



*City of Charleston
South Carolina*

Clerk of Council Department

**PUBLIC SAFETY COMMITTEE MEETING
AGENDA
City Hall, Council Chamber
80 Broad Street**

<https://www.youtube.com/@CityofCharlestonSCgov/streams>

**January 20, 2026
4:00 p.m.**

1. Moment of Silence

2. Minutes:

December 9, 2025

3. Fire Department/Fire Marshal Division – Approval of Code Enforcement Officers

4. Fire Department/Emergency Management – Approval of a Resolution for the adoption by City of Charleston City Council of the 2025 *City of Charleston Hazard Mitigation Plan* as an appendix to the *Charleston Regional Hazard Mitigation Plan*

5. Fire Department – Approval of an MOU between the City of Charleston and the International Association of Fire Chiefs for the International Fellowship Program (*To be distributed under separate cover***)**

6. Adjournment

In accordance with the Americans with Disabilities Act, people who need alternative formats, ASL (American Sign Language) Interpretation or other accommodation please contact Janet Schumacher at (843) 577-1389 or email to schumacherj@charleston-sc.gov three business days prior to the meeting.



City of Charleston

WILLIAM S. COGSWELL, JR.
MAYOR

South Carolina

DANIEL M. CURIA
FIRE CHIEF

Charleston Fire Department Fire Marshal's Office

MEMORANDUM

TO: Mayor William S. Cogswell, Jr. and members of City Council

CC: Fire Chief Daniel M. Curia
Clerk of Council Jennifer Cook

FROM: Deputy Chief | Fire Marshal Michael A. Julazadeh

RE: Code Enforcement Officers – Fire Marshal's Office

DATE: January 5, 2026

I would like to request that you authorize the following City of Charleston employees to issue municipal summons and to be added to the Code Enforcement Officers' List. These members will have the responsibility to enforce the Fire Code and related ordinances to the Fire Marshal's Office:

Scott McCullough	Assistant Fire Marshal	Phone: 843-724-5042
Andrew Dotson	Assistant Fire Marshal	Phone: 843-579-6404
Jeb Geesey	Assistant Fire Marshal	Phone: 843-724-5043
Fox Millinder	Assistant Fire Marshal	Phone: 843-973-7238

Thank you.



**A RESOLUTION FOR THE ADOPTION BY CITY OF CHARLESTON
COUNCIL OF THE 2025 *CITY OF CHARLESTON HAZARD MITIGATION PLAN*
AS AN APPENDIX TO THE CHARLESTON REGIONAL HAZARD MITIGATION
PLAN**

WHEREAS the City of Charleston adopted the *Charleston Regional Hazard Mitigation Plan* in 1999 and readopted it in 2004, 2008, 2013, 2018 and 2023, and is required to adopt the amended version of the regional plan on a five-year cycle for the City to remain eligible for certain Federal programs in which the City of Charleston participates; and

WHEREAS the most recent resolution readoption of the plan in 2023 provides that while content related to City of Charleston may require revisions to meet plan approval requirements, changes occurring after adoption do not require City of Charleston to re-adopt any further iterations of the plan;

WHEREAS *The Charleston Regional Hazard Mitigation and Public Information Plan Committee* (“Committee”) is recognized as a continuing entity charged with reviewing, maintaining in accordance with Community Rating System, Flood Mitigation Assistance, Disaster Mitigation Act and Program for Public Information requirements, and periodically reporting on the progress towards and revisions to the plan to the City of Charleston Council.

WHEREAS the Committee has reviewed and determined that the *City of Charleston Hazard Mitigation Plan* is an appropriate Appendix to the Charleston Regional Hazard Mitigation and Program for Public Information Plan; and

NOW THEREFORE be it resolved that

The *City of Charleston Hazard Mitigation Plan* shall be an Appendix to the Charleston Regional Hazard Mitigation and Program for Public Information Plan, and all required future revisions to the *City of Charleston Hazard Mitigation Plan* from the South Carolina Emergency Management Division and the Federal Emergency Management Agency are hereby adopted as an official plan of the

City of Charleston. While content related to City of Charleston may require revisions to meet the plan approval requirements, changes occurring after adoption will not require City of Charleston to re-adopt any further iterations of the plan; and

Effective this ____ Day of ____, 2026

William S. Cogswell, Jr.
Mayor, City of Charleston

HAZARD MITIGATION PLAN:

CITY OF CHARLESTON
SC

DECEMBER 2025



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SECTION 1

INTRODUCTION

This section provides a general introduction to the City of Charleston Hazard Mitigation Plan. It consists of the following five subsections:

- 1.1 Background
- 1.2 Purpose
- 1.3 Scope
- 1.4 Authority
- 1.5 Summary of Plan Contents

1.1 BACKGROUND

The City of Charleston is situated in Charleston and Berkeley County in the South Carolina “Lowcountry.” As of 2023, the City had an estimated population of 159,333, making it the largest city in the South Carolina and the county seat of Charleston County¹. Charleston is also the principal city in the Charleston-North Charleston metropolitan area and is located just south of the midpoint of South Carolina's coastline on Charleston Harbor bordered by the confluence of the Ashley, Cooper, and Wando Rivers.

The City of Charleston is exposed to a variety of natural hazards, including hurricanes, flooding, severe thunderstorms, earthquakes, and infectious diseases. Additionally, the City is at risk for human-caused hazards, such as chemical releases, hazardous material spills, and cyber-attacks. These threats endanger the lives and safety of both residents and visitors, and they can damage public and private property, disrupt the local economy, and affect the quality of life for those who live, work, and vacation in Charleston.

While hazard occurrence is inevitable, it is essential to recognize potential hazards as significant threats to life, safety, and property. Although the risks from hazardous events cannot be eliminated, strategies to mitigate potential hazard impacts can be implemented at the local level to safeguard the community and its residents. By reducing the effects of hazards on the built environment, the City can prevent such events from escalating into disasters. The concept and practice of reducing risks to people and property from known hazards is generally referred to as *hazard mitigation*.



FEMA Definition of Hazard Mitigation:

“Any sustained action taken to reduce or eliminate the long-term risk to human life and property from hazards.”

¹ <https://www.census.gov/quickfacts/fact/table/charlestoncitysouthcarolina/PST045221>

SECTION 1: INTRODUCTION

This plan recommends specific actions to minimize hazard vulnerability and protect residents from losses to hazards that pose the greatest risk. Hazard mitigation techniques include both structural measures, such as reinforcing buildings and infrastructure against potential hazards, and non-structural measures, such as implementing effective land use policies and creating public awareness programs. It is widely recognized that the most effective mitigation efforts are made at the local government level, where decisions concerning development regulation and control are determined. A comprehensive mitigation strategy addresses existing and future hazard vulnerabilities. Therefore, it is crucial to assess projected future development patterns to understand how growth may increase or decrease a community's overall vulnerability.

A vital component of a comprehensive hazard mitigation approach is the development, adoption, and regular updating of a local hazard mitigation plan. This plan outlines the City's vision and guiding principles for reducing hazard risks and proposes specific actions to holistically address identified vulnerabilities. The development and implementation of a local hazard mitigation plan, in addition to the Charleston Regional Hazard Mitigation Plan, demonstrates the City's commitment to building a more resilient community. This plan serves as a blueprint for City officials and staff to follow, helping to save lives, protect property, and ensure that any development within the City enhances resilience rather than exacerbate vulnerability. Additionally, the plan documents the City's ongoing efforts to integrate hazard mitigation principles and practices into everyday government activities, operations, and other planning initiatives. The plan should remain a living document, with implementation and evaluation procedures established to help achieve meaningful objectives.

1.1.1 The Disaster Mitigation Act and the Flood Insurance Reform Acts

In 2000, the U.S. Congress enacted the Disaster Mitigation Act of 2000 (DMA 2000) to help reduce the nation's mounting natural disaster losses. Section 322 of DMA 2000 mandates that state, local, and Tribal governments coordinate mitigation planning activities. More specifically, it requires the development of a hazard mitigation plan for any local or Tribal government seeking federal mitigation grant funds. Without an approved mitigation plan, jurisdictions are ineligible for funding from federal programs like the Hazard Mitigation Grant Program (HMG), the Building Resilient Infrastructure and Communities (BRIC) program, and the Flood Mitigation Assistance (FMA) program, all administered by the Federal Emergency Management Agency (FEMA). Therefore, communities with an adopted and federally approved hazard mitigation plan are better positioned to receive funds before and following disasters.

In 2012, major federal flood insurance legislation was introduced through the Biggert-Waters Flood Insurance Reform Act (P.L. 112-141) and the subsequent Homeowner Flood Insurance Affordability Act (HFIAA) in 2014, which amended Biggert-Waters. HFIAA also requires that communities have a FEMA-approved hazard mitigation plan to qualify for FEMA mitigation programs. These legislative acts made significant changes to the National Flood Insurance Program (NFIP), including rate increases to reflect actual flood risk and changes to how Flood Insurance Rate Map (FIRM) updates affect policyholders. This highlights Congress's emphasis on mitigating risks to vulnerable structures.

The City of Charleston Hazard Mitigation Plan has been prepared in coordination with FEMA Region 4 and the South Carolina Emergency Management Division (SCEMD) to ensure that the Plan meets all applicable FEMA and state requirements for hazard mitigation plans. A *Local Mitigation Plan Review Tool*, found in Appendix C, provides a summary of federal and state minimum standards and notes the location where each requirement is met within the Plan. Additionally, the plan was developed in accordance with updated FEMA hazard mitigation plan standards that were most recently released in April 2022.

1.2 PURPOSE

The purpose of the City of Charleston Hazard Mitigation Plan is to:

- Provide City-specific hazard mitigation recommendations (specifically goals and mitigation actions) for the City of Charleston while referencing the existing Charleston County Hazard Mitigation Plan and South Carolina State Hazard Mitigation Plan to demonstrate progress and reflect current conditions
- Increase public awareness and education
- Maintain grant eligibility for the City
- Maintain compliance with state and federal legislative requirements for local hazard mitigation plans.

1.3 SCOPE

The focus of the City of Charleston Hazard Mitigation Plan is primarily on those hazards determined to be “high” or “moderate” risks to the City of Charleston, as determined through a detailed hazard risk assessment. Other hazards that pose a “low” or “negligible” risk will continue to be evaluated during future updates to the Plan, but they may not be fully addressed until they are determined to be of high or moderate risk. This enables the City to prioritize mitigation actions based on those hazards which are understood to present the greatest risk to lives and property.

The geographic scope (i.e., the planning area) for the Plan includes the City of Charleston municipal limits.

1.4 AUTHORITY

The City of Charleston Hazard Mitigation Plan has been developed in accordance with current state and federal rules and regulations governing local hazard mitigation plans and has been adopted by the City in accordance with standard local procedures. A copy of the adoption resolution from the City is provided in Appendix A. The Plan shall be routinely monitored and revised to maintain compliance with the following provisions, rules, and 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);
- FEMA's Final Rule published in the Federal Register, at 44 CFR Part 201 (201.6 for local mitigation planning requirements);
- Flood Insurance Reform Act of 2004 (P.L. 108-264), Biggert-Waters Flood Insurance Reform Act of 2012 (P.L. 112-141) and the Homeowner Flood Insurance Affordability Act of 2014.

1.5 SUMMARY OF PLAN CONTENTS

The contents of this plan are designed and organized to be reader-friendly and functional. While significant background information is included on the processes used and studies completed (i.e., risk assessment, capability assessment), this information is separated from the planning outcomes or actions (i.e., mitigation strategy, mitigation action plan).

Section 2: Planning Process, provides a complete narrative description of the process used to prepare the Plan. This includes the identification of participants on the planning team, and how the public, including

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representatives from underserved communities and socially vulnerable populations and other stakeholders, were involved. It also includes a detailed summary for each of the key meetings held, along with any associated outcomes.

The Community Profile, located in Section 3, provides a general overview of the City of Charleston, including prevalent geographic, demographic and economic characteristics. In addition, building characteristics and land use patterns are discussed. This baseline information provides a snapshot of the planning area and helps local officials recognize the social, environmental and economic factors that affect the City's vulnerability to hazards.

The risk assessment is presented in three sections: Section 4: Hazard Identification; Section 5: Hazard Profiles; and Section 6: Vulnerability Assessment. Together, these sections serve to identify, analyze, and assess hazards that pose a threat to the City of Charleston. The risk assessment also attempts to define any hazard risks that may uniquely or exclusively affect specific areas of the City of Charleston.

The risk assessment begins by identifying existing and/or future hazards that threaten the City. Next, detailed profiles are created for each hazard, building on available historical data from past hazard occurrences, spatial extent, and probability of future occurrence to include consideration of climate change. This section culminates in a hazard risk ranking based on conclusions regarding the frequency of occurrence, spatial extent, and potential impact highlighted in each of the hazard profiles. In the vulnerability assessment, loss estimation assessments were conducted to evaluate known hazard risks by the relative long-term cost in expected damages. In essence, the information generated through the risk assessment serves a critical function as the City of Charleston seek to determine the most appropriate mitigation actions to pursue and implement—enabling it to prioritize and focus its efforts on those hazards of greatest concern and those structures or planning areas facing the greatest risk(s).

The Capability Assessment, found in Section 7, provides a comprehensive examination of the capacity of the City of Charleston to implement meaningful mitigation strategies and identifies opportunities to increase and enhance that capacity. Specific capabilities addressed in this section include planning and regulatory capability, staff and organizational (administrative) capability, technical capability, fiscal capability, and political capability. Information was obtained with a detailed survey questionnaire for City officials and an inventory and analysis of existing plans, ordinances, and relevant documents. The purpose of this assessment is to identify any existing gaps, weaknesses or conflicts in programs or activities that may hinder mitigation efforts, and to identify those activities that should be built upon in establishing a successful and sustainable local hazard mitigation program.

The Risk Assessment, and Capability Assessment collectively serve as a basis for determining the goals for the City of Charleston Hazard Mitigation Plan, each contributing to the development, adoption and implementation of a meaningful and manageable Mitigation Strategy that is based on accurate background information.

The Mitigation Strategy, found in Section 8, consists of broad hazard mitigation goal statements for the city as well as an analysis of the types of hazard mitigation techniques for the City of Charleston to consider in reducing hazard vulnerabilities. The strategy provides the foundation for a detailed Mitigation Action Plan, found in Section 9, which links specific mitigation actions for each city department or agency to locally assigned implementation mechanisms and target completion dates. Together, these sections are designed to make the plan both strategic, through the identification of long-term goals, and functional,

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through the identification of immediate and short-term actions that will guide day-to-day decision-making and project implementation.

In addition to the identification and prioritization of possible mitigation projects, emphasis is placed on the use of program and policy alternatives to help make the City of Charleston less vulnerable to the damaging forces of hazards while improving the economic, social, and environmental health of the community. The concept of multi-objective planning was emphasized throughout the planning process, particularly in identifying ways to link, where possible, hazard mitigation policies and programs with complimentary community goals related to disaster recovery, housing, economic development, recreational opportunities, transportation improvements, environmental quality, land development, and public health and safety.

Plan Maintenance, found in Section 10, includes the measures that the City of Charleston will take to ensure the plan's continuous long-term implementation. The procedures also include the way the plan will be regularly evaluated and updated to remain a current and meaningful planning document.

SECTION 2

PLANNING PROCESS

This section describes the planning process undertaken to develop the 2024 City of Charleston Hazard Mitigation Plan.

This section consists of the following eight subsections:

- 2.1 Overview of Hazard Mitigation Planning
- 2.2 History of Hazard Mitigation Planning for the City of Charleston
- 2.3 Creation of the 2024 Plan
- 2.4 City of Charleston Hazard Mitigation Planning Team
- 2.5 Community Meetings and Workshops
- 2.6 Involving the Public
- 2.7 Involving the Stakeholders
- 2.8 Documentation of Plan Progress

44 CFR Requirement

44 CFR Part 201.6(c)(1): The plan shall include 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.

2.1 OVERVIEW OF HAZARD MITIGATION PLANNING

Local hazard mitigation planning involves the organization of community resources, identification and assessment of hazard risks, and determination of measures to best minimize or manage those risks. This process culminates in a hazard mitigation plan that identifies specific mitigation actions, each designed to achieve both short-term planning objectives and a long-term community vision for disaster risk reduction.

To ensure the functionality of this Plan, responsibility is assigned for each proposed mitigation action to a specific individual, department, or agency along with a schedule or target completion date for its implementation (see Section 9: Mitigation Action Plans). Plan maintenance procedures are established for the routine monitoring of implementation progress, as well as the evaluation and enhancement of the mitigation plan itself. These plan maintenance procedures ensure that this Plan remains a current, dynamic, and effective planning document over time that becomes integrated into the routine local decision-making process (see Section 10: Plan Maintenance).

Communities that participate in hazard mitigation planning have the potential to accomplish many benefits, including:

- Saving lives and property

- Saving money
- Speeding recovery following disasters
- Reducing future vulnerability through wise development and post-disaster recovery and reconstruction
- Expediting the receipt of pre-disaster and post-disaster grant funding
- Demonstrating a firm commitment to improving community health and safety

Typically, mitigation planning is described as *having the potential to produce long-term and recurring benefits by breaking the repetitive cycle of disaster loss*. A core assumption of hazard mitigation is that the investments made before a hazard event will significantly reduce the demand for post-disaster assistance by lessening the need for emergency response, repair, recovery, and reconstruction. Furthermore, mitigation practices will enable residents, businesses, and industries to re-establish themselves during a disaster, returning to daily operations and ensuring essential functions.

The benefits of mitigation planning go beyond solely reducing hazard vulnerability. Mitigation measures such as the acquisition or regulation of land in known hazard areas can achieve multiple community goals, such as preserving open space, maintaining environmental health, and enhancing recreational opportunities. Thus, it is crucial that any local mitigation planning process be integrated with other concurrent local planning efforts, and any proposed mitigation strategies must consider other existing community goals or initiatives that will help complement and support future implementation.

2.2 HISTORY OF HAZARD MITIGATION PLANNING FOR THE CITY OF CHARLESTON

Prior to the development of the City of Charleston Hazard Mitigation Plan in 2024, the City participated (and still participates) in the Charleston Regional Hazard Mitigation Plan. The Regional Plan was developed using the multi-jurisdictional planning process recommended by the Federal Emergency Management Agency (FEMA). In 2024, this Plan was developed to provide a more detailed plan for the City of Charleston. The plan builds on the Regional Hazard Mitigation Plan by providing an in-depth risk assessment focused on the hazards that impact the City and draws city-specific conclusions about the vulnerabilities to the hazards that the city faces. The Mitigation Strategy in this plan identifies hazard mitigation goals and associated actions that are specific for Charleston. Goals and mitigation actions identified for the city in the existing regional plan have also been considered and integrated into this plan.

2.3 CREATION OF THE 2024 PLAN

To prepare the 2024 *City of Charleston Hazard Mitigation Plan*, ESP Associates, Inc. was hired by the City of Charleston to provide professional mitigation planning services for plan development. ESP partnered with Climate Adaptation Partners and Fernleaf Interactive, LLC. for this hazard mitigation plan creation. Per the contractual scope of work, the consultant team followed the mitigation planning process recommended by FEMA (Local Mitigation Planning Policy Guide effective April 19, 2023) and recommendations provided by South Carolina Emergency Management (SCEMD) and FEMA Region 4 mitigation planning staff.

The Local Mitigation Plan Review Tool, found in Appendix C, provides a detailed summary of FEMA's current minimum standards of acceptability for compliance with DMA 2000 and notes the location where each requirement is met within this Plan. These standards are based upon FEMA's Final Rule as published

SECTION 2: PLANNING PROCESS

in the Federal Register in Part 201 of the Code of Federal Regulations (CFR). The planning team used FEMA's Local Mitigation Planning Policy Guide (April 2023) for reference.

The process used to prepare this Plan included twelve major steps that were completed over the course of approximately eight months beginning in December 2022. Each of these planning steps (illustrated in **Figure 2.1**) resulted in critical work products and outcomes that collectively make up the Plan. Specific plan sections are further described in Section 1: *Introduction*.



Figure 2.1: Mitigation Planning Process for the City of Charleston

2.4 CITY OF CHARLESTON HAZARD MITIGATION PLANNING TEAM

To guide the development of this plan, the City of Charleston established the Hazard Mitigation Planning Team. This core team, primarily composed of representatives from various city departments, also included participants from critical infrastructure partners, volunteer agencies, and other public and private sector stakeholders. In January 2023, the team held a kickoff meeting and engaged in ongoing discussions, local meetings, and planning workshops to prepare the City's Hazard Mitigation Plan. This working group coordinated all aspects of plan development and provided valuable input throughout the process. Team members maintained regular communication and updates through an email distribution list.

Specifically, the tasks assigned to the City Hazard Mitigation Planning Team members included:

- Participate in City Hazard Mitigation Planning Team meetings and workshops
- Provide best available data as required for the risk assessment portion of this Plan

SECTION 2: PLANNING PROCESS

- Provide information to inform the Capability Assessment section and provide copies of any mitigation or hazard-related documents for review and incorporation into this Plan
- Support the development and update of the Mitigation Strategy, including the review of existing goals and actions and development of City-specific goals and actions
- Help update existing mitigation actions and design and propose any appropriate new mitigation actions for their department/agency for incorporation into the Mitigation Action Plan
- Review and provide timely comments on all study findings and draft plan deliverables
- Support the adoption of the 2024 City of Charleston Hazard Mitigation Plan.

Table 2.1 lists the members of the City of Charleston Hazard Mitigation Planning Team who were selected to participate in the development of this Plan.

Table 2.1: Members of the City of Charleston Hazard Mitigation Planning Team

LAST NAME	FIRST NAME	DEPARTMENT / AGENCY / TITLE	ATTENDED KICKOFF MEETING	ATTENDED MITIGATION STRATEGY WORKSHOP	ATTENDED STAKEHOLDER MEETING
Allen	Melissa	EM Specialist	Yes		
Alltop	Matt	Superintendent of Environmental Services	Yes		
Almquist	Benjamin	City of Charleston Emergency Management Director	Yes	Yes	Yes
Ash	Charles	City of Charleston EM Specialist	Yes	Yes	Yes
Bailey	Kimberly	MUSC			Yes
Barnes	Janice	Climate Adaptation Partners	Yes	Yes	
Becknell	Joe	Propac			Yes
Boykin	Darcy	Coastal Crisis Chaplaincy			Yes
Bradley	George	Lieutenant, Police Department	Yes	Yes	
Brown	Bernard	SCPA			Yes
Carter	Pat	Mount Pleasant Police Department			Yes
Chappell	Wes	Deputy Director of Facilities, Parks	Yes		
Coates	Joe	Director, Charleston County Emergency Management	Yes		
Cockcroft	Forrest	Deputy Chief, Fire Operations	Yes		Yes
Coker		SCPA			Yes
Corpuz	Alyssa	Floodplain Review Technician	Yes		
DeCiantis	Frank Clark	Deputy Director of Parks Operations	Yes		
Evans	Charles	Ingevity Corp			Yes
Flessas	Daniel	City of Charleston EM Assistant	Yes	Yes	Yes

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LAST NAME	FIRST NAME	DEPARTMENT / AGENCY / TITLE	ATTENDED KICKOFF MEETING	ATTENDED MITIGATION STRATEGY WORKSHOP	ATTENDED STAKEHOLDER MEETING
Fly	Liz	The Nature Conservancy			Yes
Fox	Diane	SC Department of Health			Yes
Frohlich	Matthew	Charleston Budget Finance and Revenue Collection		Yes	
Goshor	Ryan	DHEC			Yes
Granata	Ken	Chief Building Official	Yes		
Hackett	James	City of James Island			Yes
Hager	Sarah	Grant Writer	Yes		
Hauck	Robert	GIS Director	Yes	Yes	
Holton	Kinsley	Stormwater Regulatory Practice Leader, Floodplain Management	Yes	Yes	
Howell	Heather	Charleston County EMD			
Hurtes	William	American Red Cross			Yes
Johnson	Mark	Town of James Island			Yes
Jones	David	SCEMD			Yes
Jones	Steve	FBI			Yes
Julazadeh	Mike	Chief Fire Marshal, Fire Marshal	Yes	Yes	Yes
Kidd	Robin	Outreach Coordinator, Stormwater Management	Yes		
Kiefer	Michael	Construction Program Manager, Housing & Community Development	Yes	Yes	
Kowal	Larry	Lanxess			Yes
Kronsburg	Jason	Director of Parks	Yes	Yes	
Kutscher	Owen	Charleston County	Yes		
Levine	Norman	College of Charleston, Professor of Geology and Environmental Geosciences			Yes
Mardon	Sarah	City of Charleston Floodplain Management Technician	Yes		
Marolda	Kenneth	West Ashley Connects			Yes
Mathis	Michael	Deputy Director, Parking Operations	Yes		
McKee	Tracy	Mayor's Office of Innovation		Yes	
McKeon	Katie	PSC			Yes
Morris	Dale	Resilience and Sustainability		Yes	

SECTION 2: PLANNING PROCESS

LAST NAME	FIRST NAME	DEPARTMENT / AGENCY / TITLE	ATTENDED KICKOFF MEETING	ATTENDED MITIGATION STRATEGY WORKSHOP	ATTENDED STAKEHOLDER MEETING
O'Brien	Tom	Director of Public Service	Yes		
Overcash	Philip	Senior Planner	Yes	Yes	
Palmer	Stephanie	RSFH			Yes
Patrick	Brent	American Red Cross			Yes
Rochester	Will	EM Specialist	Yes		
Rubin	Brittany	American Red Cross			Yes
Samuel	Kianna	SCEMD			Yes
Schnell	Caroline	City of Charleston Floodplain Manager	Yes	Yes	
Searson	Chip	College of Charleston Chief of Police			Yes
Slade	Shannon	City of Charleston Mayor's Office of Innovation (Fellow)		Yes	
Shippy	Todd	Charleston County EMD			Yes
Stanley	Matt	Police Lieutenant, Police Department	Yes	Yes	
Tomlinson	Same	Alcamo			Yes
Vitello	Belivi	BCDCOG			Yes
Renshaw	Victoria	Berkeley County	Yes		
Wilbert	Mark	Senior Resilience Associate, Fernleaf	Yes	Yes	Yes

Note: In late summer of 2024, Mr. Stephen Davis, CEM became the Emergency Manager for the City and assisted with finalizing this plan.

Additional participation and input from other identified stakeholders and the public was conducted during the planning process through phone calls, distribution of emails, advertisements, and public notices aimed at providing valuable information pertaining to the Hazard Mitigation Plan status. Public and stakeholder involvement is further discussed later in this section.

2.5 COMMUNITY MEETINGS AND WORKSHOPS

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

SECTION 2: PLANNING PROCESS

The following is a summary of the key meetings and workshops held during the development of the plan update.¹ In many cases, routine discussions and additional meetings were held by local staff to accomplish planning tasks specific to their department or agency, such as the approval of specific mitigation actions for their department or agency to undertake and include in the Mitigation Action Plan.

2.5.1 Meeting Minutes

Throughout the planning process for the City of Charleston Hazard Mitigation Plan, detailed meeting minutes were recorded for each meeting to ensure transparency and effective communication among team members. A summary of the Planning Team meetings is provided below:

1. Kickoff Meeting (January 31, 2023) – During this initial gathering, team members outlined objectives, established a framework for collaboration, and reviewed mitigation, project scope, and tentative schedule.
2. Mitigation Strategy Meeting (May 16, 2023) – The team reconvened in May to brainstorm and identify potential strategies for hazard mitigation, which enabled members to share insights and leverage expertise.
3. Draft Hazard Mitigation Plan Review (October 20, 2023) – Finally, the team conducted a review of the Draft Plan allowing members to provide feedback and refine the plan before finalization.

Meeting minutes are included in Appendix D and can be referenced for more in-depth documentation.

2.6 INVOLVING THE PUBLIC

Public participation was a crucial element of the mitigation planning process. Input from stakeholders, particularly community members, enhanced the planning team's understanding of local concerns and fostered community buy-in for mitigation actions. When the community engages in safety-related decisions, it increases awareness of the hazards and heightens the likelihood that members take proactive steps to mitigate risk. Public awareness is essential to any community's mitigation strategy, aimed at making homes, neighborhoods, schools, businesses, and the entire city safer from potential hazards.

To encourage public involvement in the development of the City of Charleston Hazard Mitigation Plan, two key methods were employed: (1) an online public survey (detailed further in section 2.6.1) and (2) access to the Draft Plan for public review located on the City website and at government offices. The public was invited to participate at three distinct stages during the planning process: (1) during the drafting phase, (2) after the completion of the Final Draft but before official approval, and (3) at the time of official plan adoption by the City Council. The City also participated in the Charleston Hazards Expo on August 12, 2023, where information about the City's Hazard Mitigation Plan and the public survey was presented to over 125 attendees. Documentation of these public participation efforts can be found in Appendix D.

In addition to the opportunities for public comments previously discussed, the City of Charleston will hold public meetings before the final plan is officially adopted by the City Council. This meeting will occur once FEMA has granted conditional approval of the Plan. The adoption resolution will be included in Appendix A.

¹ Copies of agendas, sign-in sheets, minutes, and handout materials for all meetings and workshops can be found in Appendix D.

2.6.1 Public Participation Survey

The Hazard Mitigation Public Survey successfully collected stakeholder input for the mitigation planning process. The survey was designed to capture data and information from City residents, local businesses, and visitors/tourists that might not be able to participate through other means in the mitigation planning process.

The Hazard Mitigation Public Survey was primarily made available online and advertised on the City website and through the City's social media outlets. A total of 201 survey responses were received, which were used to inform plan development. Selected survey results are presented below:

- 82.3% of respondents are interested in making their homes/neighborhoods more resistant to hazards
- Respondents ranked Hurricanes and Tropical Storms as the highest threat to their neighborhood (21.1%), followed by Flooding (19.4%)
- 81.8% of respondents indicate that they do not know what office to contact regarding reducing their risks to hazards
- Prevention and Natural Resource Protection were the top ranked mitigation activities for the City to pursue in reducing risks
- Respondents noted that the internet (45.2%) is the most effective way to receive information, mail (36.76%) is the second most effective way.

Detailed survey results can be found in Appendix D of this plan.

2.7 INVOLVING THE STAKEHOLDERS

44 CFR Requirement

44 CFR Part 201.6(b)(2): The planning process shall include 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 non-profit interests to be involved in the planning process.

At the beginning of the planning process, the project consultant collaborated with the City's Emergency Management Director to identify relevant stakeholders to assist in the development of this Plan. The consultant shared a list of recommended stakeholders from FEMA Publication 386-1, "Getting Started: Building Support for Mitigation Planning," highlighting a diverse range of potential participants. The Emergency Management Director used this list as a guide to invite stakeholders from various City departments. In addition to City departments, various non-governmental stakeholders, detailed in Section 2.4, were also involved in the plan's development.

To ensure representation from underserved communities and socially vulnerable populations, the City invited representatives from the Housing and Community Development Department, the Business and Neighborhood Services Division (part of the Planning, Preparedness, and Sustainability Department), the Livability and Tourism Department, and MUSC. Each of these stakeholders actively participated and works directly with these populations in the community. The City Hazard Mitigation Planning Team aimed to promote open and widespread participation in the mitigation planning process. The City enhanced its

outreach through the design and distribution of the Hazard Mitigation Public Survey, allowing local officials, residents, businesses, academicians, and private interests to engage in the process.

2.7.1 Meeting Minutes

Similar to the Planning Team Meetings, meeting minutes were recorded for public outreach and stakeholder meetings. Again, the intent of meeting minutes is to support accurate and reliable documentation of outreach efforts to ensure this Plan reflects the needs and concerns of the community. A summary of stakeholder meetings is provided below:

1. Stakeholder Meeting (June 14, 2023) – This meeting involved a larger group of stakeholders, beyond City staff, to share overview information and collect feedback. The meeting resulted in 14 new mitigation actions being identified for the City by the Stakeholders. These actions have been incorporated into the City’s Mitigation Action Plan included in Section 9.

Meeting minutes are included in Appendix D and can be referenced for more in-depth documentation.

2.8 DOCUMENTATION OF PLAN PROGRESS

Further insights into plan implementation progress are available in the Capability Assessment. The City’s community capabilities are continually improving through the development of new plans, policies, and programs that promote local hazard mitigation. The current state of these local capabilities is detailed in Section 7: Capability Assessment.

Charleston remains committed to hazard mitigation and planning, evidenced by the creation of this plan and ongoing public involvement in the hazard mitigation process. Progress in hazard mitigation planning for the City of Charleston is documented in the City’s Plan. Since hazard mitigation planning efforts officially began in Charleston with the development of the initial Charleston Regional Hazard Mitigation Plan and FEMA Project Impact efforts in the late 1990s, many mitigation actions have been completed and implemented in Charleston. These actions will help reduce the overall risk to natural hazards for the people and property in the City of Charleston. Completed actions are documented in Section 9.

SECTION 3

COMMUNITY PROFILE

This section of the Plan provides a general overview of the City of Charleston. It consists of the following four subsections:

- 3.1 Geography and the Environment
- 3.2 Population and Demographics
- 3.3 Housing, Infrastructure and Land Use
- 3.4 Employment and Industry

3.1 GEOGRAPHY AND THE ENVIRONMENT

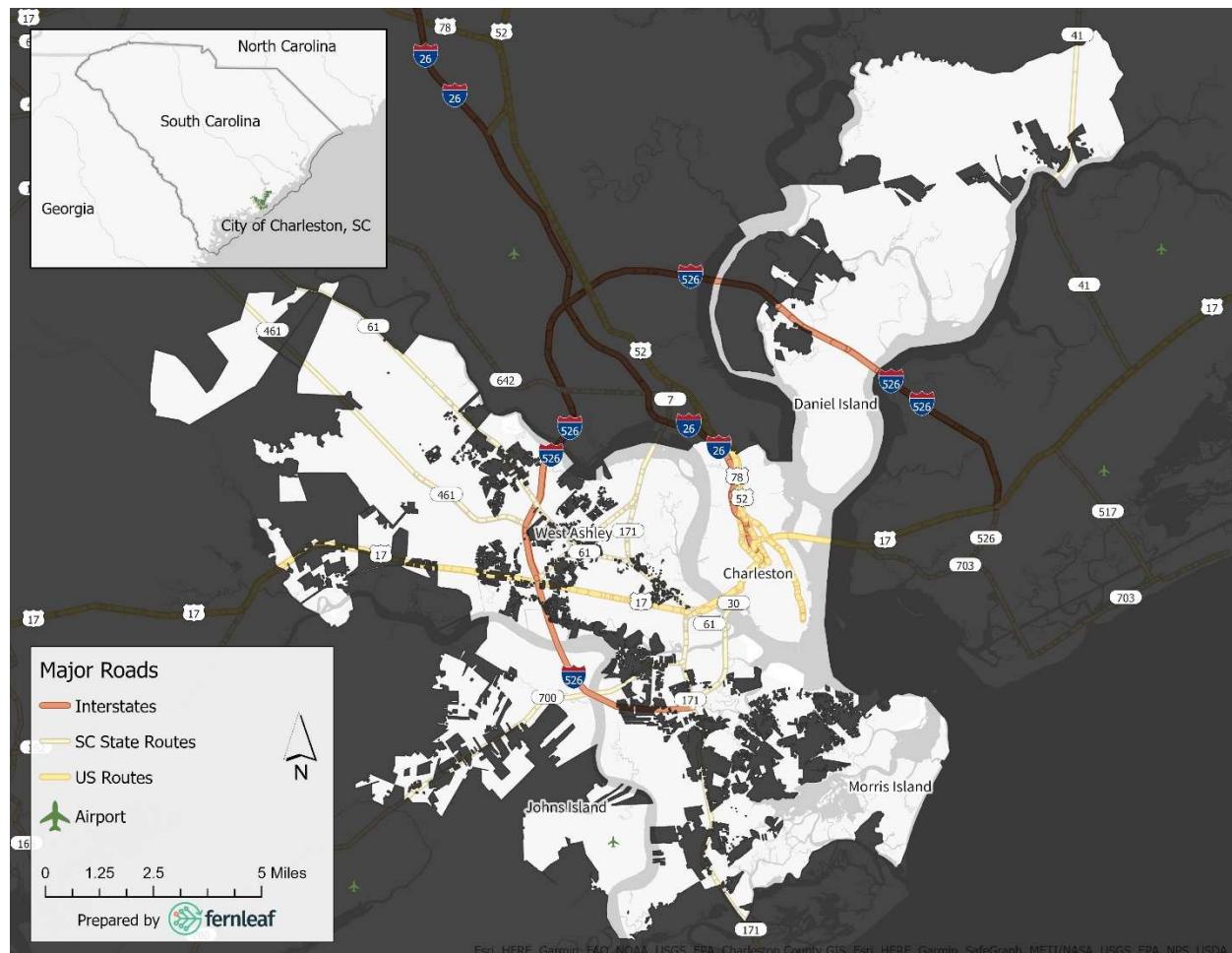
The City of Charleston is in southeastern South Carolina, within Charleston and Berkeley Counties. It is part of the Charleston-North Charleston Metropolitan Statistical Area and sits in the Atlantic Coastal Plain. Positioned on a peninsula between the Ashley and Cooper Rivers, the City faces the Atlantic Ocean and comprises six distinct districts:

- Downtown, or sometimes referred to as “The Peninsula,” which includes the historic Battery, is the city center separated by the Ashley River to the west and the Cooper River to the east
- West Ashley, a residential area west of Downtown
- Johns Island, the far western limits of Charleston, which is bordered by the Stono River to the east, Kiawah River to the south and Wadmalaw Island to the west
- James Island, a residential area located between Downtown and the town of Folly Beach
- Cainhoy Peninsula, the far eastern limits of the city that extends into Berkeley County
- Daniel Island, a residential area to the north of downtown that extends into Berkeley County

Founded in 1670 as Charles Town in honor of King Charles II, the City was originally established at Albemarle Point on the Ashley River's west bank (now Charles Towne Landing), but moved to its current location in 1680. Within ten (10) years, it became the fifth largest city in North America. It remained unincorporated during the colonial period, governed by a colonial legislature and a governor appointed by Parliament. The City adopted its current spelling upon incorporation in 1783. **Figure 3.1** provides an orientation map depicting the present City limits.

SECTION 3: COMMUNITY PROFILE

Figure 3.1: City of Charleston Base Map. Note: This image depicts the planned 526 extension, which is not yet complete.



The City of Charleston has a humid subtropical climate, characterized by hot, humid summers and cool, windy winters, along with year-round wet and partly cloudy conditions. The average annual precipitation is about 48 inches.¹ Downtown Charleston experiences a milder climate compared to the airport due to stronger maritime influences, especially in winter. The average January low in Downtown is 43.6 °F (6 °C), while the airport's average is 38.9 °F (4 °C). From May to September, average high temperatures range from the mid-70s to the mid-80s, with average lows in the mid-70s. The cool season typically lasts from December to March, with daily highs averaging in the mid-60s.

The City faces rainfall-induced flooding year-round, with larger events occurring in December, March, and April. The wetter season runs from June to September, where there's over a 35% chance of rain on any given day. August is the wettest month, averaging 14.9 days with at least 0.04 inches of precipitation, while November is the driest, with an average of 6.0 wet days. Winter in Charleston is generally moderate, though temperature extremes can occur. Many mid-November to February days reach highs of 62°F or more, occasionally reaching the mid-70s. The coldest average high occurs on January 18th at 59°F. Winter lows typically stay above freezing, with January being the coldest month. Snowfall is rare, averaging less than one inch per year.

¹ Climate information provided by weather.gov.

3.2 POPULATION AND DEMOGRAPHICS

With a population of 150,227 (according to the 2020 Census), Charleston is the largest city in South Carolina. The City's population has consistently increased since 1980, with the most significant growth occurring in the last decade. Between 1990 and 2000, Charleston's population doubled, and since 2010, it has grown by approximately 14%, averaging about 1.55% per year. During the 1990-2000 period, half of this growth was due to annexation. From 2010 to 2019, the Charleston City Plan (2021) indicates that 26% of the growth was attributed to natural increase, while 74% stemmed from migration.

The population grew from 96,650 residents in the 2000 Census to 120,083 in 2010. By July 2022, estimates put the population at 153,672. From 2000 to 2022, Charleston's population increased by roughly 60%, with an average annual growth rate of about 5%. This influx has heightened demand in the housing market, leading to a rise in new residential construction and renovations. The Charleston City Plan (2021) highlights the City's notable housing growth rate, measured as new units relative to the existing housing stock.

Table 3.1: Change in Population in Population and Housing Over Time

Year	Population	Housing Units	Area (sq. mi.)	Density (persons/sq.mi.)
1980	69,779	28,027	25.02	2,788
1990	80,414	28,111	60.82	1,322
2000	96,650	43,680	97	985
2010	120,083	59,845	108.98	1,102
2020	150,227	77,479	114.76	1,304

Source: Adapted from Comprehensive Plan Update, 2018 and 2020 U S Census Estimates

According to the 2016-2020 ACS 5-year estimates, the median age of residents in Charleston was 35.5 years. Following a similar trend to the national population, the City's population is aging. The latest estimates show a decrease in the percentage of persons under the age of 18. Similarly, there was a percentage increase in people 25 to 34, which is the largest age group within the City. All age groups ranging from 55 to 74 also experienced a percentage increase. Based on 2016-2020 ACS 5-year estimates, people 65 and older account for approximately 15% of the City's total population with a median age of 73 years.

Charleston is a racially and ethnically diverse City, however, recent trends reveal a more homogenous racial and ethnic demographic. Based on 2016-2020 ACS 5-year estimates, approximately 73.9% of the City's population is White/Caucasian and 98% of the population identifies as one race.

SECTION 3: COMMUNITY PROFILE

Table 3.2: Demographics of the City of Charleston

Jurisdiction	White, percent (2020)	Black or African American, Percent (2020)	American Indian or Alaska Native, Percent (2020)	Asian, Percent (2020)	Native Hawaiian or Other Pacific Islander, Percent (2020)	Persons of Hispanic Origin, Percent (2020)*	Two or More Races, Percent (2020)
City of Charleston	73.9	20.8	0.1	2.1	0.2	3.6	2

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

Source: United States Census Bureau

Charleston residents are well-educated with over 95% of the population 25 years or older having a high school diploma (or equivalent) or higher. This is a substantial increase of 4% from the previous 2010 ACS and ranks 7% higher than the national average. In terms of furthering education, 23.8% have some college or an associate's degree and 54.4% have a bachelor's degree or higher. When compared to the State, Charleston has a significantly higher percentage of bachelor's degree or higher education.

The average household size has remained relatively consistent over the last ten years. It was 2.18 persons in 2010, and 2.15 in 2020. The median household income increased from \$49,448 in 2010 to \$72,071 in 2020 with an estimated \$46,575 per capita income².

3.3 HOUSING, INFRASTRUCTURE, AND LAND USE

3.3.1 Housing

The City of Charleston has about 94,000 housing units within its Urban Growth Boundary according to the City Plan³. Of these, 56% are owner-occupied and 44% are renter occupied. The 2020 Census data show 58.5% of the housing units are single-unit structures. According to the 2020 Census data, 1% of the structures are mobile homes. The growth in the number of multi-family units over the past 15 years has been significant.

Most of the housing units are either single-family detached or multi-family with 10 or more units per structure. 25.4% of occupied housing units were built between 1980 –1999. 20.4% were built between 2000 and 2009. Approximately 5,885 units per year were built since 2014. Being a historical city, over 6,122 houses built before 1939 remain.⁴

3.3.2 Infrastructure

Transportation

Interstate 26 (I-26) is the primary arterial roadway through the City. Interstate 526 (I-526, Mack Clark Expressway) provides access to West Ashley to the west and Daniel Island and Mount Pleasant to the east. Other main roadways include:

² <https://www.charleston-sc.gov/106/Demographics>

³ <https://www.charleston-sc.gov/2394/Charleston-City-Plan>, page 97

⁴ Data in this paragraph was found here:

<https://data.census.gov/table?q=Housing&g=160XX00US4513330&y=2020&tid=ACSST5Y2020.S2504>

- US 78 (University Boulevard)
- US 52 (Rivers Avenue)
- US 17 (Coastal Highway)
- SC 7 (Sam Rittenberg Boulevard)
- SC 30 (James Island Expressway)
- SC 61 (Ashley River Road)
- SC 700 (Dorchester Road)
- SC 171 (Savannah Highway)
- SC 641 (Glenn McConnell Parkway)
- SC 33 (Rivers Avenue)
- SC 41 (North Rhett Avenue)

The Arthur Ravenel Jr. Bridge connects the City of Charleston with Mount Pleasant along Highway 17. The Wando River Bridge (Don N. Holt Bridge) connects to the City of Charleston from the northwest and follows along I-526. The General William C Westmoreland Bridge, the Cosgrove Bridge, the Ashley River Memorial Bridge, the T Allen Legare Bridge and the Robert B Scarborough Bridge provide connectivity of the Peninsula with West Ashley and James Island.

Air transportation is provided at Charleston International Airport and the Charleston Executive Airport. South Carolina Ports “is the state’s most significant economic asset⁵” and operates numerous port facilities including motor, ocean and passenger carriers. Passenger rail transportation provided by Amtrack is located in North Charleston. Commercial rail lines Norfolk Southern and CSX service the port.

Community Facilities

There are several public buildings and community facilities located in the City of Charleston. According to the data collected in the vulnerability assessment (Section 6.4.1), there are 18 fire stations, 14 police stations/facilities (including substations), 5 hospitals, and 96 (public, private, and prep) schools (pre-kindergarten through high school) located within the City.

In addition, there are 120 City-owned parks consisting of 1,809 acres of parks and open space located in the City of Charleston. These include the Waterfront Park, White Point Garden, Colonial Lake, Marion Square Park and many others. These facilities offer recreational opportunities to area residents and millions of visitors each year.

Utilities

Gas and electric power in the City of Charleston is provided by Dominion Energy and Berkeley Electric. Water and sewer service for the City is provided by Charleston Water, Johns Island Water, and the Plumb Island Water Treatment Site. They are responsible for the treatment, storage, and distribution of drinking water.

3.3.3 Land Use and Development Trends

The City of Charleston’s City Plan (2021) is its comprehensive guide for development. The first guiding principle, “Water First,” emphasizes that all land use and development must consider its relationship with water in and around Charleston. The City’s land uses include a mix of single-family homes, multi-family residences, condominiums, and commercial developments. In 2022, the City issued 1,673

⁵ <https://scspa.com/about-the-port/>

residential construction permits, reflecting strong ongoing development. Although the market may fluctuate annually, development in Charleston is expected to remain robust, with more projects anticipated citywide. New development is carefully planned and regulated through City ordinances, including the Zoning Ordinance, Building Code, and Stormwater Design Standards Manual (2020) to ensure that new projects are situated in appropriate areas and minimize vulnerability to hazards.

3.4 EMPLOYMENT AND INDUSTRY

The 7,353 businesses in the City of Charleston (as of 2019⁶) employ approximately 121,388 people and is primarily driven by the healthcare and social assistance sector (35,413 people) and the accommodations (hotels) and food service sector employing (13,863 people). Many technology companies and office related companies are choosing the City of Charleston as a base for their operations. The top five employers in the City were Medical University of South Carolina, Roper St. Francis Healthcare and the College of Charleston. The latest unemployment rate (as of May 2023) was 2.4% compared to the State rate of 3.1% and the national rate of 3.7% in the United States.⁷

⁶ Charleston City Plan (2021): <https://www.charlestoncityplan.com/>

⁷ Bureau of Labor Statistics: www.bls.gov

SECTION 4

HAZARD IDENTIFICATION

This section provides a description of how the City's Hazard Mitigation Planning Team identified the hazards to be included this plan. It consists of the following five subsections:

- 4.1 Overview
- 4.2 Disaster Declarations
- 4.3 Summary of Hazard Impacts
- 4.4 Hazard Evaluation
- 4.5 Hazard Identification Results

44 CFR Requirement

44 CFR Part 201.61(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.

4.1 OVERVIEW

The City of Charleston is vulnerable to a wide range of natural and human-caused hazards that threaten life and property. Current FEMA regulations and guidance under the Disaster Mitigation Act of 2000 (DMA 2000) require an evaluation of a full range of natural hazards. Although an assessment of human-caused hazards (such as technological threats and terrorism) is encouraged but not mandatory for plan approval, the City's Hazard Mitigation Planning Team is committed to mitigating impacts from all potential hazards. Therefore, a comprehensive assessment of both types of hazards has been conducted for this plan.

After reviewing the hazards, the City of Charleston has identified thirty (30) specific hazards to address in its Hazard Mitigation Plan. This identification process involved extensive efforts, gathering input from members of the Hazard Mitigation Planning Team, stakeholders, research on past disaster declarations impacting the area, and consideration of hazards outlined in the Charleston Regional Hazard Mitigation Plan (2019) and the State of South Carolina Hazard Mitigation Plan (2018).

A list of the hazards included covered in the 2019 Charleston Regional Hazard Mitigation Plan is found in **Table 4.1**, along with a summary of the hazards assessed in the City of Charleston Hazard Mitigation Plan.

SECTION 4: HAZARD IDENTIFICATION

Table 4.1: Identified Hazards

2019 Charleston Regional Hazard Mitigation Plan Identified Hazards		2023 City of Charleston Identified Hazards		Sub Hazards covered in City's 2023 Plan and Explanation
Natural Hazards	Hurricane	Natural Hazards	Coastal Storms	Storm Surge Associated with Hurricanes, High Wind associated with Hurricanes, Tornadoes associated with Hurricanes
	Flooding		Flooding	Tidal Flooding, Heavy Rain
	Sea Level Rise		Sea Level Rise	
	Earthquake		Earthquake	
	Tornado		Tornado	
	Wildfires		Fires	Wildfires, Structural Fires, Conflagration
	Tsunamis		Tsunamis	Flooding associated with Tsunamis
	Dam Failure		Dam Failure	
	Drought		Drought	Agricultural Drought, Hydrological Drought
	Severe Storm		Severe Storm	Thunderstorms, Lightning, Hailstorms, Straight Line Winds
	Winter Weather		Severe Winter Weather	Wind Chill, Extreme Cold, Snowstorms, Blizzards
			Shoreline Erosion	
			Extreme Heat	
			Sinkholes	
Technological Hazards	Rip Currents		Public Health Hazards	
	Hazardous Materials	Technological Hazards	Hazardous Materials Release	Hazardous Materials, Hazardous Chemicals, Oil Spill
			Infrastructure Failure	
			Radiological Emergency	
	Terrorism	Human-Caused Hazards	Cyber Incidents	
			Civil Disturbance	
			Terrorism	Active Threat
			Water Shortage	

4.2 DISASTER DECLARATIONS

Disaster declarations provide initial insight into the hazards that may impact the City of Charleston. Since 1977, twelve presidential disaster declarations have been reported in Charleston County, which are listed in **Table 4.2** below. This includes nine declarations related to hurricane and tropical storm events, one winter storm event, one related to severe storms and flooding and one declaration due to infectious disease.

SECTION 4: HAZARD IDENTIFICATION

Table 4.2: Disaster Declarations that have Impacted City of Charleston

Year	Disaster Number	Description
1989	843	Hurricane Hugo
1999	1299	Hurricane Floyd
2000	1313	Winter Storms
2004	1547	Tropical Storm Gaston
2004	1566	Tropical Storm Frances
2015	4241	Severe Storms and Flooding
2016	4286	Hurricane Matthew
2017	4346	Hurricane Irma
2018	4394	Hurricane Florence
2019	4464	Hurricane Dorian
2020	4492	COVID-19 Pandemic
2022	4677	Hurricane Ian

Source: FEMA.gov

4.3 SUMMARY OF HAZARD IMPACTS

Since 1955, National Centers for Environmental Information (NCEI) reported there have been 738 hazard events recorded for Charleston County¹. It is important note hazard events and consider them in the Hazard Identification section to help ensure that the appropriate hazards are being considered in the risk assessment sections and in the Mitigation Strategy. **Table 4.3** documents the hazard events recorded. Details for some of these events are discussed in further detail in the *Hazard Profiles* section.

¹ Most events in the NCEI Storm Event Database are reported at the County level. In some cases, municipalities are mentioned.

SECTION 4: HAZARD IDENTIFICATION

Table 4.3: Summary of Hazard Events (1955-2022)

Hazard Type*	Number of Reported Days with Events in Charleston County	Events that Specifically Mention City of Charleston
Coastal Flood	66	
Cold/Wind Chill	1	
Drought	20	
Excessive Heat	10	
Flash Flood	97	31
Flood	8	1
Frost Freeze	1	
Funnel Cloud	10	1
Hail	119	16
Heat	9	
Heavy Rain	5	2
Heavy Snow	3	
High Surf	11	
High Wind	9	
Hurricane	7	
Ice Storm	4	
Lightning	31	1
Rip Current	19	
Storm Surge / Tide	6	
Strong Wind	35	20
Thunderstorm Wind	280	
Tornado	39	3
Tropical Depression	4	
Tropical Storm	21	
Water Spout	5	2
Fire	3	
Winter Storm	1	
Winter Weather	3	
Total Number of Days with Reported Events	827	77

Source: NCEI

*The hazard type names that NCEI uses are different than the names of hazards used in this plan; however, one can still get an understanding of the types of hazards that impact the City as the hazard types are similar in name.

Appendix E includes detailed information about all previous historical hazard occurrence events that have occurred in the region as reported to the National Centers for Environmental Information. Some more detailed information about previous historical hazard events can be found in Section 5: Hazard Profiles under each separate hazard profile.

4.4 HAZARD EVALUATION

Table 4.4 documents the evaluation process used for determining which of the initially identified hazards are considered significant enough to warrant further evaluation in the risk assessment. The hazards included in this assessment fall into three main categories of hazards:

- Natural Hazards;
- Technological Hazards; and,
- Human-Caused Hazards.

For each hazard considered, the table indicates whether the hazard was identified as a significant hazard to be further assessed, how this determination was made, and why this determination was made. The table works to summarize not only those hazards that *were* identified (and why) but also those that *were not* identified (and why not). Hazard events not identified for inclusion at this time may be addressed during future evaluations and updates of the risk assessment if deemed necessary by the Hazard Mitigation Planning Team during the plan update process.

Table 4.4: Documentation of the Hazard Evaluation Process

Natural Hazards Considered	Was this hazard identified as a significant hazard to be addressed in the plan at this time? (YES or NO)	How was this determination made?	Why was this determination made?
NATURAL HAZARDS			
Coastal Storms	YES	<ul style="list-style-type: none"> • Review of Charleston Regional Hazard Mitigation Plan • Analysis of NOAA historical tropical cyclone tracks and National Hurricane Center Website • Review of NOAA NCEI Storm Events Database • Review of historical presidential disaster declarations • Review of City's All-Hazards Vulnerability and Risk Assessment 	<ul style="list-style-type: none"> • Hurricanes are assessed in the Charleston Regional Hazard Mitigation Plan and in the City's All-Hazards Vulnerability and Risk Assessment. • NOAA historical records indicate 43 tropical storms or hurricane events have come within 50 miles of the City of Charleston since 1971. • NCEI reported 32 days with events associated with hurricanes, tropical storms, or tropical depression events in Charleston County since 1950.
Flooding	YES	<ul style="list-style-type: none"> • Review of FEMA's Multi-Hazard 	<ul style="list-style-type: none"> • Floods occur in all 50 states and in the U.S. territories.

SECTION 4: HAZARD IDENTIFICATION

Natural Hazards Considered	Was this hazard identified as a significant hazard to be addressed in the plan at this time? (YES or NO)	How was this determination made?	Why was this determination made?
		<ul style="list-style-type: none"> Identification and Risk Assessment Review of Charleston Regional Hazard Mitigation Plan Review of NOAA NCEI Storm Events Database Review of historical disaster declarations Review of FEMA DFIRM data Review of FEMA's NFIP Community Status Book and Community Rating System (CRS) Review of City's All-Hazards Vulnerability and Risk Assessment. 	<ul style="list-style-type: none"> The flood hazard is thoroughly discussed in the Charleston Regional Hazard Mitigation Plan and the City's All-Hazards Vulnerability and Risk Assessment. NCEI reports that the City of Charleston has been affected by 43 floods events since 1996. One presidential disaster declaration for Charleston County was directly flood-related. Nine others were associated with tropical systems which likely included flooding as well. 72% of the City of Charleston located in an identified floodplain (includes 1% annual chance, 0.2 annual chance and VE flood zones). The City of Charleston joined the NFIP on 4/9/1971. Their current effective flood map data is 1/29/2021. The city joined the CRS program in 10/01/1991 and is currently a Class 6 CRS Community.
Sea Level Rise	YES	<ul style="list-style-type: none"> Review of FEMA's Multi-Hazard Identification and Risk Assessment Review of FEMA DFIRM data Review of Charleston SC Flooding and Sea Level Strategy Plan Review of NOAA Tidal Gauge Data Review of the Charleston Regional Hazard Mitigation Plan 	<ul style="list-style-type: none"> Sea level rise has been observed along the South Carolina Coast. The 2023 Charleston SC Flood and Sea Level Rise Strategy Plan states that the rate of sea level rise is increasing faster than in the past. 14" of SLR by 2050 is expected and included in City Plans NOAA Tidal Gauge Data shows the Charleston Harbor has experienced 1.07 FT of sea level rise in the past 100 years.

SECTION 4: HAZARD IDENTIFICATION

Natural Hazards Considered	Was this hazard identified as a significant hazard to be addressed in the plan at this time? (YES or NO)	How was this determination made?	Why was this determination made?
		<ul style="list-style-type: none"> Review of City's All-Hazards Vulnerability and Risk Assessment. 	<ul style="list-style-type: none"> Both the Charleston Regional Hazard Mitigation Plan and the City's All-Hazards Vulnerability and Risk Assessment address Sea Lever Rise.
Earthquake	YES	<ul style="list-style-type: none"> Review of FEMA's Multi-Hazard Identification and Risk Assessment Review of Charleston Regional Hazard Mitigation Plan Review of the City's All-Hazards Vulnerability and Risk Assessment Review of the National Geophysical Data Center USGS Earthquake Hazards Program website 	<ul style="list-style-type: none"> Earthquake events are discussed in the Charleston Regional Hazard Mitigation Plan and in the City's All-Hazards Vulnerability and Risk Assessment. Earthquakes have occurred in and around Charleston County and the City of Charleston. Charleston County is primarily affected by the Middleton Place – Summerville Seismic Zone (MPSSZ) which is composed of the northeast trending Woodstock Fault and the northwest trending Ashley River Fault. The MPSSZ experiences between 10 to 15 magnitude 3 or less events every year. At least 25 events are known to have impacted the City of Charleston according to the National Geophysical Data Center. The greatest MMI reported was an X (disastrous). According to USGS seismic hazard maps, the peak ground acceleration (PGA) with a 10% probability of exceedance in 50 years for Charleston County is approximately greater than 80%g. FEMA recommends that earthquakes be further evaluated for mitigation purposes in areas with a PGA of 3%g or more.

SECTION 4: HAZARD IDENTIFICATION

Natural Hazards Considered	Was this hazard identified as a significant hazard to be addressed in the plan at this time? (YES or NO)	How was this determination made?	Why was this determination made?
Tornadoes	YES	<ul style="list-style-type: none"> • Review of FEMA's Multi-Hazard Identification and Risk Assessment • Review of Charleston Regional Hazard Mitigation Plan • Review of NOAA NCEI Storm Events Database 	<ul style="list-style-type: none"> • Tornado events are discussed in the Charleston Regional Hazard Mitigation Plan as an individual hazard. • NCEI reported 39 days with tornadic events in Charleston County since 1957 which have caused over \$5.965 million in property damage and 17 injuries with the most severe being an EF3. Three of these events specifically mention the City of Charleston in their descriptions in the NCEI database.
Wildfire	YES (assessed under Fire)	<ul style="list-style-type: none"> • Review of FEMA's Multi-Hazard Identification and Risk Assessment • Review of Charleston Regional Hazard Mitigation Plan • Review of Southern Wildfire Risk Assessment (SWRA) Data • Review of the South Carolina Forestry Commission Wildfire Activity website 	<ul style="list-style-type: none"> • Wildfires occur in virtually all parts of the United States. Wildfire hazard risks will increase as low-density development along the urban/wildland interface increases. • Wildfires are identified as a hazard in the Charleston Regional Hazard Mitigation Plan. • A review of SWRA data indicates that there are areas of elevated concern in Charleston County and the City of Charleston.
Structural Fire	YES (assessed under Fire)	<ul style="list-style-type: none"> • Review City of Charleston Fire Department's 2020 Community Risk Assessment • Review of Charleston County Risk Assessment 2016/2017 	<ul style="list-style-type: none"> • CDF's 2020 Report indicates that structural fires tend to be most complex; Tasks must be completed to ensure the fire is extinguished in a timely manner • Structural fires have moderate probability; Ranked 8th out of 14 hazards in the 2016/2017 County Risk Assessment

Natural Hazards Considered	Was this hazard identified as a significant hazard to be addressed in the plan at this time? (YES or NO)	How was this determination made?	Why was this determination made?
		<ul style="list-style-type: none"> Review of Charleston Fire Department Annual Reports Review of Lowcountry Healthcare Preparedness Coalition Hazard Vulnerability Assessment and Mitigation 	<ul style="list-style-type: none"> CFD's Annual Reports from 2019-2022 indicate that structure fires account for approximately 30% of all fires that occur within the City. Unintentional fire (internal and external) is identified as a technological hazard that could occur at the facility level and Coalition level based on risk percentage.
Conflagration	YES (assessed under Fire)	<ul style="list-style-type: none"> Review of Charleston Fire Department Annual Reports Review of Charleston City Plan (2021) Review of Lowcountry Healthcare Preparedness Coalition Hazard Vulnerability Assessment and Mitigation 	<ul style="list-style-type: none"> Structural fires can develop into conflagration. CFD's Annual Reports from 2019-2022 indicate that structure fires account for approximately 30% of all fires that occur within the City. Historic properties/aging structures are more vulnerable to conflagration. The 2021 City Plan reports that Downtown Charleston has architecture dating back to the 17th and 18th century. Unintentional fire (internal and external) is identified as a technological hazard in the HVA. The hospital setting poses a unique risk to conflagration.
Tsunami	YES	<ul style="list-style-type: none"> Review of Charleston Regional Hazard Mitigation Plan Review of historical NOAA Storm Data Review of the South Carolina Tsunami Response Plan 	<ul style="list-style-type: none"> Tsunami events are discussed in the Charleston Regional Hazard Mitigation Plan The South Carolina Tsunami Response Plan shows there were tsunamic events in the Atlantic Coast in 1755, 1884, 1886, and 1929. Additionally, the response plan stated that the 1886 Charleston Earthquake produced a small, non-destructive tsunami in South

SECTION 4: HAZARD IDENTIFICATION

Natural Hazards Considered	Was this hazard identified as a significant hazard to be addressed in the plan at this time? (YES or NO)	How was this determination made?	Why was this determination made?
			<p>Carolina with a maximum run-up range of 0.5 to 20 inches.</p> <ul style="list-style-type: none"> NOAA historical data reported only one tsunami event caused by the 1886 Charleston Earthquake.
Dam Failure	YES	<ul style="list-style-type: none"> Review of FEMA's Multi-Hazard Identification and Risk Assessment Review of Charleston Regional Hazard Mitigation Plan Review of South Carolina Department of Health and Environmental Control (SCDHEC) SC Dam Inventory as of 8/20/20. 	<ul style="list-style-type: none"> Dam failure is identified as a hazard in the Charleston Regional Hazard Mitigation Plan. Per the SCDHEC <i>State of Dam Inventory Report</i>, there are 2 low hazard dams in total in Charleston County. (Low hazard is defined as "Dam failure may cause minimal property damage to others. Loss of life is not expected.") There are no high-hazard dams that could affect the City of Charleston, but high hazard dams nearby could cause significant damages.
Rip Currents	NO	<ul style="list-style-type: none"> Review of NOAA NCEI Storm Events Database Review of Charleston Regional Hazard Mitigation Plan 	<ul style="list-style-type: none"> Rip currents were addressed as a hazard in the Charleston Regional Hazard Mitigation Plan update. Beach areas in Charleston County include: Kiawah Island, Folly Beach, Sullivan's Island, Isle of Palms, and Seabrook Island. However, there are no beach areas within the city limits of Charleston. NCEI reported twenty-one (21) rip currents which caused 5 deaths and 7 injuries in Charleston County since 2013. However, none of these events occurred within Charleston City limits

SECTION 4: HAZARD IDENTIFICATION

Natural Hazards Considered	Was this hazard identified as a significant hazard to be addressed in the plan at this time? (YES or NO)	How was this determination made?	Why was this determination made?
Drought	YES	<ul style="list-style-type: none"> Review of FEMA's Multi-Hazard Identification and Risk Assessment Review of the Charleston Regional Hazard Mitigation Plan 	<ul style="list-style-type: none"> There are reports of drought conditions every year of the last 22 years (2000-2021) in the Charleston County and the City of Charleston, according to the South Carolina Drought Monitor. "Exceptional" drought levels were reached 7 times during this time. Droughts are identified as a hazard in the Charleston Regional Hazard Mitigation Plan
Severe Storm (Includes Thunderstorms/High Winds)	YES	<ul style="list-style-type: none"> Review of FEMA's Multi-Hazard Identification and Risk Assessment Review of the Charleston Regional Hazard Mitigation Plan Review of NOAA NCEI Storm Events Database 	<ul style="list-style-type: none"> Severe storms are identified as a hazard in the Charleston Regional Hazard Mitigation Plan NCEI reports 280 days with thunderstorm events in Charleston County 1955. These events have resulted in \$942.1 thousand (2023 dollars) in property damage and three injuries.
Lightning	YES (Assessed under Severe Storm)	<ul style="list-style-type: none"> Review of FEMA's Multi-Hazard Identification and Risk Assessment Review of Charleston Regional Hazard Mitigation Plan Review of NOAA NCEI Storm Events Database Review of Vaisala's NLDN Lightning Flash Density Map 	<ul style="list-style-type: none"> Lightning events are discussed in the Charleston Regional Hazard Mitigation Plan, although not as an individual hazard. NCEI reports 31 days with lightning events for Charleston County since 1998. These events have resulted in \$1.230 million (2022 dollars) in property damage. Only one of these events are specific to Charleston.

Natural Hazards Considered	Was this hazard identified as a significant hazard to be addressed in the plan at this time? (YES or NO)	How was this determination made?	Why was this determination made?
Hail	YES (assessed under Severe Storm)	<ul style="list-style-type: none"> Review of FEMA's Multi-Hazard Identification and Risk Assessment Review of Charleston Regional Hazard Mitigation Plan Review of NOAA NCEI Storm Events Database 	<ul style="list-style-type: none"> Hail events are discussed in the Charleston Regional Hazard Mitigation Plan, although not as an individual hazard. Hailstorm events are discussed in the state plan as its own hazard NCEI reports sixteen (16) hailstorm events (0.75 to 1.75-inch size hail) for City of Charleston between 1999 and 2022.
Severe Winter Weather	YES	<ul style="list-style-type: none"> Review of the Charleston Regional Hazard Mitigation Plan Review of FEMA's Multi-Hazard Identification and Risk Assessment Review of historical Presidential disaster declarations. Review of NOAA NCEI Storm Events Database 	<ul style="list-style-type: none"> Winter weather is identified as a hazard in the Charleston Regional Hazard Mitigation Plan. Severe winter storms, including snow storms and ice storms, are discussed in the SC State Hazard Mitigation Plan. NCEI reports that Charleston County has experienced seven (10) severe winter weather events since 2000. These events have resulted in over \$96 thousand in property damages. Winter storms were responsible for one disaster declaration in Charleston County.
Shoreline Erosion	YES	<ul style="list-style-type: none"> NOAA Tidal Gauge Data for Charleston Harbor USGS Coastal Change Hazards website 	<ul style="list-style-type: none"> NOAA Tidal Gauge data shows that Charleston Harbor, which borders the City of Charleston, has experienced four-to-six inches of sea level rise in the last two decades. USGS reports persistent long-term average erosion rate (-13.0 ± 18.8 m/yr) along the coastal barrier islands of the City of Charleston, such as Morris Island.

SECTION 4: HAZARD IDENTIFICATION

Natural Hazards Considered	Was this hazard identified as a significant hazard to be addressed in the plan at this time? (YES or NO)	How was this determination made?	Why was this determination made?
Extreme Heat	YES	<ul style="list-style-type: none"> Review of NOAA NCEI Storm Events Database Review of the Charleston Regional Hazard Mitigation Plan Review of Fernleaf's All-Hazards Vulnerability Report 	<ul style="list-style-type: none"> NCEI reported 10 excessive heat events in the City of Charleston. The Charleston Regional Hazard Mitigation Plan includes Excessive Heat as an identified Hazard for Charleston County and the City of Charleston.
Sinkholes	YES	<ul style="list-style-type: none"> Review of the South Carolina Hazard Mitigation Plan Review of FEMA's Multi-Hazard Identification and Risk Assessment Local news reports and representatives from the city Review of the Charleston Regional Hazard Mitigation Plan 	<ul style="list-style-type: none"> Sinkholes are identified as a hazard in the South Carolina Hazard Mitigation Plan Sinkholes are not addressed in the Charleston Regional Hazard Mitigation Plan.
Disease and Pandemic	YES	<ul style="list-style-type: none"> Review of South Carolina Hazard Mitigation Plan Review of Charleston Regional Hazard Mitigation Plan Review of FEMA's Multi-Hazard Identification and Risk Assessment Review of historical disaster declarations 	<ul style="list-style-type: none"> Although the Charleston Regional Hazard Mitigation Plan did not include disease and pandemic as a hazard, it is assessed in the creation of the City of Charleston plan to maintain consistency with the SC State Hazard Mitigation Plan. Public Health Hazards have caused one of the eleven disaster declarations in Charleston County (the on-going COVID-19 Pandemic).

Natural Hazards Considered	Was this hazard identified as a significant hazard to be addressed in the plan at this time? (YES or NO)	How was this determination made?	Why was this determination made?
Floodplain Inundation	YES (addressed under Flooding)	<ul style="list-style-type: none"> Review of FEMA's Multi-Hazard Identification and Risk Assessment Review of City's All Hazards Vulnerability and Risk Assessment 	<ul style="list-style-type: none"> For the purposes of the City's 2023 Hazard Mitigation Plan, Floodplain Inundation and Flooding refer to the same type of flooding.
Storm Surge	YES (addressed with Coastal Storms)	<ul style="list-style-type: none"> Review of NOAA storm surge data Review of City's All Hazards Vulnerability and Risk Assessment Review of NOAA NCEI Storm Events Database 	<ul style="list-style-type: none"> NOAA storm surge data indicates significant portions of the city would be impacted by storm surge as a result of tropical storms and hurricanes. The City's All Hazards Vulnerability and Risk Assessment addresses storm surge. NECI data indicates six storm surge events for Charleston/Charleston Harbor.
Tidal Flooding	YES (addressed with Flooding)	<ul style="list-style-type: none"> Local news reports and representatives from the city Review of Charleston Harbor NOAA Tide Gauge Data Review of City's All Hazards Vulnerability and Risk Assessment 	<ul style="list-style-type: none"> NOAA data shows a significant increase in the number of days in Charleston experiencing tidal flood Tide gauge data shows that rising sea levels are exacerbating tidal flooding events in Charleston The City's All Hazards Vulnerability and Risk Assessment addresses tidal flooding.
Heavy Rain	YES (addressed with Flooding)	<ul style="list-style-type: none"> Local news reports and representatives from the city 	<ul style="list-style-type: none"> Multiple local news outlets report on rainfall events resulting in flooding. City representatives requested

SECTION 4: HAZARD IDENTIFICATION

Natural Hazards Considered	Was this hazard identified as a significant hazard to be addressed in the plan at this time? (YES or NO)	How was this determination made?	Why was this determination made?
		<ul style="list-style-type: none"> Review of City's 2023 Flooding and Sea Level Rise Strategy Update Review of City's 2020 All-Hazards Vulnerability and Risk Assessment Review of South Carolina's Department of Natural Resources' Overview of South Carolina's Climate and Hazards Review of National Weather Service records and trends 	<p>rainfall be incorporated into the Plan Update as a sub-hazard to flooding.</p> <ul style="list-style-type: none"> City's Flood and Sea Level Rise Strategy denotes local rainfall as one of many physical factors that direct contribute to coastal flood exposure. City's All-Hazards Vulnerability and Risk Assessment includes rainfall-induced flooding. SCDNR states that fluvial flooding is typically caused by excessive freshwater from a severe or prolonged rain event showing highest rainfall events between 1956-2021. NWS notes that the Charleston area is subject to storm surge, flooding from heavy rains, and high tides (king tides).
TECHNOLOGICAL HAZARDS			
Hazardous Materials Release	YES	<ul style="list-style-type: none"> Review of FEMA's Multi-Hazard Identification and Risk Assessment Review of the Charleston Regional Hazard Mitigation Plan 	<ul style="list-style-type: none"> Review of Pipeline and Hazardous Materials Safety Administration data indicates 264 HAZMAT incidents have occurred in the City of Charleston EPA Toxic Release Inventory indicates there are seven (7) Toxic Release Inventory (TRI) facilities in the City of Charleston. The Charleston Regional Hazard Mitigation Plan identifies Hazardous Materials as a hazard.
Infrastructure Failure	YES	<ul style="list-style-type: none"> Review of local data and local official knowledge. 	<ul style="list-style-type: none"> Vulnerability of Ravenel Bridge, Wando River Bridge, etc and aging infrastructure in general.

SECTION 4: HAZARD IDENTIFICATION

Natural Hazards Considered	Was this hazard identified as a significant hazard to be addressed in the plan at this time? (YES or NO)	How was this determination made?	Why was this determination made?
Radiological Emergency	YES	<ul style="list-style-type: none"> Review of IAEA list of fixed nuclear power stations in the United States Review of local official knowledge 	<ul style="list-style-type: none"> There are no nuclear facilities within 50 miles of the City of Charleston The City is not in range of nuclear power plants, but there is nuclear power training within the region.
Cyber Incidents	YES	<ul style="list-style-type: none"> Review of local official knowledge 	<ul style="list-style-type: none"> Changing future conditions encourage the assessment of the possibility of a cyber-attack with the increase in global technology
HUMAN-CAUSED HAZARDS			
Civil Disturbance	YES	<ul style="list-style-type: none"> Review of local official knowledge Local news reports/anecdotal evidence 	<ul style="list-style-type: none"> Local officials and news reports show there were three civil disturbance incidents on record from 1876 - 2020 Review of the hazard with local officials provided indication that this is a growing hazard of concern for the City of Charleston.
Terrorism	YES	<ul style="list-style-type: none"> Review of Charleston Regional Hazard Mitigation Plan Review of local official knowledge. 	<ul style="list-style-type: none"> The Charleston Regional Hazard Mitigation Plan identifies terrorism as a hazard. The plan reported the region is always at risk due to the proximity to the Charleston Port. Rare occurrence but would have catastrophic impacts.
Active Threat	YES	<ul style="list-style-type: none"> Review of local data and official knowledge. 	<ul style="list-style-type: none"> Previous occurrences for the City have been recorded and active threat events are

Natural Hazards Considered	Was this hazard identified as a significant hazard to be addressed in the plan at this time? (YES or NO)	How was this determination made?	Why was this determination made?
			increasing rapidly at the national level.
Water Shortage	YES (Included as an impact of drought, infrastructure failure but not as hazard)	<ul style="list-style-type: none"> Review of City's All-Hazards Vulnerability and Risk Assessment 	<ul style="list-style-type: none"> Water Shortage was addressed as a hazard in the City's All-Hazards Vulnerability and Risk Assessment Water shortage is addressed as an impact of drought and infrastructure failure.

4.5 HAZARD IDENTIFICATION RESULTS

Table 4.5 provides a summary of the hazard identification and evaluation process noting that 28 of the 29 initially identified hazards are considered significant enough for further evaluation through this Plan's risk assessment (marked with a “”).

SECTION 4: HAZARD IDENTIFICATION

Table 4.5: Summary Results of the Hazard Identification and Evaluation Process

NATURAL HAZARDS	TECHNOLOGICAL HAZARDS
<input checked="" type="checkbox"/> Coastal Storms	<input checked="" type="checkbox"/> Hazardous Materials Release
<input checked="" type="checkbox"/> Flooding	<input checked="" type="checkbox"/> Infrastructure Failure
<input checked="" type="checkbox"/> Sea Level Rise	
<input checked="" type="checkbox"/> Earthquake	<input checked="" type="checkbox"/> Radiological Emergency
<input checked="" type="checkbox"/> Tornado	<input checked="" type="checkbox"/> Cyber Incident
<input checked="" type="checkbox"/> Fire	<input checked="" type="checkbox"/> Civil Disturbance
<input checked="" type="checkbox"/> Tsunami	<input checked="" type="checkbox"/> Terrorism
<input checked="" type="checkbox"/> Dam Failure	<input checked="" type="checkbox"/> Active Threat*****
<input type="checkbox"/> Rip Currents	<input checked="" type="checkbox"/> Water Shortage*****
<input checked="" type="checkbox"/> Drought	
<input checked="" type="checkbox"/> Severe Storm	
<input checked="" type="checkbox"/> Lightning*	
<input checked="" type="checkbox"/> Hail*	
<input checked="" type="checkbox"/> Winter Weather	
<input checked="" type="checkbox"/> Shoreline Erosion	
<input checked="" type="checkbox"/> Extreme Heat	
<input checked="" type="checkbox"/> Sinkholes	
<input checked="" type="checkbox"/> Disease and Pandemic	
<input checked="" type="checkbox"/> Floodplain Inundation**	
<input checked="" type="checkbox"/> Storm Surge***	
<input checked="" type="checkbox"/> Tidal Flooding****	
<input checked="" type="checkbox"/> Heavy Rain*****	
<input checked="" type="checkbox"/> Structure Fire*****	
<input checked="" type="checkbox"/> Conflagration*****	

= Hazard considered significant enough for further evaluation in the Charleston risk assessment.

* Lightning and hail are assessed as a sub hazard under the severe storms hazard.

** For the purposes of this plan, floodplain inundation is addressed under flooding.

*** Storm surge is assessed as a sub hazard of coastal storms

**** Tidal flooding is included as a sub hazard of flooding

***** Heavy Rain is included as a sub hazard of flooding

***** Structure Fire is included as a sub hazard of fire

***** Conflagration is included as a sub hazard of fire

***** Active Threat is included as a sub hazard of terrorism

***** Water Shortage is assessed as an impact of drought and infrastructure failure

SECTION 5

HAZARD PROFILES

This section includes detailed hazard profiles for each of the hazards identified in the previous section (*Hazard Identification*) as significant enough for further evaluation in the City of Charleston Hazard Mitigation Plan. It contains the following subsections:

- 5.1 Overview
- 5.2 Study Area
- 5.3 Climate Change
- 5.4 Coastal Storms
- 5.5 Flooding
- 5.6 Sea Level Rise
- 5.7 Earthquake
- 5.8 Tornado
- 5.9 Fire
- 5.10 Tsunami
- 5.11 Dam Failure
- 5.12 Drought
- 5.13 Severe Storm
- 5.14 Severe Winter Weather
- 5.15 Shoreline Erosion
- 5.16 Extreme Heat
- 5.17 Sinkholes
- 5.18 Disease and Pandemic
- 5.19 Hazardous Materials Release
- 5.20 Infrastructure Failure
- 5.21 Radiological Emergency
- 5.22 Cyber Incidents
- 5.23 Civil Disturbance
- 5.24 Terrorism
- 5.25 Conclusions on Hazard Risk
- 5.26 Final Determinations

44 CFR Requirement

44 CFR Part 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.

5.1 OVERVIEW

All hazards that have the potential to impact Charleston were identified in Section 4 (*Hazard Identification*). Identified hazards were then further refined to evaluate hazards most prevalent in the City. A hazard profile for each of these hazards. Each hazard profile includes:

- a general definition or description of the hazard,
- information about its location and extent (maps included where available),
- record of notable historical occurrences,
- consideration of changing future conditions, and
- a discussion about the probability of future occurrences of the hazard.

Each profile includes specific items noted by members of the City of Charleston Hazard Mitigation Planning Team as it relates to historical or anecdotal hazard information including previous, current, and anticipated impacts.

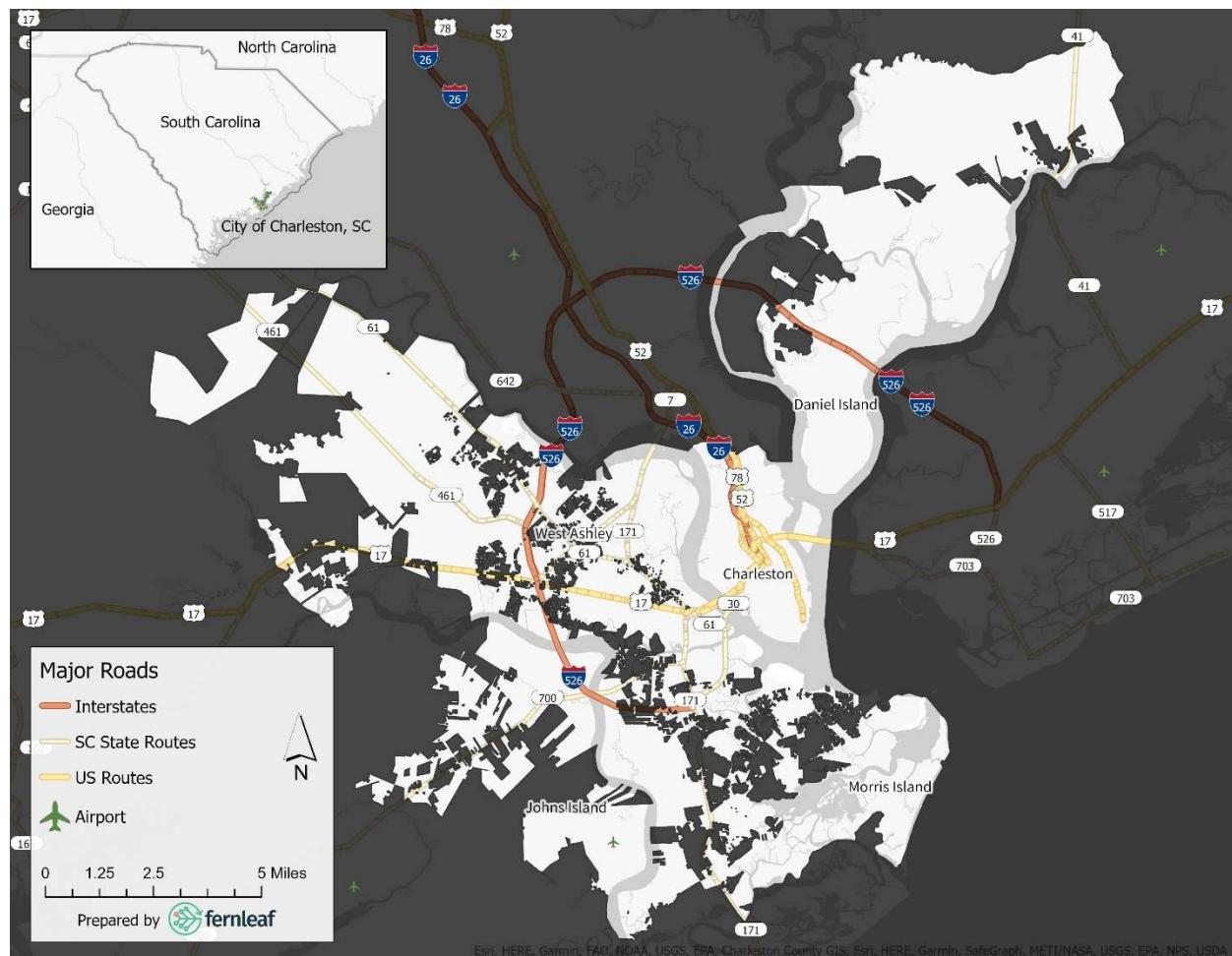
The following twenty (20) hazards were profiled:

Category	Hazard	Sub-Hazard(s)
Natural Hazards	Hurricane	Storm Surge
	Flooding	Tidal Flooding, Heavy Rainfall
	Sea Level Rise	
	Earthquake	
	Tornado	
	Fire	Wildfire, Structural Fire, Conflagration
	Tsunami	
	Dam Failure	
	Severe Storm	Thunderstorm, Lightning, Hail, Straight-Line Winds
	Severe Winter Weather	
	Shoreline Erosion	
	Extreme Heat	
	Sinkholes	
	Disease & Pandemic	
Technological Hazards	Hazardous Materials	
	Infrastructure Failure	Sinkholes (Aging Infrastructure), Water Shortage
Human-Caused Hazards	Radiological Emergency	
	Cyber Incidents	
	Civil Disturbance	
	Terrorism	Active Threat

5.2 STUDY AREA

Figure 5.1 provides a base map, for reference, of the City of Charleston, SC.

Figure 5.1: City of Charleston Base Map



5.3 CLIMATE CHANGE

This plan acknowledges climate change as a significant threat to the City of Charleston. As the Earth's climate warms, the city anticipates an increase in both the frequency and intensity of historically prevalent hazards. The analysis considers changing global weather patterns, future urban and rural developments, and evolving local and global environmental conditions, all based on historical trends and future projections.

Studies indicate that South Carolina will face some of the most severe effects of climate change.¹ The United States Environmental Protection Agency reports that most of the state has warmed by half to one degree Fahrenheit over the last century, and Charleston is preparing for a projected sea-level rise of fourteen inches by 2050. Rising water levels are eroding coastal areas, flooding lowlands, and worsening king tide events.² Over the next fifty years, anticipated impacts of climate change may include more frequent and intense hazard events, reduced crop yields, harm to livestock, increased extreme heat days, heightened vulnerability of infrastructure, and a greater risk of heat strokes and other heat-related illnesses.

¹ <https://www.theatlantic.com/science/archive/2017/06/global-warming-american-south/532200/>

² <https://19january2017snapshot.epa.gov/sites/production/files/2016-09/documents/climate-change-sc.pdf>

Each hazard profile features a section titled "Changing Future Conditions," which examines the connection between climate change and that specific hazard. This helps in understanding and anticipating the future impacts of hazards on Charleston. While it is generally accepted that climate change will increase the frequency and intensity of hazardous events, the degree of this impact varies depending on several local factors, such as geography, population dynamics, development trends, and policies. Climate change considerations are integrated into the individual hazard profiles whenever applicable.

NATURAL HAZARDS

5.4 COASTAL STORMS

This section discusses coastal storms affecting Charleston, including hurricanes, tropical storms, depressions, and nor'easters.

5.4.1 Background and Description

Hurricanes and tropical storms, classified as cyclones, develop around a low-pressure center with winds rotating counter-clockwise in the Northern Hemisphere and clockwise in the Southern Hemisphere. Their diameters typically range from 10 to 30 miles. A tropical cyclone forms over warm tropical waters and serves as a "safety valve," maintaining the balance between tropics and polar regions. The threat from these storms includes sustained winds, heavy rainfall, and tornadoes.

Tropical cyclones derive their energy from latent heat released during the condensation of warm water. Their formation requires a low-pressure disturbance, warm sea surface temperatures, Earth's rotational force, and minimal wind shear within the lowest 50,000 feet of the atmosphere. Most hurricanes and tropical storms arise in the Atlantic Ocean, Caribbean Sea, and Gulf of Mexico during the Atlantic hurricane season, which spans June to November. The season peaks from early to mid-September, averaging six hurricanes annually.

As a hurricane develops, barometric pressure at its center drops while wind speeds increase. If conditions remain favorable, it can evolve into a tropical depression. Once sustained winds reach 39 miles per hour, it is classified as a tropical storm, receives a name, and is 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 5.1**), which rates hurricane intensity on a scale of 1 to 5, with 5 being the most intense.

Table 5.1: Saffir-Simpson Scale

Category	Maximum Sustained Wind Speed (MPH)	Minimum Surface Pressure (Millibars)
1	74-95	Greater than 980
2	96-110	979-965
3	111-129	964-945
4	130-156	944-920
5	157 +	Less than 920

Source: National Hurricane Center

The Saffir-Simpson Scale categorizes hurricane intensity linearly based upon maximum sustained winds and barometric pressure, which are combined to estimate potential damage. Categories 3, 4, and 5 are classified as “major” hurricanes and, while hurricanes within this range comprise only 20 percent of total tropical cyclone landfalls, they account for over 70 percent of the damage in the United States. **Table 5.2** describes the damage associated with each hurricane category. Damage during hurricanes may also result from spawned tornadoes, storm surge, and inland flooding resulting from heavy rainfall that usually accompanies these storms.

Table 5.2: Hurricane Damage Classifications

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

Nor'easters are coastal storms that develop along the East Coast of North America, primarily between Georgia and New Jersey. Named for the northeast winds they bring, these storms can occur year-round but are most frequent and intense from September to April. Nor'easters have caused billions in damage, leading to severe economic disruptions, transportation challenges, and coastal flooding. They typically move northeastward, reaching peak intensity near New England and the Maritime Provinces of Canada, while also affecting southern Atlantic states. These storms often bring heavy rain or snow, gale-force winds, rough seas, and occasional coastal flooding, significantly impacting I-95 from Georgia to New England.³

Storm Surge

Storm surge refers to flooding caused by an abnormal rise in tide due to severe storms, such as hurricanes, exceeding normal astronomical tides. It is measured as the height above ground level. For instance, a predicted storm surge of 10 feet indicates that forecasters expect 10 feet of water to inundate the area.

³ <https://www.weather.gov/safety/winter-noreaster>

The surge's height is influenced by the storm's intensity, speed, size, direction, and the shoreline's shape. Storm surges can occur at any tidal level, and when they coincide with high tides, they lead to more flooding than during low tides. The total of a storm surge and the astronomical tide is referred to as a "storm tide." Storm surges can result in fatalities and significant property damage, including beach erosion, harm to coastal habitats, and compromised infrastructure like roads, railroads, bridges, buildings, and pipelines. The combination of wind and air pressure from the storm pushes water toward the shore, raising water levels above the natural tide.

5.4.2 Location and Spatial Extent

South Carolina is one of the most vulnerable states in the nation to be impacted by hurricanes, tropical storms and nor'easters. Charleston is located very close to the Atlantic Ocean, is surrounded by water and inland areas that may be directly affected by these storms. The city is densely populated, especially during peak tourist seasons. That density coupled with the generally low coastal elevations, significantly increases the city's vulnerability to hurricanes and associated flooding.

Storm Surge

The most significant threat to life and property from hurricanes and tropical storms is storm surge. Other impacts include high winds, tornadoes, and inland flooding caused by heavy rainfall. The extent of these threats can be gauged by the number of people affected, which may range from hundreds to thousands depending on the storm's size. With 72% of the city located in a floodplain, the risk of storm surge is considerable. According to NOAA's Sea, Lake, and Overland Surges from Hurricanes model, particularly for Category 1-3 hurricanes, storm surge can extend miles inland and affect areas along the region's four largest rivers: Stono, Ashley, Cooper, and Wando.⁴

Populated areas likely to be impacted include Charleston's Peninsula, situated between the Ashley and Cooper Rivers, as well as the West Ashley and James Island Districts, which are separated by Wappoo Creek and are directly linked to the Stono and Ashley rivers.

5.4.3 Historical Occurrences⁵

According to the National Hurricane Center's storm track records, 45 tropical systems have passed within 50 miles of Charleston since 1970. This includes 13 tropical depressions, 23 tropical storms, and eight (8) hurricanes. Hurricane events have caused eight disaster declarations in Charleston County. **Figure 5.2** below shows a map of tropical storm tracks between 1970 – 2021. **Table 5.3** below shows hurricane and tropical storm tracks that have occurred within 50 miles of the City of Charleston.

⁴ <https://www.nhc.noaa.gov/surge/momOverview.php>

⁵ Data and storm summaries were mostly found here: <https://www.weather.gov/chs/TChistory>

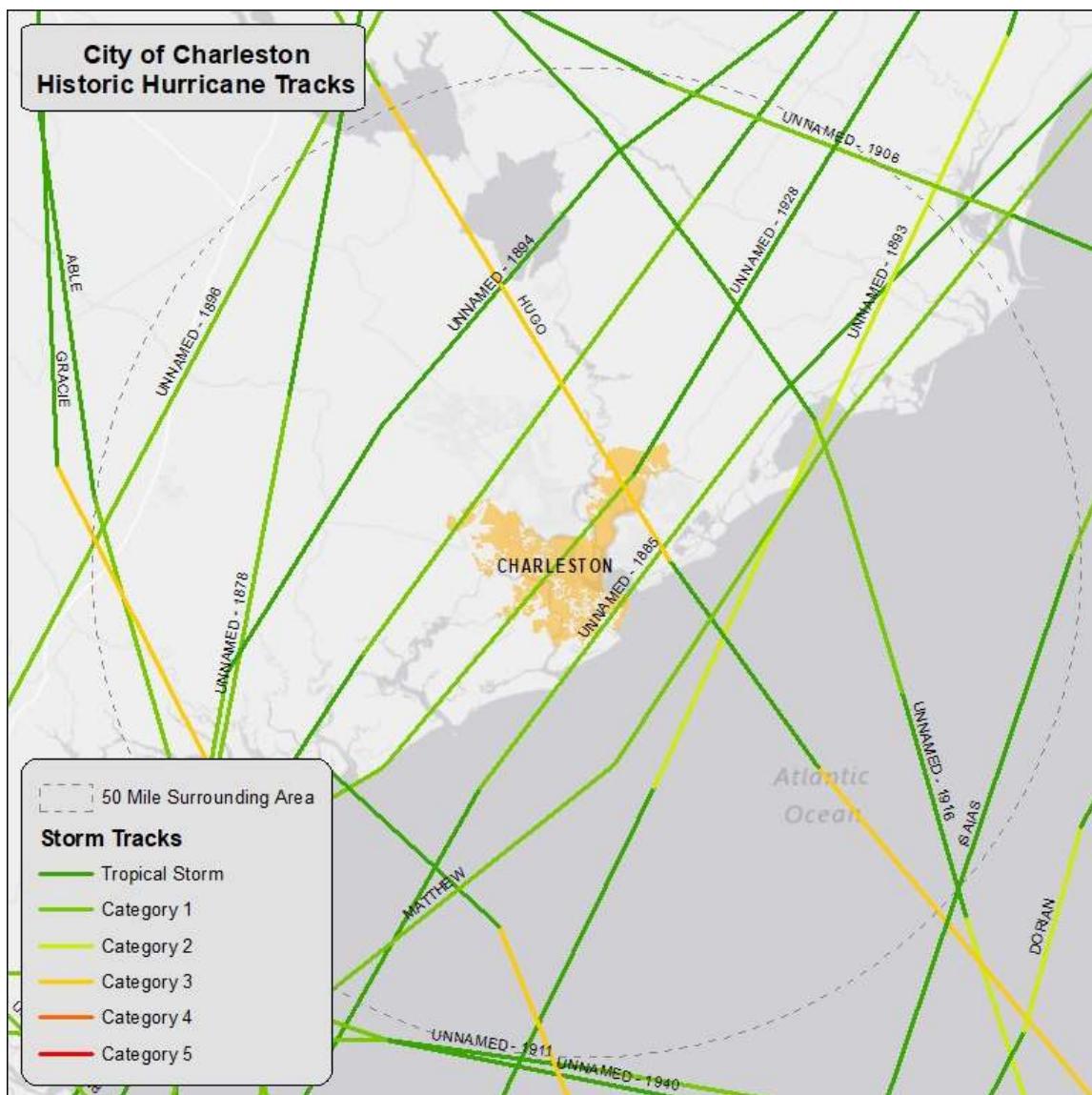


Figure 5.2: Historical Hurricane Tracks for Charleston, SC (1970-2021)

Source: National Hurricane Center's Historical Hurricane Tracks

Table 5.3: Hurricane Tracks within 50 Miles of Charleston

Date of Occurrence	Storm Name	Maximum Wind Speed (miles per hour)	Storm Category
9/11/1971	Unnamed	23	Tropical Depression
9/14/1972	Dawn	23	Tropical Depression
10/24/1975	Hallie	51	Tropical Storm
5/21/1975	Unnamed	51	Tropical Storm
8/21/1976	Dottie	40	Tropical Storm
9/13/1976	Unnamed	30	Tropical Storm
9/5/1977	Clara	23	Tropical Depression

SECTION 5: HAZARD PROFILES

Date of Occurrence	Storm Name	Maximum Wind Speed (miles per hour)	Storm Category
6/16/1979	Unnamed	35	Tropical Depression
9/5/1979	David	74	Category 1
7/3/1981	Unnamed	28	Tropical Depression
8/19/1981	Dennis	51	Tropical Storm
8/19/1982	Unnamed	69	Tropical Storm
9/29/1984	Isidore	51	Tropical Storm
7/25/1985	Bob	74	Category 1
11/22/1985	Kate	57	Tropical Storm
8/15/1986	Charley	17	Tropical Depression
8/28/1988	Chris	40	Tropical Storm
9/22/1989	Hugo	138	Category 4
7/20/1994	Unnamed	34	Tropical Depression
11/21/1994	Gordon	34	Tropical Depression
10/8/1996	Josephine	51	Tropical Storm
10/11/2002	Kyle	40	Tropical Storm
8/13/2004	Bonnie	28	Tropical Depression
8/14/2004	Charley	80	Category 1
8/29/2004	Gaston	74	Category 1
6/3/2007	Barry	45	Tropical Depression
7/19/2008	Cristobal	28	Tropical Depression
9/6/2008	Hanna	69	Tropical Storm
5/30/2012	Beryl	40	Tropical Storm
6/7/2013	Andrea	46	Tropical Storm
5/29/2016	Bonnie	35	Tropical Depression
6/7/2016	Colin	51	Tropical Storm
9/3/2016	Hermine	55	Tropical Storm
9/15/2016	Julia	46	Tropical Storm
10/8/2016	Matthew	92	Category 2
8/29/2017	Unnamed	40	Tropical Storm
9/15/2018	Florence	63	Tropical Storm
9/15/2019	Dorian	115	Category 3
5/27/2020	Bertha	51	Tropical Storm
7/8/2020	Fay	23	Tropical Depression
8/4/2020	Isaias	92	Category 1
11/13/2020	Eta	46	Tropical Storm
6/28/2021	Danny	46	Tropical Storm
9/30/2022	Ian	70	Category 1
8/30/2023	Idalia	57	Tropical Storm

Source: National Hurricane Center.

Between 1950 and 2024, the National Centers for Environmental Information reported 37 days of events linked to hurricanes, tropical storms, or tropical depressions in Charleston County. While hurricane tracks

within a 50-mile radius of Charleston differ from the disaster declarations affecting the area, federal records reveal eleven disaster declarations related to hurricanes and tropical storms: Hurricane Hugo (1989), Hurricane Floyd (1999), Tropical Storm Frances (2004), Tropical Storm Gaston (2004), Hurricane Matthew (2016), Hurricane Irma (2017), Hurricane Florence (2018), Hurricane Dorian (2019), Hurricane Ian (2022), Tropical Storm Debby (2024), and Hurricane Helene (2024). Further details on these disasters are provided below.

Hurricane Hugo, a Category 4 storm, made landfall near Charleston, SC, on September 22, 1989, with winds of 135-140 mph, causing over \$7 billion in damage and resulting in 35 fatalities. Hurricane Floyd followed in 1999, striking North Carolina as a Category 2 hurricane and causing nearly \$6.5 billion in damages, particularly from severe flooding in South Carolina. In August 2004, Tropical Storm Gaston made landfall in Virginia, bringing heavy rainfall and urban flooding totaling approximately \$16.6 million in damage across South Carolina.

Shortly after, Tropical Storm Frances produced a record 41 tornadoes in the state, leading to over \$93 million in damages. Hurricane Matthew, a Category 1 storm in October 2016, resulted in historic flooding and \$67 million in property damage. Hurricane Irma in September 2017 caused flash flooding and power outages, with damages estimated at over \$575,000. In September 2018, Hurricane Florence brought record rainfall of 23.63 inches in South Carolina, leading to devastating freshwater flooding. Hurricane Dorian in 2019 caused power outages and tornadoes in South Carolina, while Hurricane Ian, making landfall in September 2022, resulted in widespread flooding and damage despite being downgraded to a post-tropical cyclone.

Tropical Storm Debby formed in early August 2024, made landfall in Florida as a Category 1 storm, and later weakened before making a second landfall near Bulls Bay, South Carolina, on August 8. The storm produced tornadoes, storm surge, and extreme rainfall exceeding 22 inches, resulting in widespread flooding, power outages, road closures, and water rescues. More than 900 homes were damaged and public and infrastructure costs exceeded \$30 million.

Hurricane Helene became South Carolina's most destructive storm since Hugo, with its outer bands producing deadly winds, flooding, and 21 tornadoes that killed 49 people, caused massive power outages, closed hundreds of roads, and triggered record river crests and widespread evacuations. More than 2,000 homes were destroyed or severely damaged. Public Assistance repair and recovery costs exceeded \$1.2 billion, and statewide recovery efforts continue as Disaster Recovery Centers support affected communities.

Storm Surge

The National Center for Environmental Information (NCEI) reported seven storm surge incidents for the City of Charleston. **Table 5.4** below details these storm surge events. The highest storm surge at Charleston Harbor was set by Hurricane Hugo in 1989 at 12.5 feet above the mean lower low water (MLLW), or the average daily lower low tide, followed by Hurricane Irma at 9.9 feet, and the third highest recorded is Hurricane Matthew at 9.3 feet.⁶

⁶ [https://www.postandcourier.com/hurricanewire/ian-could-bring-4-7-feet-of-storm-surge-to-charleston-what-matters-is-when/article_97546530-402c-11ed-8c5c-0fc7fe31e07e.html#:~:text=\(The%20record%2C%2012.5%20feet%2C,peak%20tide%20of%208.7%20feet.](https://www.postandcourier.com/hurricanewire/ian-could-bring-4-7-feet-of-storm-surge-to-charleston-what-matters-is-when/article_97546530-402c-11ed-8c5c-0fc7fe31e07e.html#:~:text=(The%20record%2C%2012.5%20feet%2C,peak%20tide%20of%208.7%20feet.)

SECTION 5: HAZARD PROFILES

Table 5.4: Storm Surge Events for City of Charleston (2011 - 2025)

Location	Date	Description
CHARLESTON (ZONE)	8/26/2011	The tide gauge located 1 mile east of Charleston, South Carolina measured a water level of 7.64 feet MLLW in Charleston Harbor. This water level was a result of a storm surge anomaly of 1.73 feet associated with Hurricane Irene.
CHARLESTON (ZONE)	6/6/2016	The Charleston Police Department reported the following roads and intersections in downtown Charleston closed due to the combination of heavy rain and high astronomical tides: Ashley Avenue near Bennett Street, Ashley Avenue near Calhoun Street, South Market Street between Church Street and State Street, Morrison Drive to Stuart Street, Rutledge Avenue between Calhoun Street and Bennett Street, Gadson Street near Bennett Street, Fishburne Street near President Street, Hagood Avenue near Line Street and the Highway 61 ramp exit. At 9:42 PM a maximum tide level of 7.56 feet MLLW was recorded at the Charleston Harbor tide gage. A surge of 1.28 feet was also present at the time of the maximum tide level.
CHARLESTON (ZONE)	9/2/2016	The National Ocean Service tide gauge at Charleston Harbor measured a peak storm surge of 2.51 feet associated with Tropical Storm Hermine.
CHARLESTON (ZONE)	10/7/2016	Hurricane Matthew caused significant damage to more than 30 dune walkovers on the south end of Isle of Palms, with dune erosion reaching escarpments of 6 to 8 feet. Public reports indicated that Whitepoint Gardens in downtown Charleston was flooded by storm surge, as the Charleston Harbor tide gauge recorded a peak tide of 9.29 feet, the third highest on record, and a storm surge of 6.20 feet. Additionally, one boat sank and another ran aground in the Ashley River near Westmoreland Bridge. A post-event report for Kiawah Island revealed severe beach erosion, with losses ranging from 30 to 220 feet along various beaches, particularly at the Ocean Golf Course, Captain Sam's Inlet, and Beachwalker County Park.
CHARLESTON (ZONE)	9/11/2017	Charleston County Emergency Management and a National Weather Service storm survey team confirmed significant impacts from storm surge associated with Tropical Storm Irma, particularly affecting Downtown Charleston and nearby tidal areas. Inundation reached several feet, breaching the Battery wall and flooding White Point Gardens, prompting the Charleston Police Department to close the peninsula to travel. Other affected areas included James Island, with extensive dock damage on Schooner Road and Galleon Road, and flood impacts at the Wappoo Cut boat ramp and Lockwood Drive. Inundation levels varied across the county, peaking at 5.89 feet on Eagle Point Road, while erosion and dune destruction were reported at local beaches. The peak tide in Charleston Harbor reached 9.92 feet, the third highest on record, with a surge of 4.87 feet measured during the event.
CHARLESTON (ZONE)	10/11/2018	Broadcast media reported frequent waves crashing over the sea wall along the Charleston Battery and flowing over Murray Boulevard. A video via social media also showed minor damage to a marina gangway and docks near Patriots Point. A peak surge of 2.07 feet was measured at the Charleston Harbor tide gauge during the event.
CHARLESTON (ZONE)	8/30/2023	A National Weather Service Storm Survey Team evaluating water marks for Tropical Storm Idalia determined peak inundation of 2 to 3.5 feet above normally

Location	Date	Description
		dry ground occurring across downtown Charleston, SC. This determination was based on both measured high water marks and interviews with police. Extensive saltwater flooding occurred along the periphery of the peninsula, but extended into the interior by several city blocks. Highest levels of storm surge occurred along areas adjacent to the Ashley River and the Charleston Harbor.

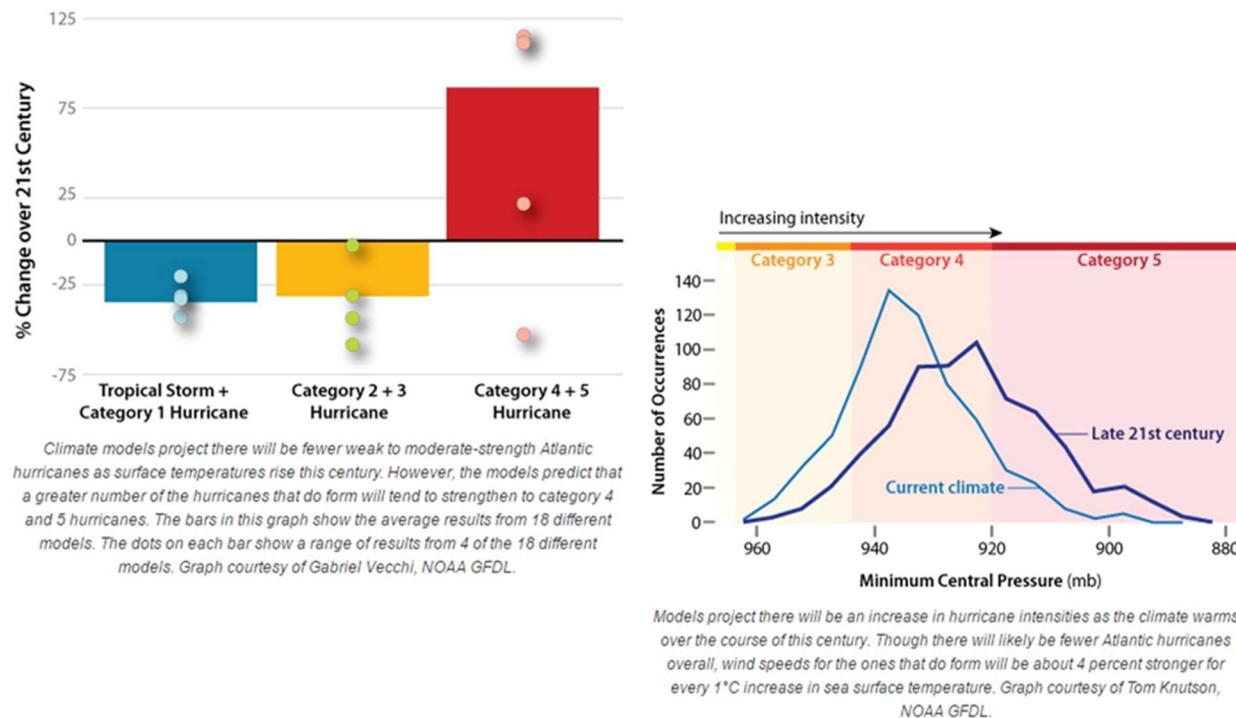
Source: NCEI

5.4.4 Changing Future Conditions

Charleston's proximity to the Atlantic coast makes it a prime target for coastal storms including hurricane landfalls, tropical storms and nor'easters and changing climate and weather conditions may increase the number and frequency of future these events. 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 in the near future⁷.

Additionally, as NOAA reports in **Figure 5:3**, weather extremes will likely cause more frequent, stronger storms in the future due to rising surface temperatures. 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.

⁷ <https://www.gao.gov/blog/how-federal-government-approaching-climate-resilience>



Climate models project there will be fewer weak to moderate-strength Atlantic hurricanes as surface temperatures rise this century. However, the models predict that a greater number of the hurricanes that do form will tend to strengthen to category 4 and 5 hurricanes. The bars in this graph show the average results from 18 different models. The dots on each bar show a range of results from 4 of the 18 different models. Graph courtesy of Gabriel Vecchi, NOAA GFDL.

Models project there will be an increase in hurricane intensities as the climate warms over the course of this century. Though there will likely be fewer Atlantic hurricanes overall, wind speeds for the ones that do form will be about 4 percent stronger for every 1°C increase in sea surface temperature. Graph courtesy of Tom Knutson, NOAA GFDL.

Figure 5:3: NOAA Climate Models Projections for Future Hurricanes

Storm Surge

Climate change is projected to have significant effects on the strength and magnitude of hurricanes and coastal hazards along the South Carolina coast. Therefore, the strength and volume of storm surge hazard events are expected to produce larger storm surge magnitude in concentrated areas, as opposed to surges with lower magnitudes that are widespread.⁸ According to the National Weather Service, population density increased by 17% in Atlantic coastal counties and much of the southeastern United States densely populated Atlantic coastline lies less than 10 feet above mean sea level⁹.

5.4.5 Probability of Future Occurrences

Given the coastal location of Charleston and proximity to the Atlantic Ocean, is the city is more than likely to be affected by future coastal storm events. Further, there is a higher probability that the city will be affected by powerful coastal storms due to the proximity to the Atlantic Ocean and Gulf Stream. Coastal storm events are known for dumping heavy amounts of rain, producing hurricane-force winds, and creating high surf that causes severe erosion and coastal flooding. Based on historical evidence, the probability level of future occurrence is *likely* (between 10 and 100% annual probability).

Storm Surge

Based on historical evidence, the probability level of future storm surge occurrence is *likely* (annual probability between 10 and 100 percent). Given the coastal location of the City of Charleston and the

⁸ <https://www.frontiersin.org/articles/10.3389/fbuil.2020.588049/full>

⁹ <https://www.nhc.noaa.gov/surge/#:~:text=From%201990-2008%2C%20population%20density%20increased%20by%2032%25%20in,less%20than%2010%20feet%20above%20mean%20sea%20level>

projected increase in hurricane and tropical storm events, the city is also more likely to be affected by storm surge events in the future.

5.5 FLOODING

5.5.1 Background and Description

Flooding is primarily caused by excessive precipitation and can be categorized into two types: general floods and flash floods. General floods occur over an extended period and involve prolonged precipitation across a river basin, often exacerbated by storm-induced wave action. In contrast, flash floods result from intense, localized rainfall over a short duration. The severity of flooding is influenced by several factors, including the topography of streams and river basins, weather patterns, soil moisture levels, and the extent of land development that reduces vegetation and increases impervious surfaces.

General floods typically last several days and can be further classified into riverine, coastal, and urban flooding. Riverine flooding arises from excessive rainfall and runoff in a watershed. Coastal flooding, a significant concern for Charleston, often results from storm surge, wind-driven waves, and heavy rainfall from hurricanes and tropical storms. Urban flooding occurs when development obstructs natural water flow and diminishes the ability of the ground to absorb runoff, often exacerbated by intense or prolonged rainfall that exceeds drainage system capacities. Flash flooding is frequently caused by slow-moving thunderstorms or heavy rains from hurricanes and tropical storms. It can also result from dam or levee failures or sudden water releases from stormwater facilities. While common along mountain streams, flash floods also frequently affect urban areas with significant impervious surfaces.

Flooding of lands adjacent to rivers and shorelines, known as floodplains, is a natural occurrence with predictable recurrence intervals. The recurrence interval indicates the average time expected between flood events of a particular magnitude. Floodplain boundaries are regularly updated by FEMA through Flood Insurance Studies (FIS) and reflected in Flood Insurance Rate Maps (FIRMs), which denote flood hazard zones, including the 100-year floodplain (1% annual chance) and the 500-year floodplain (0.2% annual chance). FEMA flood zones assess the likelihood of flooding recurrence. For instance, a "100-year flood" implies a greater than 1% chance of occurrence in any year, translating to a 26% chance over 30 years. In coastal areas like Charleston, flood zones encompass both rainfall-induced flooding, resulting from overflowing rivers or overwhelmed drainage systems, and storm surge flooding, caused by abnormal tide rises during severe storms.

Tidal Flooding

Tidal flooding, often called "sunny day flooding" or "nuisance flooding," occurs when low-lying areas, especially streets, are temporarily submerged during exceptionally high tides, typically during full and new moons. The highest tides, known as king tides, vary by location and can cause significant property damage and strain on coastal infrastructure. As sea levels rise due to climate change and issues like coastal erosion and land subsidence, tidal flooding is becoming more frequent in urban and coastal areas. Data from NOAA over the past 70 years shows a notable increase in such flooding events.¹⁰

Tidal flooding falls into three levels of severity:

- 7.0 ft MLLW is the *Minor* flood threshold for the Charleston Harbor tide gauge. Based on NWS, peak events occur September through November with 2019 having the largest number of total events.

¹⁰ https://tidesandcurrents.noaa.gov/publications/techrpt86_PaP_of_HTFlooding.pdf

- 7.5 ft MLLW is the *Moderate* flood threshold for the Charleston Harbor tide gauge. Based on NWS, 2023 had the most Moderate events with a total of 27.
- 8.0 ft MLLW is the *Major* flood threshold for the Charleston Harbor tide gauge. Based on NWS, 2020 experienced the highest number of events with a total of 7. A total of 6 Major events occurred in 2023.

King Tides

"King Tide" is a popular term for exceptionally high tides that typically occur during new or full moons and when the Moon is closest to Earth (perigee). NOAA's data reveals that water levels can exceed predictions due to factors like precipitation, onshore winds, and short-term weather events.¹¹ As sea levels rise, average daily water levels are also increasing, causing high tides to reach further inland than before.¹² King tides offer a preview of future water levels and help illustrate the long-term impacts of local sea level rise.

Heavy Rainfall

NOAA defines a very heavy rain event as the heaviest 1% of all daily events, which has been used to measure rainfall and record event occurrence over time. On the other hand, the National Weather Service uses the approach that since rainfall varies per location there is no single definition for heavy or extreme rainfall. A reasonable benchmark is considered one month's worth of rain for any given location in one day and impact varies per location.¹³ Data from the U.S. Climate Assessment show that heavy rainfall is increasing in both intensity and frequency for all US regions, and simultaneously, vulnerability to heavy rainfall is also increasing.¹⁴ In recent decades, the Northeast, Great Plains, Midwest, and Southeast have experienced the largest increases in the nation. Between 1958 and 2012, the Southeast experienced a 27% increase in heavy rainfall events and this trend is larger than the natural variations for the region.¹⁵

¹¹ <https://mycoast.org/sc/king-tides>

¹² <https://www.epa.gov/cre/king-tides-and-climate-change#:~:text=King%20tides%20bring%20unusually%20high,inland%20than%20in%20the%20past>.

¹³ [Ask the scientist: Extreme rainfall, why it happens and how we predict it | National Oceanic and Atmospheric Administration \(noaa.gov\)](#)

¹⁴ [Heavy Downpours Increasing | National Climate Assessment \(globalchange.gov\)](#)

¹⁵ NOAA defines very heavy rain event as the heaviest 1% of all daily events.

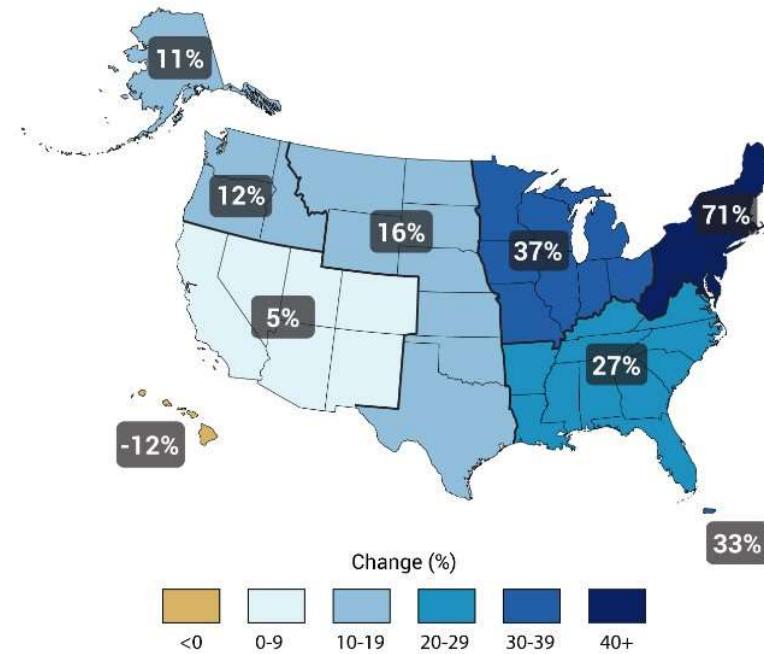


Figure 5.5: Observed Heavy Rainfall Events in the Southeast Between 1958-2012

5.5.2 Location and Spatial Extent

Large areas of Charleston are susceptible to flooding. Special Flood Hazard Areas were mapped using Geographic Information System (GIS) data and FEMA Digital Flood Insurance Rate Maps (DFIRM). These include Zone A (1% floodplain), Zone AE (1% annual chance floodplain with elevation), Zone X 500 (0.2% annual chance floodplain), and coastal high hazard areas (Zones VE, V, and V1-V30), which face additional risks from wind and wave action.

Of Charleston's 141.9 square miles, 50.5 square miles are in Zone AE, 18.7 square miles in Zone X 500, and 32.98 square miles in Zone VE, accounting for 72% of the City's land area. While FEMA data is the best available for planning, it may not accurately reflect current flood risks, as flooding can occur outside designated hazard areas. **Figure 5.6** illustrates the location and extent of currently mapped special flood hazard areas for the City of Charleston based on best available FEMA Digital Flood Insurance Rate (DFIRM) data.

Floodplain inundation, mapped by FEMA, affects both coastal regions and major rivers in Charleston. Inland areas, particularly along the Cooper and Ashley Rivers, are at risk for 100-year and 500-year floods. The Charleston peninsula may face significant impacts from a 100-year flood, particularly in the southwest (medical district) and northeastern areas. Certain neighborhoods have been identified as flood-prone in the Charleston Regional Hazard assessment.

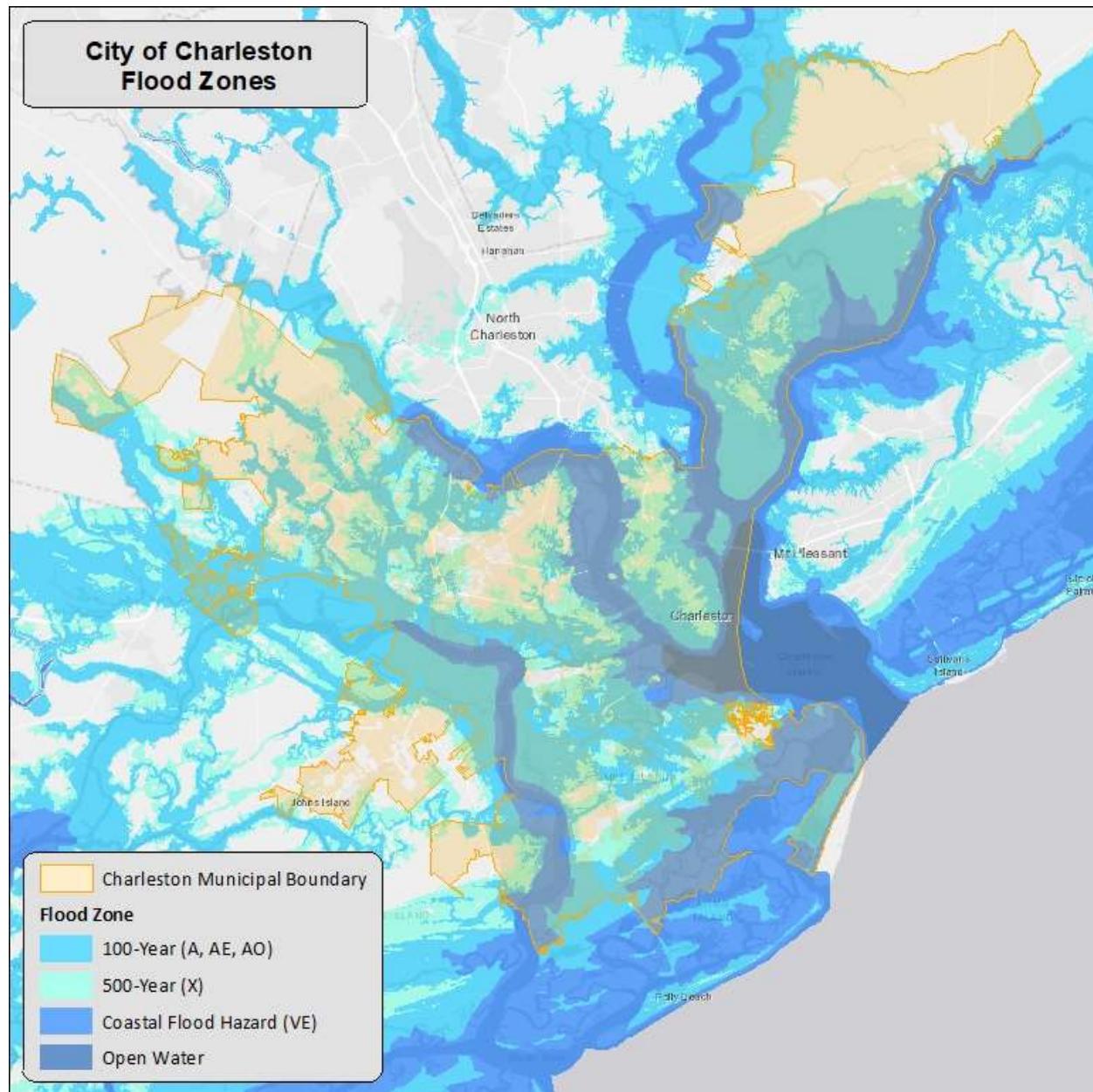


Figure 5.6: Special Flood Hazard Areas in Charleston

Tidal Flooding

Coastal communities along the Eastern Seaboard, including Charleston, are increasingly vulnerable to tidal flooding due to rising sea levels. This flooding affects both the coastline and the banks of major rivers such as the Stono, Ashley, Cooper, and Wando.

NOAA's High Tide Flooding Impact Threshold map indicates that tidal flooding could significantly impact most of James Island, as well as the northeastern edges of John's Island, the Peninsula, West Ashley, and South Windmere. Tidal flooding along the Stono River may reach as far inland as the West Ashley neighborhood, while the Wando River can cause flooding in a large portion of Daniel Island through Nowell Creek.

Data from NOAA highlights that factors like subsidence and poor development planning can increase flood risk, making tidal floods distinct from typical nuisance flooding linked to climate change. Additionally, tidal flooding disrupts the natural drainage of several Charleston tidal creeks, including Church Creek, Long Branch Creek, Halsey Creek, and Newmarket Creek.

King Tides

According to the EPA, low-lying shoreline development is at increased risk of flooding because of rising seas, and public investments in infrastructure, housing, and habitat restoration projects are often expected to last for decades¹⁶.

Heavy Rainfall

The impact of heavy rainfall on flooding in Charleston is significant due to the City's low-lying topography and proximity to major water bodies. Historically, flooding has resulted in substantial property damage, disruption of daily operations, and even loss of life in some circumstances. According to the City of Charleston's Storm Water Service, the impacts of a heavy rain event vary in extent and severity based on a variety of natural and man-made (anthropogenic) in origin and are summarized below¹⁷:

1. Natural
 - a. Tide Cycle
 - b. Intensity and Duration of Storm
 - c. Terrain
2. Man-Made
 - a. Inlets
 - b. System Size
 - c. Trash
 - d. Impervious Cover

The City notes that the infrastructure improvements and upsizing needed to handle an extreme rainfall event is not feasible (both in regards to cost and size). The aging infrastructure of the City exacerbates flood risk, specifically pertaining to stormwater systems. As stormwater infrastructure ages, its capacity to handle large volumes of runoff from heavy rain events diminishes for a few reasons. First, the system may struggle to accommodate the increased urbanization, development, and population growth that has taken place since its original construction. Second, the system was not designed to effectively address changing precipitation patterns and the increasing frequency of heavy rainfall events associated with climate change. Overall, aging infrastructure on stormwater function in the flood-prone area heightens the exposure and vulnerability of the community to flood events.

5.5.3 Historical Occurrences

Information from the National Centers for Environmental Information was used to determine historical flood events. The National Centers for Environmental Information reported a total of 40 events for the City of Charleston since 1996. A summary of major events is presented in **Table 5.5**.

¹⁶ https://www.epa.gov/sites/default/files/2014-04/documents/king_tides_factsheet.pdf

¹⁷ [Why Does It Seem Like Charleston Always Floods When It Rains? \(charleston-sc.gov\)](http://charleston-sc.gov)

SECTION 5: HAZARD PROFILES

Table 5.5: Summary of Major Flood Occurrences in Charleston

Location	Date	Property Damage	Description
Charleston	10/8/1996	0	n/a
Charleston	6/6/1997	\$125,000	n/a
Charleston	5/12/1999	0	n/a
Charleston	8/30/2002	0	Numerous roads were closed, motorists stranded and water got into homes and businesses as heavy rain continued to fall. Much of the area was already saturated from rain over the previous days.
Charleston	7/14/2003	0	Heavy rainfall at high tide caused flooding of streets in downtown Charleston.
Charleston	6/15/2004	0	Heavy rainfall over several hours caused significant flooding in the West Ashley section of Charleston. Numerous roads were flooded with several feet of water including Interstate 526, Highways 17 and 61, and Ashley Hall Road. Water flooded into some cars and many needed to be towed out of the water. The water also flooded several homes in the area.
Charleston	8/15/2004	0	An estimated 3 to 4 inches of rain fell across downtown Charleston just before high tide. Up to 1 foot of water covered Highway 17, Kent Road, Dorchester Road, and Rutledge Avenue near the Medical University of South Carolina.
Charleston	9/27/2004	0	Heavy rainfall caused flooded roads in Charleston, Mt. Pleasant, and the Isle of Palms.
Charleston	5/17/2005	0	Portions of East Bay flooded. Portions of crosstown flooded. 1 car stranded in high water on crosstown.
Charleston	6/28/2005	0	Several hours of heavy rainfall across the county caused flooding. Highway 17 in downtown Charleston was flooded with several cars becoming submerged. Also, the frontage road along Highway 17 in Mt. Pleasant was closed due to high water.
Charleston	7/9/2005	0	Highway 61 in West Ashley flooded near 526 intersection.
Charleston	8/24/2006	0	Resident on South Street indicates water coming into home. Heavy street flooding. Public reported that near the Charleston Catholic School there is several feet of water near the intersection of King and Huger streets. Near waste deep water near the intersection of Vanderhorst and Smith Street.
Charleston	8/31/2006	0	Numerous roads in downtown Charleston including Highway 17 are flooded and closed in many locations. Additional flooding and road closures have occurred on Folly Road on James Island and Bohicket Road on Johns Island. Lasalle Street and Elsey Drive flooded.
Charleston	7/30/2007	0	Two and a half to three feet of water were reported over the road at the intersection of Market Street and Church Street in downtown Charleston. President Street near the Crosstown was reportedly flooded and impassable.
Charleston	6/21/2008	0	Broadcast media reported flooding in downtown Charleston, South Carolina along Market Street. Portions of Market Street were blocked off by more than a foot of water covering the road.
Charleston	10/24/2008	\$15,000	City officials in Charleston reported that widespread flooding was occurring in downtown Charleston, South Carolina. Numerous motorists were stranded in vehicles along with several road closures. Federal officials reported road closures along Concord Street and Hazel Street due to 6 inches of standing water in downtown Charleston, South Carolina.
Charleston	7/8/2009	\$1,000	The public reported around 2 feet of standing water near Market and Meeting Streets, making portions of the roads impassable in downtown Charleston, South Carolina.

SECTION 5: HAZARD PROFILES

Location	Date	Property Damage	Description
Charleston	12/2/2009	\$10,000	Law enforcement reported 10 to 15 automobiles stalled in downtown Charleston due to flooding. At least 1 automobile had water flowing into its doors. Road closures included Calhoun Street, Ashley Avenue, Radcliffe Street, and Coming Street.
Charleston	11/3/2011	\$0	The tide level at NOS gage in Downtown Charleston reached at least 7.0 ft MLLW for 9 consecutive days (November 3-11). This included 4 tides of at least 8.0 ft MLLW. The highest tide occurred on Sunday, November 7 when 8.51 ft MLLW was observed. This ranks as the 10th highest level on record dating back to 1921.
Charleston	7/11/2012	\$10,000	Tabbli Grill on North Market Street flooded with several inches of water inside the building. Numerous side streets near the market were flooded with a half foot of water. Flooding was also reported at East Bay and Calhoun Streets. They were not officially closed, but were impassable in spots.
Charleston	8/28/2012	\$750,000	Numerous reports of street flooding in Downtown Charleston. Calhoun Street is impassable. The College of Charleston Emergency Manager reports that twenty-three buildings on campus have sustained damage from flash flooding. Flood waters are still in place across much of the campus.
Charleston	3/24/2013	0	Law enforcement reported Bennett and Barre Street closed, numerous roads closed in downtown Charleston, and portions of Ashley Avenue and Calhoun Street closed due to water on the roadway.
Charleston	6/19/2013	0	Law enforcement reported the intersections of Ashley Avenue and Bennett Street, Morris Street and Coming Street, Morrison Drive and Meeting Street, Coming Street and Spring Street, Rutledge Avenue and Beaufain Street flooded and impassable. America Street was also flooded and impassable between Cooper Street and Lee Street. A spotter reported two feet of standing water at the intersection of Smith Street and Vanderhorst Street.
Charleston	7/21/2013	\$50,000	Police reported numerous streets in Downtown Charleston were closed due to flooding. King, Line, Cannon, St Philips, President, Cross, Market, Felix, Radcliffe, Smith, Fishburne, Moultrie, Vanderhorst, Ogier Streets, along with Ashley Ave.
Charleston	8/15/2013	0	The City of Charleston reports flooding on George Street between Coming Street and St Philip Street. The road is closed.
Charleston	7/31/2014	\$5,000	Multiple reports indicate road closures due to flash flooding in downtown Charleston. South Market Street is closed between Meeting and State Streets, and North Market Street is closed between East Bay and Meeting Streets. Flooding has also closed the intersection of Ashley Avenue and Fishburne Street, as well as Bennett Street between Ashley and Rutledge Avenues. The intersection of King and Huger Streets is affected, and Ogier Street is impassable, with water surrounding homes. Additionally, President Street north of the Crosstown is closed due to flooding.
Charleston	8/9/2014	0	Law enforcement reported numerous road closures in downtown Charleston due to flash flooding, including Bull, Calhoun, Ashley Avenue, Fishburne, Morris, Huger, King, Rutledge, Sheppard, Cannon Park, Thomas, Warren and the Crosstown.
Charleston	8/18/2015	0	The Charleston Police Department and the City of Charleston Emergency Manager reported numerous roads flooded and closed in downtown Charleston. Streets closed included parts of Fishburne, King, Carolina, Line, Sumter, Beaufain, Barre, Calhoun, Ogier, Pitt, Moultrie, President, America, South, Bogard, Huger, Smith, Morris, Ashley Avenue and the Crosstown. Many

SECTION 5: HAZARD PROFILES

Location	Date	Property Damage	Description
			cars were flooded or stalled. Many homes and businesses were surrounded by water. The Market was also reported flooded and under water.
Charleston	10/3/2015	\$728,550	A Charleston County emergency manager and law enforcement reported numerous roads closed due to flooding in downtown Charleston. Roads closed included Hasell Street between Meeting Street and Washington Street. Interstate 26 exits to Meeting Street and East Bay Street were also closed due to flooding. Water was also reported entering homes and businesses at the intersection of Tradd Street and Council Street. Swift water rescues were also being reported by broadcast media in downtown Charleston.
Charleston	2/4/2016	0	The media reported Ashley Avenue closed between Tradd Street and Broad Street in downtown Charleston, SC.
Charleston	6/6/2016	0	Law enforcement reported the following roads closed in downtown Charleston due to flooding: Barre Street between Canal Street and Broad Street, Wentworth Street between Lockwood Drive and Barre Street and Cherry Street between the Crosstown and Barre Street.
Charleston	6/29/2016	0	Law enforcement and broadcast media reported the following roads closed due to flooding by heavy rain: South Market Street, Ashley Avenue between Halsey Street and Bennett Street and Ashley Avenue at Calhoun Street.
Charleston	6/8/2018	0	The media reported a building between John and Jutson Streets having a partial roof collapse following heavy rainfall at 115 pm. John and Jutson Streets were closed. Rain accumulation of 2.6 inches had fallen between 11 am and 120 pm, setting a new daily record. Additionally, the Charleston Fire Department had to assist a stranded motorist near the intersection of Morris Street and Marbel Lane.
Charleston	6/12/2021	0	Emergency management and social media indicated several businesses along Market Street flooded with 8 to 16 inches of standing water inside buildings. Additionally, rainfall amounts around 3.5 inches resulted in the following streets, intersections, and areas in downtown Charleston to be closed due to flooding: Calhoun Street between Rutledge Avenue and Smith Street, Chisolm Street between Broad Street and Tradd Street, Colonial Street between Broad Street and Tradd Street, Hagood Avenue at Fishburne Street, King Street at Huger Street, Market Street between Meeting Street and East Bay Street, Romney Street at North Nassau Street, Smith Street at Marion Street, Tradd Street between Chisholm Street and East Bay Street, the Crosstown Expressway between Coming Street and Norman Street, Washington Street and Concord Street between Laurens Street and Queens Street, the Harleston Village area and the White Point Gardens area.
Charleston	5/18/2023	0	Charleston Police Department reported numerous roads closed in downtown Charleston including Fishburne, Hagood, and Lockwood.
Charleston	8/2/2023	0	Law enforcement reported multiple road closures (Broad Street to Rutledge Avenue, Saint Andrews Ramp on Highway 17, Hagood Avenue between Fishburne Street to Spring Street, Lockwood Drive Ramp between Highway 17 and Lockwood Drive) due to major salt water flooding.
Charleston	12/17/2023	0	Law enforcement reported Market Street, Bogard Street, Lockwood Drive, Drake Street, Bennett Street in downtown Charleston closed due to saltwater flooding.
Charleston	11/14/24	0	The combination of the lunar perigee and the peak of the full moon cycle produced higher than normal astronomical high tides. Northeast flow, driven by the presence of high pressure to the north, produced an increasing tidal departure and yielded major coastal flooding along portions of the southeast

SECTION 5: HAZARD PROFILES

Location	Date	Property Damage	Description
			South Carolina coast. Most of the coastal flooding impacts were in and around the Charleston area.
Charleston	3/9/2025	\$10,000	A large area of stratiform rain spread across the southeast South Carolina in the predawn hours ahead of a warm front lifting northward. Immediately along the warm front, embedded thunderstorms developed and brought a period of strong wind gusts and intense rainfall to the region. A large area of heavy rainfall, with amounts of 2-4 inches, occurred from around Beaufort up through the Charleston metro area. Locally higher amounts of up to 5 inches occurred in and around Charleston, with the heaviest rainfall rates occurring around and just after a 7.69 ft MLLW high tide at the Charleston Harbor tide gauge. The intense rainfall produced a few instances of flash flooding around Charleston, with lots of reports of minor flooding.
Charleston	8/22/2025	n/a	From August 22-23, 2025, according to National Weather Service (NWS) Charleston, "numerous to widespread showers and thunderstorms produced heavy rainfall across the South Carolina Lowcountry and southeast Georgia as a cold front stalled over the region. This boundary caused widespread flash flooding, which was intensified by soils already saturated from heavy rain earlier in the month. Flooding along the coast was exacerbated by high tide, with the Charleston Harbor Tide Gage reporting periods of moderate coastal flooding. The event led to numerous road closures, inundated vehicles, and flooded structures, and also set new rainfall records." (NWS)

Source: National Centers for Environmental Information; National Weather Service Charleston

Tidal Flooding

Number of days with tidal flooding can be tracked for the City of Charleston with tidal gauge data reported by the NOAA in Charleston Harbor. Flooding incidents that reached at Mean Lower Low Water level for minor (7.0 ft MLLW), moderate (7.5 ft MLLW), and major (8.0 ft MLLW) flood threshold were recorded in Figure 5.7 below since 1921.¹⁸

¹⁸ The average of the lower low water height of each tidal day observed over the National Tidal Datum Epoch.

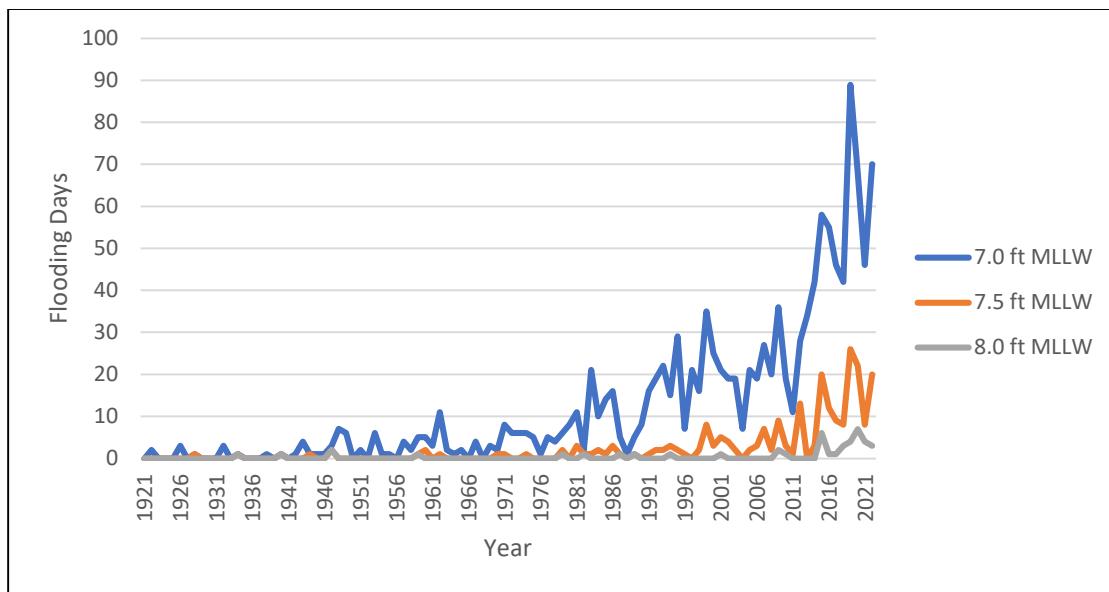


Figure 5.7: Tidal Gauge for Charleston Harbor (1921 - 2022)

Source: NOAA NWS

Heavy Rainfall

The NCEI Database only identifies two heavy rainfall events in Charleston, but the National Weather Service's records indicate that heavy rainfall events have become more frequent in the last 5 years in South Carolina. The following list reflects South Carolina Lowcountry and Southeast Georgia Significant Weather and Climate Events Archive:

- 2 Events in 2023 (December 24-27, July 23)
- 1 Event in 2022 (June 28-July 2)
- 3 Events in 2020 (April 23, April 19-20, March 3-5)
- 1 Event in 2019 (June)

Although these recorded events were not localized to Charleston, they remain crucial for assessing future flood vulnerability for the City. The records provide a historical perspective on rainfall patterns and enable the identification of trends or variations in precipitation in Charleston over time.

5.5.4 Historical Summary of Insured Flood Losses

The City of Charleston joined the NFIP on April 9, 1971. The current effective flood map date is 1/29/2021. According to FEMA flood insurance policy records as of December 31, 2022 there are 16,942 flood insurance policies in the city and there have been 1,564 flood losses reported for the City of Charleston, totaling over \$15,833,413 in claims payments. It should be noted that these numbers include only those losses to structures that were insured through the NFIP policies, and for losses in which claims were sought and received. It is likely that many additional instances of flood loss in the city have been either uninsured, denied claims payment, or not reported.

5.5.5 Repetitive Loss Properties

FEMA defines a repetitive loss (RL) property as any insurable building with two or more claims over \$1,000 paid by the NFIP within any 10-year period since 1978. Currently, there are over 140,000 RL properties nationwide. As of 2018, Charleston had 784 non-mitigated repetitive loss properties, which are likely to continue experiencing flood losses without mitigation.

A severe repetitive loss (SLR) property is an NFIP-insured single-family or multi-family structure that either has received flood-related damage resulting in four or more claims exceeding \$5,000 each, with total claims over \$20,000, or has received at least two claims where the total building payments exceed the market value of the building. Definitions may vary between NFIP and grants.

5.5.6 Changing Future Conditions

A changing environment brings higher sea levels, new weather patterns, and stronger storms. As the atmosphere warms, increased evaporation leads to more intense rainfall. Rising sea levels also heighten coastal flood risks, as higher tides and storms result in greater flooding.

Since reliable records began in 1921, sea levels in Charleston have risen by 1.3 inches per decade, nearly double the global average. Global sea levels are projected to rise by 1 to 4 feet by 2100, with South Carolina likely experiencing even greater increases. These rising sea levels threaten both natural and built environments in coastal South Carolina. In the 1970s, Charleston averaged just 2 days of tidal flooding per year; by 2050, this number could exceed 100 days. Increased flooding intensity may also pose significant public health and emergency management challenges.

Tidal Flooding

According to the NOAA, the U.S. Southeast Atlantic and Gulf coast saw an increase of over 400 to 1,100 percent respectively, in high tide flooding days compared to the year 2000. Assessed over several decades, the national trend in high tide flooding frequency is accelerating and is more than twice as likely now as it was in 2000. The rapid growth is in response to relative sea level rise, which is occurring along most U.S. Coastlines. In 2020, relative sea level along coastlines reached the second highest level on record – 0.3 meters (one foot) relative to 1920 levels.¹⁹ Additionally, the 2022 NOAA State of High Tide Flooding and Annual Outlook reported that tidal flooding is anticipated to continue with frequency over the next meteorological year with a national outlook of 3 to 7 days likely. By 2050, high tide flooding on a national scale is expected to be between about 45-70 days/year on average. Projection data from NOAA for the City of Charleston Cooper River to 2100 can be seen in **Figure 5.8** below.

¹⁹ <https://coast.noaa.gov/states/fast-facts/recurrent-tidal-flooding.html>

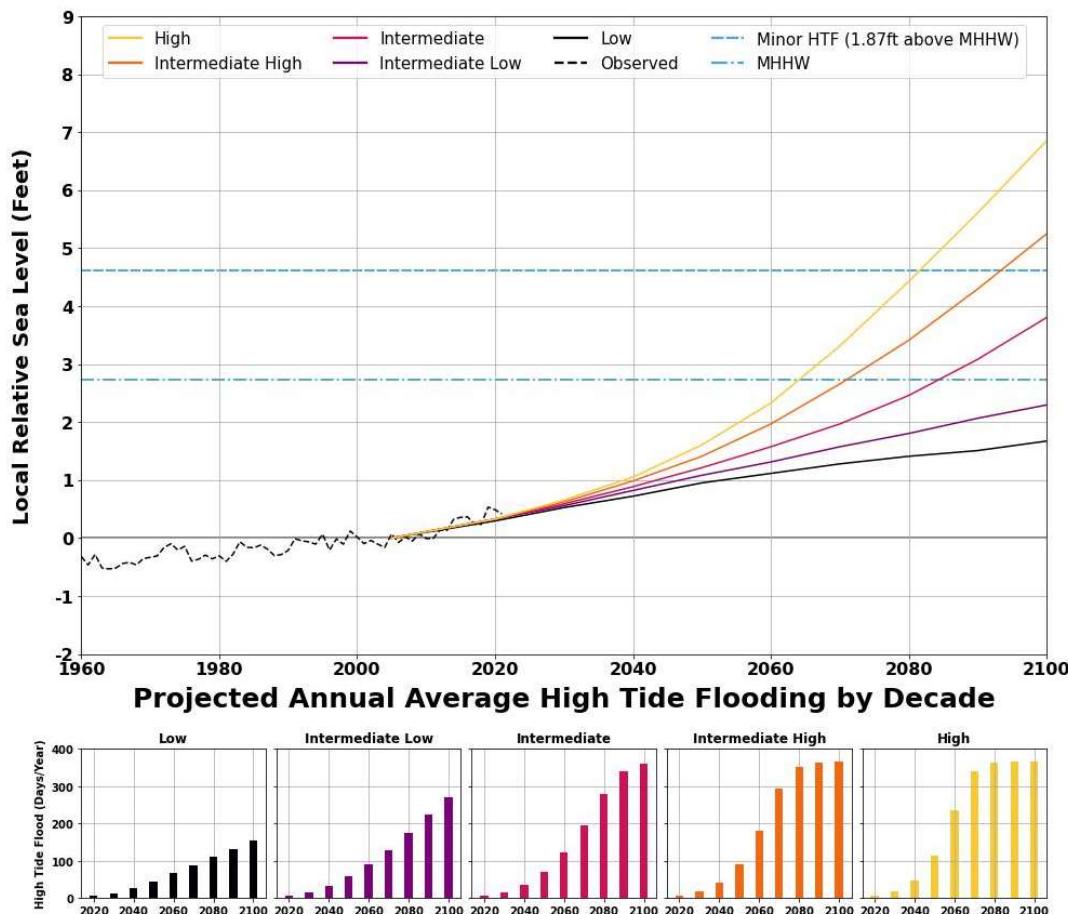


Figure 5.8: Annual Relative Sea Level Rise Since 1960 and Projections to 2100 (Charleston, Cooper River Entrance)
Source: NOAA National Water Level Observation Network

Data from the tidal gauges in the Cooper River entrance shows that even at the lowest levels of projected sea level rise shows that tidal flooding occurrences could rise to over 100 days/year.

Heavy Rainfall

As shown in **Figure 5.5**, the U.S. Southeast Region has experienced a 27% increase of annual precipitation falling in the heaviest 1% events. Under future warming, the trend of intensification is expected to continue (both in frequency and severity). According to the National Atlas 14, the historical 100-year rainfall in Charleston County, SC is 10.3 inches and by 2040-2060, Charleston County's average rainfall amount is estimated to increase to 12.7 inches.²⁰

5.5.7 Probability of Future Occurrence

Based on historical evidence, the ongoing threat of sea level rise, and the low elevation of the City of Charleston, the future probability for future flooding is *likely* (between 10 and 100 percent annual probability).

²⁰ [Climate risk assessment: Charleston County, South Carolina - Woodwell Climate](#)

Tidal Flooding

Due to the projected sea level rise increasing the number of days with tidal flooding in the City of Charleston, tidal flooding will remain a threat for the foreseeable future. As sea level rises and land subsidence occurs, strong storms and hurricanes are no longer necessary to cause coastal flooding. **Table 5.6** below indicates the increase of minor, moderate, and major scenarios in Charleston over the last forty years. Therefore, the annual probability is highly likely for tidal flooding.

Table 5.6: Historical Tidal Flooding Days Per Year Under Selected Scenario for Charleston Harbor

Severity (MILLW)	1990	2000	2010	2020
Minor (7 ft)	8	25	19	68
Moderate (7.5 ft)	0	3	3	22
Major (8 ft)	0	0	1	7

Source: NOAA NOS CO-OPS, Charleston Tidal Gauge

Heavy Rainfall

Records from the National Weather Service's South Carolina Lowcountry and Southeast Georgia Significant Weather and Climate Events Archive indicate a total of seven (7) heavy rain events between 2019 and 2023. Prior to 2019, the last recorded heavy rainfall event occurred October 1-5 in 2015 and two events in 2007 (September 1-2, September 21). There are no events recorded prior to 2007. The time intervals of heavy rain events point toward more frequent heavy rain events in the area. Therefore, it is *likely* that Charleston will continue to experience heavy rain events.

5.6 SEA LEVEL RISE

5.6.1 Background and Description

Sea level rise is primarily driven by two climate change factors: melting ice sheets and glaciers, and the expansion of warming seawater. The rate of sea level rise varies based on factors such as land movement, urbanization, and proximity to glaciers. Coastal impacts include shoreline erosion, saltwater intrusion into groundwater, wetland and estuary inundation, and threats to cultural resources and infrastructure. Human modifications, like beach nourishment and structures such as seawalls and jetties, complicate the shoreline's response to these changes.

Sea level rise can be categorized as Eustatic, which refers to global trends, and Isostatic, which pertains to local variations based on shoreline changes. Vulnerability differs among regions due to factors like land movement and urban development. Tide gauge measurements indicate that global sea level rise began in the early 20th century, with an increase of 15-24 cm (6-10 in) from 1901 to 2018.²¹ In South Carolina, sea levels are now up to 10 inches higher than in 1950, and flooding events have surged by 75% since 2000.²² The rate of rise has accelerated over the past decade, now increasing by approximately 1 inch every two years. **Figure 5.** below shows the area across the Southeastern U.S. and their vulnerability to sea level rise. The Coastal Vulnerability Index used here is based on tidal range, wave height, coastal slope, shoreline change, landform and processes, and historical rate of relative sea level rise.

²¹ https://www.ipcc.ch/site/assets/uploads/sites/3/2022/03/01_SROCC_SPM_FINAL.pdf

²² <https://sealevelrise.org/states/south-carolina/#:~:text=Sea%20levels%20around%20South%20Carolina%20have%20risen%20up,every%202%20years%20mainly%20due%20to%20land%20sinking>

Vulnerability to Sea Level Rise

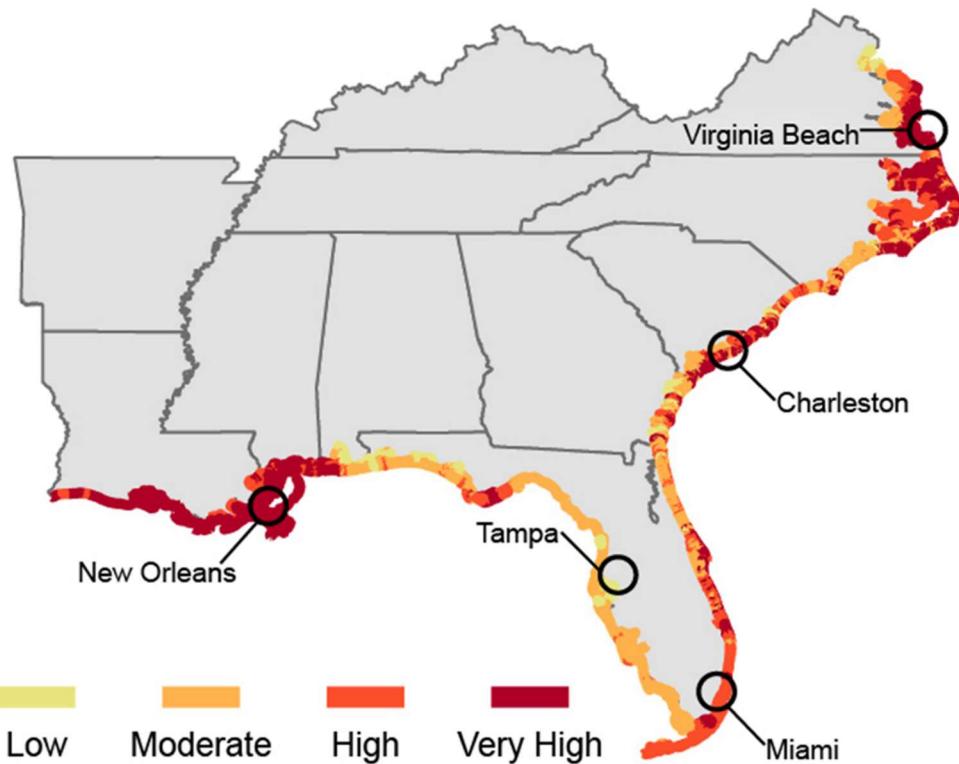


Figure 5.9: Southeastern US Sea Level Risk Vulnerability Map
Source: U.S. Global Change Research Program

Based on the National Climate Assessment intermediate high sea level rise scenario, a projected 4.1 feet of rise locally by 2100, from a 1992 baseline.²³ The City is planning for 14 inches of additional rise by 2050. Sea level rise has many more impacts on the land than simple inundation. A component of the rates of erosion and can also interact with coastal aquifers, which could possibly influence both water table height and salinity. High water tables, especially coupled with flooding and overwash events where sea level increases on top of storm surge, could keep ocean outfalls inundated longer and may slow drainage leading to prolonged flooding in low lying coastal communities.

5.6.2 Location and Spatial Extent

According to projection data from Climate Central, Charleston is first out of all cities in South Carolina for total exposure of homes on land below 5 feet for cities over 100,000 in population. Charleston is still first if ranked by its *percentage* of homes exposed, and it is first if all cities are ranked by exposure after excluding areas that appear isolated and protected.²⁴ The City of Charleston is surrounded by water and is subject to flooding from the Atlantic Ocean as well as inland flooding from the Cooper, Ashley,

²³ <https://www.ipcc.ch/srocc/chapter/chapter-4-sea-level-rise-and-implications-for-low-lying-islands-coasts-and-communities/>

²⁴ <https://www.riskfinder.org/api/reports/place/charleston.sc.us/fast-look?lang=en>

Stono and Wando Rivers and associated tributaries. The area is subject to storm surge, flooding from heavy rains and high tides (i.e. king tides).

5.6.3 Historical Occurrences

From an annual perspective, the City of Charleston has experienced sea level rise due to a combination of factors including melting ice sheets, thermal expansion of seawater, and land subsidence. The city has experienced an average annual sea level rise of around 1 inch over the past century. However, the rate of projected sea level rise is projected to increase in the coming decades, and the city has already begun to combat this increase. According to NOAA, Charleston can expect sea levels to rise by 2 to 3 feet by 2100. Recorded and projected sea level rise can be seen in **Figure 5.** below.

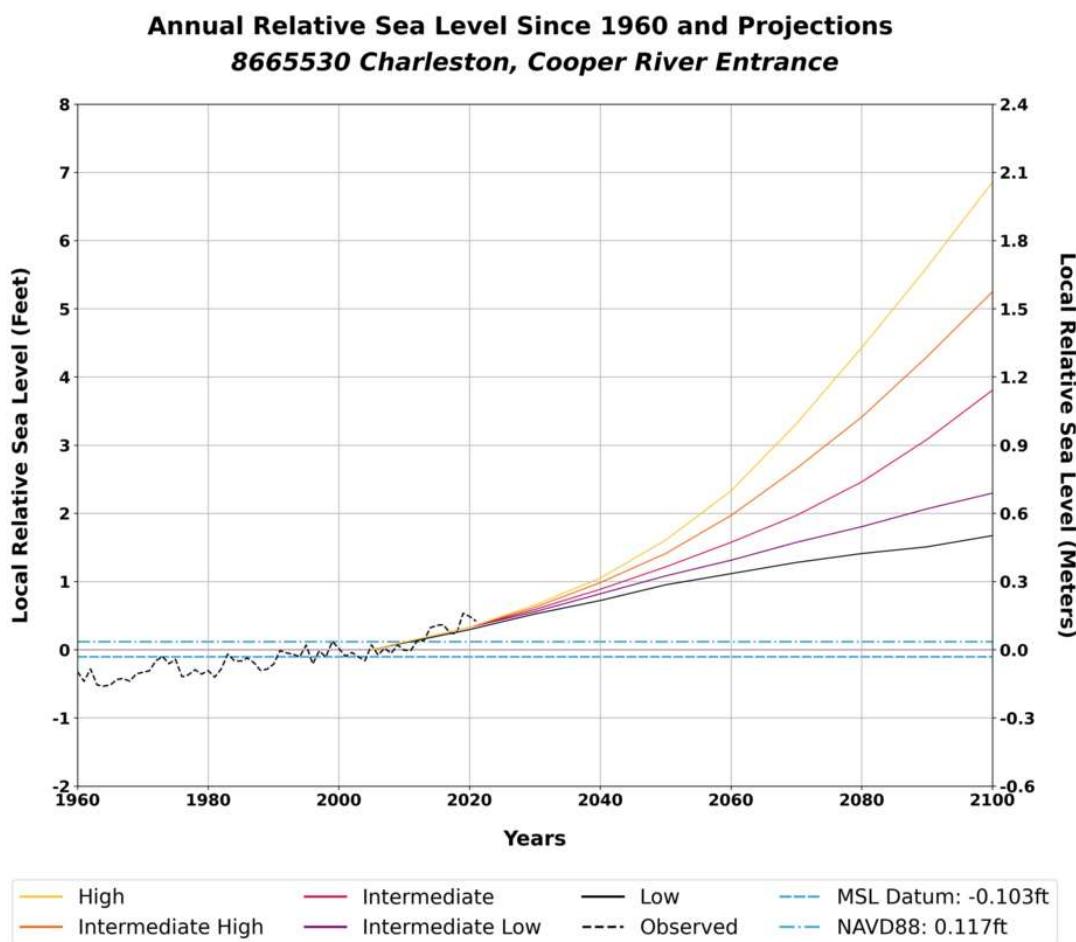


Figure 5.10: City of Charleston Annual and Project Sea Level Rise

The Charleston Harbor tide gauge has been measuring sea level continuously since 1921. According to *City of Charleston Flooding and Sea Level Rise Strategy Plan*, which is based off NOAA data, in that nearly 100-year time span, local sea level has risen 1.07 ft. Furthermore, data from the NOAA Tides and Currents database shows a relative sea level trend of 3.39 millimeters a year (**Figure 5.**) between 1901 and 2021. It

is crucial to note that this rate has substantially increased from 3.39 millimeters a year to 10+ millimeters a year over the last decade reiterating the need to plan for this expedited rise.

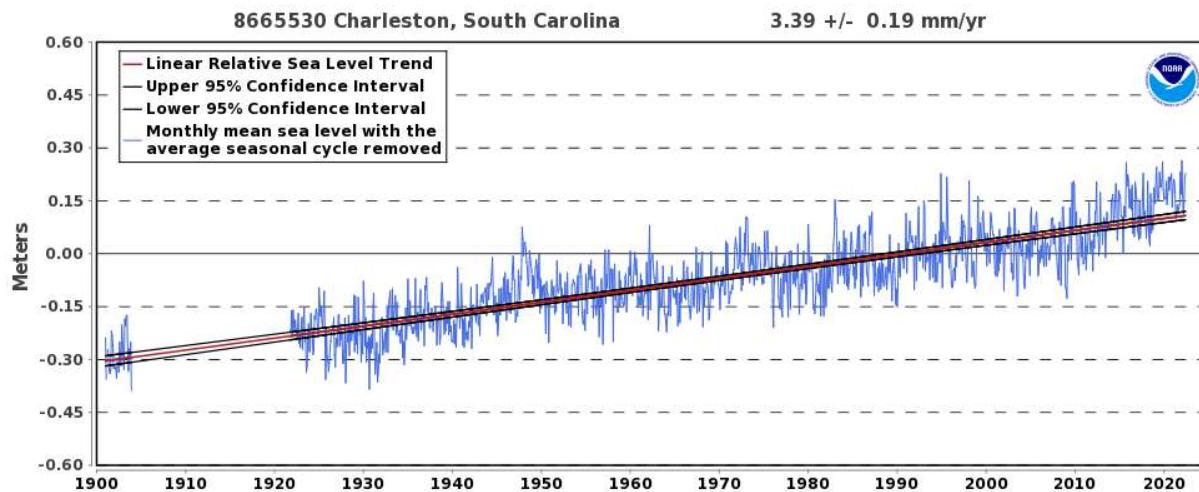


Figure 5.11: Relative Sea Level Trend for Charleston Harbor (1901-2021)

Source: NOAA Tides and Currents

Sea Level Rise Impacts on King Tides

Over time, sea level rise is raising the height of tidal systems. Average daily water levels are rising along with the oceans. As a result, high tides are reaching higher and extending further inland than in the past. According to NOAA's Tides and Currents website, 91 King Tide events have been observed so far in 2023 in South Carolina²⁵. King tides provide a glimpse of future everyday water levels, and they are a way to communicate local sea level rise impacts over long periods of time. Low-lying shoreline development is at increased risk of flooding because of rising seas, and public investments in infrastructure, housing, and habitat restoration projects are often expected to last for decades. Highlighting king tides in a community can raise awareness of potential sea level rise impacts and identify flood-prone locations. The increased understanding of sea level rise will impact local resources is valuable information for community decision-makers.²⁶

5.6.4 Changing Future Conditions

The Fourth National Climate Risk Assessment projects that by 2100, global mean sea level rise will be 1.5 feet. South Carolina's coastal property market and public infrastructure are threatened by the ongoing increase in the frequency, depth, and extent of tidal flooding due to sea level rise, with cascading impacts to the larger economy. Higher storm surges due to sea level rise and the increased probability of heavy precipitation events exacerbate the risk. In 2015, locally extreme rainfall exceeding 20 inches over 3 days caused widespread damage, including the failure of 49 state-regulated dams, one federally regulated dam, two sections of the levee adjacent to the Columbia canal, and many unregulated dams²⁷. The Union of Concerned Scientists created a hazard map for South Carolina communities facing chronic inundation

²⁵<https://mycoast.org/sc/king-tides>

²⁶<https://www.epa.gov/cre/king-tides-and-climate-change>

²⁷https://nca2018.globalchange.gov/downloads/NCA4_2018_FullReport.pdf

from coastal flooding in **Figure 5.**²⁸. Chronic inundation is an emerging hazard with sea level rise when high tide flood 10 percent or more of its usable, non-wetland area at least 26 times per year, or on average, every other week.

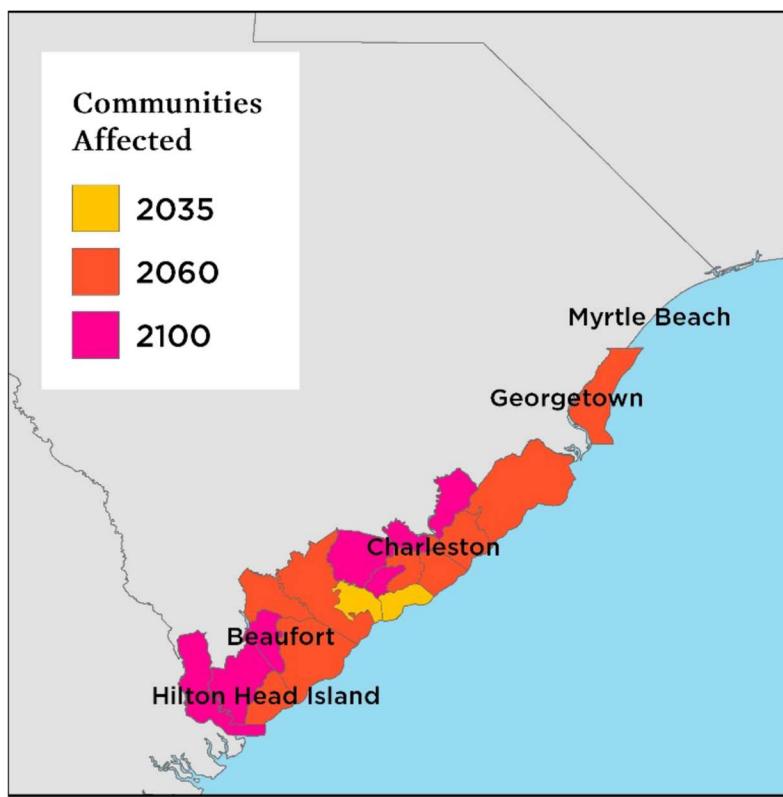


Figure 5.12: South Carolina Communities Facing Chronic Inundation*

Source: Union of Concerned Scientists

*This was based off the "Intermediate Scenario".

Three different sea level rise scenarios were assessed through 2100:

- **High Scenario** – emissions rise through the end of the century and ice sheets melt faster to yield about 6.5 feet of sea level rise
- **Intermediate Scenario** – Projects carbon emissions peaking around mid-century and about 4 feet of sea level rise globally, with ice melting at a moderate rate that increases over time
- **Low Scenario** – Assumes carbon emissions decline steeply and warming is limited to less than 2 degrees Celsius – sea level rise is driven primarily by ocean warming with very little ice loss.

By 2100, a total of 22 South Carolina communities would be chronically inundated in each high scenario²⁹.

²⁸ <https://www.ucsusa.org/sites/default/files/attach/2017/07/when-rising-seas-hit-home-southcarolina-factsheet.pdf>

²⁹ <https://www.ucsusa.org/sites/default/files/attach/2017/07/when-rising-seas-hit-home-southcarolina-factsheet.pdf>

5.6.5 Probability of Future Occurrences

Sea level rise is generally considered using a scenario approach. Scenarios of global mean sea level rise are translated to regional scenarios by accounting for factors such as vertical land movement or ocean circulations that affect local sea levels. The graphic below shows the most up-to-date sea level rise scenarios for Charleston and were released in 2022 by a U.S. interagency task force in preparation for the Fifth National Climate Assessment. Based on historical occurrence information, it is assumed that the City of Charleston has a probability level of *likely* (10 – 100 percent annual probability) for future sea level rise.

5.7 EARTHQUAKE

5.7.1 Background and Description

Earthquakes are geological events characterized by the movement or shaking of the Earth's crust, typically caused by the release of accumulated stress from ruptured rocks along fault planes at the borders of the Earth's ten tectonic plates. Areas of greatest tectonic instability are found where these plates interact, resulting in significant strain. When stress exceeds the strength of the rocks, a rupture occurs, releasing stored energy and generating seismic waves that produce the shaking felt during an earthquake. The severity of these effects depends on the energy released from the fault, with impacts often felt far beyond the epicenter and capable of causing extensive damage and casualties within moments.

Key characteristics of earthquakes include ground motion, surface faulting, ground failure, and seismic activity. Ground motion refers to the vibrations caused by seismic waves, which can be amplified by soft soils. Surface faulting describes the movement along a fracture where the ground breaks apart, while liquefaction occurs when shaking causes loose soil to behave like a fluid, leading to ground failures such as lateral spreads and loss of bearing strength. These phenomena can result in significant structural damage, including tipping or collapsing buildings.

Earthquakes are measured in terms of their magnitude and intensity. There are several different scales that are commonly used, including Richter Magnitude (**Table 5.7**), Modified Mercalli Intensity (MMI) (**Table 5.8**), Moment Magnitude and Peak Ground Acceleration (PGA) (**Figure 5.13**), among others. Magnitude is measured using the Richter Scale, an open-ended logarithmic scale that quantifies the energy released by an earthquake based on shock wave amplitude. Each unit increase in magnitude corresponds to a ten-fold increase in wave amplitude and a 244-fold increase in energy. In contrast, intensity is commonly assessed using the Modified Mercalli Intensity (MMI) Scale, a twelve-level scale that evaluates seismic effects through direct and indirect measurements. This scale is represented by Roman numerals, ranging from I (imperceptible events) to XII (catastrophic destruction).

The Global Earthquake Model's Global Hazard Map illustrates the geographic distribution of Peak Ground Acceleration (PGA) with a 10% probability of being exceeded over 50 years. This data reflects the likelihood of ground motion reaching certain levels during an earthquake. The map was created by compiling national and regional probabilistic seismic hazard models developed by various institutions and GEM Foundation scientists, indicating that the region falls within an area of low to moderate seismic risk.

SECTION 5: HAZARD PROFILES

Table 5.7: Richter Scale

Richter Magnitudes	Earthquake Effects
< 3.5	Generally, not felt, but recorded.
3.5 – 5.3	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 about 100 kilometers across where people live.
7.0 – 7.9	Major earthquake. Can cause serious damage over larger areas.
8 or >	Great earthquake. Can cause serious damage in areas several hundred kilometers across.

Source: Federal Emergency Management Agency

Table 5.8: Modified Mercalli Scale of Earthquake Intensity

Scale	Intensity	Description of Effects	Maximum Acceleration (mm/sec)	Corresponding Richter Scale
I	Instrumental	Not felt except by a very few under especially favorable conditions.	<10	
II	Feeble	Felt only by a few persons at rest, especially on upper floors of buildings.	<25	<4.2
III	Slight	Felt quite noticeably by persons indoors, especially on upper floors of buildings. Many people do not recognize it as an earthquake. Standing motor cars may rock slightly. Vibrations similar to the passing of a truck. Duration estimated.	<50	
IV	Moderate	Felt indoors by many, outdoors by few during the day. At night, some awakened. Dishes, windows, doors disturbed; walls make cracking sound. Sensation like heavy truck striking building. Standing motor cars rocked noticeably.	<100	
V	Slightly Strong	Felt by nearly everyone; many awakened. Some dishes, windows broken. Unstable objects overturned. Pendulum clocks may stop.	<250	<4.8
VI	Strong	Felt by all, many frightened. Some heavy furniture moved; a few instances of fallen plaster. Damage slight.	<500	<5.4
VII	Very Strong	Damage negligible in buildings of good design and construction; slight to moderate in well-built ordinary structures; considerable damage in poorly built or badly designed structures; some chimneys broken.	<1000	<6.1
VIII	Destructive	Damage slight in specially designed structures; considerable damage in ordinary substantial buildings with partial collapse. Damage great in poorly built	<2500	

SECTION 5: HAZARD PROFILES

Scale	Intensity	Description of Effects	Maximum Acceleration (mm/sec)	Corresponding Richter Scale
		structures. Fall of chimneys, factory stacks, columns, monuments, walls. Heavy furniture overturned.		
IX	Ruinous	Damage considerable in specially designed structures; well-designed frame structures thrown out of plumb. Damage great in substantial buildings, with partial collapse. Buildings shifted off foundations.	<5000	<6.9
X	Disastrous	Some well-built wooden structures destroyed; most masonry and frame structures destroyed with foundations. Rails bent.	<7500	<7.3
XI	Very Disastrous	Not felt except by a very few under especially favorable conditions.	<9800	<8.1
XII	Catastrophic	Felt only by a few persons at rest, especially on upper floors of buildings.	>9800	>8.1

Source: Federal Emergency Management Agency

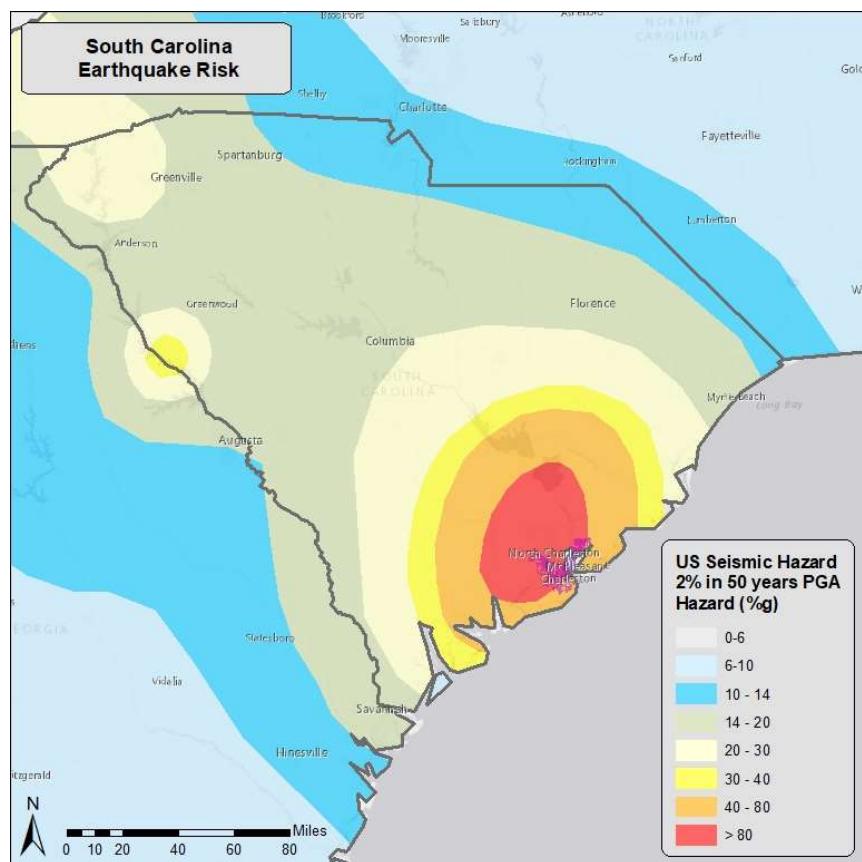


Figure 5.13: Peak Acceleration with 10 Percent Probability of Exceedance in 50 Years

Source: United States Geological Survey

5.7.2 Location and Spatial Extent

Earthquakes, though infrequent, are not uncommon in South Carolina. Around 70% of the state's seismic activity occurs in the Coastal Plain, primarily clustered in three areas: Ravenel-Adams, Run Hollywood, Middleton-Place Summerville, and Bowman. The City of Charleston is situated in one of the most seismically active regions in the Eastern United States. The Middleton Place-Summerville Seismic Zone (MPSSZ), located about 12 miles north of Charleston, encompasses significant seismic activity, particularly around Summerville and Bowman. This activity is attributed to two steeply dipping faults: the deeper, northeast-trending Woodstock Fault and the shallower, northwest-trending Ashley River Fault. Notably, recent seismic events include two earthquakes in November 2002 (magnitude 4.2 and 3.5) as well as an earthquake in the Atlantic Ocean off South Carolina's coast.³⁰

Along the coastline of South Carolina, there is a high liquefaction potential.³¹ Figure 5. below shows a modeled probability of liquefaction potential of the Charleston peninsula and surrounding areas. This liquefaction potential is based on a 475-year return period for a magnitude 7.5 earthquake and considers the relationship between soil and geologic makeup, magnitude, and depth to groundwater.³²

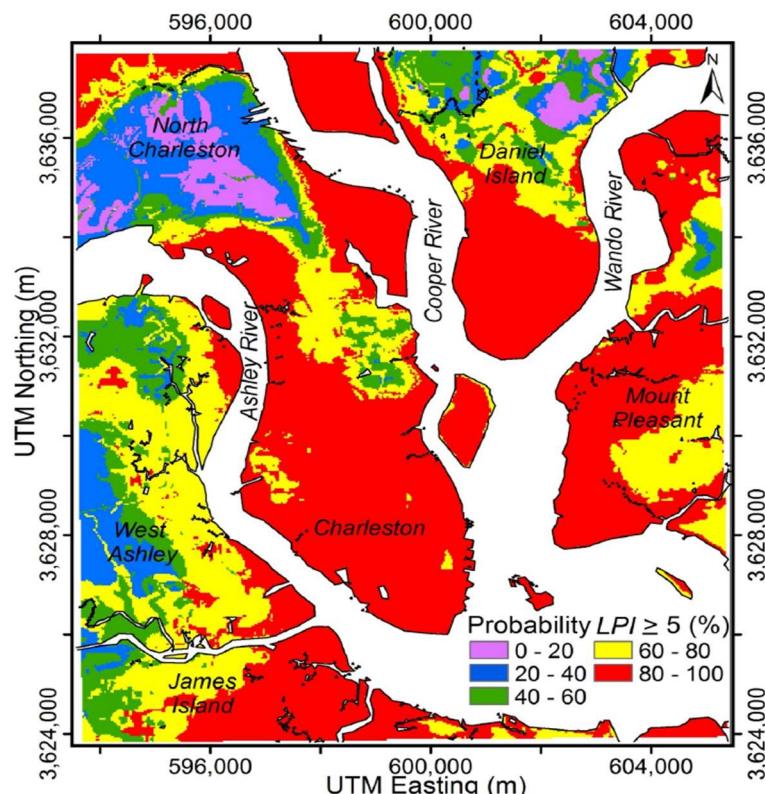


Figure 5.14: Probabilistic Liquefaction Potential of the Charleston Municipal Area

Source: University of Clemson

³⁰ SCEMD, 2017

³¹ SC Hazard Mitigation Plan, 2018 update. p.158. <https://www.scedm.org/media/1391/sc-hazard-mitigation-plan-2018-update.pdf>

³² Simonson, Lawrence. "Geology-Based Probabilistic Liquefaction Potential Mapping of the 7.5-Minute Charleston Quadrangle, South Carolina for Resilient Infrastructure Design" (2012). *All Theses*. 1386.

https://tigerprints.clemson.edu/all_theses/1386. 36-40.

While there have not been any earthquakes with a MMI intensity greater than V since 1974 in this area, it has the potential to produce an earthquake of significant intensity in the future. A projected earthquake intensity map produced by South Carolina Department of Natural Resources is shown in **Figure 5..**

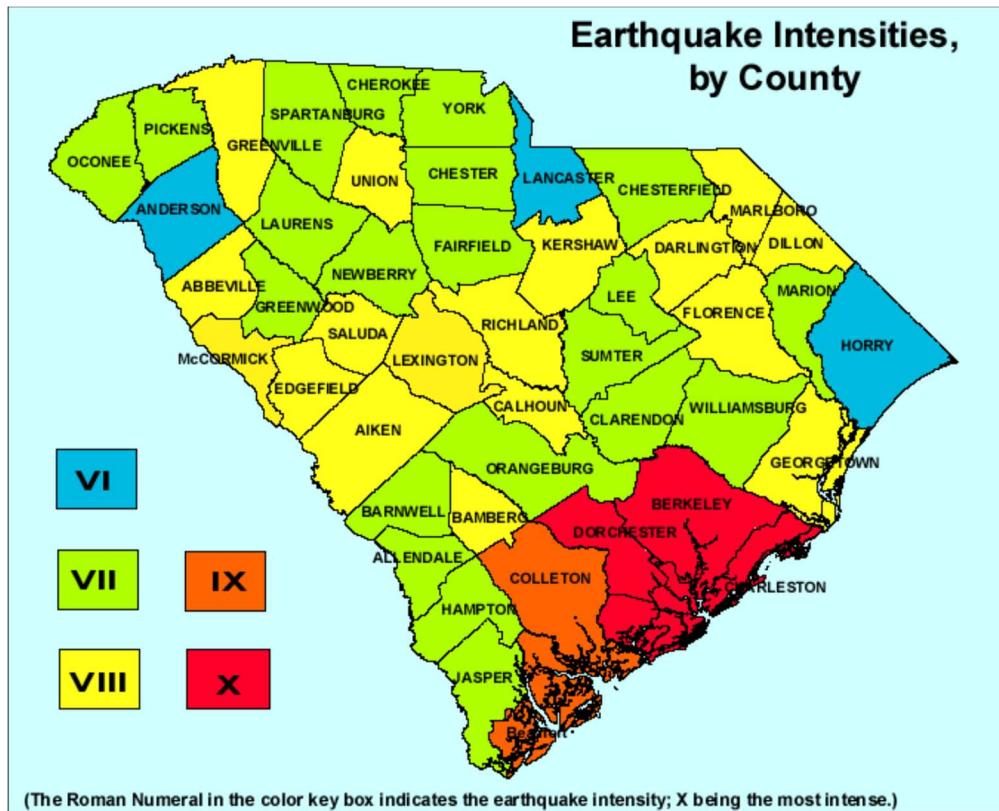


Figure 5.15: Estimated Earthquake Intensity

Source: SCDNR

5.7.3 Historical Occurrences

At least 25 earthquakes are known to have affected Charleston County since 1973. The strongest of these measured a VI on the Modified Mercalli Intensity (MMI) scale. **Table 5.9** provides a summary of earthquake events reported by the National Geophysical Data Center between 1886 and 2018.

Table 5.9: Summary of Seismic Activity in Charleston County

Location	Date	MMI Reported	Richter Scale Equivalent
Charleston, SC	8/31/1886	X	7.3
North Charleston, SC	11/22/1974	V	4.7
Lincolnton, SC	6/22/1980	I	1.6
North Charleston, SC	3/1/1982	II	3.0
North Charleston, SC	11/6/1983	II	2.2
Lincolnton, SC	11/6/1983	II	3.3
North Charleston, SC	8/17/1986	I	1.7

SECTION 5: HAZARD PROFILES

Location	Date	MMI Reported	Richter Scale Equivalent
North Charleston, SC	9/17/1986	II	2.6
Lincolnvile, SC	1/23/1988	II	3.3
North Charleston, SC	2/7/1990	II	2.7
Lincolnvile, SC	5/11/1990	II	2.6
Lincolnvile, SC	11/13/1990	II	3.2
Lincolnvile, SC	1/15/1991	I	1.7
Lincolnvile, SC	4/21/1994	II	2.4
North Charleston, SC	4/17/1995	II	3.9
Lincolnvile, SC	5/6/2009	II	3.2
North Charleston, SC	5/12/2010	II	2.8
Lincolnvile, SC	2/6/2012	I	1.6
Lincolnvile, SC	3/28/2013	I	1.5
Lincolnvile, SC	7/29/2013	I	1.4
North Charleston, SC	9/7/2013	II	2.3
Lincolnvile, SC	9/15/2013	II	2.3
Lincolnvile, SC	9/20/2013	II	2.2
North Charleston, SC	11/3/2013	I	1.9
Ladson, SC	11/18/2013	I	1.7

Source: National Centers for Environmental Information

- **August 31, 1886** – A devastating earthquake of magnitude 7.3 struck Charleston County at 9:50 PM, lasting about 45 seconds and causing significant damage to nearly all 8,000 city structures. Aftershocks occurred at 10:00 PM, 10:12 PM, and 10:25 PM, further damaging buildings over the next 24 hours.
- **January 1, 1913** – A 5.5 magnitude earthquake occurred near Union County, 27 years after the 1886 quake. It produced shock waves felt in surrounding states but caused minimal damage and no fatalities.
- **2012 – 2017** – A 5.5 magnitude earthquake occurred near Union County, 27 years after the 1886 quake. It produced shock waves felt in surrounding states but caused minimal damage and no fatalities.
- **February 14, 2014** – A 4.1 magnitude earthquake occurred at 10:23 PM near Edgefield, with statewide tremors but no significant damage or injuries reported.

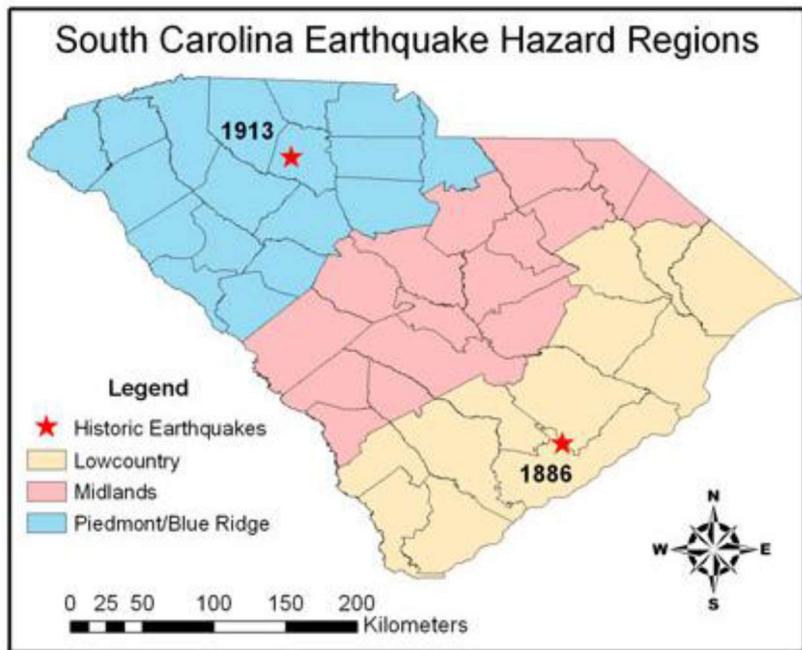


Figure 5.16: South Carolina Earthquake Regions and Major Historic Epicenters
Source: South Carolina Earthquake Education and Preparedness Program

Figure 5. was provided by SCEMD and shows the numbers, locations, and magnitudes for earthquakes in South Carolina between 1900-2022.

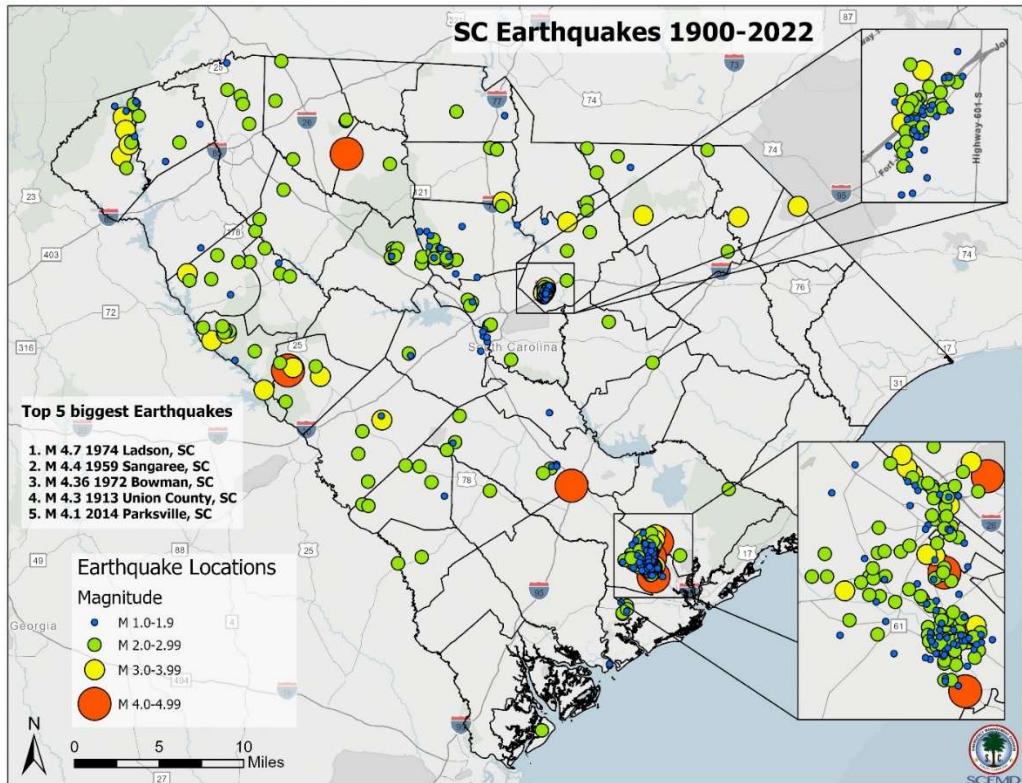


Figure 5.17: Number, Locations, and Magnitude of Earthquakes in South Carolina from 1900-2022

5.7.4 Changing Future Conditions

In South Carolina, approximately 70 percent of the earthquakes occur in the Coastal Plain and most are clustered around three areas west and north of Charleston: Ravenel-Adams, Runs-Hollywood, Middleton Place-Summerville, and Bowman.³³ The state is very susceptible to future earthquakes and has already been damaged by significant events in the past. According to the USGS, the Middleton-Place-Summerville Seismic Zone (MPSSZ), which lies near the City of Charleston, is one of the most active areas in the Eastern United States. Currently, the MPSSZ experiences between 10 to 15 magnitude 3 or less events every year.³⁴ However, there is no indication at this time that climate change contributes to the number and intensity of earthquake events.

5.7.5 Probability of Future Occurrences

The South Carolina Earthquake Education and Preparedness (SCEEP) center states that scientists believe another earthquake of the magnitude of the 1886 earthquake will occur sometime in the next 400-500 years³⁵. Smaller, less intense earthquakes are even more likely. The future probability of occurrences of earthquake events is *possible* (between 1 and 10 percent annual probability) for earthquake events.

The City of Charleston held an Executive Education Seminar on September 4th, 2024, where experts emphasized that the region remains highly vulnerable to a major earthquake similar in scale to the 1886 event, which caused widespread destruction in what was then a far smaller community. With a modern population exceeding 900,000 and many historic masonry structures prone to collapse, even a magnitude 5.0 quake could damage thousands of buildings, and a magnitude 6.0 could impact more than 70,000 structures according to FEMA risk models. Participants noted that this level of exposure is compounded by low public engagement in earthquake preparedness activities.

The discussion also highlighted the fragility and importance of the region's transportation network. Roads and bridges serve as essential lifelines, and a strong earthquake would require rapid assessment and restoration to support evacuation, emergency access, and resource distribution. Officials would face difficult decisions about prioritizing limited response resources, especially given the added complexity of transient risks such as hazardous-materials transport and large tourist populations. Attendees stressed the need for improved planning around cascading impacts and interdependencies to strengthen regional readiness.

5.8 TORNADO

5.8.1 Background and Description

A tornado is a violently rotating column of air that extends to the ground, known as a waterspout when over water. Typically generated by thunderstorms, tornadoes can also arise from hurricanes and other tropical storms when cool, dry air overrides a layer of warm, moist air, causing the warm air to rise rapidly. Tornadoes are characterized by destructive wind speeds that can exceed 300 miles per hour, turning everyday objects into deadly projectiles. The damage is primarily caused by high wind velocities and debris, often accompanied by lightning or large hail.

³³ <https://www.dnr.sc.gov/geology/earthquake-info.html#:~:text=Fault%20zones&text=In%20South%20Carolina%2C%20approximately%2070,Place%2DSummerville%2C%20and%20Bowman.>

³⁴ <http://scemd.cdn.missc.net/media/1009/sc-earthquake-guide.pdf>

³⁵ <https://blogs.cofc.edu/scearthquakes/>

Tornado season usually spans from March to August, but they can occur year-round if the right conditions are present. Tropical systems, especially during landfall, can also produce tornadoes due to intense convection and wind shear, particularly in late summer and early fall in areas like Charleston. Each year, the U.S. reports over 800 tornadoes, resulting in approximately 80 deaths and 1,500 injuries.³⁶ While the Great Plains, known as "Tornado Alley," is home to the most severe tornadoes, Florida leads the nation in tornado frequency per square mile.

Figure 5. shows tornado activity in the United States based on the number of recorded tornadoes per 1,000 square miles.

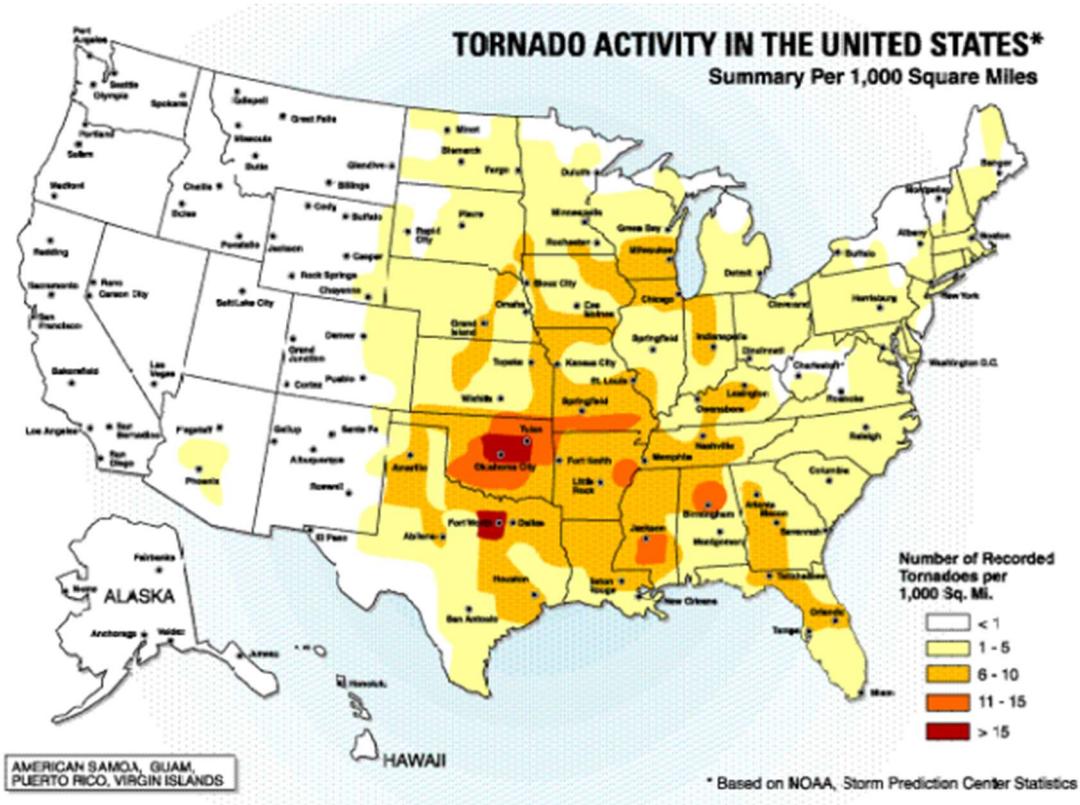


Figure 5.18: Tornado Activity in the United States

Source: NOAA

Tornadoes are most likely to occur between March and May, typically forming in the late afternoon and early evening. While most tornadoes are only a few dozen yards wide and touch down briefly, even short-lived ones can cause significant damage. Highly destructive tornadoes can create paths over a mile wide and several miles long.

The extent of destruction from tornadoes varies based on their intensity, size, and duration, with the most damage often inflicted on lightweight structures, particularly mobile homes. Tornado magnitudes are classified using the Fujita and Enhanced Fujita Scales. Tornadoes measured before 2005 followed the

³⁶ NOAA, 2009

original Fujita Scale (**Table 5.10**), while those assessed from 2005 onward use the Enhanced Fujita Scale (**Table 5.11**).

Table 5.10: The Fujita Scale (Prior to 2005)

F-Scale Number	Intensity Phrase	Wind Speed	Type of Damage Done
F0	Gale tornado	40-72 mph	Some damage to chimneys; breaks branches off trees; pushes over shallow-rooted trees; damages sign boards.
F1	Moderate tornado	73-112 mph	The lower limit is the beginning of hurricane wind speed; peels surface off roofs; mobile homes pushed off foundations or overturned; moving autos pushed off the roads; attached garages may be destroyed.
F2	Significant tornado	113-157 mph	Considerable damage. Roofs torn off frame houses; mobile homes demolished; boxcars pushed over; large trees snapped or uprooted; light object missiles generated.
F3	Severe tornado	158-206 mph	Roof and some walls torn off well-constructed houses; trains overturned; most trees in forest uprooted
F4	Devastating tornado	207-260 mph	Well-constructed houses leveled; structures with weak foundations blown off some distance; cars thrown and large missiles generated.
F5	Incredible tornado	261-318 mph	Strong frame houses lifted off foundations and carried considerable distances to disintegrate; automobile sized missiles fly through the air in excess of 100 meters; trees debarked; steel re-enforced concrete structures badly damaged.
F6	Inconceivable tornado	319-379 mph	These winds are very unlikely. The small area of damage they might produce would probably not be recognizable along with the mess produced by F4 and F5 wind that would surround the F6 winds. Missiles, such as cars and refrigerators would do serious secondary damage that could not be directly identified as F6 damage. If this level is ever achieved, evidence for it might only be found in some manner of ground swirl pattern, for it may never be identifiable through engineering studies

Source: National Weather Service

Table 5.11: The Enhanced Fujita Scale (Effective 2005 and Later)

EF-SCALE NUMBER	INTENSITY PHRASE	3 SECOND GUST (MPH)	TYPE OF DAMAGE DONE
0	GALE	65–85	Some damage to chimneys; breaks branches off trees; pushes over shallow-rooted trees; damages to sign boards.
1	MODERATE	86–110	The lower limit is the beginning of hurricane wind speed; peels surface off roofs; mobile homes pushed off foundations or overturned; moving autos pushed off the roads; attached garages may be destroyed.

2	SIGNIFICANT	111–135	Considerable damage. Roofs torn off frame houses; mobile homes demolished; boxcars pushed over; large trees snapped or uprooted; light object missiles generated.
3	SEVERE	136–165	Roof and some walls torn off well-constructed houses; trains overturned; most trees in forest uprooted.
4	DEVASTATING	166–200	Well-constructed houses leveled; structures with weak foundations blown off some distance; cars thrown and large missiles generated.
5	INCREDIBLE	Over 200	Strong frame houses lifted off foundations and carried considerable distances to disintegrate; automobile sized missiles fly through the air in excess of 100 meters; trees debarked; steel re-enforced concrete structures badly damaged.

Source: National Weather Service

5.8.2 Location and Spatial Extent

Tornadoes are a threat to the Charleston area. According to SCEMD, South Carolina has averaged 11 tornadoes each year since 1950, resulting in 47 fatalities and 1057 injuries. South Carolina ranks twenty-sixth in the United States in the number of tornado strikes, and eighteenth in the number of tornadoes per square mile. The most common type of tornado, the relatively weak and short-lived type, occurs between March and May. However, tornadoes can occur almost anywhere at any time³⁷.

5.8.3 Historical Occurrences

According to the National Centers for Environmental Information, there have been a total of 3 tornado events reported in the City of Charleston since 2002 (

³⁷ <https://www.scemd.org/prepare/types-of-disasters/tornadoes/>

Table 5.12). **Figure 5. below** shows historical tornado tracks in Charleston.

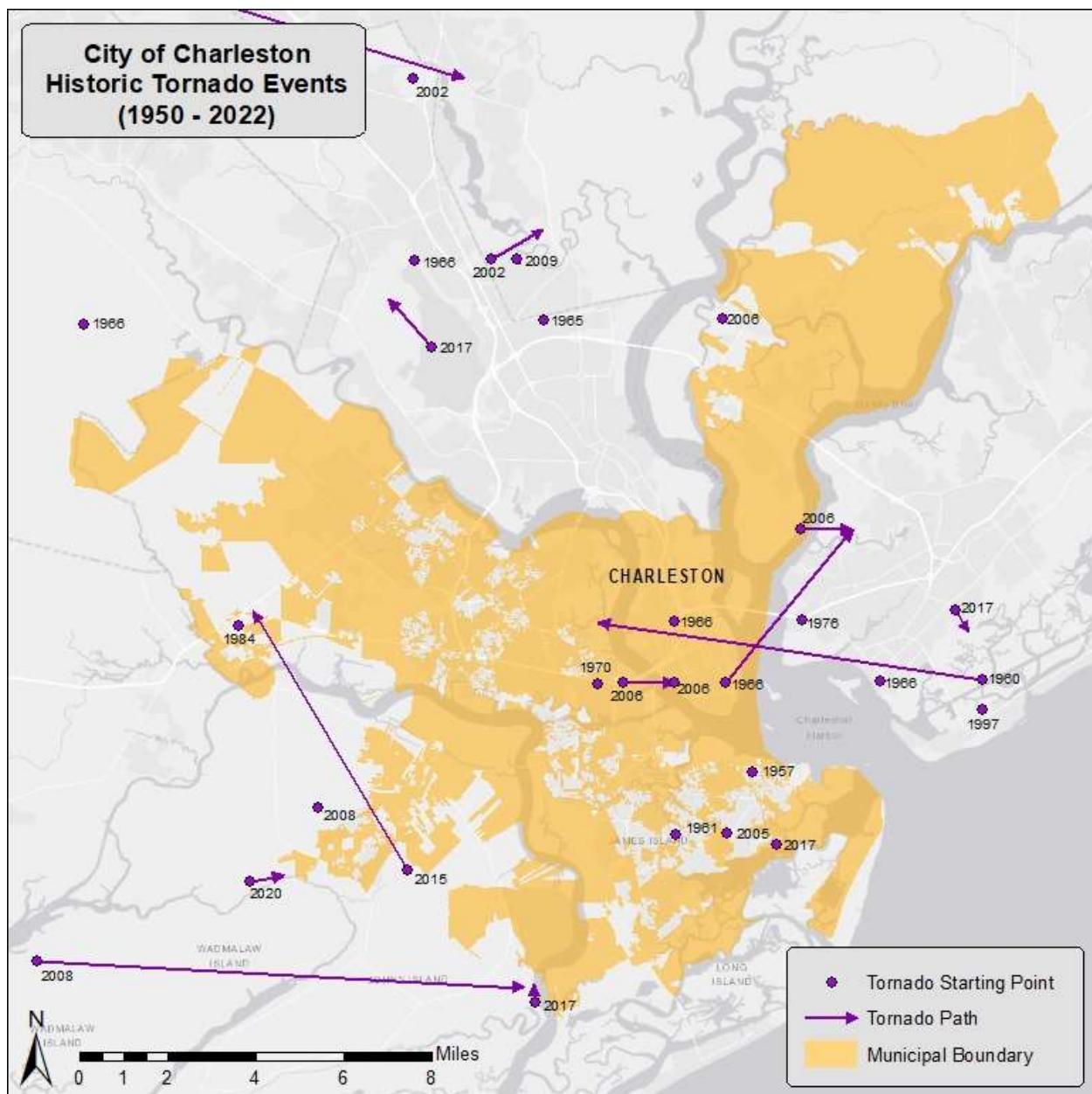


Figure 5.19: Charleston Tornado Tracks (1957-2021)

Source: National Centers for Environmental Information

SECTION 5: HAZARD PROFILES

Table 5.12: Summary of Tornado Occurrences City of Charleston (2002 – 2023)

Date	Description	Deaths	Injuries	Property Damage (2023)
7/15/2002	A brief tornado touch down caused some damage to a storage building for an apartment complex, shingles taken off for the most part, a couple of signs bent, and a few small trees uprooted and some limbs taken out of larger trees. The touchdown was near the CBS affiliate and not far from their Doppler radar.	0	0	\$0
4/8/2006	A weak tornado tracked across the Charleston Neck area. Initial touchdown was near the Dolphin Marina and the Liquid Transport Corporation along Austin Avenue. Several trees were blown down and a large deck was torn away from a trailer and blown 30 feet against a fence. The tornado tracked across Interstate 26 and Meeting Street. Several trees in the area were twisted and snapped off. Also, a Kangaroo gas station experienced minor damage. The tornado moved onto the far southern end of the old Navy Base and then across the Cooper River before crossing onto Daniel Island in southern Berkeley County. At the Cooper River Marina, tornado winds shifted around several large picnic tables, blew large dock containers into the river, and destroyed the wind measuring equipment.	0	0	\$0
6/13/2006	NWS damage survey confirms brief F0 tornado touch down near the Medical University of South Carolina Hospital. Storm track was 1 mile long with tornado path 30 yards. Tree damage was observed at the MUSC Hospital parking lot as well as numerous cars damaged from flying debris at the hospital and nearby hotel parking lot. The tornado crossed Highway 17 and produced additional tree damage off Lockwood Blvd and damaged police cars at the Charleston Police station motor pool. Winds estimated at 60 to 70 mph.	0	0	\$4,452
9/15/2015	A National Weather Service storm survey confirmed a tornado on Johns Island, starting near Cane Slash Road, where it damaged a home's roof. The tornado tracked north-northwest, crossing Maybank Highway and Brownswood Road, causing minor damage to several homes and significant damage to trees. The most severe destruction occurred on Sonny Boy Lane, where two homes sustained high-end EF-2 damage. One well-built brick home lost most of its roof and exterior walls, with debris thrown about 150 yards. Across the street, the entire back portion of another two-story house was destroyed. Continuing its path north-northwest, the tornado crossed River Road, the Stono River, Main Road, and Highway 17, where it dissipated. This segment caused widespread tree destruction and roof damage to two businesses near Highway 17. A damage assessment by the Charleston County Building Services Department reported 51 damaged structures—33 with moderate or severe damage and 18 with minor damage—totaling an estimated \$1,539,000. Thousands of trees were uprooted or snapped, blocking roads for several days following the event.	0	0	\$1.54M

Source: NCEI

5.8.4 Changing Future Conditions

Tornadoes are among the most difficult hazards to link definitively to climate change, partially because they are relatively small and short-lived events compared with wildfires, heat waves and other climate

disasters. At the same time, tornadoes have become more clustered, with outbreaks of multiple tornadoes becoming more common even as the overall number has remained unchanged.

5.8.5 Probability of Future Occurrences

While tornadoes/waterspouts are likely to occur in the future for the City of Charleston, their impact is expected to be limited to a small geographic area. While the majority of the reported tornado events are small in terms of size, intensity, and duration, they do pose a significant threat should the City of Charleston experience a direct tornado strike. The probability of future tornado occurrences affecting Charleston is *likely* (between 10 and 100 percent annual probability).

5.9 FIRE

For the purposes of this plan, fire is divided into three sub-hazards: Wildfires, Structural Fires, and Conflagration.

5.9.1 Background and Description

Wildfire

A wildfire is an uncontrolled outdoor fire occurring in grasslands, forests, or brushlands. While wildfires are a natural part of forest ecosystem management, human activity is responsible for over 80% of forest fires in the U.S., often due to negligent behaviors like improper campfire extinguishing or smoking in wooded areas. In South Carolina, nearly 3,000 wildfires occur annually, with two-thirds resulting from escaped debris burns or intentional actions.³⁸ Wildfires can be classified into three types: surface fires, which burn along the forest floor and damage trees; ground fires, which occur on or below the forest floor; and crown fires, which spread rapidly through the treetops.

The likelihood of wildfires is influenced by local weather conditions, outdoor activities, and public compliance with fire prevention measures. Droughts and natural disasters, such as tornadoes or hurricanes, can increase wildfire risk by providing additional fuel. Many homes, businesses, and recreational areas are in high wildfire hazard zones, yet residents and visitors are often unprepared for such events. Wildfires can lead to significant economic losses, particularly for industries reliant on timber, and can impact tourism if roads and attractions are closed. State and local governments can implement fire safety regulations and land management strategies—such as firebreaks and prescribed burns—to mitigate wildfire risks and enhance overall fire control.

Structural Fires

A structural fire is a fire that occurs within a building or structure. It is characterized by flames, heat, and smoke generated within the confined space of a structure. Structural fires present a significant hazard that can result in devastating consequences for both property and lives. These fires have the potential to cause extensive damage to the building, displace residents, disrupt normal operations, and threaten the safety of its occupants and individuals within the affected area. These fires can be sparked by several of factors, including, electrical malfunctions, cooking accidents, heating equipment failures, and flammable materials. Structural fires also pose the risk of spreading to surrounding properties, which has long-term implications on the community. Firefighting efforts are typically required to extinguish the flames and prevent the fire from spreading to adjacent structures leading to conflagration.

³⁸ <http://www.state.sc.us/forest/scfra.pdf>

Conflagration

A conflagration is a fire large enough to spread across a wide area, often destroying more than one property and potentially causing the loss of human lives. It can be caused by a number of scenarios including, but not limited to, electrical malfunctions, lightning strikes, wildfires, combustible materials, industrial accidents, fireworks, negligence or by a human act (i.e. arson). There are different classifications of conflagration that differentiate the events from wildfire occurrences:

- Industrial Conflagration – includes fires at oil refineries
- Urban Conflagration – A large destructive fire that spreads beyond natural or artificial barriers; it can be expected to result in large monetary loss and may or may not include fatalities.

During a conflagration a significant movement of air and combustion products occurs. Hot gaseous products of combustion move upward, causing the influx of more dense cold air to the combustion zone. In the case of an urban conflagration, the intensity of gas exchange inside a building depends on the size and location of openings in walls and floors, the ceiling height, and the amount and characteristics of the combustible materials.

5.9.2 Location and Spatial Extent

The City of Charleston is at risk to fire hazards due to the following reasons:

1. Historical Architecture and Building Materials
2. High Population Density
3. Coastal Location
4. Industrial Activities
5. Aging Infrastructure
6. Limited Access to Water Sources

Wildfires

Every state has a Wildland Urban Interface (WUI), which is the rating of potential impact of wildfires on people and their homes. The WUI is not a fixed geographical location, but rather a combination of human development and vegetation where wildfires have the greatest potential to result in negative impacts. Nationally, one-third of all homes lie in the WUI, which is a growing danger. According to the USDA Forest Service, the cost of wildfire suppression and homes lost to wildfire in the US have increased dramatically over the last 30 years. This is driven in part by the expansion of the wildland-urban interface (WUI). However, the extent of which the location of buildings affected by wildfire overlaps with WUI, and where and when outreach programs are established relative to wildfire, is unclear.

Below, **Figure 5.** shows a map of each state's WUI. Based on the data from the US Department of Agriculture, 61% of homes in South Carolina lie within the WUI.

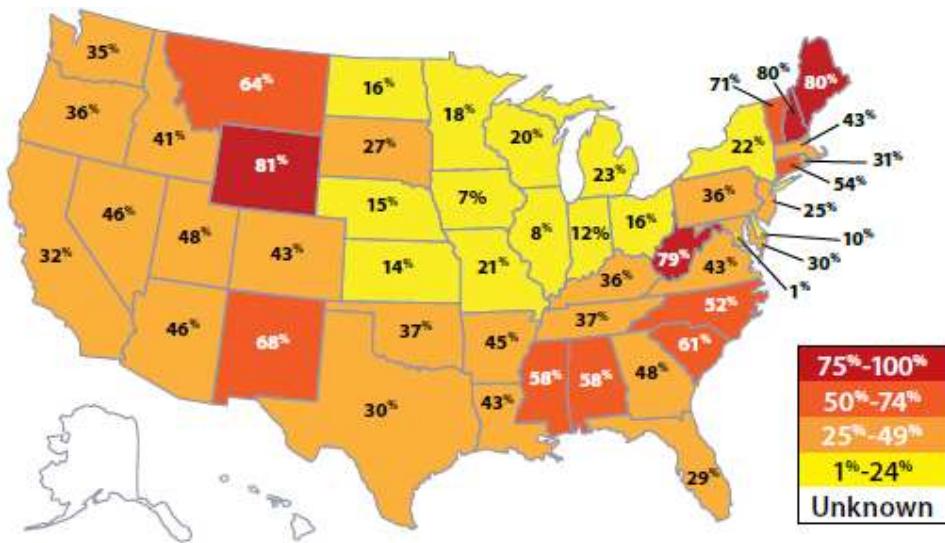


Figure 5.20: Percent of Total Homes in the Wildland Urban Interface

Source: US Department of Agriculture

Below, **Figure 5.** displays the WUI Risk Index for the City of Charleston.

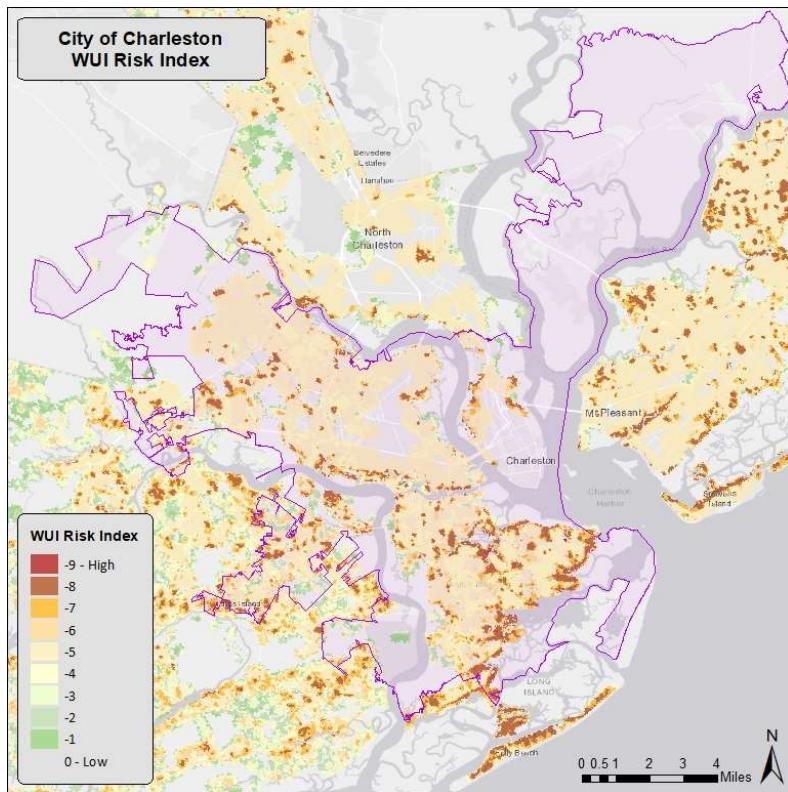


Figure 5.21: Charleston WUI Risk Index

Source: Southern Wildfire Risk Assessment

The Charleston Fire Department (CFD) identified Cainhoy and Daniel Island as areas at the greatest risk of wildfires due to development encroaching on the Francis Marion National Forests. However, CFD indicated the department deems all wildland fires to be relatively low risk.

The State of South Carolina has not adopted a specific Wildland Urban Interface (WUI) code at the state level to provide comprehensive guidelines to address fire risks in these given areas where urban development interfaces with wildland areas. The City of Charleston recognizes the importance of the implementation of specific regulations and standards aimed at mitigating fire risk in the WUI. To reflect this acknowledgement, the Charleston Fire Department has implemented the Wildland Urban Interface Fire Control as one of its core programs and has staffed a Wildland Team to assist with incidents of wildland fire extinguishment and containment, structural triage, and assistance to federal, state and local agencies.

Structural Fires

Structural fires pose a significant risk to the City of Charleston. The historical architecture prevalent in Charleston's Historic District and other older neighborhoods increases the likelihood of a structural fire and rapid spread of flames due to:

1. Building Materials – Many historic structures are made of materials that are typically highly susceptible to fire, such as aged wood and other combustible materials.
2. Structural Vulnerability – The design and construction of historic buildings may lack modern fire-resistant features, making them more prone to fire spread.
3. Limited Fire Protection Measures – Older buildings may have outdated fire protection systems. For example, inadequate sprinkler systems or fire-resistant barriers. This increases the risk of rapid fire spread.

Moreover, the limited availability of water sources for fire suppression in certain areas of Charleston further compounds the risk of structure fires in the City. These areas include, but are not limited to:

1. The Upper Peninsula – Industrial nature, limited green space, and aging infrastructure
2. The Eastside – Lack of fire hydrants, narrow streets, and the prevalence of older structures
3. West Ashley – Expansive size, limited hydrant coverage, and more remote areas
4. James Island – Coastal location and potential drainage issues

Conflagration

Conflagration is a risk to the City of Charleston. Any major urban or suburban area could be exposed to the possibility of an extensive fire which destroys a great deal of land or property. Prior to industrialization of most urban areas in the United States and the proliferation of fire suppression systems in public and private buildings, the possibility of an out-of-control urban conflagration was significantly higher. The dense urban layout of Charleston can facilitate the quick spread of fires from one structure to another. More specifically, the narrow streets and proximity of historic buildings in Charleston could heighten this concern substantially.

5.9.3 Historical Occurrences

Wildfires

According to the South Carolina Department of Emergency Management Division (SCEMD), wildfires are caused by numerous sources ranging from lightning, arson, carelessness by smokers, individuals burning debris or operating equipment which throws sparks, and children playing with matches. The largest number of wildfires in South Carolina caused by people is arson followed by careless debris burning.³⁹

Information from the South Carolina Forestry Commission was used to determine historical wildfire events. The South Carolina Forestry Commission reported that a total of 8,198 total wildfire events have occurred in Charleston County since 1946. These events have burned a total of 96,820 acres. According to the NCEI database, there were 2 wildfire incidents in Charleston County since 2011, which caused approximately \$2 million in property damage.

- **March 3, 2011:** Warm temperatures in combination with low relative humidity values and breezy conditions, resulted in conditions favorable for wildfire starts in southern South Carolina. The South Carolina Forestry Commission reported a large wildfire started on March 23rd in Northern Charleston County, 5 miles north-northeast of McClellanville, South Carolina. The wildfire was fully contained on March 25th. The wildfire burned 2600 acres over the 3-day period, resulting in the destruction of 16 non-residential structures, evacuation of the Germantown and Santee Communities, the opening of a shelter at the St. James-Santee Elementary School, and the closure of Highway 17 from Highway 45 north of the Charleston/Georgetown County line. Damages as a result of the wildfire were estimated between \$1.5 – 2 million dollars.
- **May 26 – May 31, 2019:** Local media outlets reported that a controlled burn sparked a wildfire in the Francis Marion National Forest. The controlled burn jumped from its intended location due to a shift in winds and a wildfire developed in a very dry portion of the forest. All total, approximately 1,600 acres of land were burned either directly from the wildfire or from suppression activities. The Francis Marion National Forest was very dry due to a lack of rain and record setting temperatures and very dry air created an environment supportive of the development and spread of wildfires.

Structural Fires

According to the Charleston Fire Department Community Risk Assessment (2020), the 4-year average of fires within the City was 612. Of those fires, roughly 30% of them were structural fires. CFD's 2019, 2020, 2021, and 2022 Annual Reports list the following occurrences:

1. 2019 Annual Report – 570 fires total (145 structure fires)
2. 2020 Annual Report – 564 fires total (172 structure fires)
3. 2021 Annual Report – 563 fires total (165 structure fires)
4. 2022 Annual Report – 656 fires total (206 structure fires)

Conflagration

Prior to 1900, fires were a constant threat to cities like Charleston, SC. Cities like Charleston routinely pass laws regulating the materials used in the construction of buildings and mandating frequent chimney cleanings (defective chimneys were a common cause of urban conflagrations), but the problem of fires

³⁹<https://www.scedm.org/prepare/types-of-disasters/wildfires/#:~:text=Wildfires%20are%20caused%20by%20numerous,followed%20by%20careless%20debris%20burning.>

worsened over the course of the eighteenth century as more and more people crowded into port cities.⁴⁰ The South Carolina Forestry Commission (SCFC) reported at least five (5) major urban conflagration which caused between \$9,000,000 – 12,000,000 in property damage, and nine (9) deaths. Further details of these events can be seen in **Table 5.13** below.

Table 5.13: Conflagration Event in the City of Charleston (1838 - 2022)

Date	Description	Deaths	Injuries	Property Damage (2023)
1/15/1778	A major fire burned half the city, destroying over 250 structures. Except for five tenements, every building was lost on the east side of Church Street between Broad Street and Stoll's Alley; Tradd Street east of Church Street was equally devastated.	0	0	~\$780,000
4/27/1838	An enormous fire broke out in Charleston, South Carolina, around 9:00pm. It raged until noon the next day, and damaged over 1,000 buildings. The fire ruined many businesses, a new hotel, several churches, a new theater, and the entire downtown market except for the fish section. The damaged buildings amounted to about one-fourth of all the businesses in the main part of the city.	0	0	~\$3,000,000
12/1/1861	A large fire, which started near the intersection of East Bay and Hasell Streets, reportedly burned over 540 acres, 575 homes, numerous businesses and five churches in the City of Charleston. Also known as "The Great Fire of 1861", the estimated cost in property damages destroyed in the fire was estimated to be between \$5 million and \$8 million. Although there were no deaths officially recorded, we can assume there was more than likely causalities. The fire had almost completely burnt itself out by December 12th, 1861. By that point, the City Market area and a large section of Meeting St., as well as the north side of Queen St., much of Broad St., and the north side of Tradd St., were almost completely destroyed.	0	0	~\$5,000,000 - \$8,000,000
2/17 – 18, 1865	On February 17th, 1865, the soldiers from Union General William Tecumseh Sherman's army ransacked Columbia, South Carolina, and burned most of the city. Columbia was in chaos when Mayor Thomas J. Goodwyn surrendered the city at midmorning on Thursday, February 17th. Stacks of ragged cotton bales, were rolled out of warehouses with the intention of burning them to keep them out of Union hands, lined the streets. Driven by a strong wind, loose cotton blew over the ground and covered buildings and trees. Fires erupted from the cotton spread over the city, burning almost two-thirds of Columbia, South Carolina. Additionally, the Congaree River bridge was set on fire by retreating Confederate troops, as well as the South Carolina Railroad depot and the Charlotte Railroad depot. The fires were fueled by wooden buildings with common walls and strong wind that wafted burning shingles into the air. ⁴¹	0	0	\$0

⁴⁰ Carl Bridenbaugh, *Cities in the Wilderness: The First Century of Urban Life in America, 1625 – 1742* (New York: Ronald Press Co., 1938), pp. 205-209, 364.

⁴¹ <https://www.scencyclopedia.org/sce/entries/columbia-burning-of/>

Date	Description	Deaths	Injuries	Property Damage (2023)
7/18/2007	The Charleston Sofa Super Store fire disaster occurred on the evening of June 18, 2007, and killed nine firefighters. The fire started at approximately 7:00 pm in a covered loading dock area built between the showroom and warehouse buildings which was attached to both buildings. A showroom area of the store experienced a flashover while at least 16 firefighters were working insides, trapping them under the collapsed roof of the buildings. It was the deadliest fire in South Carolina since 1979.	9	0	\$0

Source: SCFC

5.9.4 Changing Future Conditions

Wildfire

Although wildfires occur naturally and play a long-term role in the health of the ecosystems, changing wildfire patterns threaten to upset the status quo. The wildfire season has lengthened in many areas due to factors including warmer springs, longer summer dry seasons, and drier soils and vegetation. In addition, the percentage of days generally suitable for prescribed fires is expected to decrease, particularly in the summer and fall months, with spring and early fall burn winds also likely to diminish. Across the Coastal Plain, the dry season has already lengthened by as much as 130% over the past 120 years.⁴² An extension of the dry season with little to no chance in seasonal thunderstorm patterns increases the potential lightning-ignited wildfires and fire severity. Additionally, coastal areas like the City of Charleston affected by sea level rise, have increased levels of salinization which prevent the post-fire regeneration of tree species, leading to the conversion of previously forested areas to marshes.⁴³

Structural Fire

Rising temperatures, prolonged periods of drought, and more frequent extreme weather events can contribute to increased fire hazards in urban areas like Charleston. Extreme weather events, such as hurricanes or severe storms, can cause damage to buildings, power lines, and other infrastructure, which in turn could create conditions that increase the likelihood of structure fires. Additionally, limitation on water resources, saltwater intrusion into freshwater supplies, and more intense storm surge could hamper the ability of firefighting/response services to effectively combat structure fires in the city.

Conflagration

Conflagration can be fueled by factors such as high temperatures, low humidity, and strong winds, all of which are influenced by climate change. Higher temperatures can dry out vegetation, building materials, and other combustible materials, making them more susceptible to ignition and rapid fire spread. In other words, the changing climate can impact the occurrence of conflagration in the City by creating conditions conducive to large-scale and rapidly spreading fire.

5.9.5 Probability of Future Occurrences

The probability of future fire occurrences for the City of Charleston is *likely* (between 10 and 100% annual probability).

⁴² <https://southernfireexchange.org/wp-content/uploads/2021-1.pdf>

⁴³ Taillie, P. J., Moorman, C. E., Poulter, B., Ardon, M., and Emanuel, R. E. (2019). Decadal-scale vegetation change driven by salinity at leading edge of rising sea level. *Ecosystems*, 22(8), 1918-1930

Wildfire

The likelihood of wildfire increases during drought cycles and abnormally dry conditions. Fires are likely to stay small but could increase due to local climate and ground conditions. Dry, windy conditions with an accumulation fuel could create conditions of a large fire that spread quickly. Areas in the urban-wildland interface will have much more property at risk, resulting in increased vulnerability and need to mitigate compared to rural, mainly forested areas.

Structural Fire

Based on historical data and current trends, the risk of structural fires in Charleston remains significant. Factors such as aging infrastructure, historical architecture, and high population density all contribute to the likelihood of future structure fires in the city. With the ongoing development, population growth, and environmental changes in Charleston, it is reasonable to suspect the frequency and severity of structure fires may increase in the future.

Conflagration

Like structural fires, historical architecture, high population density, and aging infrastructure contribute to the likelihood of future conflagration events in Charleston. The potential for large-scale fires involving multiple structures or areas is influenced by the interplay of the listed factors and the challenges they may pose to firefighting/emergency services in their response efforts. Given the potential impacts of climate change and the existing vulnerabilities to fire hazards in Charleston, the risk of conflagration in the city is not negligible.

5.10 TSUNAMIS

5.10.1 Background and Description

A tsunami is a large seismic wave generated by shallow underwater earthquakes. It can travel unnoticed across oceans at speeds of up to 500 mph, causing significant damage to coastal structures, severe erosion, extensive inland flooding, and loss of life upon reaching land. Tsunamis can occur in oceans, seas, lakes, and rivers; those in closed bodies of water are called seiches. According to the Global Historical Tsunami Database, damaging tsunamis near their source happen approximately twice a year, while those affecting distant shores (over 620 miles away) occur about twice a decade.

Tsunamis can originate from two sources: distant and local. A distant source is more than 620 miles from the Tsunami Warning Center's Area of Responsibility (AOR), while a local source is within that distance. Local tsunamis typically have a travel time of 30 minutes or less, while regional tsunamis take 30 minutes to 2 hours. Locally generated tsunamis usually cause more fatalities than distant ones due to their larger size and quicker arrival.

The National Oceanic and Atmospheric Administration (NOAA) monitors earthquakes and tsunami events in the Pacific and Atlantic Oceans. The NOAA Tsunami Warning System aims to protect life and property by providing timely and accurate warnings to coastal communities and emergency management organizations.

Table 5.14 below details the NOAA's Tsunami Warning Centers distinct meaning and related response by local emergency response.

SECTION 5: HAZARD PROFILES

Table 5.14: NOAA Tsunami Warning System

Statement Level	Description	Relative Threat	Local Emergency Response
Information Statement	Issued to inform emergency management officials and the public that an earthquake has occurred, or that a tsunami warning, watch or advisory has been issued for another section of the ocean. Usually issued to indicate there is no threat of a destructive tsunami and to prevent unnecessary evacuations as the earthquake may have been felt in coastal areas.	Minor Waves at most	No Action Suggested
Watch	Issued to alert emergency management officials and public of an event which may later impact the watch area. Emergency management officials and the public should prepare to take action.	Danger levels not yet known	Stay alert for more info
Advisory	Issued due to the threat of a potential tsunami which may produce strong currents or waves dangerous to those in or near the water. Coastal regions historically prone to damage due to strong currents induced by tsunamis are at the greatest risk. The threat may continue for several hours after the arrival of the initial wave, but significant widespread inundation is not expected for areas under an advisory.	Strong currents likely	Stay away from the shore
Warning	Issued when a potential tsunami with significant widespread inundation is imminent or expected. Warnings alert the public that widespread, dangerous coastal flooding accompanied by powerful currents is possible and may continue for several hours after arrival of the initial wave. Warnings also alert emergency management officials to take action for the entire tsunami hazard zone. Appropriate actions to be taken by local officials may include the evacuation of low-lying coastal areas, and the repositioning of ships to deep waters when there is time to safely do so.	Inundating wave possible	Full evacuation suggested

Source: NOAA Tsunami Warning System

Table 5.15 below details the criterion for each level of tsunami system notification based on magnitude, area and which associated product is released.

Table 5.15: NOAA TWC Magnitude and Product

Magnitude	Area	Product
4.0 – 4.9	Within 50km of coast	Tsunami Seismic Information Statement
5.0 – 5.9	Within 500km of coast	Tsunami Seismic Information Statement
6.0 – 6.75	Within approximately 500km of coast	Tsunami Information Statement
6.0+	Inland	Tsunami Information Statement
6.8 – 7.5	Atlantic Coast	Fixed warning (350km)

Magnitude	Area	Product
7.6 – 7.8	Atlantic Coast	Fixed warning (1000km)
>7.8	Atlantic Coast	3-hour watch/3-hour warning

Source: NOAA Tsunami Warning System

5.10.2 Location and Spatial Extent

According to the USGS, while powerful earthquake events could cause tsunami events along the coast of South Carolina, the entire eastern coast is a lower risk of a tsunami compared to the Pacific Coastlines. There is no evidence that any of the active faults (faults that have seismic activity associated with them) in the South Carolina area would create tsunamis. Most of the active faults in South Carolina, including the Summerville/Charleston fault are located inland, and therefore could not create a tsunami.

5.10.3 Historical Occurrences

According to historical records from NOAA and the USGS, there are reports of one tsunami event affecting the City of Charleston. This tsunami event was associated with a 7.1 M earthquake which struck Charleston on August 31, 1886. The tsunami struck parts of the east coast as far as Florida, but damages associated with the tsunami event in South Carolina could not be found⁴⁴.

5.10.4 Changing Future Conditions

Although risk for the east coast for tsunami event is relatively low, a warming climate could increase the risk of both submarine and aerial landslides, thereby increasing the risk of local tsunamis.

5.10.5 Probability of Future Occurrences

Information from the USGS and Department of the Interior rated the entire Eastern coastline of the United States as having a “very low to low” probability of a tsunami event in a 500-year timeframe. According to historical information, the City of Charleston has only experienced one significant tsunami occurrence in the last 150 years. Therefore, the annual probability is *unlikely* (less than 1 percent annual probability).

5.11 DAM FAILURES

5.11.1 Background and Description

Global interest in dam and levee safety has surged in recent years due to aging infrastructure, new hydrologic data, and population growth in floodplain areas downstream. The United States has around 80,000 dams, mostly privately owned, alongside those owned by state and local authorities, public utilities, and federal agencies. Dams offer numerous benefits, including drinking water, navigation, agricultural irrigation, hydroelectric power, recreational lakes, and flood prevention, which can save lives.

However, poorly designed, operated, or maintained dams can pose serious risks to communities. A dam failure can unleash destructive water energy, leading to loss of life and significant property damage downstream. Similarly, a levee breach can inundate neighborhoods and trap residents in rising

⁴⁴ <https://library.lanl.gov/tsunami/ts203.pdf>

floodwaters. The failure of these structures can endanger many lives and properties.

5.11.2 Location and Spatial Extent

The South Carolina Department of Health and Environmental Control (SCDHEC) provides information on dams, including a hazard potential classification. There are three hazard classifications—high, significant, and low—based on its potential to cause loss of life or damage to improved property in the event of a dam's failure or improper operation. **Table 5.16** explains these classifications.

Table 5.16: South Carolina Dam Hazard Classifications

Hazard Classification	Class Level	Description
Low	Class 3	Dam failure may cause minimal property damage to others. Loss of life is not expected.
Significant	Class 2	Dam failure will not likely cause loss of life but may damage home(s), industrial and commercial facilities, secondary highway(s) or railroad(s), or interrupt the service of relatively important public utilities.
High	Class 1	Dam failure will likely cause loss of life or serious damage to home(s), industrial and commercial, facilities, important public utilities, main highway(s) or railroads.

Source: South Carolina Department of Health and Environmental Control

According to the South Carolina DHEC and the USACE National Inventory of dams, there are no high hazard dams within Charleston city limits; however, there are several high hazard dams outside of city limits that could impact the city if they were to fail. **Figure 5:** provides the location of these dams. Some of these dams were discussed by the City's Hazard Mitigation Planning Team as well. These include:

- Pineopolis Dam/Tailrace Canal
- Bushy Park
- Goose Creek Reservoir

Dam failures at Lake Marion and/or Lake Moultrie would have significant flood impacts on the city of Charleston.

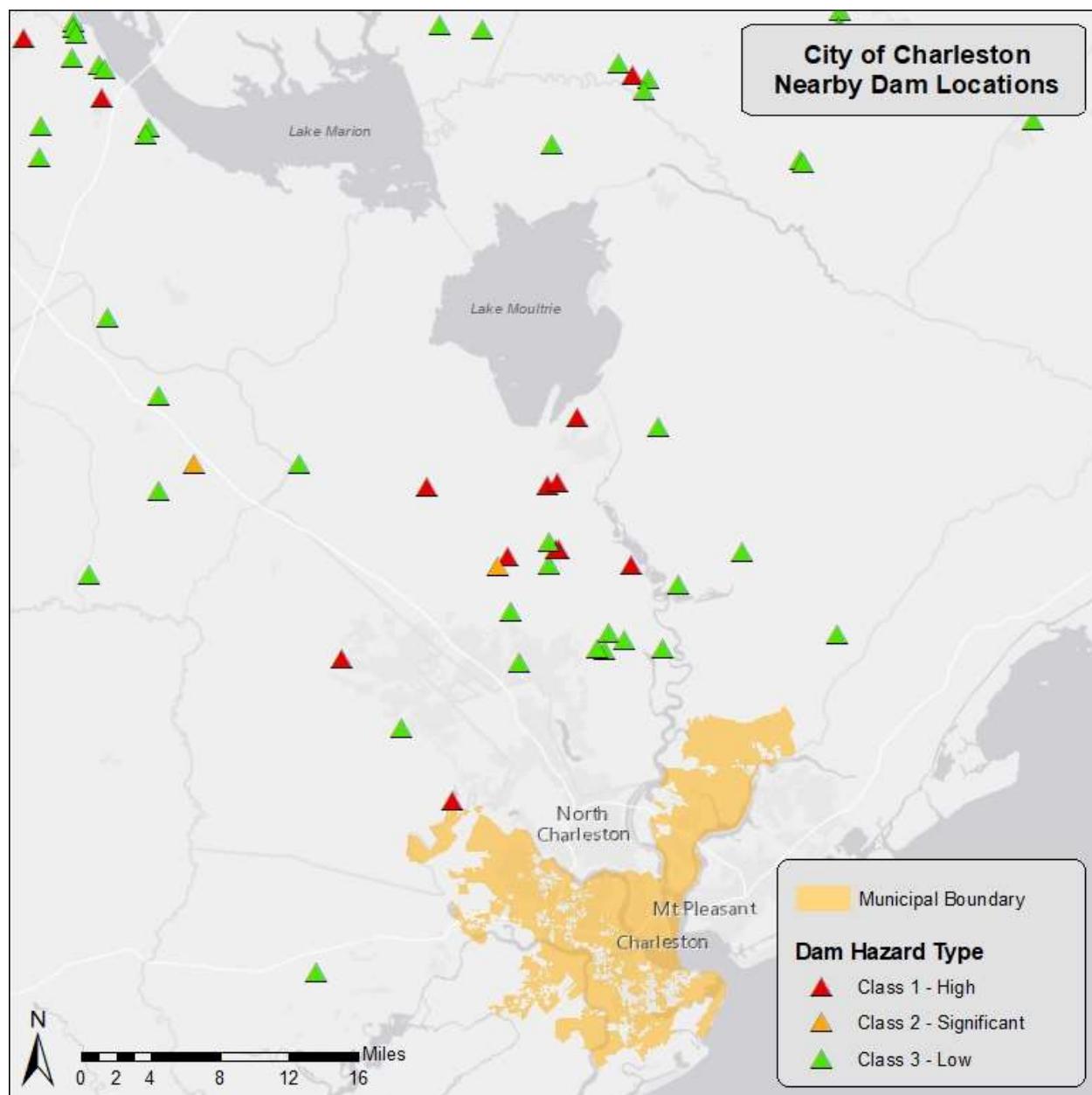


Figure 5:22: Dams in Proximity to the City of Charleston

5.11.3 Historical Occurrences

Although there have been no historical dam breaches affecting the City of Charleston, a breach scenario in the area, such as the failure of dams at Lake Moultrie or Lake Marion could be catastrophic. These dams are part of the Santee Cooper Hydroelectric and Navigation Project, which regulates the dams' water levels. A failure in either of these dams could result in significant flooding downstream, affecting areas along the Cooper River and other low-lying areas of Charleston. The potential impact of dam failure underscores the importance of monitoring and maintaining dam infrastructure, particularly those rated as high hazard, to ensure the safety of surrounding communities.

5.11.4 Changing Future Conditions

Climate and weather change patterns may not affect dams as other hazards. However, a significant projected rise in extreme weather events, such as increases in heavy precipitation events, could affect dams negatively. The real threat to dam failures is the aging infrastructure, and increasing downstream populations who rely on dams for a multitude of benefits, such as flood protection, water supply, hydropower, irrigation, and research.

During October 2015 historical severe storms and flooding which occurred across South Carolina, three dozen dam failures were reported. The floodwaters of this storm destroyed roads and bridges, damaged homes, and caused the deaths of 19 people.⁴⁵ Unfortunately, the flood levels reported due to the severe storms did not break any records. The Association of State Dam Safety Officials reported that out of the 2,409 dams in South Carolina listed in the NID, 617 are classified as high hazard potential dams. Additionally, the NID collects condition data on state-regulated high-hazard potential dams. The NID Condition ratings for regulated dams are presented in **Table 5.17** below.

Table 5.17: NID Dam Condition Ratings

Ratings	Description
Satisfactory	No existing or potential dam safety deficiencies are recognized
Fair	No existing dam safety deficiencies are recognized for normal loading conditions. Rare or extreme hydrologic and/or seismic events may result in a dam safety deficiency.
Poor	A dam safety deficiency is recognized for loading conditions which may realistically occur. Remedial action is necessary. Poor may also be used when uncertainties exist as to critical analysis parameters which identify a potential dam safety deficiency. Further investigations and studies are necessary.
Unsatisfactory	A dam safety deficiency is recognized that requires immediate or emergency remedial action for problem resolution.
Not Rated/Not Available	The dam has not been inspected or has been inspected but, for unknown reasons, has not been rated.

Source: NID, Association of State Dam Safety Officials

Data collected about the potential high-hazards dams in South Carolina showed that 125 were reported as “poor” condition, 25 in “unsatisfactory” condition, and 375 in “fair” condition.⁴⁶ The dam failures present dangers of flooding, some of which could greatly affect the City of Charleston.

5.11.5 Probability of Future Occurrences

A future dam breach event is *unlikely* (less than 1 percent annual probability) in the future. However, as has been demonstrated in the past, regular monitoring is necessary to prevent these events.

⁴⁵ <https://www.americanrivers.org/2015/12/after-extreme-flooding-south-carolina-needs-a-new-dam-management-strategy/>

⁴⁶ <https://damsafety-prod.s3.amazonaws.com/s3fs-public/files/South%20Carolina%20Dam%20Safety%20Performance%20Report%202022.pdf>

5.12 DROUGHT

5.12.1 Background and Description

Drought is a normal part of virtually all climatic regions, including areas with high and low average rainfall. Drought is the consequence of a natural reduction in the amount of precipitation expected over an extended period, which usually lasts a season or longer. High temperatures, high winds, and low humidity can exacerbate drought conditions. In addition, human actions and demands for water resources can hasten drought-related impacts. Prolonged drought events may also lead to more severe wildfires. Droughts are typically classified into one or four types: 1) meteorological, 2) hydrologic, 3) agricultural or 4) socioeconomic. **Table 5.18** presents definitions for these types of droughts.

Table 5.18: Drought Classification Definitions

Meteorological Drought	The degree of dryness or departure of actual precipitation from an expected average or normal amount based on monthly, seasonal, or annual time scales.
Hydrologic Drought	The effects of precipitation shortfalls on stream flows and reservoir, lake, and groundwater levels.
Agricultural Drought	Soil moisture deficiencies relative to water demands of plant life, usually crops.
Socioeconomic Drought	The effect of demands for water exceeding the supply as a result of a weather-related supply shortfall.

Source: Multi-hazard Identification and Risk Assessment: A Cornerstone of the National Mitigation Strategy, Federal Emergency Management Agency

Droughts are slow onset hazards, but, over time, can have very damaging affects to crops, municipal water supplies, recreational uses, and wildlife. If drought conditions extend over several years, the direct and indirect economic impact can be significant. The Palmer Drought Severity Index (PDSI) is based on observed drought conditions and range from -0.5 (incipient dry spell) to -4.0 (extreme drought).

Evident in **Figure 5.**, the Palmer Drought Severity Index Summary Map for the United States, drought affects most areas of the United States but is less severe in the Eastern United States. The figure below is the most update version of the Palmer Drought Severity Index; however, the US Drought Monitor is updated on a weekly basis. An archived map from September 2023 can be seen below in Error! Reference source not found. to reflect more current drought conditions in South Carolina.

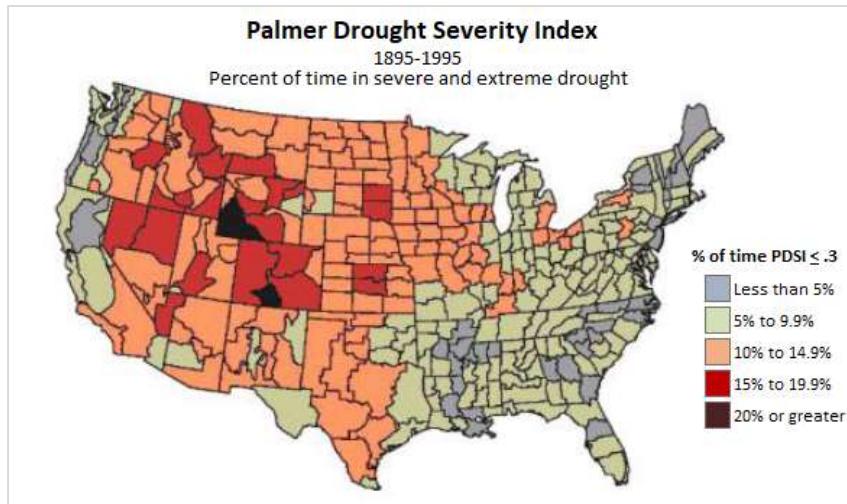


Figure 5.23: Palmer Drought Severity Index Map for the United States (1895 - 1995)

Source: National Drought Mitigation Center

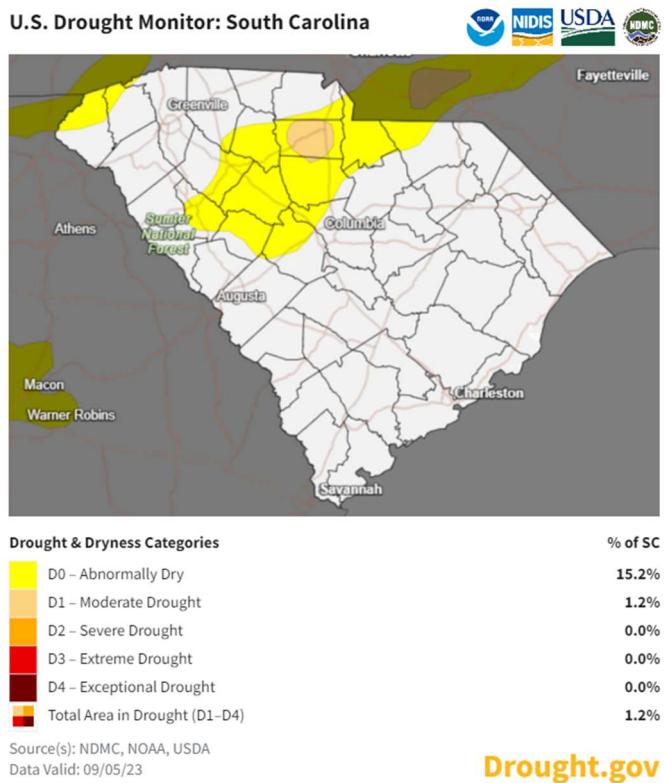


Figure 5.24: US Drought Monitor for South Carolina

Source: NOAA National Drought Monitor

Water Shortage

The risk of freshwater shortages is assessed in various ways, primarily as the gap between water supply and demand, or the likelihood of exceeding critical thresholds when demand surpasses supply. In increasingly urbanized areas, domestic water demand is expected to rise, leading to a shift of water resources from agriculture to municipal use, which stresses rural sustainability and food security. Projections indicate that by 2060, Charleston will rank as the 24th largest U.S. metro area among 348. As climate extremes worsen, effective water storage becomes crucial for adapting to climate change and other water-related challenges. Over the past 20 years, 1.43 billion people have been negatively impacted by drought. Water scarcity can lead to up to a 6% reduction in national growth, with long-lasting effects on poorer populations.

Additionally, climate change has made precipitation patterns less predictable, complicating reliable urban water supply, reducing agricultural productivity, and deterring economic investment and job creation. The Bushy Park Reservoir in the Santee River watershed is Charleston's primary drinking water source, supplemented by a small amount from the Edisto River. Water shortages may arise from prolonged droughts or increased salinity in the reservoir due to brackish water intrusion from the Cooper River.

5.12.2 Location and Spatial Extent

Drought typically covers a large area and cannot be confined to any geographic or political boundaries. According to the Palmer Drought Severity Index, the City of Charleston, has a relatively low risk for drought hazard compared to the rest of the State. It is also notable that drought conditions typically do not cause significant damage to the built environment.

Water Shortage

While spatial extent of water shortage is difficult to measure, the Charleston Water system serves Charleston, Berkley, and Dorchester Counties and the Bushy Park Reservoir (Figure 5.) is the main source of water for the service area and is located north of the City of Charleston.

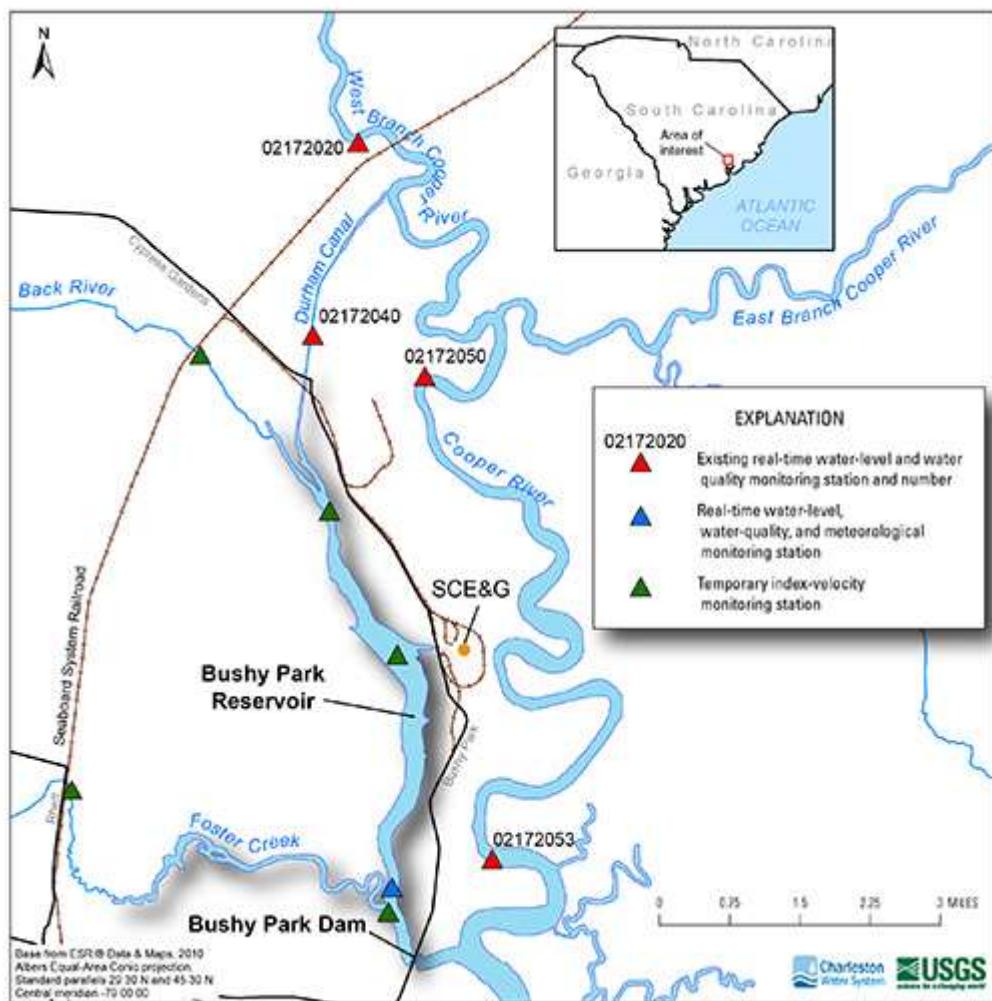


Figure 5.25: Bushy Park Reservoir Reference Map

Source: Charleston Water System, USGS

5.12.3 Historical Occurrences

The US Drought Monitor also reports data on South Carolina drought conditions from 2000 to 2019 through the South Carolina Drought Monitor. It classifies drought conditions using the scale set by the US Drought Monitor, which classifies conditions on a scale of D0 to D4. Each class is further explained in **Table 5.19**. **Table 5.20** below shows that Charleston County has experienced some level of drought every year from 2000 to 2021.

Table 5.19: USDM Drought Classifications

Scale	Description	Impacts
D0	Abnormally Dry	<ul style="list-style-type: none"> - Short-term dryness slowing planting, growth of crops - Some lingering water deficits - Pastures or crops not fully recovered
D1	Moderate Drought	<ul style="list-style-type: none"> - Some damage to crops, pastures - Some water shortages developing - Voluntary water-use restrictions requested

SECTION 5: HAZARD PROFILES

Scale	Description	Impacts
D2	Severe Drought	<ul style="list-style-type: none"> - Crop or pasture loss likely - Water shortages common - Water restrictions imposed
D3	Extreme Drought	<ul style="list-style-type: none"> - Major crop/pasture losses - Widespread water shortages or restrictions
D4	Exceptional Drought	<ul style="list-style-type: none"> - Exceptional and widespread crop/pasture losses - Shortages of water creating water emergencies

Source: US Drought Monitor

South Carolina faced one of its worst multiyear droughts from June 1998 to August 2002, with average precipitation 10-30% below normal. Stream flows reached historic lows, threatening water supply intakes and causing saltwater intrusion in coastal regions. Lakes were drained to dangerously low levels to meet water demands and prevent contamination, while groundwater levels in both shallow and deep aquifers fell to record lows. Municipal and domestic wells required adjustments, including lowering pumps, deepening wells, and occasionally drilling new ones. In some areas, groundwater depletion caused streams to lose water to the ground, reversing the usual flow.

The most severe drought conditions in Charleston County occurred in the summer of 2002. That year, eight of South Carolina's fourteen unregulated streams set new low-flow records, and many reservoirs fell below target operating levels. On July 24, 2002, the SC Drought Response Committee designated 39 of the state's 46 counties at the extreme drought level (D3).⁴⁷ By August, all counties were classified as experiencing extreme drought. The Low Country area's stream flows are primarily sustained by groundwater discharge, and the absence of replenishing winter rains in 2001-2002 exacerbated the situation.

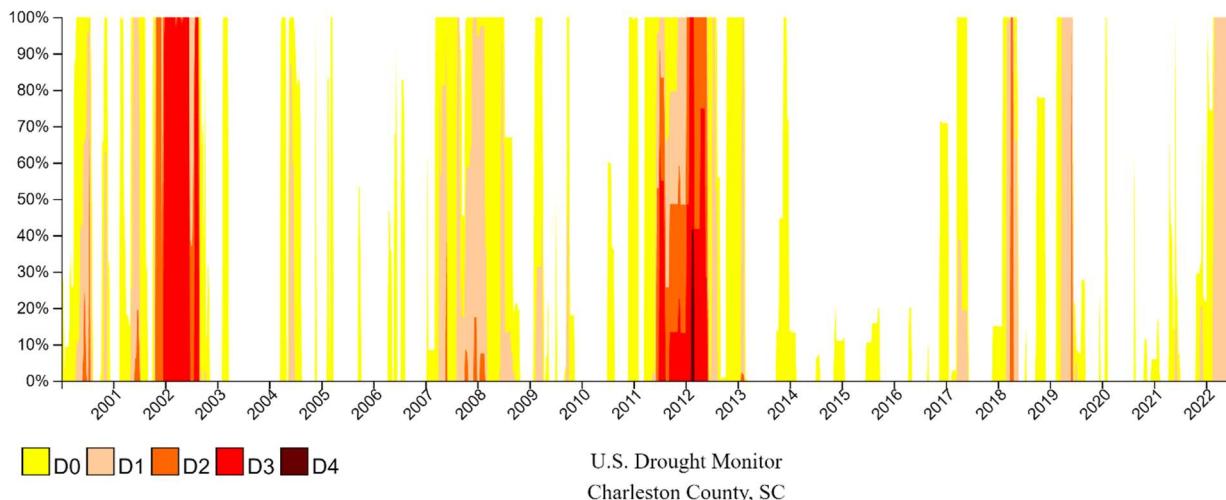


Figure 5.26: Percent Area of Drought Extent (2000-2020)

Source: US Drought Monitor

⁴⁷ <https://www.cisa.sc.edu/atlas/events-2002.html#:~:text=On%20July%202002%2C%20the,Yadkin%2D Pee%20Dee%20Basin.>

Table 5.20: Summary of Drought Occurrences in Charleston County (2000-2021)

Year	Charleston County
2000	Exceptional
2001	Extreme
2002	Exceptional
2003	Moderate
2004	Severe
2005	Moderate
2006	Severe
2007	Exceptional
2008	Exceptional
2009	Extreme
2010	Severe
2011	Exceptional
2012	Exceptional
2013	Extreme
2014	Moderate
2015	Severe
2016	Exceptional
2017	Extreme
2018	Severe
2019	Extreme
2020	Moderate
2021	Severe

Source: US Drought Monitor

Water Shortage

According to data from the Charleston Water System and the USGS, the City of Charleston has not implemented water restrictions during previous dry periods. Although the area has experienced intermittent dry spells over the past 50 years, water availability has remained largely unaffected. The Bushy Park Reservoir, located at the downstream end of the Santee River Watershed, responds slowly to drought conditions, as seen during the multi-year drought from 2006 to 2008, when no voluntary water restrictions were necessary.

The combination of drought and high tides has led to frequent salinity and tidal alerts. To mitigate salinity issues, mandatory flow release requirements based on monitoring were implemented. Additionally, the Charleston Water System has the capacity to dilute raw brackish water by increasing pumping from its Edisto River intake, allowing for a complete switch to the Edisto River if needed.

5.12.4 Changing Future Conditions

According to the South Carolina Department of Natural Resources (DNR), current climate models predict continuous warming across the Southeast, with the greatest temperature increases projected in summer.

Average annual temperatures are projected to rise 4.5 F by the 2080s under a lower emission scenario and 9 F under a higher emissions scenario with a 10.5 F in summer.⁴⁸ The frequency, duration and intensity of droughts are likely to continue to increase with higher average temperatures and a higher rate of evapotranspiration.

Water Shortage

One of the main culprits of increasing burden on available fresh water are longer and more intense drought events. In the United States, one of the region's most severely hit by recent droughts in the relatively wet areas of the US South, which includes South Carolina. Further droughts in these areas as well as more widespread droughts throughout North America may come as a result of declining summer precipitation in the latter half of the 21st century, and escalating climate variability. Additionally, as populations in South Carolina continue to grow, freshwater storage resources in the state may experience more strain.

5.12.5 Probability of Future Occurrences

Based on historical occurrence information, it is assumed that all of Charleston County has a probability level of *likely* (between 10 and 100 percent annual probability) for future drought events. This hazard may vary slightly by location but each area has an equal probability of experiencing a drought. However, historical information also indicates that there is a much lower probability for extreme, long-lasting drought conditions.

Water Shortage

As the climate changes, rising temperatures and more frequent droughts are likely to stress water availability through evaporation or drought conditions. Since drought conditions (as covered in Section 5.13) cover a large area and are not confined to any specific geographic boundary, the chance that Charleston will experience an increasing number of drought periods any given year. Due to global warming trends, the growing population of the Charleston area, and more frequent dry periods, the future probability of water shortage events are possible (between 1 and 10 percent annual probability).

5.13 SEVERE STORM

For the purposes of maintaining consistency with the Charleston Regional Hazard Mitigation Plan, this section will assess thunderstorms, lightning, and hail.

5.13.1 Background and Description

Thunderstorms

Thunderstorms, though affecting small areas, can be extremely dangerous and cause significant property damage. For a thunderstorm to form, three conditions must be met: sufficient moisture to create clouds and rain, unstable air that allows for rapid rising (often called the storm's "engine"), and a lifting mechanism such as cold or warm fronts, sea breezes, mountains, or solar heating. When these conditions align, air masses of different temperatures converge, leading to thunderstorm formation. These storms can appear as single events, lines, or clusters, and may move quickly through an area or linger for hours.

The National Weather Service reports over 100,000 thunderstorms annually, with about 10 percent classified as "severe." A severe thunderstorm is defined by the presence of at least one of the following: hail measuring three-quarters of an inch or more, a tornado, or winds of at least 58 miles per hour. Thunderstorms can produce destructive straight-line winds, especially when a pressure system from the

⁴⁸ <https://www.dnr.sc.gov/pubs/CCINatResReport.pdf>

Northeast combines with strong pressure from the Ohio Valley, creating a tight pressure gradient that enhances wind speeds, often reaching 30 to 60 miles per hour in winter. Additionally, thunderstorms can generate downbursts—powerful wind bursts exceeding 125 miles per hour caused by rain-cooled air descending rapidly. These downbursts are classified as microbursts (less than 2.5 miles wide and lasting under 5 minutes) or macrobursts (greater than 2.5 miles wide and lasting over 5 minutes).

Lightning

Lightning is a discharge of electrical energy caused by the buildup of positive and negative charges within a thunderstorm. When this charge accumulation becomes sufficiently strong, it creates a visible bolt, typically occurring within or between clouds and occasionally reaching the ground. A lightning bolt can reach temperatures of nearly 50,000 degrees Fahrenheit, rapidly heating the surrounding air, which then cools quickly, producing the accompanying thunder.

While commonly associated with severe thunderstorms, lightning can strike even in clear skies, up to 10 miles away from rainfall. These strikes are localized and can hit buildings, electrical transformers, or people. According to FEMA, lightning injures about 300 people and kills 80 annually in the United States. Direct strikes can cause significant damage, igniting fires that threaten property and even leading to widespread wildfires.

Figure 5.27 shows a lightning flash density map for the years 2010-2019 based upon data provided by Vaisala's U.S. National Lightning Detection Network (NLDN®).

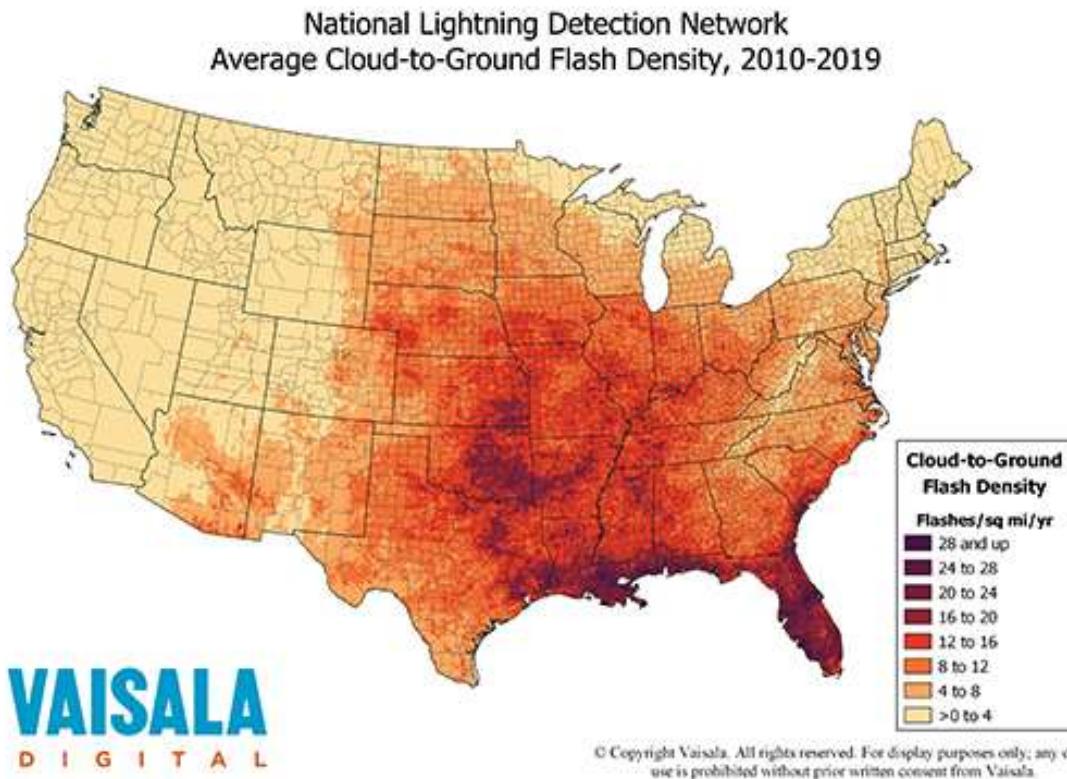


Figure 5.27: National Lightning Detection Network Average Cloud-to-Ground Flash Density, 2010 – 2019

Source: Vaisala U.S. National Lightning Detection Network

Hail

Hailstorms are a potentially damaging outgrowth of severe thunderstorms (thunderstorms are discussed separately in Section 5.8). Early in the developmental stages of a hailstorm, ice crystals form within a low-pressure front due to the rapid rising of warm air into the upper atmosphere and the subsequent cooling of the air mass. Frozen droplets gradually accumulate on the ice crystals until they develop to a sufficient weight and fall as precipitation. Hail typically takes the form of spheres or irregularly shaped masses greater than 0.75 inches in diameter. The size of hailstones is a direct function of the size and severity of the storm. High velocity updraft winds are required to keep hail in suspension in thunderclouds. The strength of the updraft is a function of the intensity of heating at the Earth's surface. Higher temperature gradients relative to elevation above the surface result in increased suspension time and hailstone size.

Table 5.21 shows the TORRO Hailstorm Intensity Scale which is a way of measuring hail severity.

Table 5.21: TORRO Hailstorm Intensity Scale

	Intensity Category	Typical Hail Diameter (mm)*	Probable Kinetic Energy, J-m ²	mm to inch conversion (inches)	Typical Damage Impacts
H0	Hard Hail	5	0-20	0 – 0.2	No damage
H1	Potentially Damaging	5-15	>20	0.2 – 0.6	Slight general damage to plants, crops
H2	Significant	10-20	>100	0.4 – 0.8	Significant damage to fruit, crops, vegetation
H3	Severe	20-30	>300	0.8 – 1.2	Severe damage to crops, damage to glass and plastic structures, paint and wood scored
H4	Severe	25-40	>500	1.0 – 1.6	Widespread glass damage, vehicle bodywork damage
H5	Destructive	30-50	>800	1.2 – 2.0	Wholesale destruction of glass, damage to tiled roofs, significant risk of injuries
H6	Destructive	40-60		1.6 – 2.4	Bodywork of grounded aircraft dented; brick walls pitted
H7	Destructive	50-75		2.0 – 3.0	Severe roof damage, risk of serious injuries
H8	Destructive	60-90		1.6 – 3.5	(Severest recorded in the British Isles) Severe damage to aircraft bodywork
H9	Super Hailstorms	75-100		3.0 – 3.9	Extensive structural damage. Risk of severe or even fatal injuries to persons caught in the open
H10	Super Hailstorms	>100			Extensive structural damage. Risk of severe or even fatal injuries to persons caught in the open

Source: <http://www.torro.org.uk/site/hscale.php>

5.13.2 Location and Spatial Extent

Thunderstorms

A thunderstorm event is an atmospheric hazard, and thus has no geographic boundaries. It is typically a widespread event that can occur in all regions of the United States. However, thunderstorms are most common in the central and southern states because atmospheric conditions in those regions are favorable for generating these powerful storms. Also, the City of Charleston typically experiences several straight-line wind events each year. These wind events can and have caused extensive damage. It is assumed that

Charleston County and the City of Charleston has uniform exposure to a thunderstorm event and/or straight-line winds and the spatial extent of an impact would be potentially large.

Lightning

It is assumed that all of Charleston is uniformly exposed to lightning. Lightning occurs randomly; therefore, it is impossible to predict where and with what frequency it will strike.

Hail

Hailstorms frequently accompany thunderstorms, so their locations and spatial extents coincide. It is assumed that Charleston is uniformly exposed to severe thunderstorms; therefore, all areas of the city are equally exposed to hail which may be produced by such storms.

5.13.3 Historical Occurrences

Thunderstorms

Severe storm resulted in one disaster declarations in Charleston County in 2015. According to NCEI, there have been 78 reported thunderstorm events since 1993 in the City of Charleston.⁴⁹ These events had over \$174 thousand in property damages, three (3) injuries, and three (3) fatalities associated with them. **Table 5.22** below summarizes this information.

Table 5.22: Thunderstorm Wind Events for the City of Charleston (1995-2022)

Date	Description	Property Damage	Deaths	Injuries
10/30/1993	Thunderstorm winds with gusts to 57 knots were reported at the Custom House Pier.	\$0	0	0
6/26/1994	Severe thunderstorms scattered across coastal South Carolina caused considerable wind damage to trees and power lines, and disrupted traffic in some areas. A funnel cloud was sighted four miles north of Beaufort Marine Air Base.	\$0	0	0
6/27/1995	Power outages to over 2,500 homes and very heavy rain.	\$9,815	0	0
7/7/1995	60 mph gust at Custom House (downtown).	\$0	0	0
10/5/1995	Seventy-six mph gust reported by Harbor Pilot at Columbus St. terminal.	\$0	0	0
5/9/1997	Trees and powerlines down several locations.	\$0	0	0
6/19/1998		\$0	0	0
8/8/1999	Large limbs down.	\$0	0	0
8/9/1999	Power lines down and large branches down on car.	\$0	0	0
8/11/2000	A container crane at a loading dock was blown into two other cranes causing several large shipping containers to be thrown into the water.	\$34,747	0	0
2/22/2003	Several trees were down.	\$0	0	0

⁴⁹ These thunderstorm events are only inclusive of those reported by the National Centers for Environmental Information. It is likely that additional thunderstorm events have occurred in the City of Charleston. As additional local data becomes available, this hazard profile will be amended.

SECTION 5: HAZARD PROFILES

Date	Description	Property Damage	Deaths	Injuries
6/23/2004	Several large trees were blown down in the West Ashley section of Charleston.	\$0	0	0
7/10/2004	Large limbs were knocked down in the West Ashley area of Charleston. Trees were also knocked down near the intersection of Ashley Hall Rd. and Gardenia, west of downtown Charleston.	\$0	0	0
7/10/2004	Powerlines down near Church Creek in West Ashley.	\$0	0	0
7/10/2004	Trees and power lines down in several locations downtown and on the peninsula.	\$0	0	0
7/13/2004	A non-severe wind gust knocked down a rotten tree which landed on a car traveling along Highway 17 in Awendaw. One passenger in the car was killed.	\$0	1	0
3/8/2005	Thunderstorm winds knocked down trees and large street signs in the West Ashley section of Charleston.	\$0	0	0
1/30/2006	Thunderstorm winds knocked down trees on Chadwick Drive and Windermere Blvd. in the West Ashley section of Charleston. Two trees were also blown down on Sullivan's Island.	\$4,452	0	0
4/26/2006	Trees down near intersection of Sam Rittenburg and Ashley Road.	\$1,484	0	0
4/26/2006	Trees and power lines down along Ashley River Road.	\$8,904	0	0
7/29/2006	Trees down along Highway 61 near Drayton Hall.	\$2,968	0	0
2/25/2007	There were numerous trees and powerlines reported down across the county.	\$14,429	0	0
6/2/2007	Trees and power lines reported down with strong winds.	\$2,886	0	0
1/30/2008	Numerous power lines were reported down along Highway 17 in West Ashley, South Carolina.	\$6,948	0	0
4/15/2008	An oak tree that was 3 feet in diameter was knocked down by the wind, landing on a truck traveling on County Line Road off Highway 165. The driver and a passenger in the vehicle were killed.	\$6,948	2	2
8/2/2008	Law enforcement reported trees down on Seewee Road.	\$2,084	0	0
1/1/2011	A National Weather Service employee reported a large tree limb and a small tree blown down along Long Point Road in Mt. Pleasant, South Carolina.	\$665	0	0
12/7/2011	South Carolina highway patrol reports a tree down on Santee Road.	\$665	0	0
12/27/2011	A large storefront sign at the Best Buy in North Charleston fell off the building due to high winds.	\$2,660	0	0
12/20/2012	A NWS employee reported large branches down along Bees Ferry Road.	\$1,303	0	0
12/26/2012	The Charleston County Warning Point reported a tree down near the intersection of River Road and Fort Trenholm Road.	\$1,303	0	0

SECTION 5: HAZARD PROFILES

Date	Description	Property Damage	Deaths	Injuries
12/26/2012	Broadcast media reported a power line down near the intersection of Johnnie Dodds Boulevard and Anna Knapp Boulevard.	\$1,955	0	0
3/25/2013	Law enforcement reported trees and power lines down near the intersection of Wentworth Street and Coming Street.	\$2,890	0	0
5/2/2013	One tree down near the intersection of 7th Avenue and Mathis Ferry Road.	\$2,568	0	0
11/12/2013	South Carolina Highway Patrol reported a tree in the roadway on River Road near Mullet Hall Road.	\$642	0	0
4/7/2014	South Carolina Highway Patrol reported a tree down and in the roadway in the eastbound lane of I-526, near mile marker 19.	\$1,264	0	0
8/2/2014	One tree was reported down in the Shemwood II subdivision.	\$1,264	0	0
12/24/2014	The Department of Highways reported a tree down near the intersection of Remount Road and North Rhett Avenue.	\$0	0	0
1/23/2015	One tree blown down across River Road.	\$631	0	0
1/24/2015	One tree down on Maybank Highway near the intersection of Cherry Point Road. Reported by South Carolina Highway Patrol and confirmed by Charleston County 911 call center.	\$1,893	0	0
2/2/2015	The media relayed a report of a tree down on Wando Park Boulevard.	\$3,787	0	0
5/7/2015	One tree reported down in the Dunes West neighborhood in Mount Pleasant.	\$631	0	0
5/20/2015	One large tree branch blown down on Bull Street between Rutledge Avenue and Ashley Avenue.	\$0	0	0
2/24/2016	The South Carolina Highway Patrol reported a tree down on Interstate 26 eastbound near mile marker 205.	\$3,116	0	0
12/12/2017	A tree was reported down in the Hobcown Creek area due to gusty winds. Numerous power outages were also reported around the area.	\$1,221	0	0
2/4/2018	Law enforcement reported a flagpole on the Kress building in Charleston, SC blown over and, on a vehicle, causing 1 minor injury to the driver.	\$1,191	0	1
4/15/2018	A large tree fell onto two cars on Garrett Avenue.	\$11,914	0	0
4/23/2018	The media reported roof damage to a mobile home in Ladson.	\$5,957	0	0
12/21/2018	The Mount Pleasant Police Department reported a shipping container unit on a truck blown over on the eastbound lanes of the James B Edwards Bridge.	\$11,914	0	0
4/19/2019	A report via social media indicated siding damage and lawn chairs rolling around.	\$8,191	0	0
2/6/2020	The public reported a glass door to a store blown in and torn off hinges.	\$2,312	0	0
4/13/2020	A picture via social media indicated a tree down in the parking lot.	\$1,156	0	0
11/12/2020	Ben Sawyer Boulevard at Center Street was closed in both directions due to downed power lines. The Ben Sawyer Bridge	\$5,780	0	0

SECTION 5: HAZARD PROFILES

Date	Description	Property Damage	Deaths	Injuries
	to and from Sullivan's Island was closed. The period of the road closure was from 7:30 pm until 10:00 pm.			
11/30/2020	A National Weather Service employee reported a large oak tree down on Grande Oak Boulevard near the intersection with Bees Ferry Road.	\$578	0	0
8/22/2021	Waterspout. Location: 32.850, -79.950. No discernable damage. WCBD news shared a video from the viewer of a waterspout in Copahue Sound. The viewer recorded the video from a home on Porchers Bluff Road looking to the southeast toward Dewees Island. The video showed the waterspout in contact with the surface of the water with a clearly defined spray ring.	\$0	0	0
3/31/2022	A large oak tree was reported down on Live Oak Drive in the Old Village area of Mount Pleasant due to gusty winds. A peak wind gust of 54 mph occurred at the Charleston International Airport (KCHS) at 10:40 am EST.	\$1,022	0	0
4/5/2022	The Shutes Folly Weatherflow sensor recorded a peak wind gust of 67 mph at 659 PM.	\$0	0	0
4/5/2022	The public reported several aircraft on the USS Yorktown moved by high winds and three trees down at the Cold War Memorial.	\$0	0	0
7/1/2022	A picture received via social media showed a downed tree within the Woodward Pointe neighborhood near Harbor View Road.	\$0	0	0
7/1/2022	Local broadcast media passed along a report of a large tree down on Legareville Road.	\$0	0	0
7/10/2022	WATERSPOUT. Location: 32.8176, -79.7645. A video of a waterspout was relayed via social media. The waterspout remained over water near Goat Island and Isle of Palms.	\$0	0	0
4/30/2023	An off-duty NWS employee reported a large tree down at the intersection of Riverland Drive and Maybank Highway.	\$0	0	0
5/9/2023	The Weatherflow site at Shutes Folly measured at 54.5 knot (63 mph) wind gust due to a thunderstorm.	\$0	0	0
7/23/2023	The Weatherflow site located at Shutes Folly in Charleston Harbor measured a peak wind gust of 53 knots.	\$0	0	0

Source: NCEI

Lightning

According to NCEI, there have been a total of 1 recorded lightning events in the City of Charleston since 2019.⁵⁰ These events resulted in only \$1,170 (2023 dollars) in property damages. Detailed information on historical lightning events can be found in

⁵⁰ These lightning events are only inclusive of those reported by the National Centers for Environmental

Table 5.23 below.

Information (NCEI). It is certain that additional lightning events have occurred in the City of Charleston. As additional local data becomes available, this hazard profile will be amended.

SECTION 5: HAZARD PROFILES

Table 5.23: Lightning Events for the City of Charleston (2019-2023)

Date	Description	Property Damage (2023)	Deaths	Injuries
7/5/2019	A social media post reported that lightning struck St. Matthew's Lutheran Church in Downtown Charleston near the corner of King Street and Vanderhorst Street.	\$1,170	0	0

Source: NCEI

Hail

According to NCEI, there have been 9 recorded hailstorm events in the City of Charleston since 1999.⁵¹ Table 5.24 below summarizes these hail events for the City of Charleston. Hail ranged in diameter from 0.75 inches to 1.75 inches. It should be noted that hail is notorious for causing substantial damage to cars, roofs, and other areas of the built environment that may not be reported to the National Centers for Environmental Information. Additionally, a single storm event may have affected multiple areas of the city and these damages would have gone unreported. Therefore, it is likely that damages are greater than the reported value.

Table 5.24: Hail Events for City of Charleston (1995 - 2022)

Date	Description	Property Damage (2023)	Deaths	Injuries
6/27/1995	Power outages to over 2,500 homes and very heavy rain.	\$0	0	0
7/7/1995	N/A	\$0	0	0
5/3/1997	Golf ball sized hail covered the ground at the 18th green at Legends Oak golf course.	\$0	0	0
5/9/1997	Nickel sized hail broke a weather service employee's automobile window.	\$0	0	0
2/28/1998	N/A	\$0	0	0
7/10/2004	Ping pong ball size hail reported at Charlestowne Landing County Park. Large trees also down in park.	\$0	0	0
4/8/2006	Quarter size hail occurred in the West Ashley section of Charleston.	\$0	0	0
4/26/2006	Hail on Orangegrove Road.	\$0	0	0
5/14/2006	Reported on Cedarhurst Ave in West Ashley.	\$0	0	0
8/4/2006	Nickel hail near Trident College.	\$0	0	0
6/13/2007	N/A	\$0	0	0
3/15/2008	Nickel sized hail was reported by a trained weather spotter in Charleston, South Carolina.	\$0	0	0
5/20/2008	A trained weather spotter reported quarter size hail near MUSC in downtown Charleston, South Carolina. Wind gusts were also estimated at 45 mph.	\$0	0	0

⁵¹ These hail events are only inclusive of those reported by the National Centers for Environmental Information (NCEI). It is likely that additional hail events have affected the City of Charleston. As additional local data becomes available, this hazard profile will be amended.

3/20/2018	Penny sized hail was reported on King Street between George and Calhoun Streets.	\$0	0	0
4/7/2022	Broadcast media relayed a video via social media of pea to nickel size hail along Church Street in downtown Charleston.	\$0	0	0
5/17/2023	Hail ranging from the size of nickels up to quarters was reported in downtown Charleston near Meeting Street and Cumberland Street. The hail lasted for about 10 minutes.	\$0	0	0

Source: NCEI

5.13.4 Changing Future Conditions

Changing weather patterns related to climate change may result in more frequent and more severe storms (thunderstorms, lightning, and hail) for the City of Charleston. According to the National Aeronautics and Space Administration (NASA), severe storms events in the future are more likely to become more frequent throughout the southeast as a result of weather extremes⁵².

5.13.5 Probability of Future Occurrences

Thunderstorms

Because of the previous number of thunderstorm events in the City of Charleston, it is certain that thunderstorm wind events will occur in the future. The future probability occurrence of thunderstorm events for the City of Charleston is *highly likely* (100 percent annual probability).

Lightning

While there have not been a significant number of lightning events for the City of Charleston via NCEI data, it is a regular occurrence accompanied by thunderstorms. In fact, lightning events will assuredly occur with most thunderstorms, though not all events will cause damage. According to Vaisala's U.S. National Lightning Detection Network (NLDN), the City of Charleston is located in an area of the country that experienced an average of 12 to 20 lightning flashes per square kilometer per year between 1997 and 2010. Therefore, the probability of future events is *highly likely* (100 percent annual probability). It can be expected that future lightning events will continue to threaten life and cause minor property damages throughout the City.

Hail

Based on historical occurrence information, it is assumed that the probability of future hail occurrences is *highly likely* (100 percent annual probability). Since hail is an atmospheric hazard (coinciding with thunderstorms), it is assumed that the City of Charleston has equal exposure to this hazard. It can be expected that future hail events will continue to cause minor damage to property and vehicles throughout the city.

5.14 SEVERE WINTER WEATHER

5.14.1 Background and Description

Severe winter weather can vary from moderate snowfall over a few hours to blizzard conditions with intense, wind-driven snow lasting several days. These storms may bring snow, sleet, freezing rain, or a

⁵² <https://climate.nasa.gov/news/897/severe-thunderstorms-and-climate-change/#:~:text=One%20study%20led%20by%20Robert%20Trapp%20of%20Purdue,occur%20in%20the%20southern%20and%20eastern%20United%20States.>

combination of these forms of precipitation, affecting either large regions or localized areas. All winter weather events pose significant dangers, especially large snowfalls that reduce visibility and create treacherous driving conditions. The National Weather Service defines a heavy snow event as an accumulation of 4 or more inches in 12 hours or less. Ice storms, resulting from cold air damming (CAD) against the Appalachian Mountains, can produce hazardous conditions through freezing rain and sleet. Freezing rain creates a slick layer of ice on surfaces, while sleet consists of partially frozen raindrops that, although they bounce upon impact, can still accumulate and pose risks like snow.

In South Carolina, winter storms typically form in the Gulf of Mexico or off the southeast Atlantic Coast. These storms have historically caused issues for the City of Charleston, particularly due to the numerous bridges in the area. The City's Hazard Mitigation Planning Team has noted that some bridges can only be treated with brine, not salt, making them vulnerable to ice buildup and increasing the risk of dangerous conditions for motorists.

5.14.2 Location and Spatial Extent

The entire state of South Carolina has a likelihood of experiencing severe winter weather. The threat varies by location and by type of storm. Coastal areas typically face their greatest threat from Nor'easters and other severe winter coastal storms. These storms can contain strong waves and result in extensive beach erosion and flooding. Freezing rain and ice storms typically occur once every several years at coastal locations and severe snowstorms have been recorded occasionally in coastal areas.

5.14.3 Historical Occurrences

The extent of winter storms can be measured by the amount of snowfall received (in inches). The greatest one-day snowfall recorded in the City of Charleston, SC was on December 23, 1989, which resulted in approximately 6.0 inches of snowfall.

According to the National Centers for Environmental Information, there have been a total of 7 severe winter storm/winter weather recorded events since 2000 (

Table 5.25). These events reported over \$96 thousand in property damage. The results will be updated in the future should better data become available.

Table 5.25: Winter Weather Events for Charleston County (2000-2023)

Date	Description	Deaths	Injuries	Property Damage (2023)
1/24/2000	Snowfall of 1 to around 2 inches fell over much of south coastal South Carolina with a mixture of small amounts of sleet and freezing rain. Numerous accidents were caused on roadways as this was the first measurable snowfall in much of the area since 1989.	0	0	\$0
1/26/2000	For the first time since records have been kept, measurable snowfall occurred on consecutive days from independent events. Snowfall measured around two (2) inches over much of the area as a shortwave moved across the area overnight. The shortwave intensified over the east central counties of the state as no other places in adjoining counties reported any snow at the surface.	0	0	\$0

SECTION 5: HAZARD PROFILES

Date	Description	Deaths	Injuries	Property Damage (2023)
2/12/2010	A National Weather Service Employee reported heavy snow falling with 1.8 inches of accumulation. South Carolina Electric and Gas company reported that downed trees and power lines resulted in over 17,400 customers without power in Charleston County. A trained weather spotter measured 2.0 inches of snow accumulation at the intersection of Folly Road and Maybank Highway, 3 miles west-southwest of Charleston, South Carolina.	0	0	\$96,039
1/3/2018	Storm total snowfall amounts generally ranged from 2 to 6 inches across Charleston County. The precipitation started as rain then changed to freezing rain in the morning, before a prolonged period of snow began. One report of a quarter of an inch of ice accumulation was received near the Shadowmoss subdivision. Elsewhere, ice accumulations ranged from trace amounts up to 2 tenths of an inch around James Island, Charleston, and Mount Pleasant. The lowest snow totals occurred in the eastern part of the county near Awendaw and McClellanville where 2 inches was measured. Other notable totals include 4 to 5 inches across James Island, Johns Island, and West Ashley. Around Mount Pleasant, amounts were also 4 to 5 inches. The maximum totals for the county occurred around Ladson and Goose Creek where 6.5 inches was measured. A 36-year-old female died a few days following the event when a vehicle slid off of an icy road and struck the pedestrian on the sidewalk. The incident occurred on Ladson Road near the intersection with Jamison Road in North Charleston.	0	0	\$0
12/29/2017	The media, NWS employees and the public reported a thin glaze of ice covering cars, fences, road signs, elevated structures and various vegetation such as trees and plants above the ground in Charleston, North Charleston, Mt Pleasant, James Island, Johns Island, West Ashley, Redtop, Rantowles, Meggett and Cainhoy, SC. Several areas also experienced a thin layer of ice on grass and roadways, especially on elevated bridges in Charleston, SC and Mt Pleasant, SC. The greatest storm total ice accumulation in Charleston County was 0.03 inches, which occurred at the National Weather Service office in North Charleston, SC. Elsewhere, storm total ice accumulation ranged from a trace to a few hundredths of an inch. The greatest impact associated with the ice accumulation was the closing of major bridges and overpasses in the Charleston, SC Metropolitan area including: Arthur Ravenel Bridge, Isle of Palms Connector, Ben Sawyer Bridge, Northbridge and the I-26/Cosgrove Ave overpass.	0	0	\$0
1/21/2022	Numerous reports of light freezing rain all across Charleston County were received. The highest ice accumulations received included 0.12 near Mount Pleasant, 0.04 in the Shadowmoss subdivision in West Ashley, and 0.08 at the National Weather Service office in North Charleston. Several roads had to be closed due to icy conditions including the off ramp from Interstate 526 to Hungry Neck Boulevard, Rivers Avenue and Interstate 26, exit 218 off of Interstate 26, and the Highway 52 connector off of	0	0	\$0

Date	Description	Deaths	Injuries	Property Damage (2023)
	Interstate 26. Also, the Ravenel Bridge between Mount Pleasant and Downtown Charleston was closed in the afternoon due to falling ice from the suspension cables. While most of the wintry precipitation reports were of freezing rain, a few locations did report snow and sleet without any accumulation.			
1/29/2022	Numerous reports of light snow, flurries, or a mix of rain and snow were received across Charleston County, even down to the beaches. No accumulation was reported.	0	0	\$0

5.14.4 Changing Future Conditions

Table 5.26 below displays the average warming change of cities in South Carolina.

Table 5.26: Winter Warming Trends for South Carolina (1970-2022)*

Location	Winter Warming (F change since 1970)	Spring Warming (F change since 1970)	Summer Warming (F change since 1970)	Fall Warming (F change since 1970)	Winter average Temperature (F)	Temperature Anomaly (F difference from normal)
Charleston, SC	3.83	2.38	1.91	1.46	54.16	2.54
Columbia, SC	3.35	3.28	3.28	2.09	50.42	2.55
Greenville, SC	3.90	2.86	2.71	2.42	46.59	2.11

Source: NOAA; Climate Central

*Warming trends were calculated by fitting a line to the data from 1970 – 2022. The change is the slope of the line multiplied by the number of years. This means that the number is how much the average conditions have changed over the period.

The increased atmospheric moisture of warmer conditions year-round, helps to intensify the water cycle – air holds about 4% more water vapor for each additional degree Fahrenheit increase in temperature – thereby increasing the likelihood of warmer and wetter conditions in winter.⁵³

5.14.5 Probability of Future Occurrences

Historical data shows that winter storm in the City of Charleston generally do not cause major damages to public facilities or private property. Additionally, they do not occur very frequently although their impact is generally of a short duration. Therefore, there is a *likely* (between 10 and 100 percent annual probability) for future winter storm occurrences.

5.15 SHORELINE EROSION

5.15.1 Background and Description

Shoreline erosion refers to the loss or displacement of land along coastlines due to the combined effects of ocean waves and human activity. It occurs when wind, waves, longshore currents, tides, and surface water runoff move sand and sediment away from the shoreline. This material is not lost from the overall system unless permanently removed by human actions such as dredging. In coastal South Carolina, shoreline erosion is a significant concern, exacerbated by rapid population growth that intensifies

⁵³ <https://toolkit.climate.gov/regions/southeast>

pressure on natural coastal environments. Over half of the U.S. population lives in coastal counties, which represent only 17% of the nation's land area, and many of these regions are actively eroding or vulnerable to rising sea levels.

Human activities can further aggravate shoreline erosion, particularly through poor land use practices. Structures that fail to account for erosion cycles or hydrodynamics may accelerate erosion or shift sediment to nearby areas. While some coastal control structures aim to prevent erosion, if not designed properly, they can exacerbate erosion in adjacent locations. The challenges posed by shoreline erosion include the loss of valuable real estate, recreational spaces, and essential natural flood protection. To address these issues, the U.S. Geological Survey (USGS) conducts regional studies and provides crucial information for the protection and management of coastal resources through its Coastal Change Hazards Portal: [USGS Coastal Change Hazards Portal](#).

5.15.2 Location and Spatial Extent

Portions of the southeastern coast (North Carolina, South Carolina, Georgia, and Florida) have experienced some extent of shoreline erosion over the past century. Figure 5: below shows long-term shoreline change rates for the Charleston region.

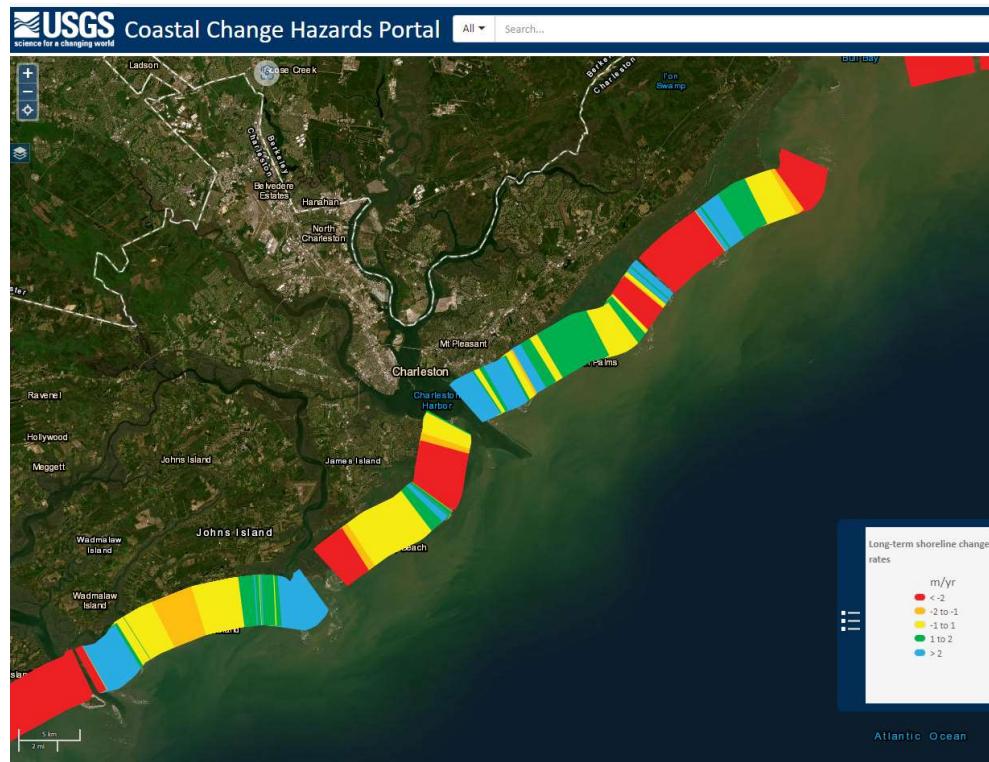


Figure 5:28 USGS Long-Term Shoreline Change Rates

5.15.3 Historical Occurrences

Shoreline erosion is a significant concern for the City of Charleston, as data from the USGS indicates some of the highest rates of land loss in the Southeast Atlantic region. Along the surrounding barrier islands, such as Morris Island, the long-term average erosion rate is -13.0 ± 18.8 m/yr. Although short-term beach

nourishment efforts have reduced the percentage of eroding shoreline to 39%, the average rate of change has slightly increased to -0.6 m/yr.⁵⁴ The South Carolina Department of Health and Environmental Control (SCDHEC) highlights the alarming erosion rate at Morris Island, noting that in 1850, the shoreline was about 300 feet seaward of the lighthouse, but by 1935, it had eroded to the edge of the shore. As of 1981, the shoreline had retreated approximately 1,600 feet inland from the lighthouse, which now stands partially in the ocean.⁵⁵

5.15.4 Changing Future Conditions

Data from the Fourth National Climate Assessment shows that the sea level in Charleston Harbor has risen by 10 inches since 1950, with an acceleration anticipated. From 2020 to 2050, Charleston Harbor is projected to experience a sea-level rise of 1.4 feet, according to recent data from NOAA. This increase in sea level could contribute to increased shoreline erosion and/or loss of shoreline.

5.15.5 Probability of Future Occurrences

Due to the projected sea level rise and threat of saltwater inundation into the salt marshes that surround the City of Charleston, future shoreline erosion will remain a threat for the foreseeable future. Therefore, the annual probability is *likely* (between 10 and 100 percent annual probability) for shoreline erosion

5.16 EXTREME HEAT

5.16.1 Background and Description

Extreme heat, often referred to as a "heat wave," poses significant health risks, even though it may not directly threaten property. The National Weather Service defines a heat wave in the U.S. as an event lasting at least three days with temperatures reaching 90°F or higher or exceeding the normal temperature by 10°F for the same duration. Heat waves can occur with high humidity or in dry conditions, leading to an average of 1,500 deaths each summer in the United States. According to the National Oceanic and Atmospheric Administration, heat is the leading weather-related killer, followed by extreme cold. To raise public awareness of heat dangers, the National Weather Service developed the Heat Index, which combines air temperature and humidity to indicate the apparent temperature. Certain populations, such as the elderly and young children, are particularly vulnerable to heat-related health issues.

⁵⁴ https://pubs.usgs.gov/of/2005/1401/ofr-2005-1401_print.pdf

⁵⁵ https://scdhec.gov/sites/default/files/docs/HomeAndEnvironment/Docs/coastal_environment.pdf

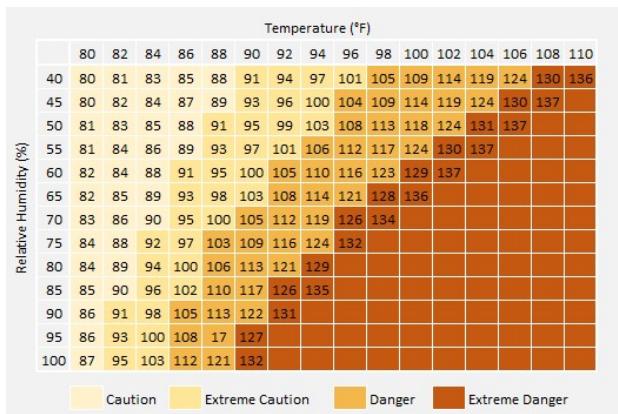


Figure 5.29: NWS Heat Index Chart

Source: NOAA, National Weather Service

The Heat Index Chart, shown in **Figure 5.**, uses air temperature and humidity to determine the heat index or apparent temperature. **Table 5.27** shows the dangers associated with different heat index temperatures.

Table 5.27: Heat Disorders Associates with Heat Index Temperature

Heat Index Temperature (Fahrenheit)	Description of Risks
80°- 90°	Fatigue possible with prolonged exposure and/or physical activity
90°- 105°	Sunstroke, heat cramps, and heat exhaustion possible with prolonged exposure and/or physical activity
105°- 130°	Sunstroke, heat cramps, and heat exhaustion likely, and heatstroke possible with prolonged exposure and/or physical activity
130° or higher	Heatstroke or sunstroke is highly likely with continued exposure

Source: National Weather Service, NOAA

NOAA has established a Heat Health Watch/Warning System to inform the public about heat-related dangers. A Heat Health Watch is issued when conditions are favorable for excessive heat within the next 12 to 48 hours, while a Heat Warning is issued when excessive heat is expected within 36 hours or is already occurring. Urban areas are particularly vulnerable to heat risks due to stagnant conditions that trap pollutants and contribute to unhealthy air quality. The “urban heat island effect” further exacerbates the situation by causing significantly higher nighttime temperatures as materials like asphalt and concrete retain and gradually release heat.

The City is developing its first Heat Plan, having completed NOAA’s HeatWatch program in 2021 and participated in the Pilot Communities program in 2022. These initiatives have helped identify areas most affected by heat islands and allowed for testing interventions like cool pavement. To address both flooding

and heat impacts, the City also maintains a limited Street Tree Canopy Inventory and employs tools to guide residents in enhancing their tree canopy.

5.16.2 Location and Spatial Extent

Extreme heat typically impacts a large area and is not confined to any geographic or political boundaries. The entire City of Charleston is susceptible to extreme heat conditions.

5.16.3 Historical Occurrences

Data from the National Centers for Environmental Information was used to determine historical extreme heat events for Charleston County. These results are reported in **Table 5.28** below:

Table 5.28: Excessive Heat Occurrences (2007-2021)

Date	Description	Deaths	Injuries	Property Damage (2023)
8/10/2007	Heat indices reached 120 degrees at Charleston International Airport. Heat indices across much of southern South Carolina topped out between 115 and 120 degrees as well.	0	0	\$0
7/22/2010	A heat index value of 116 degrees was observed at the Charleston International Airport in North Charleston, South Carolina.	0	0	\$0
7/25/2010	The heat index value reached 116 degrees at the mesonet station, in West Ashley, South Carolina.	0	0	\$0
7/26/2010	The heat index value reached 118 degrees at the mesonet station located on the College of Charleston campus in downtown Charleston, South Carolina.	0	0	\$0
7/29/2010	The mesonet station located at the College of Charleston in downtown Charleston, South Carolina measured a heat index of 117 degrees.	0	0	\$0
7/30/2010	The mesonet station located at the College of Charleston in downtown Charleston, South Carolina measured a heat index value of 117 degrees.	0	0	\$0
7/31/2011	A heat index of 115 degrees was measured by the AWOS at the East Cooper Regional Airport, 12 miles northeast of Charleston, South Carolina.	0	0	\$0
8/3/2011	A heat index of 116 F was observed at East Cooper Airport.	0	0	\$0
8/4/2011	A heat index of 118 F was measured at the College of Charleston Observatory in downtown Charleston.	0	0	\$0
7/30/2021	Several observations sites around Charleston County reported heat index values of 115 degrees or greater for several hours in the afternoon. This includes the Wambaw Remote Automatic Weather Station (RAWS) site located near Awendaw. The maximum heat index observed was 118 degrees by a weather station at the Forest Park playground in the West Ashley area, which is operated and maintained by the City of Charleston.	0	0	\$0

Source: NCEI

In addition, data from the South Carolina State Climatology Office was reviewed to obtain historical temperature records for the City of Charleston. Temperature information has been reported since 1952. The recorded maximum temperature for Charleston was 105°F which occurred on August 1, 1999.

5.16.4 Changing Future Conditions

According to data from the NOAA National Centers for Environmental Information, South Carolina temperatures have risen more than 1°F since the beginning of the 20th century. The state warmed during the early part of the 20th century and then cooled substantially during the middle of the century. The number of extremely hot days has been generally near average since 1980, following very high numbers in the early 1930s and early 1950s and a period of below average numbers from the late 1950s to the late 1970s; however, such days have been rare since 2014. Across the state, very warm nights have generally been above average since 1980, with the highest 5-year average occurring during the 2010 – 2014 period⁵⁶. **Figure 5.** below shows the observed temperatures as well as the projected temperatures changes for South Carolina.

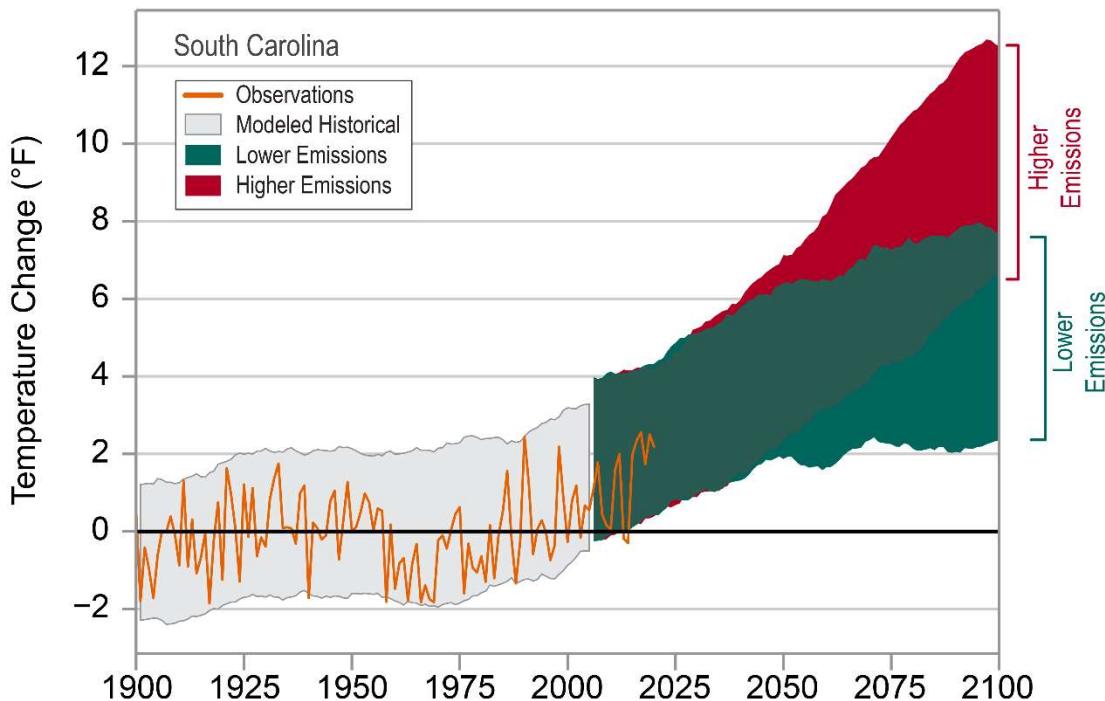


Figure 5.30: Observed and Projected Temperature Change (1900-2100)

Source: NOAA National Centers for Environmental Information

Annual average temperatures are expected to most likely exceed historical record levels by the middle of this century. Increases in the number of extremely hot days and decreases in the number of extremely cold days are projected to accompany the overall warming.

⁵⁶ <https://statesummaries.ncics.org/chapter/sc/>

5.16.5 Probability of Future Occurrences

Based on historical evidence, the probability level of future occurrence of extreme heat is *likely* (annual probability between 10 and 100 percent). Given the coastal location of the City of Charleston and the projected increase in extreme heat events for the State of South Carolina, the city is more likely to be affected by extreme heat events in the future.

5.17 SINKHOLES

5.17.1 Background and Description

Sinkholes are hazards that can be naturally occurring or human-induced. According to the United States Geological Survey, a sinkhole is an area of ground that has no natural external surface drainage – when it rains, all of the water stays inside the sinkhole and typically drains into the subsurface. Sinkholes can vary from a few feet to hundreds of acres and from less than 1 to more than 100 feet deep. Some are shaped like shallow bowls or saucers whereas others have vertical walls⁵⁷.

Most naturally occurring 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 rock dissolves, spaces and caverns develop underground. If there is not enough support for the land above the spaces then a sudden collapse of the land surface can occur. These collapses can be small, as **Figure 5.** below shows.



Figure 5.31: Sinkhole in City of Charleston

Source: <https://abcnews4.com/news/local/sinkhole-along-isle-of-palms-connector-crews-on-scene>

Human-induced sinkholes can be caused by a variety of human activity. These can include groundwater pumping and from construction and development practices. Aging and failing water infrastructure can cause sinkholes too.

⁵⁷ <https://www.usgs.gov/faqs/what-a-sinkhole>

5.17.2 Location and Spatial Extent

Figure 5. below shows areas of the United States where certain rock types that are susceptible to dissolution in water occur. In these areas, the formation of underground cavities can form and catastrophic sinkholes can happen. These rock types are evaporites (salt, gypsum, and anhydrite) and carbonates (limestone and dolomites). Evaporite rocks underlie about 35 to 40 percent of the United States, though in many areas they are buried at great depths.

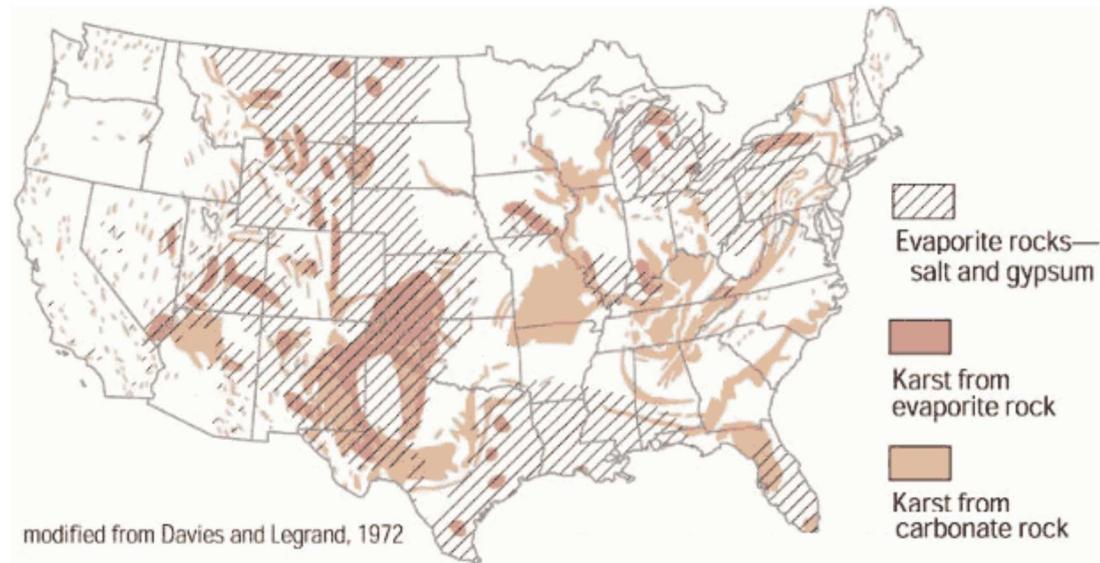


Figure 5.32: United States Geological Survey of Karst Modified from Davies and Legrand, 1972

5.17.3 Historical Occurrences

While there are no occurrences of sinkholes from the National Centers for Environmental Information (NCEI), there is anecdotal/new reports information about three (3) sinkhole occurrences in Charleston. **Table 5.29** below provides information about historical sinkhole occurrences for the City of Charleston.

Table 5.29: Sinkhole Occurrences in the City of Charleston

Date	Details	Deaths/Injuries	Property Damage (2022)
September 29, 2017	The Charleston Water Systems (CWS) reported that a main water pipe measuring ten inches in diameter under East Bay Street burst and the water carved away the soil and caused the asphalt surface to collapse.	0/0	\$0
June 6, 2021	A sinkhole opened up in the road near Coming and Bull Streets in Downtown Charleston. SCDDOT observed that the sinkhole was caused by the collapse of Pre-Civil War storm drain under the street.	0/0	\$0
July 25, 2022	Charleston Water System reported a potential sewer main line break in the right of way on the Guggenheim Terrace side a Seven Farms Drive.	0/0	\$0

Source: Local News Reports

In Charleston, sinkholes are primarily infrastructure related. According to representatives from the College of Charleston, the downtown area of Charleston still uses the pre-Civil War drainage tunnels which are the major storm drains across the city. As materials are winnowed away from the inside of the tunnels, builds pressure and erodes support holding the bricks in place shifts and the brick work collapses which causes a large void in the subsurface that pulls the material away and the roads sink or collapse.

5.17.4 Changing Future Conditions

Most research has shown that pumping water and associated drawdown is the leading cause of sinkhole formation and collapse. However, the impact of global warming should not be ignored. For example, altered global rainfall patterns and increasing evaporation because of higher temperatures leads to a decrease in groundwater flow, resulting in sinkhole formation, or such decreased flow may lead to intensification of water pumping and related drawdowns in urban and industrial areas that in itself leads to groundwater level reduction and related sinkhole development⁵⁸.

5.17.5 Probability of Future Occurrences

According to the USGS, the most damage in the United States from sinkholes tends to occur in Florida, Texas, Alabama, Missouri, Kentucky, Tennessee, and Pennsylvania. The sinkholes that have historically occurred in the City of Charleston have been small. Therefore, the future probability is *likely* (between 10 and 100 percent annual probability) that the city will continue to be affected by sinkholes.

5.18 DISEASE AND PANDEMIC

5.18.1 Background and Description

Infectious Disease

Communicable diseases are illnesses that can be transmitted directly between individuals or indirectly through vectors such as insects, air, water, or contaminated objects. Their impact varies significantly, from mild cases like the common cold to severe conditions such as pneumonic plague or anthrax. The U.S. public health system has been largely shaped by the need to manage and prevent outbreaks of these diseases through measures like disease reporting, vaccinations, and vector control. Despite these efforts, outbreaks can still occur, especially when people travel from different regions, highlighting the importance of vigilance in public health.

While many infectious diseases are rare in South Carolina, some, like botulism and bubonic plague, pose minimal risk. More concerning are diseases that have been identified as serious threats, such as the Zika virus and West Nile virus, both transmitted by mosquitoes, and human-to-human spread diseases like SARS and Ebola. Although these outbreaks have raised public health alarms, many have been contained or are less prevalent today. In contrast, diseases such as influenza and norovirus pose a more consistent threat. Influenza can lead to severe illness and death, particularly among vulnerable populations, and the potential for pandemic strains remains a concern. Norovirus, the leading cause of foodborne outbreaks, spreads easily and has no vaccine or treatment, making it particularly dangerous in crowded settings. Ongoing collaboration among public health officials, planners, and emergency responders is crucial to

⁵⁸ <https://nhess.copernicus.org/preprints/nhess-2018-18/nhess-2018-18-SC1-supplement.pdf>

addressing these threats effectively.

Vector-Borne Disease

Bacterial, viral, and parasitic diseases that are transmitted by mosquitoes, ticks, and fleas are collectively called “vector-borne diseases” (the insects and arthropods are the “vectors” that carry the diseases). Although the term “vector” can also apply to other carriers of disease – such as mammals that can transmit rabies or rodents that can transmit hantavirus – those diseases are generally called zoonotic (animal-borne) diseases. The most common vector-borne diseases found in South Carolina are carried by ticks and mosquitoes. The tick-borne illnesses most often seen in the state are Rocky Mountain Spotted Fever, ehrlichiosis, Lyme disease and Southern Tick-Associated Rash Illness (STARI). The most frequent mosquito-borne illnesses, or “arboviruses,” in South Carolina include La Crosse encephalitis, West Nile virus and Eastern equine encephalitis.

5.18.2 Location and Spatial Extent

Extent is difficult to measure for an infectious disease event as the extent is largely dependent on the type of disease and on the effect that it has on the population (discussed above). Extent can be somewhat defined by the number of people impacted, which depending on the type of disease could number in the tens of thousands within the state.

5.18.3 Historical Occurrences

Infectious Disease

Information from the South Carolina Department of Health and Environmental Concern was used to monitor and track cases of the infectious disease COVID-19. A COVID-19 Pandemic disaster declaration was declared for South Carolina on March 24th, 2020. As of August 13, 2022, Charleston County has reported 127,000 cases and 974 deaths from COVID-19. As of August 13, 2022, the SCDHEC reported there were 1.65 million cases of COVID-19 in South Carolina. These cases reflect cases that were tested and returned positive.

Vector-Borne Diseases

According to the SCDHEC, the most common existing or potential mosquito-borne viruses and parasites in South Carolina include West Nile Virus, eastern equine encephalitis virus, La Crosse encephalitis and other California serogroup viruses, Saint Louis encephalitis virus, and dog/cat heartworm. Data from 2004 – 2018 from the CDC of reported cases of West Nile Virus and Spotted fever rickettsiosis in the state of South Carolina. **Figure 5.** below shows the number of these tickborne and mosquito-borne cases.

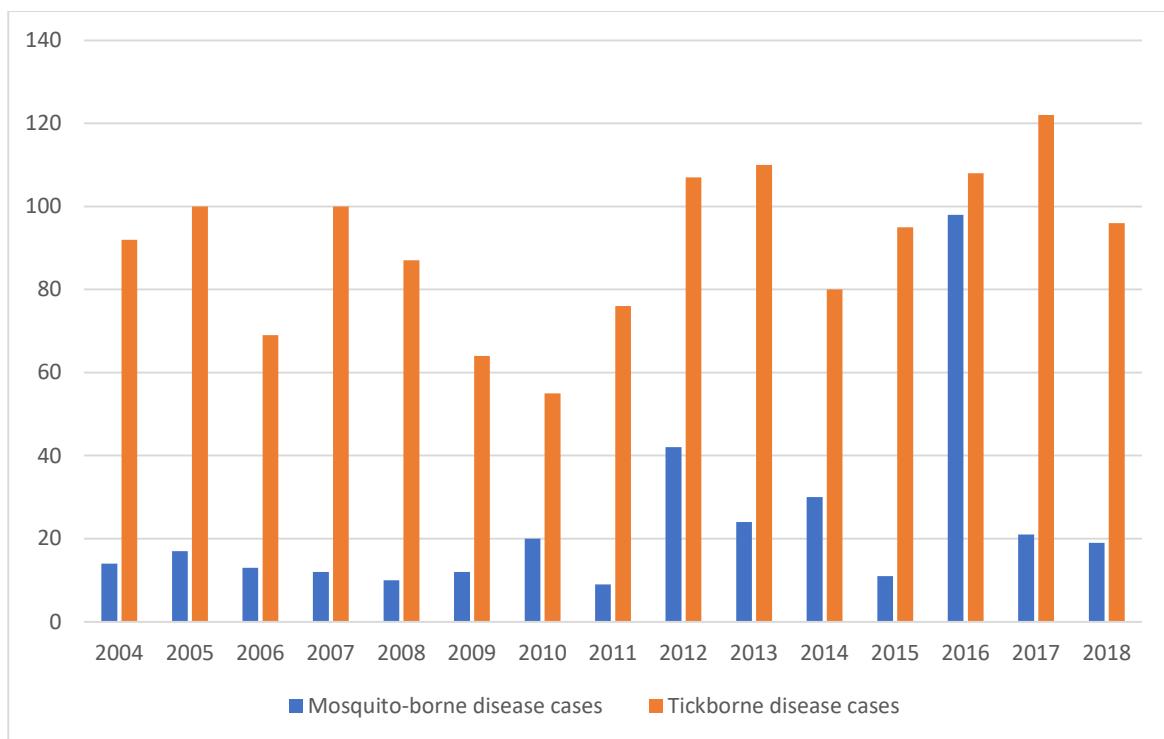


Figure 5.33: Mosquito-Borne and Tickborne Disease Cases, 2004-2018

Source: Centers for Disease Control and Prevention

5.18.4 Changing Future Conditions

According to the CDC, milder winters, warmer summers, and fewer days of frost make it easier for infectious disease and vector disease to expand to new geographic areas and infect more people. Between 2004 and 2018, the number of reported illnesses from mosquito, tick and flea bites more than doubled, with more than 760,000 cases reported in the United States. Additionally, nine new germs spread by mosquitoes and ticks were discovered or introduced into the United States during this time. In 2012, a mild winter, early spring, and a hot summer set the stage for an outbreak of West Nile Virus disease in the United States, resulting in more than 5,600 illnesses and 286 deaths⁵⁹.

5.18.5 Probability of Future Occurrences

It is difficult to predict the future probability of infectious disease due to the difficulty with obtaining information on this type of hazard. Although current events with the ongoing COVID-19 pandemic and other emerging infectious diseases has highlighted the need of local and national government bodies to monitor cases more closely. Due to recent historical data and emerging information on future infectious diseases, it is possible (1 to 10 percent annual probability) for future infectious disease events.

TECHNOLOGICAL HAZARDS

⁵⁹ <https://www.cdc.gov/ncezid/what-we-do/climate-change-and-infectious-diseases/index.html>

5.19 HAZARDOUS MATERIALS RELEASE

5.19.1 Background and Description

Hazardous materials (HAZMAT) incidents can occur at fixed facilities or during mobile transportation accidents involving air, rail, highways, or waterways. Annually, there are approximately 6,774 HAZMAT events, with 5,517 occurring on highways, 991 on railroads, and 266 from other causes.⁶⁰ These incidents can last from hours to days, and certain chemicals may pose long-term corrosive threats. In addition to the immediate release of hazardous materials, explosions and fires can result, and contaminants can spread beyond the initial area through water, wind, and wildlife.

HAZMAT incidents can also coincide with natural disasters like floods, hurricanes, tornadoes, and earthquakes, which can complicate response efforts. For instance, during Hurricane Floyd in September 1999, communities along the Eastern U.S. faced significant environmental hazards, including flooded junkyards, uncontrolled fertilizer spills, and floating propane tanks, all of which raised serious toxicological concerns.

The 1986 Emergency Planning and Community Right to Know Act (EPCRA) mandates the Environmental Protection Agency (EPA) to collect and disseminate information about hazardous materials. This includes data on the releases and transfers of specific toxic agents reported in the Toxic Release Inventory (TRI), with several TRI sites located in Charleston and surrounding areas. Hazardous materials, which can be found in homes, businesses, and during transportation, pose risks of serious health effects and property damage. This overview aims to highlight the hazard associated with hazardous materials, focusing on significant fixed and mobile sources relevant to public safety planning.

5.19.2 Location and Spatial Extent

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 the 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. The City of Charleston has fifteen (15) recognized TRI facilities.

In addition to “fixed” hazardous materials locations, hazardous materials may also impact the city via roadways and rail. All roads that permit hazardous materials transport are considered potentially at risk to an incident. **Figure 5.27** below shows the mobile HAZMAT risk for the City of Charleston.

⁶⁰ FEMA, 1997.

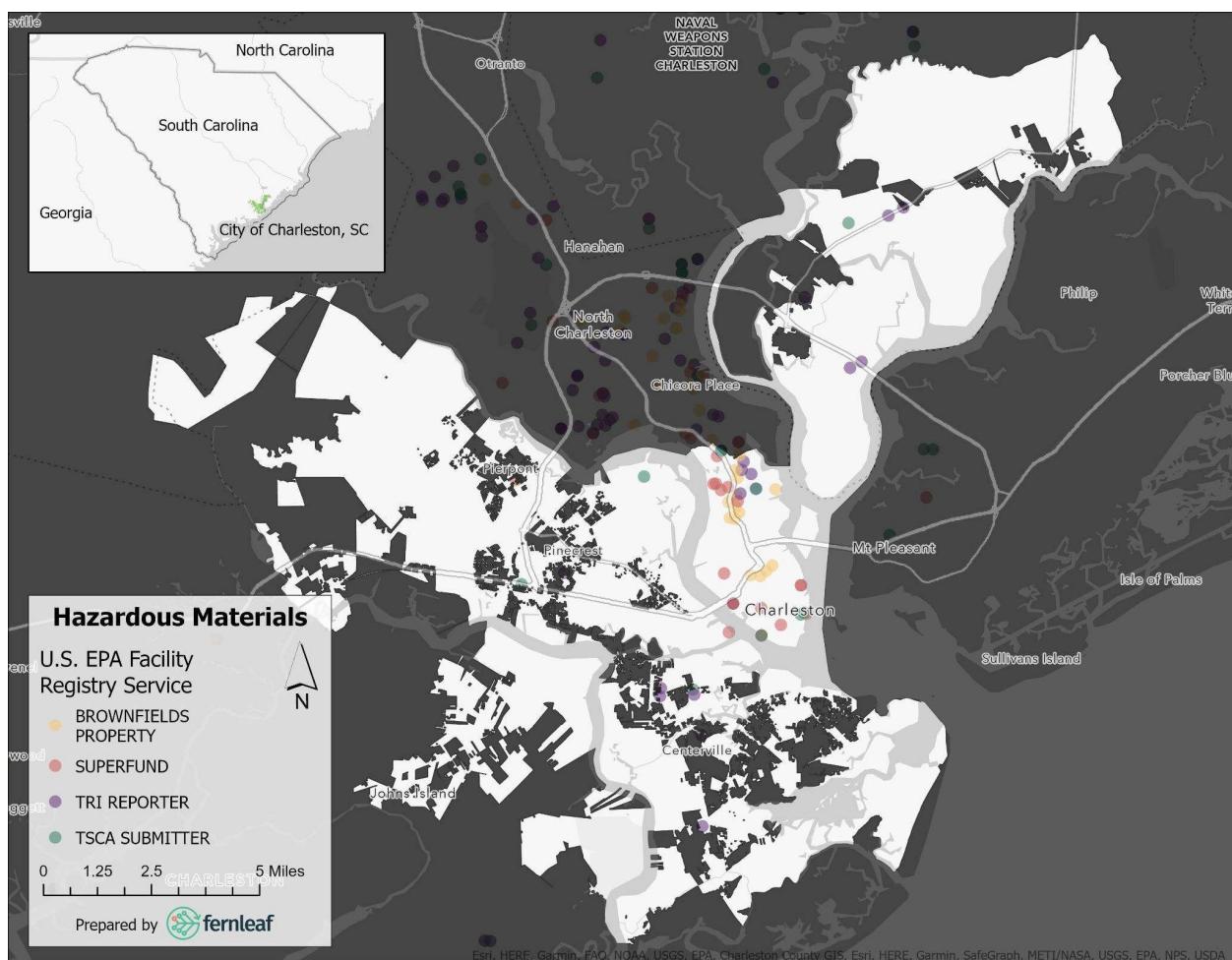


Figure 5.34: Charleston HAZMAT Sites

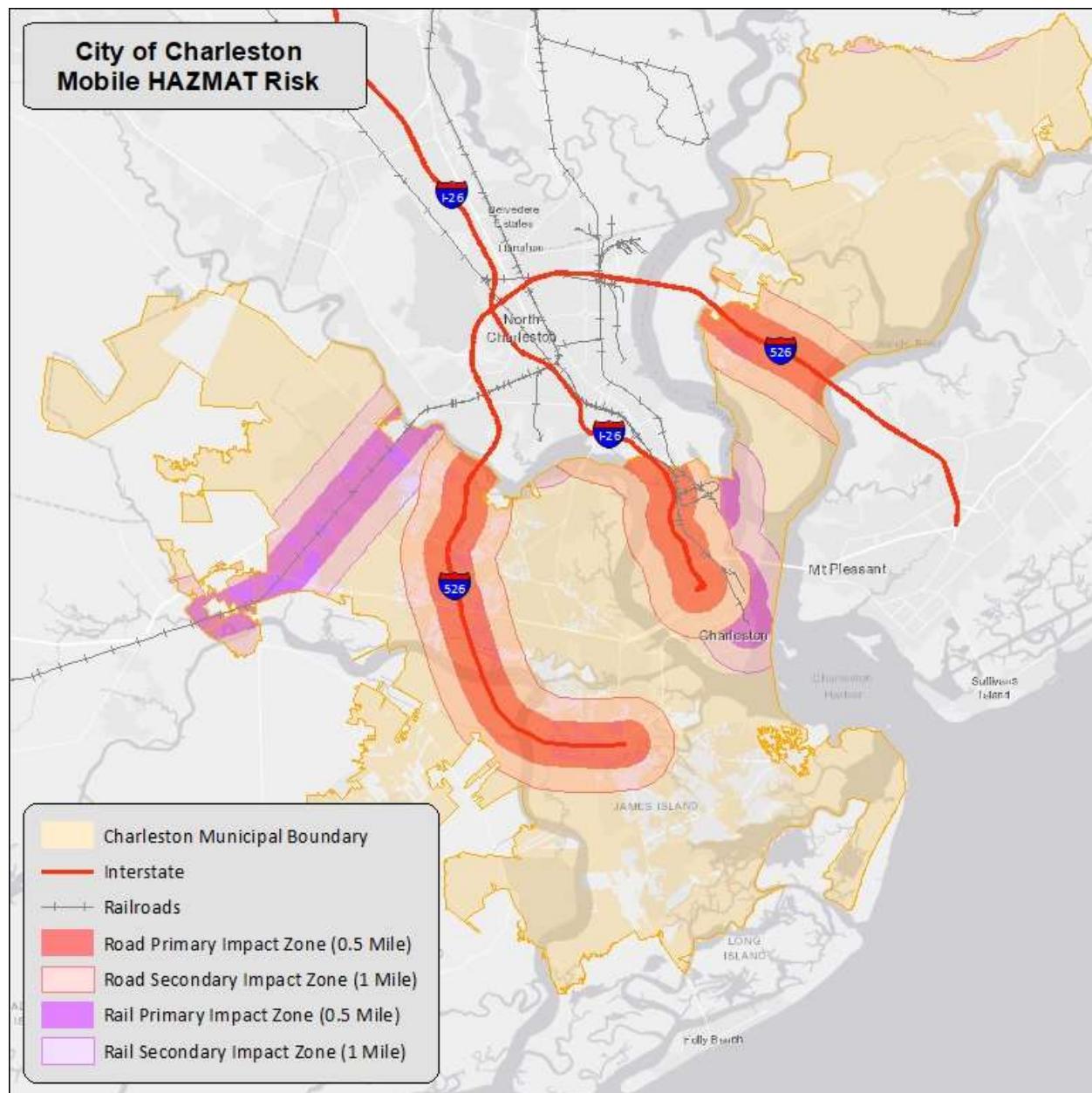


Figure 5.35: Mobile HAZMAT Buffer Areas

5.19.3 Historical Occurrences

The U.S. Department of Transportation Pipeline and Hazardous Materials Safety Administration (PHMSA) is an agency of the United States Department of Transportation that was established in 2004. The PHMSA maintains a database of hazardous materials incidents for communities across the United States. A “serious incident” is a hazardous incident that involves:

- a fatality or major injury caused by the release of a hazardous material,
- the evacuation of 25 or more persons as a result of release of a hazardous material or exposure to fire,
- a release or exposure to fire which results in the closure of a major transportation artery, the

alteration of an aircraft flight plan or operation,

- the release of radioactive materials from Type B packaging,
- the release of over 11.9 gallons or 88.2 pounds of a severe marine pollutant, or
- the release of a bulk quantity (over 199 gallons or 882 pounds) of a hazardous material.

However, prior to 2002, a hazardous material “serious incident” was defined as follows:

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

The PHMSA maintains a database of hazardous materials for communities across the United States. There have been 264 hazardous materials release incidents reported in the City of Charleston since 1990. Only ten (10) of these events were categorized by the PHMSA as “serious incidents” and are discussed further in **Table 5.30** below.

Table 5.30: Hazard Release Incidents for the City of Charleston (1991 - 2022)

Carrier Reporter Name	Date	Quantity Release	Unit of Measure	Property Damages (2023)	Mode of Transportation
CSX Transportation	5/15/1991	500	LGA	\$0	Rail
Sea-Land Service INC.	8/11/1993	2700	LGA	\$0	Water
CSX INTERMODAL	9/12/2001	130	LGA	\$0	Rail
CSX INTERMODAL	11/23/2001	160	LGA	\$0	Rail
DEFENSE FUELS SUPPORT	3/21/2007	150	LGA	\$0	Highway
Colonial Fuel and Lubricant Services	3/6/2015	10	LGA	\$3,500	Highway
HILCO TRANSPORT, INC.	5/26/2015	45	LGA	\$65,128	Highway
FEDERAL EXPRESS CORPORATION	7/28/2016	0.3	CI	\$0	Air
J.H SEALE & SON INC	12/4/2017	30	LGA	\$188,000	Highway
EAGLE TRANSPORT CORPORATION	4/9/2021	0.078089	LGA	\$54,000	Highway

Source: PHSMA

5.19.4 Changing Future Conditions

As the City of Charleston’s population continues to grow more people could become increasingly vulnerable to incidents involving hazardous materials incidents. Therefore, it is important to monitor all transportation routes and continue to attempt to prevent future incidents from occurring through continued preparedness, monitoring, and training. Unlike other hazards discussed in this plan, climate change is unlikely to affect the occurrence or frequency of future hazardous materials events.

5.19.5 Probability of Future Occurrences

Due to the number of TRI facilities in and around the City of Charleston and a the number of serious road, railway, or water incidents, the future probability of hazardous materials incidents is *likely* (between 10 and 100 percent annual probability).

5.20 INFRASTRUCTURE FAILURE

5.20.1 Background and Description

Infrastructure failure is the interruption of any component of the system of utilities that provide for our basic needs as a society, such as communications, health, mobility, power, water, and sewer. Although infrastructure failure is often felt as a secondary hazard to another incident such as a hurricane or winter weather, it can result from poor construction, design flaw, or deteriorating systems. Public and private-sector entities must diligently work together to prevent failure of critical infrastructure, and recover it as quickly as possible when an interruption does occur. There are two broad areas of concern regarding infrastructure failure include:

- **Episodic Failure** - temporary loss of power, technology associated with maintenance may fail, or some other temporary issue may occur;
- **Catastrophic Failure** – significant damage to infrastructure or anticipated prolonged outage of critical systems may trigger

5.20.2 Location and Spatial Extent

The extent which infrastructure failure can affect a community is broad because of how many different facets of essential services can fail. It is assumed that the entire City of Charleston is vulnerable to an infrastructure failure event, however, not all assets are vulnerable to the hazard.

5.20.3 Historical Occurrences

Many issues related to infrastructure failure stem from the aging American infrastructure, with many pipelines, bridges, and structures exceeding 100 years in age. In Charleston, vital infrastructure provides essential services to the community.

The Port of Charleston, located at the mouth of the Cooper and Ashley Rivers, spans three municipalities—Charleston, North Charleston, and Mount Pleasant—and includes six public terminals owned by the South Carolina Ports Authority (SCPA). These terminals handle containers, motor vehicles, non-containerized goods, project cargo, and the city's cruise ship operations. Recognized as one of the most productive ports in the U.S., it is also the deepest on the East Coast at 15.85 meters (52 feet), enabling access for larger cargo ships without tidal restrictions.⁶¹

Charleston also boasts advanced fiber optic, digital, and IP-based networks that provide communication services to businesses. While the city has not experienced significant infrastructure failures, the risk increases exponentially as infrastructure continues to age without proper maintenance.

⁶¹ http://www.worldportsource.com/ports/commerce/USA_SC_Port_Charleston_248.php

5.20.4 Changing Future Conditions

Although the City of Charleston have taken steps to protect their essential services, climate change and its impacts threaten the well-being of water, energy supply, and transportation which will be increasingly compromised. According to the National Climate Risk Assessment, infrastructure failure issues will be compounded by rising sea levels, storm surges, heat waves, and extreme weather events⁶². The City of Charleston has a long history of extreme hazard events (Hurricane Hugo in 1989 and the Charleston Earthquake in 1886), and are expected to continue to experience hazardous events, which can impact infrastructure, in the future.

5.20.5 Probability of Future Occurrences

The City of Charleston has not experienced any major infrastructure failure events. Additionally, the City has taken measures in the past to ensure that most essential services are not only up-to-date, but have been constructed with the capacity to withstand future natural hazard events. Therefore, the future probability of infrastructure failure for Charleston is *possible* (between 1 and 10 percent annual probability).

HUMAN – CAUSED HAZARDS

5.21 RADIOLOGICAL EMERGENCY

5.21.1 Background and Description

A nuclear and radiation accident is defined by the International Atomic Energy Agency as “an event that has led to significant consequences to people, the environment or the facility. Often, this type of incident results from damage to the reactor core of a nuclear power plant which can release radioactivity into the environment. The degree of exposure from nuclear accidents has varied from serious to catastrophic. While radiological emergencies generally are a rare occurrence, many incidents are extremely well known due to their large-scale impact and serious effects on people and the environment.

The International Atomic Energy Association has developed a scale called the International Nuclear and Radiological Event Scale (INES) which provides a quantitative means of assessing the extent of a nuclear event. This scale, like the MMI used for earthquakes, is logarithmic which means that each increasing level on the scale represents an event 10 times more severe than the previous level (**Figure 5**).

⁶² <https://nca2014.globalchange.gov/highlights/report-findings/infrastructure>

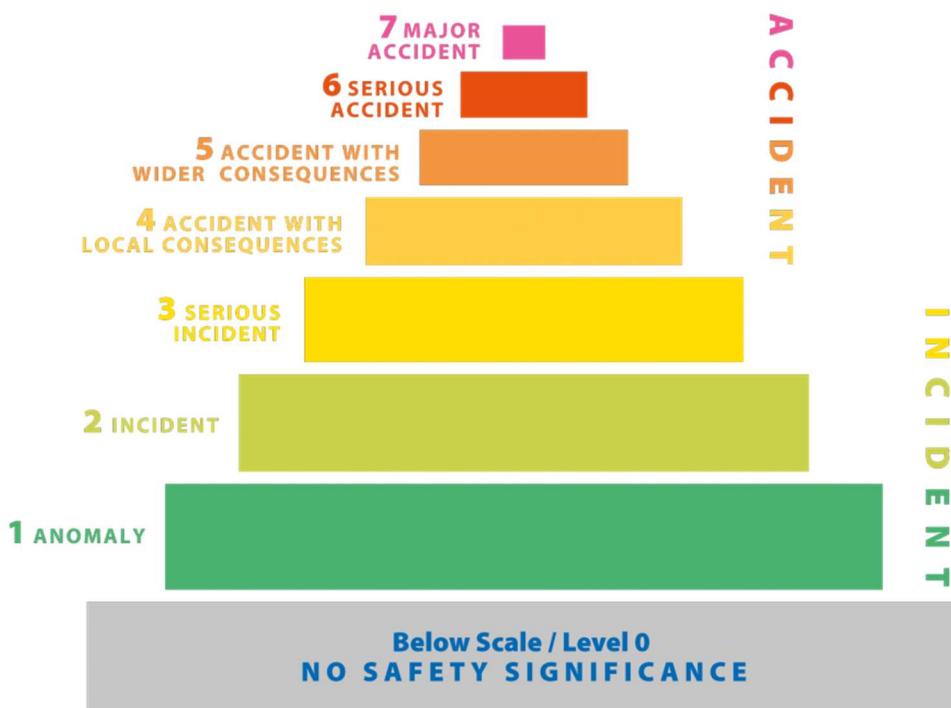


Figure 5.36: International Nuclear Event Scale

Source: International Atomic Energy Agency

5.21.2 Location and Spatial Extent

The City of Charleston is not located within a 50-mile radius from any nuclear power plant or facility. However, there are small concentrations of potential nuclear/radiological contaminants with the medical and military complexes in and around the city. **Figure 5.** below displays all nuclear power plants within the state of South Carolina.

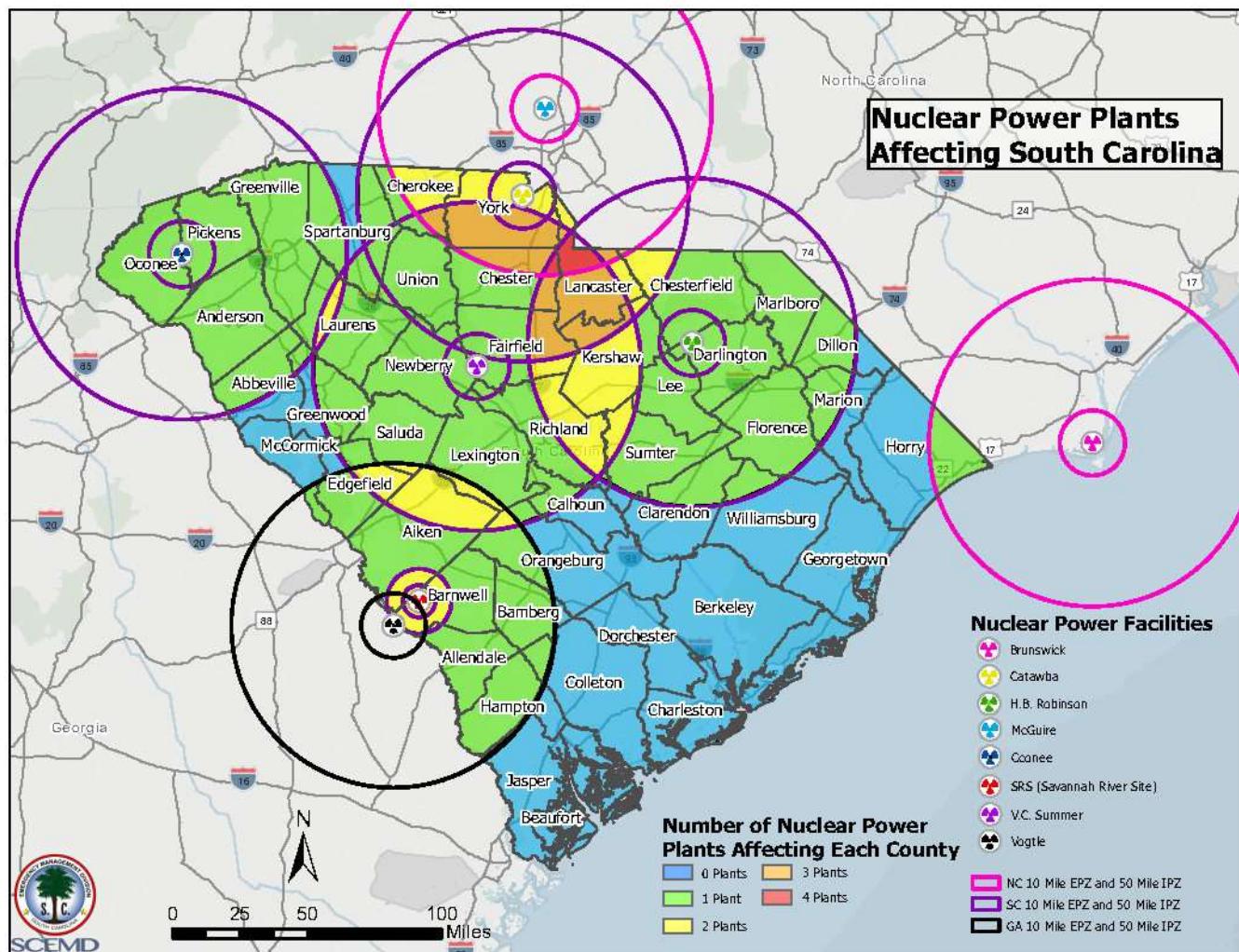


Figure 5.37: Nuclear Power Plants Affecting South Carolina

Source: South Carolina Emergency Management Division

5.21.3 Historical Occurrences

Although there have been no known radiological events in Charleston County or Charleston, the presence of the port should be taken into consideration when determining the proper emergency response and planning. Although the port does not necessarily make the city more vulnerable to a radiological emergency, it serves as a key entry point for materials and goods meaning there is some potential for the illicit transport of radioactive materials. As a major maritime trade and transportation hub, the port's role could impact the potential consequences of a radiological emergency. Through strict security and safety regulations, this threat can be minimized.

5.21.4 Changing Future Conditions

Unlike other hazards discussed in this plan, climate change is unlikely to affect the occurrence or frequency of future radiological events.

5.21.5 Probability of Future Occurrences

A nuclear event is a very rare occurrence in the United States due to the intense regulation of the industry. There have been incidents in the past, but it is considered *unlikely* (less than 1 percent annual probability).

5.22 CYBER INCIDENTS

5.22.1 Background and Description

Cyberattacks are intentional assaults on information technology systems aimed at illegally accessing computers or causing damage. As both the world and the City of Charleston become more technologically advanced and reliant on computer systems, the risk of cyberattacks grows. Also referred to as computer network attacks, these threats are often difficult to detect and typically involve malicious code that alters data or steals information.

Mitigating and preparing for cyberattacks is challenging due to their diverse and complex nature. The FBI leads investigations into these incidents, including those involving foreign adversaries and terrorists. In South Carolina, the Division of Information Security (DIS) within the Department of Administration's Office of Technology and Information Services oversees statewide cybersecurity policies, standards, and critical infrastructure coordination.

Cyberattacks can target both public and private sectors and may be executed by individuals or organized groups. Many aim to steal money or disrupt normal operations. According to the 2017 Verizon Data Breach Report, 93% of data breaches were motivated by financial gain or espionage, with the latter on the rise.

There are many types of cyberattacks incident patterns, which include:

- Web App attacks: Incidents in which web applications were attacked, which can include exploiting code-level vulnerabilities in the application
- Point of Sale Intrusions: Remote attacks against environments where card-present retail transactions are conducted
- Miscellaneous Errors: Incidents in which unintentional actions directly compromise an attribute of a security asset
- Physical Threat and Loss: Incidents where an information asset went missing
- Crimeware: Instances involving malware that do not fit into more specific pattern
- Payment Card Skimmers: Incidents involving skimming devices physically implanted on an asset that reads magnetic stripe data from payment cards
- Cyber-espionage: Unauthorized network or system access linked to state-affiliated actors
- Denial-of-Service: Any attack intended to compromise the availability of networks and systems that are designed to overwhelm systems, resulting in performance degradation or interruption of services

Figure 5. below displays nationwide cyberattack incident patterns from the 2018 Verizon Data Breach Investigations Report.

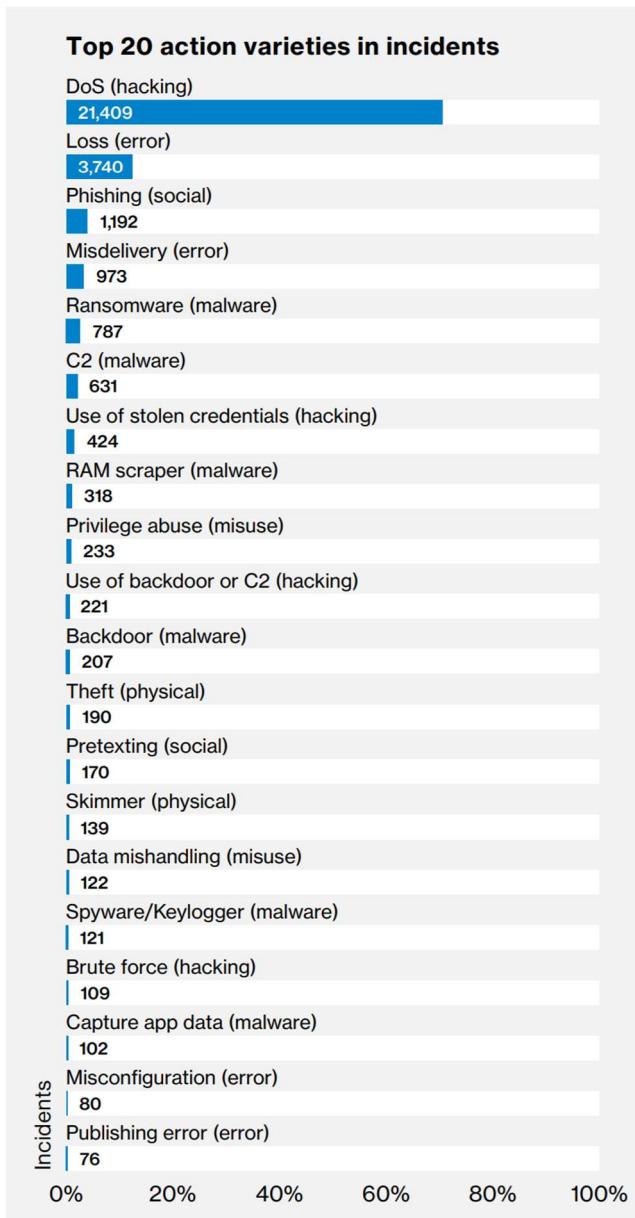


Figure 4. Top 20 threat action varieties (incidents) (n=30,362)

Figure 5.38: Percentage and Counts of Incidents per Pattern

Source: 2018 Verizon Data Breach and Investigations Report

5.22.2 Location and Spatial Extent

Cyberattacks happen all over the world and are not restricted to a certain locational boundary. One of the primary challenges of cyber incidents for the City of Charleston is the fact that agencies may not fully understand their vulnerabilities. It also may be difficult to pinpoint when or how a cyber incident initially happens, which can lead to prolonged and extensive attacks in some situations.

5.22.3 Historical Occurrences

On May 2, 2018, Governor Henry McMaster signed into law the South Carolina Insurance Data Security Act. The act became effective on January 1, 2019. South Carolina was the first state in the nation to pass this important and timely legislation which was modeled after the NAIC Insurance Data Security Model Law⁶³. The purpose of this legislation is to ensure that licensees of the South Carolina Department of Insurance have a strong and aggressive cybersecurity program to protect the personal data of consumers in South Carolina and elsewhere.

Cyber events were primarily collected from new reports or press releases from government or private entities:

- **Department of Revenue (August, 2012)** In August 2012 the South Carolina Department of Revenue (DOR) suffered a severe cybersecurity attack. Reports indicate the DOR, which serves the state's population of 4.6 million, had their computer systems comprised by hackers which exposed 3.6 million Social Security numbers. A total of 387,000 credit and debit cards were also exposed during the event. IT officials in the state informed the DOR of suspicious activity on October 10 2019. Intelligence gathered since the discovery suggested that following several attempts to access the system, hackers successfully obtained taxpayer data in mid-September.

The FBI's Internet Crime Complaint Center (IC3) reported that in 2021 alone, South Carolina lost more than \$42 million from 5,426 victims in the state. The top three schemes with the largest losses included business email compromise at \$17.2 million, confidence/romance scams at \$6.8 million and tech support scams at \$4.6 million⁶⁴. Data also showed senior citizens (60 years or older) were the most heavily impacted by the scams, which lost \$15.7 million alone.

Although the City of Charleston, SC has not reported any major catastrophic cyberattacks, reported attacks at the state level and the potential to experience one at the municipal level is unpredictable and can happen at any time.

5.22.4 Changing Future Conditions

Unlike other hazards discussed in this plan, climate change is unlikely to affect the occurrence or frequency of future cyber incident events.

5.22.5 Probability of Future Occurrences

As the world's dependency on technology grows, the possibility of experiencing cyberattacks grows as well. There have not been severe past occurrences in the city, and it is considered *unlikely* (less than 1 percent annual probability) the City of Charleston to experience one in the near future.

⁶³ <https://www.doi.sc.gov/918/Cybersecurity>

⁶⁴ <https://www.wistv.com/2022/03/22/fbi-south-carolina-lost-42-million-cyber-crime-last-year/#:~:text=Over%205%2C400%20complaints%20were%20listed%20in%20the%20state&text=The%20report%20says%20South%20Carolina,is%20responsible%20for%20the%20report>

5.23 CIVIL DISTURBANCE

5.23.1 Background and Description

Civil disturbance refers to groups deliberately choosing to disregard laws or regulations to draw attention to a cause or agenda. In modern society, laws have evolved to facilitate peaceful conflict resolution. In the United States, the Constitution protects the right to peacefully assemble; however, non-peaceful assemblies fall outside this protection, marking the distinction between crowds and mobs. Disruptive conduct is categorized into offenses that disturb public peace, ranging from misdemeanors like blocking sidewalks to felonies such as looting and rioting.

When a riot or public disturbance occurs, local law enforcement is initially responsible for managing the situation. If overwhelmed, state law enforcement may step in. According to the South Carolina Law Enforcement Division's (SLED) Civil Disturbance Plan, the SC Emergency Management Division (SCEMD) coordinates state law enforcement efforts, consulting with the State Adjutant General, the SC Attorney General, and the Director of SLED during public disturbances and emergencies.

The severity of civil disorder depends on the event's scale and location. Wider incidents are more likely to result in injuries, loss of life, and property damage, while law enforcement's ability to contain the situation is crucial in minimizing harm. In "Sociology: Understanding and Changing the Social World," published by the University of Minnesota, the typology of crowds is explored based on their purpose and dynamics. A crowd is defined as a temporary gathering of people without strong, cohesive relationships. Drawing on sociologist Herbert Blumer's work, the book identifies five types of crowds:

- **Casual Crowd** – A collection of people who happen to be in the same place at the same time. They crowd has no common identity or long-term purpose. Examples of this type include shoppers and sightseers. The likelihood of violent conduct is all but nonexistent.
- **Conventional Crowd** – A collection of people who gather for a specific or common purpose or activity, like dancing, a sporting event, or a concert. Behavior for the crowds is fairly structured and would require substantial provocation to arouse disruptive action.
- **Expressive Crowd** – A collection of people who gather primarily to be excited and to express one or more emotions. Examples include a political rally and protests.
- **Protest Crowd** – A collection of people who gather to protest a political, social, cultural, or economic issue. People in these crowds may participate in sit-ins, demonstrations, a march or rally.
- **Acting Crowd** – The crowd is made up of individuals who have assembled for a specific purpose. Acting crowds tend to be impulsive and highly emotional and require only minimal stimulation to arouse them to violence. Acting crowds sometimes become so large and out of control that they develop into full-scale riots.

5.23.2 Location and Spatial Extent

Civil disturbance can arise from a variety of reasons. Circumstances may be spontaneous or may result from escalating tensions. Civil disruption 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 a civil disruption can occur. Civil disorder can also occur in proximity to locations where a “trigger event” occurred.

5.23.3 Historical Occurrences

In the past there have been 3 examples of a civil disturbance events in the City of Charleston. These events are listed below and have caused 6 deaths and 39 injuries.

- The South Carolina Civil Disturbances of 1876 were a series of race riots and civil unrest related to the Democratic Party’s political campaign to take back control from the Republicans of the state legislature and governor’s office through their paramilitary Red Shirts division. There were two (2) deaths and twenty-one (21) injuries as a result of the civil disturbance⁶⁵.
- The Charleston Riot of 1919 was a two-day long event that led to three (3) deaths and eighteen (18) injuries. On May 10th, 1919, sailors from the Charleston Navy Yard instigated a racially-motivated riot across the city. This event was also coincident with the demobilization of U.S. troops following the end of World War I. At the start of the war hundreds of thousands of African-American men volunteered or were drafted into the armed forces. Their participation in this conflict opened doors to new rights and forms of civic engagement, which led to new public discourse about the state of race relations in America. This discourse was not welcome by large numbers of white Americans, who were openly hostile to any disruption of the racial status quo of segregation.⁶⁶
- In response to the death of George Floyd, peaceful protests and demonstrations were conducted in the City during the day on May 30th, 2020. As the day progressed, organizers were urged to remain peaceful as they marched through the streets of Charleston. However, as nightfall approached, some individuals became more aggressive leading to rioting. This led to instances of vandalism, looting, and arson in the downtown areas of the City.
- Even though these events are across almost 200 years of history for the City of Charleston, there are common factors attributed to all of these events: institutional racism against African-Americans and economic, racial, and social inequality.

5.23.4 Changing Future Conditions

While climate change would not have a direct impact on civil disturbances, the ongoing climate crisis could present a cause for civil disorder for the City of Charleston. Climate change forecasts, previously discussed with other natural hazards in this plan, could cause extreme weather events that exacerbate issues of drought, flooding, severe weather and other weather hazards nationally that could affect whole ecosystems and access to critical resources (water, food, energy, etc.). As society adjusts and confronts these changes, incidents of civil disturbance could be a secondary result related to societal unrest associated with other climate-related hazard impacts.

5.23.5 Probability of Future Occurrences

Nationwide, civil disturbances are bound to be recurrent, as they are unpredictable feature of social life. South Carolina will continue to experience protests, demonstrations, and gatherings in various cities and communities that could lead to some type of disruptive behavior. The future probability of civil disturbance incidents is *unlikely* (less than 1 percent annual probability).

⁶⁵ http://www.screconstruction.org/Reconstruction/Citations_files/GaryCampaign.pdf

⁶⁶ <https://www.ccpl.org/charleston-time-machine/charleston-riot-1919>

5.24 TERRORISM

5.24.1 Background and Description

Terrorism is defined in the United States by the Code of Federal Regulations as “the unlawful use of force or violence against persons or property to intimidate or coerce a government, civilian population, or any segment thereof, in furtherance of political or social objectives.” Terrorist acts may include assassinations, kidnappings, hijackings, bombings, small arms attacks, vehicle ramming attacks, edged weapon attacks, incendiary attacks, cyber-attacks (computer based), and the use of chemical, biological, nuclear, and radiological weapons. For the purposes of this plan, cyber-attacks are addressed as a separate hazard.

Historically the main categories of weapons of mass destruction (WMDs) used in terror attacks are Chemical, Biological, Radiological, Nuclear, and Explosive (collectively referred to as CBRNE). As we rank these categories, considering immediate danger posed, impact, probability, technical feasibility, frequency, and historical success, they are typically ranked in the following way.

Explosive

Explosive attacks lead all others due to their immediate danger to life and health, immediate and measurable impact, high probability, low cost/easy degree of technical feasibility, and a long history of successful attacks.

Chemical

Chemical attacks can pose immediate danger to life and health depending upon the materials used. Chemicals are easy to access, low cost, and easy to deploy. Chemical terrorism can have high and persistent impacts to people and places. These types of attacks are probable and have enjoyed historical success.

Radiological

Radiological attacks can pose significant threats to life and health depending upon the specific materials used. Radiological materials while restricted and regulated are accessible to people with some knowledge in this discipline. While radiological incidents have occurred, they occur less frequently than explosive and chemical attacks.

Biological

Biological attacks can pose significant threats to life and health. They are typically deployed as diseases and bio-toxins. They require some degree of technical expertise in order to be deployed successfully. While biological incidents have occurred, they occur less frequently than explosive and chemical attacks.

Nuclear

While yielding a very high impact, the nuclear attack is extremely rare due to the fact that it is cost prohibitive and very technically difficult to achieve. This type of attack, however, could be state sponsored which makes it viable.

Other

Terrorism Hazard Assessment must also account for modern trends and changes. An additional “OTHER” category should be considered that includes small arms attacks, vehicle ramming attacks, edged weapon attacks, and incendiary attacks.

Active Threat

The FBI defines an active threat incident as a dynamic, quickly evolving situation involving an individual (or individuals) using deadly physical force, such as firearms, bladed weapons, or a vehicle. An active threat typically involves an individual (or individuals) presenting an immediate threat or imminent danger to people by displaying a weapon, having made threats, and/or shown intent to cause harm or perform violence.

For the period 2017 – 2021, active threat incident data reveals an upward trend; the number of active threat incidents identified in 2021 represents a 52.5% increase from 2020 and 96.8% increase from 2017⁶⁷. Figure 5. below shows the trend of active threat incidents from 2000 to 2021.

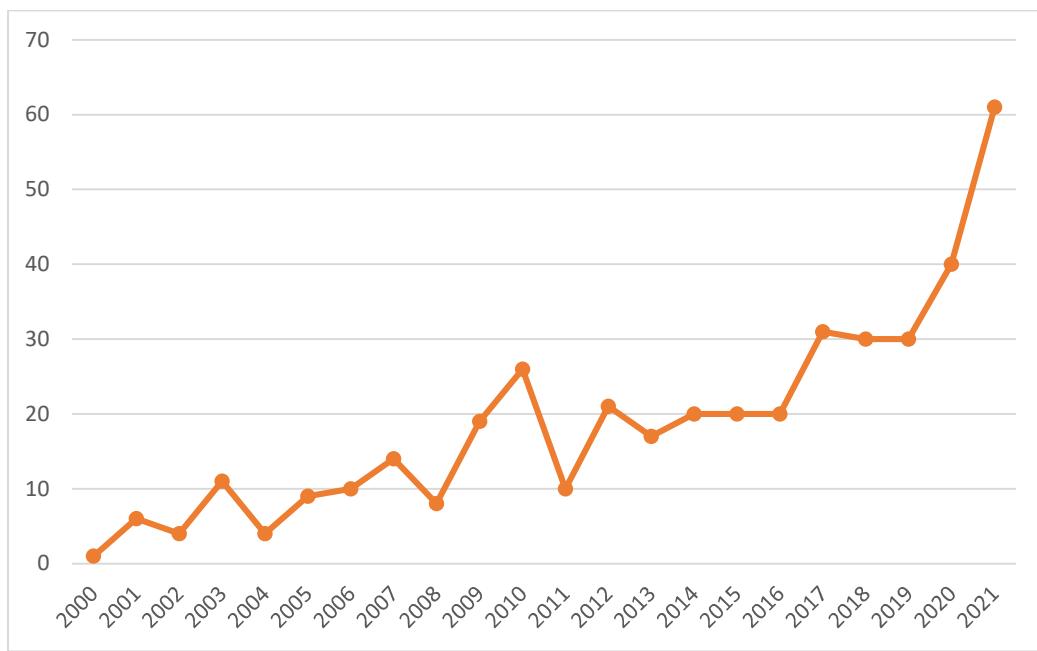


Figure 5.39: Number of Active Threat Incidents in the US, 2000-2021*

Source: FBI Crime Statistics

*Active threat incidents are defined as incidents when individuals actively engaged in killing or attempting to kill people in populated areas (excluding shootings related to gang or drug violence).

Within the last five years, there have been at least 14 prominent, high-casualty producing active threat incidents. Most of these cases have occurred in locations where the shooter has been undeterred and unobstructed from carrying out the attack. The incident locations have often been described as “soft targets” with limited active security measures or armed personnel to provide protection for members of the public. In most incidents, shooters have either taken their own lives, been shot by police, or surrendered when forced with a confrontation by law enforcement⁶⁸.

⁶⁷ <https://www.fbi.gov/file-repository/active-shooter-incidents-in-the-us-2021-052422.pdf/view>

⁶⁸ <https://cdn2.hubspot.net/hub/91068/docs/MSA%20Special%20Analysis%20-%20Active%20Shooter%20Threat%208.20.12.pdf>

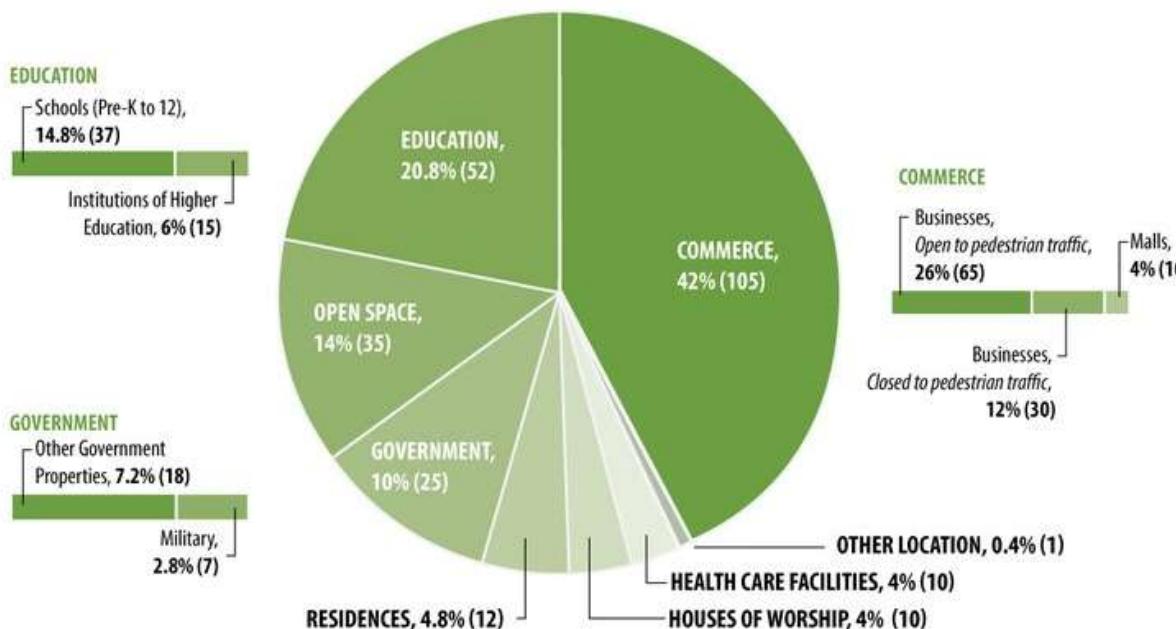
According to an FBI report summary of 160 active shooter incidents, 28.1% of active shooter incidents are ended by the application of force by police or security, 56.3% ended in on the shooter's initiative (committing suicide, fleeing or stopping shooting)⁶⁹.

5.24.2 Location and Spatial Extent

All parts of South Carolina including the City of Charleston are vulnerable to a terror event, terrorism tends to target more densely populated areas. The most recent population estimation for the City of Charleston, SC is 151,612 (2021) and it is the most populous city in South Carolina.

Active Threat

Due to the rapid and dynamic nature of active threat incidents and their propensity to occur against soft targets and unarmed persons, any facility with a high number of vulnerable populations would be the most likely targets. These could include educational facilities, healthcare and other care facilities, government properties, commercial facilities, and houses of worship. Figure 5. displays active threat incidents by location data from 2000 – 2017. It is assumed that all of South Carolina has an equal susceptibility to an active threat incident.



Source: Federal Bureau of Investigation, 2017

Figure 5.40: Active Threat Incident by Location 2000-2017

Source: Federal Bureau of Investigation (FBI)

⁶⁹ www.fbi.gov/file-repository/as-study-quick-reference-guide-updated1.pdf

5.24.3 Historical Occurrences

Active Threat

The precise inclusion criteria of an active shooter incident are disputed, and there is no broadly accepted definition. The Gun Violence Archive, a nonprofit research group that tracks shootings and their characteristics in the United States, defines a mass shooting or active threat in which four or more people, excluding the perpetrator(s), are shot in one location at roughly the same time. According to the Department of Homeland Security (DHS), there have been 6 major active threat incidents in South Carolina since 1968. These incidents resulted in 22 fatalities and 53 injuries in total Table 5.31.

Table 5.31: South Carolina Active Threat Incidents, 1968-2022

Date	Location	Dead	Injured	Total	Description
2/8/1968	Orangeburg, SC	3	27	30	South Carolina State University shooting: After responding to the scene of about 200 protestors protesting racial segregation, after an officer was assaulted, officers began to shoot into the crowd; three people were killed and twenty-seven injured.
9/26/1988	Greenwood, SC	2	9	11	Oakland Elementary School shooting: The perpetrator shot and killed two eight-year-old students and wounded nine others (seven students, a teacher, and a gym coach) in the school's cafeteria and a classroom before being arrested. He was sentenced to death.
9/15/1997	Aiken, SC	4	3	7	Aiken shooting: The perpetrator shot seven people at a manufacturing factory of his former employer. The perpetrator was executed in 2005.
6/17/2015	Charleston, SC	9	1	10	Charleston church shooting: A white supremacist killed nine black people during a prayer service at the Emanuel African Methodist Episcopal Church, wounding one other. He was taken into custody by police, and later said that he committed the shootings in an attempt to start a "race war".
9/28/2016	Townville, SC	2	3	5	Townville Elementary School shooting: A fourteen-year-old shot and killed his father before driving to the local elementary school and injuring three students and a teacher. One student later died of his injuries. The shooter was later arrested.
10/3/2018	Florence, SC	2	10	12	Florence shooting: Officers were shot at during a two-hour standoff while attempting to execute a search warrant. The perpetrator held children hostage, killing one and wounding seven before being arrested.

Source: Department of Homeland Security (DHS)

5.24.4 Changing Future Conditions

Population growth usually raises the odds of incidents involving terror within the state of South Carolina. Terrorism is also driven by trends, technology, and information exchange. Although, impacts related to climate change are unlikely to directly affect terrorist hazard events

5.24.5 Probability of Future Occurrences

The probability of a future terrorist attack in the City of Charleston, SC is unlikely (between 1 and 10 percent annual probability. However, a single event could have devastating effects on human lives, the economy, and future way of life.

Active Threat

There has been one active threat incidents in the City of Charleston. As population continued to grow in the dense urban area of the city the areas of high population are especially at risk to active threats. The probability of an active threat incident for the City of Charleston is *possible* (between 1 and 10 percent annual probability).

5.25 Conclusions on Hazard Risk

The hazard profiles presented in this section were developed using best available data and result in what may be considered principally a qualitative assessment as recommended by FEMA in its "How-to" guidance document titled *Understanding Your Risks: Identifying Hazards and Estimating Losses* (FEMA Publication 386-2). It relies heavily on historical and anecdotal data, stakeholder input, and professional and experienced judgement regarding observed and/or anticipated hazard impacts. It also carefully considers the findings in other relevant plans, studies, and technical reports.

5.25.2 Hazard Extent

Table 5.32 describes the extent of each natural hazard identified for the City Charleston where available. The extent of a hazard is defined as its severity or magnitude, as it relates to the planning area.

Table 5.32: Hazard Extent Summary Table

NATURAL HAZARDS	
Coastal Storms	Hurricane extent is defined by the Saffir-Simpson Scale which classifies hurricanes into Category 1 through Category 5 (Table 5.1) The greatest classification of hurricanes to traverse directly through the City of Charleston was Hurricane Hugo in 1989 which reached peak wind speed of 119 knots in the city (Category 4).
Flooding	Flood extent can be measured by the amount of land and property in the floodplain as well as flood height and velocity. The amount of total land area within a AE or VE flood hazard area accounts for 72% or 99.4 acres of the total land area in Charleston. The greatest depth of flooding experienced in Charleston was associated with Hurricane Hugo when a 19.3 foot storm surge impacted the City.
Sea Level Rise	According to <i>City of Charleston Flooding and Sea Level Rise Strategy Plan</i> , in the past 100 years, local sea level has risen 1.07 ft. City staff are anticipating and planning for an addition 14 inches in SLR by 2050.
Earthquakes	Earthquake extent can be measured by the Richter Scale (Table 5.7) and the Modified Mercalli Intensity (MMI) scale (Table 5.8) and the distance of the epicenter from the City of Charleston. According to the data provided by the National Geophysical Data Center, the greatest MMI to impact Charleston was reported on August 1, 1886 with an MMI of X with a correlating Richter Scale measurement of 7.3.
Tornado	Tornado hazard extent is measured the Enhanced Fujita Scale (Table 5.11). The NCEI reported a total of 9 tornado events in the City of Charleston since 1964. The greatest magnitude reported as an EF3 (last reported on September 11, 1967). It should be noted that an F5 tornado is possible although highly unlikely.
Fire	Wildfire data was provided by the Southern Wildfire Risk Assessment and National Association of State Foresters. Analyzing the data for Charleston County indicates the following wildfire hazard extent. Charleston County The greatest number of fires to occur in any year was 428 in 1984. The greatest number of acres burn in a single year occurred in 1949 when 6,873 acres were burned.
Tsunami	Maps of tsunami inundation zones (Table 5.15) provide the expected potential extent of inundation in the City of Charleston.

Dam Failure	Dam failure extent is defined using the South Carolina Department of Health and Environmental Control (SCDEHC) (Table 5.16). There are no high hazard dams with the potential to affect the City of Charleston.
Drought	Drought extent is defined by the South Carolina Drought Monitor Classifications which include Abnormally Dry, Moderate Drought, Severe Drought, Extreme Drought, and Exceptional Drought (Table 5.18). According to the South Carolina Drought Monitor Classifications, the most severe drought condition is Exceptional. Charleston County has experienced drought conditions every year from 2000 to 2019.
Severe Storm	<p><u>Lighting:</u> According to the Vaisala flash density map (Figure 5.), the majority of Charleston County is located in an area that experiences 20 - 24 flashes per square kilometer per year. It should be noted that future lightning occurrences may exceed these figures</p> <p><u>Hail:</u> Hail extent can be defined by the size of the hail stone. Hailstorm events are common in South Carolina and have occurred in all months of the year. The City of Charleston have experienced 8 significant hail events. It should be noted that future events may exceed this.</p> <p><u>Thunderstorms:</u> Thunderstorm extent is defined by the number of thunder events and wind speeds reported. According to a 64-year history from the National Centers for Environmental Information, the strongest wind event in Charleston County was reported on August 12, 2004 at 50 knots (approximately 57 mph). It should be noted future events may exceed these historical occurrences.</p>
Severe Winter Weather	The extent of severe winter weather can be measured by the amount of snowfall received (in inches). The greatest 24-hour snowfall reported in the city was 6.0 inches on December 22, 1989. Additionally, the NCEI reported a total of 9 severe winter weather events since 2000 for the City of Charleston.
Shoreline Erosion	The extent of shoreline erosion can be defined by the measurable rate of erosion that occurs. Although the City of Charleston does not have beaches, the city is affected by the loss of salt marshes and tidal creeks which protect the shoreline of the city against erosion and sea level rise.
Extreme Heat	The extent of extreme heat can be defined by the maximum temperature reached. The highest temperature recorded in Charleston is 105 degrees Fahrenheit (last reported on June 26, 1952).
Sinkholes	There have been two reported sinkholes in the City of Charleston. Although there were no injuries, deaths, or property damage reported for these events, the probability for sinkholes to form in the City are moderate.

Disease and Pandemic	Infectious disease extent can be measured by how many lives are taken as a result of the event and how many economic dollar losses are caused by disease. While dollar losses are difficult to capture, lives lost are not. The COVID-19 pandemic continues unfolding and is shaping up to be the deadliest and costliest infectious disease outbreak to impact Charleston County and the City of Charleston.
TECHNOLOGICAL HAZARDS	
Hazardous Materials Release	According to the USDOT PHMSA, there have been 264 hazardous materials incidents reported in the City of Charleston since 1990. And ten (10) of these events were categorized by the PHMSA as “serious incidents” (Table 5.30).
Infrastructure Failure	The City of Charleston have taken steps to invest heavily in their essential services in the past (water, power, transportation, etc.). Even though there have been no records of infrastructure failure events, climate change and its impacts threaten the well-being of these essential services.
HUMAN-CAUSED HAZARDS	
Radiological Emergency	The City of Charleston is not located within a 50-mile radius from any nuclear power plants or facilities (Figure 5.).
Cyber Incidents	South Carolina has experienced one recent cyberattack against the Department of Revenue (DOR) which exposed 3.6 million Social Security numbers. Although officials were notified of this incident, the hackers were able to gain access to the DOR’s servers in Mid-September. Future cyber events could potentially devastate the City’s economy and could have lasting negative impacts.
Civil Disturbance	There has only been one reported civil disturbance incident in the city’s history. The City of Charleston was affected by the South Carolina Civil Disturbance of 1876, when armed groups surrounded the city and threatened to kill everyone. Although no injuries or damages were reported from this incident, the future probability for disturbances to occur again is possible.
Terrorism	Although no severe terrorism attacks have been reported in the City of Charleston, the entire area is still at risk to a future event. Densely populated areas, such as cities, are considered susceptible. Terror events have the potential to affect the human population, buildings and infrastructure, and the economy in the City of Charleston.
	Active threat data from the FBI shows (Figure 5.35) a steady increase in the number of active threat incidents in the United States. Within the last 14 years, there have been at least 14 prominent, high-casualty producing active threat incidents in the U.S. As the population of the City of Charleston continues to grow, the probability of an active threat occurring in the city increases.

5.25.4 Priority Risk Index

In order to draw some meaningful planning conclusions on hazard risk for the city, the results of the hazard profiling process were used to generate countywide hazard classifications according to a “Priority Risk Index” (PRI). The purpose of the PRI is to categorize and prioritize all potential hazards that could impact the city as high, moderate, or low risk. Combined with the asset inventory and quantitative vulnerability assessment provided in the next section, the summary hazard classifications generated using the PRI allows for the prioritization of those high hazard risks for mitigation planning purposes, and more specifically, the identification of hazard mitigation opportunities for the city to consider as part of their proposed mitigation strategy.

The prioritization and categorization of identified hazards for the City of Charleston is based principally on the PRI, a tool used to measure the degree of risk for identified hazards in a particular planning area. The PRI is used to assist the City of Charleston Hazard Mitigation Planning Team in gaining consensus on the determination of those hazards that pose the most significant threat to the city based on a variety of factors. The PRI is not scientifically based but is rather meant to be utilized as an objective planning tool for classifying and prioritizing hazard risks for the city based on standardized criteria.

The application of the PRI results in numerical values that allow identified hazards to be ranked against one another (the higher the PRI value, the greater the hazard risk). PRI values are obtained by assigning varying degrees of risk to five categories for each hazard (probability, impact, spatial extent, warning time, and duration). Each degree of risk has been assigned a value (1 to 4) and an agreed upon weighting factor.

Table 5.33. To calculate the PRI value for a given hazard, the assigned risk value for each category is multiplied by the weighting factor. The sum of all five categories equals the final PRI value, as demonstrated in the example equation below:

$$\text{PRI VALUE} = [(\text{PROBABILITY} \times .30) + (\text{IMPACT} \times .30) + (\text{SPATIAL EXTENT} \times .20) + (\text{WARNING TIME} \times .10) + (\text{DURATION} \times .10)]$$

According to the weighting scheme and point system applied, the highest possible value for any hazard is 4.0. When the scheme is applied for the City of Charleston, the highest PRI value is 3.1 (coastal storms and flooding). Prior to being finalized, PRI values for each identified hazard were reviewed and accepted by the members of the City Hazard Mitigation Planning Team.

Table 5.33: Priority Risk Index Definitions

PRI Category	Degree of Risk			Assigned Weighting Factor
	Level	Criteria	Index Value	
Probability	Unlikely	Less than 1% annual probability	1	30%
	Possible	Between 1 and 10% annual probability	2	
	Likely	Between 10 and 100% annual probability	3	
	Highly Likely	100% annual probability	4	
Impact	Minor	Very few injuries, if any. Only minor property damage and 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 more than one day.	2	
	Critical	Multiple deaths/injuries possible. More than 25% of property in affected area damaged or destroyed. Complete shutdown of critical facilities for more than one 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 for 30 days or more.	4	
Spatial Extent	Negligible	Less than 1% of area affected	1	20%
	Small	Between 1 and 10% of area affected	2	
	Moderate	Between 10 and 50% of area affected	3	
	Large	Between 50 and 100% of area affected	4	
Warning Time	More than 24 hours	Self explanatory	1	10%
	12 to 24 hours	Self explanatory	2	
	6 to 12 hours	Self explanatory	3	
	Less than 6 hours	Self explanatory	4	
Duration	Less than 6 hours	Self explanatory	1	10%
	Less than 24 hours	Self explanatory	2	
	Less than one week	Self explanatory	3	
	More than one week	Self explanatory	4	

**It has been determined that sub-hazard PRI scores will be individually calculated in future updates.

5.25.5 Priority Risk Index Results

Table 5.34 summarizes the degree of risk assigned to each category for all initially identified hazards based on the application of the PRI. Assigned risk levels were based on the detailed hazard profiles developed for this section, as well as input from the City's Hazard Mitigation Planning Team. The results were then used in calculating PRI values and making final determinations for the risk assessment.

Table 5.34: Charleston Priority Risk Index

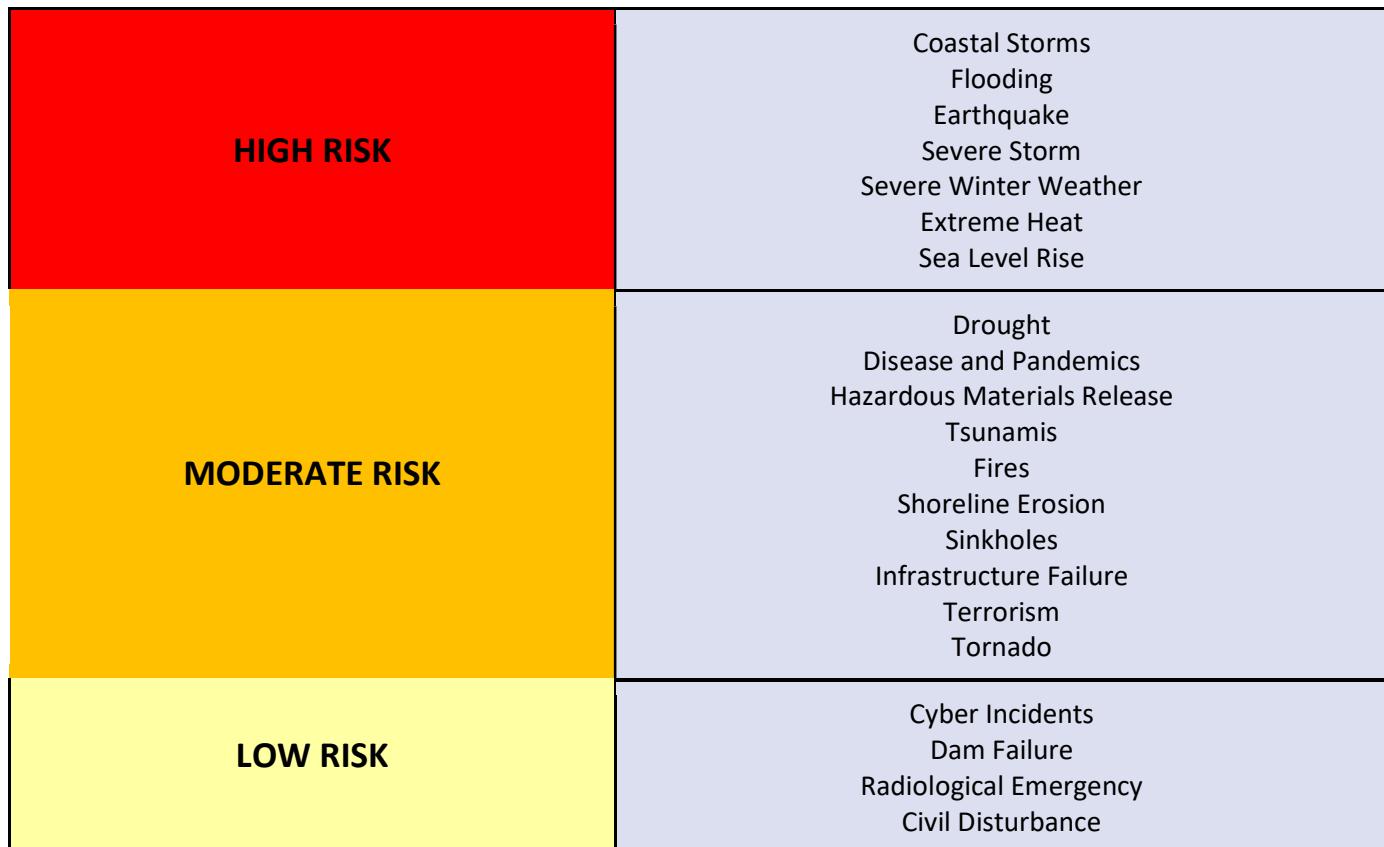
Hazard	Sub hazard(s) Assessed	Category/Degree of Risk						PRI Score
		Probability	Impact	Spatial Extent	Warning Time	Duration		
Natural Hazards								
Coastal Storms	Storm Surge	Likely	Critical	Large	More than 24 hours	More than one week	3.1	
Flooding	Tidal Flooding, King Tides, Heavy Rain	Likely	Critical	Moderate	6-12 hours	More than one week	3.1	
Sea Level Rise		Likely	Limited	Moderate	More than 24 hours	More than one week	2.6	
Earthquake		Likely	Limited	Large	Less than 6 hours	More than one week	2.8	
Tornado		Likely	Minor	Small	Less than 6 hours	Less than one week	2.0	
Fires	Structural Fire Conflagration Wildfires	Likely	Minor	Small	12 – 24 hours	Less than one week	2.1	
Tsunamis		Unlikely	Critical	Moderate	Less than 6 hours	Less than one week	2.2	
Dam Failure		Unlikely	Limited	Small	Less than 6 hours	Less than one week	1.7	
Drought	Water Shortage	Likely	Minor	Large	More than 24 hours	Less than 6 hours	2.5	
Severe Storm	Thunderstorm, Lightning, Hail	Highly Likely	Limited	Moderate	6-12 hours	Less than one week	2.8	
Severe Winter Weather		Possible	Limited	Large	More than 24 hours	Less than one week	2.7	
Shoreline Erosion		Likely	Limited	Small	More than 24 hours	More than one week	2.3	
Extreme Heat		Likely	Limited	Large	More than 24 hours	Less than one week	2.7	
Sinkholes		Likely	Limited	Small	Less than 6 hours	Less than 6 hours	2.1	
Disease and Pandemics		Unlikely	Critical	Large	More than 24 hours	More than one week	2.5	
Technological Hazards								
Hazardous Materials		Likely	Limited	Small	Less than 6 hours	Less than one week	2.2	
Infrastructure Failure		Possible	Limited	Small	Less than 6 hours	More than one week	2.1	
Human-Caused Hazards								
Radiological Emergency		Unlikely	Limited	Small	Less than 6 hours	Less than one week	1.7	

Hazard	Sub hazard(s) Assessed	Category/Degree of Risk						PRI Score
		Probability	Impact	Spatial Extent	Warning Time	Duration		
Cyber Incidents		Possible	Limited	Small	Less than 6 hours	Less than one week	2	
Civil Disturbance		Unlikely	Minor	Small	Less than 6 hours	Less than 24 hours	1.3	
Terrorism	Active Threat	Unlikely	Critical	Small	Less than 6 hours	More than one week	2.1	

5.26 Final Determinations

The conclusions drawn from the hazard profiling process for the City of Charleston, including the PRI results and input from the City Hazard Mitigation Planning Team, resulted in the classification of risk for each identified hazard according to three categories: High Risk, Moderate Risk, and Low Risk (**Table 5.35**). For purposes of these classifications, risk is expressed in relative terms according to the estimated impact that a hazard will have on human life and property throughout the City of Charleston. A more quantitative analysis to estimate potential dollar losses for each hazard has been performed separately and is described in *Section 6: Vulnerability Assessment*. It should be noted that although some hazards are classified below as posing low risk, their occurrence of varying or unprecedented magnitudes is still possible in some cases and their assigned classification will continue to be evaluated during future updates.

Table 5.35: Conclusions on Hazard Risk for the City of Charleston



SECTION 6

VULNERABILITY ASSESSMENT

This section identifies and, where feasible, quantifies the vulnerability of the City of Charleston to the significant hazards identified in the previous sections (*Hazard Identification and Profiles*). It consists of the following subsections:

- 6.1 Overview
- 6.2 Methodology for New Analyses
- 6.3 Explanation of Data Sources
- 6.4 Asset Inventory
- 6.5 Vulnerability Assessment Results
- 6.6 Conclusions on Hazard Vulnerability

44 CFR Requirement

44 CFR Part 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. The description shall include an overall summary of each hazard and its impact on the community. 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 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; (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.

6.1 OVERVIEW

This section builds upon the information provided in Section 4: *Hazard Identification* and Section 5: *Hazard Profiles* by identifying and characterizing an inventory of assets in the City of Charleston.

In 2020, the City of Charleston conducted a detailed vulnerability assessment for the following hazards:

- Floodplain Inundation¹
- Tidal Flooding
- Storm Surge
- Sea Level Rise and Future Tidal Flooding
- Earthquake
- Hazardous Materials (Hazmat)
- Extreme Heat

¹ For the purposes of the City's 2023 Hazard Mitigation Plan, Floodplain Inundation and Flooding refer to the same type of flooding.

- Water Shortage

This assessment reflects the City's commitment to understanding its vulnerability to hazards and emphasizes resilience. The Charleston Regional Hazard Mitigation Plan also contains vulnerability information for the City of Charleston. This plan integrates insights from both documents, often supplemented by additional data on the city's vulnerabilities. For instance, the Lowcountry Health Care Coalition (LCHCC) identifies priority hazards for healthcare providers based on the state's healthcare coalitions.

Where sufficient data is available, further vulnerability assessments have been conducted for each identified hazard, detailing potential impacts and estimated damages. The primary goal of these assessments is to quantify exposure and potential losses, enabling the city to better understand its unique risks and effectively prioritize hazard mitigation actions. This section begins with an overview of the methodologies used for vulnerability assessments, followed by a summary of the asset inventory for the City of Charleston. It concludes with the results of the assessment.

6.1.1 Changing Future Conditions

One of the primary challenges facing communities like the City of Charleston is the impact of changing future conditions, particularly related to climate change. To make informed decisions, it is crucial for communities to evaluate and measure these impacts systematically. Areas with significant development constraints are highly vulnerable to climatic hazards, with those in poverty or facing governance challenges, and lacking access to basic services, being at even greater risk from changing weather patterns, sea level rise, and increased flooding.

The Intergovernmental Panel on Climate Change (IPCC) Sixth Assessment Report highlights that from 2010 to 2020, human mortality from floods, droughts, and storms was 15 times higher in highly vulnerable regions compared to those with very low vulnerability. Future ecosystem vulnerability to climate change will be shaped by the historical and ongoing development of human society, including unsustainable consumption, demographic pressures, and poor management of land, ocean, and water resources. The IPCC also emphasizes that critical infrastructure—such as sanitation, water, health, transport, communications, and energy—will increasingly be at risk unless design standards adapt to changing climate conditions.

6.2 METHODOLOGY FOR NEW ANALYSES

This vulnerability assessment was conducted using a geographic information system (GIS)-based analysis. This approach provides estimates for the potential impact of hazards by using a common, systematic framework for evaluation. A brief description of the approach is provided on the following pages.

6.2.1 GIS-Based Analysis

Some hazards have specified geographic boundaries that permit additional analysis using Geographic Information Systems (GIS). These hazards include:

- Flooding
- Hazardous Materials Release
- Wildfires

The objective of the GIS-based analysis was to estimate the vulnerability of assets, critical facilities, and populations in the City of Charleston to identified hazards using the best available geospatial data. Digital data was collected from local, regional, state, and national sources, including local tax assessor records for individual parcels and georeferenced locations for critical facilities and infrastructure. ESRI® ArcGIS™ 10.6.1 was used to analyze hazard vulnerability by assessing building values within designated hazard areas. The analysis estimated the number of critical facilities at risk and the assessed value of properties potentially affected by these hazards.

Additional vulnerability assessments have been conducted in other studies, primarily found in two key documents: the All-Hazards Vulnerability and Risk Assessment and the Charleston Regional Hazard Mitigation Plan. The All-Hazards Vulnerability and Risk Assessment, prepared by consulting partner Fernleaf, provides a detailed evaluation of the exposure and sensitivity of city assets to various hazards. The full report can be accessed here: <https://www.charleston-sc.gov/1975/All-Hazards-Vulnerability-Risk-Assessment>

The Charleston Regional Hazard Mitigation Plan also contains specific vulnerability assessment information for the city, with detailed methodology outlined in that document. As of December 2022, the Lowcountry Region Healthcare Preparedness Coalition (LCHCC) was ranking hazards at both facility and coalition levels, categorizing them into natural, man-made/intentional, and technological hazards based on associated risk percentages from Health and Human Services' HCC protocol.²

Figure 6:1 below presents a preliminary ranking of these hazards.

a. Ranked Hazards		
<u>Natural</u>	<u>Man-made / Intentional</u>	<u>Technological</u>
<ul style="list-style-type: none"> Tropical Cyclones / Hurricanes / Tropical Weather Flooding Tornado Severe inclement weather Infectious Disease Earthquake Temperature Extremes 	<ul style="list-style-type: none"> Active assailants Cyber attacks / PHI Breach Weapons Infant abduction Hazmat Leaks Train derailment Civil unrest Terrorism / WMD (CBRNE) Labor shortage Supply chain Forensic admission Surge 	<ul style="list-style-type: none"> Transportation Accidents (Motor Vehicle) Aircraft Crashes Hazmat Incidents Communications failure Utility failure Water disruption Unintentional fire IT System Outage HVAC Failure Mass Casualty
b. Highest Risk (Over 20%)		
<u>Natural</u>	<u>Manmade / Intentional</u>	<u>Technological</u>
<ul style="list-style-type: none"> Earthquake Hurricane Inclement Weather Infectious Disease Outbreak Temperature Extremes 	<ul style="list-style-type: none"> Active assailant / shooter Surge Workplace violence 	<ul style="list-style-type: none"> Mass Casualty
c. Hazards with Greatest Impact		
<u>Natural</u>	<u>Manmade / Intentional</u>	<u>Technological</u>
<ul style="list-style-type: none"> Earthquake Infectious Disease Hurricane Inclement Weather Tsunami 	<ul style="list-style-type: none"> Terrorism Workplace Violence 	<ul style="list-style-type: none"> Dam Failure Explosive

Figure 6:1: HHS HVA Hazards Table

² [https://asprtracie.hhs.gov/technical-resources/3/hazard-vulnerability-risk-assessment/1#:~:text=Hazard%20vulnerability%20analysis%20\(HVA\)%20and,the%20CMS%20Emergency%20Preparedness%20Rule](https://asprtracie.hhs.gov/technical-resources/3/hazard-vulnerability-risk-assessment/1#:~:text=Hazard%20vulnerability%20analysis%20(HVA)%20and,the%20CMS%20Emergency%20Preparedness%20Rule)

SECTION 6: VULNERABILITY ASSESSMENT

As of December 2022, and in communications as of February 2023, the LCHCC listed Earthquake, Hurricane, Mass Casualty Incident, Patient Surge, Active Assailant, Temperature Extremes, Workplace Violence/Threats, Inclement Weather, and Infectious Diseases Outbreak as the highest ranking concerns.

Lowcountry Healthcare Coalition

Emergency Management

Hazards - Lowcountry Healthcare Coalition
Hazard Vulnerability Assessment Tool

Alert Type	PROBABILITY	ALERTS	ACTIVATIONS	SEVERITY = (MAGNITUDE - MITIGATION)						RISK
				HUMAN IMPACT	PROPERTY IMPACT	BUSINESS IMPACT	PREPAREDNESS	INTERNAL RESPONSE	EXTERNAL RESPONSE	
	Likelihood this will occur			Possibility of death or injury	Physical losses and damages	Interruption of services	Preplanning	Time, effectiveness, resources	Community/Mutual Aid staff and supplies	* Relative threat
SCORE	0 = N/A 1 = Low 2 = Moderate 3 = High	Number of Alerts	Number of Activations	0 = N/A 1 = Low 2 = Moderate 3 = High	0 = N/A 1 = Low 2 = Moderate 3 = High	0 = N/A 1 = Low 2 = Moderate 3 = High	0 = N/A 1 = High 2 = Moderate 3 = Low	0 = N/A 1 = High 2 = Moderate 3 = Low	0 = N/A 1 = High 2 = Moderate 3 = Low	0 - 100%
Earthquake	2	0	0	3	3	3				20%
Hurricane	2	0	0	3	3	3				20%
Mass Casualty Incident - Trauma	3	0	0	2	2	2				20%
Patient Surge	3	0	0	2	1	3				20%
Active Assailant	3	0	0	3	1	3	0	0	0	23%
Temperature Extremes	3	0	0	3	1	3				23%
Workplace Violence / Threat	3	0	0	2	2	3				23%
Inclement Weather	3	0	0	3	3	3				30%
Infectious Disease Outbreak	3	0	0	3	3	3				30%

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Figure 6-2: LCHCC Relative Risks (February 2023)

Loss estimates provided in this vulnerability assessment are based on best available data and methodologies. The results approximate risk. These estimates should be used to understand relative risk from hazards and potential losses. Uncertainties are inherent in any loss estimation methodology, arising in part from incomplete scientific knowledge concerning natural hazards and their effects on the built environment. Uncertainties also result from approximations and simplifications that are necessary for a comprehensive analysis (e.g., incomplete inventories, non-specific locations, demographics, or economic parameters).

All conclusions are presented in “**Conclusions on Hazard Vulnerability**” at the end of this section. That portion of the plan will also identify high-level summary problem statements about vulnerabilities that the city faces as a result of hazard events. Those identified problems will be addressed by mitigation actions in Sections 8 and 9 of this Plan.

Hazard Prioritization

When it comes to evaluating hazards and determining which hazards a jurisdiction should spend the most time and effort addressing, several factors affect the prioritization. As discussed in *Section 5: Hazard Profiles*, the risk (magnitude, probability, location) of a hazard is one of the primary driving forces that helps determine the relative importance of addressing the potential impacts of a hazard. However, the assessment of a hazard’s risk is generally focused on the hazard itself and how severe or likely it could be within the geographic scope of the study area. This assessment does not necessarily analyze the potential effects of that hazard on humans and the built environment. This is a critical component of planning for hazards since a hazard that does not impact human life, safety, or welfare is typically not considered as important to address through mitigation. The analysis that follows attempts to bring this consideration into the planning process by estimating the impacts on humans and the built environment and prioritizing hazards accordingly.

6.3 EXPLANATION OF DATA SOURCES

6.3.1 Hurricane and Coastal Hazards

The City's All Hazards Vulnerability and Risk Assessment includes vulnerability information for hurricanes and coastal hazards, including storm surge. This assessment included susceptible buildings by the type of structure, and the potential dollar losses associated with the buildings. It also analyzed susceptible populations, such as children and elderly. The Charleston Regional Hazard Mitigation Plan also includes City of Charleston vulnerability information for hurricanes. Those results have not been replicated in this this document.

Storm Surge

The City's All Hazards Vulnerability and Risk Assessment includes vulnerability information for storm surge. This assessment included susceptible buildings by the type of structure, and the potential dollar losses associated with the buildings. It also analyzed susceptible populations, such as children and elderly.

In the All-Hazards Vulnerability and Risk Assessment, storm surge analysis uses the Sea, Lake, and Overland Suge from Hurricanes (SLOSH) Maximum of the Maximum Envelopes of Water (MOM) layer developed by the NOAA NHC, with a focus on Categories 1- 3. This later represents a “worst-case” scenario of flooding resulting from an “ideal” storm. Vulnerability is based on assessing buildings in the inundation extents and the criticality/use of the property (for potential impact), as well as the year the structures were built to determine which BFE applies to buildings on the properties (to determine adaptive capacity).

6.3.2 Earthquakes

The City's All Hazards Vulnerability and Risk Assessment includes vulnerability information for earthquakes. This assessment included susceptible buildings by the type of structure, and the potential dollar losses associated with the buildings. It also analyzed susceptible populations, such as children and elderly. The Charleston Regional Hazard Mitigation Plan also includes City of Charleston vulnerability information for earthquakes. Those results have not been replicated in this this document.

Additionally, the College of Charleston conducted a run of FEMA's HAZUS software in 2021 to replicate the 1886 earthquake so that potential damages to today's building stock could be evaluated should a similar earthquake be experienced. A summary of those results is included in this section.

6.3.3 Flooding

Flood hazard data was obtained from the FEMA Digital Flood Insurance Rate Maps (DFIRMs) as the primary source. This data was used to determine flood vulnerability for Charleston. The data can be used in ArcGIS for mapping purposes and, they identify several features including floodplain boundaries and base flood elevations. Identified areas on the DFIRM represent some features of a Flood Insurance Rate Maps including the 100-year flood areas (1.0-percent annual chance flood), and the 500- year flood areas (0.2-percent annual chance flood). For the vulnerability assessment, local parcel data and critical facilities were overlaid on the 100-year floodplain areas and 500-year floodplain areas. It should be noted that this analysis does not account for building elevation.

The City's All Hazards Vulnerability and Risk Assessment includes vulnerability information for flooding. This assessment included susceptible buildings by the type of structure, and the potential dollar losses associated with the buildings. It also analyzed susceptible populations, such as children and elderly.

Flooding analysis used the most recent floodway, wave action, 100-year floodplain, and 500-year floodplain in the FIRM developed by FEMA to support the NFIP. The analysis provided by Fernleaf as part of the 2020 All-Hazards Vulnerability Assessment focused on identifying assets that have greater potential impact, such as critical assets to where more people could be affected. The analysis also considered how adaptive buildings are based on the year they were built and the BFE requirement in place at the time they were built. The Charleston Regional Hazard Mitigation Plan also includes City of Charleston vulnerability information for flooding. Those results have not been replicated in this document.

Tidal Flooding

The City's All-Hazards Vulnerability and Risk Assessment includes data on tidal flooding vulnerability. It identifies susceptible buildings by structure type and estimates potential financial losses, while also analyzing at-risk populations, such as children and the elderly.

For the tidal flooding analysis, the assessment utilized NOAA's "High Tide Flooding" layer, which indicates areas currently experiencing "minor" flooding at a tide elevation of 4.5 feet above NAVD88 or 7.6 feet above the average daily lower low tide (Mean Lower Low Water) at the Cooper River gauge in Charleston Harbor.

This "minor" flood threshold, established by NOAA, allows for consistent evaluation and communication of tidal flooding impacts nationwide. Notably, this threshold is approximately 7 inches higher than the National Weather Service's (NWS) thresholds used locally for issuing coastal flood advisories, indicating a level of flooding that is "more severe and deeper" than what would be anticipated during an NWS flood watch for minor flooding. The threshold scale used in this assessment can be seen in **Table 6.1** below.

Table 6.1: Tidal Flood Thresholds (ft) Cooper River at Charleston Harbor

Vertical Datum	NOAA Derived			NOAA Official (NWS Advisories)		
	Minor	Moderate	Major	Minor	Moderate	Major
MHHW	1.9	2.8	4.1	1.2	1.7	2.2
MLLW	7.6	8.5	9.8	7	7.5	8
NAVD88	4.5	5.4	6.7	3.9	4.4	4.8

Source: Fernleaf All-Hazards Vulnerability Assessment; NWS; NOAA

The vulnerability assessment focused on identifying assets that have great potential impact to current high tide levels. Higher potential impact was considered for more critical assets or where more people could be affected. Similar to the floodplain inundation assessment, the tidal flooding assessment considered how adaptive buildings are based on the year they were built and the BFE requirement in place at the time they were built. Based on current tidal flooding levels, fewer properties and roads are in harm's way compared to the FEMA Floodplains; however, these tidal flooding events happen more frequently (about 4 times per year, on average, over the last 10 years).

6.3.4 Fires

Wildfires

The data used to determine vulnerability to wildfires in the City of Charleston is based on GIS data called the Southern Wildfire Risk Assessment (SWRA). A specific layer known as the "Wildland Urban Interface" (WUI) was used to determine vulnerability of people and property. This layer uses the key input of housing density to define potential wildfire impacts to people and homes. The WUI Risk Index is then derived from a scale of -1 to -9, with the least negative impact being a -1, and uses flame length to measure fire

intensity. The primary purpose of this data is to highlight areas of concern that may be conducive to mitigation actions. Many assumptions are made, making it not a true probability; however, it does provide a comparison of risk across the city. High-risk areas were overlayed with parcel, building, and population data to estimate vulnerable buildings, potential dollar losses of those buildings, and susceptible populations.

Structural Fires

The data used to determine the City's vulnerability to structural fires is based on existing City and County Risk Assessments and Reports. The Charleston Fire Department's annual report provides a comprehensive overview of the department's activities, achievements, and challenges over the span of one year. The report includes data on response times, call volumes, types of incidents, fire prevention initiatives, training programs, equipment upgrades, and community engagement efforts. The report outlines the department's efforts to enhance firefighter safety, improve operational efficiency, and heighten public safety. The report provides insights into emerging trends, challenges, and future priorities for the Charleston Fire Department.

The Charleston Fire Department Community Risk Assessment conducted as part of the reaccreditation process is intended to evaluate specific risks and needs of the community by the department. Through analysis of demographic data, incident trends, existing infrastructure, and geographic and topographic considerations, the assessment identifies key areas of risk and vulnerability within Charleston's diverse neighborhoods. More specifically, CDF assessed risk by identifying potential hazards and potential adverse impact for the service demands in each response area. Response times, census data (including total population), and vulnerable populations (0-5 years of age and over 55) were variable used to calculate community risk. Additionally, Geographic Information System (GIS) was used to recognize an increased or decreased risk on structures based on:

1. Community impact
2. Use of building, building construction, and number of stories
3. Total square footage
4. Accessibility to fire hydrants, fire flow, and critical infrastructure

The Charleston County Risk Assessment 2016/2017 provides a detailed analysis of the potential hazards and vulnerabilities facing the county, aiming to inform emergency planning, preparedness, and mitigation efforts. The assessment used a multi-faceted approach combining historical data analysis, stakeholder discussions, risk mapping, scenario planning, and hazard modeling to identify and prioritize key risks. This assessment identifies structural fires as a significant concern highlighting the vulnerabilities and risks associated with fire incidents in the county.

The Lowcountry Healthcare Preparedness Coalition Hazard and Vulnerability Assessment (HVA) is a living tool that was developed to analyze the relationship between individual healthcare facility and the overall healthcare delivery chain within the Lowcountry region. The survey employs a systematic methodology to evaluate risks and threats present in healthcare facilities across the region on an annual basis. The potential hazards, threats, and vulnerabilities were identified through engagement with healthcare stakeholders, emergency response partners/personnel, and subject matter experts, which includes unintended fire (internal and external). Each facility must rank the following considerations when completing the HVA for each identified hazard:

1. Probability – Likelihood this will occur (Options: N/A, Low, Moderate, High)
2. Alerts – Number of alerts (specific to each facility)
3. Activations – Number of activations (specific to each facility)

4. Preparedness – Preplanning (Options: N/A, Low, Moderate, High)
5. Internal Response – Time, effectiveness, resources (Options: N/A, Low, Moderate, High)
6. External Response – Community/mutual aid staff and supplies (Options: N/A, Low, Moderate, High)
7. Human Impact – Possibility of death or injury (Options: N/A, Low, Moderate, High)
8. Property Impact – Physical losses or damages (Options: N/A, Low, Moderate, High)
9. Business Impact – Interruption of services (Options: N/A, Low, Moderate, High)

Once these considerations have been ranked using the appropriate metrics, the survey will automatically generate risk (relative threat) for each of the identified hazards, threats, or vulnerabilities which can range from 0-100%. The completed HVAs completed at the individual level are intended to help better understand risks that threaten the region's overall healthcare delivery chain.

Conflagration

The Charleston City Plan (2021) highlights the importance of investment into older communities with aging infrastructure to heighten public safety. The plan utilized a comprehensive and inclusive methodology to guide the city's sustainable development and growth initiatives. The planning process involved extensive community engagement, data analysis, stakeholder discussions, and subject matter expert input to identify challenges, opportunities, and priorities for the city's future. Key methods used include land use analysis, economic forecasting, transportation planning, environmental impact assessments, and infrastructure planning to ensure a holistic and integrated approach. By combining qualitative and quantitative data, scenario planning, and public feedback, the Charleston City Plan serves as a roadmap for guiding policy decisions, investments, and development initiatives that align with the city's long-term vision.

6.3.5 Hazardous Materials Release

Hazardous materials release incidents can occur in both fixed facilities and through mobile transportation. For the fixed incident analysis, Toxic Release Inventory (TRI) data can be used. The Toxic Release Inventory is a publicly available database from the federal Environmental Protection Agency (EPA) that contains information on toxic chemicals, releases, and other waste management activities reported annually by certain covered industry groups, as well as federal facilities. This inventory was established under the Emergency Planning and Community Right-to-Know Act of 1986 (EPCRA) and was further expanded by the Pollution Prevention Act of 1990. Facilities that meet certain activity thresholds must annually report their releases and other waste management activities for listed toxic chemicals to the EPA and to their state or tribal entity. A facility must report if it meets the following criteria:

- The facility falls within one of the following industrial categories: manufacturing; metal mining; coal mining; electric generating facilities that combust coal and/or oil; chemical wholesale distributors; petroleum terminals and bulk storage facilities; RCRA Subtitle C treatment, storage, and disposal (TSD) facilities; and solvent recovery services;
- Has 10 or more full-time employee equivalents; and
- Manufactures or processes more than 25,000 pounds or otherwise uses more than 10,000 pounds of any listed chemical during the calendar year. Persistent, bio-accumulative, and toxic (PBT) chemicals are subject to different thresholds of 10 pounds, 100 pounds, or 0.1 grams depending on the chemical.

Fixed facility Hazmat vulnerability was not run for this report but will be included in future updates.

For the mobile hazardous materials incident analysis, transportation data including major highways and railroads were obtained from the South Carolina Department of Transportation. This data is ArcGIS compatible, lending itself to buffer analysis to determine risk.

6.3.6 Sea Level Rise

The City's All Hazards Vulnerability and Risk Assessment includes vulnerability information for sea level risk. This assessment included susceptible buildings by the type of structure, and the potential dollar losses associated with the buildings. It also analyzed susceptible populations, such as children and elderly. The Charleston Regional Hazard Mitigation Plan also includes City of Charleston vulnerability information for sea level rise. Those results have not been replicated in this this document.

To assess the effects of relative sea level rise, the All Hazards Vulnerability and Risk Assessment evaluated sea level changes of different thresholds and mapped on top of current tidal datums to map the extent of permanent inundation. In the vulnerability assessment, multiple sea level thresholds are considered to provide insight into permanent inundation: 3 ft for vulnerability and risk and 5 ft for exposure only. These two levels are added to the current multi-year average daily higher high tide (MHHW), as mapped in the NOAA Sea Level Rise Viewer. The 3 ft threshold (3 ft plus current MHHW) is consistent with the city's Flooding and Sea Level Rise Strategy.

6.4 ASSET INVENTORY

An inventory of geo-referenced assets within Charleston was compiled in order to identify and characterize those properties potentially at risk to the identified hazards.³ By understanding the type and number of assets that exist and where they are in relation to known hazard areas, the relative risk and vulnerability for such assets can be assessed. Under this assessment, two categories of physical assets were created and then further assessed through GIS analysis. Additionally, social assets are addressed to determine population at risk to the identified hazards. These are presented below in **6.4.2 Social Vulnerability**.

6.4.1 Physical and Improved Assets

The two categories of physical assets consist of:

1. **Improved Property:** Includes all improved properties in the City of Charleston according to local parcel data. The information has been expressed in terms of the number of parcels and total assessed value of improvements (buildings) that may be exposed to the identified hazards.
2. **Critical Facilities:** The city provided critical facility data that were used in this section. Identified critical facilities are fire stations, police stations, medical care facilities, schools, government facilities, emergency operation centers, or other important buildings. It should be noted that this listing may not be all-inclusive for assets located in the city limits, but it is anticipated that it will be expanded during future plan updates as more geo-referenced data becomes available for use in GIS analysis.

Table 6.2 lists the number of parcels for the City of Charleston.

Table 6.2: Improved Property in the City of Charleston

Indicator	Value
Number of Parcels	66,299

Source: City of Charleston, Parcel Dataset

Table 6.3Error! Reference source not found. shows the number of each property type represented in the Charleston parcel data.

Table 6.3: Building Counts for the City of Charleston

Occupancy Type	Number
Commercial	3,368
Residential	61,781
Other	1,150
Total	66,299

Source: City of Charleston, Building Footprint Dataset

³ While potentially not all-inclusive, “georeferenced” assets include those assets for which specific location data is readily available for connecting the asset to a specific geographic location for purposes of GIS analysis.

The following table lists the fire stations, police stations, hospitals, assisted-living facilities, and public schools located in the City of Charleston. In addition,

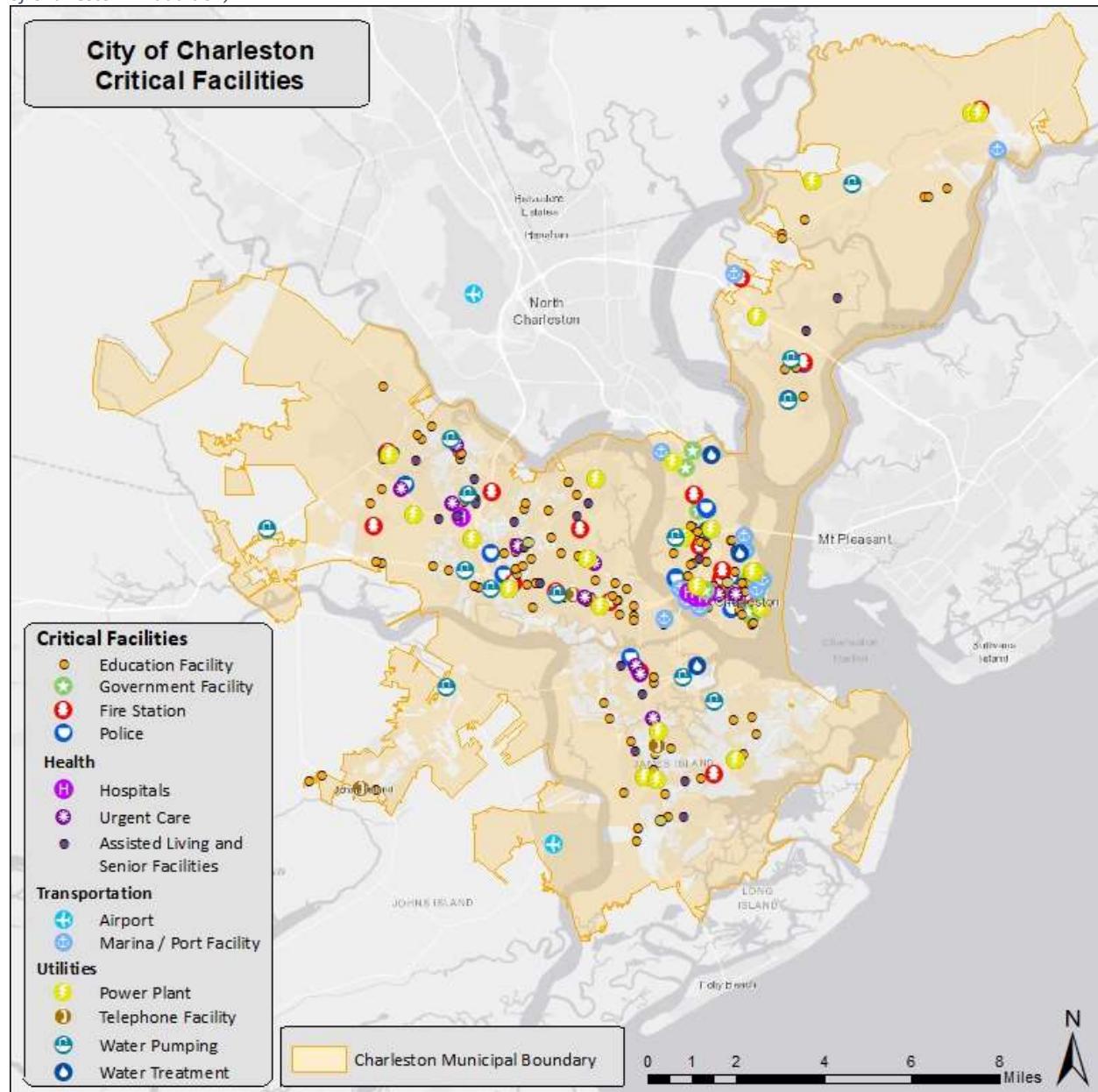


Figure 6.3: Critical Facilities **Figure 6.3: Critical Facilities** shows the locations of critical facilities in the City of Charleston. **Table 6.11** at the end of this section, shows a complete list of the critical facilities by name, as well as the hazards that affect each facility.

Table 6.4: Critical Facility Inventory

Type	Total Count
Fire Stations	18
Police Stations/Facilities (Including Substations)	14

Type	Total Count
Hospitals	5
Urgent Care Facilities	11
Assisted Living and Senior Facilities	21
Daycare/Preschools	63
Elementary Schools	24
High Schools	8
Middle Schools	6
Mixed Grade Level Schools	20
Colleges/Universities	4
Transportation Facilities	14
Utilities	46
Total Critical Facilities	268

Source: City of Charleston, Critical Facilities Dataset

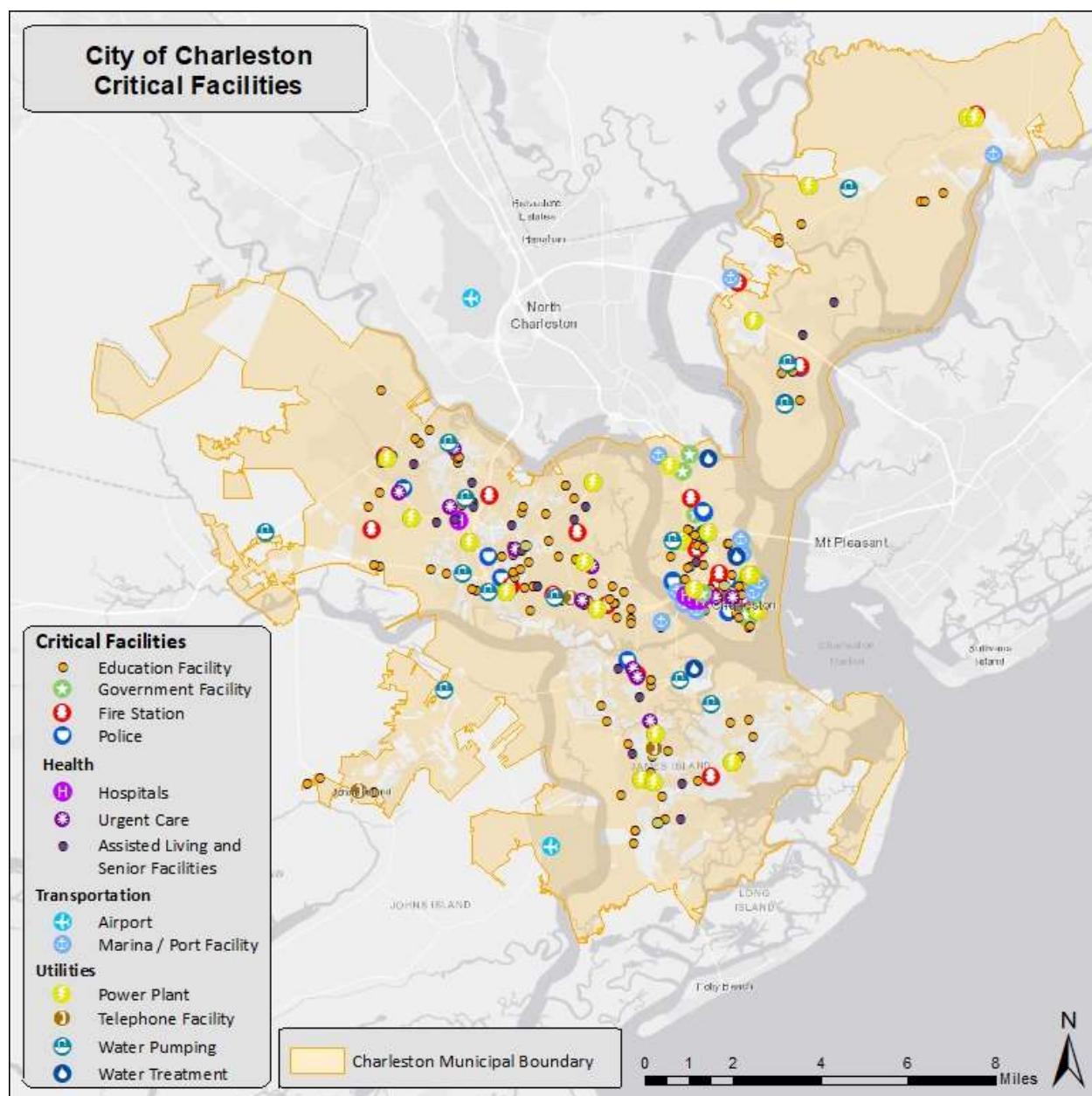


Figure 6.3: Critical Facilities

Source: City of Charleston, Critical Facilities Dataset

6.4.2 Social Vulnerability

In addition to identifying those assets potentially at risk to identified hazards, it is important to identify and assess those segments of the resident population in the City of Charleston that are potentially at risk to these hazards.

The total population in the City of Charleston, as of 2020, according to US Census data was 150,903. The population estimates are updated using the most recent census tables from 2020. Additional population estimates are presented in Section 3: Community Profile.

Previous planning efforts undertaken by the city have resulted in detailed analyses of social vulnerability. One such example was the NOAA HeatWatch program in which the city participated⁴. For that project, the following social vulnerability components were mapped:

- Overall CDC Social Vulnerability Index (SVI)
- ACS Median Household Income Variables
- ACS Educational Attainment Variables (Percent of population 25 or older whose highest education completed is less than high school)
- ACS Population Variables (Percent of Population that is 65 years and over)
- ACS Health Insurance Coverage Variables (Percent of population with no health insurance coverage)
- CDC Life Expectancy

Social vulnerability maps from the HeatWatch program and report are included in Appendix F for more detailed viewing and analysis. Future updates of this plan will work to integrate social vulnerability components, maps and analysis into the hazard mitigation plan.

6.4.3. Development Trends and Changes in Vulnerability

Since 2000, the City of Charleston has experienced relatively strong growth and development. **Table 6.5** shows population growth estimates for the city from 2010 to 2020 based on the US Census

Annual Estimates of Resident Population and 2020 population estimates.

Table 6.5: Population Growth for the City of Charleston

2010	2012	2014	2016	2018	2020	% Change 2010-2020
120,760	125,331	129,592	134,637	136,359	150,903	24.9%

Source: US Census Bureau

Based on the above data, the rate of residential development and population growth for the city since 2010 has increased. Changes in development will impact the city's vulnerability since the last update. The greater the population, the greater the risk is that persons are impacted by hazards and the greater number of assets potentially at risk. It should be noted that if future development occurs in vulnerable areas, populations and infrastructure will be exposed to potential hazards.

⁴ <https://www.charleston-sc.gov/2513/HeatWatch-Charleston-2021>

6.5 VULNERABILITY ASSESSMENT RESULTS

As noted earlier, only hazards with a specific geographic boundary, modeling tool, or sufficient historical data allow for further analysis. Those results are presented here. All other hazards are assumed to impact the entire city (drought, extreme heat, severe storms, severe winter weather) or, due to lack of data, analysis would not lead to credible results (sinkholes, erosion, dam failure, disease and pandemic terrorism, and cyber). The City's total exposure for critical facilities is presented in **Table 6.11**.

The hazards presented in this subsection include hurricanes, tornadoes, earthquakes, flooding, wildfires, and hazardous materials release.

6.5.1 Hurricane and Coastal Hazards

Historical evidence indicates that the City of Charleston is at risk to the hurricane and tropical storm hazard, mostly due to its proximity to the Atlantic Coast. Most recently, Hurricane Idalia in 2023 impacted the City. Many more storm tracks have come near or traversed through the region, as shown, and discussed in Section 5: *Hazard Profiles*.

Numerous secondary hazards, such as erosion, flooding, tornadoes, and high winds tend to be a result of hurricanes or tropical storms. These cumulative effects often make potential loss estimates difficult to calculate and track.

SOCIAL VULNERABILITY

It can be assumed that the entire population is at risk to the hurricane and tropical storm hazard. However, given the social inequities across the City of Charleston, some residents may be able to cope with and respond to these hazard occurrences more easily than others and some will experience greater impacts than others. Charleston County has the second highest “social vulnerability score” of all the counties in South Carolina.⁵

CRITICAL FACILITIES

Given equal vulnerability across the City of Charleston, all critical facilities are at risk to hurricane winds. Although some buildings may perform better than others in the face of such an event due to construction, age, and other factors, determining individual building response is beyond the scope of this plan. However, this plan will consider mitigation actions for vulnerable structures, including critical facilities, to reduce the impacts of the hurricane wind hazard. A list of specific critical facilities and their associated risk can be found in **Table 6.11** at the end of this section.

In conclusion, a hurricane event has the potential to impact many existing and future buildings, critical facilities, and populations in the City of Charleston. Hurricane events can cause substantial damage in their wake including fatalities, extensive debris clean-up, and extended power outages.

⁵ SCEMD, 2013.

6.5.2 Earthquakes

An earthquake could potentially impact all existing and future buildings, facilities, and populations in the City of Charleston. Though minor earthquakes are often recorded but not felt, they may rattle breakables and cause minimal damage. Major earthquakes have potential to damage structures and there is concern about another large earthquake impacting the area such as the Charleston earthquake of 1886.

The Modified Mercalli Intensity Scale is used to measure the potential effects of earthquakes on land, population, and built structures. **Figure 6.4** below shows the highest likely earthquake intensity by county in South Carolina based on the most adverse geologic conditions. Charleston County has a relatively high intensity rating on the Modified Mercalli Intensity Scale, representing an increased vulnerability for the City of Charleston.

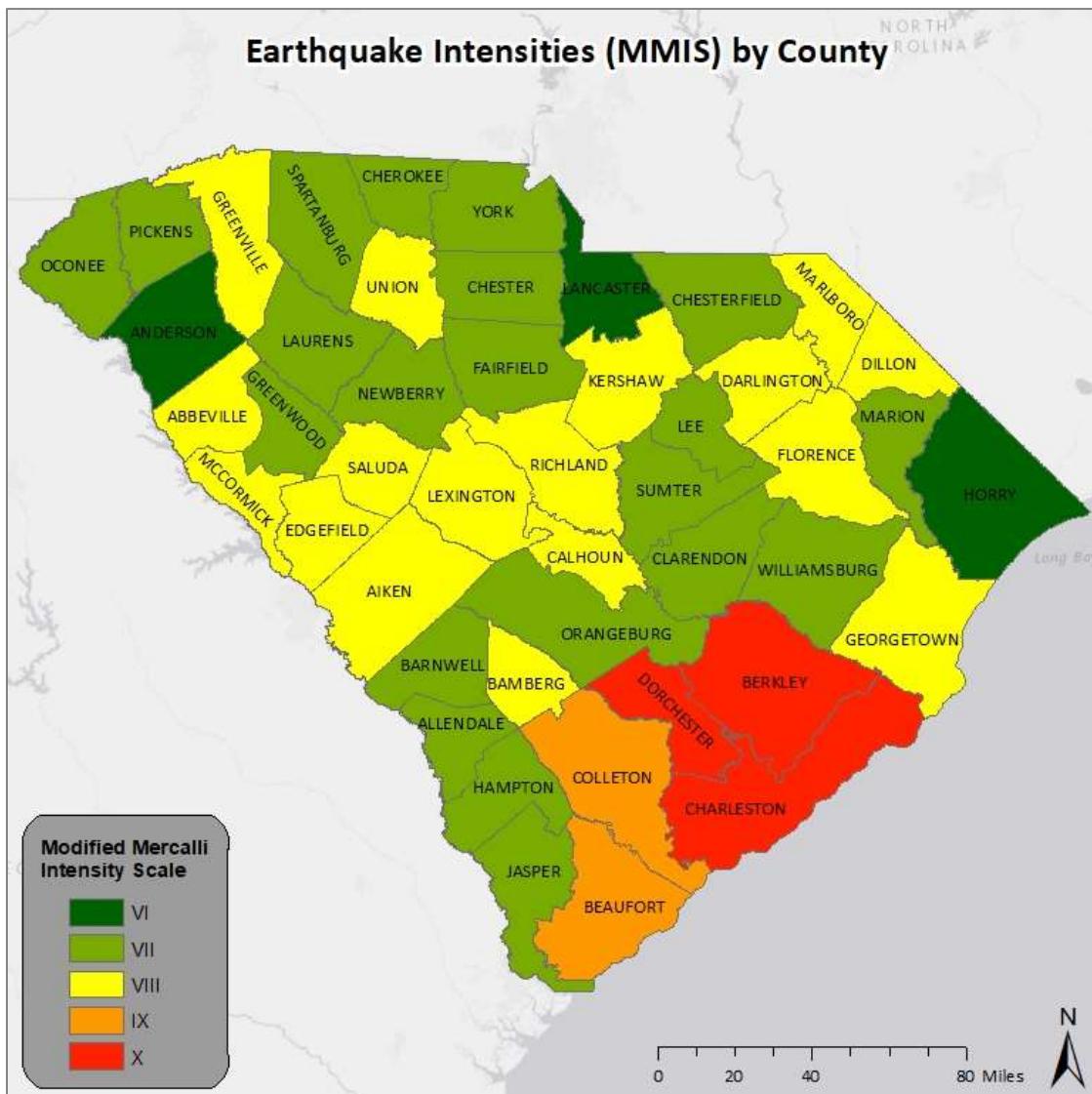


Figure 6.4: South Carolina Potential Earthquake Intensity

Source: South Carolina Department of Natural Resources

In 2021 the College of Charleston modeled a replication of the Charleston Earthquake of 1886 using FEMA's Hazus software to determine vulnerability and loss estimates to earthquakes for the City of Charleston.

This was done to help leadership within the region better understand the potential impacts that could be expected, should a similar event occur today. **Table 6.7** provides summary results from that analysis which indicate that a similar event today would, in fact have significant impacts on the city.

Table 6.6: Percent of Direct Earthquake Damage by Occupancy Type if Charleston Earthquake of 1886 were to Occur in Charleston Today

Occupancy Type	No Expected Damage	Slight Damage	Moderate Damage	Extensive Damage	Complete Damage
Agriculture	0.04	0.06	0.21	0.61	0.91
Commercial	.046	0.60	2.26	9.37	23.39
Education	0.02	0.02	0.09	0.39	1.00
Government	0.01	0.01	0.05	0.25	0.78
Industrial	0.10	0.12	0.48	2.21	6.25
Other Residential	5.15	6.68	10.36	22.41	39.79
Religion	0.34	0.34	0.45	0.76	1.52
Single Family	93.89	92.15	86.12	64.01	26.36
TOTAL OUT OF 78,571	28,234	35,324	35,734	17,650	25,188

Source: College of Charleston and FEMA Hazus software

SOCIAL VULNERABILITY

It can be assumed that the entire population is at risk to the earthquake hazard, however, given the social inequities across the City of Charleston, some residents may be able to cope with and respond to earthquake occurrences more easily than others.

CRITICAL FACILITIES

All critical facilities should still be considered at-risk to minor damage should an event occur. A list of all individual critical facilities in the city can be found in **Table 6.9**.

In conclusion, severe impacts of earthquakes may result in debris clean-up, service disruption, building collapse, and fatalities. Specific vulnerabilities for assets will be greatly dependent on their individual design and the mitigation measures in place, where appropriate. Such site-specific vulnerability determinations are outside the scope of this assessment but will be considered during future plan updates if data becomes available. Furthermore, mitigation actions to address earthquake vulnerability will be considered.

6.5.3 Flooding

In order to assess flood risk, a GIS-based analysis was used to estimate exposure to flood events using Digital Flood Insurance Rate Map (DFIRM) data in combination with local tax assessor records from Charleston County. The determination of assessed value at-risk (exposure) was calculated using GIS analysis by summing the total assessed building values for only those improved properties that were confirmed to be located within an identified floodplain. **Table 6.7** presents the potential at-risk property. Both the number of parcels and the approximate value are presented.

Table 6.7: Estimated Number and Value of Parcels Intersecting the Flood Hazard

	Approx. Number of Parcels	Approx. Value of Parcels	Approx. Improvement Value of Parcels
100-Year (AE and VE)	24,422	\$15,670,885,390	\$ 9,988,860,080
500-Year (Shaded X)	13,739	\$7,127,380,142	\$ 4,635,247,305

Source: FEMA NFHL Dataset; City of Charleston

Additionally, a detailed flood vulnerability assessment was conducted by team partner Fernleaf, LLC. The full results from that assessment can be found at: <https://www.charleston-sc.gov/1975/All-Hazards-Vulnerability-Risk-Assessmen>

SOCIAL VULNERABILITY

It can be assumed that populations located in special flood hazard areas, and some located in areas of known and/or frequent flooding that may not show up on a FEMA FIRM are at risk to the flooding hazard. However, given the social inequities across the City of Charlston, some residents may be able to cope with and respond to occurrences of flooding more easily than others and some will experience greater impacts than others.

CRITICAL FACILITIES

The critical facility analysis identified 199 facilities within the City of Charleston's 1.0% and 2.0% annual chance floodplains, based on FEMA DFIRM boundaries and GIS analysis. This assessment does not account for building elevation, which could affect risk levels. More details about these facilities are provided in Table 6.11. Of these, 95 facilities are situated in the 1% flood zone, making them particularly vulnerable.

In summary, flooding poses a significant threat to existing and future buildings, facilities, and populations in Charleston, with some areas at greater risk. The Fernleaf analysis found that 48% of all critical facilities and 90% of government-owned properties with high vulnerability are in the Downtown/Peninsula area, where most businesses and employees at risk of flooding are concentrated.

All structures in floodplains face risk, although elevated buildings are somewhat safer. The analysis considered both the 100-year and 500-year FEMA-regulated floodplain boundaries, but more severe flooding events could occur outside these zones, and urban (flash) flooding may affect additional structures. Future updates should include site-specific vulnerability assessments, particularly in areas prone to repetitive flooding, to explore potential mitigation strategies.

6.5.4 Fires

Wildfires

As described in the *Hazard Profiles*, the City of Charleston is susceptible to wildfire events. To estimate exposure to wildfire, the Wildland Urban Interface (WUI) Risk Index for the City was obtained through the Southern Wildfire Risk Assessment. The WUI uses a Response Function modeling approach and rates the potential impact of a wildfire on people and their homes. The index ranges from -1 to -9, with -9 being the most negative impact. For example, an area with high housing density and high flame lengths are rated -9, while an area with low housing density and low flame lengths are rated -1. At-risk areas fall within the range of -7 to -9. This index was layered with parcel data using GIS analysis.

Table 6.8 below shows the number of parcels and buildings, and the value of the buildings, located in the “High” WUI Risk Areas.

Table 6.8: Charleston Parcels and Buildings Located in High WUI Risk Areas

Approx. Number of Parcels	Approx. Value of Parcels	Approx. Improvement Value of Parcels
7,288	\$3,396,498,953	\$2,259,738,319

Source: Southern Wildfire Risk Assessment

The city contains lands that fall into the higher risk value. Overall, there is a high-to-medium wildfire ignition density risk index in the city which is somewhat higher than other areas in South Carolina.

SOCIAL VULNERABILITY

Even though not all areas have equal vulnerability, there is some susceptibility across the entire area of Charleston. It is assumed that the total population is at risk to the wildfire hazard. Determining the exact number of people in certain wildfire zones is difficult with existing data and could be misleading.

CRITICAL FACILITIES

Seven critical facilities in the City of Charleston fall within the high wildfire risk area (-7 or higher). Table 6.11 provides more information about those facilities.

Structural Fires

As noted in the *Hazard Profiles*, structural fires account for approximately 30% of all fires in the City of Charleston. The 2022 CFD Annual Report includes an interactive map that displays the location and the incident type. The map indicates that fire impact is city-wide. However, the Peninsula appears to have experienced a significant number of fires when compared to its adjacent counterparts and in relationship to the area’s size.

SOCIAL VULNERABILITY

Based on FEMA’S National Risk Index, which uses CDC’s Social Vulnerability Index (SVI), social vulnerability on the Peninsula ranges from Very High (90.32) to Very Low (1.8). To better align with the fire department’s methodology when calculating risk, nursing homes and daycare centers were identified to further refine vulnerable populations on the Peninsula (CFD defined vulnerable populations as person 0-5 years of age or 55 years and over). There are a total of thirteen daycare centers on the Peninsula and one nursing home.

CRITICAL FACILITIES

The Fernleaf analysis revealed that 48% of all critical facilities and 90% of all government owned properties with high combined vulnerability and risk are in the Downtown/Peninsula area meaning these properties are also at risk of structural fire. As mentioned in the *Hazard Profiles*, the Peninsula/Downtown Charleston is particularly vulnerable to structural fires due to the high urban density, historical architecture, aging infrastructure, and accessibility challenges. In terms of aging infrastructure, the secondary pipes in Downtown date back to the 1930s, which heightens concern for water source limitations. Additionally, the Medical District is connected to said aging infrastructure.

To better align with the Lowcountry Healthcare Preparedness Coalition Hazard and Vulnerability Assessment, healthcare facilities were identified on the Peninsula. There are four healthcare facilities on the Peninsula, which include:

1. Citadel Infirmary
2. Musc Medical Center
3. Ralph H. Johnson Department of Veterans Affairs Medical Center
4. Roper Hospital

Conflagration

Conflagration risk and vulnerability largely align with the information provided for structural fires. More specifically, the high occurrence of fires (including structural fires) along with the built infrastructure (high density, historical architecture, aging infrastructure) in the Downtown/Peninsula areas heightens concern for conflagration.

SOCIAL VULNERABILITY

The presence of vulnerable populations when considering healthcare, daycare, and nursing home facilities located in Downtown/Peninsula areas poses a significant challenge in the event of a fire emergency such as conflagration. Evacuating these vulnerable populations safely and efficiently during a fire incident may be more complex and time-consuming compared to other buildings/facilities. It is imperative to implement robust safety measures such as fire prevention protocols, staff training, emergency response plans, evacuation drills, and fire suppression systems to ensure the safety of all individuals within healthcare, daycare, and nursing home facilities.

CRITICAL FACILITIES

Based on the Lowcountry Healthcare Preparedness Coalition Hazard and Vulnerability Assessment (HVA), the prevalence of healthcare facilities in Downtown, and the Medical District's aging water supply system, it is worth noting that the likelihood of conflagration in a hospital can be considered heightened due to the unique characteristics and activities associated with healthcare facilities. Hospitals house many individuals, including patients, staff, and visitors, making them high-density environments where the potential for fire-related incidents is increased. Additionally, hospitals contain a variety of fire hazards, such as medical equipment, flammable substances, and electrical systems that could contribute to the rapid spread of fire.

6.5.5 Hazardous Substances

As outlined in the Hazard Profiles, the City of Charleston is vulnerable to hazardous substance events, which can have widespread impacts across the region.

Most hazardous incidents are contained and managed before causing property damage or endangering lives. However, they can lead to severe consequences, including multiple fatalities, prolonged facility closures (30 days or more), and significant damage to over 50% of affected properties. Such incidents may release solid, liquid, or gaseous contaminants from fixed or mobile containers, and weather conditions can influence the dispersion of these hazards, potentially affecting areas far beyond the initial incident site. Non-compliance with fire and building codes, along with inadequate maintenance of fire safety and containment systems, can exacerbate the damage from hazardous material releases. The duration of these incidents can range from hours to days, often with little to no warning.

To assess vulnerability, GIS intersection analysis was employed for both fixed and mobile sources. Two buffer sizes—0.5 mile and 1 mile—were used to represent immediate (primary) and secondary impacts. Sites for primary and secondary impacts were selected following FEMA 426 guidelines and engineering judgment. For the mobile analysis, major transportation routes, including interstate highways, U.S. highways, state highways, and railroads, were used to identify areas where hazardous materials are transported, posing risks to people and property. **Figure 6:5:** Charleston Mobile Hazmat Risk shows the areas used for mobile toxic release buffer analysis. The results indicate the approximate number of parcels, improved value, as shown in **Table 6.9** (mobile road sites and mobile railroad sites)⁶.

⁶ Note that parcels included in the 1-mile analysis are also included in the 0.5-mile analysis.

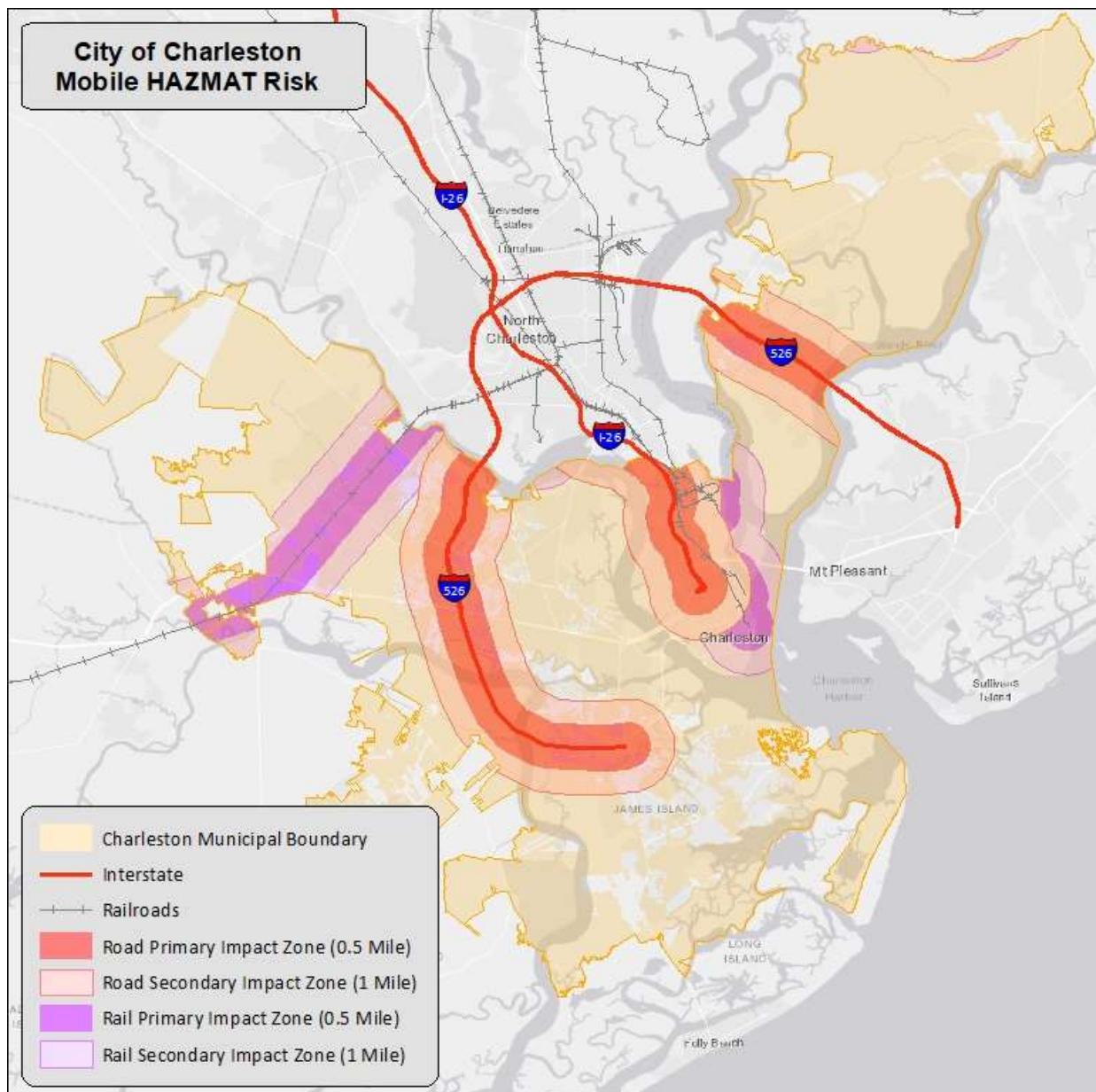


Figure 6:5: Charleston Mobile Hazmat Risk. Note: Interstate 526 has not yet been built on Johns or James Island as indicated on the map above, but is for future consideration. More information on this project can be found here: [Project Overview — Mark Clark Extension \(scdotmarkclark.com\)](http://Project Overview — Mark Clark Extension (scdotmarkclark.com))

Table 6.9: Mobile (Road and Rail) HAZMAT Vulnerability

		Approx. Number of Parcels	Approximate Value of Parcels	Approximate Improvement Value of Parcels
Roads	Primary Impact Zone	9,276	\$5,196,180,192	\$3,404,618,227
	Secondary Impact Zone	7,551	\$4,764,700,554	\$3,114,704,176
Rail	Primary Impact Zone	6,522	\$5,564,377,632	\$3,239,123,591
	Secondary Impact Zone	8,147	\$5,274,165,612	\$3,216,450,508

SOCIAL VULNERABILITY

Given high susceptibility across the entire city, it is assumed that the total population is at risk to hazardous materials incidents. It should be noted that areas of population concentration may be at an elevated risk due to a greater burden to evacuate population quickly.

CRITICAL FACILITIES

Mobile Analysis:

The critical facility analysis for mobile HAZAT vulnerability revealed that there are 59 critical facilities located in the road primary impact zone (0.5 miles) and 77 critical facilities in the secondary impact zone (1 mile). There are 52 critical facilities in the primary impact zone for rail mobile HAZMAT (0.5 miles) and 36 critical facilities in the secondary impact zone (1 mile). Although this is a worst-case scenario model, it indicates that a large portion of the critical facilities in the City of Charleston are vulnerable to a potential mobile HAZMAT incident. **Table 6.10** provides a summary of the types of critical facilities located in the buffer areas. A list of specific critical facilities and their associated risk can be found in **Table 6.11** at the end of this section.

Table 6.10: Critical Facilities Located in Road and Rail HAZMAT Buffer Areas

# Critical Facilities	Road		Rail	
	Primary Impact Zone (0.5 miles)	Secondary Impact Zone (1 mile)	Primary Impact Zone (0.5 miles)	Secondary Impact Zone (1 mile)
Education	23	36	19	16
Government	3	5	9	2
Health	10	15	1	5
Public Safety	12	6	9	7
Transportation	1	3	6	0
Utilities	10	11	8	6

Source: SC Department of Transportation; City of Charleston

In conclusion, a hazardous material incident has the potential to impact many existing and future buildings, critical facilities, and populations in the City of Charleston. Those areas in a primary buffer are at the highest risk, though all areas carry some vulnerability due to variations in conditions that could alter the impact area such direction and speed of wind, volume of release, etc.

6.6 CONCLUSIONS ON HAZARD VULNERABILITY

The results of this vulnerability assessment are useful in at least three ways:

- Improving our understanding of the risk associated with the natural hazards that can impact the City of Charleston through better understanding of the complexities and dynamics of risk, how levels of risk can be measured and compared, and the myriad of factors that influence risk. An understanding of these relationships is critical in making balanced and informed decisions on managing the risk.
- Providing a baseline for policy development and comparison of mitigation alternatives. The data used for this analysis presents a current picture of risk in the City of Charleston. Updating this risk “snapshot” with future data will enable comparison of the changes in risk with time. Baselines of this type can support the objective analysis of policy and program options for risk reduction in the City.
- Comparing the risk among the natural hazards addressed. The ability to quantify the risk to all these hazards relative to one another helps in a balanced, multi-hazard approach to risk management at each level of governing authority. This ranking provides a systematic framework to compare and prioritize the very disparate natural hazards that are present in the City of Charleston. This final step in the risk assessment provides the necessary information for local officials to craft a mitigation strategy to focus resources on only those hazards that pose the most threat to the city.

Exposure to hazards can be an indicator of vulnerability. Economic exposure can be identified through locally assessed values for improvements (buildings), and social exposure can be identified by estimating the population exposed to each hazard. This information is especially important for decision-makers to use in planning for evacuation or other public safety related needs.

The types of assets included in these analyses include all building types in Charleston. Specific information about the types of assets that are vulnerable to the identified hazards is included in each hazard subsection (for example, all building types are considered at risk to the winter storm hazard and commercial, residential, and government owned facilities are at risk to repetitive flooding, etc).

As noted previously, all existing and future buildings and populations (including critical facilities) are vulnerable to natural hazards including drought, hurricane and coastal hazards, tornadoes/thunderstorms, and severe winter weather. Some buildings may be more vulnerable to these hazards based on locations, construction, and building type. **Table 6.11** shows the critical facilities vulnerable to additional hazards analyzed in this section. The table lists those assets that are determined to be exposed to each of the identified hazards (marked with an “X”)

Based on the vulnerability assessment previously conducted for the city and evaluated by the city’s Hazard Mitigation Planning Team, the following key findings (or problem statements) have been identified to summarize vulnerability for the city.

- Based on the total number of assets, the highest levels of vulnerability citywide are to the hazards of floodplain inundation, storm surge, and earthquake.
- More than half (52%) of all flood-prone properties in the city have buildings that were built before any floodplain development requirements were in place.

- While properties are prone to flooding throughout the city, some areas have much higher levels of vulnerability and risk—especially for commercial property, critical facilities, and government-owned property.
- Storm surge has the potential to impact almost any area of the city. A large storm surge event could have devastating impacts to the core systems and assets that keep the city functioning.
- While fewer assets are vulnerable to current tidal flooding and hazmat hazards, they occur most frequently.
- Understanding the cumulative effect of hazard events is important.
- The city could face increasing risk due to several factors (both climate and non-climate), particularly sea level rise, increasing frequency and severity of heavy precipitation events, and land use conversion.
- A primary impact from sea level rise will be the increased frequency and severity of tidal flooding.
- Social vulnerability is an important consideration for all threats. Many areas that are the most vulnerable to hazards are also the most socially vulnerable.

Additional key findings and observations regarding Charleston’s vulnerability to hazards were made during the development of this plan. These include:

- There are properties in city that have experienced multiple and repeated losses from flooding events.
- Critical facilities in the City of Charleston are increasingly vulnerable to hazards in part due to increases in climate and non-climate stressors identified in the vulnerability assessment.
- Certain lifelines in the city are vulnerable to hazards. Particularly, the Port of Charleston as a large shipping hub for the United States; the Arthur Ravenel Jr. Bridge, Robert B. Scarborough Bridge, T. Allen Legare Bridge, and the Ashley River Memorial Bridge. Each of these present unique challenges for the City of Charleston.
- Sea level rise is exacerbating a number of other hazards impact and probability (i.e. tidal flooding, storm surge, water shortage, and storm surge)

These problem statements do not represent the entirety of vulnerability that the city faces, but rather identify some of the key highlights of vulnerability. The city will act to “solve” these, and other, problems brought on by hazard events through mitigation goals, objectives and actions identified in Sections 8 and 9.

SECTION 6: VULNERABILITY ASSESSMENT

Table 6.11: Critical Facility Vulnerability in the City of Charleston

Facility Name	Facility Type	Natural						Other			
		Drought	Excessive Heat	Hurricane & Coastal Hazards	Tornadoes/Thunderstorms	Flood 100-year	Flood 500-year	Wildfires	Mobile HAZMAT 0.5 Mile (Road)	Mobile HAZMAT 1 Mile (Road)	Mobile HAZMAT 0.5 Mile (Rail)
Government											
Municipal Emergency Operations Center	EOC	X	X	X	X	X	X		X	X	X
Public Safety Operations Center	EOC	X	X	X	X	X	X		X		
Hospital Emergency Operations Center	EOC	X	X	X	X	X	X		X		
116 Meeting Street	Municipal Facility	X	X	X	X	X	X			X	X
50 Broad St	Municipal Facility	X	X	X	X	X	X				X
75 Calhoun St, Third Floor	Municipal Facility	X	X	X	X	X	X		X	X	X
City Hall	Municipal Facility	X	X	X	X	X	X				X
Civic Design Center	Municipal Facility	X	X	X	X	X	X		X	X	X
Concord Street Pump Station	Municipal Facility	X	X	X	X	X	X			X	X
Fleet Services	Municipal Facility	X	X	X	X				X	X	X
Gaillard Center	Municipal Facility	X	X	X	X		X		X	X	X
Parks Department	Municipal Facility	X	X	X	X	X	X		X	X	X
Signal Maintenance Shop Property	Municipal Facility	X	X	X	X	X	X		X	X	X
Public Safety											
Fire Station 2	Fire Station	X	X	X	X	X	X			X	X
Fire Station 3	Fire Station	X	X	X	X	X	X			X	X
Fire Station 6	Fire Station	X	X	X	X	X	X		X	X	X
Fire Station 7	Fire Station	X	X	X	X	X	X				
Fire Station 8	Fire Station	X	X	X	X	X	X		X	X	X
Fire Station 9	Fire Station	X	X	X	X				X	X	X

SECTION 6: VULNERABILITY ASSESSMENT

Facility Name	Facility Type	Natural					Other				
		Drought	Excessive Heat	Hurricane & Coastal Hazards	Tornadoes/Thunderstorms	Flood 100-year	Flood 500-year	Wildfires	Mobile HAZMAT 0.5 Mile (Road)	Mobile HAZMAT 1 Mile (Road)	Mobile HAZMAT 0.5 Mile (Rail)
Fire Station 10	Fire Station	X	X	X	X		X				
Fire Station 11	Fire Station	X	X	X	X					X	
Fire Station 11 Old Location	Fire Station	X	X	X	X						
Fire Station 12	Fire Station	X	X	X	X		X				
Fire Station 13	Fire Station	X	X	X	X		X			X	
Fire Station 14	Fire Station	X	X	X	X						X
Fire Station 15	Fire Station	X	X	X	X	X	X	X	X	X	X
Fire Station 16	Fire Station	X	X	X	X	X	X	X	X	X	
Fire Station 18	Fire Station	X	X	X	X		X	X	X	X	
Fire Station 19	Fire Station	X	X	X	X					X	X
Fire Station 20	Fire Station	X	X	X	X						
Fire Station 21	Fire Station	X	X	X	X						
Police Headquarters	Police Station	X	X	X	X	X	X			X	
Police Team 1 Office	Police Station	X	X	X	X	X	X	X	X	X	X
Police Team 2 And 9 Office	Police Station	X	X	X	X		X		X	X	X
Police Team 3 Office	Police Station	X	X	X	X						
Police Team 4 and Training Office	Police Station	X	X	X	X						X
Police Team 5 Office	Police Station	X	X	X	X		X		X	X	
Police Team 6 and 8 Office	Police Station	X	X	X	X	X	X				X
Police Team 6 Satellite Office	Police Station	X	X	X	X	X	X				X
Police Team 7 Office	Police Station	X	X	X	X		X		X	X	X
Police Team 9 Satellite Office	Police Station	X	X	X	X		X		X		X

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Facility Name	Facility Type	Natural						Other				
		Drought	Excessive Heat	Hurricane & Coastal Hazards	Tornadoes/Thunderstorms	Flood 100-year	Flood 500-year	Wildfires	Mobile HAZMAT 0.5 Mile (Road)	Mobile HAZMAT 1 Mile (Road)	Mobile HAZMAT 0.5 Mile (Rail)	Mobile HAZMAT 1 Mile (Rail)
62 Brigade St	Police Station	X	X	X	X		X		X	X	X	X
Citadel Mall Police Outreach Substation	Police Station	X	X	X	X		X		X	X		
Police Fleet Maintenance	Police Station	X	X	X	X				X	X		
Police Forensic Services	Police Station	X	X	X	X						X	X
Health												
Active Day of Charleston	Assisted Living and Senior Facilities	X	X	X	X						X	
Ashley Gardens Alzheimer's Special Care Center	Assisted Living and Senior Facilities	X	X	X	X		X		X	X		
Ashley River Plantation	Assisted Living and Senior Facilities	X	X	X	X		X		X	X		
Benton House of West Ashley	Assisted Living and Senior Facilities	X	X	X	X	X	X				X	X
Bishop Gadsden Episcopal Retirement Community & Health Care Center	Assisted Living and Senior Facilities	X	X	X	X		X					
Brookdale Charleston	Assisted Living and Senior Facilities	X	X	X	X		X		X	X		
Carter-May Home	Assisted Living and Senior Facilities	X	X	X	X							
Evergreen Residential Care Inc I	Assisted Living and Senior Facilities	X	X	X	X		X					
Harmony at West Ashley	Assisted Living and Senior Facilities	X	X	X	X	X	X	X			X	

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Facility Name	Facility Type	Natural						Other			
		Drought	Excessive Heat	Hurricane & Coastal Hazards	Tornadoes/Thunderstorms	Flood 100-year	Flood 500-year	Wildfires	Mobile HAZMAT 0.5 Mile (Road)	Mobile HAZMAT 1 Mile (Road)	Mobile HAZMAT 0.5 Mile (Rail)
Heartland Hospice Services-Charleston	Assisted Living and Senior Facilities	X	X	X	X					X	
Heartland of West Ashley Rehabilitation And Nursing Center	Assisted Living and Senior Facilities	X	X	X	X						
Indigo Hall	Assisted Living and Senior Facilities	X	X	X	X		X			X	
Lenevar Community Residence	Assisted Living and Senior Facilities	X	X	X	X	X	X	X			
McLeod Manor	Assisted Living and Senior Facilities	X	X	X	X	X	X	X	X	X	
My Father's House	Assisted Living and Senior Facilities	X	X	X	X	X	X		X	X	X
NHC Healthcare Charleston	Assisted Living and Senior Facilities	X	X	X	X	X	X		X	X	
Palmettos of Charleston	Assisted Living and Senior Facilities	X	X	X	X	X	X		X	X	
Retreat at Wellmore Of Daniel Island	Assisted Living and Senior Facilities	X	X	X	X	X	X				
Savannah Place	Assisted Living and Senior Facilities	X	X	X	X		X				
Secessionville Community Residence	Assisted Living and Senior Facilities	X	X	X	X		X				

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Facility Name	Facility Type	Natural						Other			
		Drought	Excessive Heat	Hurricane & Coastal Hazards	Tornadoes/Thunderstorms	Flood 100-year	Flood 500-year	Wildfires	Mobile HAZMAT 0.5 Mile (Road)	Mobile HAZMAT 1 Mile (Road)	Mobile HAZMAT 0.5 Mile (Rail)
Wellmore of Daniel Island	Assisted Living and Senior Facilities	X	X	X	X	X	X		X	X	
Bon Secours- Roper St Francis Hospital	Hospitals	X	X	X	X	X	X		X	X	
Musc Medical Center	Hospitals	X	X	X	X	X	X			X	
Musc Shawn Jenkins Childrens Hospital	Hospitals	X	X	X	X	X	X			X	
Ralph H Johnson VA Medical Center	Hospitals	X	X	X	X	X	X			X	
Roper Hospital	Hospitals	X	X	X	X	X	X			X	
Access Urgent	Urgent Care	X	X	X	X	X	X		X		X
Charleston-Dorchester Mental Health Center--Charleston Clinic	Urgent Care	X	X	X	X					X	
Doctors Care - Charleston West	Urgent Care	X	X	X	X						X
Doctors Care - James Island	Urgent Care	X	X	X	X	X	X		X	X	
Doctors Care - West Ashley	Urgent Care	X	X	X	X	X	X				
Health First Urgent Care (West Ashley)	Urgent Care	X	X	X	X		X				
Medcare Urgent Care (West Ashley)	Urgent Care	X	X	X	X					X	
Minuteclinic	Urgent Care	X	X	X	X		X		X		X
Minuteclinic	Urgent Care	X	X	X	X				X		X
Premier Medical	Urgent Care	X	X	X	X		X			X	
Roper St Francis Express Care	Urgent Care	X	X	X	X		X			X	
Education											
Addlestone Hebrew Academy	Daycare/Preschool	X	X	X	X	X	X			X	
Ashley Hall / Judith Webber Ross	Daycare/Preschool	X	X	X	X	X	X			X	X
Ashley River Day Care	Daycare/Preschool	X	X	X	X	X	X				

SECTION 6: VULNERABILITY ASSESSMENT

Facility Name	Facility Type	Natural						Other			
		Drought	Excessive Heat	Hurricane & Coastal Hazards	Tornadoes/Thunderstorms	Flood 100-year	Flood 500-year	Wildfires	Mobile HAZMAT 0.5 Mile (Road)	Mobile HAZMAT 1 Mile (Road)	Mobile HAZMAT 0.5 Mile (Rail)
Audacy Creative Arts Preschool	Daycare/Preschool	X	X	X	X				X		
Blessed Sacrament Catholic School	Daycare/Preschool	X	X	X	X		X				
C.A.R.E. Academy	Daycare/Preschool	X	X	X	X	X	X			X	
Cadence Academy Preschool	Daycare/Preschool	X	X	X	X		X		X	X	
Cainhoy Children's Academy	Daycare/Preschool	X	X	X	X						
Carolina Bay Child Development Center	Daycare/Preschool	X	X	X	X		X				
Carousel Early Childhood Center	Daycare/Preschool	X	X	X	X					X	
Charles Towne Child Development Center	Daycare/Preschool	X	X	X	X						
Charles Towne Montessori School	Daycare/Preschool	X	X	X	X		X				
Charles Webb Center	Daycare/Preschool	X	X	X	X		X				
Charleston Catholic School	Daycare/Preschool	X	X	X	X	X	X		X	X	X
Charleston Center Therapeutic Childcare Service	Daycare/Preschool	X	X	X	X	X	X				X
Daniel Island Academy	Daycare/Preschool	X	X	X	X		X				X
Daniel Island Tech Savvy Kids Club	Daycare/Preschool	X	X	X	X						
Evangel Christian School	Daycare/Preschool	X	X	X	X	X	X				
First African Evangelical Church Day Care	Daycare/Preschool	X	X	X	X		X		X	X	X
First Baptist School of Charleston	Daycare/Preschool	X	X	X	X	X	X				X
First Klass Early Childhood Learning Center	Daycare/Preschool	X	X	X	X		X		X	X	
Harper'S Christian Day Care	Daycare/Preschool	X	X	X	X						
Holy Cross Island School 2	Daycare/Preschool	X	X	X	X		X				X
Hvpc Early Care And Education Program	Daycare/Preschool	X	X	X	X		X	X			
It's a Cool School	Daycare/Preschool	X	X	X	X	X	X				

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Facility Name	Facility Type	Natural						Other			
		Drought	Excessive Heat	Hurricane & Coastal Hazards	Tornadoes/Thunderstorms	Flood 100-year	Flood 500-year	Wildfires	Mobile HAZMAT 0.5 Mile (Road)	Mobile HAZMAT 1 Mile (Road)	Mobile HAZMAT 0.5 Mile (Rail)
James Island Christian School Early Education	Daycare/Preschool	X	X	X	X		X		X		
James Island Elementary Head Start	Daycare/Preschool	X	X	X	X						
James Island Presbyterian Child Care Center	Daycare/Preschool	X	X	X	X						
Kids Play Garden	Daycare/Preschool	X	X	X	X	X	X				
La Petite Academy	Daycare/Preschool	X	X	X	X		X			X	
La Petite Academy	Daycare/Preschool	X	X	X	X			X			
Live Oak Little School - James Island	Daycare/Preschool	X	X	X	X						
Loving & Learning Education Center	Daycare/Preschool	X	X	X	X						
Loving & Learning of Charleston	Daycare/Preschool	X	X	X	X	X	X				
Lowcountry Children's Co-Op	Daycare/Preschool	X	X	X	X						
Meeting Street Academy	Daycare/Preschool	X	X	X	X	X	X		X	X	X
Montessori Fountainhead School	Daycare/Preschool	X	X	X	X				X	X	X
Mt Sinai Christian Learning Center	Daycare/Preschool	X	X	X	X				X	X	
N.E. Miles Early Childhood Development Center	Daycare/Preschool	X	X	X	X						X
New Israel Reformed Episcopal Development Center	Daycare/Preschool	X	X	X	X		X		X	X	X
Oak Grove Montessori	Daycare/Preschool	X	X	X	X						
Open Arms Child Care	Daycare/Preschool	X	X	X	X						X
O'Quinn School	Daycare/Preschool	X	X	X	X	X	X		X	X	
Playhouse Day Care Kindergarten Inc.	Daycare/Preschool	X	X	X	X						
Plymouth Childcare Development Center	Daycare/Preschool	X	X	X	X						
Preschool Learning Center at OGEC	Daycare/Preschool	X	X	X	X						
Redeemer Children's Center	Daycare/Preschool	X	X	X	X						

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Facility Name	Facility Type	Natural					Other				
		Drought	Excessive Heat	Hurricane & Coastal Hazards	Tornadoes/Thunderstorms	Flood 100-year	Flood 500-year	Wildfires	Mobile HAZMAT 0.5 Mile (Road)	Mobile HAZMAT 1 Mile (Road)	Mobile HAZMAT 0.5 Mile (Rail)
Riverpointe Christian Academy	Daycare/Preschool	X	X	X	X		X		X		
Riverpointe Christian Academy	Daycare/Preschool	X	X	X	X		X		X		
Roper Learning Center	Daycare/Preschool	X	X	X	X						
Sanders Clyde Elementary	Daycare/Preschool	X	X	X	X	X	X		X	X	X
Smart Cookies Early Childhood Center	Daycare/Preschool	X	X	X	X						X
St. James Day School	Daycare/Preschool	X	X	X	X	X	X				X
Sundrops Montessori	Daycare/Preschool	X	X	X	X						
Sundrops Montessori School Palmetto Campus	Daycare/Preschool	X	X	X	X	X	X		X	X	X
The Children'S Center at Citadel Square	Daycare/Preschool	X	X	X	X	X	X		X	X	X
The Little Sage School	Daycare/Preschool	X	X	X	X	X	X				X
The Oaks Children's Academy	Daycare/Preschool	X	X	X	X						X
The O'Quinn School	Daycare/Preschool	X	X	X	X	X	X				X
The Preschool Academy Inc.	Daycare/Preschool	X	X	X	X						X
West Ashley Head Start	Daycare/Preschool	X	X	X	X						
West Ashley Wee Care Preschool	Daycare/Preschool	X	X	X	X						X
Wonderful Beginnings II	Daycare/Preschool	X	X	X	X		X				X
Angel Oak Elementary School	Elementary School	X	X	X	X			X			
Ashley River Creative Arts Elementary School	Elementary School	X	X	X	X						X
Capers Prepatory Christian Academy	Elementary School	X	X	X	X	X	X				X
Carolina Voyager Charter School	Elementary School	X	X	X	X						X
Charles Towne Montessori School	Elementary School	X	X	X	X		X				
Charleston Progressive Academy	Elementary School	X	X	X	X		X		X	X	X

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Facility Name	Facility Type	Natural						Other			
		Drought	Excessive Heat	Hurricane & Coastal Hazards	Tornadoes/Thunderstorms	Flood 100-year	Flood 500-year	Wildfires	Mobile HAZMAT 0.5 Mile (Road)	Mobile HAZMAT 1 Mile (Road)	Mobile HAZMAT 0.5 Mile (Rail)
Drayton Hall Elementary School	Elementary School	X	X	X	X						
Harbor View Elementary School	Elementary School	X	X	X	X	X	X			X	
James Island Elementary School	Elementary School	X	X	X	X		X				
James Simons Montessori School	Elementary School	X	X	X	X	X	X		X	X	X
Mason Preparatory School	Elementary School	X	X	X	X	X	X				
Meeting Street Academy	Elementary School	X	X	X	X	X	X		X	X	X
Memminger Elementary School	Elementary School	X	X	X	X		X				X
Mitchell Elementary School	Elementary School	X	X	X	X		X		X	X	X
Murray Lasaine Elementary School	Elementary School	X	X	X	X	X	X		X	X	
Oakland Elementary School	Elementary School	X	X	X	X	X	X		X	X	
Orange Grove Charter School (Elementary Campus)	Elementary School	X	X	X	X						
Philip Simmons Elementary School	Elementary School	X	X	X	X	X	X				
Saint Andrews School of Math and Science	Elementary School	X	X	X	X	X	X				
Springfield Elementary School	Elementary School	X	X	X	X					X	X
Stiles Point Elementary School	Elementary School	X	X	X	X		X				
Stono Park Elementary School	Elementary School	X	X	X	X		X			X	
The Cooper School	Elementary School	X	X	X	X		X				
Trinity Montessori School	Elementary School	X	X	X	X						
Burke High School	High School	X	X	X	X		X		X	X	
Early College High School	High School	X	X	X	X		X		X	X	X
First Baptist High School	High School	X	X	X	X		X				
James Island Charter High School	High School	X	X	X	X		X				

SECTION 6: VULNERABILITY ASSESSMENT

Facility Name	Facility Type	Natural						Other			
		Drought	Excessive Heat	Hurricane & Coastal Hazards	Tornadoes/Thunderstorms	Flood 100-year	Flood 500-year	Wildfires	Mobile HAZMAT 0.5 Mile (Road)	Mobile HAZMAT 1 Mile (Road)	Mobile HAZMAT 0.5 Mile (Rail)
Philip Simmons High School	High School	X	X	X	X	X	X				
Saint Johns High School	High School	X	X	X	X						
Septima P Clark Corporate Academy	High School	X	X	X	X						
West Ashley High School	High School	X	X	X	X					X	X
C.E. Williams Middle School	Middle School	X	X	X	X	X	X			X	X
Camp Road Middle School	Middle School	X	X	X	X						
Haut Gap Middle School	Middle School	X	X	X	X						
Orange Grove Charter School Middle School	Middle School	X	X	X	X		X		X	X	
Philip Simmons Middle School	Middle School	X	X	X	X	X	X				
Simmons-Pinckney Middle School	Middle School	X	X	X	X	X	X		X	X	
Adventist Christian Academy of Charleston	Mixed Grade Level School	X	X	X	X						
Addlestone Hebrew Academy	Mixed Grade Level School	X	X	X	X	X	X			X	
Allegro Charter School of Music	Mixed Grade Level School	X	X	X	X	X	X				X
Ashley Hall	Mixed Grade Level School	X	X	X	X	X	X			X	X
Bishop England High School	Mixed Grade Level School	X	X	X	X		X			X	
Blessed Sacrament Catholic School	Mixed Grade Level School	X	X	X	X		X				
Buist Academy	Mixed Grade Level School	X	X	X	X	X	X		X	X	X

SECTION 6: VULNERABILITY ASSESSMENT

Facility Name	Facility Type	Natural						Other			
		Drought	Excessive Heat	Hurricane & Coastal Hazards	Tornadoes/Thunderstorms	Flood 100-year	Flood 500-year	Wildfires	Mobile HAZMAT 0.5 Mile (Road)	Mobile HAZMAT 1 Mile (Road)	Mobile HAZMAT 0.5 Mile (Rail)
Charleston Charter School for Math and Science	Mixed Grade Level School	X	X	X	X		X		X	X	X
Charleston Day School	Mixed Grade Level School	X	X	X	X		X				X
Charleston Development Academy	Mixed Grade Level School	X	X	X	X	X	X			X	
Daniel Island School	Mixed Grade Level School	X	X	X	X		X				
First Baptist School - Downtown Campus	Mixed Grade Level School	X	X	X	X	X	X				X
James Island Christian School	Mixed Grade Level School	X	X	X	X		X			X	
Montessori Community School of Charleston	Mixed Grade Level School	X	X	X	X		X			X	X
Nativity School	Mixed Grade Level School	X	X	X	X		X				
Pattisons Academy For Comprehensive Educ (Pace)	Mixed Grade Level School	X	X	X	X					X	X
Porter-Gaud School	Mixed Grade Level School	X	X	X	X						
Sanders-Clyde Elementary/Middle School	Mixed Grade Level School	X	X	X	X	X	X		X	X	X
The Charleston Catholic School	Mixed Grade Level School	X	X	X	X	X	X		X	X	X
The Charleston Christian School	Mixed Grade Level School	X	X	X	X					X	X

SECTION 6: VULNERABILITY ASSESSMENT

Facility Name	Facility Type	Natural						Other			
		Drought	Excessive Heat	Hurricane & Coastal Hazards	Tornadoes/Thunderstorms	Flood 100-year	Flood 500-year	Wildfires	Mobile HAZMAT 0.5 Mile (Road)	Mobile HAZMAT 1 Mile (Road)	Mobile HAZMAT 0.5 Mile (Rail)
C.E. Williams Middle School											
C.E. Williams Middle School											
College Of Charleston	College/University	X	X	X	X		X		X	X	
Medical University of South Carolina	College/University	X	X	X	X	X	X			X	
The Citadel	College/University	X	X	X	X		X			X	
Trident Technical College - Palmer Campus	College/University	X	X	X	X		X		X	X	X
Transportation											
Charleston Executive Airport	Airport	X	X	X	X						
Charleston International	Airport	X	X	X	X						
Charleston Maritime Center	Marina	X	X	X	X	X	X			X	X
Daniel Island Marina	Marina	X	X	X	X		X				
Dolphin Cove Marina	Marina	X	X	X	X	X	X		X	X	X
Ripley Light Marina	Marina	X	X	X	X	X	X				
Safe Harbor Bristol	Marina	X	X	X	X	X	X			X	
Safe Harbor Charleston City	Marina	X	X	X	X	X	X	X			
Safe Harbor City Boatyard	Marina	X	X	X	X						
Seabreeze Marina	Marina	X	X	X	X	X	X		X	X	X
The Harborage At Ashley Marina	Marina	X	X	X	X	X	X				
Columbus Street Terminal	Port Facility	X	X	X	X	X	X		X	X	X
Cruise Terminal	Port Facility	X	X	X	X	X	X			X	X
Union Pier Terminal	Port Facility	X	X	X	X	X	X			X	X
Utilities											

SECTION 6: VULNERABILITY ASSESSMENT

Facility Name	Facility Type	Natural					Other				
		Drought	Excessive Heat	Hurricane & Coastal Hazards	Tornadoes/Thunderstorms	Flood 100-year	Flood 500-year	Wildfires	Mobile HAZMAT 0.5 Mile (Road)	Mobile HAZMAT 1 Mile (Road)	Mobile HAZMAT 0.5 Mile (Rail)
Charleston Water System	Administrative Site	X	X	X	X		X		X		X
James Island Public Service District	Administrative Site	X	X	X	X		X				
St. Andrews Public Service District	Administrative Site	X	X	X	X						
Bayfront Substation	Electrical Substation	X	X	X	X		X			X	
Bee Street Substation	Electrical Substation	X	X	X	X	X	X			X	
Cainhoy Transmission Substation 1	Electrical Substation	X	X	X	X						
Cainhoy Transmission Substation 2	Electrical Substation	X	X	X	X						
Carolina Bay Substation	Electrical Substation	X	X	X	X		X				
Charleston Eastside Substation	Electrical Substation	X	X	X	X	X	X			X	X
Charlotte St Substation	Electrical Substation	X	X	X	X	X	X		X	X	X
Charlotte St Substation	Electrical Substation	X	X	X	X	X	X		X	X	X
Church Creek Substation	Electrical Substation	X	X	X	X					X	X
Ft Johnson Substation	Electrical Substation	X	X	X	X		X				
Grove Street Substation	Electrical Substation	X	X	X	X		X		X	X	X
Jack Primus Substation	Electrical Substation	X	X	X	X						
James Island Substation	Electrical Substation	X	X	X	X		X				
Maryville Substation	Electrical Substation	X	X	X	X	X	X				
Meeting St Substation	Electrical Substation	X	X	X	X	X	X		X	X	X
North Bridge Terrace Substation	Electrical Substation	X	X	X	X						
Queensboro Substation	Electrical Substation	X	X	X	X		X				
Savage Rd Substation	Electrical Substation	X	X	X	X				X	X	
St Andrews Substation	Electrical Substation	X	X	X	X		X				

SECTION 6: VULNERABILITY ASSESSMENT

Facility Name	Facility Type	Natural					Other				
		Drought	Excessive Heat	Hurricane & Coastal Hazards	Tornadoes/Thunderstorms	Flood 100-year	Flood 500-year	Wildfires	Mobile HAZMAT 0.5 Mile (Road)	Mobile HAZMAT 1 Mile (Road)	Mobile HAZMAT 0.5 Mile (Rail)
Stono Park Substation	Electrical Substation	X	X	X	X				X	X	
Thomas Island Substation	Electrical Substation	X	X	X	X		X		X	X	
Hagood Natural Gas Power Plant	Power Plant	X	X	X	X	X			X	X	X
Telephone Facility	Telephone Facility	X	X	X	X		X			X	X
Telephone Facility	Telephone Facility	X	X	X	X						
Telephone Facility	Telephone Facility	X	X	X	X		X				X
Telephone Facility	Telephone Facility	X	X	X	X						
CWS Islands Booster Pump Station	Water Pumping	X	X	X	X	X					
CWS WW Pump Station 01	Water Pumping	X	X	X	X	X	X			X	X
CWS WW Pump Station 01	Water Pumping	X	X	X	X	X	X			X	X
CWS WW Pump Station 135	Water Pumping	X	X	X	X						
CWS WW Pump Station 16	Water Pumping	X	X	X	X	X	X	X	X	X	X
CWS WW Pump Station 56	Water Pumping	X	X	X	X	X	X				
CWS WW Pump Station 61	Water Pumping	X	X	X	X						
CWS WW Pump Station 77	Water Pumping	X	X	X	X		X		X	X	
CWS WW Pump Station 84	Water Pumping	X	X	X	X	X	X				X
CWS WW Pump Station 90	Water Pumping	X	X	X	X	X	X				
CWS WW Pump Station G	Water Pumping	X	X	X	X		X		X	X	
CWS WW Pump Station Pld	Water Pumping	X	X	X	X	X	X				X
CWS WW Pump Station Rt1	Water Pumping	X	X	X	X	X	X				
Daniel Island Booster Pump Station	Water Pumping	X	X	X	X		X				
Daniel Island WW Treatment Plant	Water Treatment	X	X	X	X	X	X				

SECTION 6: VULNERABILITY ASSESSMENT

Facility Name	Facility Type	Natural						Other				
		Drought	Excessive Heat	Hurricane & Coastal Hazards	Tornadoes/Thunderstorms	Flood 100-year	Flood 500-year	Wildfires	Mobile HAZMAT 0.5 Mile (Road)	Mobile HAZMAT 1 Mile (Road)	Mobile HAZMAT 0.5 Mile (Rail)	Mobile HAZMAT 1 Mile (Rail)
Enviromix Water Treatment	Water Treatment	X	X	X	X		X		X	X	X	X
Felix C. Davis Wwtp	Water Treatment	X	X	X	X					X	X	X
Plum Island WW Treatment Plant	Water Treatment	X	X	X	X	X	X					

SECTION 7

CAPABILITY ASSESSMENT

This section of the Plan discusses the capability of the City of Charleston to implement hazard mitigation activities. It consists of the following four subsections:

- 7.1 What is a Capability Assessment?
- 7.2 Conducting the Capability Assessment
- 7.3 Capability Assessment Findings
- 7.4 Conclusions on Local Capability

7.1 WHAT IS A CAPABILITY ASSESSMENT

The purpose of a capability assessment is to evaluate a local jurisdiction's ability to implement a comprehensive mitigation strategy and to identify opportunities for developing or enhancing specific mitigation policies, programs, or projects.¹ In any planning process, it is crucial to determine which goals, objectives, and actions are feasible, based on an understanding of the organizational capacity of the agencies or departments responsible for implementation. This assessment helps identify practical mitigation actions that are likely to be executed over time, considering the local government's planning and regulatory framework, administrative and technical support, financial resources, and political climate.

A capability assessment consists of two primary components: 1) an inventory of the local jurisdiction's existing plans, ordinances, or programs, and 2) an analysis of its capacity to implement them. A thorough examination of local capabilities will reveal any gaps, shortfalls, or weaknesses in ongoing government activities that could impede proposed mitigation efforts and potentially increase community vulnerability to hazards. Additionally, the assessment highlights effective mitigation measures already in place or being implemented at the local level, which should be supported and enhanced through future efforts.

Since the Disaster Mitigation Act of 2000, the City of Charleston and the Charleston Region have been building their capacity for hazard mitigation and have emerged as national leaders in this area. Numerous plans, programs, studies, and projects have been undertaken to better understand risks and vulnerabilities and to develop and advance their Mitigation Strategy. This Capability Assessment aims to capture most, if not all, of these initiatives.

¹ While the Final Rule for implementing the Disaster Mitigation Act of 2000 does not require a local capability assessment to be completed for local hazard mitigation plans, it is a critical step in developing a mitigation strategy that meets the needs of the City while taking into account their own unique abilities. The Rule does state that a community's mitigation strategy should be "based on existing authorities, policies, programs and resources, and its ability to expand on and improve these existing tools" (44 CFR, Part 201.6(c)(3)).

7.2 CONDUCTING THE CAPABILITY ASSESSMENT

To assess the City of Charleston's capacity for hazard mitigation, a detailed survey of existing plans and policies was conducted. This information was used to score the city's capability, resulting in a numerical grade (see Section 7.4 for details). The Capability Assessment Survey gathered data on various "capability indicators," including local plans, policies, programs, and ordinances that affect the City's ability to implement hazard mitigation actions. It also evaluated the City's fiscal, administrative, and technical resources, assessing access to budgetary and personnel support for mitigation. The current political climate, crucial for local planning and decision-making, was also considered in relation to hazard mitigation.

The assessment provides a comprehensive inventory of existing local plans, ordinances, programs, and resources, along with their impact on hazard loss reduction. Additionally, it identifies gaps, weaknesses, or conflicts that can be reframed as opportunities for specific actions in the hazard mitigation strategy. Data from the survey was incorporated into a database for analysis, and a scoring methodology was applied to quantify the city's overall capability.² Each capability indicator was assigned a point value based on its relevance to hazard mitigation.

Using this scoring system, the City received an overall capability rating of "high," "moderate," or "limited," in the various categories of capabilities depending on the total points scored. These classifications offer a general assessment of the City's capability, providing essential insights for developing an effective mitigation strategy.

7.3 CAPABILITY ASSESSMENT FINDINGS

The findings of the capability assessment are summarized in this Plan to provide insight into the relevant capacity of the City of Charleston to implement hazard mitigation activities. All information is based upon the survey results provided by the city and a review of existing hazard mitigation plans, the City's website and input provided by city officials during meetings of the Hazard Mitigation Planning Team.

7.3.1 Planning and Regulatory Capability

Planning and regulatory capability is based on the implementation of plans, ordinances, and programs that demonstrate a local jurisdiction's commitment to guiding and managing growth, development, and redevelopment in a responsible manner while maintaining the general welfare of the community. It includes emergency response and mitigation planning, comprehensive land use planning, and transportation planning; the enforcement of zoning or subdivision ordinances and building codes that regulate how land is developed and structures are built; as well as protecting environmental, historic, and cultural resources in the community. Although some conflicts can arise, these planning initiatives generally present significant opportunities to integrate hazard mitigation principles and practices into the local decision-making process.

This assessment is designed to provide a general overview of the key planning and regulatory tools and programs that are in place or under development for the City of Charleston along with their potential effect on loss reduction. This information will help identify opportunities to address existing gaps, weaknesses, or conflicts with other initiatives in addition to integrating the implementation of this Plan with existing planning mechanisms where appropriate. The City has **HIGH** Planning and Regulatory Capability.

² The scoring methodology used to quantify and rank the City's capability can be found in Appendix B.

Table 7.1 provides a summary of the relevant local plans, ordinances, and programs already in place or under development in the City of Charleston. A checkmark (✓) indicates that the given item is currently in place and being implemented. An asterisk (*) indicates that the given item is currently being developed for future implementation. The specific details about the plans, ordinances and programs as they relate to Charleston (to include specific plan, ordinance and program names) are further discussed in the narratives below. Each of these local plans, ordinances, and programs should be considered available mechanisms for incorporating the requirements of the City of Charleston Hazard Mitigation Plan.

Table 7.1: Relevant Plans, Ordinances and Programs

PLANNING / REGULATORY TOOL	CITY OF CHARLESTON
Hazard Mitigation Plan	*
Comprehensive Land Use Plan	✓
Floodplain Management Plan	*
Coastal Zone Management Plan	*
Open Space Management Plan (Parks & Rec/Greenway Plan)	✓
Stormwater Management Plan/Ordinance	✓
Natural Resource Protection Plan	
Community Forest Master Plan	
Flood Response Plan	
Emergency Operations Plan	✓
SARA Title III / Hazardous Materials Facility Emergency Response Plan	✓
Continuity of Operations Plan	*
Evacuation Plan	✓
Disaster Recovery Plan	*
Capital Improvements Plan	✓
Economic Development Plan	✓
Historic Preservation Plan	✓
Flood Damage Prevention Ordinance	✓

PLANNING / REGULATORY TOOL		CITY OF CHARLESTON
Zoning Ordinance		✓
Subdivision Ordinance		✓
Unified Development Ordinance		
Post-Disaster Redevelopment Ordinance		
Building Code		✓
Fire Code		✓
National Flood Insurance Program (NFIP)		✓
NFIP Community Rating System		✓

A more detailed discussion on the city's planning and regulatory capability follows, along with the incorporation of additional information based on the narrative comments provided by local officials in response to the survey questionnaire.

7.3.2 Emergency Management

Hazard mitigation is widely recognized as one of the four primary phases of emergency management. The three other phases include preparedness, response, and recovery. In reality, each phase is interconnected with hazard mitigation, as **Figure 7.1** suggests. Opportunities to reduce potential losses through mitigation practices are most often implemented before disaster strikes, such as the elevation of flood prone structures or the continuous enforcement of policies that prevent and regulate development that is vulnerable to hazards due to its location, design, or other characteristics. Mitigation opportunities will also be presented during immediate preparedness or response activities, such as installing storm shutters in advance of a hurricane, and certainly during the long-term recovery and redevelopment process following a hazard event.



Figure 7.1: The Four Phases of Emergency Management

Planning for each phase is a critical part of a comprehensive emergency management program and a key to the successful implementation of hazard mitigation actions. As a result, the Capability Assessment Survey asked several questions across a range of emergency management plans in order to assess the City of Charleston's willingness to plan and their level of technical planning proficiency.

Hazard Mitigation Plan: A hazard mitigation plan represents a community's blueprint for how it intends to reduce the impact of natural and 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 City of Charleston has previously participated (and continues to participate) in the [Charleston Regional Hazard Mitigation Plan](#). The City of Charleston Hazard Mitigation Plan represents the city's first 'city-specific' hazard mitigation planning efforts. The City intends to implement internal guidance that ensures the plan is followed and maintained regularly.
- The City completed an All Hazards Vulnerability Assessment³ which identifies populations and assets (e.g., economic, cultural, historical, critical facilities and ecosystem services) that are vulnerable to various physical threats such as sea level rise, extreme precipitation, extreme heat, etc. The assessment highlights the most critical areas and assets at risk from these various physical threats, the consequences associated with each and potential adaptation measures that could be implemented.
- The City also has hazard-specific plans in place:
 - Charleston Sea Level Rise Strategy⁴ (updated as of 2023) builds on 2015 and 2019 strategies and provides climate data, summaries of infrastructure and drainage projects, policies, regulations, initiatives, partnerships and related efforts.
 - Dutch Dialogues Charleston⁵ conceptualizes a Living With Water™ future and provides guidance to the recently updated Comprehensive Plan as well as the ongoing Integrated Water Plan.

³ <https://www.charleston-sc.gov/1975/All-Hazards-Vulnerability-Risk-Assessment>

⁴ <https://www.charleston-sc.gov/1981/Flooding-Sea-Level-Rise-Strategy>

⁵ <https://www.charleston-sc.gov/1974/Dutch-Dialogues>

SECTION 7: CAPABILITY ASSESSMENT

- Rainproof Charleston⁶ provides guidance on ways to use public and private spaces to capture rainwater.
- The City is establishing FLOODCON⁷, a flood condition awareness program to guide users in making informed decisions to avoid flooding. As a first component, the City developed Tide Eye⁸, an interactive tool (web and mobile) that summarizes tidal conditions at multiple locations across Charleston. To complement this broader program, the city hosts You Can Help⁹, an informative website to help residents understand how household-level contributions to water management can help to reduce city flooding.
- The City is in the process of developing its first Integrated Water Plan¹⁰, targeted for Fall 2023.
- The City is in the process of developing its first Heat Plan. It completed NOAA's HeatWatch¹¹ program (2021) and participated in NOAA's Pilot Communities program (2022). These efforts enabled the City to better define areas with greater heat island impacts and to begin testing interventions such as cool pavement to reduce those impacts.
- To support flooding and heat, the City has a limited Street Tree Canopy Inventory¹² and complementary canopy and preferred planting area (PPA) tools to guide residents in maintaining and supplementing existing canopy. Recently (Parks) also received a grant to further survey trees on public parcels.
- CHUCKTOWNFLOODS: The College of Charleston and S.C. Sea Grant developed CHUCKTOWNFLOODS website (chucktownfloods.cofc.edu) to serve as a tool or framework that allows stakeholders (businesses and industry, municipalities, and individual homeowners) to navigate the available resilience tools and data centered on flooding in the Charleston County area. The site is a great resource for City of Charleston staff, officials and citizens.
- Lowcountry Healthcare Coalition: South Carolina Department of the Environment and Health Control (SCDHEC) and regional partners in healthcare formed the Lowcountry Healthcare Preparedness Coalition focused on providing a source of coordination and collaboration to the Lowcountry healthcare and response service agencies to prepare for, respond to, and recover from a myriad of disruptive events within their geographic location. This group is part of the nationwide Hospital Preparedness Program (HPP) a component of the national strategy to prepare for and respond to large-scale emergencies and disasters. The regional network of health service providers use the Hazard Vulnerability Assessment Tool¹³ (HVA) to capture coastal hazard vulnerability from storm surge, shoreline change rate (erosion or accretion), flooding, and social/economic vulnerability (SoVI). Most recent data are shown on the Coastal Hazard Vulnerability Assessment site.¹⁴ In December 2022 SCDHEC and the LHPC drafted such an assessment specifically for healthcare institutions.

⁶ <https://www.charleston-sc.gov/rainproof>

⁷ <https://www.charleston-sc.gov/1977/Flood-Awareness>

⁸ <https://gis.charleston-sc.gov/tideeye/>

⁹ <https://www.charleston-sc.gov/1978/You-Can-Help>

¹⁰ <https://www.charleston-sc.gov/2818/Comprehensive-Integrated-Water-Plan-CWIP>

¹¹ <https://www.charleston-sc.gov/2513/HeatWatch-Charleston-2021>

¹² <https://www.charleston-sc.gov/2677/Tree-Canopy>

¹³ <https://scdhec.gov/environment/your-water-coast/ocean-coastal-resource-management/hazard-vulnerability-assessment-tool>

¹⁴ <https://gis.dhec.sc.gov/hva/#>

Disaster Recovery Plan: A disaster recovery plan serves to guide the physical, social, environmental, and economic recovery and reconstruction process following a disaster. In many instances, hazard mitigation principles and practices are incorporated into local disaster recovery plans with the intent of capitalizing on opportunities to break the cycle of repetitive disaster losses. Disaster recovery plans can also lead to the preparation of disaster redevelopment policies and ordinances to be enacted following a hazard event.

- A Disaster Recovery Plan for the City of Charleston has been recommended to City leadership but is not in place at this time.
- The City hosts Disaster Preparedness for Businesses¹⁵ using federal, Insurance Institute, and locally developed resources to help businesses prepare and recover from disasters. These include business continuity, business recovery, and business hurricane preparation resources. (explain)

Emergency Operations Plan: An emergency operations plan outlines responsibilities and the means by which resources are deployed during and following an emergency or disaster.

- The City's Emergency Operations Plan (REV January 2021) delineates activities essential for disaster and emergency response and short-term recovery. City staff noted that the current Emergency Operations Plan lacks development and application to all-hazards standards and does not encompass notable best practices in accordance with the National Preparedness Goal, National Incident Management System, or Incident Command System.

SARA Title III / Hazardous Material Facility Emergency Response Plan: The Emergency Planning and Community Right-to-Know Act (EPCRA), also known as Title III of the Superfund Amendments and Reauthorization Act (SARA), requires states and local governments to establish local chemical emergency preparedness programs for their communities. EPCRA requires the establishment of State Emergency Response Commissions (SERCs) and Local Emergency Planning Committees (LEPCs) which receive and disseminate to the public and local communities information from regulated entities about hazardous chemicals present at their facilities. SERCs and LEPCs are responsible for developing community plans to respond to chemical emergencies. (USEPA)

- Responsibility for SARA Title III facilities resides at the County level and/or with SC DHEC. The City maintains a hazardous materials response team through the fire department but does not keep individual facility response plans.

Radiological Emergency Plan: The radiological emergency plan provides the framework and coordination for an effective radiological emergency response effort between federal, State and local governments agencies and the Nuclear Power Plant (NPP) industry.

- The City of Charleston only local radiological site in the Tri-County area is the onboard Naval Weapons Station at the Nuclear Power School in Berkeley County. This facility maintains an internal plan and coordinates with Berkeley County EMD.

¹⁵ <https://www.charleston-sc.gov/2309/Disaster-Preparedness-for-Businesses>

Continuity of Operations Plan: A continuity of operations plan establishes a chain of command, line of succession, and plans for backup or alternate emergency facilities in case of an extreme emergency or disaster event.

- The City of Charleston's EMD has started initial internal coordination efforts for the development of a comprehensive Continuity of Operations Plan. Currently any such plans are maintained only at the individual department level.

Evacuation Plan: The purpose of an evacuation plan is to provide for the orderly and coordinated evacuation of all or any part of the population of Charleston if it is determined that such action is the most effective means available for protecting the population from the effects of an emergency situation.

- The City of Charleston is maintained by SCEMD and SCDPS at the state level. This plan is tested and updated regularly in conjunction with appropriate local government agencies.

7.3.3 General Planning

The implementation of hazard mitigation activities often involves agencies and individuals beyond the emergency management profession. Stakeholders may include local planners, public works officials, economic development specialists, and others. In many instances, concurrent local planning efforts will help to achieve or complement hazard mitigation goals, even though they are not designed as such. Therefore, the Capability Assessment Survey also asked questions regarding general planning capabilities and the degree to which hazard mitigation is integrated into other on-going planning efforts in the City of Charleston.

Comprehensive Land Use Plan: A comprehensive land use 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.

- The City of Charleston has adopted a comprehensive land use plan, the City Plan. The plan was adopted in 2021. The 2021 update was the first time that elevation and flooding were a heavy determinant in the future land use map and recommendations. It also included the first integration of extreme heat. Additionally, the plan includes a section titled Resilience and Equity which "considers the impacts of flooding, high water, and natural hazards on individuals, communities, institutions, businesses, economic development, public infrastructure and facilities, and public health, safety and welfare."

Capital Improvements Plan: A capital improvements plan guides the scheduling of spending on public improvements. A capital improvements plan can serve as an important mechanism for guiding future development away from identified hazard areas. Limiting public spending in hazardous areas is one of the most effective long-term mitigation actions available to local governments.

- The City of Charleston has adopted a capital improvement plan for 2023-2027. The five-year Capital Improvement Plan (CIP) addresses short and long-term capital needs in all functional areas of City government. Projects include the renovation and preservation of historic buildings; park and recreation improvements; road, bridge, and sidewalk improvements; Stormwater drainage projects; construction of new facilities and equipment needs.

Historic Preservation Plan: A historic preservation plan is intended to preserve historic structures or districts within a community. An often-overlooked aspect of the historic preservation plan is the assessment of buildings and sites located in areas subject to natural hazards and the identification of ways to reduce future damages. This may involve retrofitting or relocation techniques that account for the need to protect buildings that do not meet current building standards or are within a historic district that cannot easily be relocated out of harm's way.

- The City of Charleston has a current Historic Preservation Plan. The plan needs updates to reflect current City Policies of encouraging raising historic structures in flood-risk areas.

Zoning Ordinance: Zoning represents the primary means by which land use is controlled by local governments. As part of a community's police power, zoning is used to protect the public health, safety, and welfare of those in a given jurisdiction that maintains zoning authority. A zoning ordinance is the mechanism through which zoning is typically implemented. Since zoning regulations enable municipal governments to limit the type and density of development, a zoning ordinance can serve as a powerful tool when applied in identified hazard areas.

- The City of Charleston has adopted zoning ordinances. The city is currently in development to fully rewrite/revise the ordinance and maps over the next two (2) years.

Subdivision Ordinance: A subdivision ordinance is intended to regulate the development of residential, commercial, industrial, or other uses, including associated public infrastructure, as land is subdivided into buildable lots for sale or future development. Subdivision design that accounts for natural hazards can dramatically reduce the exposure of future development.

- The City of Charleston has adopted subdivision ordinances as part of the Zoning Code. Land development regulations address requirements for the process of land subdivision and definition of easements and other access.

Unified Development Ordinance: A UDO is a document in which traditional zoning and subdivision regulations are combined with other desired city regulations, such as design guidelines and water management, into a single document. It serves as a local policy instrument.

- There is no Unified Development Ordinance at this time.

Post Disaster Redevelopment / Reconstruction Ordinance: The purpose of a post-disaster redevelopment or recovery plan is to facilitate predisaster planning in a way that guides long-term recovery efforts (five years or more) following a disaster. (FEMA).

- The City does not yet have a Post Disaster Redevelopment / Reconstruction Ordinance in place but some City staff have expressed an interest in learning more. There is an opportunity to include development of a Post Disaster Redevelopment Plan /Reconstruction Ordinance as a potential Mitigation Strategy.

Building Codes, Permitting, and Inspections: Building codes regulate construction standards. In many communities, permits, and inspections are required for new construction. Decisions regarding the adoption of building codes (that account for hazard risk), the type of permitting process required both before and after a disaster, and the enforcement of inspection protocols all affect the level of hazard risk faced by a community.

- The City of Charleston enforces state adopted building codes as well as zoning and municipal ordinances. State and city adopted updated building codes every three years to meet or exceed minimum standards.

The adoption and enforcement of building codes by local jurisdictions is routinely assessed through the Building Code Effectiveness Grading Schedule (BCEGS) program developed by the Insurance Services Office, Inc. (ISO).¹⁶ In South Carolina, the South Carolina Building Codes Council assesses the building codes in effect in a particular community and how the community enforces its building codes *with special emphasis on mitigation of losses from natural hazards*. The results of BCEGS assessments are routinely provided to ISO's member private insurance companies, which in turn may offer ratings credits for new buildings constructed in communities with strong BCEGS classifications. The concept is that communities with well-enforced, up-to-date codes should experience fewer disaster-related losses and, as a result, should have lower insurance rates.

In conducting the assessment, ISO collects information related to personnel qualification and continuing education as well as the number of inspections performed per day. This type of information combined with local building codes is used to determine a grade for that jurisdiction. The grades range from 1 to 10 with a BCEGS grade of 1 representing exemplary commitment to building code enforcement and a grade of 10 indicating less than minimum recognized protection.

Fire Code: NFPA 1, Fire Code, advances fire and life safety for the public and first responders as well as property protection by providing a comprehensive, integrated approach to fire code regulation and hazard management.

- The City of Charleston Fire Marshal Division enforces the 2018 International Fire Code, National Fire Protection Association (NFPA) codes and standards referenced in the IFC or as adopted by the State of South Carolina, and various City ordinances. The City of Charleston adopted the International Code Council "family" of codes, as approved by the South Carolina Building Code Council, for enforcement within the City.

Coastal Zone Management Plan: The Coastal Zone Management Plan regulates the appropriate use, development, and conservation of coastal resources. Implementation of the plan includes the direct regulation of impacts to coastal resources within the critical areas including coastal waters, tidelands, beaches, and beach dune systems; and indirect certification authority over federal actions and state permit decisions.

- The City of Charleston falls under review of the SCDHEC's South Carolina Coastal Zone Management Program under the guidelines of the national Coastal Zone Management Act (1972). When a new development project occurs within two miles of the coast, the State manages permitting relative to the coastal zone management plan. Any site-specific requirements are to be incorporated into development plans. The coordination of reviews and requirements could be better coordinated with the City, perhaps in the Design Review Team.

Open Space Management Plan: Intended to guide the management and use of the municipality open space lands for conservation and recreational purposes. Open space is defined as an area of land or water that either remains in its natural state or is used for agriculture, or is free from intensive development for

¹⁶ Participation in BCEGS is voluntary and may be declined by local governments if they do not wish to have their local building codes evaluated.

residential, commercial, industrial or institutional use and is intended to remain in its undeveloped condition.

- The City of Charleston has not adopted an open space management plan. The City includes Open Space Management Planning (named Parks and Recreation / Greenways Plan) in its Comprehensive Plan (2021).

Economic Development Plan: The economic development plan provides a comprehensive overview of the economy, sets policy direction for economic growth, and identifies strategies, programs, and projects to improve the economy.

- The City of Charleston Economic Development Plan exists as part of the City's Comprehensive Plan (2021).

7.3.4 Floodplain Management

Flooding is the most significant natural hazard facing the nation, yet the tools available for mitigating its impacts are among the most advanced compared to other hazards. The National Flood Insurance Program (NFIP) includes regulatory measures that enable government officials to guide growth in relation to flood risks. While participation in the NFIP is voluntary for local governments, FEMA strongly encourages it as a foundational step for an effective hazard mitigation program.

To join the NFIP, communities must adopt a local flood damage prevention ordinance that mandates adherence to minimum building standards in floodplains. These standards ensure that new buildings and major renovations are protected from a 100-year flood event, and that new developments do not worsen existing flood issues. A key service of the NFIP is the mapping of flood hazard areas. Flood Insurance Rate Maps (FIRMs) are used to assess flood risk, regulate construction, and set insurance rates. FIRMs serve as crucial resources for educating residents, officials, and businesses about local flooding likelihood.

The City of Charleston participates in the NFIP, with the Building Inspections Division, Department of Stormwater Management, and Floodplain Manager collaborating to implement the program. The Floodplain Manager has identified areas for improvement. The Building Inspections Division and Department of Stormwater Management enforce floodplain regulations in Special Flood Hazard Areas (SFHAs), overseeing development permits, reviews, and inspections. The City enforces floodplain requirements through the South Carolina Building Codes and the Charleston Flood Hazard Prevention and Control Ordinance, along with FEMA and ASCE guidelines. For New Construction and Substantial Improvements in SFHAs, permits require dedicated Flood Zone Assignments and Flood Design Reviews to ensure compliance with codes.

Elevation Certificates are mandatory for new constructions and substantial improvements. These certificates, along with other floodplain-related documents like Floodproofing Certificates and V-Zone Design Certificates, are reviewed for compliance with all permit application details. The City will not issue a Certificate of Construction Completion until the Finished Construction Elevation Certificate is approved.

To ensure consistency in processing, plan reviews, and inspections, Standard Operating Procedures are updated regularly. All relevant documentation, including Elevation Certificates, is digitized and stored in the City's development and land management system and electronic file storage system.

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Table 7.2 provides NFIP entry date, current effective map date and policy and claim information for the City of Charleston.

Table 7.2: NFIP Policy and Claim Information

Jurisdiction	Date Joined NFIP	Current Effective Map Date	NFIP Policies in Force	Insurance in Force	Closed Claims	Total Payments to Date
CITY OF CHARLESTON	10/30/1970	1/29/21	17,051	\$4,914,365,100	1,564	\$15,833,413

Source: NFIP claims and policy information as of 2/28/2023; NFIP Community Status information as of 2/23/2023

Community Rating System: An additional indicator of floodplain management capability is the active participation of local jurisdictions in the Community Rating System (CRS). The CRS is an incentive-based program that encourages counties and municipalities to undertake defined flood mitigation activities that go beyond the minimum requirements of the NFIP by adding extra local measures to provide protection from flooding. All of the 18 creditable CRS mitigation activities are assigned a range of point values. As points are accumulated and reach identified thresholds, communities can apply for an improved CRS class rating. Class ratings, which range from 10 to 1, are tied to flood insurance premium reductions as shown in **Table 7.3**. As class rating improves (the lower the number the better), the percent reduction in flood insurance premiums for NFIP policyholders in that community increases.

Table 7.3: CRS Premium Discounts by Class

CRS Class	Premium Reduction
1	45%
2	40%
3	35%
4	30%
5	25%
6	20%
7	15%
8	10%
9	5%
10	0

Source: FEMA

Community participation in the CRS is voluntary. Any community that is in full compliance with the rules and regulations of the NFIP may apply to FEMA for a CRS classification better than class 10. The CRS application process has been greatly simplified over the past several years based on community comments. Changes were made with the intent to make the CRS more user-friendly and make extensive technical assistance available for communities who request it.

- The city joined the CRS in 10/01/93 and is currently a Class 6 CRS Community. Building Inspections Division, along with Department of Stormwater Management, Floodplain Management, and Resilience Policy Advisor. The Floodplain Manager has identified this as an

area for improvement. There is some difficulty identified in enforcing the higher standard of 5-year cumulative on Substantial Improvement/Damage.

Flood Damage Prevention Ordinance: A flood damage prevention ordinance establishes minimum building standards in the floodplain with the intent to minimize public and private losses due to flood conditions.

- Any community participating in the NFIP are required to adopt a local flood damage prevention ordinance. The City of Charleston participates in the NFIP and they have adopted flood damage prevention regulations but city officials have indicated they would like to refine ordinance to clarify intent and align with observations from previous hazard events.

Substantial Damage Provisions: The City of Charleston's Damage Assessment team, led by the Chief Building Official, focuses on completing Substantial Damage Determinations in Special Flood Hazard Areas (SFHAs), conducting Individual Assistance Damage Assessments, identifying unsafe structures, and providing resources to affected property owners and residents. Staff from the Building Inspections and Engineering Divisions, Department of Stormwater Management, Fire Marshal Division, and Department of Planning, Preservation & Sustainability assist with damage assessments but are not responsible for post-event emergency operations.

At the start of each hurricane season, an annual training session is held for all City staff involved in the assessment process to review procedures. After an event, once conditions are safe, City operations will pause until the entire area has been assessed. Teams of two, equipped with City vehicles, mobile devices, maps, and outreach materials, document inspected streets and recorded damages using a City-designed mobile app. This app allows for on-site logging of damage assessments and photo documentation of issues such as high-water lines and wind damage. An educational handout is provided to property owners, detailing permit requirements, debris disposal, Increased Cost of Compliance, Substantial Damage, and emergency assistance.

Properties in the SFHA that qualify as Substantial Improvements or are classified as Substantially Damaged must adhere to current floodplain management requirements. Follow-up actions may include placing HOLDS on parcels in the City's development system and notifying property owners of Substantial Damage Determinations by mail. City staff will assist property owners in exploring compliance options, including Increased Cost of Compliance payments and FEMA grants. Historically significant properties may qualify for variances from damage regulations. Building permits for Substantially Damaged structures will only be issued if the work includes compliance with current flood design requirements. If compliance is not achieved after enforcement measures, the City may recommend to the NFIP that the property be denied flood insurance coverage under Section 1316.

Floodplain Management Plan: A floodplain management plan (or a flood mitigation plan) provides a framework for action regarding corrective and preventative measures to reduce flood-related impacts.

- The City of Charleston has a Floodplain Management Plan currently under development by the Building Inspections Division, along with Department of Stormwater Management, Floodplain Management, and the Resilience Policy Advisor.

Stormwater Management Plan: A stormwater management plan is designed to address flooding associated with stormwater runoff. The stormwater management plan is typically focused on design and

construction measures that are intended to reduce the impact of more frequently occurring minor urban flooding.

- As part of the City's Phase II Permit responsibilities, the City of Charleston must have a Stormwater Management Plan. This plan outline the City's plan to comply with its National Pollutant Discharge Elimination System (NPDES) Permit Requirements for the quality of the stormwater that is being discharged to public water bodies.

7.3.5 Climate Mitigation

The City has a Climate Action Plan.¹⁷ The five-year Climate Action Plan reflects the latest science, aligns with international standards for greenhouse gas (GHG) reduction, is synergistic with other City plans, and emphasizes the importance of ongoing, equitable community engagement. Both climate adaptation and mitigation solutions are important to achieve community resilience. Since adaptation measures (those that better prepare Charleston for the impacts of climate change) are the primary initiatives in the City's Flooding and Sea Level Rise Strategy, the Climate Action Plan builds on that base by focusing on climate mitigation measures to reduce emissions and ultimately address the root cause of climate change. Implementation of the Climate Action Plan will put Charleston on a path to achieving the following short- and long-term science-based emission reduction goals:

- Reduce emissions 56% below 2018 levels by 2030
- Reduce emissions to net zero by 2050

Additionally, the City has a High Performance Buildings certification (RISES) via the Sustainability Institute. RISES certification promotes new construction projects that are at least 30% more energy and water efficient than projects that are simply code compliant, and projects that are constructed using materials and products that do not adversely affect the health and well-being of building occupants. The RISES tag is an acronym for the building ingredients that industry-leading and responsible projects focus on and adhere to: Resilient; Innovative; Sustainable; Efficient; and Safe. Charleston RISES is the regionally appropriate certification choice, designed to address the specific green building needs, priorities and strategies of the South Carolina region.

7.3.6 Administrative and Technical Capability

The ability of a local government to develop and implement mitigation projects, policies, and programs is directly tied to its ability to direct staff time and resources for that purpose. Administrative capability can be evaluated by determining how mitigation-related activities are assigned to local departments and if there are adequate personnel resources to complete these activities. The degree of intergovernmental coordination among departments will also affect administrative capability for the implementation and success of proposed mitigation activities.

Technical capability can generally be evaluated by assessing the level of knowledge and technical expertise of local government employees, such as personnel skilled in using Geographic Information Systems (GIS) to analyze and assess community hazard vulnerability. The Capability Assessment Survey was used to capture information on administrative and technical capability through the identification of available staff and personnel resources.

- The City has HIGH Administrative and Technical Capability
- Has staff skilled in GIS

¹⁷ <https://www.charleston-sc.gov/904/Climate-Action-Plan>

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- Has an Emergency Manager and Floodplain Manager

Table 7.4 provides a summary of the capability assessment results for the City of Charleston with regard to relevant staff and personnel resources. A checkmark (✓) indicates the presence of a staff member(s) in that jurisdiction with the specified knowledge or skill.

Table 7.4: Relevant Staff/Personnel Resources

STAFF / PERSONNEL RESOURCE	CITY OF CHARLESTON	DEPARTMENT / AGENCY	COMMENTS
Planners with knowledge of land development / land management practices	✓	Planning, Preservation, and Sustainability, Stormwater Management, Traffic and Transportation, and Mayors Office of Resilience, Sustainability, and Emergency Management	
Engineers or professionals trained in construction practices related to buildings and/or infrastructure	✓	Building Inspection Division	ICC Certified and SC BCC Licensed: 1 Chief Building Official (also ASFPM CFM), 1 Deputy Building Official, 5 plans Examiner, 12 Field Inspectors, 1 ASGPM CFM Certified Floodplain Review Technician
Planners or engineers with an understanding of natural and/or human-caused hazards	✓	Planning, Preservation, and Sustainability, Mayors Office of Resilience, Sustainability, and Emergency Management, Stormwater Management,	The City of Charleston has the Vulnerability Assessment report and tools, and the Sea Level Rise Strategy at their disposal.
Emergency Manager	✓	Mayor's Office of Resilience, Sustainability, and Emergency Management	City EMD has 3 emergency management staff members. Staff are required to hold SC Certified Emergency Manager credentials through South Carolina Emergency Management Association (SCEMA).
Floodplain Manager	✓	Stormwater Management (which includes Floodplain Management)	There was not a designated floodplain manager pre-2018 and between mid-2021 to mid-2022. Around 2019, a Floodplain Management Technician was added to Stormwater and in 2022 a Floodplain Review Technician was added to BID.

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STAFF / PERSONNEL RESOURCE	CITY OF CHARLESTON	DEPARTMENT / AGENCY	COMMENTS
Land Surveyors			City officials have indicated they do not have the capacity to perform surveys. The Building Inspections Department has attempted to acquire reliable hand-held elevation devices, but they were not reliable for vertical elevations. City officials have also indicated they do not perform widespread soil testing.
Scientists familiar with the hazards of the community	✓	IT/GIS, Public Service, Stormwater, EM, Consultants	The City of Charleston indicated they might not have staff specialized scientists, but do consult universities, outside consultants, and federal entities (NOAA, NMS) that do staff specialized experts
Staff with education or expertise to assess the community's vulnerability to hazards	✓	IT/GIS, Public Service, Stormwater, EM, Fire, Consultants	City has indicated they have staff familiar with community's vulnerability to hazards – especially Flooding and Sea Level Rise
Personnel skilled in GIS and/or Hazus	✓	IT/GIS, CPD, Fire, Planning, Stormwater	All groups identified by the City are staffed by members with GIS skills
Resource development staff or grant writers	✓	BRFC / CFD / Fire	The City of Charleston, while successful in securing grant funding with one designated grant writer, has indicated they need additional staff for grant writing/management.

7.3.7 Fiscal Capability

The ability of a local government to take action is often closely associated with the amount of money available to implement policies and projects. This may take the form of outside grant funding awards or locally-based revenue and financing. The costs associated with mitigation policy and project implementation vary widely. In some cases, policies are tied primarily to staff time or administrative costs associated with the creation and monitoring of a given program. In other cases, direct expenses are linked to an actual project, such as the acquisition of flood-prone homes, which can require a substantial commitment from local, state, and federal funding sources.

The Capability Assessment Survey was used to capture information on the City's fiscal capability through the identification of locally available financial resources.

- The City falls within the HIGH range
- The City has partnering arrangements or intergovernmental agreements

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Table 7.5 provides a summary of the results for the City of Charleston with regard to relevant fiscal resources. A checkmark (✓) indicates that the given fiscal resource is locally available for hazard mitigation purposes (including match funds for state and federal mitigation grant funds).

Table 7.5: Relevant Fiscal Resources

FISCAL TOOL / RESOURCE	CITY OF CHARLESTON	NOTES
Capital Improvement Programming	✓	
Community Development Block Grants (CDBG)	✓	The City of Charleston does receive CDBG funding, which can often be used as a local match (more specifically CDBG-MIT).
Special Purpose Taxes (or taxing districts)	✓	
Hospitality Tax	✓	The City of Charleston has a Hospitality Tax, however revenues can only be used in designated areas.
Gas / Electric Utility Fees	X	The City of Charleston does not manage utilities. These fees go through Dominion Energy.
Water / Sewer Fees	X	****The City of Charleston does not manage utilities. These fees go through Charleston Water Service.
Stormwater Utility Fees	✓	The City of Charleston can only use these fees toward stormwater related projects.
Development Impact Fees	X	
General Obligation, Revenue, and/or Special Tax Bonds	✓	
Partnering Arrangements or Intergovernmental Agreements	✓	Examples include Charleston County and BCDCOG.

7.3.8 Political Capability

One of the most difficult capabilities to evaluate involves the political will of a jurisdiction to enact meaningful policies and projects designed to reduce the impact of future hazard events. Hazard mitigation may not be a local priority or may conflict with or be seen as an impediment to other goals of the community, such as growth and economic development. Therefore, the local political climate must be considered in designing mitigation strategies as it could be the most difficult hurdle to overcome in accomplishing their adoption and implementation.

The Capability Assessment Survey was used to capture information on political capability of the City of Charleston. General examples of local political capability include guiding development away from identified hazard areas, restricting public investments or capital improvements within hazard areas, or enforcing local development standards that go beyond minimum state or federal requirements (i.e., building codes, floodplain management, etc.).

- The City modified existing ordinances to pass a 2'-0" Freeboard for the New Construction and Commercial Substantial Improvements. Although the City was able to pass this new ordinance, there was not much support for a 2'-0" Freeboard for Residential Improvements from the council due to cited concerns about hardship and gentrification, so the Freeboard requirement is 1'-0"
- The City Council passed a slab-on-grade prohibition ordinance in April 2023, effective for projects from January 1, 2024. See: Ordinance to Prohibit Slab-on-Grade Foundations (building diagrams 1A, 1B, 2A, and 3) in the SFHA or 100-year Floodplain will become effective for projects applied on or after January 1, 2024.¹⁸

7.3.9 Community Coordination

Climate Ambassador Program: The City has a Climate Ambassador Program¹⁹ to build climate leaders within the community. Participants are certified to share information about Charleston's Climate Action Plan (May 2021) and inspire its implementation.

Equity: The City convened a Special Commission on Equity, Inclusion, and Racial Conciliation to develop the Equity, Inclusion, and Racial Conciliation Report²⁰. Within this report, the City adopted a long-term goal to prioritize flood mitigation strategies and address racial equity and environmental justice, including guidance on open space, drainage projects, environmental initiatives, home elevation. It also includes the long-term goal of addressing climate change and systemic inequities simultaneously, advocating for pollution control measures and climate change as a public health emergency,

Community Newsletter: "Hey, Charleston!" is the City of Charleston's official weekly newsletter, compiled by the Business and Neighborhood Services Division and sent to over 8,000 subscribers. As of Spring 2023, the city uses Hey Charleston to notify community members about extreme heat.

7.4 CONCLUSIONS ON LOCAL CAPABILITY

In order to form meaningful conclusions on the assessment of local capability, a quantitative scoring methodology was designed and applied to results of the Capability Assessment Survey. This methodology,

¹⁸ <https://www.charleston-sc.gov/1944/Floodplain-Management>

¹⁹ <https://www.charleston-sc.gov/2585/Climate-Ambassador-Program>

²⁰ <https://www.charleston-sc.gov/DocumentCenter/View/29874/Special-Commission-on-Equity-Inclusion-and-Racial-Conciliation-Report---August-2021>

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further described in Appendix B, attempts to assess the overall level of capability of the City of Charleston to implement a comprehensive hazard mitigation strategy. The City's overall capability to implement hazard mitigation actions is HIGH.

	Low Vulnerability	Moderate Vulnerability	High Vulnerability
High Capability	(Best Case Scenario)		City of Charleston
Moderate Capability			
Low Capability			(Worst Case Scenario)

Figure 7.2: City of Charleston Capability and Vulnerability Comparison

Table 7.6 shows the results of the capability assessment using the designed scoring methodology. The capability score is based solely on the information provided by City staff.

Table 7.6: Capability Assessment Results

JURISDICTION	OVERALL CAPABILITY SCORE	OVERALL CAPABILITY RATING
CITY OF CHARLESTON	56	High

As previously discussed, one of the reasons for conducting a Capability Assessment is to examine local capabilities to detect any existing gaps or weaknesses within ongoing government activities that could hinder proposed mitigation activities and possibly exacerbate community hazard vulnerability. These gaps or weaknesses have been identified for the City in the tables found throughout this section. The City's Hazard Mitigation Planning Team used the Capability Assessment as part of the basis for the Mitigation Actions that are identified in Section 9; therefore, addresses their ability to expand on and improve their existing capabilities through the identification of their Mitigation Actions.

7.4.1 Linking the Capability Assessment with the Risk Assessment and the Mitigation Strategy

The conclusions of the Risk Assessment and Capability Assessment serve as the foundation for the development of a meaningful hazard mitigation strategy. During the process of identifying specific mitigation actions to pursue, the Hazard Mitigation Planning Team considered not only their level of hazard risk, but also their existing capability to minimize or eliminate that risk.

SECTION 8

MITIGATION STRATEGY

This section of the Plan provides the blueprint for the City of Charleston to follow in order to become less vulnerable to its identified hazards and increase resiliency. It is based on consensus of the City of Charleston Hazard Mitigation Planning Team and the findings and conclusions of the *Capability Assessment* and *Risk Assessment*. It consists of the following six subsections:

- 8.1 Introduction
- 8.2 Mitigation Goals
- 8.3 Identification and Analysis of Mitigation Techniques
- 8.4 Selection of Mitigation Techniques for the City of Charleston
- 8.5 Plan Update Requirement
- 8.6 Potential Funding Sources

8.1 INTRODUCTION

The Mitigation Strategy aims to provide the City of Charleston with clear goals that will guide future mitigation policies and project management, along with an analysis of techniques to achieve these goals and reduce the impact of identified hazards. It is designed to be comprehensive, strategic, and functional:

- Comprehensive: The strategy includes a thorough review of all hazards and identifies extensive measures to minimize the future impacts of high-risk hazards while supporting economic, environmental, and social goals.
- Strategic: It ensures that all proposed policies and projects align with established long-term planning goals.
- Functional: Each proposed mitigation action is linked to specific priorities and assigned to responsible departments or individuals with target completion deadlines. Funding sources are identified to support project implementation as needed.

The first step in developing the Mitigation Strategy is identifying broad mitigation goals, which guide the implementation of specific actions. These actions include hazard mitigation policies, such as regulating land use in hazard-prone areas, and projects aimed at addressing specific risks, like relocating repeatedly damaged structures.

The second step involves analyzing available mitigation measures to achieve the identified goals. This is a continuous process supported by the ongoing development and maintenance of the Plan. New mitigation opportunities will be explored as data and technology improve, funding becomes available, and the Plan is updated.

The final step is selecting and prioritizing specific mitigation actions for Charleston, detailed in Section 9: Mitigation Action Plan (MAP). The MAP serves as a clear and actionable framework, representing the most critical outcome of the planning process.

It includes a prioritized list of proposed hazard mitigation actions for Charleston, complete with information on responsible departments, potential funding sources, and estimated completion dates. This roadmap aids in implementing actions and serves as a tool for monitoring progress over time. The MAP also provides local decision-makers with an accessible overview of recommended mitigation policies and projects. In preparing each Mitigation Action Plan, officials considered the overall hazard risk and the community's capacity to mitigate these effects, as assessed through the risk and capability evaluation, while ensuring alignment with adopted goals and community needs.

8.1.1 Mitigation Action Prioritization

All existing mitigation actions for the City of Charleston found in the Charleston Regional Hazard Mitigation Plan were previously prioritized. For the city's 2023 plan, the members of the Hazard Mitigation Planning Team were asked to providing a status update for each of those actions and to pay close attention to ensuring that assigned priority for each action was still appropriate. Prioritization of the existing mitigation actions and new mitigation actions identified during the 2023 plan creation was based on the following strategies:

1. High Priority – Highly cost-effective, administratively feasible, and politically feasible strategies that should be implemented in fiscal years 2024/2025 and be continued.
2. Medium Priority – Strategies that have at least two of the following characteristics (but not all three) and should be implemented in fiscal years 2024/2025 to 2025/2026:
 - a. Highly cost-effective; or
 - b. Administratively feasible, given current levels of staffing and resources; or
 - c. Are politically popular and supportable given the current environment.
3. Low Priority – Strategies that have at least one of the following characteristics (but not two or three) and should be implemented in the next five (5) years (by the end of 2027/2028):
 - d. Highly cost-effective; or
 - e. Administratively feasible, given current levels of staffing and resources; or
 - f. Are politically popular and supportable given the current environment.

Members of the Hazard Mitigation Planning Team helped coordinate the prioritization process by reviewing each action and working with the lead agency/department responsible to determine a priority for each action using the six factors listed above.

Using these criteria, actions were classified as high, moderate, or low priority by the Hazard Mitigation Planning Team.

8.2 MITIGATION GOALS

44 CFR Requirement

44 CFR Part 201.6(c)(3)(i): The mitigation strategy shall include a description of mitigation goals to reduce or avoid long-term vulnerabilities to the identified hazards.

The primary goal of all local governments is to promote the public health, safety, and welfare of its citizens. In keeping with this standard, the City of Charleston recognizes goal statements for local hazard mitigation planning. The city's hazard mitigation goals remain consistent with the mitigation goals contained in the Charleston Regional Hazard Mitigation Plan. As previously discussed in *Section 2:*

Planning Process, the City has historically participated in the Charleston Regional Hazard Mitigation Plan and continues to do so. As a result, the city has adopted the goals of that plan which are listed below:

1. Reduce potential flood damage
2. Improve storm drainage
3. Minimize future flood occurrence
4. Minimize future hurricane damage
5. Improve resistance of infrastructure to all hazards
6. Minimize future earthquake damage
7. Protect environmental resources/preserve open and green space
8. Minimize future terrorist incidents
9. Improve water quality
10. Preserve historic building inventory
11. Higher regulatory standard
12. Minimize future hazardous material incidents
13. To enhance the provision of emergency shelters for those areas in the Region that do not currently have an emergency shelter in proximity.
14. To recognize that shelters in certain areas should not be provided, due to a lack of safe locations for such facilities.
15. Shelters that are not currently sanctioned by the American Red Cross are to be classified as “shelters of last resort”.
16. The Committee also determined that jurisdictions may have additional goals that they would like to pursue through this plan, and that these additional goals should be included in those jurisdictions action plans, as deemed appropriate.

Each goal, purposefully broad in nature, serves to establish parameters that were used in developing more mitigation actions. Consistent implementation of actions over time will ensure that community goals are achieved.

8.3 IDENTIFICATION AND ANALYSIS OF MITIGATION TECHNIQUES

44 CFR Requirement

44 CFR Part 201.6(c)(3)(ii): The mitigation strategy shall include a section that identifies and analyzes a comprehensive range of specific mitigation actions and projects being considered to reduce the effect of each hazard, with particular emphasis on new and existing buildings and infrastructure.

In formulating the Mitigation Strategy for the City of Charleston, a wide range of activities were considered in order to help achieve the established mitigation goals, in addition to addressing any specific hazard concerns. These activities were discussed during the City of Charleston Hazard Mitigation Planning Team meetings. In general, all activities considered by the Hazard Mitigation Planning Team can be classified under one of the following six broad categories of mitigation techniques: Prevention, Property Protection, Natural Resource Protection, Structural Projects, Emergency Services, and Public Awareness and Education. These are discussed in detail below.

8.3.1 Prevention

Preventative activities are intended to keep hazard problems from getting worse and are typically administered through government programs or regulatory actions that influence the way land is developed and buildings are built. They are particularly effective in reducing a community's future

vulnerability, especially in areas where development has not occurred, or capital improvements have not been substantial. Examples of preventative activities include:

- Planning and zoning
- Building codes
- Open space preservation
- Floodplain regulations
- Stormwater management regulations
- Drainage system maintenance
- Capital improvements programming
- Riverine / fault zone setbacks

8.3.2 Property Protection

Property protection measures involve the modification of a site or the modification of existing buildings and structures to help them keep the hazard away or better withstand the forces of a hazard, or removal of the structures from hazardous locations. Examples include:

- Modification of the site to keep the hazard from reaching the building
 - Flood Barriers
 - Relocation
 - Building Elevation
 - Demolition
 - Demo/Rebuild
- Modify the building (retrofit) so it can withstand impacts of the hazard
 - Wind-proofing
 - Dry Floodproofing
 - Wet Floodproofing
 - Seismic design techniques
- Critical facilities protection
- Safe rooms, shutters, shatter-resistant glass
- Insurance (private property and public property)

Site Modification

Flood Barriers

A flood protection barrier can be built of dirt or soil (a "berm") or concrete or steel (a "floodwall"). Careful design is needed to ensure that it does not create additional flooding or drainage problems on neighboring properties. Depending on how well the ground drains, if floodwaters stay up for more than an hour or two, the design needs to account for leaks, seepage of water underneath, and rainwater that will fall inside the perimeter. This is usually done with a sump or French drain to collect the internal groundwater and surface water and a pump and pipe to pump the internal drainage over the barrier. However, barriers can only be built so high and they can be overtopped by a flood higher than expected. Barriers made of earth are susceptible to erosion from rain and floodwaters if not properly sloped, covered with grass, and properly maintained.

Relocation

Moving a flood-prone building to higher ground is the surest and safest way to protect it from flooding. While almost any building can be moved, the cost increases for heavier structures, such as those with exterior brick and stone walls, and for large or irregularly shaped buildings. Relocation is also preferred for large lots that include buildable areas outside the floodplain or where the owner has a new location available outside of the hazard zone.

Building Elevation

Elevating a building above the flood level can be almost as effective as moving it out of the floodplain. Once the building is raised, water is allowed to flow under and around the building, causing little or no damage to the structure or its contents. Raising a building above the flood level is cheaper than moving it and can be less disruptive to a neighborhood. Elevation has proven to be an acceptable and reasonable means of complying with floodplain regulations that require new, substantially improved, and substantially damaged buildings to be elevated above the base flood elevation. Building elevation protects the physical building but does not eliminate life safety or rescue needs during a flood event.

Demolition

Some buildings, especially heavily damaged or repetitively flooded ones, may not be the expense to protect them from future damage. In some cases, it is cheaper to demolish them and either replace them with new, flood protected structures or relocate the occupants to a safer site. Demolition is also appropriate for buildings that are difficult to move – such as larger, slab foundation or masonry structures – and for dilapidated structures that are not cost-beneficial to protect.

Demolition/Rebuild

If a building is not in good shape, elevating it may not be feasible or it may even be dangerous. An alternative is to demolish the structure and build a new one on the site that meets or exceeds all flood protection codes. However, it can be difficult to qualify for the FEMA funding to implement this technique and it is not a regularly funded option. Certain rules must be followed to qualify for federal funds for pilot reconstruction.

Site Modification (Retrofitting)***Dry Floodproofing***

Dry floodproofing is a mitigation practice that involves making all areas of a structure below the flood protection level watertight. This can be achieved by applying waterproofing compounds or plastic sheeting to walls and sealing openings, such as doors, windows, and vents, using permanent closures, removable shields, or sandbags.

Under state, FEMA, and local regulations, dry floodproofing is allowed for both new and existing nonresidential buildings in the regulatory floodplain. Existing residential buildings can also be dry floodproofed, provided they are not substantially damaged or undergoing significant improvements. There are no restrictions on dry floodproofing for buildings outside the regulatory floodplain. However, dry floodproofing is effective only against shallow flooding, such as in areas with recurring drainage issues. It does not protect against deep flooding from lakes and large rivers during hurricanes or storms, nor does it safeguard against fast-moving floodwaters that can compromise the materials used in dry floodproofing.

Wet Floodproofing

The alternative to dry floodproofing is wet floodproofing: water is let into the structure and everything that could be damaged by a flood is removed or elevated above the flood level. Structural components below the flood level are replaced with materials that are not subject to water damage. For example, concrete block walls are used instead of wooden studs and gypsum wallboard. Mechanical fixtures such as the furnace, water heater and laundry facilities are permanently relocated to a higher floor. Where the flooding is not deep, these appliances can be raised on blocks or platforms.

Insurance***Private Property***

Although most homeowner's insurance policies do not cover a property for flood damage, an owner can insure a building for damage by surface flooding through the National Flood Insurance Program. Flood insurance coverage is provided for buildings and their contents damaged by a "general condition of surface flooding" in the area. Most people purchase flood insurance because it is required by the bank when they get a mortgage or home improvement loan. Usually, these policies just cover the building's structure and not the contents. Contents coverage can be purchased separately. Renters can buy contents coverage, even if the owner does not buy structural coverage on the building. Most people don't realize that there is a 30-day waiting period to purchase a flood insurance policy and there are limits on coverage.

Public Property

Governments can purchase commercial insurance policies. Larger local governments often self-insure and absorb the cost of damage to one facility, but if many properties are exposed to damage, self-insurance can drain the government's budget. Communities cannot expect federal disaster assistance to make up the difference after a flood.

8.3.3 Natural Resource Protection

Natural resource protection activities reduce the impact of natural hazards by preserving or restoring natural areas and their protective functions. Such areas include floodplains, wetlands, steep slopes, and sand dunes. Parks, recreation, or conservation agencies and organizations often implement these protective measures. Examples include:

- Wetland protection
- Erosion and sediment control
- Watershed management
- Stream/River Restoration
- Best Management Practices
- Dumping Regulations
- Farmland Protection
- Forest and vegetation management (e.g., fire resistant landscaping, fuel breaks, etc.)
- Habitat preservations
- Slope stabilization

Wetland Protection

Wetlands are often synonymous with floodplains and topographically depressed areas of a watershed. Many wetlands receive and store floodwaters, thus slowing and reducing downstream flows. They also

serve as a natural filter and helps improve water quality, and they provide habitat for many species of fish, wildlife and plants. Charleston is characterized by many acres of wetlands.

Erosion and Sedimentation Control

Farmlands and construction sites typically contain large areas of bare exposed soil. Surface water runoff can erode soil from these sites, sending sediment into downstream waterways. Erosion also occurs along stream banks and shorelines as the volume and velocity of flow or wave action destabilize and wash away the soil. Sediment suspended in the water tends to settle out where flowing water slows down. This sediment can clog storm drains, drain tiles, culverts and ditches and reduce the water transport and storage capacity of river and stream channels, lakes and wetlands.

There are two principal strategies to address these problems: minimize erosion and control sedimentation. Techniques to minimize erosion include phased construction, minimal land clearing, and stabilizing bare ground as soon as possible with vegetation and other soil stabilizing practices. Charleston has adopted Erosion and Sedimentation Control Ordinances and/or Stormwater Management Ordinances that address some of these issues.

Stream/River Restoration

There is a growing movement that has several names, such as "stream conservation," "bioengineering," or "riparian corridor restoration." The objective of these approaches is to return streams, stream banks and adjacent land to a more natural condition, including the natural meanders. Another term is "ecological restoration," which restores native indigenous plants and animals to an area.

A key component of these efforts is to use appropriate native plantings along the banks that resist erosion. This may involve retrofitting the shoreline with willow cuttings, wetland plants, or rolls of landscape material covered with a natural fabric that decomposes after the banks are stabilized with plant roots.

In all, restoring the right vegetation to a stream has the following advantages:

- Reduces the amount of sediment and pollutants entering the water
- Enhances aquatic habitat by cooling water temperature
- Provides food and shelter for both aquatic and terrestrial wildlife
- Can reduce flood damage by slowing the velocity of water
- Increases the beauty of the land and its property value
- Prevents property loss due to erosion
- Provides recreational opportunities, such as hunting, fishing and bird watching
- Reduces long-term maintenance costs

Best Management Practices

Point source pollutants come from pipes such as the outfall of a municipal wastewater treatment plant. They are regulated by the US EPA. Nonpoint source pollutants come from non-specific locations and are more difficult to regulate. Examples of nonpoint source pollutants are lawn fertilizers, pesticides, other chemicals, animal wastes, oils from street surfaces and industrial areas, and sediment from agriculture, construction, mining and forestry. These pollutants are washed off the ground's surface by stormwater and flushed into receiving storm sewers, ditches and streams.

The term "best management practices" (BMPs) refers to design, construction and maintenance practices and criteria that minimize the impact of stormwater runoff rates and volumes, prevent erosion, protect natural resources and capture nonpoint source pollutants (including sediment). They can prevent increases in downstream flooding by attenuating runoff and enhancing infiltration of stormwater. They also minimize water quality degradation, preserve beneficial natural features onsite, maintain natural base flows, minimize habitat loss, and provide multiple usages of drainage and storage facilities.

The City of Charleston's Stormwater Management Ordinances contains regulations for stormwater BMPs. Because of the City's unique geologic hydrologic conditions (i.e., poorly drained soils and a shallow water table), the types of appropriate BMPs that can be effectively utilized in the city are limited.

Dumping Regulations

BMPs usually address pollutants that are liquids or are suspended in water that are washed into a lake or stream. Dumping regulations address solid matter, such as shopping carts, appliances and landscape waste that can be accidentally or intentionally thrown into channels or wetlands. Such materials may not pollute the water, but they can obstruct even low flows and reduce the channels' and wetlands' abilities to convey or clean stormwater.

Many cities have nuisance ordinances that prohibit dumping garbage or other "objectionable waste" on public or private property. Waterway dumping regulations need to also apply to "non-objectionable" materials, such as grass clippings or tree branches, which can kill ground cover or cause obstructions in channels. Regular inspections to catch violations should be scheduled.

In addition, many people do not realize the consequences of their actions. They may, for example, fill in the ditch in their front yard without realizing that is needed to drain street runoff. They may not understand how regrading their yard, filling a wetland, or discarding leaves or branches in a watercourse can cause a problem to themselves and others. Therefore, a dumping enforcement program should include public information materials that explain the reasons for the rules as well as the penalties.

Farmland Protection

Farmland protection is an important piece of comprehensive planning and zoning throughout the United States. The purpose of farmland protection is to provide mechanisms for prime, unique, or important agricultural land to remain as such, and to be protected from conversion to nonagricultural uses.

Frequently, farm owners sell their land to residential or commercial developers and the property is converted to non-agricultural land uses. With development comes more buildings, roads and other infrastructure. Urban sprawl occurs, which can lead to additional stormwater runoff and emergency management difficulties.

Farms on the edge of cities are often appraised based on the price they could be sold for to urban developers. This may drive farmers to sell to developers because their marginal farm operations cannot afford to be taxed as urban land. The Farmland Protection Program in the United States Department of Agriculture's 2002 Farm Bill (Part 519) allows for funds to go to state, tribal, and local governments as well as nonprofit organizations to help purchase easements on agricultural land to protect against the development of the land.

8.3.4 Structural Projects

Structural mitigation projects are intended to lessen the impact of a hazard by modifying the environmental natural progression of the hazard event through construction. They are usually designed by engineers and managed or maintained by public works staff. Examples include:

- Reservoirs
- Dams / levees / dikes / floodwalls
- Diversions / detention / retention
- Channel modification
- Storm sewers

Levees and Floodwalls

Probably the best-known flood control measure is a barrier of earth (levee) or concrete (floodwall) erected between the watercourse and the property to be protected. Levees and floodwalls confine water to the stream channel by raising its banks. However, they must be well designed to account for large floods, underground seepage, pumping of internal drainage, and erosion and scour.

Reservoirs and Detention

Reservoirs reduce flooding by temporarily storing flood waters behind dams or in storage or detention basins. Reservoirs lower flood heights by holding back, or detaining, runoff before it can flow downstream. Flood waters are detained until the flood has subsided, and then the water in the reservoir or detention basin is released or pumped out slowly at a rate that the river can accommodate downstream.

Reservoirs can be dry and remain idle until a large rain event occurs. Or they may be designed so that a lake or pond is created. The lake may provide recreational benefits or water supply (which could also help mitigate a drought). Flood control reservoirs are most commonly built for one of two purposes. Large reservoirs are constructed to protect property from existing flood problems. Smaller reservoirs, or detention basins, are built to protect property from the stormwater runoff impacts of new development.

Diversion

A diversion is a new channel that sends floodwaters to a different location, thereby reducing flooding along an existing watercourse. Diversions can be surface channels, overflow weirs, or tunnels. During normal flows, the water stays in the existing channel. During floods, the floodwaters spill over to the diversion channel or tunnel, which carries the excess water to a receiving lake or river.

8.3.5 Emergency Services

Although not typically considered a “mitigation” technique, emergency service measures do minimize the impact of a hazard event on people and property. These commonly are actions taken immediately prior to, during, or in response to a hazard event. Examples include:

- Warning systems
- Evacuation planning and management
- Emergency response training and exercises
- Sandbagging for flood protection
- Installing temporary shutters for wind protection

Threat Recognition

The first step in responding to a flood is to know when weather conditions are such that an event could occur. With a proper and timely threat recognition system, adequate warnings can be disseminated.

The National Weather Service (NWS) is the prime agency for detecting meteorological threats. Severe weather warnings are transmitted through NOAA's Weather Radio System. Local emergency managers can then provide more site-specific and timely recognition after the Weather Service issues a watch or a warning. A flood threat recognition system predicts the time and height of a flood crest. This can be done by measuring rainfall, soil moisture, and stream flows upstream of the community and calculating the subsequent flood levels.

On smaller rivers and streams, locally established rainfall and river gauges are needed to establish a flood threat recognition system. The NWS may issue a "flash flood watch." This is issued to indicate current or developing hydrologic conditions that are favorable for flash flooding in and close to the watch area, but the occurrence is neither certain nor imminent. These events are so localized and so rapid that a "flash flood warning" may not be issued, especially if no remote threat recognition equipment is available. In the absence of a gauging system on small streams, the best threat recognition system is to have local personnel monitor rainfall and stream conditions. While specific flood crests and times will not be predicted, this approach will provide advance notice of potential local or flash flooding.

Warning

The next step in emergency response following threat recognition is to notify the public and staff of other agencies and critical facilities. More people can implement protection measures if warnings are early and include specific details.

The NWS issues notices to the public using two levels of notification:

- Watch: conditions are right for flooding, thunderstorms, tornadoes or winter storms.
- Warning: a flood, tornado, etc., has started or been observed.

A more specific warning may be disseminated by the community in a variety of ways. The following are the more common methods:

- CodeRED countywide mass telephone emergency communication system
- Commercial or public radio or TV stations
- The Weather Channel
- Cable TV emergency news inserts
- Telephone trees/mass telephone notification
- NOAA Weather Radio
- Tone activated receivers in key facilities
- Outdoor warning sirens
- Sirens on public safety vehicles
- Door-to-door contact
- Mobile public address systems
- Email notifications

Just as important as issuing a warning is telling people what to do in case of an emergency. A warning program should include a public information component.

StormReady

The National Weather Service (NWS) established the StormReady program to help local governments improve the timeliness and effectiveness of hazardous weather-related warnings for the public. To be officially StormReady, a community must:

- Establish a 24-hour warning point and emergency operations center
- Have more than one way to receive severe weather warnings and forecasts and to alert the public
- Create a system that monitors weather conditions locally
- Promote the importance of public readiness through community seminars
- Develop a formal hazardous weather plan, which includes training severe weather spotters and holding emergency exercises

Being designated a NWS StormReady community is a good measure of a community's emergency warning program for weather hazards. Charleston County is a StormReady county, which includes the City of Charleston.

Response

The protection of life and property is the most important task of emergency responders. Concurrent with threat recognition and issuing warnings, a community should respond with actions that can prevent or reduce damage and injuries. Typical actions and responding parties include the following:

- Activating the emergency operations center (emergency preparedness)
- Closing streets or bridges (police or public works)
- Shutting off power to threatened areas (utility company)
- Passing out sand and sandbags (public works)
- Holding children at school or releasing children from school (school superintendent)
- Opening evacuation shelters (the American Red Cross)
- Monitoring water levels (public works)
- Establishing security and other protection measures (police)

An emergency action plan ensures that all bases are covered and that the response activities are appropriate for the expected threat. These plans are developed in coordination with the agencies or offices that are given various responsibilities. Emergency response plans should be updated annually to keep contact names and telephone numbers current and to ensure that supplies and equipment that will be needed are still available. They should be critiqued and revised after disasters and exercises to take advantage of the lessons learned and of changing conditions. The result is a coordinated effort implemented by people who have experience working together so that available resources will be used in the most efficient manner possible.

Evacuation and Shelter

There are six key components to a successful evacuation:

- Adequate warning
- Adequate routes
- Proper timing to ensure the routes are clear
- Traffic control
- Knowledgeable travelers

- Care for special populations (e.g., disabled persons, prisoners, hospital patients, schoolchildren)

Those who cannot get out of harm's way need shelter. Typically, the American Red Cross will staff shelters and ensure that there is adequate food, bedding, and wash facilities. Shelter management is a specialized skill. Managers must deal with problems like scared children, families that want to bring in their pets, and the potential for an overcrowded facility.

8.3.6 Public Education and Awareness

Public education and awareness activities are used to advise residents, elected officials, business owners, potential property buyers, and visitors about hazards, hazardous areas, and mitigation techniques they can use to protect themselves and their property. Examples of measures to educate and inform the public include:

- Outreach projects
- Speaker series / demonstration events
- Hazard map information
- Real estate disclosure
- Library materials
- School children's educational programs
- Hazard expositions

Outreach Projects

Outreach projects are the first step in the process of orienting property owners to the hazards they face and to the concept of property protection. They are designed to encourage people to seek out more information in order to take steps to protect themselves and their properties. Awareness of the hazard is not enough; people need to be told what they can do about the hazard.

Thus, projects should include information on safety, health and property protection measures. Research has shown that a properly run local information program is more effective than national advertising or publicity campaigns. Therefore, outreach projects should be locally designed and tailored to meet local conditions. Examples include:

- Community Newsletters/Direct Mailings: The most effective types of outreach projects are mailed or distributed to everyone in the community. In the case of floods, they can be sent only to floodplain property owners.
- News Media: Local newspapers can be strong allies in efforts to inform the public. Local radio stations and cable TV channels can also help. These media offer interview formats and cable TV may be willing to broadcast videos on the hazards.
- Libraries and Websites: The two previous activities tell people that they are exposed to a hazard. The next step is to provide information to those who want to know more. The community library and local websites are obvious places for residents to seek information on hazards, hazard protection, and protecting natural resources.
- Books and Pamphlets: Can be given to libraries, and many of these can be obtained for free from state and federal agencies. Libraries also have their own public information campaigns with displays, lectures and other projects, which can augment the activities of the local government.

Today, websites are commonly used as research tools. They provide fast access to a wealth of public and private sites for information. Through links to other websites, there is almost no limit to the amount of up-to-date information that can be accessed on the Internet. Some examples of resources that can be found online include, but are not limited to, floodplain maps, information for homeowners on how to retrofit for floods and flood information for children.

Technical Assistance

Hazard Information

Residents and business owners that are aware of the potential hazards can take steps to avoid problems or reduce their exposure to flooding. Communities can easily provide map information from FEMA's FIRMs and Flood Insurance Studies. They may also assist residents in submitting requests for map amendments and revisions when they are needed to show that a building is located outside the mapped floodplain.

Some communities supplement what is shown on the FIRM with information on additional hazards, flooding outside mapped areas and zoning. When the map information is provided, community staff can explain insurance, property protection measures and mitigation options that are available to property owners. They should also remind inquirers that being outside the mapped floodplain is no guarantee that a property will never flood.

Property Protection Assistance

While general information provided by outreach projects or the library is beneficial, most property owners do not feel ready to retrofit their buildings without more specific guidance. Local building department staff are experts in construction. They can provide free advice, not necessarily to design a protection measure, but to steer the owner onto the right track. Building or public works department staffs can provide the following types of assistance:

- Visit properties and offer protection suggestions,
- Recommend or identify qualified or licensed contractors,
- Inspect homes for anchoring of roofing and the home to the foundation, and
- Explain when building permits are needed for home improvements.

Public Information Program

A Program for Public Information (PPI) is a document that receives CRS credit. It is a review of local conditions, local public information needs, and a recommended plan of activities. A PPI consists of the following parts, which are incorporated into this plan:

- Description of the local flood hazard,
- The property protection measures appropriate for the flood hazard,
- Flood safety measures appropriate for the local situation,
- The public information activities currently being implemented within the community, including those being carried out by non-government agencies,
- Goals for the community's public information program,
- The outreach projects that will be done each year to reach the goals, and
- The process that will be followed to monitor and evaluate the projects.

8.4 SELECTION OF MITIGATION TECHNIQUES FOR THE CITY OF CHARLESTON

In order to determine the most appropriate mitigation techniques for the City of Charleston, the Hazard Mitigation Planning Team members thoroughly reviewed and considered the findings of the *Capability Assessment* and *Risk Assessment* to determine the best potential mitigation activities. Other considerations included the effect of each mitigation action on overall risk to life and property, its ease of implementation, its degree of political and community support, its general cost-effectiveness, and funding availability (if necessary).

8.5 PLAN UPDATE REQUIREMENT

In keeping with FEMA requirements for plan updates, the Mitigation Actions identified for the city in the Charleston Regional Hazard Mitigation Plan were evaluated to determine their 2023 implementation status. Updates on the implementation status of each action are provided. There are many new mitigation actions provided in Section 9: *Mitigation Action Plan* which have been noted as such.

8.6 POTENTIAL FUNDING SOURCES

Federal, state, and private funding sources are identified for each of the proposed mitigation actions found in Section 9: *Mitigation Action Plan*.

Additionally, the city intends to pursue Federal grants in the future to implement mitigation activities.

Table 8.1 below, identifies programs administered by FEMA that provide funding for eligible mitigation activities that reduce disaster losses and protect life and property from future disaster damages.

Table 8.1: Potential Grant Funding Opportunities for Hazard Mitigation Actions

Program	Enabling Legislation	Funding Authorization	Hazard Mitigation Plan Required?	
			Grantee Status	Subgrantee Status
Public Assistance (PA) (Categories A, B: e.g., debris removal, emergency protective measures)	Stafford Act	Presidential Disaster Declaration	No Plan Required	No Plan Required
Public Assistance (Categories C-G: e.g., repairs to damaged infrastructure, publicly owned buildings)	Stafford Act	Presidential Disaster Declaration	✓	No Plan Required
Individual Assistance (IA)	Stafford Act	Presidential Disaster Declaration	No Plan Required	No Plan Required
Fire Management Assistance Grants	Stafford Act	Fire Management Assistance Declaration	✓	No Plan Required
Hazard Mitigation Grant Program (HMGP) Planning Grant	Stafford Act	Presidential Disaster Declaration	✓	No Plan Required

SECTION 8: MITIGATION STRATEGY

Program	Enabling Legislation	Funding Authorization	Hazard Mitigation Plan Required?	
			Grantee Status	Subgrantee Status
HMGP Project Grant	Stafford Act	Presidential Disaster Declaration	✓	✓
Flood Mitigation Assistance (FMA)	National Flood Insurance Act	Annual Appropriation	✓	✓

SECTION 9

MITIGATION ACTION PLAN

This section includes the listing of the mitigation actions proposed for the City of Charleston. It consists of the following two subsections:

- 9.1 Overview
- 9.2 Mitigation Action Plan

44 CFR Requirement

44 CFR Part 201.6(c)(3)(iii): The mitigation strategy shall include an action plan describing how the actions identified in paragraph (c)(2)(ii) of this section will be prioritized, implemented, and administered by the local jurisdiction.

9.1 OVERVIEW

The Mitigation Action Plan, or MAP, provides a functional plan of action for the City of Charleston to follow to accomplish their mitigation goals (established in Section 8: Mitigation Strategy). The MAP will be maintained on a regular basis according to the plan maintenance procedures established in Section 10: Plan Maintenance.

Each proposed mitigation action has been identified as an effective measure (policy or project) to reduce hazard risk for the City of Charleston. Each action is listed in the MAP in conjunction with background information such as hazard(s) addressed, relative priority, and estimated cost. Other information provided in the MAP includes potential funding sources to implement the action should funding be required (not all proposed actions are contingent upon funding). Most importantly, implementation mechanisms are provided for each action, including the designation of a lead agency or department responsible for carrying the action out as well as a timeframe for its completion. These implementation mechanisms ensure that the City's Hazard Mitigation Plan remains a functional document that can be monitored for progress over time. The proposed actions are not listed in priority order, though each has been assigned a priority level of "high," "moderate," or "low" as described below and in Section 8 (page 8.2).

Table 9.1 describes the key elements of the Mitigation Action Plan.

Table 9.1: Key Elements of the Mitigation Action Plan

Mitigation Action Plan Element	Brief Description of Element
Action Number	Action number based off mitigation technique and sequential numbering.
Action	Description of mitigation action to be undertaken.
Hazard(s) Addressed:	Hazard which the action addresses.
Relative Priority (High, Moderate, Low):	Criteria for action priority are defined in Section 8.
Lead Department/Stakeholder Responsible:	Department responsible for accomplishing the action.
Supporting Departments/Stakeholders:	Department(s) or stakeholders that can provide assistance in accomplishing the action.
Potential Funding Sources:	City, State, or Federal sources of funds are noted here, where applicable.
Implementation Schedule:	Date by which the action the action should be completed. More information is provided when possible.
Implementation Status (2023):	For existing actions, indication of completion, progress, deferment, or no change with each action since the previous plan. If the action is new, that will be noted here.

9.2 MITIGATION ACTION PLAN

The mitigation actions proposed by the City of Charleston are listed in the MAP on the following pages. The first table includes actions that were identified in 2023 during the development of this plan. They are all new actions and, therefore have no implementation status update. For the actions found in the Charleston Regional Hazard Mitigation Plan and incorporated into this plan, a 2023 implementation status update has been provided by City staff.

City of Charleston Mitigation Action Plan – Actions identified during 2023 Planning Process

Action Number	Type	Activity	Hazard(s) Addressed	Lead Department	Potential Funding Source	Regional Plan Goal(s)/Objective(s) Addressed	Priority
1	PA, SP	Evaluate public housing buildings and property for additional flood and heat mitigation activities.	Flood and Heat	Charleston Housing Authority and Housing and Community Development	None needed until specific projects identified. Then federal and/or state grant funding will likely be sought to implement projects.	1,3, 4.0	Moderate
2	PA, PP, SP	Partner with Charleston County and SC Department of Transportation to establish resilient road design standards.	Multiple	Zoning, Public Service	None needed	1, 4, 5.0	Moderate
3	PA, PP, PI	Assist property owners in developing resilient design solutions for existing and new development that target flooding, heat, and high winds.	Flooding, Heat, High Winds	Building Services	None needed	1, 2, 3.0	Moderate
4	PI	Develop a comprehensive outreach program to provide flood hazard information to all residents. Identify communication channels to target multiple demographics and provide Spanish translations.	Flood	Flood Plain Management	Federal and/or state grant funding will likely be sought to implement this project.	1, 3	Moderate
5	SP, NB, PA	Continue ongoing City drainage projects and studies to identify and prioritize new opportunities	Flooding	Stormwater	City budget and federal and/or state grants as available.	1, 2, 3	High
6	PA	Continue to regularly reevaluate science for appropriate SLR planning levels to inform future HMP updates.	SLR	Chief Resilience Officer	None needed	1, 3, 4, 5, 7	High
7	PP, SP	Coordinate with the Historic Preservation office on building and site retrofit projects that mitigate the impacts of tidal flooding, sea level rise, and earthquake	Flooding, SLR, Earthquake	Planning	None needed	1, 2, 3, 4, 5, 6, 10	Moderate

Action Number	Type	Activity	Hazard(s) Addressed	Lead Department	Potential Funding Source	Regional Plan Goal(s)/Objective(s) Addressed	Priority
8	ES	Improve public transportation options during evacuations to include better communications, expanded routes and times.	Hurricane	Emergency Management	Potentially federal or state grants to fund the planning.	11	High
9	PI	Establish a formal public education program around hurricane and other natural hazards to include city specific guides, city specific hurricane expo and strong connection to local media outlets.	Hurricane, Multiple	Emergency Management	City budget and federal and/or state grant funding when available to support this type of project.	1, 3, 4	Moderate
10	ES, PI	City of Charleston to acquire it's own Mass Notification System.	Hurricane	Emergency Management	City budget unless federal and/or state grant funding can be identified to support this type of project.	1, 3, 4, 6	Moderate
11	ES	Develop and implement a City of Charleston Continuity of Operations Plan (COOP) for use by city staff during emergencies.	Multiple	Emergency Management	City budget unless federal (EMPG) and/or state grant funding can be identified to support this type of project.	11	Moderate
12	ES	Locate and plan for an alternate MEOC location.	Multiple	Emergency Management	None needed	None identified	Moderate
13	PI, ES	Acquire weather/hazard sensors (weather gauge, flood monitors for city specific locations with central monitoring capabilities).	Multiple	Emergency Management	City budget unless federal and/or state grant funding can be identified to support this type of project.	1	Moderate

Action Number	Type	Activity	Hazard(s) Addressed	Lead Department	Potential Funding Source	Regional Plan Goal(s)/Objective(s) Addressed	Priority
14	ES	Establish a City-to-City aid agreement (i.e. Rock Hill or similar upstate community) in cases of major disasters.	Multiple	Emergency Management	None needed	None identified	Moderate
15	PA, PP	Implement "elevation based" zoning and development regulations that minimize flood risk (reduced/restrict in low areas and encourage or incentivize development in high areas) using future SLR projections.	Flooding	Planning	City Budget, ARPA Funding	3	High
16	SP, PP	Identify and take action to reduce vulnerabilities on major roadways (61/17 split, raise Morrison and Lockwood Drives)	Tidal Flooding, Severe Storm	Traffic and Transportation	Federal, State, and Local funds as available	1, 5	High
17	PA	Incorporate extreme heat in the city's planning processes	Extreme Heat	Planning	None needed	11	Moderate
18	PA	Include flood-risk analysis in the property annexation process.	Flooding	Planning	None needed	1, 3	Moderate
19	PI	Increase public awareness of seawall heights to build public buy-in on benefits for extreme high tides or storm surge events.	SLR	Chief Resilience Officer	City budget unless federal and/or state grant funding can be identified to support this type of project.	1, 3, 4	Moderate
20	PA, PP, NB	Complete Comprehensive city-wide stormwater planning to include: (1) Completion of stormwater infrastructure survey and conditions assessment, (2) Completion of city-wide active stormwater models (utilize to isolate areas of flooding based on survey/condition assessment & expand floodplain boundaries in city to include riverine floodplains), (3) Ultimate development of short-term and long-term storm drainage CIP	Flooding, Severe Storm	Stormwater	City budget unless federal (BRIC or USACE) and/or state grant funding can be identified to support this type of project.	1, 2, 3, 5	High

Action Number	Type	Activity	Hazard(s) Addressed	Lead Department	Potential Funding Source	Regional Plan Goal(s)/Objective(s) Addressed	Priority
21	PI	Unified CRR to: (1) Work toward unified community risk reduction, (2) Common messaging, (3) Collaboration between city communication, police PIO, fire PIO, neighborhood service, (4) Unified messaging	Multiple	Emergency Management	City budget unless federal and/or state grant funding can be identified to support this type of project.	1, 3, 4, 5	Moderate
22	PI	Media: (1) Funding to hire pro-video company, (2) Develop local messages, (3) Create short public spots, (4) Use routinely on social media, (5) Send to local TV, (6) Use during events	Multiple	Emergency Management and Public Affairs	City budget unless federal and/or state grant funding can be identified to support this type of project.	1, 3, 4, 5	Moderate
23	PA, PP, ES	Install automatic or remote-controlled bollards (can close roads as needed to vehicular traffic)	Flooding	Police, Traffic & Transportation, Fire, Emergency Management	City budget unless federal and/or state grant funding can be identified to support this type of project.	1, 3, 4, 8, 12	Moderate
24	PA, PP, NB, PI	Fully assess household vulnerabilities using Vulnerability Assessment to identify more vulnerable population areas and target unique challenges i.e (1) Renters are less likely to have flood insurance, (2) Access to vehicles/transport, (3) Non-traditional households, (4) Seniors + those with mobility challenges, (5) Unhoused population, (6) Student population	Multiple	Emergency Management	City budget unless federal and/or state grant funding can be identified to support this type of project.	1, 4, 6, 8, 12	Moderate
25	PP, NB, SP	Work with USACE to design and build the storm surge protection system for the peninsula	Storm Surge	Chief Resilience Officer	Federal and local funding as available.	1, 3, 4	High
26	PP	Identify areas for buy-outs at scale pilot program using - FEMA FMA/BRIC	Flooding	Water Plan Team	FEMA FMA/BRIC	1, 3, 4, 5, 7, 9, 10, 11	Moderate

Action Number	Type	Activity	Hazard(s) Addressed	Lead Department	Potential Funding Source	Regional Plan Goal(s)/Objective(s) Addressed	Priority
27	ES	Install flood warning and/or traffic blinking apparatus on four most common flooded roadways - (Lockwood/Broad, GI split, Hagood/Fishburne, Washington St.)	Flooding	Traffic and Transportation	Federal, State, and Local	1	High
28	SP, PP	Re-locate public safety facilities in less vulnerable location for police/emergency services (consider sub stations locations)	Multiple	Fire, Police, Emergency Management	City budget unless federal and/or state grant funding can be identified to support this type of project.	1, 3, 4, 5, 11	Moderate
29	PI, PA	Invest in pedestrian control equipment to prevent danger to pedestrians during road closures.	Multiple	Traffic and Transportation	City budget unless federal and/or state grant funding can be identified to support this type of project.	None identified	Low
30	PI, ES	Install fixed variable message signs in the City of Charleston to warn of flooding, hurricanes, accidents, etc. - work with SC-DOT	Multiple	Traffic and Transportation	City budget unless federal and/or state grant funding can be identified to support this type of project.	1, 3, 4	Moderate
31	PA, ES	Procure generators for critical facilities, including pump stations and emergency services buildings.	Multiple	Parks	City budget unless federal and/or state grant funding can be identified to support this type of project.	5	Moderate
32	PA, PP, NB, PI	Install Living Shorelines, Oyster Reefs etc where appropriate to protect from erosion	Shoreline Erosion, Flooding	Parks Department	City budget unless federal and/or state grant funding can be identified to support this type of project.	1, 2, 3, 4, 5, 7, 9	Moderate

Action Number	Type	Activity	Hazard(s) Addressed	Lead Department	Potential Funding Source	Regional Plan Goal(s)/Objective(s) Addressed	Priority
33	PA, NB	Incentivize through zoning code the installation of green roofs to reduce heat and slow rainwater runoff	Flooding, Extreme Heat	Planning	None needed	3, 9, 11, 13	Moderate
34	PA, ES	Partner with Charleston Water System for post disaster drinking water	Multiple	Emergency Management	None needed	5	Moderate
35	PA	Incentivize through zoning the use of white paint on flat roofs to reduce heat	Extreme Heat	Planning	None needed	11, 13	Moderate
36	PA	Include Titanium Dioxide in road pavement to reduce heat and pollution	Extreme Heat	Public Service	Ongoing – Charleston County	11, 13	Moderate
37	PA, NB	Coordinate with SC DOT, developers, and agencies/departments on increasing or protecting tree plantings in roadway medians and public spaces	Extreme Heat, Flooding	Traffic and Transportation	None needed	11, 13	Low
38	PA, ES	Create a volunteer boat rescue team like the "Cajun Navy" in New Orleans	Flooding, Hurricanes	Emergency Management	None needed	None identified	Low
39	PA, NB	Incentivize and regulate the use of Natural Systems Protections to protect and restore natural floodplain functions, such as stream restoration, forest management, conservation easements and wetland preservation	Flooding	Stormwater Management	None needed	1	Moderate
40	PA, PP, NB, PI	Require natural features for stormwater and/or heat management in the Zoning Rewrite or entitlements process.	Flooding	City of Charleston Planning and Stormwater	None needed	9, 3, 2.0	Moderate
41	PA, SP	Incentivize in stormwater regulations the use of cisterns under buildings and streets to retain stormwater during downpours	Flooding	City of Charleston Stormwater	None needed	1, 2, 3.0	Moderate

Action Number	Type	Activity	Hazard(s) Addressed	Lead Department	Potential Funding Source	Regional Plan Goal(s)/Objective(s) Addressed	Priority
42	ES	Assist Hospitals to procure grant for high water vehicles for transport and movements during flooding	Flooding	Emergency Management	Federal and/or state grant funding as available.	1	Moderate
43	PA, NB	Conduct a street tree inventory to develop a tree canopy program based on a strategy to reduce extreme heat and flooding vulnerabilities	Extreme Heat	Parks	City budget unless federal and/or state grant funding can be identified to support this type of project.	1	Moderate
44	PA, ES	Consider the future growth of an area and it's housing needs post disaster including potential displacement before permitting building.	Flooding, Storm Surge	Planning	City budget unless federal and/or state grant funding can be identified to support this type of project.	11	Moderate
45	PI, ES	Develop a system that works through various social networks that ensures the most vulnerable populations have access to information (who to reach out to before, during, and after an emergency)	Multiple	Emergency Management	City budget unless federal and/or state grant funding can be identified to support this type of project.	None identified	Moderate
46	PA, NB	Develop Comprehensive, Integrated Water Plan to prioritize land use, planning, infrastructure and policy to account for SLR and increased precipitation and identify open space, including parks, to store stormwater.	Flooding, SLR	Chief Resilience Officer	Ongoing City budget unless federal and/or state grant funding can be identified to support projects identified in the Water Plan.	1, 2, 3, 4, 5, 7, 9, 11	High

Action Number	Type	Activity	Hazard(s) Addressed	Lead Department	Potential Funding Source	Regional Plan Goal(s)/Objective(s) Addressed	Priority
47	ES	Identify areas of greatest need to locate permanent cooling & warming centers and develop plan to open 24/7 on extreme weather days	Extreme Heat, Severe Winter Weather	Emergency Management	None needed	None identified	Moderate
48	PA, ES, PP	Increase capacity for flood related work (resilience, response, and recovery programs & activities) through increased floodplain management, recovery, and mitigation staff	Flooding, Severe Storms	Chief Financial Officer	City budget unless federal and/or state grant funding can be identified to support this type of project.	1, 2, 11	Moderate

The following mitigations were identified for the City of Charleston through previous hazard mitigation planning efforts. These actions are currently included in the Charleston Regional Hazard Mitigation Plan. The layout of the Mitigation Action Plan from the Charleston Regional Hazard Mitigation Plan is different than the layout for action found in this plan; however, an effort has been made to attempt to align these actions with the format used for this plan.

Action #	Action	Hazard(s) Addressed	Relative Priority	Lead Department/ Stakeholder	Supporting Departments/ Stakeholders	Potential Funding Sources	Implementation Schedule
Prevention							
P-1	Continue to maintain completed FEMA Elevation Certificates on all buildings constructed in the SFHA	Flood, Earthquakes, Hurricanes, Sea Level Rise	High	Building Inspection Services	None identified	General Fund	Ongoing. The City of Charleston continues to maintain elevation certificates for structures in the SFHA. Elevation Certificates on file are immediately available for download by the public through the City's Mapnet Website, which also includes current FIRMs
P-2	Continue Storm Water Utility Program	All	High	Public Service	None identified	General Fund; Self-Funding	Ongoing
P-3	Continue enforcement of Building related, flood, and Fire Prevention Codes and Regulations	All	High	Fire Marshall Division	None identified	General Fund	Ongoing
P-4	Continue to provide coordination of City storm water management regulations	All	High	Public Service	None identified	General Fund	Continuous process. The City of Charleston continues to enforce local stormwater management regulations. The Stormwater Design Standards Manual underwent major revisions in 2020 to improve Stormwater Management regulations. Section 3.7 of the 2020 SWDSM describes some of the specific requirements designers must account for to address potential Sea Level Rise, including a minimum 5.5' NAVD88 datum tailwater elevation. Additionally, rainfall and design storm values are required to use a 10% safety factor to account for uncertainties in the design process and the increasing intensities of storms per Section 3.4.2 of the SWDSM.
P-5	Continue storm water management as guided by the "Master Drainage and Floodplain Management Plan"	All	High	Public Service	None identified	General Fund	Ongoing
P-6	Continue enforcement of zoning ordinances	All	High	Planning, Preservation & Sustainability	None identified	General Fund	Ongoing. The City of Charleston continues to enforce local zoning ordinances. The City of Charleston has begun a multi-year process of rewriting and updating its Zoning Ordinance. This new Ordinance will implement the

Action #	Action	Hazard(s) Addressed	Relative Priority	Lead Department/ Stakeholder	Supporting Departments/ Stakeholders	Potential Funding Sources	Implementation Schedule
							land-elevation and water-elevation-based approach to future land use and development procedures including Sea Level Rise considerations.
P-7	Continue to ensure that projects are approved by State's Office of Ocean and Coastal Resource Management	Flood, Sea Level Rise	High	Public Service	None identified	General Fund	Continuous Process. The City of Charleston continues to require any necessary approvals from SCDHEC OCRM, including CZC Certifications, prior to the City providing project approvals or issuing permits.
P-8	Purchase and installation of an active alert and warning system to provide emergency notifications internally to staff and externally to public	All	High	Emergency Management Division	GIS, IT, Innovation, Police, Fire	BRIC, FEMA FMA, City's General Fund	Ongoing. The City will research and coordinate the purchase and installation of an emergency messaging system as part of its alert and warning program.
P-9	Purchase and installation of flood monitoring equipment to provide notification of water levels and store data for records preservation	Flood, Sea Level Rise, Hurricanes, Severe Storm, Tidal Flooding Floodplain Inundation	High	Emergency Management Division	GIS, IT, Traffic & Transportation, Stormwater, Parks	BRIC, FEMA FMA, City's General Fund	Ongoing. The City will research and coordinate the purchase and installation of a flood monitoring system as part of its alert and warning program.
P-10	Purchase and installation of weather monitoring equipment to provide real-time and historical data on weather conditions and effects	Hurricane, Flood, Tornado, Tsunamis, Severe Storm, Winter Weather, Extreme Heat, Tidal Flooding	High	Emergency Management Division	GIS, IT, Parks	BRIC, FEMA FMA, City's General Fund	Ongoing. The City will research and coordinate the purchase and installation of weather monitoring equipment as part of its alert and warning program.

Action #	Action	Hazard(s) Addressed	Relative Priority	Lead Department/Stakeholder	Supporting Departments/Stakeholders	Potential Funding Sources	Implementation Schedule
P-11	Contract a company to conduct a Threat Hazard Identification and Risk Assessment for the City to be utilized in future updates to emergency plans, including the EOP, HMP, and COOP	All	High	Emergency Management Division	BFRC	BRIC, FEMA FMA, City's General Fund	Ongoing. The City will utilize grant funding to procure the services of a consultant company to produce a THIRA. The THIRA will be revised on a five-year cycle to coincide with the updates to the HMP.
P-12	Continue coordination and updating of road clearance of winter weather hazards.	Winter Weather	Low	Emergency Management, GIS, Police, Fire Department, Traffic and Transportation, Public Service	None identified	General Fund	Ongoing. Added in FY23 as an existing/ongoing action. The City of Charleston participates in an annual coordination meeting with Berkeley County, Charleston County, and SC DOT to review and update roadway clearance priorities for winter weather events.
P-13	Continue to create and provide hazard-related literature and information to citizens.	All	High	All Departments	None identified	General Fund	Ongoing. The City of Charleston continues to provide hazard information to citizens through the City's website and literature in multiple locations throughout City buildings, including the Permit Center. The Charleston Fire Department distributes fire, safety, and preparedness information through hand-outs, and social media postings. A City specific Hazard Mitigation Plan is currently under development to complement this plan. Recent City specific plans on relevant hazards include the 2020 All Hazard Vulnerability and Risk Assessment, 2021 Climate Action Plan, 2021 Heat Watch Report, 2023 Extreme Heat Plan, 2023 Comprehensive, Integrated Water Plan, 2023 Flooding and Sea Level Rise Strategy Update. The City of Charleston recently collaborated on the Charleston County Woodwell Climate Risk Assessment. The City is a partner on the Preservation Society's Resilience Guidelines for Historic Properties. Of note, the Dutch Dialogues Report and Sea Level Rise Strategy (2019) were previously completed.

Action #	Action	Hazard(s) Addressed	Relative Priority	Lead Department/ Stakeholder	Supporting Departments/ Stakeholders	Potential Funding Sources	Implementation Schedule
P-14	Continue participating in and providing speakers for hazard-related public expositions and partnerships.	All	High	All Departments	None identified	General Fund	Ongoing. The City of Charleston continues to participate in local hazard-related expos, forums, and conferences. In 2023, City staff participation has included the Nature-Based Solutions Workshop, SC Association of Hazard Mitigation Annual Conference, James Island Hurricane Expo and presented to AIA and the Coastal Land Surveyors groups with plans to participate in Charleston County's Natural Hazards Expo and present to local real estate agents later this year. The Charleston Fire Department attends various safety events, safety days, and expos focusing on fire prevention and emergency preparedness throughout the year.
P-15	Become a Weather Ready Nation Ambassador through partnership with the National Weather Service.	All	High	Emergency Management	None identified	General Fund	Ongoing. Added in FY23 as a new action. The City of Charleston became a Weather Ready Nation Ambassador in 2023 and continues to share hazard-related information through that program.
Property Protection							
PP-1	Provide information to citizens regarding hazard safe interior rooms	Hurricane, Tornado	Moderate	Building Inspection Services	None identified	General Fund	Ongoing. The City of Charleston continues to provide resources to citizens to improve the safety of interior rooms to minimize loss of life due to earthquakes, tornados, hurricanes, and other extreme wind events.
PP-2	Demolish structures posing a threat to public safety, considering location within the special flood hazard area as a prioritization factor	All	Low	Building Inspections, Stormwater Management, Livability & Tourism, Fire Marshall Division	None identified	General Funding, Grant Funding (FMA, HMGF)	In process. Continue to perform inspections of substandard structures in the interest of health, safety and welfare. Future plans include adding flood zone information to track demolition permits in the SFHA.

Action #	Action	Hazard(s) Addressed	Relative Priority	Lead Department/ Stakeholder	Supporting Departments/ Stakeholders	Potential Funding Sources	Implementation Schedule
PP-3	Seek funding for retrofitting, demolishing or relocating repetitively flooded properties	Hurricane, Flood, Tidal Flooding, Floodplain Inundation, Storm Surge	Moderate	Stormwater Management	None identified	Grant Funding (FMA, HMGP)	<p>Continuous process. The City of Charleston continues to seek funding and grant opportunities for structure demolition, elevation, or relocation for properties that have experienced flood losses. Since 2015, 44 buildings have been demolished to date. As of 2023, the City of Charleston is working through the grant process for 1 acquisition and 7 elevations through FMA and HMGP grants. Future plans include establishing a process for identifying or pre-approving suitable candidates and prioritization based on relevant criteria, including RL.</p>
PP-4	Continue enforcement of building-related, flood, and fire prevention codes and regulations to maintain participation in the National Flood Insurance Program (NFIP) and Community Rating System (CRS)	All	High	Building Inspections, Engineering Livability, Fire Marshals, Stormwater Management	None identified	General Fund	<p>Ongoing. The City of Charleston continued to South Carolina Building and Fire codes and regulations that help to minimize future flood, fire, earthquake, and hurricane damage. In 2020, the City of Charleston adopted a 2' freeboard requirement for all New Construction and Commercial Substantial Improvements. As of 2024, the City of Charleston will enforce a slab-on-grade prohibition (building diagrams 1A, 1B, 3) for residential buildings in the SFHA. Both ordinance amendments are to mitigate future flood losses, considering future floodplain conditions and Sea Level Rise. Additional and amended regulations to improve building protection and CRS Class are being considered.</p>
PP-5	Continue to evaluate and prepare for Wildland Urban Interface Fire Control	Wildfire	Moderate	Fire Department, GIS	None identified	General Fund	<p>In process. Added in FY23 as an existing/ongoing action. Charleston Fire Department prioritizes Wildland Urban Interface Fire Control as a core program in its strategic plan to mitigate wildfire damages.</p>

Action #	Action	Hazard(s) Addressed	Relative Priority	Lead Department/Stakeholder	Supporting Departments/Stakeholders	Potential Funding Sources	Implementation Schedule
PP-6	Continue participation in FERC-required dam failure exercises with Santee Cooper.	Dam Failure	High	Emergency Management, GIS, Police, Fire Department, T&T, Stormwater Management	None identified	General Fund	Ongoing, Added in FY23 as an existing/ongoing action. The City of Charleston participates in regular training with Santee Cooper for the Pinopolis Dam as required by FERC.
PP-7	Continue to monitor NWS Chat for real-time information on tornado activity during severe storms	All	High	Emergency Management	None identified	General Fund	Continuous Process. Added in FY23 as an existing/ongoing action. The City of Charleston partners with NWS Charleston through the NWS Chat program to maintain real-time alert and warning in the event of “no-notice” events such as tornadoes.
PP-8	Improve and expand the Damage Assessments team and GIS system for hazard-related assessments	All	High	All Departments	None identified	General Fund	Continuous Process. Added in FY23 as an existing/ongoing action. Following Hurricane Ian in 2022, multiple departments provided staff to conduct post-event damage assessments. The data was then provided to the County to demonstrate the need for IA, PA, and SBA assistance. The City of Charleston is in the process of developing a system for tracking damages to structures within permit software.

Action #	Action	Hazard(s) Addressed	Relative Priority	Lead Department/ Stakeholder	Supporting Departments/ Stakeholders	Potential Funding Sources	Implementation Schedule
PP-9	Continue to maintain critical facilities, repetitive loss, flood, street elevation, parcel, and aerial data within a GIS SystemPP, ES, GIS	All	High	Emergency Management, Stormwater Management, GIS	None identified	General Fund	Continuous Process. Added in FY23 as an existing/ongoing action. The City of Charleston maintains a Flood Planning GIS system for pre- and post- disaster vulnerabilities assessments and emergency planning.
PP-10	Continue stormwater management as guided by the "Master Drainage and Floodplain Management Plan"	Hurricane, Flood, Tidal Flooding, Floodplain Inundation, Storm Surge, Severe Storm	High	Stormwater Management	None identified	General Fund	Continuous process. The City of Charleston continues to implement the objectives of the "Master Drainage and Floodplain Management Plan".
Structural Project							
SP-1	Continue ongoing City drainage projects and studies	All	High	Public Service	None identified	General Fund; Grant Funding (FMA/HMGP) Stormwater Fees	Continuous process. The City of Charleston continues to manage current drainage projects and studies such as those projects listed on the City's Stormwater Projects webpage. The City of Charleston is also presently planning, designing, engineering and constructing drainage and tidal flooding projects. USACE CSRM feasibility study has been completed and is preparing to move into design and engineering phase for peninsula perimeter surge protection. Additionally, the city in coordination with USACE will be completing a feasibility study on tidal and inland flooding, which will be a city-wide study.

Action #	Action	Hazard(s) Addressed	Relative Priority	Lead Department/Stakeholder	Supporting Departments/Stakeholders	Potential Funding Sources	Implementation Schedule
SP-2	Seek funding for proposed City drainage projects and studies (if the FEMA cost benefit analysis is favorable towards these projects)	All	High	Public Service	None identified	Grant Funding (FMA); Storm water fees	Continuous process. The City of Charleston continues to seek opportunities for new drainage projects and studies and for funding to support those projects, including a recently funded project for drainage improvement at the intersection of King and Huger Streets, a green infrastructure flood reduction project on Johns Island, and an upfit of a stormwater pump station in the peninsula's Medical District.
SP-3	Continue the drainage inspection and maintenance and canal cleaning program	All	High	Public Service	None identified	General Fund	Ongoing. The City of Charleston continues to inspect and maintain drainage facilities in the City of Charleston. In 2022, Stormwater created a long-term maintenance plan. The City of Charleston is currently 4 years into a 6-year program rehabilitating all of its open drainage systems.
SP-4	Continue utility right of way permitting, considering emergency vehicle access and flood zone related issues in permitting decisions		High	Public Service	None identified	General Fund	Ongoing. The City of Charleston continues to manage permitting for utility rights-of-way. Emergency access and routes are reviewed by the Fire Marshal Division as part of the Technical Review Committee (TRC) process for new developments and substantial projects. Vehicle access is also considered as facilities undergo renovation to evaluate proper access for fire apparatus.
SP-5	Continue the road repair and construction program, considering needs during evacuation and soil liquefaction potential in prioritization decisions	All	High	Public Service	None identified	General Fund; Grant Funding (FMA/PDM)	Ongoing. Added in FY23 as an existing/ongoing action. The City of Charleston participates in an annual coordination meeting with Berkeley County, Charleston County, and SC DOT to review and update roadway clearance priorities for winter weather events.
Emergency Services							
ES-1	Continue hazardous material training	Hazardous Materials Release	High	Fire Department; Police Department; Public Service	None identified	General Fund	Ongoing. The City of Charleston continues to provide hazardous materials training to all appropriate staff.
ES-2	Continue Terrorist Response Training	Terrorism, Active Threat	High	Police Department	None identified	General Fund	Ongoing. The City of Charleston continues to provide terrorist response training to all appropriate staff.
ES-3	Continue coordinating Emergency Operations Center activities in the event of a hazard event	All	High	City EMD	None identified	General Fund	Ongoing. The City of Charleston continues to manage the Municipal Emergency Operations Center and coordinate interaction with other

Action #	Action	Hazard(s) Addressed	Relative Priority	Lead Department/ Stakeholder	Supporting Departments/ Stakeholders	Potential Funding Sources	Implementation Schedule
							Emergency Operations Centers in the area, including Charleston County. After Action/ Improvement Plan Reports are developed for every activation, including Table Top Exercises. The last Table Top Exercise was completed following Hurricane Ian.
ES-4	Continue responding to hazard emergencies	All	High	EMD, Fire Department; Police Department	None identified	General Fund; Enterprise Fund	Continuous process. The City of Charleston continues to provide a coordinated response and follow up to emergency events.
ES-5	Develop and maintain a Training & Exercise Program for emergency response, MEOC, and stakeholder personnel.		High	Emergency Management	None identified	General Fund	In process. Added in FY23 as a new action. The City of Charleston has started development of a Training & Exercise Program that includes four (4) exercises per year and seeks to bring various training courses to the City on a regular basis.
ES-6	Develop and maintain a City-wide Continuity of Operations Plan (COOP).	All	High	Emergency Management	None identified	General Fund	In Process. Added in FY23 as a new action. The City of Charleston will create a stand-alone Continuity of Operations Plan (COOP) for use by all departments in the event of a large-scale disaster or emergency that requires the City to modify its operations beyond the considerations outlined in the Emergency Operations Plan (EOP). The COOP will be implemented by June of 2024.
ES-7	Maintain and regularly update the City's Emergency Operations Plan (EOP)	All	High	Emergency Management	None identified	General Fund	Ongoing. Added in FY23 as an existing/ongoing action. The City of Charleston's next EOP update is scheduled for completion in April of 2024.
ES-8	Become and maintain "Storm Ready" and "Tsunami Ready" Community Designation through partnership with the National Weather Service	All	High	Emergency Management	None identified	General Fund	In process. Added in FY23 as an existing/ongoing action. The City of Charleston has submitted its application to the National Weather Service to be recognized as a "Storm Ready" Jurisdiction with plans of pursuing the "Tsunami Ready" designation, as well.
ES-9	Implement an Alert & Warning System for providing emergency messaging to City staff, stakeholders, and the public	All	High	Emergency Management	None identified	General Fund	In process. Added in FY23 as a new action. The City is in the process of inventorying existing alert systems, improving the process and implementing new technology.
ES-10	Continue to evaluate resources and logistics considerations for the effects of prolonged drought or other water shortage	Drought, Water Shortage	Low	Emergency Management	None identified	General Fund	Continuous process. Added in FY23 as an existing/ongoing action. The City of Charleston Emergency Management Department coordinates logistics concerns and needs with Berkeley County, Charleston County, and SCEMD for regular updates in the City's EOP.

Action #	Action	Hazard(s) Addressed	Relative Priority	Lead Department/ Stakeholder	Supporting Departments/ Stakeholders	Potential Funding Sources	Implementation Schedule
Natural Resource Protection							
NP-1	Continue enforcement of the tree protection and landscaping ordinance	All	Moderate	Planning, Preservation & Sustainability	None identified	General Fund	Ongoing. The City of Charleston continues to enforce its tree protection ordinances.
Public Education and Awareness							
PEA-1	Continue providing Flood Insurance Rate Map (FIRM) information and continue publicizing this service annually	Hurricane, Flood, Severe Storm, Floodplain Inundation, Storm Surge, Tidal Flooding	High	Public Service	None identified	General Fund	Ongoing. The City of Charleston continues to provide FIRM and hazard information to citizens. The service is publicized in the annual flood preparedness brochure to addresses in the SFHA and in a letter to lenders, real estate agents and insurance professionals. The letter to lenders, real estate agents and insurance professionals was last mailed in May of 2023 with supplemental materials sent to real estate agents including a Flood Insurance for Real Estate Professionals packet, Charleston County/Jurisdictions "Know Before You Buy" Brochure, and the updated SC Residential Property Disclosure.

Action #	Action	Hazard(s) Addressed	Relative Priority	Lead Department/Stakeholder	Supporting Departments/Stakeholders	Potential Funding Sources	Implementation Schedule
PEA-2	Continue providing the Flood Protection Library at the Charleston County Library branches	Hurricane, Flood, Severe Storm, Floodplain Inundation, Storm Surge, Tidal Flooding	High	Public Service	None identified	General Fund	Ongoing. The City of Charleston continues to provide and update materials for the Flood Protection Library.
PEA-3	Continue outreach project to floodplain residents and repetitive loss properties by mailing flood hazard pamphlets annually	Hurricane, Flood, Severe Storm, Floodplain Inundation, Storm Surge, Tidal Flooding	High	Public Service	None identified	General Fund	Ongoing. The City of Charleston continues to distribute the flood preparedness brochure to all addresses in the SFHA and a Repetitive Loss Area Letter to addresses in the RLA. Mailings were most recently completed September 2022 with the next mailings planned for Summer of 2023
PEA-4	Continue providing hazard-related literature/information to citizens	All	Moderate	Public Service; Building Inspections, Fire Department, Fire Marshall Division	None identified	General Fund	Ongoing. The City of Charleston continues to provide hazard information to citizens through the City's website and literature in multiple locations throughout City buildings, including the Permit Center. The Charleston Fire Department distributes fire, safety, and 1 All Departments Continuous Process preparedness information through hand-outs, and social media postings. A City specific Hazard Mitigation Plan is currently under development to complement this plan. Recent City specific plans on relevant hazards include the 2020 All Hazard Vulnerability and Risk Assessment, 2021 Climate Action Plan, 2021 Heat Watch Report, 2023 Extreme Heat Plan, 2023 Comprehensive, Integrated Water Plan, 2023 Flooding and Sea Level Rise Strategy Update. The City of Charleston recently collaborated on the Charleston County Woodwell Climate Risk Assessment. The City is a partner on the Preservation Society's Resilience Guidelines for Historic Properties. Of note, the Dutch Dialogues

Action #	Action	Hazard(s) Addressed	Relative Priority	Lead Department/Stakeholder	Supporting Departments/Stakeholders	Potential Funding Sources	Implementation Schedule
							Report and Sea Level Rise Strategy (2019) were previously completed.
PEA-5	Continue participation in hazard-related/product expos	All	High	Building Inspection Services	None identified	General Fund	Ongoing. The City of Charleston continues to participate in local hazard-related expos, forums, and conferences. In 2023, City staff participation has included the Nature-Based Solutions Workshop, SC Association of Hazard Mitigation Annual Conference, James Island Hurricane Expo and presented to AIA and the Coastal Land Surveyors groups with plans to participate in Charleston County's Natural Hazards Expo and present to local real estate agents later this year. The Charleston Fire Department attends various safety events, safety days, and expos focusing on fire prevention and emergency preparedness throughout the year.
PEA-6	Continue to sponsor and participate in "Hazard Awareness Week" and assist other communities	All	Moderate	Building Inspection Services	None identified	General Fund	Ongoing. The City of Charleston continues to sponsor and participate in "Hazard Awareness Week" with plans to expand the outreach efforts in May 2024. In 2023, the Chief Building Official proclaimed May as "Building Safety Month" and City Council has proclaimed May as "Heat Awareness Month." Additionally, an Extreme Heat Storymap and City Heat Plan have been created. The Charleston Fire Department continues to promote a variety of awareness weeks and campaigns through social media throughout the year. These campaigns range from weather awareness and safety to child passenger safety, and fire prevention topics.
PEA-7	Continue participating on the Project Impact Program for Public Information (PIP) to achieve maximum public outreach	All	High	Project Impact committee members	None identified	General Fund	Ongoing. City Floodplain website links to Charleston County and Project Impact resources. The City of Charleston continues to participate in the PIP and other Project Impact initiatives.

SECTION 10

PLAN MAINTENANCE

PROCEDURES

This section discusses how the City of Charleston Mitigation Strategy and Mitigation Action Plan will be implemented and how the Hazard Mitigation Plan will be evaluated and enhanced over time. This section also discusses how the public will continue to be involved in a sustained hazard mitigation planning process. It consists of the following four subsections:

- 10.1 Implementation and Integration
- 10.2 Monitoring, Evaluation and Enhancement
- 10.3 Continued Public Involvement
- 10.4 Evaluation of Monitoring, Evaluation and Update Process

Note: The City will continue to also participate in the Charleston Regional Hazard Mitigation Plan. This includes participating in the planning process during plan updates and adopting the plan by resolution as needed every five years. The City of Charleston Hazard Mitigation Plan will be an Annex to the regional plan. The maintenance procedures described in this Section are only applicable to the City's plan.

44 CFR Requirement

44 CFR Part 201.6(c)(4)(i):

The plan shall include a plan maintenance process that includes a section describing the method and schedule of monitoring, evaluating and updating the mitigation plan within a five-year cycle.

44 CFR Part 201.6(c)(4)(ii):

The plan maintenance process shall include a process by which local governments incorporate the requirements of the mitigation plan into other planning mechanisms such as comprehensive or capital improvement plans, when appropriate.

10.1 IMPLEMENTATION AND INTEGRATION

Each agency, department or other partner participating under the City of Charleston Hazard Mitigation Plan is responsible for implementing specific mitigation actions as prescribed in the Mitigation Action Plan. Every proposed action listed in the Mitigation Action Plan is assigned to a specific “lead” agency or department in order to assign responsibility and accountability and increase the likelihood of subsequent implementation.

In addition to the assignment of a local lead department or agency, an implementation time period or a specific implementation date has been assigned in order to assess whether actions are being implemented

in a timely fashion. The City of Charleston will seek outside funding sources to implement mitigation projects in both the pre-disaster and post-disaster environments. When applicable, potential funding sources have been identified for proposed actions listed in the Mitigation Action Plan.

The City will integrate this Hazard Mitigation Plan into relevant City government decision-making processes or mechanisms, where feasible. This includes integrating the requirements of the Hazard Mitigation Plan into other local planning documents, processes or mechanisms, such as comprehensive or capital improvement plans, when appropriate. The members of the City of Charleston Hazard Mitigation Planning Team will remain charged with ensuring that the goals and mitigation actions of new and updated local planning documents for their agencies or departments are consistent, or do not conflict with, the goals and actions of the Hazard Mitigation Plan, and will not contribute to increased hazard vulnerability in the City of Charleston.

Since the City's first efforts with hazard mitigation planning in the late 1990's, City staff have worked to integrate the hazard mitigation plan into other planning mechanisms where applicable/feasible. Examples of how this integration has occurred have been documented in the Implementation Status discussion provided for each of the mitigation actions found in Section 9. Specific examples of how integration has occurred include:

- Integrating the mitigation plan into reviews and updates of floodplain management ordinances
- Integrating the mitigation plan into reviews and updates of City emergency operations plans and procedures
- Integrating the mitigation plan into review and updates of building codes
- Integrating the mitigation plan into the capital improvements plan through identification of mitigation actions that require local funding.

Opportunities to further integrate the requirements of this Plan into other local planning mechanisms shall continue to be identified through future meetings of the Hazard Mitigation Planning Team, City staff meetings, and the annual review process described herein. Although it is recognized that there are many possible benefits to integrating components of this Plan into other local planning mechanisms, the development and maintenance of this stand-alone Hazard Mitigation Plan is deemed by the City of Charleston Hazard Mitigation Planning Team to be the most effective and appropriate method to implement local hazard mitigation actions at this time.

10.2 MONITORING, EVALUATION, AND ENHANCEMENT

Periodic revisions and updates of the Hazard Mitigation Plan are required to ensure that the goals of the Plan are kept current, taking into account potential changes in hazard vulnerability and mitigation priorities. In addition, revisions may be necessary to ensure that the Plan is in full compliance with applicable federal and state regulations. Periodic evaluation of the Plan will also ensure that specific mitigation actions are being reviewed and carried out according to the Mitigation Action Plan.

When determined necessary, the City of Charleston Hazard Mitigation Planning Team shall meet in March of every year to evaluate and monitor the progress attained and to revise, where needed, the activities set forth in the Plan. The findings and recommendations of the City of Charleston Hazard Mitigation Planning Team shall be documented in the form of a report that can be shared with interested City stakeholders and partners. The City of Charleston Hazard Mitigation Planning Team will also meet

following any disaster events warranting a reexamination of the mitigation actions being implemented or proposed for future implementation. This will ensure that the Plan is continuously updated to reflect changing conditions and needs for the City. For future updates of the plan, the City's Emergency Management office will help coordinate reconvening the City Hazard Mitigation Planning Team for these reviews through coordination with the city representatives.

Five (5) Year Plan Review

FEMA requires that hazard mitigation plans be updated every five years. The Plan will be thoroughly reviewed by the City of Charleston Hazard Mitigation Planning Team every five years to determine whether there have been any significant changes in the City of Charleston that may, in turn, necessitate changes in the types of mitigation actions proposed. New development in identified hazard areas, an increased exposure to hazards, an increase or decrease in capability to address hazards, and changes to federal or state legislation are examples of factors that may affect the necessary content of the Plan.

The plan review process provides City officials with an opportunity to evaluate those actions that have been successful and to explore the possibility of documenting potential losses avoided due to the implementation of specific mitigation measures. The plan review also provides the opportunity to address mitigation actions that may not have been successfully implemented as assigned. The City's Emergency Management office will help coordinate reconvening the Hazard Mitigation Planning Team and conducting the five-year review.

During the five-year plan review process, the following questions will be considered as criteria for assessing the effectiveness and appropriateness of the Plan:

- Do the goals address current and expected conditions?
- Has the nature or magnitude of risks changed?
- Are the current resources appropriate for implementing the Plan?
- Are there implementation problems, such as technical, political, legal or coordination issues with other agencies?
- Have the outcomes occurred as expected?
- Did city departments participate in the plan implementation process as assigned?

Following the five-year review, any revisions deemed necessary will be summarized and implemented according to the reporting procedures and plan amendment process outlined herein. Upon completion of the review and update/amendment process, the City of Charleston Hazard Mitigation Plan will be submitted to the State Hazard Mitigation Officer at the South Carolina Emergency Management Division (SCEMD) for final review and approval in coordination with the Federal Emergency Management Agency (FEMA).

Disaster Declaration

Following a disaster declaration, the City of Charleston Hazard Mitigation Plan will be revised as necessary to reflect lessons learned, or to address specific issues and circumstances arising from the event. It will be the responsibility the City's Emergency Manager Director to coordinate the reconvening of the City of Charleston Hazard Mitigation Planning Team, through coordination with each city representative, and ensure the appropriate stakeholders are invited to participate in the plan revision and update process following declared disaster events.

Reporting Procedures

The results of the five-year review will be summarized by the Hazard Mitigation Planning Team in a report that will include an evaluation of the effectiveness of the Plan and any required or recommended changes or amendments. The report will also include an evaluation of implementation progress for each of the proposed mitigation actions, identifying reasons for delays or obstacles to their completion along with recommended strategies to overcome them.

Plan Amendment Process

Upon the initiation of the amendment process, representatives from the city will forward information on the proposed change(s) to all interested parties including, but not limited to, all directly affected city departments, residents, and businesses. Information will also be forwarded to the South Carolina Emergency Management Division. This information will be disseminated in order to seek input on the proposed amendment(s) for no less than a 45-day review and comment period.

At the end of the 45-day review and comment period, the proposed amendment(s) and all comments will be forwarded to the City of Charleston Hazard Mitigation Planning Team for final consideration. The Planning Team will review the proposed amendment along with the comments received from other parties, and if acceptable, the committee will submit a recommendation for the approval and adoption of changes to the Plan.

In determining whether to recommend approval or denial of a Plan amendment request, the following factors will be considered by the City of Charleston Hazard Mitigation Planning Team:

- There are errors, inaccuracies or omissions made in the identification of issues or needs in the Plan
- New issues or needs have been identified which are not adequately addressed in the Plan
- There has been a change in information, data, or assumptions from those on which the Plan is based

Upon receiving the recommendation from the Hazard Mitigation Planning Team and prior to adoption of the Plan, the city will hold a public hearing, if deemed necessary. The Charleston City Council will review the recommendation from the Hazard Mitigation Planning Team (including the factors listed above) and any oral or written comments received at the public hearing. Following that review, the governing bodies will take one of the following actions:

- Adopt the proposed amendments as presented
- Adopt the proposed amendments with modifications
- Refer the amendments request back to the Hazard Mitigation Planning Team for further revision, or
- Defer the amendment request back to the Hazard Mitigation Planning Team for further consideration and/or additional hearings

10.3 CONTINUED PUBLIC INVOLVEMENT

44 CFR Requirement

44 CFR Part 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

Public participation is an integral component to the mitigation planning process and will continue to be essential as this Plan evolves over time. As described above, significant changes or amendments to the Plan shall require a public hearing prior to any adoption procedures.

Other efforts to involve the public in the maintenance, evaluation and revision process will be made as necessary. These efforts may include:

- Advertising meetings of the Hazard Mitigation Planning Team in local newspapers, public bulletin boards and/or City office buildings
- Designating willing and voluntary citizens and private sector representatives as official members of the Hazard Mitigation Planning Team
- Utilizing local media to update the public on any maintenance and/or periodic review activities taking place
- Utilizing the City of Charleston website to advertise any maintenance and/or periodic review activities taking place, and
- Keeping copies of the Plan in the public library.

10.4 EVALUATION OF MONITORING, EVALUATION AND UPDATE PROCESS

Over the past five years, staff from the City of Charleston have been independently implementing, monitoring and evaluating their own mitigation actions (identified in the Charleston Regional Hazard Mitigation Plan). Progress made in implementing actions has been documented in Section 9: Mitigation Action Plan where each action contains a narrative about the implementation status of the action. That said, the City did waiver slightly from the monitoring and evaluation process defined in the Charleston Regional Hazard Mitigation Plan, but still made significant process in implementing their mitigation action plan. During the creation of this plan in 2023, the City of Charleston Hazard Mitigation Planning Team determined that the procedures for the upcoming five-year monitoring and evaluation process will be applied as defined above and will be re-evaluated during the next plan update process.

For the next update of this plan, the City's Emergency Management Director will continue to take the lead on organizing and initiating the 5-year update of the plan.

Appendix A

Plan Adoption

This Appendix contains the adoption resolution from the City of Charleston.

Appendix B

Planning Tools

This Appendix includes the following:

1. A Blank Hazard Mitigation Public Survey
2. GIS Data Inventory Spreadsheet
3. Scoring Criteria for Capability Assessment
4. A Blank Mitigation Action Worksheet



City of Charleston 2023 Hazard Mitigation Plan

The City of Charleston continues to work to become more resilient and less vulnerable to the impacts of hazard events, both natural and manmade. To achieve our goals, we need your help and your input is important to us!

We are in the early stages of the planning process to develop a Hazard Mitigation Plan for the City. This Plan will identify and assess our community's hazard risks in order to better understand our vulnerabilities and to create appropriate strategies intended to minimize or manage those risks.

This survey is an opportunity for you to share your opinions and participate in the hazard mitigation planning process. The information you provide will help us better understand your hazard concerns and can lead to mitigation activities that should help lessen the impacts of future hazard events.

If you have any questions regarding this survey or would like to learn about more ways you can

participate in the update of the City's Hazard Mitigation Plan, please contact ESP Associates, Inc, planning consultant for the project. You may reach Nathan Slaughter (ESP Associates) at 919-415-2726 or by email at nslaughter@espassociates.com.

1 Where do you live?

- Own property and live inside City limits
- Rent inside City limits
- Own property inside City limits, but live outside of City limits
- Outside City limits, but neighboring community in Charleston County
- Outside City limits, but in the Lowcountry
- Out of City limits, but in South Carolina
- Out of State
- Out of Country

* Choose one.

Comments

2 Have you ever been impacted by a disaster that occurred in the City of Charleston? If yes, please explain in the comment box provided.

Yes

No

* Choose one.

Comments

3 How concerned are you about the possibility of your community being impacted by a disaster?

- Extremely concerned
- Somewhat concerned
- Not concerned
- Unsure

* Choose one.

Comments

4 Please select **five** hazards you are most concerned about in your neighborhood.

Explain your reasoning in the comment box below.

<input type="checkbox"/> Hurricanes and Tropical Storms	<input type="checkbox"/> Severe Thunderstorms and Lightning
<input type="checkbox"/> Flooding	<input type="checkbox"/> Drought
<input type="checkbox"/> Winter Storms	<input type="checkbox"/> Sinkholes
<input type="checkbox"/> Public Health Hazard/Infectious Disease	<input type="checkbox"/> Tsunami
<input type="checkbox"/> Rip Currents	<input type="checkbox"/> Coastal Erosion
<input type="checkbox"/> Tornadoes/Waterspouts	<input type="checkbox"/> Wildfire
<input type="checkbox"/> Hail	<input type="checkbox"/> Earthquake
<input type="checkbox"/> Hazardous Materials	<input type="checkbox"/> Nuclear Power Plants
<input type="checkbox"/> Terrorism	<input type="checkbox"/> Extreme Heat
<input type="checkbox"/> Cyber Threats	

* Choose between 1 and 5.

Comments

5 Are there any other hazards that you feel pose a wide-scale threat to your community? If yes, please explain. If not, state "N/A."

6 Is your home located in a floodplain?

Check your current flood zone here: <https://msc.fema.gov/portal/search>

- Yes
- No
- No, but I still experience flooding
- I'm not sure
- Prefer not to answer

* Choose one.

Comments

7 Do you have flood insurance?

- Yes, NFIP Building Coverage
- Yes, NFIP Contents Coverage
- Yes, NFIP Building and Contents Coverage
- Yes, Private Flood Insurance (Non-NFIP)
- No
- I'm not sure
- Prefer not to answer

* Choose one.

Comments

8 If you do not have flood insurance, why not? If other, please explain in the comment box provided below.

- Not located in a floodplain
- Too expensive
- Not necessary because it never floods
- Not necessary because I am elevated or otherwise protected
- Never really considered it
- I used to, but my bank no longer requires it
- I have flood insurance
- Prefer not to answer

* Choose one.

Comments

9 Have you taken any steps to make your home or neighborhood more resistant to hazards? If yes, please explain specific actions taken in the comment box provided below.

Yes

No

* Choose one.

Comments

10 Do you have interest in making your home or neighborhood more resistant to hazards?

- Yes
- No
- I'm not sure

* Choose one.

Comments

11 Do you know what office to contact to find out more information about how to reduce your vulnerability to hazards in your area?

Yes

No

* Choose one.

Comments

12 What is the most effective way for you to receive information about how to make your home and neighborhood more resistant to hazards? If other, please specify in the comment box provided below.

Newspaper

Television

Radio

Internet (including social media)

Mail

Public Workshop/Meeting

School Meetings

* Choose one.

Comments

13 In your opinion, what are some steps your local government could take to reduce or eliminate risk of future hazard damages in your neighborhood?

14 Are there any other issues regarding the reduction of risk and loss associated with hazards or disasters in your community that you think are important? If yes, please specify in the comment box provided.

- Yes
- No
- I'm not sure

* Choose one.

Comments

15 A number of community-wide activities can reduce our risk from hazards. In general, these activities fall into one of the following six broad categories. In the next six questions, please tell us how important you think each one is for your community to consider pursuing.

Prevention - Administrative or regulatory actions, policies, or local ordinances that influence the way land is developed and buildings are built.

Examples include planning and zoning, building codes, open space preservation, land use, and floodplain regulations.

- Very important
- Somewhat important
- Not important
- I'm not sure

* Choose one.

Comments

16 Property Protection - Actions that involve the modification of existing buildings to protect them from a hazard or removal from the hazard area.

Examples include acquisition, relocation, elevation, structural retrofits, and storm shutters.

- Very important
- Somewhat important
- Not important
- I'm not sure

* Choose one.

Comments

17 Natural Resource Protection - Actions that, in addition to minimizing hazard losses, also preserve or restore the functions of natural systems.

Examples include: floodplain protection, habitat preservation, slope stabilization, stream buffers, wetland and marsh protection, and forest management.

- Very important
- Somewhat important
- Not important
- I'm not sure

* Choose one.

Comments

18 Structural Projects - Actions intended to lessen the impact of a hazard by modifying the natural progression of the hazard.

Examples include dams, levees, floodwalls, berms, drainage infrastructure (ditches/channels, stormwater ponds, and pipes and pumps), detention/retention basins, channel modification, retaining walls and storm sewers.

- Very important
- Somewhat important
- Not important
- I'm not sure

* Choose one.

Comments

19 Emergency Services - Actions that protect people and property during and immediately after a hazard event.

Examples include warning systems, evacuation planning, emergency response training, and protection of critical emergency facilities or systems.

- Very important
- Somewhat important
- Not important
- I'm not sure

* Choose one.

Comments

20 Public Education and Awareness - Actions to inform citizens about hazards and the techniques they can use to protect themselves and their property.

Examples include outreach projects, school education programs, library materials and demonstration events.

- Very important
- Somewhat important
- Not important
- I'm not sure

* Choose one.

Comments

21 This survey may be submitted anonymously; however, if you provide us with your name and contact information below, we will have the ability to follow up with you to learn more about your ideas or concerns. (Optional)



Thank you for completing this survey!

GIS DATA INVENTORY

DATA DESCRIPTION	AVAILABLE?	RECEIVED?	SOURCE(S)
Administrative / Political Boundaries			
County boundaries			
Municipal boundaries			
Tax parcels *			
* At a minimum, attribute data for tax parcels should include address, building type, square footage, building value and year built.			
Population and Demographics			
Census block data *			
* Anything better than Census 2010 data?			
Buildings and Facilities			
Building footprints			
Existing building stock, by occupancy class			
Government buildings			
County offices, city/town halls, etc.			
Police stations			
Fire/Rescue stations			
Emergency Operations Centers			
Public works facilities			
Communication facilities			
Hazardous materials facilities			
Hospitals			
Schools			
Shelters			
Senior care facilities			
Day care facilities			
Historic properties			
Power generation facilities / transmission lines			
Water/wastewater facilities / distribution lines			
Pipelines			
Repetitive loss properties (NFIP)			
Topography, Hydrology, Geology			
Contour data (two foot)			
Digital Elevation Model			
Watershed boundaries			
Rivers and streams			
Lakes and ponds			
Ocean / shoreline			
Wetlands			
Geology			
Soils			
Transportation			
Highways and roads (center lines)			
Bridges			
Railways			
Airports			
Ports			
Land Use			
Land Use / Land Cover			
Zoning / Future Land Use			
Parks / Open Space			
Preserved Farmland			
Acquired properties (HMGP buyouts, etc.)			

GIS DATA INVENTORY

DATA DESCRIPTION	AVAILABLE?	RECEIVED?	SOURCE(S)
Aerial Imagery			
High-resolution digital orthophotography			
Hazards			
DROUGHT			
Palmer Drought Severity Index (PDSI)			
FLOOD			
FEMA Digital Flood Data (DFIRMs)			
Location of dams, levees and any inundation zones			
HURRICANE AND TROPICAL STORM			
Historical storm tracks			
THUNDERSTORM			
Thunderstorm frequency			
Lightning frequency			
Hail frequency			
TORNADO			
Historical tornado locations			
WILDFIRE			
Wildfire hazard areas, fuel maps, etc.			
Urban/wildland interface communities			
WINTER STORM			
Annual snow/ice precipitation			
OTHER			
Any other data on historic events/ damages			

Points System for Capability Ranking

0-19 points = Limited overall capability
20-39 points = Moderate overall capability
40-68 points = High overall capability

I. Planning and Regulatory Capability (Up to 43 points)

Yes = 3 points

Under Development = 1 point

Included under County plan/code/ordinance/program = 1 point

No = 0 points

- Hazard Mitigation Plan
- Comprehensive Land Use Plan
- Floodplain Management Plan
- National Flood Insurance Program
- NFIP Community Rating System

Yes = 2 points

Under Development = 1 point

Included under County plan/code/ordinance/program = 1 point

No = 0 points

- Open Space Management Plan / Parks & Recreation Plan
- Stormwater Management Plan
- Natural Resource Protection Plan
- Flood Response Plan
- Emergency Operations Plan
- Continuity of Operations Plan
- Evacuation Plan
- Disaster Recovery Plan
- Flood Damage Prevention Ordinance
- Post-disaster Redevelopment / Reconstruction Ordinance

Yes = 1 point

No = 0 points

- Capital Improvements Plan
- Economic Development Plan
- Historic Preservation Plan
- Zoning Ordinance
- Subdivision Ordinance
- Unified Development Ordinance
- Building Code
- Fire Code

II. Administrative and Technical Capability (Up to 15 points)

Yes = 2 points

Service provided by County = 1 point

No = 0 points

- Planners with knowledge of land development and land management practices
- Engineers or professionals trained in construction practices related to buildings and/or infrastructure
- Planners or engineers with an understanding of natural and/or human-caused hazards
- Emergency manager
- Floodplain manager

Yes = 1 point

No = 0 points

- Land surveyors
- Scientist familiar with the hazards of the community
- Staff with education or expertise to assess the community's vulnerability to hazards
- Personnel skilled in Geographical Information Systems (GIS) and/or Hazus
- Resource development staff or grant writers

III. Fiscal Capability (Up to 10 points)

Yes = 1 point

No = 0 points

- Capital Improvement Programming
- Community Development Block Grants (CDBG)
- Special Purpose Taxes (or tax districts)
- Gas / Electric Utility Fees
- Water / Sewer Fees
- Stormwater Utility Fees
- Development Impact Fees
- General Obligation / Revenue / Special Tax Bonds
- Partnering arrangements or intergovernmental agreements
- Other

MITIGATION ACTION WORKSHEETS

Mitigation Action Worksheets are used to identify potential hazard mitigation actions that participating jurisdictions in the City of Charleston will consider to reduce the negative effects of identified hazards. The worksheets provide a simple yet effective method of organizing potential actions in a user-friendly manner that can easily be incorporated into the City's Hazard Mitigation Plan.

The worksheets are to be used as part of a strategic planning process and are designed to be:

- a.) completed electronically (worksheets and instructions will be e-mailed to members of the Hazard Mitigation Planning Team following the Mitigation Strategy Workshop);
- b.) reviewed with your department/organization for further consideration; and
- c.) returned according to the contact information provided below.

Please return all completed worksheets to:

Nathan Slaughter - ESP Associates, Inc.

Electronic copies may be e-mailed to: nslaughter@espassociates.com

INSTRUCTIONS

Each mitigation action should be considered to be a separate local project, policy or program and each individual action should be entered into a separate worksheet. By identifying the implementation requirements for each action, the worksheets will help lay the framework for engaging in distinct actions that will help reduce the community's overall vulnerability and risk. Detailed explanations on how to complete the worksheet are provided below.

Proposed Action: Identify a specific action that, if accomplished, will reduce vulnerability and risk in the impact area. Actions may be in the form of local policies (i.e., regulatory or incentive-based measures), programs or structural mitigation projects and should be consistent with any pre-identified mitigation goals and objectives.

Site and Location: Provide details with regard to the physical location or geographic extent of the proposed action, such as the location of a specific structure to be mitigated, whether a program will be citywide, countywide or regional, etc.

History of Damages: Provide a brief history of any known damages as it relates to the proposed action and the hazard(s) being addressed. For example, the proposed elevation of a repetitive loss property should include an overview of the number of times the structure has flooded, total dollar amount of damages if available, etc.

Hazard(s) Addressed: List the hazard(s) the proposed action is designed to mitigate against.

Category: Indicate the most appropriate category for the proposed action as discussed during the Mitigation Strategy Workshop (Prevention; Property Protection; Natural Resource Protection; Structural Projects; Emergency Services; Public Education and Awareness).

Priority: Indicate whether the action is a "high" priority, "moderate" priority or "low" priority based generally on the following criteria:

1. Effect on overall risk to life and property
2. Ease of implementation / technical feasibility
3. Project costs versus benefits
4. Political and community support
5. Funding availability

Estimated Cost: If applicable, indicate what the total cost will be to accomplish this action. This amount will be an estimate until actual final dollar amounts can be determined. Some actions (such as ordinance revisions) may only cost "local staff time" and should be noted so.

Potential Funding Sources: If applicable, indicate how the cost to complete the action will be funded. For example, funds may be provided from existing operating budgets or general funds, a previously established contingency fund, a cost-sharing federal or state grant program, etc.

Lead Agency/Department Responsible: Identify the local agency, department or organization that is best suited to implement the proposed action.

Implementation Schedule: Indicate when the action will begin and when the action is expected to be completed. Remember that some actions will require only a minimal amount of time, while others may require a long-term or continuous effort.

Comments: This space is provided for any additional information or details that may not be captured under the previous headings.

MITIGATION ACTION	
Proposed Action:	
BACKGROUND INFORMATION	
Site and Location:	
History of Damages:	
MITIGATION ACTION DETAILS	
Hazard(s) Addressed:	
Category:	
Priority (High, Moderate, Low):	
Estimated Cost:	
Potential Funding Sources:	
Lead Agency/Department Responsible:	
Implementation Schedule:	
COMMENTS	

Appendix C

Local Mitigation Plan Review

Tool

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.

1. The Multi-Jurisdictional Summary Sheet is a worksheet that is used to document how each jurisdiction met the requirements of the plan elements (Planning Process; Risk Assessment; Mitigation Strategy; Plan Maintenance; Plan Update; and Plan Adoption).
2. The Plan Review Checklist summarizes FEMA's evaluation of whether the plan has addressed all requirements.

For greater clarification of the elements in the Plan Review Checklist, please see Section 4 of this guide. Definitions of the terms and phrases used in the PRT can be found in Appendix E of this guide.

Plan Information	
Jurisdiction(s)	City of Charleston, SC
Title of Plan	City of Charleston SC Hazard Mitigation Plan
New Plan or Update	New
Single- or Multi-Jurisdiction	Single
Date of Plan	Draft February 2024
Local Point of Contact	
Title	City of Charleston Emergency Management Director
Agency	City of Charleston
Address	
Phone Number	
Email	

Additional Point of Contact	
Title	
Agency	
Address	
Phone Number	
Email	

Review Information	
State Review	
State Reviewer(s) and Title	
State Review Date	
FEMA Review	
FEMA Reviewer(s) and Title	
Date Received in FEMA Region	
Plan Not Approved	
Plan Approvable Pending Adoption	
Plan Approved	

Multi-Jurisdictional Summary Sheet

#	Jurisdiction Name	Requirements Met (Y/N)					
		A. Planning Process	B. Risk Assessment	C. Mitigation Strategy	D. Plan Maintenance	E. Plan Update	F. Plan Adoption
1							
2							
3							
4							
5							
6							
7							
8							
9							
10							

Plan Review Checklist

The Plan Review Checklist is completed by FEMA. States and local governments are encouraged, but not required, to use the PRT as a checklist to ensure all requirements have been met prior to submitting the plan for review and approval. The purpose of the checklist is to identify the location of relevant or applicable content in the plan by element/sub-element and to determine if each requirement has been “met” or “not met.” FEMA completes the “required revisions” summary at the bottom of each element to clearly explain the revisions that are required for plan approval. Required revisions must be explained for each plan sub-element that is “not met.” Sub-elements in each summary should be referenced using the appropriate numbers (A1, B3, etc.), where applicable. Requirements for each element and sub-element are described in detail in Section 4: Local Plan Requirements of this guide.

Plan updates must include information from the current planning process.

If some elements of the plan do not require an update, due to minimal or no changes between updates, the plan must document the reasons for that.

Multi-jurisdictional elements must cover information unique to all participating jurisdictions.

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 – Planning Process	
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 1 Introduction and Section 2 – Planning Process	
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 – Planning Process, sections 2.4 and 2.7	

Element A Requirements	Location in Plan (section and/or page number)	Met / Not Met
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 – Planning process, section 2.6	
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 7 – Capability Assessment	
Element A Required Revisions		
Required Revision:		

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 – Hazard Identification	
B1-b. Does the plan include information on the location of each identified hazard?	Section 5 – Hazard Profiles	
B1-c. Does the plan describe the extent for each identified hazard?	Section 5 – Hazard Profiles, section 5.25.2	
B1-d. Does the plan include the history of previous hazard events for each identified hazard?	Section 5 – Hazard Profiles	

Element B Requirements	Location in Plan (section and/or page number)	Met / Not Met
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 5 – Hazard Profiles	
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?	NA	
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 6 – Vulnerability Assessment	
B2-b. For each participating jurisdiction, does the plan describe the potential impacts of each of the identified hazards on each participating jurisdiction?	Section 5 – Hazard Profiles, section 5.25.4 and 5.25.5 and 6 – Vulnerability Assessment	
B2-c. Does the plan address NFIP-insured structures within each jurisdiction that have been repetitively damaged by floods?	Section 5 – Hazard Profiles, section 5.5.5	
Element B Required Revisions		
Required Revision:		

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 7 – Capability Assessment	
C1-b. Does the plan describe each participant's ability to expand and improve the identified capabilities to achieve mitigation?	Section 7- Capability Assessment	
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?	Section 7 – Capability Assessment, section 7.3.4	
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 8.2	
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 9 – Mitigation Action Plan	
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 9 – Mitigation Action Plan	
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 8.1.1	

Element C Requirements	Location in Plan (section and/or page number)	Met / Not Met
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 9 - Mitigation Action Plan	
Element C Required Revisions		
Required Revision:		

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 10.3	
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 10.2	
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 10.2	
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 10.4	

Element D Requirements	Location in Plan (section and/or page number)	Met / Not Met
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 10.1	
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 10.1	
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?	NA	
Element D Required Revisions		
Required Revision:		

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?	NA	
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?	NA	
E2-b. Does the plan include a status update for all mitigation actions identified in the previous mitigation plan?	NA	

Element E Requirements	Location in Plan (section and/or page number)	Met / Not Met
E2-c. Does the plan describe how jurisdictions integrated the mitigation plan, when appropriate, into other planning mechanisms?	NA	
Element E Required Revisions		
Required Revision:		

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?	Pending	
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?	NA	
Element F Required Revisions		
Required Revision:		

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?		
HHPD1-b. Does the plan incorporate information shared by the state and/or local dam owners?		
HHPD2. Did the plan address HHPDs in the risk assessment?		
HHPD2-a. Does the plan describe the risks and vulnerabilities to and from HHPDs?		
HHPD2-b. Does the plan document the limitations and describe how to address deficiencies?		
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?		
HHPD3-b. Does the plan link proposed actions to reducing long-term vulnerabilities that are consistent with its goals?		
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?		
HHPD4-b. Does the plan describe the criteria used to prioritize actions related to HHPDs?		
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?		
HHPD Required Revisions		
Required Revision:		

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		

Plan Assessment

These comments can be used to help guide your annual/regularly scheduled updates and the next plan update.

Element A. Planning Process

Strengths

- [insert comments]

Opportunities for Improvement

- [insert comments]

Element B. Risk Assessment

Strengths

- [insert comments]

Opportunities for Improvement

- [insert comments]

Element C. Mitigation Strategy

Strengths

- [insert comments]

Opportunities for Improvement

- [insert comments]

Element D. Plan Maintenance

Strengths

- [insert comments]

Opportunities for Improvement

- [insert comments]

Element E. Plan Update

Strengths

- [insert comments]

Opportunities for Improvement

- [insert comments]

Element G. HHPD Requirements (Optional)

Strengths

- [insert comments]

Opportunities for Improvement

- [insert comments]

Element H. Additional State Requirements (Optional)

Strengths

- [insert comments]

Opportunities for Improvement

- [insert comments]

Appendix D

Planning Process

Documentation

1. Meeting Presentations
2. Meeting Attendance Logs
3. Public Survey Summary Results
4. Meeting Minutes



HAZARD MITIGATION PLAN

City of Charleston, SC

*Kickoff Meeting
January 31, 2023*

AGENDA

South Carolina



- I. Introductions
- II. Mitigation Overview
- III. Project Scope
 - I. Hazard Mitigation Planning Team Coordination
 - II. Public Involvement Strategy
 - III. Hazard Identification
 - IV. Develop Goals, Objectives, & Actions
 - V. Assemble the Plan
 - VI. Complete Plan Review & Adoption
- IV. Project Schedule
- V. Next Steps
- VI. Questions, Issues, or Comments

INTRODUCTIONS

1. Project Contractors

- ESP Associates, Inc. -
 - Nathan Slaughter, AICP, CFM – Project Manager
- Fernleaf
 - Mark Wilbert
- Climate Adaptation Partners
 - Janice Barnes

2. Charleston Leads

- Hazard Mitigation Planning Team
- Local Project Coordinator

3. Key Stakeholders

PROJECT PARTNERS



Fernleaf

Involved in the City of Charleston 2020 All Hazards Risk and Vulnerability Assessment

Climate Adaptation Partners

Charleston Medical District Adaptation Roadmap

Charleston Heat Studies



HAZARDS ARE INEVITABLE



WHAT IS MITIGATION?



“mit-i-gate”

- 1: to cause to become less harsh or hostile.
- 2: to make less severe or painful.

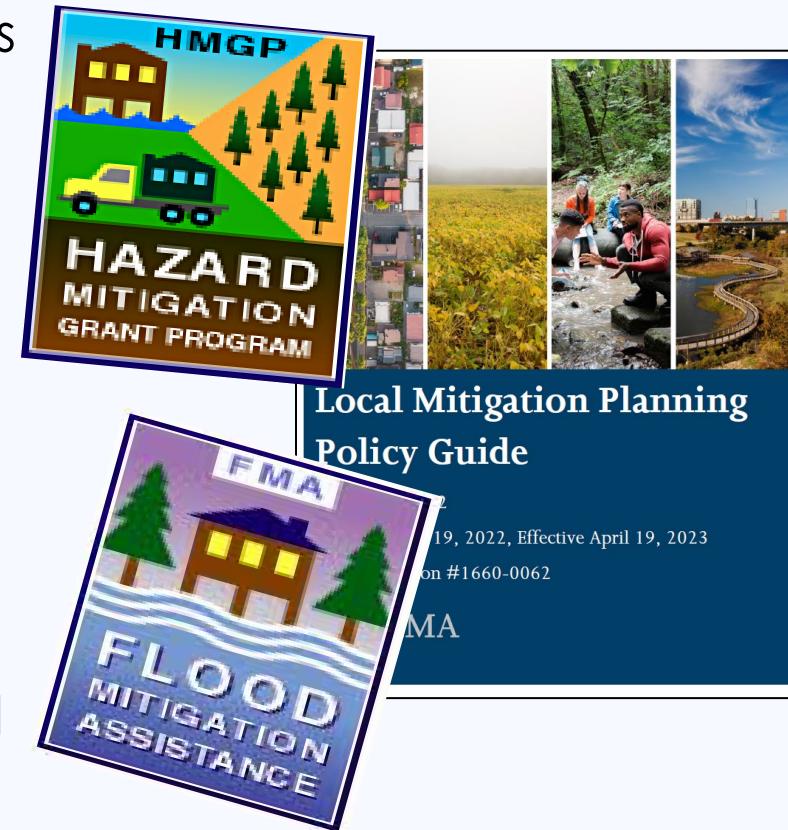


Hazard Mitigation

Any sustained action taken to reduce or eliminate the long-term risk to human life and property from hazards.

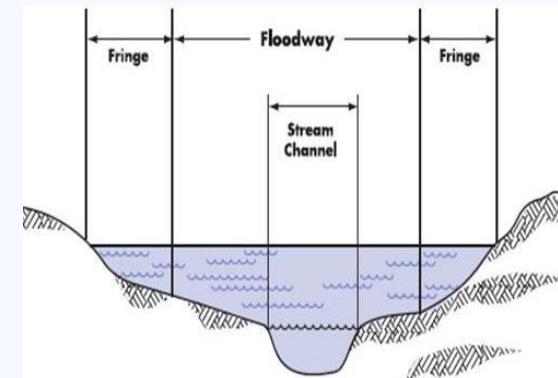
DISASTER MITIGATION ACT OF 2000

- Revitalized Federal Planning Requirements
 - State and Local Hazard Mitigation Plans
- Federal Grant Funding Eligibility
 - Hazard Mitigation Grant Program (HMGP)
 - Building Resilient Infrastructure and Communities (BRIC)
 - Flood Mitigation Assistance (FMA)
- DMA 2000 is intended to facilitate cooperation between state and local authorities on risk reduction measures and expedite funding allocation



BASIC TYPES OF MITIGATION

- We want to mitigate hazard impacts on the **existing development** in our communities
 - Houses, businesses, infrastructure, critical facilities, etc.
- We want to ensure that **future development** is conducted in a way that doesn't increase our vulnerability
 - Best done by having good plans, policies and procedures in place

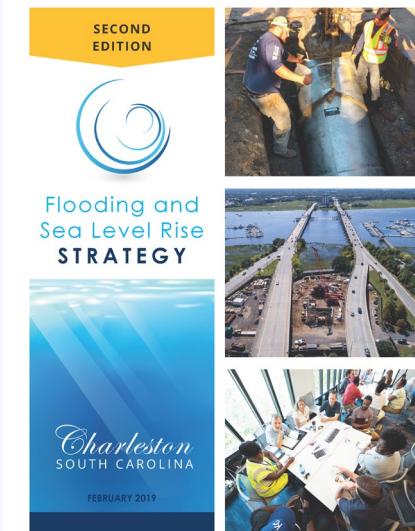


MITIGATION TECHNIQUES

1. Prevention
2. Property Protection
3. Natural Resource Protection
4. Structural Projects
5. Emergency Services
6. Public Education and Awareness



Source: [Street Tree Canopy \(arcgis.com\)](https://arcgis.com)



Charleston SC Flooding and Sea Level Rise Strategy
Source: <https://www.charleston-sc.gov/1981/Flooding-Sea-Level-Rise-Strategy>

PREVENTION

- Planning and Zoning
- Building Codes
- Open Space Preservation
- Floodplain Regulations
- Stormwater Management Regulations
- Drainage System Maintenance
- Capital Improvements Programming
- Tree Ordinance



PROPERTY PROTECTION

- Acquisition
- Relocation
- Building elevation
- Critical facilities protection
- Retrofitting
- Safe rooms
- Shatter-resistant glass
- Insurance
- Weatherization



NATURAL RESOURCE PROTECTION

- Floodplain Protection
- Watershed Management
- Riparian Buffers
- Forest Management
- Erosion and Sediment Control
- Wetland Restoration
- Habitat Preservation
- Slope Stabilization
- Canopy and Native Vegetation Maintenance



The effective management and protection of natural resources is vital to reduce disaster risks and community vulnerability to associated impacts.



STRUCTURAL PROJECTS



- Reservoirs
- Dams, levees
- Floodwalls
- Stormwater diversions
- Detention/Retention Basins
- Channel Modification
- Storm Sewers
- Cool Pavements

EMERGENCY SERVICES

- Warning Systems
- Emergency Response Equipment
- Shelters
- Evacuation Planning
- Emergency Response Training
- Sandbagging
- Temporary Shutters



PUBLIC EDUCATION & AWARENESS



- Outreach projects
- Speaker series
- Hazard map information
- Library materials
- School educational programs
- Hazard expositions
- Real estate disclosure
- Demonstration events

ACTIVITY

Go to www.menti.com and use the code 85 18 221

Prevention	Property Protection	Natural Resource Protection	Structural Projects	Emergency Services	Public Education/Awareness
Planning and zoning	Acquisition	Floodplain protection	Reservoirs	Warning systems	Outreach projects
Building codes	Relocation	Watershed management	Dams, levees, dikes	Emergency response equipment	Speaker series/ demonstration events
Open space preservation	Building elevation	Critical facilities protection	Floodwalls	Shelter Operations	Hazard map information
Floodplain regulations	Retrofitting	Riparian buffers	Stormwater diversions	Evacuation planning and management	Real estate disclosure
Stormwater management regulations	Safe rooms, shutters, shatter-resistant glass	Forest management	Detention/ retention basins	Emergency response training and exercises	Library materials
Drainage system maintenance	Insurance	Erosion and sediment control	Channel modification	Sandbagging for flood protection	School children educational programs
Capital improvements programming		Wetland preservation and restoration	Storm sewers	Temporary shutters	Hazard exposions
Setbacks		Habitat preservation			

ACTIVITY RESULTS

[City of Charleston HMP Kickoff Activity - Mentimeter](#)

PROJECT SCOPE

Six tasks and associated deliverables to develop the City's Hazard Mitigation Plan:



Task 1: Hazard Mitigation Planning Team Coordination

Task 2: Public Involvement Strategy

Task 3: Hazard Identification and Risk Assessment

Task 4: Develop Goals, Objectives, and Actions

Task 5: Assemble the Plan

Task 6: Complete Plan Review and Adoption

MITIGATION PROCESS

“Hazard mitigation is not a single event, but rather, an on-going process, which evolves over time and is best done in partnership.”



1. Planning Process
2. Risk Assessment
3. Capability Assessment
4. Mitigation Strategy
5. Plan Maintenance
6. Documentation

PLANNING PROCESS

- Establish Hazard Mitigation Planning Team (HMPT)
 - Made up of representatives from various City departments, agencies, and partners
- Widespread public participation and outreach to key stakeholders
 - Generating public interest
 - Involving media partners
 - Soliciting citizen input
- Data collection and analysis
 - Incorporation of existing data, plans, and policies into process
- Plan preparation, submission, & adoption

HAZARD IDENTIFICATION

Hazards Identified in the 2018 State of South Carolina HMP:

- Hurricanes and Tropical Storms
- Coastal (Erosion)
- Severe Thunderstorms & Lightning
- Tornadoes
- Flooding
- Wildfire
- Drought
- Hail
- Winter Storm
- Earthquake
- Sinkhole
- Landslides & Mass Wasting
- Hazardous Materials
- Public Health Hazards/Infectious Disease
- Nuclear Power Plants
- Sea Level Rise
- Tsunami
- Terrorism

Hazards Identified in the 2022 Charleston Regional HMP:

- Hurricanes
- Flooding
- Sea Level Rise
- Earthquake
- Tornado
- Hazardous Materials
- Terrorism
- Wildfire
- Tsunamis
- Dam Failure
- Rip Currents
- Severe Storm
- Drought
- Winter Weather
- Pandemics
- Heat

RISK ASSESSMENT

- Hazard Identification and Analysis
 - Detailed profiles for all hazards
 - Hazard description
 - Historical occurrences
 - Known hazard boundaries
- Priority Risk Index (PRI)

PRI Category	Degree of Risk			Assigned Weighting Factor
	Level	Criteria	Index Value	
Probability	Unlikely	Less than 1% annual probability	1	30%
	Possible	Between 1 and 10% annual probability	2	
	Likely	Between 10 and 100% annual probability	3	
	Highly Likely	100% annual probability	4	
Impact	Minor	Very few injuries, if any. Only minor property damage and 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 more than one day.	2	
	Critical	Multiple deaths/injuries possible. More than 25% of property in affected area damaged or destroyed. Complete shutdown of critical facilities for more than one 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 for 30 days or more.	4	

HAZARD IDENTIFICATION, CONT.

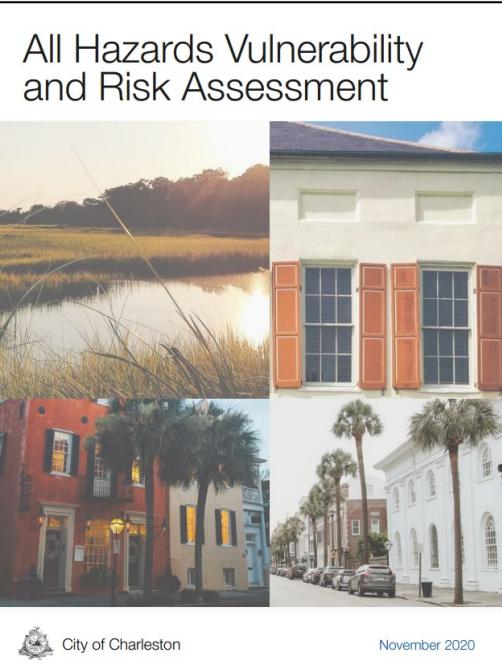
Based on historical events, the Charleston Regional HMP ranked probability of hazard occurrence within the City of Charleston with 1 being the lowest probability and 4 being the highest.

Likelihood of Event Any Year

1. 0-25% chance
2. 26-50% chance
3. 51-75% chance
4. 76-100% chance

Hazard	Probability
Hurricane	2
Flooding	4
Sea Level Rise	4
Earthquake	3
Tornado	1
Hazardous Materials	4
Terrorism	2
Wildfire	2
Tsunamis	1
Dam Failure	1
Rip Currents	1
Severe Storm	4
Drought	2
Winter Weather	3

RISK ASSESSMENT, CONT.



- Vulnerability Assessment
 - Asset inventory (exposure)
 - Where possible, identify types and numbers of assets at risk to hazards
- Consider other types of vulnerability as well
 - Social, economic, environmental
 - Loss estimates
- Development Trends and Implications

CAPABILITY ASSESSMENT

- Measures existing capabilities
 - Planning & Regulatory
 - Administrative & Technical
 - Fiscal
 - Political
- Identifies and targets gaps, conflicts and opportunities with existing local plans, programs, policies, etc.

Local Capability Assessment Survey						
Jurisdiction/Agency: _____		Point of Contact: _____		Phone: _____ E-mail: _____		
1. PLANNING AND REGULATORY CAPABILITY - Please indicate whether the following planning or regulatory local plans, ordinances, codes or programs are currently in place or under development for your jurisdiction by placing an "X" in the appropriate box. Then, for each particular item in place, identify the department or agency responsible for its implementation and indicate its estimated or anticipated effect on hazard loss reduction (Strongly Supports, Helps Facilitate or Hinders) with another "X". Finally, please provide additional comments or explanations in the space provided or with attachments.						
Planning / Regulatory Tool	In Place	Under Development	Department / Agency Responsible	Effect on Loss Reduction		
Hazard Mitigation Plan				Strongly Supports	Helps Facilitate	Hinders
Comprehensive Land Use Plan (or General, Master or Growth Mgt. Plan)						
Floodplain Management Plan						
Open Space Management Plan (or Parks & Rec / Greenways Plan)						
Stormwater Management Plan / Ordinance						
Natural Resource Protection Plan						
Flood Response Plan						
Emergency Operations Plan						
Continuity of Operations Plan						
Evacuation Plan						
Other Plans / Programs						

Points System for Capability Ranking

0-19 points = Limited overall capability
20-39 points = Moderate overall capability
40-68 points = High overall capability

I. Planning and Regulatory Capability
(Up to 43 points)

Yes = 2 points
Under Development = 1 point
Included under County plan/code/ordinance/program = 1 point
No = 0 points

- Hazard Mitigation Plan
- Comprehensive Land Use Plan
- Floodplain Management Plan
- National Flood Insurance Program
- NFIP Community Rating System

Yes = 2 points
Under Development = 1 point
Included under County plan/code/ordinance/program = 1 point
No = 0 points

- Open Space Management Plan / Parks & Recreation Plan
- Stormwater Management Plan
- Natural Resource Protection Plan
- Flood Response Plan
- Emergency Operations Plan
- Continuity of Operations Plan
- Evacuation Plan
- Disaster Recovery Plan
- Flood Damage Prevention Ordinance
- Post-disaster Redevelopment / Reconstruction Ordinance

Yes = 1 point
No = 0 points

MITIGATION STRATEGY

- Mitigation Goals
 - Based upon findings of the risk and capability assessments
- Identification and analysis of mitigation measures
 - Prevention, property protection, natural resource protection, structural projects, emergency services, and public education and awareness

MITIGATION ACTION PLAN

Example from Charleston Regional HMP

Action #	Description	Hazard(s) Addressed	Priority	Potential Funding Source	Target Completion Date	Status	
PA-4	Continue enforcement of State mandated Building Codes, the permissive codes as adopted by Town Council, and the Town's Flood Damage Prevention Ordinance/	Flood	1 (existing program)	Building Inspection Services/ Public Services/ Fire Department	General Funding	Continuous Process	<p>The Fire Department completed 4,182 code inspections last year & discovered 1,271 violations.</p> <p>Building Inspection Division fiscal year to date inspections completed total 26,649.</p>

PLAN MAINTENANCE

- Monitoring and reporting
- Evaluating and updating
- Implementation mechanisms
- Continued public involvement



DOCUMENTATION

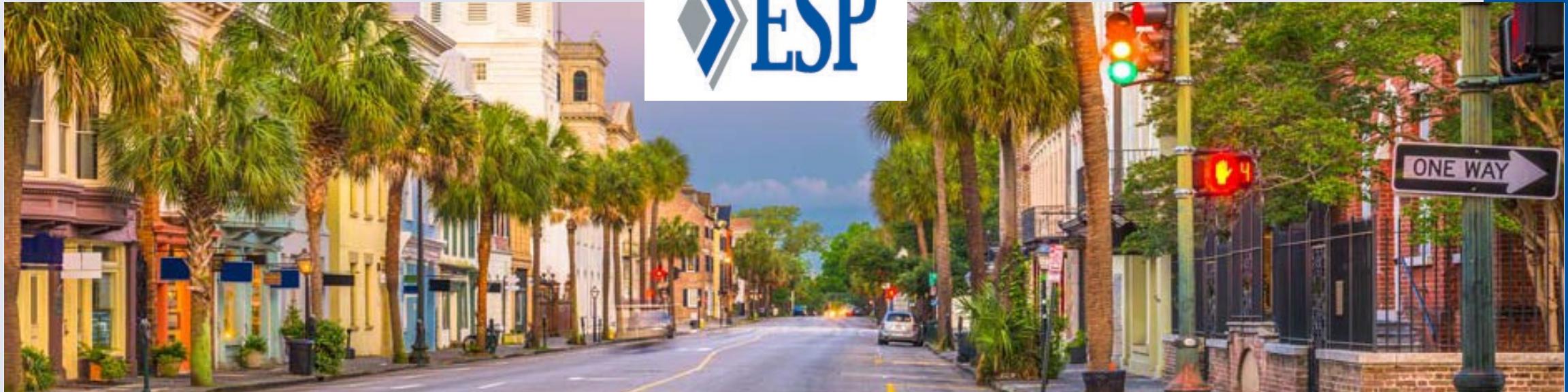
- Full description of planning process
 - Use of best available data
- Plan adoption
 - Local resolution required for final FEMA approval
- Local Mitigation Plan Review Tool “Crosswalk”

TENTATIVE PROJECT SCHEDULE

Project Tasks	Month							
	1	2	3	4	5	6	7	8
Notice to Proceed	v							
Planning Process								
Risk Assessment								
Capability Assessment								
Mitigation Strategy								
Plan Maintenance Procedures								
Documentation								
Meetings								
Kickoff Meeting	v							
Hazard Mitigation Planning Team Meetings		v			v			v
Open Public Meetings		v						v
Milestones								
Milestones		1	2	3	4	5	6	7
Submission of Draft Risk Assessment to Planning Team					v			
Submission of Draft Risk Assessment to SCEMD					v			
Submission of Draft Plan to Planning Team						v		
Submission of Draft Plan to SCEMD/FEMA						v		
Completion of Final Plan/Conditional FEMA Approval							v	
Local Adoption of Final Plan								v
Submission of Final Plan to SCEMD/FEMA								

NEXT STEPS

- Determine any additional members to participate on the Hazard Mitigation Planning Team
 - Schedule next Hazard Mitigation Planning Team meeting
 - Schedule public meeting



QUESTIONS, ISSUES, OR CONCERNS

• Nathan Slaughter

• (919) 415-2726

nslaughter@espassociates.com

Andrew Olive

• aolive@espassociates.com

Hannah Delude

• hdelude@espassociates.com



HAZARD MITIGATION PLAN

City of Charleston, SC

*Hazard Mitigation
Strategy Workshop
May 16, 2023*

AGENDA



- I. Introductions
- II. Project Summary and Status Update
- III. Risk Assessment Findings
 - I. Hazard Identification and Analysis
 - II. Vulnerability Assessment
- IV. Capability Assessment Findings
- V. Mitigation Strategy Development
 - I. Mitigation Card-storming
 - II. Goals, Objectives, and Actions
 - III. Mitigation Action Worksheets
- VI. Next Steps
- VII. Questions, Issues, or Comments



INTRODUCTIONS

1. Project Contractors

- ESP Associates, Inc. -
 - Nathan Slaughter, AICP, CFM – Project Manager
 - Hannah Delude
 - Keane McLaughlin, PLA, AICP, ENV SP
- Fernleaf
 - Mark Wilbert
 - Kim Rhodes
- Climate Adaptation Partners
 - Janice Barnes

2. Charleston Leads

- Hazard Mitigation Planning Team
- Local Project Coordinator

3. Key Stakeholders

PROJECT PARTNERS



Fernleaf

Involved in the City of Charleston 2020 All Hazards Risk and Vulnerability Assessment

climate adaptation partners
resilience through collaborative partnerships

Climate Adaptation Partners

Charleston Medical District Adaptation Roadmap

Charleston Heat Studies

WHAT IS MITIGATION?



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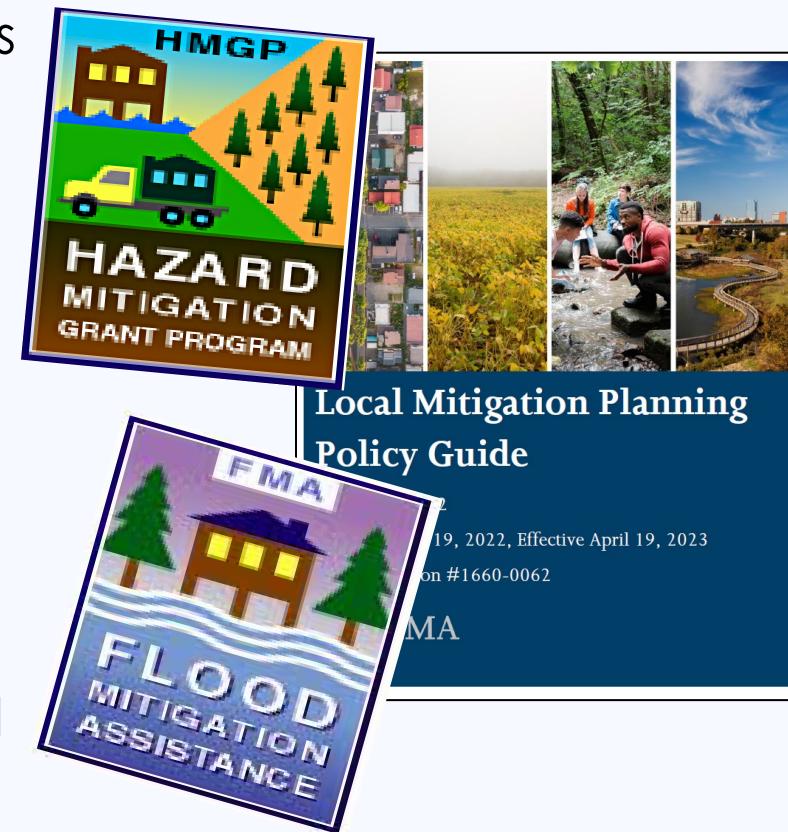


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DISASTER MITIGATION ACT OF 2000

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Key Objectives

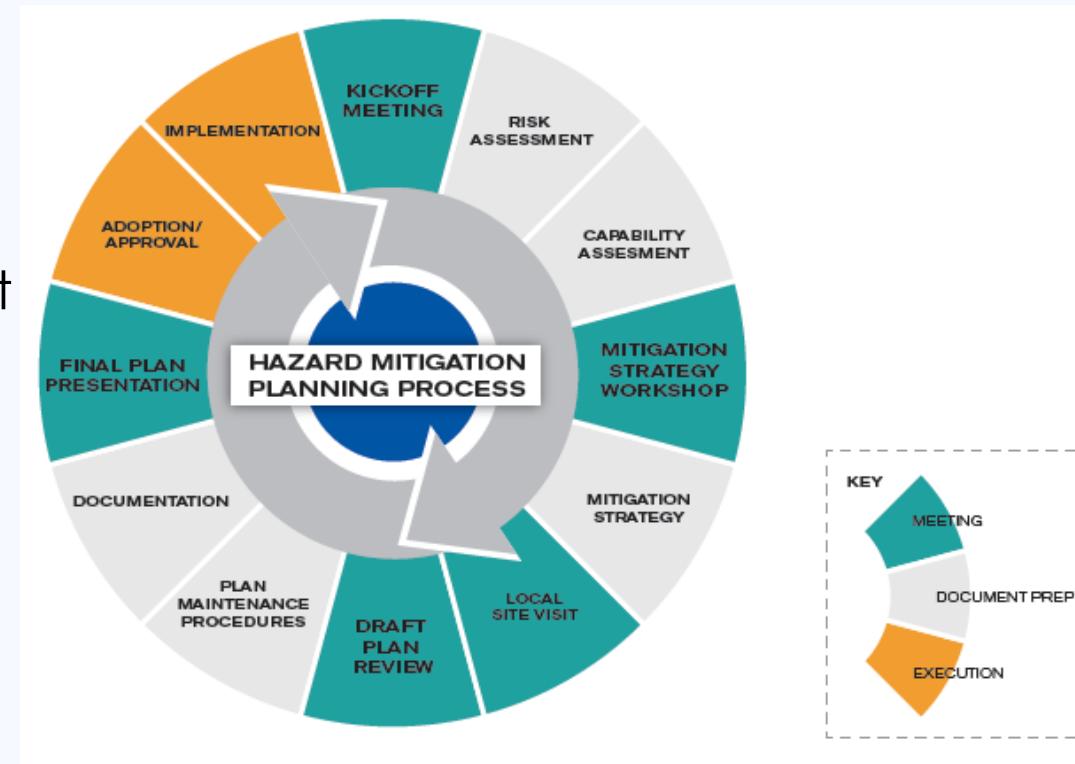
- Develop a Risk Assessment that informs the City's Hazard Mitigation and Resilience planning efforts
- Public awareness and education
- Compliance with State and Federal requirements
- Grant eligibility for the City

TENTATIVE PROJECT SCHEDULE

Project Tasks	Month							
	1	2	3	4	5	6	7	8
Notice to Proceed	✓							
Planning Process								
Risk Assessment								
Capability Assessment								
Mitigation Strategy								
Plan Maintenance Procedures								
Documentation								
Meetings								
Kickoff Meeting	✓							
Hazard Mitigation Planning Team Meetings		✓			✓			✓
Open Public Meetings		✓						✓
Milestones		1	2	3	4	5	6	7
Submission of Draft Risk Assessment to Planning Team						✓		
Submission of Draft Risk Assessment to SCEMD						✓		
Submission of Draft Plan to Planning Team							✓	
Submission of Draft Plan to SCEMD/FEMA							✓	
Completion of Final Plan/Conditional FEMA Approval								✓
Local Adoption of Final Plan								✓
Submission of Final Plan to SCEMD/FEMA								

PROJECT TASKS

1. Planning Process
2. Risk Assessment
3. Capability Assessment
4. Mitigation Strategy
5. Plan Maintenance
6. Documentation



RISK ASSESSMENT

Hazard Identification and Analysis (parallel efforts with Lowcountry Healthcare Coalition)

- Detailed Hazard Profile
 - Hazard Description
 - Historical Occurrences
 - Known Hazard Boundaries

Vulnerability Assessment

- Asset Inventory (exposure)
- Loss Estimates

Development Trends and Implications

GIS Data Inventory

RESULTS

Risk Assessment Findings

- Hazard Identification
- Hazard Profiles
- Hazard Vulnerability Assessment

ALIGNING EFFORTS

Previous plans that relate and reference the City of Charleston include:

- South Carolina Hazard Mitigation Plan (2018)
- The Charleston Regional Hazard Mitigation Plan
- Lowcountry Healthcare Preparedness Coalition – Hazard Vulnerability Assessment
- Charleston SLR Strategy
- Charleston Sustainability Action Plan
- Charleston Heat Study
- Charleston Climate Action Plan – GHG Mitigation
- Charleston All Hazards Vulnerability Assessment

Plans are a good place to start, but are broad in scope

- City's Hazard Mitigation Plan aims to identify and address hazards/impacts **specifically nuanced** for the City of Charleston's needs

PLANNING ASSUMPTIONS

WE UTILIZED BEST AVAILABLE DATA

- We use information from the National Centers for Environmental Information
- Useful, but events are often under-reported

KEEP THE END GOAL IN SIGHT

- The risk assessment's purpose is to compare hazards and determine which should be the focus of your mitigation actions
- The detailed numbers are informative, but remember the big picture

THIS IS YOUR RISK ASSESSMENT

- The data we provide is beneficial, but YOU live here!

HAZARD IDENTIFICATION

There are a variety of natural and manmade hazards that will receive consideration in the City's Hazard Mitigation Plan based on historical occurrence and future projections.

Natural

- Hurricane
- Flooding
- Sea Level Rise
- Earthquake
- Tornado
- Wildfires
- Tsunamis
- Dam Failure
- Rip Currents
- Droughts
- Severe Storm
- Severe Winter Weather
- Shoreline Erosion
- Public Health Hazards
- Floodplain Inundation
- Storm Surge
- Tidal Flooding

Technological

- Hazardous Materials Release
- Infrastructure Failure

Human-caused

- Radiological Emergency
- Cyber Incidents
- Civil Disturbance
- Terrorism
- Active Threat
- Water Shortage

LCHCC HAZARD IDENTIFICATION



LCHCC evaluates the relationship between hazard-vulnerability assessments (HVAs) conducted within individual healthcare facilities and risk to the healthcare delivery chain

Natural

- Tropical Cyclones/Hurricanes/ Tropical Weather
- Flooding
- Tornado
- Severe Inclement Weather
- Infectious Disease
- Earthquake
- Temperature Extremes

Man-Made/Intentional

- Active assailants
- Cyber-attacks / PHI Breach
- Weapons
- Infant Abduction
- HAZMAT Leaks
- Train Derailment
- Civil Unrest
- Terrorism/WMD (CBRNE)
- Labor Shortage
- Supply Chain
- Forensic Admission
- Surge

Technological

- Transportation Accidents (Motor Vehicle)
- Aircraft Crashes
- HAZMAT Incidents
- Communications failure
- Utility failure
- Water disruption
- Unintentional Fire
- IT System Outage
- HVAC Failure
- Mass Causality

DISASTER DECLARATIONS

- Hurricane Hugo (1989)
- Hurricane Floyd (1999)
- Winter Storms (2000)
- Tropical Storm Gaston (2004)
- Severe Storms and Flooding (2015)
- Hurricane Matthew (2017)
- Hurricane Irma (2017)
- Hurricane Florence (2018)
- Hurricane Dorian (2019)
- COVID-19 Pandemic (2020)
- Hurricane Ian (2022)



Hurricane Hugo – 33 Years Later (Reflections in Pictures and Videos)
Source: <https://charlestondaily.net/hurricane-hugo-30-years-later-pictorial-recollection/>

RANKING HAZARDS

- Used a scoring tool called the Priority Risk Index (PRI)
- Looks at the following criteria per hazard
 - Probability
 - Impact
 - Spatial Extent
 - Warning Time
 - Duration of Impacts

PRI Category	Degree of Risk			Assigned Weighting Factor
	Level	Criteria	Index Value	
Probability	Unlikely	Less than 1% annual probability	1	30%
	Possible	Between 1 and 10% annual probability	2	
	Likely	Between 10 and 100% annual probability	3	
	Highly Likely	100% annual probability	4	
Impact	Minor	Very few injuries, if any. Only minor property damage and 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 more than one day.	2	
	Critical	Multiple deaths/injuries possible. More than 25% of property in affected area damaged or destroyed. Complete shutdown of critical facilities for more than one 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 for 30 days or more.	4	

PRI EXPLAINED

PRI Category	Degree of Risk			Assigned Weighting Factor
	Level	Criteria	Index Value	
Probability	Unlikely	Less than 1% annual probability	1	30%
	Possible	Between 1 and 10% annual probability	2	
	Likely	Between 10 and 100% annual probability	3	
	Highly Likely	100% annual probability	4	
Impact	Minor	Very few injuries, if any. Only minor property damage and 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 more than one day.	2	
	Critical	Multiple deaths/injuries possible. More than 25% of property in affected area damaged or destroyed. Complete shutdown of critical facilities for more than one 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 for 30 days or more.	4	

PRI EXPLAINED, Continued

PRI Category	Degree of Risk			Assigned Weighting Factor
	Level	Criteria	Index Value	
Spatial Extent	Negligible	Less than 1% of area affected	1	20%
	Small	Between 1 and 10% of area affected	2	
	Moderate	Between 10 and 50% of area affected	3	
	Large	Between 50 and 100% of area affected	4	
Warning Time	More than 24 hours	Self explanatory	1	10%
	12 to 24 hours	Self explanatory	2	
	6 to 12 hours	Self explanatory	3	
	Less than 6 hours	Self explanatory	4	
Duration	Less than 6 hours	Self explanatory	1	10%
	Less than 24 hours	Self explanatory	2	
	Less than one week	Self explanatory	3	
	More than one week	Self explanatory	4	

HURRICANE

43 hurricanes or tropical storms have come within 50 miles of the city since 1970

- 13 Tropical Depressions
- 22 Tropical Storms
- 8 Hurricanes

Disaster Declarations

- Hurricane Hugo (1989)
- Hurricane Floyd (1999)
- Tropical Storm Gaston (2004)
- Hurricane Matthew (2017)
- Hurricane Irma (2017)
- Hurricane Florence (2018)
- Hurricane Dorian (2019)
- Hurricane Ian (2022)

Future occurrences are *likely*



ABC4 News on Hurricane Ian

Source: [Hurricane Ian makes landfall in South Carolina as Category 1 hurricane | WCIV \(abcnews4.com\)](https://abcnews.go.com/abc4/Hurricane-Ian-makes-landfall-South-Carolina-as-Category-1-hurricane-WCIV-abcnews4.com)

HURRICANE VULNERABILITY

Probability: Likely (Between 10 and 100% annual probability)

Impact: Critical (Multiple deaths/injuries possible. More than 25% of property in affected area damaged or destroyed. Complete shutdown of critical facilities for more than one week.)

Spatial Extent: Large (Between 50 and 100% of area affected)

Warning Time: More than 24 hours

Duration: More than one week

FLOODING

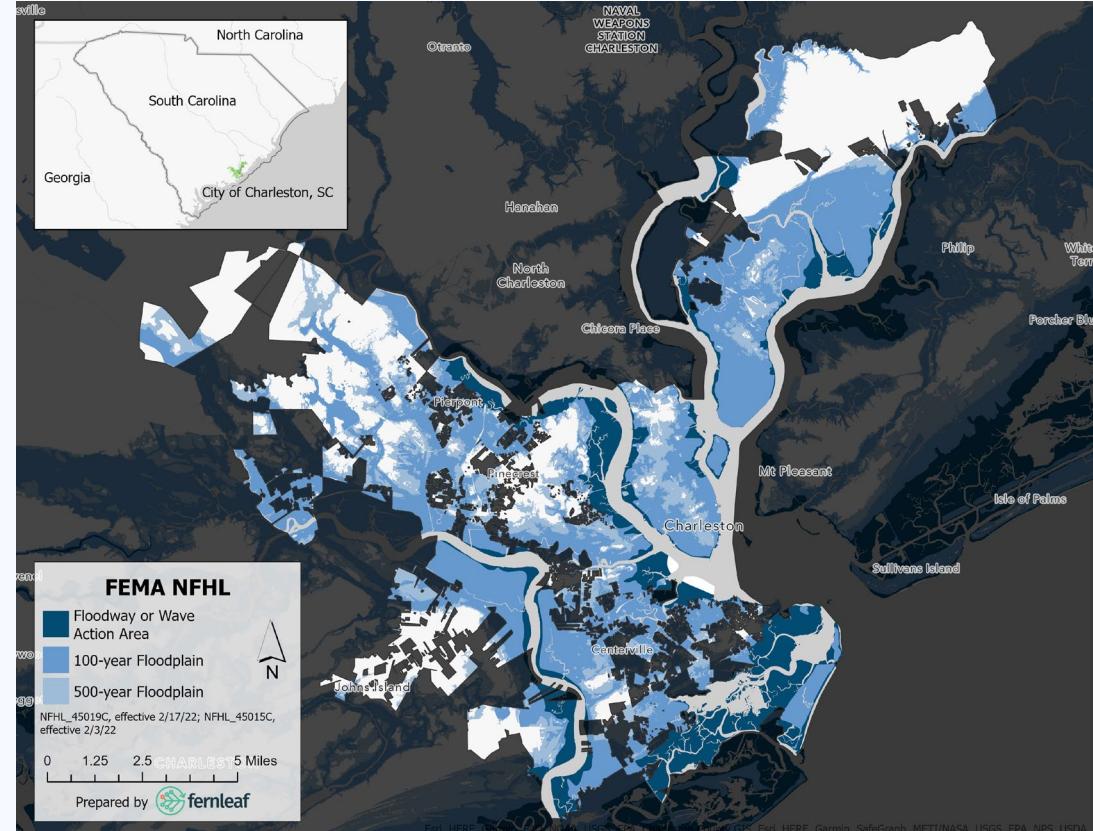
NFIP Losses

- 25,985 policies in place (2022)
- Over \$7,103,269 in coverage
- Over 6,649 claims and over \$117,737,550 claims paid

Repetitive Losses

- 1,893 properties in City of Charleston according to FEMA

Future occurrences are *likely*



FLOOD VULNERABILITY

Probability: Likely (Between 10 and 100% annual probability)

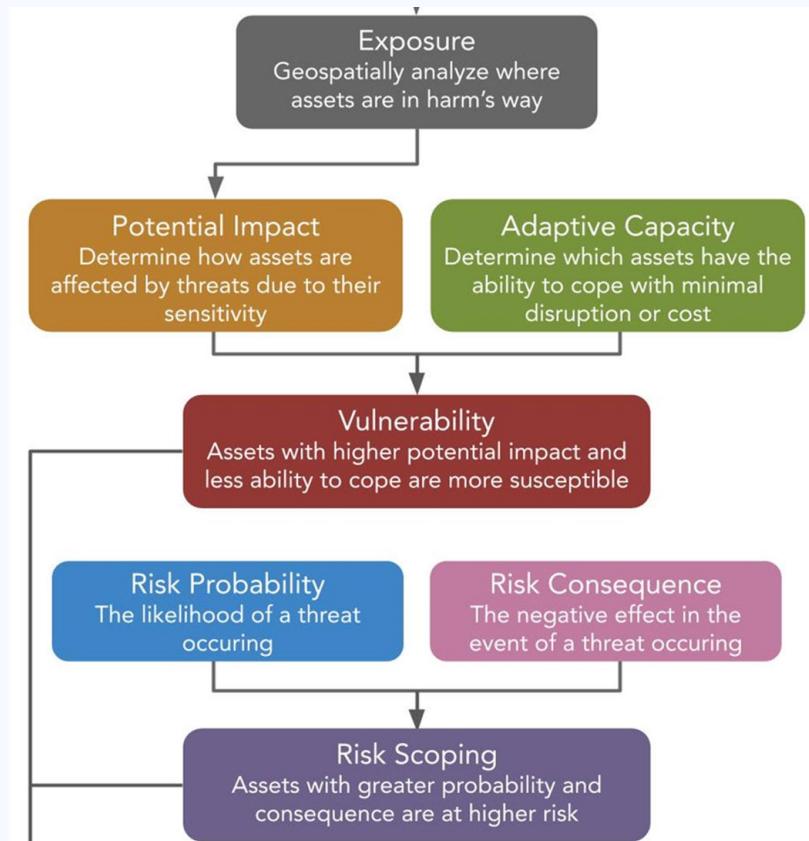
Impact: Critical (Multiple deaths/injuries possible. More than 25% of property in affected area damaged or destroyed. Complete shutdown of critical facilities for more than one week)

Spatial Extent: Moderate (Between 10 and 50% of area affected)

Warning Time: 0 – 12 hours

Duration: More than one week

FLOODING VULNERABILITY, Continued



Flood Vulnerability & Risk Assessment Components

Exposure

An asset *must* be exposed to be vulnerable or at risk

Vulnerability

Susceptibility based on sensitivity/potential impact and adaptive capacity

Risk Scoping

The probability and negative consequence of threats

FLOODING VULNERABILITY, Continued

Community Asset	Asset Total	Floodplain Inundation (Medium-High Combined Vulnerability & Risk)
Commercial	3,368	3,380 (71%)
Residential	61,781	43,119 (70%)
Critical Facilities	347	210 (61%)
Government-Owned	144	104 (72%)
Parks and Cultural	659	406 (62%)
Historic	3,562	3,372 (95%)

FLOODING VULNERABILITY, Continued

Community Asset	Asset Total	Floodplain Inundation (Medium-High Combined Vulnerability & Risk)
Major Roads Inaccessible (lane miles)	596	250 (42%) [100-yr]
Minor Roads Inaccessible (lane miles)	3,007	1,775 (59%) [100-yr]
Inaccessible Property	69,153	41,346 (60%) [100-yr]
Public Housing	103	93 (90%)

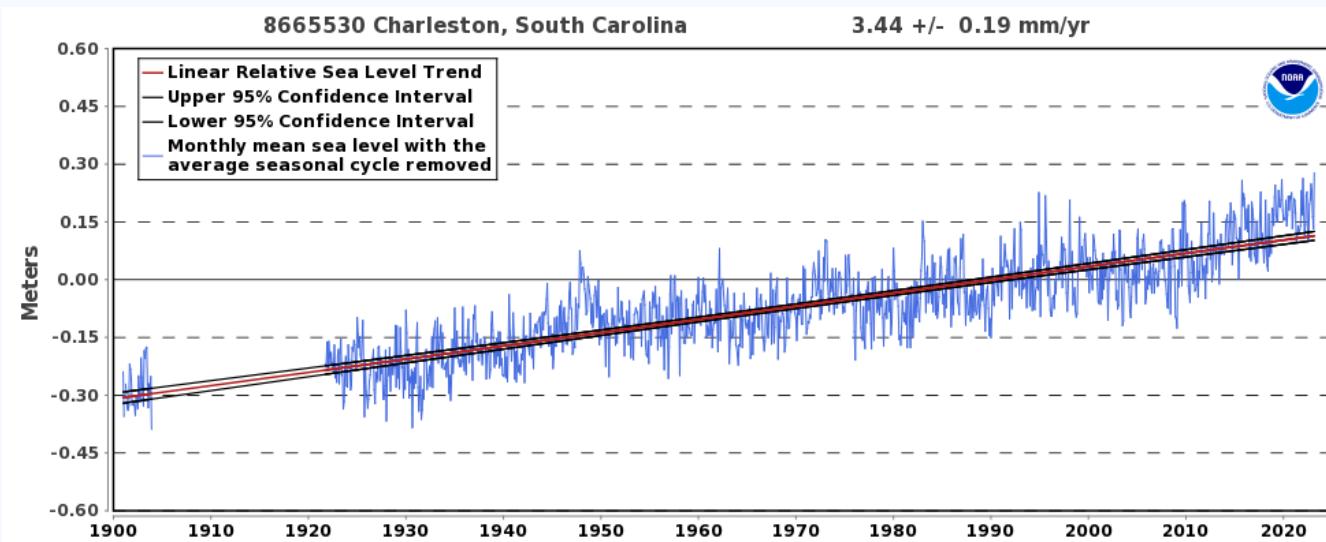
FLOODING VULNERABILITY, Continued

- **48%** of all critical facilities and **90%** of all government owned properties with high combined vulnerability and risk are located in the **Downtown/Peninsula area**
- **80%** of the city's annual sales volume and jobs/employees have high combined vulnerability and risk
- In all census areas with at least 70% of the homes vulnerable and at risk, **6** of these areas have the **highest overall social vulnerability in the city**
- Major Roads within the **West Ashley (Inner and Outer)**, and the Downtown Peninsula areas are **most vulnerable** to becoming **isolated** or **inaccessible** due to flooding

SEA LEVEL RISE

Sea level trend off South Carolina's coast is 3.44 millimeters/year.

This trend is based off monthly mean sea level data from 1901 to 2022. This equates to a 1.13 ft change in 100 yrs.



Source: NOAA, Tides and Gauges Data for Charleston, SC

SEA LEVEL RISE

Sea level rise occurs at different rates based on various factors

- Sinking/rising land
- Urbanization/development
- Soil type
- Hydrology
- Proximity to gulf stream

Charleston has high urbanization in low-lying areas, which tend to be more susceptible to sea level rise.

SEA LEVEL RISE VULNERABILITY

Probability: Likely (Between 10 and 100% annual probability)

Impact: Limited (Minor injuries only. More than 10% of property in affected area damaged or destroyed. Complete shutdown of critical facilities for more than one day.)

Spatial Extent: Moderate (Between 10 and 50% of area affected)

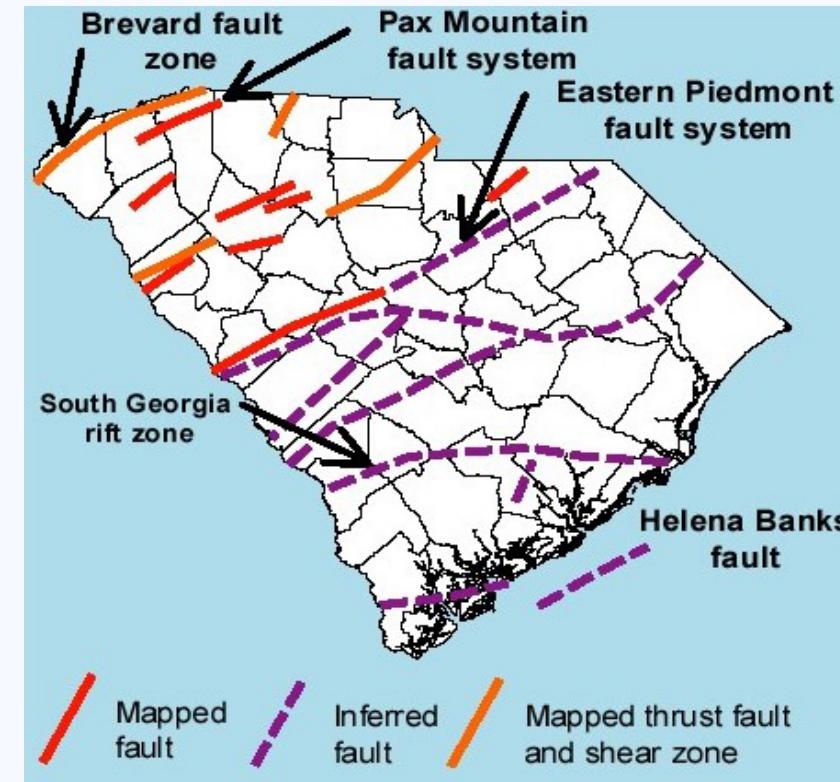
Warning Time: More than 24 hours

Duration: More than one week

EARTHQUAKE

Charleston Earthquake of 1886 is the most significant historical event on record with an estimated magnitude of 7.3 and more than 300 aftershocks

Future occurrences are possible



SCDNR Mapped Faults & Related Geologic Structures and
Inferred Faults
Source: [Earthquake Information- SCDNR](#)

EARTHQUAKE VULNERABILITY

Probability: Possible (Between 1 and 10% annual probability)

Impact: Limited (Minor injuries only. More than 10% of property in affected area damage or destroyed. Complete shutdown of critical facilities for more than one day.)

Spatial Extent: Large (Between 50 and 100% of area affected)

Warning Time: Less than 6 hours

Duration: More than one week

TORNADO

NCEI recorded 62 events from 1957 – 2022 for Charleston County

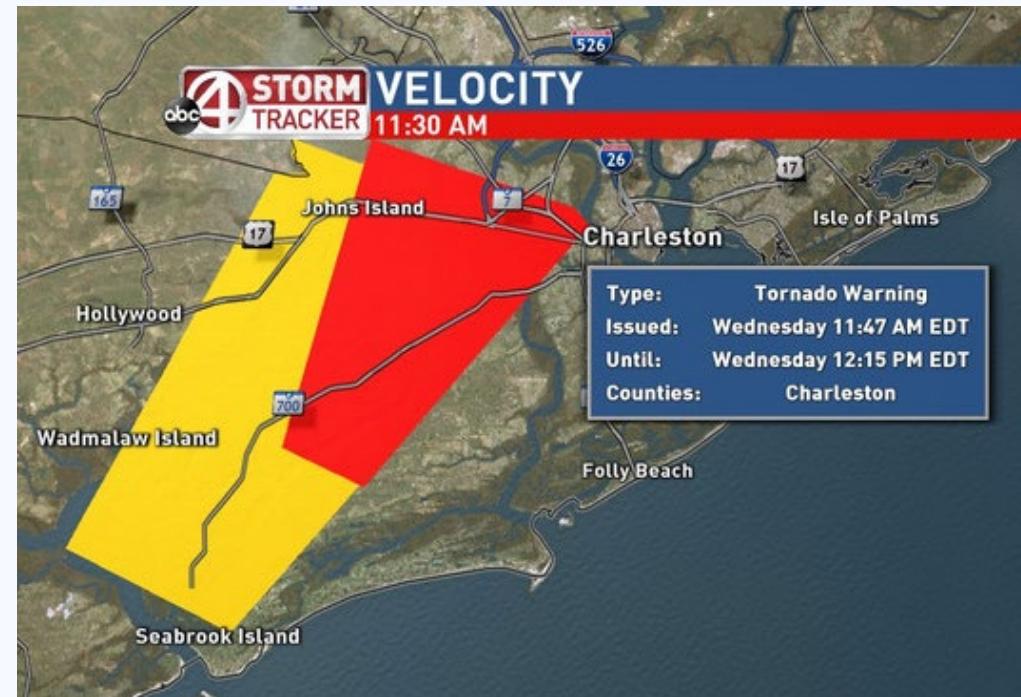
- 3 specific to City of Charleston
- \$4,452 in property damage in the City of Charleston

Greatest extent was an F3 in 1960

Uniform exposure across the city

Future occurrences are *likely*

Hurricanes are the largest threat to the city, which can also produce tornadoes



ABC4 News on Tornado Warning for Johns Island in May 2020

Source: [Tornado warning for Johns Island expired as severe thunderstorm passes through Lowcountry | WCIV \(abcnews4.com\)](https://www.wciv.com/news/tornado-warning-for-johns-island-expired-as-severe-thunderstorm-passes-through-lowcountry)

TORNADO VULNERABILITY

Probability: Likely (Between 10 and 100% annual probability)

Impact: Minor (Very few injuries, if any. Only minor property damage and minimal disruption of quality of life. Temporary shutdown of critical facilities.)

Spatial Extent: Small (Between 1 and 10% of area affected.)

Warning Time: Less than 6 hours

Duration: Days

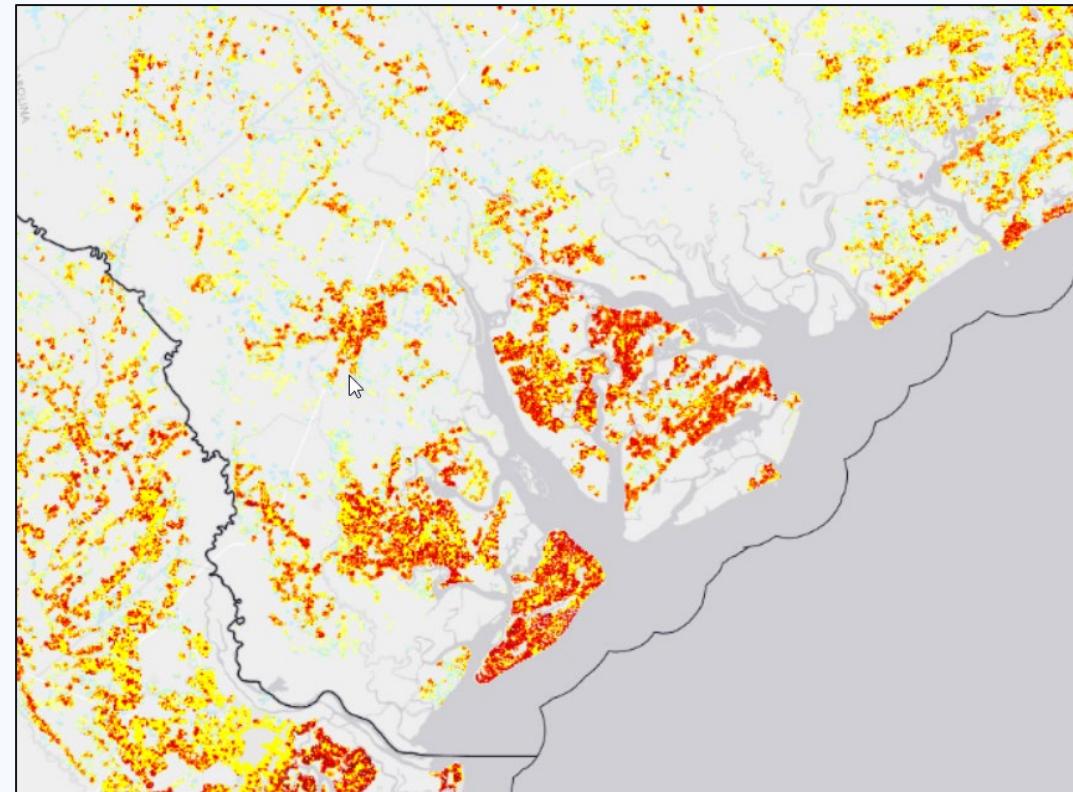
WILDFIRES

Wildland Urban Interface (WUI) Risk Index

- Rating of potential impact of wildfire on people and their property
- Relatively moderate throughout the City

Future occurrences are *likely*

Wildfire vs. Conflagration



WUI Risk Areas - SGSF Wildfire Risk Assessment Portal

WILDFIRES VULNERABILITY

Probability: Likely (Between 10 and 100% annual probability)

Impact: Minor (Very few injuries, if any. Only minor property damage and minimal disruption of quality of life. Temporary shutdown of critical facilities.)

Spatial Extent: Small (Between 1 and 10% of area affected)

Warning Time: 12 – 24 hours

Duration: Less than one week

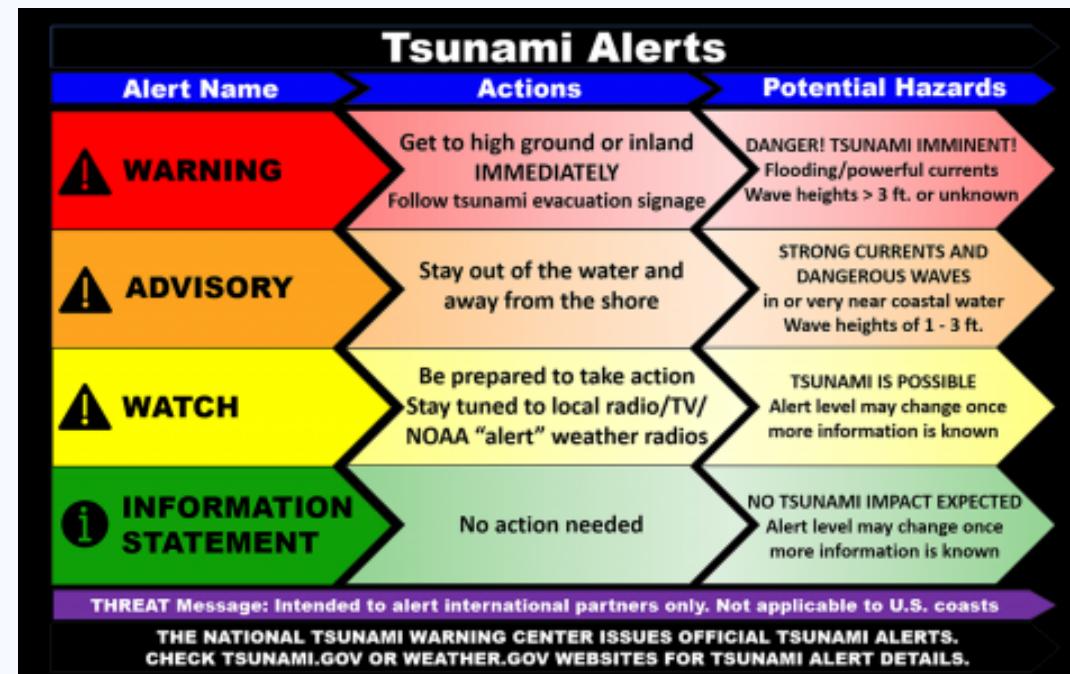
TSUNAMIS

All low-lying coastal areas **can** be impacted by a tsunami

1 event reported in City of Charleston – which is tied to the August 31, 1886 earthquake

USGS and Department of the Interior rated the **entire** Eastern coastline as having a “very low to low” probability of a tsunami event in a 500-year timeframe

Future occurrences are *unlikely*



Source: <https://www.tsunami.noaa.gov/pmel-theme/forecast-warning>

TSUNAMIS VULNERABILITY

Probability: Unlikely (Less than 1% annual probability)

Impact: Critical (Multiple deaths/injuries possible. More than 25% of property in affected area damaged or destroyed. Complete shutdown of critical facilities for more than one week.)

Spatial Extent: Moderate (Between 10 and 50% of area affected.)

Warning Time: Less than 6 hours

Duration: Less than one week

DAM FAILURE

Dam Failure Hazard Potential Classification	
Classification	Hazard Potential
High Hazard (Class I)	Dams located where failure will likely cause loss of life or serious damage to homes, industrial and commercial facilities, important public utilities, main highway(s) or railroads.
Significant Hazard (Class II)	Dams located where failure will not likely cause loss of life but may damage homes, industrial and commercial facilities, secondary highway(s) or railroads or cause interruption of use or service of relatively important public utilities.
Low Hazard (Class III)	Dams located where failure may cause minimal property damage to others. Loss of life is not expected.

Source: South Carolina Department of Health & Environmental Control

To date, there has not been any major historical event

There are no high hazard dams reported in the City of Charleston (SC Department of Health and Environmental Control) – however nearby dams could cause issues for the City – Pinopolis - Tail Race Canal, Bushy Park/Goose Creek area

Future occurrences are *unlikely*

DAM FAILURE VULNERABILITY

Probability: Unlikely (Less than 1% annual probability)

Impact: Limited (Minor injuries only. More than 10% of property in affected area damaged or destroyed. Complete shutdown of critical facilities for more than one day.)

Spatial Extent: Small (Between 1 and 10% of area affected)

Warning Time: Less than 6 hours

Duration: Less than one week

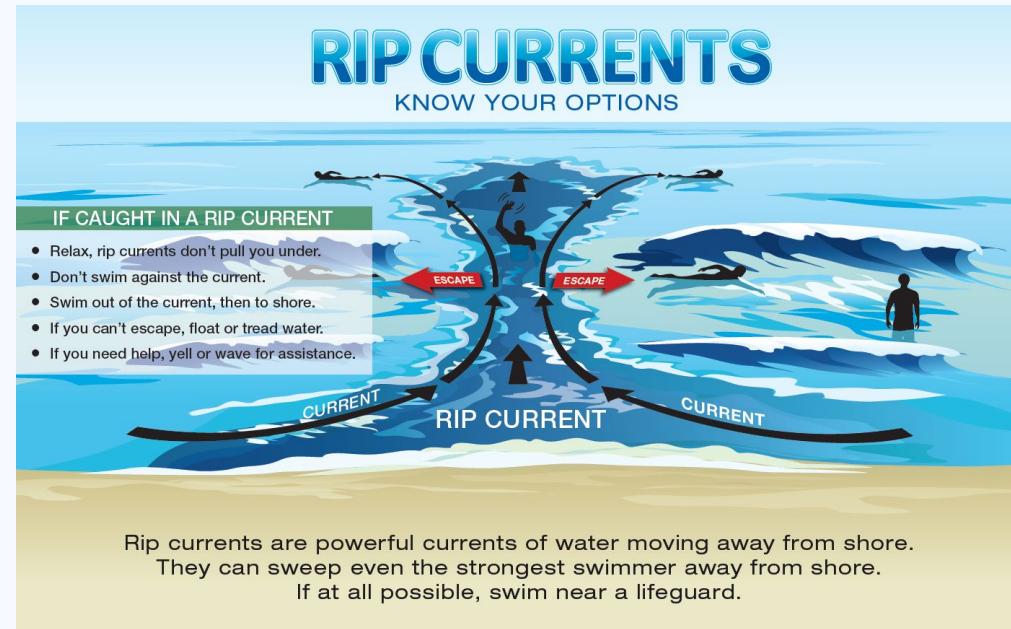
RIP CURRENTS

21 rip current events have been recorded along the shore of Charleston

- Reportedly caused 5 deaths and 7 injuries to beachgoers

Hazard significantly effected by severe weather events (thunderstorms, strong winds, and increased swell energy)

Future occurrences are *likely*



Source: South Carolina Sea Grant Consortium

RIP CURRENTS VULNERABILITY

Probability: Likely (Between 10 and 100% annual probability)

Impact: Minor (Very few injuries, if any. Only minor property damage and minimal disruption of quality of life. Temporary shutdown of critical facilities.)

Spatial Extent: Small (Between 1 and 10% of area affected)

Warning Time: Less than 6 hours

Duration: Less than 6 hours

DROUGHT

20 records of drought in the NCEI database for Charleston County (1996 to 2022)

- Status recorded weekly for each county
- All events were regional (multiple counties affected)

Losses are difficult to track

Future occurrences are *likely*

U.S. Drought Monitor South Carolina

October 15, 2019
(Released Thursday, Oct. 17, 2019)
Valid 8 a.m. EDT

	None	D0-D4	D1-D4	D2-D4	D3-D4	D4
Current	18.98	81.02	67.32	38.30	8.63	0.00
Last Week 10-08-2019	22.04	77.96	62.98	36.84	7.03	0.00
3 Months Ago 07-16-2019	56.62	43.38	3.47	0.00	0.00	0.00
Start of Climate Year 01-01-2019	100.00	0.00	0.00	0.00	0.00	0.00
Start of Water Year 10-01-2019	22.05	77.94	48.67	20.47	1.77	0.00
One Year Ago 10-16-2018	81.29	18.71	2.05	0.00	0.00	0.00

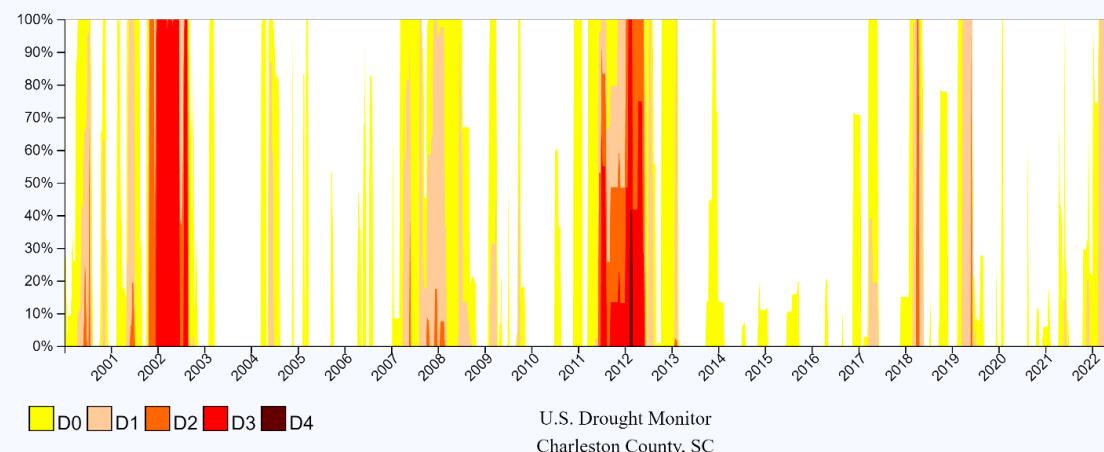
Intensity:
None (White)
D0 Abnormally Dry (Yellow)
D1 Moderate Drought (Orange)
D2 Severe Drought (Red)
D3 Extreme Drought (Dark Red)
D4 Exceptional Drought (Maroon)

The Drought Monitor focuses on broad-scale conditions. Local conditions may vary. See accompanying text summary for forecast statements.

Author:
Richard Heim
NCEI/NOAA



droughtmonitor.unl.edu



DROUGHT VULNERABILITY

Probability: Likely (Between 10 and 100% annual probability)

Impact: Minor (Very few injuries, if any. Only minor property damage and minimal disruption on quality of life. Temporary shutdown of critical facilities.)

Spatial Extent: Large (Between 50 and 100% of area affected)

Warning Time: More than 24 hours

Duration: More than one week

SEVERE STORM

Understanding Severe Thunderstorm Outlook Categories						
LEVEL	CATEGORY	DETAILS	SUMMARY	How many severe storms are possible?	How bad could the worst storms be?	DEFINITIONS
	General Thunderstorm	Although severe weather is not expected, <i>all</i> thunderstorms can produce deadly lightning, gusty winds, and small hail.	No severe thunderstorms expected	None	Numerous	<p>Similar to storms your area experiences many times per year</p> <p>Severe Storm</p> <p>Any storm that contains at least one of the following:</p> <ul style="list-style-type: none"> Wind gusts of at least 58 mph Hail at least one inch in diameter Tornado
1	Marginal (MRGL)	Some storms could be capable of damaging winds and severe hail. Localized tornado threat could develop.	Isolated severe storms possible	None	Numerous	<p>Similar to storms your area may experience several times per year</p> <p>Significant Severe</p> <p>Any of the following hazards:</p> <ul style="list-style-type: none"> Wind gusts of at least 75 mph Hail at least two inches in diameter Tornado of at least EF-2 rating
2	Slight (SLGT)	Increased confidence that some storms will contain damaging winds, severe hail, and/or tornado potential. <i>A few severe storms could be significant</i>	Isolated to scattered severe storms expected	None	Numerous	<p>Similar to storms your area may experience a few times per year</p> <p>Significant Severe</p> <p>Any of the following hazards:</p> <ul style="list-style-type: none"> Wind gusts of at least 75 mph Hail at least two inches in diameter Tornado of at least EF-2 rating
3	Enhanced (ENH)	High confidence that several storms will contain damaging winds, severe hail, and/or tornadoes. <i>Several severe storms could be significant</i>	Scattered to numerous severe storms expected	None	Numerous	<p>Similar to intense storms your area may only experience once or twice per year</p> <p>Significant Severe</p> <p>Any of the following hazards:</p> <ul style="list-style-type: none"> Wind gusts of at least 75 mph Hail at least two inches in diameter Tornado of at least EF-2 rating
4	Moderate (MDT)	High confidence that many storms will contain damaging winds, severe hail, and/or tornadoes. <i>Several severe storms likely to be significant</i>	Scattered to numerous severe storms expected	None	Numerous	<p>Similar to intense storms your area may only experience once per year or less</p> <p>Significant Severe</p> <p>Any of the following hazards:</p> <ul style="list-style-type: none"> Wind gusts of at least 75 mph Hail at least two inches in diameter Tornado of at least EF-2 rating
5	High (HIGH)	High confidence that an outbreak of storms will contain tornadoes, damaging winds, and/or severe hail. <i>Tornado outbreak and/or widespread damaging winds</i>	Numerous severe storms expected	None	Numerous	<p>Very intense storms your area may only experience once or twice in a lifetime</p> <p>Significant Severe</p> <p>Any of the following hazards:</p> <ul style="list-style-type: none"> Wind gusts of at least 75 mph Hail at least two inches in diameter Tornado of at least EF-2 rating

spc.noaa.gov | weather.gov

NCEI reported 78 thunderstorm events in Charleston since 1993

- Reported over \$174 thousand in property damage
- 3 injuries

Severe storms have caused one disaster declaration for Charleston County

Uniform exposure across the entire city

Future occurrences are *highly likely*

SEVERE STORM VULNERABILITY

Probability: Highly Likely (100% annual probability)

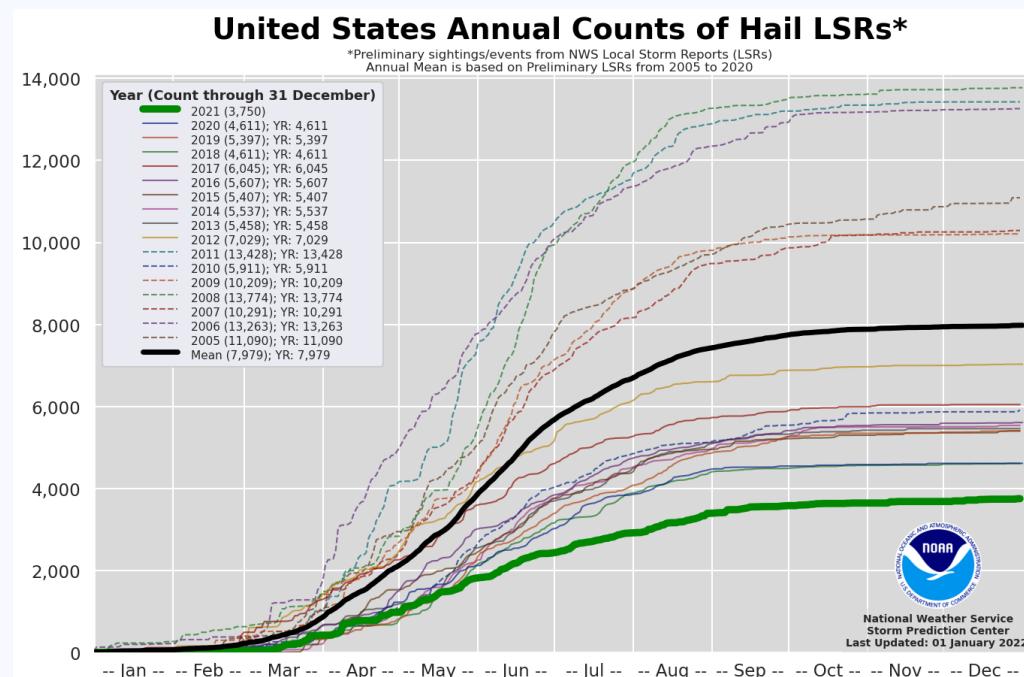
Impact: Limited (Minor injuries only. More than 10% of property in affected area damaged or destroyed. Complete shutdown of critical facilities for more than one day.)

Spatial Extent: Moderate (Between 10 and 50% of area affected.)

Warning Time: 6 – 12 hours

Duration: Less than 6 hours

HAIL



NCEI reported 9 hail events in Charleston in 1999

- No reported property damages, injuries, or deaths with these events

Hail stones reported between 0.75 and 1.75 inches in diameter

Uniform exposure across the entire city

Future occurrences are *highly likely*

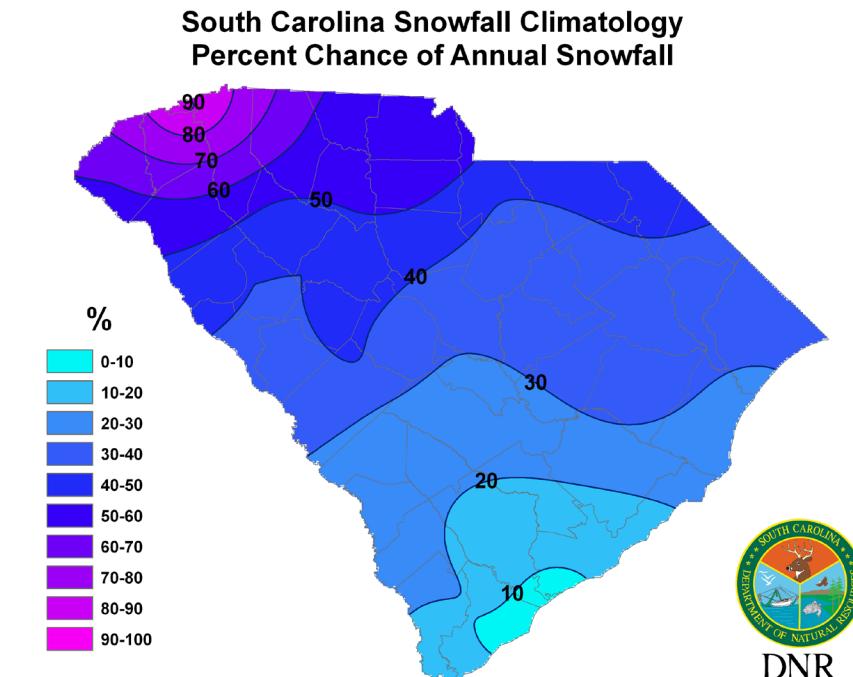
SEVERE WINTER STORM

NCEI reported 7 severe winter storm events in Charleston County since 2000

- Reported over \$96 thousand in property damages

Uniform exposure across the city

Future occurrences are possible



SEVERE WINTER STORM VULNERABILITY

Probability: Possible (Between 1 and 10% annual probability)

Impact: Limited (Minor injuries only. More than 10% of property in affected area damaged or destroyed. Complete shutdown of critical facilities for more than one day.)

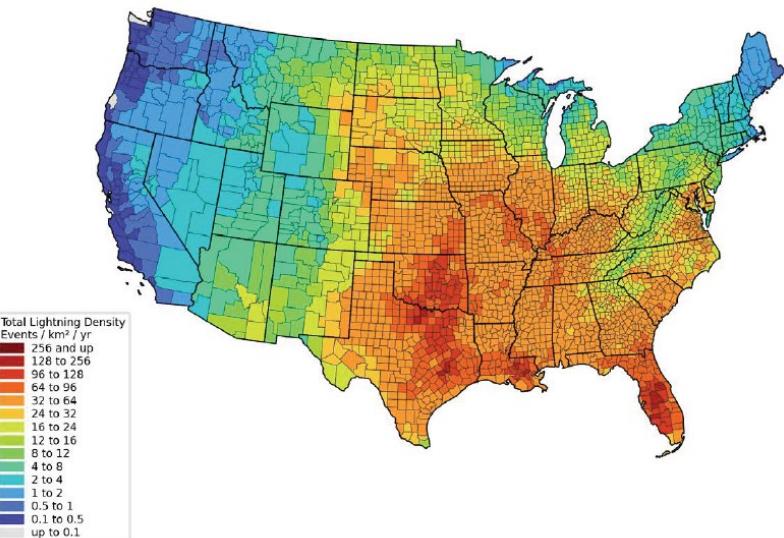
Spatial Extent: Large (Between 50 and 100% of area affected)

Warning Time: More than 24 hours

Duration: Less than one week

LIGHTNING

Total lightning density 2015-2020
per county



VAISALA

2021 ANNUAL LIGHTNING REPORT

© Vaisala 2022

Uniform exposure across the entire city

Future occurrences are *highly likely*

SHORELINE EROSION

Coastal areas at risk of shoreline erosion

USGS reports that highest rates of shoreline retreat and land loss found along the coast of South Carolina

SCDHEC reports erosion on Morris Island (located in mouth of Charleston Harbor) is eroding at an average of 30 ft/yr

Future occurrences are *likely*

SHORELINE EROSION VULNERABILITY

Probability: Possible (Between 1 and 10% annual probability)

Impact: Limited (Minor injuries only. More than 10% of property in affected area damaged or destroyed. Complete shutdown of critical facilities for more than one day.)

Spatial Extent: Small (Between 1 and 10% of area affected.)

Warning Time: More than 24 hours

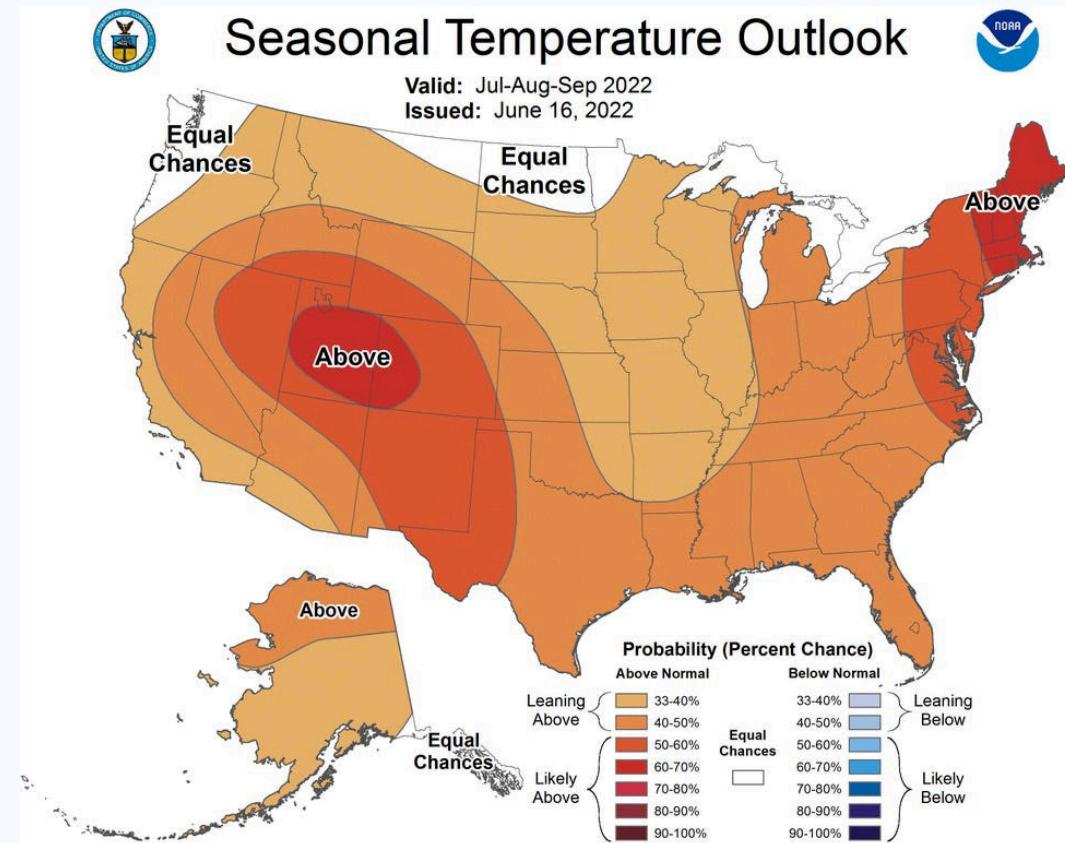
Duration: More than one week

EXTREME HEAT

NCEI reported 19 extreme heat events since 1996 in Charleston County

105F reported on August 1, 1999 is the maximum reported temperature for the City of Charleston

Future Occurrences are *likely*



EXTREME HEAT VULNERABILITY

Probability: Likely (Between 10 and 100% annual probability)

Impact: Limited (Minor injuries only. More than 10% of property damaged or destroyed. Complete shutdown of critical facilities for more than one day.)

Spatial Extent: Large (Between 50 and 100% of area affected)

Warning Time: More than 24 hours

Duration: Less than one week

SINKHOLES

Human interference and
changed in water levels in surficial
aquifers lead to sinkholes (USGS)

3 occurrences from news
reports/anecdotal evidence in
Charleston

- Deteriorating and outdated
pre-civil war era storm system
beneath city susceptible to
sinkholes

Future occurrences are *likely*



Source: <https://today.cofc.edu/2021/07/05/geology-professor-explains-cause-of-sinkhole-near-campus/>

SINKHOLES VULNERABILITY

Probability: Likely (Between 10 and 100% annual probability)

Impact: Limited (Minor injuries only. More than 10% of property in affected area damaged or destroyed. Complete shutdown of critical facilities for more than one day.)

Spatial Extent: Small (Between 1 and 10% of area affected.)

Warning Time: Less than 6 hours

Duration: Less than 6 hours

DISEASE/PANDEMIC

Hazard of great concern recently

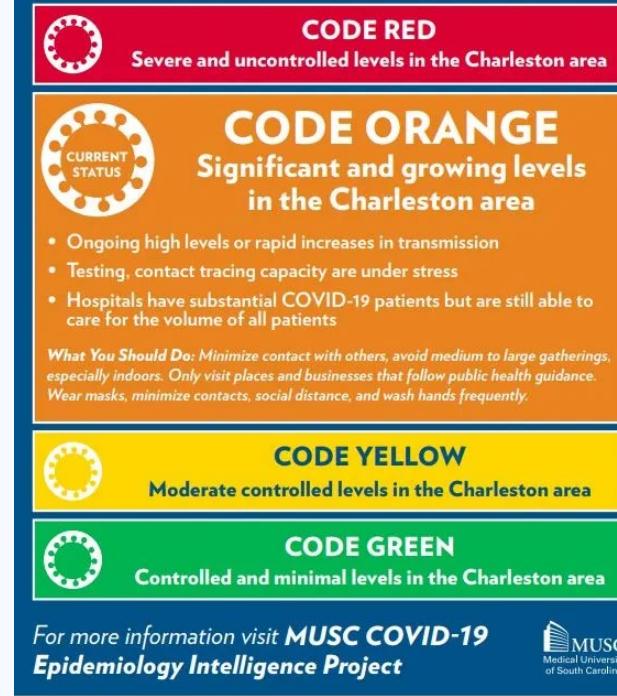
- Increasing risk/vulnerability with increasing population

Other historical occurrences include smallpox, yellow fever epidemic (1858), and influenza (1919)

One disaster declaration due to COVID-19 Pandemic on March 27th, 2020

Future occurrences are possible

Charleston Area COVID-19 Warning Levels



PUBLIC HEALTH HAZARDS VULNERABILITY

Probability: Unlikely (Less than 1% annual probability)

Impact: Critical (Multiple deaths/injuries possible. More than 25% of property in affected area damaged or destroyed. Complete shutdown of critical facilities for more than one week.)

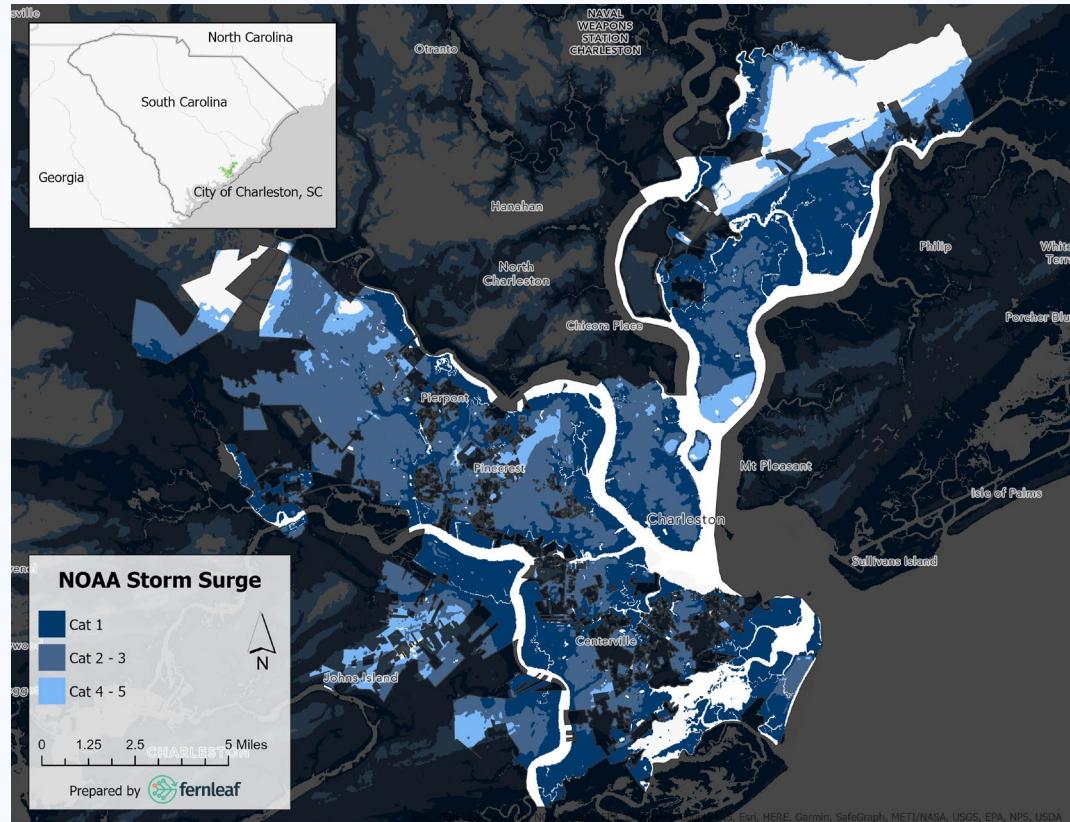
Spatial Extent: Large (Between 50 and 100% of area affected.)

Warning Time: More than 24 hours

Duration: More than one week

STORM SURGE

- More properties in the City of Charleston are vulnerable to storm surge than any other type of flooding hazard
- NCEI reported six (6) events for the City of Charleston
 - Hurricane Hugo (1989) recorded storm surge at 12.5 ft above the average low tide
 - Hurricane Irma (2017) recorded storm surge at 9.9 ft
 - Hurricane Matthew (2016) recorded storm surge of 9.3 ft
- Future occurrences are *likely*



STORM SURGE VULNERABILITY

Probability: Likely (between 10 and 100 percent annual probability)

Impact: Minor (Very few injuries, if any. Only minor property damage and minimal disruption on quality of life. Temporary shutdown of critical facilities.)

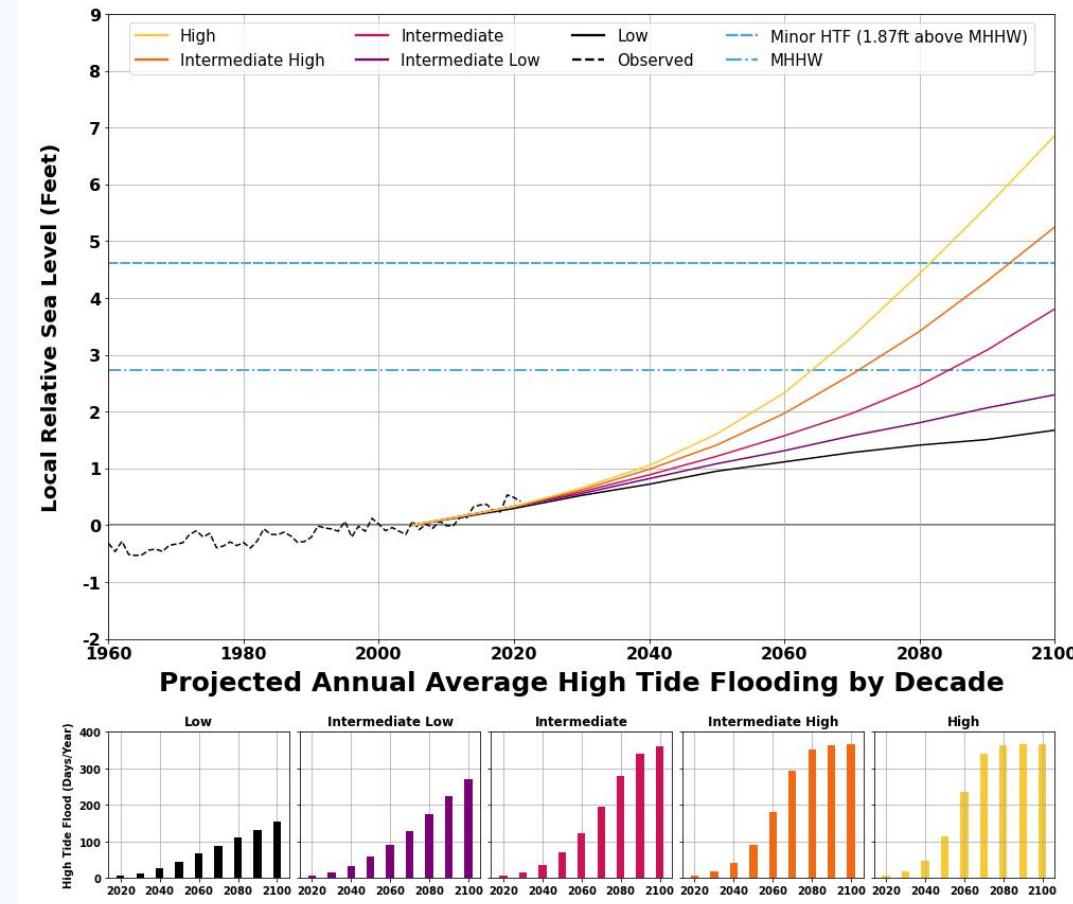
Spatial Extent: Large (Between 50 and 100% of area affected.)

Warning Time: More than 24 hours

Duration: Less than 24 hours

TIDAL FLOODING

- More common in cities and other human occupied coast areas as sea levels rise
- NOAA reports the U.S. SE Atlantic and Gulf coast had an increase of over 400 to 1,000% respectively in high tide flooding days since 2000
- Cooper River tidal gauges report tidal flooding events could rise to over 100 days/year by 2100
- Future occurrences are possible



TIDAL FLOODING VULNERABILITY

Probability: Possible (between 1 and 10 percent annual probability)

Impact: Minor (Very few injuries, if any. Only minor property damage and minimal disruption on quality of life. Temporary shutdown of critical facilities.)

Spatial Extent: Moderate (Between 50 and 100% of area affected.)

Warning Time: More than 24 hours

Duration: Less than 6 hours

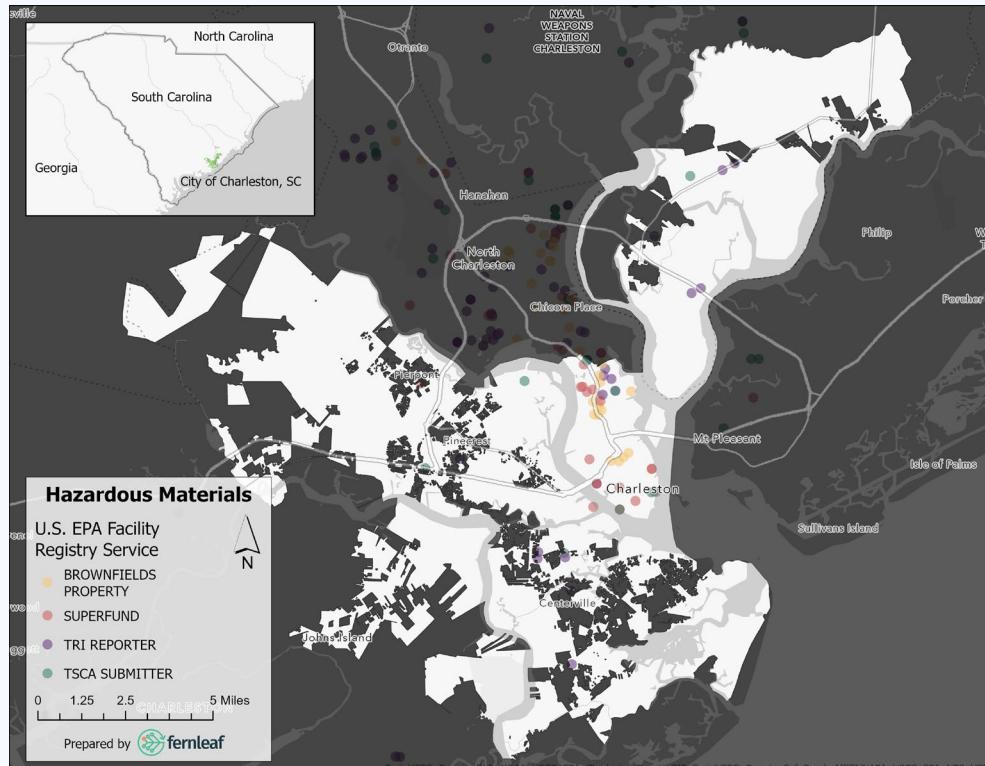
HAZARDOUS MATERIALS RELEASE

The Pipeline and Hazardous Materials Safety Administration reported 264 events in the City of Charleston

- Combination of Rail, Water, Air and Highway spill events
- \$591,391 in property damages reported from events

There are 11 TRI facilities located in the City of Charleston

Future occurrences are *likely*



HAZARDOUS MATERIALS RELEASE VULNERABILITY

Probability: Likely (Between 10 and 100% annual probability)

Impact: Limited (Minor injuries only. More than 10% of property in affected area damaged or destroyed. Complete shutdown of critical facilities for more than one day.)

Spatial Extent: Small (Between 1 and 10% of area affected)

Warning Time: Less than 6 hours

Duration: Less than 24 hours

INFRASTRUCTURE FAILURE

Network of structures, utilities, and facilities

- Basic needs for mobility, power, water, sewer, and communications

City is home to the Port of Charleston – one of the most productive ports in the US for trade, commerce and is also home to the city's cruise ship operations

Future occurrences are possible

INFRASTRUCTURE FAILURE VULNERABILITY

Probability: Possible (Between 1 and 10% annual probability)

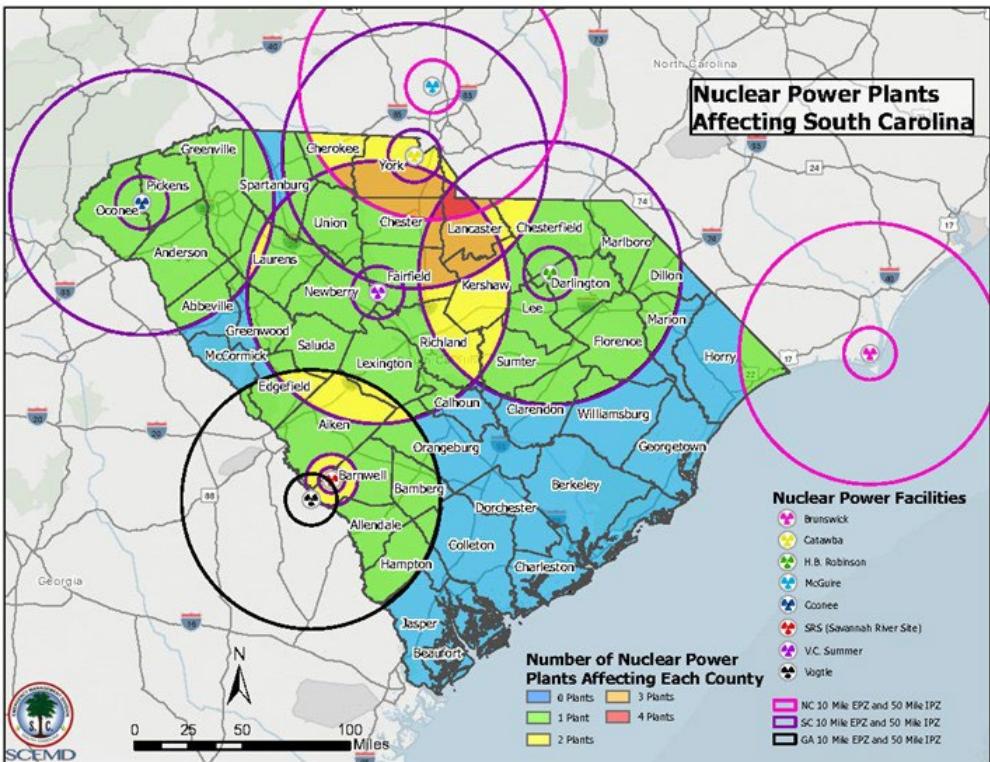
Impact: Limited (Minor injuries only. More than 10% of property in affected area damaged or destroyed. Complete shutdown of critical facilities for more than one day.)

Spatial Extent: Small (Between 1 and 10% of area affected.)

Warning Time: Less than 6 hours

Duration: More than one week

RADIOLOGICAL EMERGENCY



No serious events have occurred near the City of Charleston

- No industry in the city that manages nuclear materials

Concern with major transportation, Port, and healthcare facilities

RADIOLOGICAL EMERGENCY VULNERABILITY

Probability: Unlikely (Less than 1% annual probability)

Impact: Limited (Minor injuries only. More than 10% of property in affected area damaged or destroyed. Complete shutdown of critical facilities for more than one day.)

Spatial Extent: Small (Between 1 and 10% of area affected.)

Warning Time: Less than 6 hours

Duration: Less than one week

CYBER INCIDENTS

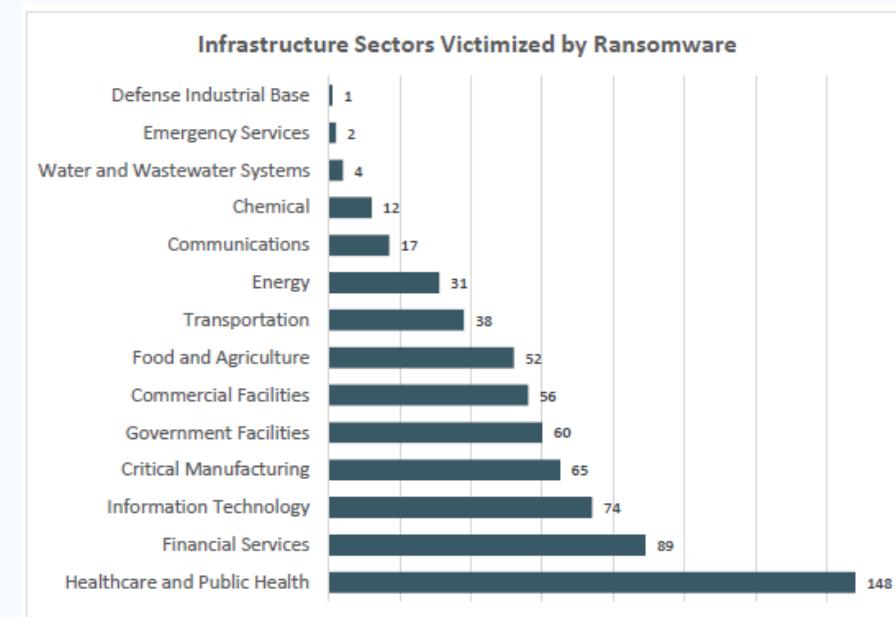
A cyber incident is an event that could jeopardize the confidentiality, integrity, or availability of digital information or information systems

- Have a significant probability of compromising regular operations

Can involve theft, fraud, and solicitation

One incident in Charleston County ransomware attack

Future occurrences are possible



CYBER INCIDENTS VULNERABILITY

Probability: Possible (Between 1 and 10% annual probability)

Impact: Limited (Minor injuries only. More than 10% of property in affected area damaged or destroyed. Complete shutdown of critical facilities for more than one day.)

Spatial Extent: Small (Between 1 and 10% of area affected.)

Warning Time: Less than 6 hours

Duration: Less than one week

CIVIL DISTURBANCE

Most often arise from political grievances, urban economic conflicts, and community unrest, terrorist acts or foreign influences

There have been 3 examples in Charleston's history of civil disturbance events which caused 6 deaths and 39 injuries (1876 – 2020)

Future occurrences are *unlikely*

CIVIL DISTURBANCE VULNERABILITY

Probability: Unlikely (Less than 1% annual probability)

Impact: Minor (Very few injuries, if any. Only minor property damage and minimal disruption on quality of life. Temporary shutdown of critical facilities.)

Spatial Extent: Small (Between 1 and 10% of area affected.)

Warning Time: Less than 6 hours.

Duration: Less than 24 hours

TERRORISM

The City of Charleston has not experienced a major threat or attack but does deal with isolated incidents of domestic terrorism such as mass shootings

Charleston has an increased probability of experiencing a terrorist attack due to being a major port city, centralized tourism, and a high urban population

Future occurrences are possible

Threat Level	Description
SEVERE	Severe Risk of Terrorist Attacks
HIGH	High Risk of Terrorist Attacks
ELEVATED	Significant Risk of Terrorist Attacks
GUARDED	General Risk of Terrorist Attacks
LOW	Low Risk of Terrorist Attacks

TERRORISM VULNERABILITY

Probability: Possible (between 1 and 10 percent annual probability)

Impact: Critical (Multiple deaths/injuries possible. More than 25% of property in affected area damaged or destroyed. Complete shutdown of critical facilities for more than one week.)

Spatial Extent: Small (Between 1 and 10 percent area affected)

Warning Time: Less than 6 hours

Duration: More than one week

ACTIVE THREAT

Areas of high population are especially at risk to active threats

There has been one major active threat incident in Charleston

- Charleston Church Shooting (2015)
- Caused nine deaths and one injury

Future occurrences are possible

Incident Statistics

Active Shooter Incidents 2017–2021

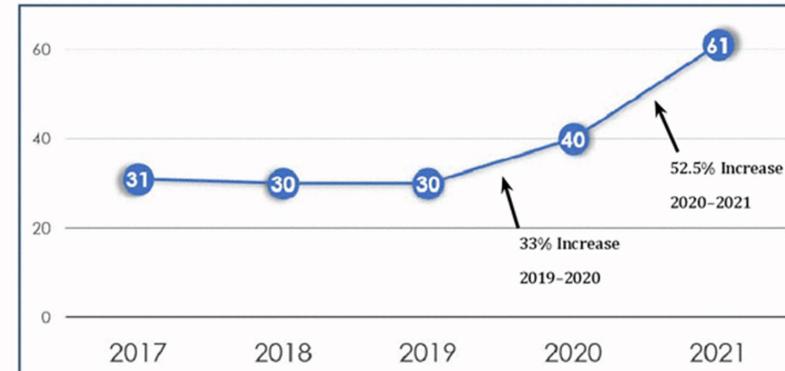


Figure 1

Summary

For the period 2017–2021, active shooter incident 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.

A breakdown of the number of incidents within the five-year period 2017–2021⁶ is as follows:

- 2017: 31
- 2018: 30
- 2019: 30
- 2020: 40
- 2021: 61

ACTIVE THREAT VULNERABILITY

Probability: Possible (Between 1 and 10 percent annual probability)

Impact: Limited (Minor injuries only. More than 10 percent of property affected area damaged or destroyed. Complete shutdown of critical facilities for more than one day.)

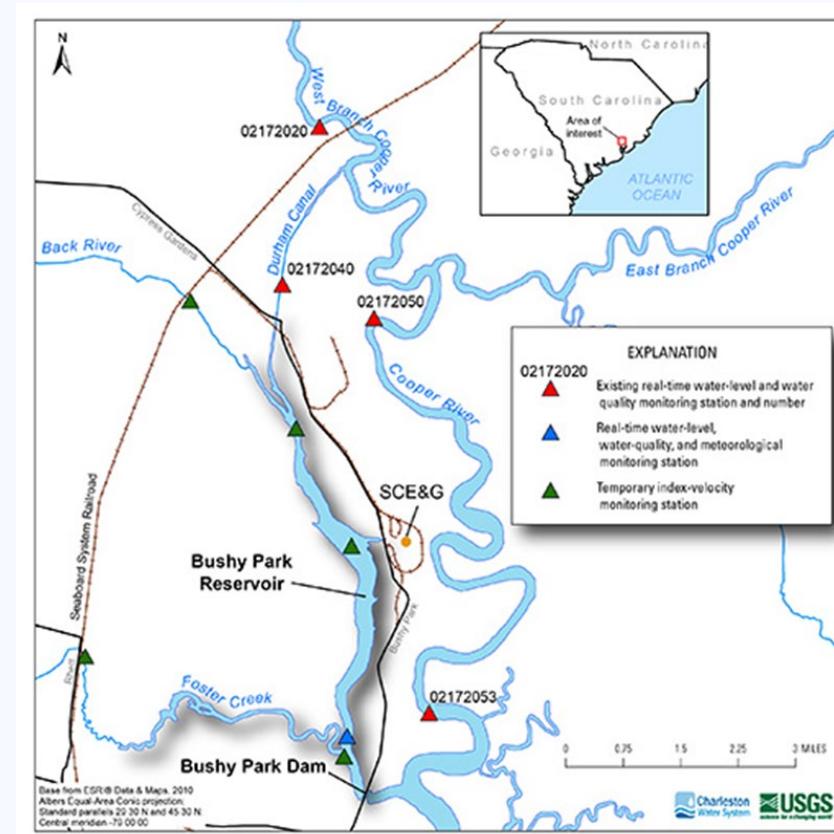
Spatial Extent: Small (Between 1 and 10 percent of area affected)

Warning Time: Less than 6 hours

Duration: Less than 6 hours

WATER SHORTAGE

- Continuous cycles of drought and rising temperatures due to climate change will exacerbate water supplies for the entirety of South Carolina
- Bushy Park Reservoir is the main source of water for the City of Charleston
- Futures occurrences are possible



Bushy Park Reservoir Reference Map
Source: Charleston Water System; USGS

WATER SHORTAGE VULNERABILITY

Probability: Possible (Between 1 and 10 percent annual probability)

Impact: Minor (Very few injuries, if any. Only minor property damage and minimal disruption of quality of life. Temporary shutdown of critical facilities.)

Spatial Extent: Large (Between 50 and 100% of area affected.)

Warning Time: More than 24 hours

Duration: More than one week

PRI RESULTS

Hazard	Sub-hazard(s) Assessed	Category/Degree of Risk						PRI Score
		Probability	Impact	Spatial Extent	Warning Time	Duration		
Natural Hazards								
Hurricane		Likely	Critical	Large	More than 24 hours	More than one week	3.1	
Flooding		Likely	Critical	Moderate	6-12 hours	More than one week	3.1	
Sea Level Rise		Likely	Limited	Moderate	More than 24 hours	More than one week	2.6	
Earthquake		Likely	Limited	Large	Less than 6 hours	More than one week	2.8	
Tornado		Likely	Minor	Small	Less than 6 hours	Less than one week	2.0	
Wildfires	Conflagration	Likely	Minor	Small	12 – 24 hours	Less than one week	2.1	
Tsunamis		Unlikely	Critical	Moderate	Less than 6 hours	Less than one week	2.2	
Dam Failure		Unlikely	Limited	Small	Less than 6 hours	Less than one week	1.7	
Rip Currents		Likely	Minor	Small	Less than 6 hours	Less than 6 hours	2.1	
Drought		Likely	Minor	Large	More than 24 hours	Less than 6 hours	2.5	
Severe Storm	Thunderstorm, Lightning, Hail	Highly Likely	Limited	Moderate	6-12 hours	Less than one week	2.8	
Severe Winter Weather		Possible	Limited	Large	More than 24 hours	Less than one week	2.7	
Shoreline Erosion		Possible	Limited	Small	More than 24 hours	More than one week	2.1	

PRI RESULTS, Continued

Extreme Heat		Likely	Limited	Large	More than 24 hours	Less than one week	2.7
Sinkholes		Likely	Limited	Small	Less than 6 hours	Less than 6 hours	2.1
Public Health Hazards		Unlikely	Critical	Large	More than 24 hours	More than one week	2.5
Storm Surge		Likely	Minor	Moderate	More than 24 hours	Less than 24 hours	2.1
Tidal Flooding		Possible	Minor	Moderate	More than 24 hours	Less than 6 hours	1.7
Technological Hazards							
Hazardous Materials		Likely	Limited	Small	Less than 6 hours	Less than one week	2.2
Infrastructure Failure		Possible	Limited	Small	Less than 6 hours	More than one week	2.1
Human-Caused Hazards							
Radiological Emergency		Unlikely	Limited	Small	Less than 6 hours	Less than one week	1.7
Cyber Incidents		Possible	Limited	Small	Less than 6 hours	Less than one week	2
Civil Disturbance		Unlikely	Minor	Small	Less than 6 hours	Less than 24 hours	1.3
Terrorism		Unlikely	Critical	Small	Less than 6 hours	More than one week	2.1
Active Threat		Possible	Limited	Small	Less than 6 hours	Less than 6 hours	1.8
Water Shortage		Possible	Minor	Large	More than 24 hours	More than one week	2.1

LCHCC PRIORITIES

Highest Rank with Great Impact		
Natural	Manmade/Intentional	Technological
Earthquake Infectious Disease Hurricane Inclement Weather Tsunami	Terrorism Workplace Violence	Dam Failure Explosive

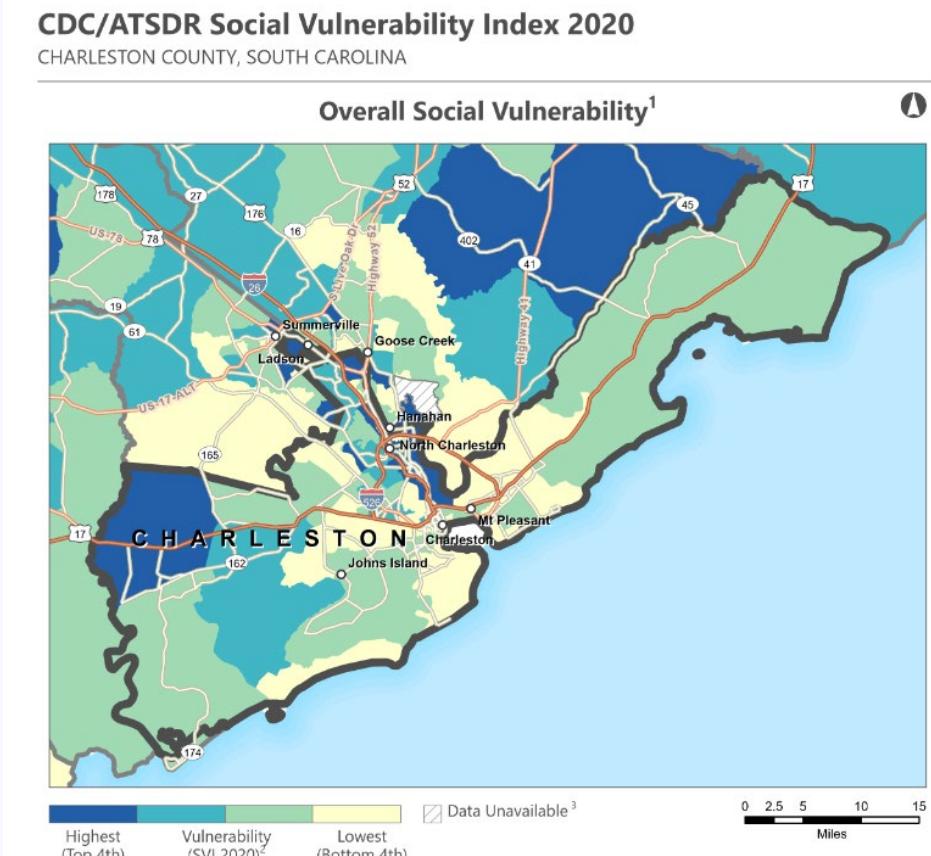
Hazards ranked at the facility level and Coalition level based on risk percentage

HVA CONCLUSIONS

HIGH RISK	Hurricane Flooding Earthquake Severe Storm Extreme Heat Sea Level Rise
MODERATE RISK	Drought Public Health Hazards Hazardous Materials Release Rip Currents Tsunamis Wildfires Severe Winter Weather Shoreline Erosion Sinkholes Infrastructure Failure Terrorism Tornado
LOW RISK	Cyber Incidents Active Threat Tidal Flooding Dam Failure Radiological Emergency Civil Disturbance

SOCIAL VULNERABILITY

- Based on CDC Social Vulnerability Index, the City of Charleston has a **varying level** of vulnerability



Charleston Area Heat Watch Context

Subdivision Age

Grid - 1 Square Mile

 CHS HeatWatch Study Area

Charleston Subdivision Age (North Charleston Data Not Available)

Average Year Built

 1840 - 1930

 1931 - 1966

 1967 - 1981

 1982 - 1999

 2000 - 2018

MEDIAN INCOME DATA

U.S. Census Bureau's American Community Survey (ACS) 2015-2019 5-year estimates, Table(s) B19013B, B19013C, B19013D, B19013E, B19013F, B19013G, B19013H, B19013I, B19049, B19053

HEALTH INSURANCE COVERAGE DATA

U.S. Census Bureau's American Community Survey (ACS) 2015-2019 5-year estimates, Table(s) B27010

POPULATION DATA

U.S. Census Bureau's American Community Survey (ACS) 2015-2019 5-year estimates, Table(s) B01001

EDUCATION DATA

U.S. Census Bureau's American Community Survey (ACS) 2015-2019 5-year estimates, Table(s) 3

ELEVATION DATA

U.S. Geological Survey, 2019, 3D Elevation Program 3-Meter Resolution Digital Elevation Model, accessed April 16, 2021 at URL <https://www.usgs.gov/core-science-systems/ngp/3dep/data-tools>

CDC SVI DATA

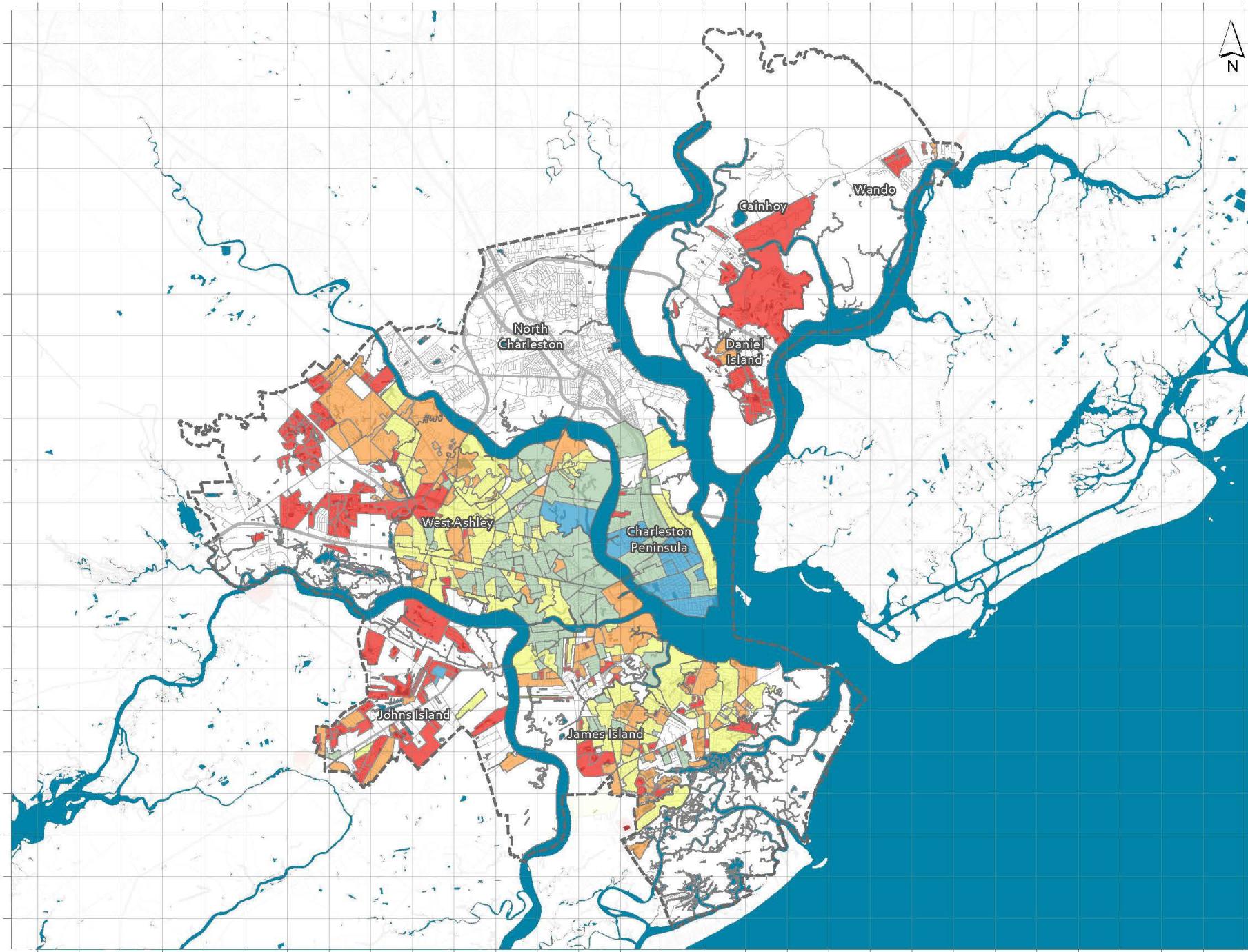
Centers for Disease Control and Prevention/ Agency for Toxic Substances and Disease Registry/ Geospatial Research, Analysis, and Services Program. CDC Social Vulnerability Index 2018 Database US. https://www.atsdr.cdc.gov/placeandhealth/svi/data_documentation_download.html. Accessed 04/2021

LIFE EXPECTANCY DATA

National Center for Health Statistics. U.S. Small-Area Life Expectancy Estimates Project (USALEEP): Life Expectancy Estimates File for [Jurisdiction], 2010-2015. National Center for Health Statistics. 2018. Available from: <https://www.cdc.gov/nchs/nvss/usalep/usleep.html>.

LANDCOVER & NEIGHBORHOOD DATA
City of Charleston GIS

 **climate adaptation partners**
resilience through collaborative partnerships



Charleston (CHS) Heat Watch Context

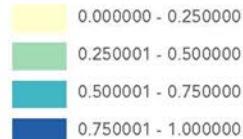
CDC SVI - Overall Vulnerability

Grid - 1 Square Mile

 CHS HeatWatch Study Area

Overall CDC Social Vulnerability Index (SVI)

Low Social Vulnerability to High Social Vulnerability (Census Tract)



MEDIAN INCOME DATA

U.S. Census Bureau's American Community Survey (ACS) 2015-2019 5-year estimates, Table(s) B19013B, B19013C, B19013D, B19013E, B19013F, B19013G, B19013H, B19013I, B19049, B19053

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EDUCATION DATA

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CDC SVI DATA

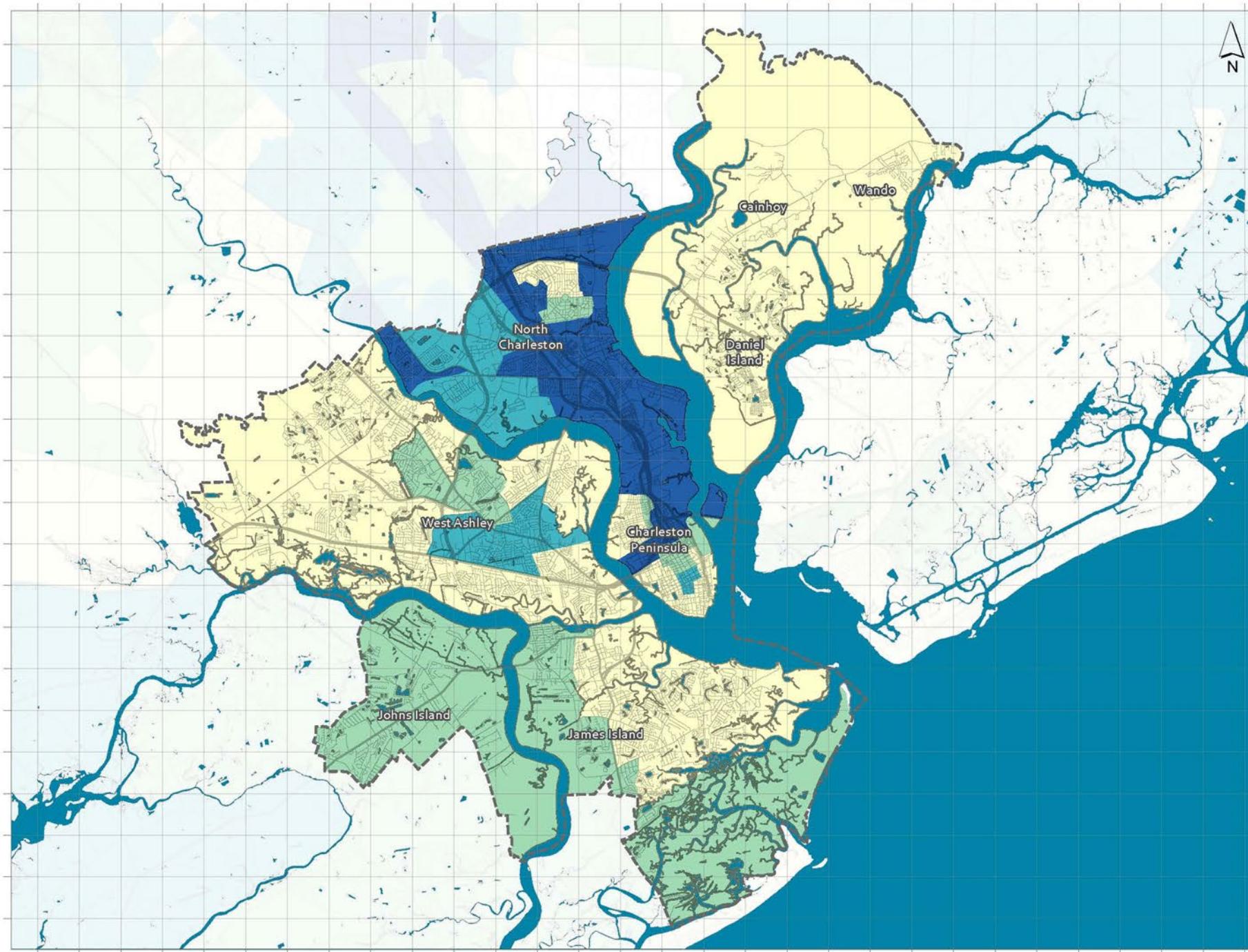
Centers for Disease Control and Prevention/ Agency for Toxic Substances and Disease Registry/ Geospatial Research, Analysis, and Services Program. CDC Social Vulnerability Index 2018 Database US. https://www.atsdr.cdc.gov/placeandhealth/svi/data_documentation_download.html. Accessed 04/2021

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LANDCOVER & NEIGHBORHOOD DATA

City of Charleston GIS



Charleston Area Heat Watch Context

Median Household Income

Grid - 1 Square Mile

 CHS HeatWatch Study Area

ACS Median Household Income Variables (Census Tract)

Median Household Income in past 12 months
(inflation-adjusted dollars to last year of 5-year range)



MEDIAN INCOME DATA

U.S. Census Bureau's American Community Survey (ACS) 2015-2019 5-year estimates, Table(s) B19013B, B19013C, B19013D, B19013E, B19013F, B19013G, B19013H, B19013I, B19049, B19053

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CDC SVI DATA

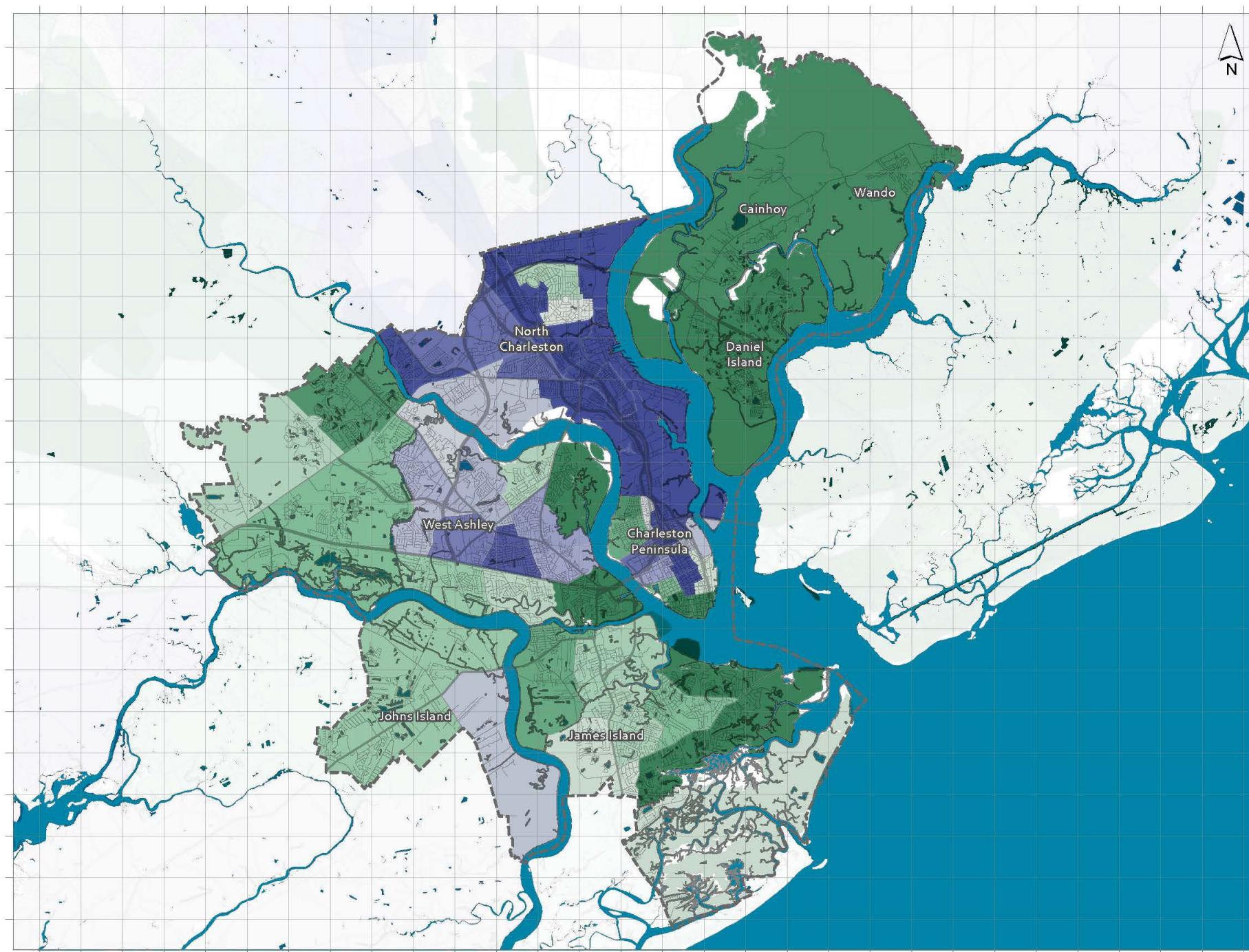
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LANDCOVER & NEIGHBORHOOD DATA

City of Charleston GIS



Charleston Area Heat Watch Context

Educational Attainment

Grid - 1 Square Mile



ACS Educational Attainment Variables

Population 25 or Older Whose Highest Education Completed is Less Than High School (Census Tract)



MEDIAN INCOME DATA

U.S. Census Bureau's American Community Survey (ACS) 2015-2019 5-year estimates, Table(s) B19013B, B19013C, B19013D, B19013E, B19013F, B19013G, B19013H, B19013I, B19049, B19053

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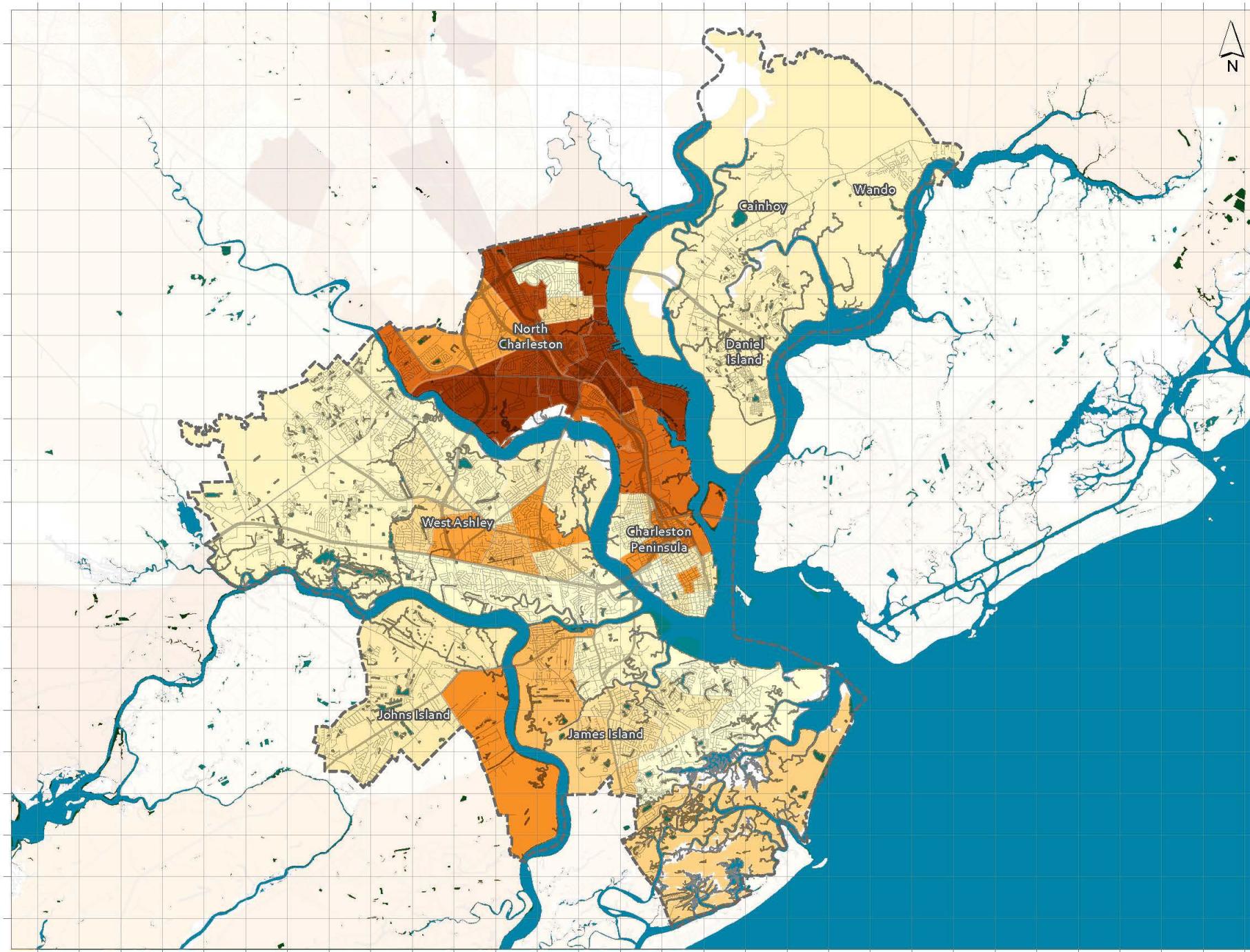
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LANDCOVER & NEIGHBORHOOD DATA

City of Charleston GIS



Charleston Area Heat Watch Context

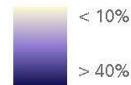
Elderly Population

Grid - 1 Square Mile

 CHS HeatWatch Study Area

ACS Population Variables

Percent of Population that is 65 Years and Over
(Census Tract)



MEDIAN INCOME DATA

U.S. Census Bureau's American Community Survey (ACS) 2015-2019 5-year estimates,
Table(s) B19013B, B19013C, B19013D, B19013E, B19013F, B19013G, B19013H,
B19013I, B19049, B19053

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Table(s) B27010

POPULATION DATA

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Table(s) B01001

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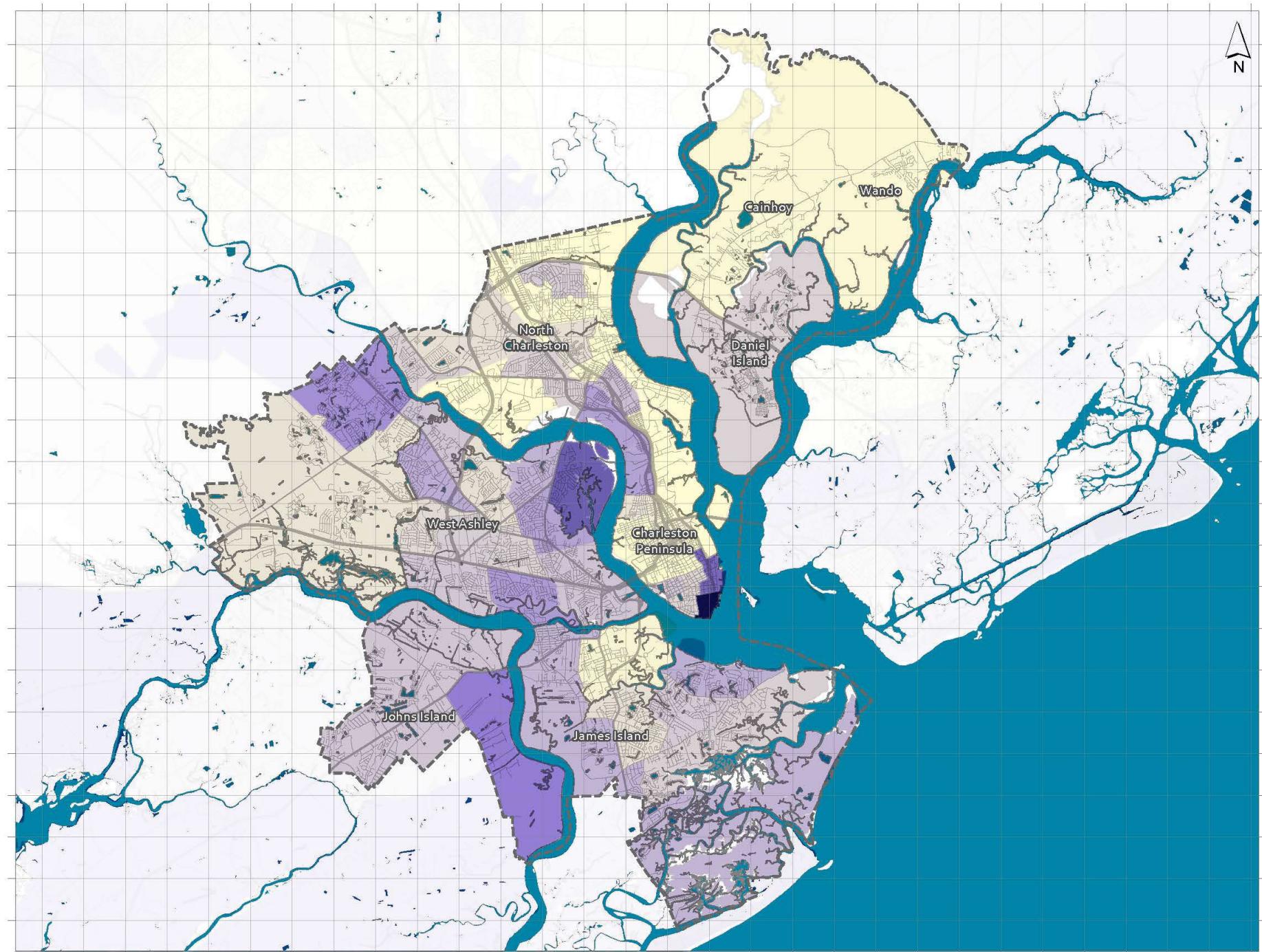
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Registry/ Geospatial Research, Analysis, and Services Program: CDC Social
Vulnerability Index 2018 Database US. https://www.atsdr.cdc.gov/placeandhealth/svi/data_documentation_download.html. Accessed 04/2021

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(USALEEP): Life Expectancy Estimates File for (Jurisdiction), 2010-2015]. National
Center for Health Statistics. 2018. Available from: <https://www.cdc.gov/nchs/nvss/usaleep/usleep.html>.

LANDCOVER & NEIGHBORHOOD DATA

City of Charleston GIS



Charleston Area Heat Watch Context

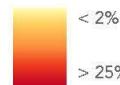
Health Insurance Coverage

Grid - 1 Square Mile

 CHS HeatWatch Study Area

ACS Health Insurance Coverage Variables

Percent of Population with No Health Insurance Coverage (Census Tract)



MEDIAN INCOME DATA

U.S. Census Bureau's American Community Survey (ACS) 2015-2019 5-year estimates, Table(s) B19013B, B19013C, B19013D, B19013E, B19013F, B19013G, B19013H, B19013I, B19049, B19053

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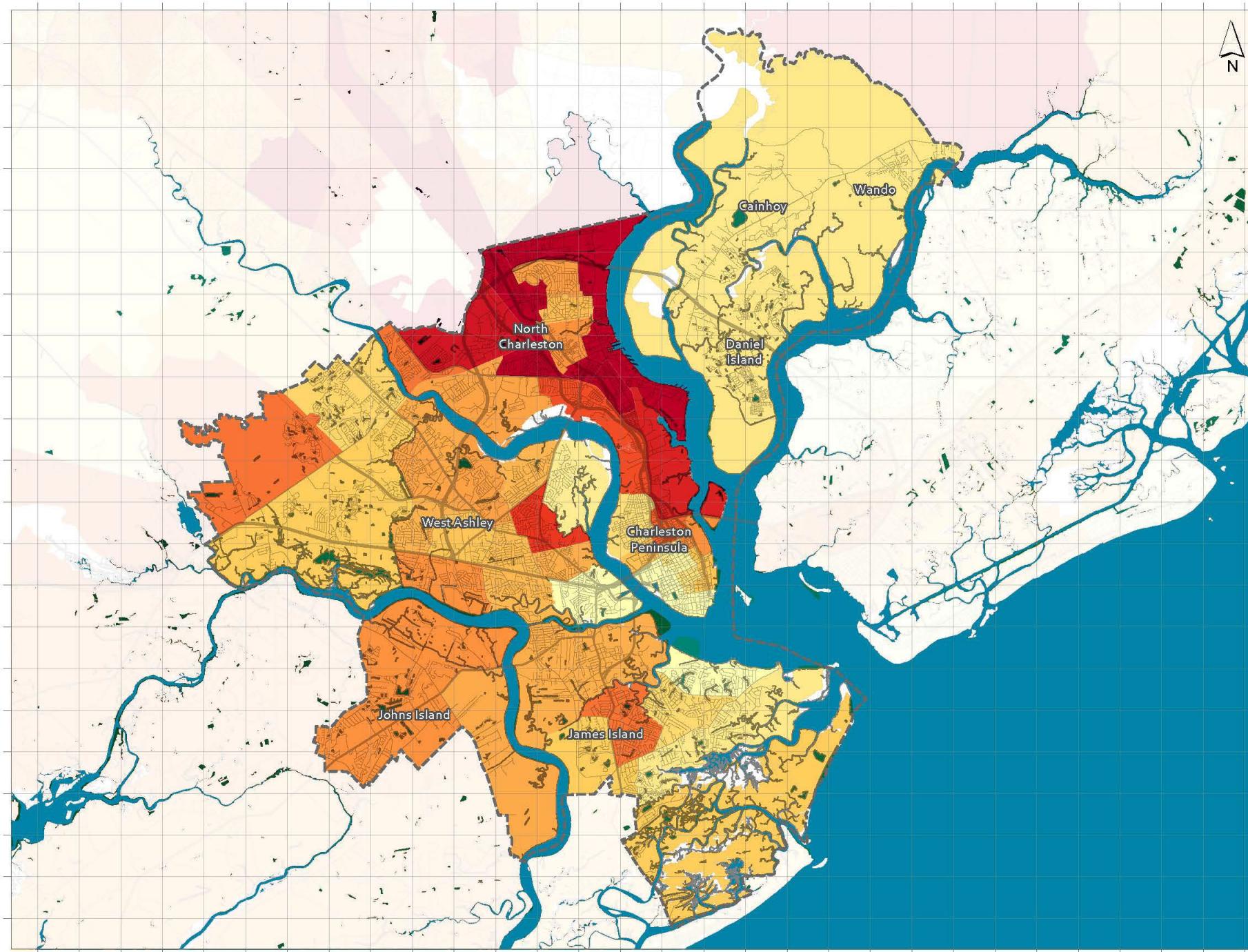
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LANDCOVER & NEIGHBORHOOD DATA

City of Charleston GIS



Charleston Area Heat Watch Context

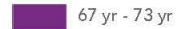
Life Expectancy at Birth

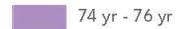
Grid - 1 Square Mile

 CHS HeatWatch Study Area

CHS Life Expectancy at Birth

CDC Life Expectancy (census tract)

 67 yr - 73 yr

 74 yr - 76 yr

 77 yr - 79 yr

 80 yr - 81 yr

 82 yr - 86 yr

 no data

MEDIAN INCOME DATA

U.S. Census Bureau's American Community Survey (ACS) 2015-2019 5-year estimates, Table(s) B19013B, B19013C, B19013D, B19013E, B19013F, B19013G, B19013H, B19013I, B19049, B19053

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EDUCATION DATA

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CDC SVI DATA

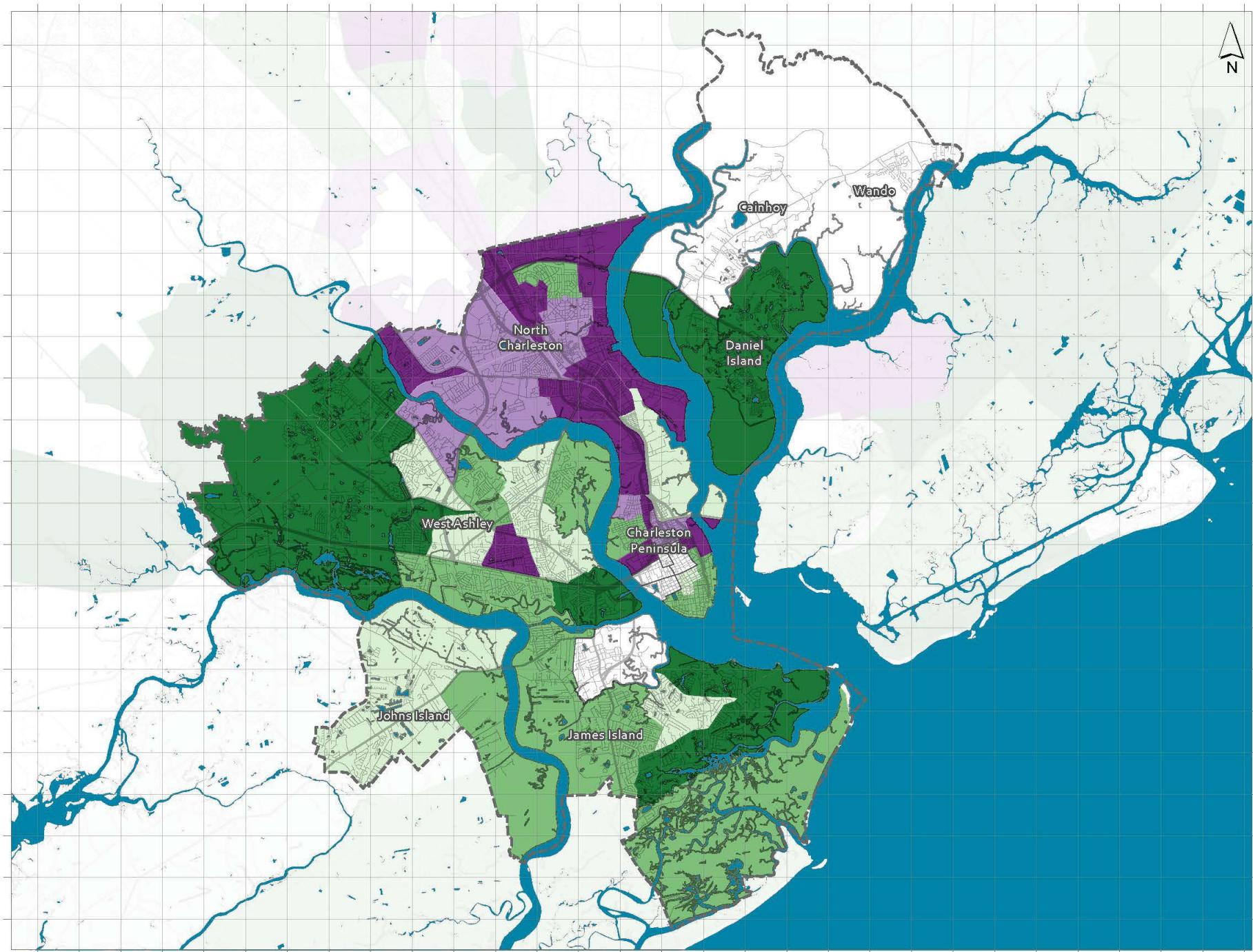
Centers for Disease Control and Prevention/ Agency for Toxic Substances and Disease Registry/ Geospatial Research, Analysis, and Services Program. CDC Social Vulnerability Index 2013 Database US. https://www.atsdr.cdc.gov/placeandhealth/swi/data_documentation_download.html. Accessed 04/2021

LIFE EXPECTANCY DATA

National Center for Health Statistics. U.S. Small-Area Life Expectancy Estimates Project (USALEEP): Life Expectancy Estimates File for [Jurisdiction], 2010-2015]. National Center for Health Statistics. 2018. Available from: <https://www.cdc.gov/nchs/nvss/usaleep/usaleep.html>.

LANDCOVER & NEIGHBORHOOD DATA

City of Charleston GIS



PUBLIC SURVEY

The survey is comprised of a total of 20 multiple choice and short answer questions. These questions pertain to the following:

1. Natural Hazards
2. Man-made hazards
3. Vulnerable populations
4. Self-Employed Mitigation Initiatives
5. Interest in Additional Mitigation Strategies
6. Existing Knowledge/Information Concerning Mitigation and Emergency Preparedness
7. Prioritization/Effectiveness Mitigation Strategy Types
8. Problem Areas Within the Community

PUBLIC SURVEY, cont.

183 Responses Collected

The survey was made available in February of 2023 and is still open. It was promoted through municipal media sites and shared through email groups.

PUBLIC SURVEY, cont.

78% response rate from those that own property and reside within city limits

12.6% response rate from those that live outside the city limits but in a neighboring community in Charleston County

Most disaster experienced responses:

- **Hurricane**
- **Flooding**
- **Extreme Heat**

PUBLIC SURVEY, cont.

Largest concern – Hurricane and Tropical Storm
(21.1%)

Second largest concern – Flooding (19.4%)

Internet (46.5%) is the most effective way to receive information, mail (36.6%) is the second most effective way

- Email and Utility Bill inserts were also suggested

PUBLIC SURVEY

83.5% showed interest in making their homes/neighborhoods more resistant to hazards

84.1% of responses said they do **NOT** know what office to contact regarding risk reduction

Examples of actions to make home/neighborhood more resilient to disasters:

- Tree Trimming, tree removal
- Landscape/vegetative improvements
- Debris removal/clearing of drains in neighborhoods

PUBLIC SURVEY

Major concerns shared regarding natural and man-made hazards:

- Rapid growth and development
- Uncertainty/preparedness of an earthquake
- Infrastructure failure (water, power, communication, etc.)
- Timely evacuation (due to traffic, congestion/population/lack of routes)
- Socially Vulnerable Populations (low-mid income and elderly)
- Aging infrastructure
- Climate Change/Sea Level Rise
- Rising temperatures/extreme heat events

PUBLIC SURVEY, cont.

What are some steps your local government could take to reduce or eliminate the risk of future hazards damages?

“Increase preservation of marshes and wetlands.”

“Follow recommendations from the Dutch Dialogues”

“Accelerate drainage projects and wall planning/construction,”

“Bury utility lines underground.”

“Complete Calhoun Stormwater Mitigation Project.”

PUBLIC SURVEY, cont.

Community's response to important mitigation techniques:

1. Prevention – 86.3%
2. Natural Resource Protection – 81.3%
3. Emergency Services – 77%
4. Structural Projects – 70.9%
5. Property Protection – 53.3%
6. Public Education and Awareness – 52.5%

CAPABILITY ASSESSMENT*

Measures community capability to implement hazard mitigation activities

Identifies and target gaps, conflicts and opportunities with existing local plans, programs, policies, etc.

Identifies mitigation measures already in place or underway

- *Coupled with the Risk Assessment, the Capability Assessment helps to form the foundation for identifying Mitigation Actions*

CAPABILITY INDICATORS

National Flood Insurance Program (NFIP) Participation

Community Rating System (CRS) Participation

Building Code Effectiveness Grading Schedule

Local Capability Assessment:

- Inventory and evaluation of existing plans, policies, programs, and ordinances
- Measure administrative, technical, fiscal and political capability

CAPABILITY ASSESSMENT

Plan Policy, Program, or Ordinance

- Hazard Mitigation Plan
- Disaster Recovery Plan
- Comprehensive Land Use Plan
- Floodplain Management Plan
- Stormwater Management Plan
- Emergency Operations Plan
- Continuity of Operations Plan
- Capital Improvements Plan
- Historic Preservation Plan
- Zoning Ordinance
- Subdivision Ordinance
- Flood Damage Prevention Ordinance
- Post-Disaster Redevelopment Plan
- Building Code
- Fire Code

CAPABILITY ASSESSMENT

PLANNING AND REGULATORY CAPABILITY

- The City has HIGH Planning and Regulatory Capability

ADMINISTRATIVE AND TECHNICAL CAPABILITY

- The City has HIGH Administrative and Technical Capability
- Has staff skilled in GIS
- Has an Emergency Manager and Floodplain Manager

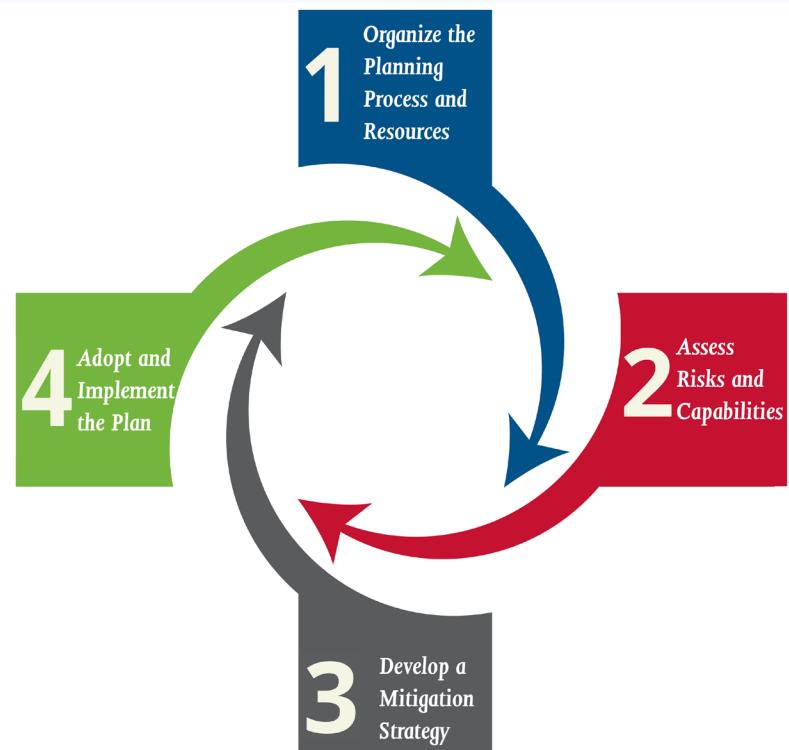
FISCAL CAPABILITY

- The City falls within the HIGH range
- The City has partnering arrangements or intergovernmental agreements

CONCLUSIONS ON CAPABILITY

	Low Vulnerability	Moderate Vulnerability	High Vulnerability
High Capability	(Best Case Scenario)		City of Charleston
Moderate Capability			
Low Capability			(Worst Case Scenario)

MITIGATION STRATEGY DEVELOPMENT



Third phase of the mitigation planning process

- The state, local, tribe or territory government sets priorities
- Long-term strategies are developed to avoid or minimize the undesired effects of disasters
- The strategy includes a description of how the mitigation actions will be implemented/administered

EVERY \$1 SPENT ON MITIGATION



SAVES \$6 ON FUTURE RECOVERY



THINK OF MITIGATION IN THIS WAY

- 1) We want to mitigate hazard impacts on the existing development in Charleston
 - Houses, businesses, infrastructure, critical facilities, etc.
- 2) We want to ensure that future development is conducted in a way that doesn't increase our vulnerability
 - Best done by having good plans, policies, and procedures in place

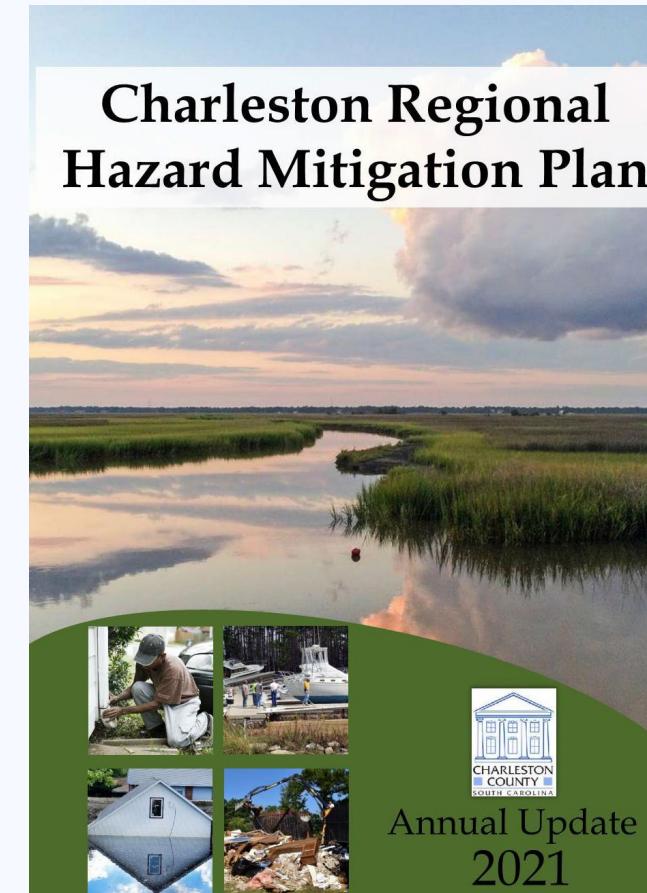
MITIGATION TECHNIQUES

Prevention	Property Protection	Natural Resource Protection	Structural Projects	Emergency Services	Public Education/Awareness
Planning and zoning	Acquisition	Floodplain Protection	Reservoirs	Warning systems	Outreach projects
Building codes	Relocation	Watershed management	Dams, levees, dikes	Emergency response equipment	Speaker series/ demonstration events
Open space preservation	Building elevation	Riparian buffers	Floodwalls	Shelter Operations	Hazard map information
Floodplain regulations	Critical facilities protection	Forest management	Stormwater diversions	Evacuation planning and management	Real estate disclosure
Stormwater management regulations	Retrofitting	Erosion and sediment control	Detention/retention basins	Emergency response training and exercises	Library materials
Drainage system maintenance	Safe rooms, shutters, shatter-resistant glass	Wetland preservation and restoration	Channel modification	Sandbagging for flood protection	School children educational programs
Capital improvements programming	Insurance	Habitat preservation	Storm sewers	Temporary shutters	Hazard expositions
Setbacks					

MITIGATION STRATEGY

Review Regional Goals (Charleston Regional HMP 2019)

- Reduce potential flood damage
- Improve storm drainage
- Minimize future flood occurrence
- Minimize future hurricane damage
- Improve resistance of infrastructure to all hazards
- Minimize future earthquake damage
- Protect environmental resources/preserve open and green space
- Minimize future terrorist incidents
- Improve water quality
- Preserve historic building inventory
- Higher regulatory standard
- Minimize future hazardous material incident



MITIGATION STRATEGY

Update Existing Mitigation Actions

- Provide status update for existing mitigation actions (completed, deleted, deferred)

MITIGATION ACTION PLAN

Action	Description	Lead Agency	Potential Funding Service	Goal Addressed	Priority	Status
Type	Activity	Lead Dept.	Funding Source	Goal(s) Addressed	Priority (1 highest, 4 lowest)	Status
PI	Continue participating in the Project Impact Outreach Program for Public Information (PPI) to achieve maximum public outreach.	Building Services/ Project Impact committee members	Operating Funds	Establishing cooperative relationships between public, private and non-profit sectors to enhance preparedness and recovery for hazard events; educating citizens regarding their vulnerability to natural hazards and steps to take to reduce vulnerability	1	Basic emergency preparedness messages were communicated via our On-Hold Messages, Customer Newsletters, and our public Website throughout the period.

MITIGATION STRATEGY

Group Activity: Identification of New Actions

- Identify and discuss a full range of possible mitigation projects/available mitigation techniques
 - Consistent with mitigation goals and other community objectives
 - Based on hazard risk and local capability
- Critical facilities that need retrofitting/relocated
- Projects/activities to reduce hazard impacts
- Alleviate repetitive flood losses
- Others?
 - Emergency Services, Prevention, Natural Resource Protection, Property Protection, Structural Projects, Public Education

MITIGATION STRATEGY

- Mitigate Repetitive loss properties
 - Areas located in the AE/VE flood zones are at higher risk
 - 1,893 of repetitive loss properties according to FEMA

MITIGATION STRATEGY

In General...

- **Strengthen and Protect Critical Facilities Educate Public**
 - Seasonal hazard awareness weeks
 - Encourage household preparedness
- **Identify pre-existing structures/rooms for sheltering**
- **Discourage future building in known hazard areas**
 - Flood prone areas are often great for parks
 - Create regulations to prevent development or require more stringent building standards

MITIGATION STRATEGY

Potential Actions to Mitigate Flooding

Local planning and regulatory efforts can be improved by:

- Limiting the percentage of allowable impervious surface within developed parcels
- Adding or increasing "freeboard" requirements (feet above base flood elevation) in the flood damage ordinance

MITIGATION STRATEGY

Potential Actions to Mitigate Flooding

Structures and Infrastructure Projects could be conducted safely by:

- Removing existing structures from flood hazard areas
- Installing, re-routing, or increasing the capacity of a storm-drainage system
- Conducting regular maintenance for drainage systems and flood control substances

Natural Systems can be Protected Through:

- Protecting and preserving wetlands to help prevent flooding in other areas
- Developing an open space acquisition, reuse, and preservation plan targeting hazard areas

MITIGATION STRATEGY

Potential Actions to Mitigate High Wind/Thunderstorm/Tornado

Strengthen building codes

- Tie-down requirements for manufactured housing
- Require structural bracing, straps/clips, anchor bolts, etc.

Protect power lines/traffic signals

- Schedule regular inspections of utility poles to ensure quality
- Mast arms for traffic lights

Retrofit buildings/facilities

- Anchor roof-mounted ventilation and heat/ac units
- Use load path connectors to strengthen structure

Safe Rooms

- Require in new schools, nursing homes
- Encourage construction in shopping malls, fairgrounds, manufactured home parks

MITIGATION STRATEGY



Report out by small groups



Review identified actions for common themes

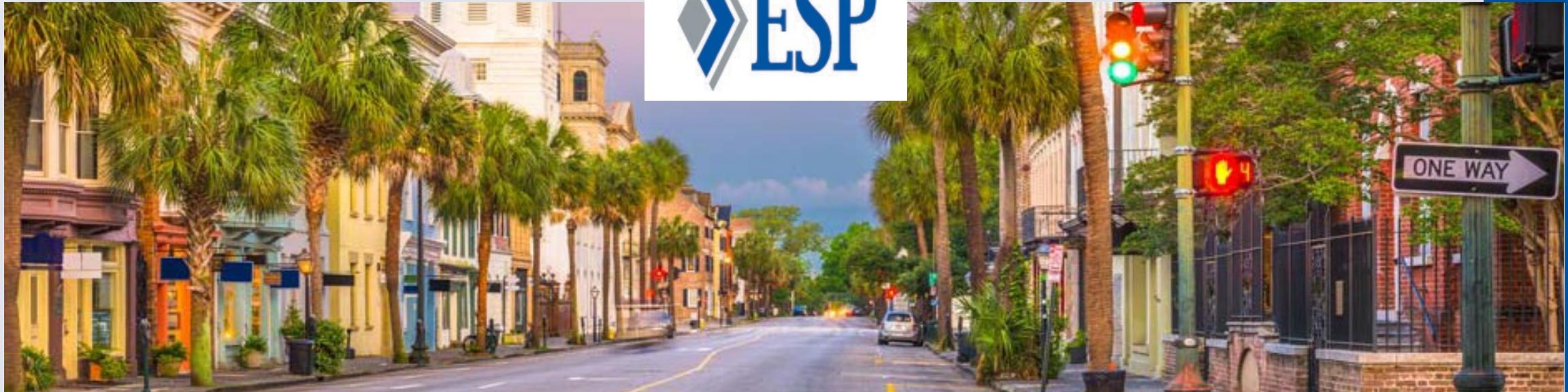
NEXT STEPS

Stay tuned for information about the public survey – we will need your help with getting the word out!

Complete draft of plan to be developed by ESP

- Will eventually be submitted to SCEMD and to FEMA for review/approval

Current Plan Expires DATE



QUESTIONS, ISSUES, OR CONCERNS

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• (919) 415-2726

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Andrew Olive

aolive@espassociates.com

Hannah Delude

hdelude@espassociates.com



HAZARD MITIGATION PLAN

City of Charleston, SC

Stakeholder Workshop
June 14, 2023

AGENDA



- I. Introductions
- II. Project Summary and Status Update
- III. Risk Assessment Findings
 - I. Hazard Identification and Analysis
 - II. Vulnerability Assessment
- IV. Capability Assessment Findings
- V. Mitigation Strategy Development
 - I. Mitigation Card-storming
 - II. Goals, Objectives, and Actions
 - III. Mitigation Action Worksheets
- VI. Next Steps
- VII. Questions, Issues, or Comments

INTRODUCTIONS

1. Project Contractors

- ESP Associates, Inc. - Nathan Slaughter, AICP, CFM – Project Manager
- Fernleaf
- Climate Adaptation Partners
- Janice Barnes

2. Charleston Leads

- Hazard Mitigation Planning Team
- Local Project Coordinator

3. Key Stakeholders

PROJECT PARTNERS



Fernleaf

Involved in the City of Charleston 2020 All Hazards Risk and Vulnerability Assessment

climate adaptation partners
resilience through collaborative partnerships

Climate Adaptation Partners

Charleston Medical District Adaptation Roadmap

Charleston Heat Studies

WHAT IS MITIGATION?



“mit-i-gate”

- 1: to cause to become less harsh or hostile.
- 2: to make less severe or painful.

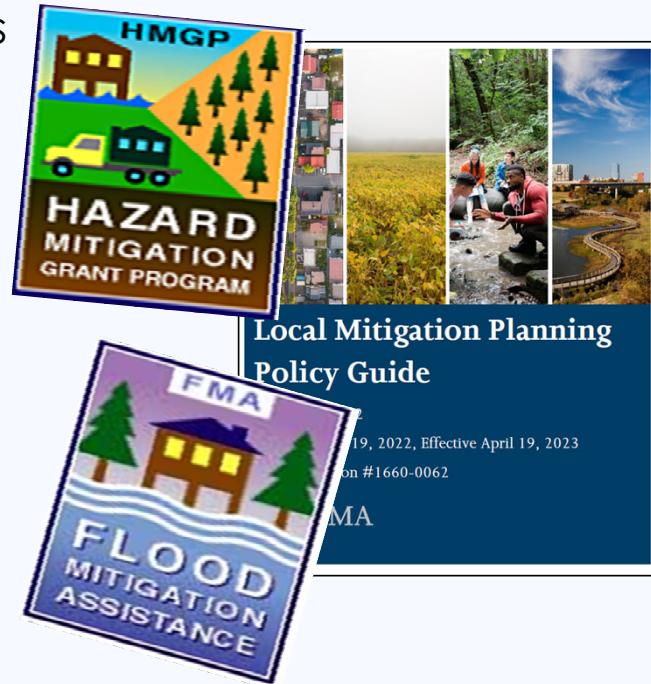


Hazard Mitigation

Any sustained action taken to reduce or eliminate the long-term risk to human life and property from hazards.

DISASTER MITIGATION ACT OF 2000

- Revitalized Federal Planning Requirements
 - State and Local Hazard Mitigation Plans
- Federal Grant Funding Eligibility
 - Hazard Mitigation Grant Program (HMGP)
 - Building Resilient Infrastructure and Communities (BRIC)
 - Flood Mitigation Assistance (FMA)
- DMA 2000 is intended to facilitate cooperation between state and local authorities on risk reduction measures and expedite funding allocation



Key Objectives

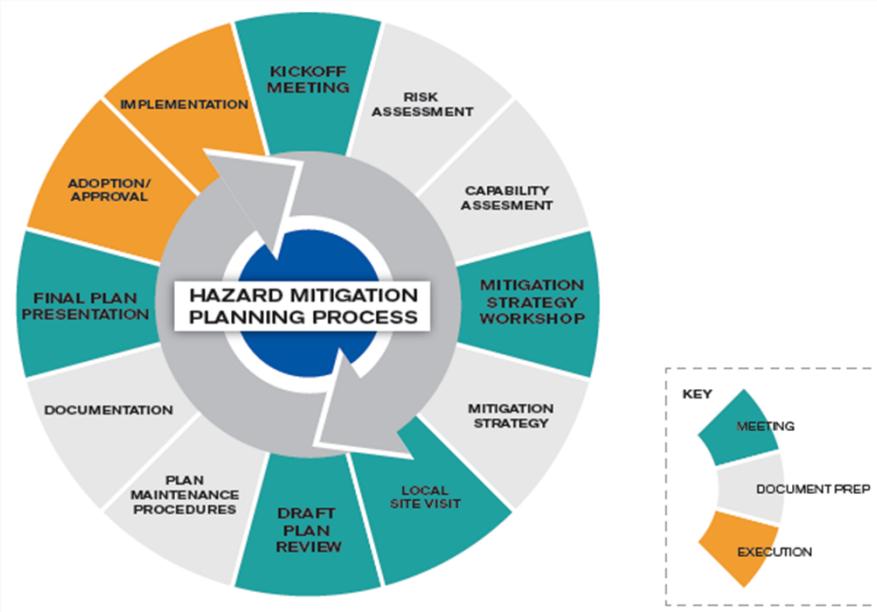
- Develop a Risk Assessment that informs the City's Hazard Mitigation and Resilience planning efforts
- Public awareness and education
- Compliance with State and Federal requirements
- Grant eligibility for the City

TENTATIVE PROJECT SCHEDULE

Project Tasks	Month							
	1	2	3	4	5	6	7	8
Notice to Proceed	✓							
Planning Process								
Risk Assessment								
Capability Assessment								
Mitigation Strategy								
Plan Maintenance Procedures								
Documentation								
Meetings	1	2	3	4	5	6	7	8
Kickoff Meeting	✓							
Hazard Mitigation Planning Team Meetings		✓			✓			✓
Open Public Meetings		✓						✓
Milestones	1	2	3	4	5	6	7	8
Submission of Draft Risk Assessment to Planning Team					✓			
Submission of Draft Risk Assessment to SCEMD					✓			
Submission of Draft Plan to Planning Team						✓		
Submission of Draft Plan to SCEMD/FEMA						✓		
Completion of Final Plan/Conditional FEMA Approval							✓	
Local Adoption of Final Plan								✓
Submission of Final Plan to SCEMD/FEMA								

PROJECT TASKS

1. Planning Process
2. Risk Assessment
3. Capability Assessment
4. Mitigation Strategy
5. Plan Maintenance
6. Documentation



RISK ASSESSMENT

Hazard Identification and Analysis (parallel efforts with Lowcountry Healthcare Coalition)

- Detailed Hazard Profile
 - Hazard Description
 - Historical Occurrences
 - Known Hazard Boundaries

Vulnerability Assessment

- Asset Inventory (exposure)
- Loss Estimates

Development Trends and Implications

GIS Data Inventory

RESULTS

Risk Assessment Findings

- Hazard Identification
- Hazard Profiles
- Hazard Vulnerability Assessment

ALIGNING EFFORTS

Previous plans that relate and reference the City of Charleston include:

- South Carolina Hazard Mitigation Plan (2018)
- The Charleston Regional Hazard Mitigation Plan
- Lowcountry Healthcare Preparedness Coalition – Hazard Vulnerability Assessment
- Charleston SLR Strategy
- Charleston Sustainability Action Plan
- Charleston Heat Study
- Charleston Climate Action Plan – GHG Mitigation
- Charleston All Hazards Vulnerability Assessment

Plans are a good place to start, but are broad in scope

- City's Hazard Mitigation Plan aims to identify and address hazards/impacts **specifically nuanced** for the City of Charleston's needs

PLANNING ASSUMPTIONS

WE UTILIZED BEST AVAILABLE DATA

- We use information from the National Centers for Environmental Information
- Useful, but events are often under-reported

KEEP THE END GOAL IN SIGHT

- The risk assessment's purpose is to compare hazards and determine which should be the focus of your mitigation actions
- The detailed numbers are informative, but remember the big picture

THIS IS YOUR RISK ASSESSMENT

- The data we provide is beneficial, but YOU live here!

HAZARD IDENTIFICATION

There are a variety of natural and manmade hazards that will receive consideration in the City's Hazard Mitigation Plan based on historical occurrence and future projections.

Natural

- Hurricane
- Flooding
- Sea Level Rise
- Earthquake
- Tornado
- Wildfires
- Tsunamis
- Dam Failure
- Droughts
- Severe Storm

Technological

- Severe Winter Weather
- Shoreline Erosion
- Public Health Hazards
- Floodplain Inundation
- Storm Surge
- Tidal Flooding

Human-caused

- Hazardous Materials Release
- Infrastructure Failure
- Radiological Emergency
- Cyber Incidents
- Civil Disturbance
- Terrorism
- Active Threat
- Water Shortage

LCHCC HAZARD IDENTIFICATION



LCHCC evaluates the relationship between hazard-vulnerability assessments (HVAs) conducted within individual healthcare facilities and risk to the healthcare delivery chain

Natural

- Tropical Cyclones/Hurricanes/ Tropical Weather
- Flooding
- Tornado
- Severe Inclement Weather
- Infectious Disease
- Earthquake
- Temperature Extremes

Man-Made/Intentional

- Active assailants
- Cyber-attacks / PHI Breach
- Weapons
- Infant Abduction
- HAZMAT Leaks
- Train Derailment
- Civil Unrest
- Terrorism/WMD (CBRNE)
- Labor Shortage
- Supply Chain
- Forensic Admission
- Surge

Technological

- Transportation Accidents (Motor Vehicle)
- Aircraft Crashes
- HAZMAT Incidents
- Communications failure
- Utility failure
- Water disruption
- Unintentional Fire
- IT System Outage
- HVAC Failure
- Mass Causality

DISASTER DECLARATIONS

- Hurricane Hugo (1989)
- Hurricane Floyd (1999)
- Winter Storms (2000)
- Tropical Storm Gaston (2004)
- Severe Storms and Flooding (2015)
- Hurricane Matthew (2016)
- Hurricane Irma (2017)
- Hurricane Florence (2018)
- Hurricane Dorian (2019)
- COVID-19 Pandemic (2020)
- Hurricane Ian (2022)



Hurricane Hugo – 33 Years Later (Reflections in Pictures and Videos)
Source: <https://charlestondaily.net/hurricane-hugo-30-years-later-pictorial-recollection/>

RANKING HAZARDS

- Used a scoring tool called the Priority Risk Index (PRI)
- Looks at the following criteria per hazard
 - Probability
 - Impact
 - Spatial Extent
 - Warning Time
 - Duration of Impacts

PRI Category	Degree of Risk			Assigned Weighting Factor
	Level	Criteria	Index Value	
Probability	Unlikely	Less than 1% annual probability	1	30%
	Possible	Between 1 and 10% annual probability	2	
	Likely	Between 10 and 100% annual probability	3	
	Highly Likely	100% annual probability	4	
Impact	Minor	Very few injuries, if any. Only minor property damage and 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 more than one day.	2	
	Critical	Multiple deaths/injuries possible. More than 25% of property in affected area damaged or destroyed. Complete shutdown of critical facilities for more than one 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 for 30 days or more.	4	

PRI EXPLAINED

PRI Category	Degree of Risk			Assigned Weighting Factor
	Level	Criteria	Index Value	
Probability	Unlikely	Less than 1% annual probability	1	30%
	Possible	Between 1 and 10% annual probability	2	
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PRI EXPLAINED, Continued

PRI Category	Degree of Risk			Assigned Weighting Factor
	Level	Criteria	Index Value	
Spatial Extent	Negligible	Less than 1% of area affected	1	20%
	Small	Between 1 and 10% of area affected	2	
	Moderate	Between 10 and 50% of area affected	3	
	Large	Between 50 and 100% of area affected	4	
Warning Time	More than 24 hours	Self explanatory	1	10%
	12 to 24 hours	Self explanatory	2	
	6 to 12 hours	Self explanatory	3	
	Less than 6 hours	Self explanatory	4	
Duration	Less than 6 hours	Self explanatory	1	10%
	Less than 24 hours	Self explanatory	2	
	Less than one week	Self explanatory	3	
	More than one week	Self explanatory	4	

HURRICANE

43 hurricanes or tropical storms have come within 50 miles of the city since 1970

- 13 Tropical Depressions
- 22 Tropical Storms
- 8 Hurricanes

Disaster Declarations

- Hurricane Hugo (1989)
- Hurricane Floyd (1999)
- Tropical Storm Gaston (2004)
- Hurricane Matthew (2017)
- Hurricane Irma (2017)
- Hurricane Florence (2018)
- Hurricane Dorian (2019)
- Hurricane Ian (2022)

Future occurrences are *likely*



ABC4 News on Hurricane Ian

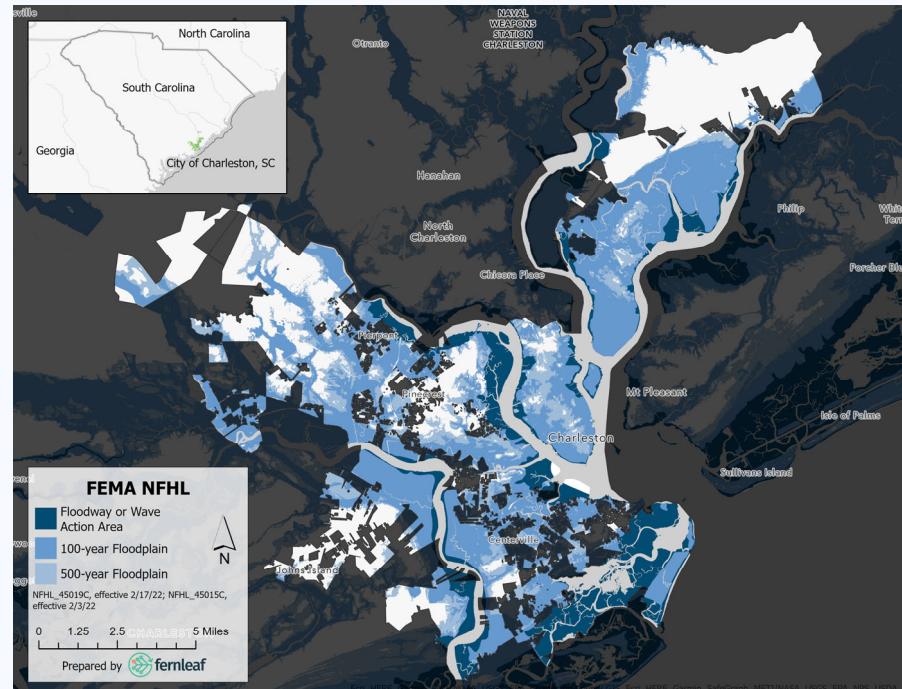
[Source: Hurricane Ian makes landfall in South Carolina as Category 1 hurricane | WCIV \(abcnews4.com\)](https://www.wciv.com/hurricane-ian-makes-landfall-in-south-carolina-as-category-1-hurricane/)

FLOODING

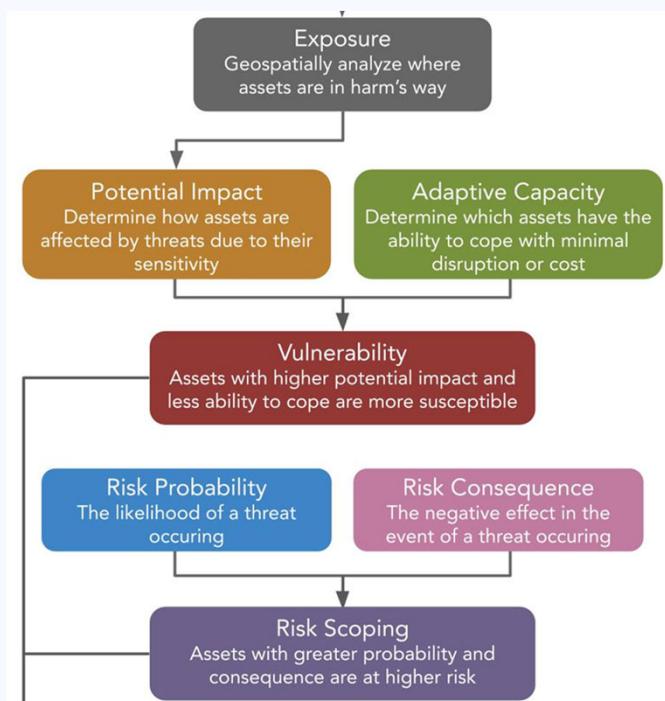
NFIP Losses

- 25,985 policies in place (2022)
- Over \$7,103,269 in coverage
- Over 6,649 claims and over \$117,737,550 claims paid

Future occurrences are *likely*



FLOODING VULNERABILITY, Continued



Flood Vulnerability & Risk Assessment Components

Exposure

An asset *must* be exposed to be vulnerable or at risk

Vulnerability

Susceptibility based on sensitivity/potential impact and adaptive capacity

Risk Scoping

The probability and negative consequence of threats

FLOODING VULNERABILITY, Continued

Community Asset	Asset Total	Floodplain Inundation (Medium-High Combined Vulnerability & Risk)
Commercial	3,368	3,380 (71%)
Residential	61,781	43,119 (70%)
Critical Facilities	347	210 (61%)
Government-Owned	144	104 (72%)
Parks and Cultural	659	406 (62%)
Historic	3,562	3,372 (95%)

FLOODING VULNERABILITY, Continued

Community Asset	Asset Total	Floodplain Inundation (Medium-High Combined Vulnerability & Risk)
Major Roads Inaccessible (lane miles)	596	250 (42%) [100-yr]
Minor Roads Inaccessible (lane miles)	3,007	1,775 (59%) [100-yr]
Inaccessible Property	69,153	41,346 (60%) [100-yr]
Public Housing	103	93 (90%)

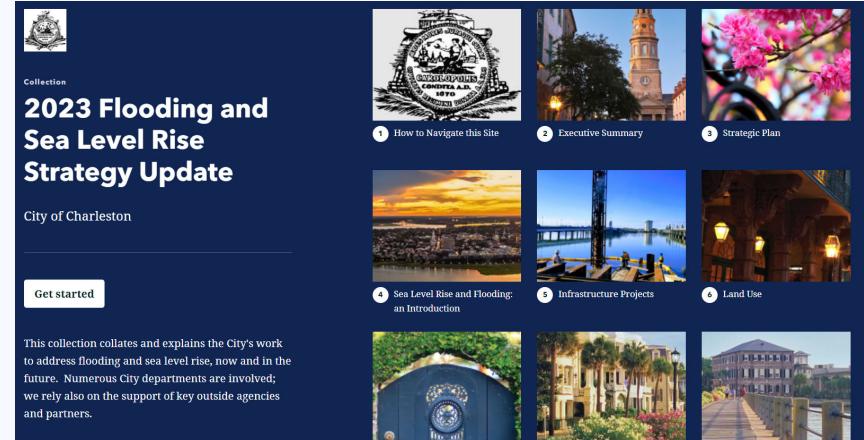
FLOODING VULNERABILITY, Continued

- **48%** of all critical facilities and **90%** of all government owned properties with high combined vulnerability and risk are located in the **Downtown/Peninsula area**
- **80%** of the city's annual sales volume and jobs/employees have high combined vulnerability and risk
- In all census areas with at least 70% of the homes vulnerable and at risk, **6** of these areas have the **highest overall social vulnerability in the city**
- Major Roads within the **West Ashley (Inner and Outer)**, and the Downtown Peninsula areas are **most vulnerable** to becoming **isolated** or **inaccessible** due to flooding

SEA LEVEL RISE

NOAA estimating 14 inches of sea level rise for Charleston by 2050.

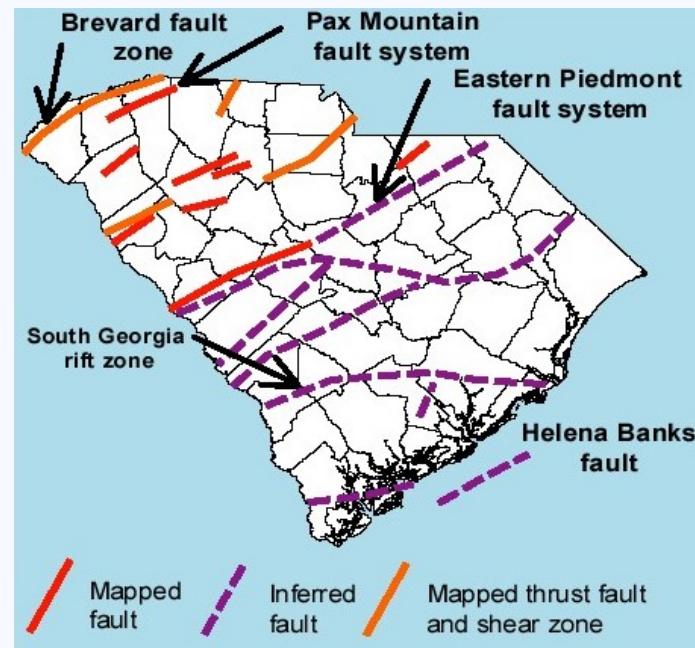
City has a Flooding and Sea Level Rise Strategy



EARTHQUAKE

Charleston Earthquake of 1886 is the most significant historical event on record with an estimated magnitude of 7.3 and more than 300 aftershocks

Future occurrences are possible



SCDNR Mapped Faults & Related Geologic Structures and Inferred Faults
Source: Earthquake Information- SCDNR

TORNADO

NCEI recorded 62 events from 1957 – 2022 for Charleston County

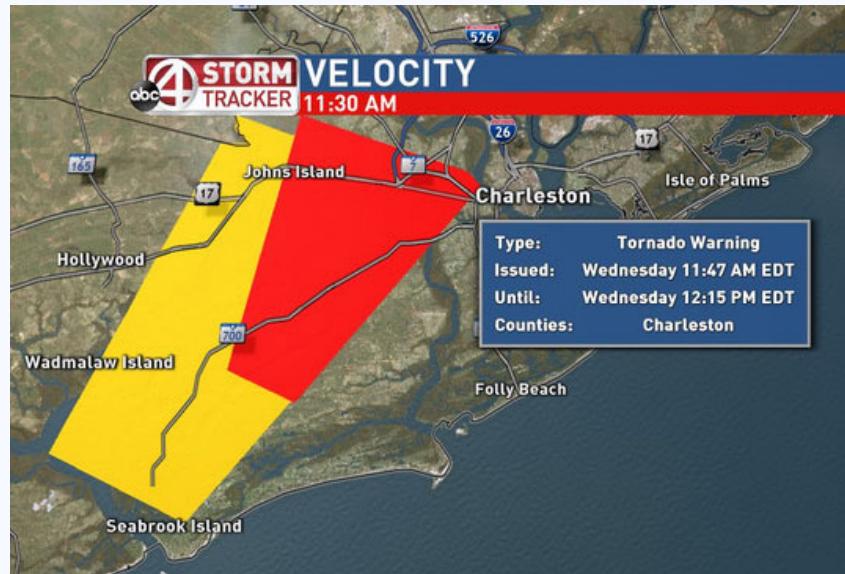
- 3 specific to City of Charleston
- \$4,452 in property damage in the City of Charleston

Greatest extent was an F3 in 1960

Uniform exposure across the city

Future occurrences are *likely*

Hurricanes are the largest threat to the city, which can also produce tornadoes



ABC4 News on Tornado Warning for Johns Island in May 2020

Source: [Tornado warning for Johns Island expired as severe thunderstorm passes through Lowcountry | WCIV \(abcnews4.com\)](https://www.wciv.com/news/tornado-warning-for-johns-island-expired-as-severe-thunderstorm-passes-through-lowcountry)

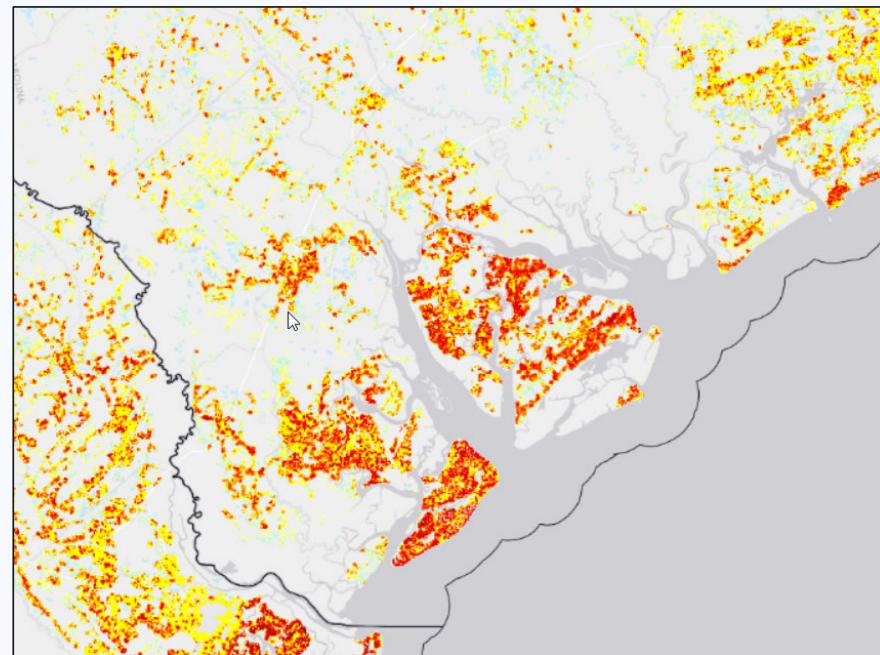
WILDFIRES

Wildland Urban Interface (WUI) Risk Index

- Rating of potential impact of wildfire on people and their property
- Relatively moderate throughout the City

Future occurrences are *likely*

Wildfire vs. Conflagration



WUI Risk Areas - SGSF Wildfire Risk Assessment Portal

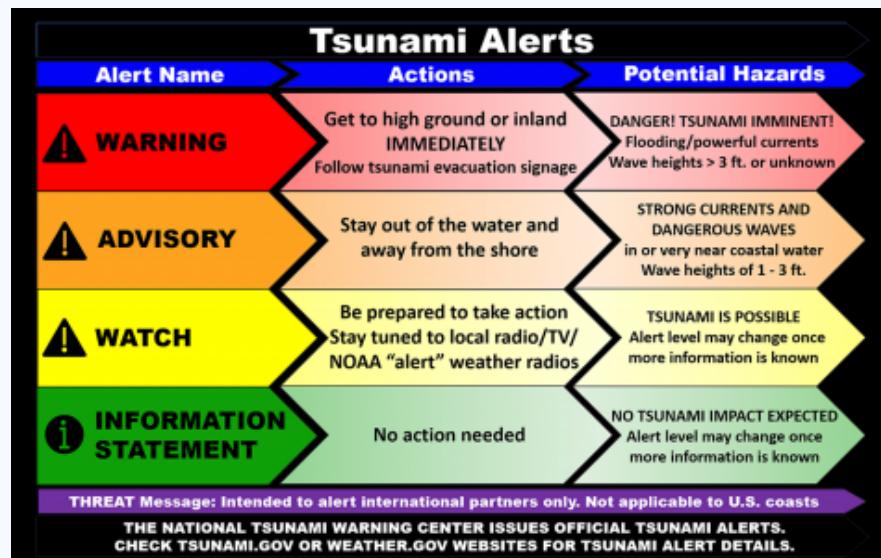
TSUNAMIS

All low-lying coastal areas **can** be impacted by a tsunami

1 event reported in City of Charleston – which is tied to the August 31, 1886 earthquake

USGS and Department of the Interior rated the **entire** Eastern coastline as having a “very low to low” probability of a tsunami event in a 500-year timeframe

Future occurrences are *unlikely*



Source: <https://www.tsunami.noaa.gov/pmel-theme/forecast-warning>

DAM FAILURE

Dam Failure Hazard Potential Classification	
Classification	Hazard Potential
High Hazard (Class I)	Dams located where failure will likely cause loss of life or serious damage to homes, industrial and commercial facilities, important public utilities, main highway(s) or railroads.
Significant Hazard (Class II)	Dams located where failure will not likely cause loss of life but may damage homes, industrial and commercial facilities, secondary highway(s) or railroads or cause interruption of use or service of relatively important public utilities.
Low Hazard (Class III)	Dams located where failure may cause minimal property damage to others. Loss of life is not expected.

Source: South Carolina Department of Health & Environmental Control

To date, there has not been any major historical event

There are no high hazard dams reported in the City of Charleston (SC Department of Health and Environmental Control) – however nearby dams could cause issues for the City – Pinopolis - Tail Race Canal, Bushy Park/Goose Creek area

Future occurrences are *unlikely*

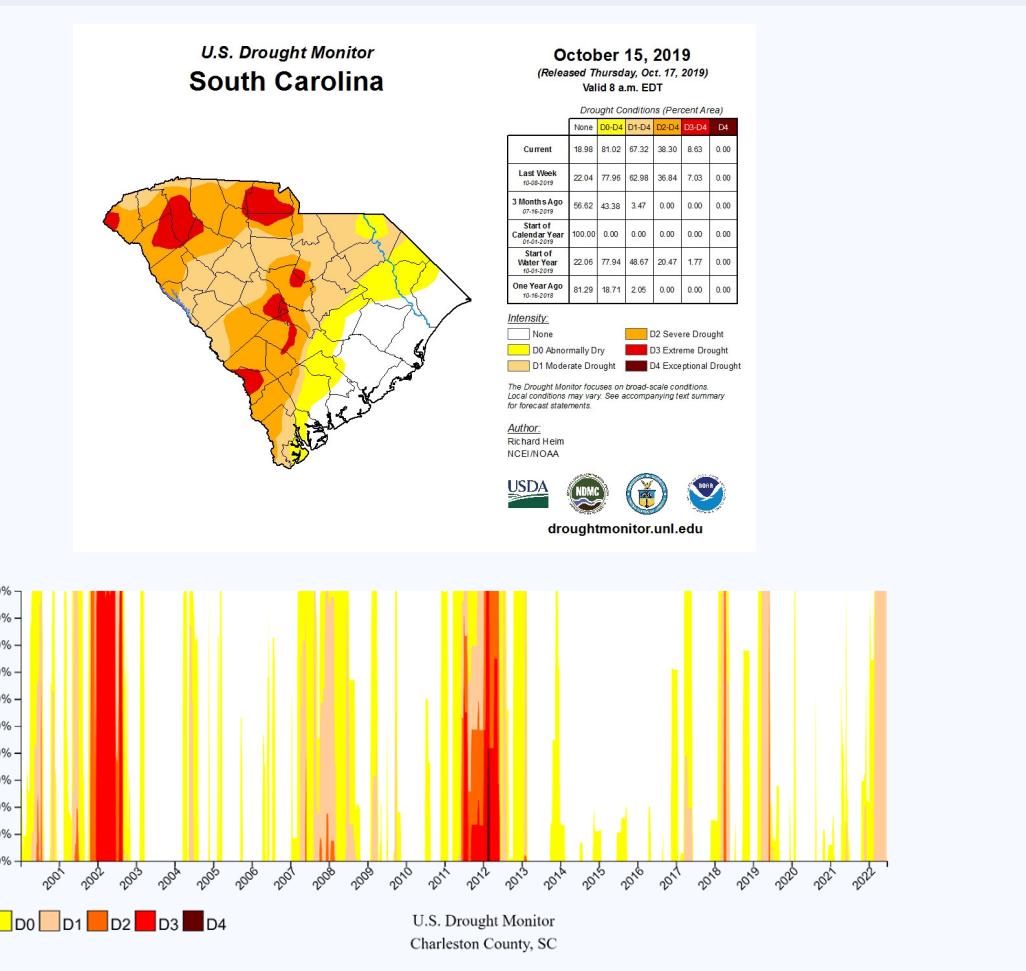
DROUGHT

20 records of drought in the NCEI database for Charleston County (1996 to 2022)

- Status recorded weekly for each county
- All events were regional (multiple counties affected)

Losses are difficult to track

Future occurrences are *likely*



SEVERE STORM

Understanding Severe Thunderstorm Outlook Categories						
LEVEL	CATEGORY	DETAILS	SUMMARY	How many severe storms are possible?	How bad could the worst storms be?	DEFINITIONS
	General Thunderstorm	Although severe weather is not expected, <i>all</i> thunderstorms can produce deadly lightning, gusty winds, and small hail.	No severe thunderstorms expected	None	Numerous	Similar to storms your area experiences many times per year
1	Marginal (MRGL)	Some storms could be capable of damaging winds and severe hail. Localized tornado threat could develop.	Isolated severe storms possible	None	Numerous	Any storm that contains at least one of the following: Wind gusts of at least 58 mph
2	Slight (SLGT)	Increased confidence that some storms will contain damaging winds, severe hail, and/or tornado potential. <i>A few severe storms could be significant</i>	Isolated to scattered severe storms expected	None	Numerous	Hail at least one inch in diameter Tornado
3	Enhanced (ENH)	High confidence that several storms will contain damaging winds, severe hail, and/or tornadoes. <i>Several severe storms could be significant</i>	Scattered to numerous severe storms expected	None	Numerous	Similar to intense storms your area may only experience once or twice per year
4	Moderate (MDT)	High confidence that many storms will contain damaging winds, severe hail, and/or tornadoes. <i>Several severe storms likely to be significant</i>	Scattered to numerous severe storms expected	None	Numerous	Similar to intense storms your area may only experience once per year or less
5	High (HIGH)	High confidence that an outbreak of storms will contain tornadoes, damaging winds, and/or severe hail. <i>Tornado outbreak and/or widespread damaging winds</i>	Numerous severe storms expected	None	Numerous	Very intense storms your area may only experience once or twice in a lifetime Tornado of at least EF-2 rating

spc.noaa.gov | weather.gov

NCEI reported 78 thunderstorm events in Charleston since 1993

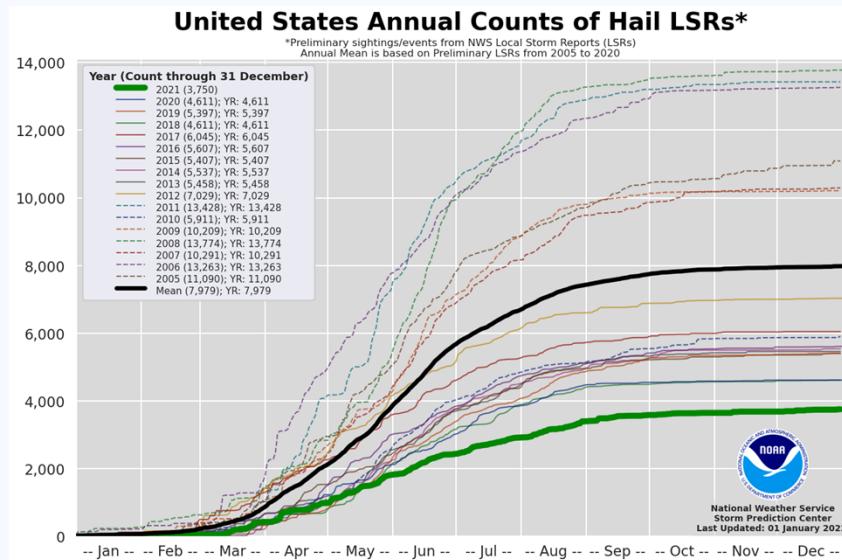
- Reported over \$174 thousand in property damage
- 3 injuries

Severe storms have caused one disaster declaration for Charleston County

Uniform exposure across the entire city

Future occurrences are *highly likely*

HAIL



NCEI reported 9 hail events in Charleston in 1999

- No reported property damages, injuries, or deaths with these events

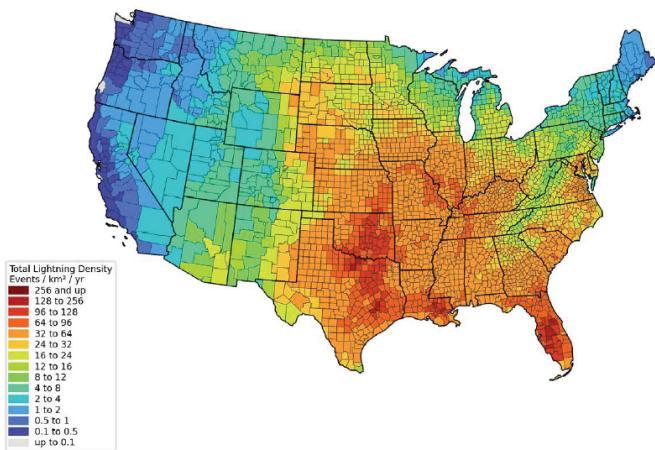
Hail stones reported between 0.75 and 1.75 inches in diameter

Uniform exposure across the entire city

Future occurrences are *highly likely*

LIGHTNING

Total lightning density 2015–2020
per county



VAISALA

2021 ANNUAL LIGHTNING REPORT

© Vaisala 2022

Uniform exposure across the entire city

Future occurrences are *highly likely*

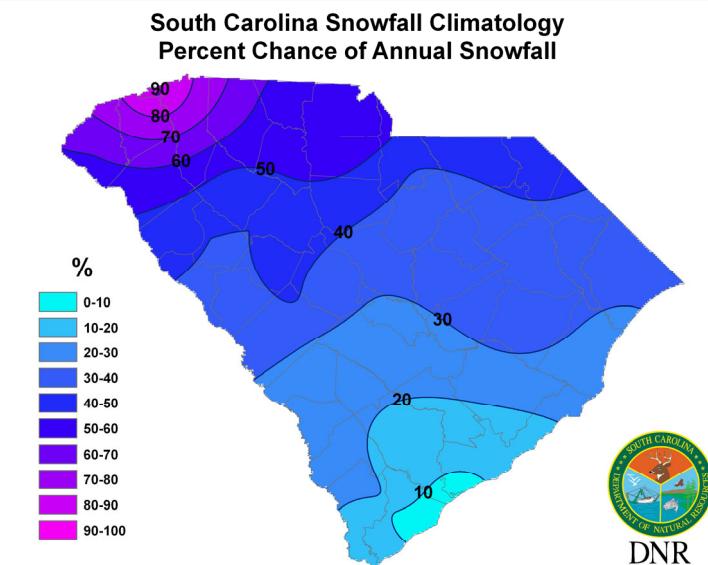
SEVERE WINTER STORM

NCEI reported 7 severe winter storm events in Charleston County since 2000

- Reported over \$96 thousand in property damages

Uniform exposure across the city

Future occurrences are possible



SHORELINE EROSION

Coastal areas at risk of shoreline erosion

USGS reports that highest rates of shoreline retreat and land loss found along the coast of South Carolina

SCDHEC reports erosion on Morris Island (located in mouth of Charleston Harbor) is eroding at an average of 30 ft/yr

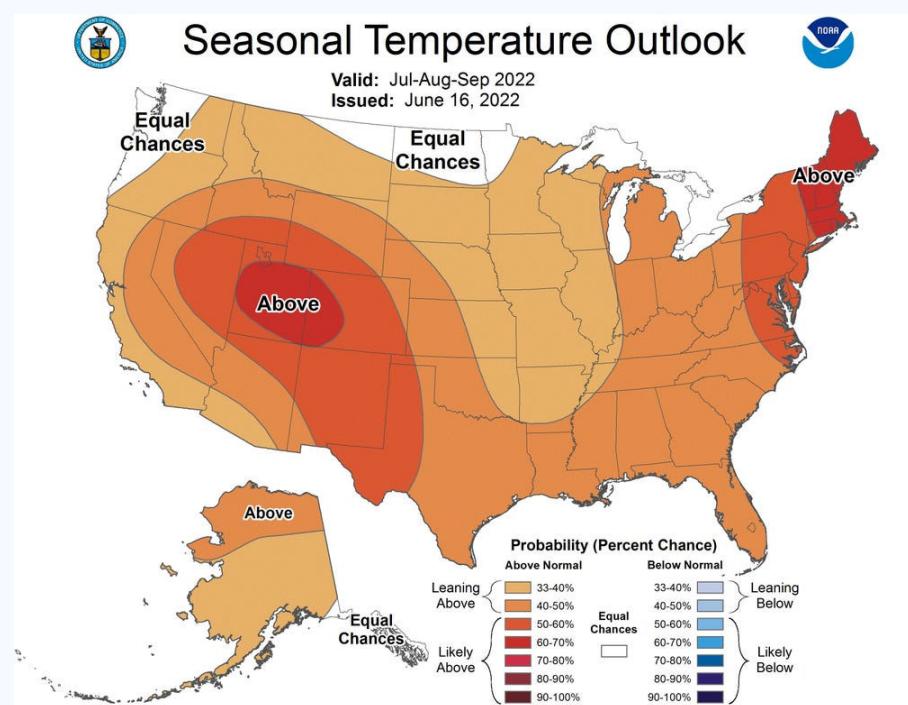
Future occurrences are *likely*

EXTREME HEAT

NCEI reported 19 extreme heat events since 1996 in Charleston County

105F reported on August 1, 1999 is the maximum reported temperature for the City of Charleston

Future Occurrences are *likely*



SINKHOLES

Human interference and
changed in water levels in surficial
aquifers lead to sinkholes (USGS)

3 occurrences from news
reports/anecdotal evidence in
Charleston

- Deteriorating and outdated
pre-civil war era storm system
beneath city susceptible to
sinkholes

Future occurrences are *likely*



Source: <https://today.cofc.edu/2021/07/05/geology-professor-explains-cause-of-sinkhole-near-campus/>

DISEASE/PANDEMIC

Hazard of great concern recently

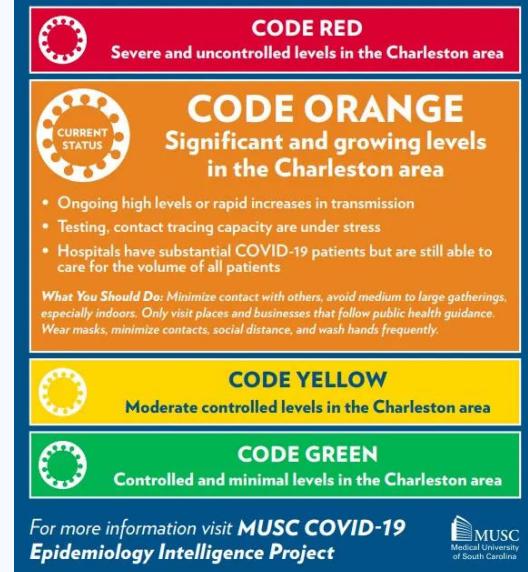
- Increasing risk/vulnerability with increasing population

Other historical occurrences include smallpox, yellow fever epidemic (1858), and influenza (1919)

One disaster declaration due to COVID-19 Pandemic on March 27th, 2020

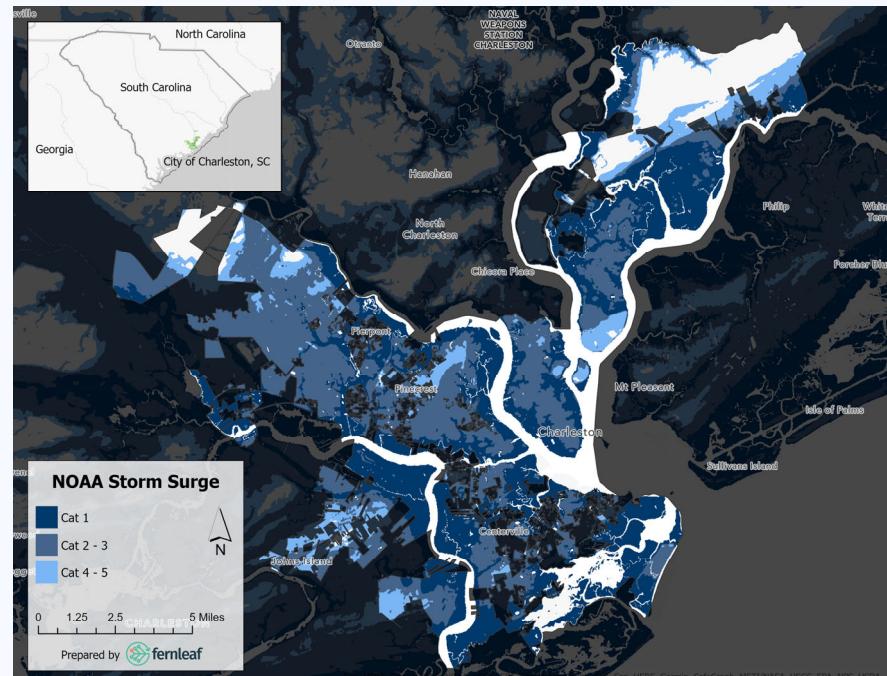
Future occurrences are possible

Charleston Area COVID-19 Warning Levels



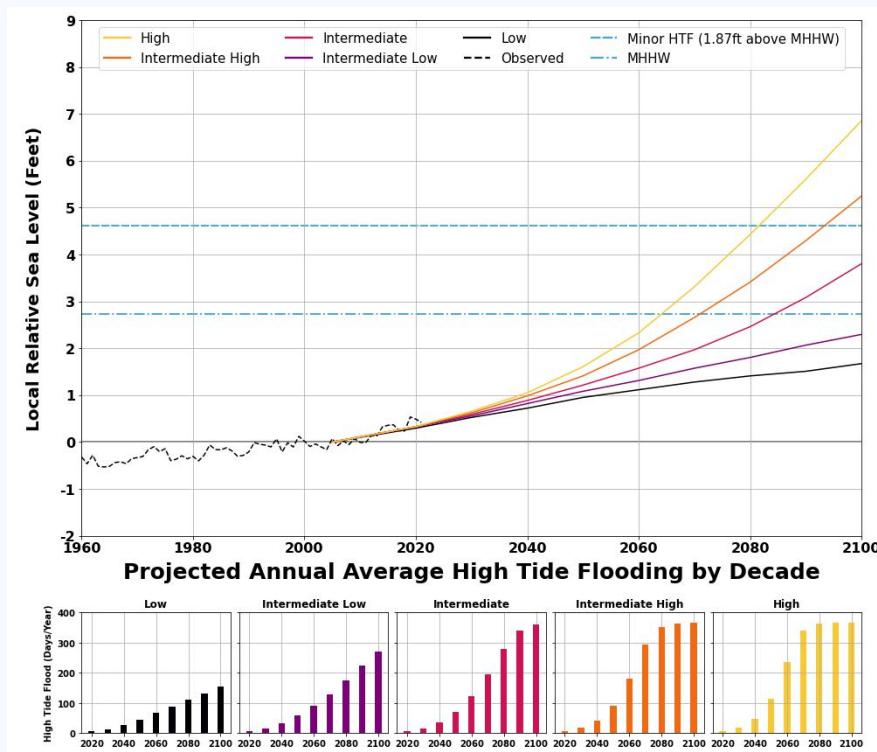
STORM SURGE

- More properties in the City of Charleston are vulnerable to storm surge than any other type of flooding hazard
- NCEI reported six (6) events for the City of Charleston
 - Hurricane Hugo (1989) recorded storm surge at 12.5 ft above the average low tide
 - Hurricane Irma (2017) recorded storm surge at 9.9 ft
 - Hurricane Matthew (2016) recorded storm surge of 9.3 ft
- Future occurrences are *likely*



TIDAL FLOODING

- More common in cities and other human occupied coast areas as sea levels rise
- NOAA reports the U.S. SE Atlantic and Gulf coast had an increase of over 400 to 1,000% respectively in high tide flooding days since 2000
- Cooper River tidal gauges report tidal flooding events could rise to over 100 days/year by 2100
- Future occurrences are possible



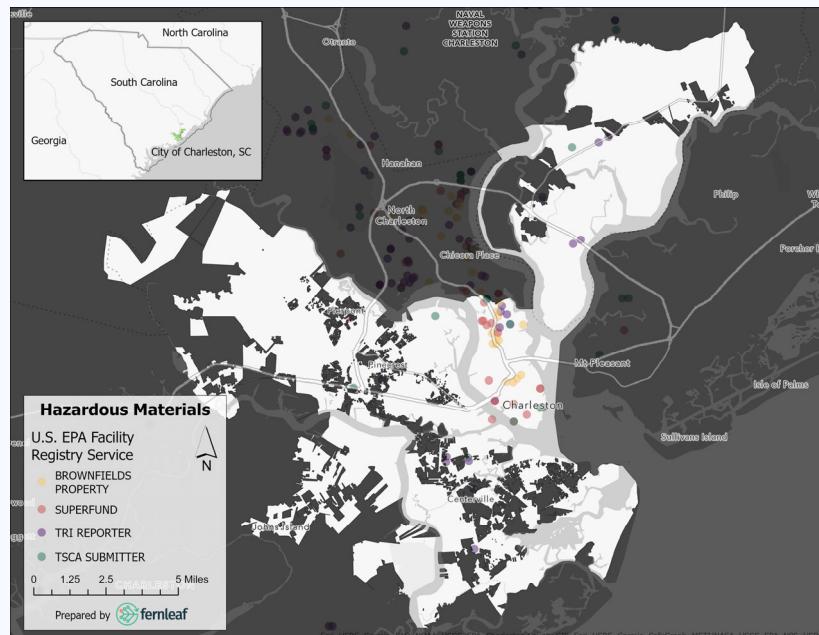
HAZARDOUS MATERIALS RELEASE

The Pipeline and Hazardous Materials Safety Administration reported 264 events in the City of Charleston

- Combination of Rail, Water, Air and Highway spill events
- \$591,391 in property damages reported from events

There are 11 TRI facilities located in the City of Charleston

Future occurrences are *likely*



INFRASTRUCTURE FAILURE

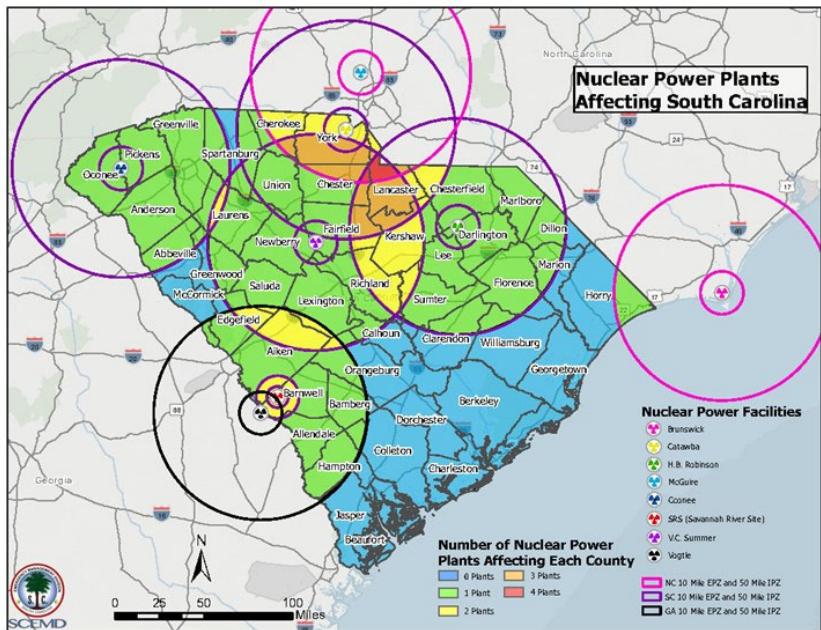
Network of structures, utilities, and facilities

- Basic needs for mobility, power, water, sewer, and communications

City is home to the Port of Charleston – one of the most productive ports in the US for trade, commerce and is also home to the city's cruise ship operations

Future occurrences are *possible*

RADIOLOGICAL EMERGENCY



No serious events have occurred near the City of Charleston

- No industry in the city that manages nuclear materials

Concern with major transportation, Port, and healthcare facilities

CYBER INCIDENTS

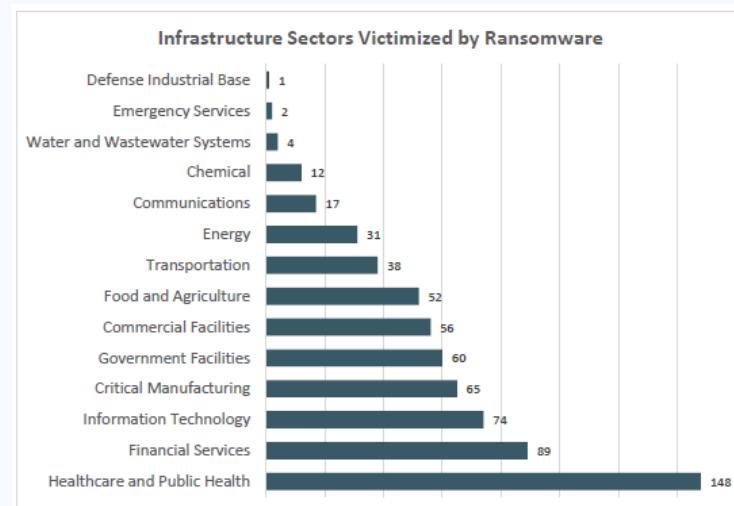
A cyber incident is an event that could jeopardize the confidentiality, integrity, or availability of digital information or information systems

- Have a significant probability of compromising regular operations

Can involve theft, fraud, and solicitation

One incident in Charleston County ransomware attack

Future occurrences are possible



CIVIL DISTURBANCE

Most often arise from political grievances, urban economic conflicts, and community unrest, terrorist acts or foreign influences

There have been 3 examples in Charleston's history of civil disturbance events which caused 6 deaths and 39 injuries (1876 – 2020)

Future occurrences are *unlikely*

TERRORISM

The City of Charleston has not experienced a major threat or attack but does deal with isolated incidents of domestic terrorism such as mass shootings

Charleston has an increased probability of experiencing a terrorist attack due to being a major port city, centralized tourism, and a high urban population

Future occurrences are possible

Threat Level	Description
SEVERE	Severe Risk of Terrorist Attacks
HIGH	High Risk of Terrorist Attacks
ELEVATED	Significant Risk of Terrorist Attacks
GUARDED	General Risk of Terrorist Attacks
LOW	Low Risk of Terrorist Attacks

ACTIVE THREAT

Areas of high population are especially at risk to active threats

There has been one major active threat incident in Charleston

- Charleston Church Shooting (2015)
- Caused nine deaths and one injury

Future occurrences are possible

Incident Statistics

Active Shooter Incidents 2017–2021

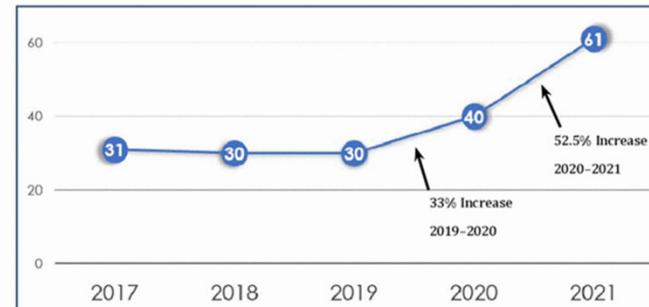


Figure 1

Summary

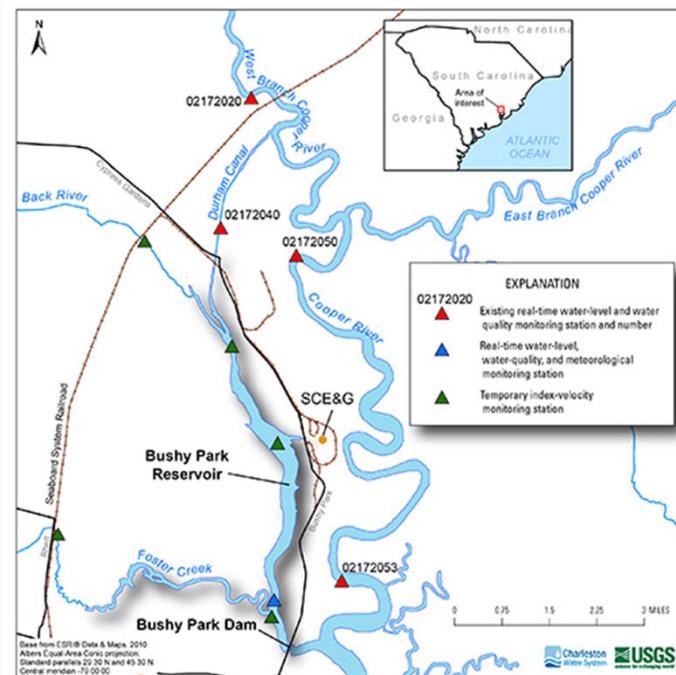
For the period 2017–2021, active shooter incident data reveals an upward trend: the number of active shooter incidents identified in 2021 represents a 52.5% increase from 2020 and a 96.8% increase from 2017.

A breakdown of the number of incidents within the five-year period 2017–2021¹ is as follows:

- 2017: 31
- 2018: 30
- 2019: 30
- 2020: 40
- 2021: 61

WATER SHORTAGE

- Continuous cycles of drought and rising temperatures due to climate change will exacerbate water supplies for the entirety of South Carolina
- Bushy Park Reservoir is the main source of water for the City of Charleston
- Futures occurrences are possible



Bushy Park Reservoir Reference Map
Source: Charleston Water System; USGS

PRI RESULTS

Hazard	Sub-hazard(s) Assessed	Category/Degree of Risk						PRI Score
		Probability	Impact	Spatial Extent	Warning Time	Duration		
Natural Hazards								
Hurricane		Likely	Critical	Large	More than 24 hours	More than one week	3.1	
Flooding		Likely	Critical	Moderate	6-12 hours	More than one week	3.1	
Sea Level Rise		Likely	Limited	Moderate	More than 24 hours	More than one week	2.6	
Earthquake		Likely	Limited	Large	Less than 6 hours	More than one week	2.8	
Tornado		Likely	Minor	Small	Less than 6 hours	Less than one week	2.0	
Wildfires	Conflagration	Likely	Minor	Small	12 – 24 hours	Less than one week	2.1	
Tsunamis		Unlikely	Critical	Moderate	Less than 6 hours	Less than one week	2.2	
Dam Failure		Unlikely	Limited	Small	Less than 6 hours	Less than one week	1.7	
Rip Currents		Likely	Minor	Small	Less than 6 hours	Less than 6 hours	2.1	
Drought		Likely	Minor	Large	More than 24 hours	Less than 6 hours	2.5	
Severe Storm	Thunderstorm, Lightning, Hail	Highly Likely	Limited	Moderate	6-12 hours	Less than one week	2.8	
Severe Winter Weather		Possible	Limited	Large	More than 24 hours	Less than one week	2.7	
Shoreline Erosion		Possible	Limited	Small	More than 24 hours	More than one week	2.1	

PRI RESULTS, Continued

Extreme Heat		Likely	Limited	Large	More than 24 hours	Less than one week	2.7
Sinkholes		Likely	Limited	Small	Less than 6 hours	Less than 6 hours	2.1
Public Health Hazards		Unlikely	Critical	Large	More than 24 hours	More than one week	2.5
Storm Surge		Likely	Minor	Moderate	More than 24 hours	Less than 24 hours	2.1
Tidal Flooding		Possible	Minor	Moderate	More than 24 hours	Less than 6 hours	1.7
Technological Hazards							
Hazardous Materials		Likely	Limited	Small	Less than 6 hours	Less than one week	2.2
Infrastructure Failure		Possible	Limited	Small	Less than 6 hours	More than one week	2.1
Human-Caused Hazards							
Radiological Emergency		Unlikely	Limited	Small	Less than 6 hours	Less than one week	1.7
Cyber Incidents		Possible	Limited	Small	Less than 6 hours	Less than one week	2
Civil Disturbance		Unlikely	Minor	Small	Less than 6 hours	Less than 24 hours	1.3
Terrorism		Unlikely	Critical	Small	Less than 6 hours	More than one week	2.1
Active Threat		Possible	Limited	Small	Less than 6 hours	Less than 6 hours	1.8
Water Shortage		Possible	Minor	Large	More than 24 hours	More than one week	2.1

LCHCC PRIORITIES

Highest Rank with Great Impact		
Natural	Manmade/Intentional	Technological
Earthquake Infectious Disease Hurricane Inclement Weather Tsunami	Terrorism Workplace Violence	Dam Failure Explosive

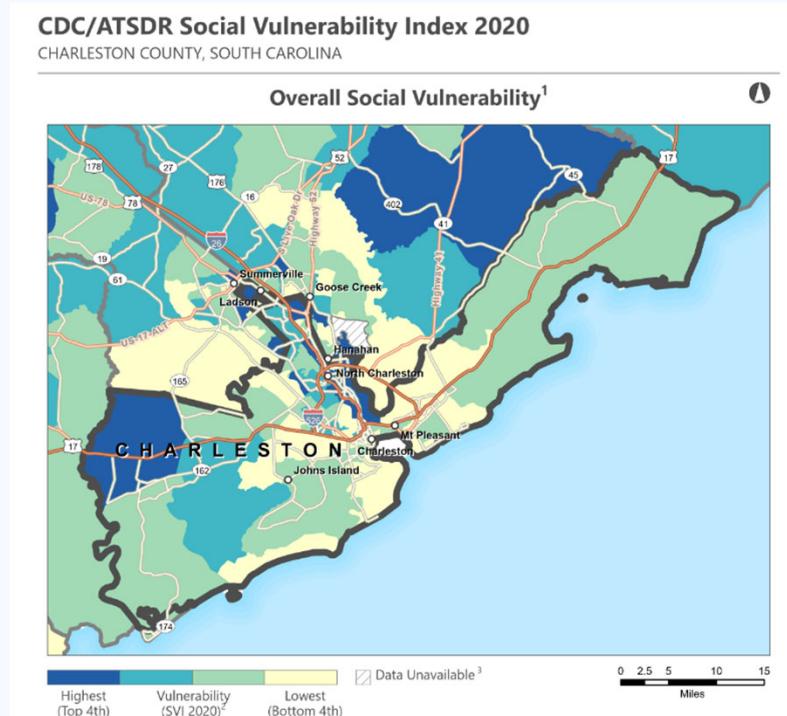
Hazards ranked at the facility level and Coalition level based on risk percentage

HVA CONCLUSIONS

HIGH RISK	Hurricane Flooding Earthquake Severe Storm Extreme Heat Sea Level Rise Infrastructure Failure Storm Surge
MODERATE RISK	Drought Pandemic / Infectious Disease Hazardous Materials Release Wildfires Severe Winter Weather Shoreline Erosion Infrastructure Failure Terrorism Cyber Incident Straight Line Winds
LOW RISK	Dam Failure Radiological Emergency Civil Disturbance Tsunami Sinkhole Tornado

SOCIAL VULNERABILITY

- Based on CDC Social Vulnerability Index, the City of Charleston has a **varying level** of vulnerability



Charleston Area Heat Watch Context

Subdivision Age

Grid - 1 Square Mile

 CHS HeatWatch Study Area

Charleston Subdivision Age (North Charleston Data Not Available)

Average Year Built



MEDIAN INCOME DATA
U.S. Census Bureau's American Community Survey (ACS) 2015-2019 5-year estimates, Table(s) B19013B, B19013C, B19013D, B19013E, B19013F, B19013G, B19013H, B19013I, B19049, B19053

HEALTH INSURANCE COVERAGE DATA
U.S. Census Bureau's American Community Survey (ACS) 2015-2019 5-year estimates, Table(s) B27010

POPULATION DATA
U.S. Census Bureau's American Community Survey (ACS) 2015-2019 5-year estimates, Table(s) B01001

EDUCATION DATA
U.S. Census Bureau's American Community Survey (ACS) 2015-2019 5-year estimates, Table(s) 3

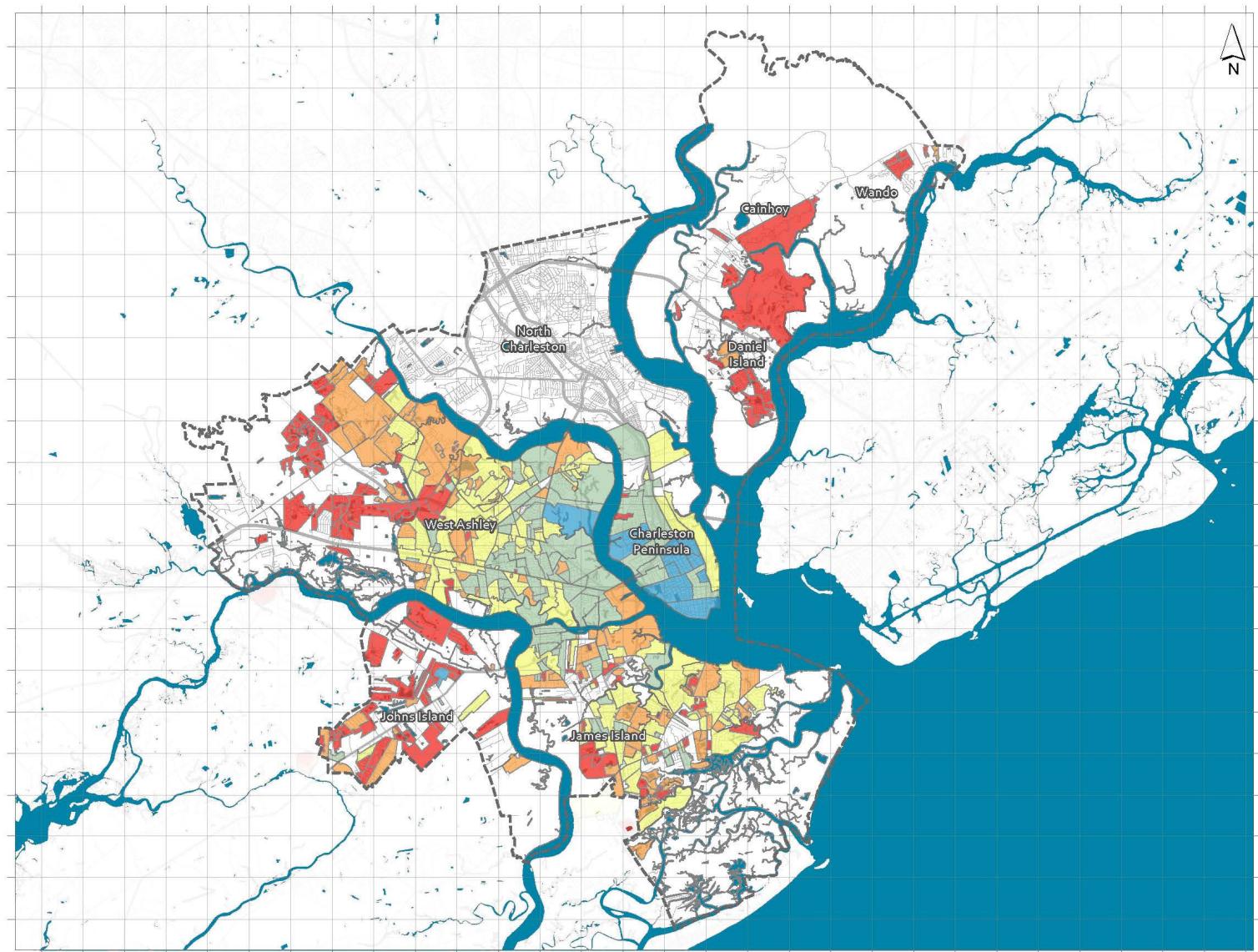
ELEVATION DATA
U.S. Geological Survey, 2019, 3D Elevation Program 3-Meter Resolution Digital Elevation Model, accessed April 16, 2021 at URL <https://www.usgs.gov/core-science-systems/ngp/3dep/data-tools>

CDC SVI DATA
Centers for Disease Control and Prevention/ Agency for Toxic Substances and Disease Registry/ Geospatial Research, Analysis, and Services Program. CDC Social Vulnerability Index 2013 Database US. https://www.atsdr.cdc.gov/placeandhealth/svi/data_documentation_download.html. Accessed 04/2021

LIFE EXPECTANCY DATA
National Center for Health Statistics. U.S. Small-Area Life Expectancy Estimates Project (USALEEP): Life Expectancy Estimates File for (Jurisdiction), 2010-2015. National Center for Health Statistics. 2018. Available from: <https://www.cdc.gov/nchs/nvss/usaleep/usaleep.html>.

LANDCOVER & NEIGHBORHOOD DATA
City of Charleston GIS

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Charleston (CHS) Heat Watch Context

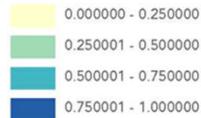
CDC SVI - Overall Vulnerability

Grid - 1 Square Mile

CHS HeatWatch Study Area

Overall CDC Social Vulnerability Index (SVI)

Low Social Vulnerability to High Social Vulnerability (Census Tract)



MEDIAN INCOME DATA
U.S. Census Bureau's American Community Survey (ACS) 2015-2019 5-year estimates, Table(s) B19013B, B19013C, B19013D, B19013E, B19013F, B19013G, B19013H, B19013I, B19049, B19053

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POPULATION DATA
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EDUCATION DATA
U.S. Census Bureau's American Community Survey (ACS) 2015-2019 5-year estimates, Table(s) 3

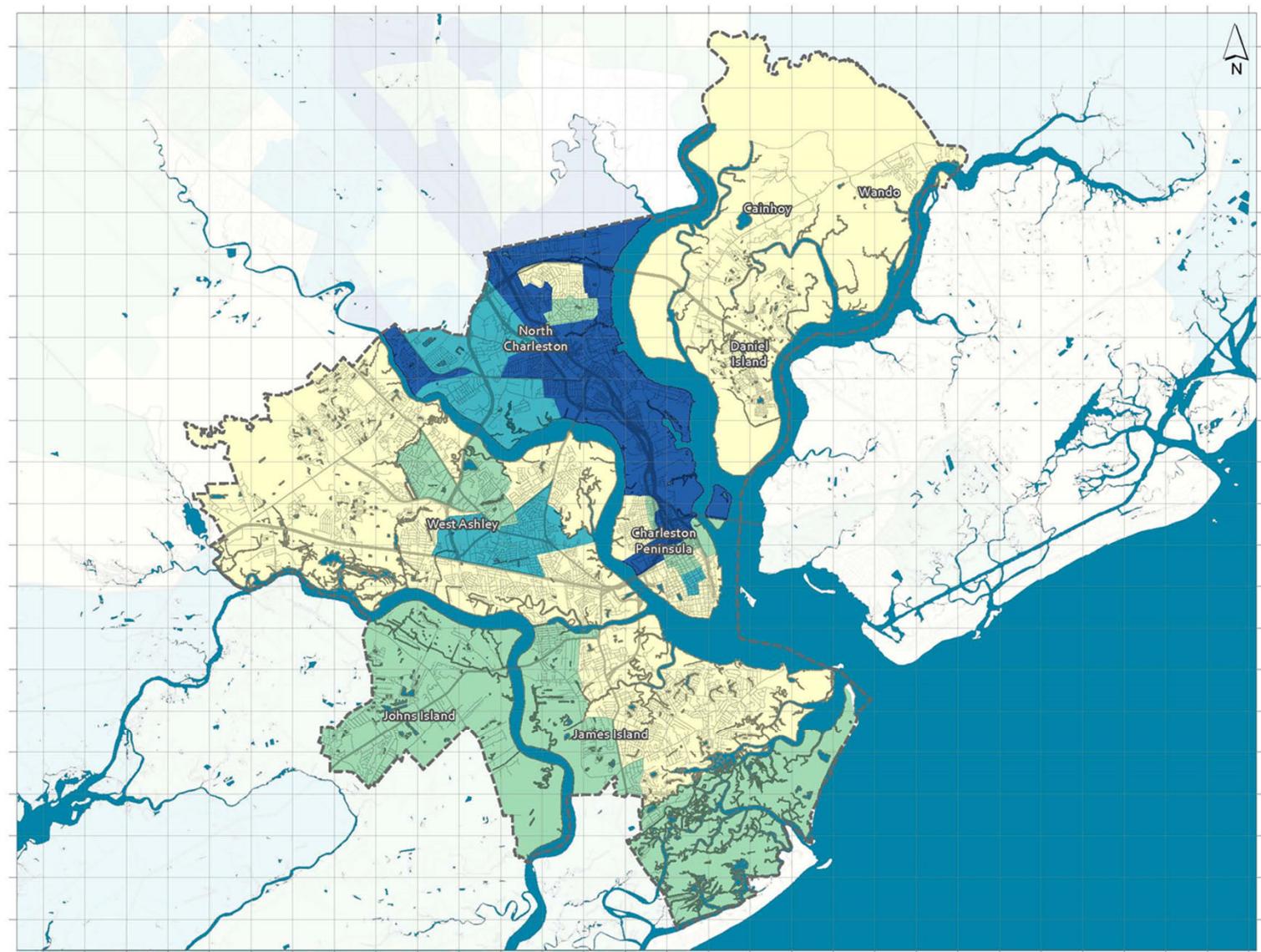
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CDC SVI DATA
Centers for Disease Control and Prevention/ Agency for Toxic Substances and Disease Registry/ Geospatial Research, Analysis, and Services Program: CDC Social Vulnerability Index 2018 Database US. https://www.atsdr.cdc.gov/placeandhealth/svi/data_documentation_download.html. Accessed 04/2021

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National Center for Health Statistics. U.S. Small-Area Life Expectancy Estimates Project (USALEEP): Life Expectancy Estimates File for (Jurisdiction), 2010-2015. National Center for Health Statistics. 2018. Available from: <https://www.cdc.gov/nchs/nvsr/usaleep/usaleep.html>.

LANDCOVER & NEIGHBORHOOD DATA
City of Charleston GIS

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Charleston Area Heat Watch Context

Median Household Income

Grid - 1 Square Mile

 CHS HeatWatch Study Area

ACS Median Household Income Variables (Census Tract)

Median Household Income in past 12 months
(inflation-adjusted dollars to last year of 5-year range)



MEDIAN INCOME DATA
U.S. Census Bureau's American Community Survey (ACS) 2015-2019 5-year estimates,
Table(s) B19013B, B19013C, B19013D, B19013E, B19013F, B19013G, B19013H,
B19013I, B19049, B19053

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Table(s) B01001

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U.S. Census Bureau's American Community Survey (ACS) 2015-2019 5-year estimates,
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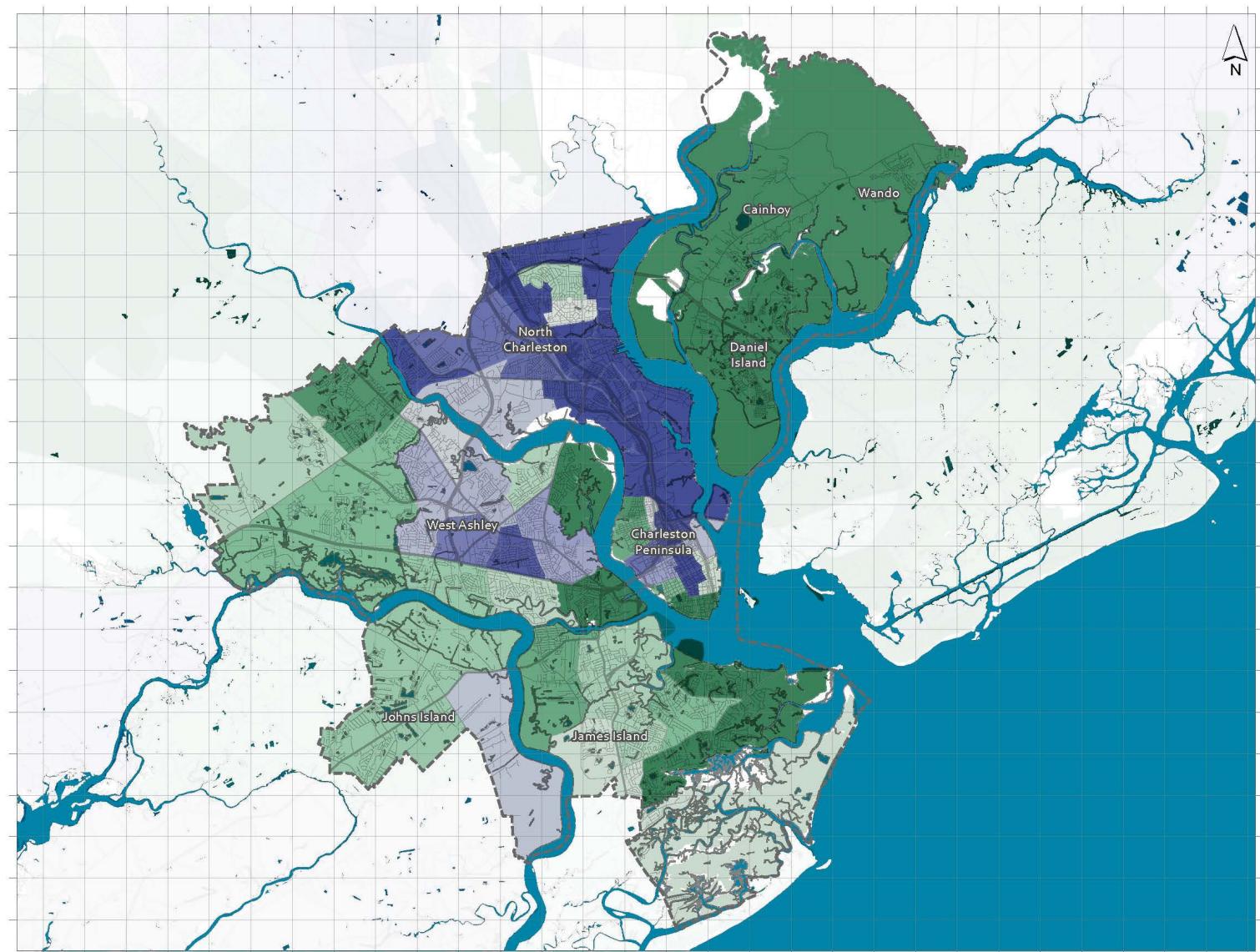
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Elevation Model, accessed April 16, 2021 at URL <https://www.usgs.gov/core-science-systems/ngdc/3dep/data-tools>

CDC SVI DATA
Centers for Disease Control and Prevention/ Agency for Toxic Substances and Disease
Registry/ Geospatial Research, Analysis, and Services Program. CDC Social
Vulnerability Index 2018 Database US. https://www.atsdr.cdc.gov/placeandhealth/svi/data_documentation_download.html. Accessed 04/2021

LIFE EXPECTANCY DATA
National Center for Health Statistics. U.S. Small Area Life Expectancy Estimates Project
(USALEP): Life Expectancy Estimates File for (Jurisdiction), 2010-2015. National
Center for Health Statistics. 2018. Available from: <https://www.cdc.gov/nchs/nvsr/usalep/usalep.html>

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Charleston Area Heat Watch Context

Educational Attainment

Grid - 1 Square Mile

 CHS HeatWatch Study Area

ACS Educational Attainment Variables

Population 25 or Older Whose Highest Education Completed is Less Than High School (Census Tract)



MEDIAN INCOME DATA

U.S. Census Bureau's American Community Survey (ACS) 2015-2019 5-year estimates, Table(s) B19013B, B19013C, B19013D, B19013E, B19013F, B19013G, B19013H, B19013I, B19049, B19053

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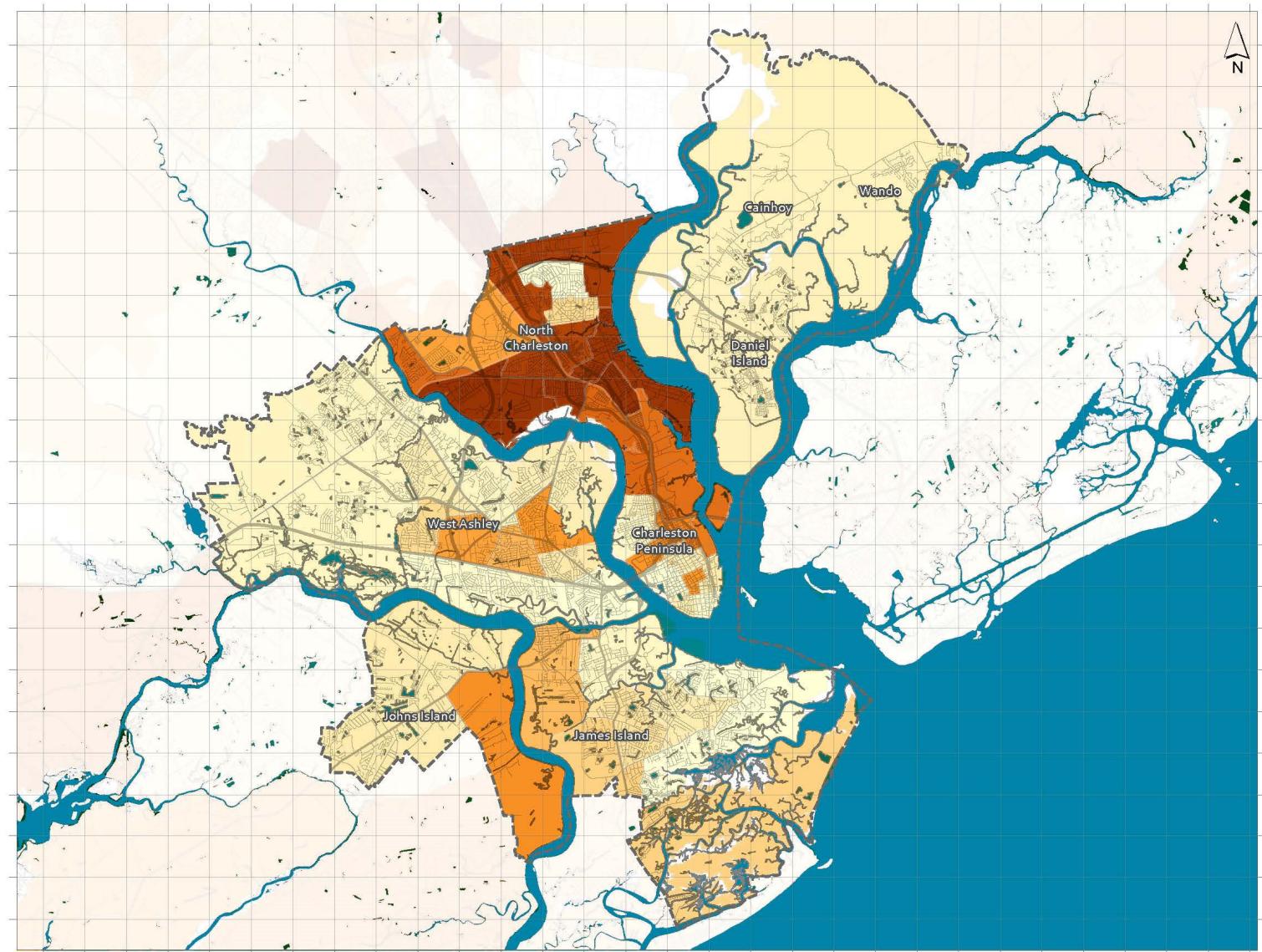
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Charleston Area Heat Watch Context

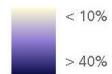
Elderly Population

Grid - 1 Square Mile

 CHS HeatWatch Study Area

ACS Population Variables

Percent of Population that is 65 Years and Over
(Census Tract)



MEDIAN INCOME DATA

U.S. Census Bureau's American Community Survey (ACS) 2015-2019 5-year estimates,
Table(s) B19013B, B19013C, B19013D, B19013E, B19013F, B19013G, B19013H,
B19013I, B19049, B19053

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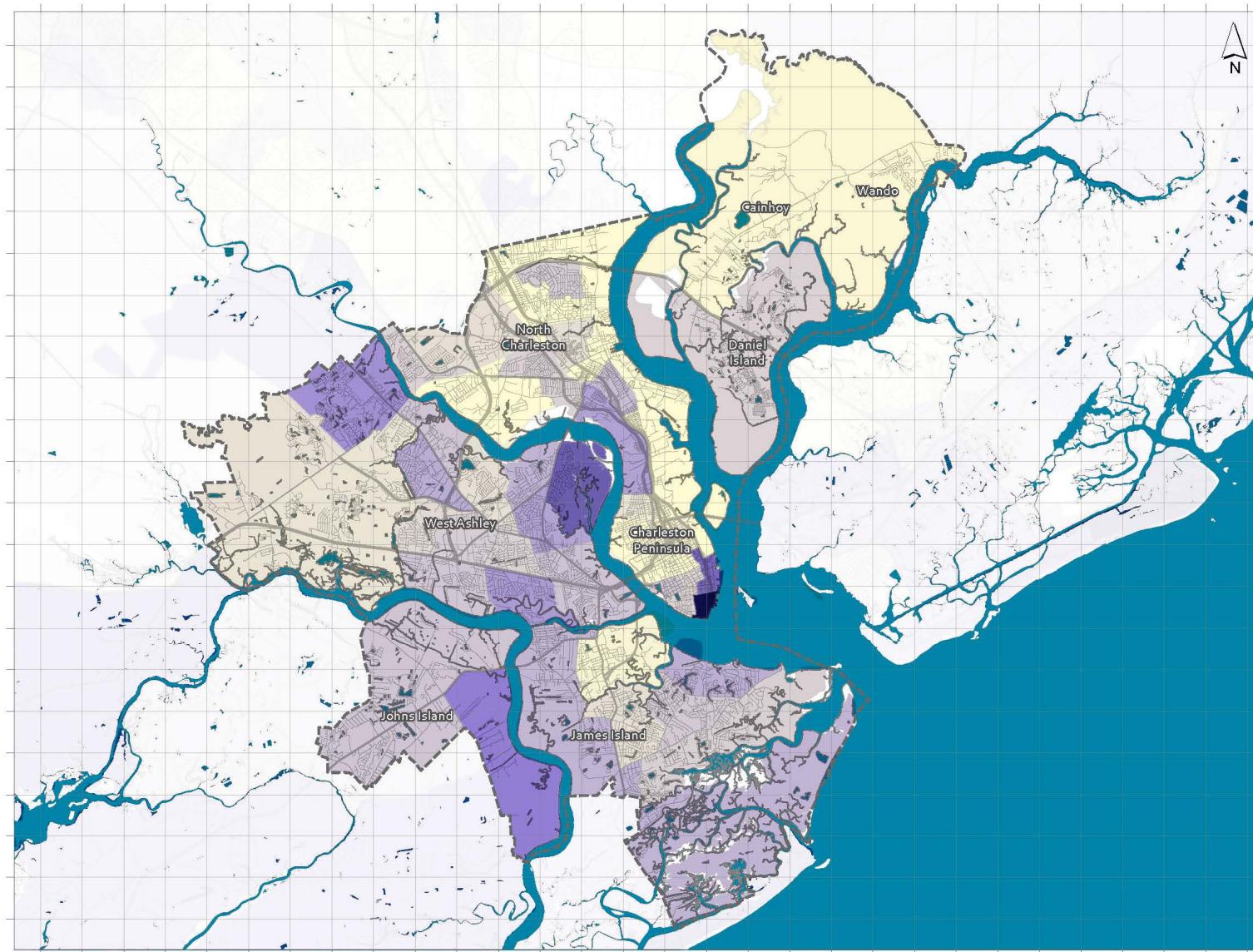
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Center for Health Statistics. 2018. Available from: <http://www.cdc.gov/nchs/nvs/usaleep/usaleep.html>

LANDCOVER & NEIGHBORHOOD DATA

City of Charleston GIS

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Charleston Area Heat Watch Context

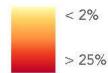
Health Insurance Coverage

Grid - 1 Square Mile

 CHS HeatWatch Study Area

ACS Health Insurance Coverage Variables

Percent of Population with No Health Insurance Coverage (Census Tract)



MEDIAN INCOME DATA

U.S. Census Bureau's American Community Survey (ACS) 2015-2019 5-year estimates, Table(s) B19013B, B19013C, B19013D, B19013E, B19013F, B19013G, B19013H, B19013I, B19049, B19053

HEALTH INSURANCE COVERAGE DATA

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U.S. Census Bureau's American Community Survey (ACS) 2015-2019 5-year estimates, Table(s) B01001

EDUCATION DATA

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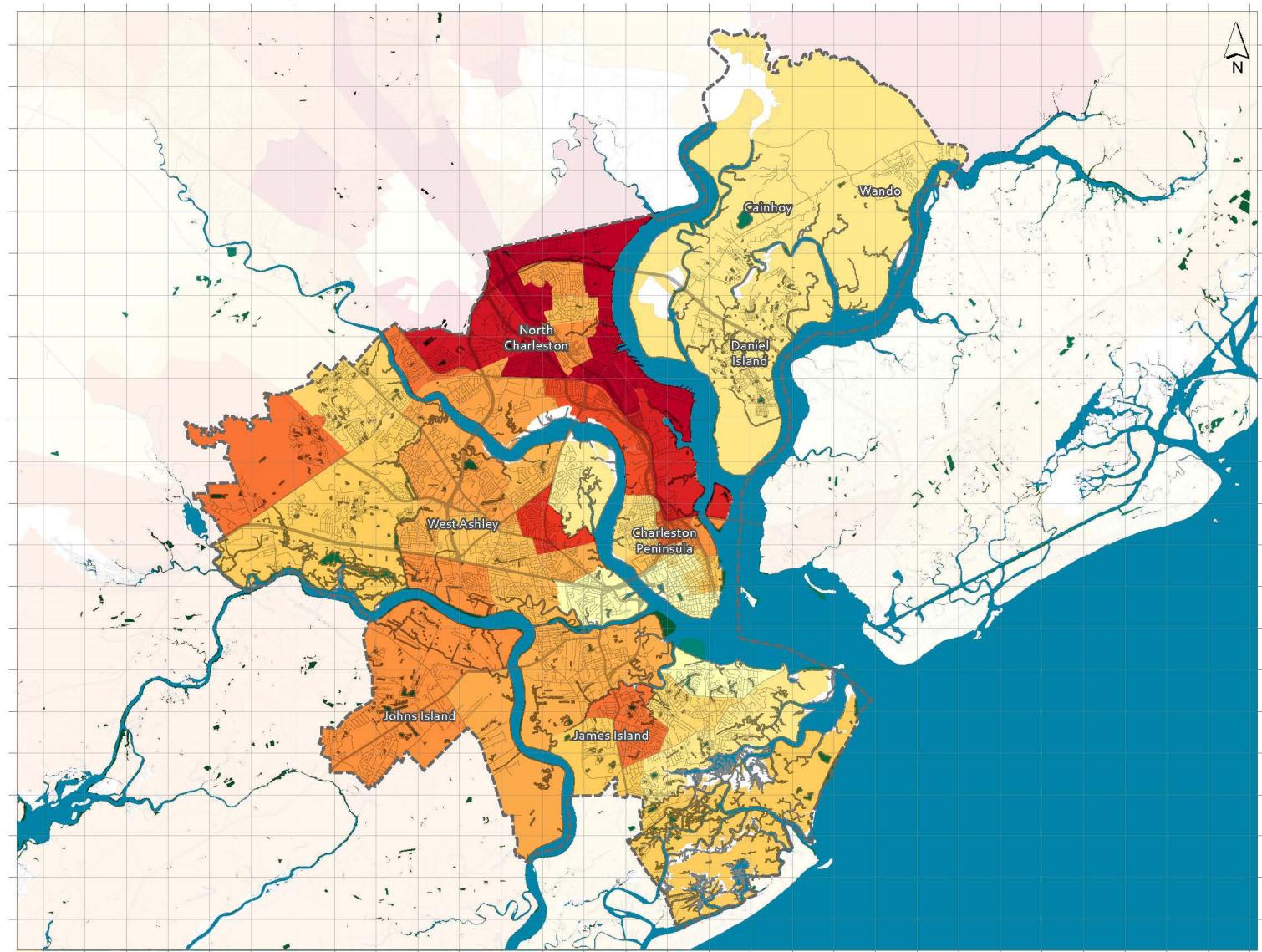
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LANDCOVER & NEIGHBORHOOD DATA

City of Charleston GIS

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Charleston Area Heat Watch Context

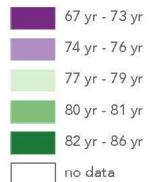
Life Expectancy at Birth

Grid - 1 Square Mile

 CHS HeatWatch Study Area

CHS Life Expectancy at Birth

CDC Life Expectancy (census tract)



MEDIAN INCOME DATA

U.S. Census Bureau's American Community Survey (ACS) 2015-2019 5-year estimates, Table(s) B19013B, B19013C, B19013D, B19013E, B19013F, B19013G, B19013H, B19013I, B19049, B19053

HEALTH INSURANCE COVERAGE DATA

U.S. Census Bureau's American Community Survey (ACS) 2015-2019 5-year estimates, Table(s) B27010

POPULATION DATA

U.S. Census Bureau's American Community Survey (ACS) 2015-2019 5-year estimates, Table(s) B01001

EDUCATION DATA

U.S. Census Bureau's American Community Survey (ACS) 2015-2019 5-year estimates, Table(s) 3

ELEVATION DATA

U.S. Geological Survey, 2019, 3D Elevation Program 3-Meter Resolution Digital Elevation Model, accessed April 16, 2021 at URL <https://www.usgs.gov/core-science-systems/ngp/3dep/data-tools>

CDC SVI DATA

Centers for Disease Control and Prevention/ Agency for Toxic Substances and Disease Registry/ Geospatial Research, Analysis, and Services Program. CDC Social Vulnerability Index 2013 Database US. https://www.atsdr.cdc.gov/placeandhealth/svi/data_documentation_download.html. Accessed 04/2021

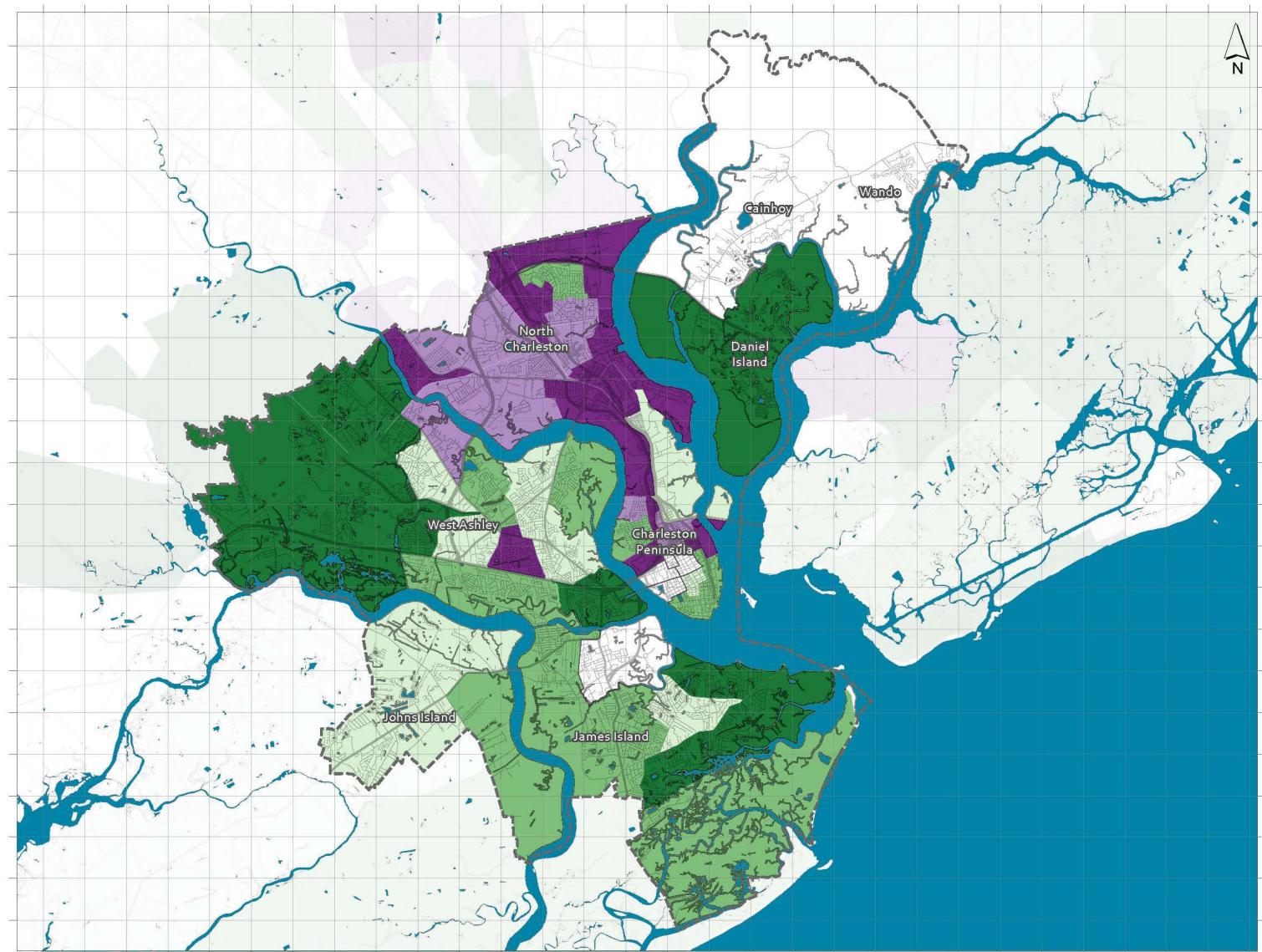
LIFE EXPECTANCY DATA

National Center for Health Statistics. U.S. Small Area Life Expectancy Estimates Project (USALEEP). Life Expectancy Estimates File for (Jurisdiction), 2010-2015. National Center for Health Statistics. 2015. Available from: <https://www.cdc.gov/nchs/nvs/usaleep/usaleep.html>.

LANDCOVER & NEIGHBORHOOD DATA

City of Charleston GIS

 climate adaptation partners
resilience through collaborative partnerships



PUBLIC SURVEY

The survey is comprised of a total of 20 multiple choice and short answer questions. These questions pertain to the following:

1. Natural Hazards
2. Man-made hazards
3. Vulnerable populations
4. Self-Employed Mitigation Initiatives
5. Interest in Additional Mitigation Strategies
6. Existing Knowledge/Information Concerning Mitigation and Emergency Preparedness
7. Prioritization/Effectiveness Mitigation Strategy Types
8. Problem Areas Within the Community

PUBLIC SURVEY, cont.

195 Responses Collected

The survey was made available in February of 2023 and is still open. It was promoted through municipal media sites and shared through email groups.

PUBLIC SURVEY, cont.

78% response rate from those that own property and reside within city limits

12.6% response rate from those that live outside the city limits but in a neighboring community in Charleston County

Most disaster experienced responses:

- **Hurricane**
- **Flooding**
- **Extreme Heat**

PUBLIC SURVEY, cont.

Largest concern – Hurricane and Tropical Storm
(21.1%)

Second largest concern – Flooding (19.4%)

Internet (46.5%) is the most effective way to receive information, mail (36.6%) is the second most effective way

- Email and Utility Bill inserts were also suggested

PUBLIC SURVEY

83.5% showed interest in making their homes/neighborhoods more resistant to hazards

84.1% of responses said they do **NOT** know what office to contact regarding risk reduction

Examples of actions to make home/neighborhood more resilient to disasters:

- Tree Trimming, tree removal
- Landscape/vegetative improvements
- Debris removal/clearing of drains in neighborhoods

PUBLIC SURVEY

Major concerns shared regarding natural and man-made hazards:

- Rapid growth and development
- Uncertainty/preparedness of an earthquake
- Infrastructure failure (water, power, communication, etc.)
- Timely evacuation (due to traffic, congestion/population/lack of routes)
- Socially Vulnerable Populations (low-mid income and elderly)
- Aging infrastructure
- Climate Change/Sea Level Rise
- Rising temperatures/extreme heat events

PUBLIC SURVEY, cont.

What are some steps your local government could take to reduce or eliminate the risk of future hazards damages?

“Increase preservation of marshes and wetlands.”

“Follow recommendations from the Dutch Dialogues”

“Accelerate drainage projects and wall planning/construction,”

“Bury utility lines underground.”

“Complete Calhoun Stormwater Mitigation Project.”

PUBLIC SURVEY, cont.

Community's response to important mitigation techniques:

1. Prevention – 86.3%
2. Natural Resource Protection – 81.3%
3. Emergency Services – 77%
4. Structural Projects – 70.9%
5. Property Protection – 53.3%
6. Public Education and Awareness – 52.5%

CAPABILITY ASSESSMENT*

Measures community capability to implement hazard mitigation activities

Identifies and target gaps, conflicts and opportunities with existing local plans, programs, policies, etc.

Identifies mitigation measures already in place or underway

- *Coupled with the Risk Assessment, the Capability Assessment helps to form the foundation for identifying Mitigation Actions*

CAPABILITY INDICATORS

National Flood Insurance Program (NFIP) Participation

Community Rating System (CRS) Participation

Building Code Effectiveness Grading Schedule

Local Capability Assessment:

- Inventory and evaluation of existing plans, policies, programs, and ordinances
- Measure administrative, technical, fiscal and political capability

CAPABILITY ASSESSMENT

Plan Policy, Program, or Ordinance

- Hazard Mitigation Plan
- Disaster Recovery Plan
- Comprehensive Land Use Plan
- Floodplain Management Plan
- Stormwater Management Plan
- Emergency Operations Plan
- Continuity of Operations Plan
- Capital Improvements Plan
- Historic Preservation Plan
- Zoning Ordinance
- Subdivision Ordinance
- Flood Damage Prevention Ordinance
- Post-Disaster Redevelopment Plan
- Building Code
- Fire Code

CAPABILITY ASSESSMENT

PLANNING AND REGULATORY CAPABILITY

- The City has HIGH Planning and Regulatory Capability

ADMINISTRATIVE AND TECHNICAL CAPABILITY

- The City has HIGH Administrative and Technical Capability
- Has staff skilled in GIS
- Has an Emergency Manager and Floodplain Manager

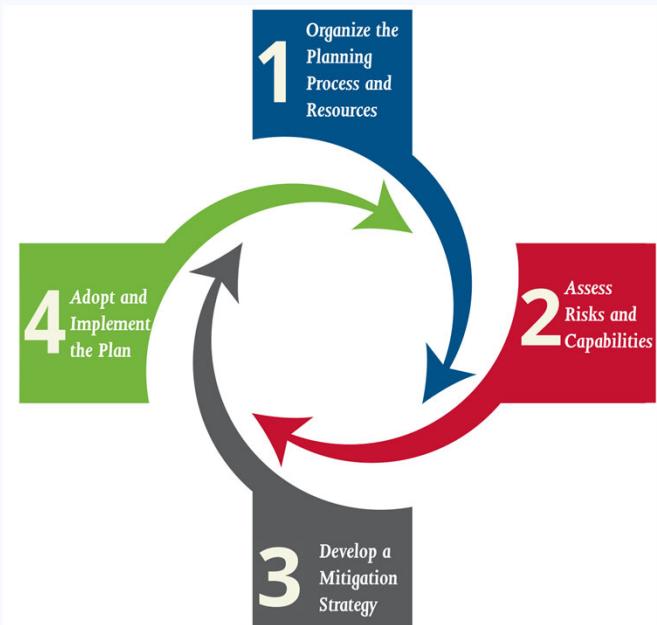
FISCAL CAPABILITY

- The City falls within the HIGH range
- The City has partnering arrangements or intergovernmental agreements

CONCLUSIONS ON CAPABILITY

	Low Vulnerability	Moderate Vulnerability	High Vulnerability
High Capability	(Best Case Scenario)		City of Charleston
Moderate Capability			
Low Capability			(Worst Case Scenario)

MITIGATION STRATEGY DEVELOPMENT



Third phase of the mitigation planning process

- The state, local, tribe or territory government sets priorities
- Long-term strategies are developed to avoid or minimize the undesired effects of disasters
- The strategy includes a description of how the mitigation actions will be implemented/administered

EVERY \$1 SPENT ON MITIGATION



SAVES \$6 ON FUTURE RECOVERY



THINK OF MITIGATION IN THIS WAY

- 1) We want to mitigate hazard impacts on the existing development in Charleston
 - Houses, businesses, infrastructure, critical facilities, etc.
- 2) We want to ensure that future development is conducted in a way that doesn't increase our vulnerability
 - Best done by having good plans, policies, and procedures in place

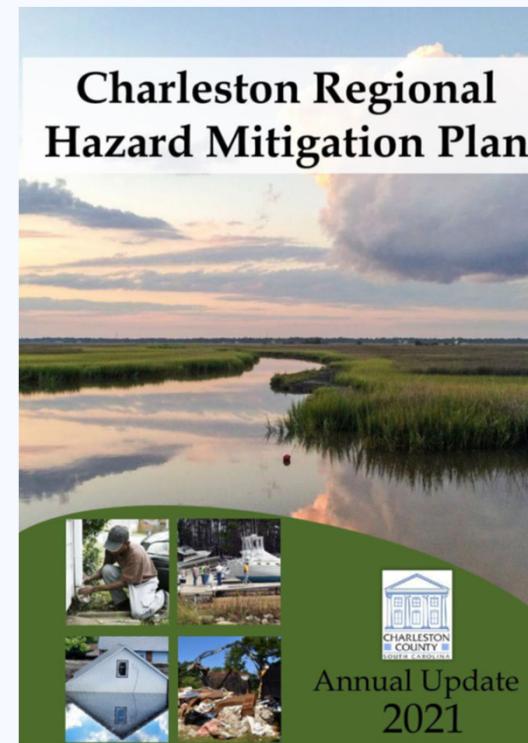
MITIGATION TECHNIQUES

Prevention	Property Protection	Natural Resource Protection	Structural Projects	Emergency Services	Public Education/Awareness
Planning and zoning	Acquisition	Floodplain Protection	Reservoirs	Warning systems	Outreach projects
Building codes	Relocation	Watershed management	Dams, levees, dikes	Emergency response equipment	Speaker series/demonstration events
Open space preservation	Building elevation	Riparian buffers	Floodwalls		
Floodplain regulations	Critical facilities protection	Forest management	Stormwater diversions	Shelter Operations	Hazard map information
Stormwater management regulations	Retrofitting	Erosion and sediment control	Detention/retention basins	Evacuation planning and management	Real estate disclosure
Drainage system maintenance	Safe rooms, shutters, shatter-resistant glass	Wetland preservation and restoration	Channel modification	Emergency response training and exercises	Library materials
Capital improvements programming	Insurance	Habitat preservation	Storm sewers	Sandbagging for flood protection	School children educational programs
Setbacks				Temporary shutters	Hazard expositions

MITIGATION STRATEGY

Review Regional Goals (Charleston Regional HMP 2019)

- Reduce potential flood damage
- Improve storm drainage
- Minimize future flood occurrence
- Minimize future hurricane damage
- Improve resistance of infrastructure to all hazards
- Minimize future earthquake damage
- Protect environmental resources/preserve open and green space
- Minimize future terrorist incidents
- Improve water quality
- Preserve historic building inventory
- Higher regulatory standard
- Minimize future hazardous material incident



MITIGATION STRATEGY

Update Existing Mitigation Actions

- Provide status update for existing mitigation actions (completed, deleted, deferred)

MITIGATION ACTION PLAN

Action	Description	Lead Agency	Potential Funding Service	Goal Addressed	Priority	Status
Type	Activity	Lead Dept.	Funding Source	Goal(s) Addressed	Priority (1 highest, 4 lowest)	Status
PI	Continue participating in the Project Impact Outreach Program for Public Information (PPI) to achieve maximum public outreach.	Building Services/ Project Impact committee members	Operating Funds	Establishing cooperative relationships between public, private and non-profit sectors to enhance preparedness and recovery for hazard events; educating citizens regarding their vulnerability to natural hazards and steps to take to reduce vulnerability	1	Basic emergency preparedness messages were communicated via our On-Hold Messages, Customer Newsletters, and our public Website throughout the period.

MITIGATION STRATEGY

Group Activity: Identification of New Actions

- Identify and discuss a full range of possible mitigation projects/available mitigation techniques
 - Consistent with mitigation goals and other community objectives
 - Based on hazard risk and local capability
- Critical facilities that need retrofitting/relocated
- Projects/activities to reduce hazard impacts
- Alleviate repetitive flood losses
- Others?
 - Emergency Services, Prevention, Natural Resource Protection, Property Protection, Structural Projects, Public Education

MITIGATION STRATEGY

- Mitigate Repetitive loss properties
 - Areas located in the AE/VE flood zones are at higher risk

MITIGATION STRATEGY

In General...

- **Strengthen and Protect Critical Facilities Educate Public**
 - Seasonal hazard awareness weeks
 - Encourage household preparedness
- **Identify pre-existing structures/rooms for sheltering**
- **Discourage future building in known hazard areas**
 - Flood prone areas are often great for parks
 - Create regulations to prevent development or require more stringent building standards

MITIGATION STRATEGY

Potential Actions to Mitigate Flooding

Local planning and regulatory efforts can be improved by:

- Limiting the percentage of allowable impervious surface within developed parcels
- Adding or increasing "freeboard" requirements (feet above base flood elevation) in the flood damage ordinance

MITIGATION STRATEGY

Potential Actions to Mitigate Flooding

Structures and Infrastructure Projects could be conducted safely by:

- Removing existing structures from flood hazard areas
- Installing, re-routing, or increasing the capacity of a storm-drainage system
- Conducting regular maintenance for drainage systems and flood control substances

Natural Systems can be Protected Through:

- Protecting and preserving wetlands to help prevent flooding in other areas
- Developing an open space acquisition, reuse, and preservation plan targeting hazard areas

MITIGATION STRATEGY

Potential Actions to Mitigate High Wind/Thunderstorm/Tornado

Strengthen building codes

- Tie-down requirements for manufactured housing
- Require structural bracing, straps/clips, anchor bolts, etc.

Protect power lines/traffic signals

- Schedule regular inspections of utility poles to ensure quality
- Mast arms for traffic lights

Retrofit buildings/facilities

- Anchor roof-mounted ventilation and heat/ac units
- Use load path connectors to strengthen structure

Safe Rooms

- Require in new schools, nursing homes
- Encourage construction in shopping malls, fairgrounds, manufactured home parks

MITIGATION STRATEGY



Report out by small groups



Review identified actions for
common themes

NEXT STEPS

Complete draft of plan to be developed by ESP

- Will eventually be submitted to SCEMD and to FEMA for review/approval



QUESTIONS, ISSUES, OR CONCERNS

Nathan Slaughter

(919) 415-2726

nslaughter@espassociates.com

Andrew Olive

aolive@espassociates.com

Hannah Delude

hdelude@espassociates.com

ATTENDEE LIST

City of Charleston Hazard Mitigation Plan

Kick-Off Meeting



Date: January 31, 2023

Time: 10:00am – 11:00am

Attendees:

Last Name	First Name	Title
Allen	Melissa	EM Specialist
Alltop	Matt	Superintendent of Environmental Services
Almquist	Benjamin	Director of Emergency Management
Ash	Charles	EM Specialist
Barnes	Janice	Climate Adaptation Partners, Founder
Bradley	George	Lieutenant, Police Department
Chappell	Wes	Deputy Director of Facilities, Parks
Coates	Joe	Director, Charleston County Emergency Management
Cockcroft	Forrest	Deputy Chief, Fire Operations
Corpuz	Alyssa	Floodplain Review Technician
DeCiantis	Frank Clark	Deputy Director of Parks Operations
DeLude	Hannah	Hazard Mitigation Planner, ESP Associates
Flessas	Daniel	EM Assistant
Granata	Ken	Chief Building Official
Hager	Sarah	Grant Writer
Hauck	Robert	GIS Director
Holton	Kinsley	Stormwater Regulatory Practice Leader, Floodplain Management
Julazadeh	Mike	Chief Fire Marshal, Fire Marshal
Kidd	Robin	Outreach Coordinator, Stormwater Management
Kiefer	Michael	Construction Program Manager, Housing & Community Develop
Kronsberg	Jason	Director of Parks
Kutscher	Owen	
Mardon	Sarah	
Mathis	Michael	Deputy Director, Parking Operations
O'Brien	Tom	Director of Public Service
Olive	Andrew	Hazard Mitigation Planner, ESP Associates
Overcash	Philip	Senior Planner
Rochester	Will	EM Specialist
Schnell	Carolina	Floodplain Manager

City of Charleston Hazard Mitigation Plan

HMP Kick-Off Meeting

Slaughter	Nathan	Project Manager, ESP Associates
Stanley	Matt	Police Lieutenant Department
Wenshaw	Victoria	
Wilbert	Mark	Senior Resilience Associate, Fernleaf

ATTENDEE LIST

City of Charleston Hazard Mitigation Plan

Mitigation Strategy Meeting



Date: May 16, 2023

Time: 10:00am – 2:00pm

Attendees:

Last Name	First Name	Title
Almquist	Benjamin	Director of Emergency Management
Ash	Charles	EM Specialist
Barnes	Janice	Climate Adaptation Partners, Founder
Bradley	George	Lieutenant, Police Department
DeLude	Hannah	Hazard Mitigation Planner, ESP Associates
Flessas	Daniel	EM Assistant
Granata	Ken	Chief Building Official
Hauck	Robert	GIS Director
Holton	Kinsey	Stormwater Regulatory Practice Leader, Floodplain Management
Julazadeh	Mike	Chief Fire Marshal, Fire Marshal
Kiefer	Michael	Construction Program Manager, Housing & Community Develop
McLaughlin	Keane	ESP Associates
Olive	Andrew	Hazard Mitigation Planner, ESP Associates
Rhodes	Kim	Fernleaf
Schnell	Caroline	Floodplain Manager
Slade	Shannon	
Slaughter	Nathan	Project Manager, ESP Associates
Stanley	Matt	Police Lieutenant Department
Wilbert	Mark	Senior Resilience Associate, Fernleaf

City of Charleston Hazard Mitigation Planning Meeting

14-Jun-23

NAME	POSITION IN THE MEOC	DEPARTMENT/ AGENCY (WHEN NOT ACTIVATED)	CONTACT #	E-MAIL (if not @charleston-sc.gov, note correct ending)	YOUR TIME IN	YOUR TIME OUT
Charles Evans	Ingevity Corp C&B F.I.D.	SCEND	(843) 9063844	Charles.Evans@Ingevity.com	1350	
David Jones	SCEND	(803) 14402161		David.Jones@endurance.com	1350	
Kianna Samuel	SCEND	(803) 17190384		Kianna.Samuel@charleston-sc.gov	1350	
Heather Howell	CCEND	(843) 1607-3919		Heather.Howell@charleston-sc.gov	1352	
Pat Carter	MPD	(843) 5346928		Pat.Carter@mpdsc.gov	1351	
Sam Tomlinson	Alcuni	(662) 240 0233		Samuel.Tomlinson@alcuni.com	153	
Doris Hockett	James Evans	(843) 795-4141		Doris.Hockett@james.evans.c.us	153	
Liz Foy	The Conservancy	(314) 757 0294		Liz.Foy@theconservancy-sc.gov	155	4:00
Katia McCormick	TPSC	()		@charleston-sc.gov	2:00	4:00
Talisha Coker	SCPA	()		@charleston-scpa.gov		
Richard Brown	SC PA	()		@charleston-scpa.gov		
Kenneth Marolda	West Ashley Comets	()		@charleston-scpa.gov		

City of Charleston Hazard Mitigation Planning Meeting

14-Jun-23

NAME	POSITION IN THE MEOC	DEPARTMENT/ AGENCY (WHEN NOT ACTIVATED)	CONTACT #	E-MAIL (if not @charleston-sc.gov, note correct ending)	YOUR TIME IN	YOUR TIME OUT
Todd F. Shipp	Charleston County EMA	843 746 3800	tschipp@charleston-sc.gov	1352	1617	
Mark Johnson	Town of James Island	843 1795 4411	mjohnson@jamesislandsc.gov	1:56		
Ryan Gorham	DHEC	(803) 1735-6716	gorham@dhec.sc.gov	1:57	3:50	
Belen Vitello	BCDCOG	()	belen@bcdcog.com	1:57		
Tee Backwell	Propane	(843) 303-3787	teebackwell@propane.com	1:57		
Rick Patrick	Red Cross	(843) 670 4633	brnt.patrick@redcross.org	1:57		
Daniel Flessig	CITY OF CHARLESTON EMA	(843) 872-8672	flessig@charleston-sc.gov	2:00		
Brittany Rubin	Red Cross	(843) 518 0391	brittany.rubin@redcross.org	2:10		
Lawry Howard	Lanxess	(843) 740-5305	Lawrence.Howard@Lanxess.com	2:50	4:03	
()			@charleston-sc.gov			
()			@charleston-sc.gov			
()			@charleston-sc.gov			

1. Summary	
Meeting title	Hazard Mitigation Stakeholder Meeting
Attended	12
Start time	6/14/23, 1:54:10 PM
End time	6/14/23, 4:04:56 PM
Meeting duration	2h 10m 46s
Average attendance time	1h 28m 23s

2. Participants

Name	First join	Last leave	In-meeting duration	Email	Participant ID (UPN)	Role
Ash, Charles	6/14/23, 1:54:35 PM	6/14/23, 4:04:35 PM	2h 10m	ashc@charleston-sc.gov	ashc@charleston-sc.gov	Organizer
Bailey, Kimberly	6/14/23, 1:54:43 PM	6/14/23, 3:30:14 PM	1h 35m 30s	baileyki@musc.edu	kib220@musc.edu	Presenter
Palmer, Stephanie	6/14/23, 1:58:50 PM	6/14/23, 4:03:27 PM	2h 1m 59s	Stephanie.Palmer@rsfh.com	Stephanie.Palmer@rsfh.com	Presenter
Darcy Boykin (Guest)	6/14/23, 1:58:59 PM	6/14/23, 2:11:48 PM	12m 48s			Presenter
Julazadeh, Mike	6/14/23, 1:59:15 PM	6/14/23, 4:03:25 PM	1h 35m 58s	JULAZADEHM@charleston-sc.gov	JULAZADEHM@charleston-sc.gov	Presenter
Steve Jones - FBI (Guest)	6/14/23, 1:59:32 PM	6/14/23, 4:03:39 PM	2h 4m 7s			Presenter
Diane Fox	6/14/23, 2:00:11 PM	6/14/23, 3:30:32 PM	1h 30m 21s			Presenter
Cockcroft, Forrest	6/14/23, 2:02:35 PM	6/14/23, 3:34:28 PM	1h 31m 52s	COCKCROFTF@charleston-sc.gov	COCKCROFTF@charleston-sc.gov	Presenter
Rubin, Brittany	6/14/23, 2:03:30 PM	6/14/23, 2:16:14 PM	12m 44s	brittany.rubin@redcross.org	brittany.rubin@redcross.org	Presenter
Searson, Chip	6/14/23, 2:09:18 PM	6/14/23, 4:04:56 PM	1h 55m 37s	searsonfm@cofc.edu	searsonfm@cofc.edu	Presenter
Darcy Boykin (Guest)	6/14/23, 2:13:05 PM	6/14/23, 4:03:16 PM	1h 50m 10s			Presenter
Hurtes, William	6/14/23, 2:49:08 PM	6/14/23, 3:48:42 PM	59m 34s	william.hurtes@redcross.org	william.hurtes@redcross.org	Presenter



City of Charleston 2023 Hazard Mitigation Plan

The City of Charleston continues to work to become more resilient and less vulnerable to the impacts of hazard events, both natural and manmade. To achieve our goals, we need your help and your input is important to us!

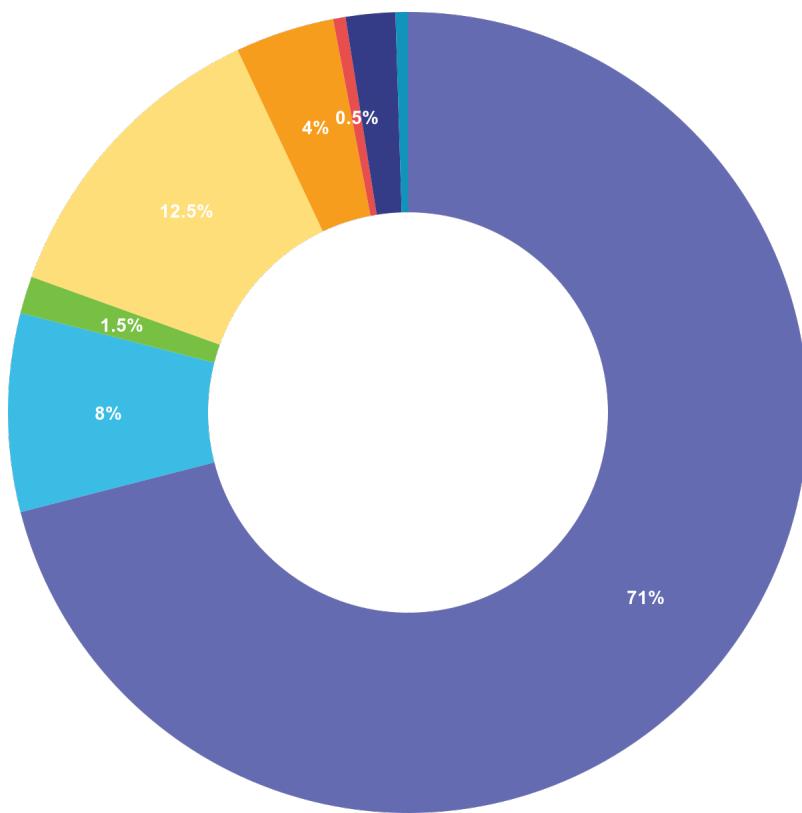
We are in the early stages of the planning process to develop a Hazard Mitigation Plan for the City. This Plan will identify and assess our community's hazard risks in order to better understand our vulnerabilities and to create appropriate strategies intended to minimize or manage those risks.

This survey is an opportunity for you to share your opinions and participate in the hazard mitigation planning process. The information you provide will help us better understand your hazard concerns and can lead to mitigation activities that should help lessen the impacts of future hazard events.

If you have any questions regarding this survey or would like to learn about more ways you can

participate in the update of the City's Hazard Mitigation Plan, please contact ESP Associates, Inc, planning consultant for the project. You may reach Nathan Slaughter (ESP Associates) at 919-415-2726 or by email at nslaughter@espassociates.com. Hard copies can be mailed to 2200 Gateway Centre Blvd., Suite 216, Morrisville, NC 27560

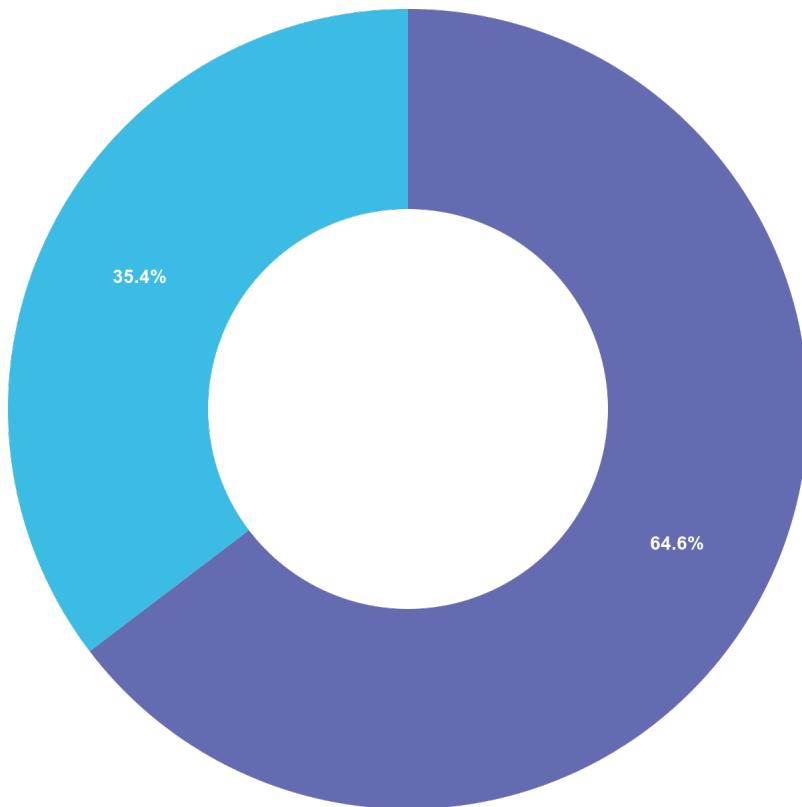
Q1 Where do you live?



Answered: 200 **Unanswered:** 2

Choice	Total
Own property and live inside City limits	142
Rent inside City limits	16
Own property inside City limits, but live outside of City limits	3
Outside City limits, but neighboring community in Charleston County	25
Outside City limits, but in the Lowcountry	8
Out of City limits, but in South Carolina	1
Out of State	4
Out of Country	1

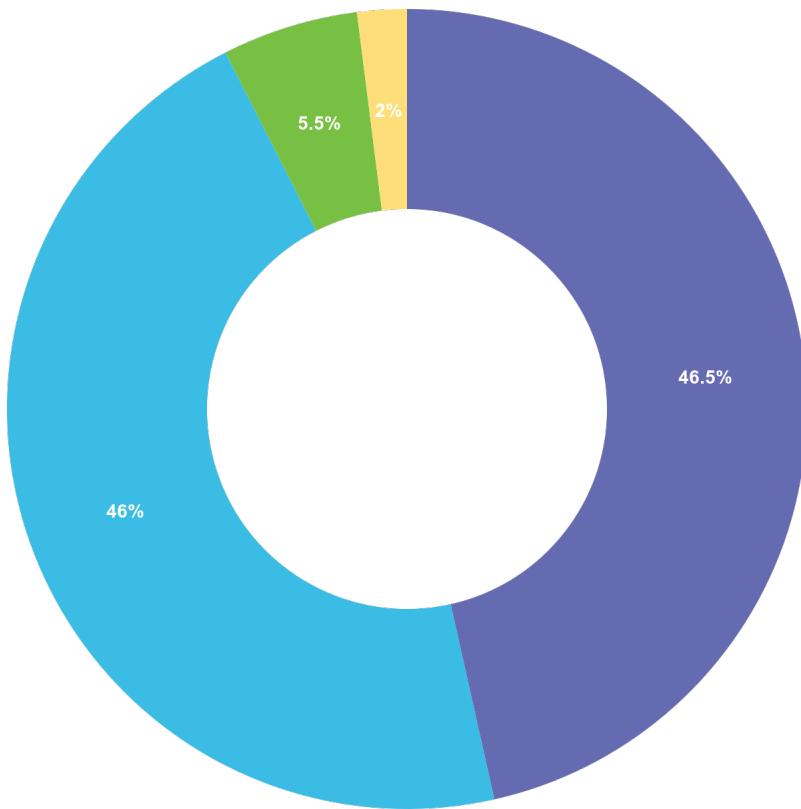
Q2 Have you ever been impacted by a disaster that occurred in the City of Charleston?
If yes, please explain in the comment box provided.



Answered: 198 **Unanswered:** 4

Choice	Total
Yes	128
No	70

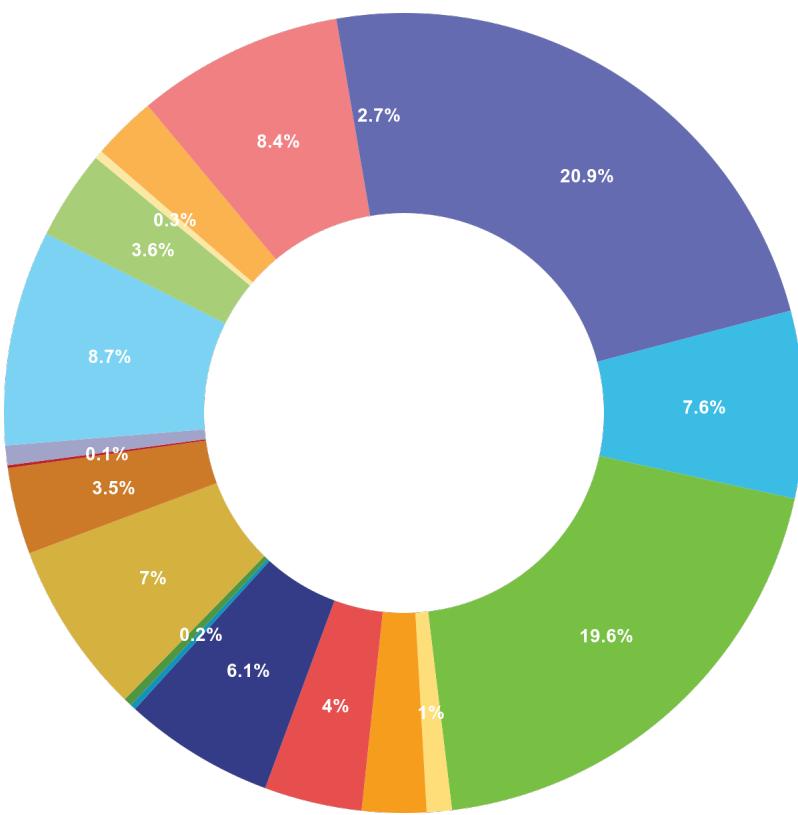
Q3 How concerned are you about the possibility of your community being impacted by a disaster?



Answered: 200 Unanswered: 2

Choice	Total
Extremely concerned	93
Somewhat concerned	92
Not concerned	11
Unsure	4

Q4 Please select **five** hazards you are most concerned about in your neighborhood.
Explain your reasoning in the comment box below.



Answered: 199 Unanswered: 3

Choice	Total
Hurricanes and Tropical Storms	185
Severe Thunderstorms and Lightning	67
Flooding	174
Drought	9
Winter Storms	23
Sinkholes	35
Public Health Hazard/Infectious Disease	54
Tsunami	2
Rip Currents	3
Coastal Erosion	62

Choice	Total
 Tornadoes/Waterspouts	31
 Wildfire	1
 Hail	7
 Earthquake	77
 Hazardous Materials	32
 Nuclear Power Plants	3
 Terrorism	23
 Extreme Heat	74
 Cyber Threats	24

Q5 Are there any other hazards that you feel pose a wide-scale threat to your community? If yes, please explain. If not, state "N/A."

Saturday, August 12, 2023 at 3:31 PM UTC

N/A

Monday, July 3, 2023 at 4:57 PM UTC

Did the city not just complete and All Hazards and Vulnerability Assessment? Why are we still planning and not changing our ways based on the information we already have? I apologize for the tone of these comments. I am very frustrated by this questionnaire.

Thursday, June 29, 2023 at 12:35 AM UTC

Poor storm drainage maintenance that does not allow for proper flow of neighborhood ponds and other drainage systems set up by the City.

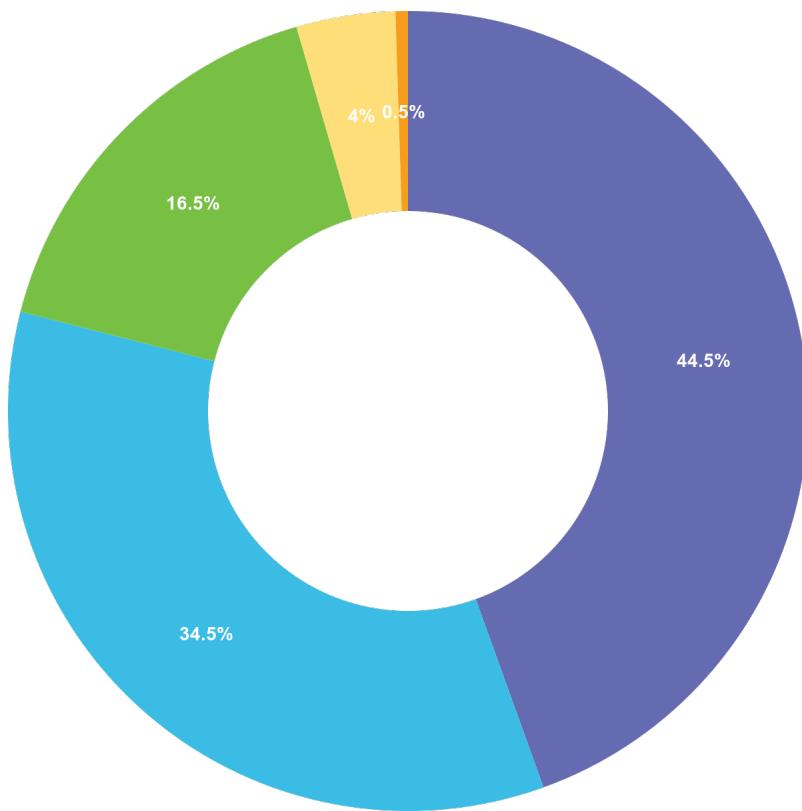
Friday, June 23, 2023 at 9:34 PM UTC
flooding

Friday, June 16, 2023 at 8:04 PM UTC
Global warming generally

Answered: 147 **Unanswered:** 55

Q6 Is your home located in a floodplain?

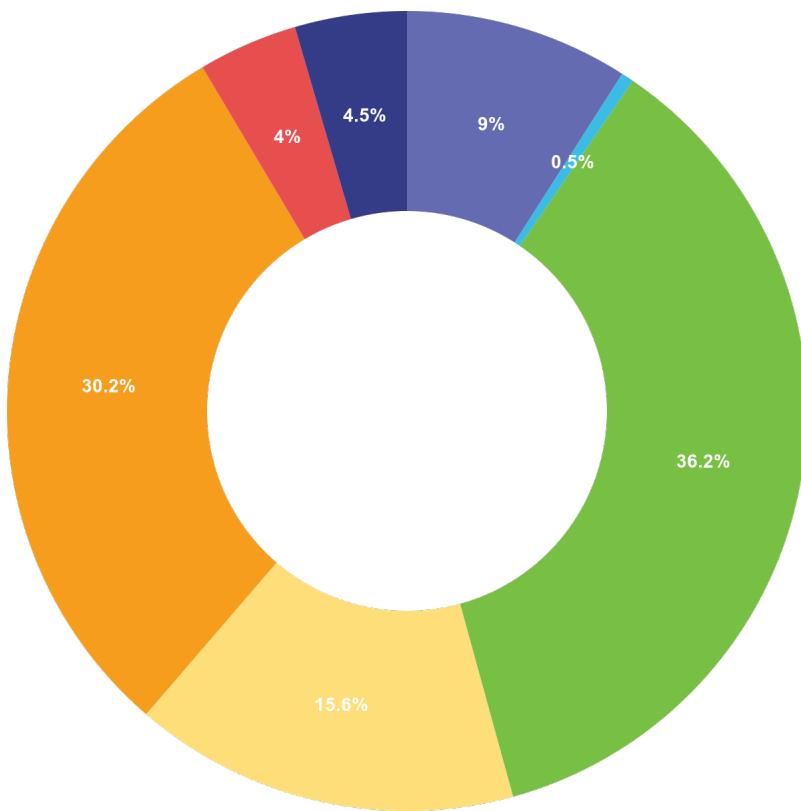
Check your current flood zone here: <https://msc.fema.gov/portal/search>



Answered: 200 Unanswered: 2

Choice	Total
Yes	89
No	69
No, but I still experience flooding	33
I'm not sure	8
Prefer not to answer	1

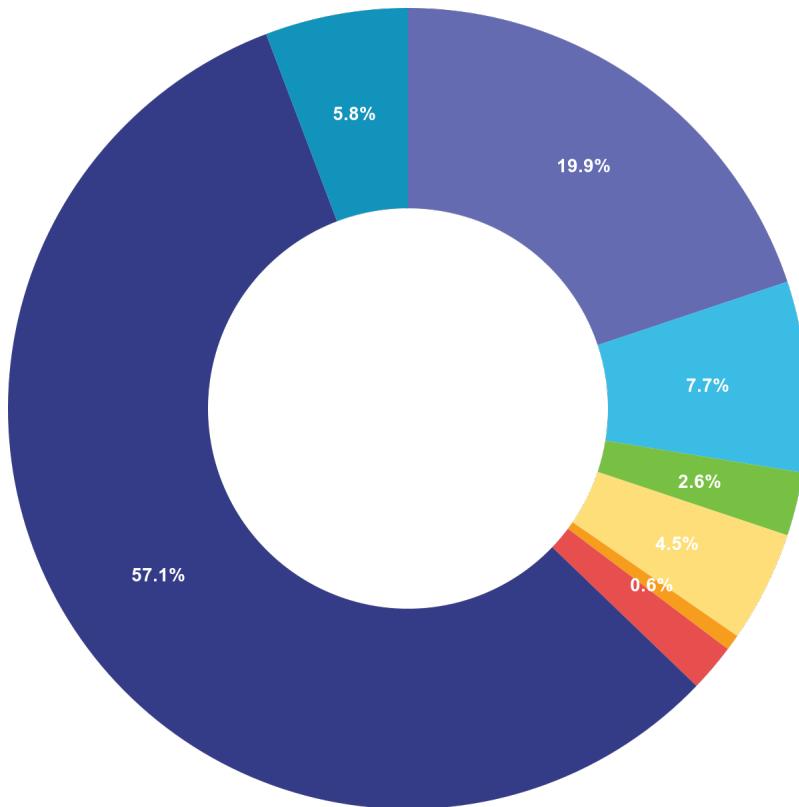
Q7 Do you have flood insurance?



Answered: 199 Unanswered: 3

Choice	Total
Yes, NFIP Building Coverage	18
Yes, NFIP Contents Coverage	1
Yes, NFIP Building and Contents Coverage	72
Yes, Private Flood Insurance (Non-NFIP)	31
No	60
I'm not sure	8
Prefer not to answer	9

Q8 If you do not have flood insurance, why not? If other, please explain in the comment box provided below.

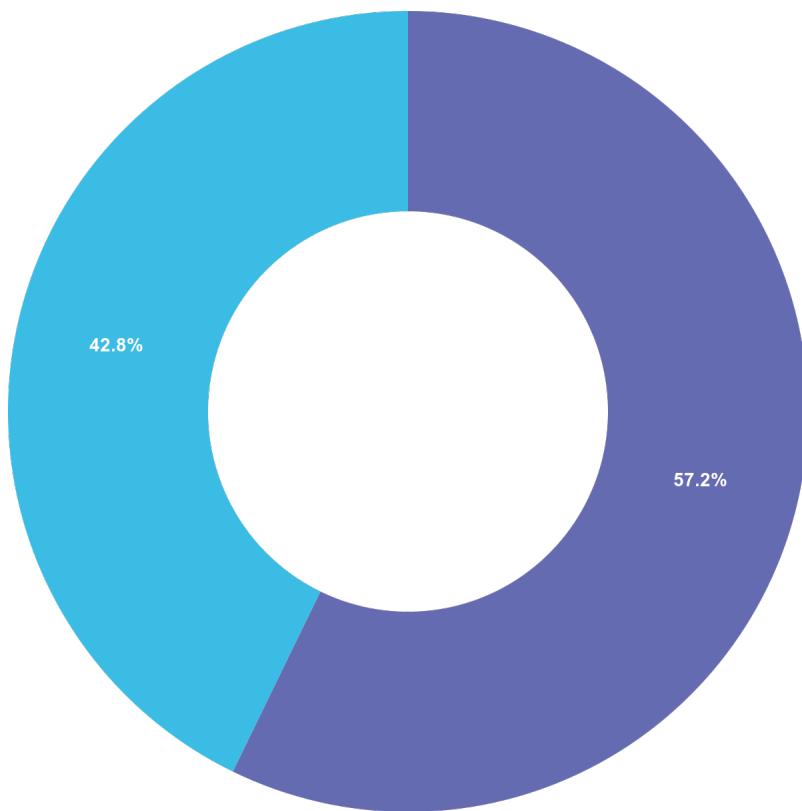


Answered: 156 **Unanswered:** 46

Choice	Total
Not located in a floodplain	31
Too expensive	12
Not necessary because it never floods	4
Not necessary because I am elevated or otherwise protected	7
Never really considered it	1

Choice	Total
I used to, but my bank no longer requires it	3
I have flood insurance	89
Prefer not to answer	9

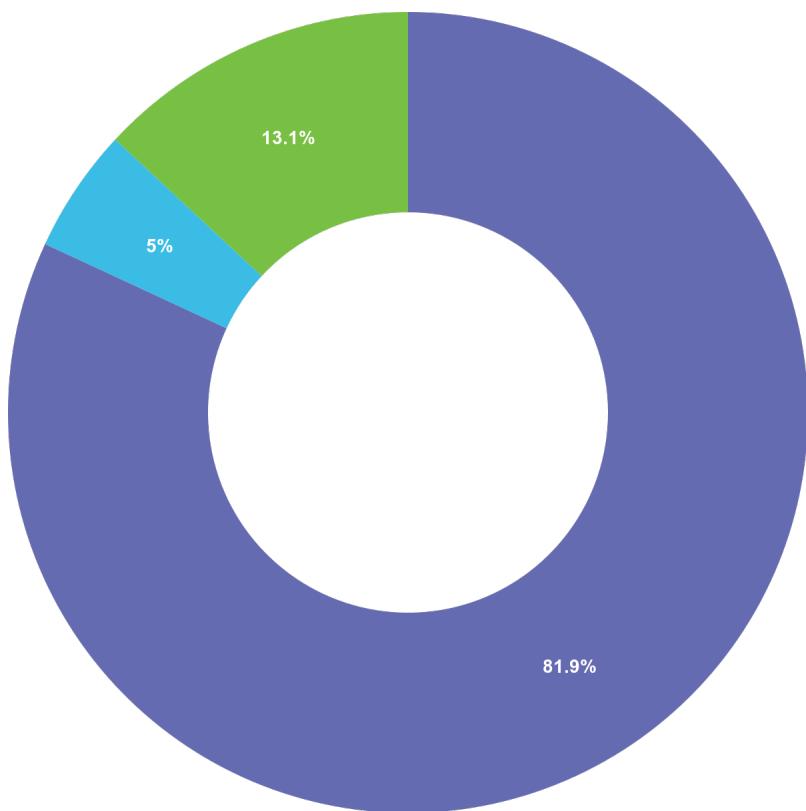
Q9 Have you taken any steps to make your home or neighborhood more resistant to hazards? If yes, please explain specific actions taken in the comment box provided below.



Answered: 194 Unanswered: 8

Choice	Total
Yes	111
No	83

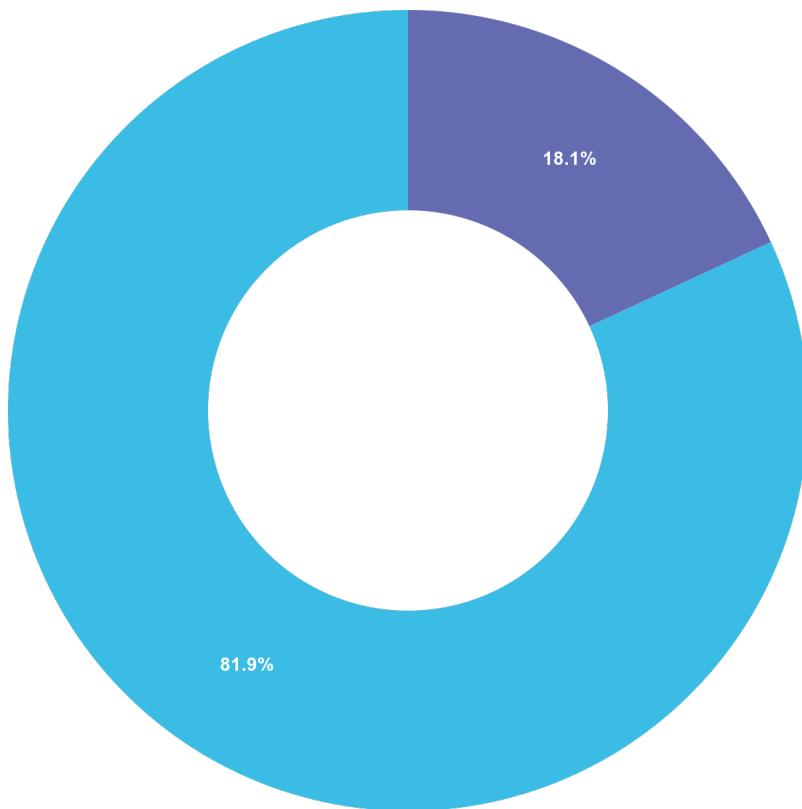
Q10 Do you have interest in making your home or neighborhood more resistant to hazards?



Answered: 199 Unanswered: 3

Choice	Total
Yes	163
No	10
I'm not sure	26

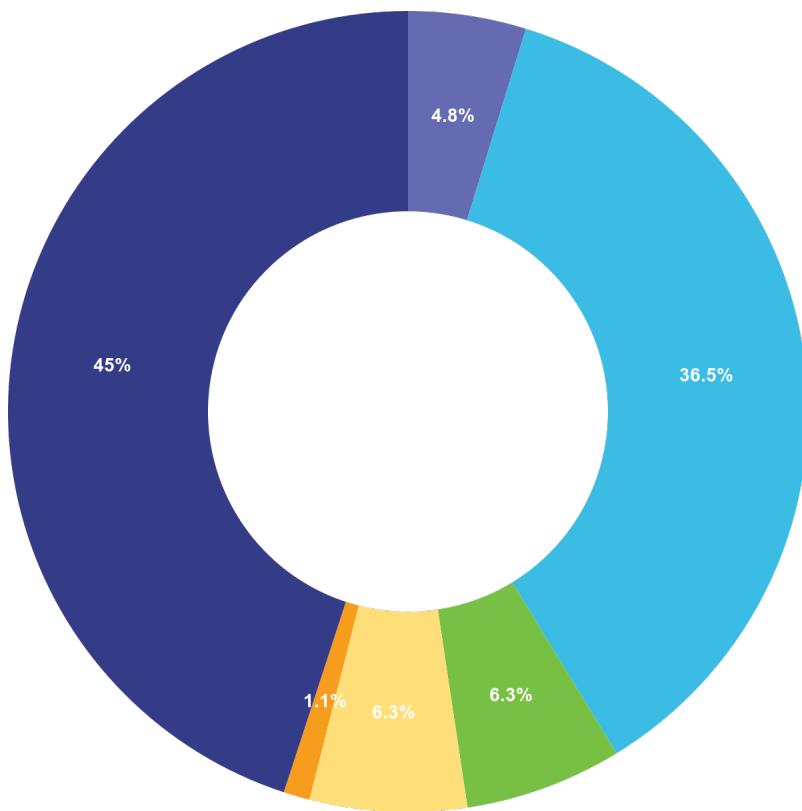
Q11 Do you know what office to contact to find out more information about how to reduce your vulnerability to hazards in your area?



Answered: 199 Unanswered: 3

Choice	Total
Yes	36
No	163

Q12 What is the most effective way for you to receive information about how to make your home and neighborhood more resistant to hazards? If other, please specify in the comment box provided below.



Answered: 189 Unanswered: 13

Choice	Total
Newspaper	9
Mail	69
Television	12
Public Workshop/Meeting	12
Radio	2
School Meetings	0
Internet (including social media)	85

Q13 In your opinion, what are some steps your local government could take to reduce or eliminate risk of future hazard damages in your neighborhood?

Saturday, August 12, 2023 at 3:31 PM UTC

I have no idea.

Monday, July 3, 2023 at 4:57 PM UTC

Nature Based Solutions

Be much pickier about the developments allowed. Charleston can afford to have nice things at developers' expense.

Thursday, June 29, 2023 at 12:35 AM UTC

1. Reduce fill and build options for new developments
2. Ensure drainage systems have been properly maintained
3. Conserve as much green space and wetlands as possible to ensure that the water has somewhere to go
4. Strengthen building codes and, in some cases, only allow for elevated buildings
5. Ensure roadways have proper drainage where possible to avoid large pools of water just sitting on the

roadway

Friday, June 23, 2023 at 9:34 PM UTC

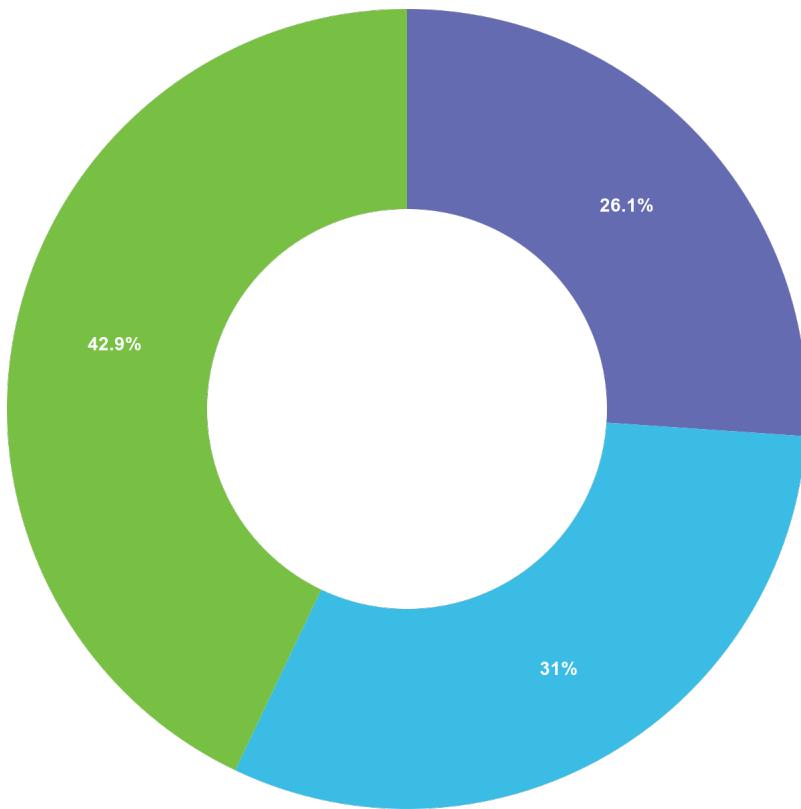
Stormwater needs more resources. SC DOT needs to maintain its roadways.

Friday, June 16, 2023 at 8:04 PM UTC

Take steps to prevent over development of expensive, single family housing, maintain water removal flows, treat climate change seriously.

Answered: 165 **Unanswered:** 37

Q14 Are there any other issues regarding the reduction of risk and loss associated with hazards or disasters in your community that you think are important? If yes, please specify in the comment box provided.



Answered: 184 Unanswered: 18

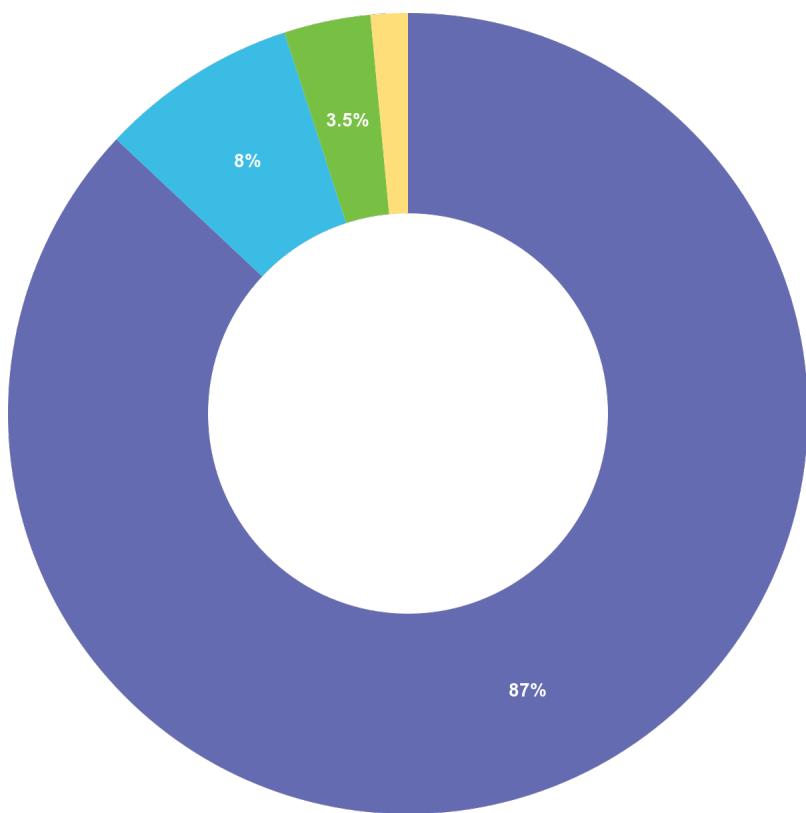
Choice	Total
Yes	48
No	57
I'm not sure	79

Q15 A number of community-wide activities can reduce our risk from hazards. In general, these activities fall into one of the following six broad categories. In the next six questions, please tell us how important you think each one is for your community to

consider pursuing.

Prevention - Administrative or regulatory actions, policies, or local ordinances that influence the way land is developed and buildings are built.

Examples include planning and zoning, building codes, open space preservation, land use, and floodplain regulations.



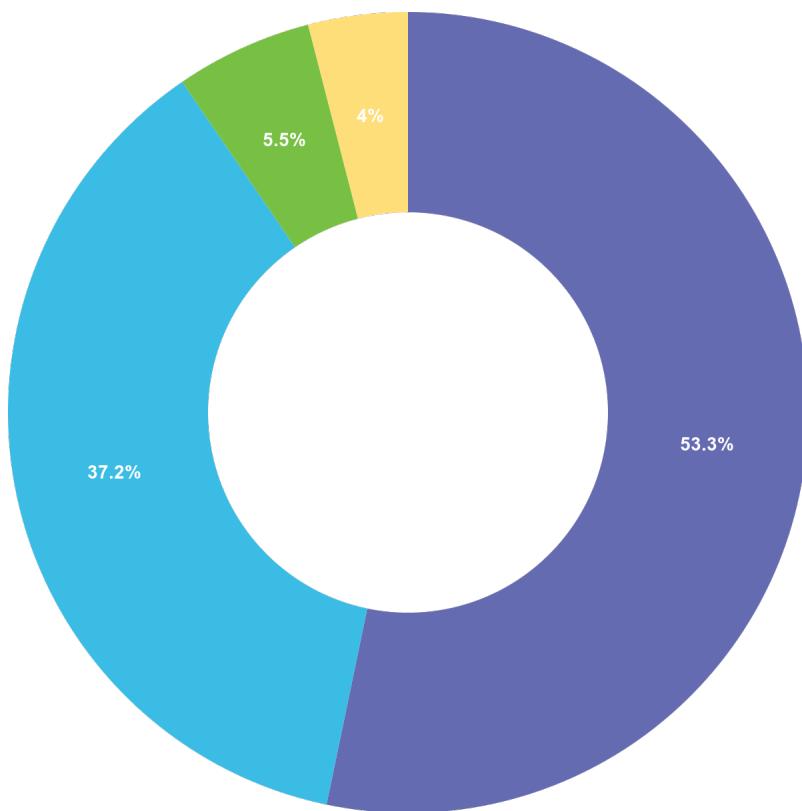
Answered: 200 Unanswered: 2

Choice	Total
Very important	174

Choice	Total
Somewhat important	16
Not important	7
I'm not sure	3

Q16 Property Protection - Actions that involve the modification of existing buildings to protect them from a hazard or removal from the hazard area.

Examples include acquisition, relocation, elevation, structural retrofits, and storm shutters.

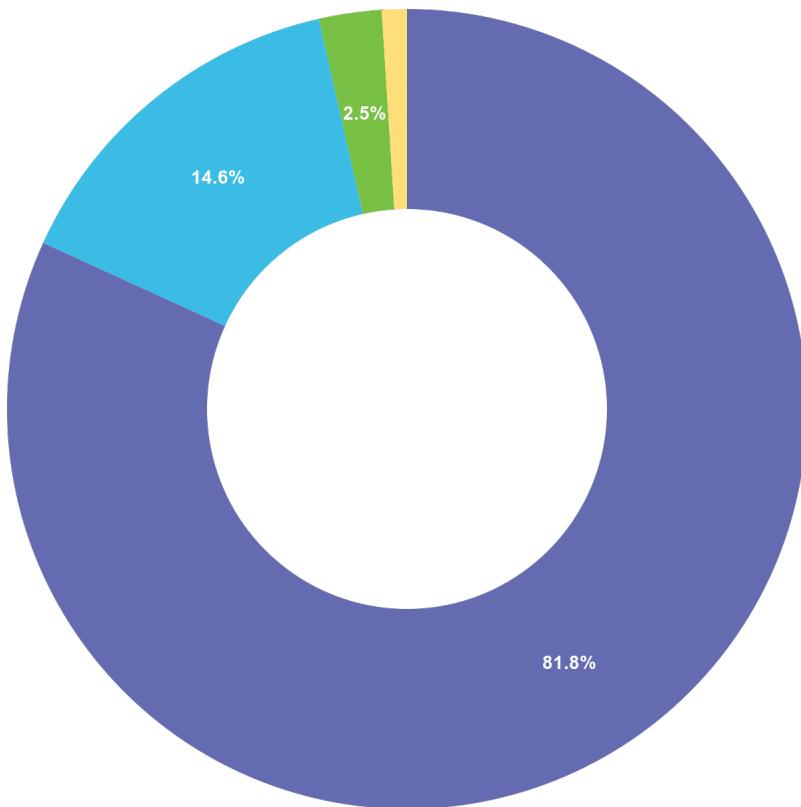


Answered: 199 Unanswered: 3

Choice	Total
Very important	106
Somewhat important	74
Not important	11
I'm not sure	8

Q17 Natural Resource Protection - Actions that, in addition to minimizing hazard losses, also preserve or restore the functions of natural systems.

Examples include: floodplain protection, habitat preservation, slope stabilization, stream buffers, wetland and marsh protection, and forest management.

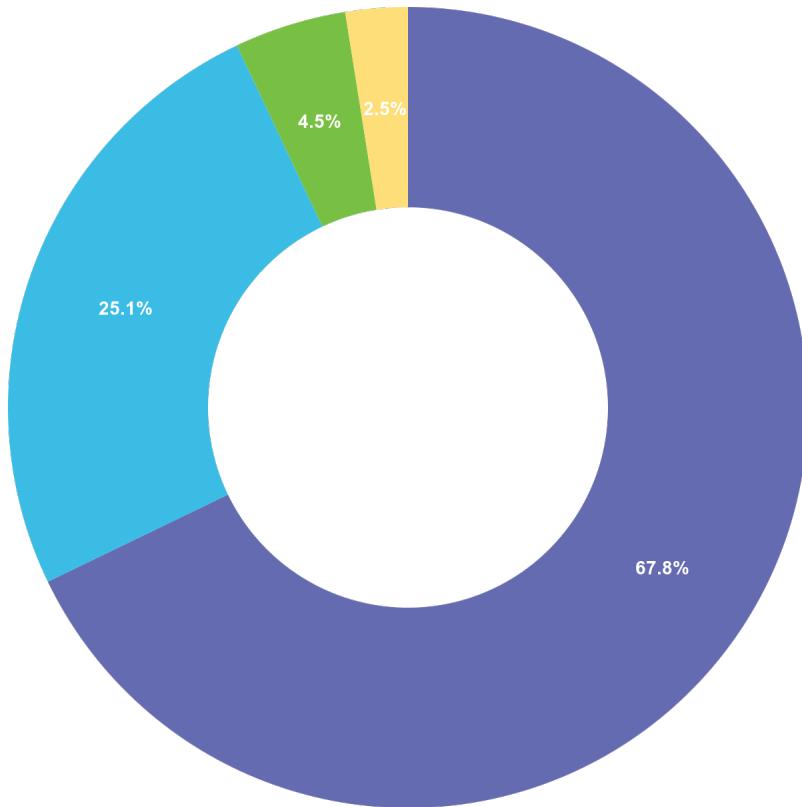


Answered: 198 Unanswered: 4

Choice	Total
Very important	162
Somewhat important	29
Not important	5
I'm not sure	2

Q18 Structural Projects - Actions intended to lessen the impact of a hazard by modifying the natural progression of the hazard.

Examples include dams, levees, floodwalls, berms, drainage infrastructure (ditches/channels, stormwater ponds, and pipes and pumps), detention/retention basins, channel modification, retaining walls and storm sewers.

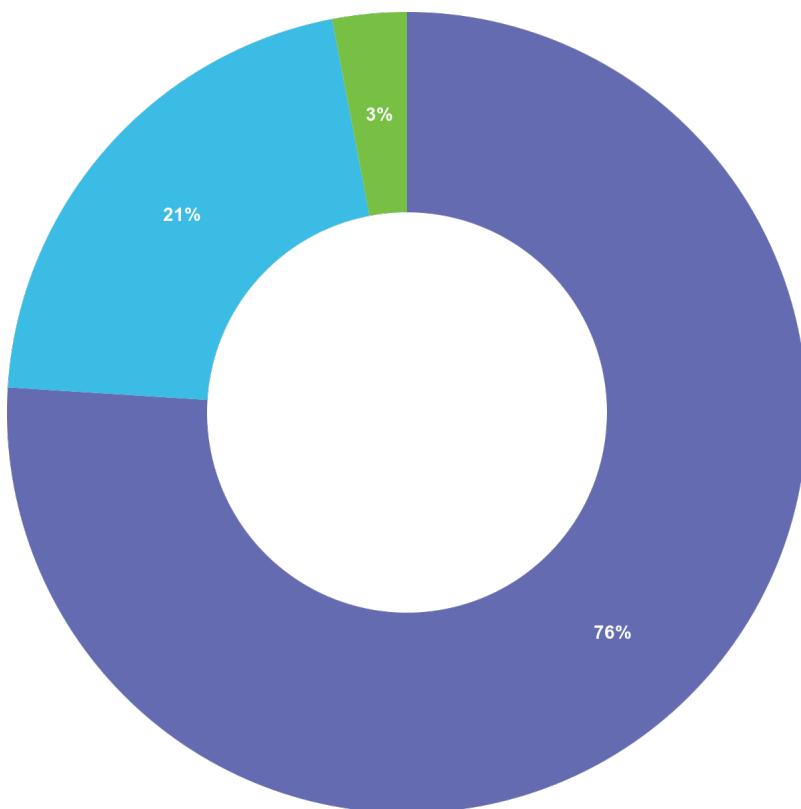


Answered: 199 **Unanswered:** 3

Choice	Total
Very important	135
Somewhat important	50
Not important	9
I'm not sure	5

Q19 Emergency Services - Actions that protect people and property during and immediately after a hazard event.

Examples include warning systems, evacuation planning, emergency response training, and protection of critical emergency facilities or systems.



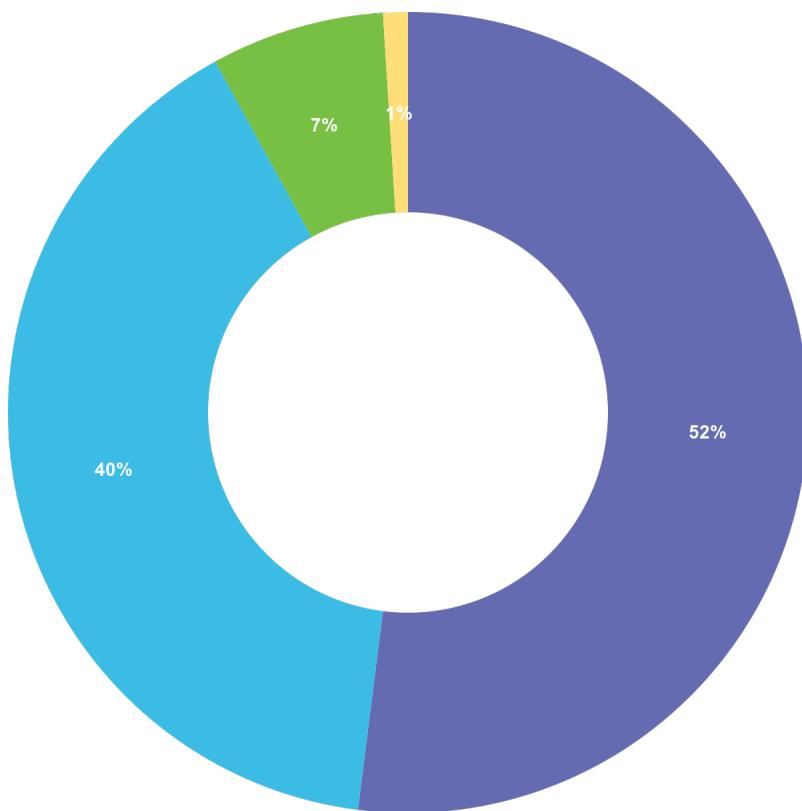
Answered: 200 **Unanswered:** 2

Choice	Total
Very important	152
Somewhat important	42
Unimportant	6

Choice	Total
Not important	6
I'm not sure	0

Q20 Public Education and Awareness - Actions to inform citizens about hazards and the techniques they can use to protect themselves and their property.

Examples include outreach projects, school education programs, library materials and demonstration events.



Answered: 200 **Unanswered: 2**

Choice	Total
Very important	104
Somewhat important	80
Not important	14
I'm not sure	2

Q21 This survey may be submitted anonymously; however, if you provide us with your name and contact information below, we will have the ability to follow up with you to learn more about your ideas or concerns. (Optional)

Saturday, August 12, 2023 at 3:31 PM UTC

Donna Flickinger. Dflickend@hotmail.com.

Monday, July 3, 2023 at 4:57 PM UTC

Sorry, but I answered very hastily and would prefer not to put a name to it.

Monday, May 22, 2023 at 4:55 PM UTC

Anthony Del Porto

anthony.delporto@gmail.com

Monday, May 22, 2023 at 3:16 PM UTC

Dr Edward Starr Hazard III

1638 Baldock Court

MtP 29464

Monday, May 15, 2023 at 6:48 PM UTC

Christine von Kolnitz, vonkolnc1@gmail.com

Answered: 58 Unanswered: 144

MEETING MINUTES

Meeting Minutes from City of Charleston Hazard Mitigation Planning Team Kickoff Meeting

City of Charleston MEOC/Microsoft Teams

January 31, 2023

10:00 am – 11:00 am

The purpose of the Kickoff Meeting was to provide an overview of mitigation, the project scope, and the tentative project schedule. The Kick-Off Meeting was intended to give a broad overview of the history, techniques, funding, and opportunities offered by effective hazard mitigation.

This meeting was conducted both online and in-person offering a hybrid approach intended to maximize attendance. There was a total of 33 participants at the Kick-Off Meeting, most of which logged on virtually. Police, fire, emergency management, community development, planning and other departments were represented at this initial meeting. There was also representation of all three (3) consultants were selected: ESP Associates, Inc., Fernleaf, and Climate Adaptation Partners.

Mr. Slaughter began the hybrid meeting with introductions. Each attendee was asked to share their name and the position they held. Mr. Slaughter briefed the participants of the consultants work in the low country of South Carolina including previous work within the City of Charleston. He then reviewed the scheduled agenda for the meeting to give attendees an idea of what the meeting would consist of in terms of content and time.

Following the agenda review, Mr. Slaughter began his presentation on mitigation and process overview. This portion of the presentation was intended to be informative before moving on to a group activity and project specific information. Below is an outline of the information provided to the planning team:

- Hazard occurrence is both natural and inevitable therefore we must plan for them accordingly,
- FEMA's definition of hazard mitigation,
- Review of the Disaster Act of 2000,
- Types of mitigation (existing development vs. future development), and
- Mitigation techniques (prevention, property protection, natural resource protection, structural project, emergency services, public education, and awareness).

Participants were then asked to participate in an activity using Menti (an online and live voting tool). The activity stated, *"You have \$100 to spend. How would you allocate that funding across the six mitigation techniques?"* The planning team's input would help gauge which activities may be most useful for the City of Charleston. They were given a few minutes to complete the activity, and all answers would remain anonymous. Since Menti offers a live feature, Mr. Slaughter shared the results of the activity in real time. The following image captures the results of the poll with a total of 22 individuals casting a vote (**Figure 2.2**).

You have \$100 to spend. How would you allocate that funding across the six mitigation techniques?

 Mentimeter



Figure 2.1: City of Charleston Menti Survey Results

Source: Menti

Answers were well balanced with prevention ranking the highest and emergency services, structural projects, and property protection all ranking second. Mr. Slaughter encouraged participants to explain their reasoning to gain a better understanding of their decision-making process. Prevention was said to yield long term return as opposed to addressing the symptoms of more entrenched issues. Mr. Slaughter explained that prevention and public awareness are a shared resource, and when strategically implemented, give the City a large return at a lower cost. It was also noted that an emergency warning system is in development for the City of Charleston.

Mr. Slaughter then reviewed the Project Scope. The Project Scope is broken down into six (6) subtasks that are intended to keep the project progressing in a timely manner while also meeting key requirements for successful implementation. The following lists gives an overview of each task:

- Task 1: Hazard Mitigation Planning Team Coordination
- Task 2: Stakeholder and Public Involvement Strategy
- Task 3: Hazard Identification and Risk Assessment
- Task 4: Develop Goals, Objectives, and Actions
- Task 5: Assemble the Plan
- Task 6: Complete Plan Review and Adoption

The City of Charleston will be conducting an all-hazard plan although FEMA only requires natural hazards. This means that in addition to traditional natural hazards, the City will also be considering man-made hazards such as terrorism, hazardous materials, infectious diseases, etc. In terms of scoring, most hazards are anticipated to score high using FEMA standards making the Charleston and the specific strategies strong candidates for future funding opportunities.

Similar to project scope, the mitigation process was also outlined. Fernleaf will be primarily responsible for analysis and data collection for the risk assessment portion of the process. The aim is to tap into good

existing data that is readily available while looking for new and updated data for more appropriate strategies. Mr. Slaughter highlighted that mitigation measures are the most important step in the process as they determine what actions are needed to reduce the impact of future occurrences. These actions will include a description, lead agency, funding, target, completion date and status. The status should be updated in the 5-year period to show whether the action has been complete, ongoing, underway, incomplete, needs funding or is no longer applicable.

Typically, this process takes about one year to complete, but has been condensed down into an eight (8) month time frame. Since the City of Charleston has participated in the Charleston County Regional Hazard Mitigation Plan, existing information and strategies exist that will serve as a strong foundation for the City's Hazard Mitigation Plan. Additionally, the City has a high capacity which is reflected in the Kick-Off Meetings large turnout, which will also help accelerate the process.

The floor was then opened to any additional comments or questions. Mr. Slaughter then presented the next steps in the process, which included the (1) Adding any members to the Planning Team, (2) scheduling the next Planning Team meeting, (3) Publishing the Public Survey, (4) Additional outreach efforts, and (5) Scheduling public meetings and workshops.

Mr. Slaughter concluded the presentation by thanking the attendees for their time. The meeting was adjourned.

Meeting Minutes from City of Charleston Hazard Mitigation Planning Team Mitigation Strategy Meeting

City of Charleston Committee Meeting Room/Microsoft Teams

May 16, 2023

10:00 AM – 2:00PM

On May 16, 2023, the City of Charleston hosted a Mitigation Strategy Workshop. The purpose of this meeting was to present initial findings from the risk and capability assessments, receive feedback from the Hazard Mitigation Planning Team and begin to discuss mitigation actions to include in the City's Mitigation Action Plan. Benjamin Almquist from Charleston Emergency Management began the meeting by welcoming attendees. He then turned the meeting over to Nathan Slaughter, Project Manager from ESP Associates who then delivered the presentation and led the discussion. Below is a summary of the presentation and the comments received.

Mr. Slaughter also welcomed attendees and reviewed the agenda for the meeting. He then asked meeting attendees to introduce themselves. The twenty-one (21) attendees represented City staff and members of the consulting team. He then gave an overview and definition of mitigation, the Disaster Mitigation Act of 2000 and why we plan, and the key objectives of the project. He reviewed the project tasks and project schedule. He stated that a draft of the Hazard Mitigation Plan would be presented in Fall of 2023.

Mr. Slaughter then began presenting the initial findings of the risk assessment. He started by providing a summary of hazards and defining vulnerability. He explained that disasters occur when hazards interface with the built environment. He shared the list of all hazards that are to be addressed in the plan, and reviewed the list of hazards addressed in the South Carolina State Hazard Mitigation Plan and the Charleston Regional Hazard Mitigation Plan. He discussed how the hazards in the City's plan would

be aligned to match up with the hazards in the State Plan and the regional plan, but would also consider other hazards that the City may want to address in addition to those hazards.

The hazards identified for the plan include the following:

Natural Hazards:

- Hurricane
- Flooding
- Sea Level Rise
- Earthquake
- Tornado
- Wildfire
- Tsunamis
- Dam Failure
- Drought
- Winter Weather
- Shoreline Erosion
- Extreme Heat
- Public Health Hazards

Technological Hazards:

- Hazardous Materials Release
- Infrastructure Failure
- Radiological Emergency

Human-Caused

- Cyber Incident
- Civil Disturbance
- Terrorism
- Active Threat
- Water Shortage

Mr. Slaughter discussed a couple of planning assumptions that were made for the risk assessment and indicated that best available data was used. He explained that best available data was used to develop the hazard profiles and that while that information is helpful, events are often under-reported, so it is important to keep the end goal in sight. The purpose of the risk assessment was shared: to compare hazards and determine which should be the focus of the mitigation actions. Finally, he mentioned to the stakeholders that it ultimately is their risk assessment, so their recommendations for adjustment are welcomed and encouraged.

Mr. Slaughter next provided a timeline of the eleven disaster declarations that have been made that included the City. These disasters help emphasize the need to continue implementing and updating the mitigation plan.

Mr. Slaughter then explained how the hazards were ranked for the city using a scoring tool called the Priority Risk Index (PRI). The PRI categorizes and prioritizes potential hazards as high, moderate or low risk based on probability, impact, spatial extent, warning time, and duration. He explained that the draft scoring for the identified hazards would be presented after summary slides for each identified hazard were shared and any additional information from the workshop participants was considered.

Following, the overview of the PRI, the following Hazard Profiles and summaries of each hazard were shared:

- HURRICANES AND COASTAL HAZARDS: 43 storm tracks have come within 50 miles of the City since 1970. 13 were tropical depressions, 22 tropical storms and 8 hurricanes. Future occurrences are likely.
- FLOODING: There are 25,985 NFIP policies in place in the City as of 2022. There have been over 6,649 reported NFIP losses since 1978 and approximately \$117 million in claims.
- SEA LEVEL RISE: According to a NOAA study, the sea level off the South Carolina coast is up to 10 inches higher than it was in 1950. The rate has accelerated over the last 10 years and is now rising by about an inch every two years. City staff indicates that they are planning for an additional 14" of sea level rise by 2050 and have mapped what that might look like. Future occurrence is likely.
- EARTHQUAKE: The Charleston Earthquake of 1886 is the most significant historical event of record with an estimated magnitude of 7.3. The occurrence of a similar event in the future is possible and would have tremendous impacts on the City. The College of Charleston has modeled what that event may look like should it occur today. Results are included in Section 6: Vulnerability Assessment. Future occurrences are possible.
- TORNADOES: There have been 62 recorded events since 1957, causing \$5.96 in property damage. The greatest extent was an F3 event in 1960. Future occurrences are likely.
- WILDFIRE: Wildfires and conflagration is a hazard of concern for the City. There are areas of wildland urban interface throughout the City and future occurrences are likely.
- TSUNAMI: Low-lying areas of the City could be impacted by a tsunami but probability of a tsunami are very low and future occurrences are unlikely.
- DAM FAILURE: There are no dams in the City, but the nearby Santee Cooper, Pinopolis, Bushy Park/Goose Creek area dams would impact the City if they were to fail. However, future occurrences of failure are unlikely.
- DROUGHT: There were 20 regional drought events between 1996 and 2022, and future occurrences are likely.

- SEVERE THUNDERSTORMS: There have been 78 severe thunderstorms reported for the City since 1995. Future occurrences are highly likely.
- HAILSTORM: There have been 9 recorded events since 1999. Future occurrences are likely.
- LIGHTNING: Since 1999, there have been 2 reported lightning events. Future occurrences are highly likely.
- WINTER WEATHER: 7 winter weather events have been reported for the region between 2000-2021. Future occurrences are possible.
- SHORELINE EROSION: While there is no beach front - salt marshes in Charleston provide buffer to against coastal storms and flooding. NOAA studies estimate that South Carolina could lose up to 23% of its existing salt marshes by 2060 and 46% by 2100 from a 4-foot rise in sea levels. Future occurrences are likely.
- EXTREME HEAT: There have been 19 extreme heat events reported in the region between 1996-2023 with a record high temperature of 105 degrees reported for Charleston in 1999. Future occurrences are likely.
- SINKHOLES: There have been 3 reported sinkhole events in Charleston. Future occurrences are possible.
- PUBLIC HEALTH EMERGENCY: Hazard of great concern recently. Most recently, the COVID-19 pandemic continues to impact the City. Future occurrences are possible.
- STORM SURGE: More properties in Charleston are vulnerable to storm surge than any other type of flooding hazard. NCEI reports six events for the City with the maximum event being associated with Hurricane Hugo at 12.5 feet above the average low tide. Future occurrences are likely.
- TIDAL FLOODING: NOAA reports the U.S. SE Atlantic and Gulf coast had an increase of over 400 to 1,000% respectively in high tide flooding days since 2000. Future occurrences are likely.
- HAZARDOUS MATERIALS INCIDENTS: The Pipeline and Hazardous Materials Safety Administration (PHMSA) reports 264 HAZMAT incidents for the City. There are 11 Toxic Release Inventory facilities in the City. The City's proximity to the Charleston Port, the Charleston airport and other nearby TRI sites make future occurrences likely.
- INFRASTRUCTURE FAILURE: A growing hazard of concern as infrastructure ages. The City is dependent on vulnerable roads and bridges for connectivity. Ports, drainage systems, and other infrastructure are at risk. Future occurrences are possible.
- RADIOLOGICAL EMERGENCY: No serious events have occurred. There is a nuclear training facility within the region. Other areas of potential concern include major transportation, the port and healthcare facilities. Future occurrences are unlikely.
- CYBER: Cyber is a hazard of concern for the City and is almost a constant hazard of concern. Future occurrences are possible.
- CIVIL DISTURBANCE: is a hazard of concern for the City. There have been 4 examples of civil disturbance which have caused 6 deaths and 39 injuries. There were 2 recent events that occurred in 2020: the George Floyd Protests and the ILA Incident on the Port.
- TERRORISM: There are a number of potential targets for terrorist in the region, including the Charleston Port, so future occurrences for the City are possible.
- ACTIVE THREAT: There has been active threat hazards in the City with the most notable in recent years being the Charleston Church Shooting in 2015 where 9 deaths and one injury were recorded. Nationwide occurrences are growing in frequency and future occurrences are possible.

In concluding the review of Hazard Profiles, Mr. Slaughter stated if anyone had additional information for the hazard profiles. Planning committee members offered a variety of comments that are included in Appendix D. Relevant information from the comments provided were integrated into this Plan in the relevant sections.

After the open discussion, Mr. Slaughter asked the planning committee members to call or email him if there were any additional concerns or comments on the risk assessment.

The initial highest PRI score for a hazard that could impact Charleston was assigned to Hurricanes and Flooding. Based on the PRI scoring, the hazards were separated into three general categories of hazards: high risk, moderate risk and low risk. After discussion with the planning team, some of the hazard rankings into these general categories was revised. The revised high-risk hazard rankings based on these discussions include hurricanes, storm surge, flooding, earthquake, severe storm, extreme heat, infrastructure failure and sea level rise.

Mr. Slaughter then displayed maps that presented the City's social vulnerability, as documented by the U.S Census Bureau and the Centers for Disease Control. The maps present how socially vulnerable areas in the City are as compared to the rest of South Carolina. These maps depict great variability in levels of social vulnerability across the City.

During the lunch break, Mr. Slaughter discussed the hazard mitigation public survey. At the time of the meeting, 183 survey responses had been received. A summary of the survey findings was presented. Mr. Slaughter stated that the survey remained open and asked for help with advertise the survey on websites and social media.

After a break for lunch, Mr. Slaughter then presented the Capability Assessment Findings. ESP Associates used a scoring system that was applied to rank the capability of the City to implement a mitigation strategy. The City was scored on its capability in four major areas: Planning and Regulatory; Administrative and Technical; Fiscal; Political. Important capability indicators include National Flood Insurance Program (NFIP) participation, Building Code Effective Grading Schedule (BCEGS) score, and Community Rating System (CRS) participation.

Mr. Slaughter reviewed the relevant plans and ordinances, relevant staff/personnel resources, and relevant fiscal resources. All of these categories were used to rate the overall capability of the City. He indicated that the best-case scenario for the City was to have high capability and low vulnerability. Conversely, the worst-case scenario for communities was to have high vulnerability and low capability. Charleston is in the high range for Planning and Regulatory Capability and in the moderate range for Fiscal Capability. The City has high Administrative and Technical Capability. Based upon the scoring methodology, it was determined that the City has an overall high capability to implement hazard mitigation programs and activities.

Mr. Slaughter then transitioned to the Mitigation Strategy portion of the presentation. He began by reviewing some of the major concepts of mitigation and then gave the results of the icebreaker exercise from the City's first Hazard Mitigation Planning Team meeting, where attendees were given "money" to spend on various hazard mitigation techniques. The results were as follows:

- Prevention 24%
- Emergency Services 16%

- Structural Projects 16%
- Property Protection 16%
- Public Education and Awareness 14%
- Natural Resource Protection 14%

Mr. Slaughter briefly presented the existing mitigation goals for the regional plan. He stated that the goals from the regional plan would be used as the City's mitigation goals.

Mr. Slaughter then indicated that the City has already identified over 50 mitigation actions in the existing regional plan and that he would be coordinating with the City to provide implementation status updates for those existing actions (completed, deleted, or deferred etc). He stated that for the purposes of this meeting, the existing actions would not be shared so that stakeholders could identify actions from a fresh perspective.

For the remainder of the meeting, participants were asked to brainstorm potential hazard mitigation actions with the other stakeholders at their tables. During the activity, stakeholders identified almost 50 mitigation actions. At the conclusions of the activity, representatives from each of the tables were asked to provide a summary of the actions they identified.

To conclude the meeting, Mr. Slaughter discussed the next steps in the planning process. These included noting that a complete draft of plan would be delivered in the coming months (draft to eventually be submitted to SCEMD and to FEMA for review/approval); and a note that the current County plan expires March 27, 2024. He thanked the group for taking the time to attend and the meeting was adjourned.

Meeting Minutes from Draft Hazard Mitigation Plan Review

October 20, 2023, MEOC

10:00 AM - noon

The purpose of this meeting was to review the draft hazard mitigation plan. The project consultant met with key members of the Hazard Mitigation Planning Team and provided an overview of the plan to include presentation of some key findings. Meeting attendees also took this opportunity to provide some feedback on the draft plan. Some of the key recommendations were to:

- Make sure that rainfall is specifically categorized and analysis provided.
- Missing Data - There were some key events that weren't included (Hurricane Irma, etc). We need to be sure we're tracking all events we can.
- "Parking Operations" should be "Traffic & Transportation".
- Figure 3.1 shows the 526 extension. That is planned but not completed.
- Page 3-5 (Community Facilities) should include private schools.
- Page 3-5 (Utilities) should include Plum Island Water Treatment Site
- Delineation of major roads: I-26, I-526, US 78, US 52, US 17, SC 7, SC 30, SC 61, SC 700, SC 171, SC 461, SC 33 and SC 41.

Appendix E

NCEI Storm Event Data

This section of the Plan includes the historic storm event data for Charleston as reported to the National Centers for Environmental Information.

- ◆ E.1 – Flood
- ◆ E.2 – Hail
- ◆ E.3 – Lightning
- ◆ E.4 – Thunderstorm Wind/High Wind
- ◆ E.5 – Tornado
- ◆ E.6 – Extreme Heat

Table E.1: Flood Events (1996 - 2021)

Location	Date	Description
City of Charleston		
Charleston	10/8/1996	n/a
Charleston	6/6/1997	A small area of heavy rain (trained) across portions of Charleston and southern Berkeley Counties produced local rainfall up to seven and three-quarter inches within a few hours. This combined with high tides to produce several feet of water on numerous roads which became impassable as water rose almost to headlights on cars. Water rose to 2 to 4 feet in some buildings and homes. Jewelry was floating" in one jewelry store that had several feet of water and the basement of the Charleston County Courthouse was flooded."
Charleston	5/12/1999	A line of nearly stationary thunderstorms stalled along the afternoon sea breeze front and produce 2 to 3 inches of rainfall in some areas, causing flooding of streets and low-lying areas and ponding of water on roads.
Charleston	8/30/2002	Numerous roads were closed, motorists stranded and water got into homes and businesses as heavy rain continued to fall. Much of the area was already saturated from rain over the previous days.
Charleston	7/14/2003	Heavy rainfall at high tide caused flooding of streets in downtown Charleston.
Charleston	6/15/2004	Heavy rainfall over several hours caused significant flooding in the West Ashley section of Charleston. Numerous roads were flooded with several feet of water including Interstate 526, Highways 17 and 61, and Ashley Hall Road. Water flooded into some cars and many needed to be towed out of the water. The water also flooded several homes in the area.
Charleston	8/15/2004	An estimated 3 to 4 inches of rain fell across downtown Charleston just before high tide. Up to 1 foot of water covered Highway 17, Kent Road, Dorchester Road, and Rutledge Avenue near the Medical University of South Carolina.
Charleston	9/27/2004	Heavy rainfall caused flooded roads in Charleston, Mt. Pleasant, and the Isle of Palms.
Charleston	5/17/2005	Portions of East Bay flooded. Portions of crosstown flooded. 1 car stranded

APPENDIX E: NCEI EVENTS

Location	Date	Description
		in high water on crosstown.
Charleston	6/28/2005	Several hours of heavy rainfall across the county caused flooding. Highway 17 in downtown Charleston was flooded with several cars becoming submerged. Also, the frontage road along Highway 17 in Mt. Pleasant was closed due to high water.
Charleston	7/9/2005	Highway 61 in West Ashley flooded near 526 intersections.
Charleston	8/24/2006	Resident on South Street indicates water coming into home. Heavy street flooding.
Charleston	8/24/2006	Public reported that near the Charleston Catholic School there is several feet of water near the intersection of King and Huger streets.
Charleston	8/24/2006	Near waste deep water near the intersection of Vanderhorst and Smith Street.
Charleston	8/31/2006	Numerous roads in downtown Charleston including Highway 17 are flooded and closed in many locations. Additional flooding and road closures have occurred on Folly Road on James Island and Bohicket Road on Johns Island.
Charleston	8/31/2006	Lasalle Street and Elsey Drive flooded.
Charleston	7/30/2007	Two and a half to three feet of water were reported over the road at the intersection of Market Street and Church Street in downtown Charleston.
Charleston	7/30/2007	President Street near the Crosstown was reportedly flooded and impassable.
Charleston	6/21/2008	Broadcast media reported flooding in downtown Charleston, South Carolina along Market Street. Portions of Market Street were blocked off by more than a foot of water covering the road.
Charleston	10/24/2008	Federal officials reported road closures along Concord Street and Hazel Street due to 6 inches of standing water in downtown Charleston, South Carolina.
Charleston	10/24/2008	City officials in Charleston reported that widespread flooding was occurring in downtown Charleston, South Carolina. Numerous motorists were stranded in vehicles along with several road closures.
Charleston	7/8/2009	The public reported around 2 feet of standing water near Market and Meeting Streets, making portions of the roads impassable in downtown Charleston, South Carolina.
Charleston	12/2/2009	Law enforcement reported a road closure due to flooding along at Radcliffe Street and Coming Street.
Charleston	12/2/2009	Law enforcement reported a road closure due to flooding at Calhoun Street and Ashley Avenue in downtown Charleston.
Charleston	12/2/2009	Law enforcement reported 10 to 15 automobiles stalled in downtown Charleston due to flooding. At least 1 automobile had water flowing into its doors.
Charleston	7/11/2012	Tabbuli Grill on North Market Street flooded with several inches of water inside the building. Numerous side streets near the market were flooded with a half foot of water. Flooding was also reported at East Bay and Calhoun Streets. They were not officially closed, but were impassable in spots.
Charleston	8/28/2012	Numerous reports of street flooding in Downtown Charleston. Calhoun Street is impassable.
Charleston	8/28/2012	The College of Charleston Emergency Manager reports that twenty-three buildings on campus have sustained damage from flash flooding. Flood waters are still in place across much of the campus.
Charleston	3/24/2013	Law enforcement reported portions of Ashley Avenue and Calhoun Street closed due to water on the roadway.
Charleston	3/24/2013	Law enforcement reported Bennett and Barre Street closed due to water on the roadway.
Charleston	3/24/2013	Law enforcement reported numerous roads closed in downtown Charleston due to water on roadways.
Charleston	6/19/2013	A spotter reported two feet of standing water at the intersection of Smith Street and Vanderhorst Street.

APPENDIX E: NCEI EVENTS

Location	Date	Description
Charleston	6/19/2013	Law enforcement reported the intersections of Ashley Avenue and Bennett Street, Morris Street and Coming Street, Morrison Drive and Meeting Street, Coming Street and Spring Street, Rutledge Avenue and Beaufain Street flooded and impassable. America Street was also flooded and impassable between Cooper Street and Lee Street.
Charleston	7/21/2013	Police reported numerous streets in Downtown Charleston were closed due to flooding...King, Line, Cannon, St Philips, President, Cross, Market, Felix, Radcliffe, Smith, Fishburne, Moultrie, Vanderhorst, Ogier Streets, along with Ashley Ave.
Charleston	8/15/2013	The City of Charleston reports flooding on George Street between Coming Street and St Philip Street. The road is closed.
Charleston	7/31/2014	Numerous reports of road closures due to flash flooding in and around downtown Charleston. South Market Street was closed between Meeting Street and State Street due to flooding. North Market Street was closed between East Bay Street and Meeting Street due to flooding. The roadway was closed due to flooding at the intersection of Ashley Avenue and Fishburne Street. The road was closed due to flooding on Bennett Street between Ashley Avenue and Rutledge Avenue. The road was closed due to flooding at the intersection of King Street and Huger Street. Ogier Street was flooded and impassable due to flooding with water surrounding homes. President Street north of the Crosstown was also closed due to flooding.
Charleston	8/9/2014	Law enforcement reported numerous road closures in downtown Charleston due to flash flooding, including Bull, Calhoun, Ashley Avenue, Fishburne, Morris, Huger, King, Rutledge, Sheppard, Cannon Park, Thomas, Warren and the Crosstown.
Charleston	8/18/2015	The Charleston Police Department and the City of Charleston Emergency Manager reported numerous roads flooded and closed in downtown Charleston. Streets closed included parts of Fishburne, King, Carolina, Line, Sumter, Beaufain, Barre, Calhoun, Ogier, Pitt, Moultrie, President, America, South, Bogard, Huger, Smith, Morris, Ashley Avenue and the Crosstown. Many cars were flooded or stalled. Many homes and businesses were surrounded by water. The Market was also reported flooded and under water.
Charleston	10/3/2015	Law enforcement and firefighters reported widespread flooding in downtown Charleston resulting in several water rescues and numerous road closures. Roads and intersections closed due to flooding included Beaufain Street between Lockwood Boulevard and Coming Street, Washington Street between Calhoun Street and Hassell Street, Morris Street between Coming Street and Smith Street, Huger Street between Senate Street and Benson Street, Rutledge Avenue and Ashely Avenue between Calhoun Street and Bennett Street, Vanderhorst Street between Rutledge Avenue and Coming Street, Rutledge Avenue between Fishburne Street and Sheppard Street, President Street between Highway 17 and Fishburne Street, Pinckney Street between Meeting Street and Church Street, Highway 17 between Cannon Street and Coming Street, the Crosstown Expressway, Calhoun Street at the intersection of Smith Street and Lockwood Boulevard at the intersection of Broad Street.
Charleston	10/3/2015	A Charleston County emergency manager and law enforcement reported numerous roads closed due to flooding in downtown Charleston. Roads closed included Hasell Street between Meeting Street and Washington Street. Interstate 26 exits to Meeting Street and East Bay Street were also closed due to flooding. Water was also reported entering homes and businesses at the intersection of Tradd Street and Council Street. Swift water rescues were also being reported by broadcast media in downtown Charleston.
Charleston	6/6/2016	Law enforcement reported the following roads closed in downtown Charleston due to flooding: Barre Street between Canal Street and Broad Street, Wentworth Street between Lockwood Drive and Barre Street and

APPENDIX E: NCEI EVENTS

Location	Date	Description
		Cherry Street between the Crosstown and Barre Street.
Charleston	6/29/2016	Law enforcement and broadcast media reported the following roads closed due to flooding by heavy rain: South Market Street, Ashley Avenue between Halsey Street and Bennett Street and Ashley Avenue at Calhoun Street.
Charleston	6/12/2021	Emergency management and social media indicated several businesses along Market Street flooded with 8 to 16 inches of standing water inside buildings. Additionally, rainfall amounts around 3.5 inches resulted in the following streets, intersections, and areas in downtown Charleston to be closed due to flooding: Calhoun Street between Rutledge Avenue and Smith Street, Chisolm Street between Broad Street and Tradd Street, Colonial Street between Broad Street and Tradd Street, Hagood Avenue at Fishburne Street, King Street at Huger Street, Market Street between Meeting Street and East Bay Street, Romney Street at North Nassau Street, Smith Street at Marion Street, Tradd Street between Chisholm Street and East Bay Street, the Crosstown Expressway between Coming Street and Norman Street, Washington Street and Concord Street between Laurens Street and Queens Street, the Harleston Village area and the White Point Gardens area.

Table E.2: Hail Events (1995 - 2021)

Location	Date	Description
City of Charleston		
Charleston	6/27/1995	Power outages to over 2,500 homes and very heavy rain.
Charleston	7/7/1995	
Charleston	5/3/1997	Golf ball sized hail covered the ground at the 18th green at Legends Oak golf course.
Charleston	5/9/1997	Nickel sized hail broke a weather service employee's automobile window.
Charleston	2/28/1998	
Charleston	7/10/2004	Ping pong ball size hail reported at Charlestowne Landing County Park. Large trees also down in park.
Charleston	4/8/2006	Quarter size hail occurred in the West Ashley section of Charleston.
Charleston	4/26/2006	Hail on Orange Grove Road.
Charleston	4/26/2006	Reported on the Charleston Battery.
Charleston	4/26/2006	Quarter size hail at MUSC.
Charleston	5/14/2006	Reported on Cedarhurst Ave in West Ashley.
Charleston	5/14/2006	Large hail reported in West Ashley.
Charleston	5/14/2006	Numerous reports of penny to golf ball size hail in sections of West Ashley.
Charleston	5/14/2006	Ping Pong ball size hail 1/2 mile south of Citadel Mall.
Charleston	8/4/2006	Nickel hail near Trident College.
Charleston	6/13/2007	
Charleston	6/13/2007	
Charleston	3/15/2008	Nickel sized hail was reported by a trained weather spotter in Charleston, South Carolina.
Charleston	3/15/2008	Hail one- and one-half inch in diameter was reported in downtown Charleston at the intersection of Market Street and King Street. The hail lasted between 10 and 15 minutes. A funnel cloud was also observed.
Charleston	5/20/2008	A trained weather spotter reported quarter size hail near MUSC in downtown Charleston, South Carolina. Wind gusts were also estimated at 45 mph.

Location	Date	Description
Charleston	3/20/2018	Penny sized hail was reported on King Street between George and Calhoun Streets.
Charleston	4/7/2022	Broadcast media relayed a video via social media of pea to nickel size hail along Church Street in downtown Charleston.

Table E.3: Lightning Events (2019 – 2021)

Location	Date	Description
City of Charleston		
Charleston	7/5/2019	A social media post reported that lightning struck St. Matthew's Lutheran Church in Downtown Charleston near the corner of King Street and Vanderhorst Street.

Table E.4: Thunderstorm Wind/High Wind Events (1993 – 2021)

Location	Date	Description
City of Charleston		
Charleston	10/30/1993	Thunderstorm winds with gusts to 57 knots were reported at the Custom House Pier.
Charleston	6/26/1994	Severe thunderstorms scattered across coastal South Carolina caused considerable wind damage to trees and power lines, and disrupted traffic in some areas. A funnel cloud was sighted four miles north of Beaufort Marine Air Base.
Charleston	6/27/1995	Power outages to over 2,500 homes and very heavy rain.
Charleston	7/7/1995	60 mph gust at Custom House (downtown).
Charleston	10/5/1995	Seventy-six mph gust reported by Harbor Pilot at Columbus St. terminal.
Charleston	5/9/1997	Trees and powerlines down several locations.
Charleston	6/19/1998	Intense and well-defined squall line of thunderstorms that extended northeast-southwest across CWA produced numerous reports of wind damage where trees, large limbs, and powerlines were downed.
Charleston	8/8/1999	Large limbs down.
Charleston	8/9/1999	Power lines down and large branches down on car.
Charleston	8/11/2000	A container crane at a loading dock was blown into two other cranes causing several large shipping containers to be thrown into the water.
Charleston	2/22/2003	Several trees were down.
Charleston	6/23/2004	Several large trees were blown down in the West Ashley section of Charleston.
Charleston	7/10/2004	Large limbs were knocked down in the West Ashley area of Charleston. Trees were also knocked down near the intersection of Ashley Hall Rd. and Gardenia, west of downtown Charleston.
Charleston	7/10/2004	Powerlines down near Church Creek in West Ashley.
Charleston	7/10/2004	Trees and power lines down in several locations downtown and on the peninsula.
Charleston	3/8/2005	Thunderstorm winds knocked down trees and large street signs in the West Ashley section of Charleston.
Charleston	1/30/2006	Thunderstorm winds knocked down trees on Chadwick Drive and Windermere Blvd. in the West Ashley section of Charleston. Two trees were also blown down on Sullivan's Island.
Charleston	4/26/2006	Trees down on power lines on Bees Ferry Road in West Ashley.
Charleston	4/26/2006	Trees down near intersection of Sam Rittenburg and Ashley Road.
Charleston	4/26/2006	Trees and power lines down along Ashley River Road.

APPENDIX E: NCEI EVENTS

Charleston	7/29/2006	Trees down along Highway 61 near Drayton Hall.
Charleston	5/20/2015	One large tree branch blown down on Bull Street between Rutledge Avenue and Ashley Avenue.
Charleston	4/19/2019	An anemometer recorded an 81 mph wind gust approximately 80 feet off the ground on the roof of the Charleston Branch Pilots Association in downtown Charleston.
Charleston	4/19/2019	The Weatherflow site at Shutes Folly in Charleston Harbor recorded a 68 mph or 59 knot wind gusts.
Charleston	4/19/2019	A 60-mph wind gust was recorded at the downtown Charleston observation site CXM.
Charleston	4/5/2022	The public reported several aircraft on the USS Yorktown moved by high winds and three trees down at the Cold War Memorial.

Table E.5: Tornado Events (2002 – 2021)

Location	Date	Description
City of Charleston		
Charleston	7/15/2002	A brief tornado touch down caused some damage to a storage building for an apartment complex, shingles taken off for the most part, a couple of signs bent, and a few small trees uprooted and some limbs taken out of larger trees. The touchdown was near the CBS affiliate and not far from their Doppler radar.
Charleston	4/8/2006	A weak tornado tracked across the Charleston Neck area. Initial touchdown was near the Dolphin Marina and the Liquid Transport Corporation along Austin Avenue. Several trees were blown down and a large deck was torn away from a trailer and blown 30 feet against a fence. The tornado tracked across Interstate 26 and Meeting Street. Several trees in the area were twisted and snapped off. Also, a Kangaroo gas station experienced minor damage. The tornado moved onto the far southern end of the old Navy Base and then across the Cooper River before crossing onto Daniel Island in southern Berkeley County. At the Cooper River Marina, tornado winds shifted around several large picnic tables, blew large dock containers into the river, and destroyed the wind measuring equipment.
Charleston	6/13/2006	NWS damage survey confirms brief F0 tornado touch down near the Medical University of South Carolina Hospital. Storm track was 1 mile long with tornado path 30 yards. Tree damage was observed at the MUSC Hospital parking lot as well as numerous cars damaged from flying debris at the hospital and nearby hotel parking lot. The tornado crossed Highway 17 and produced additional tree damage off Lockwood Blvd and damaged police cars at the Charleston Police station motor pool. Winds estimated at 60 to 70 mph.

Table E.6: Extreme Heat Events (2007 – 2021)

Location	Date	Description
Charleston		
Charleston County	8/10/2007	A large ridge of high pressure at the surface and aloft resulted in excessively hot and humid conditions across the area. Heat indices reached 120 degrees at Charleston International Airport. Heat indices across much of southern South Carolina topped out between 115 and 120 degrees as well.
Charleston County	7/22/2010	An expansive and deep layered ridge of high pressure extending across the southeast United States resulted in a very hot and humid airmass across southern South Carolina, with heat index values in excess of 115 degrees in areas. A heat index value of 116 degrees was observed at the Charleston

APPENDIX E: NCEI EVENTS

Location	Date	Description
		International Airport in North Charleston, South Carolina.
Charleston County	7/25/2010	The heat index value reached 116 degrees at the mesonet station, in West Ashley, South Carolina
Charleston County	7/29/2010	An unseasonably hot and humid airmass resulted in heat index values of 115 degrees or higher across much of coastal South Carolina. The sea breeze which pushed into the unstable airmass, managed to produce a few isolated thunderstorms despite a strong capping inversion in place. The mesonet station located at the College of Charleston in downtown Charleston, South Carolina measured a heat index of 117 degrees.
Charleston County	7/31/2011	The combination of hot temperatures and high levels of humidity, resulted in heat indices which met or surpassed Excessive Heat Warning criteria across portions of southern South Carolina and southeast Georgia. A heat index of 115 degrees was measured by the AWOS at the East Cooper Regional Airport, 12 miles northeast of Charleston, South Carolina.
Charleston County	8/3/2011	A strong mid and upper-level ridge produced large thickness values over the southeast. These thickness values supported afternoon high temperatures between 100 to 103 degrees inland and mid 90s along the coast. These temperatures in combination with low to mid 70s dewpoints pooling along an afternoon sea breeze, produced dangerous heat indices over portions of southeast South Carolina. A heat index of 116 F was observed at East Cooper Airport
Charleston County	7/30/2021	Under the influence of a strong ridge aloft, hot temperatures combined with high humidity levels to produce dangerous heat indices across southeast South Carolina. Numerous observation sites reported heat index values in excess of 115 degrees for several hours. Several observations sites around Charleston County reported heat index values of 115 degrees or greater for several hours in the afternoon. This includes the Wambaw Remote Automatic Weather Station (RAWS) site located near Awendaw. The maximum heat index observed was 118 degrees by a weather station at the Forest Park playground in the West Ashley area, which is operated and maintained by the City of Charleston.

Appendix F

Social Vulnerability Maps

This Appendix contains the following social vulnerability maps that were originally produced for the NOAA HeatWatch program in which the city participated.

- Overall CDC Social Vulnerability Index (SVI)
- ACS Median Household Income Variables
- ACS Educational Attainment Variables (Percent of population 25 or older whose highest education completed is less than high school)
- ACS Population Variables (Percent of Population that is 65 years and over)
- ACS Health Insurance Coverage Variables (Percent of population with no health insurance coverage)
- CDC Life Expectancy

Charleston (CHS) Heat Watch Context

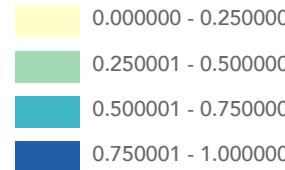
CDC SVI - Overall Vulnerability

Grid - 1 Square Mile

CHS HeatWatch Study Area

Overall CDC Social Vulnerability Index (SVI)

Low Social Vulnerability to High Social Vulnerability (Census Tract)



MEDIAN INCOME DATA

U.S. Census Bureau's American Community Survey (ACS) 2015-2019 5-year estimates, Table(s) B19013B, B19013C, B19013D, B19013E, B19013F, B19013G, B19013H, B19013I, B19049, B19053

HEALTH INSURANCE COVERAGE DATA

U.S. Census Bureau's American Community Survey (ACS) 2015-2019 5-year estimates, Table(s) B27010

POPULATION DATA

U.S. Census Bureau's American Community Survey (ACS) 2015-2019 5-year estimates, Table(s) B01001

EDUCATION DATA

U.S. Census Bureau's American Community Survey (ACS) 2015-2019 5-year estimates, Table(s) 3

ELEVATION DATA

U.S. Geological Survey, 2019, 3D Elevation Program 3-Meter Resolution Digital Elevation Model, accessed April 16, 2021 at URL <https://www.usgs.gov/core-science-systems/ngp/3dep/data-tools>

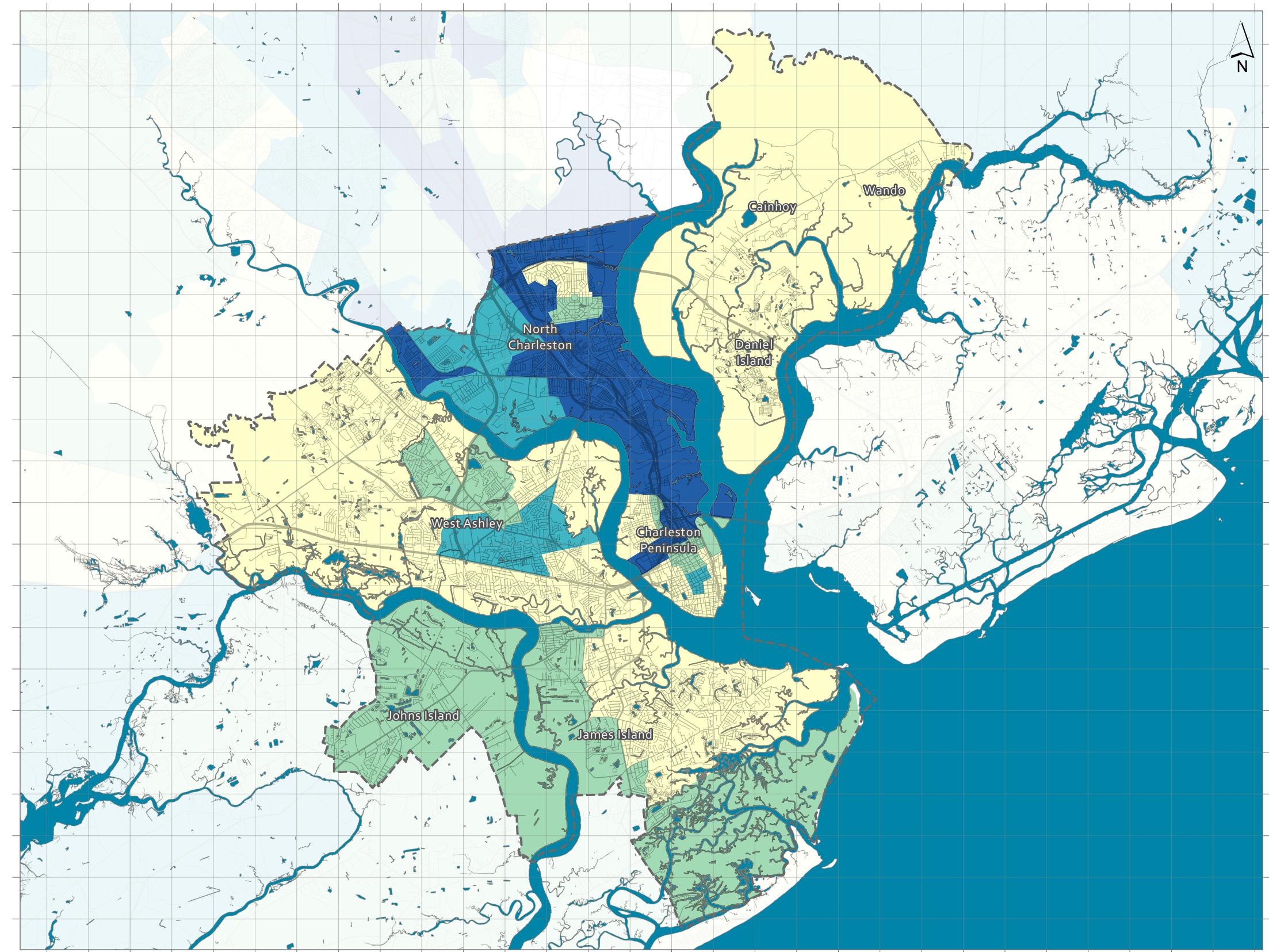
CDC SVI DATA

Centers for Disease Control and Prevention/ Agency for Toxic Substances and Disease Registry/ Geospatial Research, Analysis, and Services Program. CDC Social Vulnerability Index 2018 Database US. https://www.atsdr.cdc.gov/placeandhealth/svi/data_documentation_download.html. Accessed 04/2021

LIFE EXPECTANCY DATA

National Center for Health Statistics. U.S. Small-Area Life Expectancy Estimates Project (USALEEP): Life Expectancy Estimates File for [Jurisdiction], 2010-2015. National Center for Health Statistics. 2018. Available from: <https://www.cdc.gov/nchs/nvss/usaleep/usaleep.html>.

LANDCOVER & NEIGHBORHOOD DATA
City of Charleston GIS



Charleston Area Heat Watch Context

Median Household Income

Grid - 1 Square Mile

CHS HeatWatch Study Area

ACS Median Household Income Variables (Census Tract)

Median Household Income in past 12 months
(inflation-adjusted dollars to last year of 5-year range)



MEDIAN INCOME DATA

U.S. Census Bureau's American Community Survey (ACS) 2015-2019 5-year estimates, Table(s) B19013B, B19013C, B19013D, B19013E, B19013F, B19013G, B19013H, B19013I, B19049, B19053

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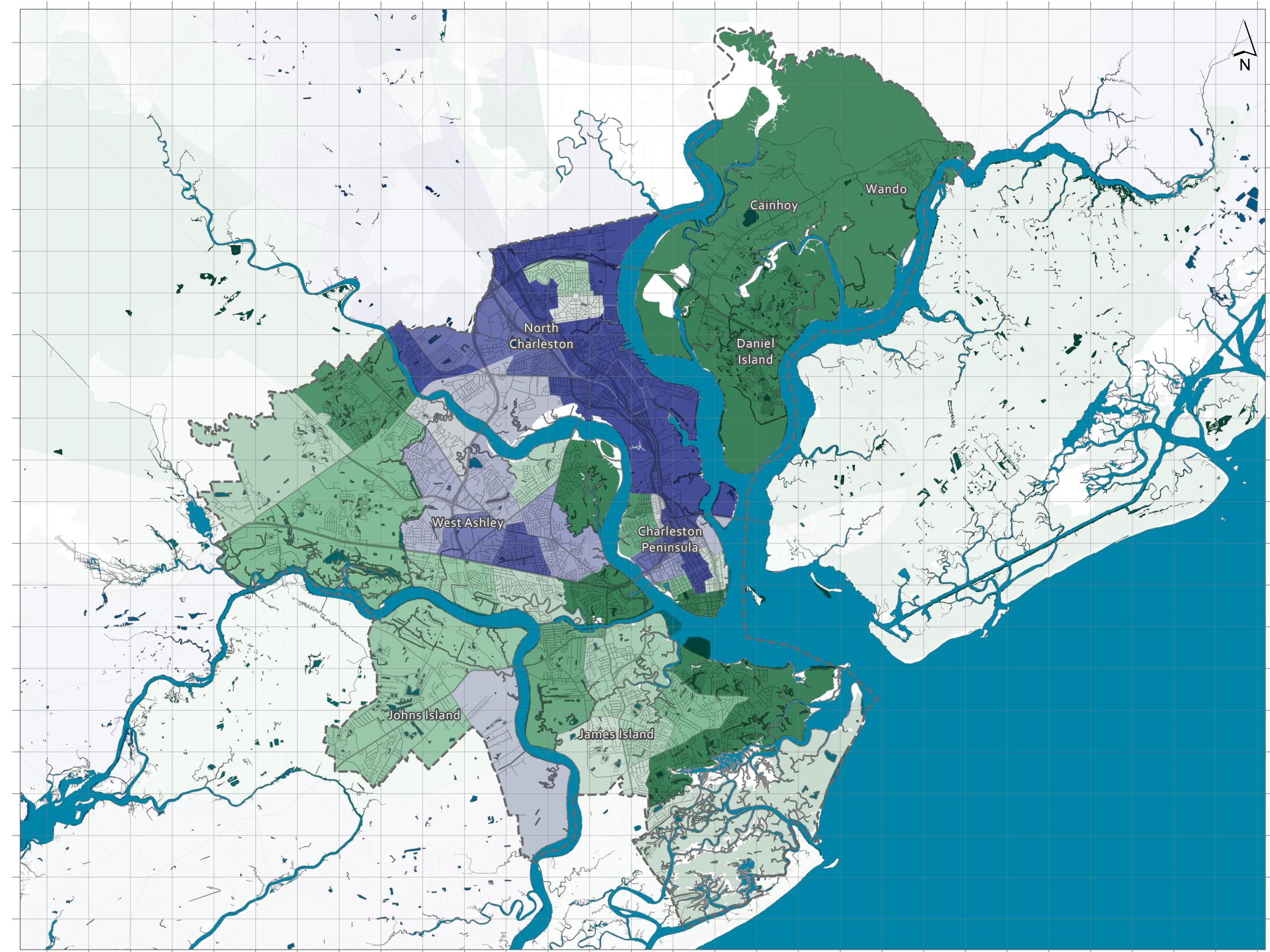
Centers for Disease Control and Prevention/ Agency for Toxic Substances and Disease Registry/ Geospatial Research, Analysis, and Services Program. CDC Social Vulnerability Index 2018 Database US. https://www.atsdr.cdc.gov/placeandhealth/svi/data_documentation_download.html. Accessed 04/2021

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LANDCOVER & NEIGHBORHOOD DATA

City of Charleston GIS



Charleston Area Heat Watch Context

Educational Attainment

Grid - 1 Square Mile

 CHS HeatWatch Study Area

ACS Educational Attainment Variables

Population 25 or Older Whose Highest Education Completed is Less Than High School (Census Tract)



MEDIAN INCOME DATA

U.S. Census Bureau's American Community Survey (ACS) 2015-2019 5-year estimates, Table(s) B19013B, B19013C, B19013D, B19013E, B19013F, B19013G, B19013H, B19013I, B19049, B19053

HEALTH INSURANCE COVERAGE DATA

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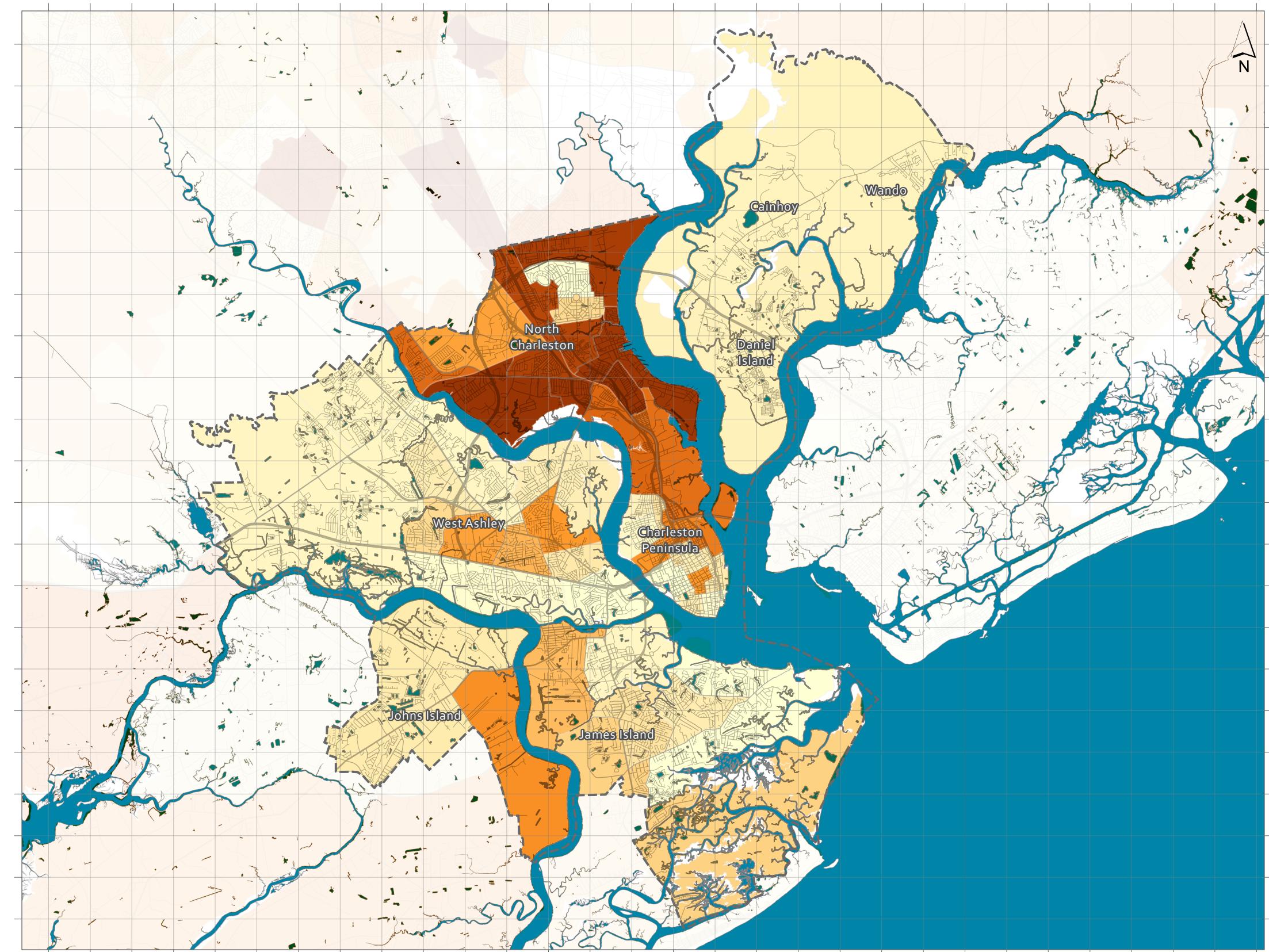
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LANDCOVER & NEIGHBORHOOD DATA

City of Charleston GIS



Charleston Area Heat Watch Context

Elderly Population

Grid - 1 Square Mile

 CHS HeatWatch Study Area

ACS Population Variables

Percent of Population that is 65 Years and Over
(Census Tract)



MEDIAN INCOME DATA

U.S. Census Bureau's American Community Survey (ACS) 2015-2019 5-year estimates, Table(s) B19013B, B19013C, B19013D, B19013E, B19013F, B19013G, B19013H, B19013I, B19049, B19053

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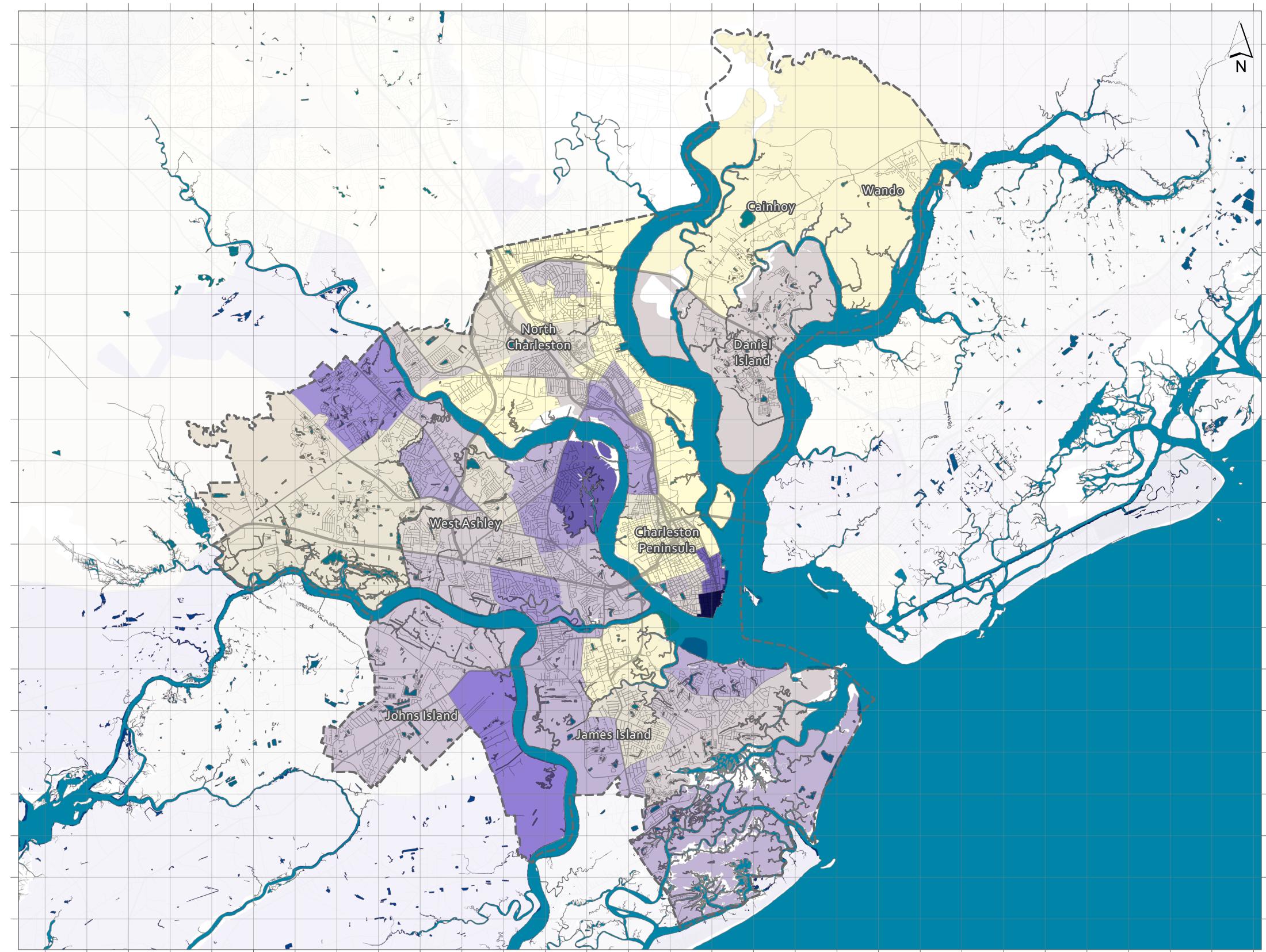
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LANDCOVER & NEIGHBORHOOD DATA

City of Charleston GIS



Charleston Area Heat Watch Context

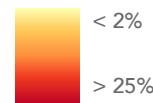
Health Insurance Coverage

Grid - 1 Square Mile

 CHS HeatWatch Study Area

ACS Health Insurance Coverage Variables

Percent of Population with No Health Insurance Coverage (Census Tract)



MEDIAN INCOME DATA

U.S. Census Bureau's American Community Survey (ACS) 2015-2019 5-year estimates, Table(s) B19013B, B19013C, B19013D, B19013E, B19013F, B19013G, B19013H, B19013I, B19049, B19053

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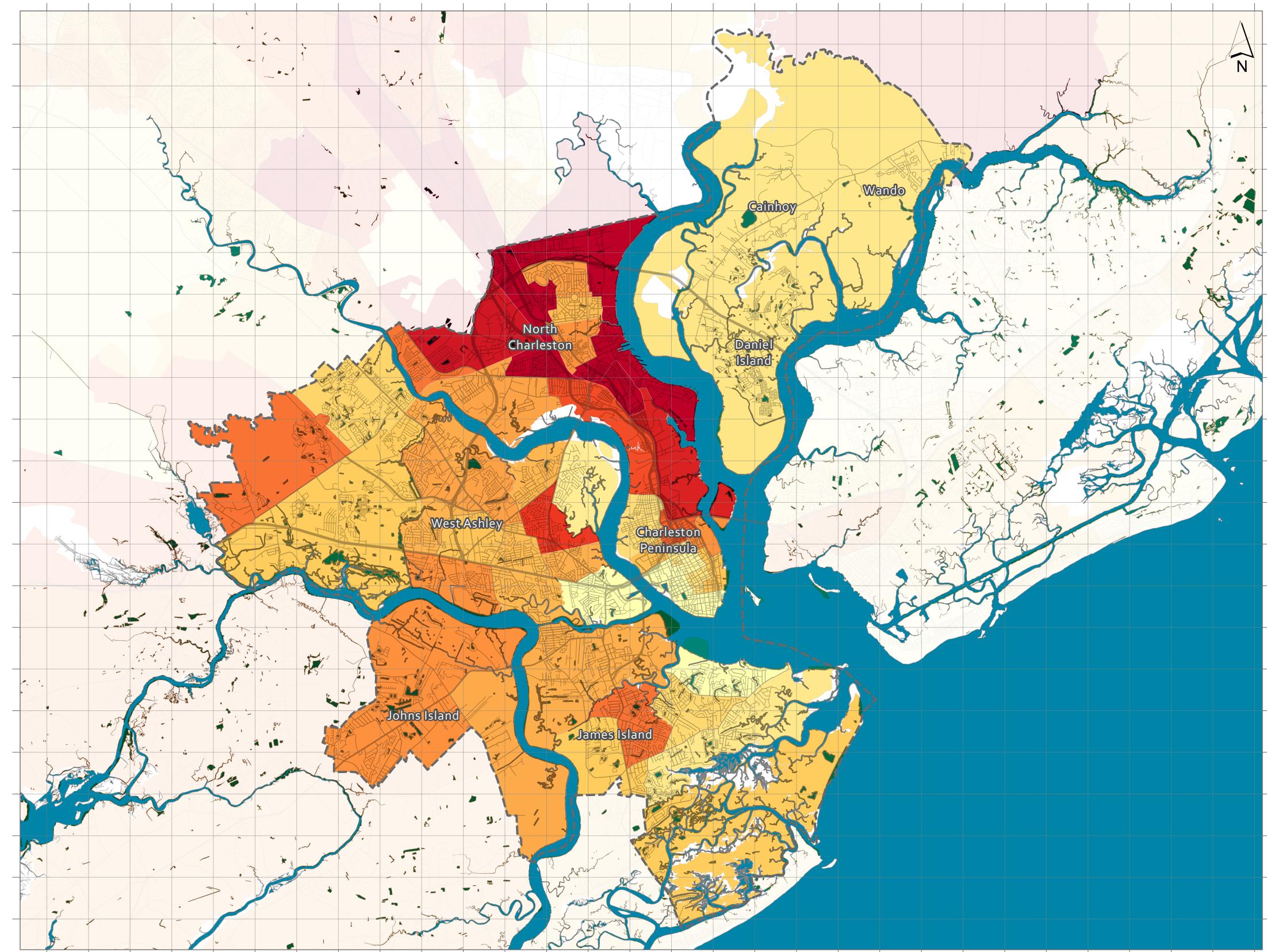
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LANDCOVER & NEIGHBORHOOD DATA

City of Charleston GIS



Charleston Area Heat Watch Context

Life Expectancy at Birth

Grid - 1 Square Mile

 CHS HeatWatch Study Area

CHS Life Expectancy at Birth

CDC Life Expectancy (census tract)

 67 yr - 73 yr

 74 yr - 76 yr

 77 yr - 79 yr

 80 yr - 81 yr

 82 yr - 86 yr

 no data

MEDIAN INCOME DATA

U.S. Census Bureau's American Community Survey (ACS) 2015-2019 5-year estimates, Table(s) B19013B, B19013C, B19013D, B19013E, B19013F, B19013G, B19013H, B19013I, B19049, B19053

HEALTH INSURANCE COVERAGE DATA

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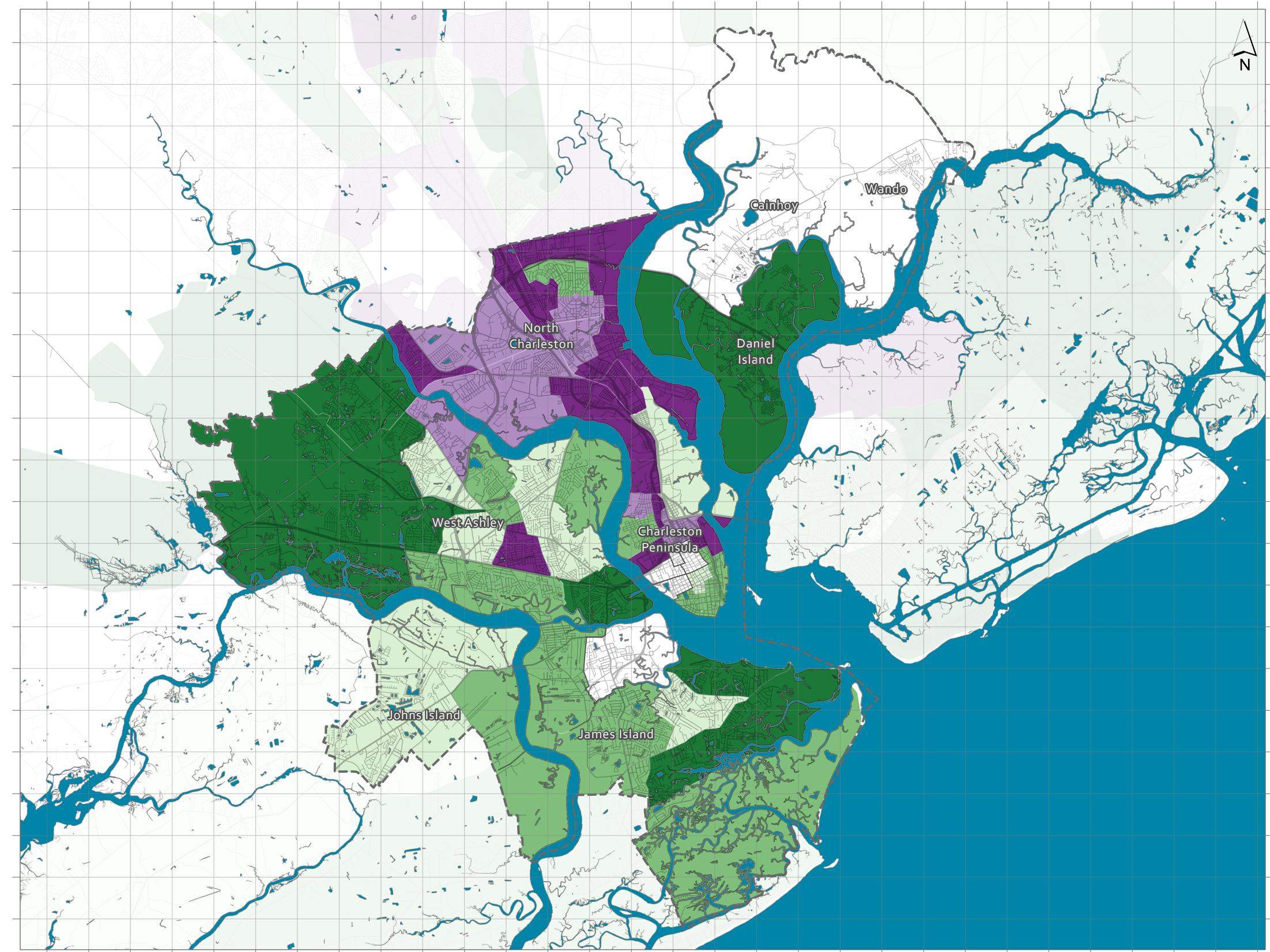
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LIFE EXPECTANCY DATA

National Center for Health Statistics. U.S. Small-Area Life Expectancy Estimates Project (USALEEP): Life Expectancy Estimates File for [Jurisdiction], 2010-2015. National Center for Health Statistics. 2018. Available from: <https://www.cdc.gov/nchs/nvss/usaleep/usaleep.html>.

LANDCOVER & NEIGHBORHOOD DATA
City of Charleston GIS





January 5, 2026

Stephen P. Davis
Emergency Manager
Charleston Fire Department/Fire Marshal's Office
2 George Street
Charleston, SC 27401

Dear Mr. Davis:

This letter serves as documentation that no charges or other associated costs have been made by our team on the development of the City of Charleston's Hazard Mitigation Plan past November 9, 2025.

We've sincerely appreciated our working relationship with the City and should you have any questions or need additional documentation, please do not hesitate to contact me at 919-264-9582 or by email at nslaughter@espassociates.com.

Sincerely,
ESP Associates, Inc.

A handwritten signature in blue ink that reads "Nathan Slaughter".

Nathan Slaughter, AICP, CFM
Group Manager – Hazard Mitigation / GIS, Water Resources



WILLIAM S. COGSWELL, JR.
MAYOR

City of Charleston

STEPHEN DAVIS
EMERGENCY MANAGER

CHARLESTON FIRE DEPARTMENT
EMERGENCY MANAGEMENT DIVISION

January 3, 2026

Mr. Anthony Williams
Hazard Mitigation Planner
South Carolina Emergency Management Division
2779 Fish Hatchery Road
West Columbia, South Carolina 29172

Re: Project Closeout Request for Grant HMGP-DR-4286-SC-0011: City of Charleston-Hazard Mitigation Plan Update

Dear Mr. Williams:

By this correspondence, I am requesting the closeout of HMGP-DR-4286-SC-0011: City of Charleston – Hazard Mitigation Plan Update as all tasks and activities are complete and we have requested reimbursement for all eligible work totaling \$ 75,000.00 (Fed share \$56,250.00, Non-Federal Share \$18,750.00). The overall Hazard Mitigation Plan (HMP) grant project is a review, update, and the addendum of mitigation actions to reduce the risk and/or impact of a hazard.

During the process, City of Charleston citizens were allowed to contribute by sharing knowledge of the area's vulnerabilities to hazards based on past occurrences.

During the overview process with ESP Associates, the hazard mitigation plan required quarterly submissions to the South Carolina Emergency Management Division to ensure incremental modifications and updates were conducted. The hazard mitigation plan is constructed to identify the



WILLIAM S. COGSWELL, JR.
MAYOR

City of Charleston

STEPHEN DAVIS
EMERGENCY MANAGER

CHARLESTON FIRE DEPARTMENT EMERGENCY MANAGEMENT DIVISION

natural hazards, hazard profiles, mitigation strategies, plan maintenance, and plan updating. All eligible project work was completed on November 9, 2025.

Furthermore, I certify that reported costs were incurred in the performance of eligible work, that the approved scope of work was completed, and in compliance with the provisions of the FEMA-State Agreement and that all bids, contracts and purchases were in compliance with all applicable federal, state, county procurement laws, regulations and ordinances. Please let me know what next steps need to be taken to close out this grant or if you have any questions.

Sincerely,

Stephen Davis,
Emergency Manager