 4.51 reflects the tracks of past tornados that passed within 10 miles of Charleston County from 1950 through 2021 according to data from the NOAA/National Weather Service Storm Prediction Center.

Tornados can occur anywhere in the County. Tornadoes typically impact a small area, but damage may be extensive. Tornado locations are completely random, meaning risk to tornado isn't increased in one area of the county versus another. Due to the small size of the campus, if a tornado were to pass through the Citadel, it would likely impact a significant portion of the campus.

Spatial Extent: 3 – Moderate

FIGURE 4.51 – TORNADO PATHS WITHIN 10 MILES OF CHARLESTON COUNTY, 1950-2021



Extent

Prior to February 1, 2007, tornado intensity was measured by the Fujita (F) scale. This scale was revised and is now the Enhanced Fujita scale. Both scales are sets of wind estimates (not measurements) based on damage. The new scale provides more damage indicators (28) and associated degrees of damage, allowing for more detailed analysis, better correlation between damage and wind speed. It is also more precise because it takes into account the materials affected and the construction of structures damaged by a tornado. Table 4.49 shows the wind speeds associated with the Enhanced Fujita scale ratings and the damage that could result at different levels of intensity.

TABLE 4.49 – ENHANCED FUJITA (EF) 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 strongest tornado in the Charleston Region was an EF2 tornado that had maximum winds reaching 120mph. The tornado touched down near Morris Acres on Johns Island in 2015. It is possible for a stronger tornado to impact the Charleston Region, though most of the tornado reports are unconfirmed or are a confirmed EF0 tornado.

Impact: 2 – Limited

Past Occurrences

According to NCEI records, Charleston County has experienced 50 tornadoes since 1950, listed in Table 4.50. These events are reported to have caused 17 injuries and close to $6M in property damage.

TABLE 4.50 – NCEI RECORDS FOR TORNADOES IN CHARLESTON COUNTY, 1950-2022

Date	Tornado Fujita Scale	Deaths/ Injuries	Property Damage	Crop Damage
5/22/1957	F0	0/0	$30	$0
09/11/1960	F3	0/10	$2,500,000	$0
04/12/1961	F1	0/0	$250,000	$0
08/29/1964	F2	0/2	$2,500	$0
07/05/1965	F1	0/0	$2,500	$0
04/13/1966	F0	0/0	$30	$0
08/07/1966	F1	0/0	$25,000	$0
09/19/1966	F1	0/0	$2,500	$0
09/19/1966	F1	0/0	$2,500	$0

Date	Tornado Fujita Scale	Deaths/ Injuries	Property Damage	Crop Damage
06/07/1968	--	0/0	$30	$0
05/25/1970	F1	0/0	$2,500	$0
03/12/1974	F1	0/0	$25,000	$0
03/08/1976	F1	0/1	$25,000	$0
09/04/1979	F0	0/0	$250	$0
06/27/1982	F1	0/0	$2,500	$0
02/27/1984	F0	0/0	$2,500	$0
07/26/1986	F0	0/3	$25,000	$0
11/07/1995	F0	0/0	$0	$0
03/14/1997	F1	0/0	$30,000	$0
03/14/1997	F1	0/0	$75,000	$0
07/23/2000	F0	0/0	$200,000	$0
08/03/2000	F0	0/0	$0	$0
06/12/2001	F0	0/0	$0	$0
07/15/2002	F0	0/0	$0	$0
09/28/2002	F0	0/0	$0	$0
08/12/2004	F1	0/0	$0	$0
08/12/2004	F0	0/0	$0	$0
05/30/2005	F1	0/0	$0	$0
04/08/2006	F1	0/1	$0	$0
04/08/2006	F0	0/0	$0	$0
04/08/2006	F0	0/0	$0	$0
04/26/2006	F1	0/0	$0	$0
05/14/2006	F1	0/0	$0	$0
06/13/2006	F0	0/0	$3,000	$0
06/13/2006	F0	0/0	$500	$0
06/13/2006	F0	0/0	$5,000	$0
05/11/2008	EF2	0/0	$1,200,000	$0
06/29/2008	EF0	0/0	$35,000	$0
08/01/2012	EF0	0/0	$0	$0
05/31/2014	EF0	0/0	$0	$0
09/24/2015	EF2	0/0	$1,540,000	$0
9/11/2017	EF0	0/0	$0	$0
9/11/2017	EF1	0/0	$0	$0
9/11/2017	EF0	0/0	$0	$0
9/11/2017	EF0	0/0	$0	$0
4/13/2020	EF1	0/0	$0	$0
4/13/2020	EF1	0/0	$0	$0
5/20/2020	EF1	0/0	$0	$0
7/8/2021	EF1	0/0	$0	$0
7/8/2021	EF1	0/0	$0	$0
Total		**0/17**	**$5,956,340**	**$0**

Source: NCEI, August 2022

The following narratives from NCEI illustrate that damage occurred in many of these incidents even if a monetary value was not recorded:

June 2001 – As the remnants of Tropical Storm Allison moved across the southeastern states, numerous funnel clouds developed with several of them touching down for brief periods of time. None of them produced major damage. In most cases, there were trees snapped off about 15 to 20 feet above the ground.

August 2004 – The remnants of Tropical Storm Bonnie caused a tornado and several incidents of straight-line wind damage. An estimated 250 trees were blown down, several of which fell on cars. Also, windows were blown out of cars. About 25 homes received minor roof and siding damage and a half dozen homes received moderate damage. An estimated 300-pound swing set was thrown about 15 feet.

May 2006 – NWS storm survey indicates a tornado touched down 3 miles northwest of Ravenel and traveled east 1.8 miles before lifting about 2.5 miles north of Ravenel. The tornado snapped off or uprooted numerous trees. The maximum path width was 175 yds. The tornado was rated F1 with maximum winds estimated from 80 to 90 mph.

May 2008 – A warm front lifted northward through South Carolina and southeast Georgia during the morning, with a strong cold front sweeping through the area during the evening. This resulted in several rounds of severe weather across the region. A confirmed EF-2 Tornado initially touched down and minor damage was observed. Minor damage was observed on River Road when the Tornado weakened before lifting just south of the Charleston Executive Airport. The damage along River Road was confined primarily to several downed trees.

September 2015 – A large mid and upper-level low pressure system helped to draw deep moisture into southeast South Carolina while a low-pressure system at the surface became centered off the southeast coast. The thunderstorm soon showed numerous radar characteristics suggestive of a ongoing tornado. Ultimately the thunderstorm spawned a tornado that created a 7-mile path of damage. According to a damage assessment performed by the Charleston County Building Services Department, 51 total structures were damaged including 33 with moderate or worse damage and 18 with only minor damage. The total damage estimate resulting solely from structures was $1,539,000. Thousands and thousands of trees were uprooted or snapped off with many falling onto structures, vehicles, and roadways.

September 2017 – A National Weather Service storm survey team confirmed an EF0 tornado on Joint Base Charleston in Charleston County. The weak, short-lived tornado, associated with the outer rain bands of Tropical Storm Irma, touched down near the Joint Base Charleston flight line and traveled along a discontinuous path toward the north-northwest.

April 2020 – A severe quasi-linear convective system (QLCS) moved through southeast South Carolina. As the QLCS swept through Southeast South Carolina, a few supercell thunderstorms became exceptionally strong while partially breaking away from the main line of thunderstorms, producing widespread wind damage and strong long-track tornadoes. A total of 13 confirmed tornadoes occurred across Southeast South Carolina.

May 2020 – A large cluster of thunderstorms developed in the morning hours and impacted portions of southeast South Carolina. One storm developed near a stationary surface front and produced a short-lived tornado, damaging straight-line wind gusts, and large hail. A National Weather Service storm survey team determined that an EF1 tornado occurred on Johns Island in Charleston County. Along the path of the tornado, most of the damage was due to numerous snapped and uprooted trees. A few homes did sustain mainly minor roof damage due to falling trees and large tree limbs.

July 2021 – Elsa initially developed as a Tropical Depression over the central tropical Atlantic late in the evening of June 30th, 2021. The primary impacts to southeast Georgia and southeast South Carolina included heavy rainfall, a few tornadoes, and gusty winds. A National Weather Service (NWS) storm survey team determined that an EF-1 tornado occurred near Edisto Island in Charleston County.

Probability of Future Occurrences

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

According to NCEI, 50 tornadoes occurred between 1957 and 2021. This correlates to a 78% annual probability that the county will experience a tornado. Four of these past tornado events were a magnitude EF2 or greater; therefore, the annual probability of a significant tornado event is approximately 6.3 percent.

Probability: 3 – Likely

Climate Change and Future Conditions

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

Consequence Analysis

Category	Consequences
Public	Injuries and fatalities are possible. Individuals who cannot take shelter are most vulnerable. Injury may also result from debris or damaged buildings.
Responders	Responders may be hindered by storm impacts; damages may block access to affected areas or make it dangerous to enter affected buildings or areas.
Continuity of Operations (including Continued Delivery of Services)	Potential impacts to continuity of operations may result if personnel are harmed or if critical systems or resources are damaged. Delays in providing services may result.
Property, Facilities and Infrastructure	The weakest tornadoes, EF0, can cause minor roof damage, while strong tornadoes can destroy frame buildings and even badly damage steel reinforced concrete structures. Buildings are vulnerable to direct impact from tornado winds and wind-borne debris. Impacts to infrastructure may also include structural damage, impassable or blocked roadways or bridges, failed utility lines, or railway failure.
Environment	Downed trees and damages to vegetation are likely. Debris may be thrown great distances and end up in natural areas, with potential impacts on habitats. If hazardous materials facilities are impacted, chemical releases may occur and would require remediation.
Economic Condition	Economic impacts are contingent on tornado's path, but a tornado can severely impact/destroy critical infrastructure and other economic drivers, halt economic activity, or cause direct losses to businesses.

Vulnerability Assessment

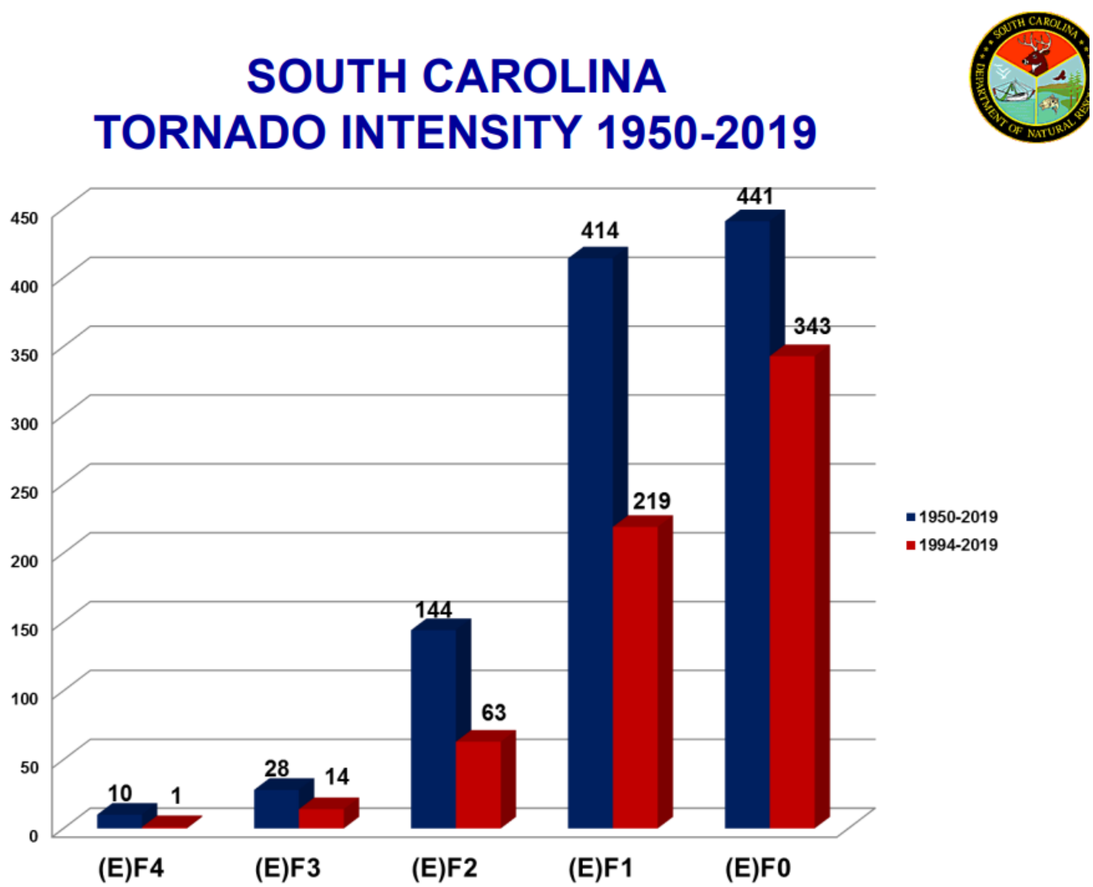
Historical evidence shows that most of South Carolina is vulnerable to tornado activity, which often is associated with other severe weather events such as thunderstorm activity or tropical cyclone activity. People exposed to the elements or outside when a tornado occurs are most vulnerable. According to NCEI reports, 17 people in Charleston County have been injured by a tornado event.

General damages to property are both direct (what the tornado physically destroys) and indirect (additional costs, damages, and losses attributed to secondary hazards spawned by the tornado or due to the damages caused by the tornado). Depending on its size and path, a tornado is capable of damaging and eventually destroying almost anything. 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.

It is difficult predict where a tornado may strike and is not possible to map geographic boundaries for this hazard. Figure 4.51, in the location section for this hazard, shows past tornado tracks in the vicinity of The Citadel campus.

A review of past tornado occurrences in the State from 1950 to 2019 shows that Charleston County has experienced the third most tornadoes in the State and the second most from 1994 – 2019. However, the majority of these tornadoes were rated low intensity EF0 and EF1 on the Enhanced Fujita scale, which is in keeping with the trend throughout the State, shown in Figure 4.52. Over that period, only 3 EF2 tornadoes and 1 EF3 tornado touched down in Charleston County.

FIGURE 4.52 – TORNADO INTENSITY IN SOUTH CAROLINA, 1950-2019



Source: South Carolina Tornado Climatology, https://www.dnr.sc.gov/climate/sco/ClimateData/SC_Tornado_Climo_2019.pdf

The majority of tornados in Charleston are short-lived, with limited track lengths. Of all tornados that touched down in the County from 1950-2019, the average track length is 3.4 miles. The average width of the tracks is 117 yards.

A hypothetical tornado path was developed to illustrate potential impacts on a "worst case" tornado track through the campus. Table 4.51 provides planning level widths and percent damage for scale of the Fujita Scale as taken from the 2010 Johnson County, Illinois Hazard Mitigation Plan. [40]

TABLE 4.51 – TORNADO PATH WIDTH AND DAMAGE CURVE

Fujita Scale	Path Width (feet)	Maximum Expected Damage
F0	300	0%
F1	600	10%
F2	1,200	50%
F3	1,800	80%
F4	2,400	100%
F5	3,000	100%

Figure 4.53, on the following page, provides the hypothetical tornado path and widths for each Fujita Scale. The number of buildings within each Fujita Scale path was determined using GIS and expected damages are shown in Table 4.52. In the worst case EF4 or EF5 scenario, estimated campus building damage and content loss would be over $1.6 billion and damage almost 94% of the buildings on campus. Note: the numbers presented in Table 4.52 are estimated based on tornado size and the hypothetical tornado path shown in Figure 4.53. A tornado probability study and a tornado damage study were not performed.

TABLE 4.52 – PROPERTIES POTENTIALLY AT RISK TO WORST CASE HYPOTHETICAL TORNADO PATH

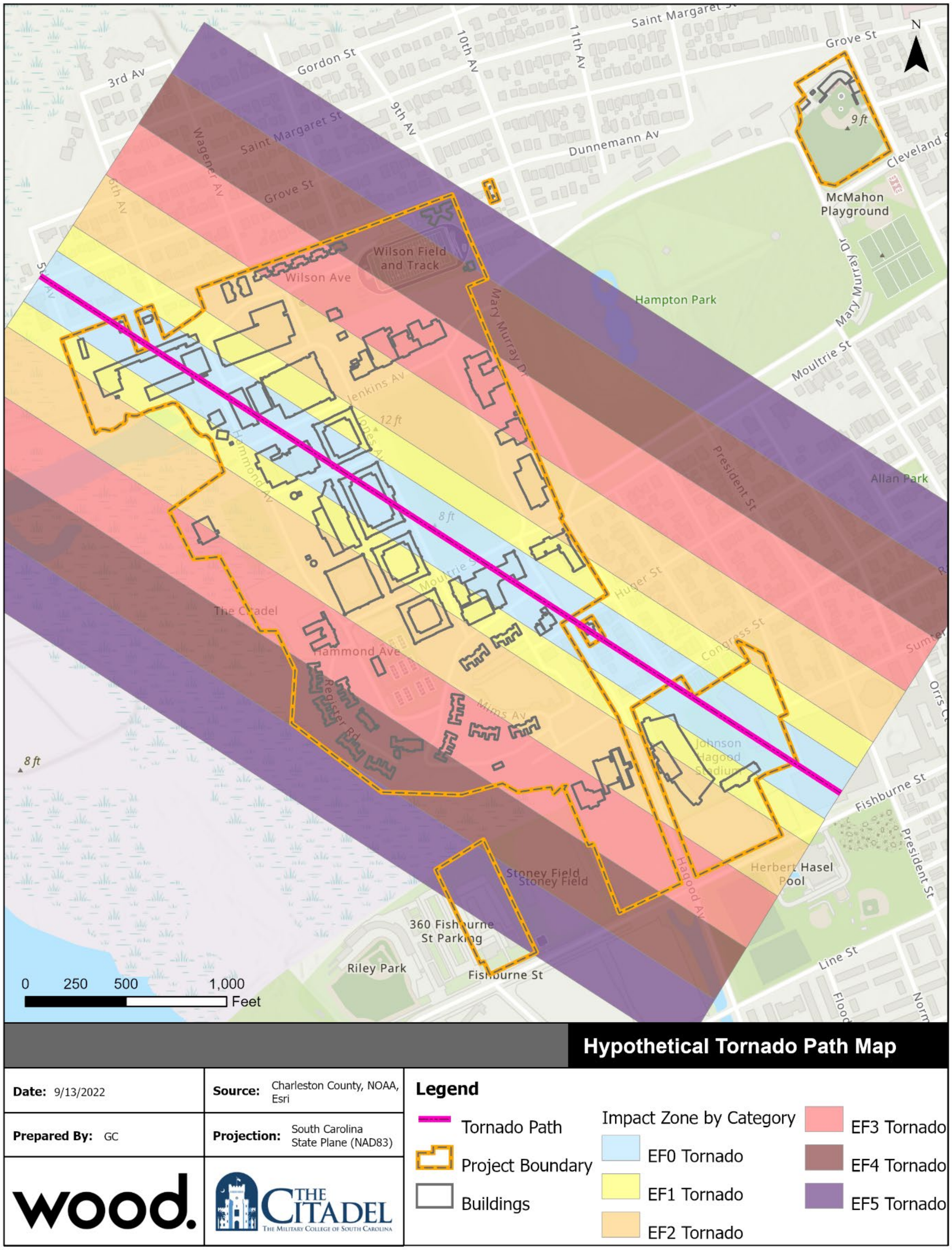
Type	Total Number of Buildings in Estimated Damaging Wind Path	Building Value	Estimated Content Value	Total Value	Estimated Total Damage
F0	14	$87,971,300	$15,213,650	$103,184,950	$0
F1	30	$194,220,900	$28,980,700	$223,201,600	$22,320,160
F2	46	$320,344,900	$44,777,950	$365,122,850	$182,561,425
F3	66	$394,753,840	$63,217,540	$457,971,380	$366,377,104
F4	75	$403,662,540	$63,332,340	$466,994,880	$466,994,880
F5	77	$406,525,140	$63,442,840	$469,967,980	$469,967,980

In conclusion, a tornado has the potential to impact almost all existing and future buildings, facilities, and populations at The Citadel. Impacts of tornadoes include building and contents damage, debris clean-up, service disruption and potentially numerous fatalities and injuries. Though EF2, EF3, and EF4 tornados are possible, they are not probable. The Citadel is more likely to face exposure to a less severe EF0 or EF1 tornado which would not cause such substantial damage to campus.

Problem Statement

- Low intensity tornadoes can often spawn as a result of hurricanes. These events are relatively common in Charleston County and could impact the Citadel campus.
- An F4 or F5 tornado could cause an estimated 100% building damage within 2,400 to 3,000 feet of its path.

FIGURE 4.53 – CITADEL HYPOTHETICAL TORNADO PATH IMPACT



4.4.11 Tsunami

Hazard	Probability	Impact	Spatial Extent	Warning Time	Duration	PRI Score
Tsunami	Unlikely	Critical*	Large*	<6 hours	<24 hours	2.6

*Based on a high tide scenario.

Hazard Description

A tsunami is a series of large ocean waves formed as a result of an underwater disturbance such as an earthquake, landslide, volcanic eruption, or meteorite. Earthquakes are the most common cause of tsunamis. Tsunami waves radiate in all directions from the site of the disturbance, traveling as fast as 450 mph and slowing as they reach shallow waters. As the waves slow, they draw together and grow in height. The resulting phenomenon appears as a constant wall of water when it reaches the shore. When they reach the coast, they can cause dangerous coastal flooding and powerful currents that can last for several hours or days.

Tsunamis can produce unusually strong currents, rapidly flood land, and devastate coastal communities. Low-lying areas such as beaches, bays, lagoons, harbors, river mouths, and areas along rivers and streams leading to the ocean are the most vulnerable. The most common cause of death during a tsunami is drowning. Tsunami waves can cause structural damage and contamination of drinking water. Tsunami-related damage is also largely affected by the amount of debris picked up and carried by the water.

Warning Time: 4 – Less than 6 hours

Duration: 2 – Less than 24 hours

Location

Tsunamis can strike any coastal area but are most commonly associated with the Pacific Coast where there is a higher probability of them occurring due to the number of subduction zones and high probability of earthquakes. Of the 754 confirmed events in the Global Historical Tsunami Database between 1900 and 2015, about 78% occurred in the Pacific Ocean (around the geologically active “Ring of Fire”), 8% in the Atlantic Ocean and Caribbean Sea, 6% in the Mediterranean Sea, 5% in the Indian Ocean, and 1% in other seas.

Tsunamis on the east coast are more likely to occur as a result of landslides or slumping associated with local earthquakes, though these events are rare. The most at risk areas are those less than 25 feet above sea level and within 1 mile of the coastline. The Charleston area is not considered to be at risk of tsunamis, but Charleston County has taken precautions by placing a warning buoy 425 miles off the coast and becoming a National Weather Service designated “Tsunami Ready Community” in 2006.

Figure 4.54 shows the locations of recorded tsunamis in the United states (green dots). The data comes from NOAA’s tsunami database. The database is a listing of historical tsunami source events and runup locations throughout the world that range in date from 2000 B.C. to the present. The events were gathered from scientific and scholarly sources, regional and worldwide catalogs, tide gauge data, deep ocean sensor data, individual event reports, and unpublished works. The maps indicates that there has been one tsunami event in Charleston in 1886.

The spatial extent of impacts would vary based on the timing of a tsunami event, but during a high tide much of The Citadel campus could be inundated.

Spatial Extent: 4 – Large

FIGURE 4.54 – HISTORICAL TSUNAMIS IN THE U.S.

Source: NOAA NCEI (https://www.ncei.noaa.gov/maps/hazards/)

Extent

The tsunami magnitude, or Mt, is a number used to compare sizes of tsunamis generated by different earthquakes and calculated from the logarithm of the maximum amplitude of the tsunami wave measured by a tide gauge distant from the tsunami source.

The DART system (Deep-ocean Assessment and Reporting of Tsunamis) is a real-time tsunami monitoring system positioned at strategic locations throughout the ocean for forecasting purposes. These monitoring devices detect irregularities in the ocean and can determine the height of the wave once it hits shore and how much time it will take to reach shore.

The largest earthquake ever recorded was a magnitude 9.5 earthquake off the coast of Southern Chile on May 22, 1960. This earthquake and the second largest earthquake, the 1964 magnitude 9.2 in Prince William Sound, Alaska, both generated devastating tsunamis.

Most tsunamis are small and nondestructive or only affect coasts near their source, but some tsunamis can cause damage and deaths on distant shores (more than 1,000 kilometers, 620 miles, away).

Most tsunami damage and destruction is caused by flooding, wave impacts, strong currents, erosion, and debris. The water can be just as dangerous as it returns to the sea, taking debris and people with it. In addition to loss of life and mass injuries, other potential impacts include damage to and destruction of homes and businesses, cultural and natural resources, infrastructure, and critical facilities. Flooding and dangerous currents can last for days. Even small tsunamis can pose a threat. Strong currents can injure and drown swimmers and damage and destroy boats in harbors.

Local tsunamis are particularly dangerous. They can strike a coast within minutes of generation with little or no warning.

Impact: 3 – Critical

Past Occurrences

The entire Eastern coastline was rated as having a "very low to low" probability of a tsunami event in a 500- year timeframe by the USGS and Department of the Interior. Tsunamis have affected the Eastern

United States in the past, however these events were not the result of traditional sources of tsunami waves (subduction zones). They are typically the result of slumping or land sliding associated with local earthquakes or with wave action associated with strong storms such as hurricanes.

There is no recent history of a tsunami impacting the Charleston area. Some reports from the August 31, 1886, earthquake in Charleston suggest that the event may have caused a follow-up tsunami. According to the 2013 South Carolina Hazard Mitigation Plan, the run-up (the vertical height of the tsunami above sea level at its furthest point inland) ranged between 0.5 to 20 inches. Any run-up of three feet or more is considered dangerous to people and property. This possible tsunami was therefore only a minor event.

NOAA's database shows zero tsunami events for the Charleston region from 2008 through April 30th, 2022.

Probability of Future Occurrences

Based on the scarcity of past occurrences and the lack of conditions likely to lead to a tsunami such as an offshore subduction zone or signs of a landslide, there is a less than 1% chance of a tsunami occurring in any given year.

Probability: 1 – Unlikely

Climate Change and Future Conditions

Climate change has no direct impact on tsunamis. However, coupled with sea level rise inundation could be more extensive.

Consequence Analysis

Category	Consequences
Public	The greatest threat to people during a tsunami is drowning. The Citadel is located far enough inland that tsunami inundation would not pose a threat to people on the campus. However, any students, faculty, or staff located close to the shore during a tsunami could be at risk if not educated on the warning signs of a tsunami and the actions to take to get out of danger.
Responders	Some areas may be difficult to access in high flood waters, putting first responders in danger during rescue operations.
Continuity of Operations (including Continued Delivery of Services)	Unless critical infrastructure or facilities essential to the operation of the government or the college are located in the impact area of the inundation, continuity of operations will likely not be disrupted. However, floods do have the potential to disrupt normal operations if there is a loss of power.
Property, Facilities and Infrastructure	Campus buildings, as well as critical infrastructure such as transportation, water, energy, and communication systems, may be damaged or destroyed by tsunami flood waters and debris carried by strong tsunami currents.
Environment	Chemicals and other hazardous substances may end up contaminating local water bodies. Tidal flooding can result in saltwater contamination of fresh water supplies.
Economic Condition	Campus buildings located in flooded areas will incur direct property damage costs. Indirectly, tidal flooding can affect commerce by interrupting normal transportation systems, forcing closure of key infrastructure, and requiring traffic diversions.

Vulnerability Assessment

Charleston County is not located in an at-risk area where significant Atlantic Ocean tsunamis are expected to occur. However, as with any coastal community along the Atlantic Ocean, there is still an extremely remote chance of events happening that can cause a tsunami. There are no studies available for Charleston, however, the Tsunami Inundation Mapping for Savannah, GA (Research Report No. CACR-15-14) and the Tsunami Inundation Mapping for Myrtle Beach, SC (Research Report No. CACR-15-13) both report maximum inundation impacts for all potential tsunami sources to be greater than 2 meters on the immediate coastline and 0.5 – 2 meters or lower for inland areas.

Given that tsunamis are events that occur and recede rapidly, it is important to note the impact of total elevation experienced may be cumulative to the tide elevation at the time of tsunami arrival. Using a maximum 2-meter (approximately 6.5 feet) tsunami for inland flooding, a vulnerability assessment was completed for Low Tide, a tide between Low Tide and High Tide, and High Tide. From tidal gage information in Charleston, Low Tide was assumed to be 0.5 feet, High Tide 6.5 feet, and the in between tide elevation used was 3.5 feet. The number and characteristics of buildings that could potentially be impacted by these three flood scenarios are shown in the tables below. Note: the numbers presented in the tables below and Figure 4.55 are estimated based on the reported flood elevations noted above. A tsunami study including a hydrologic and hydraulic analysis was not performed.

TABLE 4.53 – PROPERTIES POTENTIALLY AT RISK TO 6.5' TSUNAMI AT LOW TIDE (0.5FT)

Type	Total Number of Buildings in Estimated Inundation Area	Total Building Value	Estimated Content Value	Total Value (Building & Contents)	Estimated Total Damage
Agricultural	0	$0	$0	$0	$0
Commercial	0	$0	$0	$0	$0
Education	1	$2,839,600	$81,000	$2,920,600	$407,564
Government	0	$0	$0	$0	$0
Industrial	2	$3,178,300	$750,200	$3,928,500	$1,507,200
Religious	0	$0	$0	$0	$0
Residential	2	$1,142,400	$571,200	$1,713,600	$948,429
Total	**5**	**$7,160,300**	**$1,402,400**	**$8,562,700**	**$2,863,192**

TABLE 4.54 – PROPERTIES POTENTIALLY AT RISK TO 6.5' TSUNAMI AT BETWEEN TIDE (TIDE AT 3.5 FEET)

Type	Total Number of Buildings in Estimated Inundation Area	Total Building Value	Estimated Content Value	Total Value (Building & Contents)	Estimated Total Damage
Agricultural	1	$56,500	$2,600	$59,100	$7,431
Commercial	3	$1,385,700	$381,400	$1,767,100	$241,045
Education	3	$26,715,500	$1,275,000	$27,990,500	$407,564
Government	0	$0	$0	$0	$0
Industrial	7	$6,384,800	$1,564,100	$7,948,900	$2,400,516
Religious	0	$0	$0	$0	$0
Residential	10	$4,619,500	$804,900	$5,424,400	$1,416,802
Total	**24**	**$39,162,000**	**$4,028,000**	**$43,190,000**	**$3,056,555**

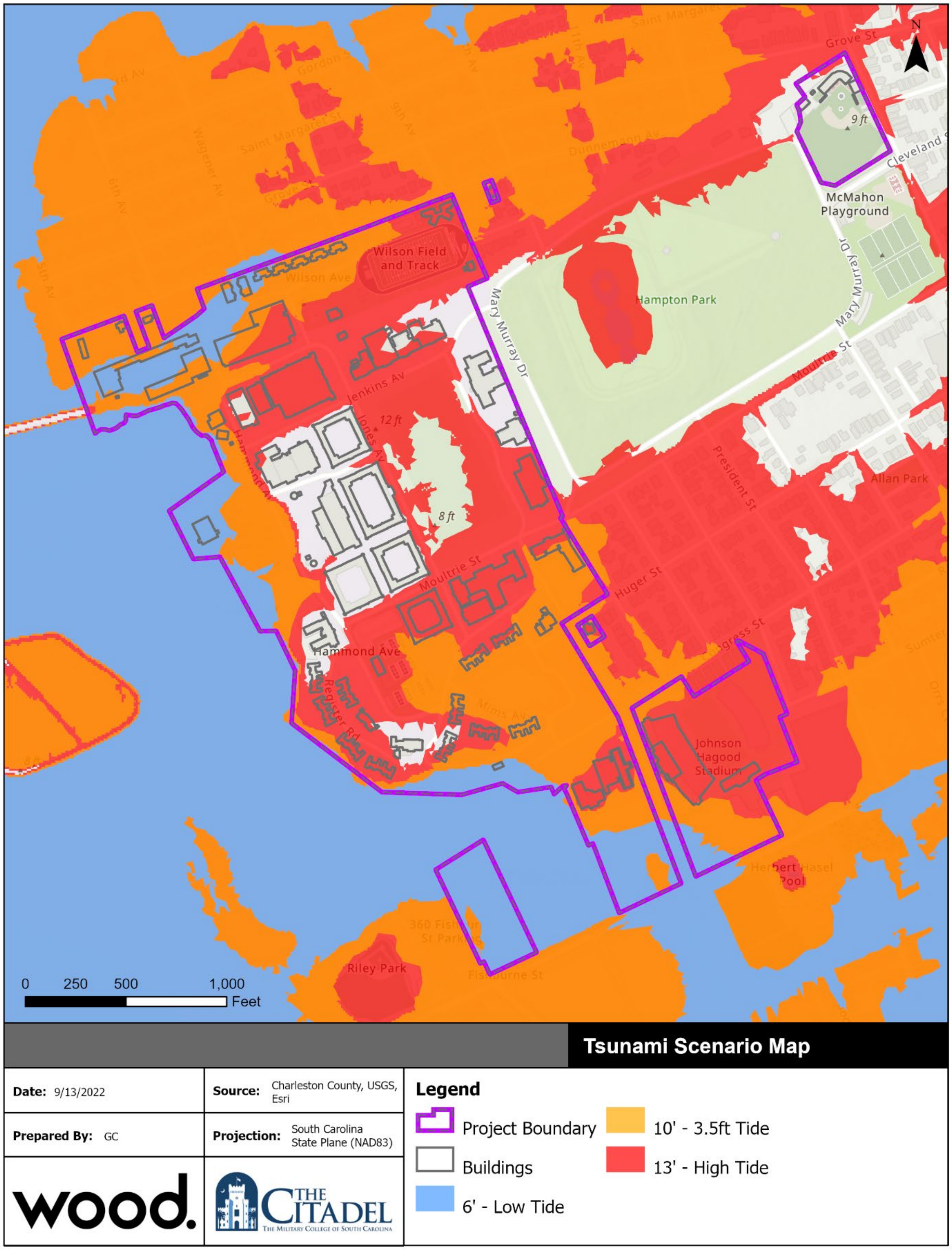
TABLE 4.55 – PROPERTIES POTENTIALLY AT RISK TO 6.5' TSUNAMI AT HIGH TIDE (TIDE AT 6.5 FEET)

Type	Total Number of Buildings in Estimated Inundation Area	Total Building Value	Estimated Content Value	Total Value (Building & Contents)	Estimated Total Damage
Agricultural	1	$56,500	$2,600	$59,100	$7,431
Commercial	10	$47,513,500	$2,545,160	$50,058,660	$241,045
Education	18	$172,980,700	$35,297,200	$208,277,900	$407,564
Government	0	$0	$0	$0	$0
Industrial	7	$6,384,800	$1,564,100	$7,948,900	$2,400,516
Religious	0	$0	$0	$0	$0
Residential	22	$31,821,700	$1,818,850	$33,640,550	$1,416,802
Total	**58**	**$258,757,200**	**$41,227,910**	**$299,985,110**	**$4,473,357**

Problem Statement

- Tsunamis are considered very unlikely and therefore, risk is low.
- Potential impacts of a tsunami could be exacerbated by high tides or sea level rise.

FIGURE 4.55 – TSUNAMI FLOOD SCENARIOS



4.4.12 Wildfire

Hazard	Probability	Impact	Spatial Extent	Warning Time	Duration	PRI Score
Wildfire	Possible*	Limited	Moderate	<6 hours	<1 week	2.5

*Based on Burn Probability

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. The second most common cause of wildfire is lighting.

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.

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.

Charleston County experiences a variety of wildfire conditions found in the Keetch-Byram Drought Index, which is described in Table 4.56. The Keetch-Byram Drought Index (KBDI) for August 2022 is shown in Figure 4.56. The KBDI for Charleston County and the surrounding areas at this time was between 100-301.

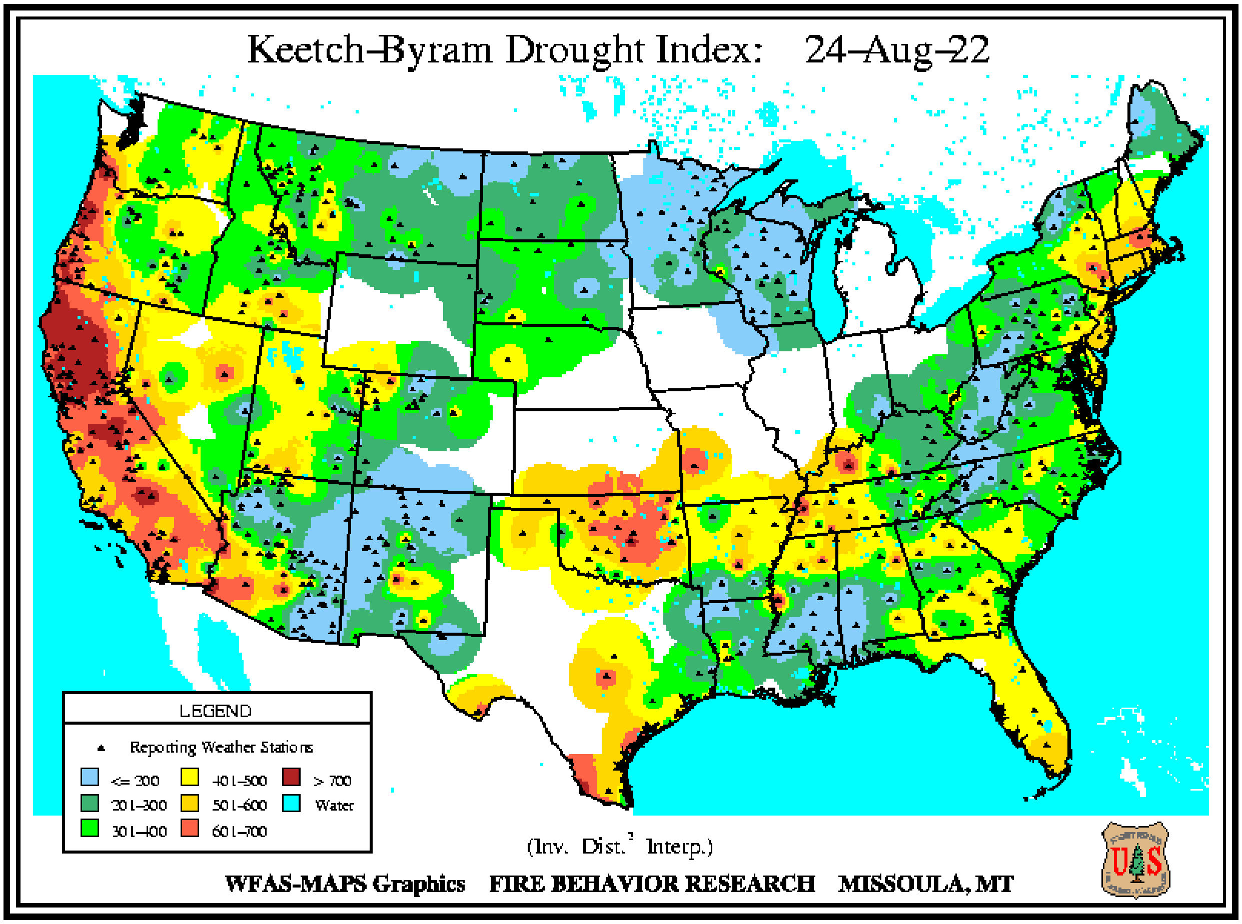
TABLE 4.56 – KEETCH-BYRAM DROUGHT INDEX FIRE DANGER RATING SYSTEM

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.

KBDI	Description
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.

Source: USFS Wildland Fire Assessment System

FIGURE 4.56 – KEETCH -BYRAM DROUGHT INDEX, AUGUST 2022



Source: USFS Wildland Fire Assessment System

Warning Time: 4 – Less than 6 hours

Duration: 3 – Less than 1 week

Location

The location of wildfire risk can be defined by the acreage of Wildland Urban Interface (WUI). The WUI is described as the area where structures and other human improvements meet and intermingle with undeveloped wildland or vegetative fuels, and thus demarcates the spatial extent of wildfire risk. The WUI is essentially all the land in the county that is not heavily urbanized. The 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.

The Southern Wildfire Risk Assessment (SouthWRAP) estimates that almost 96 percent of The Citadel Campus is within the WUI. Population growth within the WUI substantially increases the risk of wildfire.

Approximately 3 percent of The Citadel's land area is outside of the WUI. Table 4.57 details the extent of the WUI in The Citadel, and Figure 4.57 maps the WUI in and around The Citadel campus.

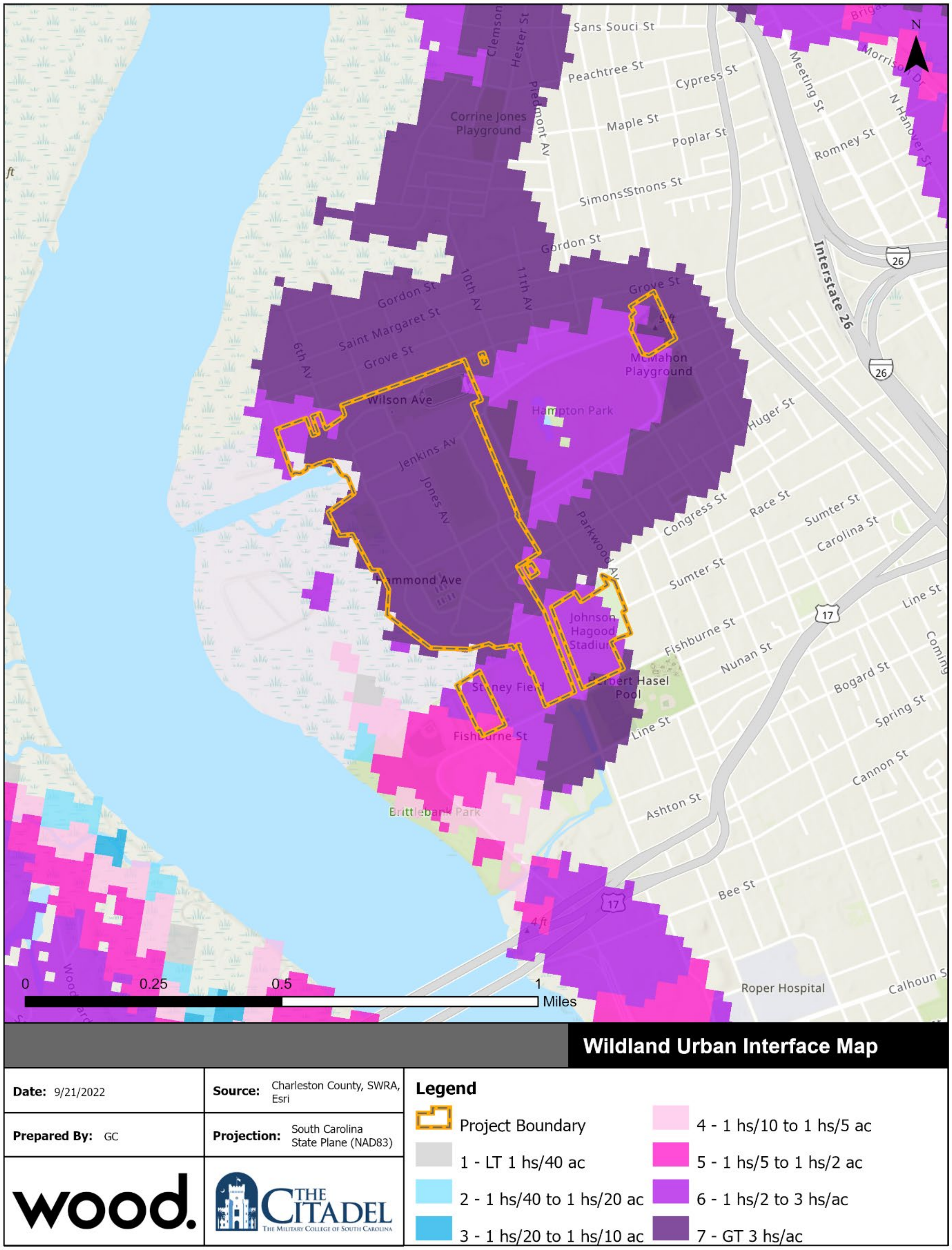
TABLE 4.57 – WILDLAND URBAN INTERFACE

Urban Interface Category	WUI Acres	Percent of WUI Acres
LT 1hs/40ac	--	0.0%
1hs/40ac to 1hs/20ac	--	0.0%
1hs/20ac to 1hs/10ac	--	0.0%
1hs/10ac to 1hs/5ac	--	0.0%
1hs/5ac to 1hs/2ac	1.1	0.8 %
1hs/2ac to 3hs/1ac	26.6	20.3 %
GT 3hs/1ac	99.3	75.8%
Total	**127.0**	**96.9%**

Source: Southern Wildfire Risk Assessment

Spatial Extent: 3 – Moderate

FIGURE 4.57 – WILDLAND URBAN INTERFACE, THE CITADEL



Extent

Wildfire extent can be defined by the fire's intensity and measured by the SouthWRAP's 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 4.58, consists of five classes, as defined by SouthWRAP. Table 4.59 details the characteristic fire intensity scale for the Citadel Campus, and Figure 4.58 shows the potential fire intensity geographically.

TABLE 4.58 – 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.

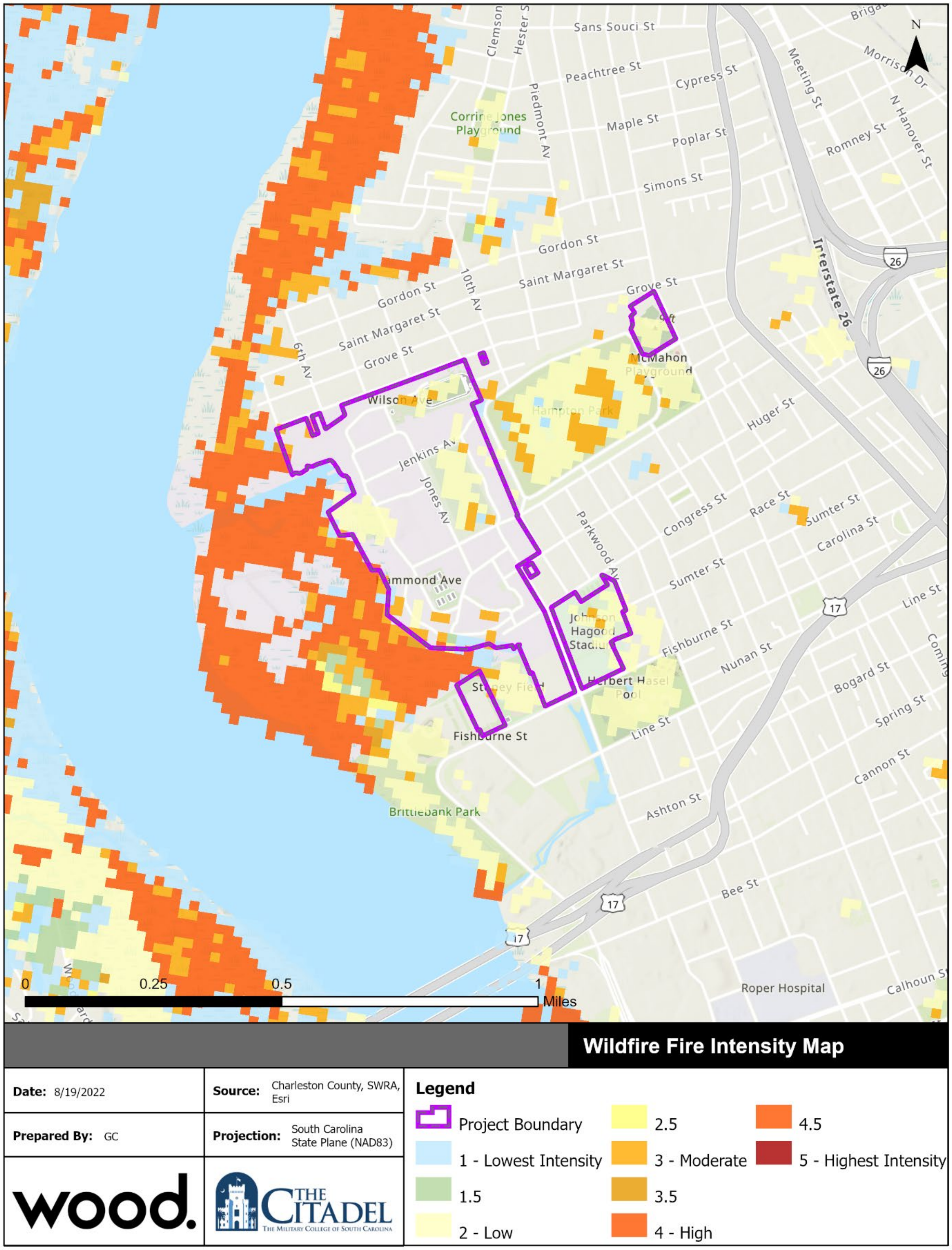
Source: Southern Wildfire Risk Assessment

TABLE 4.59 – CHARACTERISTIC FIRE INTENSITY

Fire Intensity Category	Acres	Percent
Non-Burnable	103.7	79.2 %
1- Lowest Intensity	1.9	1.4%
1.5	0.2	0.2%
2 Low	18.8	14.4%
2.5	0.1	0.1%
3 - Moderate	5.6	4.3%
3.5	0.1	0.1%
4 High	0.5	0.4%
4.5	0.0	0.0%
5 - Highest Intensity	0.0	0.0%
Total	**27.3**	**20.8%**

Source: Southern Wildfire Risk Assessment

FIGURE 4.58 – CHARACTERISTIC FIRE INTENSITY, THE CITADEL



A small portion, approximately 0.4 percent, of The Citadel Campus total land area may experience up to a Class 4 Intensity, which, if made up more of the campus' land area, could pose significant harm or damage to life and property. Approximately 4.4 percent of the county 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 majority of the campus is non-burnable (79.2%) and the remainder (16%) or would face a Class 1 through Class 2 Fire Intensity, which are easily suppressed. However, areas surrounding the campus, along the coast, have higher Fire Intensity (Class 4), and should be aware of any potential increased risk. Given the small amount of land with any risk, let alone high risk, potential impact is considered limited.

Impact: 2 – Limited

Past Occurrences

From 1950 to 2019, the South Carolina Forestry Commission reports 7,542 wildfires in Charleston County and a total 78,094 acres burned. NCEI reports only three wildfire events, which occurred in March 2011, May 2019, and April 2022. The 2011 fire reported $2M in damages.

March 2011 – A wildfire occurred in northern Charleston County and burned 2,600 acres before it was fully contained on March 25. The fire destroyed 16 structures, necessitated the evacuation of the Germantown and Santee communities and the closure of a section of Highway 17, and resulted in $2M in property damage.

May 2019 - A record setting heat wave occurred in May 2019. Coincident with this heat wave was a period of low humidity. Relatively humidity values routinely dropped to less than 30 percent, causing rapid drying of soils and plants. The effect of this period of little or no rainfall and record setting temperatures was a rapidly developing drought. A controlled burn sparked a wildfire in the Francis Marion National Forest. Approximately 1,600 acres of land were burned either directly from the wildfire or from suppression activities.

April 2022 – An extended period of below normal rainfall led to a period of moderate drought and dry fuel conditions favorable for wildfires across Southeast South Carolina. The United States Forest Service reported a wildfire approximately 250 acres in size.

Probability of Future Occurrences

According to historic records, 7,542 wildfires have occurred in Charleston County between 1950 and 2019 (over 100% chance of occurring each year). However, The Citadel is located within a low probability area.

SouthWRAP 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 Charleston County is illustrated in Figure 4.59 and summarized in Table 4.60.

FIGURE 4.59 – THE CITADEL BURN PROBABILITY

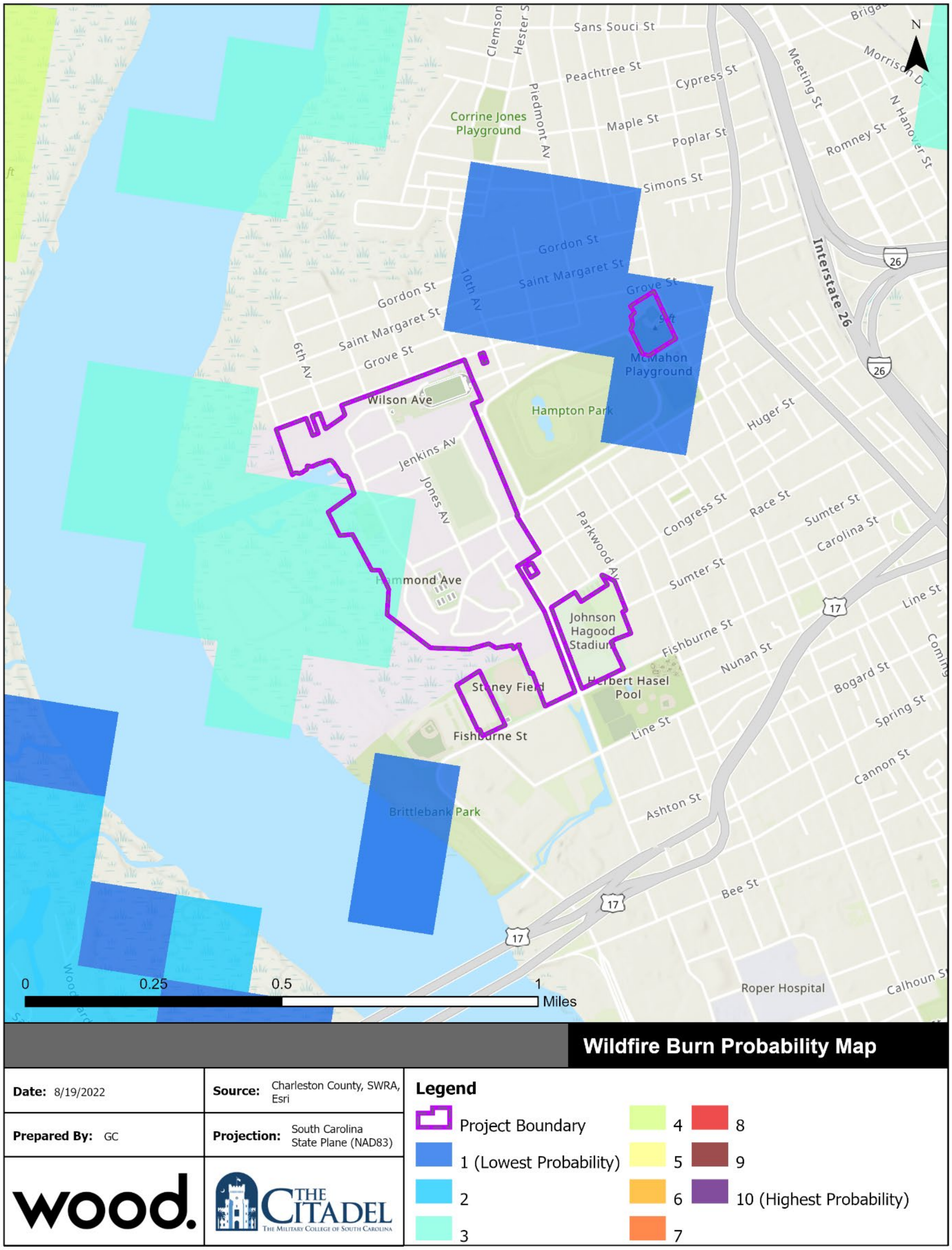


TABLE 4.60 – THE CITADEL BURN PROBABILITY

	Class	Acres	Percent
	1	4.3	3.3%
	2	0	0.0%
	3	13.1	10.0%
	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	**17.5**	**13.3%**

Source: Southern Wildfire Risk Assessment

The Citadel campus has areas of low burn probability (Class 1 and 3) and these areas only encompass 13.3% of the total campus land area. Areas not colored on the map or shown in the table, are zero values and represent non-burnable land cover. Nearly all of campus falls in this non-burnable area. The remaining data suggest there is a very low probability of any burn occurring around The Citadel. In sum, the Burn Probability data indicates a very low risk of a wildfire starting or spreading around The Citadel. The probability of wildfire occurring on The Citadel Campus is considered unlikely, as only a small portion of the campus has a very low probability of experiencing wildfire.

Probability: 1 – Unlikely

Climate Change and Future Conditions

Per the Fourth National Climate Assessment, the Southeast is projected to experience an increase in the duration and intensity of drought, which is expected to increase wildfire occurrence and reduce the effectiveness of prescribed fire. Although total area burned by wildfire is greatest in the western U.S., the Southeast has historically had the highest number of wildfires and the most area burned by prescribed fire.

Consequence Analysis

Category	Consequences
Public	In addition to the potential for fatalities, wildfire and the resulting diminished air quality pose health risks. Smoke and air pollution can cause serious health problems, including asthma attacks and pneumonia, and can worsen chronic heart and lung diseases.
Responders	Wildfires are a significant threat to the health and safety of the emergency services, both while fighting the fire and from after effects from smoke inhalation and heat stroke.
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	Damage to buildings and facilities, especially those in the wildland urban interface, is possible.
Environment	Wildfires damage 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. The secondary effects of wildfires, including erosion, introduction of invasive species, and changes in water quality, are often more disastrous than the fire itself. Water supplies can be degraded by post-fire erosion and stream sedimentation.

Category	Consequences
Economic Condition	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, and can destroy crops and other agricultural property.

Vulnerability Assessment

Wildfire can cause fatalities and human health hazards, particularly when air quality is a concern. Exposure to wildfire smoke can cause serious health problems, including asthma attacks and pneumonia, and can worsen chronic heart and lung diseases. Vulnerable populations include people with respiratory problems or with heart disease. Even healthy people may experience minor symptoms, such as sore throats and itchy eyes. Other potential impacts include direct property losses, including damage to buildings, vehicles, landscaped areas. Similarly, wildfire can cause loss of power, downed trees, or damage/blockage of roads and other transportation systems. Most of The Citadel campus is not at risk of high impact events that would cause such damages.

The text and figures used to assess The Citadel's vulnerability to wildfire are derived from SouthWRAP data, which provides a WUI Risk Index that produces a rating of the potential impact of a wildfire on people and properties. The WUI Risk Index for The Citadel is displayed in Figure 4.60 on the following page.

The WUI Risk Rating is derived using a Response Function modeling approach which involves assigning a net change in the value to a resource or asset based on susceptibility to fire at different intensity levels, such as flame length. The range of values is from -1 to -9, with -1 representing the least negative impact and -9 representing the most negative impact. For example, areas with high housing density and high flame lengths are rated -9 while areas with low housing density and low flame lengths are rated -1.

To calculate the WUI Risk Rating, the WUI housing density data was combined with Flame Length data and response functions were defined to represent potential impacts. The response functions were defined by a team of experts based on values defined by SouthWRAP. By combining flame length with the WUI housing density data, you can determine where the greatest potential impact to homes and people is likely to occur.

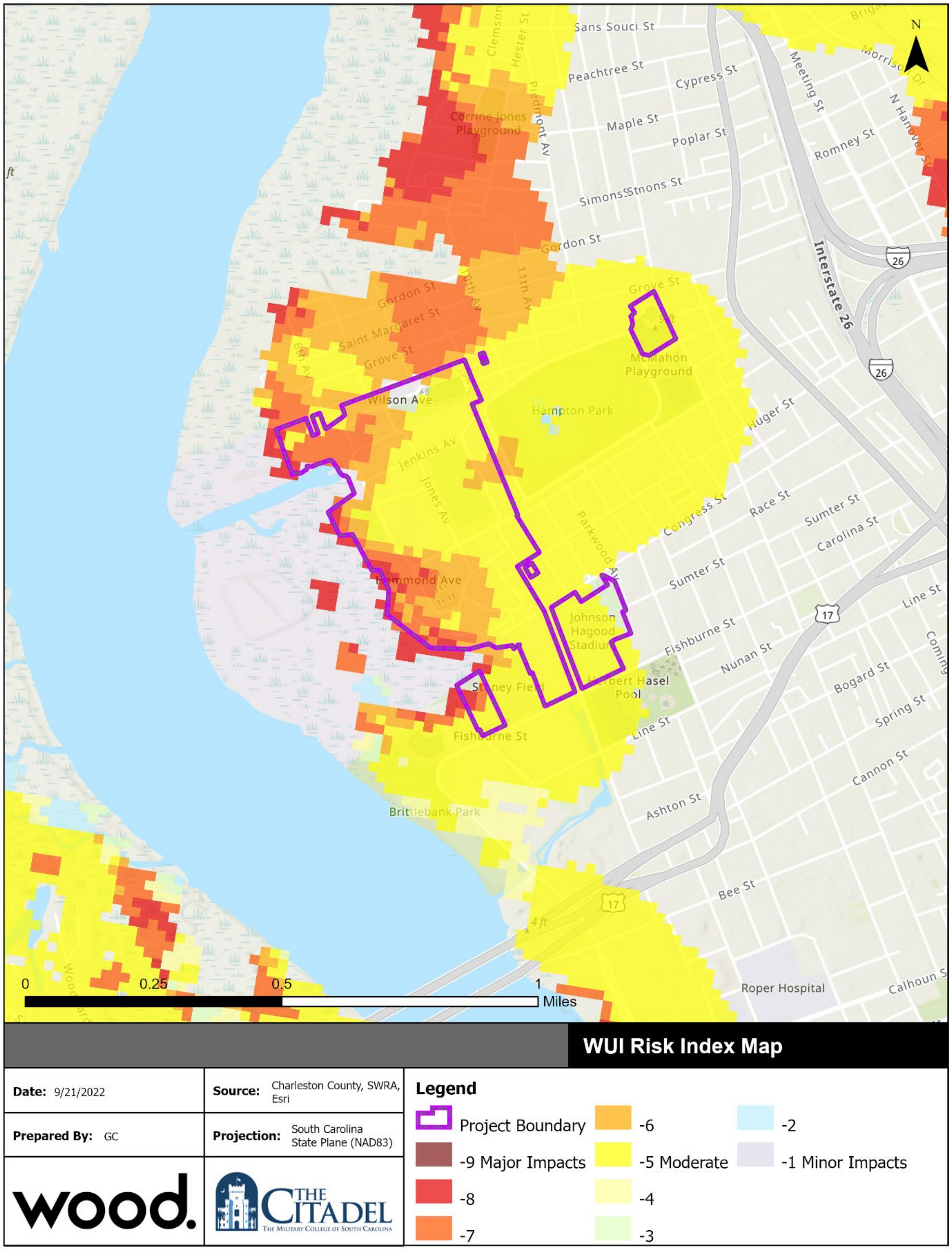
According to the information in Figure 4.60, the areas of the campus that would experience the greatest impact are those properties located closest to the marsh along the Ashley River. Table 4.61 shows a breakdown of campus acreage by WUI rating. Areas with the greatest rating (-8 and -7) only make up about 15% of the burnable area. The majority, 79.3%, of the land area has a moderate risk rating (-5).

TABLE 4.61 – WUI RISK INDEX, THE CITADEL

Risk Class		Acres	Percent
	-9 Major Impacts	0.0	0.0%
	-8	4.7	3.6%
	-7	15.1	11.5%
	-6	25.8	19.7%
	-5 Moderate	79.3	60.5%
	-4	0.0	0.0%
	-3	0.0	0.0%
	-2	0.0	0.0%
	-1 Minor Impacts	0.0	0.0%
	Total	**124.8**	**95.2%**

Source: Southern Wildfire Risk Assessment

FIGURE 4.60 – THE CITADEL WILDLAND URBAN INTERFACE RISK INDEX



SouthWRAP provides analysis of wildfire behavior characteristics in order to further assess fire potential based on the manner in which a fire will react to three environmental influences: fuel, weather, and topography. One of these fire behavior metrics is Characteristic Rate of Spread, which is the speed with which a fire moves in a horizontal direction across the landscape in chains per hour (ch/hr). In SouthWRAP, Characteristic Rate of Spread describes the typical or representative rate of spread of a potential fire based on a weighted average of four percentile weather categories. These weather categories were created to adjust for weather variability and are defined based on historical weather observations to represent low, moderate, high, and extreme weather days.

The Rate of Spread for The Citadel is displayed in Figure 4.61 on the following page, and the data for rate of spread is shown in Table 4.62 below. This data indicates that several acres of land along the Ashley River west and north of The Citadel would burn fairly quickly, at a rate of 30 chains per hour or faster. However, the rate of burn slows as it approaches campus and surrounding developed areas. Moreover, the vast majority of land on campus, is considered non-burnable.

TABLE 4.62 – THE CITADEL RATE OF SPREAD

Rate of Spread		Acres	Percent
	0-5 ch/hr	0.7	0.6%
	5-10 ch/hr	1.9	1.4%
	10-15 ch/hr	2.5	1.9%
	15-20 ch/hr	1.6	1.2%
	20-30 ch/hr	1.3	1.0%
	30-50 ch/hr	0.8	0.6%
	50-150 ch/hr	0.0	0.0%
	150+ ch/hr	0.0	0.0%
	Total	**8.8**	**6.7%**

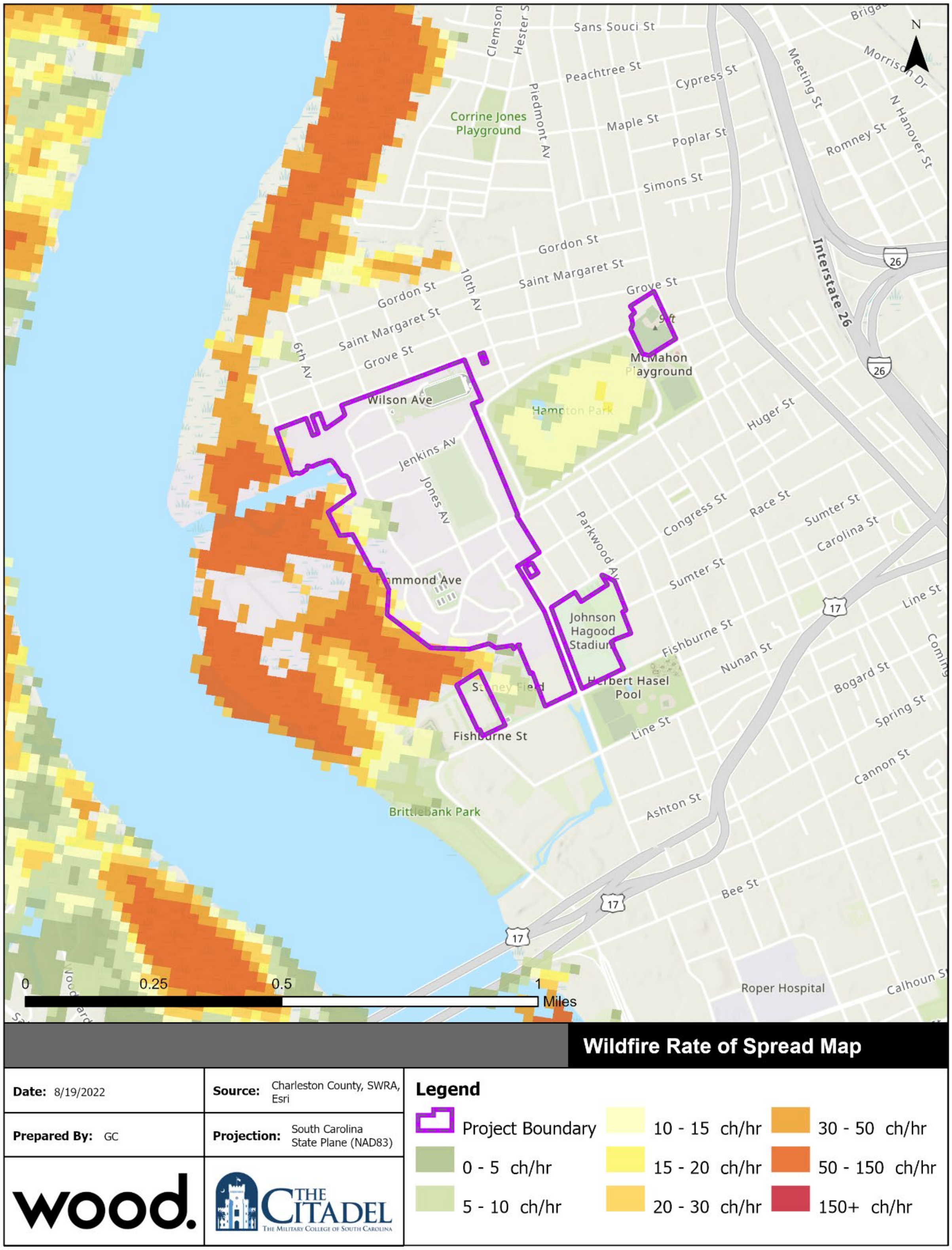
Source: Southern Wildfire Risk Assessment

After assessing each of the SouthWRAP variables, it can be determined that the risk of wildfire at The Citadel is very low. Most of the campus is considered not burnable (79.2%). The remaining area analyzed has a very low probability of burn. Some areas along the Ashley River to the west and southwest of campus have high fire intensity scale ratings and high WUI Risk Index ratings, which could indicate risk of a high magnitude event, however, the likelihood of any burn occurring is extremely low. Therefore, despite a large number of past occurrences of wildfire in Charleston County, the localized risk of and vulnerability to wildfire at The Citadel is very low.

Problem Statement

- Fire intensity data from SouthWRAP indicates that over 79 percent of the campus is non-burnable. Much of the campus has low or no burn probability.
- Despite low probability, there is risk of moderate impacts across much of the campus according to the WUI Risk Index estimates.

FIGURE 4.61 – WILDFIRE RATE OF SPREAD, THE CITADEL



4.4.13 Winter Weather

Hazard	Probability	Impact	Spatial Extent	Warning Time	Duration	PRI Score
Winter Weather	Likely	Limited	Large	>24 hours	<1 week	2.5

Hazard Description

Winter weather 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. Heavy snow might also cause significant property damages, such as roof collapses on older buildings.

All winter storm events—snow, sleet, ice, freezing temperatures, etc.—have the potential to present dangerous conditions to the affected area. The typical elements of winter storm events are described below according to the NCEI Storm Events

Cold/Wind Chill – Period of low temperatures or wind chill temperatures reaching or exceeding locally/regionally defined advisory. Wind chill advisories are issued when the wind chill temperature is expected to fall between -15°F and -24°F. The NWS Wind Chill Temperature Index, as presented in Figure 4.62 below, provides a useful formula for calculating the dangers of winter winds and freezing temperatures.

Frost/Freeze - A surface air temperature of 32 degrees Fahrenheit (°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 – Heavy snow can immobilize a campus by stranding commuters, stopping the flow of commerce, and disrupting emergency and medical services. The weight of snow can cause roofs to collapse and knock down trees and power lines. Cadets, students, faculty and staff may be isolated for days. The cost of snow removal and repairing damages can have economic impacts. Heavy snow is defined by accumulation meeting or exceeding locally/regionally defined 12 and/or 24-hour warning criteria, on a widespread or localized basis. In some heavy snow events, structural damage, due to the excessive weight of snow accumulations, may occur in the few days following the meteorological end of the event.

Ice Storm – Ice accretion meeting or exceeding locally/regionally defined warning criteria. This is generally considered a storm that results in accumulations of ¼ inch of ice or greater on a widespread or localized basis.

Winter Storm – A winter weather event which has more than one significant hazard (i.e., heavy snow and blowing snow; snow and ice; snow and sleet; sleet and ice; or snow, sleet and ice) and meets or exceeds locally/regionally defined 12 and/or 24-hour warning criteria for at least one of the precipitation elements, on a widespread or localized basis.

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. A Winter Weather event could result from one or more winter precipitation types (snow, or blowing/drifting snow, or freezing rain/drizzle), on a widespread or localized basis.

All winter storm elements—snow, sleet, ice, freezing temperatures, etcetera—have the potential to cause significant hazard to a community. Even small accumulations can down power lines and tree limbs, 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

Location

Severe winter weather is usually a countywide or regional hazard, impacting the entire county at the same time. The entire Citadel campus can be considered at risk to winter storm events. This includes the entire population (cadets, students, faculty and staff) and all critical facilities, buildings, and infrastructure.

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. Charleston County is accustomed to smaller scale severe winter weather conditions and is most likely to receive winter weather from December to February. Given the atmospheric nature of the hazard, severe winter weather can occur anywhere in the county.

Spatial Extent: 4 – Large

Extent

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.

NOAA uses the Regional Snowfall Index (RSI), shown in Table 4.63, to assess the societal impact of winter storms. The index uses the spatial extent of a storm, the amount of snowfall, and the juxtaposition of these elements with population 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.

TABLE 4.63 – 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

The NWS Wind Chill Temperature Index, shown in Figure 4.62, provides a formula for calculating the dangers of winter winds and freezing temperatures.

Impact: 2 – Limited

FIGURE 4.62 – NWS WIND CHILL TEMPERATURE INDEX

NWS Windchill Chart

Temperature (ºF)

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

Frostbite Times: 30 minutes, 10 minutes, 5 minutes

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

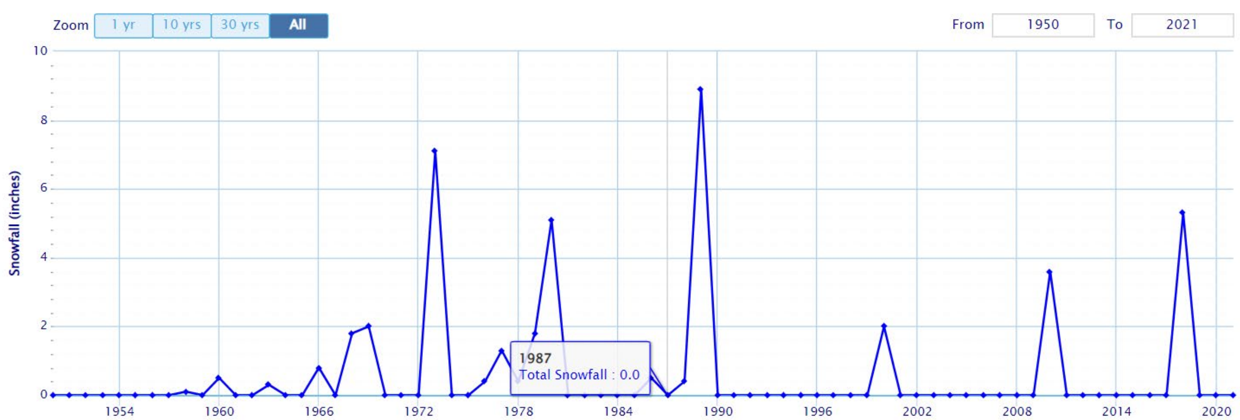
Where, T= Air Temperature (ºF) V= Wind Speed (mph)

Effective 11/01/01

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

Figure 4.63 graphs snowfall extremes at the Charleston International Airport for the period of record from 1950 through 2021.

FIGURE 4.63 – SNOWFALL EXTREMES, CHARLESTON INTERNATIONAL AIRPORT



Source: Northeast Regional Climate Center CLIMOD 2

Past Occurrences

According to NCEI records, Charleston County has experienced 32 winter storm events since 1950, presented in Table 4.64. However, this number is likely much higher due to the first recorded event occurring in 1996. These events are reported to have caused one death due to extreme cold.

TABLE 4.64 – NCEI RECORDS FOR WINTER STORM EVENTS IN CHARLESTON COUNTY, 1950-2022

Type of Winter Storm	# of Events	Deaths/Injuries	Property Damage	Crop Damage
Cold/Wind Chill	1	1/0	$0	$0
Frost/Freeze	1	0/0	$0	$0
Ice Storm	7	0/0	$160,000	$0
Heavy Snow	19	0/0	$73,000	$0
Winter Storm	1	0/0	$0	$0
Winter Weather	3	0/0	$0	$0
Total	**32**	**1/0**	**$233,000**	**$0**

Source: NCEI, August 2022

The following provides details on select winter storm events recorded in the NCEI database and by the State Climatology Office:

December 23, 1989 – Charleston experienced both its first "white Christmas" on record and its 24-hour record snowfall, with 6 inches of snowfall measured at the Charleston International Airport.

March 12-14, 1993 – the "Superstorm of 1993" affected all of South Carolina from the coast to the mountains. Though snowfall was limited to the upstate region, areas along the coast, including Charleston, experienced strong winds that accompanied the storm, downing trees and powerlines.

February 3, 1996 – Record low temperatures resulted in one fatality. The cold also froze road surfaces, causing some minor accidents and requiring several road and bridge closures.

January 24-26, 2000 – Starting on the 24th and continuing into the 25th, 1 to 2 inches of snow fell on coastal South Carolina with additional sleet and freezing rain. The event was the first measurable snow accumulation since 1989 and caused many accidents. The 26th brought an additional 2 inches of snow and marked the first time since records have been kept that measurable snowfall fell on consecutive days from independent events.

January 26, 2004 – Freezing rain fell on the 26th and into the early morning hours of the 27th with accumulations of ice between ¼ inch and ½ inch. The ice downed trees, large limbs, and power lines, disrupting power for several days.

February 12, 2010 – All of South Carolina experienced heavy snowfall from late afternoon into the evening resulting in up to 5 inches of snow in some areas. The storm downed trees, left over 17,400 customers in Charleston County without power, and resulted in $73K in property damage.

January 10, 2011 – Freezing rain brought nearly ½ inch of ice accumulation and led to the closure of the Ravenel Bridge connecting Mount Pleasant to downtown Charleston. The storm also brought down trees and large limbs, and resulted in $160K in property damage.

January 28, 2014 – Freezing rain fell all day from the morning of the 28th into the 29th. Ice accumulations ranged between ¼ inch and ¾ inch, and snow and sleet accumulation was under an inch. The Ravenel Bridge, the Ben Sawyer Bridge, and the Isle of Palms Connector Bridge were all closed, and many trees and power lines were downed, resulting in many power outages. Temperatures remained below freezing for several days, prolonging the event. Additional damages and one reported injury occurred as a result of melting ice chunks falling from the cables/towers of the Ravenel Bridge on the 31st.

December 2017 – The combination of moisture associated with the passing low and cold temperatures caused light rain to freeze during early morning hours. Several bridges were shut down around the Charleston Metropolitan area as a trace to a few hundredths of an inch ice accumulated. A peak storm total ice accumulation of 0.03 inches occurred at the National Weather Service office in North Charleston, SC.

January 2018 – A developing surface low pressure system combined with unusually cold air to produce widespread significant winter precipitation across southeast South Carolina. Most of the precipitation fell as snow, with amounts ranging from 1 to 7 inches. The official storm total snowfall for the day at the Charleston International Airport was 5.3 inches which ranks as the 3rd highest one day snowfall on record, dating back to 1938. The daily snow depth at the Charleston International Airport was a trace or greater for 5 consecutive days, which set a new record. Travel was very hazardous during and after the event, with many secondary roads remaining snow covered for nearly a week. Many schools and businesses were closed for several days. There were 3 indirect fatalities as a result of the event. One person died as a result of slipping and falling on ice on a walkway, another died while being pulled on a sled behind a vehicle and striking a parked vehicle, and a pedestrian died after being struck by a vehicle that slid off an icy roadway.

January 2022 – With a cold front positioned offshore, upper-level forcing helped produce light precipitation across southeast South Carolina in the early morning hours. The low-level airmass was cold and below freezing with warm air observed aloft, leading to reports mixed wintry precipitation. Though most of the precipitation fell as freezing rain or freezing drizzle, some sleet and snow did occur as well. Several roads had to be closed due to icy conditions

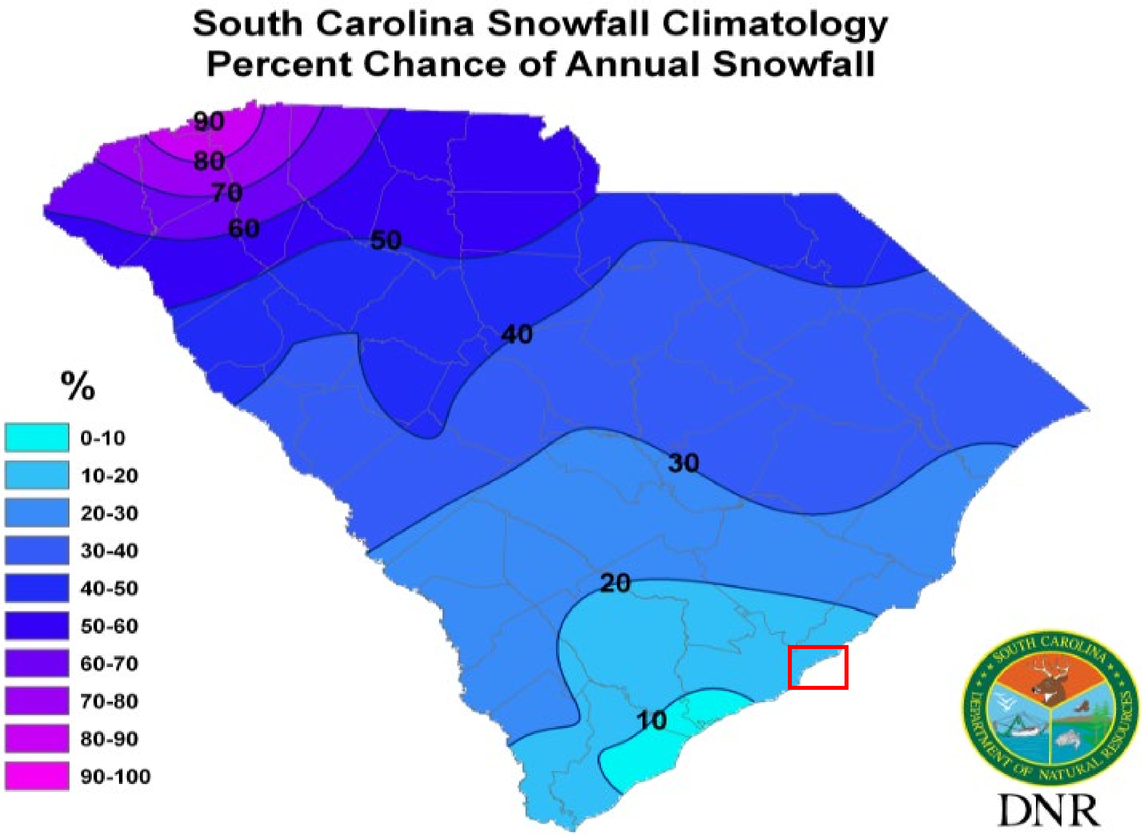
Probability of Future Occurrences

Based on both NCEI and the State Climatology Office, 33 winter storm events have occurred over a 65-year period between 1950 and 2022, resulting in approximately a 51% chance of a winter storm event in any given year.

The probability of a heavy snowfall occurring with that winter storm event is less likely. Figure 4.64 below presents the probability of snowfall to be between 10% and 20% per year for much of the Charleston County Region. Regardless, snow accumulation in the Lowcountry rarely remains on the ground for very long.

Probability: 3 – Likely

FIGURE 4.64 – PROBABILITY OF SNOWFALL



Source: South Carolina State Climatology Office
Note: Red rectangle indicates location of Charleston.

Climate Change and Future Conditions

The atmosphere now holds more moisture which drives heavier than normal precipitation, including heaver snowfall. For the entire Northern Hemisphere, winter storms have increased in frequency and intensity since the 1950s, which could suggest greater hazard impacts in the future. However, winter storm tracks have shifted northward over the United States; therefore, the increase in intensity may be offset in South Carolina by the northward shift of the storm tracks.

Consequence Analysis

Category	Consequences
Public	Winter storms can create dangerous driving conditions by limited visibility or making roads slick. Loss of power can create very cold conditions increasing the risk of hypothermia or frostbite. Individuals seeking alternative means of heating their homes may run the risk of carbon monoxide poisoning or fire hazards.
Responders	Responders face heightened risk due to slick roads and limited visibility. Snow and ice accumulations may block roads, limited access for responders to reach areas in need.
Continuity of Operations (including Continued Delivery of Services)	Continuity of operations is generally expected to be maintained. However, localized disruption of roads and/or utilities may postpone delivery of some services or make it difficult for emergency management personnel to arrive at work. Schools may be delayed or closed, which can lead to logistical problems for teachers and administrators.
Property, Facilities and Infrastructure	Disruption of major and local roads is possible, limiting mobility. Air travel delays are possible. Disruption of utilities is likely; utilities at risk include water, cable, internet, water, and power.

Category	Consequences
Environment	Environmental damage to trees and other vegetation may occurred. Environmental impacts may result when snow is cleared from roadways, picking up contaminants from chemicals, oil products, and salt mixture used to de-ice roads. These contaminants can be carried to local waterways and impact water quality.
Economic Condition	Local economy and finances may be adversely affected, depending on damage and business interruption costs. During a winter storm event, there is a high potential for business and office closures, modified business and office hours, and cancellation or postponement of events, especially due to power outages and poor road conditions.

Vulnerability Assessment

Based on historical records, Charleston County has experienced 32 winter weather events since 1950. These events are reported to have caused one death due to extreme cold. There are no historical records for crop damage, but these events did cause $233,000 in property damage.

While NCEI only reports one death in the county, winter storms are considered to be deceptive killers because most deaths are indirectly related to the storm event. Though snow accumulation occasionally occurs, South Carolina more commonly receives a “wintery mix” of rain, freezing rain, and sleet, which freezes on contact with wires, branches, bridges, and roads, increasing the likelihood of downed trees, power outages, dangerous travel conditions, and property damage.

The leading cause of death during winter storms is from automobile or other transportation accidents. Exhaustion and heart attacks caused by overexertion are the two most likely causes of direct winter storm-related deaths. Power outages during very cold winter storm conditions can result in a potentially dangerous situation. 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.

A qualitative factor in terms of vulnerability is a general lack of awareness on the part of residents in preparing for and responding to winter storm conditions in a manner that will minimize the danger to themselves and others. This lack of awareness is especially apparent when driving/roadway conditions catch motorists off-guard. According to the State Climatology Office, about 70% of snow- and ice-related injuries in South Carolina result from vehicle accidents and about 25% of those accidents occur when people are caught out in a storm. People are also vulnerable to injuries related to cold. These injuries are in part a result of lack of preparedness for a winter storm, including failure to find alternate sources of heat in the event of a power outage.

Potential losses associated with winter storms include the cost of the removal of snow from roadways, debris clean-up, and some indirect losses from power outages, etc. Clearing ice- or snow-covered roads is also a problem. With limited equipment in Charleston due to the relative infrequency of events, priority is given to main thoroughfares while secondary roads are largely untouched during the initial hours after a storm has passed.

After the winter storm events in January and February of 2014, The Citadel created a Winter Storm Operations Plan forming a crisis management team and emergency operations center, detailing critical decision timelines, assigning staff responsibilities, and defining procedures for cadet evacuation or sheltering, among other key needs. This plan helps to reduce vulnerability to winter storm events at The Citadel by increasing campus preparedness.

Problem Statement

- Charleston County has received one past disaster declaration for winter weather.
- Automobile accidents are the leading cause of death or injury during winter storm events.

4.4.14 Active Shooter

Hazard	Probability	Impact	Spatial Extent	Warning Time	Duration	PRI Score
Active Shooter	Possible	Catastrophic	Small	<6 hours	<6 hours	2.7

Hazard Description

The definition of an active shooter—as agreed upon by U.S. government agencies, including the White House, U.S. Department of Justice/FBI, U.S. Department of Education, and U.S. Department of Homeland Security/Federal Emergency Management Agency—is "an individual actively engaged in killing or attempting to kill people in a confined and populated area. Implicit in this definition is that the subject's criminal actions involve the use of firearms.

There is no mandated database collection or central intake point for reporting active shooter incidents, which exists for other crimes. The FBI has completed studies to provide information and statistics on active shooter incidents to provide law enforcement officers, other first responders, corporations, educators, and the public with a baseline understanding of such incidents.

The Investigative Assistance for Violent Crimes Act of 2012, signed into law in January 2013, permits the attorney general (AG), at the request of an appropriate state or local law enforcement official, to provide federal assistance during active shooter incidents and mass killings in public places. The AG delegated this responsibility to the FBI. In 2013, the FBI began its initial review of active shooter incidents. Since then, FBI personnel researched official federal, state, and local law enforcement records and open sources in an effort to identify all potential active shooter incidents throughout the country.

Warning Time: 4 – Less than 6 hours

Duration: 1 – Less than 6 hours

Location

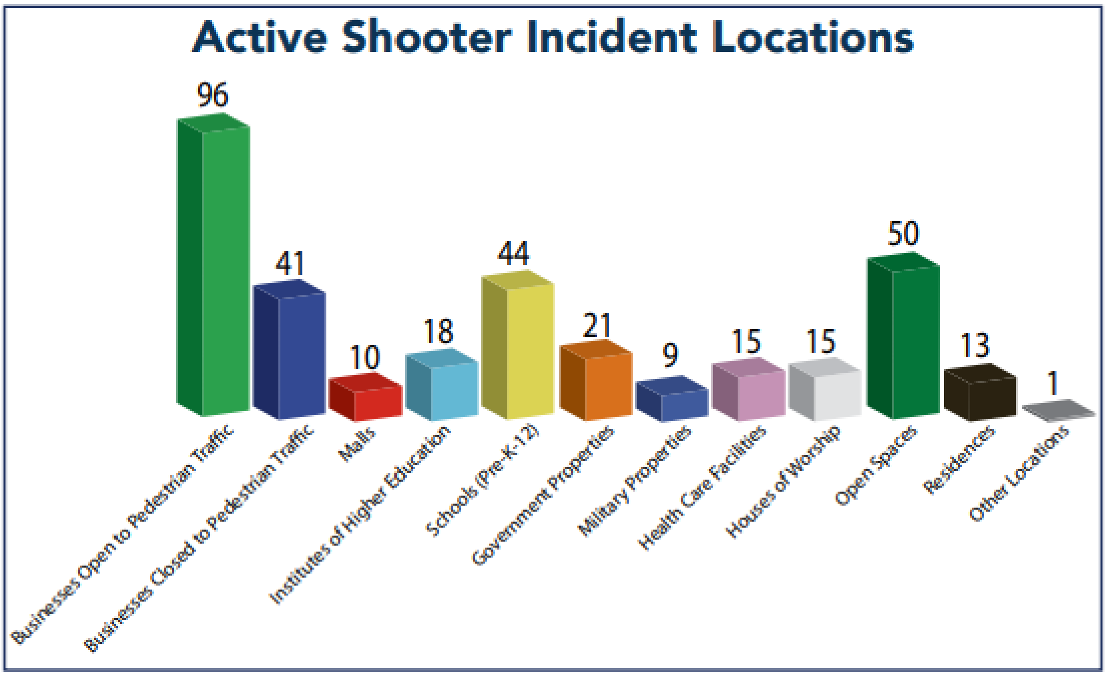
A study conducted by the Federal Bureau of Investigation (FBI), A Study of Active Shooter Incidents in the United States Between 2000 and 2019, identified 333 active shooter incidents between 2000 and 2019. The incidents reported in the 2000-2019 study occurred in small and large towns, in urban and rural areas, and in 43 of 50 states and the District of Columbia. Of the 333 incidents, businesses open to pedestrian traffic had the highest number of incidents with 96, followed by open spaces with 50, and schools (Pre-K-12) with 44. In all, 44 of the 333 incidents involved shootings at two or more locations (incidents were categorized by the location where the public was most at risk). Figure 4.65 presents the location categories identified by the FBI. Educational environments are the second-largest location grouping, with schools (Pre-K-12) representing 13-percent (44 incidents) of the 333. In 2021, alone, two of the 61 incidents occurred at education locations, resulting in four killed (students) and ten wounded (eight students, two employees).

Between 2000-2019 California (42), Florida (27), Texas (25), and Pennsylvania (21) had the highest number of active shooter incidents. There have been eight incidents in South Carolina from 2000-2021.

The geographic extent of an active shooter event is categorized as small but could occur anywhere on The Citadel campus.

Spatial Extent: 2 – Small

FIGURE 4.65 – LOCATION OF ACTIVE SHOOTER INCIDENTS, 2000-2019



Source: Federal Bureau of Investigation, 2020

Extent

When evaluating shooting incidents to determine if they met the FBI's active shooting definition, researchers considered the follow incidents:

- Shootings in public places
- Shootings occurring at more than one location
- Shootings where the shooter's action were not the result of another criminal act
- Shootings resulting in mass killing (3 or more)
- Shooting indicating apparent spontaneity by the shooter
- Shootings where the shooter appeared to methodically search for potential victims
- Shootings that appeared focused on injury to people and not buildings or objects

Over the 21-year period from 2000-2021 there have been 1,203 fatalities from active shooter incidents. 152 incidents have been classified as mass shooters where three of more people have been killed.

Impact: 3 – Catastrophic

Past Occurrences

According to the 2021 FBI study, the 18 active shooter incidents that occurred at Institutes of Higher Education resulted in 75 fatalities and 82 wounded individuals. The shooters, 2 of whom were female, ranged in age from preteens to 60s. In 2021, most incidents occurred on Saturdays (14) with others occurring on Tuesdays (12), Thursdays (11). Details on specific incidents include the following:

January 16, 2002 – at 1:15 p.m., an active shooter armed with a handgun, began shooting in the Appalachian School of Law located in Grundy, Virginia. Three people were killed; three were wounded. Three students—two of whom were off-duty police officers—tackled and restrained the shooter until police arrived and took him into custody.

October 28, 2002 – at approximately 8:30 a.m., an identified male, 41, armed with five handguns, entered the second floor of the University of Arizona College of Nursing building in Tucson, Arizona, and killed a professor in her office. The shooter proceeded to the fourth floor, where he entered a classroom and killed two more professors. Three people were killed; no one was wounded. The shooter committed suicide at the location.

May 9, 2003 – at 3:55 p.m., an active shooter armed with a rifle and a handgun, began shooting in the Weatherhead School of Management building at Case Western Reserve University in Cleveland, Ohio. One person was killed; two were wounded. The shooter was wounded during an exchange of gunfire with police.

April 16, 2007 – at 7:15 a.m., an active shooter armed with two handguns, began shooting in a dormitory at Virginia Polytechnic Institute and State University in Blacksburg, Virginia. Two-and-a-half hours later, he chained the doors shut in a classroom building and began shooting at the students and faculty inside. Thirty-two people were killed; 17 were wounded. In addition, six students were injured jumping from a second floor classroom and were not included in other reported injury totals. The shooter committed suicide as police entered the building.

February 8, 2008 – at 8:35 a.m., an active shooter armed with a handgun, began shooting in a second-floor classroom at Louisiana Technical College in Baton Rouge, Louisiana. She fired six rounds, then reloaded and committed suicide before police arrived. Two people were killed; no one was wounded.

February 14, 2008 – at 3:00 p.m., an active shooter armed with a shotgun and three handguns, began shooting in the Cole Hall Auditorium at Northern Illinois University in DeKalb, Illinois. He had attended graduate school at the university. Five people were killed; 16 were wounded, including three who were injured as they fled. The shooter committed suicide before police arrived.

April 26, 2009 – at 12:57 a.m., an active shooter armed with three handguns, began shooting in Harkness Hall, a residence hall at Hampton University in Hampton, Virginia, and then shot himself before police arrived. The shooter had briefly attended the university. A dormitory manager pulled the fire alarm when the shooting began, emptying the building. No one was killed; two were wounded. He was apprehended by police.

February 12, 2010 – at 4:00 p.m., an active shooter armed with a handgun, began shooting during a biology department meeting in the Shelby Center at the University of Alabama in Huntsville, Alabama. She sat in the meeting for 30 minutes, then stood up and began firing. Three people were killed; three were wounded. The shooter surrendered to responding police.

March 9, 2010 – at 3:30 a.m., an active shooter armed with two handguns, began shooting in the maintenance building at Ohio State University in Columbus, Ohio. He had just been fired for allegedly lying on his job application. One person was killed; one was wounded. The shooter committed suicide before police arrived.

March 8, 2012 – at 1:40 p.m., an active shooter armed with two handguns, began shooting inside the lobby of the Western Psychiatric Institute and Clinic at the University of Pittsburgh Medical Center in Pittsburgh, Pennsylvania. One person was killed; seven were wounded, including one police officer. The shooter was killed by University of Pittsburgh police.

April 2, 2012 – at 10:30 a.m., an active shooter armed with a handgun, began shooting inside Oikos University in Oakland, California. He then killed a woman to steal her car. Seven people were killed; three were wounded. The shooter was arrested by police later that day.

April 12, 2013 – at 1:55 p.m., an active shooter armed with a shotgun, began shooting in the New River Community College satellite campus in the New River Valley Mall in Christiansburg, Virginia. No one was killed; two were wounded. The shooter was apprehended by police after being detained by an off-duty mall security officer as he attempted to flee.

June 7, 2013 – at 11:52 a.m., an active shooter armed with a handgun, fatally shot his father and brother in their home in Santa Monica, California. He then carjacked a vehicle and forced the driver to take him to the Santa Monica College campus. He allowed the driver to leave her vehicle unharmed but continued shooting until he was killed in an exchange of gunfire with police. Five people were killed; four were wounded.

Campus incidents since the 2014 FBI Study include the following:

May 23, 2014 – an active shooter shot and killed two women in front of a sorority house and one man inside a deli in the college town of Isla Vista near the University of California, Santa Barbara. The active shooter also shot others as he drove around town, and injured others by striking them with his vehicle. He committed suicide by shooting himself in his car as police closed in. Prior to the rampage, the assailant stabbed three people to death at his apartment.

October 1, 2015 – an active shooter shot and killed eight fellow students and a teacher at Umpqua Community College. Authorities described the active shooter, who recently had moved to Oregon from Southern California, as an individual with anti-religion and white supremacist leanings who had long struggled with mental health issues.

April 30, 2019 – at approximately 5:42 p.m., Trystan Andrew Terrell, 22, armed with a handgun, allegedly began shooting inside a Woodford A. Kennedy Building classroom at the University of North Carolina at Charlotte. One of the students restrained the shooter, ending the threat. Two people (students) were killed (including the student who restrained the shooter); four were wounded. The shooter, a former student at the university, was apprehended by campus police at the scene.

October 17, 2021 – A gunman opened fire on a group of students at Grambling State University leaving one person dead and several others wounded. The shooter opened fire at about 1 a.m. outside a dining hall where students were celebrating a homecoming event — forcing attendees to lock down and shelter in place. One victim was a student enrolled at the university.

There have been no previous occurrences of an active shooter on The Citadel campus.

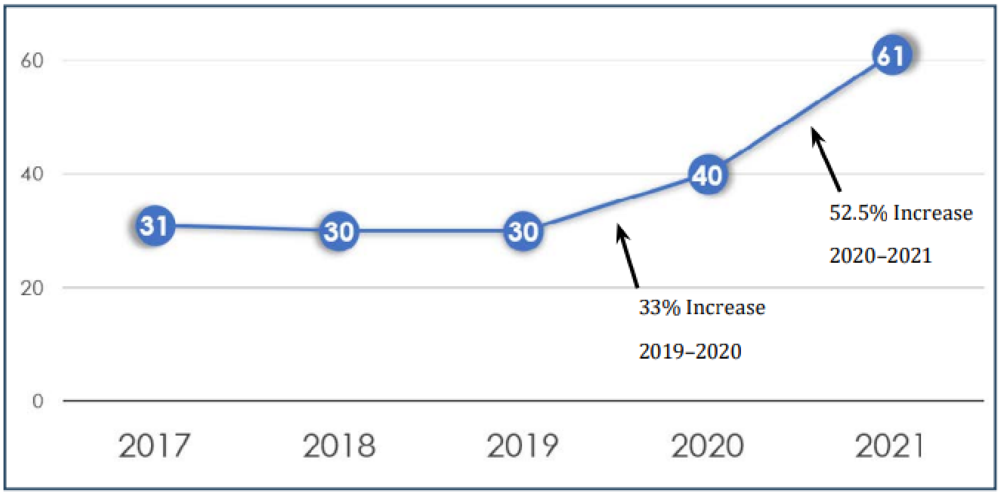
Probability of Future Occurrences

The FBI identified 434 active shooter events between 2000 – 2021, with 61 events occurring in 2021 alone. Based on these statistics there is an average of 20.6 incidents per year. For Institutes of Higher Learning, 20 incidents occurred during this 21-year period for an average of 0.95 incidents per year.

There is no sure way to predict an active shooter event. However, for the period of 2017-2021 active shooter incidents data reveals an upward trend: the number of active shooter incidents identified in 2021 represents a 52.5% increase from 2020 and a 96.8% increase from 2017. Figure 4.66, below shows the number of incidents between 2017-2021. Increases in gun violence can be attributed to a number of factors and is difficult to predict.

Probability: 2 – Possible

FIGURE 4.66 – ACTIVE SHOOTER INCIDENTS, 2017-2021



Source: FBI, Active Shooter Incidents in the United States in 2021

Climate Change and Future Conditions

Climate change is not expected to affect the occurrence of active shooter threats. However, exposures to short-lived or prolonged climate- or weather-related events and their health consequences can have mental health consequences, ranging from minimal stress and distress symptoms to clinical disorders, such as anxiety, depression, post-traumatic stress, and suicidality. These mental health impacts can interact with other health, social, and environmental stressors to diminish an individual's well-being.

Consequence Analysis

Category	Consequences
Public	In addition to the threat of death or severe injury, an active shooter incident can have long term psychological effects such as post-traumatic stress disorder. The resulting stress of an active shooter incident can take its toll in the form of aggravated physical and mental health problems.
Responders	If first responders to an active shooter event arrive while the shooter is still active, they face the same danger as those members of the public exposed to the incident.
Continuity of Operations (including Continued Delivery of Services)	Continuity of operations may be affected by the long-term economic and psychological impacts of an active shooter incident. The potential psychological and physical health impacts of an incident extend to students, faculty, and staff, who's academic and job performance may suffer as a result, leading to enrollment issues and subsequent financial problems. Continuity of operations may also be affected if a large number of students, faculty, or staff decide to leave for other institutions not associated with the trauma of the event.
Property, Facilities and Infrastructure	Shots fired in an active shooter incident can potentially cause minor damage to buildings.
Environment	Active shooter incidents do not have any significant or direct impacts on the natural environment.
Economic Condition	Active shooter incidents at schools can impact the school's finances. If enrollment declines, a school's income will decline, which can force a school to cut jobs or programming and initiate a cycle of economic downturn. Additionally, if the school faces liability lawsuits for a shooting occurring on its campus, the financial impact can be even greater.

Vulnerability Assessment

Based on historical records, the percentage of active shooter events, as compared to the total number of events, on Institutions of Higher Educations was 4.6% and on Military facilities the percentage was 2.5% (11 incidents).

Using the statistics from the FBI Active Shooter Study, the average number of individuals killed in each incident is 2.7 and the average number of individuals wounded in each incident is 4.7. Utilizing FEMA's dollar values for avoided casualties, $6.9M for fatality and $2.3M for hospitalized injury, this mean number of fatalities and injuries results in $29.4M in potential loss per incident. This figure does not include long-term health care disability costs, public safety response costs, damage to facilities, lost wages, or lost business operating income or workers compensation, which could easily add millions of dollars in additional damages.

Problem Statement

- Active shooter events are not predictable but can be catastrophic and are becoming more frequent.

4.4.15 Civil Disturbance

Hazard	Probability	Impact	Spatial Extent	Warning Time	Duration	PRI Score
Civil Disturbance	Possible	Limited	Small	<6 hours	<1 week	2.3

Hazard Description

According to FEMA, a civil disturbance is "a civil unrest activity such as a demonstration, riot, or strike that disrupts a community and requires intervention to maintain public safety." These incidents can take many forms, from a small group of people to a large crowd, from peaceful sit-in to violent demonstration. Even in a peaceful form, a civil disturbance can still block roads, sidewalks, or buildings or otherwise interrupt normal operations. In its worst form, a civil disturbance can result in violence, injury, looting, and property destruction. The character of a civil disturbance depends on the crowd that initiates it.

In the United States, a crowd itself is constitutionally protected under "the right of the people to peacefully assemble." However, assemblies that are not peaceable are not protected, and this is generally the dividing line between crowds and mobs. The laws that deal with disruptive conduct are generally grouped into offenses that disturb the public peace. They range from misdemeanors, such as blocking sidewalks or challenging another to fight, to felonies, such as looting and rioting.

Warning Time: 1 – Less than 6 hours

Duration: 3 – Less than 1 week

Location

Civil disorder can erupt anywhere, but the most likely locations are those areas with large population groupings or gatherings. Sites that are attractive for political or other rallies should be considered as probable locations for the epicenter of civil disorder events; arenas and stadiums are another type of venue where civil disorder can occur. Civil disorder can also occur in proximity to locations where a "trigger event" occurred.

Colleges/Universities are common sites for crowds to gather, particularly due to large gathering places and the concentration of people in one location. The specific location of a civil disturbance is unpredictable and could be anywhere on campus, however, the barracks, Summerall Field, Johnson Hagood Stadium, or other athletic fields on campus are likely locations. Cadets, students, faculty, and staff could also encounter civil disturbances in downtown Charleston.

Spatial Extent: 2 – Small

Extent

The ultimate extent of any civil disorder incident will depend on the magnitude of that event and its location. The more widespread an incident is, the greater the likelihood of excessive injury, loss of life and property damage; additional factors, such as the ability of law enforcement to contain the event, are also critical in minimizing damages.

According to traditional mob psychology and police literature, crowds can be classified into the following four types:

Casual Crowd – A group of people who happen to be present in the same place at the same time but are not unified or organized. Violent conduct does not usually occur in casual crowds.

Conventional Crowd – A group of people assembled and engaged in some type of shared behavior or activity such as watching a sporting event, parade, play, or fire.

Expressive Crowd – A group of people held together by a common commitment or purpose, and engaged in expressive behavior such as singing or dancing. This expressive behavior is not intended to be destructive.

Aggressive Crowd – An unorganized group willing to be led into lawless behavior but lacking organization and unity of purpose. This type of crowd is most likely to become a mob and incite a civil disturbance.

In addition to aggressive mobs, which are considered most likely to cause violence, mobs that disrupt normal operations and public order can also include:

Escape Mobs – large groups of people attempting to flee from something such as a fire, flood, or other hazard.

Expressive Mobs – large, highly emotional groups formed out of revelry, such as celebrating a sporting event win.

Impact: 2 – Limited

Past Occurrences

There are no official records of civil disturbances kept by The Citadel, but some events have made local news and may represent the types of events that could be expected at The Citadel.

May 4, 2022 – An estimated 100 to 150 demonstrators gathered on Broad Street in downtown Charleston for a pro-choice rally after a Supreme Court draft that could overturn Roe v. Wade was leaked sparking protest nationwide. The gathering was peaceful and consisted of people chanting, telling stories, and giving contact information while displaying signs to passersby with pro-choice messaging.

July 13, 2016 – A peaceful crowd of protesters with the Black Lives Matter movement gathered in downtown Charleston to call for peace and racial equality. The group of hundreds gathered in Marion Square, marching and chanting. Another group holding anarchy signs stepped in an attempted to taunt police officers monitoring the protest, but protesters told them to step away. (29)

October 24, 2014 – Citadel cadets angry about losing some campus privileges attempted to organize a riot in the Quad using a social media app called "Yik Yak" which allows anonymous posting based on a user's geography. The posts called for cadets to storm the quad in full uniform at 10:30 p.m. The plans were discovered and discouraged with threats of punishment and no riot took place. (30)

October 26, 2009 – At 10:50 p.m. a campus public safety officer saw a cadet standing in the bed of a moving truck and attempted to get him down. The cadet resisted and got into a physical altercation with the officer, who punched the cadet in self-defense, before arresting the cadet on charges of disorderly conduct and resisting arrest. In response to the arrest, cadets in Watts Barracks (as well as Law and Stevens Barracks) began screaming and throwing objects. Charleston police were called in to assist in controlling the situation but did not make any arrests. (31)

November 16, 1986 – 200 protesters marched on The Citadel campus to protest racial hazing that resulted in the resignation of a black cadet. The protesters picketed with signs calling for the resignation of then college president Maj. Gen. James Grimsley Jr. and marched from the main gate to Johnson Hagood Stadium.

Probability of Future Occurrences

It is difficult to predict if or when a civil disturbance will occur. By identifying certain upcoming events, such as matriculation, sports games, alumni weekend, parents' weekend, or graduation when either large crowds are gathered on campus or when annual events that might lead to disturbances occur, the college can prepare ahead and prevent peaceful gatherings from escalating into civil disturbances.

Probability: 2 – Possible

Climate Change and Future Conditions

Climate change is not expected to affect the occurrence of civil disturbances that would impact The Citadel.

Consequence Analysis

Category	Consequences
Public	A violent civil disturbance could put cadets, students, faculty or staff at risk of personal injury. Events are not likely to cause any harm but may interrupt normal routines of cadets, students, faculty, or staff, or interfere with their ability to complete their work.
Responders	First responders may be at risk of personal injury if responding to a violent civil disturbance.
Continuity of Operations (including Continued Delivery of Services)	Depending on the time of day, a civil disturbance on The Citadel campus would likely interfere to some degree with the normal operations of the college. A large civil disturbance off campus could also interrupt normal operation if it were to interfere with faculty, staff, or contract workers' ability to get to work.
Property, Facilities and Infrastructure	When they become violent, civil disturbances can cause substantial property damage, such as broken windows, vandalism, and fires. Symbolic structures are often those first singled out for damage.
Environment	Aside from the possibility of incidental damage such as trampled vegetation or litter, there are no significant impacts on the natural environment.
Economic Condition	Aside from the cost of property damage, there are no major or long-term economic impacts associated with the scale or type of civil disturbance that could be expected to occur at The Citadel.

Vulnerability Assessment

A violent civil disturbance on The Citadel campus could put cadets, students, faculty or staff at risk of personal injury. Past events involved some altercations but did not cause any serious injuries. Peaceful events are not likely to cause any harm but may interrupt normal routines of cadets, students, faculty, or staff, or interfere with their ability to complete their work.

When a large civil disturbance does break out, it generally proves extremely difficult for first-responder law enforcement authorities to quell the mob promptly. However, past events at The Citadel that required police response did not involve any serious injuries.

A civil disturbance could physically block sidewalks, streets, or building entrances, preventing students, faculty, or staff from accessing facilities. It could also simply create a distraction and prevent classes from proceeding on schedule.

Depending on the extent and nature of the civil disturbance, costly property damage can occur. However, based on past occurrences any damage would likely occur in downtown Charleston or other locations outside of The Citadel campus.

Problem Statement

- Civil disturbance could interrupt normal campus operations.

4.4.16 Cyber Disruption

Hazard	Probability	Impact	Spatial Extent	Warning Time	Duration	PRI Score
Cyber Disruption	Possible	Critical	Large	<6 hours	<1 week	3.0

Hazard Description

Cyber disruption is a hazardous threat arising from intentional or unintentional incidents that cause a breach in security, damage to digital devices and networks, or a network outage. Un-intentional disruptions are more common as they usually occur when a portion of the system fails. This can look like disruptions due to human error like a typo or mistake in the code used to design the system or a physical failure of hardware or network.

Cyber disruptions can also happen as secondary effects from other kinds of hazards. Earthquakes, floods, and fires can destroy computer and network equipment. Most of the time the effects are limited due to the availability of back-up systems and the ability to route networks around problem sites. Nevertheless, if a significant network node goes down the effects could be wide-spread and possibly prolonged. Additionally, communications can be disrupted by physical damage to copper or fiber cables, or radio equipment located on buildings.

Intentional disruption, or a cyber-attack, is usually malicious in intent. These types of disruptions are the most worrisome as they pose the potential to cause irreparable harm to the function and capability of critical or supporting systems that are used in daily operations. The FBI defines this intentional disruption as a threat: "a cyber-threat is any circumstance or event with the potential to adversely impact operations (including mission, functions, image, or reputation), agency assets, or individuals through an information system via unauthorized access, destruction, disclosure, modification of information, and/or denial of service."

Unlike physical threats, cyber threats are often difficult to identify and comprehend. Cyber-attacks can be intruders breaking into systems and altering files, using someone's computer to attack others, stealing confidential information, or erasing entire systems or files. Some attacks are more serious than others and can have wide ranging effects on individuals, organizations, and at the national level. Risks include disrupted services or power to transportation, data breaches with organizations, governments, or other institutions, and obtaining individuals' personal information.

The risks associated with the Nation's dependence on networked technologies led to the development of Presidential Policy Directive 41 (PPD-41): United States Cyber Incident Coordination, which outlines the roles of federal agencies during any significant cyber incident, whether involving government or private sector entities.

PPD-41 recognizes that the frequency of cyber incidents is increasing, and this trend is unlikely to be reversed anytime soon. The National Cyber Incident Response Plan (NCIRP) was developed according to the direction of PPD-41). In 2010, the Department of Homeland Security (DHS) issued the NCIRP Interim Version. This plan was recently updated in December of 2016 (https://www.us-cert.gov/ncirp).

The Citadel's Information Technology department provides IT Security (ITS) that assists with information security education and allows members of the Citadel community to report potential cyber-attacks or threats. Below is a list of examples of events that people should report to Citadel ITS:

- Abuse of an electronic system
- You are a target of a "Social Engineering"

  - (Example: Someone calls you or emails you "pretending" to be a system administrator and asks you for your passwords, pin numbers, personal information, etc.)
- You notice unauthorized changes to a system you administer
- You suspect that someone's account may have been used or tampered with by another individual
- A compromise of college data
- You notice internal or external Citadel website defacements
- You notice scans of your workstation that you did not permit
- Electronic harassment

Staff, students, and faculty can report events to itsecurity@citadel.edu or call 843-953-5114.

Warning Time: 4 – Less than 6 hours

Duration: 3 – Less than 1 week

Location

Cyber disruption events can occur and/or impact virtually any location in Charleston or the Citadel Campus that computing devices are used. A disruption to a cybernetic system can have far-reaching effects beyond the location of the system. As a result, cyber disruption that occurs outside of the Citadel, or even Charleston, can impact the campus. The converse is true as well; an event that impacts systems at the Citadel could cause impacts outside the campus.

Spatial Extent: 4 – Large

Extent

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

The City of Seattle Office of Emergency Management has summarized a list of common cyber-attacks and potential impacts which can be found in Table 4.65 below.

Impact: 3 – Critical

TABLE 4.65 – COMMON CYBER ATTACKS AND IMPACTS

Type	Impact
Malware (ransomware, spyware, viruses, worms) Malicious software used by attackers to breach a network through a vulnerability, such as clicking a link, that automatically downloads the software to the computer.	• Blocks legitimate access to components of the network • Installs additional harmful software • Obtains information by transmitting data from the hard drive • Disrupts components and makes the system inoperable
Phishing Fake communications (typically through email) appearing to be from a trustworthy source that allow hackers to obtain login information or install malware on a computer when someone interacts with their message.	• Obtains a person's confidential information for financial gain • Obtains employee log-in credentials to attack a specific company • Installs malware onto a computer
Man-in-the-middle attack (MitM) Attackers insert themselves into a two-party transaction. Common points of entry include unsecure public Wi-Fi networks and computers affected with malware	• Interrupts a transaction to steal personal data

Type	Impact
Denial-of-service attack (DoS) Attackers flood a site host or network with digital traffic until the target site/service cannot respond or crashes completely. A distributed denial of service attack (DDoS) is when multiple machines are used to attack a single target. Botnets, which are networks of devices that are infected with malware, are often used in DDoS attacks.	• Legitimate users cannot access websites, online services, or devices • Slows down network performance
Structured Query Language (SQL) injection Attackers use malicious code on vulnerable servers to force the server to reveal information. Can be done by submitting malicious code into vulnerable search boxes on websites.	• Obtains contents of an entire database, including sensitive information • Allows attackers to modify and delete records in a database
Zero-day exploit Attackers hack a network vulnerability before it is noticed and fixed by a patch or permanent solution.394 Used by nation-state actors and sophisticated hackers	• Allows attacker to plant malware into a system without the victim knowing

Past Occurrences

As cyber disruption is an emerging hazard, the reporting and tracking of disruptive events can be 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 are several complex databases that track cyber disruption occurrences. Verizon has compiled a 2022 Data Breach Investigations Report (DBIR) that provides insight and analysis of over 23,000 incidents and 5,200 confirmed breaches around the world.

The Verizon report did an industry analysis to better understand specific challenges facing various industries and organizations – one of which is education services. The report found that the education industry is experiencing a dramatic increase in Ransomware attacks (more than 30% of total breaches). The report also suggests that the education industry should protect itself against stolen credentials and Phishing attacks potentially exposing the personal information of its employees and students. Other findings noted in the report explain that the education industry continues to be impacted by attacks targeting external infrastructure and is largely targeted by external actors with financial motives. Table 4.66 below highlights additional statistics about cyber-attacks facing educational services over the past year.

TABLE 4.66 – 2022 TRENDS IN EDUCATION SERVICES CYBER ATTACKS

Number of Incidents	1,241 incidents, 282 with confirmed data disclosure
Top Attack Trends	System Intrusion, Basic Web Application Attacks and Miscellaneous Errors represent 80% of breaches.
Threat Actors	External (75%), Internal (25%) (breaches)
Actor Motives	Financial (95%), Espionage (5%) (breaches)
Data Compromised	Personal (63%), Credentials (41%), Other (23%), Internal (10%) (breaches)
Suggested Protective Controls	Security Awareness and Skills Training, Access Control Management, Secure Configuration of Enterprise Assets and Software

Source: Verizon 2022 Data Breach Investigations Report

Based on the findings in the Verizon report and Table 4.66 above, System Intrusion (Malware), Social Engineering (Phishing) and DoS are the leading causes of incidents in the education sector and System Intrusion, Basic Web Application Attacks (BWAA) and Miscellaneous Errors are the leading causes of breaches. BWAA are incidents in which web applications are attacked, which can include exploiting code-level vulnerabilities in the application. Miscellaneous Errors are defined as incidents in which unintentional actions directly compromise security. For example, Verizon's data breach report found that 34% of the errors observed in the education industry were from an email sent to the wrong people, or with the wrong attachment.

There have been some notable cyber-attacks at colleges and universities that attained national attention in the last few years. A Forbes article titled, *Cyberattacks Pose Existential Risk to Colleges – And Sealed One Small College's Fate*, reports the growing trend of cyberattacks on education institutions. The article centers around a 2021 incident at Lincoln College in Illinois where cyber criminals had encrypted many of the rural college's files so the institution no longer had access to critical enrollment, admissions and fundraising information. The college paid tens of thousands of dollars to the criminals and it took months to regain access to all of their systems.

The article found that in 2022, a handful of other U.S. higher education institutions have publicly disclosed cyberattacks. North Carolina A&T State University reported a ransomware attack in March while the university was on spring break. North Orange County Community College District suffered a data breach in January that exposed student and employee personal information. Ohlone Community College District in California and Midland University in Nebraska also reported ransomware attacks in the same year.

Experts have found that the reported cyber incidents are only a fraction of the total attacks. Many colleges and universities are unwilling to disclose cyberattacks unless required by law, as they could be subject to lawsuits if the attack jeopardized the security of student or employee personal information.

Probability of Future Occurrences

There is always a possibility for both intentional and un-intentional cyber disruptions. It is difficult to quantify an exact probability or severity of a disruption due to the limited information available and the many unknown factors. The intent of an intentional disruptor could range from something as minor as leaving a message to a major issue with sensitive data collection. While large scale cyber-attacks targeting the Citadel are less likely, human errors and phishing attempts are common on college campuses. Additionally, cybersecurity companies have observed a significant increase in ransomware attacks over the past two years between 2020 and 2022. This is largely due to Covid-19 transitioning everybody remote.

Probability: 2 – Possible

Climate Change and Future Conditions

Climate change is not expected to have direct impacts on The Citadel, however, severe weather could cause unintentional disruptions if various utilities or network equipment is damaged. An increase in frequency and intensity of some hazards may increase potential for damaged infrastructure. Additionally, if severe weather causes the campus to shut down and transition to remote work, people may be more vulnerable to cyber disruptions or attacks.

Consequence Analysis

Category	Consequences
Public	People sensitive information may be at risk. Additionally, disruptions may interrupt normal routines of cadets, students, faculty, or staff, or interfere with their ability to complete work.
Responders	Limited impacts on first responders. Law enforcement may help with initial investigation if a malicious cyber incident occurs.
Continuity of Operations (including Continued Delivery of Services)	Depending on the extent of the incident and the time of day, a cyber disruption would likely interfere to some degree with the normal operations of the college. A large cyber disruption could interrupt normal operation if it were to interfere with faculty, staff, or cadets ability to access online work and cyber systems.

Category	Consequences
Property, Facilities and Infrastructure	Cyber disruptions likely won't have direct impact to the Citadel campus, however larger disruptions in Charleston or South Carolina could impact utility or infrastructure access.
Environment	There are no impacts on the natural environment.
Economic Condition	Physical damage to utilities or network infrastructure could result in costly repairs. Incidents like ransom attacks could cost tens of thousands of dollars to recover data and fix systems.

Vulnerability Assessment

The environment of information sharing and different computer systems across departments make colleges and universities prime targets for cyber criminals. Students and employees enrolled in online courses or working remotely may be more vulnerable to phishing scams, information sharing errors, or cyberattacks.

Cyberattacks, like the one Lincoln College experienced, are extremely costly for institutions, and they are becoming more frequent. Ransomware attacks, the most frequent types of cyberattacks in the higher education sector, cost institutions an average of $112,000 in ransom payments. However, these payments are only a fraction of what it costs to resolve the attack, which averages about $2.7 million per incident.

As comparison, the average cost to an organization in the private sector is $1.8 million U.S. dollars after a ransom attack, which is almost a million dollars less than what it costs educational institutions to recover. The Forbes article explains that colleges and universities notoriously fail to back up their systems which adds to the cost of recovery. Cybersecurity experts also noted that academic departments are often siloed, thus making comprehensive security protocols difficult for college IT departments to implement.

In addition to ransomware attacks, colleges and universities are also targets for more sophisticated cyber criminals that are after intellectual property and research. Some of these actors seek to sell stolen data or information to other nation-states. As other colleges and universities, The Citadel is vulnerable to cyber attacks and disruptions. Its military association may make it increasingly vulnerable. Actions should be taken to protect the sensitive information of cadets and faculty.

Problem Statement

- Cyberattacks are becoming more frequent and can be highly disruptive to operations.
- Training is a critical way to reduce vulnerability to cyber attacks.

4.4.17 Hazardous Materials

Hazard	Probability	Impact	Spatial Extent	Warning Time	Duration	PRI Score
Hazardous Materials	Possible	Limited	Small	<6 hours	<1 Week	2.2

Hazard Description

A hazardous material is any item or agent (biological, chemical, physical) which has the potential to cause harm to humans, animals, or the environment, either by itself or through interaction with other factors. Hazardous materials can be present in any form: gas, solid, or liquid. Environmental or atmospheric conditions can influence hazardous materials if they are uncontained.

The U.S. Occupational Safety and Health Administration's (OSHA) definition of hazardous material includes any substance or chemical which is a health hazard or physical hazard, including: chemicals which are carcinogens, toxic agents, irritants, corrosives, sensitizers; agents which act on the hematopoietic system; agents which damage the lungs, skin, eyes, or mucous membranes; chemicals which are combustible, explosive, flammable, oxidizers, pyrophoric, unstable-reactive or water-reactive; and chemicals which in the course of normal handling, use, or storage may produce or release dusts, gases, fumes, vapors, mists or smoke which may have any of the previously mentioned characteristics.

A release or spill of bulk hazardous materials could result in fire, explosion, toxic cloud or direct contamination of people and property. The effects may involve a local site or many square miles. Health problems may be immediate, such as corrosive effects on skin and lungs, or be gradual, such as the development of cancer from a carcinogen. Damage to property could range from immediate destruction by explosion to permanent contamination by a persistent hazardous material.

According to the South Carolina Emergency Management Department the state's industrial capacity and the network of interstate highways and railways result in vulnerabilities to hazardous material releases from both stationary sites and transportation sources.

Warning Time: 4 – Less than 6 hours

Duration: 3 – Less than 1 week

Location

According to the Emergency Management Department facilities that use or store hazardous materials are located throughout the state in both rural and densely populated areas. Many facilities are located in coastal counties that could be impacted by hurricane force winds and rains. Toxic release inventories indicate the greatest number of various fixed facilities are clustered along Interstate 85. However, numerous other facilities, more evenly spread across the state, emit greater amounts. Further, the extensive network of interstate highways and railways that supply industries with chemical and petroleum products could result in a moderate to large accidental release of hazardous materials from a transportation source.

As a result of the 1986 Emergency Planning and Community Right to Know Act (EPCRA), the Environmental Protection Agency provides public information on hazardous materials. One facet of this program is to collect information from industrial facilities on the releases and transfers of certain toxic agents. This information is then reported in the Toxic Release Inventory (TRI). TRI sites indicate where such activity is occurring. According to the data in the South Carolina State Hazard Mitigation Plan, there are 120 hazardous material sites in Charleston County, including 58 TRI sites, 3 Superfund sites, 9 treatment, storage, and disposal facilities, and 50 solid waste landfills.

Hazardous materials (HAZMAT) accidents pose a threat to The Citadel due to the campus' proximity to Interstate 26 and US-17, the Charleston port, and Joint Base Charleston. Furthermore, hazardous materials are stored on-site in various locations on campus for grounds maintenance, building maintenance, and chemistry laboratory uses.

Spatial Extent: 2 – Small

Extent

HAZMAT incidents consist of solid, liquid and/or gaseous contaminants that are released from fixed or mobile containers, whether by accident or by design as with an intentional terrorist attack. A HAZMAT incident can last hours to days, while some chemicals can be corrosive or otherwise damaging over longer periods of time. In addition to the primary release, explosions and/or fires can result from a release, and contaminants can be extended beyond the initial area by persons, vehicles, water, wind and possibly wildlife as well.

Accidents involving the transportation of hazardous materials could be just as catastrophic as accidents involving stored chemicals, possibly more so, since the location of a transportation accident is not predictable. The U.S. Department of Transportation divides hazardous materials into nine major hazard classes. A hazard class is a group of materials that share a common major hazardous property, i.e., radioactivity, flammability, etc. These hazard classes include:

- **Class 1**—Explosives
- **Class 2**—Compressed Gases
- **Class 3**—Flammable Liquids
- **Class 4**—Flammable Solids; Spontaneously Combustible Materials; Dangers When Wet Materials/Water-Reactive Substances
- **Class 5**—Oxidizing Substances and Organic Peroxides
- **Class 6**—Toxic Substances and Infectious Substances
- **Class 7**—Radioactive Materials
- **Class 8**—Corrosives
- **Class 9**—Miscellaneous Hazardous Materials/Products, Substances, or Organisms

Impact: 2 – Limited

Past Occurrences

According to the 2020 TRI data for the City of Charleston, seven facilities reported toxics release information to the U.S. Environmental Protection Agency. A "release" refers to different ways that toxic chemicals from industrial facilities enter the air, water and land. Releases include spilling, leaking, pumping, pouring, emitting, emptying, discharging, injecting, escaping, leaching, dumping, or disposing into the environment

The National Response Center (NRC) is the federal government's national communications center, which is staffed 24 hours a day by U.S. Coast Guard officers and marine science technicians. The NRC is the sole federal point of contact for reporting all hazardous substances releases and oil spills. The NRC receives all reports of releases involving hazardous substances and oil that trigger federal notification requirements under several laws. The NRC maintains reports of all releases and spills in a national database. A list of 47 incidents recorded by the NRC in 2022 for the City of Charleston is displayed in Table 4.67 below.

TABLE 4.67 – NRC HAZARDOUS MATERIALS RELEASE RECORDS FOR CITY OF CHARLESTON, 2022

Incident ID	Responsible Company	Incident Type	Damages
1326627	Unknown	Unknown Sheen	N
1327174	Unknown	Fixed	N

Incident ID	Responsible Company	Incident Type	Damages
1329306	Unknown	Vessel	N
1330300	Unknown	Vessel	N
1330404	Unknown	Fixed	N
1330538	Lanxess	Fixed	N
1330797	IMPERIAL DOCKS	Vessel	N
1331271	Unknown	Vessel	N
1331810	Unknown	Vessel	N
1331904	Harborage At Ashley Marina	Vessel	N
1331952	Unknown	Vessel	N
1332717	Unknown	Unknown Sheen	N
1334009	Unknown	Vessel	N
1334195	Lanxess (Charleston, Sc Site)	Fixed	N
1334294	Unknown	Vessel	N
1334491	Unknown	Unknown Sheen	N
1335303	Unknown	Aircraft	N
1336416	Unknown	Unknown Sheen	N
1336995	Unknown	Unknown Sheen	N
1337149	Unknown	Railroad Non-Release	Y
1337329	Unknown	Vessel	N
1337435	Unknown	Unknown Sheen	N
1337448	Unknown	Vessel	N
1337782	Unknown	Unknown Sheen	N
1338373	Unknown	Unknown Sheen	N
1338434	Unknown	Vessel	N
1339417	Unknown	Vessel	N
1340712	Unknown	Vessel	N
1341611	Unknown	Unknown Sheen	N
1341920	Unknown	Unknown Sheen	N
1342153	Unknown	Vessel	N
1342326	Unknown	Unknown Sheen	N
1342424	Unknown	Mobile	N
1342891	Unknown	Vessel	N
1343171	Unknown	Vessel	N
1343205	Unknown	Vessel	N
1343217	Kinder Morgan	Pipeline	N
1343469	Unknown	Vessel	N
1343654	Unknown	Vessel	N
1343838	Unknown	Unknown Sheen	N
1344762	Rio Chico	Fixed	N
1345143	Unknown	Unknown Sheen	N
1346486	Unknown	Vessel	N
1347771	Unknown	Unknown Sheen	N
1347807	Unknown	Unknown Sheen	N
1348246	Unknown	Unknown Sheen	N
1348537	Unknown	Unknown Sheen	N

Source: United States Coast Guard, National Response Center; https://nrc.uscg.mil/

In total, there were 1,348 hazardous release incidents in the City of Charleston between 2000 and 2022. From 2000 to 2015 incidents resulted in 9 fatalities, 16 hospitalizations, 17 injuries, 10 people evacuated, and $200,000 in damages. Nearly 50% of all incidents were mobile vehicle incidents, and another 12% were fixed site incidents.

Probability of Future Occurrences

Based on the rate of occurrence of 1,348 incidents within the City of Charleston in 22 years, there is a 100% likelihood that a hazardous material release will occur in any given year. However, only a small percentage of these incidents caused any damages, including property damage, injuries, hospitalizations, or evacuations. Using damages as an indicator of a severe event, the probability of a severe event is possible. The likelihood of a severe event affecting the campus is less probable.

Probability: 2 – Possible

Climate Change and Future Conditions

Climate change is not expected to affect the occurrence of hazardous materials incidents.

Consequence Analysis

Category	Consequences
Public	People in close proximity to facilities storing or transporting hazardous materials are at higher risk of exposure to a release incident. Additionally, any students, faculty, or staff working with hazardous materials on campus are also at heightened risk. Depending on the materials, they may pose certain health hazards. If hazardous materials contaminate soils or water supply, people may be at risk of exposure through food or water.
Responders	First responders may be exposed to hazardous materials during any rescue or clean-up operations, especially if they are not prepared with appropriate protective equipment.
Continuity of Operations (including Continued Delivery of Services)	A severe event could interrupt normal operations by requiring evacuations or site remediation. A contingency plan may be required if a site on campus cannot be used for an extended period of time. Continuity of operations may also be affected if a hazardous material spill affects access to safe food and water.
Property, Facilities and Infrastructure	Explosive, flammable, or corrosive materials could cause structural property damage. Structures may also be affected by contamination or inaccessibility. Some materials could also cause damage to critical infrastructure; for example, the water distribution system could be damaged if hazardous materials were to infiltrate into the water supply.
Environment	Consequences for the natural environment depend on the type of material released, the location of the incident, and its relation to the natural environment. Possible ecological losses include loss of wildlife, loss of habitat, and degraded air and water quality.
Economic Condition	Economic impacts of a hazardous material release depend on the magnitude and severity of the incident. These impacts can include response, clean-up, and remediation costs, as well as litigation and property damage costs. If the spill requires evacuation and/or long-term site closure, the costs may also include lost labor productivity.

Vulnerability Assessment

The Citadel routinely stores a variety of chemicals on campus. These chemicals range from cleaning products to chemicals used in research, any of which may be considered hazardous or sensitive under certain conditions. The presence of chemicals on campus increases the risk of a hazardous materials release occurring and makes it imperative that The Citadel enforce policies for the safe transport, storage, handling, and disposal of these chemicals. The Citadel has in place a Hazard Communication Program, in compliance with the South Carolina Occupational Safety and Health standard on Hazard Communication, in order to "assist Citadel employees in locating information concerning the safe and proper use, handling and storage of materials that may be considered hazardous under normal circumstances." The program details policies for labeling, material safety data sheets, piping, and employee training, and information dissemination. This program decreases the likelihood of a fixed-site hazardous material release occurring on campus by ensuring that employees are trained in safety precautions. However, the plan does not specify dissemination of information and training to students and therefore overlooks a key campus demographic in need of training on hazardous material safety.

In addition to addressing hazardous material use, handling, and storage safety, The Citadel has in place a Fire and Emergency Action Plan which could help to reduce the magnitude of an incident involving combustible or flammable hazardous materials. The plan promotes general fire safety rules, ensures the availability of fire evacuation plans in all campus buildings, and outlines the proper response in the event of a fire. The Citadel's Emergency Response Plan (ERP) also addresses hazardous materials response, providing specific actions and precautions to take in the event of a spill, release, or other incident.

The Citadel campus is located adjacent to the Ashley River and within one mile of Interstate 26 and US-17. Due to its proximity to these major transportation routes, the campus could be exposed to a mobile hazardous material release. Mobile incidents comprised nearly 50% of all hazardous material releases in Charleston County in 2015. A nearby incident of significant magnitude could require evacuation of the campus. The ERP details building evacuation plans but does not discuss full-scale campus evacuation procedures.

Problem Statement

- Hazardous materials spills can threaten health and safety of anyone in the vicinity. Lasting impacts can occur if a spill is not property maintained and cleaned.

4.5 Risk and Vulnerability Conclusions

4.5.1 Priority Risk Index Results

Table 4.68 summarizes the degree of risk assigned to each identified hazard using the PRI method.

TABLE 4.68 – SUMMARY OF PRI RESULTS

Hazard	Probability	Impact	Spatial Extent	Warning Time	Duration	PRI Score
Dam Failure	Unlikely	Limited	Moderate	>24 hours	<1 week	1.9
Drought	Highly Likely	Minor	Large	>24 hours	>1 week	2.8
Earthquake	Possible	Critical	Large	<6 hours	>1 week	3.1
Extreme Heat	Likely	Minor	Large	>24 hours	<1 week	2.4
Flood	Highly Likely	Critical	Large	6 to 12 hours	<1 week	3.5
Hurricane/Tropical Storm	Highly Likely	Critical	Large	>24 hours	<1 week	3.3
Sea Level Rise	Highly Likely	Limited	Small	>24 hours	>1 week	2.7
Severe Weather	Highly Likely	Minor	Large	6 to 12 hours	<6 hours	2.7
Sinkhole	Unlikely	Limited	Negligible	<6 hours	<6 hours	1.6
Tornado	Likely	Limited	Moderate	<6 hours	<6 hours	2.6
Tsunami	Unlikely	Critical	Large	<6 hours	<24 hours	2.6
Wildfire	Possible	Limited	Moderate	<6 hours	<1 week	2.5
Winter Weather	Likely	Limited	Large	12 to 24 hours	<1 week	2.7
Active Shooter	Possible	Catastrophic	Small	<6 hours	<6 hours	2.7
Civil Disturbance	Possible	Limited	Small	<6 hours	<1 week	2.3
Cyber Disruption	Possible	Critical	Large	<6 hours	<1 week	3.0
Hazardous Materials	Possible	Limited	Small	<6 hours	<1 week	2.2

The results from the PRI have been classified into three categories based on the assigned risk value summarized in Table 4.69 below:

- **Low Risk**: Minimal potential impact. The occurrence and potential cost of damage to life and property is minimal.
- **Medium Risk:** Moderate potential impact. This ranking carries a moderate threat level to the general population and/or built environment. Here the potential damage is more isolated and less costly than a more widespread disaster.
- **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.

TABLE 4.69 – SUMMARY OF HAZARD RISK CLASSIFICATION

High Risk **(≥ 3.0)**	Flood Hurricane/Tropical Storm Earthquake Cyber Disruption	
Moderate Risk **(2.0 – 2.9)**	Drought Sea Level Rise Severe Weather Winter Weather Active Shooter	Tornado Tsunami Wildfire Extreme Heat Civil Disturbance Hazardous Materials
Low Risk **(< 2.0)**	Dam Failure Sinkhole	

5 CAPABILITY ASSESSMENT

Chapter 5 discusses the mitigation capabilities, including planning, programs, policies, land management tools, and education and outreach typically used to implement hazard mitigation activities. It consists of the following subsections:

- **5.1 Overview of Capability Assessment**
- **5.2 Planning and Regulatory Capability**
- **5.3 Administrative and Technical Capability**
- **5.4 Fiscal Capability**
- **5.5 Education and Outreach Capability**

5.1 Overview of Capability Assessment

The purpose of conducting a capability assessment is to determine the ability of the college to implement a comprehensive, but feasible mitigation strategy, and to identify potential opportunities for establishing or enhancing specific mitigation polices, programs, or projects. As in any planning process, it is important to try to establish which goals, objectives, and actions are feasible based on an understanding of the capacity of the departments and staff tasked with their implementation. 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. The information discussed in the capability assessment is based upon input provided by community representatives on the HMPC as well as research conducted by the planning consultant. 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 should be supported through future mitigation efforts.

5.2 Planning and Regulatory Capability

Planning and regulatory capability is based on the implementation of plans, ordinances, policies, and programs that guide development on campus. It includes emergency response and mitigation planning, comprehensive land use planning, and transportation planning. Regulatory capability also includes the enforcement of zoning or subdivision ordinances and building codes that regulate how land is developed and structures are built, as well as protecting environmental, historic, and cultural resources in the community. Although some conflicts can arise, these planning initiatives generally present significant opportunities to integrate hazard mitigation principles and practices into the local decision-making process.

This assessment provides a general overview of the key planning and regulatory tools or programs in place or under development for The Citadel. It should be noted that many of the plans and regulatory tools may not be implemented at the campus level. However, additional regulatory tools for the City of Charleston and Charleston County are included, as many policies and programs for the city and county likely impact The Citadel campus in some way. Table 5.1 lists local plans, ordinances, policies, and programs currently in place at The Citadel. Plans and tools regulated at the City or County level are noted in the comments column.

TABLE 5.1 – PLANNING AND REGULATORY CAPABILITY

Regulatory Tool (ordinances, codes, plans)	Y/N	Comments
Strategic Plan	Y	Our Mighty Citadel 2026

Regulatory Tool (ordinances, codes, plans)	Y/N	Comments
Hazard Mitigation Plan	Y	The Citadel HMP 2016, Charleston Regional Hazard Mitigation Plan 2022, South Carolina Hazard Mitigation Plan 2018
Zoning Code	N	Zoning Ordinance of Charleston, SC – Supplement 18
Land Use	N	Zoning Ordinance of Charleston, SC – Article 2: Land Use Regulations
Comprehensive Plan	Y	Charleston City Plan, 2021, Charleston County Comprehensive Plan, 2018, Citadel Master Plan, 2020
Floodplain Ordinance	Y	Chapter 27 of the City of Charleston Ordinance
Building Code	Y	International Code Council "family" of codes, as approved by the South Carolina Building Code Council
Erosion or Sediment Control Program	N	
Stormwater Management Program	N	Charleston Stormwater Management Plan, Charleston County Stormwater Management Program
Site Plan Review Requirements	N	
Capital Improvements Plan	N	City of Charleston Capital Improvements Plan, 2022-2026
Economic Development Plan	Y	Our Mighty Citadel 2026
Local Emergency Operations Plan	Y	2016 Campus Emergency Response Plan, Citadel Safety and Emergency Procedures Program, Charleston County EOP 2021
Fire and Emergency Action Plan	Y	
Flood Insurance study or Other Engineering Study for Streams	Y	FEMA 2021 FIS Report
Elevation Certificates	Y	
Transportation Plan	N	Charleston People Pedal Plan
Other Special Plans	Y	The Citadel Hurricane Operations Guide 2020, Charleston Flooding and Sea Level Rise Strategy 2019, Charleston All Hazards Vulnerability and Risk Assessment

Additional plans include the Charleston Climate Action Plan which creates a 5-year strategic framework to reduce carbon pollution with the goal to reduce emissions by 56% by 2030 and to net zero by 2050. This plan helps to address the root cause of climate change and is integrated with plans that help the City better adapt to climate change, like the Flooding and Sea Level Rise Strategy and the All Hazards Vulnerability and Risk Assessment. The city has also worked with the USACE to develop the USACE Charleston Peninsula Storm Risk Management Study. The study is a federal study investigating coastal storm impacts on the Charleston peninsula and, in partnership with the City of Charleston and its stakeholders, is exploring effective, economically viable and environmentally-sound solutions to mitigate risks and build enduring coastal storm resiliency.

Additional planning initiatives include the Trees to Offset Stormwater study completed by the City of Charleston. The study examines the City’s tree canopy cover and how to better integrate trees into Charleston’s stormwater management programs. Tree coverage also has a range of other environmental and heat mitigation benefits. The City of Charleston also has two plans centered around affordable housing, the Housing and Community Development Annual Action Plan, and the Affordable Housing

Bond Funds Strategic Plan. Both plans expand safe affordable housing options. The availability of affordable housing is critical in any community, particularly after a hazardous event. Access to affordable housing after a severe weather event can ensure people like faculty, staff, and students, can remain in the community even if housing is damaged in a hazard event.

Based upon the results summarized in the above table, The Citadel, with support of City and County tools, has significant planning capability. 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 The Citadel.

Hazard Mitigation Plan

A hazard mitigation plan is a community's blueprint for how it intends to reduce the impact of natural, and in some cases human-caused, hazards on people and the built environment. The essential elements of a hazard mitigation plan include a risk assessment, capability assessment, and mitigation strategy.

The Citadel, the City of Charleston, and Charleston County have Hazard Mitigation Plans making each community eligible for the associated hazard mitigation funding mechanisms.

The City of Charleston also developed an All-Hazards Vulnerability Assessment aimed at understanding various levels of vulnerability to better inform the City's resilience planning efforts. Both mitigation and resilience efforts from the City help mitigate existing hazards and better prepare and respond to future threats.

Strategic Plan

A Strategic Plan, in broad terms, is a policy statement to guide the future placement and development of campus facilities. The Citadel's 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. Strategic Initiative 4 and the objectives listed below are relevant to the hazard mitigation goals of this plan.

Strategic Initiative 4: Create and maintain safe and secure campus facilities to advance student learning, innovation, and campus operations.

- **Objective 4.1**: Engage in comprehensive strategic master planning effort to chart roadmap of The Citadel for the next fifty years.
- **Objective 4.2**: Maintain, build, renovate, and/or repurpose facilities on campus in support of the Campus Masterplan concept.
- **Objective 4.3**: Invest in experiential and innovative teaching and learning space.
- **Objective 4.4:** Enhance campus safety and security.

Zoning Code

Zoning regulations describe what type of land use and specific activities are permitted in a given area or district, and also regulate how buildings, signs, parking, and other construction may be placed on a parcel. Zoning regulations also provide procedures for rezoning and other planning applications. A zoning ordinance is the mechanism through which zoning is typically implemented and normally consists of both a zoning map and a written ordinance/code that divides the planning area into zoning districts. Since zoning regulations enable municipal governments to limit the type and density of development, a zoning ordinance can serve as a powerful tool when applied in identified hazard areas. The City of Charleston has a zoning ordinance in place.

Comprehensive Plan

A comprehensive plan, or general plan, establishes the overall vision for what a community wants to be and serves as a guide for future governmental decision making. Typically, a comprehensive plan contains sections on demographic conditions, land use, transportation elements, and community facilities. Given the broad nature of the plan and its regulatory standing in many communities, the integration of hazard mitigation measures into the comprehensive plan can enhance the likelihood of achieving risk reduction goals, objectives, and actions. Regular updates of comprehensive plans are important for guiding the growth and development of a community.

The Charleston City Plan was adopted by the City in 2021 and is an update to the previous Century V comprehensive plan. The plan has nine key elements, three of which directly support mitigation efforts: Natural Resources, Land Use, and Resilience & Equity. Recommendations from these elements can be incorporated in the Citadel's mitigation strategy. Some of the relevant elements are listed below:

1. **Natural Resources**
    - Create incentives for the use of conservation easements, including developing a toolkit for green space preservation.
    - Continue to promote planning and zoning policies that align with the "living with water approach" outlined in the Dutch Dialogues Charleston study, including encouraging the use of green infrastructure in landscaping practices and stormwater management. Green infrastructure includes features such as bioswales, porous pavements, rain gardens, and wetland buffers; and other practices that leave existing natural features and ecosystems undisturbed.
    - Dedicate staff and resources to support collaboration between Stormwater Management, Parks and Planning to oversee preservation, creation and maintenance of green infrastructure.
    - Implement recommendations from the Trees to Offset Stormwater study including updating the City's Tree Protection Ordinance to preserve clusters of trees during the development process, track and increase tree canopy percentages around the city, and prioritize underserved areas or areas with aging inventory for tree planting.
2. **Land use**
    - Encourage use of green stormwater infrastructure including clusters of trees, use of pervious surfaces, green roofs, etc.
    - Further limit fill-and-build construction methods in areas vulnerable to future flooding and potential marsh migration
3. **Resilience & Equity**
    - Work with other City departments to implement the recommendations in the All Hazards and Vulnerability Risk Assessment, Sea Level Rise Strategy, Climate Action Plan, Trees to Offset Stormwater and Dutch Dialogues Charleston.
    - Expand incentives for sustainable construction and renewable energy via the zoning code, such as building certification programs like Charleston RISES.
    - Continue to study the effects of extreme heat and pursue policies that protect people in all areas of the city from extreme heat, especially lower income and elder community members who may have more limited ability to adapt.

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 1%-annual chance 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. Charleston County's FIS report was completed in January 2021. This information is used by Palmetto Bay to implement floodplain regulations as part of participation in the NFIP and to promote sound land use and floodplain development within the community. The FIS was used in the development of this FMP to identify FEMA flood hazard areas and to calculate the associated flood depths for the 1%-annual-chance flood event.

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 1%-annual chance flood event and that new development in the floodplain will not exacerbate existing flood problems or increase damage to other properties.

Stormwater Management Program/Plan

A stormwater management plan is designed to address flooding associated with stormwater runoff and is typically focused on design and construction measures that are intended to reduce the impact of more frequently occurring minor urban flooding.

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. Both the City and County have stormwater management programs established.

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.

The City of Charleston does not have an erosion and sediment control ordinance, however, new development does have to comply with state regulations outlines in the South Carolina Stormwater Management and Sediment Reduction Act. The state also outlines Erosion and Sediment Control Practices for Developing Areas by the South Carolina Land Resources Conservation Commission, Erosion and Sediment Control Division.

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 city's ordinance and comprehensive plan. The City of Charleston has a site plan review and approval process for all developments except most small dwellings and routine maintenance.

Building Codes and Inspections

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. Building codes can ensure that the first floors of new buildings are constructed to be higher than the elevation of the 1%-annual chance flood. Hazard protection standards for all new and improved or repaired buildings can be incorporated into the local building code. The International Code Council "family" of codes, as approved by the South Carolina Building Code Council, apply to buildings on The Citadel campus.

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) guides the scheduling of spending on public investments. CIPs typically provide a five-year outlook for anticipated projects and are primarily related to improvement in public service, parks and recreation, public utilities, and facilities. These plans can serve as an important mechanism for guiding future development away from identified hazard areas. Limiting public spending in hazardous areas is one of the most effective long-term mitigation actions available to local governments. Additionally, the Citadel's mitigation strategy may include structural projects that could potentially be included in a CIP and funded through a Capital Improvement Program.

The City of Charleston has a CIP with many mitigation focused projects including drainage repair projects, seawall repairs, Church Creek NFWF Renaturalization, Habitat Restoration & Flood Protection Project, and other similar projects.

Emergency Operations Plan

An emergency operations plan outlines the responsibilities of different departments and how resources will be deployed during and following an emergency or disaster.

The Charleston County Emergency Operations Plan also establishes and emergency support function (ESF) for long-term recovery and mitigation which enacts post-disaster mitigation policies and procedures. The purpose of these procedures is to support municipal governments, nongovernmental organizations, and private sector entities in enabling post-disaster mitigation and recovery. The following activities will be undertaken to support post-disaster mitigation and recovery in Charleston County:

1. **Preparedness**
   - Develop systems to use predictive modeling, to include the HAZUS loss estimation methodology, to determine vulnerable critical facilities as a basis for identifying recovery activities.
   - Charleston County Building Services, Project Impact and Charleston County CCEMD will provide educational material and information to the citizens in mitigation practices and procedures to reduce vulnerability.
2. **Recovery**
   - Review the state mitigation plan and local mitigation plans for affected areas to identify potential mitigation projects.
3. **Mitigation**
   - Using the HAZUS loss estimation methodology support and other mitigation strategies, plan for mitigation measures.
   - Update annually the Charleston Regional Hazard Mitigation Plan.
   - Support requests and directives resulting from the County Administrator, Governor and/or FEMA concerning mitigation and/or re-development activities.
   - Charleston County Building Services will make recommendations to the County Administrator and County Council on issues directly related to codes and zoning that will prevent/mitigate the potential for damages caused by natural and technological disasters.

- Document matters that may be needed for inclusion in agency or state/federal briefings, situation reports and action plans.

The Citadel also maintains a Hurricane Operations Plan and a Winter Storm/ Severe Weather Operations Plan that has been prepared to summarize what actions need to be implemented by various college activities in response to the threat of a tropical storm or hurricane or a winter storm or severe cold weather event. Additionally, The Citadel's Emergency Response Plan outlines key response actions for a range of hazards covered in this plan as well as a disaster recovery plan. The Citadel also has an Emergency Operations Center (EOC) Guide that outlines emergency response organization.

5.3 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 5.2 provides a summary of the administrative and technical capabilities for The Citadel.

TABLE 5.2 – ADMINISTRATIVE AND TECHNICAL CAPABILITY

Personnel Resources	Yes/No	Department/Position
Planner/Engineer with knowledge of land development/land management practices	Yes	Facilities & Engineering
Engineer/Professional trained in construction practices related to buildings and/or infrastructure	Yes	Facilities & Engineering
Planner/Engineer/Scientist with an understanding of natural hazards	Yes	Facilities & Engineering
Personnel skilled in GIS	No	N/A
Full time building official	Yes	Facilities & Engineering
Floodplain Manager	Yes	Facilities & Engineering
Emergency Manager	Yes	Environmental Health & Safety
Grant Writer	Yes	Facilities & Engineering
Warning Systems	Yes	Environmental Health & Safety
GIS data: flood zones/hazard areas	Yes	Facilities & Engineering
GIS data: critical facilities	Yes	Facilities & Engineering
GIS data: building footprints	Yes	Facilities & Engineering

5.4 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 5.3 provides a summary of the fiscal resources available to The Citadel.

TABLE 5.3 – FISCAL RESOURCES

Resource	Ability to Use for Mitigation Projects? Y/N
In-Kind Services	Y
Tuition & Fees	Y
SCOR Mitigation Funding	Y
SCOR Stormwater Infrastructure Program	Y
Hazard Mitigation Assistance (HMA) Grants	Y
State Appropriations	Y
Sales & Services	Y
Other Sources (Gifts, Investment Income, Permanent Endowments)	Y

5.5 Education and Outreach Capability

This type of capability refers to education and outreach programs and methods already in place that could be used to implement mitigation activities and communicate hazard-related information. Examples include natural disaster or safety related awareness programs, a community alert system; and activities conducted as part of hazard awareness campaigns such as a Severe Weather Awareness Month. The following is a brief list of education and information programs at The Citadel:

BulldogAlert: The BulldogAlert messaging system broadcasts emergency information to email addresses and phone numbers provided by students, faculty, and staff.

Hazard Communication Program: This program has been developed to assist Citadel employees in locating information concerning the safe and proper use, handling and storage of materials that may be considered hazardous under normal circumstances.

Citadel Safety Newsletter: The Citadel Safety Newsletter is a monthly publication produced by the Department of Facilities and Engineering/Environmental Health and Safety.

The Student Safety Information & Policies website could be updated with relevant information about hazard mitigation and safety. This could include information about evacuations and what to do when a certain hazard event arises. Additionally, the Resources section on the Environmental Health and Safety website should update links to Storm Ready University and Disaster Preparedness websites.

6 MITIGATION STRATEGY

Chapter 6 discusses the mitigation strategy process and mitigation action plan for The Citadel Multi-Hazard Mitigation Plan. This chapter also describes how the HMPC met the following requirements from the 10-step planning process. This chapter consists of the following subsections:

- **6.1 Mitigation Strategy Overview**
- **6.2 Goals**
- **6.3 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.

6.1 Mitigation Strategy: Overview

The results of the planning process, the risk assessment, the goal setting, and the identification of mitigation actions led to the mitigation strategy and mitigation action plan for this HMP. The following umbrella mitigation strategy was used during development of this HMP:

- **Communicate** the hazard information collected and analyzed through this planning process as well as HMPC success stories so that the community better understands what can happen where and what they themselves can do to be better prepared.
- **Implement** the action plan recommendations of this plan.
- **Use** existing rules, regulations, policies, and procedures already in existence.
- **Monitor** multi-objective management opportunities so that funding opportunities may be shared and packaged, and broader constituent support may be garnered.

6.2 Goals

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.

Chapter 4 documents the hazards and associated risks that threaten The Citadel planning area including the vulnerability to structures, infrastructure, and critical facilities. Chapter 5 evaluates the capacity of The Citadel to reduce the impact of those hazards. The intent of goal setting is to identify areas where improvements to existing capabilities (policies and programs) can be made so that campus vulnerability is reduced. Goals are also necessary to guide the review of possible mitigation measures. This Plan needs to make sure that recommended actions are consistent with what is appropriate for the College. Mitigation goals need to reflect overarching priorities and should be consistent with other policies and programs currently in place at The Citadel.

Goals are general guidelines that explain what is to be achieved. They are usually broad-based policy type statements, long term and represent global visions. Goals help define the benefits that the plan is trying to achieve and reflect the college's priorities.

6.2.1 Coordination with Other Planning Efforts

The goals of this plan need to be consistent with and complement the goals of other planning efforts. The primary planning documents where the goals of this Plan must complement and be consistent with are The Citadel's Strategic Plan, otherwise known as Out Mighty Citadel, 2026, and The Citadel Master Plan 2020. Both documents are important as they are developed and designed to guide future growth at the college. Therefore, there should be some consistency in the overall goals and how they relate to each other.

6.2.2 Goal Setting Exercise

At the third HMPC meeting, held on February 8, 2023, an open discussion took place on the goals for The Citadel Multi-Hazard Mitigation Plan. The goals from the 2017 plan were reviewed and discussed. The HMPC was asked to consider whether the goals were still relevant and appropriate or if there were new or changing priorities that necessitated any changes. Committee members were also asked to suggest other goals they felt would be appropriate. Following this discussion and further review, the HMPC decided to reaffirm the goals from the 2017 plan.

6.2.3 Resulting Goals

Five general goals developed during the 2017 planning process were reviewed and reaffirmed for this plan update. The numbering of goals is for identification purposes and does not reflect any priority. The goals are as follows:

- **Goal 1:** Reduce the vulnerability of the people and property of the College from the effects of natural and man-made hazards.
- **Goal 2:** Safeguard the College's mission of education, outreach and engagement against natural or man-made hazards.
- **Goal 3:** Preserve and strengthen protection of critical facilities and infrastructure through the implementation of mitigation actions to create a safer, more sustainable College.
- **Goal 4:** Enhance campus education programs to raise awareness of and preparedness for hazard events.
- **Goal 5:** Improve and coordinate mitigation activities with surrounding communities, non-profits and private businesses.

6.3 Identification and Analysis of Mitigation Actions

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.

In order to identify and select mitigation projects to support the mitigation goals, each hazard identified in Chapter 4 was evaluated. The HMPC then analyzed viable mitigation options that supported the identified goals. The HMPC reviewed a PowerPoint presentation covering the following six mitigation categories as well as examples of potential mitigation actions for each of these categories which are utilized as part of the FEMA recommended mitigation planning process:

- Prevention (Required to be evaluated)
- Property Protection
- Natural Resource Protection

- Emergency Services
- Structural Projects
- Public Information and Outreach

The HMPC was also provided with FEMA's *Mitigation Ideas* guidance document dated January 2013 which provides example mitigation actions organized by natural hazard. The HMPC was instructed to consider both future and existing buildings in evaluating possible mitigation actions and to also consider including projects from other plans and studies. Additionally, it was noted that the HMPC must identify a mitigation action for each identified hazard. A facilitated discussion then took place to review the status of existing mitigation actions and examine and analyze options for new actions.

6.3.1 Prioritization Process

Once the mitigation actions were identified, the HMPC was provided with several decision-making tools, including FEMA's recommended prioritization criteria, STAPLEE, as well as sustainable disaster recovery criteria, Smart Growth principles, and others, to assist in deciding why one recommended action might be more important, more effective, or more likely to be implemented than another. STAPLEE stands for the following:

- **Social:** Does the measure treat people fairly and produce equitable outcomes? (e.g. different groups, different generations, underserved populations, socially vulnerable populations)
- **Technical:** Is the action technically feasibly? Does it solve the problem?
- **Administrative:** Are there adequate staffing, funding and other capabilities to implement the project?
- **Political:** Who are the stakeholders? Will there be adequate political and public support for the project?
- **Legal:** Does the jurisdiction have the legal authority to implement the action? Is it legal?
- **Economic:** Is the action cost-beneficial? Is there funding available? Will the action contribute to the local economy?
- **Environmental:** Does the action comply with environmental regulations? Will there be negative environmental consequences from the action?

In accordance with DMA requirements, an emphasis was also placed on the importance of a benefit-cost analysis in determining action priority. While detailed cost estimates were not prepared for each action, the HMPC considered the potential cost of each action. To weigh costs and benefits, the following four criteria were considered:

- Contribution of the action to save life or property
- Ability of the action to address the problem
- Availability of funding and perceived cost-effectiveness
- Available resources for implementation

Note that 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.

With these criteria in mind, HMPC members were asked to prioritize each mitigation project based on whether the project should be considered a low, medium, or high priority action.

Another element of prioritization involved identifying an implementation timeline for each action. Actions were categorized as short-, medium- or long-range priorities. The priority time frames for project implementation were determined to be as follows:

- **Short Range** = Project should be completed in less than one year
- **Medium Range** = Project should be completed in two to three years
- **Long Range** = Project should be completed in four to five years

6.3.2 Documentation of Plan Progress

The HMPC also reviewed the status of all existing mitigation actions. Actions that were completed were removed from the Mitigation Action Plan. Incomplete actions were discussed to determine whether they are still relevant and applicable to the plan goals and should be carried forward, or whether they should be deleted. A list of completed and deleted actions from the 2017 plan is provided in Table 6.1 below.

TABLE 6.1 – COMPLETED AND DELETED ACTIONS FROM THE 2017 PLAN

Action #	Action Description	Action Status
5	Continue annual active shooter training	Completed. Drill was conducted in the Fall of 2022 through the Public Safety Department and has become an annual training exercise.
6	Utilize Quartzy (or similar software) to inventory all chemicals on campus. Maintain a copy of the inventory on OneDrive.	Completed. The school is in the process of phasing out Quartzy and moving to a SDS Chemical Software program called Vector Solutions. The software has been installed and is being utilized. Most all SDS's have been migrated over to the new system.
10	Implement hazard warning system for cadets who are outside, away from phone system.	Completed. Installation of the "Giant Voice" allows verbal warnings real time. There are three speaker array systems on and off campus for coverage everyone can hear. Also, an Emergency Warning Siren can be sounded if necessary. The warning system is tested monthly.
11	Pursue grant to improve shelving for chemical storage, eye wash stations, etc.	Completed. Chemical storage area has been cleaned and organized.
16	Develop a policy requiring a hazard assessment for all new construction/ projects to ensure potential risks to natural and man-made hazards are noted and mitigation considerations incorporated into the planning/design process.	Completed. The Director of Environmental Health and Safety participates in the initial contractor orientations on campus and makes periodic audits of the worksites. We also attend all new employee orientations on campus in coordination with the Human Resource Department. Implementation will be ongoing.
17	Consider alternative parking for areas that frequently flood during heavy rains.	Completed. This problem persists on campus. There are discussions and plans on corrective actions and alternative parking areas have been identified. Implementation will be ongoing.
19	Develop/implement a communications system for classrooms to alert humans real-time during an active shooter event or other immediate danger.	Completed. Installation of the "Giant Voice" allows verbal warnings real time. There are 3 speaker array systems on and off campus for coverage everyone can hear. Also, an Emergency Warning Siren can be sounded if necessary. Implementation will be ongoing.
20	Develop/implement an automated personnel accountability system or application activated upon a hazardous event to alert staff.	Completed. Each building has a person(s) that are responsible to account for individuals in case of an emergency. All buildings conduct annual evacuations drills with those buildings considered assembly areas conducting evacuations drills 4 times per year. Implementation will be ongoing.

7 MITIGATION ACTION PLAN

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.

Chapter 7 presents the mitigation action plan developed by The Citadel. The action plan presents the recommendations developed by the HMPC for how the college can mitigate risk and reduce the vulnerability of people, property, infrastructure, and natural and cultural resources to future hazard events. Emphasis was placed on both future and existing development. The action plan summarizes who is responsible for implementation, the actions' priorities, timelines for implementation, estimated costs and potential funding sources, the hazards addressed, the related goals achieved, and the status of actions that were carried forward from the 2017 plan.

It should be clarified that the actions included in this mitigation strategy are subject to further review and refinement; alternatives analyses; and reprioritization due to funding availability, changing capabilities, or other criteria. The Citadel is not obligated by this document to implement these projects. Rather this mitigation strategy represents the desires of The Citadel to mitigate the risks and vulnerabilities from identified hazards.

TABLE 7.1 – MITIGATION ACTION PLAN

Action Number	Action Description	Issue/Background Statement	Responsible Department	Priority	Anticipated Cost	Funding Sources	Timeframe	Goals Addressed	Hazard Addressed	Status
1	Develop GIS capabilities to provide spatial, structural, environmental, and inventory information.	The College does not currently have a GIS system in place on campus which could aid in providing essential data on campus buildings, land use, future planning, and protection from natural disasters. This can be a system installed and maintained on campus or the services could be provided through an outside vendor.	Emergency Operations	Medium	$100,000 – Campus $30,000 - Vendor	Operating Budget	Medium Range	1, 2	All Hazards	Carried forward. Emergency Operations is researching a phone app for Public Safety that will allow the ability to develop GIS capabilities along with geofencing on campus. Currently aiming to have this app fully implemented by year end 2023
2	Develop a web based and social media all hazards outreach program.	To enhance the preparedness for and education of faculty, staff and cadets, the College should develop an online (website) and social media campaign to promote information, facts and procedures for various natural and man-made hazards. There could be a different hazard promoted each month.	Public Information Office/Emergency Operations	High	Staff Hours	Operating Budget	Short Range	1, 2, 4	All Hazards	Carried forward. The school uses the Citadel website created by OCM and now has a Public Safety Website that can communicate campus hazards.
3	Continue the library's annual hurricane preparedness exhibit.	Continue to enhance the preparedness of cadets, faculty and staff by providing hurricane preparedness information in the library annually.	Library Staff	High	Staff Hours	Operating Budget	Short Range	1, 2, 4	Hurricane, Flood	Carried forward. This is an ongoing project during hurricane season June 1 to Nov 30. State SCEMD brochures are sent to the library and distributed to the entire campus.
4	Participate in a combined hurricane preparedness exercise with City of Charleston and Charleston County.	To enhance staff knowledge and preparedness through regular coordination activities with City and County Emergency Management Offices.	Public Information Office/Emergency Operations	High	Staff Hours	Operating Budget	Short Range	1, 2, 4, 5	Hurricane	Carried forward. The Citadel Emergency Manager works very closely with the City, County, State and FEMA. This includes the National Weather Service in Charleston, SC.
5	Abide by City of Charleston Floodplain Management Ordinance for new development on campus.	All new development on campus should abide by the City of Charleston Floodplain Management Ordinance in order to protect new buildings from future flood damage.	Facilities & Engineering	High	Staff Hours	Operating Budget	Short Range	1, 3	Flood	Carried forward. The school's Emergency Manager works very closely with the City and has participated in flood planning with city officials.
6	Apply for grants to implement earthquake retrofit projects on campus buildings.	Earthquake is considered a High Risk hazard for the Citadel campus. Earthquake retrofits would reduce the vulnerability of campus structures to earthquake damage.	Facilities & Engineering	Medium	Staff Hours	Operating Budget	Medium Range	1, 3	Earthquake	Carry forward. This is ongoing as grants become available and building are identified for retrofits.
7	Consider flap gates for outlets that drain to Ashley River or tidally influenced water bodies.	The Citadel campus often floods during heavy rain events due to high tides and the drainage of campus stormwater to tidally influenced water bodies. Flap gates would eliminate the back-up of floodwaters onto campus.	Facilities & Engineering	Low	$30,000 - Vendor	Operating Budget	Long Range	1, 3	Flood, Sea Level Rise	Carried forward. This is part of the school's long-range planning through the Facilities and Engineering Department.
8	Develop a system to ensure that new cadets, faculty and staff are exposed to basic all-hazards preparedness training during orientation activities.	Orientation is a convenient and logical time to present hazard information/training and ensure that all new cadets, faculty and staff are exposed to the training.	Public Information Office/Emergency Operations	High	Staff Hours	Operating Budget	Short Range	1, 2, 4	All Hazards	Carried forward. Communication has been developed and handed over to the Commandant's office Sgt Major. This information is presented to each incoming class at the beginning of the school year in Aug/Sept. The EHS Newsletter communicated campus hazards to the entire Citadel campus.
9	Develop a policy for training, inspection and enforcement of hazardous materials storage procedures.	Chemicals should be properly stored in order to reduce vulnerability in the event of a hazard. Property cadet/staff training is necessary to ensure safe storage procedures are followed.	Chemistry	Medium	Staff Hours	Operating Budget	Medium Range	1, 2	Hazardous Materials	Carried forward. This is part of the 29CFR1910.1200 Hazcom training that is conducted annually. All maintenance and Public Safety employees will receive OSHA 10 or 30 training in 2023.

Action Number	Action Description	Issue/Background Statement	Responsible Department	Priority	Anticipated Cost	Funding Sources	Timeframe	Goals Addressed	Hazard Addressed	Status
10	Control access for large classrooms during lock-down situations while staying within the requirements of the Fire Code.	To reduce cadet, faculty and staff vulnerability during an active shooter event while also ensuring a proper number of exits are available for evacuation in the event of a fire.	Public Safety	High	Staff Hours	Operating Budget	Short Range	1	Active Shooter	Carried forward. All new construction will implement control access on all doors. Barracks are complete with new buildings coming online. Existing buildings will be included as renovations are completed.
11	Coordinate with City of Charleston/Charleston County to develop a debris management plan.	In the event of a hazard resulting in a large amount of debris, early and on-going coordination with City/County staff will help ensure a quick and smooth response during recovery.	Emergency Operations	Medium	Staff Hours	Operating Budget	Medium Range	1, 5	Earthquake, Hurricane, Tornado, Severe Weather, Flood	Carried forward. Implementation is ongoing as weather conditions arise. In the 2022 hurricane season Emergency Operations coordinated with the city, county, and federal DHS agencies for reimbursement for debris pick up and disposal. Most of this work is completed in house.
12	Develop a Comprehensive Land Use Plan to guide future development on campus and for future expansion.	All new campus development should be assessed against the spatial extent and likelihood of future occurrence for all hazards profiled in the Plan. Building design and location should minimize risk to all hazards.	Facilities & Engineering	Low	Staff Hours	Operating Budget	Long Range	1, 3	All Hazards	Carried forward. This is a part of the overall campus 25-year plan. The plan is updated every 10 years and was last updated in 2020.
13	Enforce a higher freeboard for new or renovated buildings on campus.	Elevating the lowest floor of new buildings above the base flood elevation will reduce flood damages by protecting new development against a higher magnitude of flooding.	Facilities & Engineering	High	Staff Hours; increased costs of construction on buildings	Operating Budget	Short Range	1, 2	Flood, Hurricane, Sea Level Rise	New
14	Add signage to frequently flooded areas of campus warning about potential flood risk.	Several areas have been identified on campus that frequently flood during heavy rains. Parking or driving through flooded streets and parking lots can result in damages. Awareness can help reduce exposure.	Facilities & Engineering	High	Less than $1,000	Operating Budget	Medium Range	1, 4	Flood, Sea Level Rise	New
15	Encourage cadets, faculty, and staff to sign up for emergency alerts through South Carolina Emergency Management Division or Charleston County Citizen Alert Notification System.	Voluntary alert programs exist to keep people informed of impending hazard events and risks. Encouraging sign up will improve awareness and preparedness.	Emergency Operations	High	Staff Hours	Operating Budget	Short Range	1, 4	All Hazards	New
16	Coordinate with the City of Charleston and other local stakeholders of stormwater management and drainage improvement projects.	Stormwater flooding issues must be addressed comprehensively to avoid diverting problems from one area to another. Coordination with he City and other stakeholders will encourage holistic solutions.	Facilities & Engineering	Low	Staff Hours	Operating Budget	Long Range	1, 5	Flood, Sea Level Rise	New

8 PLAN ADOPTION

44 CFR Subsection D §201.6(c)(5): [The plan shall include] documentation that the plan has been formally approved by the governing body of the jurisdiction requesting approval of the plan (e.g., City Council, County Commissioner, Tribal Council).

The purpose of formally adopting this plan is to secure buy-in, raise awareness of the plan, and formalize the plan's implementation. The adoption of this plan completes Planning Step 9 of the 10-step planning process: Adopt the Plan, in accordance with the requirements of DMA 2000. This plan has been formally adopted by The Citadel and approved by FEMA as shown below.

THE CITADEL

MEMORANDUM 17 February 2024

Subject: **ADOPTION OF THE UPDATED MULTI-HAZARD MITIGATION PLAN**

References: The Disaster Mitigation Act of 2000 (DMA 2000)

1. In accordance with DMA 200, The Citadel adopts the updated five-year Multi-Hazard Mitigation Plan as prepared in conjunction with the Federal Emergency Management Agency (FEMA) Region Four, the South Carolina Office of Resilience, and the South Carolina Emergency Management Division. Section 1.4 of the Plan details other relevant authorities and references.

2. This plan was developed via a grant provided through DMA 2000. It focuses on hazard identification and mitigation resources and strategy and is an update of the original Plan approved in October 2017.

3. The Citadel participated in FEMA-prescribed planning and review with the aforementioned agencies in this update.

4. With adoption of this Plan, The Citadel is fully committed to hazard identification and risk mitigation. The college will use this Plan where applicable and appropriate in campus operations, preparation, and as part of its strategic planning.

GLENN M. WALTERS '79
General, USMC (Retired)
President

Office of the President

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9 PLAN IMPLEMENTATION AND MAINTENANCE

This Chapter provides an overview of the overall strategy for plan integration and maintenance and outlines the method and schedule for monitoring, evaluating, and updating the plan. The section also discusses incorporating the plan into existing planning mechanisms and how to address continued public involvement. It consists of the following subsections:

- **9.1 Integration into Local Planning Mechanisms**
- **9.2 Monitoring, Evaluating, and Updating**
- **9.3 Continued Public Involvement**

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.

9.1 Integration into Local Planning Mechanisms

Implementation and maintenance of the plan is critical to the overall success of hazard mitigation planning. This is Planning Step 10 of the 10-step planning process. An important implementation mechanism that is highly effective and low-cost is incorporation of the Hazard Mitigation Plan recommendations and their underlying principles into other plans and mechanisms. Where possible, plan participants will use existing plans and/or programs to implement hazard mitigation actions. Mitigation will be most successful when it is incorporated into the day-to-day functions of the college. This plan builds upon the momentum developed through previous and related planning efforts and recommends implementing actions, where possible, through these other program mechanisms. These existing mechanisms include:

- Strategic Plan
- Master Plan
- Emergency Operations Plan
- Ordinances
- Building Code
- Other plans, regulations, and practices with a mitigation focus

The HPMC has developed a process by which the principles and actions included in this hazard mitigation plan will be incorporated into other plans. During the planning process for new and updated planning documents such as those listed above, the HMPC will provide a copy of the hazard mitigation plan to the advisory committee for each relevant planning document. The advisory committee will be directed to ensure that all goals and strategies of the new or updated planning document are consistent with the hazard mitigation plan and will not increase the spatial extent or probability of future occurrence of the hazards.

Incorporation into existing planning mechanisms will be done through the routine actions of:

- Monitoring other planning/program agendas;
- Attending other planning/program meetings;
- Participating in other planning processes; and
- Monitoring budget meetings for other program opportunities.

Other opportunities to integrate the requirements of this plan into other local planning mechanisms shall continue to be identified through annual meetings of the HMPC and through the five-year update process described herein.

9.2 Monitoring, Evaluating, and Updating

Plan maintenance implies an ongoing effort to monitor and evaluate plan implementation and to update the plan as progress, roadblocks, or changing circumstances are recognized. The HMPC identified in Chapter 2 will convene annually, following a hazard event, and for a five-year update following the DMA process used for this plan and described in Chapter 2. The HMPC will be responsible for facilitating, coordinating, and scheduling reviews and maintenance of the plan, including evaluating the efficacy of the plan and reconvening to direct the five-year update of the plan.

9.2.1 Role of HMPC in Implementation, Monitoring, and Maintenance

- Act as a forum for mitigation issues;
- Disseminate mitigation ideas and activities;
- Pursue the implementation of the mitigation strategy, beginning with high-priority, low/no-cost recommended actions;
- Ensure mitigation remains a consideration for campus decision makers;
- Lead the plan review process to track the progress of action implementation and effectiveness;
- Provide notices to the campus, federal, state, and local agencies, non-profit groups, local planning agencies, representatives of business interests, neighboring communities, and others advising them of the date, time, and place for the review;
- Coordinate with department heads and others tasked with implementation prior to the review and discuss the progress of various activities for each members responsible tasks and ask them to present a report at the review meeting;
- Provide a copy of the current plan for public comment; and
- Develop a status report after the review meeting outlining implementation of projects over the past year.

The HMPC's primary duty moving forward is to see the plan successfully carried out and report 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 posting relevant information on campus and local websites (and others as appropriate).

9.2.2 Criteria for Annual Reviews

To ensure regular monitoring and provide adequate information to support the five-year update evaluation process, the HMPC will convene for annual reviews. The criteria recommended in 44 CFR 201 and 206 will be utilized in reviewing and updating the plan. More specifically, the annual reviews will include the following information:

- Campus growth or change in the past year.
- The number of substantially damaged or substantially improved structures by flood zone.
- The renovations to public infrastructure including water, sewer, drainage, roads, bridges, gas lines, and buildings.
- Natural hazard occurrences that required activation of the Emergency Operations Center (EOC) and whether or not the event resulted in a presidential disaster declaration.
- Natural hazard occurrences that were not of a magnitude to warrant activation of the EOC or a federal disaster declaration but were severe enough to cause damage to the campus.
- The dates of hazard events descriptions.
- Documented damages due to the event.
- Closures at the college and the number of days closed.
- Road or bridge closures due to the hazard and the length of time closed.

- Assessment of the number of campus buildings damaged and whether the damage was minor, substantial, major, or if buildings were destroyed.
- Review of any changes in federal, state, and local policies to determine the impact of these policies on the college and how and if the policy changes can or should be incorporated into the Hazard Mitigation Plan. Review of the status of implementation of projects (mitigation strategies) including projects completed will be noted. Projects behind schedule will include a reason for delay of implementation.

9.2.3 Schedule for Five-year Update

The HMPC will submit a five-year written update to SCEMD and FEMA Region 4, unless disaster or other circumstances (e.g., changing regulations) require a change to this schedule. The five-year update will follow the four-phase DMA process, described in Chapter 2, and will be led by the HMPC. With this plan update anticipated to be fully approved and adopted in 2023, the next plan update will conclude in 2028.

9.3 Continued Public Involvement

Requirement §201.6(c)(4)(iii): [The plan maintenance process shall include a] discussion on how the community will continue public participation in the plan maintenance process.

Continued public involvement is imperative to the overall success of the plan's implementation. The annual review process provides an opportunity to solicit participation from new and existing stakeholders and to publicize success stories from the plan implementation and seek additional public comment. The plan maintenance and update process will include continued public and stakeholder involvement and input through attendance at designated committee meetings, web postings, press releases to local media, and through public hearings.

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 develop a plan for public involvement and will be responsible for 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.

APPENDIX A – Local Mitigation Plan Review Tool

Cover Page

The Local Mitigation Plan Review Tool (PRT) 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 local governments, including special districts.

Plan Information	
Jurisdiction(s)	The Citadel
Title of Plan	The Citadel Multi-Hazard Mitigation Plan
New Plan or Update	Update
Single- or Multi-Jurisdiction	Single-jurisdiction
Date of Plan	4/12/2023
Local Point of Contact	
Title	Dave Orr, Director
Agency	Environmental Health and Safety
Address	171 Moultrie Street, Charleston, SC 29409
Phone Number	843-953-4816
Email	horr@citadel.edu

Additional Point of Contact	
Title	David Stroud
Agency	WSP
Address	4021 Stirrup Creek Drive, Suite 100, Durham, NC 27703
Phone Number	919-325-6497
Email	david.stroud@wsp.com

Review Information	
State Review	
State Reviewer(s) and Title	Click or tap here to enter text.
State Review Date	Click or tap to enter a date.
FEMA Review	
FEMA Reviewer(s) and Title	Click or tap here to enter text.
Date Received in FEMA Region	Click or tap to enter a date.
Plan Not Approved	Click or tap to enter a date.
Plan Approvable Pending Adoption	Click or tap to enter a date.
Plan Approved	Click or tap to enter a date.

Plan Review Checklist

Element A: Planning Process

Element A Requirements	Location in Plan (section and/or page number)	Met / Not Met
A1. Does the plan document the planning process, including how it was prepared and who was involved in the process for each jurisdiction? (Requirement 44 CFR § 201.6(c)(1))		
A1-a. Does the plan document how the plan was prepared, including the schedule or time frame and activities that made up the plan's development, as well as who was involved?	Section 2, p.7-12	Choose an item.
A1-b. Does the plan list the jurisdiction(s) participating in the plan that seek approval, and describe how they participated in the planning process?	Section 2.1, p.7-8	Choose an item.
A2. Does the plan document 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 non-profit interests to be involved in the planning process? (Requirement 44 CFR § 201.6(b)(2))		
A2-a. Does the plan identify all stakeholders involved or given an opportunity to be involved in the planning process, and how each stakeholder was presented with this opportunity?	Section 2.2.1.3, p.10-11; Appendix B, p.261-262	Choose an item.
A3. Does the plan document how the public was involved in the planning process during the drafting stage and prior to plan approval? (Requirement 44 CFR § 201.6(b)(1))		
A3-a. Does the plan document how the public was given the opportunity to be involved in the planning process and how their feedback was included in the plan?	Section 2.2.1.2, p.10; Appendix B, p.244-260	Choose an item.
A4. Does the plan describe the review and incorporation of existing plans, studies, reports, and technical information? (Requirement 44 CFR § 201.6(b)(3))		
A4-a. Does the plan document what existing plans, studies, reports and technical information were reviewed for the development of the plan, as well as how they were incorporated into the document?	Section 2.2.1.3, p.10-11	Choose an item.
ELEMENT A REQUIRED REVISIONS		
Required Revision: Click or tap here to enter text.		

Element B: Risk Assessment

Element B Requirements	Location in Plan (section and/or page number)	Met / Not Met
B1. Does the plan include a description of the type, location, and extent of all natural hazards that can affect the jurisdiction? Does the plan also include information on previous occurrences of hazard events and on the probability of future hazard events? (Requirement 44 CFR § 201.6(c)(2)(i))		
B1-a. Does the plan describe all natural hazards that can affect the jurisdiction(s) in the planning area, and does it provide the rationale if omitting any natural hazards that are commonly recognized to affect the jurisdiction(s) in the planning area?	Section 4.1, p.28-32	Choose an item.
B1-b. Does the plan include information on the location of each identified hazard?	Section 4.4, p.42-196 "Location" subheadings	Choose an item.
B1-c. Does the plan describe the extent for each identified hazard?	Section 4.4, p.42-196 "Extent" subheadings	Choose an item.
B1-d. Does the plan include the history of previous hazard events for each identified hazard?	Section 4.4, p.42-196 "Past Occurrences" subheadings	Choose an item.
B1-e. Does the plan include the probability of future events for each identified hazard? Does the plan describe the effects of future conditions, including climate change (e.g., long-term weather patterns, average temperature and sea levels), on the type, location and range of anticipated intensities of identified hazards?	Section 4.4, p.42-196 "Probability of Future Occurrence" subheadings	Choose an item.
B1-f. For participating jurisdictions in a multi-jurisdictional plan, does the plan describe any hazards that are unique to and/or vary from those affecting the overall planning area?	N/A	Choose an item.
B2. Does the plan include a summary of the jurisdiction's vulnerability and the impacts on the community from the identified hazards? Does this summary also address NFIP-insured structures that have been repetitively damaged by floods? (Requirement 44 CFR § 201.6(c)(2)(ii))		
B2-a. Does the plan provide an overall summary of each jurisdiction's vulnerability to the identified hazards?	Section 4.3, p.39-41; Section 4.4, p.42-196 "Vulnerability Assessment" subheadings	Choose an item.
B2-b. For each participating jurisdiction, does the plan describe the potential impacts of each of the identified hazards on each participating jurisdiction?	Section 4.4, p.42-196 "Vulnerability Assessment" and "Consequence Analysis" subheadings	Choose an item.

Element B Requirements	Location in Plan (section and/or page number)	Met / Not Met
B2-c. Does the plan address NFIP-insured structures within each jurisdiction that have been repetitively damaged by floods?	N/A; public buildings, self-insured	Choose an item.
ELEMENT B REQUIRED REVISIONS		
Required Revision: Click or tap here to enter text.		

Element C: Mitigation Strategy

Element C Requirements	Location in Plan (section and/or page number)	Met / Not Met
C1. Does the plan document each participant's existing authorities, policies, programs and resources and its ability to expand on and improve these existing policies and programs? (Requirement 44 CFR § 201.6(c)(3))		
C1-a. Does the plan describe how the existing capabilities of each participant are available to support the mitigation strategy? Does this include a discussion of the existing building codes and land use and development ordinances or regulations?	Section 5, p.198-205	Choose an item.
C1-b. Does the plan describe each participant's ability to expand and improve the identified capabilities to achieve mitigation?	Section 5, p.198-205	Choose an item.
C2. Does the plan address each jurisdiction's participation in the NFIP and continued compliance with NFIP requirements, as appropriate? (Requirement 44 CFR § 201.6(c)(3)(ii))		
C2-a. Does the plan contain a narrative description or a table/list of their participation activities?	N/A; public buildings, self-insured	Choose an item.
C3. Does the plan include goals to reduce/avoid long-term vulnerabilities to the identified hazards? (Requirement 44 CFR § 201.6(c)(3)(i))		
C3-a. Does the plan include goals to reduce the risk from the hazards identified in the plan?	Section 6.2, p.206-207	Choose an item.

Element C Requirements	Location in Plan (section and/or page number)	Met / Not Met
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 44 CFR § 201.6(c)(3)(ii))		
C4-a. Does the plan include an analysis of a comprehensive range of actions/projects that each jurisdiction considered to reduce the impacts of hazards identified in the risk assessment?	Section 6.3, p.207-209; Section 7, p.210-212	Choose an item.
C4-b. Does the plan include one or more action(s) per jurisdiction for each of the hazards as identified within the plan's risk assessment?	Section 7, p.210-212	Choose an item.
C5. Does the plan contain an action plan that describes how the actions identified will be prioritized (including a cost-benefit review), implemented, and administered by each jurisdiction? (Requirement 44 CFR § 201.6(c)(3)(iv)); (Requirement §201.6(c)(3)(iii))		
C5-a. Does the plan describe the criteria used for prioritizing actions?	Section 6.3.1, p.208-209	Choose an item.
C5-b. Does the plan provide the position, office, department or agency responsible for implementing/administrating the identified mitigation actions, as well as potential funding sources and expected time frame?	Section 7, p.210-212	Choose an item.
ELEMENT C REQUIRED REVISIONS		
Required Revision: Click or tap here to enter text.		

Element D: Plan Maintenance

Element D Requirements	Location in Plan (section and/or page number)	Met / Not Met
D1. Is there discussion of how each community will continue public participation in the plan maintenance process? (Requirement 44 CFR § 201.6(c)(4)(iii))		
D1-a. Does the plan describe how communities will continue to seek future public participation after the plan has been approved?	Section 9.3, p.216	Choose an item.

Element D Requirements	Location in Plan (section and/or page number)	Met / Not Met
D2. Is there a description of the method and schedule for keeping the plan current (monitoring, evaluating and updating the mitigation plan within a five-year cycle)? (Requirement 44 CFR § 201.6(c)(4)(i))		
D2-a. Does the plan describe the process that will be followed to track the progress/status of the mitigation actions identified within the Mitigation Strategy, along with when this process will occur and who will be responsible for the process?	Section 9.2, p.215	Choose an item.
D2-b. Does the plan describe the process that will be followed to evaluate the plan for effectiveness? This process must identify the criteria that will be used to evaluate the information in the plan, along with when this process will occur and who will be responsible.	Section 9.2, p.215-216	Choose an item.
D2-c. Does the plan describe the process that will be followed to update the plan, along with when this process will occur and who will be responsible for the process?	Section 9.2, p.215-216	Choose an item.
D3. Does the plan describe a process by which each community will integrate the requirements of the mitigation plan into other planning mechanisms, such as comprehensive or capital improvement plans, when appropriate? (Requirement 44 CFR § 201.6(c)(4)(ii))		
D3-a. Does the plan describe the process the community will follow to integrate the ideas, information and strategy of the mitigation plan into other planning mechanisms?	Section 9.1, p.214	Choose an item.
D3-b. Does the plan identify the planning mechanisms for each plan participant into which the ideas, information and strategy from the mitigation plan may be integrated?	Section 9.1, p.214	Choose an item.
D3-c. For multi-jurisdictional plans, does the plan describe each participant's individual process for integrating information from the mitigation strategy into their identified planning mechanisms?	N/A	Choose an item.
ELEMENT D REQUIRED REVISIONS		
Required Revision: Click or tap here to enter text.		

Element E: Plan Update

Element E Requirements	Location in Plan (section and/or page number)	Met / Not Met
E1. Was the plan revised to reflect changes in development? (Requirement 44 CFR § 201.6(d)(3))		
E1-a. Does the plan describe the changes in development that have occurred in hazard-prone areas that have increased or decreased each community's vulnerability since the previous plan was approved?	Section 3.7, p.26; Section 4.3, p. 39-41	Choose an item.
E2. Was the plan revised to reflect changes in priorities and progress in local mitigation efforts? (Requirement 44 CFR § 201.6(d)(3))		
E2-a. Does the plan describe how it was revised due to changes in community priorities?	Section 6.2, p.206-207	Choose an item.
E2-b. Does the plan include a status update for all mitigation actions identified in the previous mitigation plan?	Section 6.3.2, p.209; Section 7, p.210-212	Choose an item.
E2-c. Does the plan describe how jurisdictions integrated the mitigation plan, when appropriate, into other planning mechanisms?	Section 9.1, p.214	Choose an item.
ELEMENT E REQUIRED REVISIONS		
Required Revision: Click or tap here to enter text.		

Element F: Plan Adoption

Element F Requirements	Location in Plan (section and/or page number)	Met / Not Met
F1. For single-jurisdictional plans, has the governing body of the jurisdiction formally adopted the plan to be eligible for certain FEMA assistance? (Requirement 44 CFR § 201.6(c)(5))		
F1-a. Does the participant include documentation of adoption?	Section 8, p.213	Choose an item.
F2. For multi-jurisdictional plans, has the governing body of each jurisdiction officially adopted the plan to be eligible for certain FEMA assistance? (Requirement 44 CFR § 201.6(c)(5))		
F2-a. Did each participant adopt the plan and provide documentation of that adoption?	Section 8, p.213	Choose an item.

Element F Requirements	Location in Plan (section and/or page number)	Met / Not Met
ELEMENT F REQUIRED REVISIONS		
Required Revision: Click or tap here to enter text.		

Element G: High Hazard Potential Dams (Optional)

HHPD Requirements	Location in Plan (section and/or page number)	Met / Not Met
HHPD1. Did the plan describe the incorporation of existing plans, studies, reports and technical information for HHPDs?		
HHPD1-a. Does the plan describe how the local government worked with local dam owners and/or the state dam safety agency?	Click or tap here to enter text.	Choose an item.
HHPD1-b. Does the plan incorporate information shared by the state and/or local dam owners?	Click or tap here to enter text.	Choose an item.
HHPD2. Did the plan address HHPDs in the risk assessment?		
HHPD2-a. Does the plan describe the risks and vulnerabilities to and from HHPDs?	Click or tap here to enter text.	Choose an item.
HHPD2-b. Does the plan document the limitations and describe how to address deficiencies?	Click or tap here to enter text.	Choose an item.
HHPD3. Did the plan include mitigation goals to reduce long-term vulnerabilities from HHPDs?		
HHPD3-a. Does the plan address how to reduce vulnerabilities to and from HHPDs as part of its own goals or with other long-term strategies?	Click or tap here to enter text.	Choose an item.
HHPD3-b. Does the plan link proposed actions to reducing long-term vulnerabilities that are consistent with its goals?	Click or tap here to enter text.	Choose an item.
HHPD4-a. Did the plan include actions that address HHPDs and prioritize mitigation actions to reduce vulnerabilities from HHPDs?		
HHPD4-a. Does the plan describe specific actions to address HHPDs?	Click or tap here to enter text.	Choose an item.

HHPD Requirements	Location in Plan (section and/or page number)	Met / Not Met
HHPD4-b. Does the plan describe the criteria used to prioritize actions related to HHPDs?	Click or tap here to enter text.	Choose an item.
HHPD4-c. Does the plan identify the position, office, department or agency responsible for implementing and administering the action to mitigate hazards to or from HHPDs?	Click or tap here to enter text.	Choose an item.
HHPD Required Revisions		
Required Revision: Click or tap here to enter text.		

Element H: Additional State Requirements (Optional)

Element H Requirements	Location in Plan (section and/or page number)	Met / Not Met
This space is for the State to include additional requirements		
Click or tap here to enter text.	Click or tap here to enter text.	Choose an item.

APPENDIX B – PLANNING PROCESS DOCUMENTATION

Planning Step 1: Organize to Prepare the Plan

TABLE B-1: HMPC MEETING DATES

Meeting Type	Meeting Topic	Meeting Date/Time	Meeting Location
HMPC #1	3) Introduction to DMA and CRS planning process 4) Organize resources: the role of the HMPC, planning for public involvement, and coordinating with other agencies and stakeholders	October 11, 2022 1:00pm – 2:00pm	Bond Hall, Rm. 514 Citadel Campus
HMPC #2	4) Review/discussion of Hazard Risk Assessment 5) Review/discussion of Vulnerability Assessment 6) Review and discussion of the capability assessment	December 8, 2022 11:00am – 12:00pm	Microsoft Teams
HMPC #3	3) Review and update the mitigation goals and existing mitigation actions 4) Discuss new mitigation action alternatives	February 8, 2023 11:00am – 12:00pm	Microsoft Teams
HMPC #4	3) Review "Draft" Hazard Mitigation Plan 4) Solicit comments and feedback from the HMPC	March 28, 2023 2:00 – 3:00pm	Bond Hall, Rm. 514 Citadel Campus

HMPC Meeting 1: October 11, 2022

Attendance

THE CITADEL

The Citadel Hazard Mitigation Plan Committee (HMPC) Meeting
October 11, 2022

Name	Agency/Department/Stakeholder	E-mail
DAVID STROUD	WSP	david.stroud@wsp.com
David Orr	The Citadel	horr@citadel.edu
Tessa Baron	SCOR	[illegible]
Shawn WEBB	SCOR	shawn.webb@scor.sc.gov
Kevin Bower	Provost Office	kevin.bower@citadel.edu
[illegible]	IT	consolvoj1@[illegible]
Abigail Hatch	Financial Services	ahatch@citadel.edu
Mike Turner	Public Safety	mturner7@citadel.edu
WILLIAM LIND	CoS	wlind@citadel.edu
Amy Orr	Auxiliary Svcs	orra1@citadel.edu

Minutes

The Citadel Disaster Resistant Hazard Mitigation Plan Update

Hazard Mitigation Planning Committee Meeting #1
Tuesday, October 11th, 2022, 1:00 p.m.
Room 514, Bond Hall

David Stroud from WSP, the consultant, facilitated the meeting according to the following agenda:

- Trends in Disasters
    - Why Plan?
- Project Overview
- Disaster Mitigation Act (DMA) Planning Requirements
- Planning Process
    - Community Coordination
    - Public Outreach
    - Risk Assessment Update
- Project Schedule
- Next Steps

There were ten people in attendance, members of the HMPC:

- Dave Orr – Director Environmental Health and Safety & Emergency Manager/Public Safety
- Kevin Bower – Provost Office
- Tessa Baran – South Carolina Office of Resilience
- Shauna Webb – South Carolina Office of Resilience
- Abigail Hatch – Financial Services
- Mike Turner – Public Safety
- William Lind – Chief of Staff
- Amy Orr – Auxiliary Services
- Justin Consolvo - IT
- David Stroud - WSP

Dave Orr gave a brief overview of the project and asked everyone to introduce themselves. Dave also mentioned that if any member felt they did not belong on this committee to let him know and he would find an alterative appointment. Tessa Baran indicated that the South Carolina Office of Resilience provided the grant money for the update to the plan.

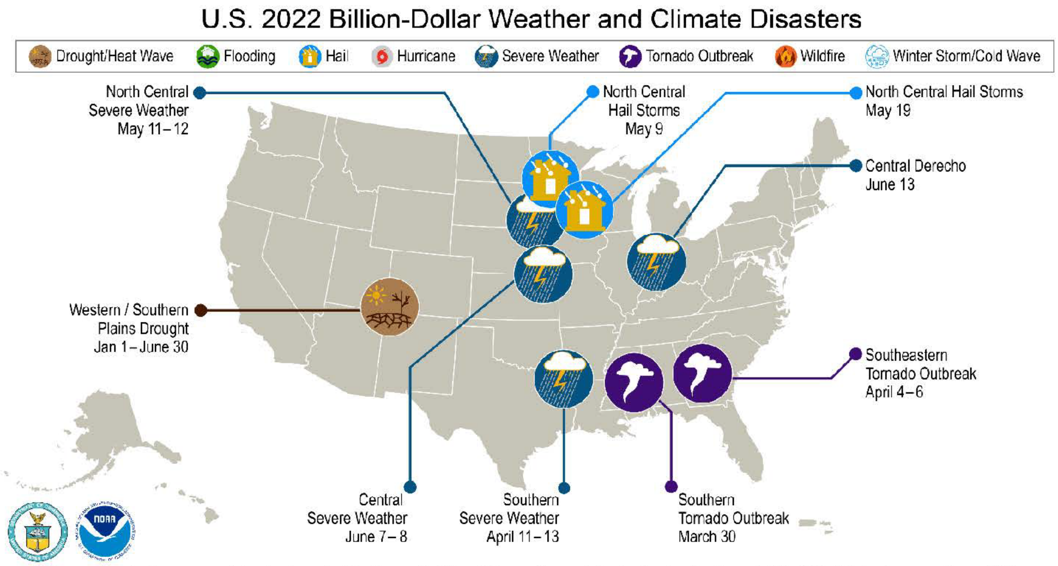
David Stroud with WSP began the presentation with why we plan in the first place. David discussed that Disaster Mitigation Act of 2000 (DMA) which is part of federal legislation through the Code of Federal Regulations 44 CFR 201.6 and that an updated plan is required to receive FEMA pre- and post-disaster mitigation funding through the Hazard Mitigation Assistance funding programs. David went on to review some trends in disasters including that we now have more people in harm's way and greater exposure to risk (people, property and critical infrastructure). Below is a graphic showing the nine billion-dollar disaster and climate events so far in 2022. In 2021 there were eighteen-billion-dollar disaster and climate events across the US.

Mr. Lind asked the difference between a hazard and risk and provided an example of a hazard being a tree root sticking up out of the ground and risk is probability that you could trip over that root and be injured. Mr. Stroud explained that in hazard mitigation planning there is a two-prong effort in first evaluating the various hazards and then preparing a vulnerability risk assessment. The term used for what is the largest portion of a hazard mitigation plan is Hazard Identification and Risk Assessment or HIRA.

Additional information was provided on the costliest disasters in both the US since 1980 and in South Carolina. Hurricane IRMA in 2017 resulted in approximately $57.5 billion in damage.

Mr. Stroud also indicated why Hazard Mitigation should be a priority for the Citadel because the cost of response and recovery are increasing, many of the events are predictable and repetitive, and loss reductions activities work.

1 The Citadel Disaster Resistant HMP Update | HMPC Meeting 1



This map denotes the approximate location for each of the 9 separate billion-dollar weather and climate disasters that impacted the United States January – June of 2022.

Mr. Stroud went on to discuss the project overview including looking at the four-phases of (DMA). The discussion included what DMA is and why DMA is important:

- Outlines the planning requirements that local governments must follow
- Provides continued eligibility for mitigation funds, pre- and post-disaster funding
- Guides mitigation activities in a coordinated & economical manner
- Integrates into other existing planning mechanisms
- Directs future development and informs wise planning and building
- Reduces losses and makes communities more disaster resistant

Phase 1: Organizing Resources which included the work that The Citadel Emergency Management did in establishing the Hazard Mitigation Planning Committee along with the need to reach out to additional stakeholders in a plan for public involvement.

Phase 2: Assessing Risks where the questions asked: Hazard Identification-Can it happen here? Vulnerability Assessment-What will be affected or impacted? And with a Capability Assessment-How can we implement mitigation?

The HMPC committee reviewed the natural and man-made or human-caused hazards from the 2016 Disaster Resistant Hazard Mitigation Plan against the hazards in the 2018 South Carolina State Hazard Mitigation Plan along with the 2020 Charleston County Regional Hazard Mitigation Plan to determine the new list of hazards for the 2022/2023 updated plan.

The committee decided that all natural hazards would continue with this plan update. Mr. Stroud asked if sinkholes were a prevalent hazard on campus. There was indication that there have been sinkholes on campus. Since there is no data source that can be accessed for this type of supporting information, the plan will have to rely on anecdotal information or reports from staff at the Citadel.

There was a lot of discussion surrounding the human caused and/or man-made hazards. It was concluded that the three hazards from the current plan will be carried forward (active shooter, civil disturbance and hazardous materials). Additional discussion took place around other human caused or man-made hazards specifically around cyber security and pandemic. After that discussion it was concluded that cyber security would be added to this plan update. Mr. Stroud mentioned that terrorism is really broad-based and that it could be part of the civil disturbance hazard.

Phase 3 includes reviewing the previous goals and objectives and updating them if necessary for this current update, review a comprehensive list of mitigation project alternatives to determine that the appropriate projects are selected for implementation, and drafting and action plan with both ongoing mitigation projects along with new selected projects.

Mr. Stroud provided a couple of slides which showed the 20 mitigation projects from the current plan. Mr. Stroud indicated that staff would need to provide a status of each mitigation project as to whether it is complete, not started, ongoing or other. FEMA requires a status of each mitigation project in the plan.

Phase 4 requires the HMPC to meet at least annually to review the plan; however, it is encouraged to meet more often via a conference call or in person meeting as having the plan in front of the HMPC more often hopefully results in projects more likely to be implemented.

The next discussion focused on the project schedule and milestones. It is anticipated that the Hazard Identification and Risk Assessment (HIRA) Section of the plan will be finished and the next HMPC meeting would occur in November. The draft HIRA will be provided to the committee for review. The 3rd HMPC mitigation strategy meeting would occur in December and the fourth and final HMPC meeting on the final draft plan will most likely occur in January.

David explained the public outreach strategy and that there would be a website developed which would be a one-stop shop for all information on hazard mitigation planning and this plan update. The Citadel should post a link and QR code (shown below) on their website to get broader public support though the planning process.

Survey link: https://forms.office.com/r/mutegkp2Xb

Mr. Stroud explained that he would be in contact with Dave Orr to set up the first public meeting within a couple of weeks to try to get broader support for the planning process.

As far as next steps, the HMPC members should begin looking at the existing mitigation projects and determine the status of each project as well as help with public engagement and getting the word out on the public survey.

The meeting ended at 1:45 PM

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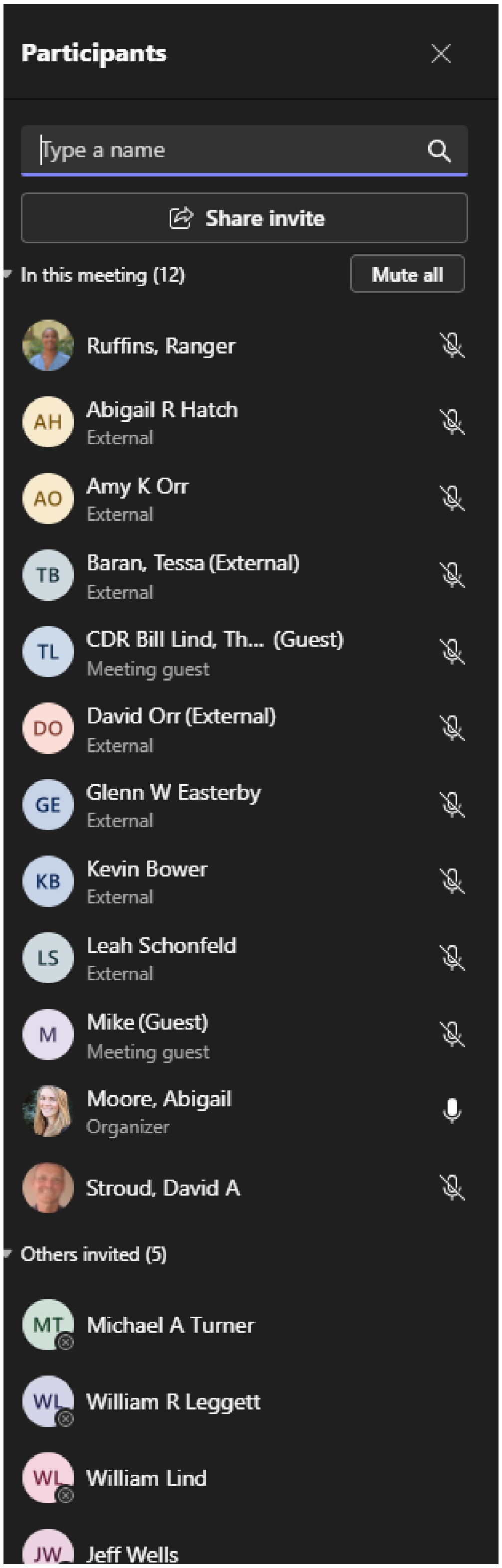
HMPC Meeting 2: December 8, 2022

Attendance



Minutes

The Citadel Disaster Resistant Hazard Mitigation Plan Update

Hazard Mitigation Planning Committee Meeting #2
Thursday, December 8th, 2022, 11:00 a.m.
Microsoft Teams Meeting

David Stroud, Abby Moore, and Ranger Ruffins from WSP, the consultant, facilitated the meeting according to the following agenda:

- Where we are in the planning process
  - Step 4 & Step 5
  - HIRA Organization in the plan
- Hazard Identification
  - Major Disaster Declarations & past events
  - Hazards from the State/County plans & existing Citadel HMP
- Asset Inventory
- Hazard Profiles: Risk & Vulnerability Assessment
- Next Steps

There were nine people in attendance, members of the HMPC:

- Dave Orr – Director Environmental Health and Safety & Emergency Manager/Public Safety
- Kevin Bower – Provost Office
- Tessa Baran – South Carolina Office of Resilience
- Glenn Easterby – Facilities and Engineering
- Leah Schonfeld – Human Resources
- Abigail Hatch – Financial Services
- Mike Turner – Public Safety
- William Lind – Chief of Staff
- Amy Orr – Auxiliary Services

Where We Are in the Planning Process

David updated the HMPC on where WSP is in the 10-Step Planning Process. The planning process is currently at Steps 4 and 5 (Assess the Hazard and Assess the Problem). These steps comprise the Hazard Identification and Risk Assessment (HIRA). Abby noted that there are three key factors that are assessed to determine risk and a hazards potential impact – the hazard itself, vulnerability to a given hazard, and exposure. Once Steps 4 and 5 are complete, the information gathered in this process will factor into the remaining steps.

Hazard Identification

Hazards were identified for initial review based on the list of hazards included in the 2017 Citadel Hazard Mitigation Plan, the 2019 Charleston Regional Hazard Mitigation Plan, the 2018 South Carolina State Hazard Mitigation plan, major disaster declarations for the county, and HMPC input from the previous meeting. The full list of hazards profiled is as follows:

- Dam Failure
- Drought
- Earthquake
- Extreme Heat
- Flood
- Hurricane & Tropical Storm (Storm Surge & Wind)
- Sea Level Rise
- Severe Weather (Thunderstorm Wind, Hail & Lightning)
- Sinkhole
- Tornado
- Tsunami
- Wildfire
- Winter Weather
- Active Shooter
- Civil Disturbance
- Cyber Disruption
- Hazardous Materials

Asset Inventory

The asset inventory details what exists on The Citadel Campus that may be impacted by the various hazards profiled. Assets include buildings and critical facilities at risk in the planning area. 82 buildings and ten critical facilities on campus have been identified.

It was noted that the new Capers Hall building was elevated. The WSP team will determine if this elevation has already been included in the vulnerability assessments. If not included, they will adjust and note these changes in the plan.

The HMPC also discussed the importance of the campus barracks and mess hall, noting that damage to these buildings would greatly impact campus life and operations. The WSP team will ensure this is noted in the vulnerability assessment sections of the appropriate hazards.

Hazard Profiles

The Hazard Profiles, presented by Abby and Ranger, summarized the results of the risk and vulnerability analyses of each of the hazards listed above. Abby reviewed the Priority Risk Index (PRI) methodology which rates each hazard on probability, impact, spatial extent, warning time, and duration. Each category is rated on a scale of 1-4 which provides a weighted sum prioritization that allows hazards to be compared like-for-like and rated high, moderate, or low priority. The hazard profiles were created using qualitative and quantitative data gathered from national, state, and local sources. Where applicable, WSP used FEMA's Hazus program to approximate the potential risk/loss The Citadel might face in the event of the hazards.

In total, two hazards were rated low risk – dam failure and sinkhole. Four hazards (earthquake, flood, sea level rise, and cyber disruption) were rated high risk, and the remaining 11 hazards were rated moderate risk. A summary table of the PRI results are below.

The HMPC noted that sinkholes have become increasingly common on campus in roadways and parking lots. There have been three in the last year, and they estimate one pothole every four to five months. The holes are about the size of a dinner plate and causes have been attributed to soil type, utilities, increases of fill over time. HMPC staff will follow up with locations and more detail of these occurrences which will be added to the plan.

Hazard	Probability	Impact	Spatial Extent	Warning Time	Duration	PRI Score
Natural Hazards						
Dam Failure	Unlikely	Limited	Moderate	>24 hours	<1 week	1.9
Drought	Highly Likely	Minor	Large	>24 hours	>1 week	2.8
Earthquake	Possible	Critical	Large	<6 hours	>1 week	3.1
Extreme Heat	Likely	Minor	Large	>24 hours	<1 week	2.4
Flood	Highly Likely	Critical	Large	6 to 12 hours	<1 week	3.5
Hurricane & Tropical Storm	Highly Likely	Critical	Large	>24 hours	<1 week	3.3
Sea Level Rise	Highly Likely	Limited	Small	>24 hours	>1 week	2.7
Severe Weather (Thunderstorm, Hail, Lightning)	Highly Likely	Minor	Large	6 to 12 hours	<6 hours	2.7
Sinkhole	Unlikely	Limited	Negligible	<6 hours	<6 hours	1.6
Tornado	Likely	Limited	Moderate	<6 hours	<6 hours	2.6
Tsunami	Unlikely	Critical	Large	<6 hours	<24 hours	2.6
Wildfire	Possible	Limited	Moderate	<6 hours	<1 week	2.5
Winter Weather	Likely	Limited	Large	12 to 24 hours	<1 week	2.7
Technological & Human-Caused Hazards						
Active Shooter	Possible	Catastrophic	Small	<6 hours	<6 hours	2.7
Civil Disturbance	Possible	Limited	Small	<6 hours	<1 week	2.3
Cyber Disruption	Possible	Critical	Large	<6 hours	<1 week	3.0
Hazardous Materials	Possible	Limited	Small	<6 hours	<1 week	2.2

Next Steps

Ranger noted that the HMP survey is still open and asked that another push be made to generate more responses.

Survey link: https://forms.office.com/r/mutegkp2Xb

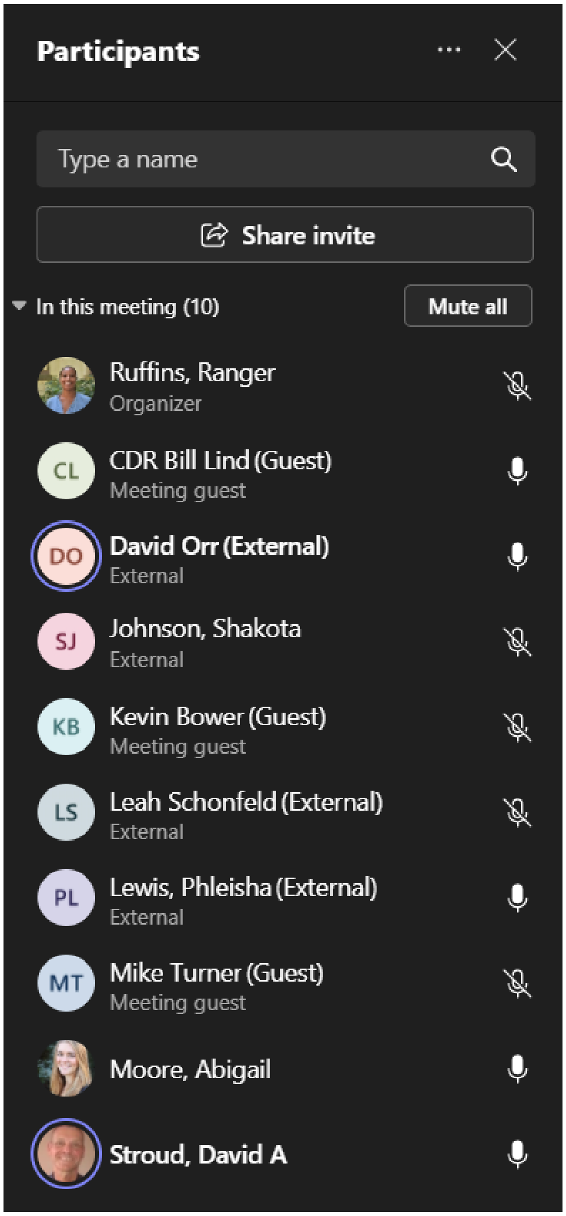
The HMPC was also asked to review the draft HIRA document which will be sent to Committee members by the WSP staff. Please send WSP consultants any questions or comments.

WSP staff will work with the HMPC to schedule the next meeting where we will review the findings from the capability assessment, discuss plan goals and objects, and review potential mitigation actions. As the HMPC reviews the draft HIRA members should begin looking thinking about any new strategies that should be included in the updated mitigation strategy.

The meeting ended at 11:55 AM

HMPC Meeting 3: February 8, 2023

Attendance



Minutes

THE CITADEL

The Citadel Disaster Resistant Hazard Mitigation Plan Update
Hazard Mitigation Planning Committee Meeting #3
Wednesday, February 8th, 2023, 11:00 a.m.
Microsoft Teams Meeting

David Stroud, Abby Moore, and Ranger Ruffins from WSP, the consultant, facilitated the meeting according to the following agenda:

- Where we are in the planning process
  - Step 6, Step 7, & Step 8
- Hazard Identification & Risk Assessment Recap
- Mitigation Goals
- Mitigation Action Plan Update & Mitigation Ideas
- Public & Stakeholder Engagement
- Next Steps

There were seven people in attendance, members of the HMPC and SCOR:

- Dave Orr – Director Environmental Health and Safety & Emergency Manager/Public Safety
- Kevin Bower – Provost Office
- Leah Schonfeld – Human Resources
- Mike Turner – Public Safety
- William Lind – Chief of Staff
- Shakota Johnson – South Carolina Office of Resilience
- Phleisha Lewis – South Carolina Office of Resilience

Where We Are in the Planning Process
David updated the HMPC on where WSP is in the 10-Step Planning Process. The planning process is currently at Steps 6, 7 and 8 – Set Goals, Review Possible Activities, and Draft an Action Plan, respectively. The information from Steps 4 and 5, the hazard identification and risk assessment, will factor into the next phase.

Hazard Identification & Risk Assessment Recap
Hazards were identified for initial review based on the list of hazards included in the 2017 Citadel Hazard Mitigation Plan, the 2019 Charleston Regional Hazard Mitigation Plan, the 2018 South Carolina State Hazard Mitigation plan, major disaster declarations for the county, and HMPC input from the previous meeting. The full list of hazards profiled is as follows:

- Dam Failure
- Drought
- Earthquake
- Extreme Heat
- Flood
- Hurricane & Tropical Storm (Storm Surge & Wind)
- Sea Level Rise
- Severe Weather (Thunderstorm Wind, Hail & Lightning)
- Sinkhole
- Tornado
- Tsunami
- Wildfire
- Winter Weather
- Active Shooter
- Civil Disturbance
- Cyber Disruption
- Hazardous Materials

David reviewed the Priority Risk Index (PRI) methodology which rates each hazard on probability, impact, spatial extent, warning time, and duration and allows the hazards to be compared like-for-like and rated high, moderate, or low priority. A summary table of the PRI results are below.

1 The Citadel Disaster Resistant HMP Update | HMPC Meeting 3

Hazard	Probability	Impact	Spatial Extent	Warning Time	Duration	PRI Score
Natural Hazards						
Dam Failure	Unlikely	Limited	Moderate	>24 hours	<1 week	1.9
Drought	Highly Likely	Minor	Large	>24 hours	>1 week	2.8
Earthquake	Possible	Critical	Large	<6 hours	>1 week	3.1
Extreme Heat	Likely	Minor	Large	>24 hours	<1 week	2.4
Flood	Highly Likely	Critical	Large	6 to 12 hours	<1 week	3.5
Hurricane & Tropical Storm	Highly Likely	Critical	Large	>24 hours	<1 week	3.3
Sea Level Rise	Highly Likely	Limited	Small	>24 hours	>1 week	2.7
Severe Weather (Thunderstorm, Hail, Lightning)	Highly Likely	Minor	Large	6 to 12 hours	<6 hours	2.7
Sinkhole	Unlikely	Limited	Negligible	<6 hours	<6 hours	1.6
Tornado	Likely	Limited	Moderate	<6 hours	<6 hours	2.6
Tsunami	Unlikely	Critical	Large	<6 hours	<24 hours	2.6
Wildfire	Possible	Limited	Moderate	<6 hours	<1 week	2.5
Winter Weather	Likely	Limited	Large	12 to 24 hours	<1 week	2.7
Technological & Human-Caused Hazards						
Active Shooter	Possible	Catastrophic	Small	<6 hours	<6 hours	2.7
Civil Disturbance	Possible	Limited	Small	<6 hours	<1 week	2.3
Cyber Disruption	Possible	Critical	Large	<6 hours	<1 week	3.0
Hazardous Materials	Possible	Limited	Small	<6 hours	<1 week	2.2

Hazard Mitigation Goals

David presented the goals from the previous 2017 Citadel HMP which are as follows:

- **Goal 1:** Reduce the vulnerability of the people and property of the college from the effects of natural and manmade hazards.
- **Goal 2:** Safeguard the College's mission of education, outreach, and engagement against natural or man-made hazards.
- **Goal 3:** Preserve and strengthen protection of critical facilities and infrastructure through the implementation of mitigation actions to create a safer, more sustainable College.
- **Goal 4:** Enhance campus education programs to raise awareness of and preparedness for hazard events.
- **Goal 5:** Improve and coordinate mitigation activities with surrounding communities, non-profits and private businesses.

David noted that the goals are still relevant and can be carried forward for the plan update but asked the Committee to review the goals and provide any updates.

Mitigation Action Plan Update

Abby reviewed the mitigation actinon plan requirements which indicate that the plan must have at least one mitigation action for each hazard, and while "all hazards" actions can count as one project for each hazard, emergency services actions do not count toward this requirement. Abby also explained that the action plan should try to include mitigation action from each FEMA Mitigation Category to ensure a comprehensive and robust mitigation approach. The FEMA categories are as follows:

- Prevention
- Property Protection
- Natural Resource Protection
- Structural Projects
- Emergency Services
- Public Education & Awareness

Abby reviewed each action item and the Committee discussed which actions have been completed and which ones should be carried forward in the plan update. The completed actions will be removed from the plan and the no progress actions will be carried forward. The in-progress actions are also likely to be carried forward (pending any additional Committee feedback). The tables below summarize the status of the discussed actions.

Completed Actions

Action #	Action Description	Year Completed	Comments
5	Continue annual active shooter training.	2021	Drill was conducted in the Fall of 2022 through the Public Safety Department and has become an annual training exercise.

Action #	Action Description	Year Completed	Comments
6	Utilize Quartzy (or similar software) to inventory all chemical on campus. Maintain a copy of the inventory on OneDrive.	2019	The school is in the process of phasing out Quartzy and moving to a SDS Chemical Software program called Vector Solutions. Software has been installed and being utilized. Most all SDS's have been migrated over to the new system.
10	Implement hazard warning system for cadets who are outside, away from phone system.	2019	Installation of the "Giant Voice" allows verbal warnings real time. 3 speaker array systems on and off campus for coverage everyone can hear. Also, an Emergency Warning Siren can be sounded if necessary. Warning system is tested every month (regularly).
11	Pursue grant to improve shelving for chemical storage, eye wash stations, etc.	2020	Chemical storage area has been cleaned and organized.

In-Progress and No Progress Actions

Action #	Action Description	Comments
In-Progress		
2	Develop a web based and social media all hazards outreach program.	The school utilizes the Citadel website created by OCM and now has a Public Safety Website that can communicate campus hazards.
3	Continue the library's annual hurricane preparedness exhibit.	This is an ongoing project that is emphasized during hurricane season June 1 to Nov 30. State SCEMD brochures are sent to the library and distributed to entire campus.
4	Participate in a combined hurricane preparedness exercise with City of Charleston and Charleston County.	The Citadel Emergency Manager works very closely with the City, County, State and Federal Emergency Management Agencies. This includes the local National Weather Service in Charleston, SC
7	Abide by City of Charleston Floodplain Management Ordinance for new development on campus.	As the school's Emergency Manager, we work very closely with the City and have participated in Flood planning with city officials.
8	Apply for grants to implement earthquake retrofit projects on campus buildings.	Ongoing as the grants become available
12	Develop a system to ensure that new cadets, faculty and staff are exposed to basic all-hazards preparedness training during orientation activities.	Communication has been developed and handed over to the Commandant's office Sgt Major. This information is presented to each incoming class at the beginning of the school year in Aug/Sept. The EHS Newsletter communicated campus hazards to the entire Citadel campus.
13	Develop a policy for training, inspection and enforcement of hazardous materials storage procedures.	This is part of the 29CFR1910.1200 Hazcom training that is conducted annually. All maintenance and Public Safety employees will receive OSHA 10 or 30 training in 2023.
14	Control access for large classrooms during lock-down situations while staying within the requirements of the Fire Code.	All new construction will implement control access on all doors. Barracks are complete with new buildings coming online. Existing buildings will be included as renovations are completed.
15	Coordinate with City of Charleston/ Charleston County to develop a debris management plan.	Ongoing as weather conditions exist. In the 2022 hurricane season we coordinated with the city, county and federal Homeland Security Agencies reimbursement for debris pick up and disposal. Most of this work is completed in house.
16	Develop a policy requiring a hazard assessment for all new construction/projects to ensure potential risks to natural and man-made hazards are noted and mitigation considerations incorporated into the planning/design process.	The Director of Environmental Health and Safety participates in the initial contractor orientations on campus and makes periodic audits of the worksites. We also attend all new employee orientations on campus in coordination with the Human Resource Department.
17	Consider alternative parking for areas that frequently flood during heavy rains.	Problem continues to exist on campus - there are discussions and plans on corrective actions and those areas have been identified.
18	Develop a Comprehensive Land Use Plan to guide future development on campus and for future expansion.	This is a part of the overall campus 25-year plan. Plan is updated every 10 years.
19	Develop/implement a communications system for classrooms to alert humans real-time during an active shooter event or other immediate danger.	Installation of the "Giant Voice" allows verbal warnings real time. 3 speaker array systems on and off campus for coverage everyone can hear. Also an Emergency Warning Siren can be sounded if necessary.
20	Develop/implement an automated personnel accountability system or application activated upon a hazardous event to alert staff.	Each building has a person(s) that are responsible to account for individuals in case of an emergency - all building conduct annual

3 The Citadel Disaster Resistant HMP Update | HMPC Meeting 3

Action #	Action Description	Comments
		evacuations drills with those buildings considered assembly areas conduct evacuations drills 4 times per year.
No Progress		
1	Develop GIS capabilities to provide spatial, structural, environmental, and inventory information.	We are researching a phone app for Public Safety that will allow up the ability to develop GIS capabilities along with Geofencing on campus. Goal is to have app fully implemented by year end 2023
9	Consider flap gates for outlets that drain to Ashley River or tidally influenced water bodies.	Part of the school's long-range planning through the Facilities and Engineering Department.

The existing mitigation actions do meet the regulatory requirements – each hazard has an action item, several of which fall under "all-hazards" actions. As the Committee reviews the mitigation strategy, they may want to consider hazard-specific actions for the following hazards: dam failure, drought, extreme heat, sea level rise, severe weather, wildfire, winter weather, and cyber disruption. The WSP staff will provide the FEMA Mitigation Ideas resource guide to help brainstorm any new potential hazards. Abby provided the following suggestions for new mitigation actions:

Drought:
- Encourage drought-tolerant landscaping such as xeriscaping
- Promote permeable paving to reduce runoff and promote groundwater recharge

Extreme Heat:
- Increase tree plantings around buildings and public rights-of-way to increase shade
- Installation of green roofs and/or cool roofs

Severe Weather:
- Install surge protection on critical electronic equipment
- Incorporate structural bracing, shutters, laminated glass, hail resistant roof covering, etc. into new buildings and building retrofits

Wildfire:
- Create defensible zones around power lines, oil and gas lines, and other infrastructure systems

Abby also reviewed mitigation action input from the public survey. One comment discussed flooding at the Fishburne-Hagood intersection. Addressing this specific problem is beyond the capabilities of the College, however future actions could include coordination with the City to improve drainage in nearby parking lots or the surrounding area. However, Committee members did note that any major adjustments to parking on campus could cause flooding challenges elsewhere. It was suggested that more signage could be added around parking areas to communicate the potential for flood risk around various locations on campus.

It was also suggested that the College enforce a higher freeboard for new or renovated buildings on campus and HMPC members agreed that this should be a new action added to the updated mitigations strategy.

The HMPC also discussed adding an action that promotes the statewide warning and alert system and encourage cadets, faculty, and staff to register via text or email to receive important public safety information about local incidents.

The Committee should review the existing list of actions and consider any new additional actions to be included in the plan update.

Next Steps

- WSP team asked the HMPC to promote the public survey to capture any final input to be included in the plan
  - **Survey link:** https://forms.office.com/r/mutegkp2Xb
- HMPC should review the list of existing actions and information from this meeting and provide any additional actions to include in the mitigation strategy
- HMPC should review the plan goals and provide any comments or edits
- WSP staff will work with the HMPC to schedule the next meeting where we will review the completed draft, discuss ongoing implementation and maintenance, and present eh updated plan to the public

This meeting ended at 11:50 AM

4 The Citadel Disaster Resistant HMP Update | HMPC Meeting 3

HMPC Meeting 4: March 28, 2023

Attendance

The Citadel Hazard Mitigation Planning Committee (HMPC) Meeting
March 28, 2023

THE CITADEL
THE MILITARY COLLEGE OF SOUTH CAROLINA

Name	Department/Role	E-mail
DAVID STROUD	WSP	davidstroud@wsp.com
David Orr	Citadel	horr@citadel.edu
Abby Moore	WSP	abigail.moore@wsp.com
William Lind	COS	wlind@citadel.edu
Amy Orr	AUX SVCS	orra1@citadel.edu
Leah Schonfeld	HR	leah.schonfeld@citadel.edu
MIKE TURNER		
KEVIN BOWEN		

Minutes

The Citadel Disaster Resistant Hazard Mitigation Plan Update
Hazard Mitigation Planning Committee Meeting #4
Tuesday, March 28th, 2023, 2:00 p.m.
Bond Hall, Room 514 & Microsoft Teams Meeting

David Stroud and Abby Moore from WSP, the consultant, facilitated the meeting according to the following agenda:

- Where we are in the planning process
  - Steps 8 and 9
- Organization of the Plan
- Review of Key Plan Components
  - Planning Process
  - Hazards & Priority Risk Index
  - Goals & Objectives
  - Mitigation Actions
- Plan Implementation & Maintenance
- Next Steps

There were eleven people in attendance:

- Dave Orr – Director Environmental Health and Safety & Emergency Manager/Public Safety
- Kevin Bower – Provost Office
- Leah Schonfeld – Human Resources
- Mike Turner – Public Safety
- William Lind – Chief of Staff
- Amy Orr – Auxiliary Services
- Shakota Johnson – South Carolina Office of Resilience (attended virtually)
- Phleisha Lewis – South Carolina Office of Resilience (attended virtually)
- David Stroud – WSP
- Abby Moore – WSP
- Ranger Ruffins – WSP (attended virtually)

Where We Are in the Planning Process

David updated the HMPC on where we are in the 10-Step planning process. The planning process is currently at Steps 8 – Draft an Action Plan, and Step 9 – Adopt the Plan.

Plan Organization

David reviewed each of the nine sections of the updated plan document. Section 1 Introduction provides an overview of the plan and the requirements met in its preparation. Section 2 Planning Process summarizes the 10 steps of the planning process, who was involved in the HMPC, and how the public and stakeholders were involved. Section 3 Campus Profile provides a summary of the current conditions at the Citadel. Section 4 Hazard Identification and Risk Assessment identifies the hazards relevant to the Citadel and presents the detailed hazard profiles with risk and vulnerability information, an inventory of exposure and estimates of the potential impact of each hazard. Section 5 Capability Assessment reviews the Citadel tools, resources, staff, and other capabilities to support mitigation project implementation. Section 6 Mitigation Strategy presents the updated goals, the process used to develop them, and prioritization criteria for the mitigation action review. Section 7 Mitigation Action Plan presents the updated mitigation action plan. Section 8 Plan Adoption has the plan adoption documents and Section 9 Plan Implementation and Maintenance describes the procedures for monitoring and implementing the plan over the next five years and through the next plan update.

There are also three appendices with additional information on the plan review tool, planning process documentation, a review of mitigation alternatives, and plan references.

Key Plan Components

David reviewed key steps in the planning process, including HMPC meetings, community data collection meetings, and public meetings. Public outreach efforts were also reviewed to demonstrate the ways the Citadel and communities sought to encourage public input. David also reviewed the public survey, which unfortunately only had nine responses. While broad conclusions could not

1 The Citadel Disaster Resistant HMP Update | HMPC Meeting 4

be drawn from this small number of responses, the answers were reviewed to support the hazard identification and risk assessment as well as the mitigation strategy. Opinions on the most important mitigation categories align with what the Citadel is already doing.

Abby reviewed the identified hazards and the Priority Risk Index (PRI) results. A summary table of the PRI results is below.

Hazard	Probability	Impact	Spatial Extent	Warning Time	Duration	PRI Score
Natural Hazards						
Dam Failure	Unlikely	Limited	Moderate	>24 hours	<1 week	1.9
Drought	Highly Likely	Minor	Large	>24 hours	>1 week	2.8
Earthquake	Possible	Critical	Large	<6 hours	>1 week	3.1
Extreme Heat	Likely	Minor	Large	>24 hours	<1 week	2.4
Flood	Highly Likely	Critical	Large	6 to 12 hours	<1 week	3.5
Hurricane & Tropical Storm	Highly Likely	Critical	Large	>24 hours	<1 week	3.3
Sea Level Rise	Highly Likely	Limited	Small	>24 hours	>1 week	2.7
Severe Weather (Thunderstorm, Hail, Lightning)	Highly Likely	Minor	Large	6 to 12 hours	<6 hours	2.7
Sinkhole	Unlikely	Limited	Negligible	<6 hours	<6 hours	1.6
Tornado	Likely	Limited	Moderate	<6 hours	<6 hours	2.6
Tsunami	Unlikely	Critical	Large	<6 hours	<24 hours	2.6
Wildfire	Possible	Limited	Moderate	<6 hours	<1 week	2.5
Winter Weather	Likely	Limited	Large	12 to 24 hours	<1 week	2.7
Technological & Human-Caused Hazards						
Active Shooter	Possible	Catastrophic	Small	<6 hours	<6 hours	2.7
Civil Disturbance	Possible	Limited	Small	<6 hours	<1 week	2.3
Cyber Disruption	Possible	Critical	Large	<6 hours	<1 week	3.0
Hazardous Materials	Possible	Limited	Small	<6 hours	<1 week	2.2

Abby reviewed the goals which did not change based on the HMPC's guidance that the existing goals remain relevant.

The resulting goals for the plan update are listed below.

- **Goal 1:** Reduce the vulnerability of the people and property of the College from the effects of natural and manmade hazards.
- **Goal 2:** Safeguard the College's mission of education, outreach, and engagement against natural or man-made hazards.
- **Goal 3:** Preserve and strengthen protection of critical facilities and infrastructure through the implementation of mitigation actions to create a safer, more sustainable College.
- **Goal 4:** Enhance campus education programs to raise awareness of and preparedness for hazard events.
- **Goal 5:** Improve and coordinate mitigation activities with surrounding communities, non-profits and private businesses.

Abby reviewed the mitigation actinon plan noting that all regulatory requirements have been met. There are 16 mitigation actions, including four new actions and actions for all identified hazards.

Implementation and Maintenance

Abby described the HMPC responsibilities for implementation and maintenance which includes an annual review of the plan, plan implementation, monitoring funding securities, and ensure continued public involvement.

An HMPC member asked about the process moving forward for approval and adoption. David and Abby explained that the plan will be revised according to any HMPC and public feedback and then submitted to the Citadel. Once the Citadel approves the plan, it will be sent to SCEMD and FEMA for review and final approval.

Discussion

The HMPC asked WSP staff about funding for mitigation projects and support for plan implementation.

It was asked if a building rebuild would qualify for FEMA funding. Abby and David explained that this would not be a project supported by FEMA. Abby described HMGP and BRIC funding and will follow up with more details about these funding opportunities.

Phleisha from the South Carolina Office of Resilience indicated that SCOR is opening up an application for funding that addresses riverine flooding and stormwater challenges and indicated that the Citadel could apply for funding if it has a project it would like to apply for. Phleisha did note that application process is highly competitive.

Phleisha expressed concern about outreach for the public meeting. The meeting was advertised through The Citadel's Office of Communications and Marketing and announcements were posted online on March 22nd on the Citadel Today website and on local neighborhood Facebook groups.

Next Steps

- A final public meeting will be held in the evening after this meeting
- HMPC members are asked to review the final draft plan and provide feedback by April 12th
- WSP staff will incorporate feedback into the plan
- Plan will be submitted to SCEMD and FEMA for review and approval
- The Citadel will need to formally adopt the plan after SCEMD approval

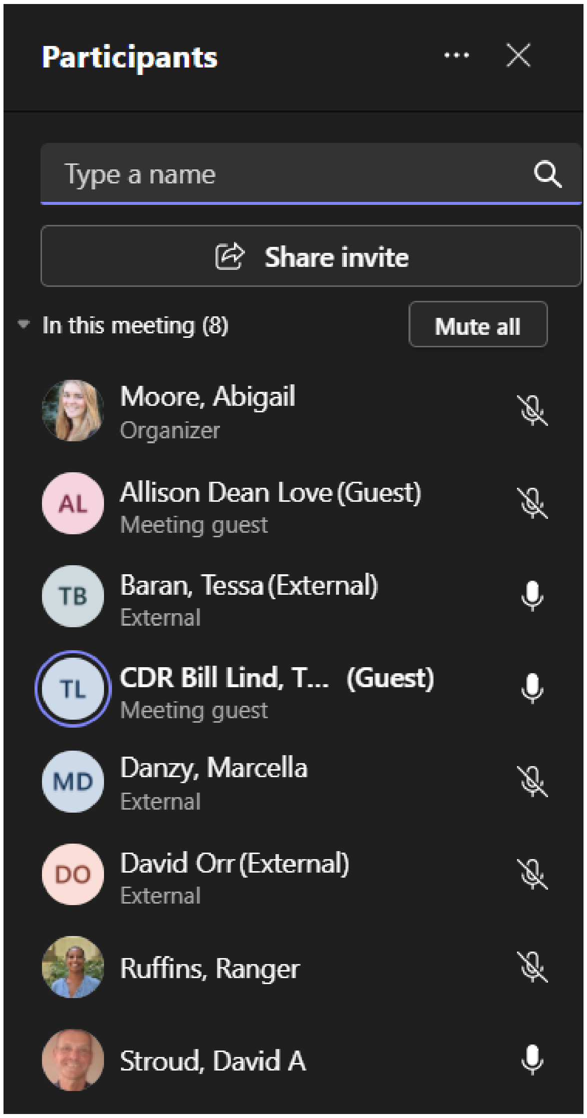
Planning Step 2: Involve the Public

TABLE B-3: PUBLIC MEETING DATES

Meeting Type	Meeting Topic	Meeting Date/Time	Meeting Location
Public Meeting #1	3) Introduction to DMA, CRS, DRU, and the planning process 4) Introduction to hazard identification	November 16, 2022 5:00 – 6:00PM	Microsoft Teams
Public Meeting #2	3) Review complete draft Hazard Mitigation Plan 4) Solicit comments and feedback from the public	March 28, 2023 5:00 – 6:00pm	Bond Hall, Rm. 514 Citadel Campus

Public Meeting 1: November 16, 2022

Attendance



Minutes

The Citadel Disaster Resistant University Hazard Mitigation Plan Update

Public Meeting #1
Wednesday, November 16th, 2022, 5:00 p.m.
Microsoft Teams

David Stroud and Ranger Ruffins from WSP, the consultant for this plan update, facilitated the meeting according to the following agenda:

- Why Plan?
- Project Overview
- Disaster Mitigation Act (DMA) Planning Requirements
- Planning Process
- Public Outreach
- Project Schedule
- Next Steps

There were eight people in attendance:

- Dave Orr – Director Environmental Health and Safety & Emergency Manager/Public Safety
- Bill Lind, Chief of Staff, The Citadel
- Allison Love, Member of the Board of Visitors and professional in the insurance industry
- Tessa Baran, SCOR
- Marcella Danzy, Buyout Case Manager, SCOR
- David Stroud, WSP
- Ranger Ruffins, WSP
- Abby Moore, WSP

Why Plan?

David Stroud with WSP began with why we plan in the first place. David discussed that Disaster Mitigation Act of 2000 (DMA) which is part of federal legislation through the Code of Federal Regulations 44 CFR 201.6 and that an updated plan is required to receive FEMA pre- and post-disaster mitigation funding through the Hazard Mitigation Assistance funding programs.

David reviewed some trends in disasters including that we now have more people in harm's way and greater exposure to risk (people, property, and critical infrastructure). As of July, there have been nine billion-dollar disaster and climate events so far in 2022. In 2021, there were 18 billion-dollar disaster and climate events across the United States. Information was provided on the costliest disasters since 1980 across the U.S. and in South Carolina. Hurricane Irma in 2017 resulted in approximately $57.5 billion in damage.

David also indicated that hazard mitigation should be a priority for the Citadel because the cost of response and recovery are increasing, many of the events are predictable and repetitive, and loss reductions activities work.

Project Overview

Ranger provided an overview of the project, beginning with the following information on what the DMA is and why it is important:

- Outlines the planning requirements that local governments must follow
- Provides continued eligibility for mitigation funds, pre- and post-disaster funding
- Guides mitigation activities in a coordinated & economical manner
- Integrates into other existing planning mechanisms
- Directs future development and informs wise planning and building
- Reduces losses and makes communities more disaster resistant

Ranger reviewed the four phases of the DMA planning process, outlined below:

1 The Citadel Disaster Resistant University HMP Update | Public Meeting 1

Phase 1: Organizing Resources includes the work that The Citadel Emergency Management did in establishing the Hazard Mitigation Planning Committee and scheduling this public outreach meeting. It also includes the need to reach out to stakeholders and conduct additional public outreach through a plan for public involvement.

Ranger highlighted an important opportunity for public input which is the public survey. The survey is available online. The following link and QR code can be used to access and share the survey:

- Survey link: https://forms.office.com/r/mutegkp2Xb

Phase 2: Assess Risks includes the following components: Hazard Identification (What can happen here?), Vulnerability Assessment (What will be affected or impacted?), and Capability Assessment (How can we implement mitigation?)

The HMPC committee reviewed the natural and technological/human-caused hazards from the 2016 Disaster Resistant Hazard Mitigation Plan against the hazards in the 2018 South Carolina State Hazard Mitigation Plan and the 2020 Charleston County Regional Hazard Mitigation Plan to determine the updated list of hazards for the 2022/2023 plan.

The following 17 hazards were identified by the HMPC for evaluation in this plan:

- Dam Failure
- Drought
- Earthquake
- Extreme Heat
- Flood
- Hurricane/Tropical Storm (Storm Surge & Wind)
- Sea Level Rise
- Severe Weather (Thunderstorm Wind, Lightning, Hail)
- Sinkhole
- Tornado
- Tsunami
- Wildfire
- Winter Weather
- Active Shooter
- Civil Disturbance
- Cyber Disruption
- Hazardous Materials

Phase 3 includes reviewing the previous goals and objectives and updating them if necessary for this update, reviewing a comprehensive list of mitigation project alternatives to select appropriate projects for implementation, and drafting and action plan with both ongoing mitigation projects and newly selected projects. Ranger noted that all actions will fall within the six FEMA mitigation categories, which are prevention, property protection, structural projects, emergency services, natural resource protection, and public information.

Phase 4 involves adopting the plan and pursuing ongoing plan implementation and maintenance.

Project Schedule
Ranger presented the project schedule and milestones. The first HMPC meeting was held in October. The Hazard Identification and Risk Assessment (HIRA) and the Capability Assessment are already updated and drafted and will be reviewed by the HMPC at their next meeting, which is anticipated to be held later in November. Mitigation action updates will be drafted through November and December. Final HMPC and public meetings will be held in January.

Questions and Discussion
Allison noted that she would share the information presented with other members of the Board of Visitors. She asked about responses to the survey so far; however, responses are limited as the survey was just made public earlier this week. David noted that the survey will remain open through January and encouraged sharing it with any other stakeholders.

There was some discussion on the date of the next HMPC meeting, which should be scheduled soon after the Thanksgiving holiday.

The meeting ended at 5:25 PM.

Meeting Advertisements via Website and Social Media

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ACADEMICS | ATHLETICS | CAMPUS LIFE | PEOPLE | THE CITADEL MAGAZINE | IN THE NEWS

Public invited to participate in update of The Citadel's hazard mitigation plan

November 14, 2022 Campus Life

THE CITADEL

The Citadel is beginning to update the 2017 Hazard Mitigation Plan and wants the public's input in the planning process. Public input will help the planning committee to identify hazard risks, understand local vulnerabilities and select appropriate and achievable mitigation strategies to protect the campus from hazard impacts. An online public kickoff meeting is scheduled for 5 – 6 p.m. on Wednesday, Nov. 16.

To RSVP and receive a link to join the virtual meeting, click here.

The planning committee – which consists of representatives from campus administration – hopes cadets, students and other campus stakeholders will provide additional input and information about local hazard risk to support the planning process.

Individuals who cannot attend the public meeting but would like to provide feedback to the planning committee can complete the public survey at this link.

The development of the plan is funded by a grant from the Federal Emergency Management Agency (FEMA).

Comments, data and other input for the planning committee to consider can also be sent to The Citadel's planning consultant, David Stroud, at david.stroud@wsp.com.

Featured Posts

Mission Essential: Special Agent Yates Gupton, '97

November 14, 2022

"I instantly knew that this was the place for me": Meet Coast Guard veteran student Ricardo Quintero

November 12, 2022

The Citadel presents posthumous degree to Army Ranger Sgt. 1st Class Christopher Celiz, '08

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Useful Links

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The Citadel
17h
The Citadel is updating its 2017 Hazard Mitigation Plan and wants your input. For more information about attending the meeting or providing feedback, click here: https://bit.ly/3UVTwSJ
THE CITADEL
TODAY.CITADEL.EDU
Public invited to participate in update of The Citadel's hazard mitigation plan - The Citadel Today
11


The Citadel @Citadel1842 · 17h
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The Citadel is beginning to update the 2017 Hazard Mitigation Plan and wants the public's input in the planning process.
1
6

Public Meeting 2: March 28, 2023

Attendance

THE CITADEL
THE MILITARY COLLEGE OF SOUTH CAROLINA

The Citadel Hazard Mitigation Plan Public Meeting
March 28, 2023

Name	Department/Role	E-mail
David Stroud	WSP	david.stroud@wsp.com
Abby Moore	WSP	abigail.moore@wsp.com
Scott Curtis	Physics/Near Center for Climate Studies	wcurtis1@citadel.edu
Zach Watson	OEM	zwatson2@citadel.edu

Minutes

The Citadel Disaster Resistant Hazard Mitigation Plan Update

Public Meeting #2
Tuesday, March 28th, 2023, 5:00 p.m.
Bond Hall, Room 514

David Stroud and Abby Moore from WSP, the consultant, facilitated the meeting according to the following agenda:

- Where we are in the planning process
  - Steps 8 and 9
- Organization of the Plan
- Review of Key Plan Components
  - Planning Process
  - Hazards & Priority Risk Index
  - Goals & Objectives
  - Mitigation Actions
- Plan Implementation & Maintenance
- Next Steps

There were four people in attendance:

- Scott Curtis – Physics / Near Center for Climate Studies
- Zach Watson – Citadel Office of Communications and Marketing
- David Stroud – WSP
- Abby Moore – WSP

Where We Are in the Planning Process

David updated the public on where we are in the 10-Step planning process. The planning process is currently at Steps 8 – Draft an Action Plan, and Step 9 – Adopt the Plan.

Plan Organization

David reviewed each of the nine sections of the updated plan document. Section 1 Introduction provides an overview of the plan and the requirements met in its preparation. Section 2 Planning Process summarizes the 10 steps of the planning process, who was involved in the HMPC, and how the public and stakeholders were involved. Section 3 Campus Profile provides a summary of the current conditions at the Citadel. Section 4 Hazard Identification and Risk Assessment identifies the hazards relevant to the Citadel and presents the detailed hazard profiles with risk and vulnerability information, an inventory of exposure and estimates of the potential impact of each hazard. Section 5 Capability Assessment reviews the Citadel tools, resources, staff, and other capabilities to support mitigation project implementation. Section 6 Mitigation Strategy presents the updated goals, the process used to develop them, and prioritization criteria for the mitigation action review. Section 7 Mitigation Action Plan presents the updated mitigation action plan. Section 8 Plan Adoption has the plan adoption documents and Section 9 Plan Implementation and Maintenance describes the procedures for monitoring and implementing the plan over the next five years and through the next plan update.

There are also three appendices with additional information on the plan review tool, planning process documentation, a review of mitigation alternatives, and plan references.

Key Plan Components

David reviewed key steps in the planning process, including HMPC meetings, community data collection meetings, and public meetings. Public outreach efforts were also reviewed to demonstrate the ways the Citadel and communities sought to encourage public input. David also reviewed the public survey, which unfortunately only had 9 responses. While broad conclusions could not be drawn from this small number of responses, the answers were reviewed to support the hazard identification and risk assessment as well as the mitigation strategy. Opinions on the most important mitigation categories align with what the Citadel is already doing.

Scott asked if the campus sustainability group was involved in the plan update and suggested getting them involved during the next update cycle.

Abby reviewed the identified hazards and the Priority Risk Index (PRI) results. A summary table of the PRI results is below. Scott indicated that he agreed with the ratings for the high priority hazards. However, he thought that extreme heat warranted

1 The Citadel Disaster Resistant HMP Update | Public Meeting 2

consideration as a high priority hazard given the potential health and safety impacts of heat and that the campus has many cadets who are often outside and doing physical activity during periods of extreme heat.

Hazard	Probability	Impact	Spatial Extent	Warning Time	Duration	PRI Score
Natural Hazards						
Dam Failure	Unlikely	Limited	Moderate	>24 hours	<1 week	1.9
Drought	Highly Likely	Minor	Large	>24 hours	>1 week	2.8
Earthquake	Possible	Critical	Large	<6 hours	>1 week	3.1
Extreme Heat	Likely	Minor	Large	>24 hours	<1 week	2.4
Flood	Highly Likely	Critical	Large	6 to 12 hours	<1 week	3.5
Hurricane & Tropical Storm	Highly Likely	Critical	Large	>24 hours	<1 week	3.3
Sea Level Rise	Highly Likely	Limited	Small	>24 hours	>1 week	2.7
Severe Weather (Thunderstorm, Hail, Lightning)	Highly Likely	Minor	Large	6 to 12 hours	<6 hours	2.7
Sinkhole	Unlikely	Limited	Negligible	<6 hours	<6 hours	1.6
Tornado	Likely	Limited	Moderate	<6 hours	<6 hours	2.6
Tsunami	Unlikely	Critical	Large	<6 hours	<24 hours	2.6
Wildfire	Possible	Limited	Moderate	<6 hours	<1 week	2.5
Winter Weather	Likely	Limited	Large	12 to 24 hours	<1 week	2.7
Technological & Human-Caused Hazards						
Active Shooter	Possible	Catastrophic	Small	<6 hours	<6 hours	2.7
Civil Disturbance	Possible	Limited	Small	<6 hours	<1 week	2.3
Cyber Disruption	Possible	Critical	Large	<6 hours	<1 week	3.0
Hazardous Materials	Possible	Limited	Small	<6 hours	<1 week	2.2

Abby reviewed the goals which were carried forward from the existing HMP:

- **Goal 1:** Reduce the vulnerability of the people and property of the College from the effects of natural and manmade hazards.
- **Goal 2:** Safeguard the College's mission of education, outreach, and engagement against natural or man-made hazards.
- **Goal 3:** Preserve and strengthen protection of critical facilities and infrastructure through the implementation of mitigation actions to create a safer, more sustainable College.
- **Goal 4:** Enhance campus education programs to raise awareness of and preparedness for hazard events.
- **Goal 5:** Improve and coordinate mitigation activities with surrounding communities, non-profits and private businesses.

Abby reviewed the mitigation action plan and presented the four new mitigation actions that were identified by the HMPC:

- Enforce a higher freeboard for new or renovated buildings on campus.
- Add signage to frequently flooded areas of campus warning about potential flood risk.
- Encourage cadets, faculty, and staff to sign up for emergency alerts through South Carolina Emergency Management Division or Charleston County Citizen Alert Notification System.
- Coordinate with the City of Charleston and other local stakeholders of stormwater management and drainage improvement projects.

Abby noted that most of these new actions focus on flood-related mitigation. Scott suggested that variable message boards or other temporary signage may be more effective than permanent signs in frequently flooded areas because they may be more likely to catch people's attention during impending floods.

Implementation and Maintenance

Abby explained that the plan will be revised according to any public feedback and then submitted to the Citadel. Once the Citadel approves the plan, it will be sent to SCEMD and FEMA for review and final approval. After approval the Citadel can formally adopt the plan. The HMP will be updated every five years.

Next Steps

- Stakeholders and members of the public are encouraged to review the draft plan and provide feedback by April 12th. In particular, attendees were encouraged to review the mitigation action plan for any actions that should be added.
- WSP staff will incorporate feedback into the a final draft plan
- The final draft will be submitted to SCEMD and FEMA for review and approval
- The Citadel will adopt the plan after it is approved by SCEMD

Meeting Advertisements via Website and Social Media

Public invited to provide input on The Citadel's hazard mitigation plan

March 22, 2023 Campus Life

THE CITADEL

The Citadel has prepared an updated Hazard Mitigation Plan and is seeking public input on the draft plan.

A public input meeting is scheduled for Tuesday, March 28 at 5 p.m. in Bond Hall Room 514, located on The Citadel's campus. This is the final public meeting about this plan update.

The updated plan evaluates hazard risk and vulnerability, sets goals for mitigation and identifies mitigation actions to protect the people and property of The Citadel campus from the effects of natural and non-natural hazards. The planning committee, which consists of representatives from campus administration, hopes that cadets and other campus stakeholders will review the plan and provide additional suggestions for mitigation activities to pursue over the next five years.

The development of the plan is funded by a grant from the Federal Emergency Management Agency (FEMA).

Individuals who cannot attend the public meeting but would like to provide feedback to the planning committee can send comments to the Citadel's planning consultant, David Stroud, at david.stroud@wsp.com.

Related:

Featured Posts

Regimental Band and Pipes collaboration brings "Echoes on the Ashley" to life at The Citadel

March 21, 2023

The Citadel to provide additional funding to eligible, incoming ROTC cadets for 2023-24

March 16, 2023

Looking ahead to Corps Day and Recognition Day, two of the most important events for The Citadel

March 6, 2023

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- Good to Go: Graduate Success Stories
- Merit: Student Achievements
- News Archives
- Emergency Alerts
- Hurricane Procedures


Westside Neighborhood (Charleston, SC)

Emily Arnson Johnson
March 22 at 11:29 AM ·

Good morning! The Citadel has prepared an updated Hazard Mitigation Plan and is seeking public input on the draft plan.
A public input meeting is scheduled for Tuesday, March 28 at 5 p.m. in Bond Hall Room 514, located on The Citadel's campus. This is the final public meeting about this plan update. More information here:

THE CITADEL

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Public invited to provide input on The Citadel's hazard mitigation plan - The Citadel Today

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THE CITADEL
Disaster Resistant University
Multi-Hazard Mitigation Plan Update

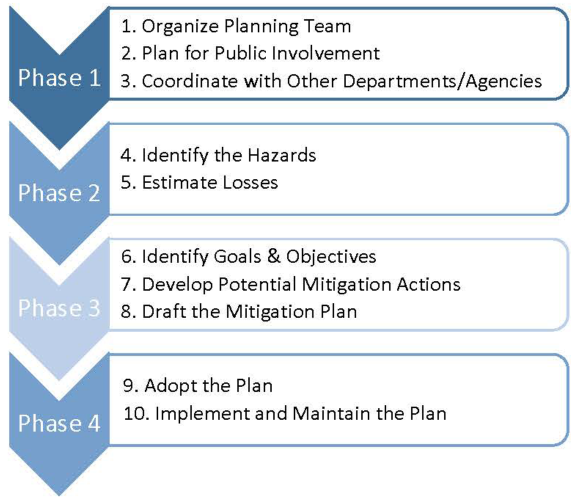
The Citadel is in the process of updating the Disaster Resistant University Multi-Hazard Mitigation Plan to better protect the people and property of the university from the effects of natural and man-made hazard events and to obtain eligibility for mitigation funding from the Federal Emergency Management Agency (FEMA).

What Is a Hazard Mitigation Plan?

A Hazard Mitigation Plan is the result of a planning process to determine how to reduce or eliminate the loss of life and property damage resulting from hazards. This plan will address a comprehensive list of natural hazards – ranging from flooding and earthquakes to tornadoes and severe winter weather – and will assess the likely impacts of these hazards to the university. This planning process is structured around the four phases of the Disaster Mitigation Act of 2000:

- ♦ Phase 1: Organize Resources
- ♦ Phase 2: Assess Risks
- ♦ Phase 3: Develop a Mitigation Plan
- ♦ Phase 4: Implement and Monitor the Plan

These four phases are further broken down into 10 planning steps, shown in the graphic on the right.



Why is it Important to Me?

It is important for citizens to become involved in mitigation planning in their community. The planning team needs your input on the types of hazards that are your priority concern. Your opinion on ways to prevent or lessen the impacts of hazards is also valuable input for the planning team.

What Can I do to Participate?

The planning committee will hold two public meetings. Sign up to receive information about how to participate (https://forms.office.com/r/29Zvh6xAQi). Additional meeting information will be posted on the Citadel website and social media. The planning team has also developed a survey to collect public input. Please complete the survey to ensure your opinion is captured. To access the survey, scan the QR code on the right, or follow this link (https://forms.office.com/r/mutegkp2Xb). Additionally, prior to being submitted to FEMA, the draft plan will be circulated for public comment. Information on how to access and comment on the plan will be posted on the Citadel's website in the future.

Scan QR Code for Survey

Planning Status

In early October the planning team began Phase 1 and participated in the first Hazard Mitigation Planning Committee Meeting to organize the planning effort, plan for public involvement opportunities and initiate coordination with other departments and agencies. Work is now underway on Phase 2 to assess risks and vulnerabilities on campus.

Implementation of the Plan is the Ultimate Goal!

The goal of this planning process is implementation of mitigation actions that will prevent or lessen the impacts of hazards to people and property at the Citadel campus.

For more information, please contact David Orr, Environmental Health & Safety Director, at horr@citadel.edu

Public Survey Results

1. Where do you live?

More Details

Citadel Campus Housing	1
The City of Charleston	4
Other	4

2. Have you ever experienced or been impacted by a disaster

More Details

Yes	8
No	1

3. If you answered "Yes" to question 2, please explain your experience.

7 Responses

1	anonymous	The apartment we used to live at in West Ashley got caught in the flooding after the thunderstorm after Hurricane Irene some years ago. It was deep enough to destroy my car and get into the apartment - and we were at the TOP of the hill. The buildings lower than us fared much worse.
2	anonymous	Hurricane Hugo, many flooding events in the low country.
3	anonymous	I have been personally involved in an active shooter incident, several hurricanes
4	anonymous	Hurricanes and floods
5	anonymous	I have worked in the insurance industry for 25+ years and worked at a state and national level handling a variety of disasters, such as hurricanes, fires, floods, tornadoes, wildfires, hail storms, ice storms, etc. My greatest fear for The Citadel is an earthquake.
6	anonymous	Multiple major hurricanes and a 1000 year flood as a lifetime resident of Charleston. Also, in my career, I have been part of a response force for major accidents and other serious emergencies.
7	anonymous	4 hurricanes. Avoided all. 1 other storm was called a hurricane but was 6 days of rain instead. Probably 50+ inches of rain in those 6 days. Stayed home with 2 friends during storm.

4. How concerned are you about the possibility of being impacted by a disaster?

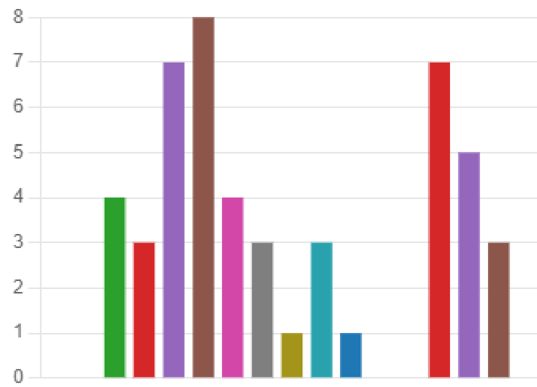
More Details

Very concerned	3
Somewhat concerned	3
Not concerned	3

5. What hazards (natural and man-made) do you feel pose a threat to the Citadel? Check all that apply.

More Details

Dam Failure	0
Drought	0
Earthquake	4
Extreme Heat	3
Flood	7
Hurricane & Tropical Storm (Sto...	8
Sea Level Rise	4
Severe Weather (Thunderstorm ...	3
Sinkhole	1
Tornado	3
Tsunami	1
Wildfire	0
Winter Weather	0
Active Shooter	7
Civil Disturbance	5
Hazardous Materials	3
Other	0



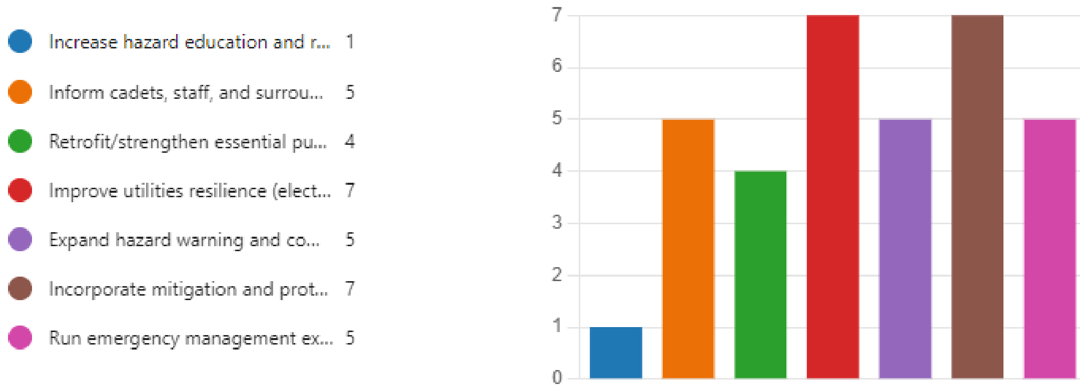
6. How prepared do you feel for a hazard event?

More Details

Not at all prepared	1
Somewhat prepared	5
Prepared	2
Very prepared	1

7. What types of mitigation actions do you feel would be most effective for the Citadel?

More Details



8. Are there other mitigation actions The Citadel should consider for reducing future losses caused by natural or man-made hazards?

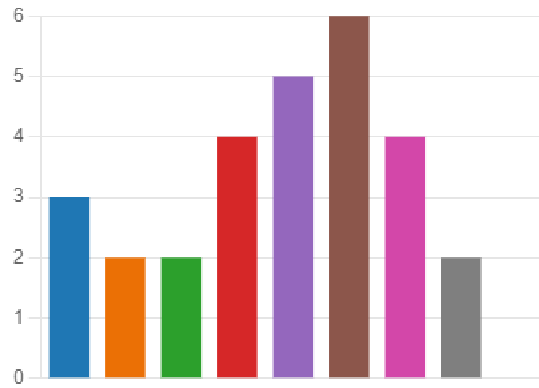
4 Responses

1	anonymous	The Fishburne-Hagood intersection is the weakest link in getting to campus from West Ashley. It's also the strongest weak link during flooding in that trying to bypass Fishburne-Hagood leads you to deeper flooding elsewhere. The Citadel can't do anything about that intersection, but perhaps improving drainage of the nearby parking lot we usually cut through to get to campus would help a little.
2	anonymous	Disband The Citadel Department of Public Safety as it currently exists. Terrible leadership with no accountability. No tangible coordination with surrounding agencies. Woefully underprepared and would be quickly overwhelmed by any significant active threat incident.
3	anonymous	The Insurance Institute for Business & Home Safety offers a lot of free information on business continuity planning, their FORTIFIED building standards and other advice on mitigation for a variety of hazards. Their website is www.ibhs.org The business continuity portion is at https://ibhs.org/guidance/business-continuity/ The Insurance Institute for Business & Home Safety (IBHS) is an independent, 501 (C) nonprofit scientific research and communications organization. Their specialty is exactly what we need help with at The Citadel.
4	anonymous	Design disaster response teams composed mostly of cadets. Cadets are a valuable and readily available resource that only needs specialized training

9. What is the best way for you to revive information about hazard events?

More Details

TV News/Ads	3
Radio News/Ads	2
Print Media - Newspaper, Mailin...	2
Citadel Social Media - Facebook...	4
Citadel Website	5
Email	6
Text Message	4
Campus/Public Library	2
Option 9	0



Planning Step 3: Coordinate

An important component of the planning process is to coordinate with relevant local, state, and federal stakeholders and incorporate other agencies' and organizations' plans and efforts into the development of this hazard mitigation plan. The Citadel contacted other agencies and organizations to invite their participation in the planning process by providing them the opportunity to review the draft plan and provide comments or other feedback to the planning committee. The HMPC identified a variety of stakeholders and emailed them with information about the planning process, a link to download and review the draft plan, and a request for input. The email sent to stakeholders is documented below. A list of the stakeholders who were contacted is provided on the following page.

From:	David Orr
To:	brint.patrick@redcross.org; action@sccl.org; info@charlestonwaterkeeper.org; hhowell@charlestoncounty.org; hamiltoncn@cofc.edu; brwood@musc.edu; mbryant@csuniv.edu; jcoates@charlestoncounty.org; Almquist, Benjamin; jason.hunter@fema.dhs.; jmshelto@usgs.gov; CoxM@dnr.sc; mitigation@emd.sc; Lewis, PHeisha; CESA-EMD@usace.army.mil
Cc:	Moore, Abigail; Stroud, David A
Subject:	The Citadel"s Hazard Mitigation Plan
Date:	Thursday, April 6, 2023 11:44:20 AM
Attachments:	image001.png

CAUTION: External email. Please do not click on links/attachments unless you know the content is genuine and safe.

Good afternoon all,

You are receiving this updated version (draft) of The Citadel's Hazard Mitigation Plan since you are listed as a stakeholder of the plan.

RE: The Citadel Multi-Hazard Mitigation Plan

The Citadel is in the process of preparing an updated Multi-Hazard Mitigation Plan in an effort to better protect the people and property of the college from the effects of natural and human-caused hazard events. The plan has been fully reviewed and updated and includes a revised hazard risk & vulnerability assessment and mitigation action plan.

This plan will be compliant with the Disaster Mitigation Act of 2000 which encourages coordination with other local, state, and federal agencies and organizations who may bring additional information and associated data to support evaluation of the various hazards profiled in the plan and identification of appropriate and feasible mitigation strategies to pursue. As such, we would like to invite your input on the draft plan, which can be viewed here: https://today.citadel.edu/wp-content/uploads/2023/03/Citadel-HMP-Update_Draft_03062023.pdf.

If you would like additional information, please contact Dave Orr, Environmental Health & Safety Director, at horr@citadel.edu. You can also send any questions or comments on the draft plan to our consultant for the planning process, David Stroud with WSP, at david.stroud@wsp.com.

We look forward to hearing from you and appreciate your input.

Thanks

Dave

H. David Orr, MS-EHS
Director Environmental Health and Safety
Emergency/Risk Manager/IRF Insurance
Public Safety – *Constable Level 3 Advanced*
The Citadel
p: (843) 953-4816 **c:** (843) 906-3492
w: citadel.edu **e:** horr@citadel.edu

THE CITADEL HAZARD MITIGATION PLAN STAKEHOLDERS			
First Name	***Last Name***	***Organization/Title***	***Email Address***
Non-Profit Organizations			
Brint	Patrick	American Red Cross, Executive Director Lowcountry SC	Brint.Patrick@redcross.org
Faith Rivers	James	Coastal Conservation League, Executive Director	action@scccl.org
Andrew	Wunderley	Charleston Waterkeeper, Executive Director	info@charlestonwaterkeeper.org
Ashley	Demosthenes	Lowcountry Open Land Trust, President & CEO	ademosthenes@lowcountrylandtrust.org
Heather	Howell	Charleston County Local Emergency Planning Committee	hhowell@charlestoncounty.org
Educational Institutions			
Clifford	Hamilton	Director of Environmental Health & Safety	hamiltoncn@cofc.edu
Bryan	Wood	Medical University of South Carolina, Emergency Manager	woodbr@musc.edu
Dr. Michael L.	Bryant	Charleston Southern University, Executive Vice President	mbryant@csuniv.edu
Surrounding Municipalities			
Joe	Coates	Charleston County Emergency Management	jcoates@charlestoncounty.org
Ben	Almquist	City of Charleston Emergency Management	almquistb@charleston-sc.gov
Federal Government			
Jason	Hunter	FEMA Region IV, Chief, Floodplain Management & Insurance Branch	jason.hunter@fema.dhs.gov
John	Shelton	USGS - South Carolina Office	jmshelto@usgs.gov
Lisa	Metheney	Corps of Engineers - Charleston District	cesac-pao@usace.army.mil
State Government			
Maria	Cox Lamm	State NFIP Coordinator	CoxM@dnr.sc.gov
Candice	Shealey	State Hazard Mitigation Officer	mitigation@emd.sc.gov
Phleisha	Lewis	South Carolina Office of Resilience	phleisha.lewis@scor.sc.gov

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