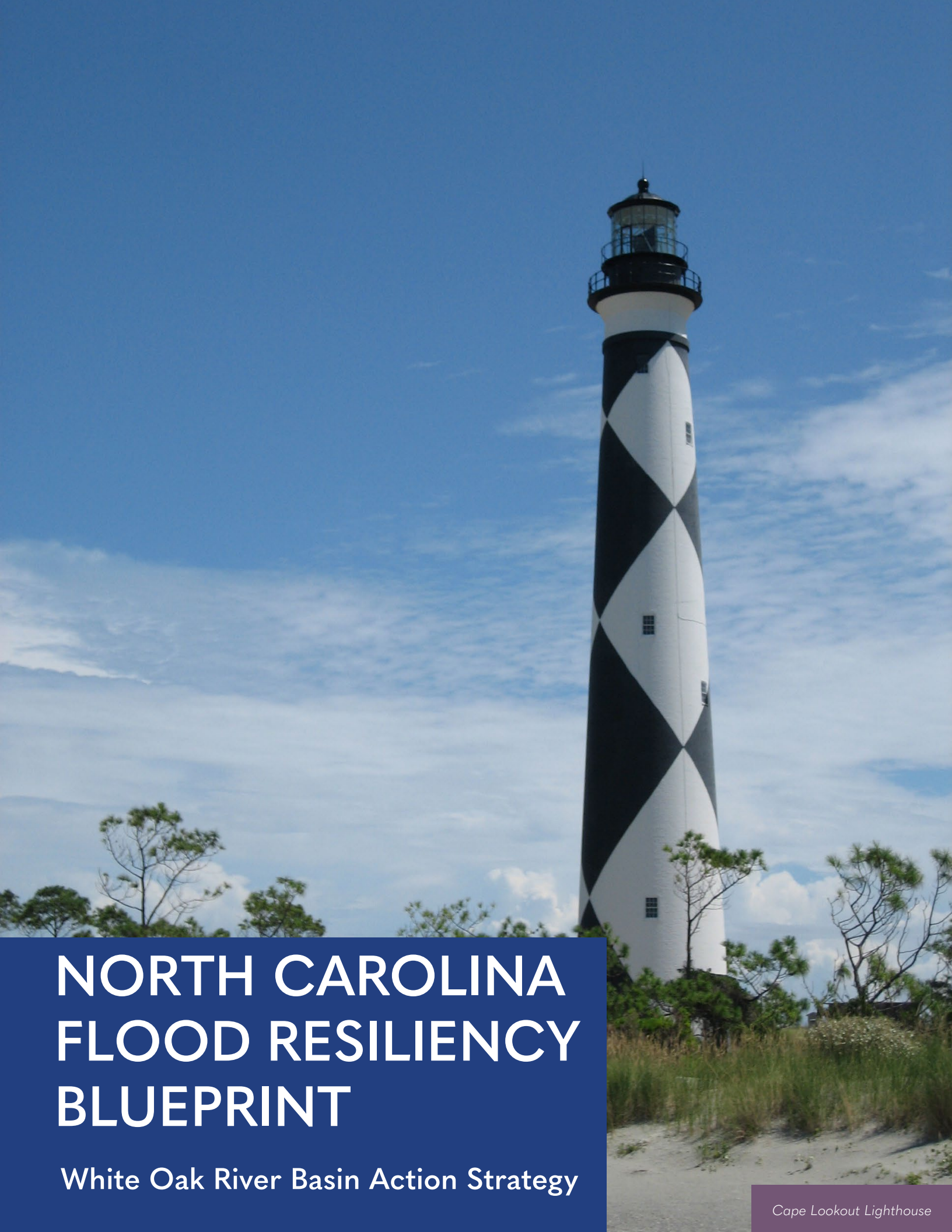


A tall, cylindrical lighthouse with a black and white diamond-patterned exterior. The top section is white with a black lantern room and a black gallery. The lighthouse is situated on a sandy dune with sparse green vegetation. The sky is a clear, bright blue with some light, wispy clouds near the horizon.

NORTH CAROLINA FLOOD RESILIENCY BLUEPRINT

White Oak River Basin Action Strategy

Cape Lookout Lighthouse

TABLE OF CONTENTS



Topsail Island, North Carolina

WHITE OAK RIVER BASIN ACTION STRATEGY	3
EXECUTIVE SUMMARY	4
TERMS & ACRONYMS	8
INTRODUCTION	10
Basin Overview	16
RIVER BASIN ACTION STRATEGY DEVELOPMENT PROCESS	20
Actionable Data, Modeling, & Analysis	21
Community Engagement & Discovery	24
Flood Risk Planning & Analysis	28
Action Review, Creation, Adjustment, And Selection	40
Priority Action List	43
WHITE OAK RIVER BASIN ACTION STRATEGY	52
Flood Resiliency Vision & Guiding Principles	54
Goals & Strategies	55
What is an Action?	55
PRIORITIZED BASIN ACTIONS	61
Goal 1: Protect People and Life Safety	63
Goal 2: Strengthen Critical Systems	71
Goal 3: Protect and Restore Coastal Natural Systems	80
Goal 4: Reduce Flood Risk Through Land Use and Development	89
Goal 5: Build A Durable Pathway from Evidence to Implementation	95
Review of Funding Sources	100
Action Strategy Take-Aways	108
Next Steps And Implementation	109
ACKNOWLEDGEMENTS	110
PHOTO CREDITS	113
APPENDICES	115



EXECUTIVE SUMMARY

Flood Risk, Vulnerability, and Capacity

The White Oak River Basin Action Strategy (White Oak RBAS) was developed as part of the North Carolina Flood Resiliency Blueprint (Blueprint) to identify flood resilience actions that address current and future flood risk throughout the basin. The White Oak RBAS was developed through the integration of basin-wide flood risk and vulnerability analyses, local and regional priorities, existing planning efforts, and implementation considerations. The result is a RBAS that supports flood resilience planning, investment, and decision-making across the White Oak River Basin.

Flooding affects communities, infrastructure, economies, and natural systems throughout North Carolina and remains a recurring challenge across the White Oak River Basin. The basin encompasses more than 1, 400 square miles across 6 counties and includes a diverse range of geographic, hydrologic, and community conditions ([see Basin Overview](#)). Flood hazards within the basin are influenced by riverine flooding, stormwater flooding, coastal flooding processes, land use patterns, and future development. These characteristics result in varying levels and kinds of flood risk and resilience needs across the basin.

The White Oak RBAS evaluates current and future flood conditions using advisory flood modeling developed by the NC Emergency Management, exposure analyses, and vulnerability assessment methods supported by the Blueprint Tool. The White Oak RBAS vulnerability assessment (Appendix E) identified locations where flooding impacts people, structures, and systems today and estimates changes to risk into the future ([see Flood Risk Planning & Analysis](#)). Flood exposure is projected to increase throughout the basin over time as changes in precipitation patterns, land use, development, and coastal influences impact the number of people, assets, and systems vulnerable to flooding.

Under current conditions, approximately 19% of the basin’s land area and more than 12,000 households are exposed to flooding during a 1% Annual Exceedance Probability event (commonly referred to as 100-year storm). By mid-century (2050), the exposed population is projected to exceed 17,000 households. Increases in exposure and impacts are also projected for residential structures, critical facilities, and infrastructure.

Flood risk varies across the basin. The inland communities of the White Oak River Basin contain key population centers and defense infrastructure, such as Jacksonville and Marine Corps Base (MCB) Camp Lejeune, where urban growth and localized riverine flows drive flood exposure. The inland areas of the basin namely rural stretches of Onslow, Carteret, and Jones counties, include low-lying agricultural and natural areas where future exposure is projected to increase alongside expanded development, groundwater rise, and heavy rainfall. In the estuarine and soundside portion of the basin, short tidal rivers, storm surge, king tides, and sea level rise create compound flood risks for coastal communities such as Morehead City, Beaufort, Swansboro, and the barrier islands. These differing conditions highlight the need for resilience actions that reflect local flooding conditions while supporting basin-wide resilience objectives.[]

The White Oak RBAS also considers local and regional capacity to support flood resilience planning and implementation ([see Actionable Data, Modeling, & Analysis](#)). There is variation in the administrative, technical, and financial capacity of communities across the basin. While some jurisdictions have established resources and programs to support flood resilience activities and involvement in the Blueprint program, other communities face staffing, funding, technical expertise, and other related challenges. These differences in capacity influence the ability of communities to pursue, implement, and sustain resilience projects.



Prioritized Actions

The White Oak RBAS establishes a prioritized portfolio of actions intended to reduce flood risk and support long-term flood resilience ([see Priority Action List](#)), organized in five major goals with 19 supporting strategies.

The portfolio opens with a clear vision of flood resilience developed with White Oak stakeholders: *The White Oak River Basin is a strong, connected and adaptable region where people, places and natural systems withstand floods. The White Oak River Basin Action Strategy turns science into fundable, on the ground solutions so communities - rural and urban, beachfront and inland - can prepare, recover, and thrive rather than simply survive.*

Reflecting this vision, the White Oak River Basin Action Strategy presents a basin-wide framework for reducing flood risk and strengthening resilience across coastal and inland communities with varied exposure, infrastructure, and capacity. Organized around five goals:

- protecting people and life safety,
- strengthening critical systems,
- protecting and restoring coastal natural systems,
- reducing flood risk through land use, redevelopment,
- and property mitigation, and building a durable pathway from evidence to implementation.

The strategy translates local input, regional guiding principles, and actions identified in existing plans into a coordinated set of 95 actions included in the RBAS. Together, these actions provide a practical roadmap for advancing flood resilience through both immediate projects and longer-term planning, with high-priority actions identified through a structured screening and scoring process.

A central theme of the White Oak RBAS is reducing flood impacts through a balanced mix of drainage and infrastructure improvements, nature-based solutions, land-use tools, and property mitigation. The plan supports:

- | | |
|-----------------------------------|---|
| • culvert and roadway upgrades, | • redevelopment strategies |
| • stormwater mapping, | • evacuation-route improvements |
| • tidal backflow protection, | • elevating wetlands |
| • utility resilience, | • shoreline restoration |
| • building buyouts | • floodplain conservation, and |
| • elevation of existing buildings | • other coastal natural systems as essential resilience assets. |

The strategy emphasizes that implementation depends on strong local data, project prioritization, funding pathways, monitoring, and regional coordination so that communities can move from planning to measurable risk reduction over time.

The White Oak RBAS used a structured process for creating, reviewing, and selecting actions. Local governments and partners contributed many actions through the Blueprint Tool ([see River Basin Action Strategy Development Process](#)). Additional actions were added from existing plans to improve geographic coverage and ensure attention to high-vulnerability areas. All actions were screened to confirm a clear flood-resilience purpose, then scored using four equally weighted factors: flood resilience benefits, local support, feasibility and technical readiness, and alignment with basin-specific guiding principles developed from stakeholder input. The highest-scoring actions were designated as high priority, creating a focused set of projects that can move into implementation while remaining flexible enough to be updated as local plans and conditions change.

Implementation Considerations

Successful implementation of the White Oak RBAS will require continued coordination among local governments, regional organizations, state and federal agencies, nonprofit organizations, and private-sector partners ([see Community Engagement & Discovery](#)). The White Oak RBAS provides information about some potential funding sources and implementation pathways that may support advancement of prioritized actions ([see Review of Funding Sources](#)).



Through coordinated implementation of prioritized actions, communities and partner organizations can work to reduce flood risk, support resilient community development, protect critical assets and infrastructure, and improve preparedness for future flood conditions. Continued investment in resilience planning, project development, and implementation can help reduce future flood-related damages, support more resilient infrastructure systems, and improve community preparedness for future flood conditions.

Key Takeaways

The White Oak River Basin has an above average risk of flood exposure.

Flood exposure in the White Oak Basin is significant and is expected to increase by more than 40% by mid-century (2050), with additional increases by 2100.

The 95 actions listed in the RBAS are estimated to have implementation costs in the range of \$60 million to \$80 million.

High-priority actions identified by local communities are focused on:

- infrastructure projects,
- small-scale stormwater capital projects,
- nature-based solutions, and
- building buyout, elevation and retrofitting.

The RBAG and White Oak partners identified the need to strengthen the pathway from project identification to implementation, with particular focus on additional planning.

Communities identified the need for additional data through increased monitoring and modeling to help guide evidence design making.



Displaced vessel after Hurricane Florence



Morehead City waterfront and marina overlooking the Port of Morehead City



TERMS & ACRONYMS

AAL	Average Annualized Loss	DOT	U.S. Department of Transportation
Action	A flood mitigation or resilience measure that can be implemented by a local government or a set of partners; may be a capital project, policy/planning measure, or other defined effort that reduces flood risk; may be local, regional, or basin-wide and may require coordination across jurisdictions or sectors.	DRF	Disaster Relief Fund
		DRMF	Disaster Relief and Mitigation Fund
		DWR	Division of Water Resources
		DWSRF	Drinking Water State Revolving Fund
		EAPs	Emergency Action Plans
		ECL	End of Century Higher
ACS	American Community Survey	EDA	Economic Development Administration
ADA	Americans with Disabilities Act	EEG	Environmental Enhancement Grant
ASCP	Agricultural Stream Cleanup	EPA	U.S. Environmental Protection Agency
Blueprint	North Carolina Flood Resiliency Blueprint	EQIP	Environmental Quality Incentives Program
Blueprint Tool	North Carolina Flood Resiliency Blueprint Tool	ER	Emergency Relief
BPP	Blueprint Partners	EWP	Emergency Watershed Protection
BRIC	Building Resilient Infrastructure and Communities	FEMA	Federal Emergency Management Agency
CAMA	Coastal Area Management Act	FIRM	Flood Insurance Rate Maps
CDBG DR	Community Development Block Grants Disaster Recovery	Flood Resilience	The capacity of individuals, a community, business, or natural environment to reduce, withstand, respond to, and recover from flooding by positively mitigating the impacts of changing conditions and challenges including climate change, increasing rain fall, and sea level rise, and adapting to those conditions.
CDBG MIT	Community Development Block Grants Mitigation		
CDC ATSDR SVI	Place-based database and mapping tool designed by the Centers for Disease Control and Prevention (CDC) and the Agency for Toxic Substances and Disease Registry (ATSDR)	Floodwise	Understanding flood risks and taking practical steps to prepare for, reduce, and recover from flooding.
CIP	Capital Improvement Plan(s)		
COG	Council of Government	FMA	Flood Mitigation Assistance
CPF	Community Project Funding	GIS	Geographic Information System
CWSRF	Clean Water State Revolving Fund	HMGP	Hazard Mitigation Grant Program
DCM	Division of Coastal Management	HMP	Hazard Mitigation Plan
DEQ	Department of Environmental Quality	HMRRP	Hurricane Matthew Resilient Redevelopment Plan

HUD	U.S. Department of Housing and Urban Development	NOAA	National Oceanic and Atmospheric Administration
L-PDM	Legislative Pre-Disaster Mitigation	NPDES	National Pollutant Discharge Elimination System
Local Action Plan	Plans submitted through the Blueprint Tool that consist of flood resilience action(s) submitted by local governments or delegated authorities of local governments	NRCS WFPO	Natural Resources Conservation Service Watershed and Flood Prevention Operations
		O&E Plan	Outreach and Engagement Plan
LMI	Low and Moderate Income	PARTF	Parks and Recreation Trust Fund
Locally Prioritized Actions	Actions where local governments know specific actions are needed; inductively collected from direct outreach with local government stakeholders; prioritized and vetted through community engagement and have greater public support.	Priority Actions	Actions that met defined standards for flood risk reduction and appropriateness
		PUBG	Potentially Underserved Block Group
		RISE	Regions Innovating for Strong Economies and Environment
MCB	Marine Corps Base	RCCP	Resilient Coastal Communities Program
MCH	Mid Century Higher	RBAG	River Basin Advisory Group
MJHMPs	Multi-jurisdictional Hazard Mitigation Plans	RBAS	River Basin Action Strategy
MPO	Metropolitan Planning Organization	REDD	Rural Economic Development Division
MS4	Municipal Separate Storm Sewer System	Representative Actions	Actions that showcase a balanced, illustrative suite of flood resilience solutions across the river basin.
NBS	Nature-Based Solutions	Resilience	Capacity of individuals, a community, business, or natural environment to reduce, withstand, respond to, and recover from flooding by positively adapting and mitigating the impacts of changing conditions and challenges, including flooding and climate change.
NCEI	National Center for Environmental Information		
NCDA&CS	North Carolina Department of Agriculture and Consumer Services		
NCEM	North Carolina Emergency Management	RHMPs	Regional Housing Mobility Plans
NCFMP	North Carolina Flood Mapping Program	RPO	Rural Planning Organization
NFIP	National Flood Insurance Program	SRF	State Revolving Funds
NCGA	North Carolina General Assembly	USACE	U.S. Army Corps of Engineers
NCLWF	North Carolina Land & Water Fund	USDA	U.S. Department of Agriculture
NCOSBM	North Carolina Office of State Budget and Management	Vulnerability Assessment Based Actions	Actions compiled through a deductive process reflecting recommended actions to mitigate flood risks identified through the Action Strategy's Vulnerability Assessment results.
NIFMP	Natural Infrastructure Flood Mitigation Program		
NCDMS	Division of Mitigation Services		
NCDOT	North Carolina Department of Transportation	WRDG	Water Resources Development Grant Program
NFWF	National Fish and Wildlife Foundation		
NCORR	North Carolina Office of Recovery & Resilience		

INTRODUCTION

In 2021, the North Carolina General Assembly (NCGA) directed the North Carolina Department of Environment Quality (DEQ) to develop a statewide Flood Resiliency Blueprint (Blueprint). The Blueprint serves as the backbone of NC’s flood resiliency planning and is based on the best available science, stakeholder engagement, and sound decision-making to develop cost-effective flood resilience actions. Working closely with local governments and state agencies, the Blueprint supports coordinated, proactive investments that strengthen community resilience across North Carolina. At the heart of the Blueprint is an online decision-support tool to help local governments, agencies, and non-governmental partners develop, evaluate, and prioritize resilience actions as well as plan and marshal funding to implement those priorities. The Blueprint supports a wide array of potential actions such as floodplain restoration, stream debris removal, elevation of utilities, stormwater controls, and policy changes. The Blueprint will make North Carolina more resilient to flooding by funding projects that limit flood extent and severity, allowing communities to recover more quickly and limit future risk as storms become more frequent and severe.

Flood Resiliency Blueprint Overview

Over the past decade, North Carolina has experienced an increase in major flood events including Hurricanes Matthew (2016), Florence (2018), and Helene (2024). Recently, Hurricanes Helene and Debby (2024), Potential Tropical Cyclone Eight (2024), and Tropical Storm Chantal (2025) have had devastating impacts across the state. Flooding is not limited to tropical storms. Flash flooding from localized severe rain events has caused tremendous damage and loss of life across the state.

These flood events have demonstrated that flood risk is a statewide challenge that affects communities, infrastructure, economies, and natural systems across all of North Carolina’s 17 river basins, highlighting the need for coordinated, proactive investments to increase flood resilience statewide.

The Blueprint was established to address this need. The North Carolina General Assembly (NCGA) directed DEQ to develop the Blueprint through NC Session Law 2021-180, SB105. The Blueprint is North Carolina’s science-based and stakeholder-driven initiative designed to support the planning, evaluation, and implementation of flood resilience actions.

Flooding impacts North Carolina’s people, infrastructure, and systems in many ways. Building flood resilience and making proactive investments to reduce flood damage and disruption requires coordinated efforts across all levels of government. The Blueprint is working closely with local governments, organizations, and fellow state agencies to craft and implement resilience strategies throughout the six priority basins – Cape Fear, French Broad, Lumber, Neuse, Tar-Pamlico, White Oak (Figure 1) – to progress the program’s mission.

Blueprint Mission

To provide the data, tools, and capacity to support decision making at the local, regional, and state level, while also strategically implementing flood resilience projects by leveraging available funding and filling gaps left by existing programs.

North Carolina River Basins

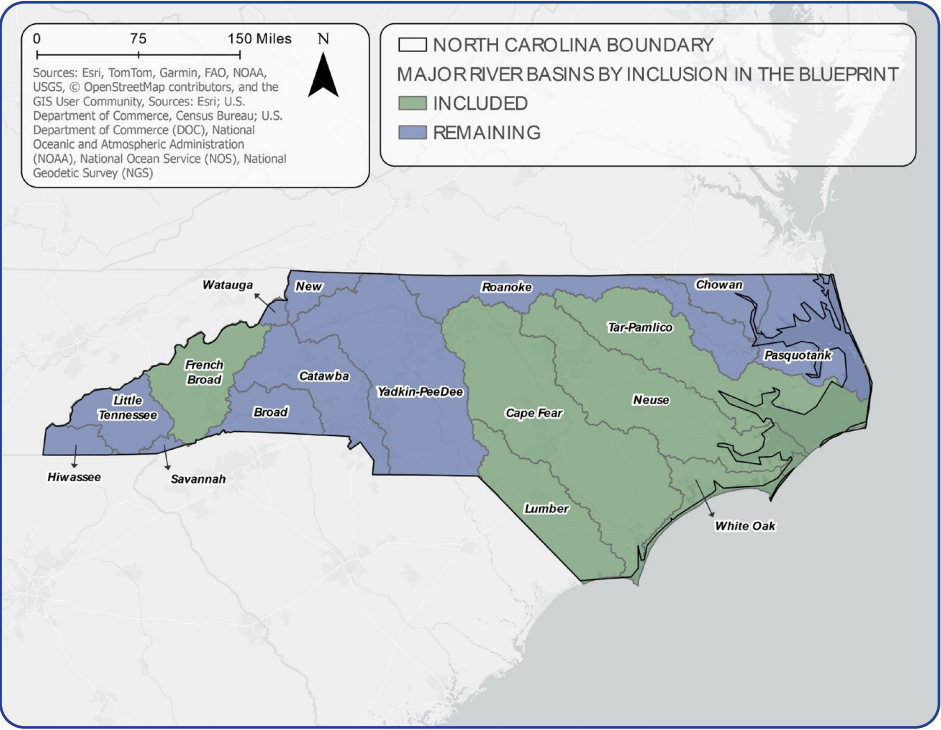


Figure 1. Map of North Carolina River Basins and Blueprint program status.

Objectives

As a first-of-its-kind comprehensive program for planning, modeling, and project development, the Blueprint unifies existing resources and knowledge, leveraging the best available science and tools in order to enhance North Carolina’s flood resilience in a cost-effective manner. The Blueprint consists of several components developed in three phases, each of which will be covered in more detail. Each component has been developed to achieve the Blueprint’s three legislative objectives.

Blueprint Objectives:

- Increase community resilience to flooding
- Serve as the backbone of State flood planning
- Reduce the cost and complexity for local governments in the planning and implementation of flood risk reduction projects

Blueprint Phases

Blueprint is being completed in three phases of development, each focused on a core program component:

1

Develop the
**Blueprint
Process**

2

Build and
launch the
**Blueprint
Tool**

3

Publish
**River Basin
Action
Strategies**

Blueprint in Action

These phases can be broken down into eight key steps (Figure 2) that guide communities through the development of River Basin Action Strategies (RBAS), including this White Oak RBAS.

The Blueprint process (Figure 2) is intended to move communities from shared understanding of flood risk to locally informed action identification, evaluation, implementation, and future updates. This structure is important for the White Oak RBAS because the basin includes varied flood sources, development patterns, community capacity, and infrastructure vulnerabilities. As such, recommended actions must be grounded in both technical analysis and local input. The steps shown in Figure 2 also help explain the organization of this document: the sections that follow summarize basin context, data and modeling, engagement, risk and vulnerability findings, action review and prioritization, funding considerations, and next steps for implementation – all critical components of the Blueprint.

Phase I established the Blueprint process by applying foundational resilience planning practices to create a structured, step-based framework (Figure 2). This framework reduces cost and complexity while supporting consistent RBAS development. A Draft Neuse RBAS was also developed in Phase I to serve as both a model and the foundation for later phases.

In Phase II, the Blueprint Tool was created, tested, and launched. The Blueprint Tool is an online decision support resource that enables a user to work through the Blueprint process steps. The Tool provides flood risk and vulnerability assessments, supports evaluation and prioritization of mitigation actions, and informs the development of Local Action Plans. Phase II also advanced a 2D Rain-on-Grid modeling approach which better represents exposure to flooding under current conditions. This also allows for the projection of future flooding in the White Oak River Basin that reflects expected changes in precipitation, sea level, and land use. These enhancements improve the accuracy and usability of flood risk information and are integrated into the Tool. Ongoing efforts focus on Tool refinement and expanding local adoption.

Flood Modeling, Mapping, and Risk

Federal Emergency Management Agency (FEMA) Flood Insurance Rate Maps (FIRMs) are official maps developed to support the National Flood Insurance Program (NFIP). They are a useful tool, but they have limitations. A study of eastern North Carolina found that 43% of flood damages between 1996 and 2020 occurred outside mapped FEMA floodplains (Garcia et al.,2025).¹ To address these limitations, DEQ partnered with North Carolina Emergency Management to develop improved 2D rain-on-grid models. This approach provides enhanced insight into flood depth, extent, and velocity across watersheds and can identify potential flood risk in areas that may not be fully captured by regulatory maps. The resulting flood maps and risk data underpin the Blueprint tool and the analysis presented in this RBAS.

¹ Garcia et al. (2025, July 14). Reconstructing Repetitive Flood Exposure Across 78 Events From 1996 to 2020 in North Carolina, USA. Retrieved from AGU: <https://agupubs.onlinelibrary.wiley.com/doi/10.1029/2025EF006026>

Now, the Blueprint program is entering a critical stage as early investments in planning, modeling, and tool development are applied across the six priority basins. Phase III, launched in 2024, applies the Blueprint process and the Tool to develop RBAS for priority basins. During the White Oak RBAS development, local and regional government staff have been engaged and trained on the use of the Tool to submit Local Action Plans. Eighty-seven priority actions were identified from these Local Action Plans and other sources ([for more about identifying and evaluating actions, see White Oak River Basin Action Strategy section](#)).

The Blueprint Beyond RBAS Development

The completion of the White Oak RBAS is an important milestone toward flood resilience, but much work remains. Sustained technical support for local governments and other partners is critical to continuing the planning and implementation of flood resilience actions. DEQ and its partners will continue to provide targeted assistance to local governments to support planning, project development, and implementation while building local capacity. Through the implementation of the White Oak RBAS, DEQ will work to align efforts across local, state, and federal levels, resulting in more impactful and efficient investments in flood resilience.

The Blueprint process calls for each RBAS to be updated on a 5-year cycle, contingent on funding. In each update, River Basins will integrate newly available data and review updated Local Action Plans within the Tool to revise the RBAS priority action list. These are just some of the reasons continued investment in the Blueprint by the NCGA and NC DEQ leadership will enable broader implementation, support resilient recovery, and advance prioritized projects, strengthening flood resilience across North Carolina.

Combined, these phases can be broken down into eight key steps (Figure 2).

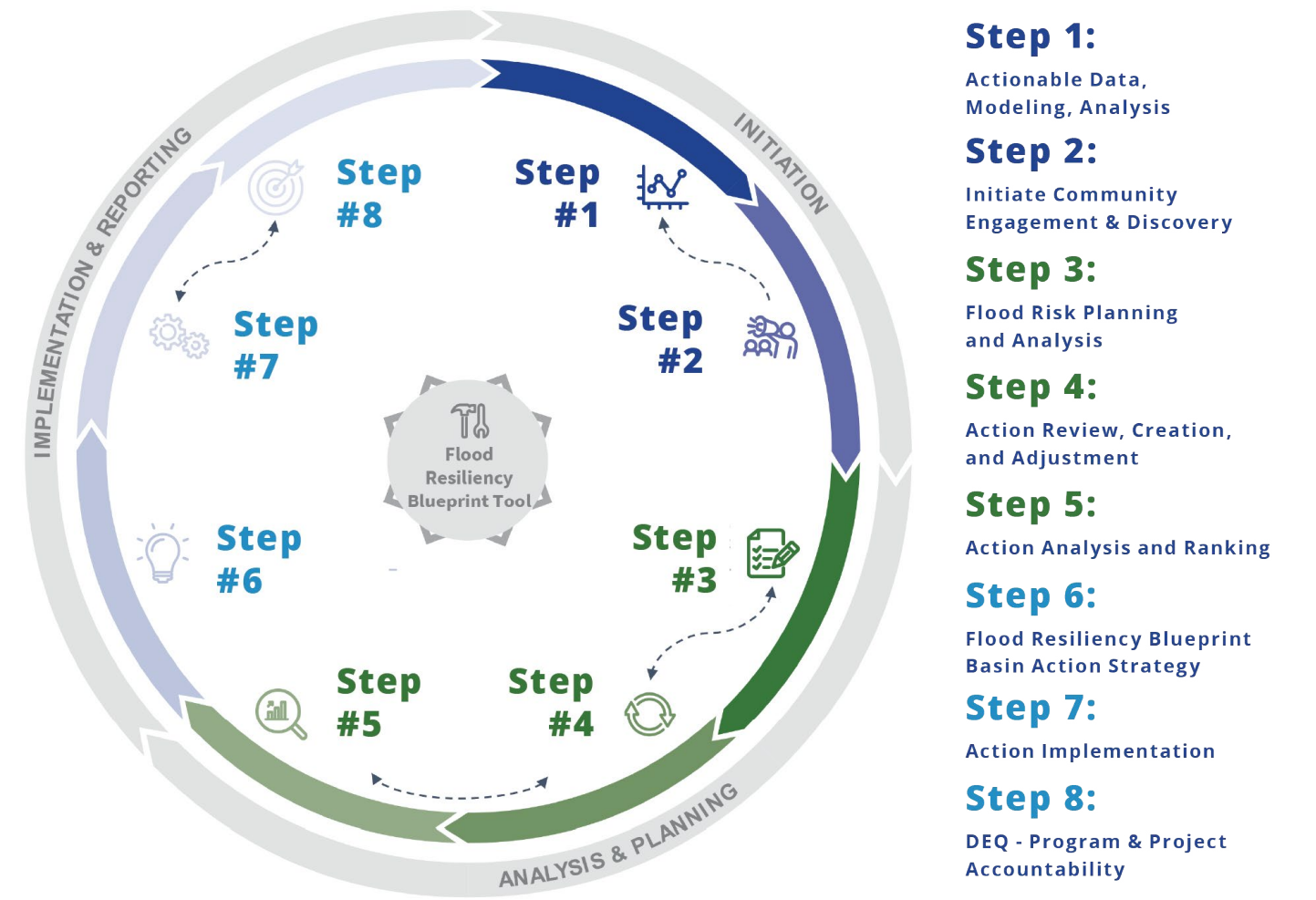
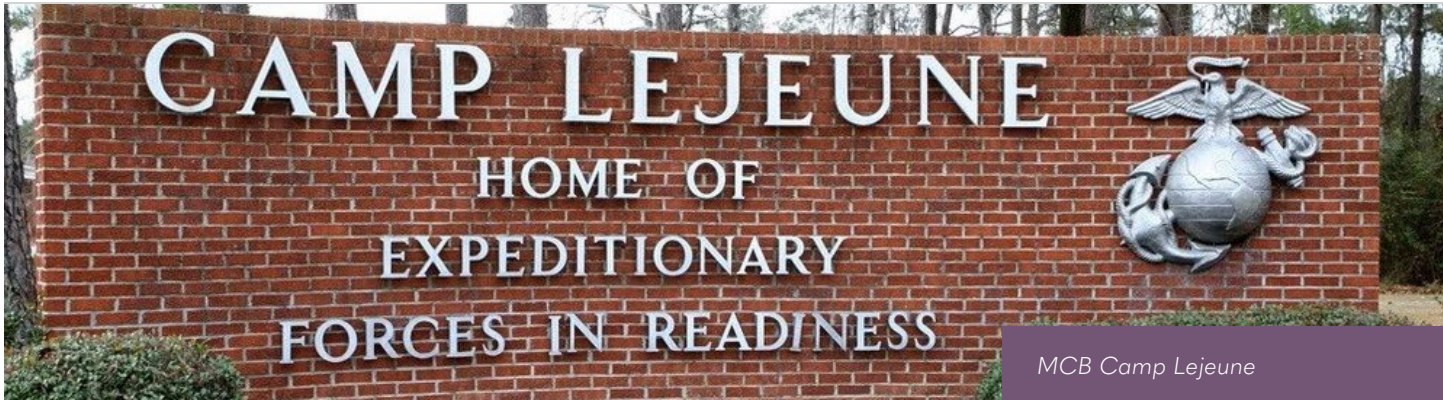


Figure 2. North Carolina Department of Environmental Quality (DEQ) Flood Resiliency Blueprint Tool and Process (DEQ, 2024b).

Purpose of RBAS

Within this broader Blueprint framework, the RBAS applies the statewide process to basin-specific flood risks, needs, and priorities. DEQ’s objective for each RBAS is to identify priority regions and mitigation actions within the basin. The RBAS also documents data needs and limitations to highlight areas where continued refinement may be needed. Development of an RBAS uses detailed flood modeling datasets for both current and future conditions to produce a detailed vulnerability assessment and support long-term planning. The RBAS process also features a capacity assessment to understand local governments’ ability to plan, fund, and implement flood resilience actions. The capacity and vulnerability assessments help the State focus support and resources. Stakeholder engagement is also a central component of the RBAS process, helping ensure that decisions and recommendations are informed by local and regional entities and the specific needs of the basin. Overall, the RBAS results in a prioritized list of flood resilience actions that provides a starting point for making the basin more resilient to flooding.



BASIN OVERVIEW

About the Basin

Location

The White Oak River Basin is a coastal river basin in eastern North Carolina, spanning nearly 1,400 square miles across 6 counties. The basin includes four river systems, The New, White Oak, Newport, and North rivers that flow into the estuaries of the Back, Core and Bogue sounds (North Carolina Office of Environmental Education and Public Affairs, 2018). MCB Lejeune, forest, and wetlands cover about half of the basin.

The White Oak River Basin encompasses diverse ecosystems, supports local economies including vibrant tourism, and serves as a source of water for communities across the basin. The basin has a long history of flooding, and these events have repeatedly affected infrastructure, natural resources, and public safety.

(Figure 3) provides an overview of the basin and its counties.

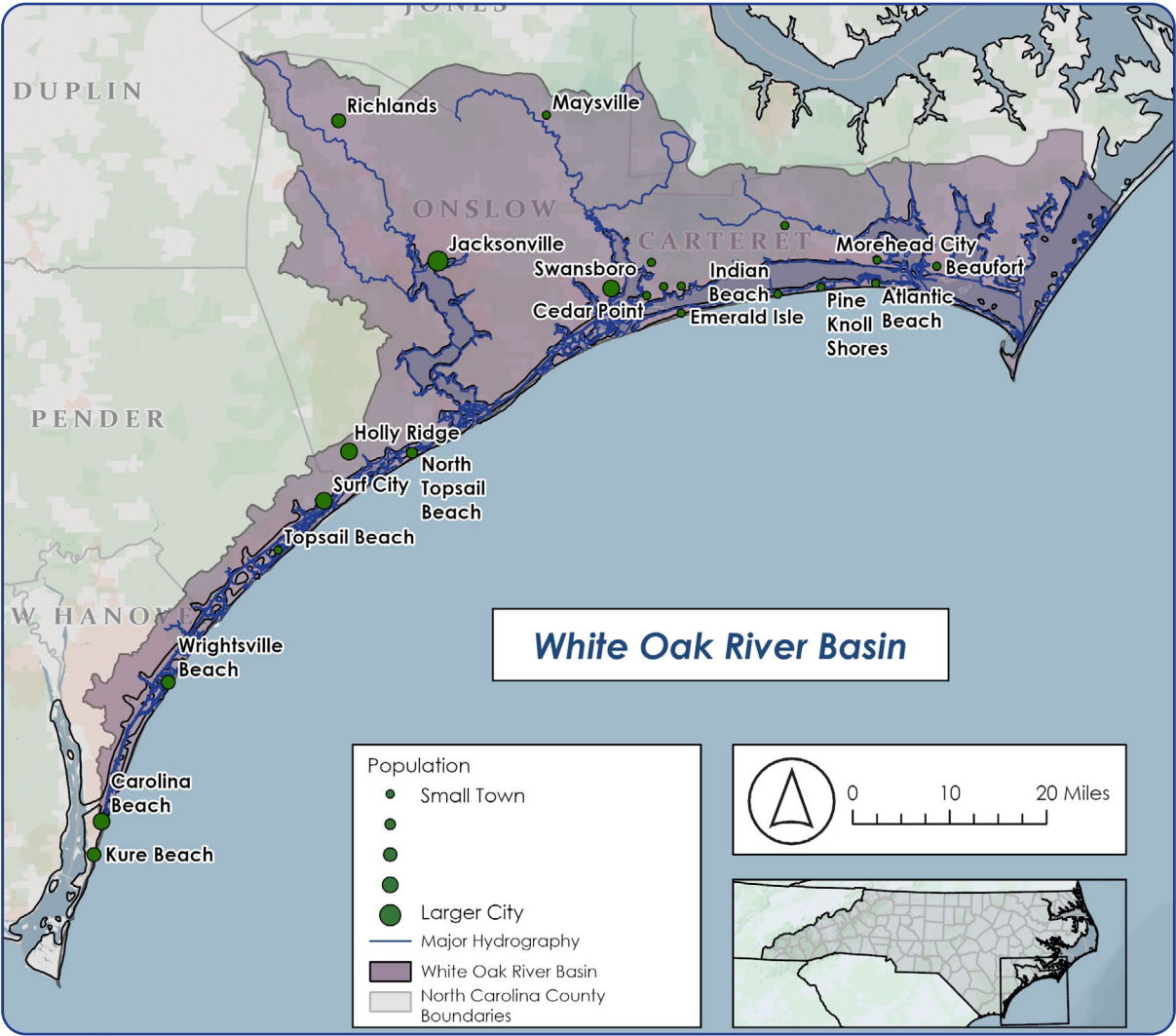


Figure 3: Map of the municipalities in the basin.

Flood Risk

The White Oak River Basin experiences a variety of flood risks ranging from localized and flash flooding from frequent, small-scale occurrences to high-impact events, most often associated with hurricanes and tropical systems. Long-term flood risk in the White Oak River Basin will be influenced by changes in climate that are expected to increase the frequency and magnitude of flooding over time. Population growth and rapid development are expected to lead to increases in impervious surfaces and altered hydrology.

Under current conditions, approximately 19% of the basin’s land area and more than 12,000 households are exposed to flooding during a 1% Annual Exceedance Probability event (commonly referred to as 100-year storm). By mid-century (2050), the exposed population is projected to exceed 17,000 households, an increase in more than 40%. Increases in exposure and impacts are also projected for residential structures, critical facilities, infrastructure, the economy, and the environment.

Flood mitigation actions developed using historical conditions alone may not fully account for future precipitation patterns, coastal influences, or development trends. Considering historic, current, and future flood conditions can help support more effective and adaptable mitigation investments that strengthen long-term resilience. For more information on flood risk and vulnerability in the White Oak River Basin, [see the Flood Risk Analysis and Planning section](#) of this document.

Flood Drivers

Intense rainfall can produce flash flooding, urban runoff, and localized tributary flooding even when the mainstem rivers remain within their banks. Flood hazards are primarily characterized by short, low-gradient coastal river systems, such as the New, White Oak, Newport, and North Rivers, converging with Core Sound, Bogue Sound, and the Atlantic Ocean. Intense hurricane rainfall and localized stormwater runoff frequently combine with ocean-driven storm surge, lunar high tides, and sea level rise. These intersecting coastal and hydrological dynamics create compound flooding, high-tide inundation including king tides, and acute storm impacts in Beaufort, Morehead City, Swansboro, Jacksonville, North Topsail Beach, and low-lying areas across MCB Camp Lejeune. Mainstem river flooding remains a concern but is increasingly affected by downstream water levels in the sounds.

FEMA's Flood Insurance Studies ² for the counties in the White Oak River Basin, indicate the dominant source of flooding in Onslow County and Carteret County is wind-driven surge generated in the Atlantic Ocean by tropical storms and hurricanes. Flooding from heavy rainfall occurs on many streams in the county. During such an event, flooding can also occur along the oceanfront. High winds associated with tropical storms can also produce extremely high waves which produce damage at elevations greater than the elevation of storm surge alone. Repeated wave impacts from waves 1.5 feet or taller can damage or destroy the wall of a building reducing the structural strength of the building, which increase the likelihood of total loss of the building.

North Carolina experiences hurricanes, tropical storms, and severe extratropical cyclones usually referred to as northeasters. Unlike a hurricane which typically passes over a coastal location as quickly as less than a day, a northeaster may cause impacts over large areas for several days.

History of Flooding

Over the past several decades, tropical storms and hurricanes have caused extensive flooding, loss of life, and significant economic damage across North Carolina. Flooding associated with Hurricanes Fran (1996), Bonnie (1998), and Floyd (1999) highlighted limitations in existing floodplain management, hazard mitigation planning, and preparedness efforts. Flooding from Hurricanes Matthew (2016) and Florence (2018) reinforced the need for approaches that better account for future conditions and changing flood behavior. More recent events, like Hurricane Dorian (2019), further demonstrate the basin’s continued exposure to flood hazards and have highlighted the need for continued improvements in forecasting, planning assumptions, and flood resilience strategies (Davis, 2024).³ Significant flooding is also experienced throughout the basin during unnamed storm events. Events such as high tide or king tide flooding, flash flooding, and intense rainfall events cause considerable impacts to communities, causing road closures and damage to homes and businesses. These events can also cause fatalities, especially when the intensity of a storm is unexpected.

² Flood Insurance Study Federal Emergency Management Agency A Report of Flood Hazards in Onslow County, North Carolina and Incorporated Areas Revised: 1/17/2025 Federal Emergency Management Agency State of North Carolina. Flood Insurance Study Federal Emergency Management Agency A Report of Flood Hazards in Carteret County, North Carolina and Incorporated Areas Revised: 1/17/2025 Federal Emergency Management Agency State of North Carolina

³ Davis, C. (2024, September 5). Five Years Ago, Dorian Tested Our Post-Florence Preparedness. Retrieved from North Carolina State Climate Office: <https://climate.ncsu.edu/blog/2024/09/five-years-ago-dorian-tested-our-post-florence-preparedness/>

Basin Dynamics

Weather and Climate

The White Oak River Basin experiences a humid subtropical climate characterized by warm, humid summers, generally mild winters, and precipitation throughout the year. Tropical storms and hurricanes have played a significant role in some of the basin’s most damaging flood events, while seasonal thunderstorms and prolonged rainfall can also contribute to flooding. North Carolina’s climate has warmed by more than 1°F since the beginning of the 20th century, and climatic conditions across the basin contribute to a range of flood hazards, including flash, riverine, coastal, and compound flooding (NOAA NCEI, 2022).⁴

Projections from downscaled climate models indicate increasing frequency and intensity of heavy rainfall, greater coastal and tidal influences, and higher potential for compound flooding events (NCDEQ, 2026).⁵ These drivers interact with development patterns, infrastructure conditions, and land modifications, increasing flood risk in some areas of the basin.

The 2023 North Carolina Enhanced State Hazard Mitigation Plan anticipates increased flood hazards due to climate trends, including increases in extreme precipitation, storm intensity, and sea level rise.

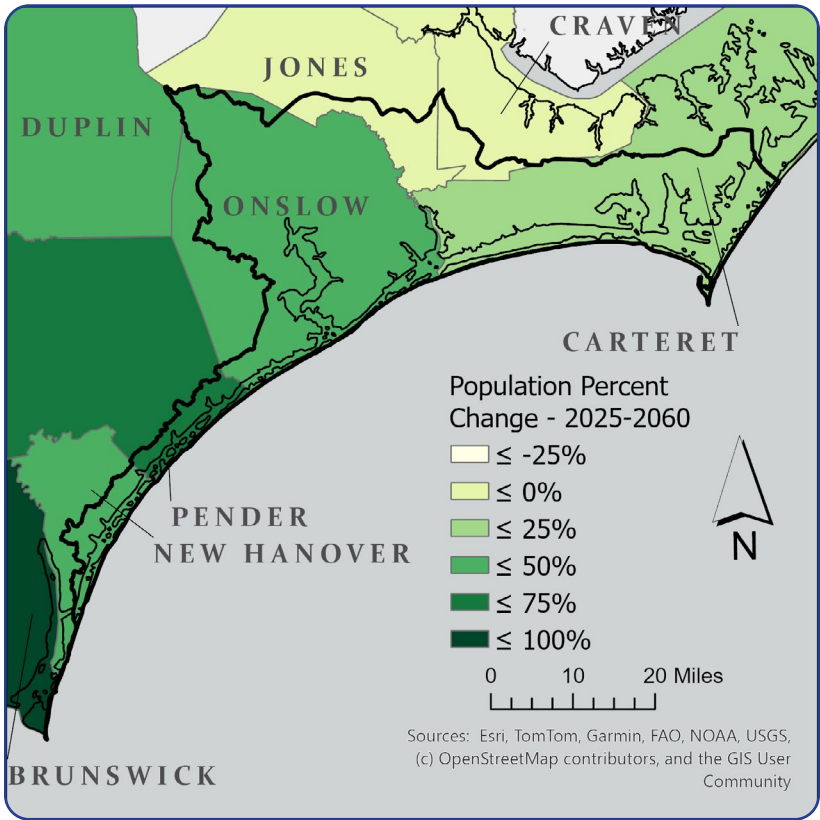


Figure 4: Projected Percent Change in County Population, 2025 to 2060. Source: North Carolina Office of State Budget & Management, Vintage 2025 Population Projections.

⁴ National Oceanic and Atmospheric Administration (NOAA) National Centers for Environmental Information (NCEI). North Carolina State Climate Summary 2022. Asheville, NC: NOAA National Centers for Environmental Information, 2022.

⁵ NCDEQ, Neuse River Basin Flood Resiliency Action Strategy, North Carolina Flood Resiliency Blueprint. Raleigh, NC, 2026.



Population Shifts

The White Oak River Basin is home to approximately 336,000 people ⁶, with nearly two thirds of the basin population living in Onslow County, which include Jacksonville and MCB Camp Lejeune. The basin population doubled between 1990 and 2000, and recent growth continues at rates near 30%. Figure 4 shows projected county-level population change across the basin between 2025 and 2060 (North Carolina Office of State Budget and Management, 2025)⁷, illustrating some counties are projected to continue growing, while others are projected to remain relatively stable.

Projected population growth is relevant to White Oak RBAS development and strategic flood resilience planning because growth can influence where land use and development changes occur. In communities with limited growth or population decline, capacity constraints may affect the ability to plan for, fund, and implement flood risk management actions. The population changes shown in Figure 4 provide context for interpreting future population exposure, local capacity needs, and the types of actions that may be needed across different parts of the basin.

⁶ Draft 2021 White Oak River Basin Water Resources Plan. North Carolina Department of Environmental Quality Division of Water Resources Basin Planning Branch

⁷ North Carolina Office of State Budget & Management (NC OSBM), Vintage 2024 Population Estimates & Vintage 2025 Population Projections

RIVER BASIN ACTION STRATEGY DEVELOPMENT PROCESS

The White Oak RBAS was developed through a multi-step process (Figure 2). The first step in that process involved a literature review to identify existing plans, data, and programs in the White Oak River Basin (Figure 5). This review was done to document previous and current flood resilience efforts in the basin and compile a list of pre-identified flood resilience actions. The resulting list of 459 pre-identified actions was then used as a resource during Blueprint engagement with local and regional governments.

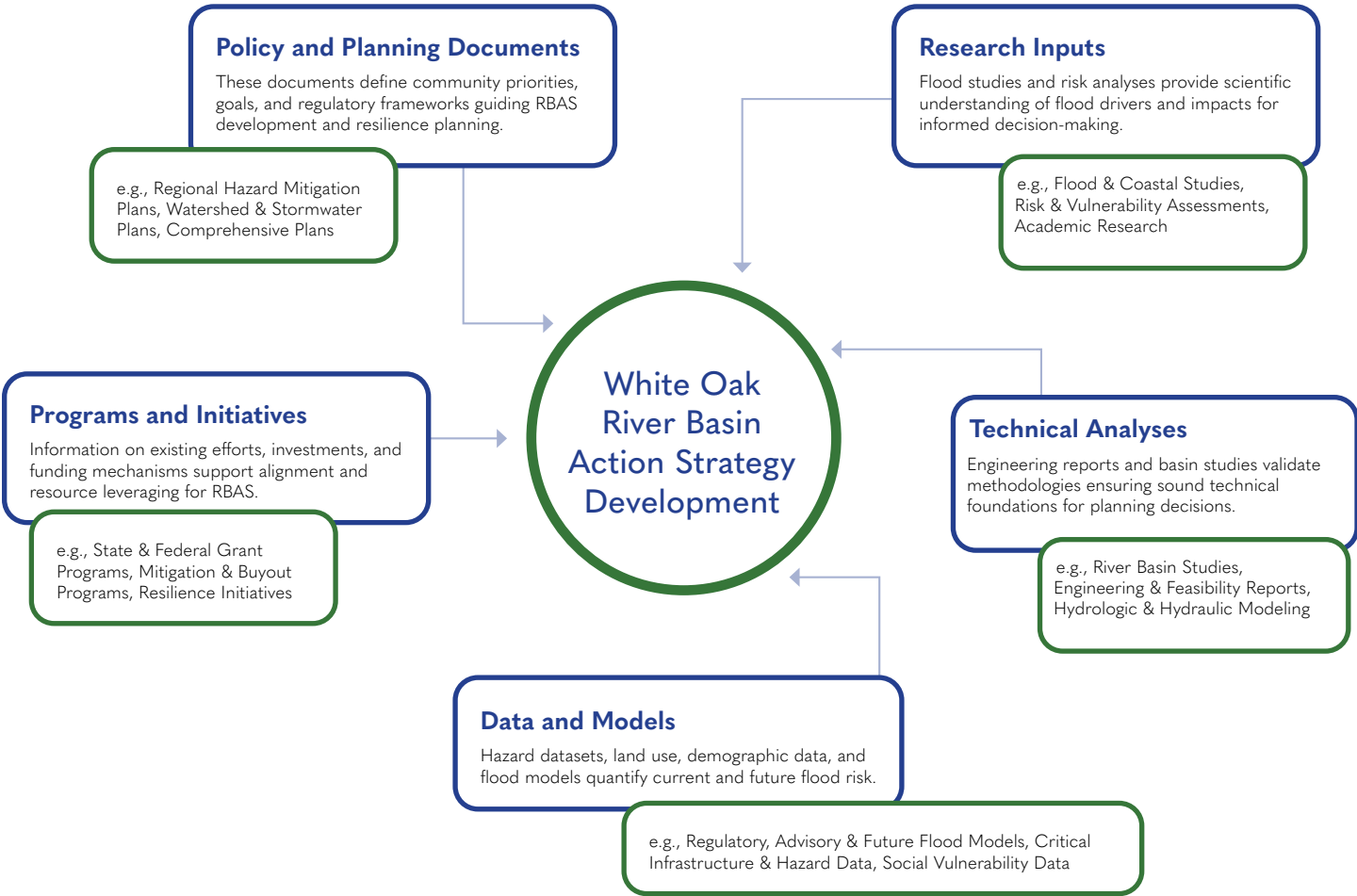


Figure 5. Resource types informing the White Oak River Basin Action Strategy Development Process

The White Oak River Basin Flood Risk and Vulnerability Analysis Report (Appendix E) provides a clear understanding of current and potential future flood risk across the basin. Using outputs from the 2D data created for the Blueprint Tool, new insights were made into flood risk locations and magnitudes; these insights informed the identification and selection of several priority actions (Table 2) across the river basin. Stakeholders and the public were engaged throughout the White Oak RBAS development process to gather key insights and perspectives on flood resilience needs and community priorities.

ACTIONABLE DATA, MODELING, & ANALYSIS

Inventory of Existing Data, Programs, & Studies

Historical and ongoing flood hazard challenges in the White Oak River Basin have resulted in an array of resilience efforts and investments at the federal, state, and local level. A review of existing data, programs, and studies produced an inventory of up-to-date and credible flood resilience efforts. This inventory includes a wide variety of information types as shown in Figure 5. These resource types served complementary purposes: plans and strategies identified documented priorities, research projects provided technical insight, programs outlined implementation pathways, and datasets are relevant to modeling, screening, and action evaluation.

Figure 5 summarizes the major resource types reviewed during development of the White Oak RBAS, including plans and strategies, research projects, programs, and datasets. These resources collectively help to update the inventory of existing flood resilience efforts in the basin, identify previously documented actions and needs, and inform later steps in modeling, engagement, action development, and prioritization. The range of resource types also reflects the purpose of the Blueprint process: to build from existing local, regional, and state knowledge rather than duplicating prior efforts.

Resources included in the literature review and data inventory met the following criteria:

- Regional or smaller geographic scope: The basin-wide geographic area spans all or part of 6 counties and 30 municipalities.
- Credible and vetted: Resources have federal, state, or agency support and/or have been reviewed by subject matter experts.
- Up-to-date, latest version: Generally, state resources were published in 2019 or later, in response to NC 2018 Executive Order 80. For resources updated annually, the latest version was reviewed.
- Importantly for the development of the White Oak RBAS, this inventory provided a starting point for identifying pre-existing flood resilience actions to support the development of Local Action Plans. Actions documented in plans, studies, programs, and related datasets were compiled and used to inform stakeholder discussions. It also allowed for the pre-population of actions in the Tool, potentially streamlining the development of Local Action Plans and reducing capacity demands on local governments in the Blueprint process.

As flood resilience related planning, research, and other efforts continue, this inventory should be revisited in collaboration with local and regional governments to ensure that relevant advancements are integrated into the updated RBAS (currently planned for a 5-year update cycle, contingent on funding). Additional detail about the resource inventory and update process is compiled in Appendix A: Actionable Data Collection, Modeling, and Analysis Report. State-scale resources reviewed during earlier Blueprint phases are summarized in the RBAS Strategy.

Plans and Strategies

Primary plan and strategy types with White Oak River Basin-relevant flood resilience efforts include Hurricane Matthew Resilient Redevelopment Plans (HMRRP), Regional Resilience Portfolios, and Hazard Mitigation Plans (HMP). Some local municipal plans, such as the City of Jacksonville's Adopted Capital Improvement Plan (CIP) for Fiscal Years 2025-2034, were included in the literature review as well.

State and Local Programs

Four state and local programs were identified within the White Oak River Basin. DEQ Division of Coastal Management (DCM) administers the Resilient Coastal Communities Program (RCCP) providing technical and financial assistance for coastal resilience efforts. Division of Mitigation Services (NCDMS) was authorized by the NC General Assembly to incorporate flood storage capacity enhancement under the Natural Infrastructure Flood Mitigation Program (NIFMP). Several projects within the White Oak River Basin are underway under both programs. The North Carolina Flood Mapping Program (NCFMP) also supports projects within the basin by providing flood hazard data and mapping products.



National Guard in Oak Island after Hurricane Isaias

⁶ NC Policy Collaboratory at The University of North Carolina at Chapel Hill. (2021). Collaboratory Flood Resiliency Study Final Report to the North Carolina General Assembly, June 2021. Retrieved from <https://collaboratory.unc.edu/wp-content/uploads/sites/476/2021/06/flood-resiliency-report.pdf>

⁷ North Carolina Institute for Climate Studies. (2020). North Carolina Climate Science Report. Retrieved from <https://ncics.org/programs/nccsr/>

Research Projects

Two (2) major research projects were identified within the White Oak River Basin based on an inventory of activities at regional academic institutions.

The Collaboratory Flood Resiliency Study was submitted as a final report to the North Carolina General Assembly in June 2021, as a product of the NC Policy Collaboratory at The University of North Carolina at Chapel Hill. The primary legislative charge of the report was to conduct research related to flood resiliency in eastern North Carolina, including the White Oak River Basin.

The North Carolina Climate Science Report was published by the North Carolina Institute for Climate Studies in September 2020 (revised). The report is a scientific assessment of historical climate trends and potential future climate change and includes an overview of the physical science of climate change, detailed information on observed and projected changes in temperature and precipitation averages and extremes, hurricanes and other storms, sea level, and other relevant climate metrics. The report also includes chapters on sea level rise, trends involving interactions of multiple aspects of the climate system (including inland flooding, wildfire, forest ecosystem changes, urban heat island effects, and air pollution), and findings relevant to engineering design standards.

Data Sets

Data sets inventoried for the White Oak RBAS are classified in six distinct groups: Hazards and Engineering, Foundational, Natural Environmental, Built Environment, Demographic, and Mitigation Support Datasets. The data is sourced from different federal, state, and local agencies and is used to support modeling and action development.

Local & Regional Capacity

A Local and Regional Government Blueprint Capacity Assessment (Appendix C) was completed as part of the White Oak RBAS development process. The purpose of the capacity assessment is to better understand each community's ability to plan, assign staff resources, and provide the administration needed to identify and implement actions. This includes consideration of whether or not the community has a planner or engineer on staff with specific knowledge of local hazards and risks; and whether the community has an established planning department. The assessment complements capacity scores in the Blueprint Tool and is not intended as a definitive measure; rather, it provides a baseline understanding of relative capacity across communities and helps identify where additional support may be needed.

The assessment was conducted through a desktop review of publicly available information from municipal and county websites, regional planning councils and Councils of Government, state databases, regional hazard mitigation plans, resilient redevelopment plans, and other relevant sources. Each jurisdiction was scored across three assessment domains, which were combined into a composite score. Where information was missing or could not be interpreted, the relevant indicator was scored as zero, which may understate capacity in some cases. Additional information on the assessment domains is provided below, with full methods and results included in Appendices A (Actionable Data Collection, Modeling, and Analysis Report) and C (Blueprint Capacity Results Spreadsheet).

Capacity Assessment Domains

Previous determinations from HMPs: community capability rankings from existing, locally adopted Regional Hazard Mitigation Plans (RHMPs) and Multi-jurisdictional Hazard Mitigation Plans (MJHMPs) were used to pull summary designations of “High,” “Moderate,” or “Low” capability (or their equivalent) for each jurisdiction. <i>Example of previous determinations derived from an HMP: Carteret County was identified as having high capability for hazard mitigation, with its 13 incorporated municipalities having separate capability rankings ranging from low and moderate to high.</i>	Previous determinations from other regional plans: Hurricane Matthew Resilient Redevelopment Plans, NC Office of Recovery and Resiliency (NCCORR) Regions Innovating for Strong Economies and Environment Program (RISE) Regional Resilience Portfolios, and NC RCCCP plans were used for references to local capacity. <i>Example of previous determination from a Hurricane Matthew RRP: Onslow County was identified as having high capacity for flood resilience, with its five incorporated municipalities having separate capacity rankings ranging from limited to high.</i>	Vulnerable populations and overall support indicators: vulnerable populations based on CDC ATSDR SVI data; past trends and future projections in population growth derived from US Census Bureau and State of North Carolina data; existence of a community planner or engineer with specific knowledge of local hazards; and existence of local planning departments were used in conjunction with the previous determinations to establish an overall assessment of capacity. <i>Example of determination based on vulnerable populations: Jones County has a medium-high determination of vulnerable populations, with its one incorporated municipality having a separate vulnerable population ranking of high.</i>
--	--	---

Higher-capacity jurisdictions are generally better positioned to manage activities such as planning, engineering and design, procurement, grant administration, program management, and long-term operations and maintenance. Smaller jurisdictions often have fewer dedicated planning staff, stormwater tools, and local funding sources, increasing reliance on county services, Councils of Governments (COG), Blueprint staff, or other regional partners. Lack of a full-time community planner, lack of an established planning department, and/or lack of a planner or engineer with knowledge of local hazards and risks were most common among the smallest jurisdictions, highlighting where follow-up and targeted assistance may be warranted.

These findings have direct implications for implementation. Capacity constraints can affect a jurisdiction's ability to identify needs, develop projects, secure funding, and manage implementation over time. Existing support from Blueprint staff, COG partnerships, and programs such as RCCCP can help supplement local capacity, but additional recurring resources and sustained technical assistance will be needed to address gaps more comprehensively over time.

COMMUNITY ENGAGEMENT & DISCOVERY

People and places in the White Oak River Basin are best protected when communities understand flood risks, share ideas about how flood risks can be reduced, and actively participate in resilience planning. To create a community-informed River Basin Action Strategy (RBAS), an Outreach and Engagement Plan (Appendix B) was developed. The Outreach and Engagement Plan (O&E Plan) established a framework for connecting with local governments and other organizations that play direct roles in flood resilience planning throughout the White Oak River Basin. It served as a roadmap of intent to direct specific engagement activities.

The O&E Plan supports the Blueprint program’s mission: to provide local governments, state agencies, and partners with the data, tools, and processes to guide investments that minimize the cost and disruption of future flooding. The plan follows established guidance from the [NCDEQ Public Participation Plan](#) to promote transparency and address the changing diversity of North Carolina’s population and culture.

Building on the valuable information gathered during these engagement efforts, the White Oak RBAS reflects the flood resilience needs of communities across the river basin.

Engagement with Local Communities & Agencies

River Basin Action Stakeholders

During Phase I of the Blueprint Framework development in 2024, NCDEQ piloted the Blueprint approach in the Neuse River Basin, engaging over 150 subject matter experts and key stakeholders through six Technical Advisory Groups, a Neuse Regional Advisory Group, and a Principal Advisory Group. The structure and approach used in the Neuse River Basin informed the stakeholder engagement model later established for the White Oak River Basin, adapting lessons learned from the pilot to support effective participation and input.



Building on Phase I pilot efforts, the project team formed a River Basin Advisory Group (RBAG) to advise the overall RBAS development and a Blueprint Partners group focused on broad participation for the White Oak Basin. These groups served as key forums for stakeholder engagement, facilitating coordination, information sharing, and feedback. Each group provided critical perspective for the Action Strategy development and will be discussed in more detail on the following pages.

In addition to formalized outreach activities, NCDEQ also engaged stakeholders in the White Oak and other river basins through engaging with programs, events, and networks outside the Blueprint program. This included presentations at:

- Southeastern NC Community Rating System Users Group,
- Newport and Jacksonville Resilient Coastal Communities Program meetings,
- North Carolina Beach, Inlet & Waterway Association conference and
- Carteret County Down East Resilience workshops.

It also included participation in the National Oceanic and Atmospheric Administration’s Adaptation Planning for Coastal Communities stakeholder workshop attendance at numerous meetings regarding sister agency funding agreements, direct funding contracts, and partnership with the Agriculture Pond Retrofit Pilot Project; and over 75 direct outreach stakeholder meetings. NCDEQ also provided weekly virtual office hours for Blueprint Tool walk-through and questions. NCDEQ also provided weekly virtual office hours for Blueprint Tool walk-through and questions. This effort reflects the state’s commitment to connecting with those who can share local knowledge and technical expertise, ensuring that the needs and context of Blueprint communities are at the center of the RBAS.

Blueprint Stakeholder Participants

For the White Oak River Basin, stakeholders were identified and engaged from across the basin’s communities. The stakeholder identification process sought to include representatives from local, regional, state, tribal, academic, nonprofit, military, and private-sector organizations to ensure that planning efforts incorporated a wide range of technical knowledge, community priorities, and implementation considerations. This approach helped create a balanced and inclusive forum for collaboration, supporting the development of strategies that are both locally informed and regionally relevant. Emphasis was placed on local government participation because of their critical role in developing and executing flood risk reduction actions.





White Oak River Basin Advisory Group

Blueprint Partners

The White Oak RBAG was created to provide subject-matter knowledge and local insights throughout Action Strategy development milestones. The RBAG was composed of subject matter experts from state agencies, local and regional governments, nongovernmental organizations, academic institutions, and technical fields. Members pointed to research on flooding impacts, best practices for flood resilience actions, and creative approaches for the most challenging flooding problems. This input helped to shape the key topics assessed in the Vulnerability Assessment as well as the White Oak River Basin Vision and Guiding Principles, which guided development of the Action Strategy. The RBAG also sourced community resources for action identification. RBAG members provided continual support to ensure that the RBAS is practical, effective, and responsive to the needs and priorities of the White Oak River Basin communities.

The Blueprint Partners included a broad and diverse range of stakeholders—including governmental agencies, non-profit organizations, and others—to capture locally distinct information about flooding within their community. Among other topics, the Blueprint Partners provided input on the development of the guiding principles, the Vulnerability Assessment, and project identification and prioritization.



White Oak RBAG Meetings Summary

The White Oak RBAG met five times over the course of Action Strategy development: March 2025, May 2025, October 2025, June 2026, and August 2026. The first meeting (March 2025) focused on gathering input from RBAG members on the planned Action Strategy development process. The second meeting (June 2025) focused on flood concerns in the river basin that included literature review results, findings from the Community Capacity Assessment, overview of the Blueprint Tool, and breakout groups to solicit input on identified actions. During the third meeting (October 2025), RBAG members identified priorities and needs within the basin to inform the development of the vision statement and guiding principles for the RBAS. The fourth meeting (June 2026) reviewed the preliminary results of the Vulnerability Assessment and provided walk through of the Blueprint Tool to demonstrate how to submit actions for inclusion in the RBAS. The final meeting (August 2026) presented the draft RBAS and provided details on how to provide comments and feedback.



Blueprint Partners Meetings Summary

The Blueprint Partners met five times over the course of Action Strategy development: May 2025, July 2025, October 2025, June 2026, and August 2026. The first meeting (May 2025) provided overview of Blueprint program, including the planning effort and the Blueprint Tool. The meeting also reviewed expectations and role of partners, provided overview of the RBAG and RBAS, and reviewed findings from the literature review. The second meeting (July 2025) focused on flood concerns in the river basin that included literature review results, actions identified to-date, gap analysis, findings from the Community Capacity Assessment, overview of the Blueprint Tool, and breakout groups to solicit input on identified actions. During the third meeting (October 2025), Blueprint Partners identified priorities and needs within the basin to inform the development of the vision statement and priorities to guide the development of the RBAS. The final meeting (June 2026) reviewed the preliminary results of the Vulnerability Assessment and provided additional walk through of Blueprint Tool to demonstrate how to submit actions for inclusion in the RBAS.



Local Government Survey

In December 2025, the project team launched a dynamic local government survey to capture feedback on the large inventory of pre-existing flood resilience actions. These actions, captured in the *White Oak River Basin Actionable Data Collection, Modeling, and Analysis Report*, came from diverse sources such as hazard mitigation plans, comprehensive plans, stormwater plans, regional resilience plans, and others. This survey allowed local government users to display only actions identified for their jurisdiction and provide feedback on the relevance of those actions. Users indicated for each action whether it was completed, underway, not started but still desired, or no longer relevant. The survey captured feedback from 9 communities about a total of 303 actions. Actions described as “not started but still desired,” or “underway” with notes about needing additional resources, were add to the prioritization list.



Dock and Oyster Farms

FLOOD RISK PLANNING & ANALYSIS

Flood risk planning in the White Oak River Basin identifies where flooding occurs and the extent to which people, buildings, and systems are exposed under both current and future conditions. For this Action Strategy, a basin-wide Vulnerability Assessment (Appendix E: Flood Risk and Vulnerability Analysis Report) was conducted to provide a data-driven view of how flood hazards, development patterns, and assets interact and influence flooding impacts across the White Oak River Basin.

The assessment considered both flood risk and flood vulnerability across the basin. Flood risk focuses on the magnitude and distribution of exposure, including people, structures, assets, and more, associated with a 100-Year Storm event and how outcomes are expected to change over time. Flood vulnerability reflects how that exposure translates into impacts on people, housing, infrastructure, and essential services.

While flood risk describes where flooding occurs and what is exposed, vulnerability helps characterize where flooding is more likely to disrupt daily life and affect populations facing greater challenges preparing for, responding to, and recovering from flood events. Across the basin, vulnerability varies based on several characteristics including development patterns, infrastructure concentration, and the distribution of potentially underserved block groups (PUBGs). Assessing vulnerability as part of this Action Strategy helps support and inform targeted flood resilience actions across the White Oak River Basin.

Explore Flood Data in the Blueprint Tool

Detailed flood maps and risk data can be explored through the [Blueprint Tool](#) (see the [Tool's quick start guide](#)). The Tool also includes impact assessments and community-scale vulnerability information for communities throughout the White Oak River Basin. This vulnerability assessment and additional flood risk data can be viewed within the Tool for local governments and organizations to explore, craft, analyze, and evaluate flood resilience actions. This advisory data can help support communities in their long-term flood resilience planning, as the data available includes flood risk extents based on future conditions (2050 and 2100).

Flood Risk

Flood risk in the White Oak River Basin is shaped by multiple flood sources that vary across the basin and, in some cases, combine to produce compound flooding. Coastal flooding remains the dominant driver, primarily due to geographic characteristics, short river conveyances, and high susceptibility to storm surge, wave action, and chronic high-tide flooding. When combined with riverine flooding, these coastal factors can lead to severe drainage blockages downstream, greater flood depths and extended periods of inundation, underground hydraulic failures due to extreme saturation, and cascading infrastructure breakdowns. These conditions are expected to worsen as flood extents expand under future conditions, heavier rainfall increases runoff, continued development adds impervious cover, and coastal influences intensify flooding in downstream communities.

Across the basin, flood behavior reflects differences in topography, land use, and other location and vulnerability-based characteristics (for more information on geographic influences on flood risk see Appendix E. Flood Risk and Vulnerability Report). While there is considerable variation in flooding hazards and impacts across the basin, there are some themes that are helpful in characterizing risk and vulnerability in different community contexts.

In the more urbanized and rapidly developing areas (including Wilmington, Jacksonville, and surrounding communities), flood risk is also influenced by urban stormwater and flash flooding. In those areas, concentrations of cement and other types of impervious cover can overwhelm drainage systems and increase localized flooding. In the lower relief inland portion of the basin, broader floodplains and slower drainage contribute to extended inundation durations and slower recovery. This kind of disruption from flooding can particularly affect agricultural assets (more than 100 agricultural buildings are exposed to the 100 year storm in the White Oak River Basin), as well as transportation corridors and access to population centers.

In areas bordering the estuaries, Core Sound, and Bogue Sound, flood hazards are shaped not only by localized stream and riverine flow but also by tidal processes (including king tides), storm surge, backwater effects, and more intense rainfall, creating compound flooding conditions in communities such as Beaufort, Morehead City, Swansboro, Emerald Isle, North Topsail Beach, and in low-lying areas around Harkers Island and MCB Camp Lejeune. Localized heavier rainfall is an especially acute driver in more heavily urbanized areas.

The White Oak River Basin has experienced profound, compounding impacts from major tropical systems since the 1990s. Hurricane Fran (1996) and Hurricane Floyd (1999) caused extensive wind damage, severe coastal storm surge, and prolonged estuary inundation that severely disrupted local fisheries and coastal infrastructure. In 2018, Hurricane Florence brought catastrophic, unprecedented impacts to the basin, making landfall nearby and subjecting barrier island communities, low-lying coastal towns like Swansboro and Beaufort, and major installations like MCB Camp Lejeune to record-breaking rainfall, extreme storm surge, and multi-day inundation. Storms systems such as Hurricane Matthew (2016) and Hurricane Dorian (2019) further exposed these vulnerabilities through heavy localized rainfall and recurring high-tide and surge flooding across the basin's coastal, agricultural, and maritime assets.

These flood sources may occur independently or concurrently and can affect human safety, residential and commercial structures, transportation systems, utilities, critical facilities, and natural systems. Understanding the different sources and locations of flooding across the White Oak River Basin provides important context for the current and future flood risk results presented in the following pages.



Cow Channel at Hammocks Beach

Current Conditions - Risk

Under current conditions, approximately 19% of the White Oak River Basin’s land area is exposed to flooding during a 100-Year Storm event. Additionally, flooding exposure includes 12,000 of the basin’s 189,000 households, or 6% of the basin-wide housing stock (Table 1). Figure 6 shows the modeled existing 100-Year Storm extent and provides spatial context for how exposure varies across the basin. Within the Basin, the counties with the greatest flood exposure from the 100-Year Storm extent are Pender, Carteret, and Onslow. The municipalities with the greatest area in the 100-Year Storm extent are Beaufort, Jacksonville, Morehead City, North Topsail Beach, Surf City, and Wilmington.

Figure 7 shows the distribution of potentially underserved populations across the basin.

Table 1. Housing at Risk by Flood Scenario

	10-Year Storm (Current Conditions)	100-Year Storm (Current Conditions)	500-Year Storm (Current Conditions)
Number of houses at risk (0+ feet)	360	11, 780	23, 772
Value of houses at risk (0+ feet)	\$7,118,582	\$718,565,619	\$2,049,816,672
Percentage of total housing in the basin	0.2%	6.2%	12.6%

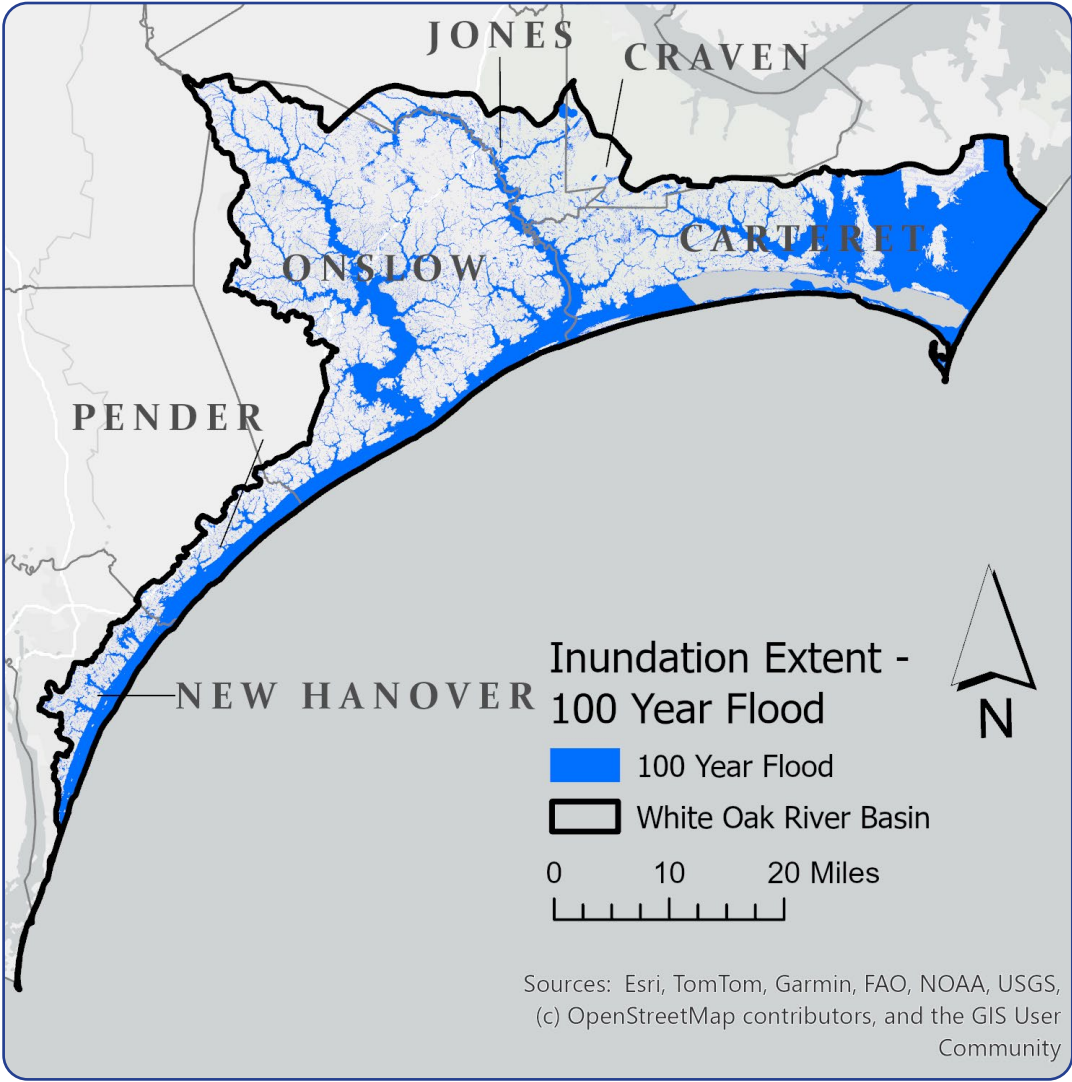


Figure 6. Flood extents for the 100-Year Storm event

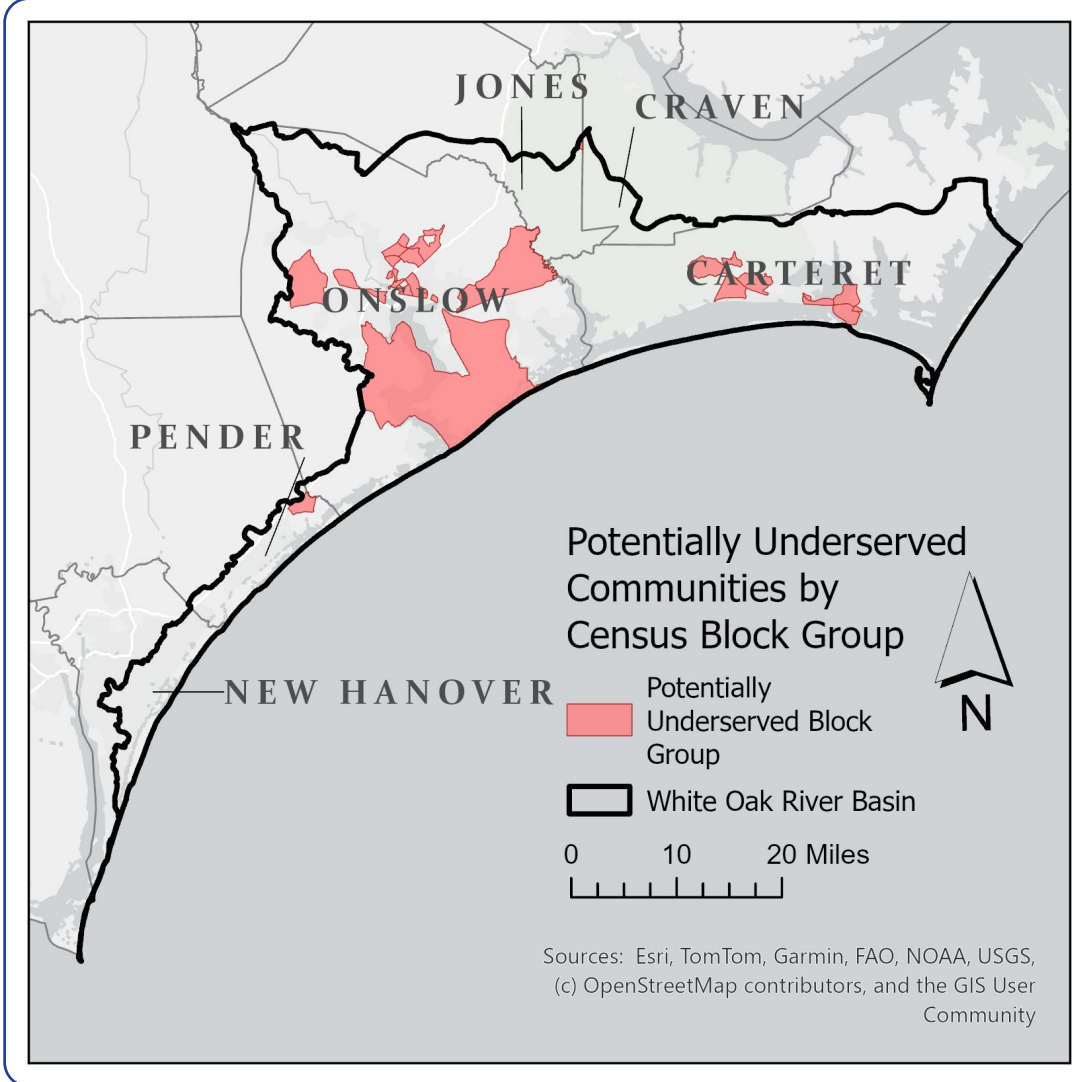


Figure 7. Distribution of potentially underserved populations





Future Conditions - Risk

Under mid-century future conditions, flood exposure increases across the White Oak River Basin (Figure 8 and Table 2). Basin-wide land exposure is projected to reach approximately 22%, a 3% increase from current conditions, and increase again to 28% by 2100 (Figure 9). Household exposure is also projected to increase from approximately 6% to 9%. This results in 17,000 households projected to be exposed to flooding by 2050 during a 100-Year Storm, a 44% increase from current conditions.

Figure 7 (previous page) shows the distribution of potentially underserved communities, including communities with fewer resources to prepare for, respond to, or recover from flooding. These areas may warrant particular attention during action refinement, technical assistance, and implementation planning in relation to increased exposure over time.

As future flood exposure increases across the basin, implications are expected to vary by localized area, particularly when comparing barrier island locations to inland locations, building a case for why area-specific flood resilience approaches are needed.

Vulnerability assessment results indicate that the extent of land area flooded will increase in the future compared to existing conditions. As a result, some communities that have not historically had flooding issues will be impacted in the future.

Table 2. Future Floodplain Growth by Municipality*

Community	Inland/ Barrier Island	Growth of Area in Floodplain – today to 2050	Growth of Area in Floodplain – today to 2100
Indian Beach	Barrier Island	293%	407%
Pine Knoll Shores	Barrier Island	292%	463%
Bogue	Barrier Island	229%	375%
Cape Carteret	Inland	227%	390%
Cedar Point	Inland	207%	296%
Emerald Isle	Barrier Island	196%	316%

*Communities where the current 100-year floodplain exposure was less than 5 percent of the areal extent were excluded from the analysis to avoid overrepresentation of communities with very minor empirical change in the floodplain.

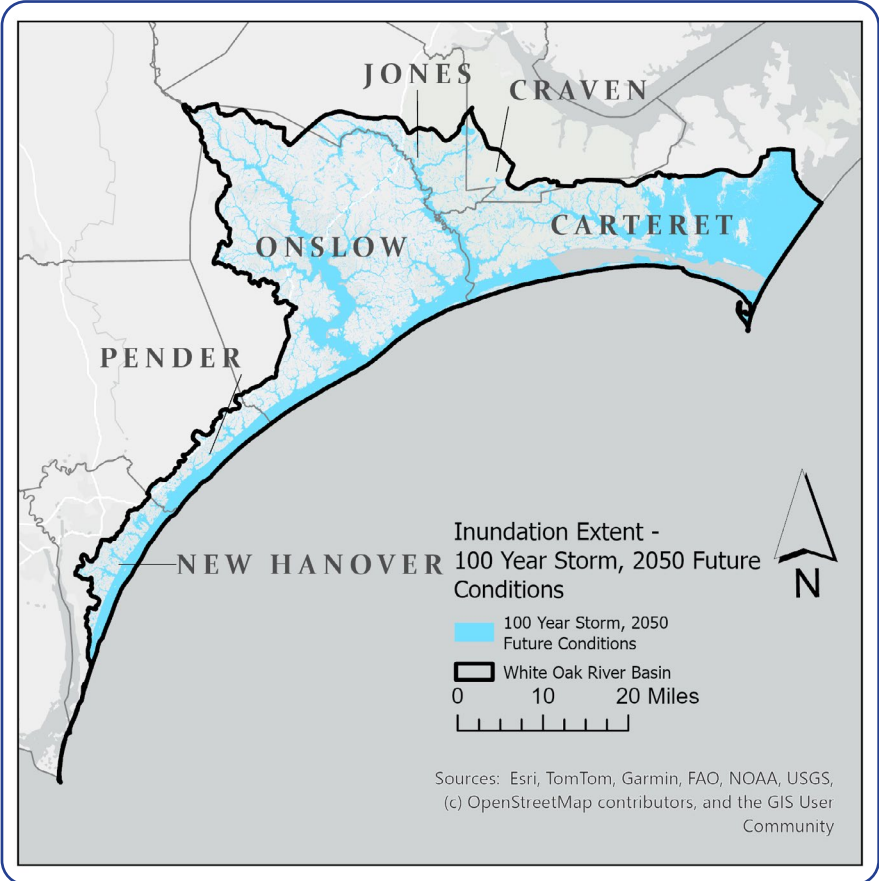


Figure 8. Flood extents for the mid-century (2050) 100-Year Storm

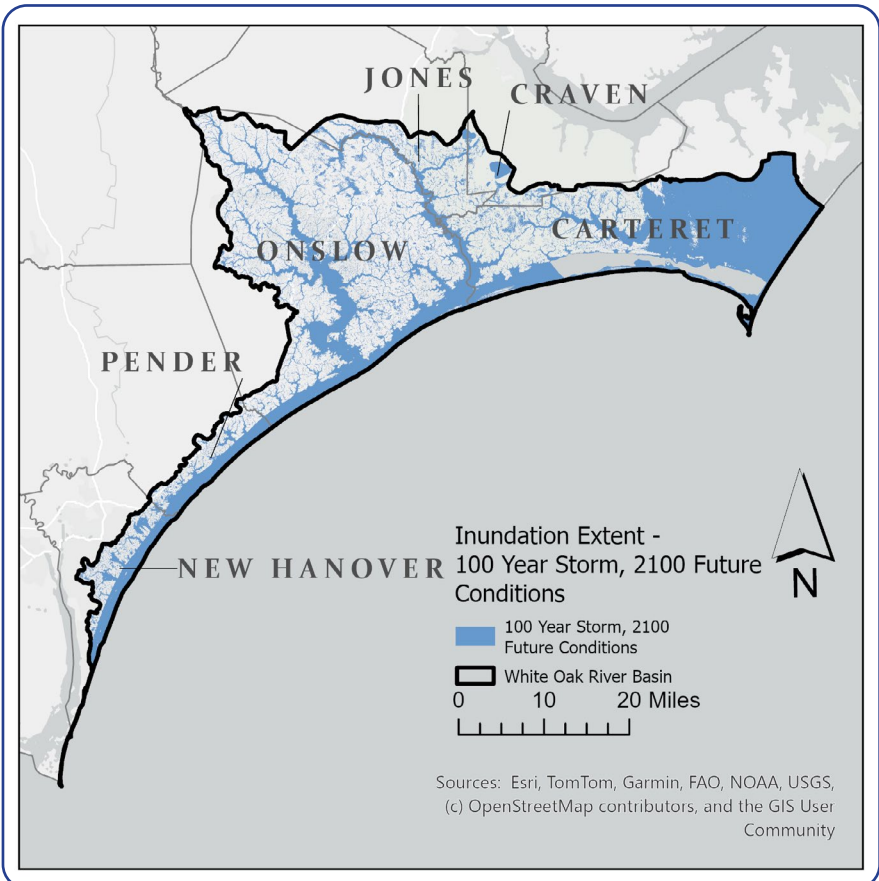


Figure 9. Flood extents for the end-of-century (2100) 100-Year Storm





Flood Vulnerability Analysis

Current Conditions - Vulnerability

Under current conditions, flood vulnerability across the White Oak River Basin reflects the distribution of exposed households (Figure 10), critical facilities, including hospitals and emergency services (Figure 11), and roadway infrastructure and structurally deficient bridges (Figure 12). As with flood risk, vulnerability is not uniform across the basin. Flood exposure may cause roadway inundation and impact exposed critical facilities, increasing the potential for service disruptions during flood events. Roadway exposure is already widespread, especially in coastal portions of the basin, where riverine flooding, coastal flooding, storm surge, king tides, and heavy localized rainfall can combine to affect transportation corridors. Water and transportation infrastructure have notable exposure under current conditions. Flood impacts under current conditions extend beyond direct building damages to affect broader community function and mobility.

Residential structures comprise the largest share of exposed buildings basin-wide and remain the dominant contributor to damages under current conditions. Potentially underserved communities in Onslow, Carteret, and Pender Counties may require flood resilience actions that are tailored to individual needs and vulnerabilities, such as elevation projects with custom ADA-compliant retrofits, accessible community resilience hubs, multilingual warning systems and risk information, affordable replacement housing options, and neighborhood-specific infrastructure upgrades. To assess the potential vulnerability of housing stock in the White Oak River Basin, approximately 189,000 housing structures were analyzed. This included single-family dwellings, mobile/manufactured homes, duplexes, apartments, condominiums, hotels/motels, dormitories, and nursing homes. The number of at-risk households ranges from approximately 400 during a 10-year storm to nearly 12,000 in a 100-year storm (a 2,900% increase), and 24,000 in a 500-year storm (a 100% increase). This represents a range of total at-risk residential property values of \$7.1 million to \$2 billion. (Figure 8.)

Counties in the White Oak River Basin include low- and moderate-income (LMI) households exposed to the current 100-year floodplain, ranging from approximately 375 in Pender County out of nearly 23,000 households (2% of the total), to at least 1,000 in Carteret County out of just over 30,000 households (3% of the total). The largest number of LMI households at the municipal level are located in the Town of Surf City (215 out of 1,500 or 14% of total households).

Table 3 shows how the top 9 communities rank for population, infrastructure, environment, and economy under existing conditions. The higher the number the greater the impact for each category.

Table 3. Community risk scores for overall, population, infrastructure, environment, and economy categories under existing (100-Year) conditions.

Community	Overall Impact	Population Impact	Infrastructure Impact	Environmental Impact	Economic Impact
Town of Topsail Beach	36	39	54	0	53
Town of Wrightsville Beach	35	29	61	6	42
Town of Atlantic Beach	35	29	46	20	47
City of Wilmington	34	29	35	30	41
Town of Carolina Beach	33	35	36	8	52
Town of Cedar Point	22	18	37	5	28
Town of Kure Beach	18	11	27	0	33
Town of Indian Beach	16	19	15	0	29
Town of Emerald Isle	15	10	19	4	26

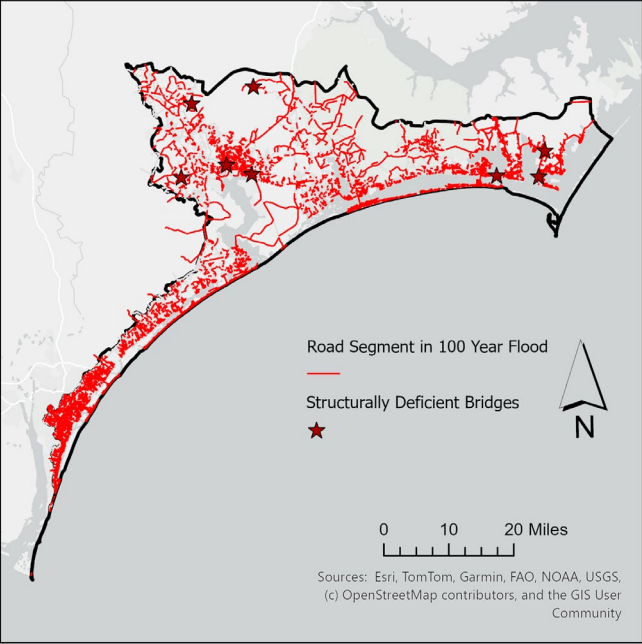
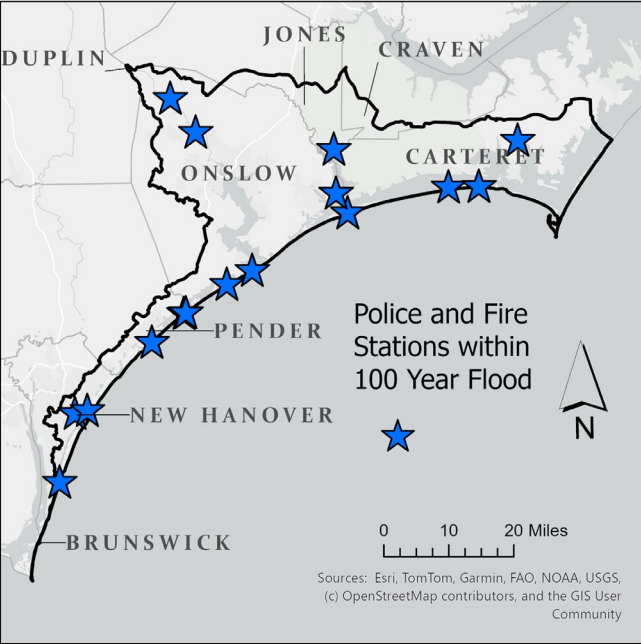
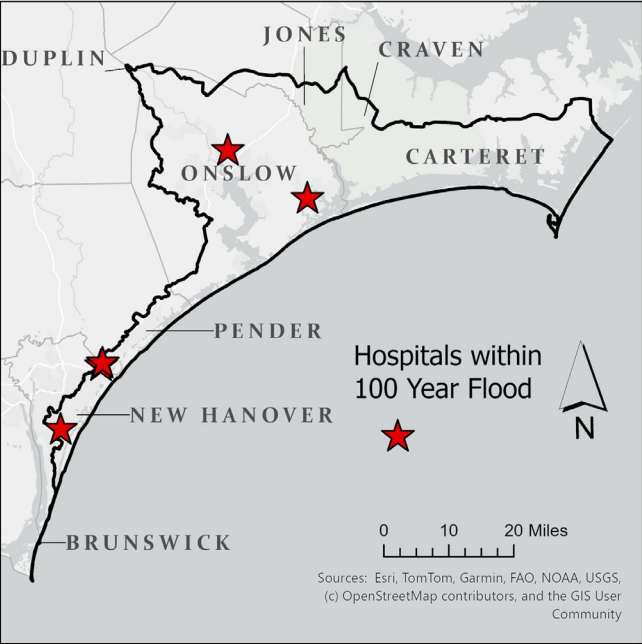
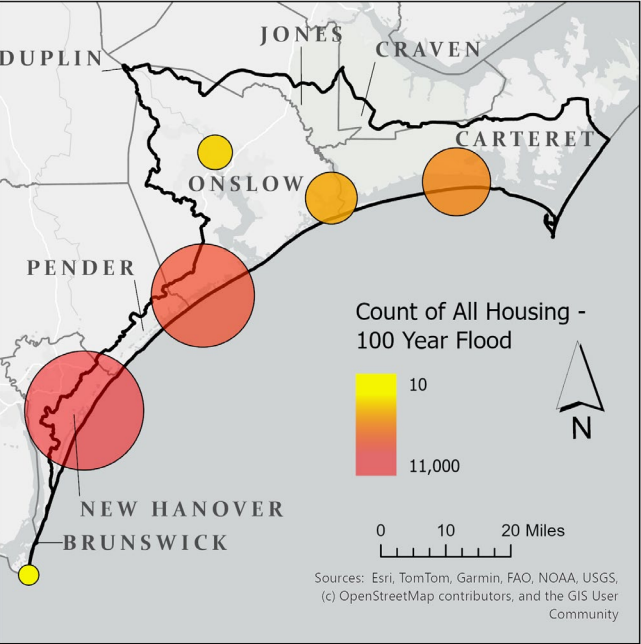


Figure 10. Count of all households exposed to the 100-Year Storm

Figure 11. Critical facilities, including hospitals and emergency services exposed to the 100-Year Storm

Figure 12. Roadway infrastructure exposed to the 100-Year Storm

Future Conditions - Vulnerability

Flood vulnerability is expected to increase across the White Oak River Basin with expanded exposure affecting a greater share of residents, residential structures, critical facilities, and infrastructure systems. Increased exposure increases the potential for flooding to cause disruptions to housing, mobility, utility service, emergency response, and other essential community functions.

Counties in the White Oak River Basin are projected to experience up to a 59% increase in residential building exposure. The number of at-risk households ranges from approximately 17,000 during a 100-year storm under 2050 future conditions to nearly 27,000 during a 100-year storm under 2100 future conditions. This represents a range of at-risk residential property values of \$1 billion for the 100-year storm in 2050 to \$2.1 billion for the 100-year storm in 2100. Importantly, the numbers and values of at-risk housing units more than doubles from the 100-year storm event under current conditions to the 100-year storm event under 2100 future conditions. Figure 13 shows the

distribution of at-risk housing under 2050 future conditions and Figure 14 shows the distribution of at-risk housing under 2100 future conditions.

Land exposure and damages are expected to increase, with flooded land area increasing from approximately 19% to 22% basin wide. Total exposure increases from approximately \$719 million to \$1.1 billion and estimated damages increase from approximately \$756 million to about \$2.2 billion.

Figure 15 shows building damages by occupancy class under existing and mid-century 100-Year Storm conditions for the White Oak Basin. Commercial structures account for the highest exposure in the basin with more than 2,200 commercial structures totaling nearly \$800 million in value exposed by mid-century. Future flooding is expected to have growing implications across sectors, serving as motivation for the development of this Action Strategy.

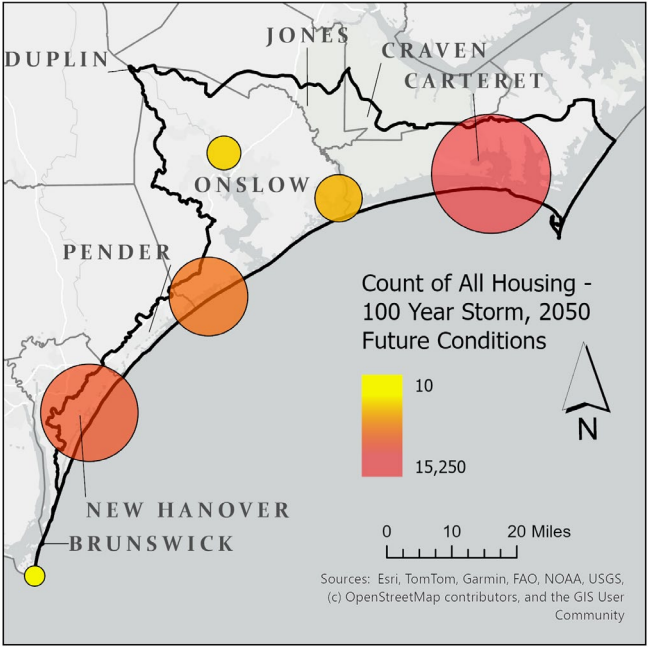


Figure 13. Distribution of at-risk housing under 2050 future conditions

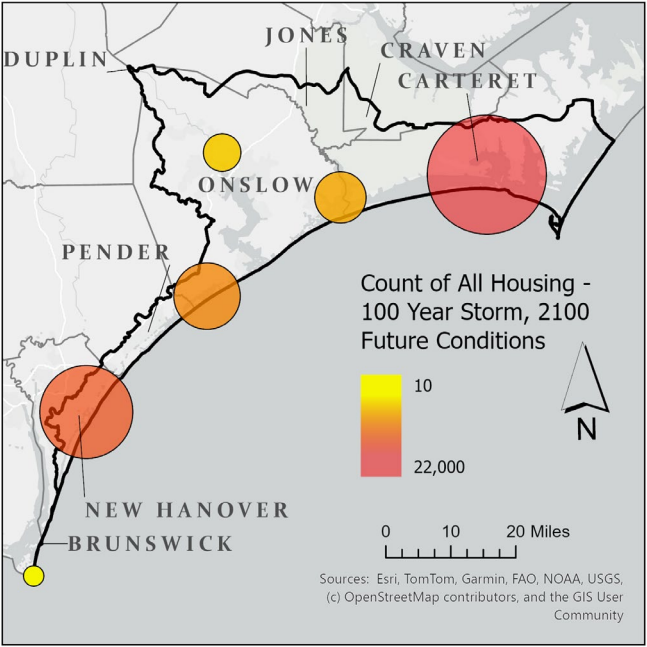


Figure 14. Distribution of at-risk housing under 2100 future conditions

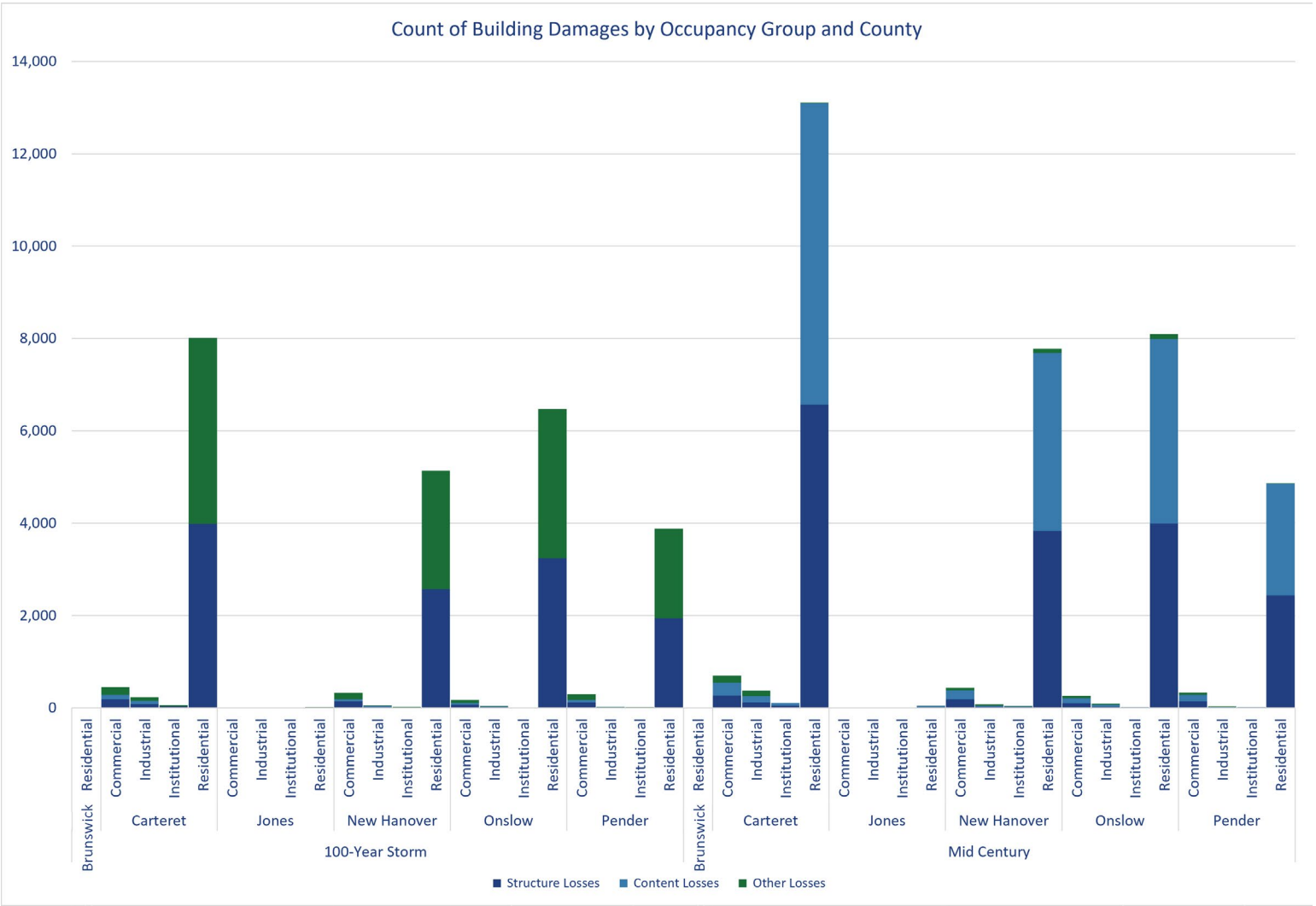


Figure 15. Building damages by occupancy group and County.
* Craven and Duplin counties have negligible counts and are not shown on the graphic above.

Fluvial, Pluvial, Coastal, and Urban and Stormwater - Current and Future

The Blueprint program included support for the NCEM’s development of basin-wide 2D engineering hydrologic and hydraulic models. The modeling effort included building-level risk data for current land use and precipitation conditions, reported as risk scores, for all impacted buildings in the White Oak River Basin. The NCEM 2D models incorporate future land use and precipitation conditions for two climate scenarios and two buildout conditions scenarios that incorporate future land use (2050 Buildout and 2100 Buildout).

The Mid Century Higher (MCH) scenario represents estimated future conditions for the year 2050. The End of Century Higher (ECL) scenario represents estimated future conditions for the year 2100. The future land use dataset is created by the US Environmental Protection Agency (EPA) and utilizes future population data to create scenarios that predict land use through 2100 (US EPA, 2025). Further information on the modeling of the future and buildout conditions can be found in Appendix E.

The NCEM 2D modeling has basin-wide coverage and includes urban areas of communities. Since the 2D modeling includes urban areas, the modeling provides flooding extents, risk and vulnerability in areas general referenced as stormwater flooding. For consistency with fluvial areas, information included in the RBAS utilized data

from the NCEM’s 2D modeling and the Blueprint Tool for urban areas. Communities, especially those with National Pollutant Discharge Elimination System (NPDES) Municipal Separate Storm Sewer System (MS4) programs, may have more information regarding urban/stormwater flooding in local stormwater master plans, CIP(s), or stormwater modeling that is more detailed than the data provided by the NCEM 2D modeling. In communities with more detailed data, the local data will serve as better input than the 2D modeling data for actions within the Blueprint Tool.

In addition to riverine and stormwater runoff, coastal flooding plays a dominant role in shaping flood vulnerability across the White Oak River Basin. The NCEM 2D modeling accounts for ocean- and soundside coastal dynamics—including storm surge, astronomical high tides, and sea level rise—which frequently compound with inland fluvial and pluvial flows. By integrating projected sea level rise and increased surge heights into the 2050 (MCH) and 2100 (ECL) scenarios, the modeling captures how backwater effects and elevated base water levels expand inundation boundaries, accelerate coastal erosion, and drive higher building-level risk scores in low-lying estuarine and soundside communities.



Shackleford Banks



Residual Risk – Dams and Levees

Residual risk is exposure to risk in systems where safety features have been put in place. For flooding, this is generally associated with dams and levees, and for these features residual risk is defined as the risk to flooding associated with failure of the dam or levee. In the White Oak Basin, there are no levees included in the US Army Corps of Engineers (USACE) National Levee Database. The NC Dam Safety Program indicates 13 dams in the basin, five of which are considered High Hazard. Hazard classifications are based on the height and total storage of a dam, as well as the potential for loss of life or damage to infrastructure in the event of a dam failure.

Dams have very low rates of failure making comparisons to the flooding events included in the RBAS difficult or the comparison could result in potentially misleading information. Failure can occur from multiple factors, including overtopping of the dam, defects in construction, age of the dam, and maintenance. Additionally, failure can occur concurrently with other flooding events or independently, such as with a “sunny day” failure. As such, residual risk is not included in the RBAS. Vulnerability information for dams with Emergency Action Plans (EAPs) is on file with NC Dam Safety. For more information about NC dams please visit <https://www.deq.nc.gov/DamSafety>.

Implications for the White Oak River Basin Action Strategy

Current and future flood risk and vulnerability analyses inform the White Oak RBAS and why a mix of approaches is appropriate. Results from the White Oak River Basin Flood Risk and Vulnerability Analysis Report (Appendix E) were used to develop strategic, vulnerability assessment-based actions to be considered alongside locally prioritized actions, which were developed by White Oak River Basin communities. The results of this analysis demonstrate that in order for the White Oak RBAS to be effective, it needs to include a variety of action types that address the range of different flood risk conditions across the basin.



ACTION REVIEW, CREATION, ADJUSTMENT, AND SELECTION

The White Oak RBAS translates flood vulnerability analyses and stakeholder engagement outputs into a set of flood resilience actions that can be advanced at the local, regional, or basin-wide scale. The RBAS documents a refined action set and summarizes the evaluation of actions against metrics to identify high priority actions. The flood resilience actions recommended in this RBAS include new actions as well as actions previously documented in locally adopted plans and other relevant documents.

Locally Prioritized Actions

Local governments and their closest partners have a critical understanding of flood resilience needs in their communities. Most of the actions in the RBAS were submitted by local governments as part of Local Action Plans in the Blueprint Tool (or through other communication channels when technology was a barrier). These actions reflect local support and local needs. Many of these actions have already been publicly identified, prioritized ,and vetted in the community. They may be specific or broad, developed or undeveloped, and they may have no funding, partial funding, or nearly complete funding.

Additional Actions

Additional actions were added from the pre-identified actions list to generate greater geographic balance in the RBAS. A geographic analysis of Tool submittals and review of the communities with the highest vulnerability identified communities where no resilience actions had been submitted. In these locations, actions were added based on:

- Responses to the local government survey,
- RCCP plans where applicable, and
- Other pre-identified actions from existing plans in the literature review.

Action Prioritization Process

The action prioritization process used a structured screening and scoring approach to compare flood resilience actions in a consistent and practical way. The methodology was designed to evaluate actions based on their general intent, likely benefit, feasibility, local support, and alignment with the Basin's guiding principles, which were developed during the community engagement process. The methodology does not require engineering or design-level detail. It was intended to work for a broad range of action types, including capital and non-capital actions such as projects, planning efforts, policy measures, preparedness actions, and other implementation strategies.

Action Screening

Before an action was scored, reviewers use a basic screening test to determine whether it addressed the reduction of flood risk or flood impacts. Actions advanced to scoring if they had a clear flood resilience purpose and/or were intended to reduce flooding, flood damages, exposure, disruption, or recovery burden. This approach allowed the review to include a wide range of action types while maintaining a focus on flood resilience. In general, the following actions passed screening:

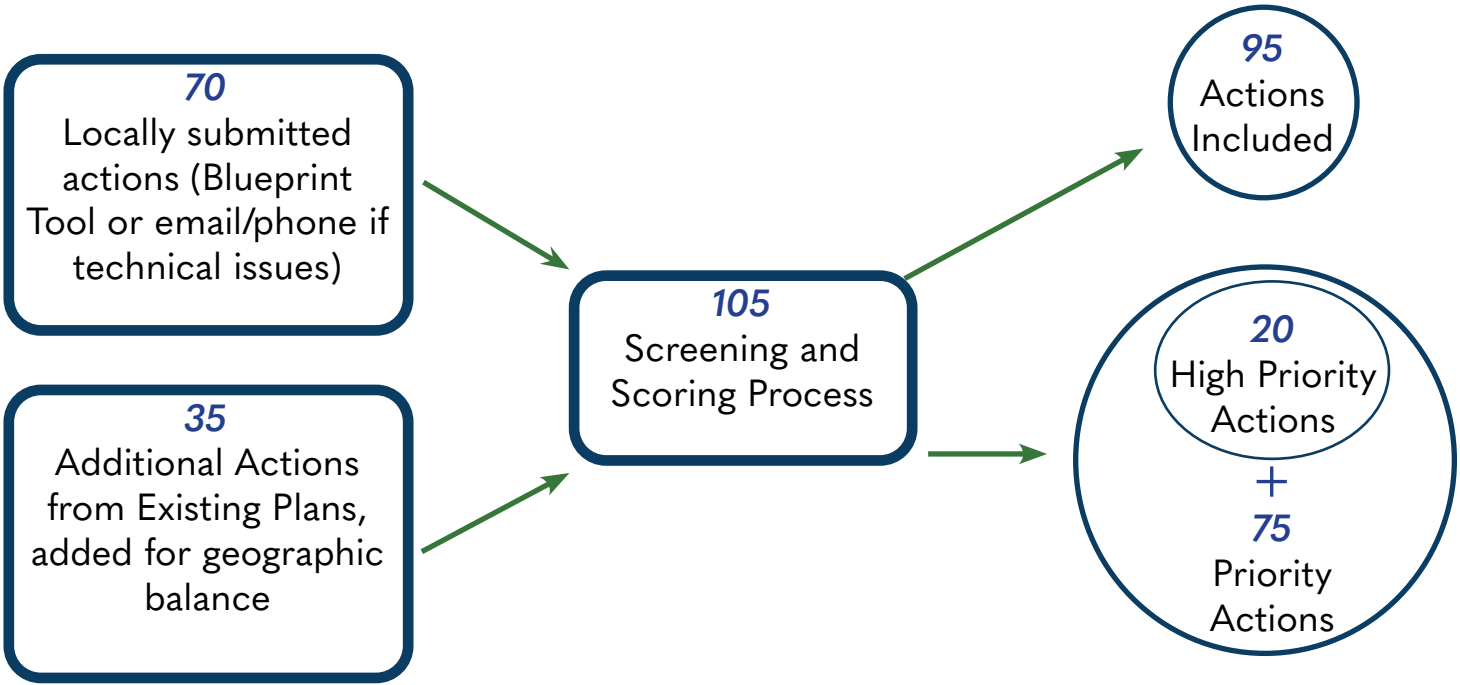
- Flood mitigation,
- Buyouts,
- Elevation,
- Floodproofing
- Floodplain or wetland restoration that supports risk reduction
- Flood planning
- Warning systems and preparedness

In total, 95 actions were included in the RBAS. All actions meeting the screening criteria were included in the RBAS, and are detailed in Appendix H (Prioritized Actions Profiles).

Action Scoring

After screening, actions were scored using four equally weighted factors: Flood Resilience Benefits, Local Support, Feasibility and Technical Readiness, and Advancement of Guiding Principles. Reviewers used all relevant, readily available information and the general intent of the action, which was especially important because many actions were early-stage or described with limited detail. Where supporting documentation was available, reviewers were encouraged to use it to inform scoring. Apart from the Feasibility and Technical Readiness factor, actions were not penalized simply because they were early stage if the intent was clear and relevant.

- Each factor sought to capture key components of the Blueprint Program’s intent. The Flood Resilience Benefits factor assessed the extent to which an action reduced flood risk, flood damages, exposure, disruption, or recovery burden.
- The Local Support factor reflected community, local government, or implementing partner backing and whether the action appeared to reflect local priorities.
- The Feasibility and Technical Readiness factor captured whether the action appeared practical and ready to advance based on the information available.
- The Advancement of Guiding Principles factor assessed whether the action supported one or more basin-specific guiding principles in a clear and meaningful way. This last factor was evaluated through short narrative questions and a binary yes/no determination for each principle, allowing for a quick but direct connection to the basin framework.



High Priority Action Selection

To select high priority actions, actions were ordered by score and the highest scoring actions were marked as high priority. Approximately 25 percent of the scored projects were selected as high priorities, or 20 actions total. These actions are listed in the [“Prioritized Basin Actions”](#) section and marked in Appendix H (Prioritized Actions Profiles).

Local Action Plans

Local governments are strongly encouraged to continuously update their flood resilience actions within their Local Action Plans in the Blueprint Tool. Therefore, local governments can stay updated on projects that are being pursued and implemented to identify potential co-benefits, and DEQ can be aware of the potential technical and financial needs of communities throughout the basin. Projects prioritized through Local Action Plans are eligible for Blueprint funding.

Action List

The 95 actions in the White Oak River Basin Action Strategy include a diversity of action types, costs, and locations. The following list provides key characteristics for each action. The list is organized alphabetically by action type and then by cost. Some actions have a variable cost estimate based on yet-to-be-determined details such as potential participation level for buyouts or elevations, opportunities related to siting an action, or the action is a combination of planning and implementation. For these actions, the relative cost shown in the Action List may vary, potentially dramatically, given the final scale and scope of the action when implemented. For actions with more specific estimated costs, costs are included in Appendix H (Prioritized Actions Profiles).



PRIORITY ACTION LIST

Table 4: Priority Action List

Action Name*	Action Type	Relative Cost Estimate**	Community
Cedar Point Voluntary Repetitive Loss Buyouts	Acquisition/Demolition/ Buyouts	\$-\$\$\$\$\$	Cedar Point
Property and Infrastructure Retrofits	Acquisition/Demolition/ Buyouts	\$-\$-\$\$\$	North Topsail Beach
Carolina Beach Buyout or Property Transition Exploration	Acquisition/Demolition/ Buyouts	\$-\$-\$\$\$	Carolina Beach
Mitigate High-Risk Properties through Buyouts, Retrofits, Elevations, and Open Space Conservation	Acquisition/Demolition/ Buyouts	\$-\$-\$\$\$	New Hanover County
Newport Abandoned Property Buyouts and Recreational Conversion	Acquisition/Demolition/ Buyouts	\$-\$-\$\$\$	Newport
Innovative Floodplain Management in New Hanover County	Advanced Regulations (Land Use and Impervious Surface Restrictions)	\$-\$\$\$\$\$	New Hanover County
Pages Creek 319 Water Quality Enhancement Project	Bioretention	\$-\$-\$	New Hanover County
Green Infrastructure around Carolina Beach Lake	Bioretention	\$\$\$\$-\$\$\$\$\$	Carolina Beach
Cape Fear Public Utility Authority Water and Wastewater Vulnerability Assessment	Critical Infrastructure	\$	New Hanover County, Wrightsville Beach, Wilmington
Cape Fear Public Utility Authority Tactical Redundancies	Critical Infrastructure	\$-\$-\$	New Hanover County, Wrightsville Beach, Wilmington
Morehead City Stormwater Improvements on Highway 70 / Evacuation Route	Critical Infrastructure	\$\$	Morehead City
Pine Knoll Shores Asset Mapping	Critical Infrastructure	\$\$	Pine Knoll Shores

*Actions that did not fit neatly into an action type are marked miscellaneous. Miscellaneous actions include outreach, planning, data collection, and other flood resilience steps not captured in the typology.

** Cost estimates are as follows: \$ < \$100,000; \$\$ \$100,000 - \$500,000; \$\$\$ \$500,000 - \$1M; \$\$\$\$ \$1M - \$5M; \$\$\$\$\$ > \$5M. Some actions have a variable cost estimate based on yet-to-be-determined details such as potential participation level for buyouts or elevations, opportunities related to siting an action, or the action is a combination of planning and implementation. For these actions, the relative cost shown in the Action List may vary, potentially dramatically, given the final scale and scope of the action when implemented.



Action Name*	Action Type	Relative Cost Estimate**	Community
Cape Fear Public Utility Authority Emergency Generators	Critical Infrastructure	\$-\$-\$-\$	New Hanover County, Wrightsville Beach, Wilmington
Cape Fear Public Utility Authority Pumping Station and Infrastructure Retrofits	Critical Infrastructure	\$-\$-\$-\$	New Hanover County, Wrightsville Beach, Wilmington
Pender Sewer Lift Station Flood Mitigation Program	Critical Infrastructure	\$-\$-\$-\$	Pender County
Atlantic Beach Pump Station Improvements	Critical Infrastructure	\$-\$-\$-\$	Atlantic Beach
Expand Sewer in Flood-Prone Areas - Exploration and Implementation	Critical Infrastructure	\$\$\$-\$-\$-\$	New Hanover County
Surf City Sewer Lift Station Flood Mitigation Program	Critical Infrastructure	\$\$\$-\$-\$-\$	Surf City
Historical Structure Elevation	Dry Floodproofing	\$-\$-\$-\$	Beaufort
Scales Creek Wetland Creation	Flood Storage Wetlands	\$\$\$\$	Jacksonville
Carteret County Wetland Restoration Project Phase 1	Flood Storage Wetlands	\$\$\$\$\$	Carteret County
Carteret County Wetland Restoration Project Phase 2	Flood Storage Wetlands	\$\$\$\$\$	Carteret County
Carteret County Wetland Restoration Project Phase 3	Flood Storage Wetlands	\$\$\$\$\$	Carteret County
Cape Fear Public Utility Authority Tributary Conservation	Floodplain Preservation	\$-\$-\$-\$	New Hanover County, Wrightsville Beach, Wilmington
Wisteria/Clearbrook Drive Drainage Improvement Project (Phase 2)	Floodplain Preservation	\$-\$-\$-\$	Wilmington
Open Space Corridor Prioritization Study	Floodplain Preservation	\$\$\$-\$-\$-\$	New Hanover County

*Actions that did not fit neatly into an action type are marked miscellaneous. Miscellaneous actions include outreach, planning, data collection, and other flood resilience steps not captured in the typology.

** Cost estimates are as follows: \$ < \$100,000; \$\$ \$100,000 - \$500,000; \$\$\$ \$500,000 - \$1M; \$\$\$\$ \$1M - \$5M; \$\$\$\$\$ > \$5M. Some actions have a variable cost estimate based on yet-to-be-determined details such as potential participation level for buyouts or elevations, opportunities related to siting an action, or the action is a combination of planning and implementation. For these actions, the relative cost shown in the Action List may vary, potentially dramatically, given the final scale and scope of the action when implemented.



Action Name*	Action Type	Relative Cost Estimate**	Community
Pages Creek Dunbar Headwaters Restoration Feasibility with Buyout Parcels	Floodplain Restoration	\$-\$-\$-\$	New Hanover County
Pine Knoll Shores Proactive Dune Stabilization and Protection Program	Floodplain Restoration	\$-\$-\$-\$	Pine Knoll Shores
Pine Knoll Shores Nature-based or Hybrid Stormwater Solutions	Floodplain Restoration	\$-\$-\$-\$	Pine Knoll Shores
Halls Creek Stream Restoration	Floodplain Restoration	\$-\$-\$-\$	Swansboro
Pages Creek Watershed Restoration Plan Implementation	Floodplain Restoration	\$\$\$-\$-\$-\$	New Hanover County
Recreational/Restoration Improvement for FEMA Buyout Properties	Floodplain Restoration	\$\$\$-\$-\$-\$	New Hanover County
Scales Creek Stream Restoration	Floodplain Restoration	\$\$\$\$	Jacksonville
Living Shoreline / Stabilization	Living Shorelines	-\$-\$	Morehead City
Cape Carteret Living Shorelines	Living Shorelines	\$\$\$-\$-\$-\$	Cape Carteret
Atlantic Beach Private Property Owner Outreach	Miscellaneous	\$	Atlantic Beach
Swansboro Engagement and Education on Sea Level Rise and Other Hazards	Miscellaneous	\$	Swansboro
Onslow Countywide Flood Warning and Monitoring Program	Miscellaneous	\$-\$-\$-\$	Onslow County
Pine Knoll Shores Comprehensive Shoreline Management Plan	Miscellaneous	\$-\$-\$-\$	Pine Knoll Shores

*Actions that did not fit neatly into an action type are marked miscellaneous. Miscellaneous actions include outreach, planning, data collection, and other flood resilience steps not captured in the typology.

** Cost estimates are as follows: \$ < \$100,000; \$\$ \$100,000 - \$500,000; \$\$\$ \$500,000 - \$1M; \$\$\$\$ \$1M - \$5M; \$\$\$\$\$ > \$5M. Some actions have a variable cost estimate based on yet-to-be-determined details such as potential participation level for buyouts or elevations, opportunities related to siting an action, or the action is a combination of planning and implementation. For these actions, the relative cost shown in the Action List may vary, potentially dramatically, given the final scale and scope of the action when implemented.



Action Name*	Action Type	Relative Cost Estimate**	Community
Pine Knoll Shores Salt Water Intrusion Monitoring	Miscellaneous	\$\$-\$\$\$	Pine Knoll Shores
Brunswick Flood-Prone Area Mapping for Project Review	Miscellaneous	\$\$-\$\$\$	Brunswick County
Pender Critical Facility Backup Generator Program	Miscellaneous	\$\$\$-\$\$\$\$	Pender County
Wilmington Resilient Coastal Communities Program (RCCP) Phases 1 & 2 Completion	Miscellaneous	\$\$-\$\$\$	Wilmington
Shoreline and Bulkhead Improvements	Miscellaneous	\$\$\$\$	Carolina Beach
Swansboro Townwide Floodplain Restoration Framework	Multi-Use Floodplains	\$\$	Swansboro
Wrightsville Ave Drainage and Enhancement	Permeable Pavement	\$\$\$\$	Wilmington
Green Infrastructure Suitability Analysis	Raingardens/Sand Filters/Bio-Swales	\$\$-\$\$	Holly Ridge
Atlantic Beach Dune Infiltration	Raingardens/Sand Filters/Bio-Swales	\$\$-\$\$	Atlantic Beach
Atlantic Beach Raingardens/ Sand Filters/Bio-Swales	Raingardens/Sand Filters/Bio-Swales	\$\$-\$\$	Atlantic Beach
Topsail Beach Rocky Mt Ave Drainage Improvements	Raingardens/Sand Filters/Bio-Swales	\$\$\$\$	Topsail Beach
Holly Ridge Multi-Use Path with Bioswales and GSI: Construction Phase	Raingardens/Sand Filters/Bio-Swales	\$\$\$\$	Holly Ridge
701 Scorpion Bank Restoration / Outfall Design	Riparian Buffers	\$\$-\$\$\$	New Hanover County
Vowell Avenue Culvert Replacement	Roadway Elevation/ Road Crossing Modification	\$\$-\$\$\$	New Hanover County

*Actions that did not fit neatly into an action type are marked miscellaneous. Miscellaneous actions include outreach, planning, data collection, and other flood resilience steps not captured in the typology.

** Cost estimates are as follows: \$ < \$100,000; \$\$ \$100,000 - \$500,000; \$\$\$ \$500,000 - \$1M; \$\$\$\$ \$1M - \$5M; \$\$\$\$\$ > \$5M. Some actions have a variable cost estimate based on yet-to-be-determined details such as potential participation level for buyouts or elevations, opportunities related to siting an action, or the action is a combination of planning and implementation. For these actions, the relative cost shown in the Action List may vary, potentially dramatically, given the final scale and scope of the action when implemented.



Action Name*	Action Type	Relative Cost Estimate**	Community
202 South Channel Haven Pipe Canal Bank Restoration	Roadway Elevation/ Road Crossing Modification	\$\$-\$\$\$	New Hanover County
Queens Point Project Ditch and Culvert Upgrade	Roadway Elevation/ Road Crossing Modification	\$\$-\$\$\$	New Hanover County
Evacuation Routes & Drainage in New Hanover County	Roadway Elevation/ Road Crossing Modification	\$\$\$-\$\$\$\$	New Hanover County
Hardison Hills Culvert and Emergency Access Path	Roadway Elevation/ Road Crossing Modification	\$\$\$\$	Jacksonville
Private Property Stormwater Outreach and Incentivization	Storm Water Management Activities	\$	Carolina Beach
North 20th Street tidal crossing improvement	Storm Water Management Activities	\$	Morehead City
Elisha Dr./Camberly Dr./ Gregory Rd Drainage Improvement	Storm Water Management Activities	\$\$-\$\$	Wilmington
Old McCumbers Outfall (FY28)	Storm Water Management Activities	\$\$-\$\$	Wilmington
Whisky Creek Branch (FY29)	Storm Water Management Activities	\$\$-\$\$	Wilmington
4615 Tall Tree Ln Ditch Improvement	Storm Water Management Activities	\$\$-\$\$	New Hanover County
7404 Tillson Ct / 214 Stoneybrook Rd Ditch and Pipe Upgrade	Storm Water Management Activities	\$\$-\$\$	New Hanover County
7421 Brightleaf Pipe System Upgrade	Storm Water Management Activities	\$\$-\$\$	New Hanover County
Country Place Pump System Pipe Install	Storm Water Management Activities	\$\$-\$\$	New Hanover County
Stormwater Flaps/Gates S. 14th, S. 9th Streets	Storm Water Management Activities	\$\$-\$\$	Morehead City

*Actions that did not fit neatly into an action type are marked miscellaneous. Miscellaneous actions include outreach, planning, data collection, and other flood resilience steps not captured in the typology.

** Cost estimates are as follows: \$ < \$100,000; \$\$ \$100,000 - \$500,000; \$\$\$ \$500,000 - \$1M; \$\$\$\$ \$1M - \$5M; \$\$\$\$\$ > \$5M. Some actions have a variable cost estimate based on yet-to-be-determined details such as potential participation level for buyouts or elevations, opportunities related to siting an action, or the action is a combination of planning and implementation. For these actions, the relative cost shown in the Action List may vary, potentially dramatically, given the final scale and scope of the action when implemented.



Action Name*	Action Type	Relative Cost Estimate**	Community
Atlantic Beach Stormwater Facility Improvements	Storm Water Management Activities	\$-\$ \$	Atlantic Beach
Kelly Road Capital Improvements Drainage Project	Storm Water Management Activities	\$ \$	Wilmington
Red Berry Drainage Improvement Project	Storm Water Management Activities	\$ \$-\$ \$ \$	Wilmington
Greenville Loop/Darby/Harvest Grove Lane (FY28)	Storm Water Management Activities	\$ \$-\$ \$ \$	Wilmington
Holly Ridge Stormwater Master Plan	Storm Water Management Activities	\$ \$-\$ \$ \$	Holly Ridge
Multi-site Ditch Maintenance	Storm Water Management Activities	\$ \$-\$ \$ \$	Pender County
Atlantic Beach Storm Water Infrastructure Mapping	Storm Water Management Activities	\$ \$-\$ \$ \$	Atlantic Beach
Cape Carteret Stormwater Pretreatment	Storm Water Management Activities	\$ \$-\$ \$ \$	Cape Carteret
Harbor and Marina Area Stormwater	Storm Water Management Activities	\$ \$-\$ \$ \$	Carolina Beach
Emerald Isle Multi-Method Roadway Flooding Reduction	Storm Water Management Activities	\$ \$-\$ \$ \$	Emerald Isle
Battle Park Drainage Improvements Ditch and Culvert Installation	Storm Water Management Activities	\$ \$-\$ \$ \$	New Hanover County
4709 Rushing Dr / Crosswinds Ditch and Culvert Replacement	Storm Water Management Activities	\$ \$-\$ \$ \$	New Hanover County
209 Bayshore Ditch Grading	Storm Water Management Activities	\$ \$-\$ \$ \$	New Hanover County
5115 Old Myrtle Grove Road Ditch and Culvert Upgrade	Storm Water Management Activities	\$ \$-\$ \$ \$	New Hanover County
Drainage Improvements and Master Plan	Storm Water Management Activities	\$ \$-\$ \$ \$	Pender County

*Actions that did not fit neatly into an action type are marked miscellaneous. Miscellaneous actions include outreach, planning, data collection, and other flood resilience steps not captured in the typology.

** Cost estimates are as follows: \$ < \$100,000; \$\$ \$100,000 - \$500,000; \$\$\$ \$500,000 - \$1M; \$\$\$\$ \$1M - \$5M; \$\$\$\$\$ > \$5M. Some actions have a variable cost estimate based on yet-to-be-determined details such as potential participation level for buyouts or elevations, opportunities related to siting an action, or the action is a combination of planning and implementation. For these actions, the relative cost shown in the Action List may vary, potentially dramatically, given the final scale and scope of the action when implemented.



Action Name*	Action Type	Relative Cost Estimate**	Community
Water Street Rehabilitation	Storm Water Management Activities	\$ \$-\$ \$ \$	Swansboro
Beaufort Public Housing Flood Mitigation	Storm Water Management Activities	\$ \$-\$ \$ \$	Beaufort
Whispering Pines/Masonboro Drainage	Storm Water Management Activities	\$ \$-\$ \$ \$	Wilmington
Pirates Cove Drainage Improvement Project	Storm Water Management Activities	\$ \$-\$ \$ \$	Wilmington
Brookshire Beasley Phase 2	Storm Water Management Activities	\$ \$-\$ \$ \$	Wilmington
Runoff Study Carolina Beach Ave North	Storm Water Management Activities	\$ \$ \$-\$ \$ \$ \$ \$	Carolina Beach
Cape Carteret Stormwater Facility Improvements	Storm Water Management Activities	\$ \$ \$ \$-\$ \$ \$ \$ \$ \$	Cape Carteret
Carolina Beach Lake Improvements	Storm Water Management Activities	\$ \$ \$ \$-\$ \$ \$ \$ \$ \$	Carolina Beach
Canal Drive / North End Stormwater Management Activities	Storm Water Management Activities	\$ \$ \$ \$ \$	Carolina Beach
Canal Drive / Carolina Beach Avenue North, Carl Winner Drive, and Harper Avenue Intersections Stormwater Conveyance, Storage, and Drainage Improvements	Storm Water Management Activities	\$ \$ \$ \$ \$	Carolina Beach
Surf City Downtown Rehabilitation and Business Elevation Program	Structural Elevation	\$ \$ \$-\$ \$ \$ \$ \$	Surf City
Elevate Floodplain Pump Stations	Utility Elevation	\$ \$-\$ \$ \$ \$	New Hanover County
Generators for Wastewater Pumps in New Hanover County	Utility Elevation	\$ \$ \$-\$ \$ \$ \$ \$	New Hanover County

*Actions that did not fit neatly into an action type are marked miscellaneous. Miscellaneous actions include outreach, planning, data collection, and other flood resilience steps not captured in the typology.

** Cost estimates are as follows: \$ < \$100,000; \$\$ \$100,000 - \$500,000; \$\$\$ \$500,000 - \$1M; \$\$\$\$ \$1M - \$5M; \$\$\$\$\$ > \$5M. Some actions have a variable cost estimate based on yet-to-be-determined details such as potential participation level for buyouts or elevations, opportunities related to siting an action, or the action is a combination of planning and implementation. For these actions, the relative cost shown in the Action List may vary, potentially dramatically, given the final scale and scope of the action when implemented.



Action Name*	Action Type	Relative Cost Estimate**	Community
Newport River Restoration Initiative Phase II	Water Farming	\$\$\$\$	Carteret County

*Actions that did not fit neatly into an action type are marked miscellaneous. Miscellaneous actions include outreach, planning, data collection, and other flood resilience steps not captured in the typology.

** Cost estimates are as follows: \$ < \$100,000; \$\$ \$100,000 - \$500,000; \$\$\$ \$500,000 - \$1M; \$\$\$\$ \$1M - \$5M; \$\$\$\$\$ > \$5M. Some actions have a variable cost estimate based on yet-to-be-determined details such as potential participation level for buyouts or elevations, opportunities related to siting an action, or the action is a combination of planning and implementation. For these actions, the relative cost shown in the Action List may vary, potentially dramatically, given the final scale and scope of the action when implemented.



Beaufort NC with Taylor Creek and Carrot Island in the distance



Jacksonville, NC



WHITE OAK RIVER BASIN ACTION STRATEGY

Emerald Isle Woods Park

FLOOD RESILIENCY VISION & GUIDING PRINCIPLES

To guide development of the White Oak RBAS, stakeholders contributed to a vision and guiding principles that would reflect the unique characteristics, priorities, and values of the White Oak River Basin. An initial set of meetings was held in Fall 2025 to gather stakeholders around this topic. A follow-up survey was offered to RBAG and Blueprint Partners who were unable to attend meetings in person. During these engagements, stakeholders described the flood resilience strategies that have been most successful across the Basin. They also identified issues that are often overlooked when discussing flood resilience in their communities. These responses and other stakeholder insights were distilled into a single vision and set of guiding principles. Together with other Blueprint materials, local input, and stakeholder advice, the vision and guiding principles informed goal development, strategy development, and action prioritization.

Vision

The White Oak River Basin is a strong, connected and adaptable region where people, places and natural systems withstand floods. The White Oak River Basin Action Strategy turns science into fundable, on the ground solutions so communities - rural and urban, barrier island and inland - can prepare, recover, and thrive rather than simply survive.

Guiding Principles

Multi scale, locally actionable, and coordinated

Plan at the basin scale while producing locally actionable guidance. Projects should relate to one another based on shared systems, e.g. transportation, drainage, or ecological systems, so neighborhood, municipal and basin outcomes align.

Data driven and transparent

Use up to date, high resolution datasets to guide decisions. Make sure that assumptions, scoring and outputs are transparent and accessible.

Future ready

Use modeling based on best available scientific understanding of future conditions when possible and appropriate. Discuss timelines of functionality for proposed projects.

From evidence to funded implementation

Move fluently from vulnerability assessment and strategy to shovel ready, fundable projects and recurring maintenance. Success is measured by reductions in loss.

People centered

Resilience starts with people. Prioritize life safety. Protect vulnerable and low income communities, isolated communities, elderly residents, and workers of all kinds. Ensure equitable access to funding, information, and administrative support. Communities should not be excluded from funding opportunities based on low or high socioeconomic status.

Nature-based, nature-informed, and cost effective portfolios

Favor nature-based and hybrid solutions when effective because they provide multiple benefits like habitat, water quality, and flood water storage, while evaluating overall cost effectiveness and readiness to implement.

Preparedness, communication & continual learning

Educate residents, especially newcomers, integrate citizen reporting and monitoring, and iterate communication strategy through monitoring, evaluation and shared lessons.



GOALS AND STRATEGIES

To bridge the gap from the vision and guiding principles to specific actions, the Action Strategy uses a set of tailored goals and strategies. The goals and strategies are based on three sources of White Oak Blueprint input:

- All the projects submitted by local government or other stakeholders, regardless of score or whether they were deemed high priority
- Input from RBAG and Blueprint Partners, including Guiding Principles
- All pre-identified actions cataloged in the literature review. These are actions that appear in local, regional, or state plans that have flood resilience benefits

Goals and strategies organize actions within a repeatable framework of flood risk reduction tailored to the White Oak River Basin. They also ensure that the objectives of local communities and other stakeholders are captured in the RBAS, even if specific actions have not yet been identified.

White Oak River Basin Goals

- Goal 1. Protect people and life safety
- Goal 2. Strengthen critical systems
- Goal 3. Protect and restore coastal natural systems
- Goal 4. Reduce flood risk through land use, redevelopment, and property mitigation
- Goal 5. Build a durable pathway from evidence to implementation

Three to five strategies for each goal are enumerated in the next section of the RBAS.

WHAT IS AN ACTION?

In the context of this Action Strategy, an action is a flood mitigation or resilience measure that can be implemented by a local government or a set of partners. Actions may be capital projects, policy and planning measures, or other defined efforts that reduce risk of flooding. Actions may be local, regional, or basin-wide in scale, and may require coordination across jurisdictions or sectors.

Actions are organized into five main categories within the Blueprint Tool: Building Level Mitigation, Channel Modification, Infrastructure & Control Structures, Nature-Based Solutions, Policy & Planning, and others. Below, the action categories and action types are described. Action types featured in this White Oak RBAS reflect a variety of both flood mitigation best practices expected and approaches to addressing region-specific flooding concerns. Updates to the White Oak RBAS may result in the inclusion of additional action types as novel approaches and technologies continue to emerge.



Building Level Mitigation

ACTION TYPES

- Relocation
- Utility Elevation
- Acquisition/Demolition/Buyouts
- Dry Floodproofing
- Mitigation Reconstruction
- Wet Floodproofing
- Structural Elevation

The building level mitigation action category highlights targeted physical and policy measures implemented at the individual structure scale to reduce flood exposure and improve resilience. Action types include Relocation (moving a structure or people out of a high-risk area), Utility Elevation (raising critical mechanical, electrical, and plumbing systems), Acquisition/Demolition/Buyouts (buying and/or removing vulnerable structures), Dry Floodproofing (sealing a structure to prevent floodwaters from entering), Mitigation Reconstruction (rebuilding or retrofitting a structure to improved standards), Wet Floodproofing (designing a structure to allow controlled inundation while minimizing damage), and Structural Elevation (raising the structure above forecasted flood levels).

Building level mitigation delivers risk reduction where people live and work, providing a path to loss reduction and continuity of operations at the smallest scale. These actions protect life and property, lower insurance and recovery costs, and preserve community assets and economic recovery after flooding events. They also offer flexible, scalable options, from individual property upgrades to neighborhood-scale buyouts, which can be prioritized based on cost-effectiveness and environmental considerations. Since these actions operate at the individual structure scale, they can sometimes be faster to implement than projects at the local-government wide or interjurisdictional scale, but they can sometimes face funding and private property ownership challenges.

Channel Modification

ACTION TYPES

- Debris Removal
- Channel Dredging, Widening, Diversion

Channel modification actions include interventions designed to alter natural or manmade waterways to improve their capacity and functionality. Key Action types include Debris Removal (clearing blockages such as sediment, vegetation, and waste) and Channel Dredging, Widening, and Diversion (deepening, expanding, or redirecting channels to increase flow capacity and reduce bottlenecks).

Channel modification actions help manage flood risk by enabling water to flow more efficiently and predictably through vulnerable areas. By removing debris and altering channels, these interventions help prevent blockages and overflow, reducing the likelihood of disruptive and damaging floods. Channel modifications minimize property damage, protect critical infrastructure, and support rapid recovery by moving flood waters away from vulnerable areas to reduce disruptions. These actions can restore or enhance natural water movement.



Infrastructure & Control Structures

ACTION TYPES

- Storm Water Management Activities
- Levee/Dike/Berm
- Critical Infrastructure
- Quarries
- Roadway Elevation/Road Crossing Modification
- New and Existing Dam Structures

Infrastructure and control structures include a range of engineered systems that prevent or redirect water from reaching vulnerable areas. Action types include Storm Water Management Activities (such as retention basins and green infrastructure), Levee/Dike/Berm construction (earthen or structural barriers preventing overflow), Critical Infrastructure protection (safeguarding utilities and essential services), Quarries (used for temporary water storage), Roadway Elevation/Road Crossing Modification (raising or redesigning roads to prevent flooding), and New and Existing Dam Structures (controlling water flow and storage).

Infrastructure and control structure actions are a key part of flood resilience strategies because they block or redirect water, keeping it away from people, property, and essential services. Protecting critical infrastructure ensures that power, water, healthcare, communications, and other critical services remain operational during and after flooding events. Collectively, these actions are crucial for maintaining public safety, minimizing economic disruption, and quickly recovering after severe flooding events by preventing water from moving into areas where it can do the most harm.

Nature-Based Solutions

ACTION TYPES

- Water Farming
- Permeable Pavement
- Bioretention
- Green Roofs
- Living Shorelines
- Raingardens/Sand Filters/Bio-Swales
- Afforestation
- Floodplain Preservation
- Flood Storage Wetlands
- Floodplain Restoration
- Riparian Buffers

Nature-based solutions (NBS) actions leverage natural processes and green infrastructure to manage water while enhancing ecosystem services. Key action types include Water Farming (temporarily storing water on agricultural land), Permeable Pavement (allowing water to infiltrate through surfaces), Bioretention (using soil and plants to filter and store runoff), Green Roofs (vegetated rooftops that absorb and slow the release of rainfall), Living Shorelines (using natural materials to stabilize coasts), Raingardens/Sand Filters/Bio-Swales (landscape features that capture and treat runoff), Afforestation (planting trees to increase infiltration and reduce runoff), Floodplain Preservation (protecting existing floodplains that absorb water) and Floodplain Restoration (restoring floodplains to original or enhanced water absorbing capacities), Flood Storage Wetlands (areas that absorb and release floodwaters), and Riparian Buffers (vegetated zones along waterways).

Nature-based solutions provide an array of benefits for flood risk reduction by harnessing the power of natural processes and landscapes. These solutions help to slow, absorb, and safely move excess water, reducing the intensity and frequency of flooding events. By increasing the capacity of soil and vegetation to capture and store rainfall, nature-based actions lower runoff and decrease the likelihood of overwhelming drainage systems. Restored wetlands, floodplains, and riparian buffers provide natural storage areas for floodwaters, protecting downstream communities from sudden surges. Additionally, nature-based solutions improve water quality, support biodiversity, and offer recreational and aesthetic value to local communities. They are often cost-effective, adaptable, and sustainable, making them a resilient approach to managing flood risks.



Policy & Planning

ACTION TYPES

- Advanced Regulations (Land Use and Impervious Surface Restrictions)
- Stormwater, Water Quality, Floodplain Regulations
- Advanced Regulations (GIS Capacity Building)
- Multi-Use Floodplains
- Advanced Regulations (Enhanced Zoning)

Policy and planning actions focus on the frameworks and regulatory tools that govern how communities prepare for and manage flood risks. Key action types include Advanced Regulations such as land use and impervious surface restrictions (limiting development and hard surfaces in vulnerable areas), Stormwater, Water Quality, and Floodplain Regulations (guiding how water is managed and protected), Advanced Regulations for Geographic Information System (GIS) Capacity Building (enhancing data-driven decision-making through geographic information systems), Multi-Use Floodplains (designating areas for recreation, habitat, and temporary water storage), and Enhanced Zoning (adapting land use codes to reflect flood risk).

Planners, policymakers, and local governments use these actions to inform which flood risk reduction measures are required, permitted, funded, prioritized, and implemented. By setting clear regulations and guidelines, these actions promote development that occurs in safer locations, that infrastructure is built to withstand flooding, and that natural landscapes are preserved for their protective benefits. Strong policy and planning frameworks create the foundation for coordinated, long-term flood risk management, ensuring that public resources are invested wisely and that communities become more resilient over time. Local governments have noted that current state statutes limit their ability to adopt many policies that would help prevent development that can increase future flood risk and damages.

Other

ACTION TYPES

- Coastal - Road Elevation/Modification
- Coastal - Building Mitigation
- Beaver Management

Some actions do not fit neatly into the other categories of actions. The actions in the 'other' category, however, are still critical to flood resilience and blend across action categories where special considerations are required. Coastal Road Elevation or Modification is the elevation of roadways that are impacted by coastal flooding. Coastal Building Mitigation is building level adaptation strategies that account for the periodic or enduring flooding that comes with coastal and tidal conditions, including storm surge, saltwater intrusion, and others. Beaver management includes actively managing beaver populations and removing beaver-made dams to restore the natural flow of waterways and prevent blockages that worsen flooding during heavy rainfall events.



PRIORITIZED BASIN ACTIONS



Intercoastal Waterway Wrightsville Beach

A Diversity of Actions for Different Communities

This section presents the goals, strategies, and the 95 actions of the White Oak River Basin Action Strategy. Ideally, a local action aligns with the conditions of the area it is intended to serve. In the White Oak RBAS, those conditions include the physical, environmental, and policy context of a place, as well as the flood hazards it faces and the constraints that may affect whether an action is feasible. Action alignment also depends on a place’s vulnerability—that is, the people, structures, infrastructure, services, and natural systems most likely to be affected by flooding. Together, context and vulnerability help explain why the same action may be a priority for one community but less effective or infeasible in another.

As flood risk changes across the White Oak River Basin, the mix of resilience actions needed to address that risk may also change. In some cases, communities may need additional policy or decision-making flexibility to respond proactively to changing conditions. Future updates to the RBAS may also create opportunities to expand the range of action types, including emerging financial, policy, or structural approaches to improving flood resilience.

Goals, Strategies, Critical Needs, and Actions

The actions included in the RBAS are organized by goal. Each goal section provides recommendations about critical needs, a table of actions, and profiles for select actions to illustrate examples of flood resilience solutions across the basin.

Some actions align with recommended critical needs, while others highlight locally supported or technically appropriate approaches. Some goals and strategies have many actions. Others reflect desires of White Oak stakeholders and needs identified by Basin-wide analysis that are not yet filled by a full suite of actions. The Blueprint Tool provides a mechanism for continual update of local action plans as actions to address needs continue to be identified.

Descriptions, maps, and supporting details for each profiled action are included within the relevant goal section. This structure is intended to show how basin-wide analysis, stakeholder input, and action screening translate into specific flood resilience priorities.

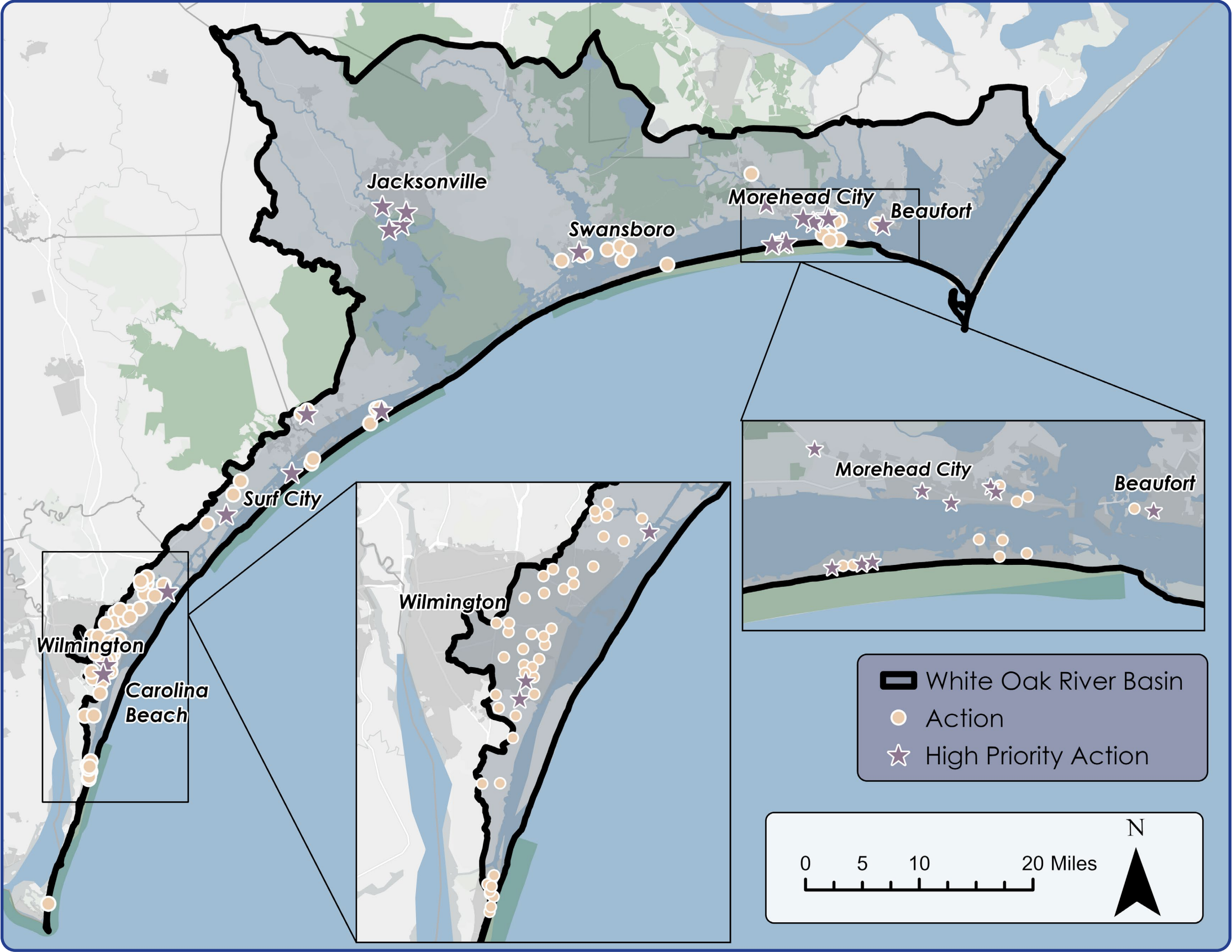


Figure 16: Basin-Wide Map with High Priority and Actions identified.

GOAL 1. PROTECT PEOPLE AND LIFE SAFETY

Goal 1: Protect People and Life Safety focuses on reducing flood-related risks to the people and places that are most vulnerable in the White Oak River Basin. Because the basin includes coastal communities, low-lying neighborhoods, and areas with frequent roadway and drainage flooding, this goal emphasizes protecting critical facilities, maintaining safe evacuation routes, and strengthening warning systems. It also prioritizes actions that support vulnerable communities, including residents with limited access to resources, isolated areas, and properties where repeated flooding threatens safety and daily function. In the White Oak context, this goal reflects the reality that resilience begins with keeping residents safe before, during, and after flood events.

Strategy 1.1: Protect Critical Facilities and Emergency Assets

This strategy focuses on reducing flood risk at the facilities communities depend on most during emergencies and daily operations. In the White Oak River Basin, including emergency operations centers, fire and EMS stations, shelters, schools serving as shelters, wastewater lift stations, and other critical infrastructure. Flooding at these sites can interrupt response, damage equipment, and delay recovery. Actions under this strategy may include elevation, dry floodproofing, backup power, relocation, and other structural or operational improvements that help facilities remain functional during and after flood events. Protecting these assets helps ensure that essential services are available when residents need them most.

Strategy 1.2: Improve Evacuation Routes, Access, and Life Safety Systems

This strategy is centered on keeping people moving safely during flood events and ensuring that emergency responders can reach affected areas. In the White Oak River Basin, evacuation and access concerns often involve flooded roads, overtopped crossings, bridges, and drainage chokepoints that can isolate neighborhoods or interrupt travel to shelters, hospitals, schools, and other essential destinations. Actions may include roadway elevation, culvert upgrades, bridge improvements, flood warning signs, stream and water-level gauges, and other measures that improve real-time awareness and transportation reliability. The goal is to reduce the risk of people becoming stranded, improve emergency access, and support safe evacuation before conditions become dangerous.

Strategy 1.3: Prioritize Most Vulnerable Communities

This strategy recognizes that flood impacts are not experienced equally and some communities have fewer resources to prepare, respond, or recover. In the White Oak River Basin, priority should be considered for neighborhoods with repeated flooding, limited access, lower income households, elderly residents, isolated communities, transient populations and agricultural workers, and places where property loss or access problems can quickly become life-safety issues. Actions under this strategy may include property-based approaches like buyouts, relocations, or retrofits as well as targeted outreach or support. The intent is to ensure that resilience investments reach the communities that need them most and that may be less able to recover on their own.

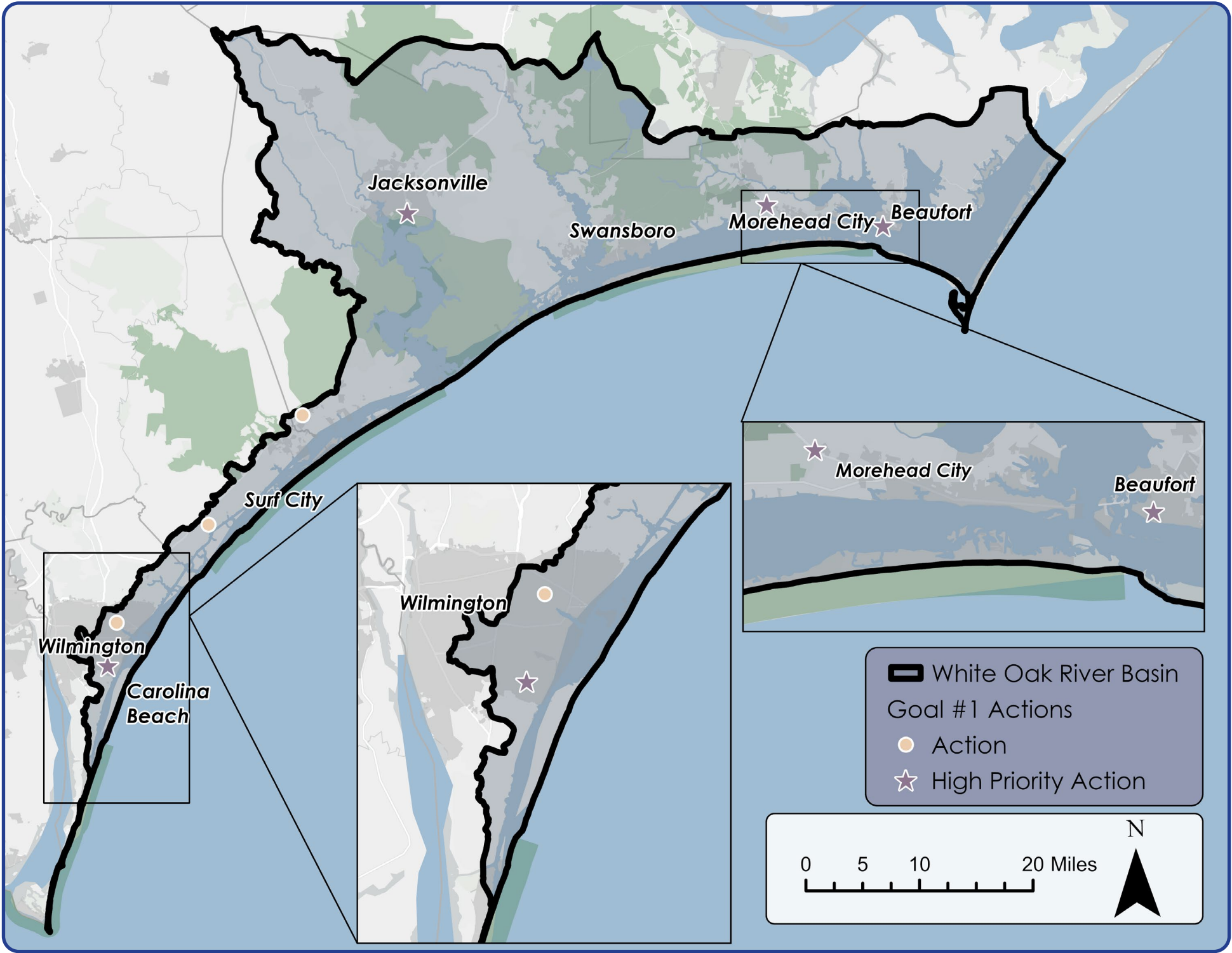


Figure 17: Basin-Wide Map with Goal 1 High Priority and Actions identified.

Goal 1. Protect People and Life Safety / Actions Descriptions

Goal 1. Protect people and life safety includes 8 actions focused on reducing the risks of emergency flooding for White Oak River Basin residents. Of these, 5 were identified as high priority actions. These high priority actions include locally prioritized actions submitted by Jacksonville, Beaufort, Morehead City and New Hanover County. These actions reflect a range of action types, with a particular focus on infrastructure considerations. Strategy 1.3: Prioritize Most Vulnerable Communities is an approach captured in many of the actions included in this and other goals, and just one action was selected to illustrate it.

Recommended Critical Needs

- Add water level gauges at flood-prone locations
- Establish or improve early warning systems
- Protect critical facilities that must remain operational during floods
- Improve access to isolated or frequently flooded communities
- Improve flood depth signage and public warning information on low-water roads
- Use data and stakeholder input to ensure that most at risk or socially vulnerable communities are served by flood risk reduction actions

Profiled Actions

- Hardison Hills Culvert Enlargement and Emergency Access Path Construction
- Onslow Countywide Flood Warning and Monitoring Program
- Beaufort Public Housing Flood Mitigation
- Morehead City Stormwater Improvements on Highway 70 / Evacuation Route

Profiled actions are highlighted in detail after the Priority Action List.

Priority Action List

*High priority actions are highlighted in blue.

Table 5: Priority Action List - Goal 1

Action Name	Type*	Relative Cost Estimate*	Community Locations
Strategy 1.1 Protect critical facilities and emergency assets			
Cape Fear Public Utility Authority Emergency Generators	Critical Infrastructure	\$\$-\$\$\$\$	New Hanover County, Wrightsville Beach, Wilmington
Pender Critical Facility Backup Generator Program	Miscellaneous	\$\$\$-\$\$\$\$\$	Pender County
Strategy 1.2 Improve evacuation routes, access, and life safety systems			
Morehead City Stormwater Improvements on Highway 70 / Evacuation Route	Critical Infrastructure	\$\$	Morehead City
Onslow Countywide Flood Warning and Monitoring Program	Miscellaneous	\$\$-\$\$\$\$	Onslow County

*Actions that did not fit neatly into an action type are marked miscellaneous. Miscellaneous actions include outreach, planning, data collection, and other flood resilience steps not captured in the typology.

** Cost estimates are as follows: \$ < \$100,000; \$\$ \$100,000 - \$500,000; \$\$\$ \$500,000 - \$1M; \$\$\$\$ \$1M - \$5M; \$\$\$\$\$ > \$5M. Some actions have a variable cost estimate based on yet-to-be-determined details such as potential participation level for buyouts or elevations, opportunities related to siting an action, or the action is a combination of planning and implementation. For these actions, the relative cost shown in the Action List may vary, potentially dramatically, given the final scale and scope of the action when implemented.

PRIORITIZED BASIN ACTIONS



Action Name	Type*	Relative Cost Estimate*	Community Locations
Evacuation Routes & Drainage in New Hanover County	Roadway Elevation/ Road Crossing Modification	\$\$\$-\$\$\$\$\$	New Hanover County
Hardison Hills Culvert and Emergency Access Path	Roadway Elevation/ Road Crossing Modification	\$\$\$\$	Jacksonville
Holly Ridge Multi-Use Path with Bioswales and GSI: Construction Phase	Raingardens/Sand Filters/Bio-Swales	\$\$\$\$\$	Holly Ridge
Strategy 1.3 Prioritize Most Vulnerable Communities			
Beaufort Public Housing Flood Mitigation	Storm Water Management Activities, Elevation, Dry Floodproofing	\$\$-\$\$\$\$	Beaufort

*Actions that did not fit neatly into an action type are marked miscellaneous. Miscellaneous actions include outreach, planning, data collection, and other flood resilience steps not captured in the typology.

** Cost estimates are as follows: \$ < \$100,000; \$\$ \$100,000 - \$500,000; \$\$\$ \$500,000 - \$1M; \$\$\$\$ \$1M - \$5M; \$\$\$\$\$ > \$5M. Some actions have a variable cost estimate based on yet-to-be-determined details such as potential participation level for buyouts or elevations, opportunities related to siting an action, or the action is a combination of planning and implementation. For these actions, the relative cost shown in the Action List may vary, potentially dramatically, given the final scale and scope of the action when implemented.



PRIORITIZED BASIN ACTIONS





Hardison Hills Culvert Enlargement and Emergency Access Path Construction

Community:
City of Jacksonville

Cost:
\$1,000,000

Goal:
Protect people and life safety

Strategies:
1.2 Improve evacuation routes, access, and life safety systems; 2.2 Upgrade stormwater, outfalls, and tidal drainage systems; 2.3 Retrofit roads, streets, and public rights-of-way

Guiding Principles:
Future ready, From evidence to funded implementation, People centered

Source:
Locally prioritized for Blueprint

Category:
Infrastructure & Control Structures

Type:
Roadway Elevation/Road Crossing Modification

Priority:
High

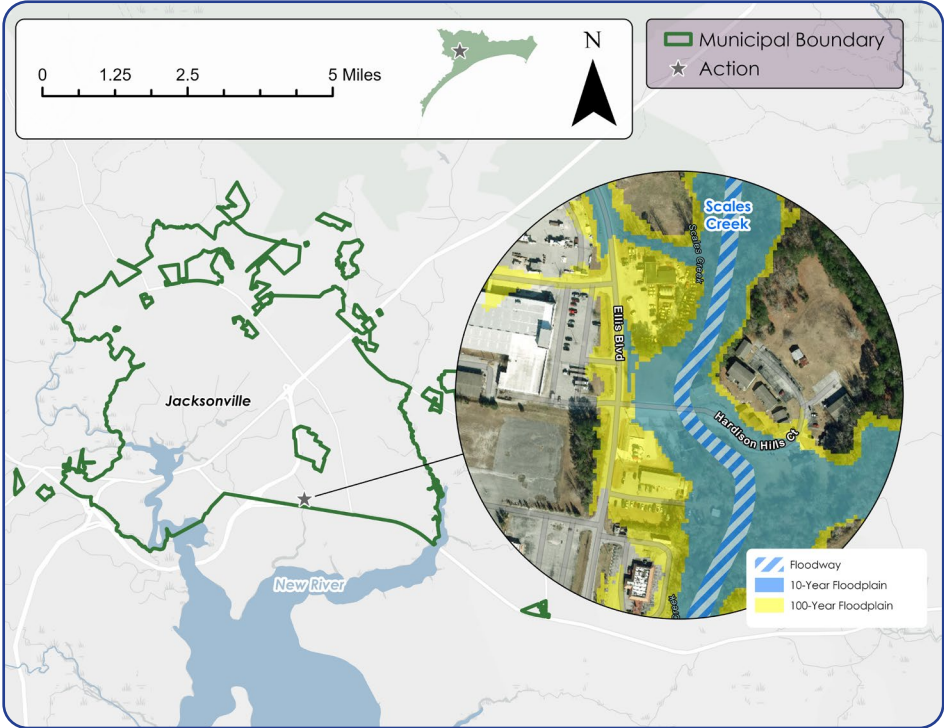


Figure 18: Hardison Hills Individual Action Map.

The Hardison Hills Culvert Enlargement and Emergency Access Path Construction action will reduce flood risk and improve emergency access for an underserved community within the Scales Creek Watershed. A preliminary site inspection and analysis found that the culvert beneath Hardison Hills Court is undersized, contributing to roadway flooding during large storm events and creating serious public safety concerns. In past events, including Hurricanes Florence and Matthew and Tropical Storm Idalia, floodwater prevented residents from entering or leaving their homes and, at times, delayed evacuation assistance. Vehicles have also been washed into the stream, further increasing risk to the public.

To address these conditions, the action proposes enlarging the culvert to better convey stormwater and reduce overtopping of Hardison Hills Court. It also includes an emergency access path along the backside of Hardison Hills Court and the existing Rails to Trail path to provide first responders with reliable access during severe storms. In addition, an incorporated spillway will divert some flow from Scales Creek to Ellis Creek, offering further protection against flash flooding and helping improve community resilience.



Onslow Countywide Flood Warning and Monitoring Program

Community:
Onslow County

Cost:
\$500,000 - \$1 million (total cost dependent upon the final number of signs and gauges included)

Goal:
Protect people and life safety

Strategies:
1.2 Improve evacuation routes, access, and life safety systems; 2.3 Retrofit roads, streets, and public rights-of-way; 5.1 Ground actions in local data and watershed-scale analysis

Guiding Principles:
Coordination, Data driven and transparent, Future ready, People centered, Preparedness

Source:
Onslow County Hurricane Matthew Resilient Redevelopment Plan

Category:
Other

Type:
Miscellaneous

Priority:
High

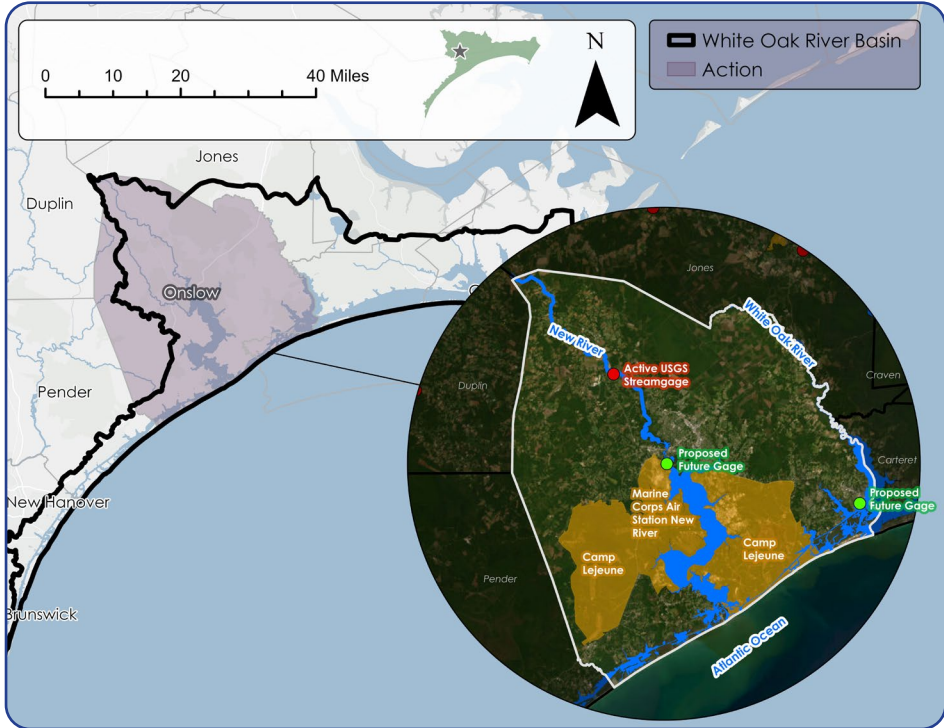


Figure 19: Onslow County Individual Action Map.

The Onslow Countywide Flood Warning and Monitoring Program will strengthen public safety by improving both flood warning communication and real-time monitoring across the County. The action, submitted as part of the Onslow County Hurricane Matthew Resilient Redevelopment Plan, proposes installing flood depth warning signs at low-water priority locations where road blockages and drainage issues frequently create hazardous conditions. In many cases, inadequate signage can lead drivers to mistakenly believe that a flooded road is passable, increasing the risk of vehicles becoming stranded and requiring dangerous swift-water rescues. By providing clearer warnings at vulnerable crossings, the County can reduce life safety risks for residents, passengers, and first responders.

The program also includes installing additional stream and river monitoring gauges to improve flood prediction capabilities for emergency managers. Proposed gauge locations include Marine Corps New River Air Station on the New River and Swansboro on the White Oak River, supplementing the County's existing gauge at Richlands. These additional gauges would provide more accurate stage information and help support earlier flood response and public communication. Together, the warning signs and monitoring network would improve countywide flood preparedness, situational awareness, and emergency decision-making.





Beaufort Public Housing Flood Mitigation

Community:
Town of Beaufort

Cost:
\$500,000 - \$1 million (total cost dependent upon the total number of structures included)

Goal:
Protect people and life safety

Strategies:
1.3 Prioritize communities most at risk or socially vulnerable; 2.2 Upgrade stormwater, outfalls, and tidal drainage systems; 4.2 Elevations and retrofits

Guiding Principles:
Future ready, From evidence to funded implementation, People centered, Nature-based

Source:
Locally prioritized for Blueprint

Category:
Infrastructure & Control Structures, Building Level Mitigation

Type:
Multiple

Priority:
High

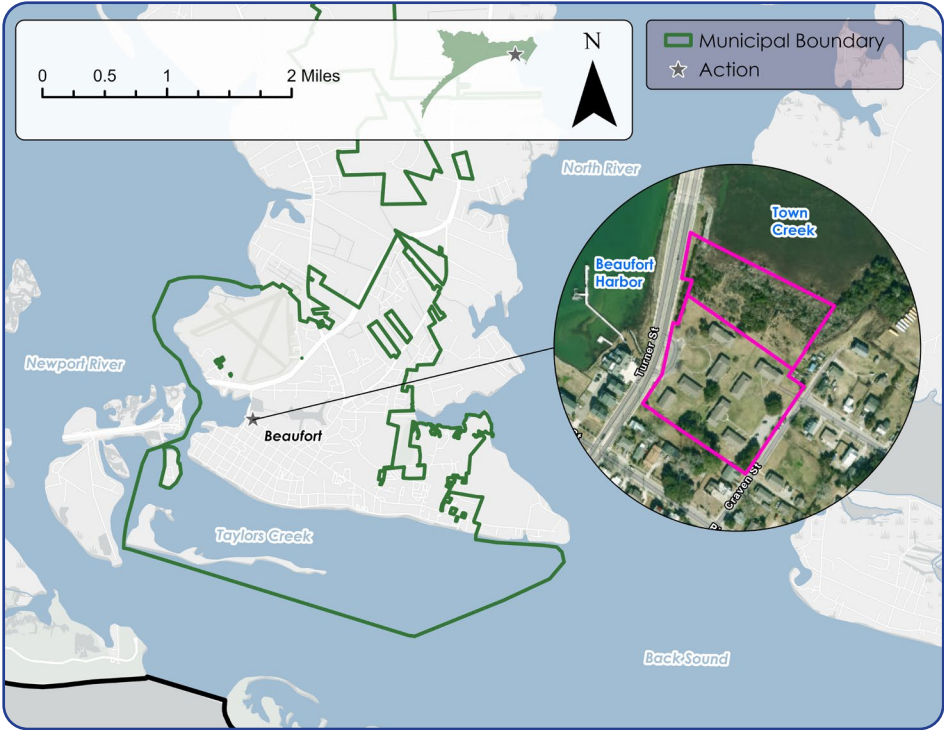


Figure 20: Beaufort Public Housing Individual Action Map.

This action was first outlined in Resilient Beaufort, the Town of Beaufort’s 2022 Resilient Coastal Communities Program plan. The Public Housing Flood Mitigation effort will support flood mitigation at public housing properties through coordination with the Beaufort Housing Authority, beginning with the Turner Street public housing complex. The action will begin with a flood assessment of the site to better understand stormwater drainage conditions, backflow issues from the outfall, and other sources of flooding that may affect the property. This evaluation will help identify practical measures to reduce flood exposure and improve the long-term resilience of the housing complex.

Based on the assessment, the action will explore a range of mitigation options, including elevating structures, modifying the parking area, and implementing additional floodproofing measures across the property. These improvements are intended to reduce flood damage risk, improve resident safety, and support continued functionality of the housing site during heavy rain and flood events. By focusing on a public housing complex, the action also advances resilience for a vulnerable population that may have limited ability to recover from flood impacts.



Morehead City Stormwater Improvements on Highway 70/Evacuation Route

Community:
Morehead City

Cost:
\$200,000

Goal:
Protect people and life safety

Strategies:
1.1 Protect critical facilities and emergency assets; 1.2 Improve evacuation routes, access, and life safety systems; 2.2 Upgrade stormwater, outfalls, and tidal drainage systems; 2.3 Retrofit roads, streets, and public rights-of-way

Guiding Principles:
Coordination, People centered

Source:
Locally prioritized for Blueprint

Category:
Infrastructure & Control Structures

Type:
Critical Infrastructure

Priority:
High

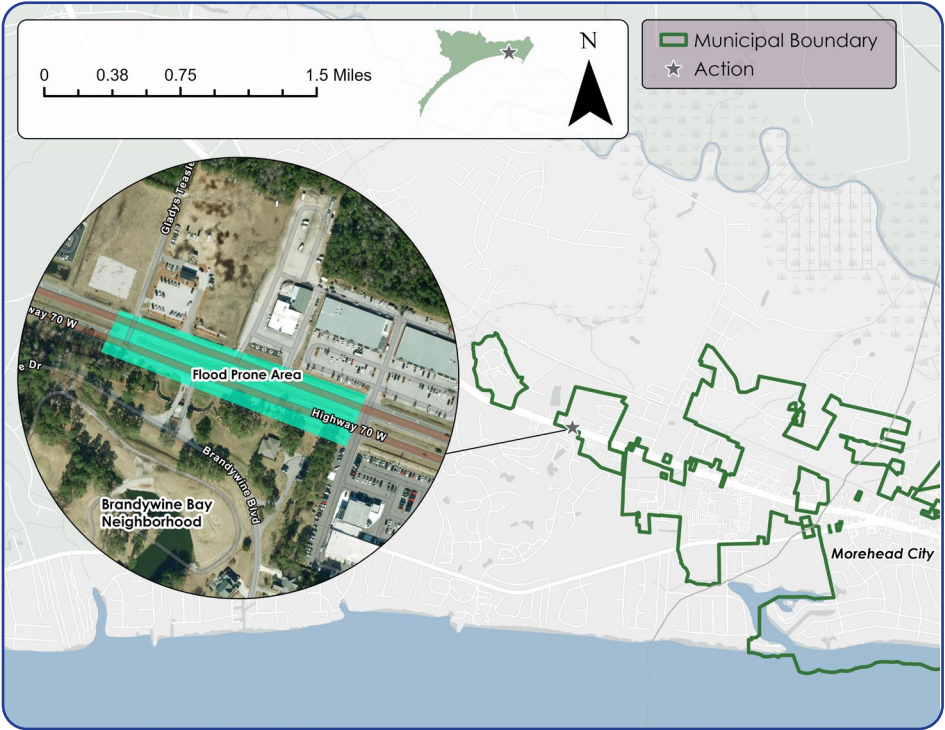


Figure 21: Morehead City Stormwater Improvements Individual Action Map.

The Highway 70 Stormwater Improvements action will evaluate and address recurring flooding along a critical evacuation route near Brandywine subdivision in Morehead City. The action seeks funding to assess the causes and extent of stormwater flooding in this area and to identify practical mitigation measures that will help keep the roadway safe and usable during heavy rainfall and storm events. Because Highway 70 serves an important role in evacuation and emergency access, flooding in this corridor presents a significant public safety concern.

This action will focus on protecting a key piece of transportation infrastructure by reducing the likelihood of roadway overtopping and related disruptions. Potential improvements may include drainage upgrades, conveyance enhancements, or other stormwater mitigation measures determined through the evaluation process. By improving flood performance along Highway 70, the action will support safer evacuation operations, maintain access for residents and emergency responders, and strengthen overall community resilience.



GOAL 2. STRENGTHEN CRITICAL SYSTEMS

Goal 2. Strengthen critical systems focuses on the infrastructure systems that keep communities functioning during floods and support day-to-day life across the basin. In the White Oak River Basin, that includes infrastructure that manages water, such as stormwater networks, roadside ditches, culverts and outfalls, but it also includes other public infrastructure that is vulnerable to flooding, tidal backflow, or repeated damage like lift stations, wastewater systems, road networks, and water supply facilities. The goal emphasizes not only fixing weak points but also understanding how systems work together so that local improvements support basin-wide resilience. Actions under this goal may include asset mapping, drainage maintenance, stormwater retrofits, utility protection, and improvements to roads and crossings that are part of larger interconnected systems.

Strategy 2.1: Map infrastructure and systematically assess vulnerability

This strategy provides the foundation for effective action by identifying what infrastructure exists, where it is located, and how vulnerable it is to flooding. In the White Oak River Basin, this may include stormwater systems, drainage features, lift stations, utilities, roads, and other public assets that are affected by tidal flooding, storm surge, or heavy rainfall. Mapping and vulnerability assessments help communities understand service gaps, recurring failure points, and priority locations for investment. They also support more transparent decision-making by allowing local governments to compare needs across jurisdictions and build a stronger case for projects that reduce risk and protect essential services. This strategy is one of the most important foundational steps for communities at risk of flooding.

Strategy 2.2: Upgrade stormwater, outfalls, and tidal drainage systems

This strategy addresses the physical drainage infrastructure that helps move water through developed places. In the White Oak River Basin, many actions involve ditch cleaning, culvert replacement, storm drain repairs, pipe upsizing, outfall retrofits, pump installations, tide gates, and other measures that improve the movement of stormwater or prevent backflow from tidal waters. These projects are especially important where repeated ponding, roadway flooding, or poor drainage disrupts travel and damages property. By improving the basic performance of drainage systems, this strategy helps reduce nuisance flooding, limit long-term infrastructure deterioration, and make neighborhoods and public spaces more resilient to frequent and coastal flood conditions.

Strategy 2.3: Retrofit roads, streets, and public rights-of-way

Roads, streets, and rights-of-way often carry both traffic and stormwater, making them essential for resilience. In the White Oak River Basin, this may include roadway elevation, regrading, permeable pavement, green street design, roadside infiltration, and related drainage improvements. (Roadway projects focused on hydraulics are listed under Strategy 2.2, but relevant here as well.) These actions can reduce ponding, support safe circulation, and improve the reliability of evacuation and emergency access. Because many flood-prone areas are built-out and space is limited, public rights-of-way can serve as practical corridors for low-impact flood mitigation and neighborhood-scale resilience investments. Note that evacuation route improvements are included under Goal 1. Protect People and Life Safety.

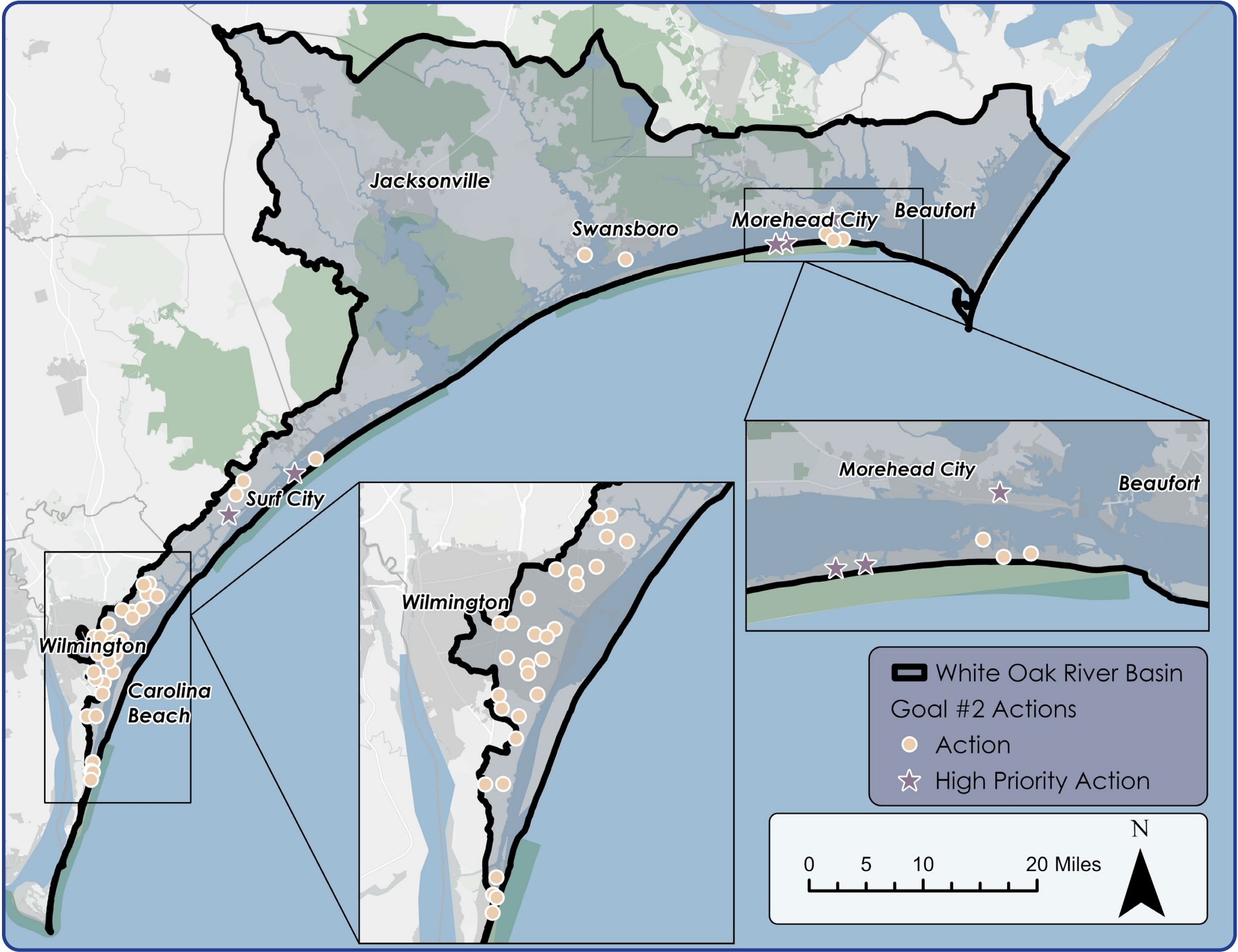


Figure 22: Basin-Wide Map with Goal 2 High Priority and Actions identified.

Strategy 2.4: Improve utility resilience

This strategy focuses on the systems that deliver water, wastewater, and other essential services, which are often highly vulnerable to flooding. In the White Oak River Basin, that includes lift stations, pump stations, sewer lines, water infrastructure, emergency generators, and other utility assets that can be damaged by floodwater or lose service during storms. Utility failures can quickly become public health and safety issues, especially when they affect wastewater treatment, drinking water access, or emergency response capability. Actions under this strategy may include elevating equipment, adding backup power, floodproofing facilities, improving redundancy, and planning for long-term maintenance so utility systems can remain operational when flood conditions occur.

Goal 2. Strengthen Critical Systems / Actions Descriptions

Goal 2. Strengthen critical systems includes 45 actions focused on the infrastructure systems that keep communities functioning during floods and support day-to-day life across the basin. Of these, 5 were identified as high priority actions. These high priority actions include locally prioritized actions submitted to the Blueprint Tool by Topsail Beach, Morehead City, Pender County, and Pine Knoll Shores. While including a diversity of action types, this goal had particular representation from smaller stormwater capital projects from communities that had master plans or other assessments. This reflects the importance of Strategy 2.1 Map infrastructure and systematically assess vulnerability as a foundational component of strengthening critical systems.

Recommended Critical Needs

- Develop and update stormwater master plans, including asset inventories
- Map drainage in rural communities and develop master plans or other prioritized action strategies
- Replace, upsize, and repair undersized drainage infrastructure where there are no downstream adverse impacts
- Maintain and modernize drainage systems through routine maintenance
- Secure lifecycle maintenance funding
- Add backup power and redundancy for critical utility systems
- Address tidal backflow and outfall performance in coastal areas

Profiled Actions

- Morehead City Stormwater flaps/gates S. 14th, S. 9th Streets
- Pine Knoll Shores Asset Mapping
- Pine Knoll Shores Saltwater Intrusion Monitoring

Action List

*High priority actions are highlighted in blue.

Table 6: Priority Action List - Goal 2

Action Name	Type*	Relative Cost Estimate**	Community Location
Strategy 2.1 Map infrastructure and systematically assess vulnerability			
Pine Knoll Shores Asset Mapping	Critical Infrastructure	\$ \$	Pine Knoll Shores
Cape Fear Public Utility Authority Water and Wastewater Vulnerability Assessment	Critical Infrastructure	\$	New Hanover County, Wrightsville Beach, Wilmington
Atlantic Beach Storm Water Stormwater Infrastructure Mapping	Storm Water Management Activities	\$ \$-\$ \$ \$ \$	Atlantic Beach

*Actions that did not fit neatly into an action type are marked miscellaneous. Miscellaneous actions include outreach, planning, data collection, and other flood resilience steps not captured in the typology.

** Cost estimates are as follows: \$ < \$100,000; \$ \$ \$100,000 - \$500,000; \$ \$ \$ \$500,000 - \$1M; \$ \$ \$ \$ \$1M - \$5M; \$ \$ \$ \$ \$ \$ > \$5M. Some actions have a variable cost estimate based on yet-to-be-determined details such as potential participation level for buyouts or elevations, opportunities related to siting an action, or the action is a combination of planning and implementation. For these actions, the relative cost shown in the Action List may vary, potentially dramatically, given the final scale and scope of the action when implemented.



Action Name	Type*	Relative Cost Estimate**	Community Location
Strategy 2.2 Upgrade stormwater, outfalls, and tidal drainage systems			
Topsail Beach Rocky Mt Ave Drainage Improvements	Raingardens/Sand Filters/Bio-Swales	\$ \$ \$ \$	Topsail Beach
Stormwater Flaps/Gates S. 14th, S. 9th Streets	Storm Water Management Activities	\$-\$ \$	Morehead City
202 South Channel Haven Pipe Canal Bank Restoration	Roadway Elevation/ Road Crossing Modification	\$ \$-\$ \$ \$ \$	New Hanover County
Queens Point Project Ditch and Culvert Upgrade	Roadway Elevation/ Road Crossing Modification	\$ \$-\$ \$ \$ \$	New Hanover County
Elisha Dr./Camberly Dr./Gregory Rd Drainage Improvement	Storm Water Management Activities	\$-\$ \$	Wilmington
Old McCumbers Outfall (FY28)	Storm Water Management Activities	\$ \$-\$ \$ \$ \$	Wilmington
Whisky Creek Branch (FY29)	Storm Water Management Activities	\$ \$-\$ \$ \$ \$	Wilmington
Whispering Pines/Masonboro Drainage	Storm Water Management Activities	\$ \$-\$ \$ \$ \$	Wilmington
Pirates Cove Drainage Improvement Project	Storm Water Management Activities	\$-\$ \$	Wilmington
Brookshire Beasley Phase 2	Storm Water Management Activities	\$ \$-\$ \$ \$ \$	Wilmington
Red Berry Drainage Improvement Project	Storm Water Management Activities	\$ \$ \$-\$ \$ \$ \$ \$	Wilmington
Greenville Loop/Darby/Harvest Grove Lane (FY28)	Storm Water Management Activities	\$ \$-\$ \$ \$ \$	Wilmington
Drainage Improvements and Master Plan	Storm Water Management Activities	\$ \$-\$ \$ \$ \$	Pender County
Carolina Beach Lake Improvements	Storm Water Management Activities	\$ \$ \$ \$-\$ \$ \$ \$ \$ \$	Carolina Beach

*Actions that did not fit neatly into an action type are marked miscellaneous. Miscellaneous actions include outreach, planning, data collection, and other flood resilience steps not captured in the typology.

** Cost estimates are as follows: \$ < \$100,000; \$ \$ \$100,000 - \$500,000; \$ \$ \$ \$500,000 - \$1M; \$ \$ \$ \$ \$1M - \$5M; \$ \$ \$ \$ \$ \$ > \$5M. Some actions have a variable cost estimate based on yet-to-be-determined details such as potential participation level for buyouts or elevations, opportunities related to siting an action, or the action is a combination of planning and implementation. For these actions, the relative cost shown in the Action List may vary, potentially dramatically, given the final scale and scope of the action when implemented.



Action Name	Type*	Relative Cost Estimate**	Community Location
Strategy 2.3 Retrofit roads, streets, and public rights-of-way			
Multi-site Ditch Maintenance	Storm Water Management Activities	\$-\$-\$\$\$	Pender County
Wrightsville Ave Drainage and Enhancement	Permeable Pavement	\$\$\$\$\$	Wilmington
4615 Tall Tree Ln Ditch Improvement	Storm Water Management Activities	\$-\$	New Hanover County
7404 Tillson Ct / 214 Stoneybrook Rd Ditch and Pipe Upgrade	Storm Water Management Activities	\$-\$	New Hanover County
7421 Brightleaf Pipe System Upgrade	Storm Water Management Activities	\$-\$	New Hanover County
Country Place Pump System Pipe Install	Storm Water Management Activities	\$-\$	New Hanover County
Atlantic Beach Stormwater Facility Improvements	Storm Water Management Activities	\$-\$	Atlantic Beach
Kelly Road Capital Improvements Drainage Project	Storm Water Management Activities	\$	Wilmington
4709 Rushing Dr / Crosswinds Ditch and Culvert Replacement	Storm Water Management Activities	\$-\$-\$\$\$	New Hanover County
209 Bayshore Ditch Grading	Storm Water Management Activities	\$-\$-\$\$\$	New Hanover County
5115 Old Myrtle Grove Road Ditch and Culvert Upgrade	Storm Water Management Activities	\$-\$-\$\$\$	New Hanover County
Water Street Rehabilitation	Storm Water Management Activities	\$-\$-\$\$\$	Swansboro
Runoff Study Carolina Beach Ave North	Storm Water Management Activities	\$\$\$-\$\$\$\$	Carolina Beach
Cape Carteret Stormwater Facility Improvements	Storm Water Management Activities	\$\$\$\$-\$\$\$\$\$	Cape Carteret

*Actions that did not fit neatly into an action type are marked miscellaneous. Miscellaneous actions include outreach, planning, data collection, and other flood resilience steps not captured in the typology.

** Cost estimates are as follows: \$ < \$100,000; \$\$ \$100,000 - \$500,000; \$\$\$ \$500,000 - \$1M; \$\$\$\$ \$1M - \$5M; \$\$\$\$\$ > \$5M. Some actions have a variable cost estimate based on yet-to-be-determined details such as potential participation level for buyouts or elevations, opportunities related to siting an action, or the action is a combination of planning and implementation. For these actions, the relative cost shown in the Action List may vary, potentially dramatically, given the final scale and scope of the action when implemented.

PRIORITIZED BASIN ACTIONS



Action Name	Type*	Relative Cost Estimate**	Community Location
Canal Drive / North End Stormwater Management Activities	Storm Water Management Activities	\$\$\$\$\$	Carolina Beach
Canal Drive / Carolina Beach Avenue North, Carl Winner Drive, and Harper Avenue Intersections Stormwater Conveyance, Storage, and Drainage Improvements	Storm Water Management Activities	\$\$\$\$\$	Carolina Beach
Strategy 2.4 Improve utility resilience			
Pine Knoll Shores Salt Water Intrusion Monitoring	Miscellaneous	\$-\$-\$\$\$	Pine Knoll Shores
Cape Fear Public Utility Authority Tactical Redundancies	Critical Infrastructure	\$-\$	New Hanover County, Wrightsville Beach, Wilmington
Cape Fear Public Utility Authority Pumping Station and Infrastructure Retrofits	Critical Infrastructure	\$-\$-\$\$\$	New Hanover County, Wrightsville Beach, Wilmington
Pender Sewer Lift Station Flood Mitigation Program	Critical Infrastructure	\$-\$-\$\$\$	Pender County
Atlantic Beach Pump Station Improvements	Critical Infrastructure	\$-\$-\$\$\$	Atlantic Beach
Surf City Sewer Lift Station Flood Mitigation Program	Critical Infrastructure	\$\$\$-\$\$\$\$\$	Surf City
Elevate Floodplain Pump Stations	Utility Elevation	\$-\$-\$\$\$	New Hanover County
Generators for Wastewater Pumps in New Hanover County	Utility Elevation	\$\$\$-\$\$\$\$\$	New Hanover County

*Actions that did not fit neatly into an action type are marked miscellaneous. Miscellaneous actions include outreach, planning, data collection, and other flood resilience steps not captured in the typology.

** Cost estimates are as follows: \$ < \$100,000; \$\$ \$100,000 - \$500,000; \$\$\$ \$500,000 - \$1M; \$\$\$\$ \$1M - \$5M; \$\$\$\$\$ > \$5M. Some actions have a variable cost estimate based on yet-to-be-determined details such as potential participation level for buyouts or elevations, opportunities related to siting an action, or the action is a combination of planning and implementation. For these actions, the relative cost shown in the Action List may vary, potentially dramatically, given the final scale and scope of the action when implemented.

PRIORITIZED BASIN ACTIONS





Morehead City Stormwater Flaps and Gates S. 14th, S. 9th Streets

Community:
Morehead City

Cost:
\$70,000

Goal:
Strengthen critical systems

Strategies:
2.2 Upgrade stormwater, outfalls, and tidal drainage systems

Guiding Principles:
From evidence to funded implementation

Source:
Locally prioritized for Blueprint

Category:
Infrastructure & Control Structures

Type:
Stormwater Management Activities

Priority:
High

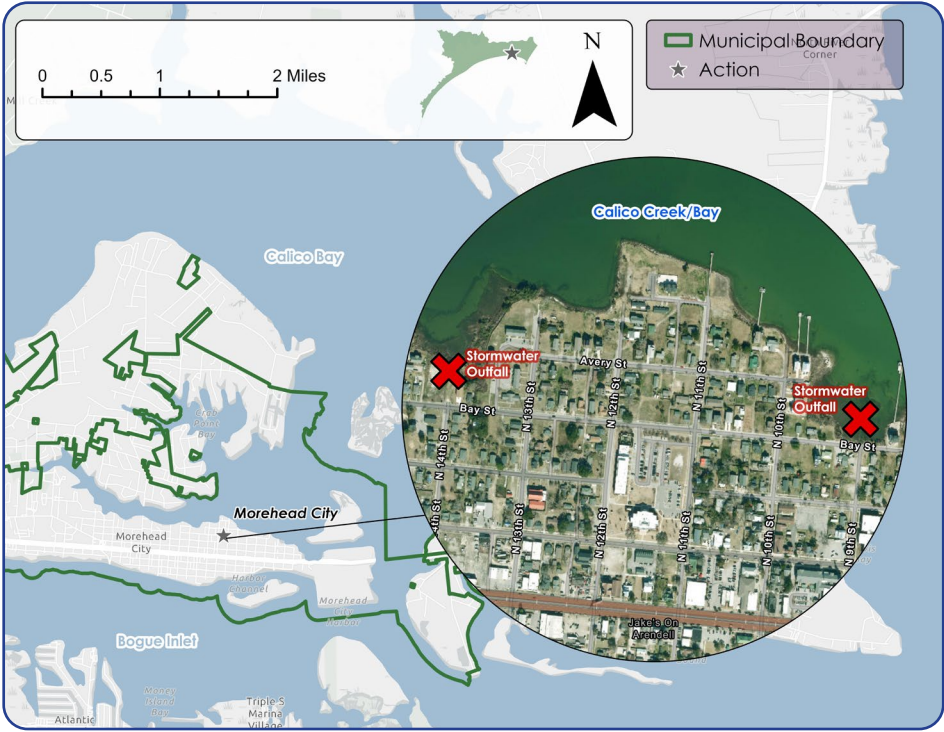


Figure 23: Morehead City Individual Action Map.

The Stormwater Flaps/Gates action will address localized stormwater flooding in the South 14th Street and South 9th Street areas of Morehead City by testing additional flap or tidal gates at the end of stormwater outlets that discharge into the sound. These control structures are intended to help limit backflow from tidal waters into the drainage system, improving the performance of existing outfalls during high-water conditions and reducing nuisance flooding in nearby streets and properties.

This action, first identified in the 2022 Morehead City Floodplain Management Plan, supports a targeted stormwater management approach in an area affected by tidal influence and recurring drainage concerns. By preventing water from pushing back into the stormwater network, the proposed gates can help improve outfall efficiency and reduce the frequency and severity of localized flooding. The action would strengthen the City’s stormwater system and improve neighborhood resilience in low-lying areas.



Pine Knoll Shores Asset Mapping

Community:
Pine Knoll Shores

Cost:
\$100,000 - \$500,000

Goal:
Strengthen critical systems

Strategies:
1.1 Protect critical facilities and emergency assets; 2.1 Map infrastructure and assess system vulnerability; 2.4 Improve utility resilience

Guiding Principles:
Future ready, From evidence to funded implementation, Preparedness

Source:
Pine Knoll Shores Resilience Strategy

Category:
Infrastructure & Control Structures

Type:
Critical Infrastructure

Priority:
High

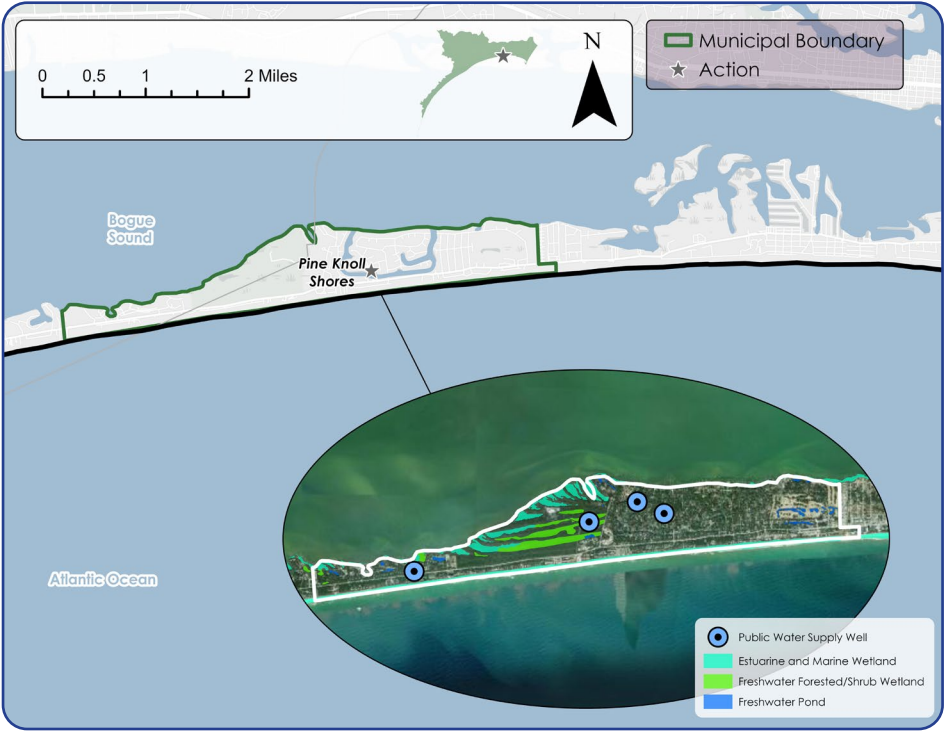


Figure 24: Pine Knoll Shores Asset Mapping Individual Action Map.

The Pine Knoll Shores Asset Mapping action will improve the Town’s understanding of its infrastructure assets and strengthen long-term service resilience. This action proposes evaluating existing Town infrastructure mapping and datasets, then updating them as needed to create a more accurate and complete inventory of critical systems. By identifying current conditions and service gaps, the Town can better understand where infrastructure may be vulnerable to damage or where important services could be disrupted during flood or storm events.

In addition to updating asset information, the action will identify opportunities to provide system redundancy in the event that primary infrastructure is damaged. This planning effort will help the Town prioritize improvements that support continuity of operations and reduce service interruptions during emergencies. Submitted as part of the 2022 Pine Knoll Shores Resilience Strategy (a RCCP project), the action will provide a stronger foundation for future infrastructure planning, emergency preparedness, and resilience investment





Masonboro Island and Reserve

Pine Knoll Shores Saltwater Intrusion Monitoring

Community:

Pine Knoll Shores

Cost:

\$500,000 - \$1,000,000

Goal:

Strengthen critical systems

Strategies:

2.4 Improve utility resilience;
5.1 Ground actions in local data and watershed-scale analysis;
5.4 Track outcomes, monitor conditions, and adapt over time

Guiding Principles:

Data driven and transparent,
Future ready, From evidence to funded implementation,
Preparedness

Source:

Pine Knoll Shores Resilience Strategy

Category:

Other

Type:

Miscellaneous

Priority:

High

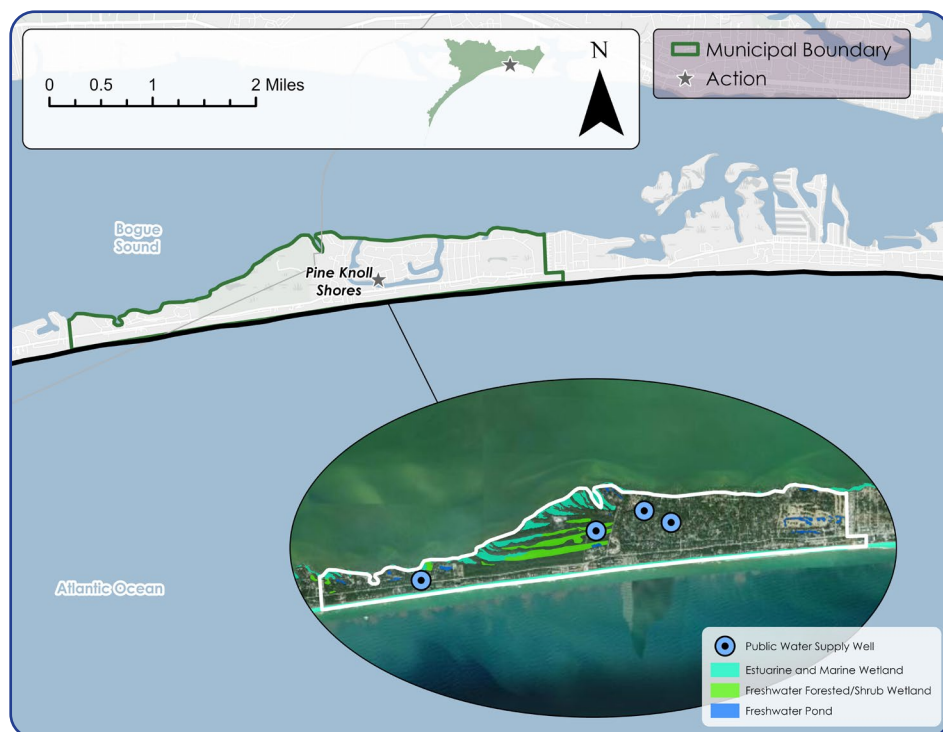


Figure 25: Pine Knoll Shores Saltwater Intrusion Individual Action Map.

The Pine Knoll Shores Saltwater Intrusion Monitoring action will help protect the Town's drinking water resources by tracking the extent of saltwater intrusion into groundwater and other water sources. This action proposes installing gauges or related monitoring equipment to measure salinity conditions and identify where saltwater may be affecting municipal supplies. By improving awareness of changing groundwater conditions, the Town can better understand emerging risks and respond before intrusion creates more serious water quality or service impacts.

The action also recommends developing a comprehensive monitoring program to coordinate data collection, evaluate trends, and identify appropriate solutions to address system needs. Where possible, monitoring equipment may be installed alongside stormwater or other infrastructure improvements to maximize efficiency and reduce implementation costs. Included as part of the 2022 Pine Knoll Shores Resilience Strategy (a RCCP project), the action supports long-term planning for water quality, floodplain management, and infrastructure resilience in a coastal community vulnerable to saltwater intrusion.

GOAL 3. PROTECT AND RESTORE COASTAL NATURAL SYSTEMS

Goal 3: *Protect and Restore Coastal Natural Systems* reflects the White Oak River Basin’s strong coastal identity and the essential role that natural systems play in reducing flood risk. Beaches, dunes, marshes, wetlands, floodplains, and shoreline habitats are not only ecological assets, but also part of the basin’s flood protection system. In White Oak, many of the most effective resilience actions use nature-based solutions to store water, slow runoff, reduce erosion, and buffer tidal flooding and storm surge. This goal captures the concept that healthy natural systems can protect development while also improving water quality, habitat, and recreation. It also supports restoration approaches that help sustain the basin’s long-term resilience.

Strategy 3.1: Open space conservation

This strategy protects land that naturally supports flood storage, habitat, and water quality. In the White Oak River Basin, open space conservation may include floodplain acquisition, land conservation, conservation easements, and preservation of wetlands, maritime forests, and other sensitive lands. These areas can absorb floodwaters, provide room for natural processes, and reduce future development exposure. Conserving open space is especially valuable where the cost of structural mitigation would be high or where land is already ecologically important. It also creates opportunities for public access, recreation, and habitat continuity while keeping vulnerable lands in a lower-risk, lower-maintenance condition over time.

Strategy 3.2: Shoreline preservation, living shorelines, and dune restoration

This strategy recognizes the White Oak River Basin’s coastal edge as a critical line of defense against erosion, tides, storm surge, and sea level rise. Living shorelines, dune restoration, and shoreline stabilization practices can reduce erosion while preserving the natural character of the coast. These approaches often provide habitat and water quality benefits in addition to flood protection. In White Oak, they are particularly relevant where bulkheads, shoreline armoring, or tidal exposure threaten adjacent property and public access. The strategy supports projects that maintain protective coastal features while shifting toward solutions that are more adaptive and ecologically beneficial over time.

Strategy 3.3: Expand use of nature-based solutions and green infrastructure

This strategy promotes stormwater practices that work with natural processes instead of relying only on conventional pipes and hard infrastructure. In the White Oak River Basin, that includes bioswales, rain gardens, bioretention, infiltration areas, natural ditches, and other low-impact approaches that can be used on streets, parks, private property, and public facilities. These measures can reduce runoff, improve water quality, and lessen pressure on drainage systems. They are especially useful in coastal communities where flooding is caused by both rainfall and tidal conditions. This strategy also supports demonstration projects that show how nature-based solutions can be practical, cost-effective, and visually compatible with coastal places.

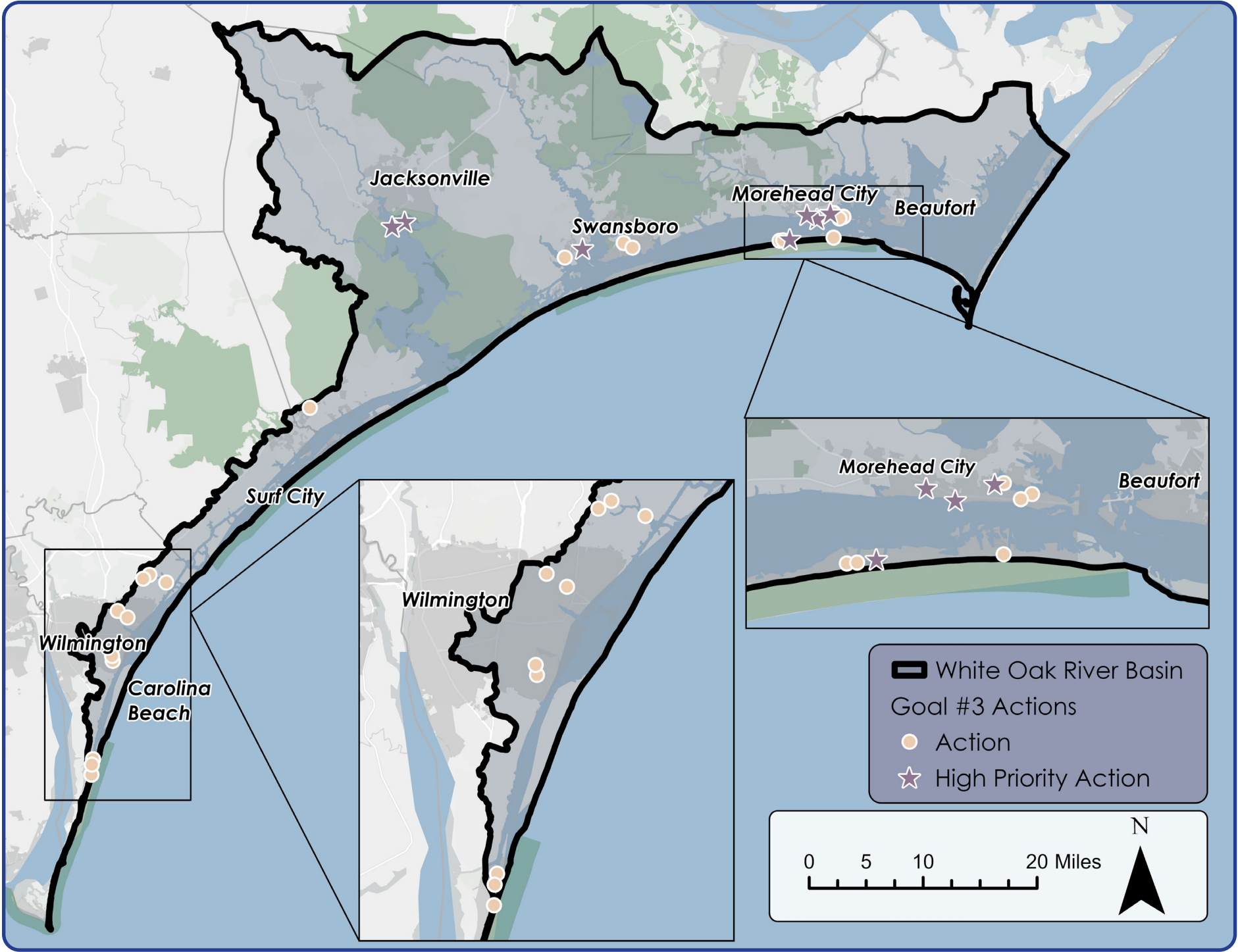


Figure 26: Basin-Wide Map with Goal 3 High Priority and Actions identified.

Goal 3. Protect and Restore Coastal Natural Systems/ Actions Descriptions

Goal 3: Protect and Restore Coastal Natural Systems includes 28 actions focused on the essential role that natural systems play in reducing flood risk. Of these, 6 were identified as high priority actions. These high priority actions span across the basin from Carteret County to New Hanover County, including barrier island communities and inland communities. The White Oak River Basin benefits from particularly strong representation of action proposals for nature-based solutions that use restoration as a tool for flood resilience with multiple additional benefits for ecosystems, cultural heritage, recreation, and tourism.

Recommended Critical Needs

- Study and identify most suitable locations for green infrastructure, stream restoration, and other nature-based solutions in individual communities
- Identify and prioritize open space parcels or other areas most critical for flood water retention and ecosystem protection from communities.
- Reuse FEMA buyout properties for open space, habitat, and low-impact community uses
- Restore hydrology on strategic upstream lands to retain water in the basin
- Install living shorelines and other coastal nature-based solutions
- Restore and stabilize streams to slow runoff and reduce erosion

Profiled Actions

- Scales Creek Restoration and Wetland Flood Storage Enhancement
- Carteret County Wetland Restoration Phase 1
- Pine Knoll Shores Comprehensive Shoreline Management Plan
- Swansboro Townwide Floodplain Restoration Framework

Action List

*High priority actions are highlighted in blue.

Table 7: Priority Action List - Goal 3

Action	Type*	Relative Cost Estimate**	Community Location
Strategy 3.1 Open space conservation			
Swansboro Townwide Floodplain Restoration Framework	Multi-Use Floodplains	\$ \$	Swansboro
Open Space Corridor Prioritization Study	Floodplain Preservation	\$ \$ \$ - \$ \$ \$ \$	New Hanover County
Recreational/Restoration Improvement for FEMA Buyout Properties	Floodplain Restoration	\$ \$ \$ - \$ \$ \$ \$	New Hanover County

*Actions that did not fit neatly into an action type are marked miscellaneous. Miscellaneous actions include outreach, planning, data collection, and other flood resilience steps not captured in the typology.

** Cost estimates are as follows: \$ < \$100,000; \$ \$ \$100,000 - \$500,000; \$ \$ \$ \$500,000 - \$1M; \$ \$ \$ \$ \$1M - \$5M; \$ \$ \$ \$ \$ \$ > \$5M. Some actions have a variable cost estimate based on yet-to-be-determined details such as potential participation level for buyouts or elevations, opportunities related to siting an action, or the action is a combination of planning and implementation. For these actions, the relative cost shown in the Action List may vary, potentially dramatically, given the final scale and scope of the action when implemented.

PRIORITIZED BASIN ACTIONS



Action	Type*	Relative Cost Estimate**	Community Location
Strategy 3.2 Shoreline preservation, living shorelines, and dune restoration			
Pine Knoll Shores Comprehensive Shoreline Management Plan	Miscellaneous	\$ \$ - \$ \$ \$	Pine Knoll Shores
Pine Knoll Shores Proactive Dune Stabilization and Protection Program	Floodplain Restoration	\$ \$ - \$ \$ \$	Pine Knoll Shores
Living Shoreline / Stabilization	Living Shorelines	\$ - \$ \$	Morehead City
Cape Carteret Living Shorelines	Living Shorelines	\$ \$ \$ - \$ \$ \$ \$ \$ \$	Cape Carteret
Shoreline and Bulkhead Improvements	Miscellaneous	\$ \$ \$ \$ \$	Carolina Beach
Strategy 3.3 Expand use of NBS and GI			
Scales Creek Wetland Creation	Flood Storage Wetlands	\$ \$ \$ \$ - \$ \$ \$ \$ \$ \$	Jacksonville
Carteret County Wetland Restoration Phase 1	Flood Storage Wetlands	\$ \$ \$ \$ \$	Carteret County
Carteret County Wetland Restoration Project Phase 2	Flood Storage Wetlands	\$ \$ \$ \$ \$	Carteret County
Carteret County Wetland Restoration Project Phase 3	Flood Storage Wetlands	\$ \$ \$ \$ \$	Carteret County
Scales Creek Stream Restoration	Floodplain Restoration	\$ \$ \$ \$	Jacksonville
Pages Creek 319 Water Quality Enhancement Project	Bioretention	\$ - \$ \$	New Hanover County
Green Infrastructure around Carolina Beach Lake	Bioretention	\$ \$ \$ \$ - \$ \$ \$ \$ \$ \$	Carolina Beach
Cape Fear Public Utility Authority Tributary Conservation	Floodplain Preservation	\$ \$ - \$ \$ \$	New Hanover County, Wrightsville Beach, Wilmington

*Actions that did not fit neatly into an action type are marked miscellaneous. Miscellaneous actions include outreach, planning, data collection, and other flood resilience steps not captured in the typology.

** Cost estimates are as follows: \$ < \$100,000; \$ \$ \$100,000 - \$500,000; \$ \$ \$ \$500,000 - \$1M; \$ \$ \$ \$ \$1M - \$5M; \$ \$ \$ \$ \$ \$ > \$5M. Some actions have a variable cost estimate based on yet-to-be-determined details such as potential participation level for buyouts or elevations, opportunities related to siting an action, or the action is a combination of planning and implementation. For these actions, the relative cost shown in the Action List may vary, potentially dramatically, given the final scale and scope of the action when implemented.

PRIORITIZED BASIN ACTIONS



Action	Type*	Relative Cost Estimate**	Community Location
Wisteria/Clearbrook Drive Drainage Improvement Project (Phase 2)	Floodplain Preservation	\$-\$-\$-\$	Wilmington
Halls Creek Stream Restoration	Floodplain Restoration	\$-\$-\$-\$	Swansboro
Pine Knoll Shores Nature-based or Hybrid Stormwater Solutions	Floodplain Restoration	\$-\$-\$-\$	Pine Knoll Shores
Pages Creek Watershed Restoration Plan Implementation	Floodplain Restoration	\$-\$-\$-\$-\$	New Hanover County
Green Infrastructure Suitability Analysis	Raingardens/Sand Filters/Bio-Swales	\$-\$-\$	Holly Ridge
Atlantic Beach Dune Infiltration	Raingardens/Sand Filters/Bio-Swale	\$-\$-\$	Atlantic Beach
Atlantic Beach Raingardens/Sand Filters/Bio-Swales	Raingardens/Sand Filters/Bio-Swale	\$-\$-\$	Atlantic Beach
701 Scorpion Bank Restoration / Outfall Design	Riparian Buffers	\$-\$-\$-\$	New Hanover County
North 20th Street tidal crossing improvement	Storm Water Management Activities	\$	Morehead City
Cape Carteret Stormwater Pretreatment	Storm Water Management Activities	\$-\$-\$-\$	Cape Carteret
Harbor and Marina Area Stormwater	Storm Water Management Activities	\$-\$-\$-\$	Carolina Beach
Newport River Restoration Initiative Phase II	Water Farming	\$\$\$\$	Carteret County

*Actions that did not fit neatly into an action type are marked miscellaneous. Miscellaneous actions include outreach, planning, data collection, and other flood resilience steps not captured in the typology.

** Cost estimates are as follows: \$ < \$100,000; \$\$ \$100,000 - \$500,000; \$\$\$ \$500,000 - \$1M; \$\$\$\$ \$1M - \$5M; \$\$\$\$\$ > \$5M. Some actions have a variable cost estimate based on yet-to-be-determined details such as potential participation level for buyouts or elevations, opportunities related to siting an action, or the action is a combination of planning and implementation. For these actions, the relative cost shown in the Action List may vary, potentially dramatically, given the final scale and scope of the action when implemented.





Atlantic Beach Pier

Scales Creek Restoration and Wetland Flood Storage Enhancement

Community:
Jacksonville

Cost:
\$8,925,000 (Restoration) + \$1,985,537 (Wetland Creation)

Goal:
Restore and use coastal natural systems

Strategies:
3.3 Expand use of nature-based solutions and green infrastructure

Guiding Principles:
Coordination, Future ready, From evidence to funded implementation, People centered, Nature-based

Source:
Locally prioritized for Blueprint

Category:
Nature-Based Solutions

Type:
Floodplain Restoration, Flood Storage Wetlands

Priority:
High

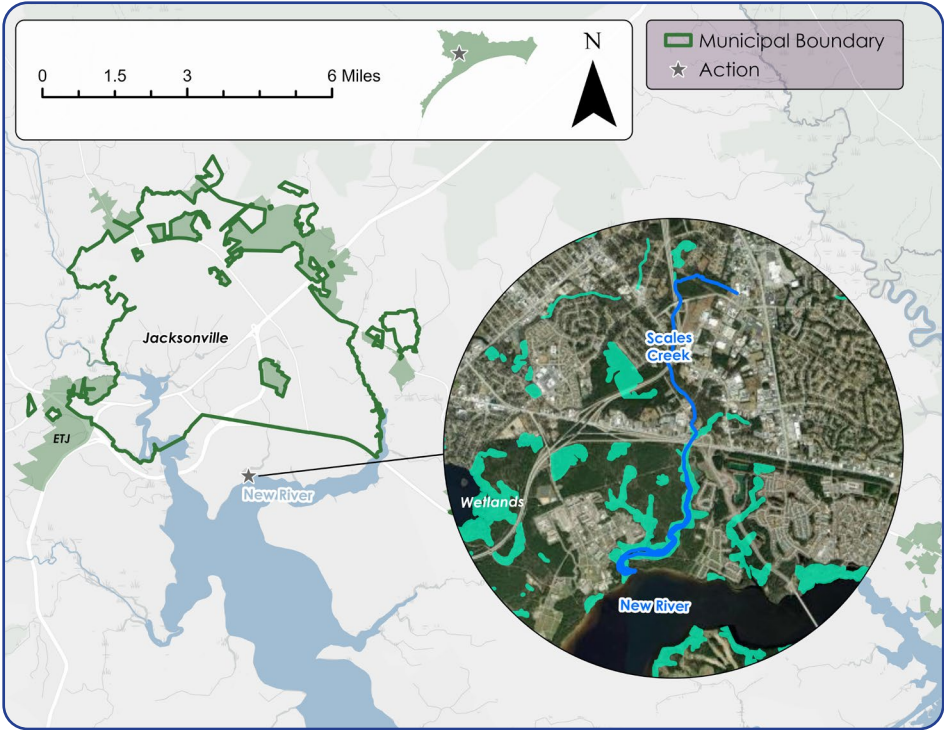


Figure 27: Scales Creek Individual Action Map.

The Scales Creek project, submitted in part as part of the 2024 Jacksonville CIP and supported by completed feasibility studies, includes two interconnected components: stream restoration and wetland creation within the Scales Creek Watershed. The Scales Creek Restoration component will restore approximately 6,900 linear feet of stream across Scales Creek, Ellis Creek, and Unnamed Tributary (UT) Scales Creek by using a nature-based design that modifies the existing channel cross section to increase capacity and reconnect the stream to its floodplain.

The Scales Creek Wetland Creation component will create 2.1 acres of wetlands across two wetland cells along Ellis Creek and UT Scales Creek. Designed as constructed flow-through wetlands, this component will provide flood attenuation and water quality treatment by increasing infiltration, slowing runoff, and reducing peak flow rates during storm events. The wetlands have been strategically located to maintain necessary buffers from roadways and existing utilities while connecting to the proposed stream restoration action. Together, these two components are expected to provide significant stormwater storage and flow management, with preliminary calculations indicating that the wetlands could attenuate incoming peak flows by 40 percent.



Carteret County Wetland Restoration Phase 1

Community:
Carteret County

Cost:
\$11,988,346

Goal:
Restore and use coastal natural systems

Strategies:
3.1 Open space conservation; 3.3 Expand use of nature-based solutions and green infrastructure

Guiding Principles:
Coordination, Future ready, From evidence to funded implementation, Nature-based

Source:
Locally prioritized for Blueprint

Category:
Nature-Based Solutions

Type:
Flood Storage Wetlands

Priority:
High

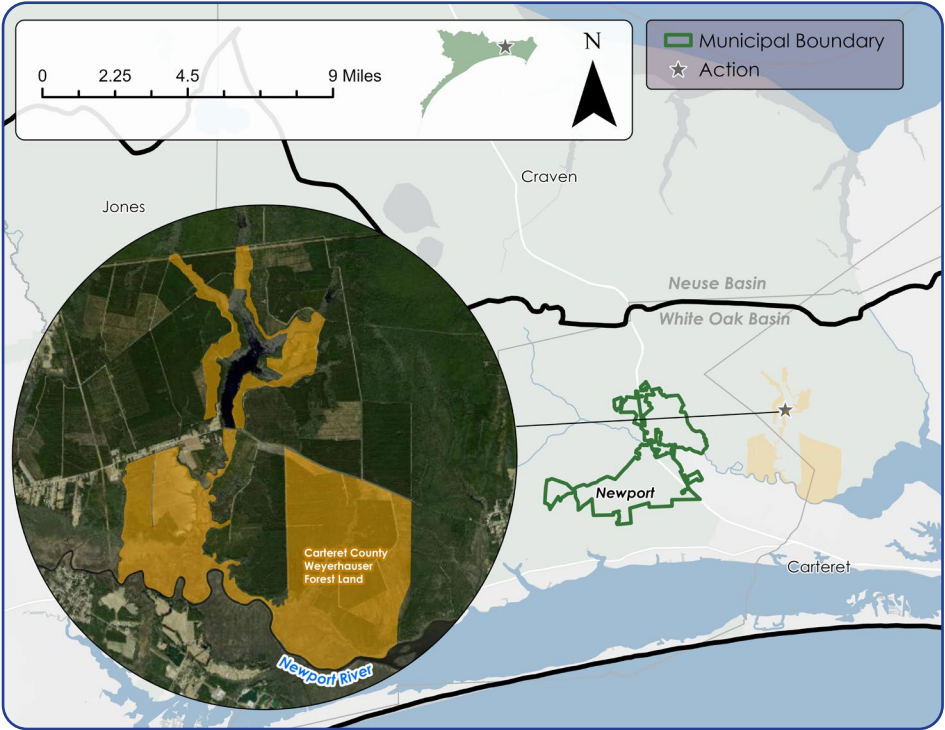
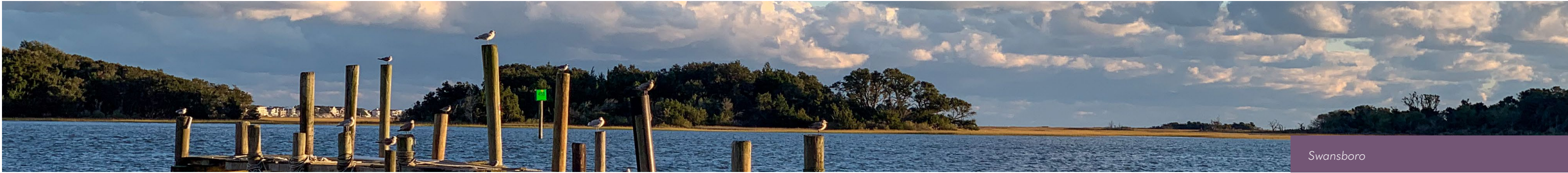


Figure 28: Carteret County Individual Action Map.

Carteret County Wetland Restoration Phase 1 is a large-scale nature-based action led by the North Carolina Coastal Federation to restore wetlands and reduce stormwater runoff from former timberland draining to the Newport River. Phase 1 covers approximately 1,423 acres of the broader 3,000-acre action area and will improve infiltration, reduce runoff volumes, and attenuate peak flows reaching downstream communities during storm events. The action is also intended to improve water quality, reduce sedimentation in the Newport River, and enhance flood resiliency across the site and surrounding area.

The proposed design includes dikes, ditch plugs, stream restoration, slough grading, wetland cell grading, and water control structures to manage water levels and distribute retained water across the landscape. Road elevation along Mill Creek Road, along with setbacks designed to protect neighboring parcels and existing wetlands, will further reduce flood exposure and preserve sensitive habitat. In addition to flood and water quality benefits, the action will restore native tree species and plant communities, support longleaf pine habitat, and provide recreation opportunities for visitors.





Swansboro

Pine Knoll Shores Comprehensive Shoreline Management Plan

Community:
Pine Knoll Shores

Cost:
\$500,000 - \$1 million

Goal:
Restore and use coastal natural systems

Strategies:
3.2 Shoreline preservation, living shorelines, and dune restoration; 5.1 Ground actions in local data and watershed-scale analysis; 5.2 Create a project identification and prioritization pipeline; 5.4 Track outcomes, monitor conditions, and adapt overtime

Guiding Principles:
Data driven and transparent, Future ready, From evidence to funded implementation, Nature-based

Source:
Pine Knoll Shores Resilience Strategy

Category:
Other

Type:
Coastal - Road Elevation/Modification

Priority:
High

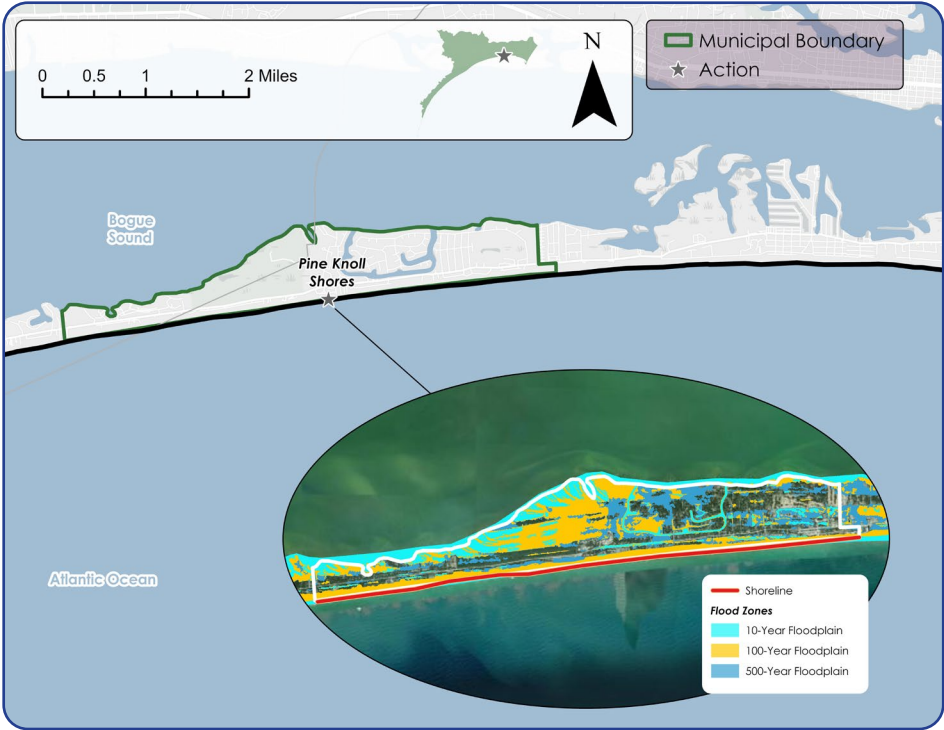


Figure 29: Pine Knoll Shores Individual Action Map.

Pine Knoll Shores will develop a comprehensive shoreline management plan to evaluate erosion hazards and identify solutions that reduce the impacts of storm surge and wave action. With detail to the parcel level, the plan will help the Town determine which shoreline protection strategies are most appropriate for project areas, based on site conditions, exposure, and resilience needs. This detailed assessment will provide a strong foundation for future coastal adaptation decisions.

As part of the analysis, the plan will consider options such as tidal breaks and living shorelines along sections of Bogue Sound. These nature-based and hybrid approaches can help stabilize the shoreline, reduce erosion, and lessen wave energy before it reaches vulnerable properties and infrastructure. Submitted as part of the 2022 Pine Knoll Shores Resilience Strategy (a RCCP project), the action will support long-term coastal resilience planning and guide future implementation of shoreline protection measures.



Swansboro Townwide Floodplain Restoration Framework

Community:
Swansboro

Cost:
\$100,000 - \$500,000

Goal:
Restore and use coastal natural systems

Strategies:
3.1 Open space conservation; 3.3 Expand use of nature-based solutions and green infrastructure; 5.1 Ground actions in local data and watershed-scale analysis; 5.2 Create a project identification and prioritization pipeline

Guiding Principles:
Coordination, Future ready, Nature-based

Source:
Swansboro Shores Resilience Strategy

Category:
Policy & Planning

Type:
Multi-Use Floodplains

Priority:
High

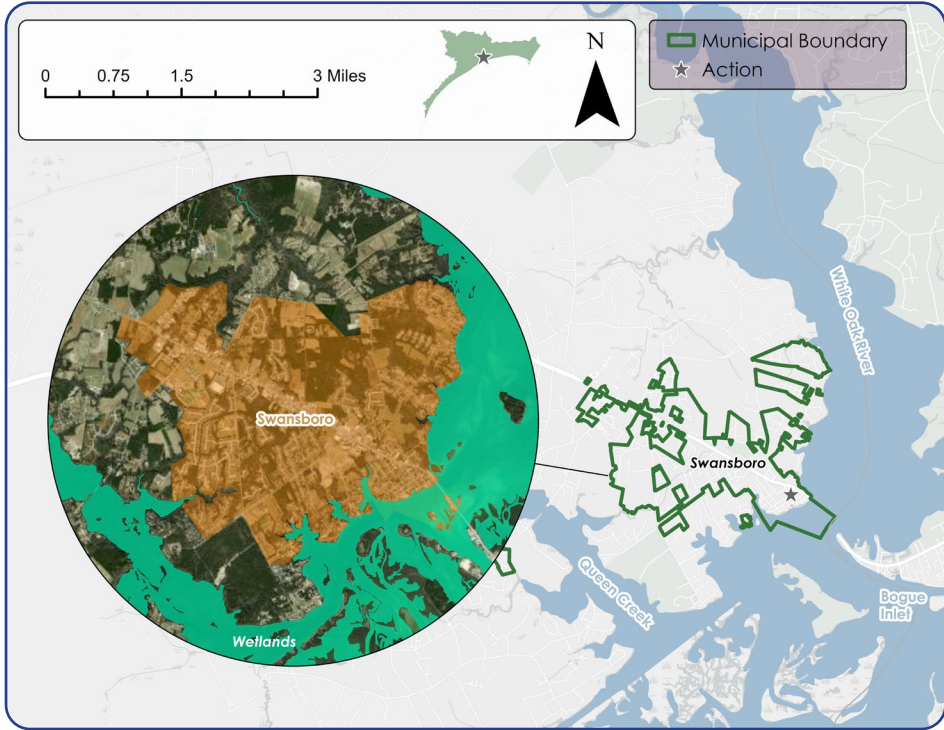


Figure 30: Swansboro Individual Action Map.

The Town of Swansboro is proposing a townwide wetland restoration plan to support floodplain restoration and protect critical wetland systems throughout the community. This planning effort will identify critical wetland systems and develop recommendations for restoration and preservation actions that can help maintain their flood storage, ecological, and water quality functions. By focusing on the town’s wetland network, the action will strengthen flood resilience while also supporting the long-term health of natural systems that help absorb and store excess water.

The plan will also address opportunities to work with private property owners on wetland restoration projects, expanding the potential for implementation beyond publicly owned lands. This collaborative approach can help protect vulnerable wetland areas and create more connected floodplain benefits across Swansboro. Submitted as part of the 2022 Swansboro Resilience Strategy (a RCCP project), the action will provide a framework for prioritizing restoration actions and preserving multi-use floodplains that contribute to both flood reduction and community resilience.



GOAL 4. REDUCE FLOOD RISK THROUGH LAND USE AND DEVELOPMENT

Goal 4: Reduce Flood Risk Through Land Use and Development focuses on preventing future risk while reducing exposure in places that are already vulnerable. In the White Oak River Basin, flood resilience depends on how land is used, where growth occurs, and how environmental change is occurring. This goal brings together property mitigation, development standards, and land use choices that reduce long-term losses. It supports wise, balanced decisions about redevelopment, density, setbacks, and conservation, while also helping communities avoid repeating patterns of damage. The intent is to align growth and property decisions with flood realities so future investments are safer and more durable.

Strategy 4.1: Buyouts

This strategy removes flood-prone structures from harm’s way. In the White Oak River Basin, buyouts may be appropriate where properties have experienced repeated losses, where elevation or floodproofing is not sufficient, or where returning land to open space would provide greater long-term benefit. Buyouts can reduce public costs over time by eliminating future damages and maintenance needs. They also create opportunities to restore land for flood storage, recreation, habitat, or conservation. Because buyouts depend on voluntary participation and funding availability, they are best used where the benefits are clear and where the property can contribute to a broader resilience or open space strategy. Local governments should be supported in strategizing related to changes to property tax income.

Strategy 4.2: Elevations and retrofits

This strategy focuses on protecting existing buildings that are important to residents, businesses, and community function. In the White Oak River Basin, this can include elevating homes, businesses, historic buildings, and public or nonprofit facilities, as well as floodproofing or retrofitting properties where elevation is not practical. These actions reduce damage during flood events and can help preserve community character, housing, and economic activity. Elevation and retrofits are especially relevant in developed coastal areas where properties are already in place and likely to remain exposed without intervention. This strategy helps communities reduce recurring losses while keeping important places operational and accessible.

Strategy 4.3: Promote floodwise and resilient development

This strategy supports development patterns and regulations that reduce future flood exposure. In the White Oak River Basin, that may include higher freeboard, stronger stormwater requirements, cluster development, improved subdivision standards, and permitting guidance. The goal is to ensure that new development and redevelopment do not create future liabilities or increase runoff problems in already vulnerable areas. This strategy also helps local governments align growth with available infrastructure and natural hazard conditions. By making resilience part of the development process, communities can reduce future costs while creating safer, more durable places to live and work.

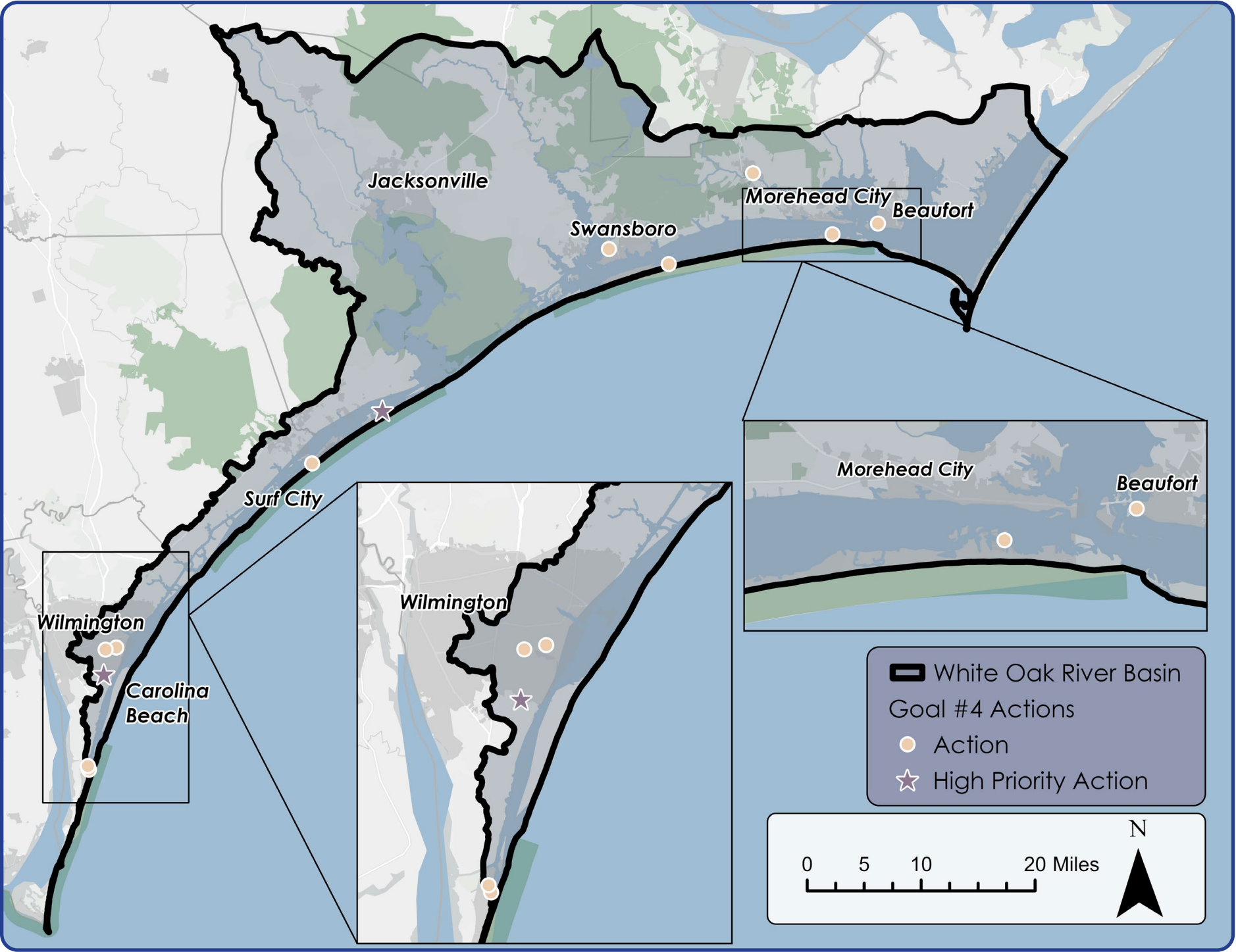


Figure 31: Basin-Wide Map with Goal 4 High Priority and Actions identified.

Strategy 4.4: Guide development away from risky areas

This strategy keeps the most vulnerable lands from becoming more heavily developed over time. In the White Oak River Basin, that includes floodplains, erosion-prone areas, and other places where repeated flooding or coastal hazards make development difficult to protect. Tools may include zoning restrictions, setbacks, conservation areas, and limits on certain uses in high-risk locations. By steering growth to safer ground, local governments can reduce future damage, lower infrastructure costs, and preserve areas that naturally support flood storage and habitat. This strategy is especially important in a basin where coastal exposure and land constraints make long-term avoidance of risk a critical part of resilience planning.

Goal 4. Reduce Flood Risk Through Land Use and Development Actions Descriptions

Goal 4: Reduce Flood Risk Through Land Use and Development includes 12 actions focused on preventing future risk while reducing exposure in places that are already vulnerable. Of these, 2 were identified as high priority actions. Actions for this goal include locally prioritized actions submitted by Cedar Point, North Topsail Beach, and Beaufort. This goal featured buyout, elevation, and other retrofit projects that reflect an existing pattern of land use that creates flood risk. It also includes exploration and development of innovative local development tools to reduce the flood risk generated by new development for new residents as well as existing structures located nearby. The actors that influence this goal are particularly varied, including many private sector actors. Several actions are focused on working with private land owners or other private parties to collaborate on reducing flood risk.

Recommended Critical Needs

- Pursue voluntary buyouts in at-risk areas
- Mitigate individual properties, including elevations, floodproofing, and other retrofits
- Develop datasets needed to understand where frequent flooding occurs, even if outside the floodplain, to help guide new development
- Explore and develop local regulatory tools that minimize the growth of flood risk within a community for new and existing residents
- Provide private development stakeholders such as developers, homeowner associations, and homeowners information that empowers them to reduce the flood risk generated by land use change or mitigate the risk on individual properties

Action List

*High priority actions are highlighted in blue.

Table 8: Priority Action List - Goal 4

Action Name	Type*	Relative Cost Estimate**	Community Location
Strategy 4.1 Buyouts			
Cedar Point Voluntary Repetitive Loss Buyouts	Acquisition/ Demolition/Buyouts	\$-\$-\$-\$-\$	Cedar Point
Carolina Beach Buyout or Property Transition Exploration	Acquisition/ Demolition/Buyouts	\$-\$-\$-\$	Carolina Beach
Mitigate High-Risk Properties through Buyouts, Retrofits, Elevations, and Open Space Conservation	Acquisition/ Demolition/Buyouts	\$-\$-\$-\$	New Hanover County

*Actions that did not fit neatly into an action type are marked miscellaneous. Miscellaneous actions include outreach, planning, data collection, and other flood resilience steps not captured in the typology.

** Cost estimates are as follows: \$ < \$100,000; \$\$ \$100,000 - \$500,000; \$\$\$ \$500,000 - \$1M; \$\$\$\$ \$1M - \$5M; \$\$\$\$\$ > \$5M. Some actions have a variable cost estimate based on yet-to-be-determined details such as potential participation level for buyouts or elevations, opportunities related to siting an action, or the action is a combination of planning and implementation. For these actions, the relative cost shown in the Action List may vary, potentially dramatically, given the final scale and scope of the action when implemented.

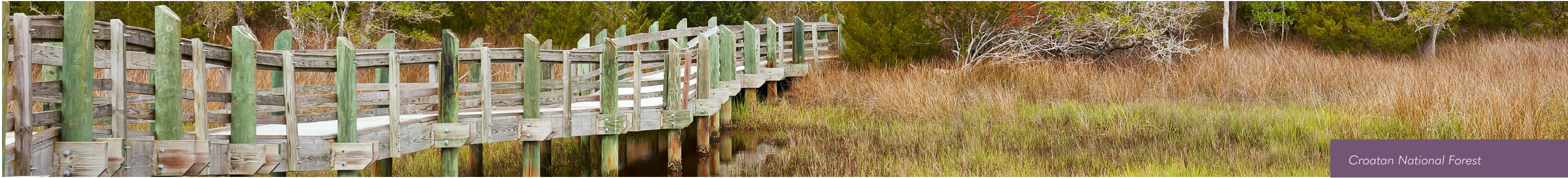


Action Name	Type*	Relative Cost Estimate**	Community Location
Newport Abandoned Property Buyouts and Recreational Conversion	Acquisition/ Demolition/Buyouts	\$-\$-\$-\$	Newport
Strategy 4.2 Elevations and retrofits			
Property and Infrastructure Retrofits	Acquisition/ Demolition	\$-\$-\$-\$	North Topsail Beach
Historical Structure Elevation	Dry Floodproofing	\$-\$-\$-\$	Beaufort
Atlantic Beach Private Property Owner Outreach	Miscellaneous	\$	Atlantic Beach
Surf City Downtown Rehabilitation and Business Elevation Program	Structural Elevation	\$-\$-\$-\$-\$	Surf City
Strategy 4.3 Promote wise development to avoid increasing flood risk			
Expand Sewer in Flood-Prone Areas - Exploration and Implementation	Critical Infrastructure	\$-\$-\$-\$-\$	New Hanover County
Private Property Stormwater Outreach and Incentivization	Storm Water Management Activities	\$	Carolina Beach
Emerald Isle Multi-Method Roadway Flooding Reduction	Storm Water Management Activities	\$-\$-\$-\$	Emerald Isle
Strategy 4.4 Direct development away from risky areas			
Innovative Floodplain Management in New Hanover County	Advanced Regulations (Land Use and Impervious Surface Restrictions)	\$-\$-\$-\$-\$	New Hanover County

*Actions that did not fit neatly into an action type are marked miscellaneous. Miscellaneous actions include outreach, planning, data collection, and other flood resilience steps not captured in the typology.

** Cost estimates are as follows: \$ < \$100,000; \$\$ \$100,000 - \$500,000; \$\$\$ \$500,000 - \$1M; \$\$\$\$ \$1M - \$5M; \$\$\$\$\$ > \$5M. Some actions have a variable cost estimate based on yet-to-be-determined details such as potential participation level for buyouts or elevations, opportunities related to siting an action, or the action is a combination of planning and implementation. For these actions, the relative cost shown in the Action List may vary, potentially dramatically, given the final scale and scope of the action when implemented.





Carolina Beach Buyout or Property Transition Exploration

Community:
Carolina Beach

Cost:
\$500,000 - \$1 million

Goal:
Reduce flood risk through land use and redevelopment

Strategies:
4.1 Buyouts; 5.1 Ground actions in local data and watershed-scale analysis

Guiding Principles:
Evidence to funded implementation

Source:
Locally prioritized for Blueprint

Category:
Building Level Mitigation

Type:
Acquisition/ Demolition

Priority:
Regular

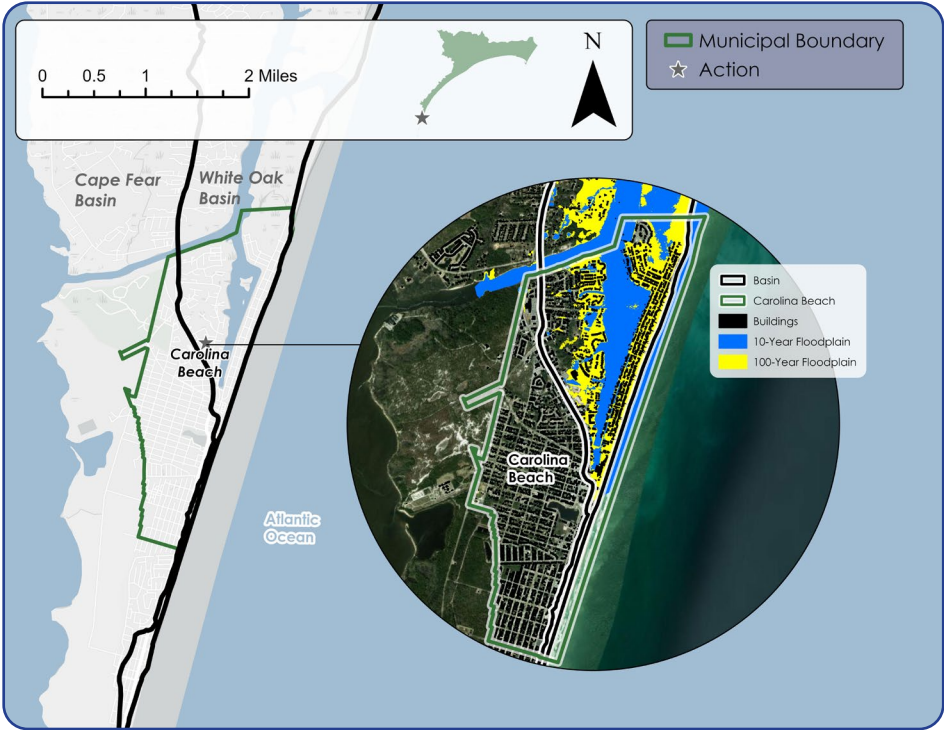


Figure 32: Carolina Beach Individual Action Map.

The Carolina Beach Buyout or Property Transition Exploration action will evaluate voluntary buyout and property transition strategies for selected low-lying areas that experience repeated flooding and shoreline vulnerability. In locations where infrastructure improvements alone may not fully resolve long-term flooding, access, or erosion-related challenges, this action will help the Town identify whether acquisition or transition approaches may provide a more durable resilience solution. The action focuses on reducing long-term risk in areas that are difficult and costly to protect through conventional structural measures.

This effort will support informed planning by identifying properties where recurring flood exposure may continue to threaten public safety, infrastructure, and long-term land use compatibility. By considering voluntary buyouts or other transition strategies, the Town can explore options that reduce future maintenance burdens, lower repetitive damage, and create space for more sustainable floodplain or shoreline management over time. This action provides a proactive framework for addressing chronic vulnerability while preserving flexibility for residents and decision-makers.



Cedar Point Voluntary Repetitive Loss Buyouts

Community:
Cedar Point

Cost:
\$10,000-\$20,000,000

Goal:
Reduce flood risk through land use and redevelopment

Strategies:
4.1 Buyouts

Guiding Principles:
From evidence to funded implementation

Source:
Locally prioritized for Blueprint

Category:
Building Level Mitigation

Type:
Acquisition/ Demolition

Priority:
Regular

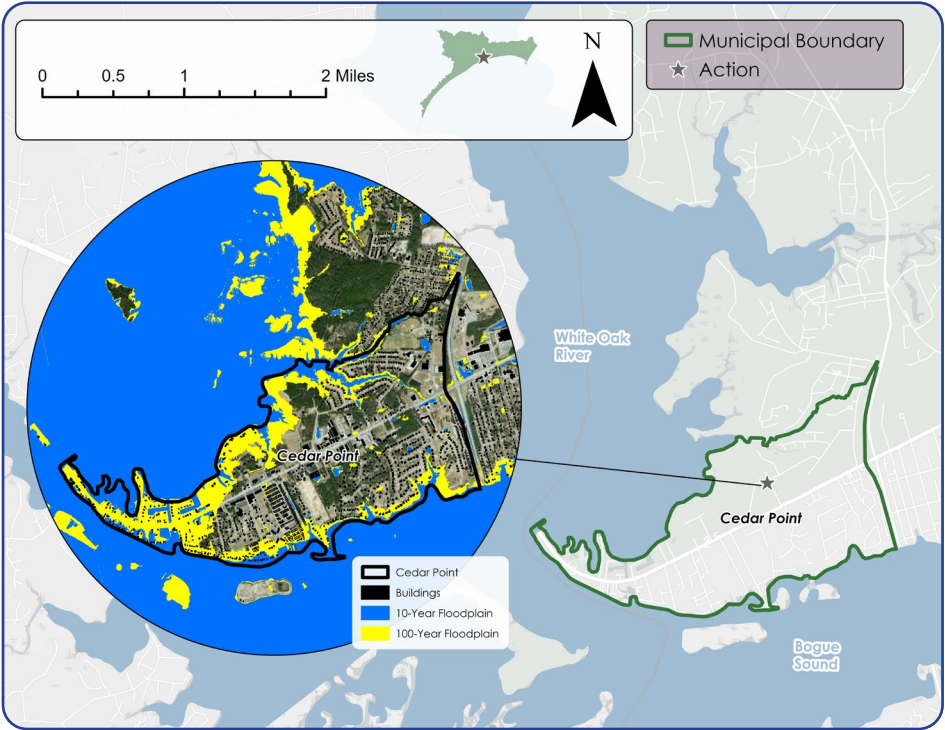


Figure 33: Cedar Point Individual Action Map.

The Cedar Point Voluntary Repetitive Loss Buyouts action will reduce flood risk by targeting repetitive loss properties within the Town, with a particular focus on the western portion of Cedar Point where the largest losses have occurred. This action proposes the acquisition and demolition of vulnerable structures in areas that experience recurring flood impacts, helping to remove residents and buildings from high-risk locations and reduce the Town's long-term exposure to future damage. By addressing repetitive loss properties directly, the action can lower recovery costs, improve public safety, and reduce the burden on local infrastructure and emergency response resources.

In addition to reducing repeated flood losses, buyouts create opportunities for more sustainable long-term land use in areas that are difficult to protect through structural improvements alone. Removing the most flood-prone buildings can help reduce future claims and maintenance costs while allowing the Town to consider more resilient uses for acquired parcels over time. Overall, the action supports a proactive building-level mitigation strategy that prioritizes the most vulnerable properties and helps strengthen Cedar Point's overall flood resilience.



GOAL 5. BUILD A DURABLE PATHWAY FROM EVIDENCE TO IMPLEMENTATION

Goal 5. Build a durable pathway from evidence to implementation aims to ensure that the Basin’s priorities can move from one-off ideas into funded, coordinated, and measurable action. In the White Oak River Basin, many flood resilience ideas are strong but need more analysis, clearer scope, or a delivery strategy before they can advance. This goal brings together the data, prioritization, funding, monitoring, and coordination needed to make implementation realistic, especially in smaller jurisdictions. It also recognizes that flood resilience is an ongoing process, not a one-time plan.

Strategy 5.1: Ground actions in local data and watershed-scale analysis

This strategy is focused on using the best available data to guide decisions. In the White Oak River Basin, that may include the Blueprint’s watershed-scale modeling as well as local assessments and engineering studies. Importantly, it also includes the creation and regular updating of local datasets to keep information current and useful for decision-making.

Strategy 5.2: Create a project identification and prioritization pipeline

This strategy provides a sustainable way to turn broad ideas into a more organized list of candidate projects. In the White Oak River Basin, that means using assessment and planning to align needs, prioritize projects, and maximize synergies across projects. The NCDEQ Resilient Coastal Communities Program is an excellent example of this strategy, offering a structured path for communities to move from vulnerability assessment to project identification and beyond into implementation. A systematic approach for identifying needs and priorities is especially important in a basin where the action list includes many promising but still early-stage proposals. This strategy was identified as a need during the development of the RBAS, but no actions were submitted that address this need.

Strategy 5.3: Create a funding and delivery pipeline

This strategy connects priority projects to grants, capital planning, and phased implementation. This strategy is supported by actions from stakeholders outside local government. Smaller jurisdictions especially benefit from a framework of technical assistance and reliable, regular funding opportunities. In the White Oak River Basin, many high-value projects will depend on outside funding and/or multiple funders. This strategy was identified as a need during the development of the RBAS, but no actions were submitted that address this need.

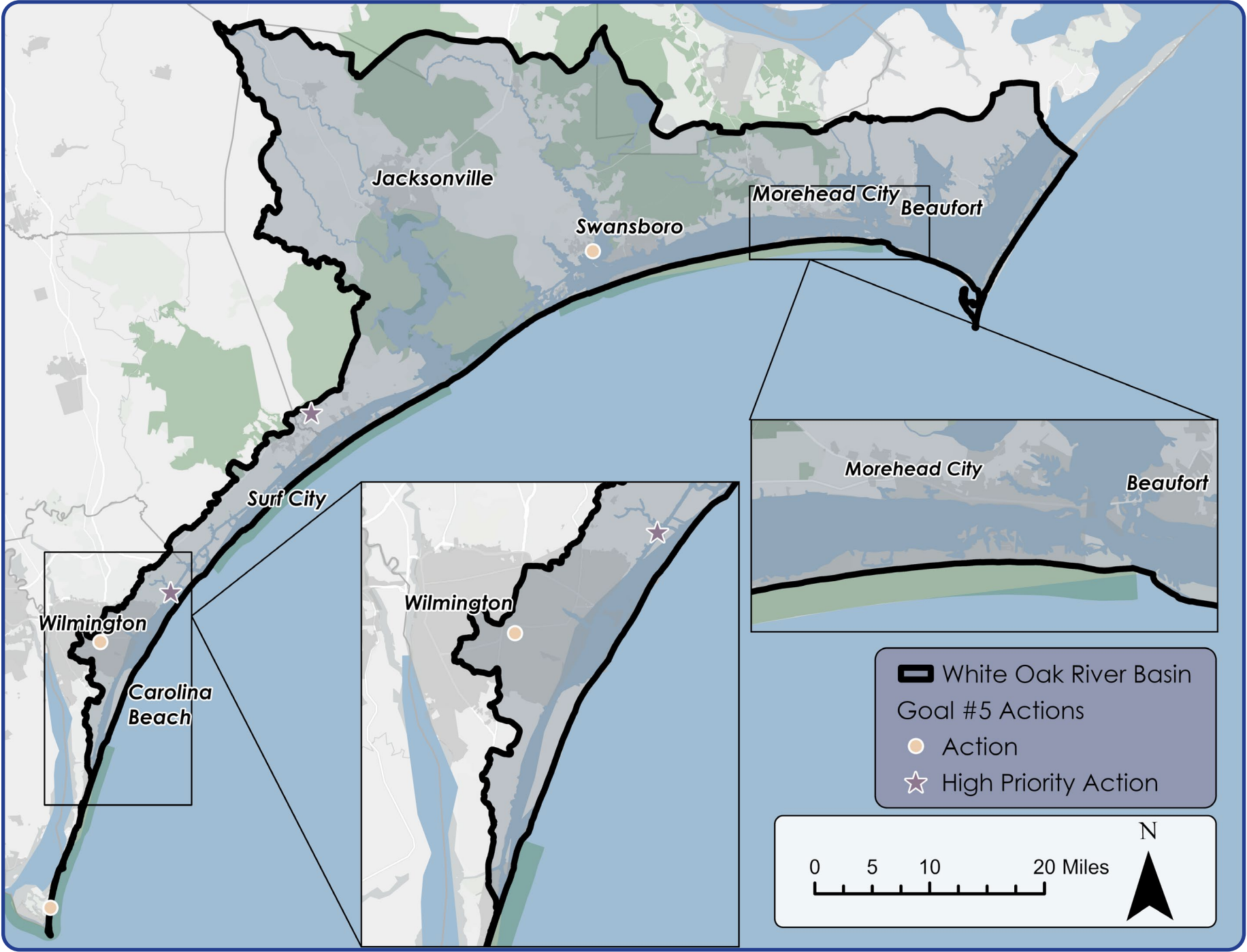


Figure 34: Basin-Wide Map with Goal 4 High Priority and Actions identified.

Strategy 5.4: Track outcomes, monitor conditions, and adapt over time

This strategy supports continuous learning and adaptive management. This is essential in the White Oak River Basin, where flood risks are varied, conditions are changing, and development patterns are diverse. This strategy can include environmental monitoring with tools like monitoring gauges or performance tracking. It can also include post-project evaluation or a calendar and process for revisiting existing priorities. This strategy also supports accountability by helping show whether projects are reducing risk, protecting assets, or improving flood response. This strategy was identified as a need during the development of the RBAS, but no actions were submitted that directly address it in the project descriptions. However, it is possible that many of the projects will track outcomes, monitor conditions, and adapt over time.

Strategy 5.5: Strengthen regional coordination and technical support

This strategy recognizes that many flood resilience challenges in the White Oak River Basin cross jurisdictional boundaries, require shared effort, or exceeds the capacity of smaller jurisdictions to implement in-house. Coordination among local, regional, and state partners can improve consistency, reduce duplication, and provide helpful knowledge transfer. It helps ensure that actions are consistent and complementary across administrative boundaries. This strategy also helps ensure that all communities, including those with fewer administrative and technical resources, can participate in and benefit from basin-wide resilience efforts.

Goal 5. Build a Durable Pathway from Evidence to Implementation Actions Descriptions

Goal 5. Build a durable pathway from evidence to implementation includes 5 actions, 2 of which are high priority, that demonstrate how the Basin’s priorities can move from one-off ideas into funded, coordinated, and measurable action. The actions in this goal include action types, with a common thread of identifying a clear pathway from studying the need to designing the project to construction.

The number of local actions for this goal reflects three trends. First, some strategies in this goal describe processes applicable to actions under other goals. Many actions under other goals do use techniques like grounding action in local data. Second, some strategies in this goal are better matched to organizations outside of local government, for example, councils of government or state agencies. Finally, some of these strategies are considered best practices but are not yet commonly implemented, such as systematic post-project monitoring or adaptive management.

Recommended Critical Needs

Profiled Actions

- Create local and regional environmental datasets needed for monitoring flood risk and developing projects
- Use best available data, such as the future conditions modeling provided by the Blueprint, to support project design and engineering
- Use consistent frameworks to guide resilience planning from vulnerability assessment to strategy development to implementation
- For resilience plans, reconvene key contributors on a yearly basis to revisit priorities and reflect on progress

- Pages Creek — Dunbar Headwaters Restoration Feasibility (FEMA Buyout Parcels)
- Holly Ridge Storm Water Management Activities

Action List

*High priority actions are highlighted in blue.

Table 9: Priority Action List - Goal 5

Action Name	Type*	Relative Cost Estimate**	Community Location
Pages Creek Dunbar Headwaters Restoration Feasibility with Buyout Parcels	Floodplain Restoration	\$\$-\$\$\$	New Hanover County
Holly Ridge Stormwater Master Plan	Storm Water Management Activities	\$	Holly Ridge
Swansboro Engagement and Education on Sea Level Rise and Other Hazards	Miscellaneous	\$	Swansboro
Brunswick Flood-Prone Area Mapping for Project Review	Miscellaneous	\$\$-\$\$\$	Brunswick County
Wilmington Resilient Coastal Communities Program (RCCP) Phases 1 & 2 Completion	Miscellaneous	\$\$-\$\$\$	Wilmington

*Actions that did not fit neatly into an action type are marked miscellaneous. Miscellaneous actions include outreach, planning, data collection, and other flood resilience steps not captured in the typology.

** Cost estimates are as follows: \$ < \$100,000; \$\$ \$100,000 - \$500,000; \$\$\$ \$500,000 - \$1M; \$\$\$\$ \$1M - \$5M; \$\$\$\$\$ > \$5M. Some actions have a variable cost estimate based on yet-to-be-determined details such as potential participation level for buyouts or elevations, opportunities related to siting an action, or the action is a combination of planning and implementation. For these actions, the relative cost shown in the Action List may vary, potentially dramatically, given the final scale and scope of the action when implemented.





Bogue Sound

Pages Creek
Dunbar
Headwaters
Restoration
Feasibility (FEMA
Buyout Parcels)

Community:
New Hanover County

Cost:
\$500,000 - \$1,000,000

Goal:
Build a pathway to implementation

Strategies:
3.3 Expand use of nature-based solutions and green infrastructure; 5.1 Ground actions in local data and watershed-scale analysis; 5.2 Create a project identification and prioritization pipeline

Guiding Principles:
Data driven and transparent, Future ready, From evidence to funded implementation, Nature-based

Source:
Locally prioritized for Blueprint

Category:
Nature-Based Solutions

Type:
Floodplain Restoration

Priority:
High

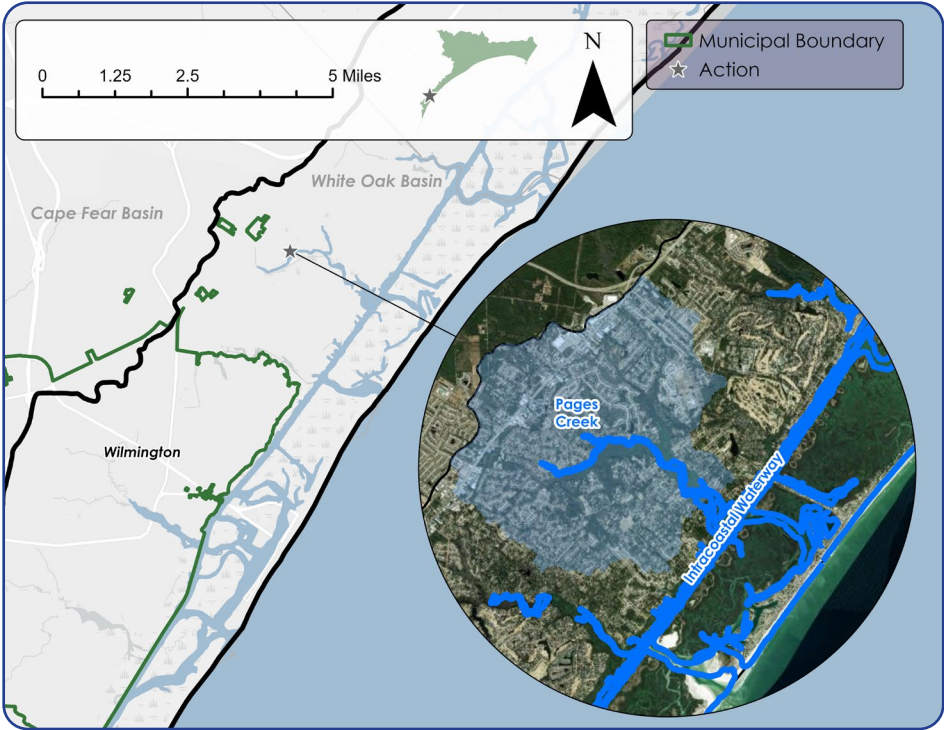


Figure 35: Pages Creek Individual Action Map.

The Pages Creek Dunbar Headwaters Restoration Feasibility action will use local data and watershed-scale analysis to evaluate nature-based stream restoration opportunities in the headwaters upstream of Dunbar Road within the Pages Creek Watershed in New Hanover County. Led by Cape Fear Resource Conservation & Development and Moffatt & Nichol in coordination with New Hanover County, this feasibility study will use hydrologic modeling, updated local datasets, and concept design development to better understand flood risk, stormwater behavior, and stream function in a highly vulnerable part of the watershed. The study area includes public properties, rights-of-way, and four FEMA buyout parcels, allowing the action team to assess a range of implementation opportunities within the headwaters.

The action will culminate in a restoration concept plan and set of recommendations that can help move a promising action toward a more defined, measurable, and implementable project. By focusing on stream restoration and flood mitigation in the upper watershed, the study will help identify where flooding occurs, how upstream conditions affect downstream areas, and which nature-based solutions are likely to produce the greatest benefit. It will also support long-term resilience planning by creating a stronger technical foundation for future design, funding, and implementation as opportunities become available.

PRIORITIZED BASIN ACTIONS



Holly Ridge
Storm Water
Master Plan

Community:
Holly Ridge

Cost:
\$100,000

Goal:
Build a pathway to implementation

Strategies:
2.1 Map infrastructure and systematically assess vulnerability; 2.2 Upgrade stormwater, outfalls, and tidal drainage systems; 5.1 Ground actions in local data and watershed-scale analysis

Guiding Principles:
Future ready, From evidence to funded implementation, Nature-based

Source:
Town of Holly Ridge Resilience Strategy

Category:
Infrastructure & Control Structures

Type:
Stormwater Management Activities

Priority:
High

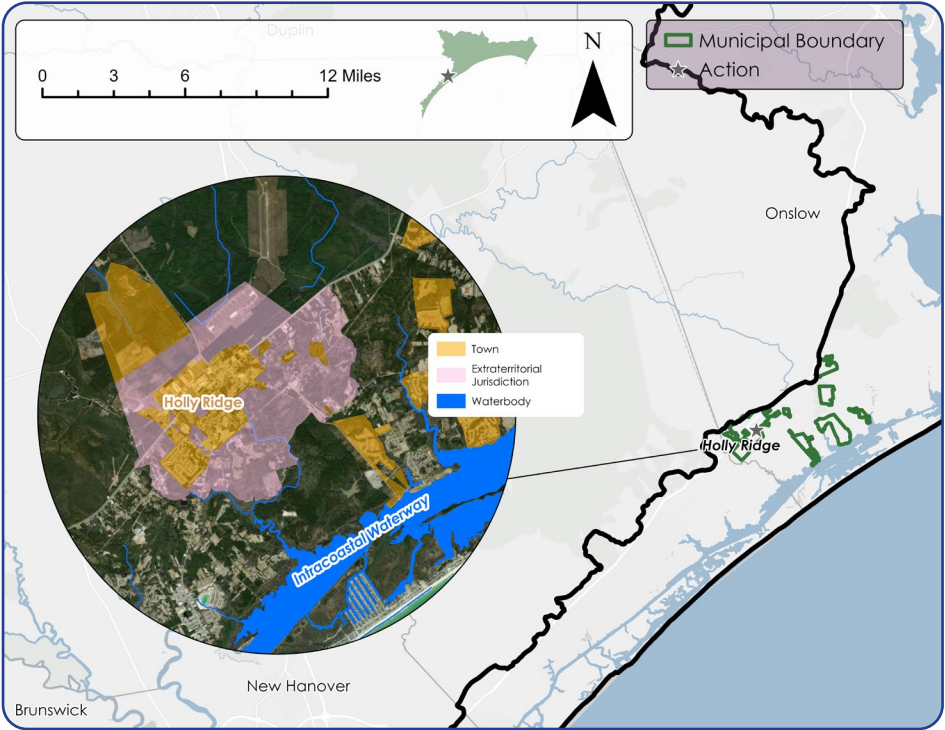


Figure 36: Holly Ridge Individual Action Map.

The Town of Holly Ridge is proposing a Stormwater Master Plan to strengthen long-term stormwater management and flood resilience. Included in the 2024 *Town of Holly Ridge Resilience Strategy*, the \$100,000 planning effort will begin with an inventory of existing municipal stormwater resources, providing the Town with a clearer understanding of its current infrastructure and maintenance needs. This foundational assessment will help identify system gaps, capacity shortfalls, and areas where stormwater performance may be limited during heavy rainfall events.

Using the inventory and gap analysis, the action will prioritize future actions to address water quality, maintenance tracking, flood mitigation, floodproofing, and public messaging needs. As the Resilience Strategy explains, “With no plan in place for improvements, issues can only be addressed on a case-by-case basis, limiting community impact. A stormwater master plan can provide short and long-term planning for maximum benefit.” By establishing a more organized and data-driven approach to stormwater planning, the Town can better target capital investments and operational improvements. The master plan will also support proactive decision-making by linking current conditions to future resilience needs, helping Holly Ridge prepare for evolving flood and drainage challenges.

PRIORITIZED BASIN ACTIONS



REVIEW OF FUNDING SOURCES

North Carolina communities face growing challenges from flooding, aging infrastructure, rapid development, and extreme weather. A wide ecosystem of federal, state, regional, and private funding sources exists to address these risks, but navigating this landscape is complex. The Funding Sources Writeup provides a comprehensive catalog of the programs available to support resilient infrastructure, watershed restoration, nature-based solutions, disaster recovery, stormwater improvements, and long-range community planning.

This summary synthesizes key funding takeaways, highlighting major categories of funding, core features of key programs, and strategic considerations for project selection, eligibility, and implementation. It is intended to support staff, local governments, and partners in identifying viable funding pathways and leveraging a variety of potential funding sources – including opportunities that are not directly focused on flood resilience – to align resilience needs with the strongest opportunities.

Federal Funding Landscape

Federal agencies administer a wide range of programs that support flood mitigation, disaster recovery, transportation resilience, water/wastewater infrastructure, land conservation, and ecosystem restoration. Many of these

programs are competitive, require detailed benefit cost analysis, and operate on recurring annual cycles or disaster specific funding streams.

FEMA Programs

FEMA funds are among the most significant sources for hazard mitigation and flood resilience:

25%

Across all FEMA programs, eligible applicants in North Carolina include local governments, tribes, and state agencies. Projects generally require a 25% local match unless the community qualifies for disadvantaged or severe repetitive loss adjustments.

- Building Resilient Infrastructure and Communities (BRIC)**
provides competitive funding for mitigation projects, with strong emphasis on shovel-ready infrastructure protection solutions, improved codes and code enforcement and long-term resilience in the face of changing conditions.
- Flood Mitigation Assistance (FMA)**
supports repetitive loss and severe repetitive loss properties through elevation, acquisition, and floodproofing, floodplain restoration, and flood mitigation planning.
- Hazard Mitigation Grant Program (HMGP)**
is available after major disasters and supports a wide range of projects such as buyouts, structural mitigation, and infrastructure retrofits.
- Disaster Relief Fund (DRF)**
is available post disaster for emergency projection, repair and restoration of public infrastructure, hazard mitigation, survivor assistance and fire management.

It is important to note that while the Blueprint Program uses advisory flood maps for risk and vulnerability assessment, FEMA programs reference regulatory floodplains.



HUD Community Development Block Grants (CDBG)

The U.S. Department of Housing and Urban Development (HUD) administers CDBG Disaster Recovery (CDBG DR) and CDBG Mitigation (CDBG MIT) programs following major disasters. These funds support:



Housing Reconstruction



Long-term Recovery



Mitigation



Infrastructure Upgrades



Planning

States manage allocation plans that define eligible activities and target low and moderate income communities.

U.S. Department of Agriculture (USDA) Programs

The USDA supports agriculture focused and rural community water infrastructure:

- Natural Resources Conservation Service Watershed and Flood Prevention Operations (NRCS WFPO)
- Emergency Watershed Protection (EWP)
- Rural Development Water & Waste Disposal Loans and Grants

These programs fund watershed improvements, streambank restoration, emergency stabilization, and water/sewer infrastructure in rural communities.

EPA and Water Infrastructure Programs

EPA's major programs include:

- Clean Water State Revolving Fund (CWSRF)
- Drinking Water State Revolving Fund (DWSRF)
- WIFIA Loans for large scale water infrastructure

These sources offer low interest loans and forgivable principal for eligible communities.

Department of Transportation (DOT) Programs

DOT's programs—including PROTECT, RAISE, Emergency Relief (ER), and other discretionary grants—support projects that improve resilience of transportation systems, culverts, roadways, and multimodal networks.

National Oceanic and Atmospheric Administration (NOAA) and Interior Programs

Environmental agencies support conservation, floodplain restoration, and nature-based solutions. NOAA's funding for habitat restoration and coastal resilience and the U.S. Fish & Wildlife Service's programs for wetlands, rivers, and wildlife corridors offer opportunities for ecosystem based flood mitigation.

USACE Section 205

The 205 program provides funding for small flood control projects with a focus on structural projects such as levees, dams and flood walls. The program requires a 35% local cost share.

Department of Agriculture Natural Resources Conservation Service (NRCS)

Funding for wetland restoration and protection with focus areas on floodplain easements and hydrology.



Department of Commerce Economic Development Administration (EDA)

EDAs Public Works and Economic Adjustment Assistance Programs and Disaster Supplemental support economic development, workforce development, economic diversification, small business, industry recovery, public infrastructure, planning, capacity building, strategic planning, implementation planning, and industry transformation.

Congressional Spending

Legislative Pre-Disaster Mitigation (L-PDM) and Community Project Funding (CPF) are Congressionally directed spending programs that can be used to mitigate against flooding. These funds are accessed directly through the local Congressional representative.

Evaluating Cost Effectiveness for Flood Resilience Actions

When creating a flood resilience action in the Blueprint Tool, the tool generates an estimated cost for the proposed action, as well as an estimated cost effectiveness ratio. The ratio is calculated based on dividing the estimated cost benefit if the action were implemented by the estimated cost of the action. Local governments and partners can use this information as a starting point for resilience planning but should consult the applicable technical experts for exact development costs for each flood resilience action.



State of North Carolina Funding Programs

North Carolina has one of the most diverse state-level funding environments for water, land, flood, and resilience-related projects. Many state sources provide match flexibility, technical assistance, or planning support not available from federal programs.

North Carolina Land & Water Fund (NCLWF)

NCLWF supports land acquisition, stream and floodplain restoration, innovative stormwater management, and planning for water quality and flood resilience. Programs include:

- Acquisition Grants for riparian buffers, wetlands, and floodplain conservation
- Restoration Grants for streams, wetlands, and natural infrastructure
- Innovative Stormwater Projects
- Planning Grants for long-range watershed and restoration strategies

Division of Water Resources (DWR)

DWR administers several programs including:

- Water Resources Development Grant Program (WRDG)
- State cost share support for flood mitigation and water-based recreation
- Planning assistance for hydrologic and watershed studies

These programs support construction and planning for flood reduction projects, stormwater controls, and water supply solutions.

State Revolving Funds (SRF)

North Carolina administers CWSRF and DWSRF with added benefits for disadvantaged communities. Funds include loan forgiveness, match assistance, and priority scoring for resilience and green infrastructure.

NC Department of Commerce Rural Economic Development Division (REDD)

REDD's Small Business Infrastructure Grant Program assists small businesses by providing grants to local governments to expedite infrastructure repairs.

Environmental Quality Incentives Program (EQIP)

DEQ and NRCS program to help farmers, ranchers, and forest landowners integrate conservation into working lands with goals of Improved water and air quality; conserved ground and surface water; increased soil health; reduced soil erosion and sedimentation; improved or created wildlife habitat; and mitigation against drought and increasing weather volatility.



Disaster Relief and Mitigation Fund (DRMF)

Funding can be used for flood mitigation, transportation infrastructure resilience against natural disasters, and engineering assistance grants to local governments to identify and design shovel-ready projects

Dam Safety Grant Fund

Provides financial assistance for the repair, modification, or removal of eligible dams with focus areas on stormwater and flood control.

Parks and Recreation Trust Fund (PARTF)

Provides matching grants to local governments to assist with public park and recreation projects through acquisition and/or development of park and recreational projects.

Golden Leaf Flood Mitigation

Provides funding to local government and 501(c)(3) organizations for localized infrastructure repair, flood mitigation, drainage and retention.

Community Foundation Disaster Relief Fund

Supports long-term recovery, addresses unmet needs, and builds community resilience and preparedness for future disasters.

Streamflow Rehabilitation Assistance Program (StRAP)

The Streamflow Rehabilitation Assistance Program (StRAP) also provides funds to organizations working on projects that help reduce flooding, restore streams, and protect the integrity of drainage infrastructure across North Carolina’s waterways.

Agricultural Stream Cleanup (ASCP)

The Division of Soil and Water Conservation’s program to provide stream cleaning and debris removal on agricultural streams.

Coastal and Environmental Programs

For coastal communities, the state offers:

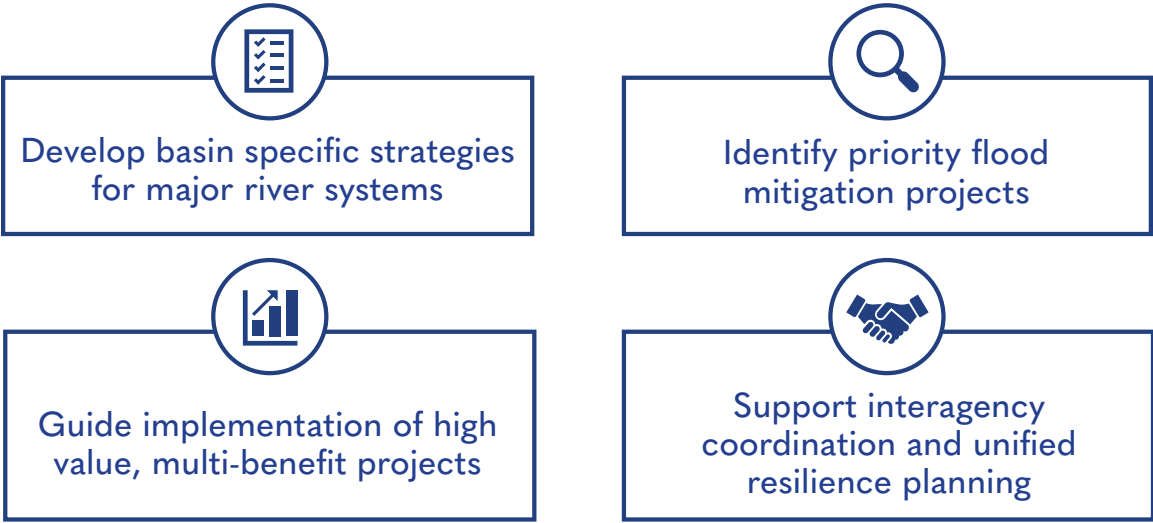
- Coastal Storm Damage Mitigation Fund
- RCCP
- CAMA grants for shoreline, planning, and hazard mitigation

Other programs, such as the Environmental Enhancement Grant (EEG) and agricultural conservation programs, support habitat restoration, water quality enhancements, and preservation of natural lands. The Blueprint also encourages leveraging programs such as the North Carolina Department of Agriculture’s Agricultural Development and Farmland Preservation fund to undertake actions focused on working lands that can have flood resilience co-benefits.



Blueprint Project Implementation Funding

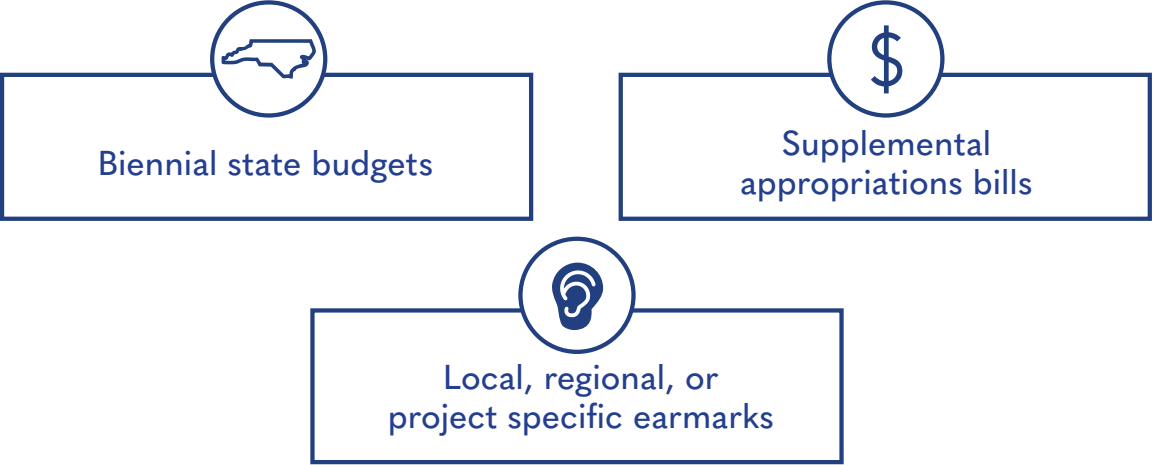
The North Carolina Flood Resiliency Blueprint represents one of the largest state investments in long term flood mitigation planning. Funded initially with \$96 million and now operating with \$76 million, the Blueprint aims to:



Blueprint implementation funds are designed to move high priority projects from concept to construction, particularly where solutions reduce community flood risks, restore natural systems, and provide durable watershed benefits. As strategies are finalized for each basin, these funds will act as a state-level catalyst for projects that align with Blueprint priorities.

Legislative Appropriations from the NC General Assembly

The North Carolina General Assembly can allocate funding for resilience and infrastructure through:



Recent budgets have included substantial statewide investments in water, sewer, and stormwater infrastructure, as well as direct allocations to counties, municipalities, and utilities. Legislative appropriations are often strategic tools for addressing urgent needs or advancing major projects that do not fit traditional grant programs. One unique example is the Private Roads and Bridges program that provides funding for repairs to private roads / bridges that are the sole access for emergency services to residential properties occupied by the property owner for over six months of the calendar year; and repairs to private roads / bridges providing access to multiple residential homes, recreation or commercial facilities

Local governments can work with legislators to elevate priority projects for potential inclusion in budget cycles, especially when projects align with statewide resilience, infrastructure, and economic development objectives.



Local, Regional, and Nonprofit Funding Sources

Local governments, regional planning organizations, and nonprofit partners provide essential complementary resources that can fill match requirements, support early-stage planning, or implement smaller scale resilience solutions.

Local and Utility Funding

Local sources include:



These funds can be used as match for federal or state programs or to advance preliminary engineering.

- **General funds**
- **Stormwater utility fees**
- **Water & sewer enterprise funds**
- **Local CIPs**



Regional Transportation Planning Funds

Metropolitan Planning Organizations (MPOs) and Rural Planning Organizations (RPOs), in coordination with the North Carolina Department of Transportation (NCDOT), can incorporate resilience components into transportation improvement programs, often unlocking federal dollars for culverts, bridges, greenways, and road related stormwater improvements.

Nongovernmental Organizations and Philanthropy

Nongovernmental organizations can serve as applicants, co applicants, match partners, land stewards, or technical supporters. Key partners include:

- North Carolina Community Foundation
- National Fish & Wildlife Foundation (NFWF)
- The Nature Conservancy
- Conservation Trust for NC
- Local land trusts and conservation groups

These partners often bring additional capacity, volunteer support, specialized expertise, and access to philanthropic funding streams.

Climate Smart Communities Initiative

Provides funding and technical assistance to advance community-based climate resilience in communities or regions that are highly vulnerable to the impacts of climate change and in need of additional technical and administrative capacity from a 3rd party adaptation practitioner



Strategic Considerations for Project Success

The document highlights several cross cutting considerations:

Eligibility and Governance

Eligibility differs across programs:

- Some require the applicant to be a unit of local government
- Others accept nonprofit organizations or special districts
- Utility authorities may be eligible for water infrastructure funds
- FEMA programs require state sponsorship and hazard mitigation planning compliance

Understanding institutional eligibility early in project development is critical.

Matching, Cost Share, and Funding Stacking

Most major programs require local match contributions, typically ranging from 0% to 25%, though disadvantaged community provisions may reduce this requirement. Many projects are financed through braided funding, combining:

- Federal grants
- State grants or loans
- Local funds
- Philanthropic contributions

Conclusion

North Carolina has access to one of the most diverse and strategically aligned funding environments for flood mitigation, watershed restoration, and resilience in the United States. The programs cataloged in the Funding Sources Writeup provide a broad spectrum of opportunities for planning, engineering, land conservation, stormwater improvements, resilient infrastructure, and long-term community capacity building.

Aligning local project needs with the right funding source—while leveraging multi-agency partnerships and taking full advantage of the Flood Resiliency Blueprint—positions communities to make transformative progress in reducing flood risks and improving watershed health.

Planning and Readiness

Competitive programs prioritize:

- Strong benefit cost analysis
- Permitting readiness
- Engineering feasibility
- Multi benefit outcomes (e.g., water quality + flood reduction + recreation)
- Community engagement and social impact outcomes

Nature-Based Solutions

Many programs strongly encourage or explicitly prioritize nature-based approaches such as:

- Floodplain reconnection
- Wetland restoration
- Stream restoration and buffer enhancement
- Green stormwater infrastructure

These solutions typically score well in competitive evaluations and provide durable long term benefits.



ACTION STRATEGY TAKE-AWAYS

The White Oak RBAS is intended to support local governments, regional partners, state agencies, and other organizations in identifying and advancing flood resilience actions that are appropriate to different conditions across the basin. The vulnerability assessment shows that flood risk is increasing under future conditions, with more people, homes, critical facilities, and essential systems exposed to flooding over time. These and other findings support the need for an Action Strategy that can guide both near-term risk reduction and longer-term flood resilience planning across the basin.

This Action Strategy includes a mix of Priority Actions that reflect differences in flood risk, vulnerability, and implementation context across the White Oak River

Basin. The actions were identified through the Blueprint planning process and include action prioritized by local communities.

The actions identified in this RBAS reflect the diversity of the river basin and flooding sources. Some actions are intended to reduce concentrated flood losses in more developed areas, some are intended to protect infrastructure and maintain access to essential services, and others are intended to support adaptation in places where flooding is widespread or persistent. Taken together, the Action Strategy provides a basin-wide framework for understanding flood resilience needs and for advancing actions through continued coordination, funding, technical assistance, and project development.



Stacy Home Elevation



NEXT STEPS AND IMPLEMENTATION

DEQ Program and Project Accountability

Through the development of the River Basin Action Strategies, local governments, Councils of Government, and other partners have used the Blueprint Tool and staff support to develop local resilience plans. RBAGs and Blueprint Teams have further evaluated and prioritized actions for inclusion in the RBAS. These planning efforts are a critical part of building a more resilient state, but they must be matched with funding and implementation.

The completion of the River Basin Action Strategies is not an endpoint. The Blueprint team will continue working with local governments and other partners to support flood resilience planning and will collaborate with basin partners to help identify funding for prioritized mitigation actions. As of April 2026, DEQ has received funding for RBAS development in six basins, as well as an additional \$96 million for project implementation in those basins. To implement projects, DEQ has used a range of funding mechanisms, including direct partnerships with local governments, funding private firms for full-delivery flood mitigation projects, and collaboration with fellow state agencies and programs, including North Carolina Emergency Management (NCEM), NCLWF, the North Carolina Department of Agriculture and Consumer Services (NCDA&CS), DWR, and NCDOT. These partnerships support the efficient implementation of priority projects and help address gaps in current mitigation efforts. The RBAS process has also identified a need for funding to support engineering and design, in addition to construction. For many actions, implementation may begin with project development

rather than construction. Natural infrastructure, hybrid infrastructure, stormwater, roadway, and floodplain projects often require additional screening, field verification, community and landowner coordination, technical analysis, alternatives evaluation, permitting review, cost refinement, conceptual design, and benefit documentation before they are ready for final design or construction. Recognizing these early-phase activities as important implementation steps can help communities move from planning-level concepts to fundable, permittable, constructible, and maintainable projects, particularly where local capacity is limited. Moving forward, this is an area where the Blueprint can be especially impactful.

Additional funding is needed to complete RBAS development, identify projects, and support project implementation in the remaining eleven river basins. In addition, the RBAS process will identify areas where data improvements are needed, allowing those needs to be prioritized to ensure that the most accurate data is used to inform these critical decisions. Overall, DEQ is committed to making the state more flood resilient by providing local governments, state agencies, and other partners with the data, tools, and support needed to guide investments that reduce the cost and disruption of future flooding.

Blueprint Tool

The Blueprint Tool is available statewide, but as of the publication of this report, the tool functionality is limited outside the initial six basins. With additional funding, improved flood mapping and expanded data development will be completed for the rest of the state, allowing the Blueprint Tool to effectively support all communities across North Carolina. Continued investments to improve and refine the Blueprint Tool will better serve North Carolina's residents and ensure the state remains a leader in data-driven flood resilience planning.

In the basins currently engaged, Blueprint staff will continue providing support and resources to build local capacity to use the Tool from project conception through completion. This approach will enable local entities and basins to continue applying the Blueprint Process beyond the initial RBAS effort.



ACKNOWLEDGEMENTS

River Basin Advisory Group Members

Chris Baillie, Eastern North Carolina Sentinel Landscape Partnership

Joseph Bauer, Onslow County

Mike Benson, Town of North Topsail Beach

Kyle Breuer, Town Surf City

Kristin Caracappa, Kleinfelder Engineering

Bree Charron, North Carolina Coastal Federation

Jefferey Conaway, Swansboro Board of Commissioners

Pam Cook, North Carolina Department of Transportation

Kay Coole, Carteret Long Term Recovery Alliance

Samantha Darlington, North Carolina Rural Planning Center

Ryan Davenport, Carteret County Shoreline Protection Office

Sarah Deskar, Eastern Carolina Council

Barbara Doll, North Carolina Sea Grant

Pat Donovan-Brandenburg, City of Jacksonville

Kristina Fischer, North Carolina Department of Agriculture & Consumer Services

Andy Fox, North Carolina State University

Kurt Golembesky, North Carolina Department of Transportation

Tabatha Hart, Camp Lejeune

Jonathan Hinkle, Bolton and Menk, Inc.

Mary Houston, North Carolina Department of Transportation

John Joiner, South Atlantic Water Science Center

Todd Kelly, Carteret County Soil and Water Conservation

Julia Lane, Kleinfelder Engineering

Laurette Leagon, Onlsow County Chamber of Commerce

Scott Leahy, Carteret County Community College

Jessi Leonard, North Carolina Department of Transportation

Riley Lewis, Coastal Carolina River Watch

Holly Lippitt, Eastern Carolina Council

Jeffrey Lohr, Onslow Water and Sewer Authority

Rick Luetlich, University of North Carolina Chapel Hill Institute of Marine Sciences

David M. Rief, Town of Cedar Point

Taylor McCune, Carteret County Chamber of Commerce

Joann McDermon, Town of North Topsail Beach

Susan Meyer, Town of North Topsail Beach Planning Board

Behshad Norowzi, North Carolina Department of Transportation

Christian Owen, Weyehauser Company

Raquel Painter, Onslow Strong United Way

Ken Parks, North Carolina Department of Agriculture & Consumer Services

David Rosado, East Carolina Council of Governments

Nazia Sarder, North Carolina Department of Transportation

Milt Seekins, Coastal Carolina Community College

Allen Serkin, Cape Fear Council of Governments

Giovanni Simpson, Pender County Long Term Recovery Group

Garrett Sumner, North Carolina State University

Hope Taylor, Wilmington-Cape Fear Home Builders Association

Marcia Thomas, North Carolina Department of Environmental Quality



Andrew Thomas, Jr., Town of Maysville

Andy Thomas, Town of Maysville Planning Board

Mackenzie Todd, North Carolina Department of Environmental Quality

Nicole Warren, Onslow County Soil and Water Conservation District

Elisabeth Webster, Town of Atlantic Beach

Andrea Webster, North Carolina Office of Recovery and Resiliency

Blueprint Partners and Other Collaborators

American Flood Coalition

Town of Atlantic Beach

Village of Bald Head Island

Bolton and Menk, Inc

Town of Beaufort

Beaufort County

Town of Bogue

Brunswick County

Jones County

Camp Lejeune

Town of Cape Carteret

Cape Fear Council of Governments

Town of Carolina Beach

Carteret County

Carteret County Chamber of Commerce

Carteret County Community College

Carteret County Shoreline Protection Office

Carteret County Soil and Water

Town of Cedar Point

Coastal Carolina Riverwatch

Village of Craven

Down East Rural Planning Organization

Duke Marine Lab

East Carolina Council of Government

Eastern North Carolina Sentinel Landscape Partnership

Town of Emerald Isle

Foundation for Soil and Water Conservation

Town of Holly Ridge

City of Jacksonville

Jacksonville Recreation & Parks Dept

Jacksonville Stormwater Department

Jones County

Jones County Emergency Services

Kleinfelder, Inc

Town of Kure Beach

Town of Maysville

Morehead City

Town of Newport

National Oceanic and Atmospheric Administration

North Carolina Beach, Inlet & Waterway Association

North Carolina Coastal Federation

North Carolina Community Emergency Response Team

North Carolina Division of Coastal Management

North Carolina Department of Agriculture & Consumer Services

North Carolina Department of Environmental Quality



North Carolina Department of Environmental Quality, Division of Mitigation Services	Sunny Day Flooding Project
North Carolina Department of Transportation	Town of Surf City
North Carolina Emergency Management	Town of Swansboro
North Carolina Foundation for Soil & Water Conservation	Summit Design & Engineering Services
North Carolina Home Builders Association	Swansboro Parks and Recreation
North Carolina Land and Water Fund	Swansboro Police Department
North Carolina Seafood Festival	Swansboro Public Works Department
North Carolina Sea Grant	Tetra Tech, Inc
North Carolina State Resilience Officer	Town of Topsail Beach
North Carolina State University	Topsail Chamber of Commerce
North Carolina State University Sea Grant	White Oak Riverkeeper
North Carolina Wildlife Resources Commission	United States Geological Survey
New Hanover County	United States Weather Service
Town of Newport	United Way Onslow County
North Carolina Fisheries Association, Inc.	Weyehauser Company
Town of North Topsail Beach	City of Wilmington
North Topsail Beach Fire Department	Wilmington Urban Area Metropolitan Planning Organization
North Topsail Beach Police Department	Town of Wrightsville Beach
Onslow County	
Onslow County Chamber of Commerce	
Onslow Water and Sewer Authority	
Town of Peletier	
Pender County	
Town of Pine Knoll Shores	
Town of Richlands	
Shortway Brewing Company	
Village of Sneads Ferry	
Southeast Coastal Ocean Observing Regional Association	



PHOTO CREDITS

Unless otherwise noted below, all photographs included in this document are in the public domain. Permission to reproduce the photographs identified below has been obtained from the respective copyright holders or sources.

Cover Page: Cape Lookout Lighthouse; Brian D Bell, Wikimedia Commons; https://commons.wikimedia.org/wiki/File:Cape_Lookout_Lighthouse.jpg

Table of Contents: Topsail Island, North Carolina; Tom, Flickr; <https://flic.kr/p/Msagep>

Page 6: A displaced vessel after Hurricane Florence; Coast Guard News, Flickr; <https://flic.kr/p/PZ4Xss>

Page 7: Morehead City waterfront and marina overlooking the Port of Morehead City; <https://stock.adobe.com/images/morehead-city-port-from-above/165848650>

Page 14: MCB Camp Lejeune; <https://www.military.com/base-guide/marine-corps-base-camp-lejeune?>

Page 15: Kure Beach, North Carolina; Alistair Nicol, Flickr; <https://flic.kr/p/fyonub>

Pages 18-19: Marshallberg Harbor; NCDEQ (Brad Connell)

Page 22: The National Guard in Oak Island, NC after Hurricane Isaias; The National Guard, Flickr; <https://www.flickr.com/photos/thenationalguard/50198440553/>

Pages 28- 29: Aerial shot of a dock and oyster farms in the waters off Wilmington, North Carolina, showcasing marine industry; Mark Stebnicki, Pexels; <https://www.pexels.com/photo/aerial-view-of-dock-and-oyster-farms-in-north-carolina-36029470/>

Pages 30-31: Cow Channel at Hammocks Beach; NCDEQ (Brad Connell)

Pages 32-33: Emerald Isle; NCDEQ (Brad Connell)

Pages 34-35: Atlantic Beach Pier; James Willamor, Flickr; <https://www.flickr.com/photos/bz3rk/15430414128/>

Page 38: Shackleford Banks; NCDEQ (Brad Connell)

Page 42: Stunning aerial view capturing Surf City, NC, coastline and beach in vibrant summer light. Curtis Adams, Pexels; <https://www.pexels.com/photo/houses-on-the-coast-19227301/>

Page 50: Colorful kayaks lined up on the shore in Beaufort NC with Taylor Creek and Carrot Island in the distance; <https://stock.adobe.com/images/colorful-kayaks-lined-up-on-the-shore-in-beaufort-nc-with-taylor-creek-and-carrot-island-in-the-distance/845830452>

Page 51: Jacksonville, NC; City of Jacksonville, NC

Pages 52-53: Emerald Isle Woods Park; Patrick Mueller, Flickr; <https://www.flickr.com/photos/pmuellr/42907013672/>

Page 55: Emerald Isle Boat Ramp; Patrick Mueller, Flickr; <https://www.flickr.com/photos/ncwetlands/50184921506/>

Pages 59-60: Aerial capture of serene waterway and marshlands near Wrightsville Beach, NC; Mark Stebnicki, Pexels; <https://www.pexels.com/photo/scenic-aerial-view-of-intracoastal-waterway-36029463/>

Page 66: Aerial panoramic view of Beaufort, North Carolina and waterfront.; <https://stock.adobe.com/images/aerial-panoramic-view-of-beaufort-north-carolina-and-waterfront/1832119421>

Pages 67-68: Boats at the Cape; NCDEQ (Brad Connell)



Pages 69-70: Aerial View of Bear Island and Hammocks Beach State Park in Onslow County, North Carolina; <https://stock.adobe.com/images/aerial-view-of-bear-island-and-hammocks-beach-state-park-in-onslow-county-north-carolina/369156852>

Pages 77-78: Emerald Isle; NCDEQ (Brad Connell)

Page 79: Masonboro Island Reserve, New Hanover County, NC — original photo source unknown

Pages 85-86: Atlantic Beach Pier; iStock / Getty Images

Pages 87-88: Swansboro / White Oak River, NC

Pages 93-94: View from the Cedar Point (Tideland) boardwalk trail, located in the Croatan National Forest near Emerald Isle, North Carolina; <https://stock.adobe.com/images/view-from-the-cedar-point-tideland-boardwalk-trail-located-in-the-croatan-national-forest-near-emerald-isle-north-carolina/221495580>

Pages 98-99: Long pier out to Bogue Sound, Emerald Isle, North Carolina; <https://stock.adobe.com/images/long-pier-out-to-bogue-sound-emerald-isle-north-carolina-landscape/221609094>

Page 102: Topsail Beach, NC; <https://stock.adobe.com/images/topsail-beach-nc/510961357>

Page 103: Waves crash under the green wooden pier at Wrightsville Beach, NC; Shoshonnah Quick, Pexels; <https://www.pexels.com/photo/bottom-of-the-pier-on-the-wrightsville-beach-24917081/>

Page 106: Harbor in Beaufort, NC; Gerry Dincher, Flickr; <https://www.flickr.com/photos/gerrydincher/37092372364/>

Page 108: Home Elevation in Carteret County; NCDEQ (Brad Connell)

Pages 113-114; Ocean Views from the Boat in the Topsail Inlet; <https://stock.adobe.com/images/ocean-views-from-the-boat-in-the-topsail-inlet/311972583>



APPENDICES

- APPENDIX A:
Actionable Data Collection, Modeling, and Analysis Report
- APPENDIX B:
Outreach and Engagement Plan
- APPENDIX C:
Blueprint Capacity Results Spreadsheet
- APPENDIX D:
Gap Analysis Report
- APPENDIX E:
Flood Risk and Vulnerability Analysis Report
- APPENDIX F:
Actions Prioritizing Report
- APPENDIX G:
Funding Data Sheets
- APPENDIX H:
Prioritized Actions Profiles

