



Town Council Quarterly Workshop

Tuesday, October 27, 2026 at 5:00 PM

Theodore D. Washington Municipal Building, Henry "Emmett" McCracken Jr. Council Chambers,
20 Bridge Street, Bluffton, SC

AGENDA

This meeting can be viewed live on [BCTV](#), on Sparklight Channel 9 and 417 or on Spectrum Channel 1304.

I. CALL TO ORDER

II. PUBLIC COMMENTS - Pertaining only to agenda items

III. WORKSHOP AGENDA ITEMS

- [1.](#) Discussion of Short-term Resilience Recommendations - Beth Lewis, Watershed Resilience Manager and Andrea Moreno, Watershed Division Manager
2. Parks and Rec Survey and Event and Venue Survey - Chris Forster, Assistant Town Manager
3. Preliminary Site Analysis of Town Owned Land – Chris Forster, Assistant Town Manager

IV. ADJOURNMENT

"FOIA Compliance – Public notification of this meeting has been published and posted in compliance with the Freedom of Information Act and the Town of Bluffton policies."

In accordance with the requirements of Title II of the Americans with Disabilities Act of 1990 ("ADA"), the Town of Bluffton will not discriminate against qualified individuals with disabilities on the basis of disability in its services, programs, or activities. The Town of Bluffton Council Chambers are ADA compatible. Auditory accommodations are available. Any person requiring further accommodation should contact the Town of Bluffton ADA Coordinator at 843.706.4500 or adacoordinator@townofbluffton.com as soon as possible but no later than 48 hours before the scheduled event.

Executive Session – The public body may vote to go into executive session for any item identified for action on the agenda.

**Please note that each member of the public may speak at one public comment session and a form must be filled out and given to the Town Clerk. To submit a public comment online, please click here:*

<https://www.townofbluffton.sc.gov/FormCenter/Town-15/Public-Comment-60>

Public comment is limited to 3 minutes per speaker.

TOWN COUNCIL

STAFF REPORT
Projects and Watershed Resilience Department



MEETING DATE:	October 27, 2026
PROJECT:	Discussion of a Short-term Resilience Recommendations
PROJECT MANAGER:	Beth Lewis, Watershed Resilience Manager Andrea Moreno, Watershed Division Manager

REQUEST: Staff requests Town Council’s guidance on several proposed resilience opportunities. These recommendations resulted from work related to:

- 1. Developing a Resilience Ordinance for the Town’s consideration; and
- 2. A completed SC Sea Grant Consortium Resilience Planning Analysis (“Resilience Analysis”).

BACKGROUND: In January of 2025, Town Council approved a Master Service Agreement (MSA) task authorization with McCormick Taylor, Inc. and Center for Watershed Protection (“Consultants”). The Consultants were tasked with developing a Town Wetland Ordinance and a Resilience Ordinance to protect health, safety, and welfare of our citizens and natural resources.

Table 1. McCormick Taylor & Center for Watershed Protection Tasks.

CONSULTANTS’ TASKS – WETLAND PROTECTION AND RESILIENCE ORDINANCES		STATUS
1	Review current Town policies.	Completed
2	Identify and inventory wetlands within the Town’s jurisdiction.	Completed
3	Develop a map of wetlands to be protected.	Completed
4	Develop a Wetland Ordinance for the Town.	Completed – 2 nd Reading 8/2026
5	Apply comprehensive drainage study results to identify and map resiliency zones.	Completed
6	Identify primary stormwater drainage channel systems.	Completed
7	Develop a Resilience Ordinance for the Town.	In progress – following Council’s direction

In 2024, the Town engaged SC Sea Grant Consortium to conduct a Resilience Planning Analysis (“Resilience Analysis”) independent of the Consultants’ work. SC Sea Grant’s Resilience Analysis Final Report (completed June 2025) included the key findings below.

Table 2. SC Sea Grant Consortium Resilience Analysis Recommendations.

SC SEA GRANT CONSORTIUM RESILIENCE ANALYSIS OF THREATS & POSSIBLE OPPORTUNITIES TO CONSIDER	
1	<u>Flood Vulnerability is Increasing</u> : Areas currently experiencing minor flooding are projected to face more severe events in the future. Parcels presently outside of flood-prone zones may also become vulnerable.
2	<u>Future Development</u> : New construction and land use changes increase the risk of flooding.
3	<u>Protecting Wetlands</u> : Preserving wetlands and requiring buffers significantly reduces flood risk.
4	<u>Land Elevation-Based Zoning</u> : Areas at lower elevations face higher flood risks, while those at higher elevations are less susceptible.
5	<u>Significance of Community Engagement</u> : Community input was instrumental in shaping the Resilience Analysis and emphasized the necessity for stronger flood mitigation policies.

RESILIENCE RECOMMENDATIONS FOR DISCUSSION: The following is a list of resilience recommendations that resulted from the Consultants’ scope of work and the Resilience Analysis. Detailed recommendations from the Consultants and the Resilience Analysis can be found in **Attachment #1** and **Attachment #2**, respectively. Staff is requesting Council’s guidance to prioritize which, if any, resilience recommendations Staff should explore further. Future Workshops with Council will occur as needed as these recommendations are further developed in a phased approach.

Phase 1 (proposed completion FY27):

1. Strengthen Wetlands Protection (Completed):

- Implement comprehensive wetland protections to steer new development away from ecologically sensitive wetlands and ensure long-term preservation.

2. Expand Land Acquisition and Partnerships:

- Collaborate with land trusts and conservation organizations to acquire and protect critical wetlands and floodplain areas. Conservation priority areas have been identified.
- Update the Town’s Land Acquisition Manual to expand the acquisition criteria to include identified conservation priority areas.

3. Update Flood Management Policies and Strategies:

- Strengthen the Town’s Flood Damage Prevention Ordinance to include compensatory storage requirements and expand on requirements that help prevent downstream flooding.
- Join the Community Rating System (CRS) to allow residents to receive discounted flood insurance premiums.
- Expand the Federal Emergency Management Agency (FEMA) Flood Hazard Area to include the 500-year floodplain to help protect life and property in areas facing increased flood risk due to future projections.

4. Implement Cove Buffer Ordinance:

- Adopt a buffer ordinance applicable to the coves of the May River to protect water quality, stabilize cove banks, and enhance flood control.
- Apply different buffer widths based physical characteristics of coves.

Phase 2 (anticipated, FY28):**1. Implement Resilience Zone Overlay District:**

- Restrict development in flood-prone, low-lying areas by integrating land elevation criteria into local zoning regulations.
- Apply the Town’s Flood Damage Prevention Ordinance and an enhanced resilience-focused stormwater plan review to development in this overlay district.

2. Offer Financial Incentives for Resilient Development:

- Enhance programs like Transfer of Development Rights (TDR) and considering additional financial incentives to encourage resilient construction and land use.

CONSIDERATIONS & NEXT STEPS: Below is a list of recommended items for Town Council’s consideration, should you choose to proceed.

1. Update the Town’s Land Acquisition Manual
2. Update Floodplain Management Regulations
3. Implement Cove Buffer Ordinance

If Council agrees, staff will move forward with these resilience recommendations per the tentative timelines, below.

Resilience Recommendation	Next Steps	Tentative Date
Update the Town’s Land Acquisition Manual	Resolution	December 2026
Update Flood Management Regulations	Workshop	December 2026
Implement Cove Buffer Ordinance	Workshop	April 2026

ATTACHMENTS:

1. McCormick Taylor Memos
2. SC Sea Grant Resilience Analysis



MEMORANDUM

To: Town of Bluffton Project Team

From: McCormick Taylor

Date: 6/3/2026

Subject: Task 3.1 – Resiliency Ordinance

Project: Town of Bluffton – Wetlands and Resiliency Ordinance

1 PURPOSE

Given the state's vulnerability to hurricanes, sea-level rise, and flooding, resilience has become a major focus for many communities, and jurisdictions along the coast have been actively implementing resiliency plans and related policy updates. For example, in 2023, the South Carolina Office of Resilience completed the first ever Statewide Resilience and Risk Reduction Plan for South Carolina and at the local level, in 2025, the Town of Sullivan's Island developed its first Sea Level Adaptation and Resilience Plan. To address resilience, most local plans call for comprehensive updates to their municipal code. Recommendations typically focus on strengthening stormwater management and requiring low-impact development and green infrastructure, updating development standards and floodplain management requirements, and redesigning zoning regulations with overlay districts to limit development in vulnerable areas.

The Town of Bluffton recently adopted a wetland ordinance to protect wetlands and their associated buffers from development, preserving the essential natural functions these areas provide. This action follows the 2023 *Sackett v. EPA* decision, which removed protection from millions of acres of wetlands across the United States that no longer qualify as federally jurisdictional. Other coastal communities, such as the Town of Mount Pleasant and Georgetown County, are also considering or actively drafting similar wetland protection ordinances. To further strengthen resilience to flooding, higher intensity storm events, and projected sea level rise, the Town of Bluffton has begun exploring methods to map "resiliency zones" and develop a resilience zone ordinance. These resiliency zones are locally defined as undeveloped areas that provide critical environmental services, such as stormwater and floodwater storage, natural buffering from storm surge, and groundwater recharge, all of which help mitigate the impacts of a changing climate. The methodology used to identify and map these resilience zones is described in Memo 3.4. This memo provides recommendations to incorporate into a resilience zone ordinance aimed at protecting and preserving the mapped areas.

2 OTHER COASTAL JURISDICTIONS- RESILIENCE ORDINANCE REVIEW

As part of this effort, McCormick Taylor (MT) reviewed the municipal codes and regulations of nearby jurisdictions to identify whether any resiliency zone ordinances had been adopted and if so, what elements they contained that could help inform the Town's approach. Focusing on coastal South Carolina municipalities, MT reviewed the municipal codes from Charleston County, the City of Charleston, the Town of Hilton Head, the City of Beaufort, Beaufort County, the Town of Kiawah Island, the Town of Mount Pleasant, and the City of Myrtle Beach. While no jurisdiction has formally adopted a resiliency zone ordinance in name, many municipalities have addressed resiliency through strengthened stormwater



regulations, flood management ordinances, and updated development standards and zoning districts. The following section provides a high-level overview of resilience elements from each jurisdiction.

2.1 CHARLESTON COUNTY, SC

Charleston County does not have a specific resilience ordinance, however, in 2020, the County appointed its first Chief Resilience Officer and created a Resilience Committee to help fulfill the resilience element of the [Comprehensive Plan](#). Members of the committee discussed proposed changes to the zoning and land-use regulations, building and flood codes, and stormwater manual to increase resilience, and in 2022, three recommended ordinances were adopted: [Ordinance #2217](#) which amended the zoning and land development regulations (ZLDR) regarding building height measurements, [Ordinance #2218](#) which amended the ZLDR to encourage parking under buildings, thereby promoting building designs that encourage flow beneath structures, and [Ordinance #2232](#) which updated impervious surface limits. Other long-range recommendations that have been proposed for inclusion, but require further study, include updating parking limits, strengthening tree protection ordinances, encouraging elevation-based development, and updating design standards to reduce building footprints and incentivize green infrastructure.

In 2022, the County passed [Ordinance #2225](#) which formally established a permanent Resilience and Sustainability Advisory Committee and in 2024, the County updated their Flood Damage Prevention and Protection Ordinance ([Ordinance #2306](#)), updating design flood elevation (DFE) to base flood elevation (BFE) plus two (2) feet. Charleston County also maintains minimum buffers and setbacks from all saltwater wetlands, waterways, and OCRM critical lines. Depending on the zoning district, the buffers range from 15 to 35 feet, and the setbacks are an additional 35 to 50 feet.

Chief Resilience Officer: Karen Burney-Green

Email: kgreen@charlestoncounty.org

Charleston County municipal code: [Code of Ordinances | Charleston County, SC | Municode Library](#)

2.2 CITY OF CHARLESTON, SC

Despite not having a formal resilience ordinance, the City of Charleston has implemented regulations that address flood protection, sea level rise, and overall community resilience. In 2015, the City updated its zoning and land-use ordinances to encourage growth in low-risk areas such as the Upper Peninsula. The Upper Peninsula Zoning District is an incentive-based zoning district that provides opportunities to earn height and density bonuses provided that developers implement community identified benefits such as open space protection or green infrastructure. In 2018, the City of Charleston established the Mayor's Office of Resilience and Sustainability to spearhead resiliency initiatives. More recently, in 2023, the City passed an ordinance banning "slab-on grade" foundations within the 100-year floodplain for single family homes and multi-family dwellings.

The City of Charleston is currently undergoing a project to update and modernize its zoning code to make it more user friendly, address the goals of the recently adopted comprehensive plan ([Charleston City Plan](#)), and address rising water levels. Based on the Charleston City Plan and a recent code assessment, one of the recommendations was for the City to adopt "elevation-based" development regulations. These regulations would address development and redevelopment in the context of the rising water environment,



which will cause an increased risk of flooding for low elevation areas. The Charleston City Plan included a [Land and Water Analysis](#) (LWA) that used elevation, in consideration with watershed and environmental sensitivity, to develop four broad planning strategies: grow, defend, adapt, and reserve. From this analysis, four elevation risk zones were developed to guide the elevation-based zoning: Tidal Flood Risk Zone, Compound Flood Risk Zone, Adapt Zone, and High Ground Elevation Risk Zone. The Tidal Flood Risk Zone encompasses the lowest land in Charleston, nearly 100% of which is in the 100-year floodplain. This includes elevations of approximately 7 feet and below, which is the point where tidal flooding of land can occur and where marsh migration is likely to occur with 3 feet of sea level rise. This zone informed the creation of boundaries for the Low/Impact/Conservation land use category as part of the City Plan's Future Land Use Map. The High Ground Elevation Risk Zone encompasses the highest elevations in the City, generally 15 feet and above. These areas were used to map out areas of the town for higher intensity growth, residential density, and a wide range of uses. The Adapt Zone consists of land outside of the FEMA 100-year floodplain that is still within the NOAA maximum storm surge of a category 3 hurricane. Lastly, the Compound Flood Risk Zone encompasses areas within the floodplain but above the tidal risk zone where flood risk comes from a mixture of rainfall, runoff, and tidal conditions. The elevation-based zoning is expected to be implemented over the next one to two years.

Director of Planning, Preservation, & Sustainability: Robert Summerfield

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City of Charleston Municipal Code:

https://library.municode.com/sc/charleston/codes/code_of_ordinances?nodeId=10245

2.3 TOWN OF HILTON HEAD, SC

While the Town does not have a formal resilience ordinance, Hilton Head encourages resilience through natural resource protection. Under the land management regulations, the Town maintains a wetland protection ordinance to regulate development and activities in and around wetlands and wetland buffers. Wetland buffer width requirements are 20 feet for single-family homes and vary for multi-family and non-residential development. Additionally, under this ordinance, no work may be undertaken within a wetland buffer without first receiving approval from the Town through a natural resources permit. The Town also requires mitigation for any activity where the alteration of a wetland cannot be avoided. The loss of the wetland must be mitigated for through any approved combination of wetland revegetation, wetland restoration, wetland creation, wetland preservation, wetland mitigation banking, or the payment of fees in lieu of mitigation.

The Town maintains strong flood hazard reduction standards, requiring all new construction and substantial improvements to be elevated three (3) feet above BFE or to an elevation of 13 feet in special flood hazard areas. The Town is currently working with a consultant team to develop a resilience plan addressing sea level rise and climate adaptation and is in the process of updating the current land management ordinance. Both efforts are expected to include resilience-based policy recommendations.

Chief Environmental Officer: TJ Lett

Email: TJJ@hiltonheadislandsc.gov

Town of Hilton Head municipal code: [Code of Ordinances | Hilton Head Island, SC | Municode Library](#)



2.4 CITY OF BEAUFORT, SC

While the City of Beaufort does not have a specific resilience zone ordinance, the local planning commission has discussed implementing a wetland ordinance, though nothing has formally been adopted. The City currently maintains critical area buffer requirements to preserve and restore native landscape along the marsh edge. For transect-based zoning districts, the buffer is 30 feet and for conventional districts the buffer is 50 feet. The City has also adopted the Southern Lowcountry Stormwater Design Manual (SoLoCo) which emphasizes the use of green infrastructure and low impact development for post-construction stormwater management.

While the City's current flood damage prevention ordinance only requires all new construction and substantial improvements to be elevated one (1) foot above BFE or to an elevation of 13 feet in special flood hazard areas, the City has limited the amount of fill allowed on a parcel to three (3) feet to meet these requirements.

City Planner III: Christopher Klement

Email: cklement@cityofbeaufort.org

City of Beaufort municipal code: [Code of Ordinances | Beaufort, SC | Municode Library](#)

2.5 BEAUFORT COUNTY, SC

Beaufort County maintains natural resource protection standards that help preserve and protect wildlife habitat, species diversity, and water quality. The current ordinance addresses tidal wetlands, non-tidal wetlands, beach dune systems, endangered species and bird nesting habitat, flood hazard area, and forests. Development in non-tidal wetlands is prohibited except for approved activities, and on-site or off-site mitigation is required under certain conditions. The County requires a setback along the edges of all freshwater wetlands in the form of a vegetative strip. For single family residential the setback is 20 feet and for multifamily residential, commercial/industrial, and impervious parking areas/roads/driveways the setback is 50 feet. A vegetated river buffer must also be established landward of the OCRM (BCM) critical line. River buffer widths vary based on zoning district and range from 20 to 50 feet.

Beaufort County maintains a fill ordinance in special flood hazard areas. Similar to the City of Beaufort, fill may not increase the existing natural grade more than three (3) feet and can only be placed underneath the elevated structure. The County has also adopted the SoLoCo manual for post construction stormwater management.

In 2024, Beaufort County updated its 2015 Sea Level Rise Action Plan to develop the [Beaufort County Long-Term Resilience Strategy](#), which focuses on sea level rise and includes recommendations for mitigating localized flooding. The report includes recommendations categorized into four resilience strategy groups: Awareness, Study, Action, and Reassess. Awareness and Study recommendations focus on research and data gathering to support future decision making. Action recommendations focus on resilience policies and planning strategies along with timelines for implementation. Reassess recommendations address ways to ensure the policies and strategies are reaching the intended outcomes. A few of the relevant "Action" recommendations from the report regarding resiliency include: 1) designing and constructing future capital improvements and infrastructure to account for project sea level rise, 2) periodically evaluating policies related to Base Flood Elevation (BFE), 3) adopting a coastal resilience overlay district that corresponds with



areas in the 100-year and/or 500-year floodplain and developing a set of policies to require new infrastructure to be located outside of the district unless deemed necessary, and 4) identifying low lying properties that serve important drainage and stormwater functions based on elevation and soils and considering acquiring them or transferring development rights.

Planning and Zoning Department Director: Robert Merchant

Email: robm@bcgov.net

Beaufort County municipal code:

https://library.municode.com/sc/beaufort_county/codes/code_of_ordinances

2.6 TOWN OF KIAWAH ISLAND, SC

The Town of Kiawah is addressing resilience through planning initiatives and code updates. In 2023, the Town adopted its [Comprehensive Marsh Management Plan](#) to guide future development while protecting the Island's vulnerable salt marshes. The Town established a Resiliency Committee to advise Town Council on resilience and sustainability issues while helping to implement the recommended strategies from the Marsh Management Plan and 2018 [Flood Mitigation and Sea Level Rise Report](#). The Town recently approved the 2025 Comprehensive Plan, [KiawahNext](#). This plan, along with the Marsh Management Plan, details recommended policy actions to meet the Town's resiliency goals, such as creating a Chief Resiliency Officer position, developing a consolidated Resiliency Plan, and forming an education program to increase community awareness of resilience issues. In July 2025, the Town adopted an ordinance requiring all development to submit a stormwater management plan for review and approval to help reduce flooding, protect water quality, control erosion, and manage runoff. Previously, only construction projects larger than one acre that required coverage under a NPDES construction general permit were regulated for stormwater management.

The Town of Kiawah held its second reading for an ordinance to establish a Beachfront Overlay Zoning District (BOD). The purpose of the BOD is to establish and protect a transition zone between the built environment and the ocean, beach and dune system and promote coastal resilience and aesthetic compatibility through zoning and vegetation standards. As of April 2026, Town Council has chosen to defer action on the proposed BOD. While the Town does not have a wetland or wetland buffer ordinance, it maintains critical line buffer and setback requirements. For residential development, the critical line setback is 30 feet, and the critical line buffer is 10 feet. For non-residential development, the critical line setback is 50 feet, and the critical line buffer is 35 feet.

Planning and Zoning Department Director: John Taylor

Phone Number: 843-768-9979

Town of Kiawah Island municipal code: [Code of Ordinances | Kiawah Island, SC | Municode Library](#)

2.7 TOWN OF MOUNT PLEASANT, SC

The Town of Mount Pleasant has several resilience-based standards already in place and created a Committee on Flood Resilience and a GREEN (Green Space, Environment, Ecology, and Natural Resources) Commission tasked with continuing to build town-wide resilience. In 2021, the Town updated the design flood elevation from one (1) foot to two (2) feet plus BFE. The Town developed an "[Environmental Guidelines for Land Development](#)" program for commercial and non-residential development that encourages low



impact design, green infrastructure, nature-based solutions and sustainable building practices to make the Town more resilient to flooding, habitat loss, and pollution. The program is based off a point system, and any eligible project must be designed to meet a minimum of 100 points across four categories: 1) Protect, Restore, and Conserve Natural Water Resources, 2) Protect and Improve Ecosystem Biodiversity, 3) Improve Community Livability (Mobility, Aesthetics, Well-Being), and 4) Promote Energy Efficiency and Sustainable Material Resources. They are currently considering implementing a similar program for residential development. The Town also maintains a Single-Family Residential Stormwater Management and Tree Preservation Program. The ordinance regulates construction on single family lots and ensures neighboring properties are protected from stormwater and construction site sediment.

The Town of Mount Pleasant is currently (as of April 2026) moving to adopt a [local ordinance](#) to protect isolated non-jurisdictional wetlands. The proposed ordinance would also require a buffer around all isolated wetlands or vernal pools with an average width of 10 feet (no more than 20 feet and no less than five feet). The Town has an existing wetland buffer ordinance, establishing a 35-foot buffer around all freshwater wetlands and a critical area buffer ordinance with an average buffer width of 35 feet and a minimum of 20 feet.

Director of Planning, Land Use, & Neighborhoods: Michele Reed

Email: planning@tompsec.com

Town of Mount Pleasant municipal code: [MOUNT PLEASANT, SOUTH CAROLINA CODE OF ORDINANCES](#)

2.8 CITY OF MYRTLE BEACH, SC

The City of Myrtle Beach does not have a specific resilience zone ordinance; however, resilience is partially addressed through their zoning and development standards. The City maintains a Coastal Protection Overlay Zone for properties seaward of the projected 50-year erosion control line to control erosion, preserve and maintain the beach, safeguard property, and promote public safety. Under the City's zoning code, there are four different "development options" one of which, the Sustainability and Conservation Development Option, helps to promote resilience and the protection of natural resources. This development option is allowed in any new subdivision in any district that allows residential use, with the intent of preserving and protecting natural resources such as groundwater, floodplains, wetlands, streams, and woodlands for natural flood control, filtration, habitat for wildlife, and aesthetics. This option provides the developer with various incentives for implementing certain measures. For example, if the land developer maintains at least a 50' vegetated buffer around all existing wetland and riparian areas, they are allowed to construct one additional multifamily dwelling unit per 3,000 square feet of provided buffer area. Similarly, if native plants are used for landscaping, one additional multifamily dwelling unit per 0.5 acre of native landscape area, including the utilization of rain harvesting and/or water recycling for irrigation, is allowed. Incentives are additionally granted for trails and open space connectivity, additional provision of open space, low-impact development, affordable housing, and energy and water efficiency/sustainable construction certification.

The City also maintains strong flood management requirements and requires all development in the 100-year flood zones and coastal high hazard zones to be elevated three (3) feet above BFE.

Director of Planning & Zoning: Kenneth May

Phone Number: 843-918-1167



City of Myrtle Beach municipal code: [CODE OF ORDINANCES CITY OF MYRTLE BEACH, SOUTH CAROLINA](#) | [Code of Ordinances](#) | [Myrtle Beach, SC](#) | [Municode Library](#)

3 JURISDICTIONS OUTSIDE SC- RESILIENCE ORDINANCE REVIEW

MT reviewed regulations from four other coastal jurisdictions along the East Coast that have established resilience or wetland ordinances. This section summarizes the ordinances from Norfolk, Virginia, Beaufort, North Carolina, Savannah, Georgia, and Boston, Massachusetts.

3.1 CITY OF NORFOLK, VA

The City of Norfolk underwent a comprehensive zoning ordinance update and in 2018 adopted new regulations that established resilience overlay districts and a resilience quotient system. The resilience overlay districts, which were identified in [Norfolk's Vision 2100 plan](#), consists of a Coastal Resilience Overlay (CRO) district and an Upland Resilience Overlay (URO) district. The CRO district is defined as all land within the 100-year floodplain with the intent of reducing flood risk to individual properties and the surrounding community. The CRO district has specific regulations for ground floor height, landscaping, open space set-asides, and parking. For example, landscaping must consist of exclusively salt tolerant and native species and paved parking is limited to reduce stormwater runoff. The URO district applies to all land outside of the CRO district and is intended to encourage development in upland areas, away from flood risk.

Concurrently, the City established a resilience quotient system within its development standards. All new and redevelopment must comply with the resilient quotient and undergo site plan review to ensure resilient development is addressed by reducing risk from flooding, managing stormwater, promoting energy resilience, conserving water resources and protecting water quality, supporting multiple mode of mobility, developing in a manner that promotes health and safe environments and lifestyles, and providing inclusionary dwelling units with mixed-income residential or mixed-use developments. In lieu of the site plan review process, depending on the development type (multi-family residential or non-residential) and number dwelling units or total square footage, applicants may elect to achieve a minimum number of points from the resilient quotient across three categories: flood risk reduction, stormwater management, and energy resilience. Single-family development may also choose to comply with the resilience quotient for single family development in lieu of the City's site plan review process. Instead of achieving a minimum number of points, under this option, flood risk reduction must be addressed by elevating the lowest habitable floor and all significant electrical and mechanical equipment at least 16 inches above the highest existing adjacent grade. Stormwater requirements must be met by either capturing and detaining roof runoff on site with at least 200 gallons of storage or by planting one healthy medium or large tree (or two healthy small trees) for every 25 feet of lot frontage. Lastly, energy resilience must be addressed by designing the electrical system with pre-installed wiring and connections to safely support a generator and/or connection to solar, wind, or other locally generated electricity sources.

The CRO and URO overlay districts also have specific requirements under the resilience quotient. If located within the CRO district, developers for multiple dwelling unit residential development and non-residential and mixed-use development must reach a higher minimum point requirement or provide 25% greater flooding risk reduction and stormwater management efforts if utilizing the site plan review procedure. If



developing in the URO, four points may be counted towards the resilient quotient if a developer extinguishes development rights in the CRO, either through direct purchase or easement.

Zoning Administrator: Jeremy Sharp

Email: Jeremy.sharp@norfolk.gov

City of Norfolk zoning ordinance: [Norfolk Zoning Ordinance](#)

3.2 TOWN OF BEAUFORT, NC

The Town of Beaufort is currently drafting a new Unified Development Ordinance (UDO) that will consolidate its zoning, subdivision, flood protection, and minimum housing ordinances into a single document. As part of the new UDO and as recommended by the Town's [Comprehensive and CAMA Land Use Plan](#), the new UDO will include a Coastal Resilience Overlay District (CR-O). As of October 2025, the Town has completed a proposed draft CR-O which will establish two subdistricts: the CR-NIZ, non-intensification zone subdistrict and the CR-M, moderate hazard subdistrict. The CR-NIZ corresponds to the 100-year floodplain (Zones AE and VE) and the CR-M corresponds to the 500-year floodplain (Shaded Zone X). The overlay will include specific regulations for residential density, impervious surface coverage, shoreline management, and low-impact development. For example, within the CR-NIZ, new critical facilities and new residential uses other than detached single family homes are prohibited. Additional regulations include:

1. New developments within the CR-NIZ subdistrict are limited to a maximum density of five dwelling units per acre;
2. All lots in the CR-O subdistrict that have frontage along a natural waterbody must maintain or establish a shoreline buffer with native vegetation; and
3. All new developments in the CR-O that are subject to Chapter 54, Stormwater must use at least two LID techniques to manage at least 50% of the developments peak flow.

The proposed regulations will also incorporate incentives for developers. If an existing development is proposed to be renovated, repaired, altered, or otherwise improved by more than 50% of its replacement value, developers can receive incentives for stormwater retrofits. For example, adding vegetation to existing retention/detention areas or installing a bioswale or raingarden may count toward the on-site landscaping requirements. Replacing impervious surfaces with pervious materials may also allow a reduction in the required shoreline buffer area, equivalent to the amount of impervious surface removed, up to 750 square feet. Additional incentives are provided if the development incorporates increased construction standards. For instance, if the principal structure is elevated above the regulatory flood protection elevation (RPFE), the maximum building height may increase by 1 foot for each additional foot the structure is elevated above RPFE. If at least 75% of the structure's windows and doors are impact resistant, the maximum impervious surface coverage may increase by up to 2%. The complete list of incentives can be found in the draft ordinance.

Planner: Michelle Eitner

Phone number: 252-728-2141

Town of Beaufort draft coastal resilience overlay district: [Draft Coastal Resilience Overlay District 09-05-25 | Town of Beaufort, NC](#)



3.3 CITY OF SAVANNAH, GA

While not a formal resilience ordinance, the City of Savannah, Georgia has several natural resource ordinances in place to protect riparian systems, groundwater recharge areas, and wetlands. The city has a Protected River Corridor Buffer limiting certain land-disturbing activities and uses within a designated 100-foot buffer for perennial streams or watercourses with an average annual flow of at least 400 cubic feet per second. The city maintains a Groundwater Recharge Area ordinance in which land uses that generate, use, or store pollutants within groundwater recharge areas are restricted. The boundaries of this area are defined by the Georgia Department of Natural Resources Pollutant Susceptibility Map in the Hydrologic Atlas. For wetlands, the City has a Wetlands Assessment regulation in which any applicant seeking land disturbance, building, or demolition permits must consult the U.S. Environmental Protection Agency West Chatham County Advance Identification Map of Wetlands and Uplands (ADID map) or the U.S. Fish and Wildlife Service NWI map. If the proposed activity is located within a wetland inventory area or within 100 feet of one, a USACE jurisdictional determination is required. If jurisdictional features are found and a USACE permit is required, the city will only issue a land disturbance, building, or demolition permit after receiving the USACE permit. The City also maintains a wetland and marsh buffer ordinance, with a wetland buffer width of 35 feet along jurisdictional wetlands and a marsh buffer width of 35 feet along all marsh. Activities such as soil disturbance, clearing of vegetation, and filling are prohibited within the wetland and marsh buffers, and an approved modified wetland or marsh buffer permit is required from the city before any approved land-disturbing activities can be conducted within the buffer area.

Director of Planning and Urban Design: Bridget Lidy

Email: Blidy@savannahGA.gov

City of Savannah municipal code: [City of Savannah Code of Ordinances](#)

3.4 CITY OF BOSTON, MA

Boston, MA has integrated resilience in numerous ways. All projects subject to or electing to comply with Article 80 Large Project Review, Planned Development Area Review, Institutional Master Plan Review, or Small Project Review must comply with [Zoning Article 37](#) and the City's [Climate Change Review Policy](#), and be designed, constructed, and managed to minimize and mitigate adverse environmental impacts, promote sustainable development, and minimize and mitigate the impacts of greenhouse gas emissions. In 2017, the Climate Change Review Policy was updated, requiring all Large Project, Planned Development Area, and Institutional Master Plan review to complete a [climate resiliency checklist](#) as part of their development review procedure. As of July 2025, small project review applications must also include a [climate resiliency checklist](#). Utilizing the checklist, applicants must consider and analyze the impacts of near and future climate conditions and incorporate measures to avoid, eliminate, or mitigate greenhouse gas emissions and impacts related to climate change in project planning, design, and construction. The review process requires applicants to consider a range of climate stressors including sea level rise, higher annual temperatures, more frequent and longer extreme heat events, increased precipitation, more severe rain events, and increased greenhouse gas concentrations.

Boston also developed and adopted a Coastal Flood Resilience Overlay District (CFROD) in 2021 to address long-term flood risks. The overlay district corresponds to the area anticipated to be flooded with a 1% chance storm event in 2070 with 40 inches of sea level rise. Within the CFROD, all projects must be designed to meet the minimum sea level rise design flood elevation (SLR-DFE). Per Article 25A of the zoning



code, a Resilience Reviewer will ensure project compliance with the City's [resilience policies and requirements](#). For projects not subject to Article 80 Large Project review, the Boston's Planning and Development Agency (BPDA) will conduct resilience review through the resilience component of the Small Project review process. In addition to the elevation requirements, projects within the CFROD must be consistent with the [coastal flood resilience design guidelines](#). These guidelines include incorporating resilient practices to reduce flood risk, enhancing the character of the public realm, integrating district-scale resilience solutions, and including sustainability co-benefits.

Deputy Director for Climate Change and Environmental Planning: Rich McGuinness

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City of Boston municipal code: [ARTICLE 25A - COASTAL FLOOD RESILIENCE OVERLAY DISTRICT | Redevelopment Authority | Boston, MA | Municode Library](#)

4 TOWN OF BLUFFTON'S EXISTING MUNICIPAL CODE

MT reviewed the Town of Bluffton's municipal code to identify existing resilience-based elements to help guide the creation of the recommended resilience zone ordinance.

4.1 FLOODPLAIN MANAGEMENT

As summarized in the Memo 3.2, the Town of Bluffton regulates all development within FEMA-designated Special Flood Hazard Areas (SFHAs) through a permitting process that requires scaled site plans, elevation data, and professional certifications for new or improved structures. Development is prohibited in floodplains if alternative locations exist, and projects that affect floodways, base flood elevations (BFE), or watercourses must obtain FEMA Conditional Letters of Map Revision (CLOMRs) before construction and submit as-built certifications upon completion, which require professional engineer certification. General floodplain development standards require anchoring, flood-resistant materials, and utility protection to BFE +3 ft. The first floor of residential, non-residential, and manufactured housing construction must be elevated at least one foot above the adjacent roadway centerlines or three (3) feet above BFE, whichever is higher, and enclosures below BFE are limited to non-habitable uses with flood openings provided to relieve hydrostatic pressure. Critical development (hospitals, fire stations, etc.) elevations must meet or exceed the 500-year flood elevation or the highest known historical flood.

Additional provisions address a wide range of development scenarios to ensure flood risk is minimized across the community. Floodways prohibit encroachments is prohibited unless certified as "no-impact," and Coastal High Hazard Areas (V-Zones) require pile or column foundations with breakaway walls to accommodate wave action. Recreational vehicles (RVs) are only permitted if temporary, road-ready, or compliant with manufactured housing standards, while accessory structures and utility rooms must be anchored and floodproofed according to FEMA guidance. Subdivisions, streams without mapped BFEs, shallow flooding zones, and coastal hazard areas all have tailored requirements mandating hydrologic and hydraulic studies when necessary.



4.2 ZONING AND DEVELOPMENT STANDARDS

The Town's design standards are intended to promote development that allows for more open space to be preserved to help promote infiltration, reduce flooding, and lower the amount of pollution entering local waterbodies. Bluffton maintains open space requirements for all development and redevelopment activities. A minimum of 20% of the gross acreage must be developed/preserved as open space, and for residential development a minimum of 10% of the gross residential use acreage must be specifically identified and developed to use as common open space and accessible to the residents and the general public. Lands designated as open space includes active recreation areas, central greens, community parks, natural open land, greenbelts, or stormwater detention areas with greenway trails and footpaths. Current lot and building standards include maximum lot coverage percentages, but do not indicate specific impervious surface limits. However, the ordinance does encourage shared parking and block and roadway layouts that reduce overall impervious surfaces.

The Town maintains a preserve (PR) zoning district. The PR district is intended to preserve and protect sensitive environmental areas, restrict development that could compromise these areas, and maintain open spaces that provide an ecological and aesthetic value to the community. The Town's development ordinance also incentivizes sustainable neighborhood design and development through the implementation of Smart Growth Principals in four of the Town's "Place Types" (Rural Crossroads, Hamlet, Village, or Town Center). To receive incentives, a project must score a minimum of 15 out of 20 points from six different criteria: redevelopment site, compact, complete, and connected development, environmental sustainability, water conservation/efficiency/management, energy efficiency, and operations and maintenance education. Developments that meet these criteria can receive a 25 % fee reduction and up to a 50% fee reduction if 20 points are achieved.

4.3 STORMWATER MANAGEMENT

The Town adopted the Southern Lowcountry Stormwater Design Manual, or the SoLoCo Manual in 2021. The manual, which was amended March of 2025, standardizes how stormwater elements of projects are designed, submitted, reviewed, approved, and inspected and emphasizes the use of green infrastructure and low impact development to address post-construction stormwater management. The design criteria in the manual are applicable to any new development or redevelopment activity that meets one of more of the following criteria or is a major substantial improvement: 1) development that involves 5,000 square feet or more of land disturbing activities, 2) redevelopment/infill that will result in an additional 2,000 square feet or more of impervious surface, or 3) land disturbance, regardless of size, that is part of a larger common plan of development that meets criteria 1 or 2. The SoLoCo manual has designated three separate watershed protection areas with unique stormwater management requirements based on the current and anticipated water quality control measures for their contributing watersheds. The Town falls within the Bacteria and Shellfish Watershed Protection area, and therefore any applicable new development, redevelopment, or major substantial improvement must meet the following performance requirements below.

- To address water quality, the developer must implement Better Site Design (BSD) and retain the 95th percentile storm on site with approved infiltration/filtering BMPs. For the Bacteria and Shellfish Watershed Protection Areas this is 1.95 inches of rainfall. The developer must also fulfill maximum



extent practical (MEP) requirements or, as a last resort, fulfill off-site credit and/or fee-in-lieu requirements.

- As a pollutant removal minimum, the developer must intercept and treat stormwater runoff volume to at least an 80% reduction in total suspended solid loads, 30% reduction of total nitrogen load, and 60% reduction in bacteria load.
- The developer must control the post-development peak runoff discharge rate for the 2, 10, 25, 50, 100-year, 24-hour design storm events to the pre-development discharge rates.
- The developer must accommodate the 100-year, 24-hour storm event conveyance through the site and downstream without causing damage/inundation to structures and provide 10% rule analysis.

4.4 NATURAL RESOURCE PROTECTION

The Town recently adopted an wetland and wetland buffer ordinance following the 2023 Sackett v. EPA decision that removed protection from millions of acres of wetlands that no longer qualify as federally jurisdictional. The Town also maintains a riparian buffer ordinance requiring a buffer of 100 feet from the SCDES Critical Line adjacent to any tidal wetlands and waterways (see memo from Task 3.4 for more information on riparian buffers). The Town maintains a tree conservation ordinance where the preservation and enhancement of native vegetation is encouraged and any impacts to protected trees (all trees that are 8 inches in diameter at breast height (DBH) or greater and all American holly, dogwood, redbud, southern magnolia and red buckeye trees that are 4 inches in DBH or greater) and significant trees (24 inches in DBH or greater, any tree listed on America's Historic Tree Register, and all trees that are located within regulated wetland buffers) requires a permit. If protected trees are removed, they are required to be replaced according to the standards established in the ordinance. Native and regionally appropriate plant species must be planted, and replacing invasive species with hardwood species is encouraged. For sites less than one (1) acre, a tree canopy with a minimum 75% coverage must be provided. When land disturbance is proposed for sites of at least one (1) acre, a minimum of 15 hardwood trees per acre must be provided.

5 RESILIENCE ZONE ORDINANCE RECOMMENDATIONS

A resilience ordinance could be implemented using two general approaches. The first approach would be to establish a resilience-focused site plan review process which could be implemented alongside the Town's current development plan review procedures. This option would apply town-wide and take a more comprehensive approach to resilience, evaluating not only flood reduction, primarily addressed in the SoLoCo manual, but also broader resilience objectives such as energy resilience and risk reduction. Alternatively, the Town could establish a resilience zone overlay district to focus protection on the more vulnerable flood prone areas. The boundary of the overlay district could correspond to the locally derived conservation priority areas, the elevation-based analysis, or the 100 year and/or 500-year FEMA floodplain boundaries, depending on the Town's goals. Within the overlay district, additional regulations would apply to increase resilience to flooding, sea level rise, and other climate related impacts and encourage development and redevelopment in areas outside of the resilience zones. Consideration should be made regarding redevelopment or remodeling of structures; the threshold constituting a "substantial improvement" to a structure should be predefined. Following FEMA guidance of 50% of the structure's value would be in line with the current flood damage requirements.



An overview of the two approaches is described below, though the selected approach will depend on the Town's ability to implement and enforce the suggested policy and procedures.

5.1 RESILIENCE PLAN REVIEW PROCESS

Under the resilience plan process, applicants seeking approval for new or redevelopment would be required to submit a resilience plan demonstrating how the proposed development addresses the Town's identified resilience objectives. The resilience plan could be submitted as a standalone document or incorporated into the required stormwater management plan (SWMP) submittal to reduce redundancy. The Town could require that the applicant pay an additional resilience review fee as part of the process. Revenue generated through this fee could go towards a resilience fund used to support resilience initiatives or purchase conservation easements.

The proposed approach is adapted from Boston, Massachusetts Climate Resiliency Guidelines, Norfolk, Virginia's resilient quotient and site plan review process, and Mount Pleasant's Environmental Guidelines for Land Development. Under this framework, a developer must also achieve a minimum number of points across a range of resilience categories. The required point threshold could be based on factors such as project size, location, or development type. For example, more points could be required for developing within the previously identified resilience zones or FEMA regulated flood hazard areas versus areas outside of these zones. Point requirements could also vary based on development type (single family residential, multi-family, commercial, institutional, industrial), with single family, single lot development needing fewer points. Subdivisions of greater than four lots should follow the same requirements as multi-family development since subdivisions will typically include infrastructure such as roads and community centers. Whereas single lot residential developments are typically built off of an existing road and includes only the structure and driveway.

As part of the review process, applicants would submit a resilience plan with a standardized resilience checklist, providing supporting information and calculations demonstrating how the proposed development meets the Town's requirements. This approach allows for flexibility in how the applicant achieves compliance with these standards and is not intended to discourage development, but instead ensure developers integrate resilience into all steps of the planning and design process. Resilience categories may include stormwater and floodplain management, energy resilience, protection of natural resources, hazard and risk reduction, and the promotion of healthy and safe communities, though the specific categories can be tailored to the Town's priorities. To ensure a balanced approach, the Town should require that the applicant meet a minimum point threshold from all resilience categories. Alternatively, the Town could require points to be earned from a specific number of categories (e.g., 3 or 4). While incentives could be offered for projects that exceed the minimum point thresholds, given the suburban nature of the Town, expedited review times or reduced permitting fees are recommended rather than density bonuses or relaxed building codes.

The following section outlines recommended resilience elements the Town may choose to incorporate into their resilience plan process. It's important to note that many of these techniques require maintenance and continued financial investment. The Town should require that the applicant provide a maintenance agreement along with the resilience plan submission.

***Stormwater Management*****All development:**

- Exceed SoLoCo requirements for water quality and quantity management using projected precipitation rates
- Reduce impervious surface on the site by a predetermined percentage
- Design the drainage system for future climate conditions such as the current 25-year storm or use projected precipitation rates
- Consider increased tailwater conditions that reflect sea level rise or increase in downstream water surface elevations due to precipitation changes for storm drain computations
- Provide downspout disconnection

Single family, single lot, residential development:

- Construct new hard landscaping (driveways, walkways, pool surrounds) using pervious materials
- Intercept and detain roof drainage on site via rain gardens or cisterns

Multiple Lot Single Family Development or Multi-family residential development/commercial development:

- Use pervious pavement or grass paving systems on at least 50% of a parking lot
- Construct new hard landscaping (driveways, walkways, pool surrounds) using pervious materials on all parking bays except ADA
- Intercept and detain roof drainage on site via rain gardens or cisterns
- Install pet waste stations
- Utilize open section roadways with grass swales
- Develop gray water reuse systems for irrigation or other non-potable uses

Floodplain Management**All development:**

- Minimize floodplain fill (1 foot or less) within any site buildout
- Provide compensatory storage at a ratio of 1.5 to 1
- Increase finished floor elevations above the minimum standards

Energy Resilience**All development:**

- Generate a predetermined percentage of electricity from on-site solar, wind, geothermal, or other renewable energy source
- Install electric vehicle charging stations

Natural Resources



All development:

- Provide a wider wetland buffer or riparian buffer than what is currently required by the Town's ordinance
- Provide a minimum 35' riparian buffer along all streams
- Plant exclusively native and salt-tolerant landscaping
- Install a pollinator garden
- Retain all existing large trees or expand the existing tree canopy
- Reforest previously disturbed areas
- Utilize stormwater marshes and wetlands instead of wet ponds, or incorporate varying grading schemes within ponds to allow for various planting zones of native species
- Install a naturalized riparian buffer around stormwater ponds
- Install floating wetlands within the stormwater ponds

Hazard and Risk Reduction

All development:

- Install impact (hurricane or wind) resistant windows
- Install storm shutters
- Impact resistant roof

Healthy and Safe Communities

All development:

- Provide public walkways or connect to an existing trail or path system utilizing pervious surfaces
- Provide open space greater than what is currently required
- Provide a community garden space at a ratio of 50 square feet per residential dwelling unit
- Provide bicycle amenities

The process would work as follows: a trigger mandates a required resilience plan review – for example, projects with a land disturbance greater than 5,000 square feet. Once required, the developers, architects, consultants, and engineers would complete the resilience checklist consisting of a range of quantitative and qualitative questions about the site and how the development addresses the proposed resilience elements and achieves the required points. As part of this process, project planners must evaluate if the location and site conditions are vulnerable to flooding (FEMA 100 and 500-year floodplain as an example) or fall within the Town's resilience zone (see hybrid approach below). This framework encourages projects to be designed around future risk, and the Town may decide to choose a set year, say 2070, as a project target for sea level rise, changes in precipitation, and projected development within the area. The process should not be rigid but instead considered as a resilience framework that can be adapted to broader landscapes or risk patterns while removing bias. The following section provides an example of what information and questions the checklist could include:



Project Information
Owner, Developer, Architect, Engineer, etc. contact information and licenses
Parcel and Building Information including: • Site location • Property area and building area • Area of disturbance • Existing site elevation low and high • Proposed site elevation low and high • Proposed first floor elevation
Is any portion of the parcel in a FEMA SFHA, what zone and what elevation?
Is any portion of the parcel in the Town's selected Resilience Zone?
Is any portion of the parcel within the SC projected sea level rise or marsh migration area?
Applicable green building rating systems: • LEED Version, Certification, Rating and Point Score
Project Specifications
Building Envelope – R Values: • Roof, exposed floor, foundation wall, slab edge • Above-grade assemblies such as windows, doors, and spandrels
Energy Loads and Performance: • Annual Electric (kWh), Peak Electric (kW) • Annual Heating (MMbtu/hr), Peak Heating (MMbtu) • Annual Cooling (Tons/hr), Peak Cooling (Tons) • Energy Use – Below ASHRAE 90.1-2013 (%) • Energy Use – Below SC Code (%) • Energy Use Intensity (kBtu/SF)
Back-up / Emergency Power System: ▪ Electrical generation output (kW) ▪ System type (kW) ▪ Number of power units ▪ Fuel source
Greenhouse Gas Reduction and New Zero / Net Positive Carbon Building Performance: ▪ Annual building GHG emissions ▪ Describe how building energy performance has been integrated into project planning, design and engineering, provide supporting analysis or modeling. ▪ Describe passive energy efficiency measures ▪ Describe specific active energy efficiency measures ▪ Describe building specific load reduction strategies ▪ Describe any area or district scale emission reduction strategies ▪ Describe any energy efficiency assistance or support provided ▪ Describe utilization of renewable energy resources ▪ Describe how the building and its systems will evolve to further reduce GHG emissions

**Climate:**

- Temperature range (low/high)
- Annual heating degree days and cooling degree days
- What extreme heat event characteristics will be / have been used for project planning
- Days above 90 degrees, days above 100 degrees
- Number of and duration of heatwave per year
- Describe building and site measures to reduce heat island effects
- Describe how the building and its systems will be adapted to efficiently manage future higher average temperatures, additional heatwaves, and longer heatwaves
- Describe all mechanical and non-mechanical strategies that will support building functionality during extended interruptions of utility services and infrastructure including proposed and future adaptations

Resilience:

- Describe how the site meets the resilience point requirements
- Describe all building and site measures for reducing storm water runoff
- Describe how site and building systems will be adapted to efficiently accommodate future more significant rain events
- Describe site design strategies for adapting to sea level rise including building access during flood events, elevated site areas, hard and soft barriers, wave/velocity breaks, stormwater systems, utilities, etc.
- Describe how the proposed building design flood elevation will be achieved including dry/wet flood proofing, critical systems protection, utility service protection, temporary flood barriers, waste and drain back flow prevention
- Describe how occupants might shelter in place during a flooding event including any emergency power, water, and wastewater provisions and the expected availability of such measures
- Describe any strategies that would support rapid recovery after a weather event
- Describe future site design and or infrastructure adaption strategies for responding to sea level rise including future elevating of site areas, access routes, barriers, etc.

5.2 RESILIENCE ZONE OVERLAY DISTRICT

Alternatively, the Town may choose to address resilience through the establishment of a resilience overlay district. Overlay districts are a flexible planning tool that would allow for additional requirements to be implemented while keeping the base zoning regulations in place. Implementing an overlay district would also prevent the need to rewrite the existing zoning code, which is a substantial and time-intensive process, and is consistent with the approach taken by Norfolk, Virginia, Beaufort, North Carolina, and Boston, Massachusetts. A variety of mapping methods and approaches were evaluated as the boundary for the resilience zone (see Task 3.4). If the Town's primary focus is to reduce flood risk and protect the most vulnerable areas, MT recommends establishing the overlay district based on the low and medium elevation areas identified through the Town's elevation analysis in combination with the 100- and 500-year floodplains. However, the elevation-based boundary may not protect upland areas with high infiltration rates from development, potentially increasing flooding impacts downstream. Utilizing the conservation priority areas identified using the methodology developed by the South Carolina Office of Resilience as the resilience zone boundary may be more beneficial from a Town-wide resilience standpoint.



The proposed resilience overlay district would complement the SoLoCo manual and further protect water quality, reduce stormwater runoff, preserve natural habitat and floodplains, encourage resilient construction, and prepare for and minimize the effects of future sea level rise. MT recommends the following standards be implemented within the resilience overlay district:

<i>Stormwater Management</i>
• Set impervious surface limits or limits on what percentage of the lot should remain naturally vegetated/landscaped. Recommended 30% impervious surface limits for residential development and 50% for non-residential. • Require driveways and new hard landscaping (walkways, driveways, pool surrounds) to be constructed using pervious materials. • Require developments exceed SoLoCo requirements for water quality and quantity management using projected precipitation rates. • Require storm drain computations to consider increased tailwater conditions that reflect sea level rise or increase in downstream water surface elevations due to precipitation changes. • Do not allow variances or Maximum Extent Practical Waivers. • Require a comprehensive watershed study that depicts the impact on the downstream conveyances for storm events up to the 100-year. The study should include the hydrograph peaks for the main discharge channel / water course and the specific site discharge.
<i>Floodplain Regulations</i>
• Set a limit on the amount of fill for any site buildout. Recommended no fill be allowed within SFHA, or if fill is allowed, compensatory storage should be required at a ratio of 1.5 to 1. • Include language to allow easy adjustment of the BFE+3 to account for sea level rise and increased storm surge. • Place the same floodplain requirements for the 500-year event that is currently in place for the 100-year event.
<i>Risk Reduction</i>
• Require at least 75% of the windows and doors to be impact resistant. • Require at least 75% of the windows to include storm shutters. • Require an impact resistant roof.
<i>Natural Resources/Landscaping</i>
• Require the use of native and salt-tolerant landscaping. ◦ Consider adding a table of preferred or recommended native vegetation for plantings. • Require a naturalized riparian buffer around stormwater ponds. • Require an increased tree canopy or greater replacement requirements.

While other municipalities have explored a transfer of development rights (TDR) program to encourage development elsewhere, the City of Norfolk has found this approach to not be successful at shifting development patterns. The overlay district approach could instead include incentives that encourage development in areas outside of the resilience zone such as expedited permitting or permit fee reductions. If using the elevation-based boundary, it should be noted that encouraging development in upland areas may lead to increase runoff further exacerbating flooding within the resilience zones. If incentives of this



nature are explored, careful consideration on enactment of additional stormwater requirements should be considered.

5.3 HYBRID APPROACH

The resilience site plan review process and resilience zone overlay district could also be implemented together as a hybrid resilience framework. Under this approach, optional measures identified in the site plan review process could become mandatory for projects within the resilience zone overlay district. For properties outside of the resilience zone, the resilience site plan review process/checklist could either be voluntary with incentives offered to encourage participation, or mandatory through a lower threshold of points required. *MT recommends the latter approach that would hold all development to a level of resilience planning, while areas within the resilience zone should have additional requirements.* With any ordinance, a waiver or variance mechanism must be in place. Variances should only be granted upon demonstration that strict compliance would create exceptional hardship, the variance will not increase public danger or flood risk, and the variance is the minimum necessary relief and complies with all local, state and federal requirements.

6 CONCLUSION

While many local communities in South Carolina have incorporated resilience elements through floodplain management standards, stormwater requirements, and other green initiatives, none have adopted a comprehensive resilience zone ordinance. In review of the above approaches, it is recommended that the Town of Bluffton adopt a hybrid approach, combining a town-wide resilience site plan review process with a resilience zone overlay district. Under this approach, all development and applicable redevelopment would be required to consider resilience throughout the review process, while projects located within the overlay district would be required to follow more stringent resilient practices. Incentives could be provided for development in areas outside of the overlay district, including expedited permitting, density bonuses where appropriate, stormwater fee reduction, reduced parking requirements and public recognition programs. The launch of the resilience plan process can begin as a recommended checklist for developers. Then, a scheduled rollout date can be set for mandatory compliance. The success of a resilience ordinance and enhanced development requirements is reliant on public education. The Town should launch a “Resilient Bluffton” public information campaign that promotes the values of this program and how it will ultimately provide for a safer, more resilient community. Care should be taken though that these guidelines do not burden socially vulnerable populations or workforce housing initiatives.



MEMORANDUM

To: Town of Bluffton Project Team, Attn: Beth Lewis & Andrea Moreno

From: McCormick Taylor

Date: 5/5/2026

Project: Town of Bluffton – Wetlands and Resiliency Ordinance

Subject: Task 3 – Resiliency Ordinance, Components and Considerations

Purpose:

This memorandum summarizes the findings from Task 3.2, which involved reviewing the Heyward Cove project report while considering the framework and methodology, reviewing and summarizing existing Town of Bluffton flood prevention codes, and recommending flood mitigation ordinances including a minimum first floor elevation for structures, compensatory storage needed to avoid upstream/downstream impacts, and minimum fill and elevated “flow through” construction approaches. All thoughts, analysis, concerns, and recommendations provided in the following memorandum are intended as an objective report and are not intended as legal advice.

1 HEYWARD COVE STUDY REVIEW

In 2023, J. Bragg Consulting completed an engineering analysis of the Heyward Cove drainage basin in Bluffton, South Carolina. That project included a stormwater asset inventory of drainage infrastructure, hydrologic and hydraulic analysis, and program and project recommendations. McCormick Taylor (MT) reviewed the J. Bragg Consulting final report. A summary of their methods and findings is included here. Additionally, the project’s framework was evaluated to provide recommendations on application of that project’s findings on buffer and protection areas.

1.1 HEYWARD COVE STUDY SUMMARY

1.1.1 Stormwater Asset Inventory

A comprehensive stormwater asset inventory was developed for the Heyward Cove basin using Beaufort County LiDAR and DEM data, Bluffton and Beaufort County GIS stormwater inventories, SCDOT as-built plans, NOAA tidal and rainfall records, FEMA flood maps, USDA soils data, and other regional resilience and climate references. Assets such as inlets, pipes, culverts, channels, and streams were documented for type, size, ownership, material, location, elevation, and condition, while smaller pipes, roadside ditches, and non-stormwater infrastructure were excluded. The assessment categorized assets into structural or maintenance defects, reflecting collapse, deterioration, sedimentation, or vegetation issues. Bluffton’s stormwater infrastructure policy framework guided classification by Level of Service (LOS), emphasizing citizen safety, flood hazard reduction, and natural resource protection at the strategic level, while tactical LOS directed maintenance, minor rehabilitation, and replacement priorities.

1.1.2 Hydrologic and hydraulic analysis

Hydrologic and hydraulic conditions were evaluated using PCSWMM 2D and QGIS, with calibration supported by a local rain gauge and the Town’s monitoring station (BV01). Hydrology was simulated with the NRCS curve number method using conservative soil assumptions and the NOAA B rainfall distribution,



and watersheds were delineated from 2020 LiDAR with 10' resolution in developed areas. Conveyance piping was modeled without accounting for existing sedimentation or structural deterioration, but iterative calibration against two major storm events included adjustments to roughness and entrance losses to reflect assets' field conditions. Model performance met CIWEM guidance for error tolerances, and simulations were run for 10- through 100-year storm events under existing, proposed, and proposed with future sea level rise conditions. Culvert and open channel analyses revealed deficiencies in SCDOT subgrade freeboard and culvert headwater to depth ratios under existing conditions, identified capacity improvements from ditch cleaning paired with culvert upgrades, and highlighted the need for downstream improvements to prevent upstream backwater conditions.

1.1.3 Recommendations

The analysis demonstrated that proposed improvements significantly reduced inundation footprints and lowered hydraulic grade lines, while future sea level rise scenarios also indicate improved flood conditions based on modeled road flooding events between existing conditions and proposed retrofits with future sea level rise conditions. Findings supported the prioritization of capital improvement projects based on downstream conveyance capacity, choke points, and flood-prone areas, with four projects defined and cost-estimated at the ditch and pipe level. Maintenance projects were divided into structural (rehabilitation and replacement) and general O&M (inspections, cleaning, mowing, and minor repairs) categories, aligned with Bluffton's LOS framework. Several bullet points are provided in the report as general recommendations for flood prevention policies for the town to consider.

1.2 GENERALIZED FRAMEWORK REVIEW

The Heyward Cove study was conducted using a specific framework or order of analysis. The framework includes the typical steps for drainage or flood studies, in which existing conditions are evaluated, engineering models are built, and recommendations for improvement are made.

The primary steps in the Heyward Cove analysis include:

1. Background data gathering (desktop analysis)
2. Field data gathering (survey, asset inventory, conditions assessment)
3. Hydrologic analysis/modeling
4. Hydraulic analysis/modeling
5. Conceptual improvement project development and implementation

In many cases, a similar framework should be used to evaluate vulnerability to flood-related hazards. In others, portions of this framework can be reduced or eliminated. Some specific aspects of the framework can also be used to inform regulations aimed at reducing flooding or protecting against future stressors.

In the following sections, each aspect of the framework is discussed with a description of the utility of the findings as related to regulation.



1.2.1 Background data gathering

Engineering background data was collected to support modeling and recommendations. These data include topographic, land cover, soils, rainfall, roadway, County GIS, and other peripheral data. The datasets listed in the Heyward Cove report appear to be sufficient to support modeling and analysis.

These background data provide the needed insight into field conditions that are difficult or impossible to obtain directly on-site at the project scale. For example, reliance on USDA for soils data at large scales is common practice for H&H modeling. Additional background data regarding existing drainage and flooding issues were also collected. These data are used to define the trajectory of the study and to identify focus areas. Typically, known drainage issues are targeted for improvement in drainage studies to allow the analysts to limit the project scope to a manageable and cost-effective scale.

Application to other sites: Most of this background data is typically available on demand through local, county, state, and federal agency websites. Some datasets, for example SCDOT's web portal for historic plans, require login credentials and a subscription fee. Some gauge data, due to the limited number of gauges deployed by federal agencies (e.g., USGS), are available for purchase from private enterprises or through partnerships. For example, the SC Office of Resilience (SCOR) has partnered with Clemson University for a pilot project to deploy 125 water level gauges at bridge crossings and other key locations in the Upper Savannah and Saluda watersheds. Those gauges are intended to help fill in local data gaps in flood monitoring. Private industries (such as Hohonu and CoCoRaHS) also offer partnering opportunities for locally deployed water level and precipitation sensors and monitoring platforms.

For broader adoption, the collection, synthesis, and delivery of these background data should be required as they will be used for most levels of analysis from conceptual planning to final design. Background data can take the form of locally obtained or generated datasets (e.g., the Town's wetlands data generated as a part of this study), or state and federal agency data (e.g., National Land Cover Dataset, NLCD). When locally generated or obtained background data is available, that should take precedence over larger-scale agency data. This means that, for example, local land cover data if available is preferable to NLCD. This is related to the different scales at which these data are generated. Federal and state data are often less granular and may miss prominent landscape or hydrologic features when applied to the local scale. If local data is unavailable or unobtainable (due to time, funding, or other constraints), agency data should be used with an understanding of the tradeoff between confidence in model/analysis results and data precision. For the Heyward Cove study, local rainfall and water level data was obtained for model validation. A similar data source prioritization is recommended with field monitoring data which is discussed in the next section.

Locations of existing drainage or flooding concerns can be obtained from several sources including internal Town knowledge, feedback gathered from public meetings, and service or maintenance requests to the Town and agencies (e.g., local SCDOT maintenance office) from residents. These sources collectively provide insight into recurring drainage problems, and a catalog of known drainage issues can be developed at a Town-wide scale prior to conducting detailed H&H studies such as the Heyward Cove study. The information collected may document a wide range of flooding conditions, from small-scale nuisance issues, such as ponded water in a front yard or driveway, to large scale events that result in road closures or widespread property damage. Identifying known flooding areas along with the nature, severity, and



frequency of flooding provides a better understanding of the existing system. This allows consultants to better prepare project scopes, reduce the costs and turnaround times of future drainage studies, and identify areas for capital improvement projects.

Application to regulatory requirements: Background data collection and synthesis will inform resilience zones, buffers, and protection areas by establishing baseline conditions and a scientific understanding of the environmental conditions. Background data gathering is, in part, being completed as part of the current project through the compilation and creation of GIS layers.

Data on known flooding problems in Bluffton were collected as part of the Town's Sea Grant Resilience Planning stakeholder involvement. A flood reporter survey was created using Survey123, an ArcGIS software, to document past floods experienced by residents. The survey collected data on the location, timing of flood events, as well as water depth and movement. Paper surveys were also distributed, and residents were able to identify flood locations in person at Town hosted public meetings. An ArcGIS data layer was developed with the flood information collected through the various methods. Data on existing drainage and flooding issues is also being continuously collected by residents using the SeeClickFix application, which allows users to report issues directly to the Town. These submissions are routed to OpenGov Enterprise Asset Management (formerly Cartegraph) where they can be evaluated and tracked. Dedicated reporting tools such as this application are often one of the most effective ways to identify existing flooding or drainage concerns as residents can report issues in real-time with location specific information and include photos or videos of the extent of flooding. In addition, the Town may choose to distribute annual or quarterly flood surveys to residents to ensure broader community participation and capture feedback from potentially underreported areas. The Town's catalog of reported drainage and flooding issues can help identify areas of recurring problems which can be used to prioritize study areas and focus resources on locations with the greatest need.

1.2.2 Field data gathering

Field data collected includes an inventory of drainage assets and assessments of the condition of those assets. Stormwater infrastructure assets include inlets, pipes, culverts, channels, and streams, and the attributes and condition of those assets represent the existing stormwater conveyance network. Existing conditions assessments are conducted for any drainage study to establish a baseline which is later compared against proposed improvements to demonstrate and quantify impacts of projects. When evaluated at the built-infrastructure scale, detailed field inventory is needed. This data is critical to model the drainage systems to identify areas of concern and opportunities for maintenance and improvement. In the event an infrastructure asset is inaccessible either due to property access restrictions or being submerged, typically engineering-based assumptions are justifiable for planning level studies. For final design, full field data is typically needed. This may require advanced surveying techniques such as divers or vessels to access submerged areas. Right of entry or eminent domain letters from the Town may be needed to grant surveyors access to property for data collection. The cost associated with these in-depth measures is not warranted for planning level assessments, but for final design and construction phases, those costs are warranted. These decisions are site and project specific. In some cases, novel approaches may be employed for data collection. For example, if an entire drainage system is flooded, limiting data acquisition, it is possible to select a downstream limit, insert an inflatable bladder, and dewater the system above the



bladder so that visual observations could be made. The cost of such efforts needs to be balanced with the desired outcomes and the impact of reduced precision.

Application to other sites: An inventory of assets will be needed for projects that involve changes to the built stormwater management system. Similar field data is needed when investigating natural drainage systems. The inventory data is used by hydraulic modelers to calculate key design parameters including water surface elevations, velocities, flow capacity, and others. These data are also required for final design and construction projects to develop design plans and details. However, for planning projects and studies, survey grade inventories may not be necessary. Hydraulic modelers and designers can assist with determining site-specific minimum data needs to support their analyses tailored for the purpose of the particular study or planning effort. Oftentimes, reasonable assumptions can be made to limit the need for detailed field inventories depending on the scale and purpose for the study. For example, large-scale regional planning studies will be minimally affected by residential driveway culvert performance.

Relating to scale, built systems are designed to convey stormwater up to a specified design storm event. For example, SCDOT roadside drainage is typically designed to convey the 10-year (10% chance) storm. For larger or higher intensity storms, those systems become ineffective, and larger conveyance pathways (e.g., entire roadway sections) become more important. This means that for projects that aim to address flooding from larger storms, greater than the 25-year event, detailed field inventory may not be necessary. Ultimately, the decision to conduct a detailed asset inventory depends on how the information will be used, whether it is intended to inform planning studies, support resilience modeling, or, as a secondary use, to identify maintenance and capital improvement projects based on a system's current condition and age. Often the data gathered to build a model can have secondary benefits such as populating an asset management plan with maintenance needs or with assets nearing their end-of-life cycle. This offers an ideal time to accomplish two tasks under one project.

Application to regulatory requirements: The asset inventory and conditions assessment at the neighborhood scale is necessary to build models that will identify hazard vulnerability. Full inventories may not be necessary when examining large-scale drainage pathways and vulnerability. For example, impacts of sea level rise can be assessed based on projected ocean levels and topography and details of the local drainage network will add very little to the understanding of sea level rise impacts on a large scale. If neighborhood-scale vulnerability is desired, detailed inventory is needed to the extent required by the hydraulic analysis. Outside of its use in hydraulic modeling, asset inventories and conditions assessments also provide valuable data for policy development and updates, help to identify partnership and funding opportunities, and support budget planning and capital improvement programs.

1.2.3 Hydrologic analysis and modeling

The Heyward Cove study used the USDA NRCS methodology (Curve Number method). An SCS Type-III rainfall distribution was assumed. Area weighted curve number was calculated using USDA soils data and NLCD for land cover.

Application to other sites: The NRCS method is standard practice for infrastructure scale modeling. However, more recently NOAA rainfall distributions are favored over SCS distributions and should be used



for most analyses. Additionally, runoff-weighting should be considered over area-weighting when determining a composite curve number.

NLCD land cover data is commonly used for planning level studies. If local land cover, zoning, or other higher resolution local data is available, that should be used since NLCD data is at a resolution of 30 meters and may oversimplify local runoff potential for small-scale investigations.

In addition to the hydrologic conditions used by the Heyward Cove study authors, other rainfall distributions and durations should be evaluated. For example, a short-duration, high-intensity storm in developed watersheds or ones with unfavorable soils can be more damaging than the standard 24-hour storm. Additionally, varying levels of build-out scenarios should be modeled against the varying storm intensities and frequencies. Current land use and ultimate build-out land use should both be considered when assessing future conditions. A no-action scenario should also be considered which combines existing control measures with future climate stressors including sea level rise and changing storm characteristics. These various scenarios can 1) demonstrate the value of implementing improvements, 2) assess impacts of potential projects, 3) project future performance of existing and proposed mitigation measures, and 4) project the impact of future land development against an array of stormwater and flood control management measures. Depending on the time horizons for implementing mitigation measures, intermediate build-out scenarios should also be considered. Defining the “future year” to be assessed is a key decision during project planning and will be based on the specific goals and targeted outcomes of individual studies and projects.

Application to regulatory requirements: The hydrologic analysis can be conducted for other portions of the Town to assist with identifying resilience zones. Identified drainage areas, flow pathways, groundwater conditions, etc. can inform the Town of areas that will generate higher runoff as well as areas that may be leveraged for stormwater management. Additionally, the Town’s larger watersheds can be refined by evaluating local drainage pathways to create more refined resilience zone boundaries. If hydraulic analysis is to be conducted, hydrologic analysis will be needed. The hydrologic analysis, similar to the field inventory, can be limited depending on scale and project needs.

1.2.4 **Hydraulic analysis and modeling**

The hydraulic analysis included an integrated 1D/2D PCSWMM model of the Heyward Cove drainage network. The model included the pipe and channel conveyance system as well as the overland flow generated from subcatchments. The model used a tidal downstream boundary condition. The model was calibrated for flow and stage at two simulation times. The models were run for three scenarios including the existing system, proposed system (based on recommended improvements), and the proposed system with future (2073) rainfall depth predictions and sea level rise (Resiliency Model Condition). Conveyance features were assessed for key performance metrics such as headwater depth at culvert crossings at key locations.

Application to other sites: PCSWMM is a powerful modeling tool and can be leveraged to assess a variety of hydrologic and hydraulic scenarios and small and large scales. The Heyward Cove study report includes details on the specific modeling approaches, with many being standard practice. Hydraulic modeling



involves targeted simplifications, assumptions, method selections based on a combination of project purpose, experience, and site-specific conditions. The details of the modeling approach appear to be well justified, but a critique of those would require a full understanding of the conditions at Heyward Cove.

For some situations, 1D/2D modeling is likely the best way to represent the field conditions. The 2D (overland flow) components of the modeling take many forms in practice and can be developed in several ways. For example, the overland flow can be exclusively generated from a back-up of the 1D conveyance system, or overland flow can be directly generated from rainfall at the 2D mesh scale. Rainfall at this scale is termed “rain-on-grid” and involves resolving the full connectivity of the overland and built infrastructure system within the model.

The future conditions analysis in the Heyward Cove study included future sea level rise and the updated NOAA B rainfall distribution. These are important components to evaluate, though additional stressors can be included. On the scale of Bluffton’s drainage basins, future changes to land use due to build-out of development agreement sites should be included. Reasonable assumptions as to the density, impervious cover, etc. of those developments can be made to create a model scenario reflecting future climate and development conditions. Changes to precipitation intensity should also be considered. Currently, NOAA is finalizing updates to published rainfall depths for storm recurrence intervals, and throughout the majority of South Carolina those values are increasing. Future changes to temperature, vegetative uptake, groundwater, and land subsidence can also be reflected in future-conditions scenarios if deemed significant for a particular location and planning effort.

Generally, future conditions models should include future climate stressors, future land cover, and future management practices. Future stressors include sea level rise and changing storm characteristics. These include higher-intensity, shorter-duration storms as well as long-duration events. Future land cover should include the ultimate build-out of the expected future developments. Future management practices should include both the future performance of existing management practices as well as new practices when exploring improvement alternatives.

Application to regulatory requirements: Pluvial flooding vulnerability can best be assessed through hydraulic analysis of the drainage system. This can include both built and natural drainage systems using varying levels of model sophistication. In some cases, simple analyses using spreadsheets or hand calculations may suffice – particularly for individual drainage assets or roadside drainage. In other cases, full two-dimensional modeling best represents the interplay of overland and drainage system stormwater flows. The models in all cases can identify system pinch points, vulnerabilities, and improvement opportunities. These can help refine resilience zone boundaries at a local level.

1.2.5 **Conceptual improvement project development and implementation**

Based on the evaluation of the existing model, areas of concern were identified, and improvement projects were proposed. The level of service improvements were quantified, and reduction in flooding was determined. Improvement projects were categorized into capital projects and maintenance programs. Importantly, project dependency was identified. Costs were estimated to implement the project, and a discussion of the projects was included. Conceptual-level displays were presented in the report.



Application to other sites: The strategy of the Heyward Cove report generally follows common practice and can be applied elsewhere. Although considered when developing project recommendations, a discussion of implementation hurdles should be included with each project to include permit needs, easements/ownership, maintenance, and potential for community buy-in. Additionally, benefits can be quantified using FEMA's Benefit/Cost Analysis (BCA) methodology based on H&H modeling. While generally difficult to quantify and costly to develop due to the need for detailed flood data, the inundation maps produced through the modeling efforts, like those developed for Heyward Cove, can streamline the analysis. Quantifying the project benefits helps with securing capital by making the project eligible for grant funds for future project implementation, potentially outweighing the initial investment.

Application to regulatory requirements: Along with new improvement projects, recommendations could include retrofits or improvements to existing stormwater management facilities or natural storage areas and conveyances. Identifying where these opportunities exist can help inform resilience zone planning by identifying parts of Town that may be at full capacity in terms of stormwater management versus areas that have reserve capacity.

1.3 APPLICATION OF HEYWARD COVE FINDINGS

The findings of the Heyward Cove study can be applied to recommended first floor elevations for the purpose of flood protection. The study authors developed inundation maps based on their H&H models which depict flood depth for various design storms.

As will be discussed in Section 2 of this memo, the Town currently requires flood damage protection in accordance with the National Flood Insurance Program (NFIP) for development within FEMA special flood hazard areas (SFHA). However, FEMA stops delineating SFHAs at a certain scale of tributary, even though upstream areas may still face flood risks. Consequently, this means that the absence of a SFHA for a drainage ditch or stream does not guarantee that flooding or damaging flooding will not occur. As a result, the Town can choose to develop comparable requirements for development outside of SFHAs. For these areas, locally generated flood models can be used to establish flood risk, similar to the procedure of the Heyward Cove study. To ensure that additional burdens are not placed on developers and property owners, the same level of protection should be required inside and outside of the SFHA. This means that first floor elevations should be elevated to the local base flood elevation (BFE) plus freeboard (3 ft currently for Bluffton).

The analysis procedure will be as follows:

- I. Determine if the development/redevelopment site is within the FEMA SFHA.
 - a. If within the SFHA, the Flood Damage Prevention Ordinance applies.
 - b. If outside of the SFHA, a local comprehensive drainage study is needed.
- II. If outside of the SFHA, the applicant should prepare H&H models to generate a 100-year flood map for the area.
 - a. Specific modeling requirements will depend on the site and type of development (e.g., single-family lots, multifamily dwellings, commercial buildings), but the flooding from the nearest flood source



- as well as any compound flooding effects (e.g., multiple cresting riverine sources or riverine plus coastal flooding, etc.) is required.
- b. Future conditions assessments may be considered as well but will require guidance from the Town as to the appropriate future conditions scenarios (i.e., sea level rise only, sea level rise plus buildout, etc.)
- III. If the proposed structure is within the locally generated 100-year flood plain, flood damage protection including elevation of the first floor will be required.

2 EXISTING BLUFFTON CODES SUMMARY

The Town of Bluffton regulates all development within FEMA-designated Special Flood Hazard Areas (SFHAs) through a permitting process that requires scaled site plans, elevation data, and professional certifications for new or improved structures. Development is prohibited in floodplains if alternative locations exist, and projects that affect floodways, base flood elevations (BFE), or watercourses must obtain FEMA Conditional Letters of Map Revision (CLOMRs) before construction and submit as-built certifications upon completion, which require professional engineer certification. General floodplain development standards require anchoring, flood-resistant materials, and utility protection to BFE +3 ft. The first floor of residential, non-residential, and manufactured housing construction must be elevated at least one foot above the adjacent roadway centerlines or three (3) feet above BFE, whichever is higher, and enclosures below BFE are limited to non-habitable uses with flood openings provided to relieve hydrostatic pressure. Critical development (hospitals, fire stations, etc.) elevations must meet or exceed the 500-year flood elevation or the highest known historical flood.

Additional provisions address a wide range of development scenarios to ensure flood risk is minimized across the community. Floodways prohibit encroachments unless certified as “no-impact” and Coastal High Hazard Areas (V-Zones) require pile or column foundations with breakaway walls to accommodate wave action. Recreational vehicles (RVs) are only permitted if temporary, road-ready, or compliant with manufactured housing standards, while accessory structures and utility rooms must be anchored and floodproofed according to FEMA guidance. Subdivisions, streams without mapped BFEs, shallow flooding zones, and coastal hazard areas all have tailored requirements mandating hydrologic and hydraulic studies when necessary.

The Town of Bluffton has also adopted the Southern Lowcountry Stormwater Design Manual (SoLoCo manual) to address post-construction stormwater management. The SoLoCo manual has designated three separate watershed protection areas with unique stormwater management requirements based on the current and anticipated water quality control measures for their contributing watersheds. The Town falls within the Bacteria and Shellfish Watershed Protection Area, and therefore any applicable new development, redevelopment, or major substantial improvement must meet the following performance requirements.

- Water Quality: Implement Better Site Design (BSD) and retain the 95th percentile storm on-site with approved infiltration/filtering BMPs. Fulfill MEP requirements or, as a last resort, fulfill off-site credit and/or fee-in-lieu requirements.
- As a pollutant removal minimum, intercept and treat stormwater runoff volume to at least an 80% reduction in total suspended solid loads, 30% reduction of total nitrogen load, and 60% reduction in bacteria load.



- Peak control: Control the post-development peak runoff discharge rate for the 2, 10, 25, 50, 100-year, 24-hour design storm events to the pre-development discharge rates.
- Accommodate the 100-year, 24-hour storm event conveyance through the site and downstream without causing damage/inundation to structures. Provide 10% rule analysis.

2.1 BLUFFTON CODES RECOMMENDATIONS

After reviewing the existing Bluffton flood protection codes, MT has developed a series of recommendations regarding 1) compensatory floodplain storage needed to avoid upstream/downstream impacts, and 2) methods to demonstrate a no impact designation for construction. The existing code regarding structures' first-floor elevations, as well as the existing code for elevated "flow through" construction approaches was determined to be comparable to other vulnerable communities and therefore no additional changes are recommended at this time

2.1.1 Compensatory floodplain storage

Compensatory floodplain storage is the excavation or creation of equivalent floodplain volume to offset the loss of storage caused by filling or development, ensuring flood levels are not increased. MT recommends a 1:1 cut to fill ratio for compensatory storage to ensure that any loss of flood storage capacity from development is offset. This standard would require that for every unit of fill placed in the floodplain, an equal volume of storage is excavated within the same flood zone (e.g., compensatory storage in zone AE-9 must be provided for fill within zone AE-9). Fill volume within a flood zone is defined as the post-development lost storage volume within the flood zone. This can be measured by the volume of the wedge of fill material that is placed from existing ground elevation up to the effective BFE. The ideal excavation for floodplain storage is at the same river station as the floodplain fill, on the opposite side of the stream/floodplain source as the fill. If this is not possible, the next best alternative is upstream on the same side of the stream as the fill, prioritizing proximity to the fill area. Compensatory storage located downstream of the fill will not be effective, because under the hydraulic flow conditions typical of this region, additional downstream storage cannot offset the choke point created by the fill. In parts of the Town where officials have observed high rates of floodplain development, MT recommends considering a 1.5:1 cut to fill ratio for new developments/redevelopments to reclaim floodplain storage.

2.1.2 No-Impact Certification

The purpose of a no-impact designation for construction is to ensure development is not contributing to increased flood risk of adjacent properties and the community. MT recommends different regulations based on the property's location with regard to FEMA flood zones. For development within a FEMA flood zone, MT recommends a hydrology study to show no increase in peak discharges or volumes from a range of storm events from the 2-year to the 100-year. If the 100-year storm post-development hydrology shows an increase in peak discharges or volumes compared to pre-development hydrology, a rise of nearby BFEs is likely. In this case, a full engineering study conducted by a professional engineer is needed to obtain a no-impact certification. The Town of Bluffton requires that post-development peak runoff discharges do not exceed pre-development conditions for the 2-, 10-, 25-, 50-, and 100-year, 24-hour storm, however, the current regulations do not require stormwater volume control for the higher storm events (10-year and greater). Peak rate control maintains the same or lower peak discharge under proposed conditions when compared to existing. To achieve this standard when proposed conditions generate more runoff, stormwater management practices are installed, which lower the peak discharge, but elongate the peaking time. That is, the post-development peak discharge is sustained for a longer period of time. The consequence of extended peaking times is that the sites that drain to the same watercourse may now have coincidental peaks.



Although both sites maintain peak discharges at or below predevelopment values, the extended peaking times could overlap, resulting in flood conditions. Because of this, modeling of the entire watershed is often critical so that overlapping or delayed peaks can be identified and addressed. It is not practical to provide volume reduction for large storm events such as the 100-year event, though it would help manage this potential issue. One effective method is to incorporate the various Town watersheds into a master watershed model at a coarse scale. Information from site-specific models can be input into the master model to evaluate broader impacts.

Part of the no impact certification is accounting for downstream impacts that can occur due to cumulative developments in a watershed. Currently, the Town requires the applicant to demonstrate via the 10% rule described in the SoLoCo manual that there are no negative impacts to the 10% downstream reach of the property. While this is a reasonable approach, MT recommends instead that the Town's floodplain manager, stormwater manager, or comparable municipal official identifies and approves the location of a downstream impact point. The downstream impact point should be set at a confluence, bridge, or culvert, since these hydraulic controls strongly influence water surface elevations and flow conditions and should be selected based on knowledge of the overall watershed, sensitivity of the watershed, and planned development. If it is found that there is an impact at the downstream analysis point requiring, for example, upsizing a drainage feature, the downstream analysis should be extended farther downstream including the proposed upgrades. This should continue downstream until no impact is achieved. Adverse downstream impacts are often seen in the form of a shortened time of concentration, which is the time it takes for runoff from the most distant point on a parcel to travel to the parcel's outlet. If enough parcels independently decrease their time of concentration, it will result in higher discharges and water surface elevations downstream not seen with a parcel-by-parcel analysis. If officials are concerned with a development's downstream impact based on overall watershed development trends, they should require a development to show no increase in peak discharges and volumes for a less frequent storm event, regardless of FEMA flood hazard zone boundaries.

2.1.3 Additional recommendations

As an alternative to subdividing areas based on proximity to the FEMA floodplain and flood sources, the Town may prefer to designate development and environmental regulations based on proximity to streams by stream order. As part of this project, MT has categorized the drainage pathways in Town by stream order. First and second order streams are considered headwater streams and collect and convey stormwater from relatively small areas. Higher order streams must convey runoff from larger areas and the contributing low-order streams. Generally, protection zones should focus on higher order streams when limited opportunities exist. This will have a broader impact than protections along headwater streams. Opportunities for protection or regional solutions should be focused on higher-order streams.

Due to the terrain of Bluffton and existing development agreements, providing compensatory floodplain storage at a parcel-by-parcel or even at the neighborhood level may be problematic. If space does not exist for compensatory storage, the developers should first investigate alternative site designs to minimize lost storage volume. Limitations to the developable area may be needed and the same weight provided to downstream flood prevention as to what is provided for stormwater management requirements and the required set aside property within a development to meet those requirements. These limitations further stress the importance of a holistic watershed model that considers sub-watersheds, existing stormwater management systems, and the impact the proposed development will have on this system. This is sometimes not possible depending on the existing development agreements. As an alternative, the Town could identify regional opportunities for flood storage on Town owned properties or through



drainage easements. As development takes place, developers could be required to contribute to the enhancement of the receiving systems, specifically at those regional countermeasures. For example, funds from these imposed fees could be used to design and construction regional stormwater management projects, and cover the costs associated with site selection, engineering design, property, easement, or right-of-way acquisition, construction of the stormwater management facilities, as well as any necessary upgrades, enhancements, or maintenance. While the Town does not commonly experience repetitive loss, the funds could also be used to buy out flood-prone properties. An additional option would be to utilize these funds to purchase undeveloped properties or portions of properties that are adjacent to riverine systems to be placed into perpetual conservation easements, similar to the SC Office of Resilience Buyout Program.



MEMORANDUM

To: Town of Bluffton Project Team, Attn: Beth Lewis & Andrea Moreno

From: McCormick Taylor

Date: 5/3/2026

Project: Town of Bluffton – Wetlands and Resiliency Ordinance

Subject: Task 3.3 – Primary Conveyance Systems

Data Summary

This memorandum summarizes the methodology for classifying the Town of Bluffton’s primary conveyance systems. The data package included with this submission contains four separate shapefiles. The “Streams” shapefile contains all the streams with a stream order attribute. The “Nodes” shapefile represents the junctions between stream segments. The “Outfalls” shapefile represents the outfall locations around the Town of Bluffton. Lastly, the “Streams by Outfall” folder contains all the streamlines separated by outfall.

Stream Order Classification Background

Streams can be classified using a variety of methods. A common approach is to classify streams by hydrology, or flow duration, as either ephemeral, intermittent, or perennial, or by morphology using the Rosgen stream classification system. Stream order is another method which classifies streams based on their relative size and position within the watershed, where each link within a stream network is assigned a numeric number. In this system, first order streams are the smallest, fed primarily by overland flow rather than upstream tributaries. Stream order increases as tributaries merge, with streams becoming larger and wider as they drain a larger watershed area. The upper reaches of a stream network, referred to as headwater streams, typically include first- and second-order streams, though it often depends on watershed size and characteristics, and can sometimes include third-order streams. Typically, fourth to sixth-order streams are considered medium sized streams, and seventh-order streams and above constitute larger riverine systems.

Classifying a waterways stream order can provide insight into its role in the drainage network and can provide an indication of the relative significance of a waterway to the overall conveyance. For example, conveyance reduction within a higher-order stream will translate to reduced conveyance of all lower-order streams feeding into it. Stream order can also help identify a stream’s potential vulnerability to environmental stressors. Headwater streams, for example, are dominated by overland flow, and are therefore particularly susceptible to non-point source pollution. Since headwater and higher-order streams are characteristically different, stream order can be used to improve riparian buffer best management practice (BMP) guidelines and inform future policy updates. For instance, establishing or strengthening riparian buffer regulations for headwater streams can improve local water quality and reduce the potential pollutant load throughout the downstream network. Additionally, because higher-order streams typically carry larger volumes of water, establishing regulations that protect the conveyance capacity of high-order

streams will also protect the conveyance capacity of lower-order stream, helping to mitigate potential flooding.

There are two conventional methods for assigning stream order: the Strahler (1957) method and the Shreve (1966) method, though other methods exist.

Strahler method

The Strahler method is the most common method for stream ordering. Under this method, all stream links without any tributaries are assigned an order of one and are referred to as first-order links. Stream order increases when streams of the same order intersect. For example, the intersection of two first-order links creates a second-order link. However, the intersection of two links of different orders will not result in an increase in order. For example, the intersection of a first-order and second-order stream will retain the order of the highest ordered link and will therefore be classified as a second-order link.

Shreve Method

Similar to the Strahler method, the Shreve method assigns an order of one to all exterior links. However, unlike the other method, the orders are additive. For example, the intersection of a first-order and second-order stream link would create a third-order link. Due to the additive nature of this method, instead of stream orders, they are often considered stream magnitudes.

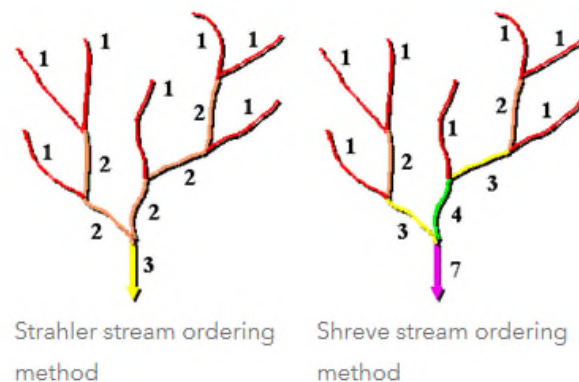


Figure 1: Visual representation of the two stream order methods.

Source: ArcGIS <https://pro.arcgis.com/en/pro-app/3.4/tool-reference/spatial-analyst/how-stream-order-works.htm>

Methods for Classifying the Town's Conveyance Systems

McCormick Taylor used the Strahler method to classify the Town's stream network as it is the most widely used stream classification system and establishes a hierarchical structure based on a streams relative size within the drainage network. The stream network to be classified was obtained from USGS StreamStats. While there is channel and stream data mapped for two drainage basins within the Town, Heyward Cove

and Guerrard/Crooked, the rest of the Town lacks a complete streamline dataset. USGS StreamStats streamlines are derived from digital elevation models (DEMs) and flow accumulation analysis. While they may not necessarily represent true streams, the data depicts potential flow paths, creating a continuous line through features such as lakes, ponds, and culverts. The streamlines from USGS StreamStats were not modified for this analysis, except for minor corrections to connectivity resulting from the USGS delineation procedure and DEM resolution. The outer town boundary was used to clip the USGS linework, however the order of streams flowing from outside of the Town boundary into the Town were included.

Stream Order Results

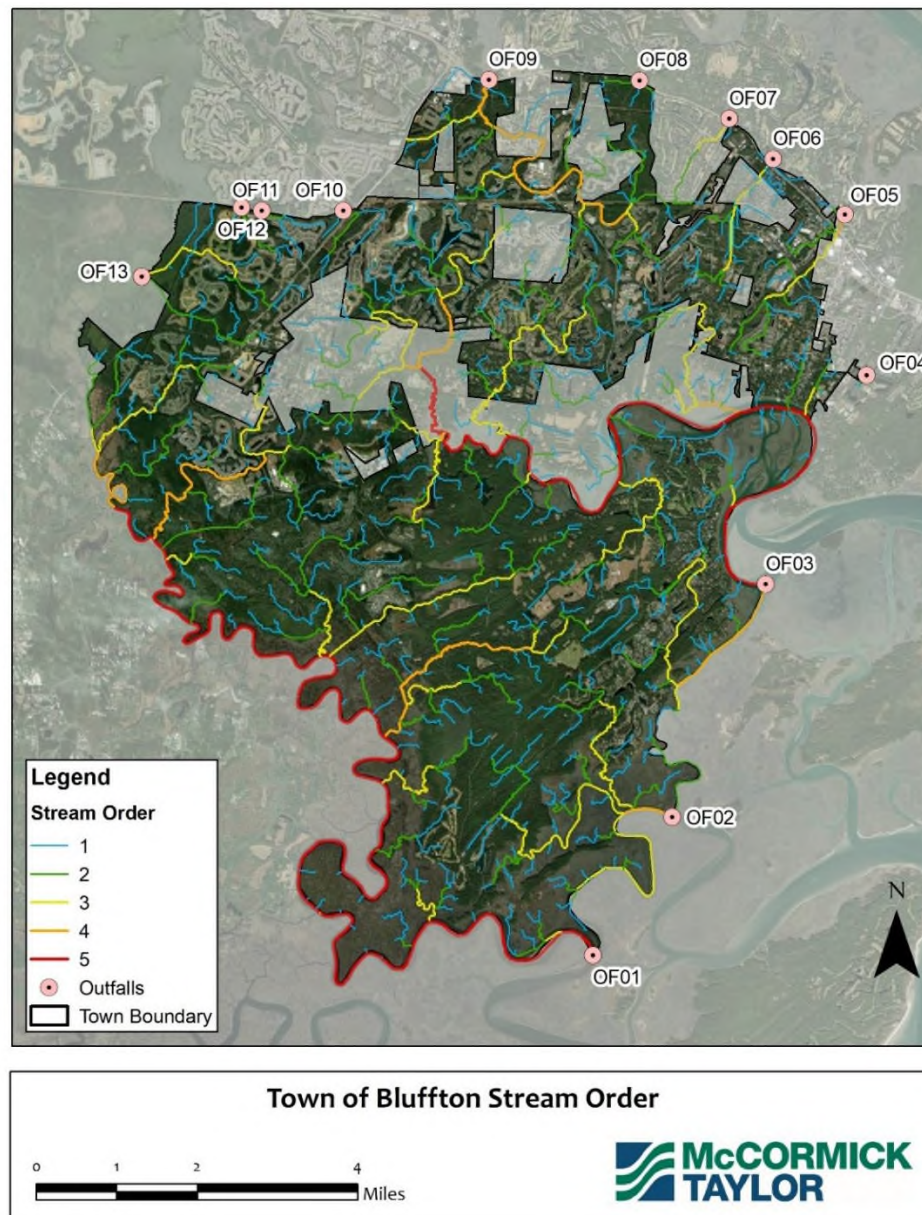


Figure 2: Town of Bluffton stream order map



The streams within the Town ranged in order from one to five (Figure 2). Headwater streams, (first- through second-order) comprise approximately 69% of the 321 total stream miles. There are two fifth-order streams within the Town, the New River and May River, which comprise approximately 10% of the total stream miles (Table 1).

Table 1: Stream length by stream order.

Stream Order	Stream Miles	Percent of Total
1	141.75	44.09%
2	80.41	25.01%
3	50.3	15.65%
4	17.07	5.31%
5	31.95	9.94%
Total	321.48	100%

The analysis identified 13 outfalls, defined as locations where a stream network conveys flow outside of the Town boundary. Stream networks vary considerably in size and are listed in Table 2. The largest stream networks are those draining to outfalls 1 (OF01) and 3 (OF03) along the New River and May River, respectively.

Table 2: Stream length by outfall.

Outfall	Stream Miles
OF01	111.44
OF02	31.09
OF03	112.65
OF04	0.28
OF05	8.61
OF06	10.72
OF07	2.32
OF08	1.93
OF09	25.30
OF10	3.05
OF11	1.73
OF12	2.39
OF13	9.96
Total	321.48

Riparian Buffer Recommendations

McCormick Taylor reviewed the Town of Bluffton's current riparian buffer ordinance and the available literature to provide recommendations for implementing riparian buffers based on stream order.



Current Town Ordinance

Bluffton's current ordinance concerning riparian buffers is summarized below and can be found in Section 5.5 of the UDO- Natural Resources: River Buffer.

The ordinance applies to all building, development, redevelopment and site alteration of any land within 100 feet from the South Carolina Office of Ocean and Coastal Resource Management (OCRM) Critical line adjacent to tidal wetlands and waterways in and around the Town of Bluffton. This area shall not exceed 40% of the area of the lot provided that no disturbance is closer than 25 feet to the CORM Critical Line unless expressly permitted in Section 5.5.3.

Under 5.5.3, all vegetation, ground cover, understory trees and shrubs and overstory trees shall be retained throughout the entire buffer. Removal of the existing vegetation shall only occur to accommodate the following:

- 1) To accommodate views, one-third of the total buffer zone area can be selectively trimmed and landscaped to provide a view between a height of 2 feet and 20 feet measured from the adjacent grade provided that no more than a maximum contiguous area measuring 75 feet in horizontal distance parallel to the critical line is selectively trimmed and landscaped at any one location, separated by a matching undisturbed buffer. Selective landscaping shall include native understory and groundcover plantings that do not require chemical treatment for survival or maintenance.

Provided that the minimum land area required to serve the purpose is used, no development is permitted in the buffer with the exception of the following uses:

- 1) Pedestrian and/or vehicular access ways leading to docks, fishing piers, boat landings, other access way, or other approved water/marsh uses, provided that only permeable or semi-permeable paving materials are used.
- 2) Docks, fishing piers, boat landings, or other approved water/marsh uses that by design must tie into the high ground adjacent to the marsh/water.
- 3) Flood control devices, erosion control devices, and other activities related to soil and water conservation
- 4) Utility lines, including irrigation, which must cross the buffer shall be buried and any disturbed area shall be replanted with vegetation.
- 5) Roads leading to bridges or causeways that cross the waterway provided the roads are configured to minimize disturbance into and within the buffer, and provided all shoulders are vegetated.

Riparian Buffer Literature

Riparian buffers provide numerous benefits. They improve water quality by intercepting pollutants before they enter waterways, stabilize stream banks, provide shade that lowers in stream temperatures, and provide food sources and habitat for wildlife. Riparian buffers also serve as effective stormwater controls, providing important water quantity benefits such as floodwater storage, groundwater recharge, and runoff velocity reduction (Environmental Protection Agency, n.d.). Buffers help slow the movement of water in the upper reaches of a watershed, providing water in larger segments downstream more time to move through the system and flush out. They reduce erosion and trap sediment that would otherwise accumulate in stream channels, decreasing



channel capacity and contributing to additional flooding. Riparian buffers also help protect floodplains from development for non-FEMA mapped streams.

There are multiple types of buffers that can be implemented such as variable width buffers, fixed width buffers, or zoned riparian buffers. A variable width buffer considers individual site factors in determining buffer width like slope or erodibility while fixed width buffers are the easiest to enforce and tend to be more conservative. A zoned riparian buffer system consists of two to three zones with various widths and allowable uses. A three-zone system is commonly used in the Chesapeake Bay region. Zone 1 or the streamside zone typically extends 15 to 30 feet from the top of bank on either side of the stream and remains forested and undisturbed. Zone 2 or the middle core extends an additional 30 to 100 feet. Minimal uses are typically allowed in this zone, and the native vegetation is maintained. Zone 3, or the outer zone, usually extends another 20 to 30 feet. This zone is typically maintained as grass and designed to act like a vegetated filter strip, with most uses unrestricted (Cunningham, n.d.; University of South Carolina [USC], 2000).

Numerous studies have provided recommendations on buffer widths for riparian areas, though individual site characteristics such as slope, soil type, and vegetation will influence their effectiveness. Hawes and Smith (2005) conducted a literature review on riparian buffer widths, which are summarized by function in Table 3. The Natural Resource Conservation Service (NRCS) also provides recommended buffer widths based on function. To reduce overland flow of sediment and organic matter, a minimum buffer width of 35' is recommended. If pathogens, chemicals, pesticides or nutrients are a concern, the buffer should be extended to 50'. Depending on wildlife species habitats, a 50' buffer is recommended for invertebrates, aquatic species, reptiles, and amphibians, a 100' buffer for birds needing interior habitat and small mammals, and a 165' buffer for large mammals (Natural Resource Conservation Service, 2020). Within South Carolina, the Department of Natural Resources Scenic Rivers Program recommends a minimum buffer width of 50 to 100' for water quality protection, 100' for aesthetic/scenic values, and between 100' and 300' for conserving and enhancing wildlife diversity (South Carolina Department of Natural Resources, 2020).

Table 3. Riparian Buffer Widths taken from Hawes and Smith (2005)		
Riparian Buffer Function	Recommended Buffer Widths (feet)	Sources
Sediment Control	82-328	Wenger 1999
	33-148	Army Corps 1991
	30-200	Fisher and Fischenich 2000
	49-213	Broadmeadow and Nisbet 2004
Nutrient Retention	50-100	Wenger 1999
	52-164	Army Corps 1991
	16.4-98	Fisher and Fischenich 2000
	16.4- 98	Broadmeadow and Nisbet 2004
Aquatic Wildlife	98	Army Corps 1991
	>98	Fisher and Fischenich 2000
	33-164	Broadmeadow and Nisbet 2004
Stream Temperature	33-98	Wenger 1999
	33-66	Army Corps 1991
	49-230	Broadmeadow and Nisbet 2004
Bank Stabilization/Erosion Control	49-98	Army Corps 1991
	30-66	Fisher and Fischenich 2000

There are limited studies that provide recommended buffer widths specifically for water quantity control, as hydrologic responses and the effectiveness of the buffers vary widely with topography, stream characteristics, and other watershed-dependent factors (Figure 3). One approach is to implement buffer widths based on drainage area or discharge. In Greenville County, South Carolina, a 50' buffer is required for all Waters of the State, which increases to 100' for all waters with a drainage area of 50 acres or more. Similarly, Savannah, Georgia maintains a Protected River Corridor Buffer ordinance which sets a 100' buffer for perennial streams or watercourses with an average annual flow of at least 400 cubic feet per second, exceeding the state's mandated 25' buffer. While larger streams convey a greater volume of water, buffers along smaller streams also play an important role in downstream flood reduction (Palone and Todd, 1997).

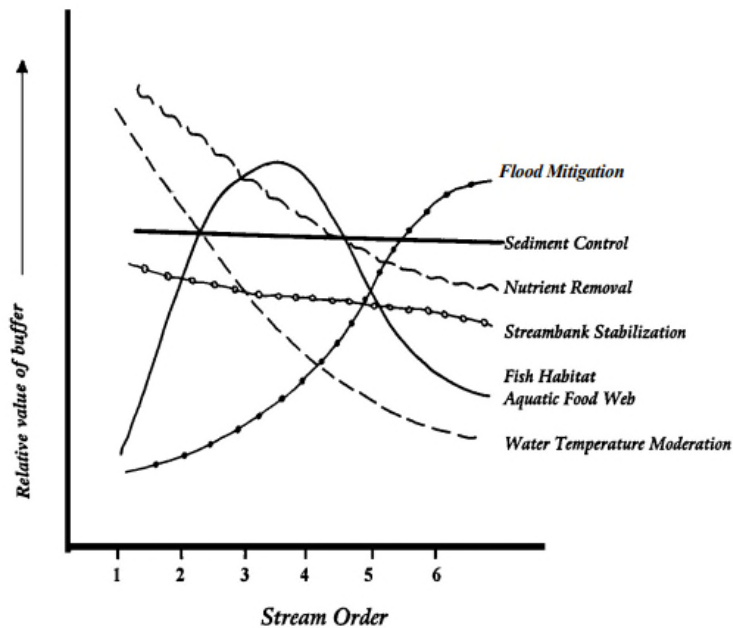


Figure 3: Generalized effect of stream order on variations in buffer function.
Source: Palone and Todd (1997)

While most buffer ordinances are designed to protect larger rivers and tributaries, they do not always extend protection to all streams. For example, in North Carolina, the Department of Environmental Quality only requires riparian buffers for intermittent or perennial streams that appear on the NRCS Web Soil Survey or USGS Topo map, which leaves unmapped streams, primarily headwater streams, unprotected. To provide protection for all streams regardless of stream type and provide adequate water quality and quantity control, buffer widths can be implemented based on stream order. Using stream order ensures that vulnerable headwater streams near development, as well as the rest of the stream network, are protected from point and non-point source pollution. Simultaneously, using stream order allows for the implementation of wider buffers for higher-order streams to account for the larger drainage areas.

Riparian Buffer Recommendations

The Town's current riparian buffer ordinance only requires buffers for rivers/streams within the critical area which leaves streams outside of the tidal area unprotected. McCormick Taylor recommends the following buffer widths based on stream order. For first- and second-order streams, a two-zone system is recommended. As stream



order increases, wider buffers are necessary to protect water quality, stabilize stream banks, and provide flood control. All buffer widths are measured from the top of bank on either side of the stream (Figure 4).

- I. For 1st and 2nd order streams, a 50' buffer is recommended with Zone 1 extending 35' and Zone 2 extending an additional 15'. Allowable uses within the buffer shall be left up to the Town's discretion. Is it recommended that Zone 1 be left as undisturbed natural habitat. Zone 2 may be maintained as lawns or gardens, however there should be no land-disturbing activities or impervious surfaces located within this zone. Allowable uses within Zone 2 may include: establishing view corridors, removing invasive vegetation, allowing pedestrian footpaths for docks, piers, and boat landings, and recreational activities. If portions of the stream are tidally influenced and within the critical area, the Town's existing 100' buffer ordinance should take precedence.
- II. For 3rd order streams, a 50' buffer is recommended. The buffer should be left as undisturbed natural habitat. If portions of the stream are tidally influenced and within the critical area, the Town's existing 100' buffer ordinance should take precedence. Allowable uses within the buffer should be limited to the Town's existing ordinance.
- III. For 4th order streams, including those tidally and non-tidally influenced, a 100' buffer is recommended. Allowable uses within the buffer should be limited to the Town's existing ordinance.
- IV. The 5th order streams that were mapped within the Town likely fall within the SCDES critical area; therefore, the Town's existing riparian buffer ordinance should apply. Allowable uses should remain the same.

Property owners should use the Town's stream map to determine what order stream they have on their property and therefore what buffer width applies. It is important to note on the map or website that the stream network does not represent surveyed data and must be field verified to determine its precise location. If a stream is not shown on the map but field verification has determined that is a Water of the State, the buffer widths for a 1st and 2nd order stream should apply.

Although the Town of Bluffton is largely developed, buffer ordinances should be enforced whenever building plans for site improvements (patio, pool, detached structures) are submitted. In areas where the recommended 35' buffer may not be feasible, likely near 1st and 2nd order streams, the Town may allow reduced buffers widths. These exceptions should be established on a case-by-case basis provided that a grass filter strip is installed at a minimum.

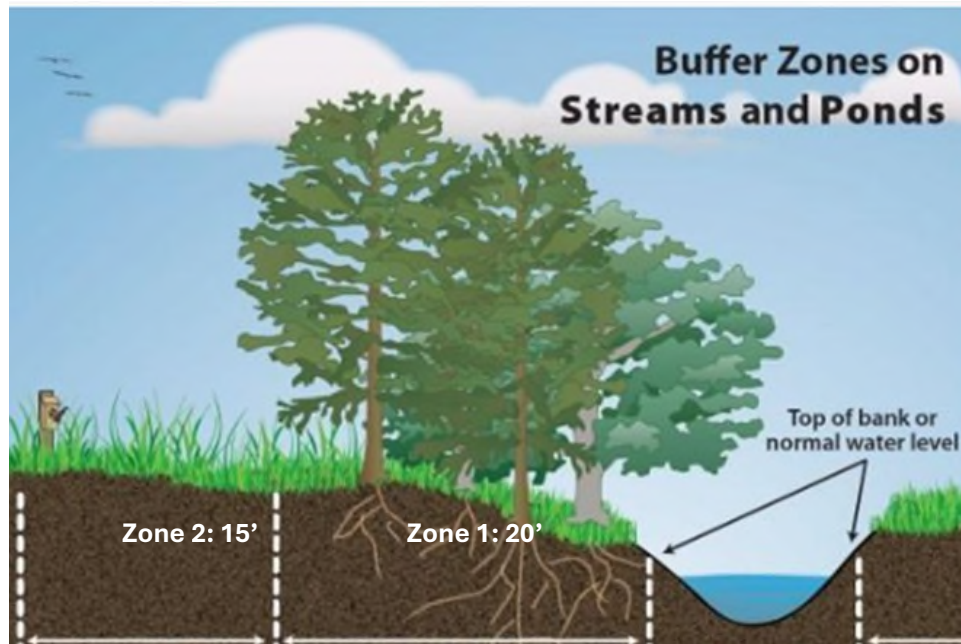


Figure 4: Example of a two-zone riparian buffer for 1st and 2nd order streams. Figure adapted from www.deq.nc.gov

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To: Town of Bluffton Project Team
From: McCormick Taylor
Date: 3/30/2026
Subject: Task 3.4 – Resiliency Zone Mapping
Project: Town of Bluffton – Wetlands and Resiliency Ordinance

1 PURPOSE

Bluffton faces significant flooding risks due to its location along the May River, low-lying coastal setting, and rapidly expanding development. Riverine flooding, also referred to as fluvial flooding, occurs when prolonged or intense rainfall causes nearby creeks and tributaries to exceed their banks, particularly in low-lying areas with limited floodplain storage. Pluvial flooding occurs during heavy rainfall events that overwhelm local drainage systems and stormwater infrastructure, resulting in flooding due to lack of stormwater system capacity. Coastal flooding poses a major concern for the Town because of the direct connection to tidal waterways. Storm surge from hurricanes or tropical storms flow landward through streams and drainage systems, inundating roads and homes. High tide flooding, especially during king tide events, can occur even without rainfall, known as “sunny day flooding”. Coastal flooding issues can then compound when high tides coincide with heavy rain, preventing runoff from draining effectively. Future conditions sea level rise is expected to exacerbate coastal, fluvial, and pluvial flooding by elevating baseline water levels, thereby increasing flood frequency and reducing the effectiveness of existing stormwater systems and natural flood buffers.

To provide an additional layer of protection from flooding, more frequent and higher intensity storm events, and projected sea level rise, the Town of Bluffton is interested in mapping and protecting “resiliency zones”. Resiliency zones consist of undeveloped areas within the Town that can provide valuable services such as storage for stormwater and flood waters, natural protection from storm surge, and enhanced infiltration, all which can further help mitigate the effects of a changing climate. While these zones are likely to occur in low-lying areas near the coast or along rivers and streams, they may also exist in hydrologically unconnected areas as a result of pluvial flooding or in upland areas with well-drained soils. The following section summarizes the available data layers that can be used to help inform the development of resilience zones.

2 EXISTING DATA

Identifying and mapping resilience zones within the Town can be approached using several methods. In the absence of detailed hydrologic and hydraulic modeling, the process generally relies on overlaying multiple datasets, such as topography, land use, and soil conditions, to identify where they overlap. Several organizations, such as NOAA and the South Carolina Office of Resilience (SCOR), have already developed composite layers which combine multiple datasets to identify flood-prone areas or conservation areas which can be leveraged in this analysis. The following section summarizes the available base and composite data layers that can be used to help identify resilience zones within the Town.



2.1 BASE LAYERS

2.1.1 FEMA Flood Layer

The Federal Emergency Management Agency (FEMA) flood data depicts areas at risk of flooding based on hydrologic and hydraulic modeling, for a variety of storm events. This information can be accessed through FEMA's website and details flood hazard areas for the 1% annual chance flood, the 0.2% annual chance flood, the future conditions 1% annual chance flood, and floodways where applicable, among other data. The data can be accessed at the FEMA Map Services Center.

2.1.2 NOAA National Hurricane Center SLOSH Data

The National Oceanic and Atmospheric Administration (NOAA) National Hurricane Center (NHC) Sea Lake and Overland Surges from Hurricanes (SLOSH) model is used to simulate storm surge from hurricanes and tropical storms. NOAA hosts SLOSH model results for 29 different basins across the US [e.g., South Carolina/Charleston Basin]. The data is available for hurricane categories 1 through 5 and depicts areas expected to flood less than 3 feet above ground, between 3 to 6 feet, between 6 to 9 feet, and greater than 9 feet for a selected hurricane category. The data can be accessed from the National Hurricane Center.

2.1.3 NOAA Sea Level Rise Viewer and Marsh Migration

The NOAA Sea Level Rise Viewer is a web-based application that allows users to visualize areas of inundation for various sea level rise scenarios. The application features a sliding bar which allows users to specify a sea level increase, from one to ten feet, relative to the mean higher high water (MHHW) datum and visualize the resulting inundation extents and depth. Low-lying hydrologically unconnected areas which may be prone to flooding are also mapped by this tool. This tool also allows viewers to visualize marsh migration by depicting changes in coastal land use as sea level increases. This data can be accessed at NOAA's Digital Coast website.

2.1.4 Watershed Characteristics

Additional GIS data that can aid in a flood vulnerability analysis includes topographic layers (slope, elevation, DEM), hydrologic layers (distance to drainage network, stream order, Topographic Wetness Index (TWI)), soil data (hydrologic soil group (HSG)), land cover/land use data (National Land Cover Database (NLCD), National Wetland Inventory (NWI), impervious surface, Normalized Difference Vegetation Index (NDVI)), and climatic data (precipitation). These layers can be overlayed to help identify low lying areas where runoff is likely to accumulate. Most of the data is publicly available online from federal (USGS, USFWS) and state agencies (SCDNR) or can be acquired from local jurisdictions.

2.2 COMPOSITE LAYERS

2.2.1 South Carolina Office of Resilience-Conservation Priority Areas

During the development of the Statewide Resilience and Risk Reduction Plan, SCOR identified priority flood mitigation areas, referred to as *Conservation Priority* areas. These areas were identified by assessing where flood hazards are expected, where wetlands exist, and where infiltration rates are high. Protecting these areas can help to reduce flood risk and allow for natural storage and conveyance functions. The composite layer was generated using the data and methods described below.

- 1) Flood hazard areas:



- a. FEMA's 1% and 0.2% annual chance flood hazard areas were used for current conditions.
 - b. To incorporate future flood risk, the First Street Foundation's flood model was used to identify areas that would experience over 3 feet of flooding during a 0.2% annual chance flood scenario in 2052.
- 2) Available land for future marsh migration:
 - a. Marsh migration and sea-level rise data from the NOAA Sea Level Rise Viewer were used to identify where marsh migration is likely to occur. NOAA predicts a 1.5-foot rise in sea level by 2050 for South Carolina, with coastal marshes naturally migrating inland. Conserving available land next to marshes can help preserve future natural storage.
- 3) Wetlands:
 - a. Wetland data was incorporated from the U.S. Geological Survey (USGS) 2019 National Land Cover Dataset.
- 4) Upland areas with high infiltration rates:
 - a. To identify upland areas outside of floodplains and wetlands with permeable soils, the USGS SSURGO Soils mapping was used in conjunction with the USGS 2019 National Land Cover Dataset (NLCD) and the USDA 30-meter Digital Elevation Model. Runoff curve numbers were calculated using the USDA NRCS TR-55 method, with high curve numbers indicating high runoff potential, and low curve numbers indicating low runoff potential. An analysis was performed to identify the 10th percentile best infiltration areas for each HUC-8 watershed, identifying the upland areas that should be prioritized for conservation.

Areas that were removed from the analysis include developed areas (low, medium or high developed from the 2019 NLCD layer), open water areas (from the 2019 NLCD layer), and protected areas (from the USGS Protected Area Database and the South Carolina Conservation Bank). The Conservation Priority areas were identified as having one or more of the following characteristics: 1) areas within the 1% or 0.2% flood zone (FEMA or First Street Data), 2) areas where future marsh migration is expected (NOAA Marsh Migration Model for 2050 using 1.5' sea level rise scenario), 3) areas where current wetlands exist, and 4) areas where the curve number is in the lowest 10% (derived from the Land Cover Dataset). This data can be accessed at SCORs Resilience Atlas website.

2.2.2 NOAA Coastal Flood Hazard Composite

The NOAA Coastal Flood Hazard Composite layer was developed by overlaying multiple flood hazard datasets to identify areas exposed to coastal flooding potential. Data layers used in the analysis include FEMA flood data (V zones, A zones, shaded X zones), NOAA flood frequency zones, NOAA storm surge inundation for Category 1 through 3 hurricanes, and sea level rise inundation extents for 1, 2, and 3 feet above current mean higher high water (MHHW). Land is categorized into hazard zones 1 through 11, where hazard zone 1 represents the least vulnerable areas and zone 11 the most vulnerable. The Coastal Flood Hazard mapper provides coverage for the U.S. coastal areas along the Gulf of Mexico and Atlantic Coasts, and the data can be accessed at NOAA's Digital Coast website.

2.2.3 South Carolina Department of Environmental Services Coastal Hazard Vulnerability Assessment

The South Carolina Department of Environmental Services (SCDES) developed the Hazard Vulnerability Assessment (HVA) tool which evaluates coastal hazard vulnerability within the South Carolina critical area from four hazards: storm surge, shoreline change rate (erosion or accretion), flooding, and social/economic



vulnerability (SoVI®). The HVA tool was developed to improve hazard mitigation planning, post-disaster redevelopment, and restoration/mitigation project siting. The analysis produced multiple composite layers including an inundation vulnerability layer (combining flooding & storm surge), an inundation and SoVI vulnerability layer (combining flooding, storm surge, and SoVI®) layer, and a shoreline change vulnerability layer (combining shoreline change rate, temporal variability, and spatial variability). For each layer, values are assigned an HVA rank from 1 through 5, with 1 being the least vulnerable and 5 being the most vulnerable. The rankings for each of the individual input data layers can also be viewed in the tool.

The flood data is based on FEMA's DFIRM data where an HVA rank of 5 includes categories V, VE, and Open Water while a rank of 1 includes D and 0.2% annual chance flood hazard. Storm surge is taken from NOAA's SLOSH model and the HVA rank is based on height exceeding 1 ft for a given hurricane category. A rank of 5 is assigned to areas where a Category 1 hurricane would reach that level of inundation while a rank of 1 is assigned to areas where it would take Category 5 hurricane to reach that level of inundation. The SoVI® index is produced by the University of South Carolina's Hazards and Vulnerability Research Institute and incorporates 29 socioeconomic variables. For this analysis, SoVI® scores are relative and based on standard deviations from the mean. A rank of 5 represents scores > +2 standard deviations from the mean while a rank of 1 represents scores < -2 standard deviations from the mean. The shoreline change data is taken from the SCDES's Bureau of Coastal Management (BCM) which was generated using an open-source geospatial tool called AMBUR (Analyzing Moving Boundaries Using R). The analysis uses three-time steps, 1800's, 1930's, and 2000's, and the tool uses the End Point Rate (EPR) to assign a rank. The HVA tool can be accessed from SCDES's website.

2.2.4 First Street Flood Data

The South Carolina Office of Resilience has partnered with First Street Technology, Inc. (First Street) to obtain hazard data for the entire state. First Street is a non-profit research organization that estimates climate risk for individual properties, neighborhoods, and communities focusing on five factors: flooding, fire, wind, air, and heat. The flood model includes risks associated with pluvial, riverine, and coastal flooding and simulates flood depths for current and future conditions for the 2-, 5-, 20-, 100-, 200-, and 500-year return periods. Building structure data is also used to calculate annual financial losses from a modeled storm event. Additional information on the methodology can be found on First Street's website and data within the state of South Carolina can be obtained by contacting SCOR.

2.2.5 SeaGrant Resiliency Analysis Vulnerability Layers

SeaGrant and the College of Charleston recently conducted a resilience planning analysis for the Town of Bluffton to assess the Town's vulnerability to current and future environmental conditions. To assess vulnerability, Digital Elevation Models (DEMs) and Digital Surface Models (DSMs) were created and the First Street flood data was used to determine the mean flood depth per parcel for the 50%, 20%, 5%, 1%, and 0.2% chance flood events for 2023 and 2053. A build-out analysis was then performed. Maximum allowed density and maximum dwelling units were obtained from the Town's active planned unit development (PUD) agreements and the Unified Development Ordinance (UDO), and parcels greater than 5 acres with zoning categories of PUD, agricultural (AG), and Residential General (RG) were isolated for the analysis. After removing National Wetland Inventory (NWI) critical area and open water areas, areas that overlapped with the NOAA's 2021 Coastal Change Analysis Program (C-CAP) water layer, and areas that intersect with road network data, the parcels were subdivided based on the allowed maximum density and the average



depth of flooding for each flood scenario was assigned to each parcel. The resulting data layer can be found in the Resilience Planning Analysis: Town of Bluffton, SC report.

An elevation analysis was also performed to determine the potential vulnerability reduction resulting from prioritizing development in upland zones within each development area. Using the buildout parcels from the previous analysis, the average parcel elevation was calculated using the DEM, and the mean and standard deviation of elevations within each development zone (PUD, AG, or RG) were used to assign categories of low, moderate, and high elevation. Low elevation parcels were those with an elevation lower than the mean minus one standard deviation. Moderate elevation parcels are those within one standard deviation from the mean. High elevation parcels have elevation above the mean plus one standard deviation. The resulting data layer can be found in the Resilience Planning Analysis: Town of Bluffton, SC report.

3 TOWN OF BLUFFTON RESILIENCE ZONES

3.1 RESILIENCE ZONE MAPPING

After reviewing the available data, McCormick Taylor (MT) determined that the Conservation Priority areas identified by SCOR closely align with what the Town would like to prioritize as resilience zones. As summarized in Section 2.2.1, datasets from FEMA, First Street, NOAA, and the USGS were used to identify areas for conservation that reduce flood risk, promote infiltration, and preserve natural storage and conveyance functions. SCOR has conducted its analysis at the statewide scale using publicly available data. To refine the conservation priority areas at the local level, MT recreated the dataset for the Town using locally derived data when available. The analysis was completed using the following steps:

- 1) Data was compiled from FEMA and First Street Foundation for the 1% (100-year) and 0.2% (500-year) storm events. Areas that would have equal to or greater than 3 feet of flooding in 2055 were also included from First Street Foundation to incorporate future climate conditions.
- 2) Data was compiled from NOAA's Marsh Migration model for the year 2050 based on 1.5 feet of sea level rise.
- 3) The wetland potential layer developed by CWP was used as the existing wetlands layer and included wetlands classified as either medium or high potential.
- 4) Areas of high infiltration were identified using Bluffton's existing land cover layer and SSURGO hydrologic soil group (HSG) data. A curve number (CN) was assigned at the pixel scale using the lookup table below (Table 1). The 10th percentile highest infiltration areas were identified. Higher curve numbers indicate higher runoff potential; thus, the highest infiltration areas had the lowest curve numbers.
- 5) Ineligible locations were eliminated, including:
 - a. Developed areas, based on the Town's existing land cover data layer.
 - b. Open water based on the NOAA Marsh Migration data layer.
 - c. Protected areas from the South Carolina Conservation Bank layer and the USGS Protected Area Database.
- 6) The data was combined into a single layer, and the ineligible locations above were removed.



Table 1: Curve numbers by land use and HSG

Existing Land Use Categories	HSG				Existing Land Use Categories	HSG			
	A	B	C	D		A	B	C	D
Club House	89	92	94	95	Open Space - Undeveloped	43	65	76	82
Commercial	89	92	94	95	Open Space - Park	49	69	79	84
Commercial - Office-Warehouse	89	92	94	95	Residential - Condo	77	85	90	92
Commercial - Old Town	89	92	94	95	Residential - MF	77	85	90	92
Commercial - Vacant	89	92	94	95	Residential - Mobile Home	61	75	83	87
Education	89	92	94	95	Residential - Single Family	61	75	83	87
Faith	89	92	94	95	Residential - Single Family Attached	61	75	83	87
Golf and Clubhouses	46	65	77	82	Residential - Single Family Vacant	61	75	83	87
Industrial	81	88	91	93	ROW	83	89	92	93
Industrial - Mini Warehouses	81	88	91	93	Service	83	89	92	93
Marsh	98	98	98	98	Service - Utilities	83	89	92	93
Open Space - Conservation	43	65	76	82	Waterway	98	98	98	98
Open Space - Equine	49	69	79	84					
Open Space - HOA Park	49	69	79	84					
Open Space - Other	49	69	79	84					
Open Space - Passive	49	69	79	84					

The resulting layer, Figure 1, identifies areas within the Town capable of infiltrating, storing, and conveying water, for current and future conditions, thereby providing important flood mitigation benefits. The areas identified through this analysis should be prioritized for conservation, helping to prevent or limit future development in locations that are essential to the Town's long-term resilience.

3.2 FLOOD VULNERABILITY MAPPING

McCormick Taylor is also supporting the Town of Bluffton in developing a resilience ordinance. The resilience ordinance is intended to provide an additional layer of protection from flooding, increased storm events, and projected sea level rise. While still under development, the ordinance will focus on updating zoning regulations, building codes, and stormwater management requirements to reduce flood vulnerability and enhance the Town's long-term climate resilience. While the resilience zone mapping was originally intended to support the resilience ordinance, it was determined that performing a vulnerability analysis to identify flood-prone areas would better inform the regulations. McCormick Taylor followed two different strategies to identify vulnerable areas within the Town.

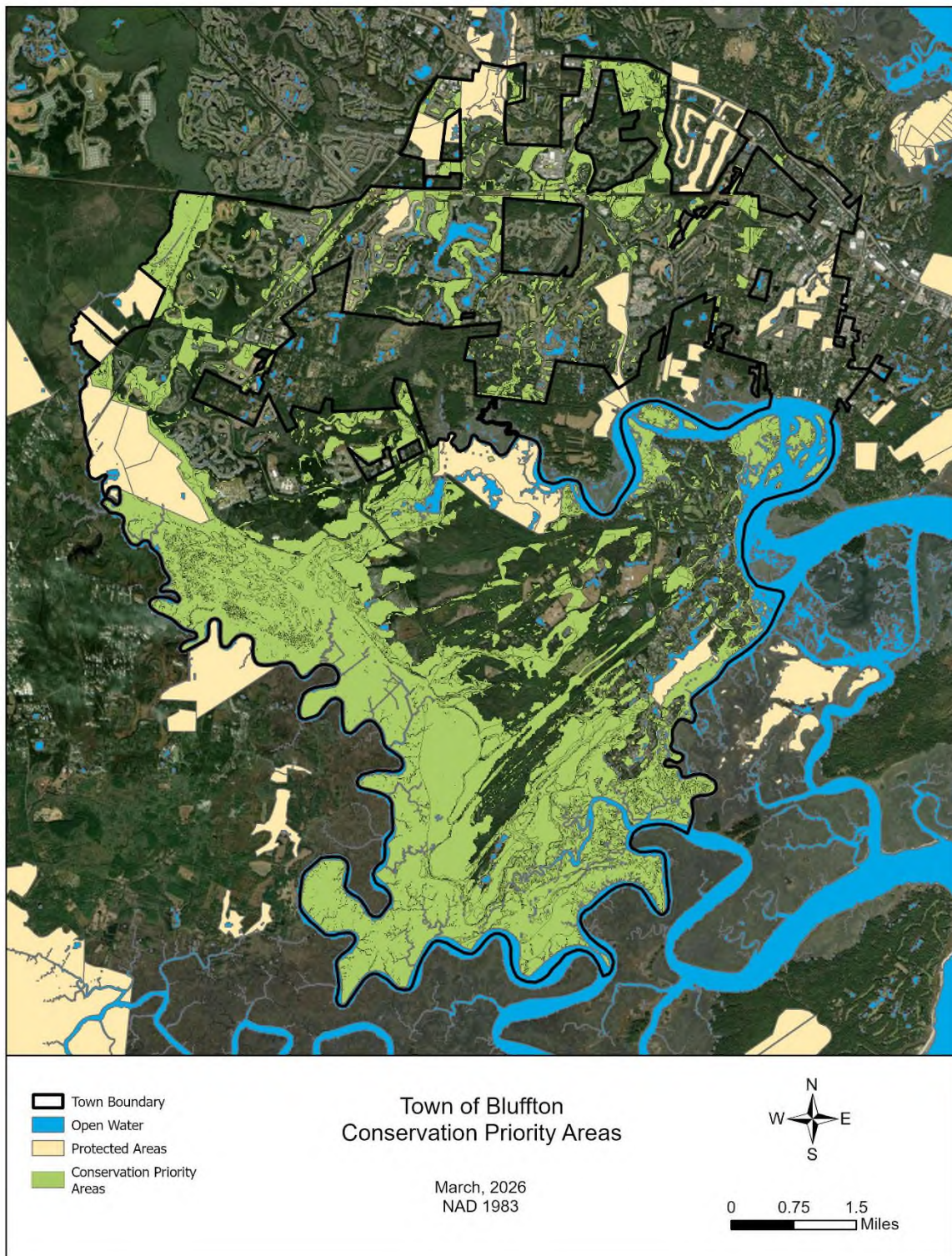


Figure 1: Conservation priority areas within the Town



3.2.1 Elevation-based Analysis

McCormick Taylor performed an elevation-based analysis using methods adapted from the SeaGrant Resiliency Analysis to identify low elevation areas within the Town that may be more vulnerable to flooding. While the SeaGrant analysis only included land with the PUD, AG, or RG development zones, all land within the Town was included for this analysis. Additionally, instead of determining the average elevation at the parcel level, the analysis was done at the resolution of the DEM. The analysis was completed using the following steps:

- 1) The NWI Wetlands and Storm Ponds – Town Asset data layers were clipped to the Town of Bluffton boundary.
 - a. Estuarine and Marine Deepwater/Wetland, Freshwater Pond, Lake, Riverine categories from the NWI wetlands layer were queried and isolated to a new working layer.
 - b. The Town Storm Ponds layer was added to this working layer.
- 2) After noticing that many of the stormwater ponds in the new subdivisions were not included in the town's Storm Ponds layer, using aerial imagery, MT digitized any remaining pond and added them to the working layer.
- 3) The NWI Wetlands and Storm Pond areas were clipped from the terrain, so they are excluded from the elevation analysis.
- 4) The DEM was clipped to the town boundary and reclassified based on three levels of standard deviation that are described in the SeaGrant report.
 - a. The reclassified DEM was then converted into a polygon layer with three classification codes.
 - i. Zone 1 = -4.8' – 9.6'
 - ii. Zone 2 = 9.6' – 26.9'
 - iii. Zone 3 = 26.9' – 85.9'
- 5) The NWI Wetlands and Storm Ponds areas were then merged with the reclassified polygon layer and assigned a unique code in that polygon layer.
 - a. Zone 4 = Estuarine and Marine Deepwater/Wetland, Freshwater Pond, Lake, Riverine NWI Wetlands and Town Storm Ponds.
- 6) All features were then dissolved based on the four different classification zones.

The results from the elevation-based analysis are shown in Figure 2 with Zone 1 (red) as the low elevation zone, Zone 2 (yellow) as the medium elevation zone, and Zone 3 (green) as the high elevation zone. The low elevation zone aligns closely with the FEMA 100-year floodplain as shown in Figure 3. The elevation-based analysis can support the resilience ordinance by encouraging development in high-ground areas that may be less vulnerable to coastal and riverine flooding. This could be accomplished through overlay zoning districts, as noted in the SeaGrant report.

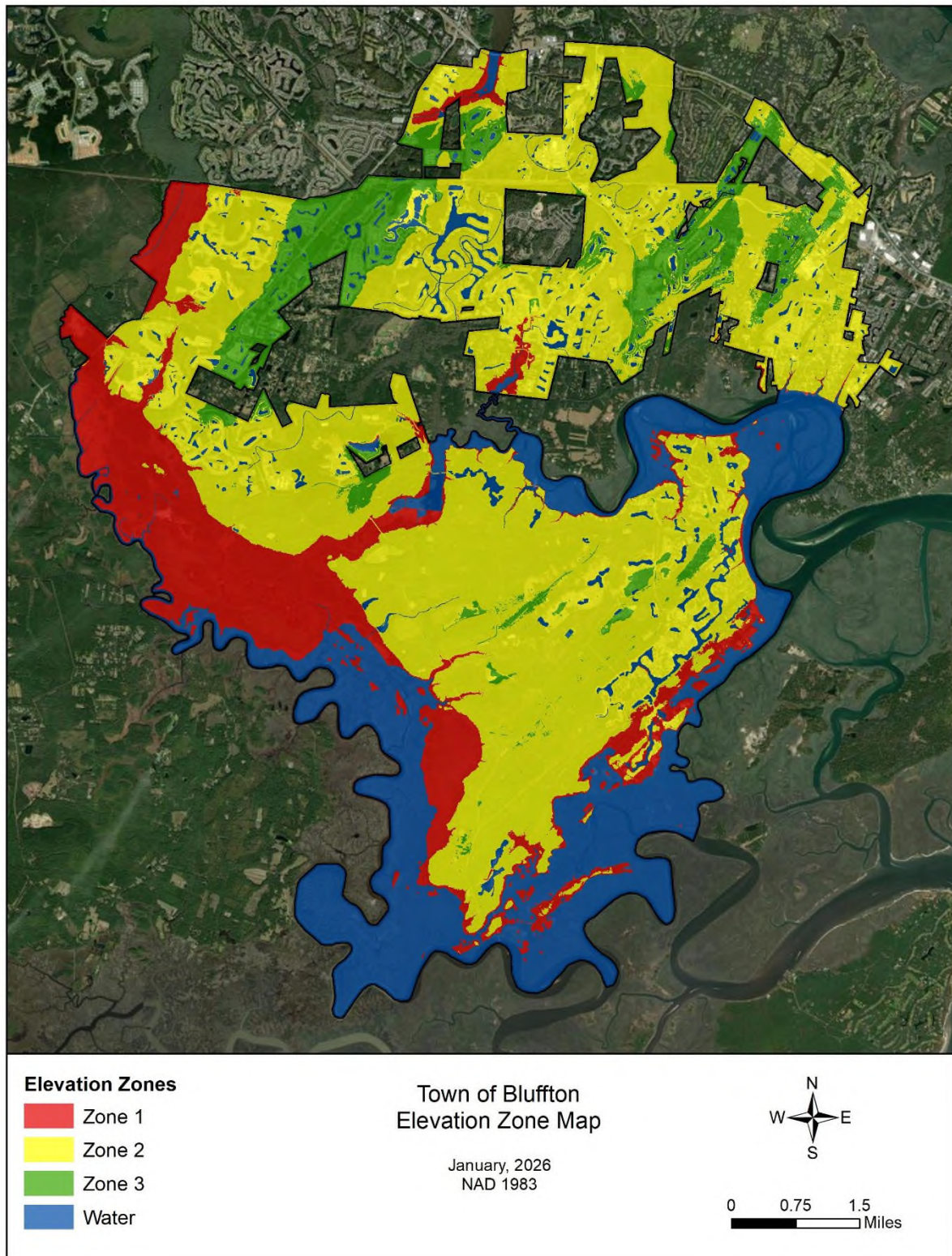


Figure 2 : Elevation-based zones within the Town of Bluffton

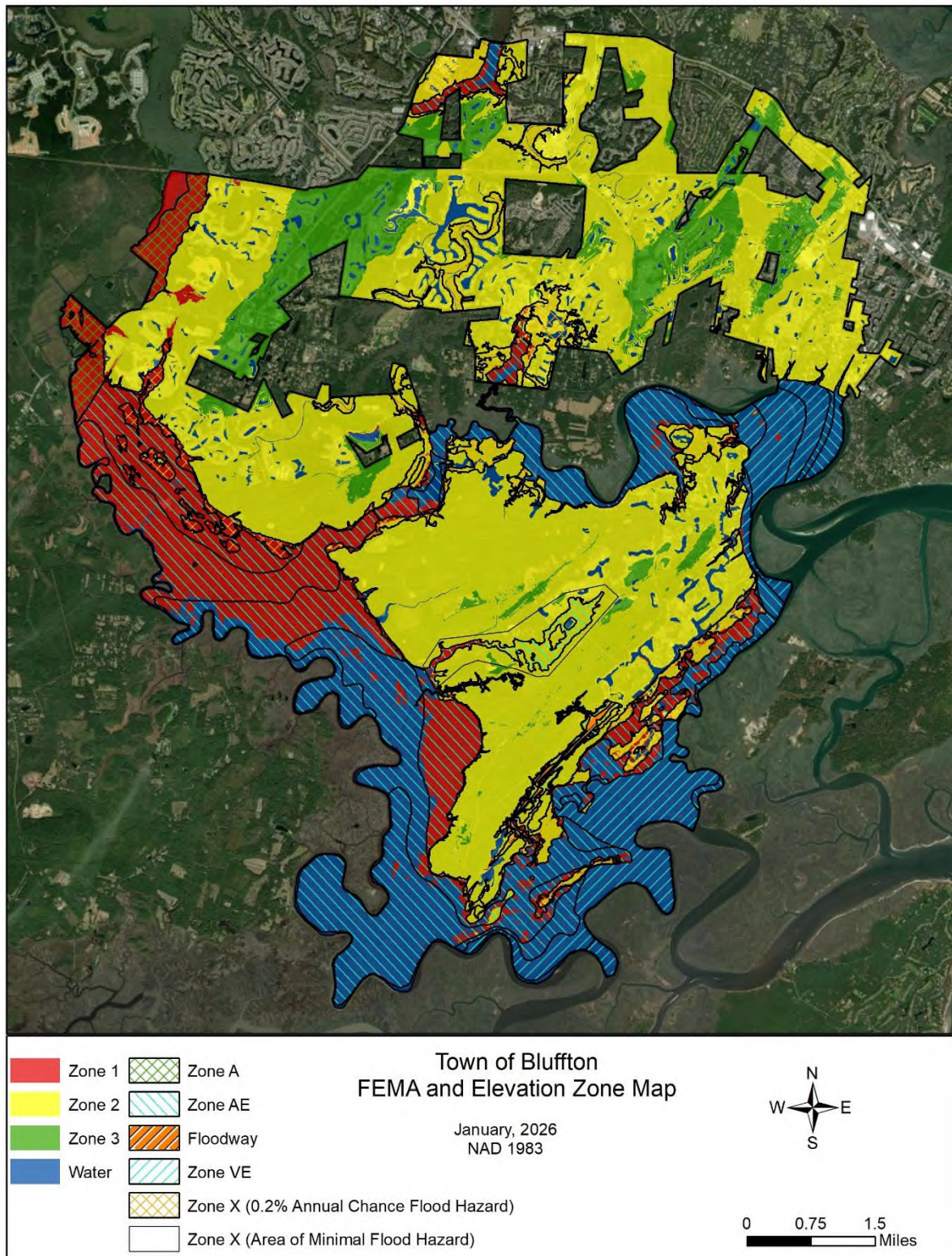


Figure 3: FEMA flood zones and elevation-based zones



3.2.2 Composite Flood Vulnerability Analysis

To further assess which areas within the Town are least or most vulnerable to flooding, MT conducted a flood vulnerability analysis. The analysis combined data reflective of riverine, coastal, and pluvial flooding using a weighted overlay approach. A vulnerability score was first developed for each type of flooding (riverine, coastal, pluvial) using various input data layers. For each layer, values were assigned a score from 0 to 3 or 1 to 3, with 0 or 1 being the least vulnerable and 3 being the most vulnerable. Data layers were then weighted based on priority. A final composite layer was developed by overlaying the three individual flood vulnerability layers. The details and weightings of each individual flood type are outlined below.

3.2.2.1 Riverine Flooding

The riverine vulnerability score was estimated using two layers: FEMA's National Flood Hazard Layer (NFHL) and distance to the natural drainage network. The flood zones outlined by FEMA were assigned a score ranging from 0 to 3, shown in Table 2. Land located with the Floodway, Zone VE, and Open Water received the highest score and were assigned a 3, while Zone X areas located outside of the 500-year floodplain (shaded Zone X) were assigned a score of 0.

Table 2: Scoring breakdown for FEMA NFHL input layer

Score	FEMA Flood Zones
3	Floodway, Zone VE (High-risk coastal areas), and Open Water
2	Zone Coastal A, AE, or AO (excluding areas noted as Floodway)
1	Shaded Zone X noted as 0.2% annual chance of flooding (the 500-year floodplain)
0	All remaining Zone X areas (areas located outside of the 500-year floodplain)

Distance to the natural drainage network was included since land closer to streams is likely to be more vulnerable to flooding. The distance to the natural drainage network was calculated using the USGS StreamStats stream network from the 2024 Release. The stream network was used as an input in the Distance Accumulation tool within ArcGIS Pro, which calculates accumulated distance for each cell to the stream network. The results were then clipped to the Town of Bluffton limits and Jenks natural breaks were used to establish class thresholds. The resulting scoring categories are shown in Table 3.

Table 3 : Scoring breakdown for distance to drainage network input layer

Score	Distance to Natural Drainage Network
3	Distance to nearest stream is < 290.2ft
2	Distance to nearest stream is >= 290.2 ft and < 649.0 ft
1	Distance to nearest stream is >= 649.0 ft
0	N/A

The cumulative riverine vulnerability score was calculated based on the weights assigned to each layer in Table 4. The spatial distribution of these results is shown in Figure 4.

Table 4: Riverine vulnerability scoring input weights

Riverine Data Layers	Weight
FEMA Flood Zones	70%
Distance to Drainage Network	30%



3.2.2.2 Coastal Flooding

Coastal flooding was estimated using two layers: NOAA sea-level rise inundation data and NOAA storm surge (SLOSH) data. To align the sea-level rise data with the Beaufort County Long Term Resilience Strategy, scoring categories were developed using NOAA 2022 sea level rise projections for Ft. Pulaski based on estimates for the 2050, 2080, and 2100 timeframes, using the intermediate-high scenario. Scores were assigned to inundated areas based on the lowest increase in sea-level rise that would cause flooding at a given location. Therefore, scores are inversely related to sea-level rise and an area inundated from a 1.5 ft increase in sea-level is considered to be more vulnerable than an area only inundated with a 5 ft increase in sea-level. The resulting scoring categories are shown in Table 5.

Table 5 : Scoring breakdown for NOAA sea-level rise input layer

Score	NOAA Sea-Level Rise
3	Area within the inundation zone associated with 1.5 ft of SLR
2	Area within the inundation zone associated with 3.5 ft of SLR
1	Area within the inundation zone associated with 5.0 ft of SLR
0	Area outside of the inundation zone associated with 5.0 ft of SLR

To evaluate the impacts of storm surge, NOAA's SLOSH data was used to categorize areas based on the extent of inundation associated with different hurricane categories. Although the model includes Category 1 through 5 hurricanes, this analysis focused on Categories 1 through 3, which represent hurricanes that occur more frequently and therefore have lower recurrence intervals. For each category, the mapped inundation extent assumes landfall at high tide, resulting in maximum potential storm surge. This assumption represents a risk-averse modeling approach and captures a worst-case inundation scenario for each hurricane category.

Scores were assigned to inundated areas based on the lowest hurricane category that would cause flooding at a given location, similar to sea-level rise. As a result, the score is inversely related to hurricane category and an area inundated during a Category 1 hurricane is considered to be more vulnerable than an area only inundated during a Category 3 hurricane. This reflects both the greater likelihood of lower-category hurricanes and the generally greater flood depths experienced at locations inundated during more frequent storm events. The scoring framework associated with the inundation extents is summarized in Table 6.

Table 6 : Scoring breakdown for storm surge risk map input layer

Score	Hurricane Storm Surge Inundation Extent
3	Area within the Category 1 storm inundation extent
2	Area within the Category 2 storm inundation extent
1	Area within the Category 3 storm inundation extent
0	Area outside the Category 3 storm inundation extent

The cumulative coastal vulnerability score was then calculated based on these weights assigned to each layer in Table 7. The spatial distribution of these results is shown in Figure 5.



Table 7: Coastal vulnerability scoring input weights

Coastal Data Layers	Weight
NOAA Sea-Level Rise	50%
NOAA Storm Surge (SLOSH)	50%

3.2.2.3 Pluvial Flooding

Pluvial flooding occurs when rainfall overwhelms local stormwater infrastructure, resulting in flooding in urban areas. Identifying where pluvial flooding is likely to occur generally requires detailed hydrologic and hydraulic modeling that accounts for stormwater infrastructure, rainfall intensity, and fine-scale topography. In the absence of this detailed flood modeling, vulnerability to pluvial flooding was assessed using an approach that incorporates key physical and land-use variables known to influence where pluvial flooding is most likely to occur. The six input layers used in the analysis were:

- US Department of Agriculture (USDA)'s Natural Resources Conservation Service (NRCS) Hydrologic Soil Group,
- Impervious surface area,
- Land use/land cover,
- Slope,
- Wetness Index based on Landscape Topography (WILT), and
- First Street Flood Model data.

Hydrologic soil group is an indicator of a soil's runoff potential. Soils are assigned to one of four groups (A, B, C, and D) or three dual classes (A/D, B/D, and C/D). Group A soils have high infiltration rates and the least runoff potential, while group D soils consist of soils with a very slow infiltration rate and thus have high runoff potential. Soils with dual designations indicate the soil responds like a group D soil when wet.

For this analysis, soils with a slow infiltration rate and high runoff potential were scored higher than soil with a high infiltration rate and low runoff potential. For soils with dual classes (i.e., Group A/D, Group B/D, Group C/D), scores were assigned based on the second letter. The scoring breakdown for the NRCS HSG layer is shown in Table 8.

Table 8: Scoring breakdown for NRCS HSG input layer

Score	NRCS Hydrologic Soil Groups
3	Group D, Group A/D, Group B/D, and Group C/D soils
2	Group B or C soil
1	Group A soil
0	N/A

Several data layers that depicted various types of impervious surface were provided by the Town of Bluffton and combined to form one impervious surface data layer. Because impervious surfaces play a large role in determining where pluvial flooding is more likely to occur, impervious areas were assigned a 3 and all other areas were assigned a 1. The scoring breakdown for the impervious surface layer is shown in Table 9.



Table 9: Scoring breakdown for impervious surface input layer

Score	Impervious Surface Area
3	Impervious surface areas
2	N/A
1	All other surface areas within the Town
0	N/A

Land cover data was derived from a raster layer (Bluffton_Landcover_Classification) which provides a numeric value representing a specific land cover for each cell (each cell is roughly 4 feet by 4 feet, covering approximately an 18 sq. ft. area). Similar types of land cover were combined to create three different land cover groups, which were then assigned a score. Forest and grasslands are non-developed and typically have high infiltration rates and were therefore assigned the lowest score of 1. Wetlands, open water, and developed areas were assigned the highest score of 3 as their position in the landscape and high levels of impervious surfaces make them the most vulnerable to flooding. The scoring breakdown is shown in Table 10.

Table 10: Scoring breakdown for the land cover input layer

Score	Land Cover
3	Wetland, Water, and Developed land cover classes
2	Residential and Barren land cover classes
1	Forest and Grassland land cover classes
0	N/A

The slope layer was derived from the Town's digital elevation model (DEM). Areas with slopes less than or equal to 2% were assigned a score of 3 while areas with slopes greater than or equal to 5% were assigned a score of 1. The scoring breakdown for the slope layer is shown in Table 11.

Table 11: Scoring breakdown for the slope input layer

Score	Slope
3	Grade is less than or equal to 2%
2	Grade is between 2% and 5%
1	Grade is greater than or equal to 5%
0	N/A

The Wetness Index based on Landscape Topography (WILT) is an index that can be used to infer how wet or flood-prone a location is relative to the surrounding area. WILT was used for this analysis over Topographic Wetness Index (TWI) as it is typically a better indicator of relative wetness within a coastal plain landscape. For this study, the WILT layer was provided by the Center for Watershed Protection, Inc. (CWP). The WILT accounts for groundwater depth, flow accumulation, and the tangent of slope. To categorize the WILT data, Jenks natural breaks were used to establish class thresholds. Areas with a higher WILT were assigned a score of 3 while areas with a low WILT were assigned a score of 1. The scoring breakdown for the WILT layer is shown in Table 12.



Table 12: Scoring breakdown for wetness index based on landscape topography (WILT) input layer

Score	Wetness Index based on Landscape Topography (WILT)
3	WILT greater than or equal to 7.37
2	WILT greater than or equal to 1.65
1	WILT less than 1.65
0	N/A

First Street flood data was provided by SCOR. For this analysis, the future conditions (2053) model was used to account for projected changes in climate, such as the intensification of storm events and sea-level rise. The spatial data was categorized based on the lowest recurrence interval storm event that would result in flooding. Land that is inundated during a lower recurrence interval (more common) flood event was assigned a score of 3 while areas that would only flood during a higher recurrence interval (less common) flood event were assigned a lower score. The scoring breakdown for the First Street flood model data is shown in Table 13.

Table 13: Scoring breakdown for first street flood model (2053) input layer

Score	First Street Flood Model (2053)
3	Within the flooding extent of the 5% (20-year) flood event
2	Within the flooding extent of the 1% (100-year) flood event
1	Within the flooding extent of the 0.2% (500-year) flood event
0	Outside the flooding extent of the 0.2% (500-year) flood event

The cumulative pluvial vulnerability score was then calculated based on weights assigned to each layer in Table 14. The spatial distribution of these results is shown in Figure 6.

Table 14: Pluvial vulnerability scoring input layer weights

Pluvial Data Layers	Weight
NRCS Hydrologic Soil Group	15%
Impervious Surface Areas	15%
Land Cover	15%
Slope	30%
First Street Flood Model 2053 data	15%
WILT	10%

3.2.2.4 Composite Vulnerability Score

The impacts of riverine, coastal, and pluvial flooding were combined to generate a composite vulnerability score. Each of the scoring layers (riverine, coastal, pluvial) were weighted equally and summed to give a final score ranging between 1.05 to 9, with higher values indicating higher vulnerability. The spatial distribution of these results is shown in Figure 7. Results from this analysis can also be used to inform the Town's resilience ordinance and coincide with SCOR's Conservation Priority areas to help prioritize the most vulnerable land to conserve. The vulnerability analysis can also be used in conjunction with the Town's wetland mapping analysis to identify wetlands near highly vulnerable areas that should be protected from future development.

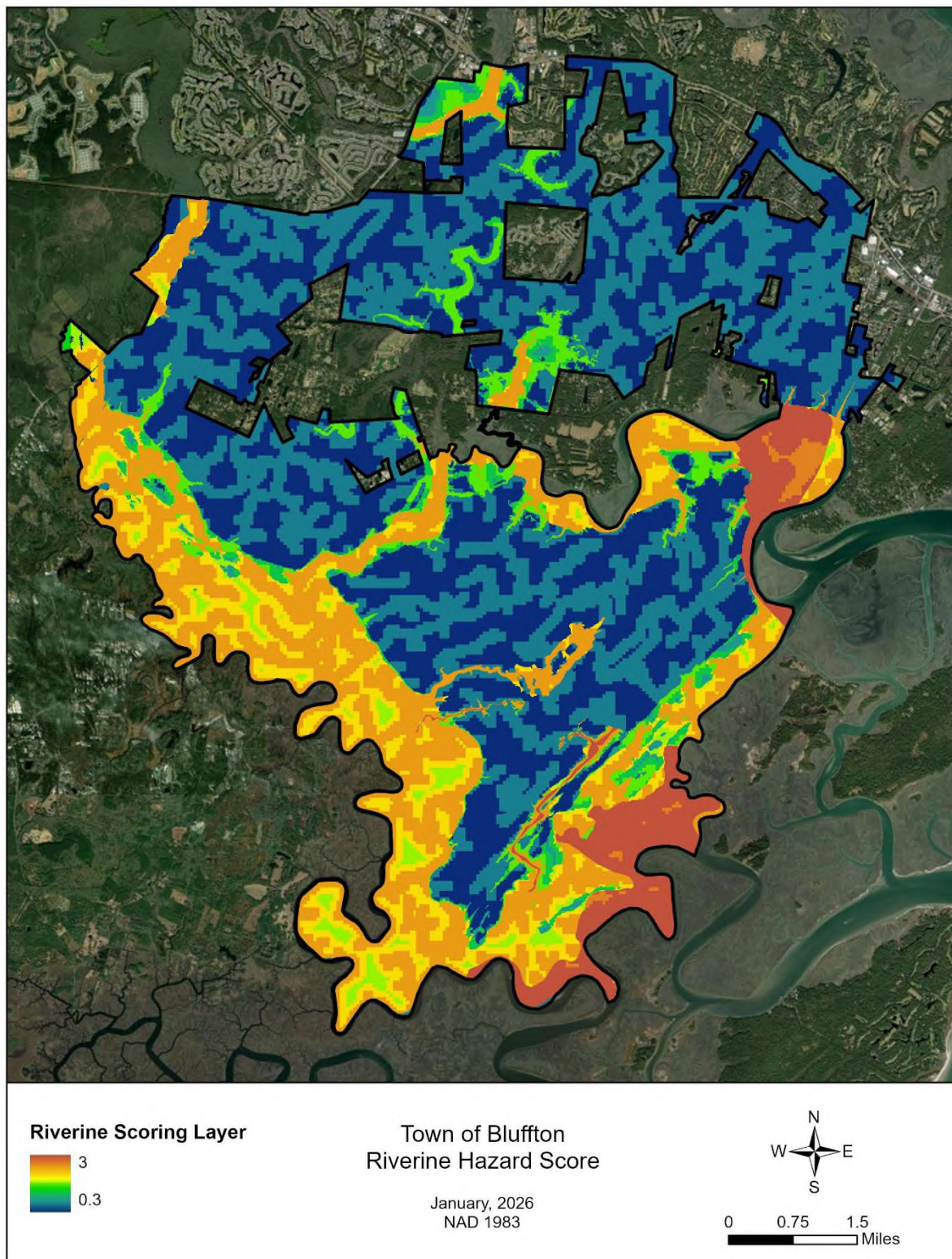


Figure 4: Riverine hazard score

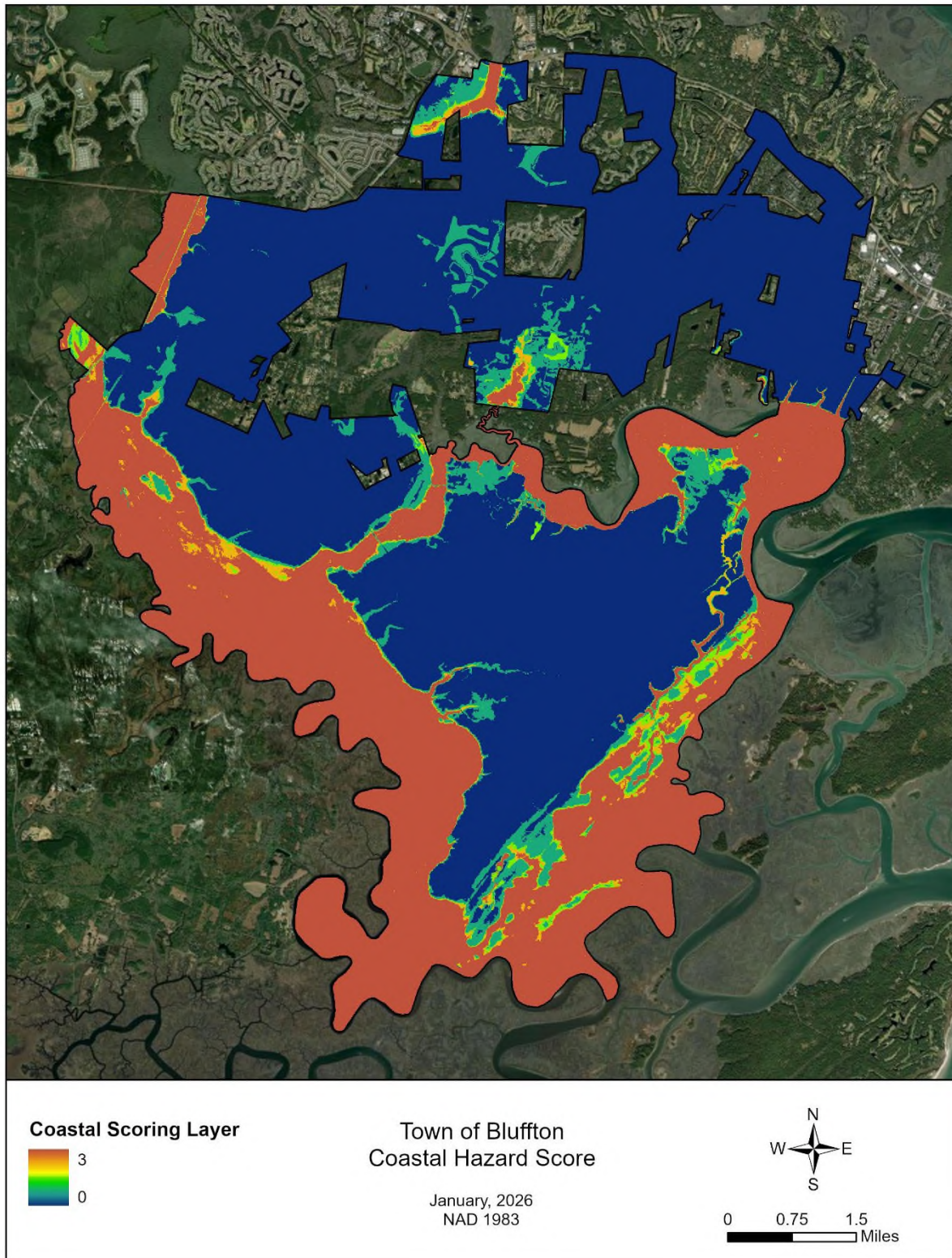


Figure 5: Pluvial hazard score

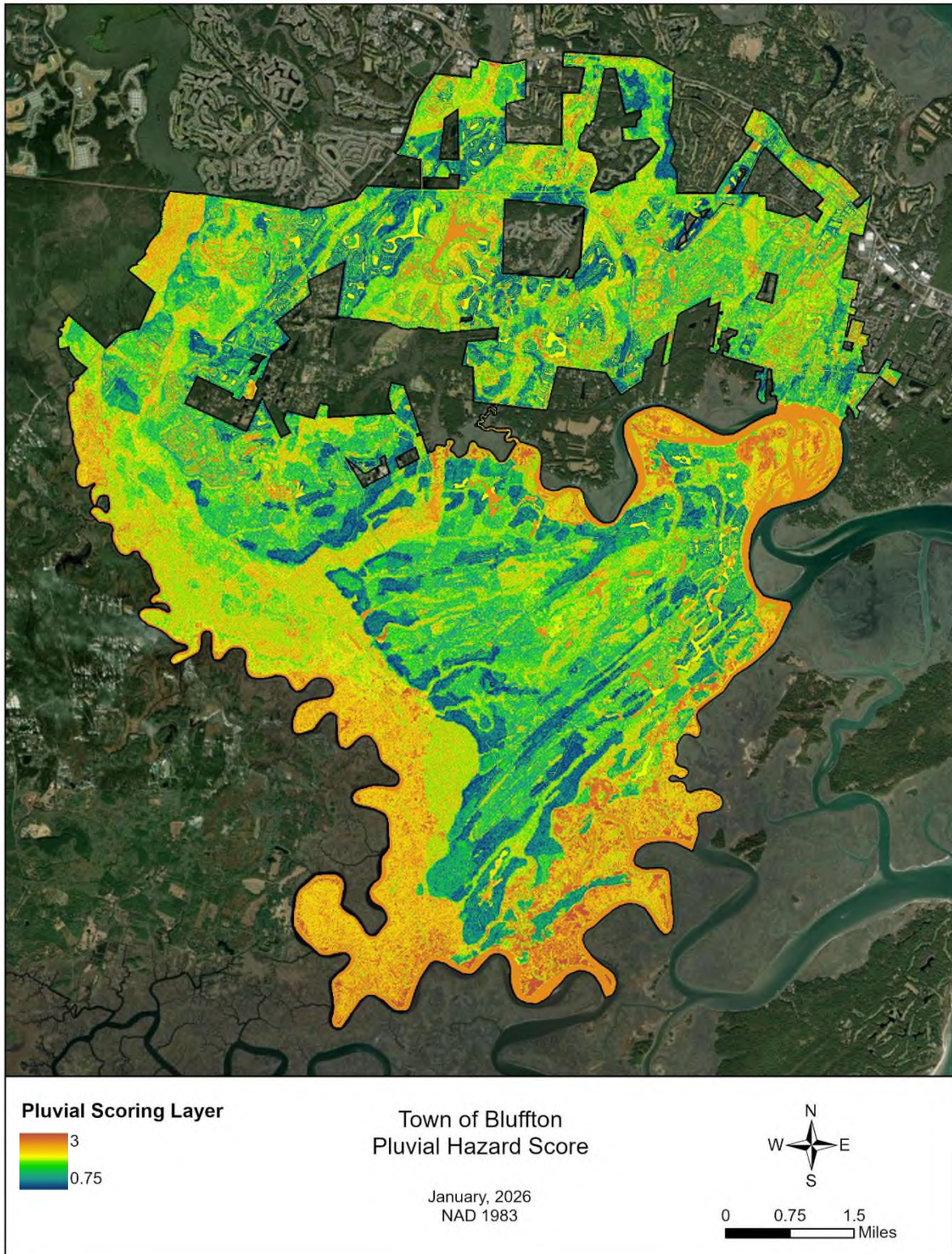


Figure 6: Pluvial hazard score

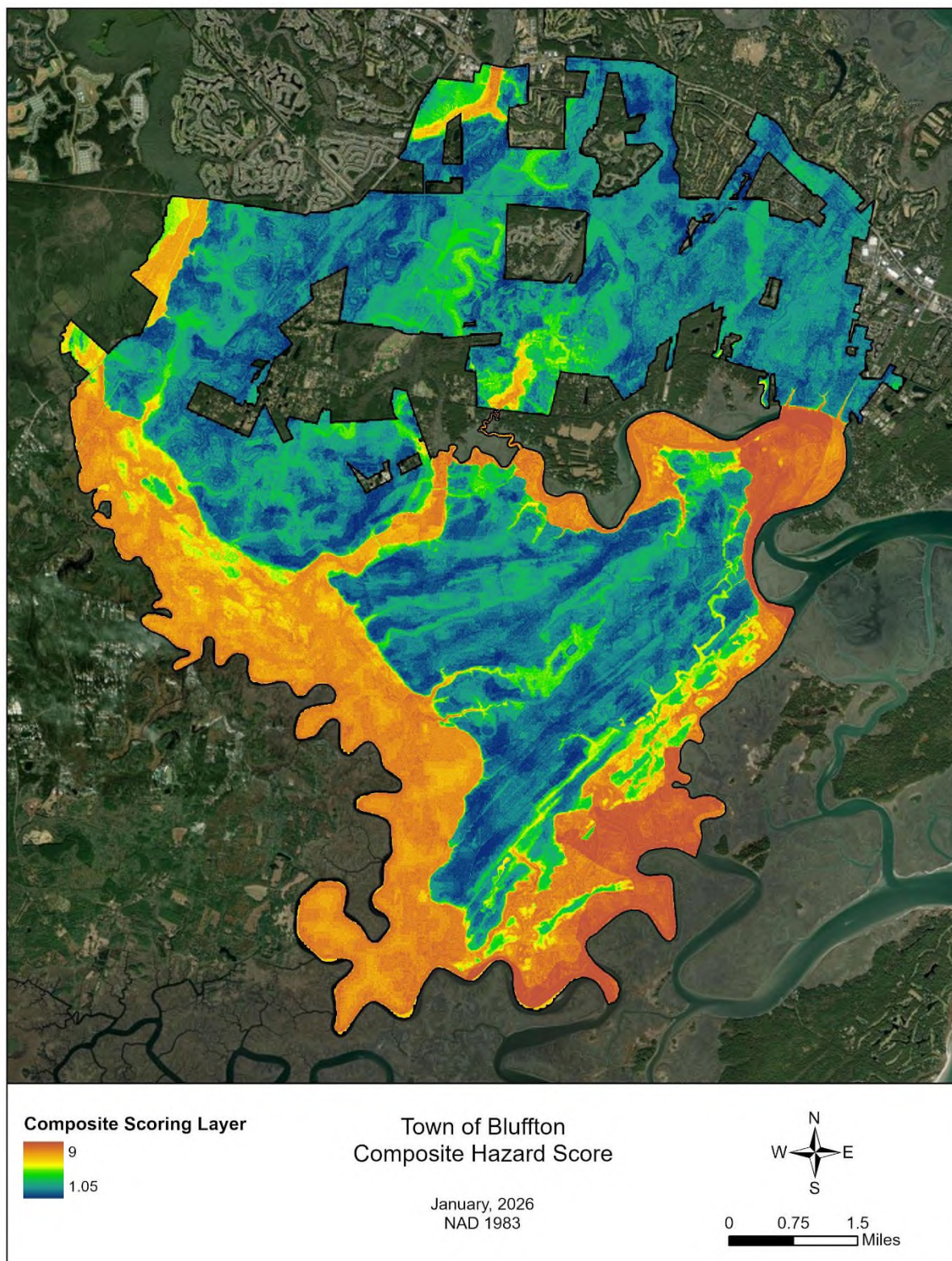


Figure 7: Composite hazard vulnerability score

RESILIENCE PLANNING ANALYSIS: TOWN OF BLUFFTON, SC

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Photo: Bluffton, SC



JUNE 2025

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EXECUTIVE SUMMARY

The Town of Bluffton (Bluffton), in partnership with the College of Charleston and the South Carolina Sea Grant Consortium, conducted a Resilience Planning and Engagement Project (Resilience Analysis) to assess Bluffton's vulnerability to current and future environmental conditions, with a focus on flooding risks and the impacts of land development on resilience. The aim of the project was to identify flood hazards affecting key infrastructure, identify potential policy options for enhancing resilience, and ensure public input through community engagement efforts. The analysis involved mapping and modeling current flood risks, evaluating development scenarios through a build-out analysis, and assessing the role of wetlands in mitigating flood impacts.

The analysis involved multiple layers of data to assess current and future flood vulnerability, focusing on both parcel-based flood depth and potential future development. Digital Elevation Models (DEMs) and Digital Surface Models (DSMs) were used to represent the topography, while the First Street Foundation flood dataset was used to analyze flood depth across different flood scenarios. A buildout analysis demonstrated future development to understand the potential flood impacts, with additional focus on wetlands and elevation-based zoning to determine how limiting development in certain areas could reduce vulnerability and potential flood damage. Additionally, community outreach events were held to gather local input, and a flood reporter survey was used to document residents' experiences with past flooding.

Key Findings:

1. **Flood Vulnerability:** The analysis revealed significant flood risks for Bluffton's assets and infrastructure under both current and future conditions. Increased flood depths were projected for frequent flood events (1-in-2-year storm), with many parcels that currently experience minor flooding facing more severe inundation by 2053. The vulnerability was particularly notable for high-impact flood events (1-in-100-year and 1-in-500-year storms), which would affect parcels that are currently outside of major flood risk areas.
2. **Future Development Risks:** A buildout analysis projected that 99,423 additional parcels could be developed in Bluffton by 2053. However, this increase in development heightens flood risks, with over 63% of these parcels at risk from the 1-in-500-year flood event. Protection of wetlands and surrounding areas through buffers as well as implementation of elevation-based zoning could significantly reduce future flood vulnerability. After modeling the implementation of each of the policy options analyzed in this study, more parcels were available for development than are required based on active Planned Unit Development agreements.
3. **Role of Wetlands:** Wetlands play a crucial role in absorbing floodwaters, especially during higher intensity events where over half of the vulnerable developable lands are within wetland areas. By 2053, more than 20% of the flood risk from low intensity storm

events could be associated with areas near wetlands. Protecting these vital ecosystems through local ordinances could help mitigate the impacts of future flooding events, potentially reducing overall damage. Protecting wetlands plus a 50-ft buffer reduces more than 60% of the vulnerability of future development to the 1-in-100-year storm event.

4. **Elevation-Based Zoning:** Areas with lower elevations showed greater vulnerability to flooding. Conversely, high ground zones had very little flood risk, with less than 6% of flooding for the highest intensity storms in this area and no flooding for the lowest intensity storm. Damage models showed an even greater proportion of property-damaging floodwaters in low elevation zones. Implementing elevation-based zoning could drastically reduce the exposure of development to flood risks, ensuring that future growth occurs in safer, higher-elevation areas.
5. **Community Engagement:** Public input gathered during community engagement events, particularly after Tropical Storm Debby in August 2024, provided valuable insights into flood concerns in low-lying areas. These insights helped shape the flood risk assessment and reinforced the need for stronger flood management policies.

Conclusions: Bluffton is at increasing risk of flooding due to both current and future climate impacts. Bluffton's vulnerability is compounded by projected increases in development and changes in land use. Protecting wetlands and implementing strategic growth policies, such as elevation-based zoning, could help reduce these risks and safeguard Bluffton's infrastructure and natural resources. Furthermore, community feedback has underscored the importance of addressing local flood concerns in future resilience strategies.

Recommendations:

1. **Strengthen Wetlands Protection:**
Consider adopting a wetland overlay zoning district (e.g. marsh migration overlay) or expansion of the Preserve (PR) District to safeguard flood-prone ecosystems. Use permitting requirements to guide development away from sensitive areas.
2. **Implement Elevation-Based Zoning:**
Limit development in low-lying areas by incorporating elevation into zoning criteria, following models from Charleston, SC, and Norfolk, VA.
3. **Update Flood Management Policies:**
Enhance Bluffton's 2021 Flood Damage Prevention Ordinance to ensure that new developments adhere to stricter flood protection standards.
4. **Offer Financial Incentives for Resilient Development:**
Strengthen the Transfer of Development Rights (TDR) program and consider tax or fee incentives for projects in low-risk zones. Explore impact or conservation fees for developments in sensitive areas.

5. Expand Land Acquisition and Partnerships:

Work with land trusts to secure key wetlands and floodplains. Use conservation tools and funding strategies to grow Bluffton's Land Acquisition Fund and prioritize high-impact parcels.

By implementing these recommendations, Bluffton can enhance its resilience to future flooding events and protect valuable ecosystems while balancing developmental goals.

BACKGROUND

The Town of Bluffton (Bluffton, Figure 1) is one of the fastest growing municipalities in South Carolina, with a 1,233% growth increase since 2000 (Town of Bluffton, 2022). In 2020, Bluffton had a population estimate of 34,493 based on the 2020 US Census Bureau projections (US Census Bureau, 2020). Out of 50,000 acres of land (not including waterways and marshes, ~14,000 acres), 10,344 acres of undeveloped open space remain (Town of Bluffton, 2022).

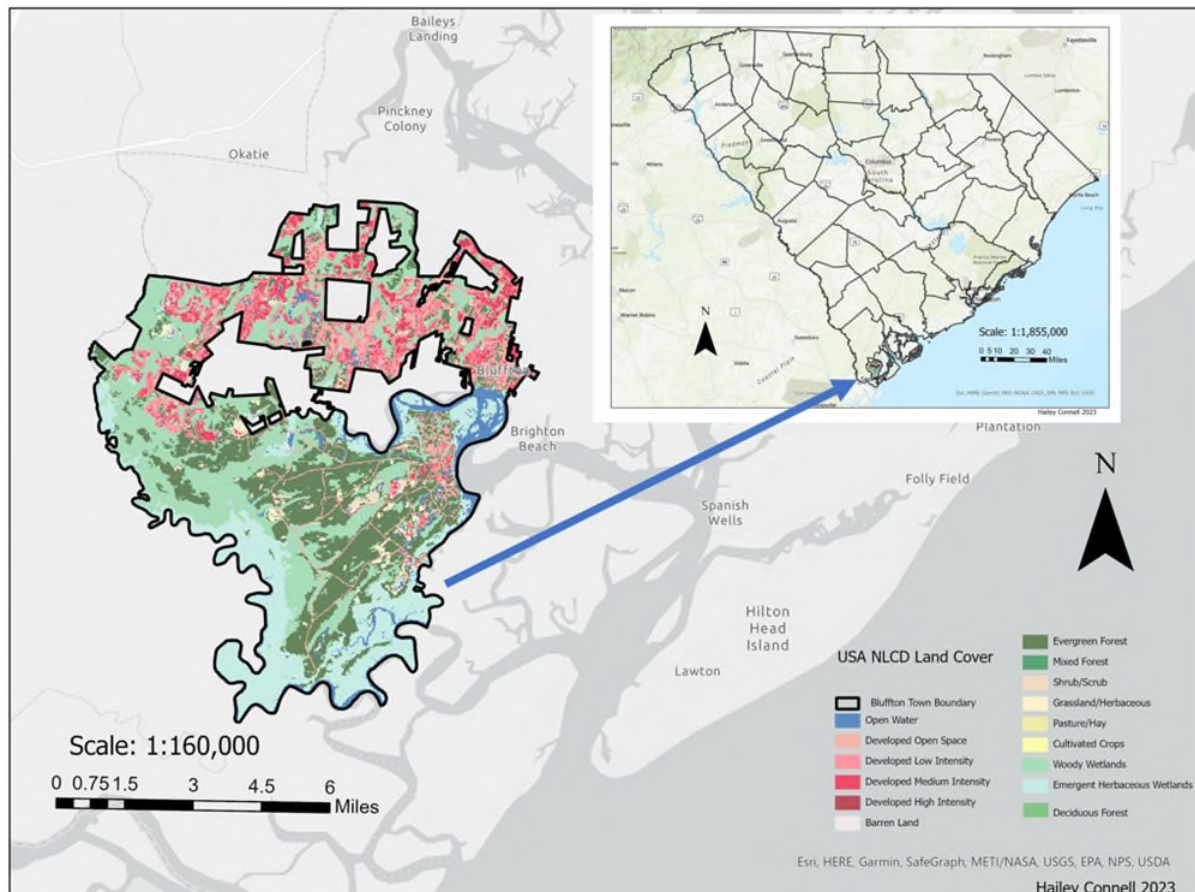


Figure 1: Town of Bluffton with land cover displayed

Within Bluffton's Comprehensive Plan, sections on natural resources and land use highlight the importance of locating areas for conservation and stormwater infiltration and preparing joint land use plans for undeveloped lands to address density and environmental protection (Town of

Bluffton, 2022). This is also shown in the May River Watershed Action Plan, though this plan centers mainly on water quality (fecal coliform, *E. coli.*, bacteria loading, etc.) and recommendations for land use alteration to negate the contamination impact of stormwater (Town of Bluffton, 2020).

Hazards and Land Use Change

The Fort Pulaski National Oceanic and Atmospheric Administration (NOAA) Tide Gauge was established in 1935 and is located approximately 7 miles south of Bluffton. This gauge is the closest tidal monitoring station to Bluffton, and because of its long-term, quality-controlled recording history, it is commonly used to represent trends throughout Beaufort County. The recorded mean daily tide range at the station is 6.92 feet. Since the station was established, the relative mean sea level has risen on average 0.14 inches per year, or 1.4 inches per decade (NOAA, 2025) (Figure 2). As sea levels continue to rise, records of high tide flooding also rise on all U.S. coastlines. These events are defined as a daily rise in water level above the minor flooding threshold set locally by NOAA's National Weather Service (Fly et al., 2017).

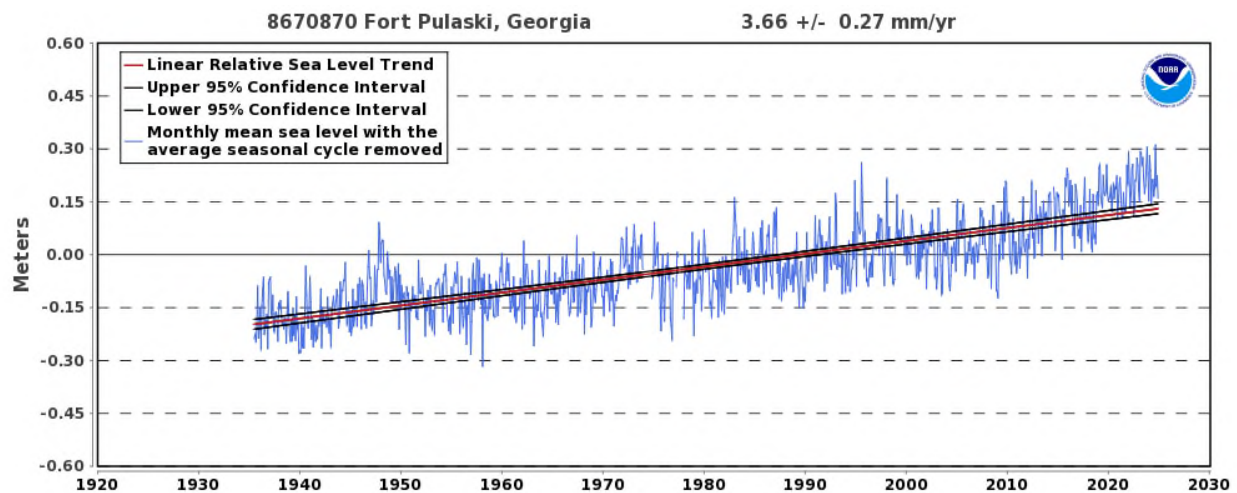


Figure 2: Rising mean sea levels recorded at NOAA's Fort Pulaski, GA Tide Station (NOAA, 2025)

An analysis of coastal South Carolina by the US Army Corps of Engineers (USACE) (Table 1) identified Bluffton as a high-risk coastal hazard area (USACE, 2022). The study focused on storm surge and sea level rise as those hazards were identified as the greatest threat to negatively impact coastal populations and infrastructure in the region. Of note is the increasing damage rating for North and East Bluffton when projecting out from Existing Infrastructure Damage to Future Infrastructure Damage. These results highlight the need for investigating the vulnerability of future development to coastal hazards, expanding the breadth of traditional vulnerability assessments which focus only on existing community assets.

Table 1: Future flood cost and damage rating for areas of Beaufort County with Bluffton areas shaded (USACE, 2022, Table 4-16)

County	Census Place or Location Name	State	Identified as Existing High-Risk Location	Identified as Future High-Risk Location	Existing Infrastructure Damage (\$)	Damage Rating	Future Infrastructure Damage (\$)	Damage Rating
Beaufort	Hilton Head Island	SC	X	X	\$159,517,000	High	\$313,723,000	High
Beaufort	Port Royal	SC	X	X	\$10,755,000	Med	\$21,752,000	Med-High
Beaufort	Beaufort	SC	X	X	\$7,198,000	Med	\$14,811,000	Med
Beaufort	Shell Point	SC	X	X	\$1,361,000	Low	\$2,729,000	Low
Beaufort	Burton	SC	X	X	\$1,109,000	Low	\$3,661,000	Low-Med
Beaufort	Bluffton	SC	X	X	\$575,000	Low	\$2,093,000	Low
Beaufort	Yemassee	SC	n/a	n/a	\$91,000	Low	\$235,000	Low
Beaufort	North Beaufort	SC	n/a	n/a	\$3,072	Low-Med	\$6,253	Med
Beaufort	East Beaufort and St. Helena	SC	n/a	n/a	\$24,206	Med-High	\$41,094	High
Beaufort	Dataw Island	SC	n/a	n/a	\$5,532	Low-Med	\$8,267	Med
Beaufort	Fripp Island	SC	n/a	n/a	\$8,401	Med	\$17,567	Med-High
Beaufort	North Bluffton	SC	n/a	n/a	\$23,898	Med-High	\$56,558	High
Beaufort	East Bluffton	SC	n/a	n/a	\$9,634	Med	\$19,611	Med-High

Figure 3 shows areas of development and general land use change within Bluffton and in the surrounding watersheds from 2001 to 2024. There is a significant increase in high density areas resulting in much higher levels of impervious surface across the study area.

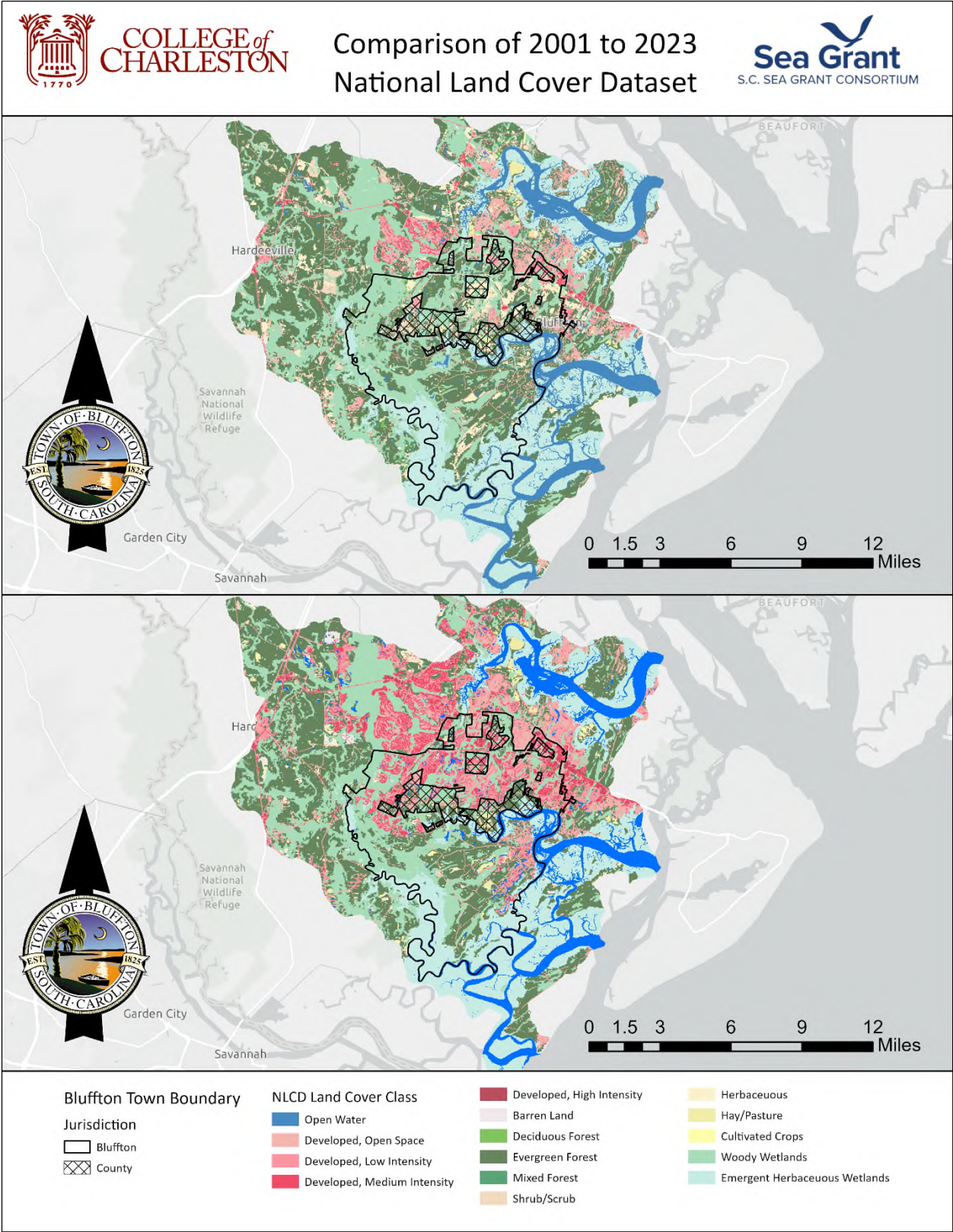


Figure 3: Change in land use from National Land Cover Dataset (NLCD) 30m data from 2001 (above)-2024 (below)

Resilience Planning Analysis

In order to assess Bluffton's vulnerability to current and future environmental conditions along with its changing landscape, Bluffton entered into an agreement with the College of Charleston, with the support of the South Carolina Sea Grant Consortium (S.C. Sea Grant Consortium), to conduct a Resilience Planning and Engagement Project ("Resilience Analysis"). The goal of the Resilience Analysis was to determine the flood vulnerability of Bluffton's assets and infrastructure within key watersheds. Bluffton's aim was to leverage the latest methods of coastal scientific analysis to inform effective policies and resilience plans. Bluffton also wanted to ensure that public input was considered in this project with ample community engagement opportunities.

A project team was formed with researchers from the College of Charleston and S.C. Sea Grant Consortium to conduct this interdisciplinary project. The S.C. Sea Grant Consortium led the community engagement components and provided project management, while the College of Charleston performed the mapping, modeling, and discussion of results. As a result of the U.S. Supreme Court's *Sackett vs. Environmental Protection Agency (EPA)* decision, Bluffton identified wetlands as particular features of interest. Bluffton staff requested an additional assessment of options for local wetlands protection ordinances in South Carolina. The project team partnered with the National Sea Grant Law Center to conduct this assessment.

While previous studies have identified sea level rise and tidal flooding as top concerns in coastal areas, Bluffton is fairly unique in that it has relatively high ground areas relative to neighboring Lowcountry communities. To assess current and future risk from flooding, a range of modeled storm events from lower intensity to higher intensity events were analyzed across the landscape (1-in-2-yr, 1-in-20-yr, 1-in-100-yr, and 1-in-500-yr storm events). These events were intersected with the property parcels within and surrounding Bluffton to investigate development vulnerability to flood hazards. In addition to current and future flood conditions, current and future development conditions were analyzed within this study. A buildout analysis was conducted to project areas of potential development by subdividing developable parcels to the maximum allowable density within the geographic information systems (GIS) framework. This allowed researchers to overlay potential development areas with flood hazards and conduct if/then scenarios to analyze changes in vulnerability with changing development patterns. The scenarios included analyzing the impact of protecting wetlands from future development and implementing elevation-based zoning. These analyses are described in the Methods and Results sections, with discussion following. Results are presented as mapping products as well as tables and charts describing the number of parcels and estimated damages of each storm event under each policy scenario. A review of land acquisition processes and policy options as well as local financial incentives to guide development away from areas vulnerable to flooding is described in the Discussion section as well.

METHODS

Study Area

For this study, the datasets collected were based on Hydrologic Unit Codes (HUC-12), using the watershed boundaries that cross or contain Bluffton jurisdictional boundaries (Figure 4). Studying flooding using the watershed boundaries ensures that all the data collected will account for water

movement that crosses political boundaries and offers a more accurate representation of hydrological processes. The five (5) different watersheds that make up the study area include the Upper New River-Atlantic Intracoastal Waterway, the Lower New River-Atlantic Intracoastal Waterway, the Cooper River-Calibogue Sound, the May River, and the Colleton River. The analysis of current development flood vulnerability was conducted for the full study area, while the maximum buildout flood vulnerability was performed within the confines of Bluffton's boundary, as this was the area with established Development Agreements in place. A Development Agreement is a legally binding agreement between local government (such as Bluffton) and property owner(s) for long-term development of large tracts of land. Each of Bluffton's Development Agreements provides for maximum build out and includes general uses, density, and general site layouts.

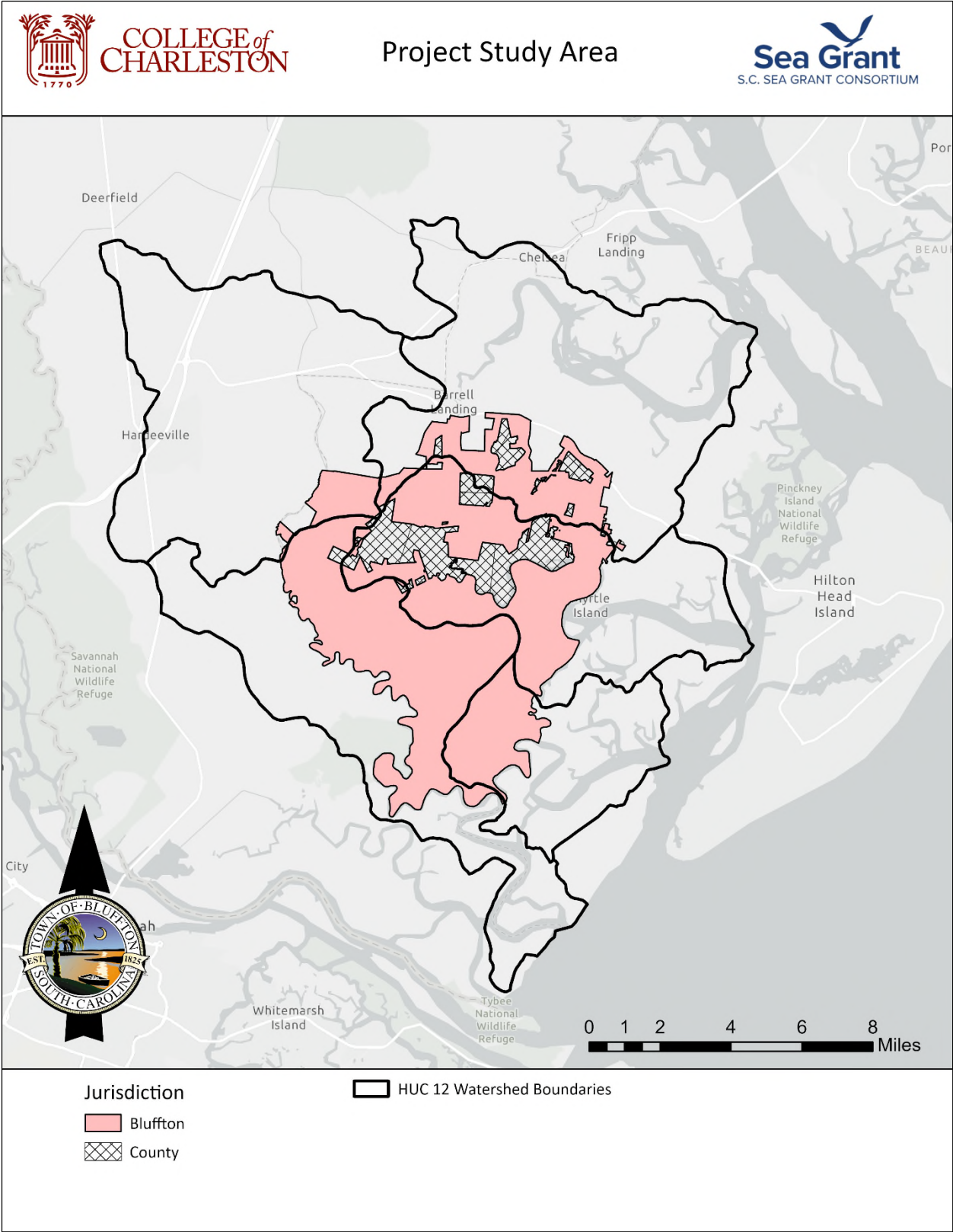


Figure 4: Project study area represented by HUC-12 boundaries with Bluffton and Beaufort County jurisdictions shown

Community Engagement

Bluffton incorporated community engagement as a core component of this assessment to ensure the knowledge and perspectives of residents were documented. The methodology for this aspect was established based on discussions during the project meeting held on June 3, 2024. During this meeting, Bluffton identified key locations to hold three (3) community outreach events that would ensure broad representation from citizens. Bluffton also agreed on the scope of work and goals of the outreach events. To inform residents of these events, [a website](#) was created for the project with event details and social media posts. Bluffton created a flyer, press release, and additional notifications. Outreach events took place at the Bluffton Rotary Community Center on July 18, 2024, from 6 to 7 PM, Pritchardville Elementary School on August 20, 2024, from 6 to 7 PM, and at the Historic Bluffton Arts & Seafood Festival on October 19, 2024, from 10 AM to 5 PM (Figure 5).



Figure 5: Photos taken from outreach event at the Historic Bluffton Arts & Seafood Festival (Photo credit SC Sea Grant)

Maps of Bluffton were divided according to the broader community boundaries expected to be represented at each event. However, residents from various areas attended all the outreach events, so maps of the entire Bluffton area were included to ensure full coverage. Maps of specific communities were also provided to help participants easily identify areas of concern. These unofficial boundaries and communities of interest were identified by Bluffton during a project meeting. Figure 6 shows an example of the maps provided. Attendees were provided with circle stickers to mark specific parcels, road sections, wetlands, or any other areas they wished to provide feedback on, along with adhesive note pads to document their comments. This approach enabled community members to share their personal experiences with flood hazards, providing a sense of involvement by their local government.

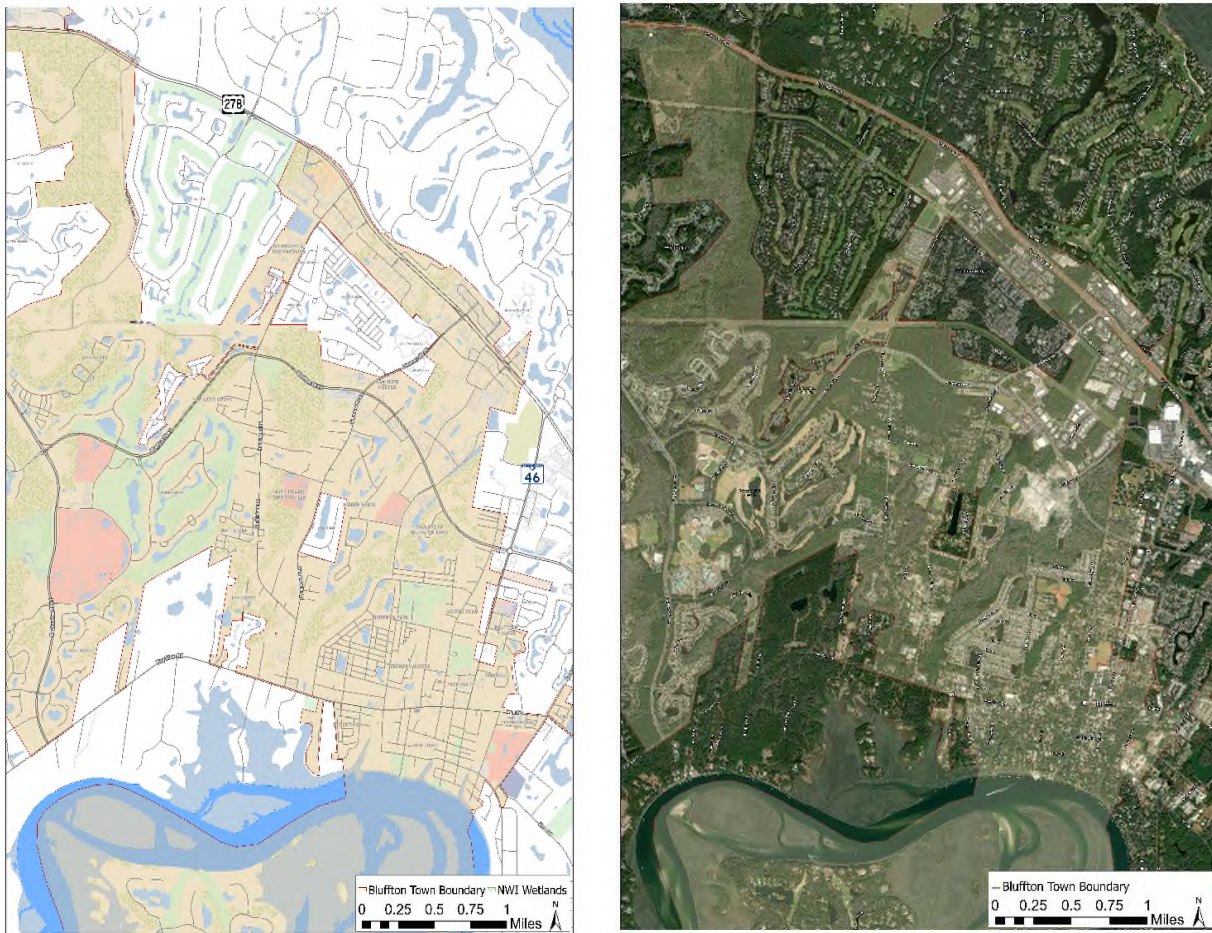


Figure 6: Example of maps created for outreach events

Flood Reporter Survey

A flood reporter survey was created to document past floods experienced by Bluffton residents. This was built using Survey123, an ArcGIS software that captures on-the-ground data from residents to track flood information temporally and spatially. The survey included questions about the timing of the flooding, water depth and movement, and provided space for residents to upload photos for visual documentation. Because Survey123 can download spatial information directly from submissions, an ArcGIS layer was created with all information automatically linked to the submitters identified location. Paper surveys were distributed and gathered from the outreach events which were manually entered into the layer, separating markers by survey versus outreach event as well as date of survey event. Additionally, signs were created and printed by the S.C. Sea Grant Consortium Communications Team, which asked residents to “tell us about flooding in your community” with a QR code directing them to the flood reporter survey. These signs were displayed in strategic locations by Bluffton staff throughout the study area. Additionally, an online viewer was created to display the community’s input for Bluffton staff.

Selection of Vulnerability Metrics

Vulnerability metrics were curated through a review of literature and selected in collaboration with Bluffton, ensuring the resulting models were scientifically and practically applicable. Correspondence via emails and meetings with Bluffton Town staff of the Watershed Management Division led to the creation of a Coastal Vulnerability Form for Bluffton. The primary purpose of this form was to gather detailed input on which factors Bluffton considered most crucial in assessing its specific vulnerabilities to coastal hazards and to determine what data, other than elevation and imagery, should be included in the model.

Through a literature review of common and applicable metrics used for areas such as coastal South Carolina, the form was divided by different physical, socio-economic, and ecological characteristics that totaled 21 possible metrics. Each metric was accompanied by a brief description and an explanation of its importance in the context of coastal vulnerability. This ensured that participants understood the significance of each factor before assigning it a rank. The ranking system allowed respondents to score each metric on a scale from 0 (not essential) to 4 (most important), offering a structured way to assess which factors had the most significant local impact. The Coastal Vulnerability form was created and distributed by Bluffton's Project Manager to groups including Town Council members, Bluffton Senior Staff, Emergency Management, Growth Management, and the Watershed Management Division.

Policy (*Adapted from National Sea Grant Law Center Report [NSGLC-24-04-06]*)

The National Sea Grant Law Center "Options for Local Wetlands Protection Ordinances in South Carolina Advisory Report" includes a review of federal regulations of wetlands and implications of the recent *Sackett v. EPA* U.S. Supreme Court decision. This includes a discussion of the pre-*Sackett* legal landscape of wetlands and jurisdictional determinations of wetlands in Bluffton. The report also examines existing wetlands regulations in South Carolina and examples of local wetlands protections in the Southeast region and across the United States. The report provides municipal options to protect wetlands, and key elements that should be considered if a municipality decides to develop local wetlands protections are explained. An overview of the results of this report can be found in the Discussion section. See Figure 7 for a diagram of waterway and wetland protections based on U.S. Supreme Court rulings through 2023.

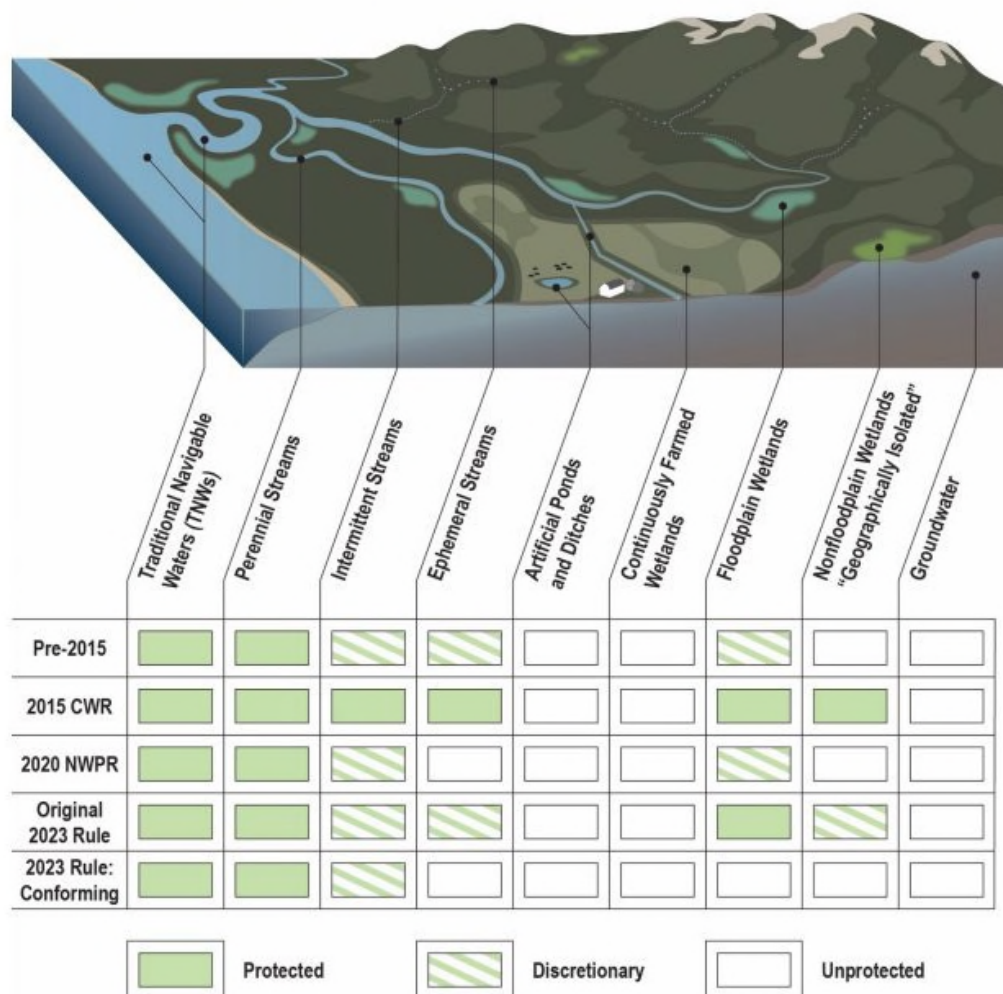


Figure 7: Wetland protection definition through the different U.S. Supreme Court rulings through 2023 (Sullivan & Gardner, 2023)

Mapping & Modeling

See Appendix E for detailed mapping & modeling methods

Flood vulnerability was analyzed using the First Street Foundation flood dataset with five modeled storm scenarios ranging from higher frequency, lower impact events such as the 1-in-2-yr storm to moderate (1-in-20-yr storm) to lower frequency, higher impact events such as the 1-in-100-yr and 1-in-500-yr storm. These storms were modeled for climate conditions in the year 2023 as well as projected climate conditions in year 2053 to give two time points of vulnerability. The analysis was separated into a review of the flood vulnerability of the existing development to-date in Bluffton as well as a prospective analysis of the vulnerability of future development zones. Each assessment was performed for every property parcel, with future development parcels created via a buildout analysis, which simulates the subdivision of all developable parcels into their maximum

development density. Future development vulnerability was summarized based on number of subdivided parcels touched by flood waters as well as the estimated damages that would occur if there were a home built on that property. If/then scenarios were run to show the ways different policy options could reduce the flood vulnerability of future development within Bluffton. These policy options included wetland protections, wetland buffers, and elevation-based zoning.

RESULTS

Community Engagement

Each community outreach event was attended by members of the community, with a suspected increase in participation at the second event due to Tropical Storm Debby impacting the area on August 8, 2024. Both SC Sea Grant Consortium and the College of Charleston were represented at all events, as well as the Watershed Management Staff to ensure all parties behind the research project were available for questions. There was also an increase in the flood report survey submissions around the time of Tropical Storm Debby.

Figure 8 shows the data layered over the basic digital elevation model (DEM), showing the clustering of flood concern in the low-lying areas, as well as an example of the type of information linked to each data point. The example data point shown in Figure 8 includes information such as the depth of floodwater, duration of the event, extent of water movement, and any infrastructure affected (e.g., roads, homes). This detailed local knowledge provides real-world insights, enabling a more accurate and community-informed assessment of flood risks. A total of 89 surveys were completed with a heat map created (Figure 9) to show the density of where locals reported flood issues. This is another tool that Bluffton can use when visualizing flooding issues.

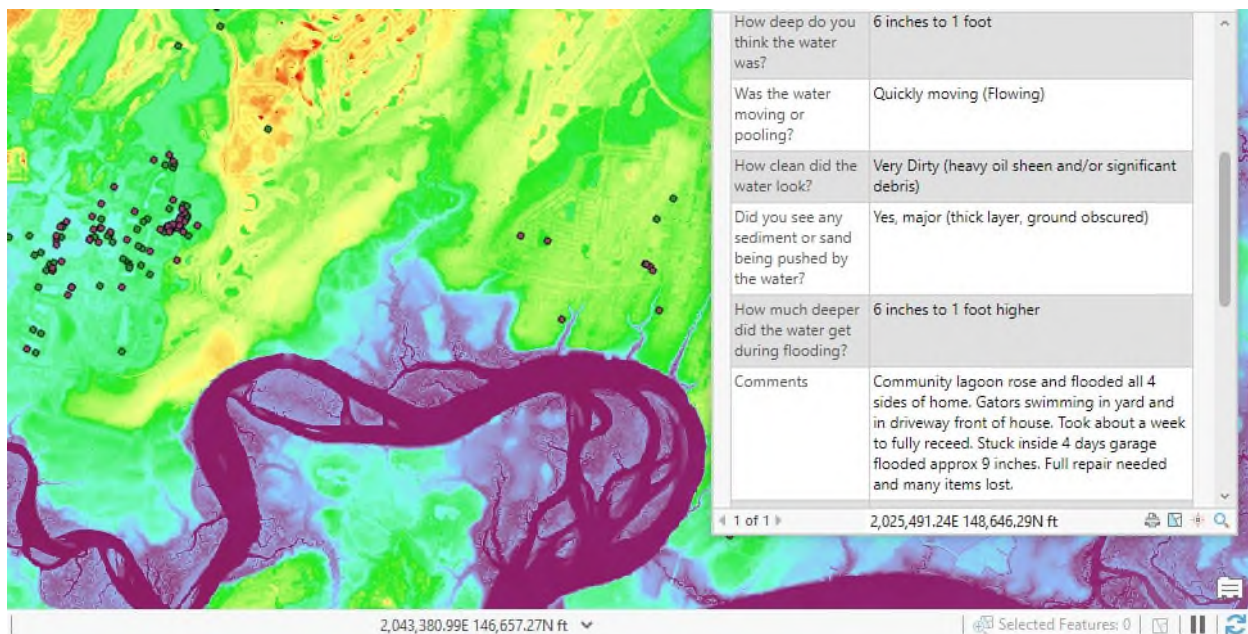


Figure 8: Community flood submissions with example submission in right dialogue box

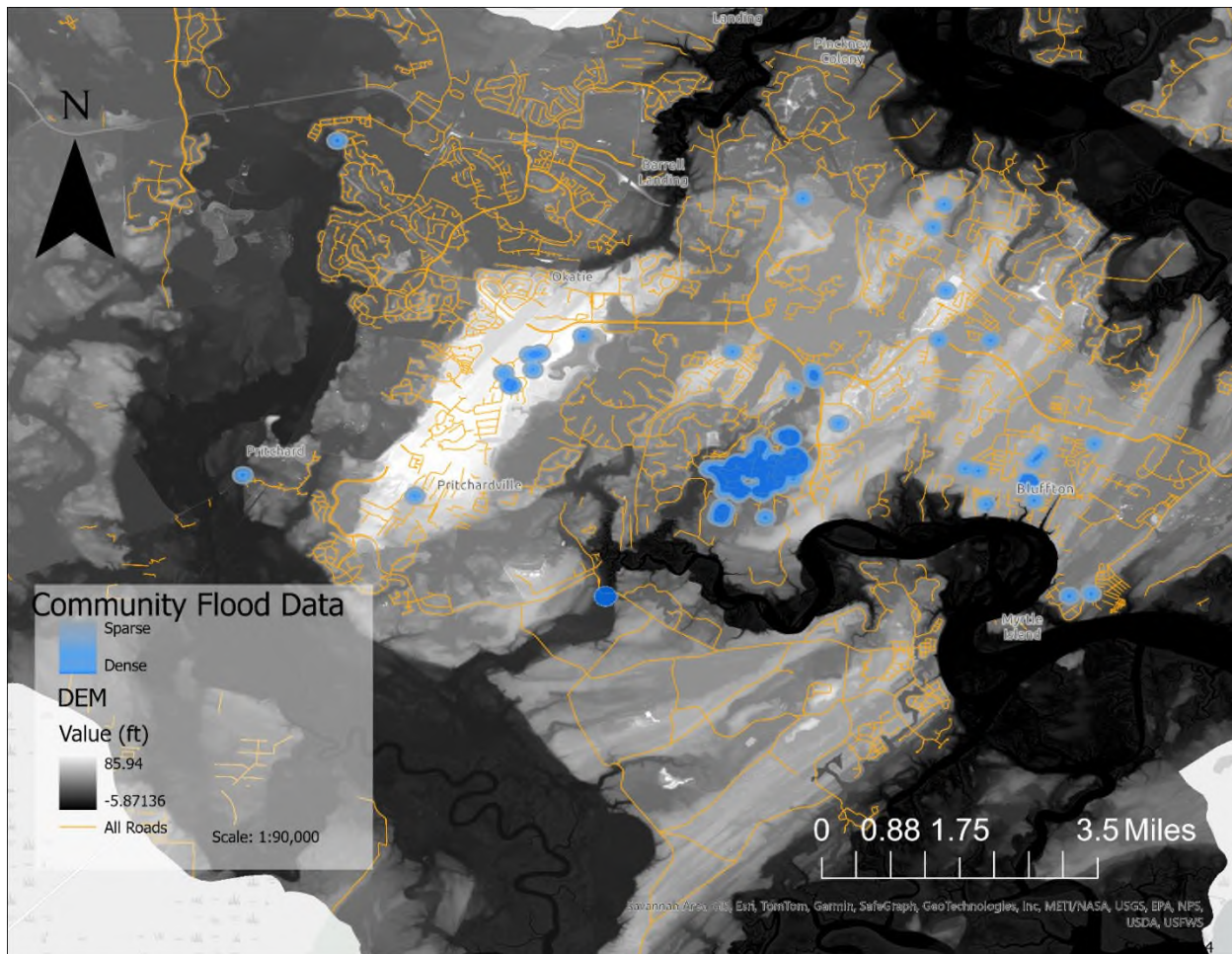


Figure 9: Heat map of community flood submissions with high and low elevations displayed showing clustering in low elevations

Selection of Vulnerability Metrics

A total of 22 responses were collected from the various Bluffton departments and Council members shown in Figure 10. The results of the Vulnerability Metrics Form shown in Figure 11 provide a clear overview of how Bluffton prioritized vulnerability metrics. Several of the following top concerns were identified as being feasible within the time constraints of this analysis: Wetland Loss, Flooding/Inundation, Rainfall-runoff, Storm Frequency, and Intensity. Of the top two concerns for Bluffton staff, water quality was outside of the scope of this analysis, while Evacuation Routes is a component of an analysis that is forthcoming from the South Carolina Office of Resilience (SCOR). However, addressing flooding issues in Bluffton will also provide significant benefits to water quality by limiting runoff pollution, protecting natural filtration systems such as wetlands and riparian zones, preventing erosion, and preserving aquatic ecosystems.

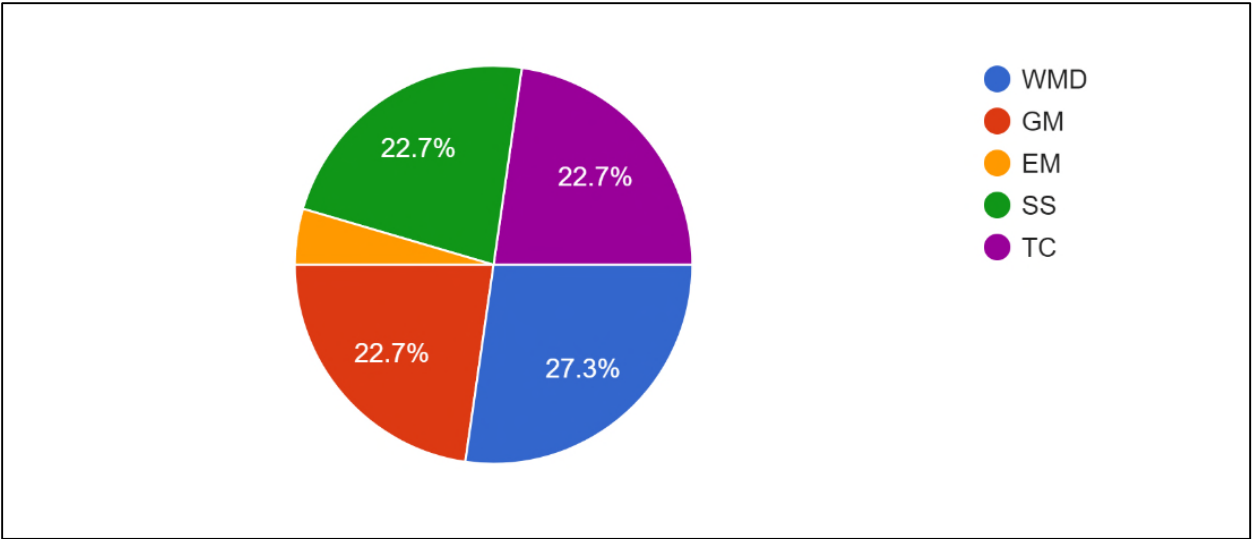


Figure 10: Distribution of responses from local government groups. WMD = Watershed Management Division, GM = Growth Management, EM = Emergency Management, SS = Senior Staff, and TC = Town Council

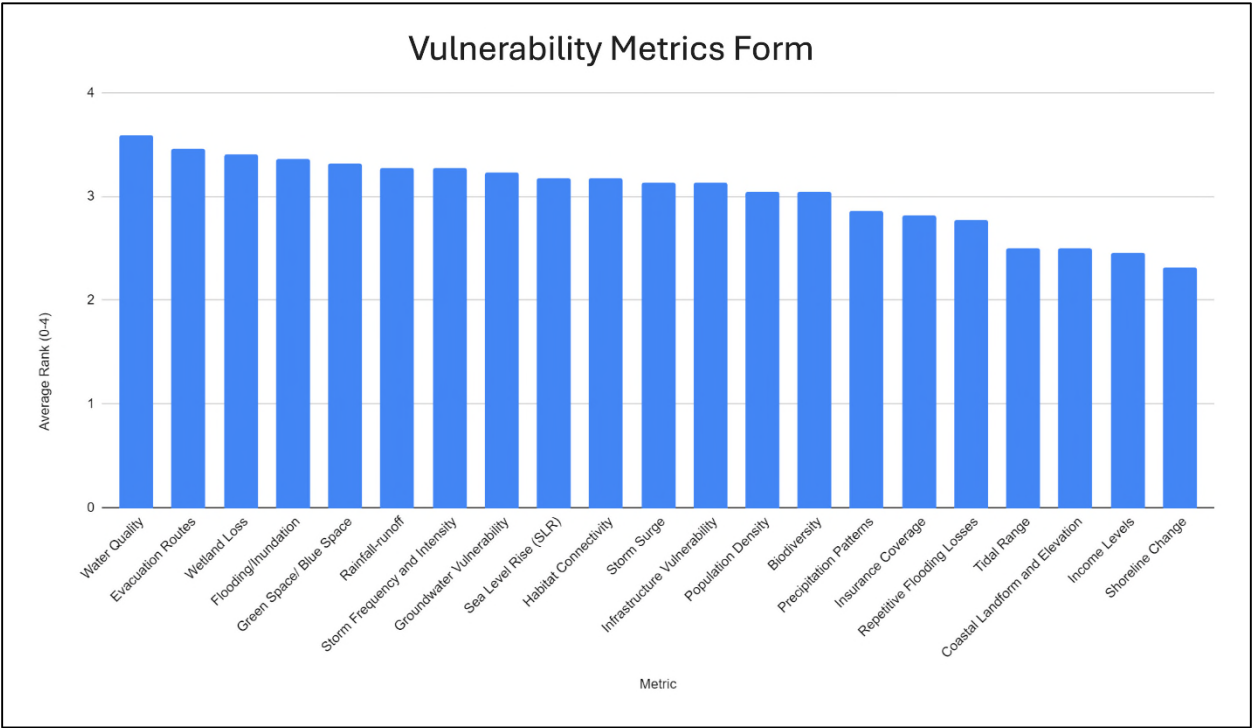


Figure 11: Final average ranks of all metrics in the Vulnerability Metrics Form

Mapping & Modeling

A total of 99,423 parcels were generated by subdividing remaining developable land within Bluffton's development areas to the maximum allowable density. Of those developable parcels, 43% were susceptible to flooding by the 1-in-100-yr storm in year 2023 conditions, rising to 60% of parcels for the 1-in-500-yr storm. When analyzing future conditions, many of the currently developed areas see a shift in flood inundation from minor or no flooding in 2023 to more severe depths of flooding in 2053. This trend was similar for future development, with the lowest intensity event (1-in-2-yr storm) having a 42% increase in parcels covered by the 2053 event versus the 2023.

The number of developable parcels generated by the buildout analysis (99,423) far exceeded the number of remaining residential dwelling units under development agreements (5,903). This surplus of available land allowed for scenario planning to determine the flood risk reduction different policy applications would have in Bluffton based on the location of future development in relation to flood hazards. Wetlands accounted for just over half of the vulnerable lands within development areas for all but the smallest storm scenario (1-in-2-yr). The 1-in-100-yr storm in year 2023 conditions resulted in 23,733 parcels flooded within wetland areas, resulting in an estimated \$1.84 billion in damages if those parcels were developed. Protecting wetlands plus a 50-ft buffer protects 25,986 potential parcels that would be flooded with an estimated damage value of \$1.99 billion if those parcels were developed and experienced that size storm event. Within the 50-ft buffer zone itself (excluding wetlands), 2,253 potential parcels experienced flooding by the 1-in-100-yr storm with an associated \$153.3 million of estimated damages. When analyzing elevation zones within each development area, the flood risk is almost entirely within the lower two out of three elevation zones. The high elevation zone contained less than 6% of flooded parcels and less than 3% of damages for each storm event. If policies were implemented prioritizing high elevation zones or protecting wetlands plus a 50-ft buffer, there would be more parcels available for development than are required based on active Planned Unit Development agreements as of December 2024.

Land Use and Flow Direction

Figure 12 shows the difference between impervious and pervious surface between the years 2001 and 2024 in the watersheds within and surrounding Bluffton, using NLCD (National Land Cover Database) data. Another aspect to note is the general water flow direction, which the arrows in the figure represent. Understanding the complexities of water flow at a watershed level helps understand where potential runoff will lead (Ongaga et al., 2024). This information is important for the study of both water quantity as well as water quality.

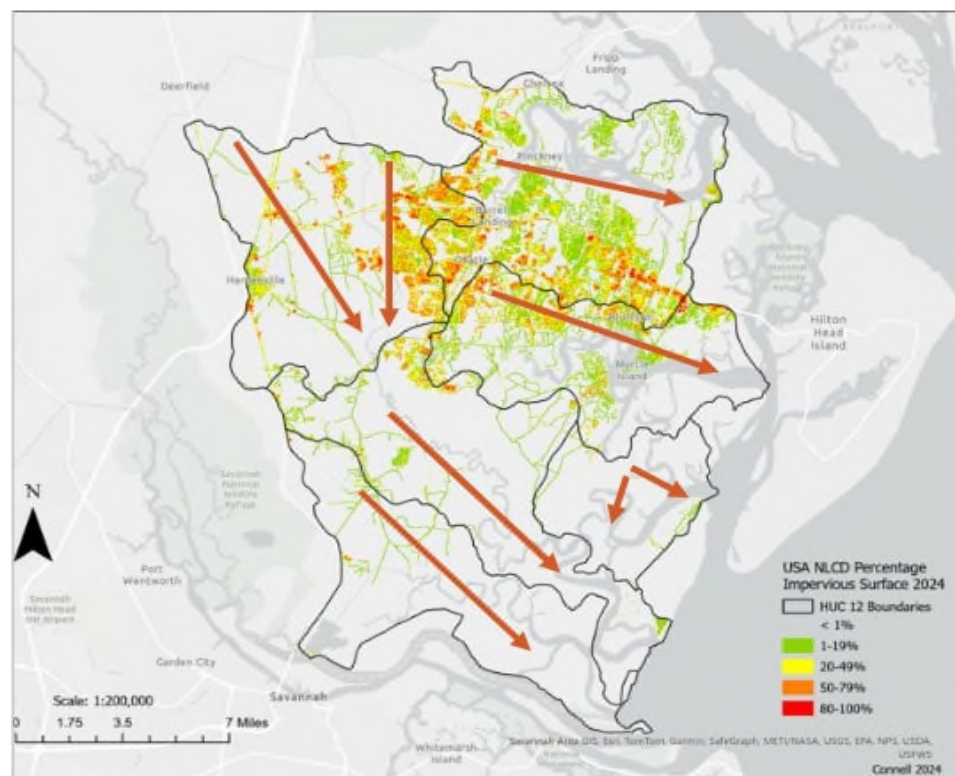
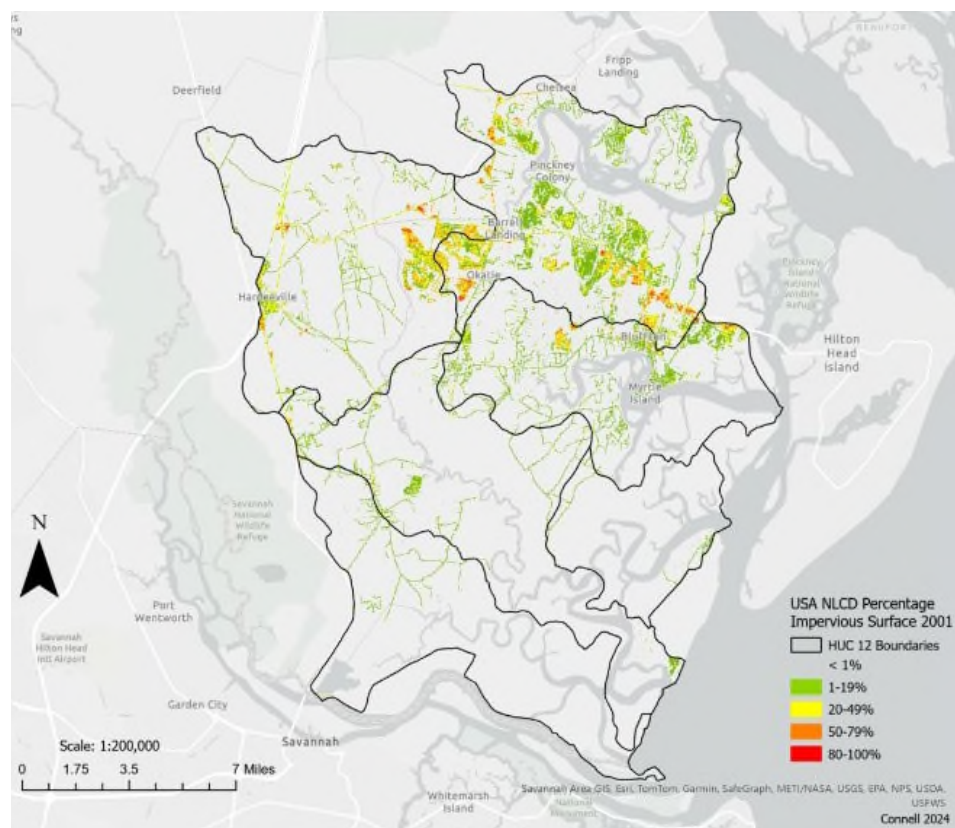
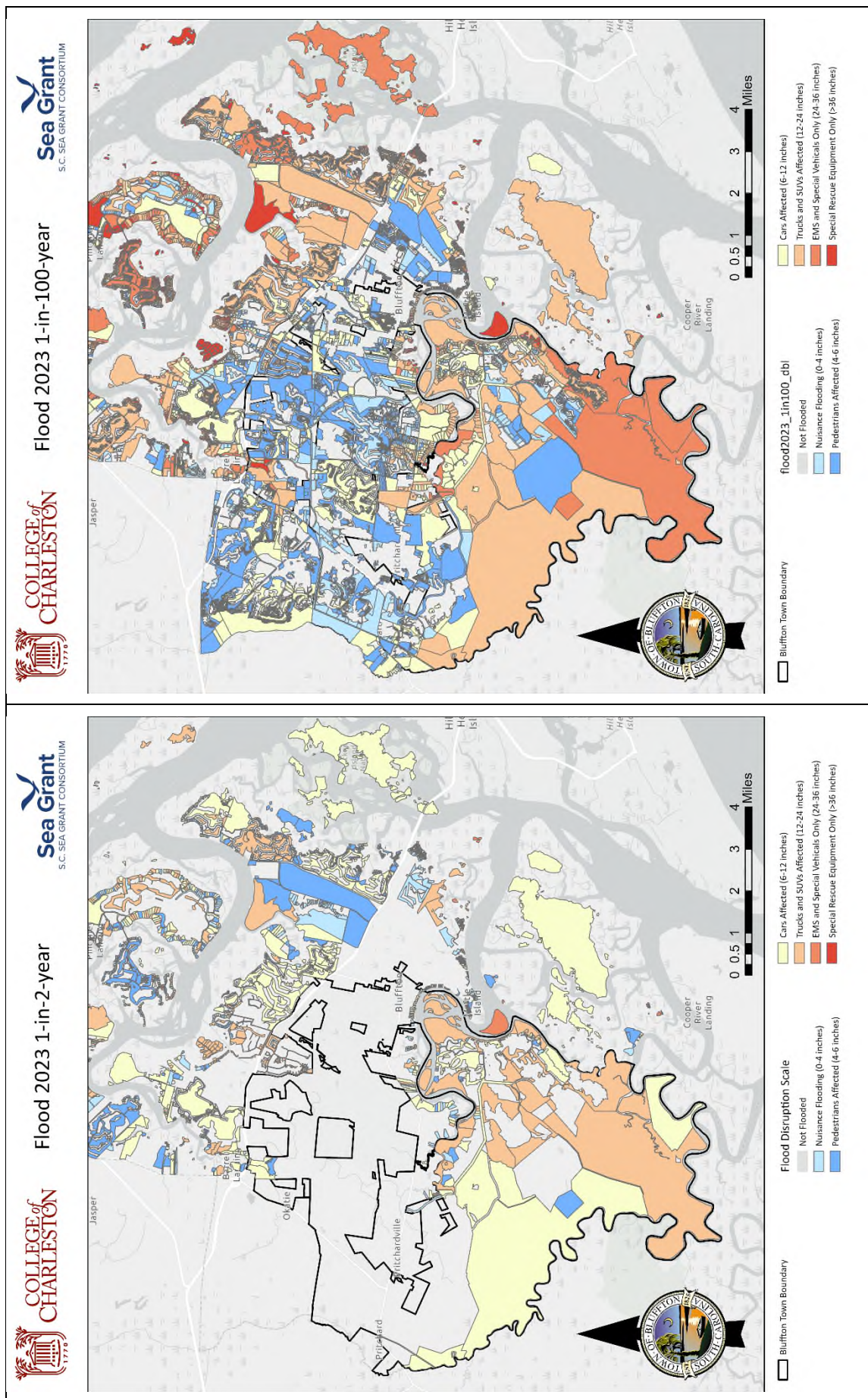


Figure 12: Impervious surface in 2001 (above) versus 2024 (below) from US NLCD. Red arrows represent the predominant direction of water movement through each HUC-12 watershed

Current Development Flood Vulnerability

Results indicate an escalating severity of flood depths across all scenarios between 2023 and 2053. For higher-frequency events (1-in-2-yr storm), many parcels experiencing minor flooding in 2023 are projected to face more inundation by 2053. The driver of this increased inundation is the increased level of precipitation expected for each storm scenario by 2053, which is incorporated into the flood models used in this study. This progression highlights areas where previously manageable events may increasingly disrupt properties, infrastructure, ecosystems, and daily life of Bluffton citizens. In the less frequent, high-impact flood scenarios (1 in-100-yr and 1-in-500-yr storms), the analysis reveals a stark rise in flood depths, exposing parcels previously outside major flood risk to considerable future hazard. Figure 13 shows the difference between a 1-in-2-yr flood scenario (a flood event that has a 50% chance of occurring each year) and a 1-in-100-yr flood scenario (a flood that has a 1% chance of occurring in any given year) in 2023, showcasing the expansion of the number of parcels effected between the least and most likely flood occurrences under current conditions. See Appendix A for parcel maps of vulnerability for each flood scenario and year conditions for the study area.



Section 3. Item # 1.

Figure 13: 1-in-2-yr versus 1-in-100-yr flood scenarios for 2023

Maximum Buildout Flood Vulnerability

A total of 99,423 parcels were generated by subdividing remaining developable land within Bluffton's development areas to the maximum allowable density (Figure 14). See Appendix B for results presented for each PUD. For the 1-in-100-yr storm with 2023 conditions, 42,852 parcels (43%) experienced some level of flooding. The parcels containing flood waters increased with each increasing storm scenario intensity, with the 2053 storm conditions increasing the vulnerability compared to the 2023 conditions. The proportion of parcels that experienced an increase in flooding from 2023 to 2053 storm scenarios declined with each progressively larger storm event, with a 42% increase in the 1-in-2-yr storm and a 27% increase for the 1-in-20-yr storm, declining down to 8% and 4% increases for the 1-in-100-yr and 1-in-500-yr storms respectively (Table 2, Figure 15). This indicates that future conditions will yield a greater increase in flood impacts from storms that are more likely to occur on a year-to-year basis relative to current impacts from these events. The 2053 storm conditions covered 5% (4,514) of the total buildout parcels in the 1-in-2-yr storm while the 1-in-500-yr storm covered 63% (62,454) of the total buildout parcels. This highlights the need for strategic growth in these areas to reduce vulnerability to future flood hazards.

Table 2: Vulnerable buildout parcels for each flood scenario and each study year with the percentage increase in parcels when going from 2023 to 2053 conditions

Year	1-in-2	1-in-20	1-in-100	1-in-500
2023	3,182	22,137	42,852	59,825
2053	4,514	27,052	46,082	62,454
<i>Percent Increase 2023-2053</i>	42%	22%	8%	4%

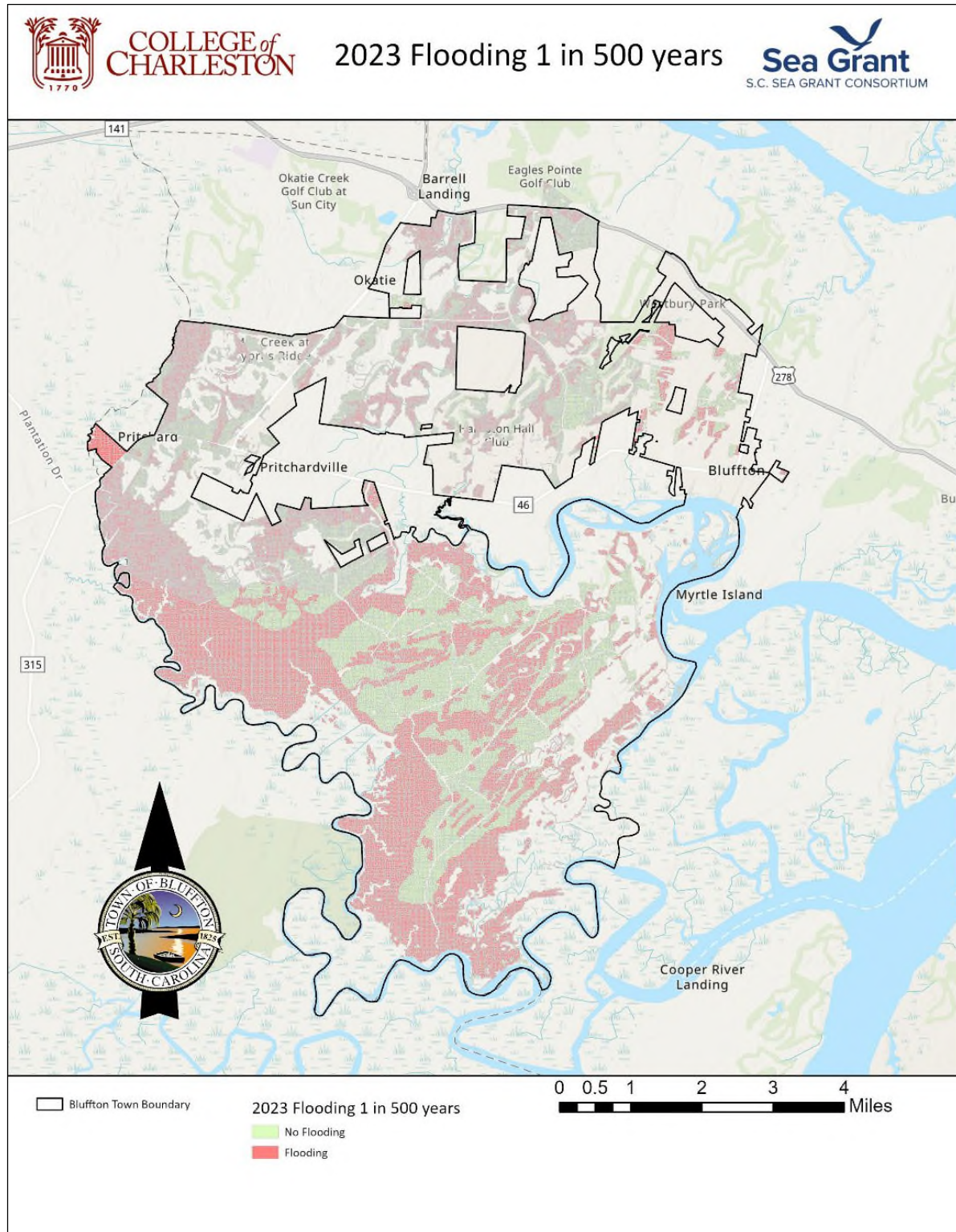


Figure 14: Parcels touched by flood waters of the 1-in-500-yr storm event (red) and those not touched by those flood waters (green) for year 2023 flood conditions

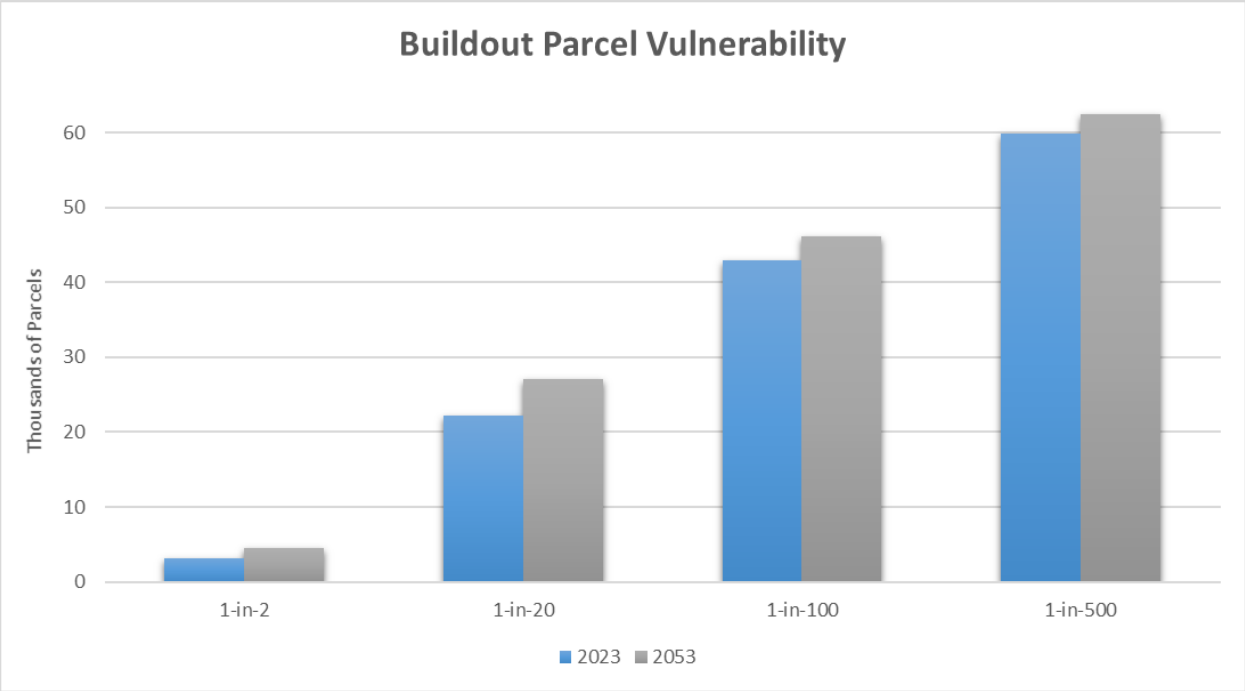


Figure 15: Vulnerable buildout parcels (thousands) for each flood scenario with year 2053 flood conditions shown in addition to year 2023 flood conditions

Forested Wetlands Analysis

When analyzing the buildout parcels that cover the wetlands in Bluffton, these parcels represent just over half of the vulnerability for all but the lowest intensity event (1-in-2-yr) (Figure 16). As climate conditions worsen in the year 2053, a greater number of buildout parcels are impacted by each storm event, while the proportion of parcels that fall within wetland areas for those future events remain relatively constant. Only 8% of the 1-in-2-yr storm vulnerability is within wetland areas for the year 2023; however, that proportion grows to 23% for the year 2053. For parcels inundated by the 1-in-100-yr storm, 55% (23,733) were within wetland areas accounting for an estimated \$1.84 billion in damages if those parcels were developed and impacted in year 2023 conditions. The damage models showed similar trends with roughly equal proportions of damage within and outside of wetlands as the parcel analysis revealed. For the highest intensity scenario (1-in-500-yr storm) in 2023 conditions, roughly \$3.11 billion in damages were accounted for by the parcels within wetlands versus \$2.94 billion in damages outside of wetlands. These numbers rose by roughly \$475 million for wetlands and \$420 million for non-wetlands when accounting for year 2053 conditions. These results indicate that, while lower severity events are distributed across the landscape, wetland areas are critical to absorbing the waters of higher intensity events.

There were ample buildout parcels available in non-wetland areas to fully reach the development goals of each PUD without future wetland development. Buckwalter PUD had the lowest proportion of available non-wetland parcels compared to remaining dwelling units in the PUD agreement, yet still had five times more buildout parcels available in non-wetland areas than are required (Table 3). See Appendix C for results presented for each PUD.

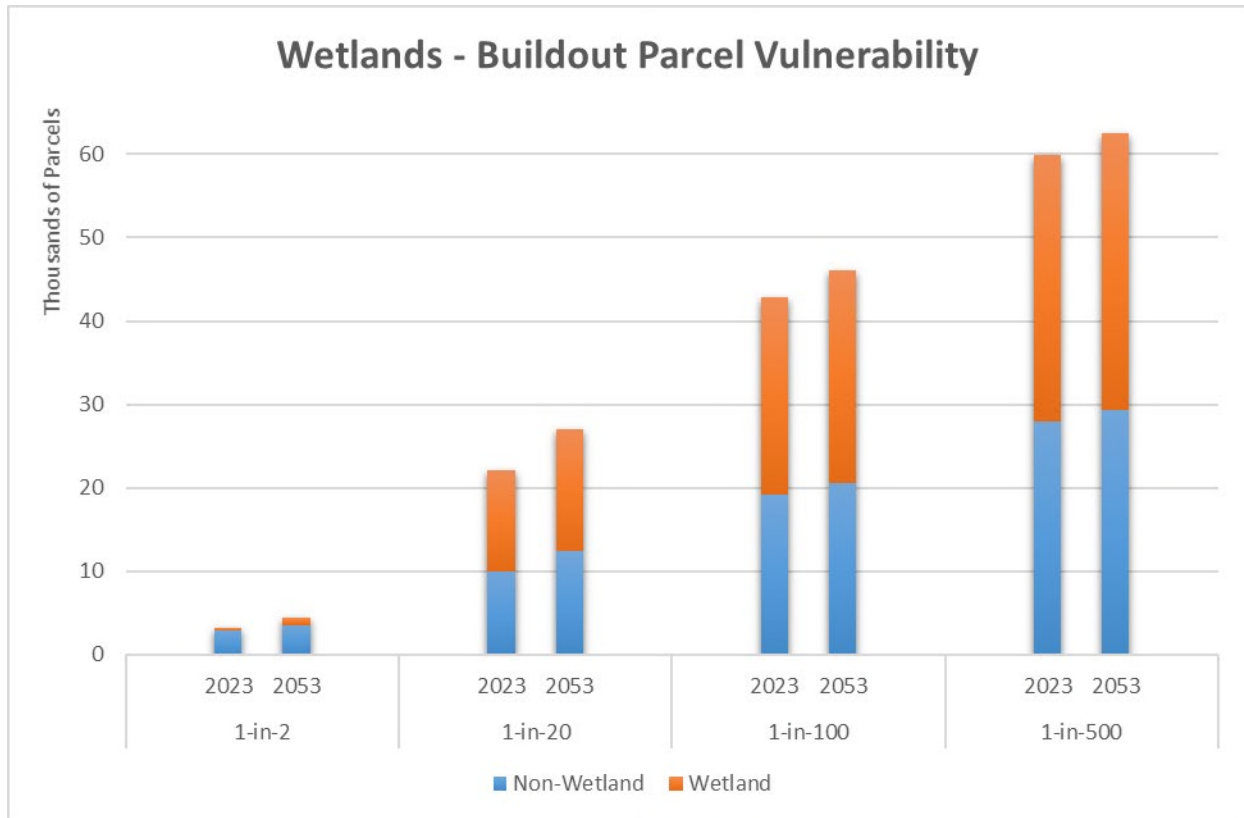


Figure 16: Vulnerable buildout parcels (thousands) for each flood scenario and each study year with parcels within freshwater wetlands (orange) shown in addition to those outside of those wetlands (blue)

Table 3: Planned Unit Developments analyzed with non-wetland parcels shown for each, remaining dwelling units from each Development Agreement, and the percent of those remaining units that would be reached with only non-wetland buildout parcels

Planned Unit Development	Non-Wetland Available	Remaining Dwelling Units	Proportion Non-Wetland
Buckwalter	10,960	2,176	504%
Jones Estate	4,597	413	1,113%
New Riverside	10,408	724	1,438%
Palmetto Bluff	28,335	2,515	1,127%
Shultz Tract	604	66	915%
Village at Verdier	200	9	2,222%

Because Bluffton lies slightly inland, the wetlands that now fall under unprotected land have increased, based off National Wetlands Inventory data showing emergent wetlands within Bluffton's boundary (Figure 17). Several of these wetland areas are already slated as potential medium density residential and commercial land use zones. The current definition of WOTUS allows the development of these areas shown in Figure 17 from a federal perspective, despite the potential hazards that may occur.



Wetland Buffers

An analysis of buffer zones surrounding wetlands was conducted for a 25-ft buffer, 50-ft buffer, and 100-ft buffer using the 1-in-100-yr storm scenario with 2023 conditions. Over 1/3 of all available buildout parcels were vulnerable to floodwaters within each buffer distance. Protecting wetlands plus a 50-ft buffer protects 25,986 potential parcels that would be flooded with an estimated damage value of \$1.99 billion if those parcels were developed and experienced this size storm event. Within the 50-ft buffer zone itself, 2,253 potential parcels experienced flooding with an associated \$153.3 million of estimated damages. Going from a 25-ft to a 50-ft buffer increases modeled protections by an additional 1,098 parcels and \$75.5 million of potential damages. Increasing the buffer size to 100-ft adds additional protection to 1,784 potential parcels with \$129.2 million in estimated damages compared to the 50-ft buffer; however, the proportion of total parcels protected is slightly less in this zone (33% compared to 36%). There were substantial buildout parcels available in areas outside of wetlands and a 50-ft buffer to fully reach the development goals of each PUD (Table 4).

Table 4: Planned Unit Developments analyzed with remaining dwelling units from each Development Agreement, parcels available outside of a 50-ft wetland buffer shown for each, and the percent of those remaining units that would be reached with only non-buffer buildout parcels

Planned Unit Development	Remaining Dwelling Units	Available Outside 50-ft Buffer	Proportion Available Outside 50-ft Buffer
Buckwalter	2,176	9,004	414%
Jones Estate	413	4,185	1013%
New Riverside	724	8,833	1220%
Palmetto Bluff	2,515	26,208	1042%
Shultz Tract	66	539	817%
Village at Verdier	9	187	2078%

Elevation Analysis

Subdividing each development zone into elevation groups of low (Marginal Land), moderate (Moderate Risk), and high elevation (Low Risk) reveals distinct patterns in the vulnerability of developable land within Bluffton's boundaries (Figure 18). For all but the highest intensity event, the majority of vulnerable buildout parcels fall within the Marginal Lands of Bluffton, with 92% of the vulnerable parcels within this category for the lowest intensity event (1-in-2-yr storm). The Moderate Risk category holds an increasing proportion of vulnerability as the storm intensity increases. This could be due to the number of Marginal Lands being close to fully occupied with flood waters during higher intensity events and therefore water reaching higher elevations during those events. For the year 2053, 85% of buildout parcels in Marginal Lands were covered by flood conditions for the 1-in-100-yr storm, with 94% covered by the 1-in-500-yr storm. The Low-Risk group showed very little vulnerability for each of the flood scenarios, with 0 parcels affected by the 1-in-2-yr storm and only 6% for the highest 1-in-500-yr storm, with numbers rising by 1-3 percentage points with each rising level of storm severity. The damage models showed an even greater proportion of damage accounted for by Marginal Lands, with 74% of damages occurring within this category for the 1-in-20-yr storm and an average of 58.5% of damages for the 1-in-

500-yr storm, with those damages coming from 41.5% of parcels flooded by that event. The Low-Risk areas accounted for an even smaller proportion of damage than the parcels analysis showed, with only 3% of the damage in this elevation group for the 1-in-500-yr storm. This indicates that, while any flood waters on a property are impactful, the lower elevation groups are experiencing greater flood depths and therefore greater flood damage in these models.

Enough available land exists within the Low Risk zone to meet all PUD agreements, while a combination of Low and Moderate Risk parcels contains at least six times more parcels than are required in each area (Table 5). See Appendix D for results presented for each PUD.

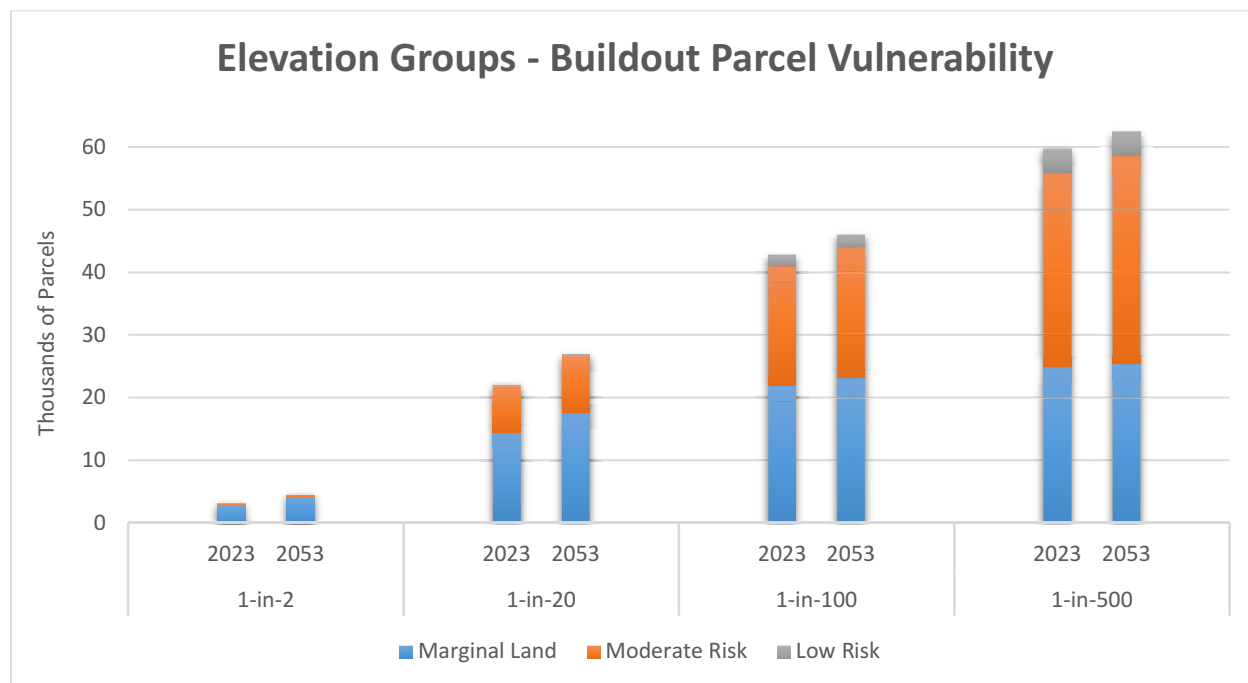


Figure 18: Vulnerable buildout parcels (thousands) for each flood scenario and each study year with parcels from each elevation group that are touched by that flood condition shown

Table 5: Planned Unit Developments analyzed with Low and Moderate Risk parcels shown for each, remaining dwelling units from each Development Agreement, and the percent of that maximum that would be reached with Low Risk as well as Low and Moderate Risk buildout parcels

Planned Unit Development	Remaining Dwelling Units	Low Risk Available	Proportion Low Risk	Moderate Risk Available	Proportion Low + Moderate Risk
Buckwalter	2,176	2,923	134%	18,669	992%
Jones Estate	412	1,045	254%	1,779	685%
New Riverside	724	2,880	398%	10,857	1,897%
Palmetto Bluff	2,515	8,976	357%	22,444	1,249%
Shultz Tract	66	176	267%	721	1,359%
Village at Verdier	9	40	444%	241	3,122%

DISCUSSION

This section contains recommendations by College of Charleston faculty and partners

Overall, Bluffton has several options to enact protections for non-jurisdictional wetlands and other vulnerable areas. These include but are not limited to: providing protections by amending existing zoning codes, establishing overlay districts and elevation-based zoning, adopting wetland-specific ordinances, strengthening floodplain management policies, establishing public-private and non-profit partnerships, strengthening/implementing financial incentives, implementing land acquisition policy options, and applying for land acquisition grant programs with the help of organizations, like The Nature Conservancy and The Open Land Trust. The exact framework for resilience initiatives in Bluffton will depend on how restrictive Bluffton wants to be regarding development, how much power their zoning/development authority has, and the municipality's staff and financial capacity to implement and enforce programs and policies.

Zoning and Overlay Recommendations

The evaluation of forested wetlands and elevation zones within Bluffton's boundaries highlights the resilience benefit of additional policy protections, while maintaining the ability to reach development goals established through PUD agreements. Locally protecting freshwater wetlands, which recently lost federal protection, could cut the vulnerability of Bluffton's future development in half. Additionally, elevation-based zoning has the potential to dramatically reduce the vulnerability of future development. The clustering of community flood submissions in low lying areas further supports the argument for elevation-based zoning by Bluffton, as it highlights current flood vulnerabilities that could potentially be avoided in future development areas with strategic growth planning. The City of Charleston, SC is an example of a municipality in South Carolina that is recommending elevation-based zoning for future consideration (City of Charleston, 2021). The City of Norfolk, VA underwent an ordinance rewrite to protect sensitive areas as well as incentivize development in higher elevations of the municipality through coastal resilience and upland resilience overlays (Pew, 2019).

For local governments where state wetland regulations are either in flux after *Sackett* or are being drastically rolled back, adopting comprehensive zoning ordinances may not be feasible. In the final report by the National Sea Grant Law Center, overlay zoning districts, which layer additional environmental protections on top of existing zoning, seem to be one of the more feasible solutions for Bluffton. Dekalb County, GA, uses this method to protect environmentally sensitive areas, and the local board defines what qualifies as "environmentally sensitive" based on local needs (DeKalb County, Georgia, n.d.). This flexibility could be key for Bluffton, where specific environmental issues, such as flooding and wetland preservation, need a targeted approach (Drescher et al., 2014). Overlay districts allow municipalities to address these concerns without navigating hurdles that may arise in zoning changes. Overlays or other forms of permitting requirements do not restrict or prohibit all forms of development but rather require local approval prior to beginning a project to ensure sensitive areas are protected. Additionally, as Bluffton already has a historical preservation overlay and a Preserve District, establishing a wetlands protection overlay may comply well with the zoning code. Although Bluffton's Preserve District allows for very little development and therefore protects wetland areas within the district, Bluffton might consider expanding the

coverage of the Preserve District to cover other sensitive environmental areas through a Zoning Map amendment.

Lastly, a different overlay that Bluffton could consider implementing is a marsh migration area overlay district, which would help designate areas that can support future marsh migration as resource protection through shoreland zoning. Flood protection-based requirements as shown in an example from Hilton Head Island were deemed another viable option for Bluffton based on the municipal structure for the Town of Hilton Head Island (n.d.). Like the overlay, this option doesn't require a large change in Bluffton's ordinance or zoning in order to adopt and reach their goals, like other more burdensome policy tools may. The use of overlay zoning districts and flood protection requirements presents a viable and less disruptive solution. The National Sea Grant Law Center found that these strategies have been successfully implemented in other local governments, allowing them to protect environmentally sensitive areas (DeKalb County, Georgia, n.d.). By adopting similar approaches, this is a possible avenue for Bluffton to effectively safeguard its wetlands while maintaining political and developmental flexibility. For example, Bluffton's updated 2021 flood damage ordinance, which does not restrict development within flood hazard areas, could be adapted to provide wetlands protection, similar to Hilton Head's ordinance.

Per the final report by the National Sea Grant Law Center, wetlands protection at the municipal level varies widely from very restrictive of all development to not very restrictive. Some municipalities, like Tampa, FL do not limit development as much as simply impose additional requirements/approval for developers to get prior to beginning their activities. The level of protection often depends on whether there are state-level protections and requirements in place. In Washington and Virginia, the state has provided requirements and model ordinances for municipalities to adopt which allows for these ordinances to be more comprehensive and for development to be more restricted at the local level. These models are not replicable everywhere as not every state has deferred such power to the local level. As federal and state wetlands regulations continue to change, it will be up to municipal governments to find and adopt the best fit for them when they want to further protect these vital resources.

Financial Incentive Recommendations

Bluffton may also consider strengthening local financial incentive programs to guide development away from vulnerable areas susceptible to flooding and to protect wetlands. Bluffton could enhance its current Transfer of Development Rights (TDR) program by offering more significant development density incentives in receiving areas to ensure that growth is concentrated in appropriate zones. At the same time, Bluffton could narrow the areas designated as "sending areas" to focus on the most flood-prone or environmentally sensitive lands.

Other incentives might include tax abatements (tax breaks), streamlined permitting processes, or discounted application fees for development that occur outside vulnerable areas. Bluffton could also consider impact fees, special study fees, or environmental protection fees for development in sensitive areas. These measures would discourage growth in wetlands while helping offset the costs of structural flood protection and conservation initiatives.

Land Acquisition Policy Options and Recommendations

In addition to regulatory strategies, land acquisition remains a critical tool for advancing conservation and flood mitigation goals in Bluffton. Among available approaches, maintaining and strengthening partnerships with land trusts operating in this area of the state, such as the Open Land Trust (OLT) and The Nature Conservancy (TNC), stand out as particularly effective. These partners bring technical expertise, funding mechanisms, and longstanding experience in negotiating with private landowners and securing conservation easements to protect critical floodplains and wetland systems.

Fee simple acquisitions—such as Bluffton’s 44-acre purchase from Palmetto Bluff—should continue to be pursued for high-priority parcels, particularly those vulnerable to flooding. Partnering with TNC and OLT to jointly fund and manage future acquisitions would increase Bluffton’s capacity to conserve key properties while minimizing municipal financial burden.

Bluffton may also benefit from articulating a long-term vision for land use and growth over a 50-year planning horizon. Incorporating projections for sea-level rise, storm surge, and other climate-related risks into future land use decisions will provide a forward-looking framework to guide sustainable development. Land use planning should align with existing state and regional conservation resources, including the South Carolina Conservation Bank map, the Southeast Conservation Adaptation Strategy (SECAS) blueprint, and the South Atlantic Salt Marsh Initiative (SASMI) map.

A flexible suite of acquisition options can further support Bluffton’s conservation objectives. For example, Bluffton could consider using rolling easements to protect coastal and flood-prone lands. These easements provide flexibility by allowing conservation protections to migrate inland as the landscape changes due to sea-level rise or erosion, offering long-term resilience benefits. The inland shift could be guided by a clear benchmark, such as the average elevation of the highest daily tides (the mean higher high water, or MHHW), to ensure consistency and transparency over time.

To guide land acquisition investment, a tiered approach based on risk and opportunity may be helpful. In lower-risk scenarios, the purchase of conservation easements can reduce land value and attract conservation-minded buyers. In medium-risk situations, Bluffton may benefit from coordinating with partner organizations to acquire land for public use, with the potential for state or federal reimbursement. For higher-risk or more complex acquisitions, Bluffton could consider purchasing large tracts outright, then selling portions of the land under conservation easements to offset costs.

Bluffton should maximize credit under the FEMA Community Rating System (CRS) by ensuring that conserved land, including those tied to development agreements, are eligible. Doing so could reduce flood insurance premiums and enhance Bluffton’s overall resilience. Large tracts such as Palmetto Bluff should be prioritized as undeveloped lands become more limited.

Finally, Bluffton may consider strengthening its Land Acquisition Fund by identifying new and diversified revenue sources. Potential mechanisms include a small fee on home sales in new

Planned Unit Developments (PUDs), conservation contributions in development agreements, and permit-linked development fees. Simultaneously, optimizing future PUD layouts by encouraging cluster development and maximizing open space preservation could enhance ecological function while maintaining allowable density.

Review of Local/State and Federal Land Acquisition Programs

Collaborating with land trusts which are eligible to apply for many of these grants, are effective strategies Bluffton can take to leverage existing funding opportunities.

State Grant Programs:

1. [Beaufort County Green Space Program](#)
 - Supports land conservation and preservation in Beaufort County.
 - Continue submitting applications to this program, especially for corridor preservation along the May River.
2. [South Carolina Conservation Bank \(SCCB\)](#)
 - Provides grants for the voluntary conservation of natural resources, working lands, and historic sites.
3. [South Carolina Office of Resilience \(SCOR\) Buyout Program](#)
 - Focuses on relocating residents from flood-prone areas and restoring the natural function of floodplains.
4. [South Carolina Resilience Revolving Fund](#)
 - Assists local governments and homeowners with acquiring and restoring flood-prone properties.
5. [South Carolina Lowcountry Sentinel Landscape](#)
 - Supports conservation in ecologically significant areas to sustain military readiness while protecting natural resources.

Federal Grant Programs:

1. [Section 319 Nonpoint Source \(NPS\) Program](#)
 - Improves water quality by addressing nonpoint source pollution, including from septic systems.
2. [Coastal Wetlands Conservation Grant Program](#)
 - Funds acquisition, restoration, and management of coastal wetlands ecosystems.

3. [North American Wetlands Conservation Act \(NAWCA\) Program](#)
 - Supports conservation of wetlands and migratory bird habitats across North America.
4. [Land and Water Conservation Fund \(LWCF\) Program](#)
 - Provides funding for the acquisition of land for parks, outdoor recreation, and public access.
5. [Flood Mitigation Assistance \(FMA\) Program](#)
 - Funds flood mitigation projects, including voluntary property acquisitions, to reduce long-term flood damage.

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APPENDICES

Appendix A: Current Development Flood Vulnerability Result

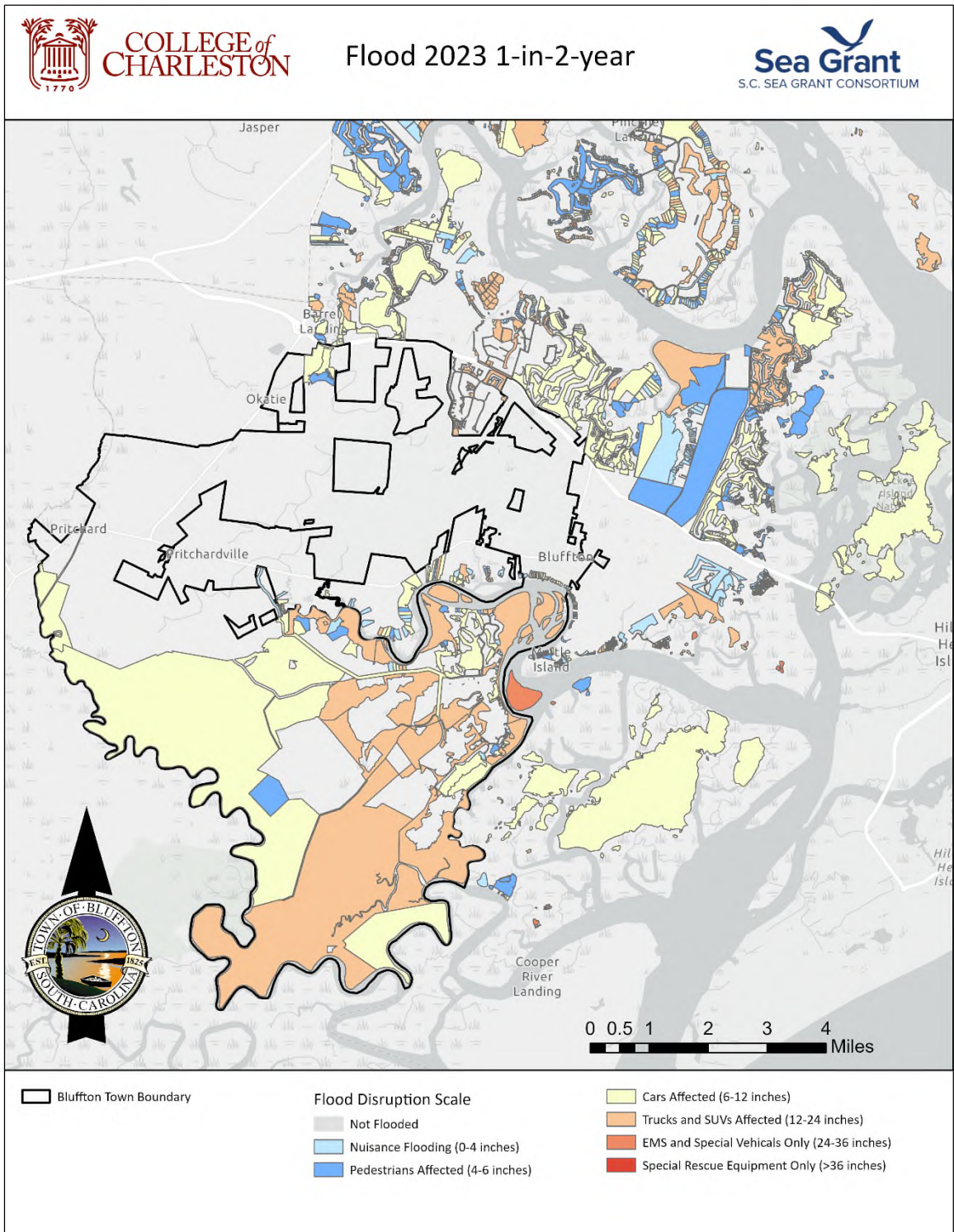


Figure 19: Current development parcel vulnerability to the 1-in-2-yr storm in 2023 conditions

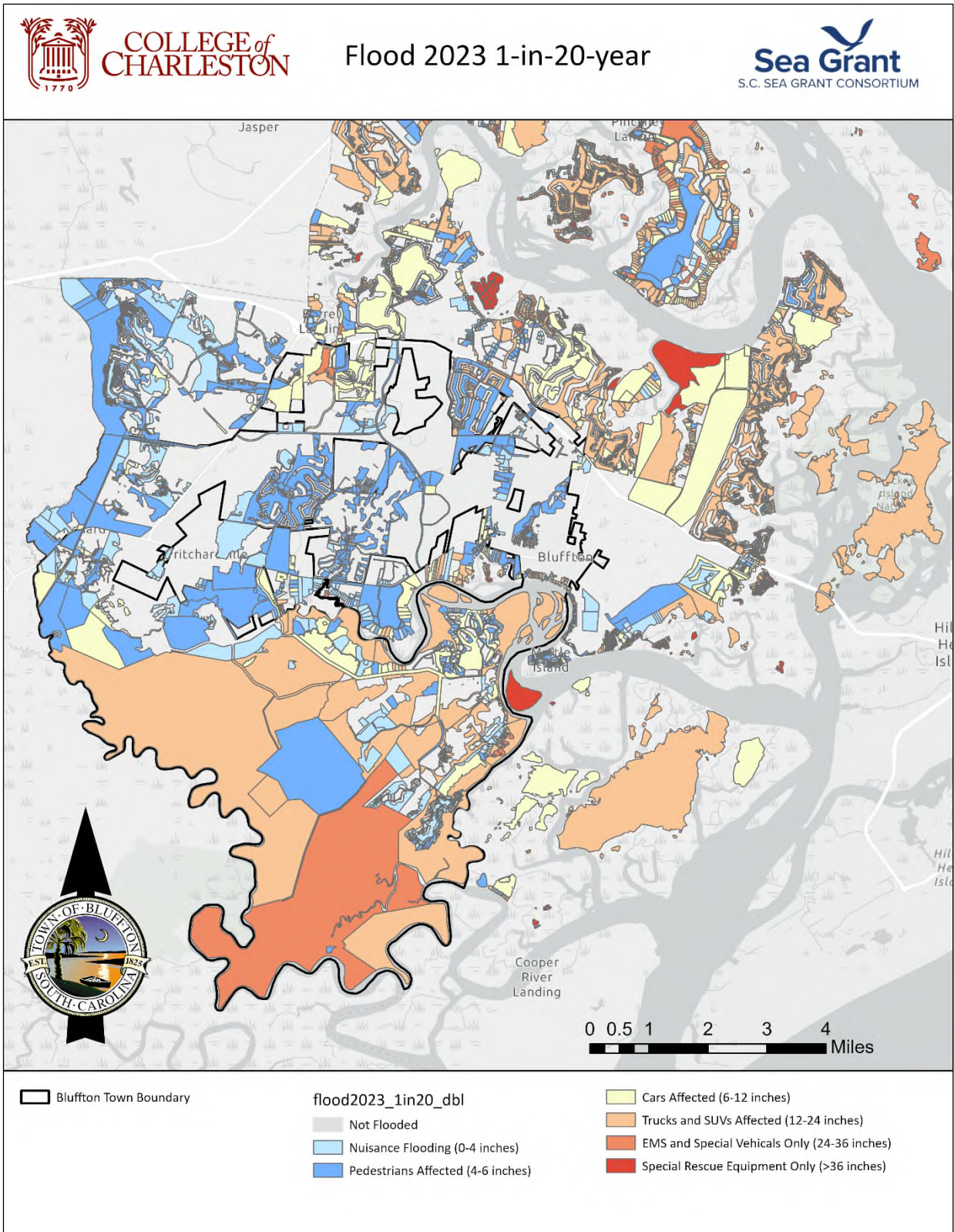


Figure 20: Current development parcel vulnerability to the 1-in-20-yr storm in 2023 conditions

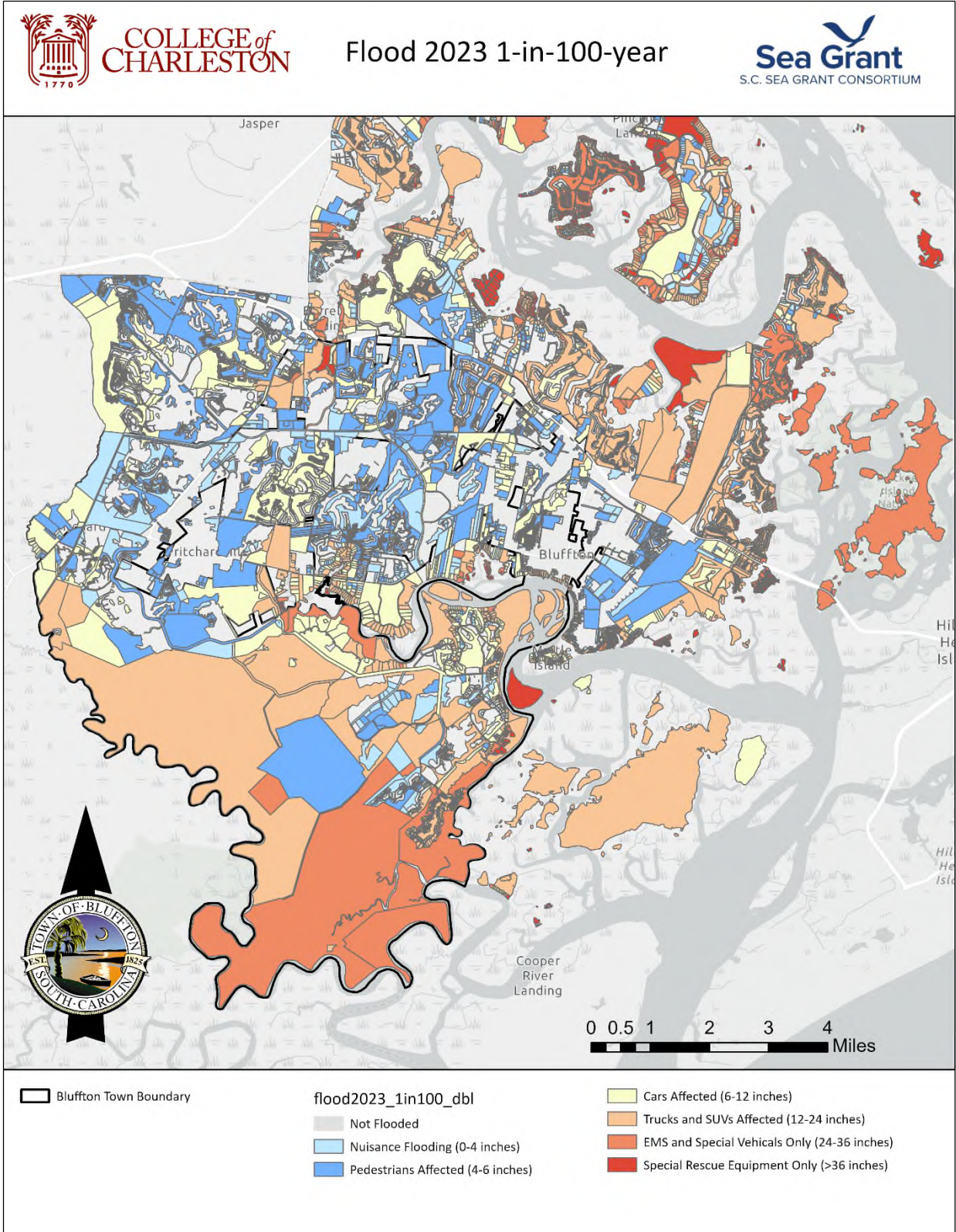


Figure 21: Current development parcel vulnerability to the 1-in-100-yr storm in 2023 conditions



Flood 2023 1-in-500-year

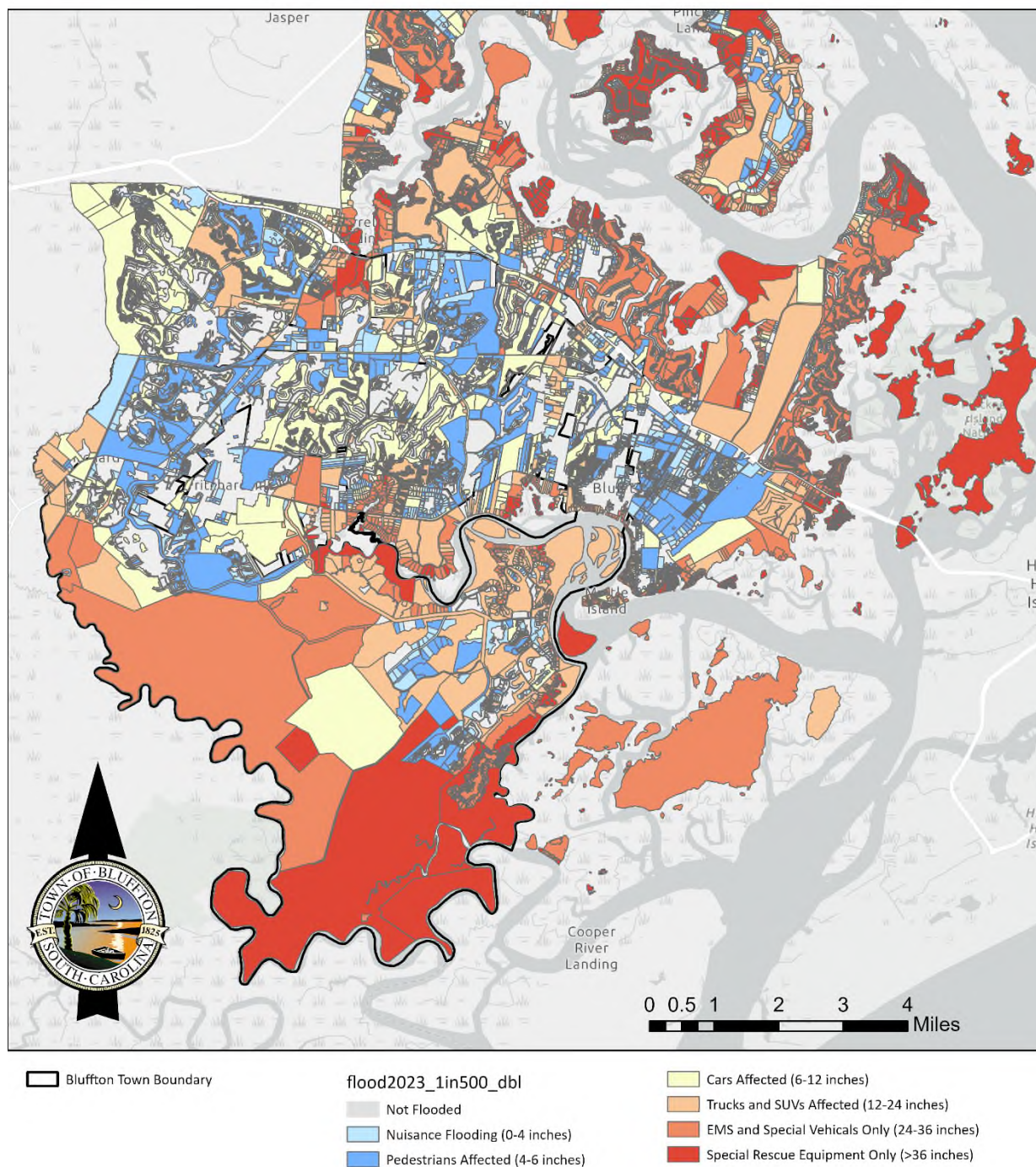


Figure 22: Current development parcel vulnerability to the 1-in-500-yr storm in 2023 conditions



Flood 2053 1-in-2-year

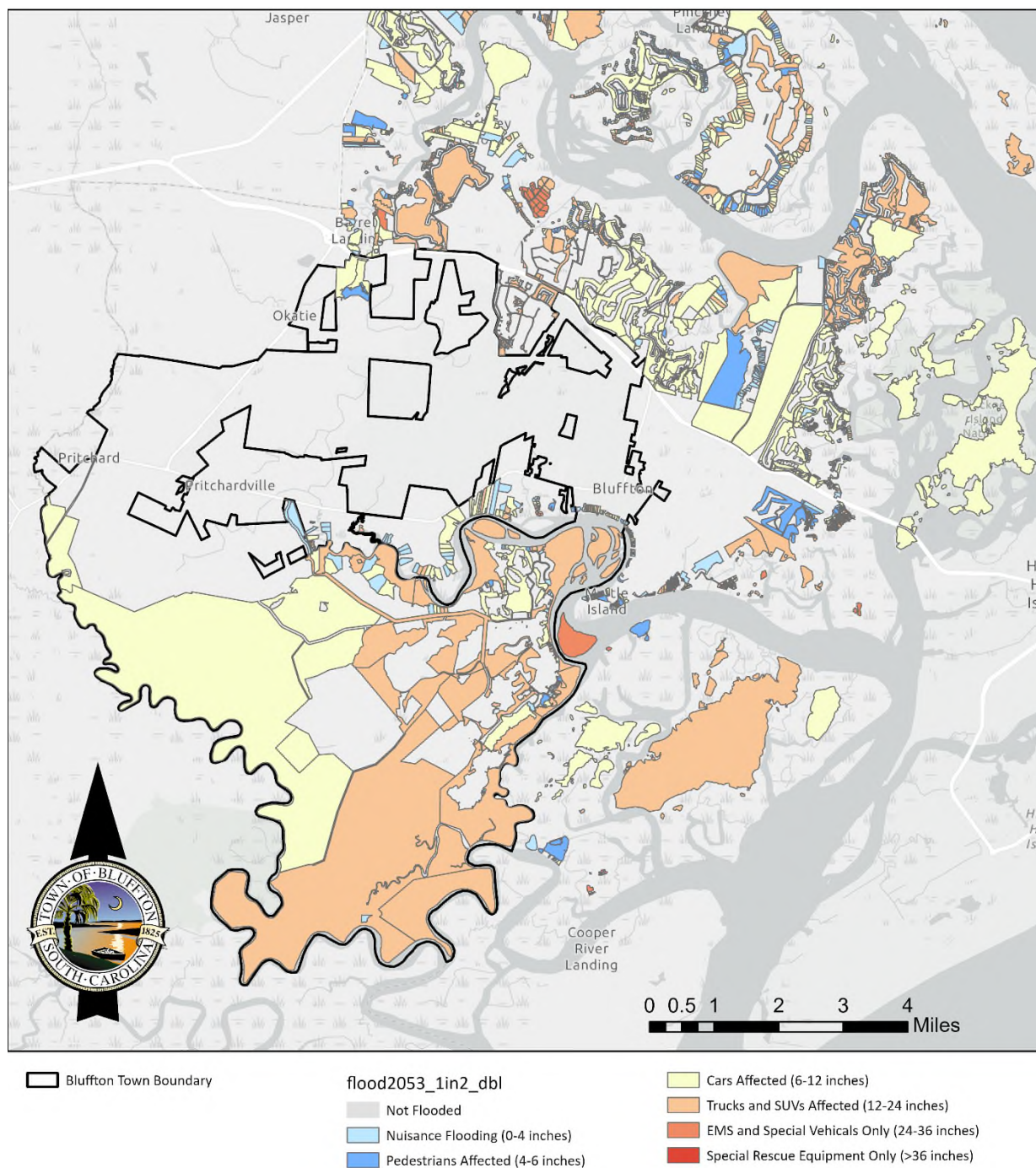


Figure 23: Current development parcel vulnerability to the 1-in-2-yr storm in 2053 conditions



Flood 2053 1-in-20-year

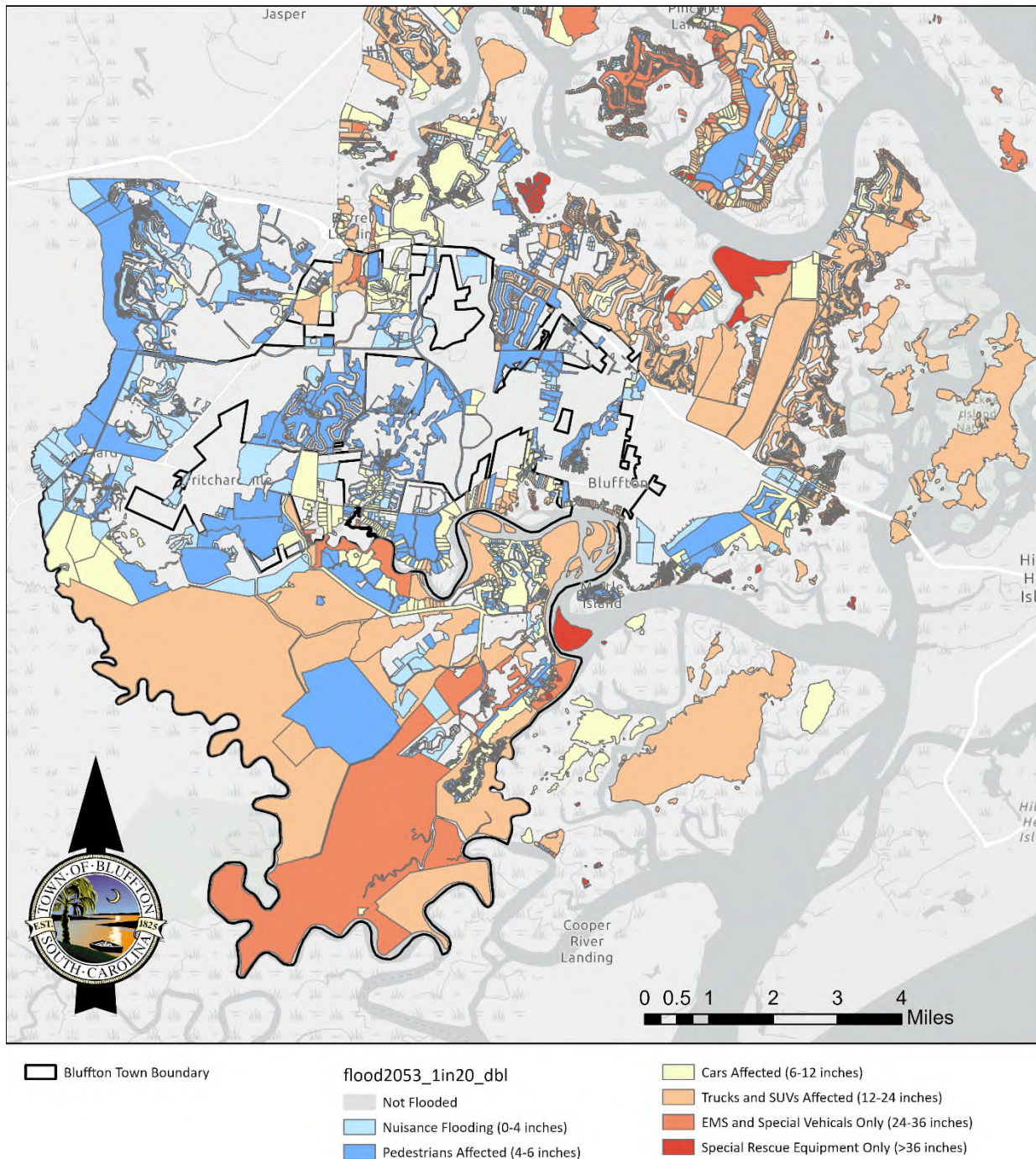


Figure 24: Current development parcel vulnerability to the 1-in-20-yr storm in 2053 conditions

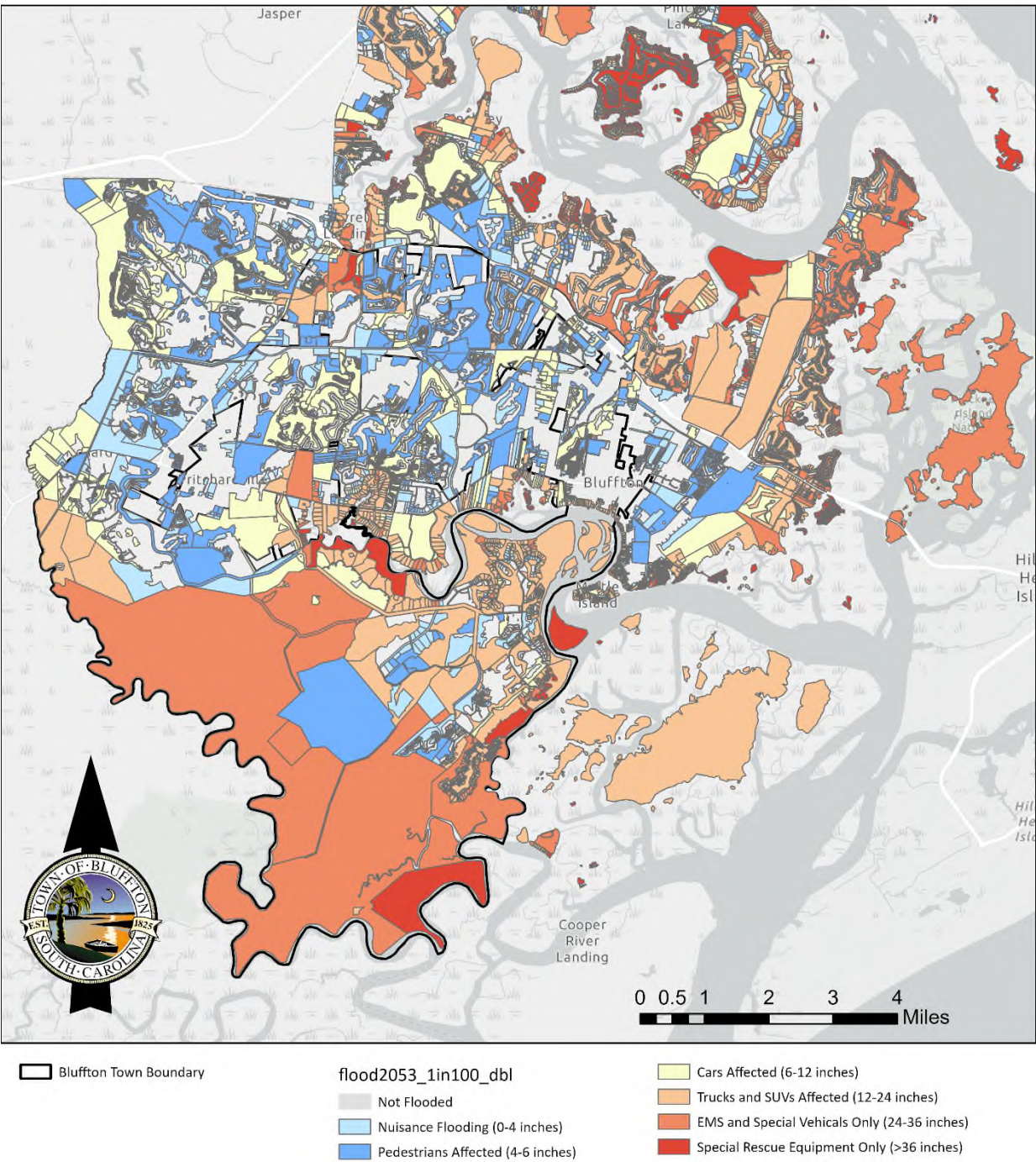


Figure 25: Current development parcel vulnerability to the 1-in-100-yr storm in 2053 conditions



Flood 2053 1-in-500-year

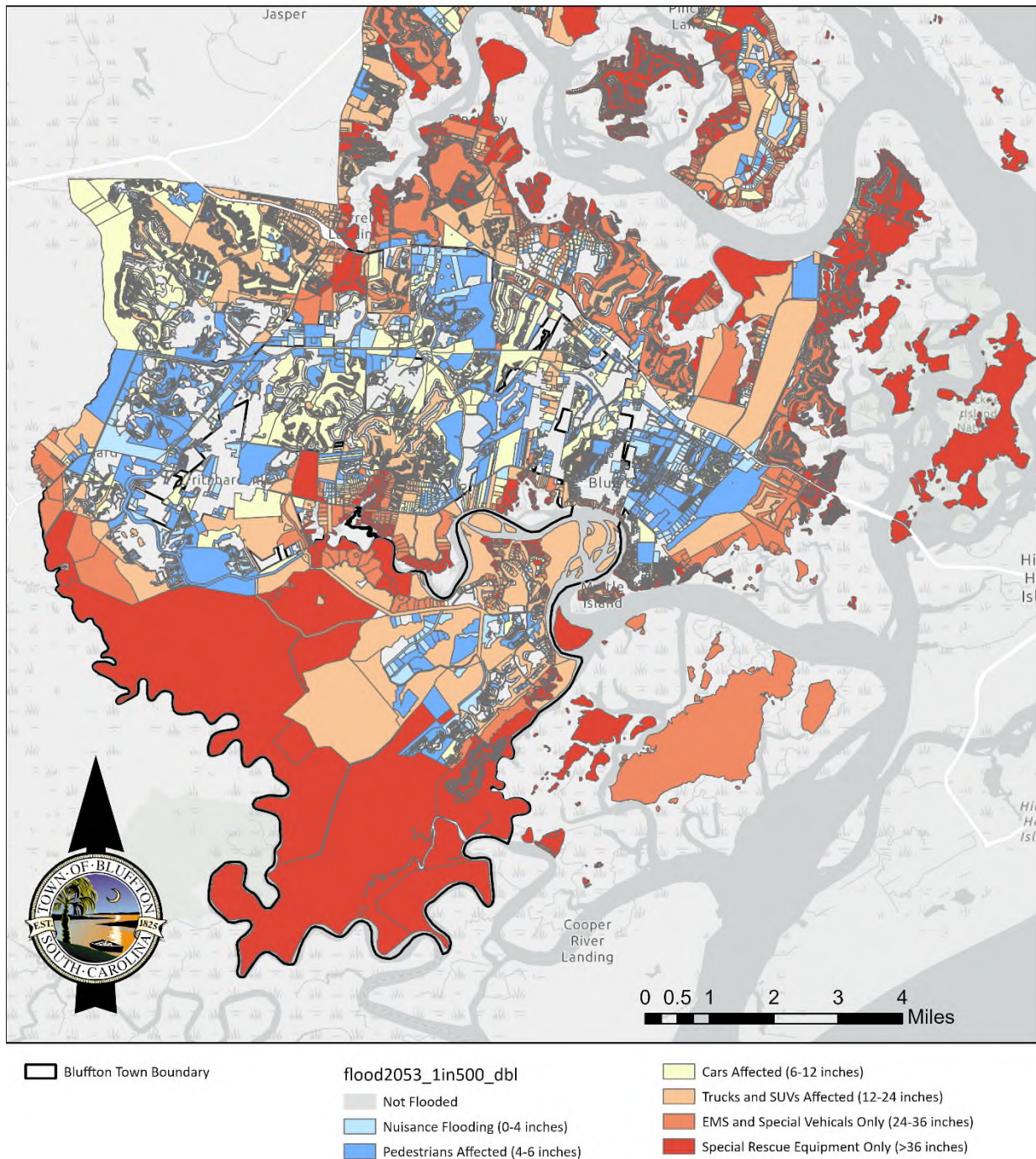


Figure 26: Current development parcel vulnerability to the 1-in-500-yr storm in 2053 conditions

Appendix B: Maximum Buildout Flood Vulnerability Results

This appendix contains results of the maximum buildout flood vulnerability analysis for each Planned Unit Development (PUD) considered within this study. Results are displayed as number of buildout parcels which are touched by flood waters in each of the model scenarios for each study year (2023, 2053).

Please note: the vertical scale bar displaying number of parcels has a different range for each chart, with Schultz Tract and Village at Verdier in hundreds of parcels versus thousands for the other PUDs in this study.

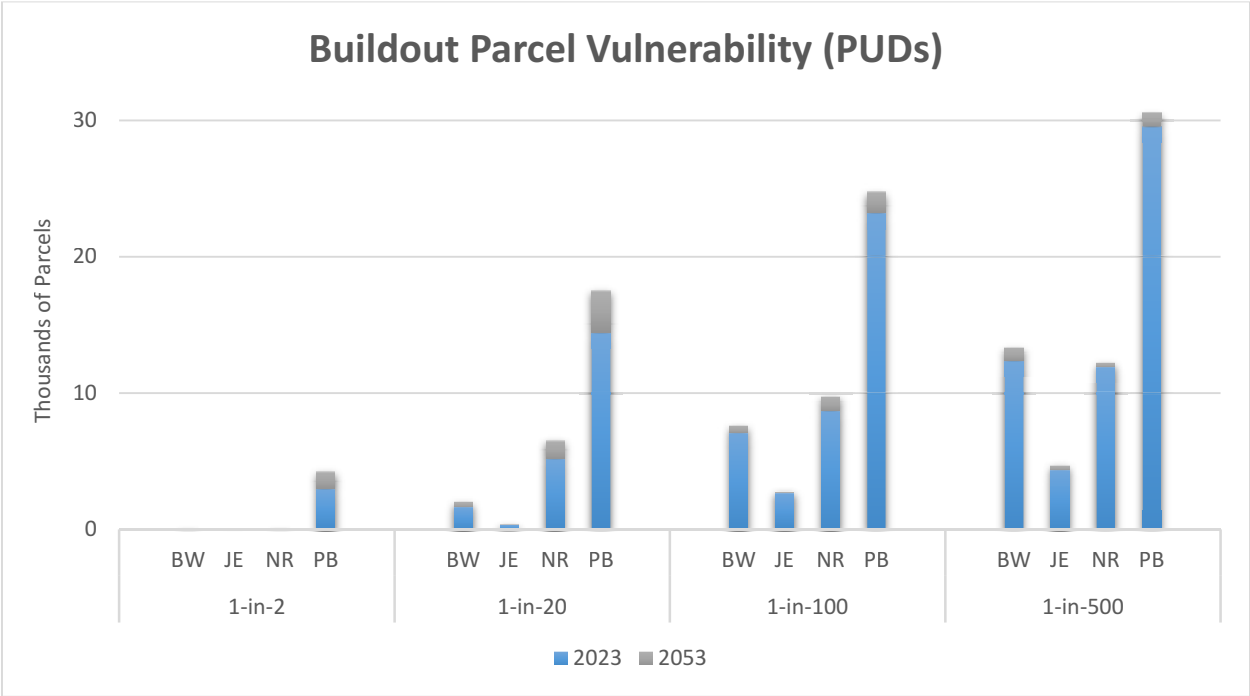


Figure 27: Vulnerable buildout parcels (thousands) for each flood scenario with year 2053 flood conditions shown in addition to year 2023 flood conditions (larger PUDs shown). BW = Buckwalter, JE = Jones Estate, NR = New Riverside, PB = Palmetto Bluff

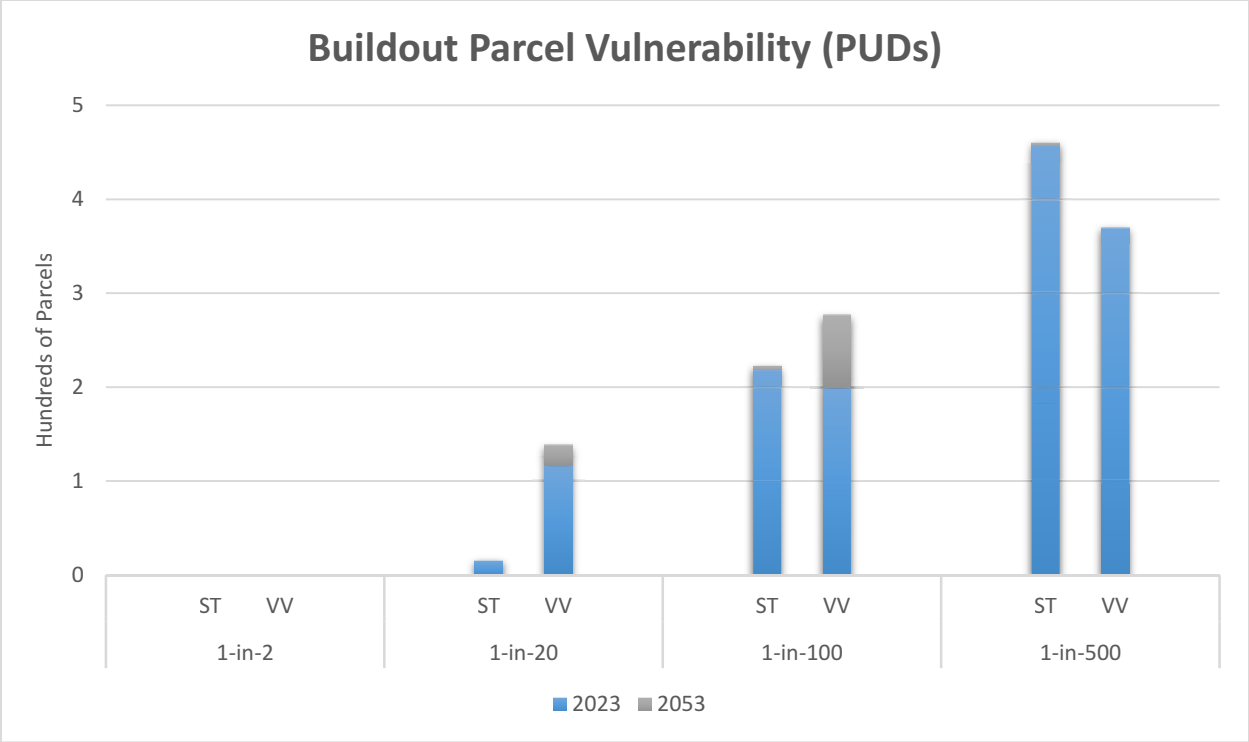


Figure 28: Vulnerable buildout parcels (hundreds) for each flood scenario with year 2053 flood conditions shown in addition to year 2023 flood conditions (smaller PUDs shown). ST = Schultz Tract, VV = Village at Verdier

Appendix C: Forested Wetlands Analysis Results

This appendix contains results of the forested wetlands analysis for each Planned Unit Development (PUD) considered within this study. Results are displayed as number of buildout parcels which are touched by flood waters in each of the model scenarios for each study year (2023, 2053).

Please note: the vertical scale bar displaying number of parcels has a different range for each PUD so that the full range of data can be best visualized for each figure. A major point of difference is that the vertical scales for Schultz Tract and Village at Verdier are in hundreds of parcels versus thousands for the other PUDs in this study.

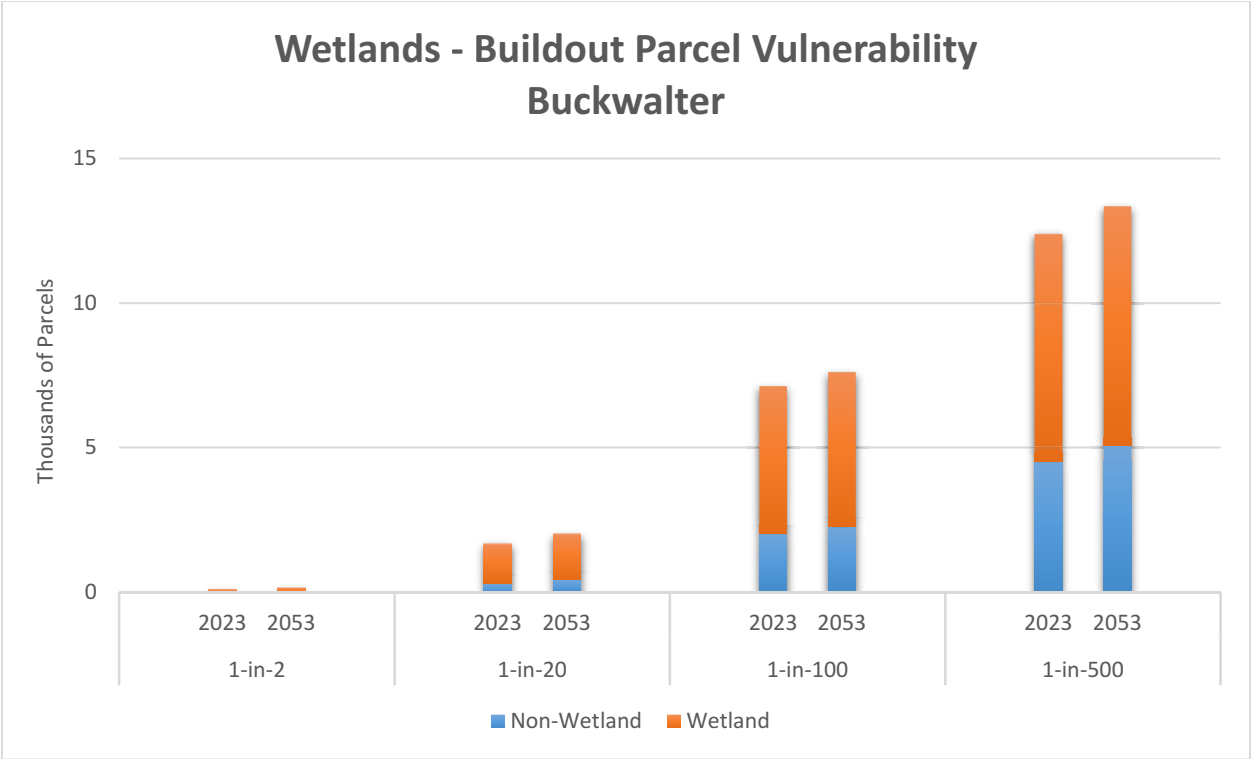


Figure 29: Vulnerable Buckwalter buildout parcels (thousands) for each flood scenario and each study year with parcels within freshwater wetlands (orange) shown in addition to those outside of those wetlands (blue)

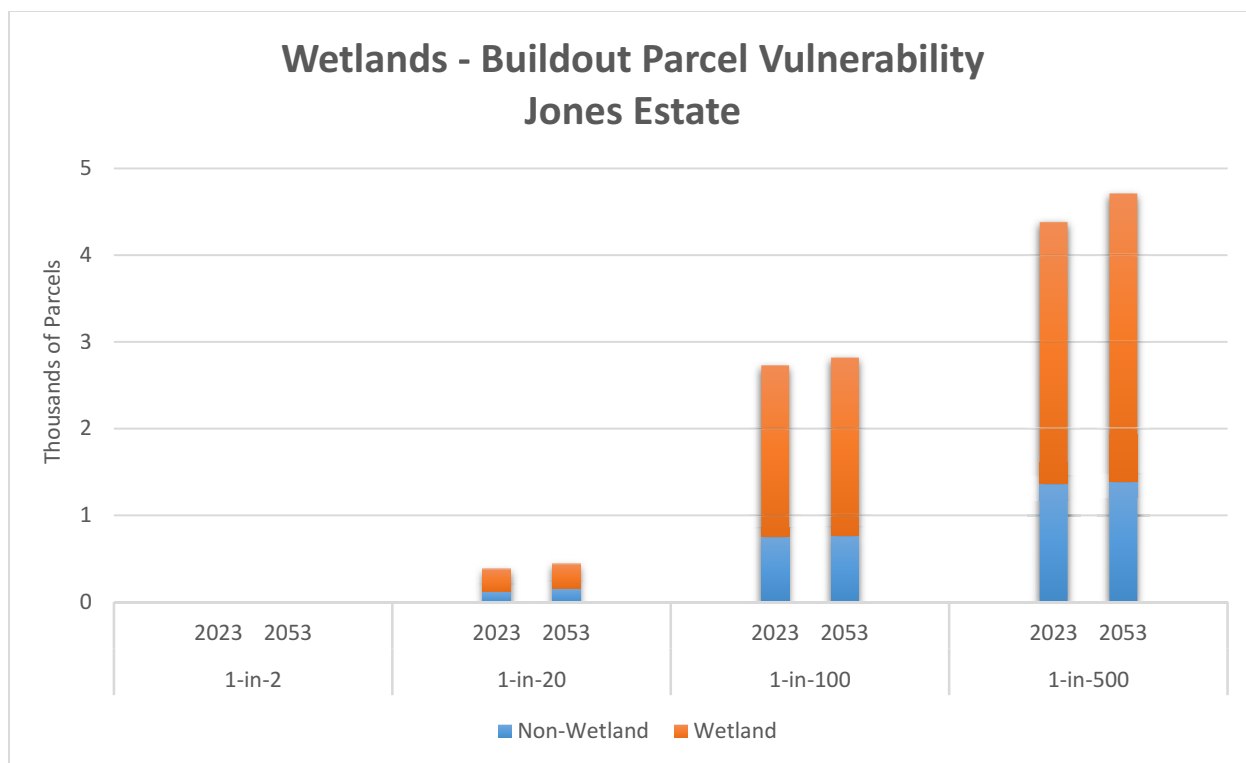


Figure 30: Vulnerable Jones Estate buildout parcels (thousands) for each flood scenario and each study year with parcels within freshwater wetlands (orange) shown in addition to those outside of those wetlands (blue)

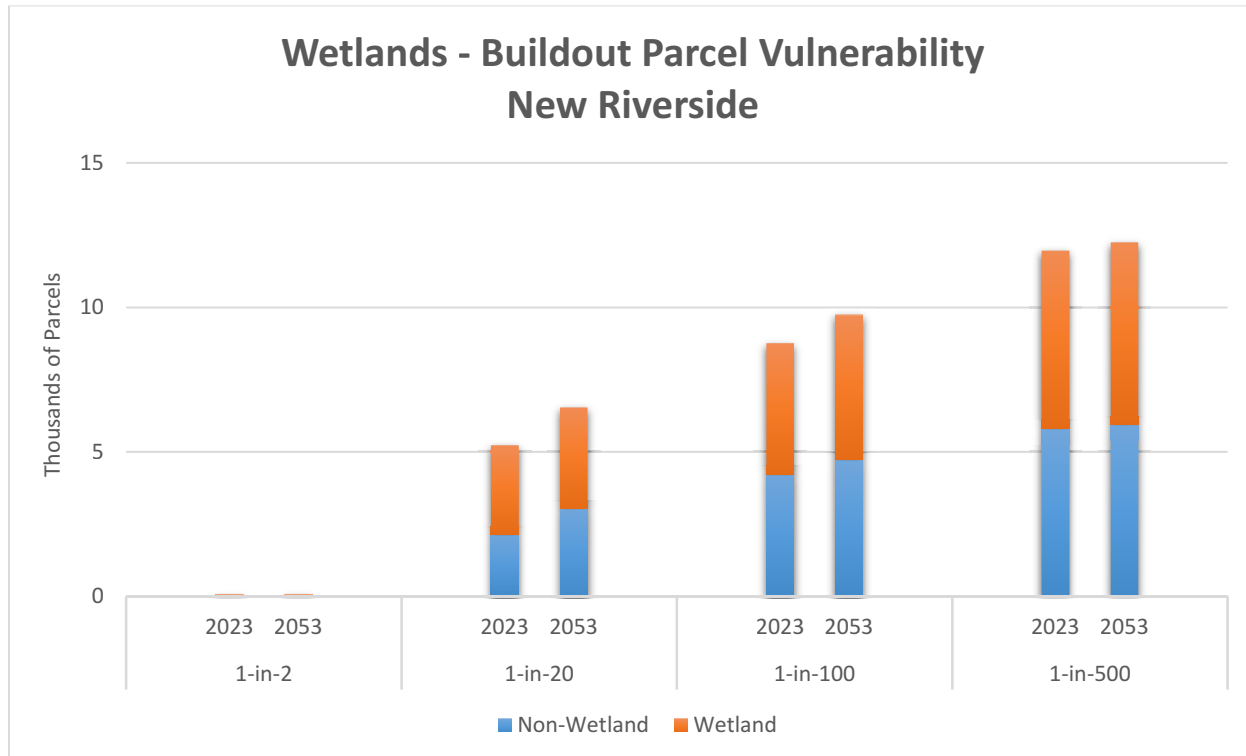


Figure 31: Vulnerable New Riverside buildout parcels (thousands) for each flood scenario and each study year with parcels within freshwater wetlands (orange) shown in addition to those outside of those wetlands (blue)

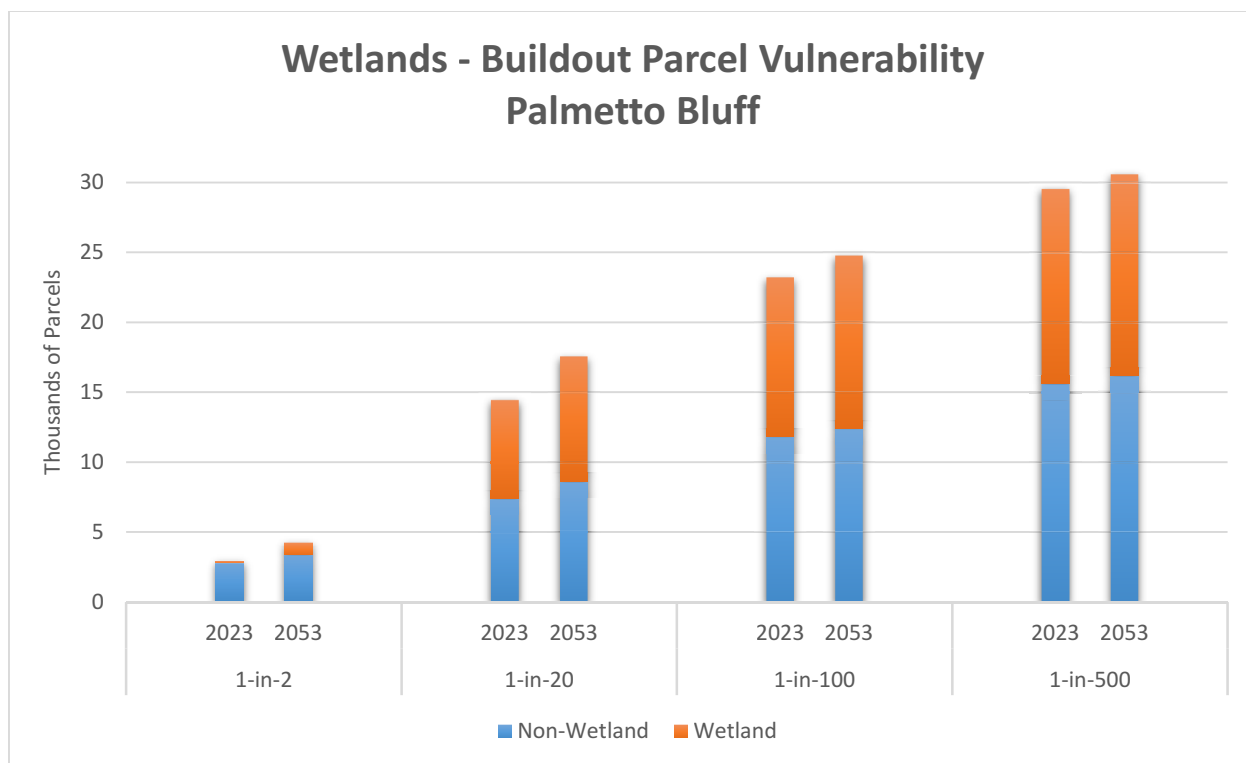


Figure 32: Vulnerable Palmetto Bluff buildout parcels (thousands) for each flood scenario and each study year with parcels within freshwater wetlands (orange) shown in addition to those outside of those wetlands (blue)

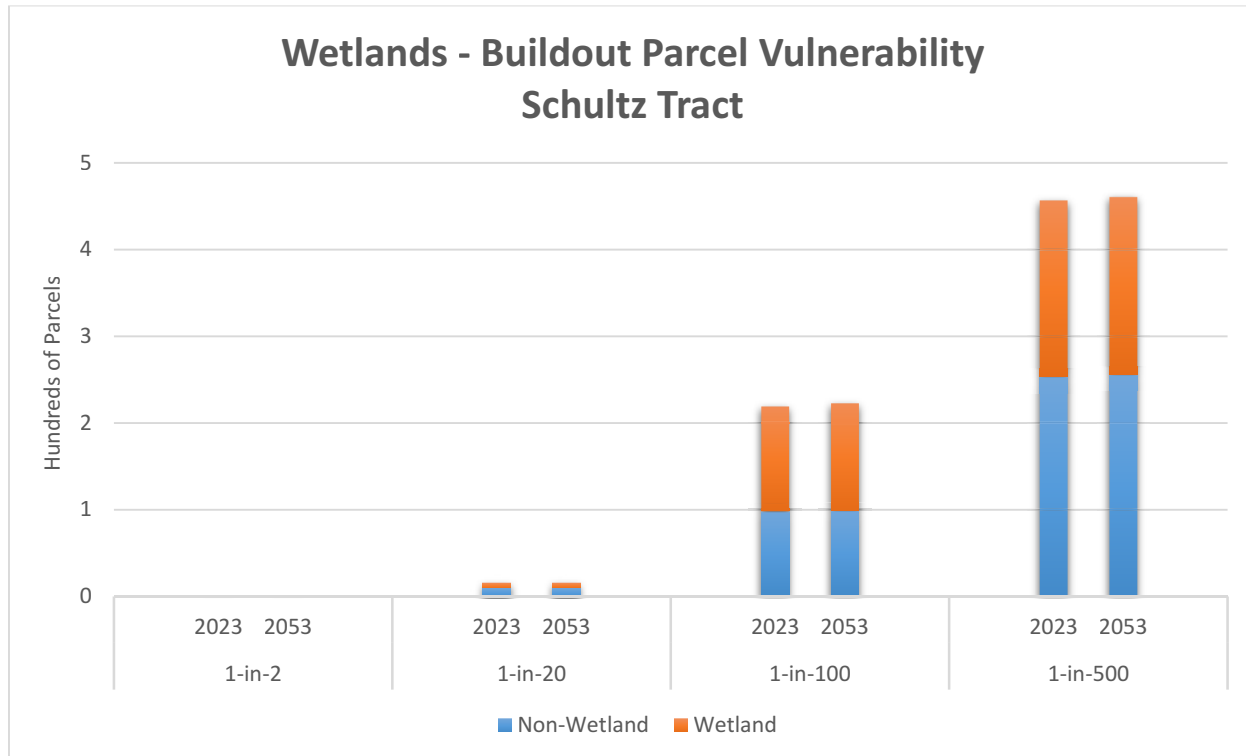


Figure 33: Vulnerable Schultz Tract buildout parcels (hundreds) for each flood scenario and each study year with parcels within freshwater wetlands (orange) shown in addition to those outside of those wetlands (blue)

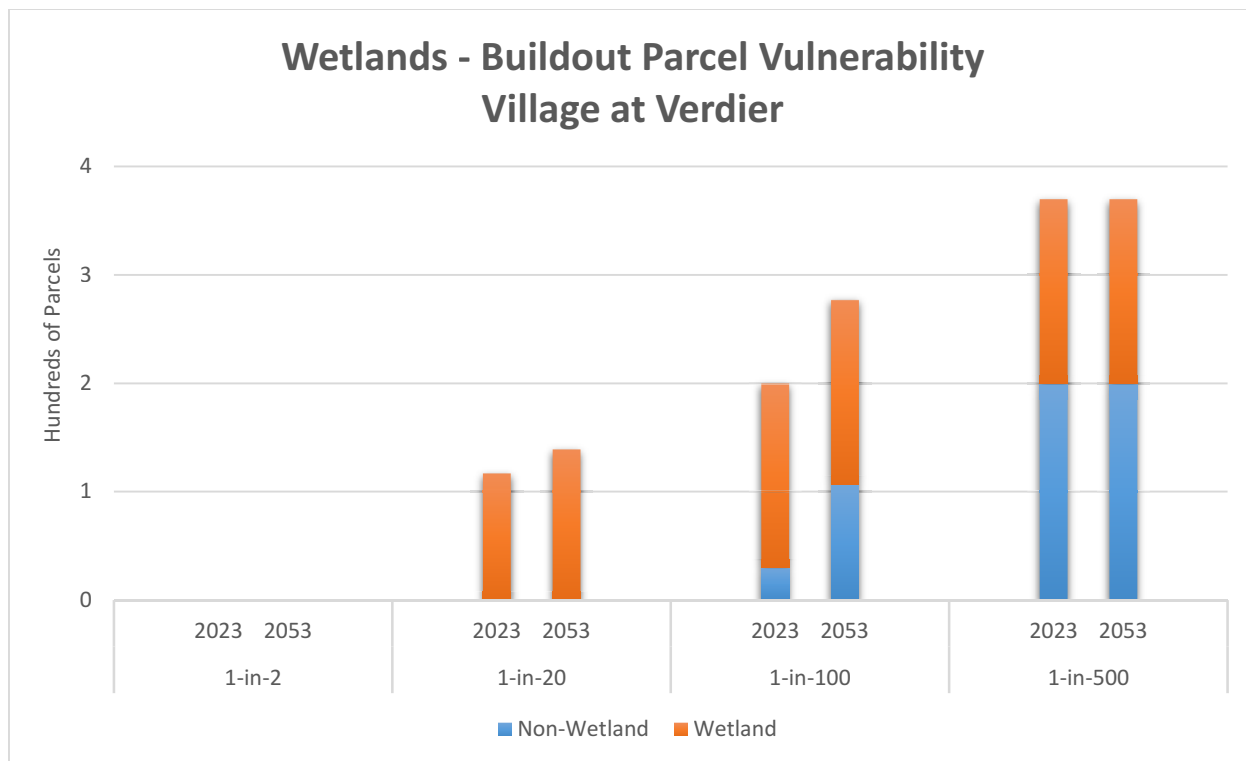


Figure 34: Vulnerable Village at Verdier buildout parcels (hundreds) for each flood scenario and each study year with parcels within freshwater wetlands (orange) shown in addition to those outside of those wetlands (blue)

Appendix D: Elevation Analysis Results

This appendix contains the results of the elevation analysis for each Planned Unit Development (PUD) considered within this study. Results are displayed as number of buildout parcels which are touched by flood waters in each of the model scenarios for each study year (2023, 2053).

Please note: the vertical scale bar displaying number of parcels has a different range for each PUD so that the full range of data can be best visualized for each figure. A major point of difference is that the vertical scales for Schultz Tract and Village at Verdier are in hundreds of parcels versus thousands for the other PUDs in this study.

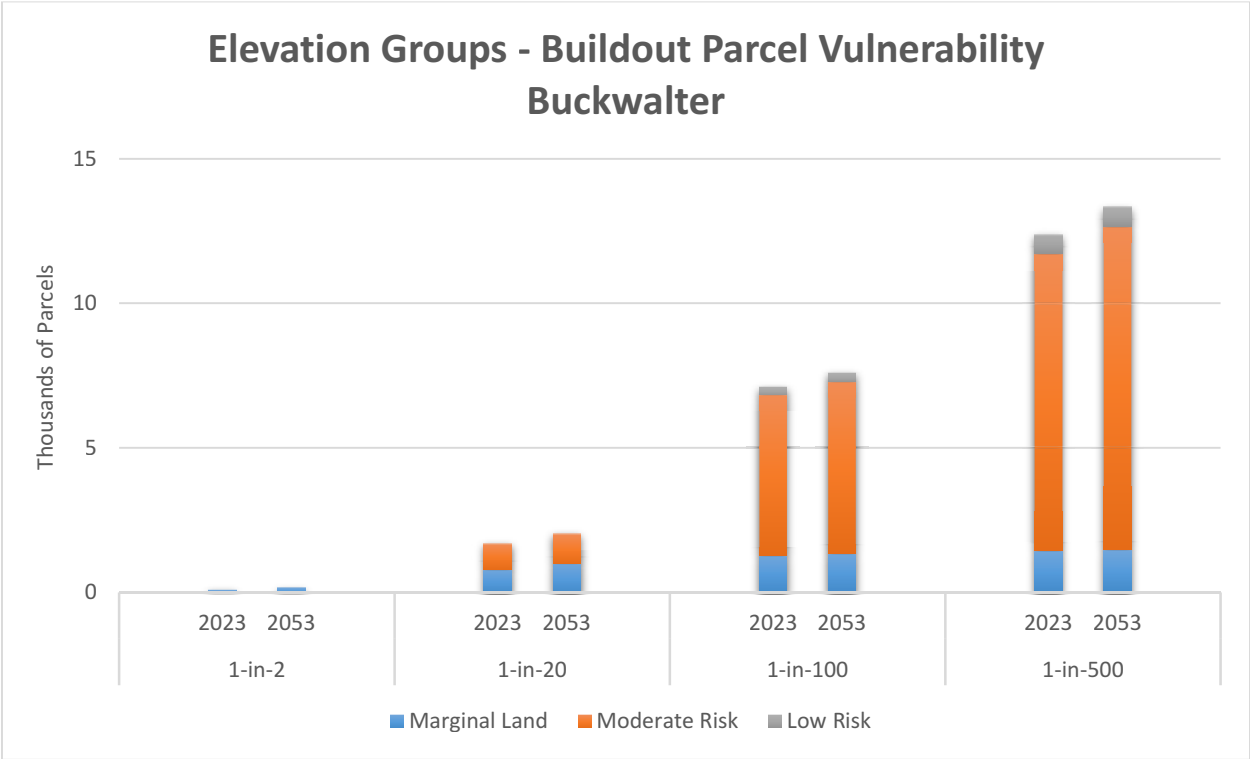


Figure 35: Vulnerable Buckwalter buildout parcels (thousands) for each flood scenario and each study year with parcels from each elevation group that are touched by that flood condition shown

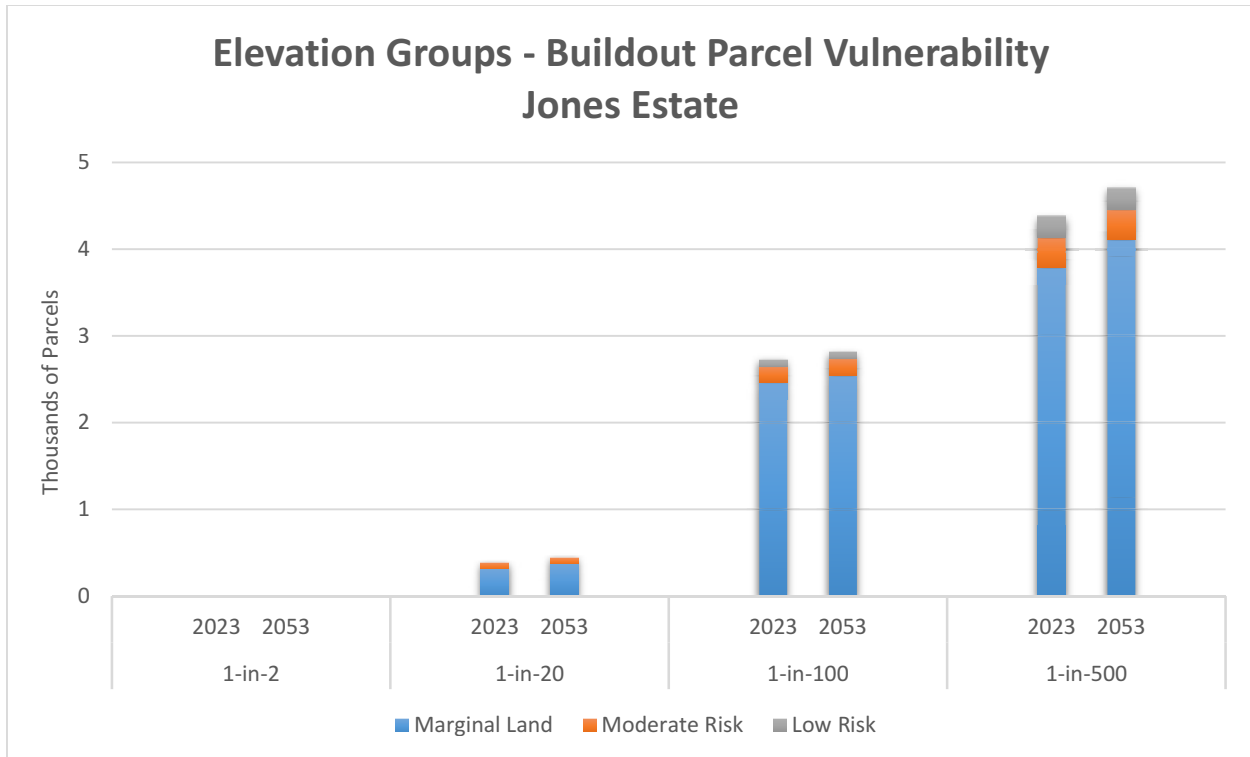


Figure 36: Vulnerable Jones Estate buildout parcels (thousands) for each flood scenario and each study year with parcels from each elevation group that are touched by that flood condition shown

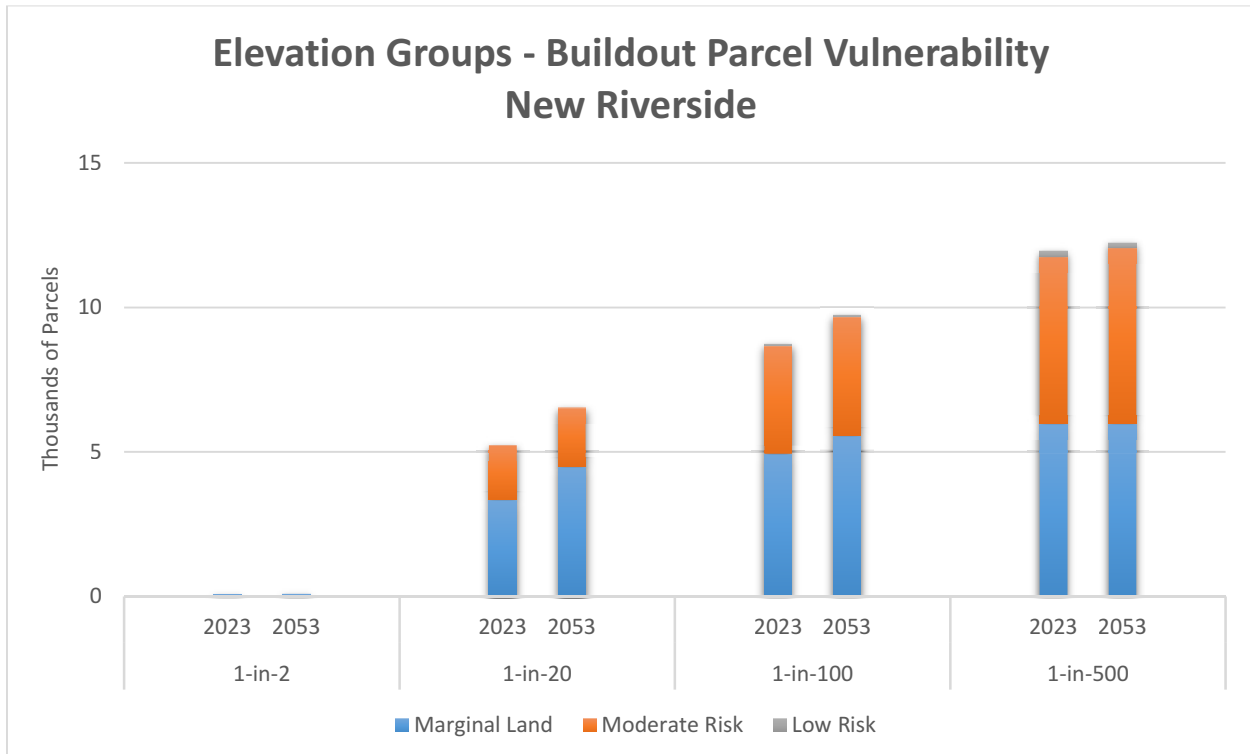


Figure 37: Vulnerable New Riverside buildout parcels (thousands) for each flood scenario and each study year with parcels from each elevation group that are touched by that flood condition shown

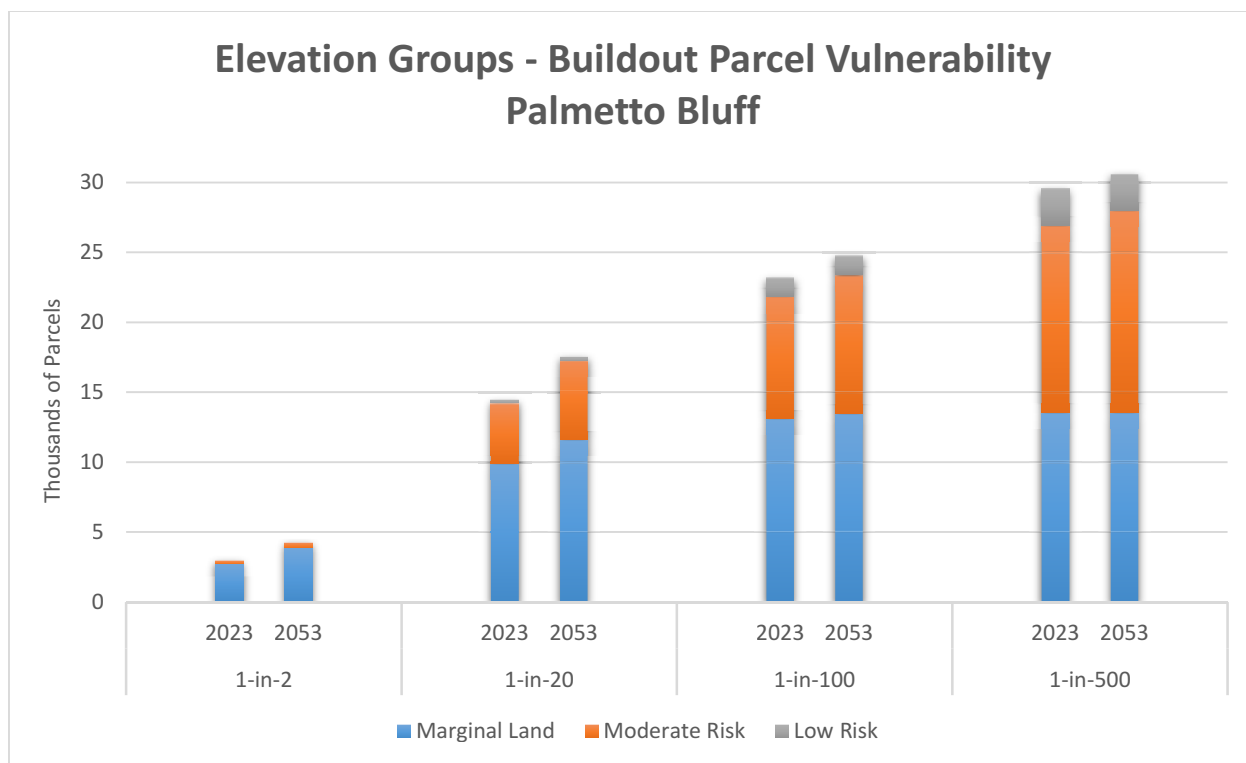


Figure 38: Vulnerable Palmetto Bluff buildout parcels (thousands) for each flood scenario and each study year with parcels from each elevation group that are touched by that flood condition shown

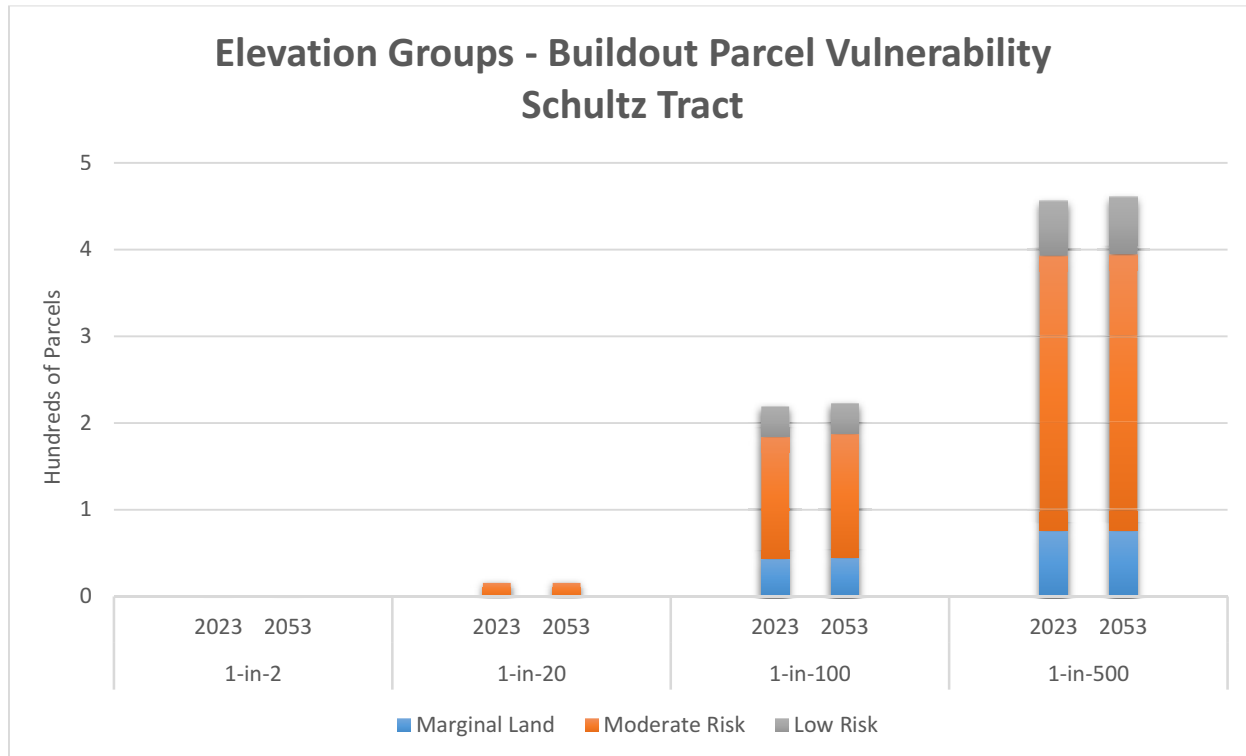


Figure 39: Vulnerable Schultz Tract buildout parcels (hundreds) for each flood scenario and each study year with parcels from each elevation group that are touched by that flood condition shown

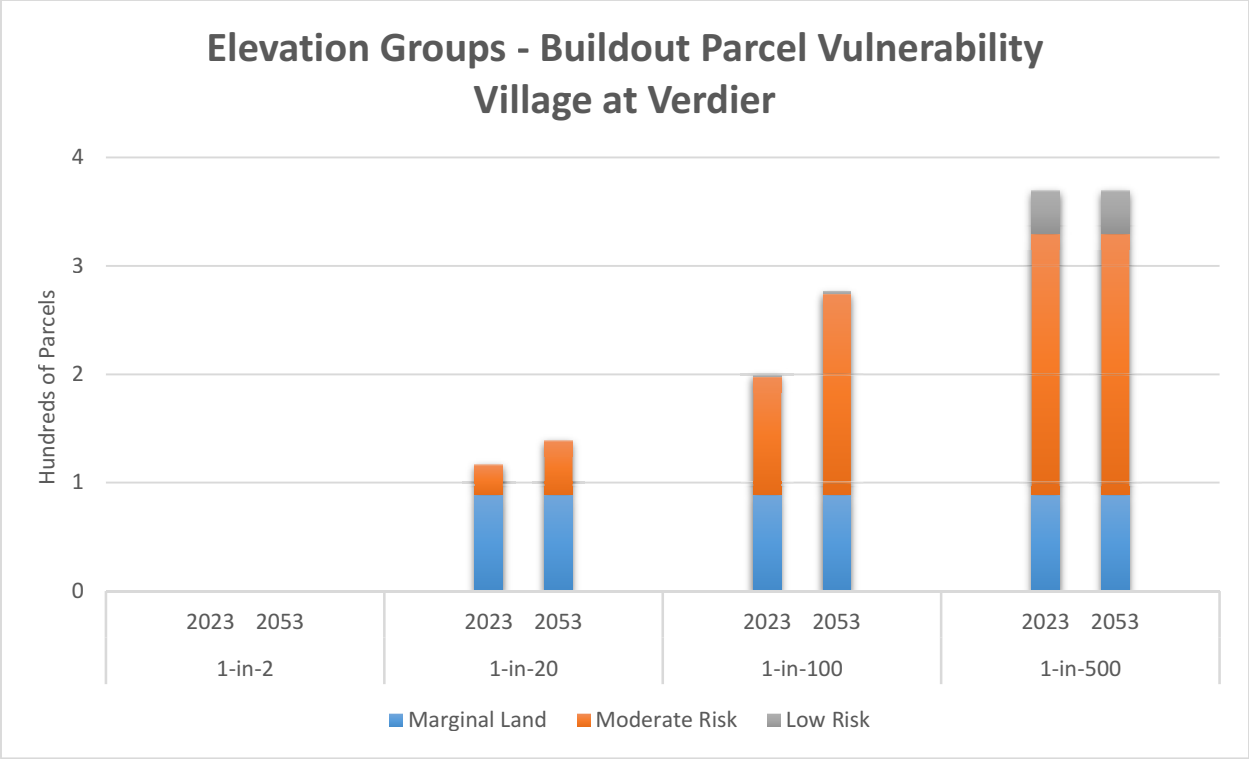


Figure 40: Vulnerable Village at Verdier buildout parcels (hundreds) for each flood scenario and each study year with parcels from each elevation group that are touched by that flood condition shown

Appendix E: Mapping and Modeling Methods

Vulnerability Mapping

Digital Elevation Models (DEMs) and Digital Surface Models (DSMs) were created for the full study area (see Appendix F). The DEM represents the most accurate and up to date geomorphological representation of Bluffton and surrounding HUC-12 boundaries. A contextual analysis was additionally performed using NLCD (National Land Cover Database) data from 2001 and 2024 to analyze changing development conditions.

The flooding data selected for this analysis was the First Street Foundation flood dataset obtained via use agreement from the South Carolina Office of Resilience (SCOR). Provided by this state agency, the dataset is regarded as an authoritative model for flood risks in the region, having been used for the state's Strategic Statewide Resilience and Risk Reduction Plan. Its credibility as a vetted source helps to minimize potential disputes related to flood mapping. To determine the mean flood depth per parcel to understand what areas of Bluffton had the most susceptibility to inundation, zonal statistics were applied to SCOR First Street flood data. This data includes scenarios for 1-in-2-, 1-in-20-, 1-in-100-, and 1-in-500-year flooding for the years of 2023 and 2053, resulting in comparison of current and future conditions.

Current Development Flood Vulnerability

Parcel-based flood depth analysis for Bluffton highlights areas most susceptible to flooding, both now and under future projections. Using zonal statistics with flood data and Bluffton parcel data, mean flood depths per parcel were calculated across flood scenarios of 1-in-2-, 1-in-20-, 1-in-100-, and 1-in-500-year flooding for 2023 and 2053. Flood depths were categorized based on the College of Charleston's Flood Disruption Scale, which describes flood disruption based on impacts to access the parcel. The lowest flooding hazard (0–4 inches of flood depth) represents nuisance flooding while the most extreme flooding (over 36 inches) indicates potentially life-threatening conditions that could necessitate emergency rescue. This classification offers a real-world understanding of the severity of projected flood depths, emphasizing that future conditions may require significant adaptation and planning to manage both everyday flooding and more extreme events. Tabular analyses were generated summarizing the extent of flooding across various land use categories obtained from Bluffton's GIS data. This dataset provides insights into Bluffton's current flood exposure and its expected increase under future climate conditions.

Maximum Buildout Flood Vulnerability

A buildout analysis was conducted to analyze the potential future flood vulnerability of Bluffton. The purpose of the buildout analysis was to simulate the subdivision of all developable parcels into their maximum development density in order to run future flood vulnerability models as well as if/then scenarios. Since it is impossible to forecast the exact location of future development, the analysis was run for all developable parcels regardless of the cap on maximum dwelling units. Maximum dwelling units refer to the highest number of individual residential units allowed to be built on a specific piece of land, as defined by Bluffton's zoning regulations. All of the development agreements have had residential development occur since the agreement was executed, so the number of remaining dwelling units for each development area was obtained from Bluffton as of December 2024. The number of remaining dwelling units (homes that have yet to

be built but are authorized in the agreement) were utilized to determine whether certain policy conditions would still allow the necessary development to occur within each Planned Unit Development (PUD).

To obtain maximum buildout conditions, the active PUD agreements within Bluffton's jurisdiction were obtained from Bluffton staff as well as the municipality's website. Maximum allowed density for single family residential units was obtained from each PUD agreement, which designates the smallest home lot size and therefore the maximum number of homes that are allowable per acre (e.g. 1/4-acre lot size = 4 homes per acre). Parcels coded as R/W (right of way) were first removed from the parcel database. Parcels within zoning categories of PUD (Planned Unit Development), AG (Agricultural), and RG (Residential General) were isolated for analysis, as those zoning districts have established maximum density of development standards either through Development Agreements or the Unified Development Ordinance (UDO). Only parcels equal to or greater than five (5) acres were included in the buildout analysis, as that is the standard size used for these analyses representing likely areas for subdivision. Next, the following National Wetlands Inventory (NWI) categories were grouped to represent either SC Department of Environmental Services Critical Area or open water inland systems and therefore unlikely to be subdivided for development: Estuarine and Marine Deepwater, Estuarine and Marine Wetland, Freshwater Pond, Lake, Riverine. The Erase tool was used to remove any parcels or segments of parcels which overlapped those features.

The remaining parcels were then subdivided based on the maximum allowed density obtained from the zoning documents (e.g. 8 dwelling units per acre = 1/8-acre subdivided parcels) resulting in buildout parcels. The water layer from the 2021 NOAA Coastal Change Analysis Program (C-CAP) land cover data was then isolated and any buildout parcels still overlapping water features were removed. Next, the buildout parcels were intersected with road network data and any areas of overlap were removed. This resulted in the maximum buildout for each of the development areas of Bluffton with maximum allowed densities established. The maximum buildout performed here produced far more parcels than what will be realized within Bluffton's boundaries; however, it demonstrates the locations of potential development. Next, the average depth of flooding for each flood scenario for the years 2023 and 2053 was assigned to each buildout parcel using the zonal statistics tool. An additional analysis was conducted to determine buildout parcels with and without any level flooding.

To calculate potential damage if every parcel were developed, there first needed to be a home value assigned to each of the buildout parcels. This home value was assigned by downloading the U.S. Census Bureau 2021 American Community Survey (ACS) 5-year Block Group Dataset for the area and assigning the average home value for each Block Group to the buildout parcel contained within it. A Jupyter Notebook was then written to recreate depth-damage-curves from the USACE Economic Guidance Memorandum (EGM) 04-01, Generic Depth-Damage Relationships for Residential Structures with Basements. These curves assign a generalized percentage of damage which would result from different depths of flooding depending on the size and type of the home, which is based on actual losses from flood events. Since the development in this analysis is theoretical and it is unknown the size of these future buildings, the damage

functions for 1-story and 2 or more story structures without basements were averaged to result in a single depth-damage-curve for the study area. This methodology assumes half of the future structure will be 1-story structures and half will be 2 or more stories. It also assumes that all homes are slab on grade. A USACE Chief of Economics confirmed the validity of this application. Potential flood damage for each scenario was then calculated by multiplying the average flood depth by the depth-damage-curve for each buildout parcel.

Forested Wetlands Analysis

An analysis was conducted to determine the potential vulnerability reduction resulting from limiting future development within wetland areas that are no longer protected because of the *Sackett* decision. The buildout parcels from the Maximum Buildout Flood Vulnerability analysis were overlaid with the following NWI categories representing freshwater wetlands: Freshwater Emergent Wetland, Freshwater Forested/Shrub Wetlands (Figure 41). The total damages for each scenario were calculated for the buildout parcels overlaying those wetland features demonstrating the potential damages reduced by limiting future development in these areas.



Bluffton National Wetlands Inventory (NWI)

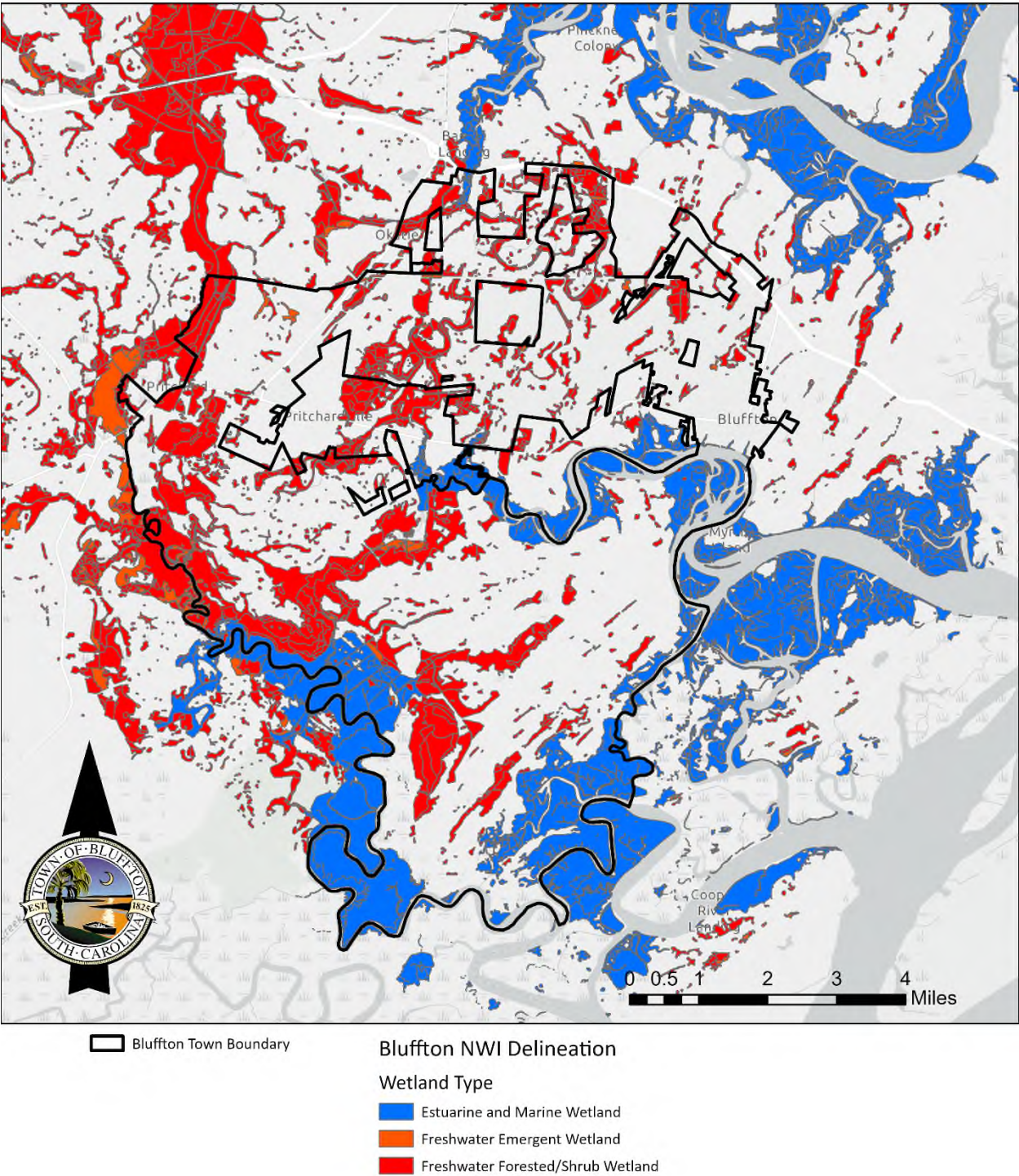


Figure 41: National Wetlands Inventory (NWI) categories within and surrounding the Town of Bluffton

Elevation Analysis

An additional analysis was conducted to determine the potential vulnerability reduction resulting from prioritizing development in upland zones within each development area. The average elevation was first calculated for each of the buildout parcels by using the zonal statistics tool on the DEM created in prior steps. Next, the mean and standard deviation of elevations within each development zone (e.g. individual PUDs, AG, or RG) were calculated with buildout parcels assigned to categories of low, moderate, or high elevation. Low elevation parcels were defined as those with an elevation of more than one standard deviation less than the mean, moderate elevation parcels had an elevation within one standard deviation +/- of the mean, and high elevation parcels had an elevation greater than one standard deviation higher than the mean. These zones were labeled Marginal Land for low elevation, Moderate Risk for moderate elevation, and Low Risk for high elevation (Figures 42 and 43). The total damages for each scenario were then calculated for the buildout parcels in each elevation category within each development zone.



Elevation Zones

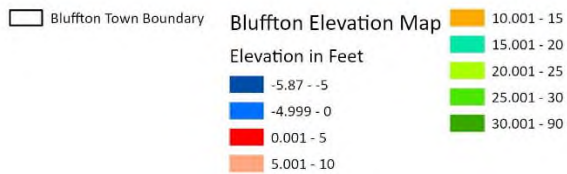
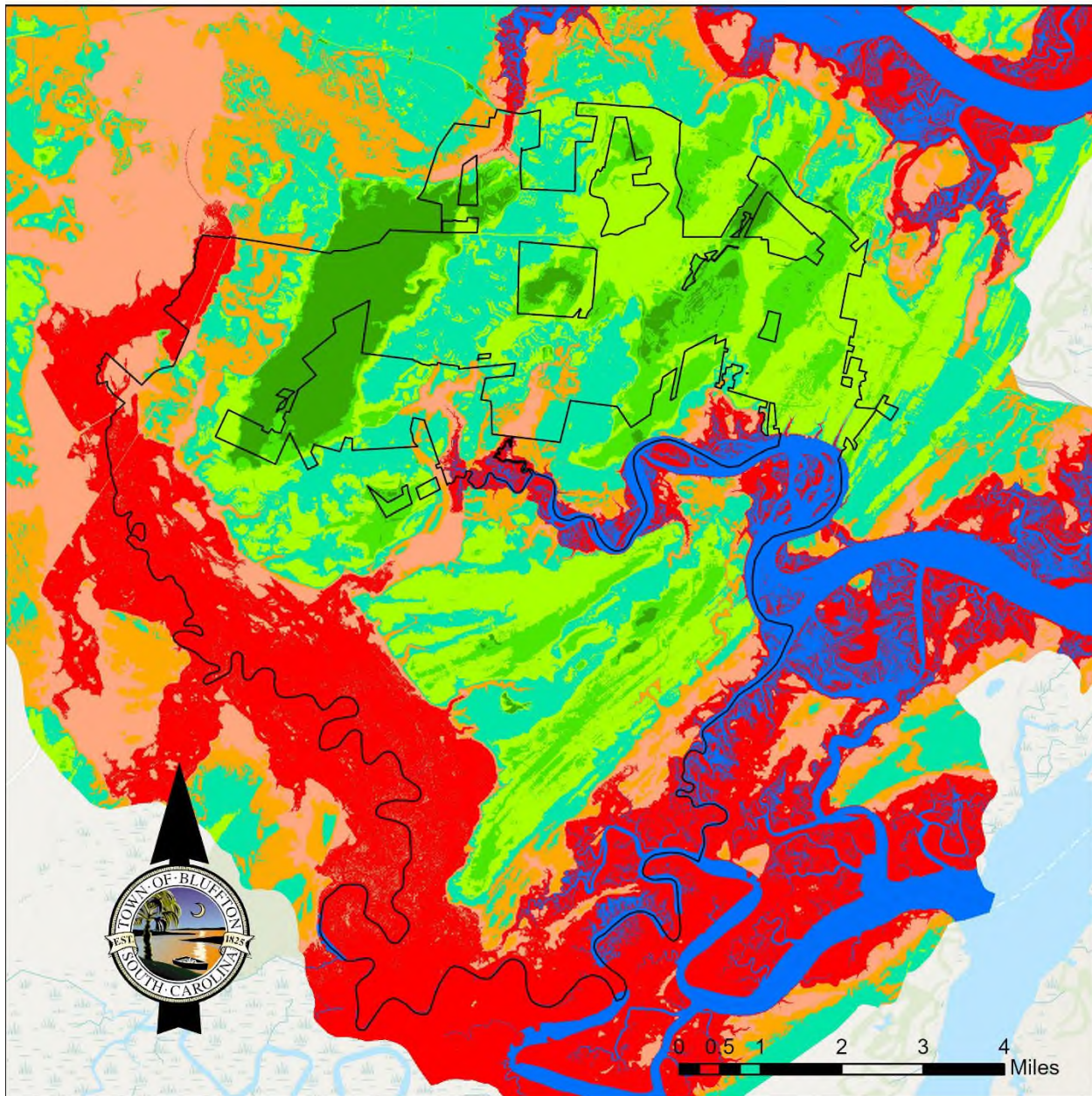


Figure 42: Elevations within and surrounding Bluffton



Bluffton Elevation Group

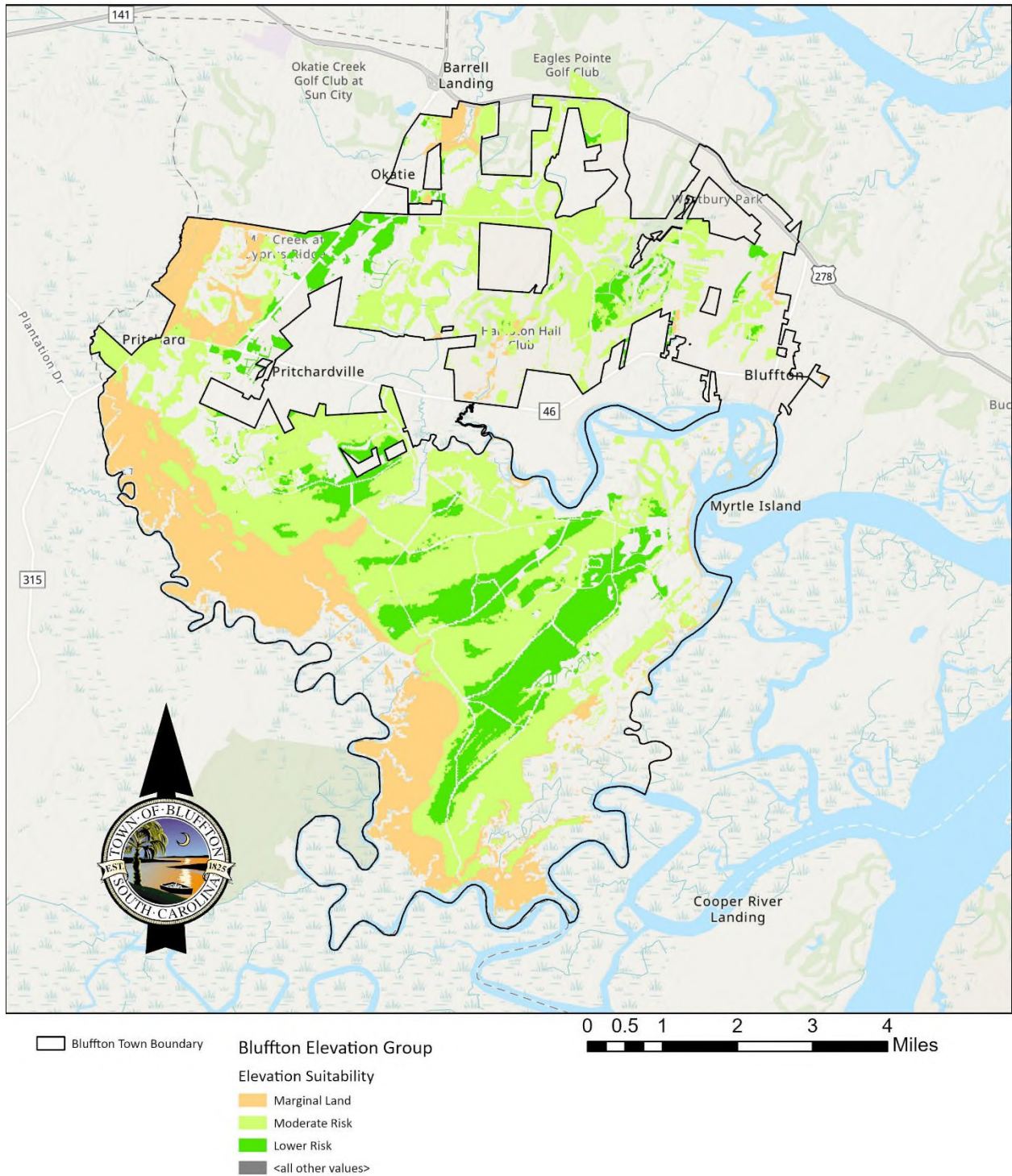


Figure 43: Elevation groups generated for buildout analysis

Appendix F: Digital Elevation Models (DEMs) and Digital Surface Models (DSMs)

DSMs, including an all-points DSM, upper story DSM, mid-story DSM, and lower story DSM were produced. Simultaneously, the generation of DEMs such as the Last Return DEM, Ground Return DEM, was created to capture current terrain characteristics precisely (Tanim et al., 2023). LiDAR data was accessed from South Carolina LiDAR Data Access. Desired data was obtained by selecting Beaufort County and navigating to Data Access, NOAA LAS Bulk Download. This dataset included data for the entire state of SC. Data for Bluffton was downloaded from Block 6, based on information provided by the 2020 USGS Lidar: Savannah Pee Dee, SC website. After downloading the LiDAR data files, they were extracted and converted to LAS format for usability. The resolution is 2 points per square meter, with a 0.71-meter nominal point spacing.

The Geoprocessing Tool used to create the DEM and DSM from the las data points was the LAS Dataset to Raster tool. Due to the flat topography and nature of LAS data, the chosen interpolation type of Binning, cell assignment of Inverse Distance Weighting (IDW), and Void Fill Method of Natural Neighbor was chosen. In order to achieve maximum resolution from the DEM and DSM raster, a sampling value of 2 was chosen, due to the data's 0.71-meter nominal point spacing, converted to feet and adjusted to minimize interpolation error.

Appendix G: Supplemental Information

What was the approximate time of the flooding

-Please select-

Please provide the location where flooding was seen*

• Enter an address to zoom to that property

• Click and drag to move the map and zoom in until the blue arrow is on the location here.

Find address or place

US 17

US 17

SC 176

GA 25

Map data © OpenStreetMap contributors, CC BY-SA

Powered by Esri

If you have a photo of the flooding you can upload it here

If you have a photo taken at approximately the place and time entered above, please upload it here.

Drop image here or select image

Optional second view

If you have another photo taken at approximately the same place and time, please upload it here.

Drop image here or select image

How deep do you think the water was?

Use the dropdown below

No water

Was the water moving or pooling?

Not moving (pooling)

Slowly moving

Quickly moving (Flowing)

Town of Bluffton Flood Observations



This form is for residents of the Town of Bluffton to document floods within Bluffton, SC. The data collected from residents will help researchers assist the town with understanding how flooding occurs and help improve scientific flood models. To report damage, please also fill out the Town's Damage Reporting Form.

Please use a new sheet for each flooding event you are documenting and note in the comments section any additional observations.

If you would like to fill out the survey or report damage electronically, please use this QR code: 

Please provide your name
(First Last - e.g. Jane Doe)

What was the date of the flooding event
Date Format: MM/DD/YYYY

What was the approximate time of the flooding

☐ Morning

☐ Midday

☐ Afternoon

☐ Evening

☐ Night

☐ All day

☐ Multiple days in a row

Please provide the location where flooding was seen
Enter an address, cross street, landmark, or other geographic specifier

How deep do you think the water was?

☐ No Water

☐ 0-4 inches

☐ 4-6 inches

☐ 6 inches to 1 foot

☐ 1-2 feet

☐ 2-3 feet

☐ Above 3 feet



COLLEGE of
CHARLESTON

UNIVERSITY CENTER
RESEARCH CENTER

Figure 44: Online (left) Survey123 form and paper (right) form for community flood observations

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