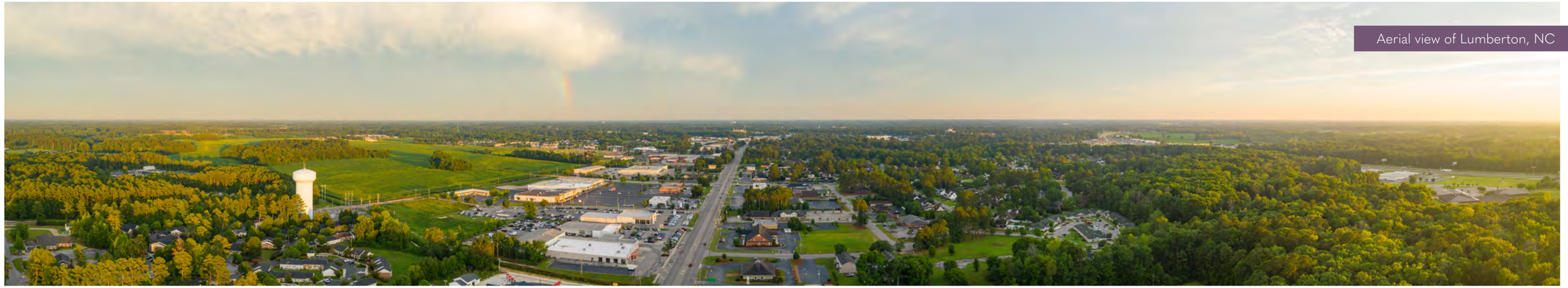
NORTH CAROLINA
Flood Resiliency
BLUEPRINT

NORTH CAROLINA FLOOD RESILIENCY BLUEPRINT

Lumber River Basin Action Strategy (RBAS)

A paddler's view of the Lumber River



Aerial view of Lumberton, NC

TABLE OF CONTENTS

EXECUTIVE SUMMARY 4

TERMS & ACRONYMS 6

INTRODUCTION 10

- BLUEPRINT GOALS 12
- PROGRAM APPROACH 12
- RATIONALE AND OBJECTIVES OF THE RBAS 13
- BASIN OVERVIEW 15

RIVER BASIN ACTION STRATEGY DEVELOPMENT PROCESS 22

- ACTIONABLE DATA, MODELING, & ANALYSIS 22
- COMMUNITY ENGAGEMENT & DISCOVERY 24
- FLOOD RISK PLANNING & ANALYSIS 30
- ACTION REVIEW & SELECTION 37

LUMBER RIVER BASIN PRIORITIZED ACTIONS 42

- PRIORITIZED RESILIENCY ACTIONS 48
- REVIEW OF FUNDING SOURCES 63
- ACTION STRATEGY TAKEAWAYS 80
- NEXT STEPS & IMPLEMENTATION 82

ACKNOWLEDGEMENTS 84

- RBAG MEMBERS 84
- COLLABORATING ENTITIES 84

REFERENCES 86

APPENDICES 88

- APPENDIX A: LUMBER RIVER BASIN DATA INVENTORY REPORT A-1
- APPENDIX B: PUBLIC ENGAGEMENT PLAN B-1
- APPENDIX C: BLUEPRINT CAPACITY RESULTS C-1
- APPENDIX D: GAP ANALYSIS REPORT D-1
- APPENDIX E: FLOOD RISK AND VULNERABILITY ANALYSIS REPORT E-1
- APPENDIX F: ACTIONS PRIORITIZATION REPORT F-1
- APPENDIX G: FUNDING DATA SHEETS G-1
- APPENDIX H: BLUEPRINT TOOL REPORTS FOR LOCALLY PRIORITIZED ACTIONS H-1

EXECUTIVE SUMMARY

The Lumber River Basin Action Strategy (RBAS) is a key component of North Carolina's Flood Resiliency Blueprint and provides a comprehensive, data-driven framework for reducing flood risk and strengthening long-term resilience throughout the basin. Developed through rigorous technical analysis, stakeholder engagement, and economic evaluation, the strategy identifies and prioritizes actions that address existing and future flood hazards while supporting resilient communities, infrastructure, and natural systems.

Flood resilience is the ability of individuals, communities, ecosystems, and infrastructure systems to prepare for, withstand, adapt to, and recover from flooding. As climate conditions evolve and development continues across the basin, building resilience requires coordinated investments and policies that reduce flood impacts while preparing communities for increasing rainfall intensity, sea level rise, and changing land use patterns.

The Lumber River Basin encompasses approximately 3,329 square miles across ten counties in southeastern North Carolina and is home to more than 330,000 residents. Population growth is expected to continue through 2060, increasing demands on public infrastructure, housing, and community services. At the same time, climate change and ongoing development are expected to amplify flood risks, placing additional pressure on communities that are already vulnerable to flooding.

Flood hazards within the basin arise from multiple sources, including riverine flooding, rainfall-driven flooding, stormwater flooding, coastal influences, and potential failures of dams and levee systems. These hazards are compounded by more frequent and intense storms, changing precipitation patterns, rising sea levels, and continued development in flood-prone areas. Historic events such as Hurricanes Matthew (2016) and Florence (2018) underscore the significant social, economic, and environmental consequences of flooding within the basin and highlight the need for sustained investment in resilience.

The basin faces substantial and growing flood risk. More than 18,000 structures are currently exposed to flood hazards, with additional properties projected to become vulnerable under future conditions. The basin also contains 52 high-risk dams and a high-risk levee system, further contributing to potential flood impacts. The vulnerability assessment identified Lumberton, Fair Bluff, Whiteville, and several coastal communities as areas facing particularly high levels of flood risk. Future conditions analyses indicate that flood exposure and potential damages are likely to increase, reinforcing the urgency of implementing coordinated mitigation and resilience measures.

Lake Waccamaw, NC

Key Takeaways

- Flood risk in the Lumber River Basin is significant and growing, driven by more frequent and severe weather, development, and aging infrastructure.
- This RBAS provides a comprehensive, data-driven roadmap for reducing risk and improving resilience.
- The RBAS evaluated 328 resilience actions and identified 17 priority actions that address both locally identified needs and basin-wide flood risks.
- Priority actions focus on protecting high-risk communities, critical infrastructure, and vulnerable populations.
- Successful implementation will depend on sustained funding, coordination, and improved data and modeling.
- There are currently capacity challenges for local governments. The Blueprint process, including capacity building, will improve flood resiliency outcomes for these areas and the basin.

The RBAS follows a structured five-step planning framework designed to support transparent and evidence-based decision-making. This process includes: (1) inventorying existing data, plans, and projects; (2) conducting thorough stakeholder and community engagement; (3) assessing basin-wide flood risk and vulnerability; (4) identifying resilience actions; and (5) prioritizing actions using benefit-cost and effectiveness analyses. Throughout the process, the strategy incorporated input from local governments, tribal communities, regional organizations, nongovernmental organizations, and residents to ensure that recommended actions reflect local needs and priorities.

More than 300 existing and proposed resilience actions were evaluated, and additional regional-scale actions were developed to address identified gaps and high-risk areas. Particular emphasis was placed on engaging under-resourced and historically vulnerable communities to ensure that local knowledge and community priorities informed the decision-making process. This inclusive approach helps ensure that resilience investments provide equitable benefits across the basin.

A total of 328 resilience actions were evaluated through this process. These actions were assessed based on their ability to reduce flood risk, enhance resilience, address community priorities, and provide economic and environmental benefits. The resulting portfolio includes a balanced mix of structural improvements, nature-based solutions, and policy and planning initiatives that together, support a comprehensive, multi-layered approach to flood resilience. Of the 17 prioritized actions, four are regional in scale, 12 are local, and one is building-specific (**Table 2. Prioritized Resiliency Actions List for the Lumber River Basin).**

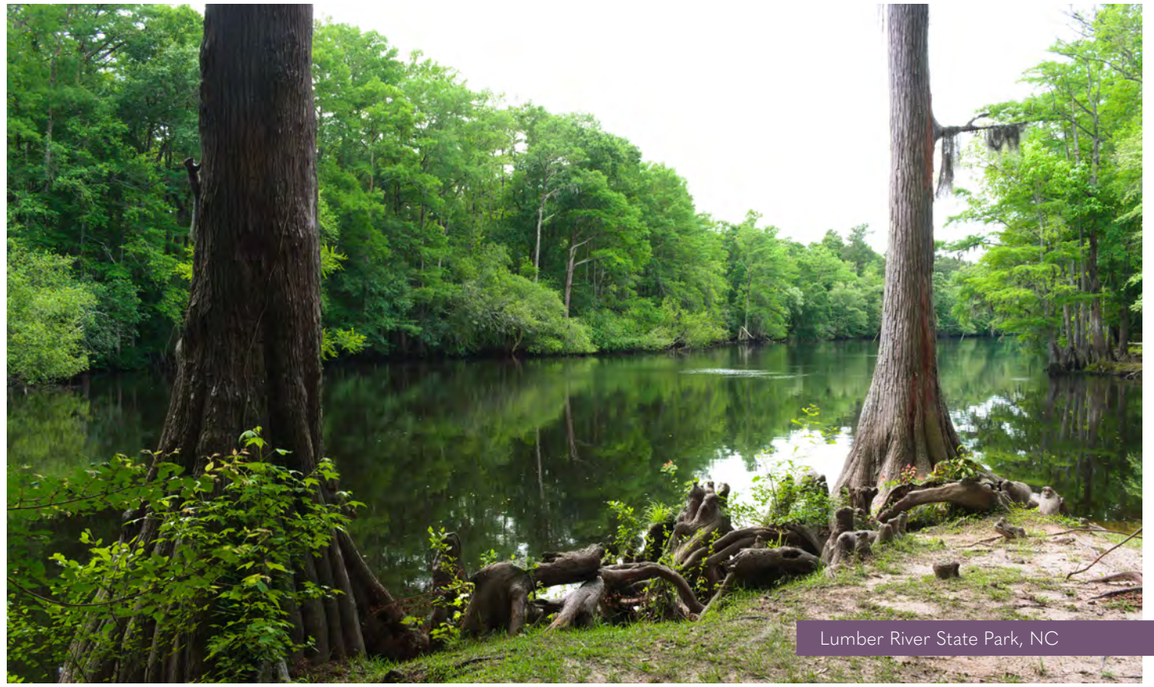
Implementation of the RBAS will require sustained collaboration among federal, state, regional, tribal, and local partners. The strategy identifies a diverse range of potential funding sources, including Federal Emergency Mitigation Agency (FEMA) hazard mitigation programs, U.S. Department of Agriculture watershed programs, state grant programs, and local funding mechanisms. Given the scale and cost of many recommended projects, successful implementation will depend on leveraging multiple funding sources, fostering strategic partnerships with agencies such as FEMA, the U.S. Army Corps of Engineers (USACE), and North Carolina state agencies, and providing support for local cost-share requirements. Strengthening local capacity will be particularly important to ensure that under-resourced communities can effectively pursue funding opportunities, manage projects, and implement resilience measures.

By establishing a clear, prioritized roadmap for action, the Lumber River Basin Action Strategy provides a foundation for reducing flood risk, protecting communities and critical infrastructure, and advancing long-term resilience throughout the basin. Through coordinated planning, sustained investment, and strong partnerships, the strategy will help support safer, more resilient communities in the face of increasing flood challenges.

TERMS & ACRONYMS

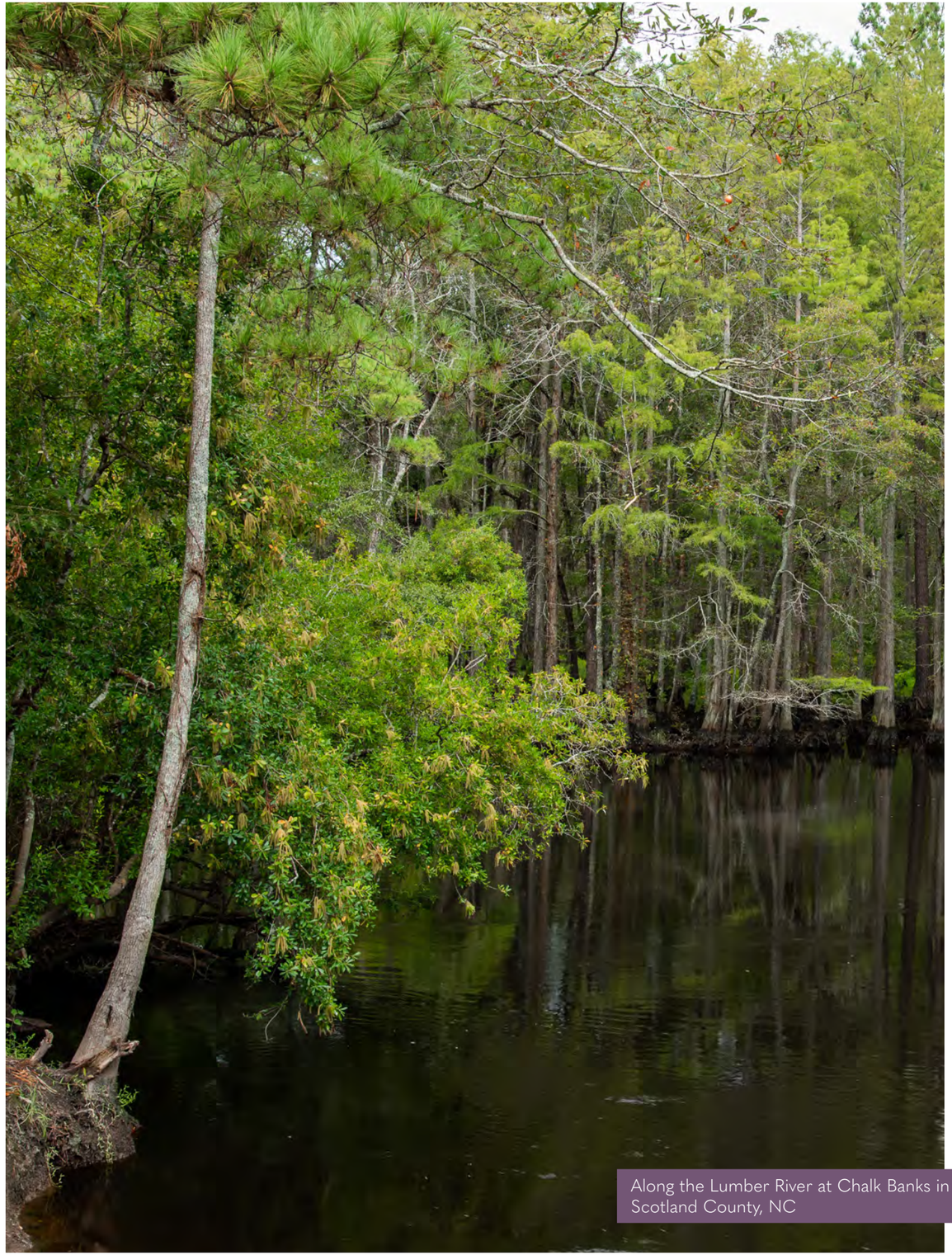
AADT	Annual Average Daily Traffic
Action	In the Blueprint, "actions" denote specific flood resilience measures identified and ranked at the basin scale. DEQ, in collaboration with communities, utilizes the Flood Resiliency Blueprint Tool to assess and prioritize these actions based on a variety of parameters.
ALE	Annualized Loss Estimate
AMEXCAN	Association of Mexicans in North Carolina
Annual-Chance Flood Event	The probability that a flood event will occur in a given year.
ADSO	Association of State Dam Safety Officials
Basin	An area of land that contains a common set of waterbodies (streams, rivers, lakes, or wetlands) that all drain into a single larger body of water. Watersheds can be defined at multiple geographic scales. In North Carolina, 17 "major" watersheds (basins) are defined by statute.
BCA	Benefit-Cost Analysis
Benefit-Cost Analysis	A decision-making tool used to evaluate the cost-effectiveness of resilience actions based on expected losses avoided and cost of implementation (FEMA, 2026).
BCR	Benefit-Cost Ratio
Benefit-Cost Ratio	The result of a BCA, equal to the net action benefits divided by the action costs. A ratio of 1.0 or greater indicates the project is cost effective (FEMA, 2009).
BLE	Base Level Engineering
BRIC	Building Resilient Infrastructure and Communities
BUILD	Better Utilizing Investments to Leverage Development
CDBG	Community Development Block Grants
CDBG-DR	Community Development Block Grants- Disaster Recovery
CDBG-MIT	Community Development Block Grants- Mitigation
CIP	Capital Improvement Plan
COG	Council of Governments
CWA	Carolina Wetlands Association
CWSRF	Clean Water State Revolving Fund
DEQ	North Carolina Department of Environmental Quality
DOT	Department of Transportation
DWR	Division of Water Resources
DWSRF	Drinking Water State Revolving Fund
ECL	End of Century Lower
ECH	End of Century Higher
ECS	End of Century Severe
EEG	Environmental Enhancement Grant
EPA	Environmental Protection Agency
EQIP	Environmental Quality Incentives Program
FEMA	Federal Emergency Management Agency

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 more exteme weather, increasing rain fall, and sea level rise, and adapting to those conditions.
FMA	Flood Mitigation Assistance
H&H	Hydrologic and Hydraulic
HMGP	Hazard Mitigation Grant Program
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.
Locally Prioritized Actions	Actions where local governments know specific actions are needed; inductively collected from direct outreach with local government.
LRC	Lumber River Conservancy
LSAC	Levee Safety Action Classifications
MCL	Mid Century Lower
MCH	Mid Century Higher
MPO	Metropolitan Planning Organization
NC	North Carolina
NCB&TC	North Carolina Budget and Tax Center
NCBA	North Carolina Black Alliance



Lumber River State Park, NC

NCCN	North Carolina Conservation Network
NCDA&CS	North Carolina Department of Agriculture and Consumer Services
NCEM	North Carolina Emergency Management
NCGA	North Carolina General Assembly
NCICS	North Carolina Institute for Climate Studies
NCIDR	North Carolina Inclusive Disaster Recovery Network
NCLWF	North Carolina Land & Water Fund
NFIP	National Flood Insurance Program
NFWF	National Fish and Wildlife Foundation
NLD	National Levee Database
NOAA	National Oceanic and Atmospheric Administration
NRCS	Natural Resources Conservation Service
NRI	National Risk Index
O&M	Operations and Maintenance
OSBM	North Carolina Office of State Budget and Management
PDM	Pre-Disaster Mitigation
Pre-Identified Action	Mitigation actions that have been identified through the research performed in Step 1 of the Blueprint Process. These actions have been previously proposed in existing studies, plans, and programs.
Proposed Action	Actions that were developed through Step 3 of the Blueprint Process based on the results of the flood risk and vulnerability analysis. These actions are conceptual and would require future feasibility studies to determine effectiveness.
PROTECT	Promoting Resilient Operations for Transformative, Efficient, and Cost-saving Transportation
RCCP	Resilient Coastal Communities Program
RBAG	River Basin Advisory Group
RBAS	River Basin Action Strategy
RL	Repetitive Loss
RPO	Rural Planning Organization
SCOR	South Carolina Office of Resilience
SDTSA	State Designated Tribal Statistical Area
SERA	State Emergency Response Application
SCSJ	Southern Coalition for Social Justice
SILC	North Carolina Statewide Independent Living Council
SLR	Sea Level Rise
SRF	State Revolving Fund
USACE	United States Army Corps of Engineers
USDA	United States Department of Agriculture
Vulnerability Assessment Based Actions	Actions compiled through a deductive process to mitigate flood risks identified through the RBAS Vulnerability Assessment results.
WFPO	Watershed and Flood Prevention Operations
WIFIA	Water Infrastructure and Innovation Act
WRDG	Water Resources Development Grant



Along the Lumber River at Chalk Banks in Scotland County, NC

INTRODUCTION

In 2021, the North Carolina General Assembly directed the North Carolina Department of Environmental Quality (DEQ) to develop a statewide Flood Resiliency Blueprint. The Blueprint serves as the backbone of North Carolina's (NC) flood resiliency planning and is based on the best available science, stakeholder engagement, and sound decision-making to develop cost-effective projects. 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.

Over the past decade, North Carolina has experienced an increasing number of significant flood events, including Hurricanes Matthew (2016), Florence (2018), and Helene (2024). In just the last two years alone, Hurricanes Helene and Debby, Tropical Storm Chantal, and Potential Tropical Cyclone Eight have caused devastating impacts across the entire state. These events underscore the urgent need for proactive planning and strategic investments to strengthen flood resilience throughout the state.

Flood resilience cannot be achieved by any one agency or program alone. It depends on strong coordination among communities; local, tribal, state, and federal governments; and a broad network of public and private stakeholders, including residents and businesses. Through strategic planning, collaboration, and targeted investment, communities can reduce flood-related damages and improve their ability to recover when flooding occurs.

The North Carolina Flood Resiliency Blueprint was created to support this collaborative approach by providing the data, tools, and decision-making framework needed to identify priorities and guide investments. By addressing gaps in existing flood mitigation efforts and focusing resources on actions that reduce future flood risk, the Blueprint helps lessen the economic, environmental, and social impacts of flooding. Through close partnerships with local governments and state agencies, the Blueprint promotes proactive, coordinated investments that enhance long-term resilience for communities across North Carolina.

Alligator in canal near Lake Waccamaw, NC

The Blueprint is built upon three foundational components:

1 DATA

The DEQ Flood Resiliency Blueprint has partnered with North Carolina Emergency Management (NCEM) to develop enhanced advisory flood models. These models provide communities with improved information about existing and future flood risks, enabling data-driven planning and decision-making.

2 TOOLS

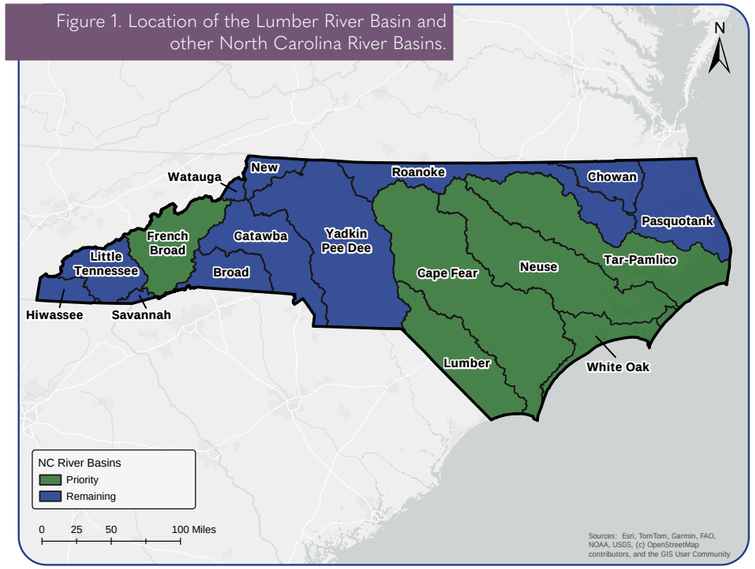
The Blueprint Tool is a free, web-based resource that provides flood risk data, mapping capabilities, and resilience planning support. It equips communities with the information necessary to evaluate vulnerabilities, identify mitigation opportunities, and develop informed flood resilience strategies.

3 PROCESS

Blueprint staff work directly with stakeholders across the state to facilitate clear, actionable flood resilience planning at multiple geographic scales. This collaborative process helps ensure that local needs, priorities, and expertise are incorporated into resilience planning efforts.

The Blueprint serves as a flood planning framework and decision-support system that enables state, tribal, regional, and local stakeholders to identify, prioritize, and implement effective flood resilience strategies. The initial phase involves six priority basins of North Carolina – Cape Fear, French Broad, Lumber, Neuse, Tar-Pamlico and White Oak (**Figure 1**).

Figure 1. Location of the Lumber River Basin and other North Carolina River Basins.



By leveraging the best available science and data, the Blueprint helps communities better understand current and future flood risks in their river basins. The framework is designed to be adaptive, incorporating new information as it becomes available to ensure that planning and investment decisions are still effective. Through improved coordination among agencies and programs at all levels of government, the Blueprint seeks to maximize the use of available resources and support informed decisions that increase flood resilience across North Carolina.

BLUEPRINT GOALS

The Blueprint is guided by three overarching goals:

1 Develop a statewide online decision-support tool.

The Blueprint Tool was created to serve stakeholders and communities in their flood resiliency planning efforts by offering flood risk data in tandem with a decision support tool. This Tool offers a flood resilience and community data hub to bolster the flood mitigation work that is already happening.

2 Establish community- and basin-specific planning processes.

Through the RBAS, the Blueprint creates a structured approach to identify and develop solutions tailored to the needs and priorities of individual communities and river basins. Addressing this challenge on a basin-wide scale allows for a more coordinated approach that is in concert with the hydrologic profile of the basin.

3 Create a repeatable statewide methodology.

Developing RBAS plans for all North Carolina river basins using a consistent methodology that enables each basin to identify and advance appropriate flood resilience solutions.

PROGRAM APPROACH

To achieve these goals, the Blueprint program is being implemented through three integrated phases:

- Blueprint Process Development: Establishing a statewide planning framework that utilizes the best available data, science, and resources.
- Blueprint Tool Development: Creating an accessible platform that supports planning, analysis, and stakeholder engagement across North Carolina.
- River Basin Action Strategy Development: Developing RBAS plans for all eligible North Carolina river basins using a consistent methodology that enables each basin to identify and advance appropriate flood resilience solutions.

Together, these efforts (broken down into the eight key steps in **Figure 2**) provide North Carolina with a comprehensive, data-driven approach to reducing flood risk, strengthening community resilience, and supporting long-term recovery and adaptation in the face of increasing flood hazards.

RATIONALE AND OBJECTIVES OF THE RBAS

The RBAS is a strategic plan specific to an individual river basin developed with the assistance of the Blueprint process and Tool. The strategy will be informed by community and stakeholder input and will outline specific flood resilience actions and potential funding sources.

The Blueprint process includes a unified approach to identifying resiliency actions across the state, but each basin has its unique needs. DEQ's objective for the RBAS is to identify priority regions and mitigation actions within each basin. Additionally, any data needs or limitations are presented to highlight the growth and continued efforts needed within the basin. Development of an RBAS will utilize the latest detailed flood modeling datasets for both current and future conditions, ensuring that long-term planning is incorporated. Stakeholder engagement is also a large component of the RBAS process to ensure that decisions and recommendations are made in conjunction with local and regional entities and the specific needs of the basin. Overall, the RBAS will result in a list of prioritized actions, providing a starting point to making the basin more resilient to flooding.

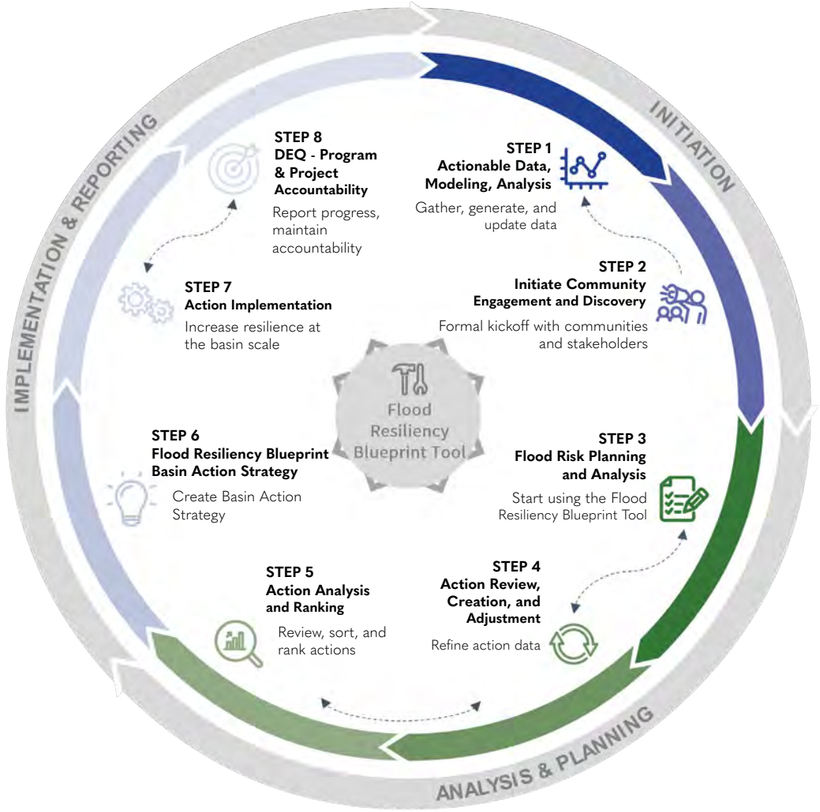


Figure 2. DEQ Flood Resiliency Blueprint Tool and Planning Process (DEQ, 2024a).

Long leaf pine forest in the Sandhills Region of NC

BASIN OVERVIEW

About the Basin

Location

The Lumber River Basin occupies a total area of 3,329 square miles within southeastern NC. The basin is made up of four smaller watersheds that ultimately flow into either South Carolina or the Atlantic Ocean. As shown in **Figure 3**, the basin encompasses portions of ten counties: Scotland, Robeson, Columbus, Cumberland, Brunswick, Bladen, Hoke, Richmond, Moore, and Montgomery. In these counties, the five most populous municipalities contained within the basin are the Cities of Lumberton, Laurinburg, and Whiteville and the Towns of Shallotte and Sunset Beach.

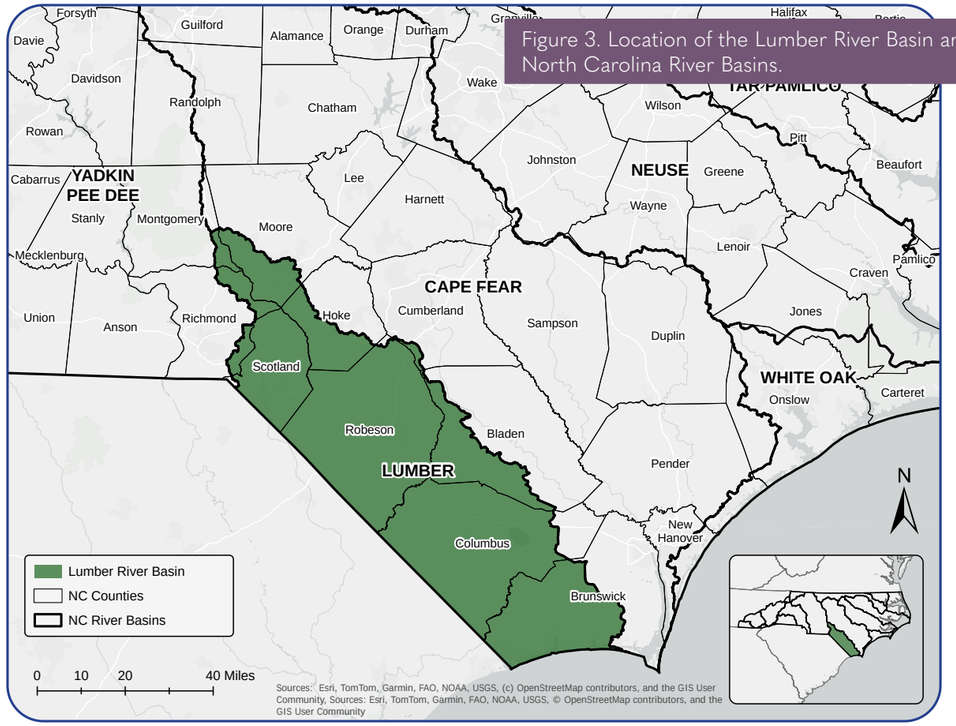


Figure 3. Location of the Lumber River Basin and the other North Carolina River Basins.

Demographics

As of the 2020 US Census, there are an estimated 330,991 people living in the Lumber River Basin (DEQ, 2026).

The county level poverty rate of 18.9% is higher than the state average of 13.2%. Additionally, the median county household income of $57,972 is lower than the state median of $69,904 (US Census Bureau, 2023).

The basin contains two state designated tribal statistical areas (SDTSA), the Lumbee and the Waccamaw Siouan. The Lumbee Tribe has more than 55,000 members and resides in Robeson, Hoke, Cumberland, and Scotland Counties with its headquarters in the Town of Pembroke. The Waccamaw Siouan Tribe has more than 2,000 citizens in Bladen and Columbus Counties near its homeland on the edge of Green Swamp (NCDOA, n.d.).

There are five Councils of Government (COGs) serving these communities that provide additional services and support (**Figure 4**).

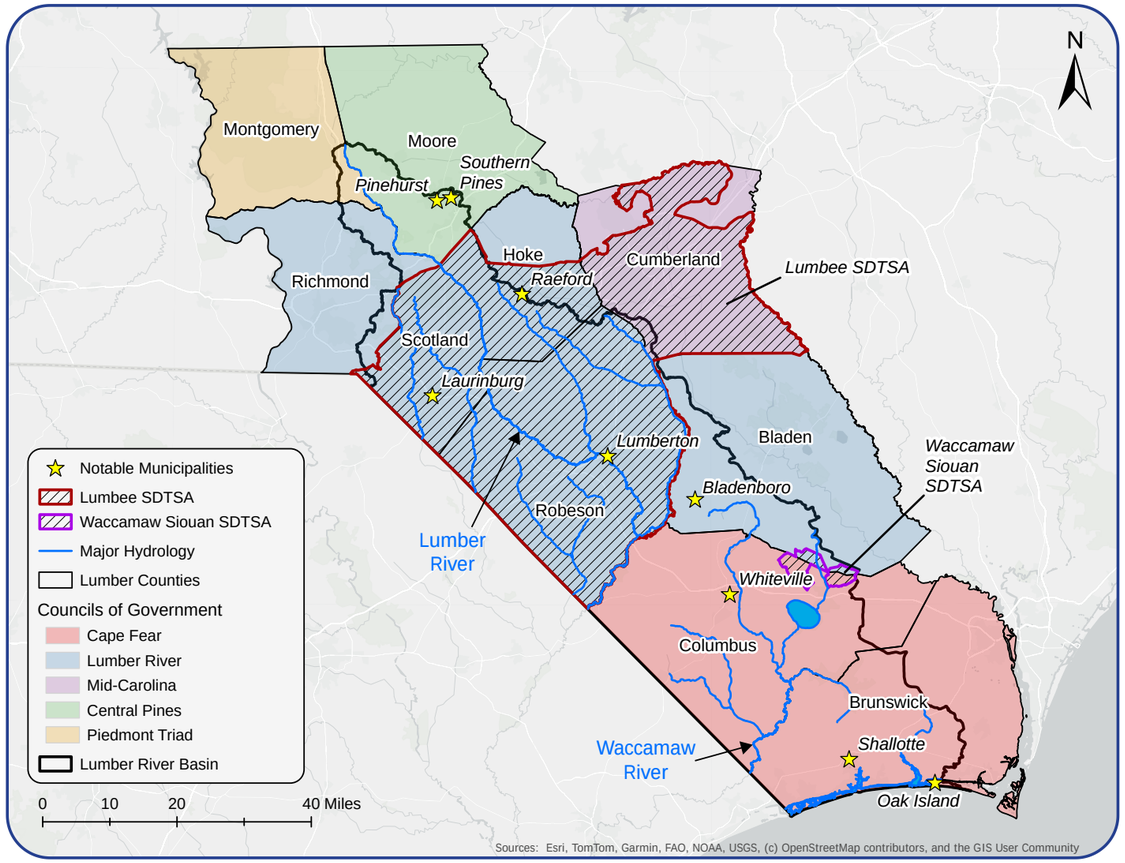


Figure 4. COGs, Counties, notable municipalities, SDTSA and major waterways of the Lumber River Basin.

Climate

The climate of the Lumber River Basin, like much of the southeastern United States, is classified as a humid, subtropical climate, characterized by hot, humid summers and mild winters (Koppen-Geiger Climate Classification (GloH2O, 2025)). According to 1991-2020 climate normals, the average annual temperature in the basin is 62.7 °F, higher than the state average of 59.9 °F. The basin experiences an average annual rainfall of 50.6 inches per year, in line with North Carolina's annual average (PRISM, 2025).

Flood Risk

The Lumber River Basin has experienced multiple severe flooding events, causing widespread social, environmental, and economic impacts on communities throughout the basin.

Five main flooding sources were identified within the basin: riverine flooding, rainfall-driven flooding, coastal flooding and sea level rise, urban and stormwater flooding, and flooding resulting from the breach of dams and levees. Compound flooding is a concern within the basin, especially within the coastal communities. Compound flooding results from the interaction of two or more flooding sources, most commonly coastal, riverine, and rainfall-driven in any combination. Other secondary flooding sources including groundwater flooding may contribute to flooding within the basin. However, groundwater flooding was not assessed as a separate source in this report.

FEMA's National Risk Index (NRI) investigates a county's vulnerability to 18 hazards, including riverine and coastal flooding, relative to all counties within the U.S. (FEMA, n.d.). Lumber River Basin counties closer to the coast, such as Brunswick County, tend to have higher risk due to increased exposure to hurricanes and coastal flooding. The NRI classifies riverine flooding risk as "relatively low" for most of the northern parts and "relatively moderate" for the rest of the basin. NRI scores for counties within the Lumber River Basin are provided in **Appendix A**.

In addition to the NRI, FEMA's National Flood Insurance Program (NFIP) collects data on flood related insurance claims including information on Repetitive Loss (RL) properties. These properties have flooded multiple times over a 10-year period causing more than $1,000 in damages for each flooding event (FEMA, 2020). **Figure 5** shows the NFIP payments, as of 2019, and total RL properties, as of 2025, within the Lumber Basin counties.

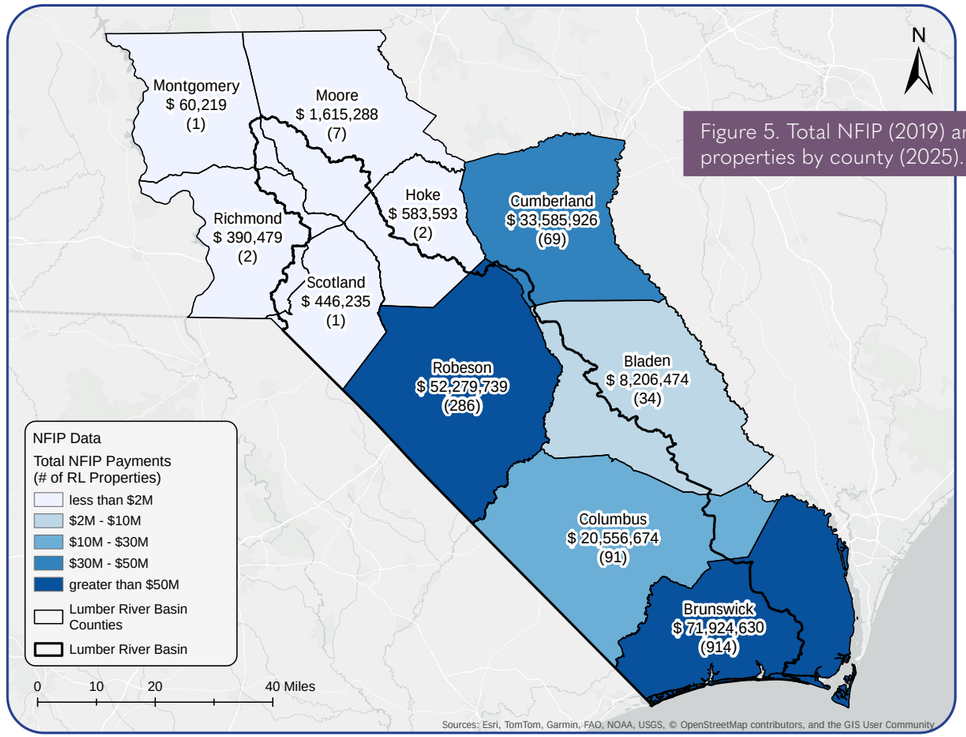


Figure 5. Total NFIP (2019) and total RL properties by county (2025).

History of Flooding

The Lumber River Basin experienced major hurricanes and tropical storm events including Hurricane Hazel (1954), Hurricane Fran (1996), Hurricanes Floyd (1999), Hurricane Matthew (2016), and Hurricane Florence (2018). These storms have brought high levels of flooding and damage to communities across the Lumber River Basin.

Hurricane	Year	Basin Impacts
Hazel	1954	• Record storm surge (18ft) in Brunswick County, NC • 19 NC deaths (NWS, n.d.-a)
Fran	1996	• $5+ billion in damages* • 23 NC deaths (NWS, n.d.-b)
Floyd	1999	• Preceded by Hurricane Dennis 2 weeks prior which created highly saturated conditions • 15" of rain in Whiteville, NC • 36 NC deaths (NWS, n.d.-c)
Matthew	2016	• $1.5+ billion in flood damages* • Record Lumber River peak flood stage (multiple locations) • 12.6" of rain in Lumberton, NC
Florence	2018	• $17+ billion in damages* • Record Lumber River peak flood stage (multiple locations) • 27.4" of rain at Green Swamp in Brunswick County, NC (NWS, n.d.-d) • Peak of 22.2 feet at the West 5th street at Lumberton stream gage (USGS Gage: 02134170) (NWPS, 2025)

*Damages not adjusted for inflation

In addition to named storms, unnamed localized flooding events impact communities in the Lumber River Basin every year. Events such as high tide, flash flooding, and intense rainfall can cause major damage to infrastructure, homes, and businesses. In September 2024, 12 to 20 inches of rain fell on southeastern NC during an unnamed storm event, causing flash flooding and damages in areas of the Lumber River Basin (NWS, n.d.-e). In July 2026, Lumberton, NC experienced major flash flooding which inundated roughly 50 homes causing varying levels of damage (NWPS, 2025). These two specific accounts of localized flooding in the basin are an example of major flood challenges that Lumber River Basin communities are facing.

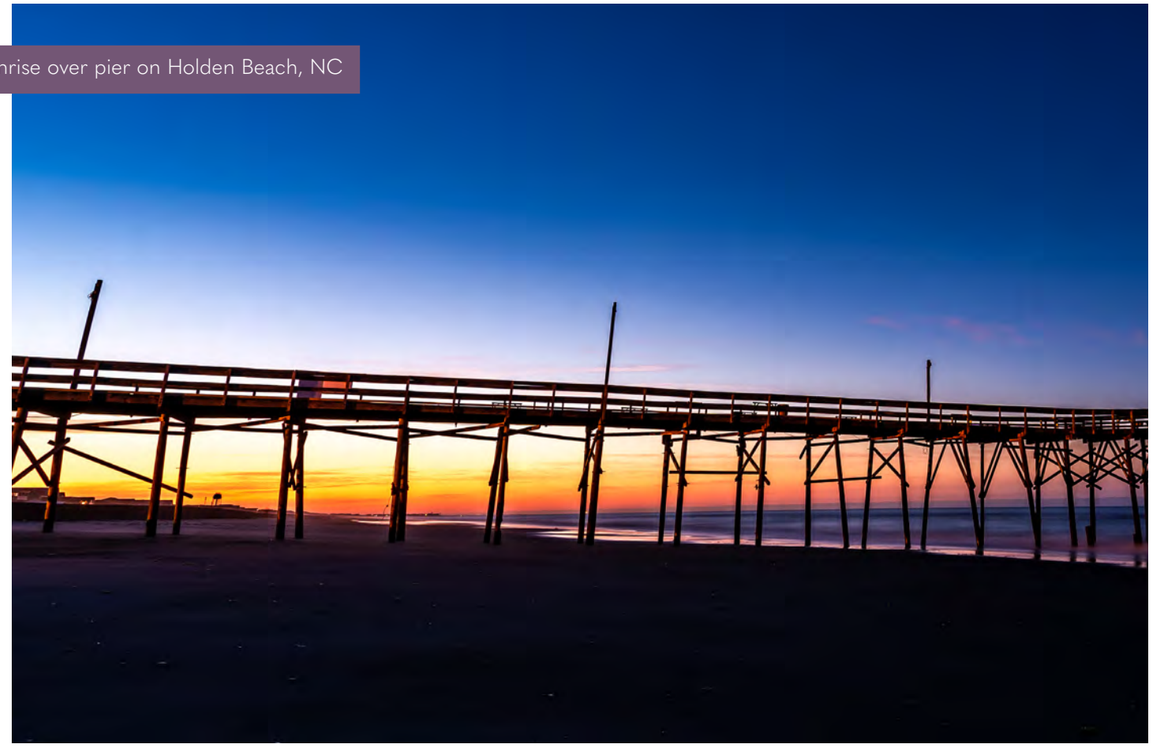
Basin Dynamics

Land Use Changes and Development

The percentage of the Lumber River Basin that is developed is expected to almost triple from 2023 to 2050 and increase by four-fold by 2100. The predicted increase in developed areas throughout the basin could impact surface runoff levels, water storage capacity, and reduce the level of natural stormwater mitigation.

	Current Conditions	2050 Conditions	2100 Conditions
Land Use Type	**Land Use Percentage**		
Wetlands	32.9%	23.2%	14.6%
Cultivated Land	26.2%	20.8%	13.2%
Forest	21.6%	20.3%	15.8%
Developed Area	11.9%	30.1%	42.8%

Sources: (MRLC, 2023) and (EPA, 2025)



Sunrise over pier on Holden Beach, NC

Climate

North Carolina has warmed over the past century, and temperatures will continue to rise. Average annual precipitation has largely remained the same but is becoming more concentrated in larger and more intense events. More frequent and intense storms will lead to increased levels of flooding in coastal and low-lying communities (NCICS, 2020).

Population Shifts

The North Carolina Office of State Budget and Management (OSBM) projects an additional 36.5% in growth by 2060 across the Lumber River Basin. Although the total population is expected to increase, changes will not be uniform across the communities within the basin. The populations of some communities are expected to increase while others are expected to decrease (**Table 1**). Brunswick County is expected to grow faster than any other county in the basin from 2020 to 2060 (OSBM, 2025).

Table 1. Population projections for the Lumber River Basin counties (OSBM, 2025).

County	Census 2020 Population	Projected 2040 Population	Projected 2060 Population	% Change 2020-2060
Bladen	29,606	35,281	43,371	46.5%
Brunswick	136,693	239,871	309,279	126.3%
Columbus	50,623	52,524	52,836	4.4%
Cumberland	334,728	337,972	337,971	1.0%
Hoke	52,082	68,776	86,329	65.8%
Montgomery	25,751	26,195	26,196	1.7%
Moore	99,727	148,540	196,130	96.7%
Richmond	42,946	39,830	39,683	-7.6%
Robeson	116,530	123,424	141,849	21.7%
Scotland	34,174	30,066	25,948	-24.1%

Sandhills Horticultural Gardens in Pinehurst, NC

RIVER BASIN ACTION STRATEGY DEVELOPMENT PROCESS

The RBAS development process involved five main steps (**Figure 1**). Step 1 involved the development of an inventory of local actions, existing data, planning efforts, research projects, studies, and existing regional-scale modeling within the basin. The community engagement process (Step 2) has been an ongoing process, with the River Basin Advisory Group (RBAG) receiving updates and providing feedback throughout the process. Step 3 involved conducting flood risk and vulnerability analyses and development of regional resiliency actions to address identified areas of concern. Steps 4 and 5 of the Blueprint process involved the development of a list of priority resilience actions. This section summarizes the outcomes from these steps.

ACTIONABLE DATA, MODELING, & ANALYSIS

Inventory of Existing Data, Programs, & Studies

A literature review of all potential data, studies, plans, and programs (through January 2025) was performed to obtain knowledge on resiliency planning and action implementation within the Lumber River Basin. The outcome is a list of 328 resiliency actions that have been proposed, planned, or completed (see **Appendix A**). Qualifying actions fall under one of the following investment types: structural, non-structural, nature-based, planning, and policy. Common themes that emerged from the inventory of existing data, programs, and studies were post-hurricane recovery, future flood prevention through resiliency, and funding sources.

The existing flood risk data within the Lumber River Basin comes in the form of hydrologic and hydraulic (H&H) modeling and floodplain data. National, statewide, and local level data sources were inventoried, and this data was utilized to determine the level of flood risk and vulnerability in communities across the basin. DEQ collaborated with NCEM to complete 2D flood modeling for the Lumber River Basin as part of the Blueprint process and development of the RBAS. The 2D modeling work considered both current and future conditions flooding. A complete list of the modeling and dataset sources identified through the literature review can be found in **Appendix A**.

Local & Regional Capacity

The capacity of communities is a key factor in their ability to develop, fund, manage, and implement resiliency actions. Governmental structure, population, demographics, and socioeconomics all influence a community's capacity. Understanding each community's staffing, budget, and programmatic composition is vital to assessing its ability to successfully participate in the Blueprint process.

The Blueprint Capacity Analysis assessed each municipality and county's capacity to participate in the following six components:
1) Blueprint Tool and planning process training;
2) Independent or supported use of the Blueprint Tool to identify, analyze, and prioritize action strategies;
3) Project feasibility or conceptual design creation for selected strategies;
4) Action strategy funding;
5) Action strategy implementation; and
6) Ongoing stewardship or management of completed action strategies.

According to the analysis, Cumberland, Bladen, Columbus, and Brunswick counties have high capacity to participate in the Blueprint process while the rest of the counties have moderate capacity (**Figure 6**). Municipalities and unincorporated communities were more varied, with 27 low, 14 moderate, and 11 high overall capacity ratings (**Figure 7**). Details on the metrics and data that were used in the capacity analysis can be found in **Appendix C**.

Effective flood risk reduction and resilience-building depend on the ability of local governments to lead and support the implementation of resilience projects. Strengthening local capacity through dedicated resources, technical assistance, and funding support will enable communities to develop plans, secure investments, and successfully administer grant-funded initiatives.

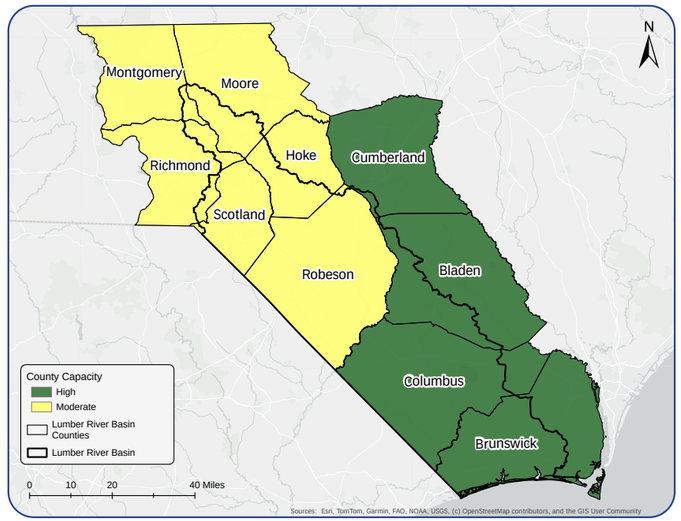


Figure 6. Lumber River Basin county level overall Blueprint capacity.

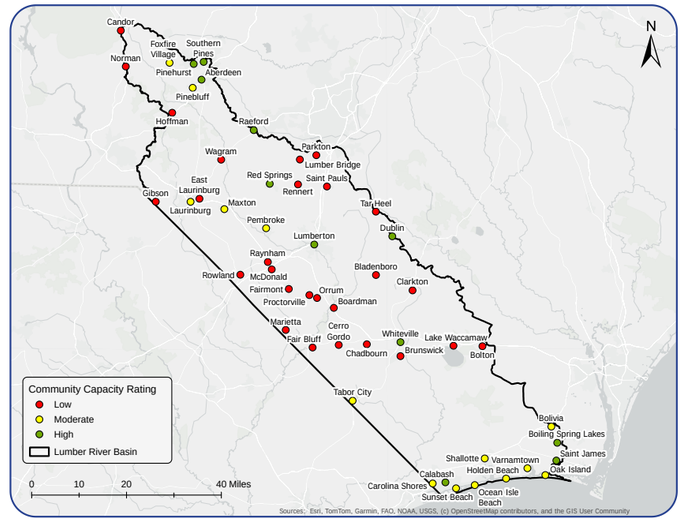


Figure 7. Lumber River Basin community level overall Blueprint capacity.

COMMUNITY ENGAGEMENT & DISCOVERY

Engagement with Local Communities & Agencies

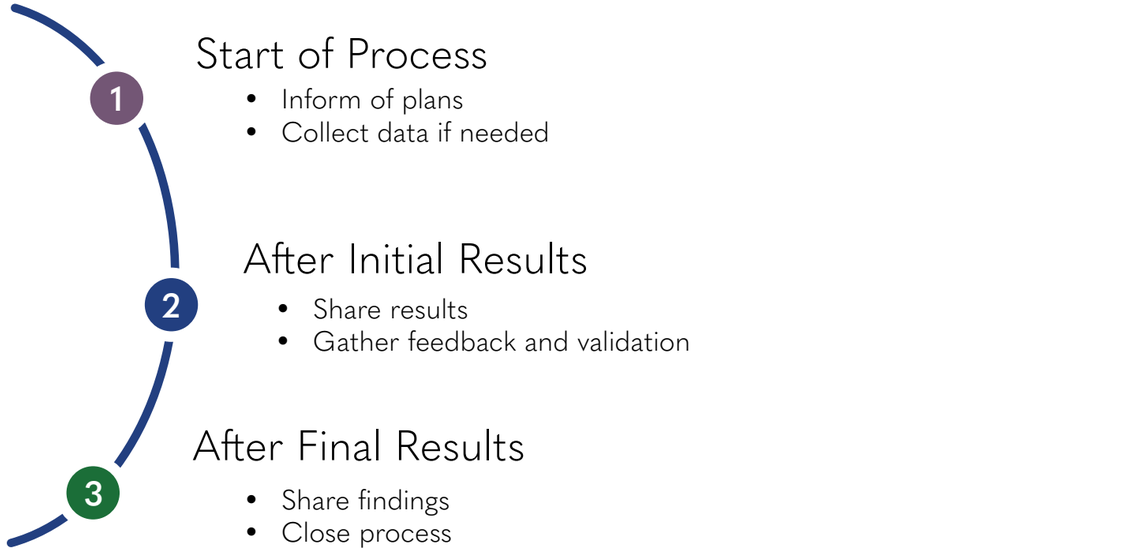
Planning for flood resilience works best when it is shaped by the people and communities who experience flooding firsthand. In the Lumber River Basin, outreach and engagement were designed to make sure local voices, experiences, and priorities played a central role in developing the Lumber River Basin Action Strategy.

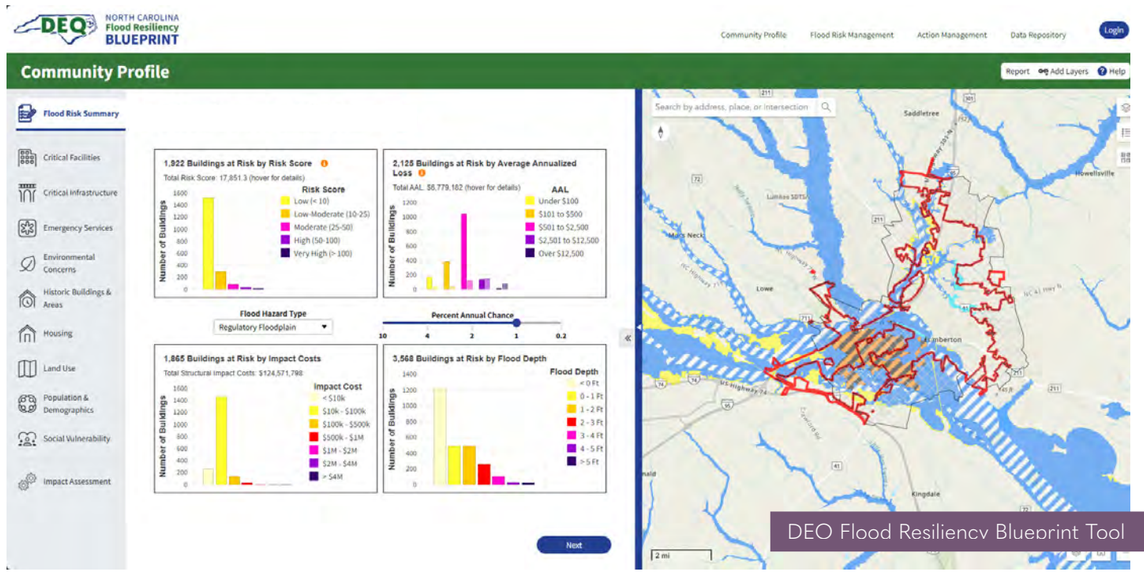
During the development of the River Basin Action Strategy, engagement efforts focused on regional and basin-wide planning, and included communities, local governments, and tribal representatives, along with nonprofit and regional organizations across the basin. A structured Outreach and Engagement Plan guided this work, establishing a coordinated approach to sharing information, gathering feedback, and building partnerships (**Figure 8**). A strong focus was placed on reaching and including vulnerable, under-resourced, and underserved communities to ensure their perspectives helped shape the process.

Central to this approach was the commitment to two-way communication. Regular meetings, training sessions, and accessible "office hours" provided opportunities for stakeholders to learn, ask questions, and offer feedback. Continuous one-on-one support ensured that participants could engage at a level appropriate to their needs. As the process progressed, stakeholder input directly informed improvements to tools, data, and planning methods.

Through these sustained engagement efforts, the Action Strategy reflects a collaborative, data-informed approach to reducing flood risk. By integrating technical analysis with local expertise and community perspectives, the Blueprint process supports decision-making that is both regionally coordinated and responsive to on-the-ground needs.

Figure 8. River Basin Action Strategy data analysis engagement cycle.





DEO Flood Resiliency Blueprint Tool

Blueprint Tool Trainings

To ensure the success of the Flood Resiliency Blueprint, stakeholders across the river basin were given multiple opportunities to become familiar with the Flood Resiliency Blueprint Tool, understand the planning process, and apply it to strengthen their community's flood resilience. DEQ encouraged stakeholders to use the Tool and planning framework and committed to providing training and ongoing technical support to maximize project impact. Partners who become Blueprint Tool users can share information within their agencies or neighborhoods and help train others. Some Blueprint Partners may not use the Tool directly but can still contribute valuable community knowledge relevant to flood resiliency.

The Blueprint Tool training process began with a kickoff meeting introducing the Tool, its purpose within the broader Blueprint process, and available training options. Regular email updates kept stakeholders informed about Tool developments, planning progress, and meeting activities, while also offering a structured way to submit questions, concerns, and suggestions.

> The Blueprint Tool is just one step within a structured planning and decision-making process. Stakeholder trainings and communications help to explain how users move from an initial vulnerability analysis to identifying potential actions, comparing multiple options, including cost-benefit considerations, and finally selecting an action or project concept for submission as a formal proposal.

Virtual office hours and one-on-one meetings provided Partners with additional opportunities to ask about Tool registration and strengthen community networks. Stakeholders were also invited to review and provide feedback on community guidance materials and the effectiveness of the overall use of the Blueprint Tool, with the process being continuous such that changes can continue to be incorporated.

River Basin Action Stakeholders

Several main groups were involved in developing the Action Strategy: the Blueprint Partners, River Basin Advisory Group, and the general public, including collaborations outside of regularly scheduled meetings. These groups met from March 2025 through July 2026 and were structured to include a diverse range of participants, including municipal and county staff, watershed experts, nonprofit leaders, and community representatives. The result is a network of individuals at varying levels of involvement that will continue to engage and grow after the action strategy is complete. Detailed information on the network of stakeholders and meeting summary notes can be found in **Appendix B**. The roles of Additional Collaborators and Councils of Government participation in the process are included in the appendix.

Blueprint Partners

Blueprint Partners are community leaders and end users who are interested in the Blueprint Tool and can assist with training and communication to other members of their community and the broader river basin. Partners had several opportunities to learn about the Blueprint process and Tool at information and hands-on training sessions. Details about this group and meeting summary notes are included in **Appendix B**.

Lumber Blueprint Partners meeting in Whiteville

River Basin Advisory Group

Because the Lumber River Basin is the first basin in the Flood Resiliency Blueprint project to cross state lines, at least one RBAG member represents South Carolina.

Geographical representation of the basin was a key consideration as stakeholder groups were formed. To create inclusive and effective groups, DEQ staff selected a diverse set of representatives from local and tribal municipalities, as well as regional and statewide resilience groups.

Advisory Group members come from local and tribal governments, community and faith-based organizations, and other groups involved in flood-related issues across the basin.

RBAG members provided guidance on how to effectively engage with and use information from the NC Flood Resiliency Blueprint at the regional scale. They reviewed summaries of existing flood mitigation plans, flood risk and vulnerability analyses, and potential actions to strengthen regional flood resilience. They also helped prioritize these actions and offered feedback on DEQ's community guidance for using the Blueprint Tool and planning process.

Engagement with the General Public

Throughout the development of the River Basin Action Strategy, DEQ Basin Leads connected with community-focused individuals and organizations interested in the Blueprint Tool and planning process. While these groups wanted to stay informed, they were not identified as Blueprint Partners or Advisors due to limited capacity, roles that did not align with intended tool users, or commitments in other Blueprint river basins.

This two-way relationship building, which took place outside specific stakeholder meetings, enabled DEQ to share information and learn from communities. Participants shared their organization's priorities, challenges and on-the-ground experiences, many of which were in vulnerable, underserved, and under-resourced communities. Basin Leads provided updates and resources that could be shared with networks. These partnerships gave DEQ a clearer understanding of local needs and strengthened DEQ's engagement approach. This collaboration also ensured that the Blueprint Tool and planning process better supported DEQ's goal of making all of North Carolina's communities more resilient to flooding.

These additional collaborators include, but are not limited to:

- The Association of Mexicans in North Carolina (AMEXCAN)
- North Carolina Black Alliance (NCBA)
- NC Statewide Independent Living Council (SILC)
- Southern Coalition for Social Justice (SCSJ)
- North Carolina Budget & Tax Center (NCB&TC)
- North Carolina Conservation Network (NCCN)
- North Carolina Inclusive Disaster Recovery Network (NCIDR)
- Carolina Wetlands Association (CWA)
- Lumber River Conservancy (LRC)
- South Carolina Office of Resilience (SCOR)
- North Carolina Department of Environmental Quality Division of Coastal Management
- NC State Coastal Dynamics Design Lab
- Jay Leggette (The Stimulus)

The NC Flood Resiliency Blueprint Program also hosted a public information session in March 2026. The session recording can be viewed on DEQ's YouTube page.

Lumber Blueprint Partners meeting in Whiteville

Engagement with Under-Resourced Communities

To help ensure engagement efforts included the basin communities most affected by flooding, DEQ and project partners used a data-driven approach to identify areas with higher flood risk and greater social and economic challenges. This analysis combined national and state data with local knowledge to better understand where support and engagement were most needed.

Using mapping and analysis tools, the project team reviewed data on flood risk, economic conditions, and community vulnerability across the basin and identified and ranked areas based on overall vulnerability and flood risk. The initial findings were presented to the Basin Lead and the engagement team who work in these communities. Based on their input, additional communities and counties were identified for outreach.

DEQ then contacted representatives from these communities and invited them to take part in the engagement process, including Blueprint Partners and RBAG meetings. Stakeholders were also encouraged to meet one-on-one with the Basin Lead for more personalized conversations about the community's interest and ability to be involved in the Blueprint process. In some cases, outreach resulted in community representatives inviting the Basin Lead to present information about the Blueprint Tool and process to their local government.

This approach helped ensure outreach was fair and reached the communities most impacted by flooding. It also created new connections and strengthened existing relationships.

Detailed information on the data inputs used, findings, and additional outreach completed, are included in **Appendix B**.

Lumber RBAG meeting in Pembroke

Lumberton City Hall, NC, USA

FLOOD RISK PLANNING & ANALYSIS

A basin-scale risk and vulnerability analysis was completed to identify vulnerable areas within the basin and develop up to 20 new regional or multi-jurisdictional resiliency actions that mitigate the risk of flooding. The regional actions, however, may not mitigate all the risk within the basin. Local actions were selected to mitigate the residual risk, after the regional actions are in place.

The flood risk analysis estimated the potential damage to buildings and other infrastructure from flooding. The vulnerability analysis identified the areas that exhibit the highest levels of risk density across the basin. Where possible, regional or multi-jurisdictional resiliency actions were developed for the areas that exhibited the highest levels of risk density.

To develop a comprehensive list of areas vulnerable to flooding and potential mitigation actions, the risk and vulnerability analysis was completed separately for the combined riverine, rainfall-driven, coastal, and urban and stormwater flooding sources, and for the dam and levee breach flooding source. The combined riverine, rainfall-driven, coastal, and urban & stormwater flood risk was assessed under existing climate conditions and future climate conditions.

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 Lumber River Basin. This data can be viewed within the Tool for local governments and organizations to explore, craft, analyze, and evaluate flood resilience actions.

Flood Risk Analysis

Riverine, Rainfall-Driven, Coastal, and Urban and Stormwater Flood Risk Analysis - Current Conditions

A part of the Blueprint process was the development of 2D Base Level Engineering (BLE) deliverables, which included building-level risk data for current land use and precipitation conditions, reported as risk scores, for all impacted buildings in the Lumber River Basin. A risk score provides an estimate of the likelihood that a structure would experience damage during a flood event using an annualized loss estimate (ALE) value and the building's replacement value (DEQ, 2025a).

Of the 217,244 total buildings within the basin, 18,456 had a risk score greater than zero based on current conditions modeling (**Figure 9**). Additional details can be found in **Appendix E**.

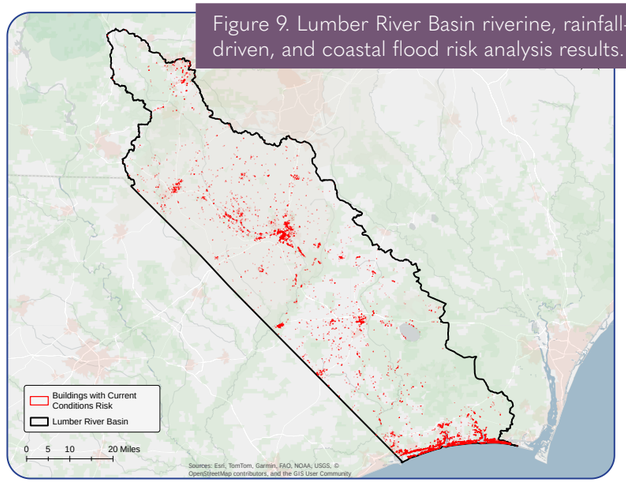


Figure 9. Lumber River Basin riverine, rainfall-driven, and coastal flood risk analysis results.

Riverine, Rainfall-Driven, Coastal, and Urban and Stormwater Flood Risk Analysis - Future Conditions

The NCEM 2D BLE models incorporated future land use and precipitation conditions for five climate scenarios (Mid Century Lower (MCL), Mid Century Higher (MCH), End of Century Lower (ECL), End of Century Higher (ECH), and the End of Century Severe (ECS)) and two buildout conditions scenarios that incorporate future land use (2050 Buildout and 2100 Buildout). The MCL and MCH scenarios represent estimated future conditions for the year 2050. The ECL, ECH, and the ECS scenarios represent estimated future conditions or 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 the land use up until 2100 (US EPA, 2025). Further information on the modeling of the future and buildout conditions can be found in **Appendix E.**

To understand the total losses in relation to each future event, the ratio of the total losses relative to the total building replacement value was calculated, referred to here as the "damage ratio." The ratio was then scaled to make the possible range 0 to 100. A damage ratio value of zero indicates the flood depth would not cause any damage at that building and 100 indicates that the total losses were equal to the total building replacement value.

The future flood risk analysis indicates that there are 16,765 buildings impacted by at least one of the seven future or buildout condition scenarios (**Figure 10**). The results of the future flood risk analysis point to increased flood risk in the future. More information on the future conditions flood risk analysis can be found in **Appendix E**.

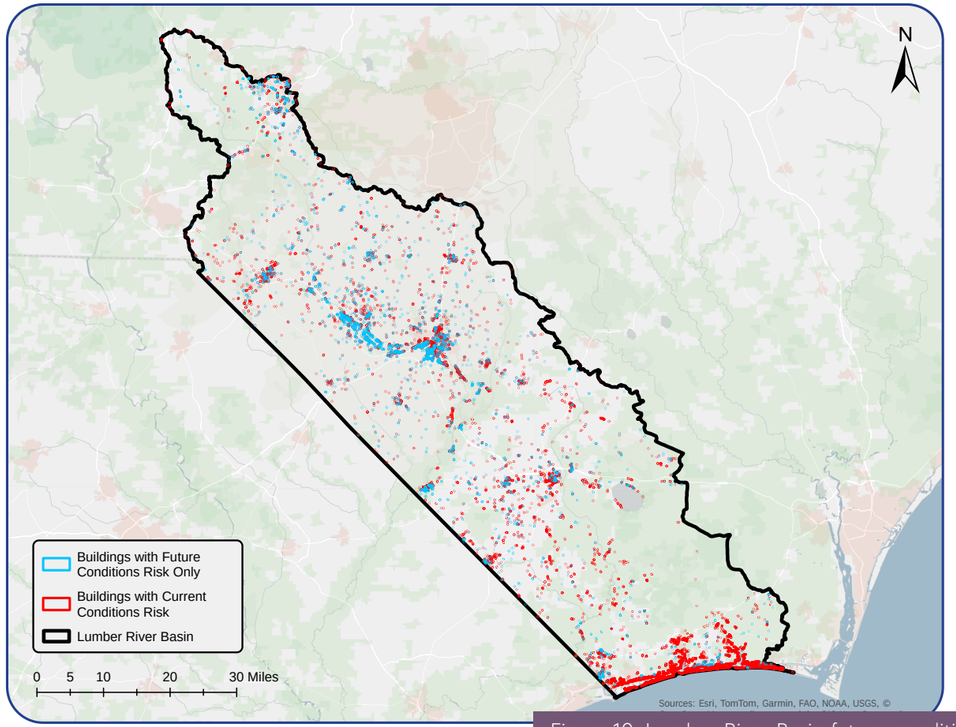


Figure 10. Lumber River Basin future conditions riverine, rainfall-driven, and coastal flood risk results.

Dam and Levee Breach Risk

There are 186 dams and one levee embankment system, the Lumberton Levee, within the Lumber River Basin.

Four key criteria were summarized at the dam level to provide a comprehensive view of dam risk: the average damage ratio, total losses, maximum Annual Average Daily Traffic (AADT) disrupted (NCDOT, 2025), and impacts to other critical infrastructure.

Levee breach risk analysis was performed on the Lumberton Levee system utilizing information from the National Levee Database (NLD) (USACE, n.d.), NCEM 2D BLE modeling, NC Statewide building footprints, and terrain data provided by NCEM (NCEM, 2026).

The risk levels for the 186 dams show a picture of dam breach flood risk. In total, 52 dams were identified as high risk, 9 moderate risk, and 125 low risk (**Figure 11**).

The Lumberton Levee system was observed as a high-risk levee based on the flood risk analysis and the criteria listed above. **Figure 12** identifies the area that would be impacted if the levee were to breach and floodwater is not held back.

Further information on the dam and levee breach flood risk analysis can be found in **Appendix E**.

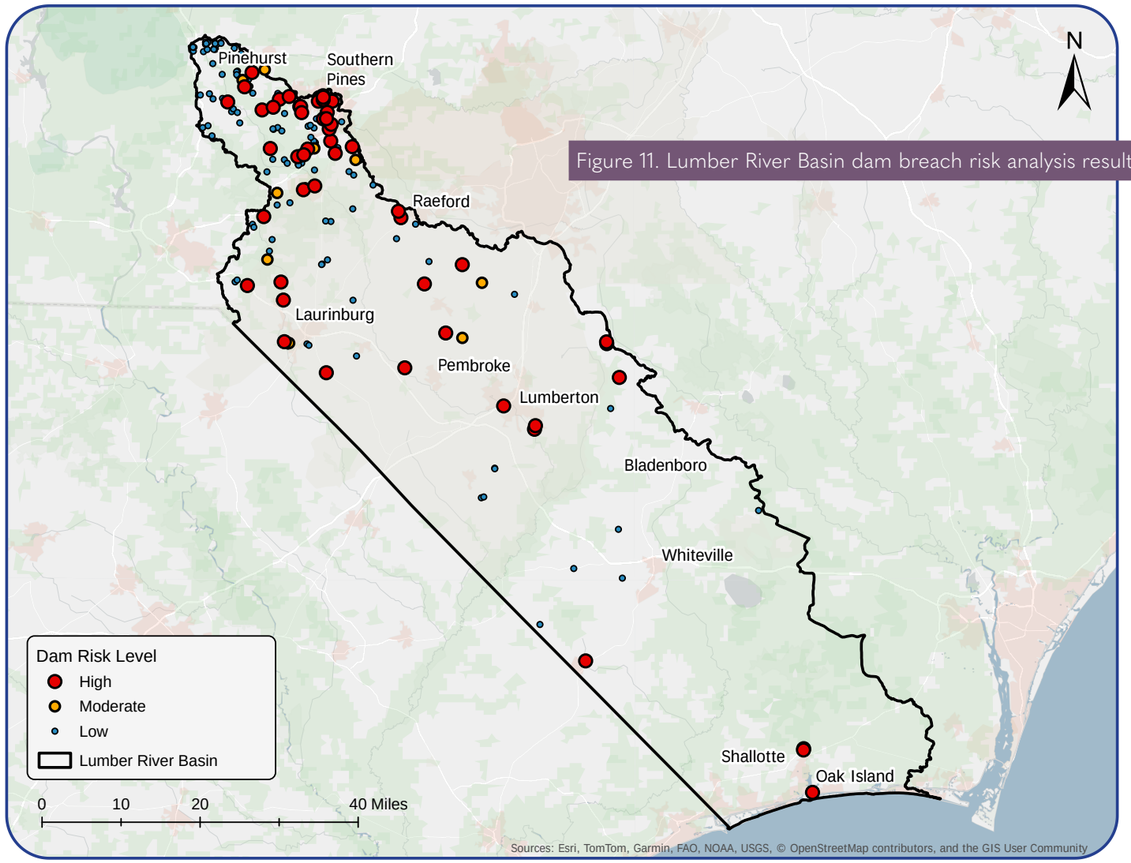


Figure 11. Lumber River Basin dam breach risk analysis results.

Lake Waccamaw, NC

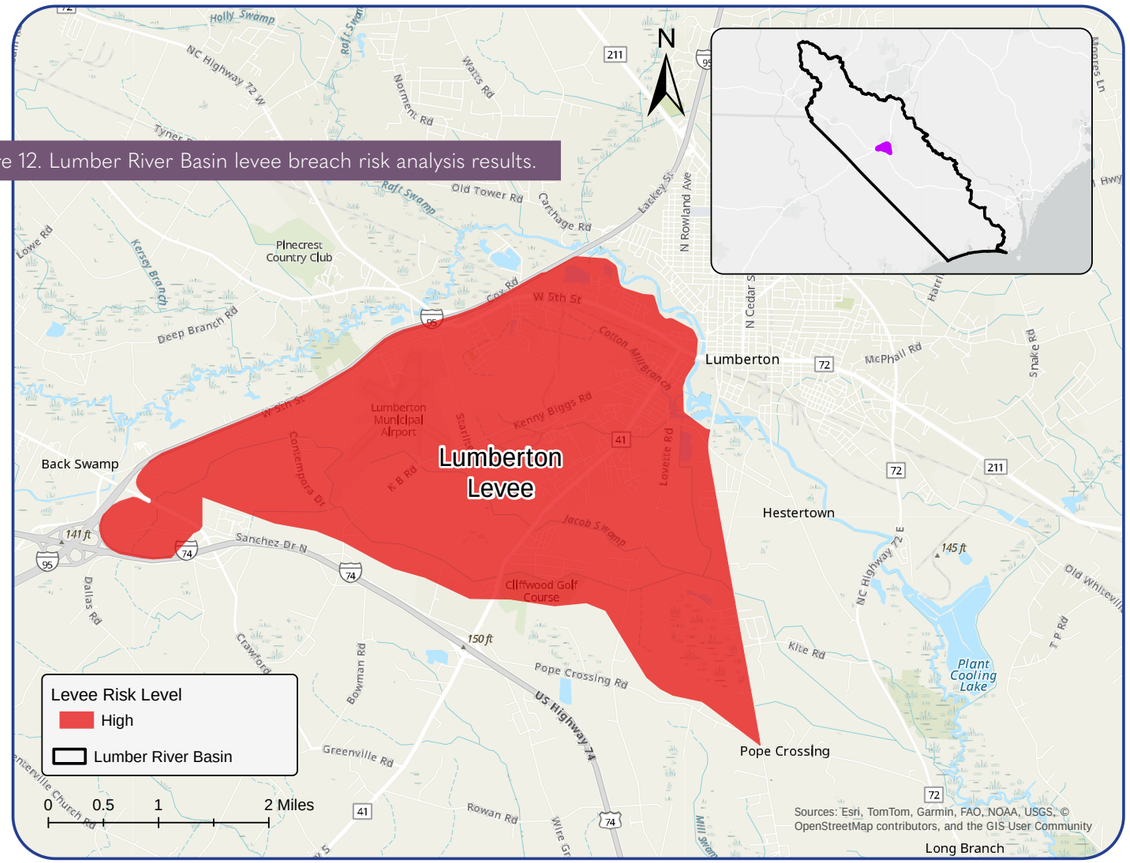


Figure 12. Lumber River Basin levee breach risk analysis results.

Flood Vulnerability Analysis

Riverine, Rainfall-Driven, Coastal, and Urban and Stormwater Vulnerability Analysis - Current Conditions

A cluster analysis was performed on the current conditions building risk results to delineate the regions with the highest risk density, denoting high vulnerability. Four concentrated areas of risk were identified as highly vulnerable within the Lumber River Basin: the City of Lumberton and surrounding areas, the Town of Fair Bluff, the City of Whiteville and surrounding areas, and the Coastal Areas.

Riverine, Rainfall-Driven, Coastal, and Urban and Stormwater Vulnerability Analysis - Future Conditions

A cluster analysis was performed on the future conditions building risk results to delineate the areas with the highest risk density, indicating high vulnerability. The future conditions analysis indicates that the areas that are highly vulnerable under current conditions will be even more vulnerable in the future. These results are elaborated further in **Appendix E**.

Dam and Levee Breach Vulnerability

Two factors that influence the likelihood of a dam breach are condition and age, with both metrics included in the NC Dam Inventory (DEQ, 2025b). A poor rating indicates that action may be necessary to reduce risk for realistic conditions, while an unsatisfactory rating indicates a deficiency that requires "immediate or emergency remedial action for problem resolution" (ASDSO, 2025). Therefore, the downstream impacted area of an identified high risk dam which is also noted as being in poor or unsatisfactory condition was classified as highly vulnerable.

The age of a dam is important because the quality and integrity of the structure itself can degrade over time. Older dams are also likely to have been designed using outdated design standards and may not be equipped to handle the same hydrologic loads as newer dams. As such, the downstream impacted area of an identified high risk dam which was also indicated as being over 50-years old was classified as highly vulnerable.

Overall, current analysis and available data identified 52 areas vulnerable to dam flooding. Of these, 26 of the areas were classified as highly vulnerable, as they are also downstream of dams with either an age greater than 50 years or in poor or unsatisfactory condition.

The National Levee Database (NLD) describes the condition and past performance of the levee, which provides context for the risk ratings. A levee with a history of overtopping or breaching may have remaining deficiencies that require mitigation. The Levee Safety Action Classification (LSAC) ratings and qualitative descriptions of condition, and history were gathered from the NLD. Taking these factors into consideration, areas protected by levees with high risk levels were considered vulnerable and high risk levees with noted condition issues or a history of failure were classified as highly vulnerable. The Lumberton levee system was classified as vulnerable based on this classification.

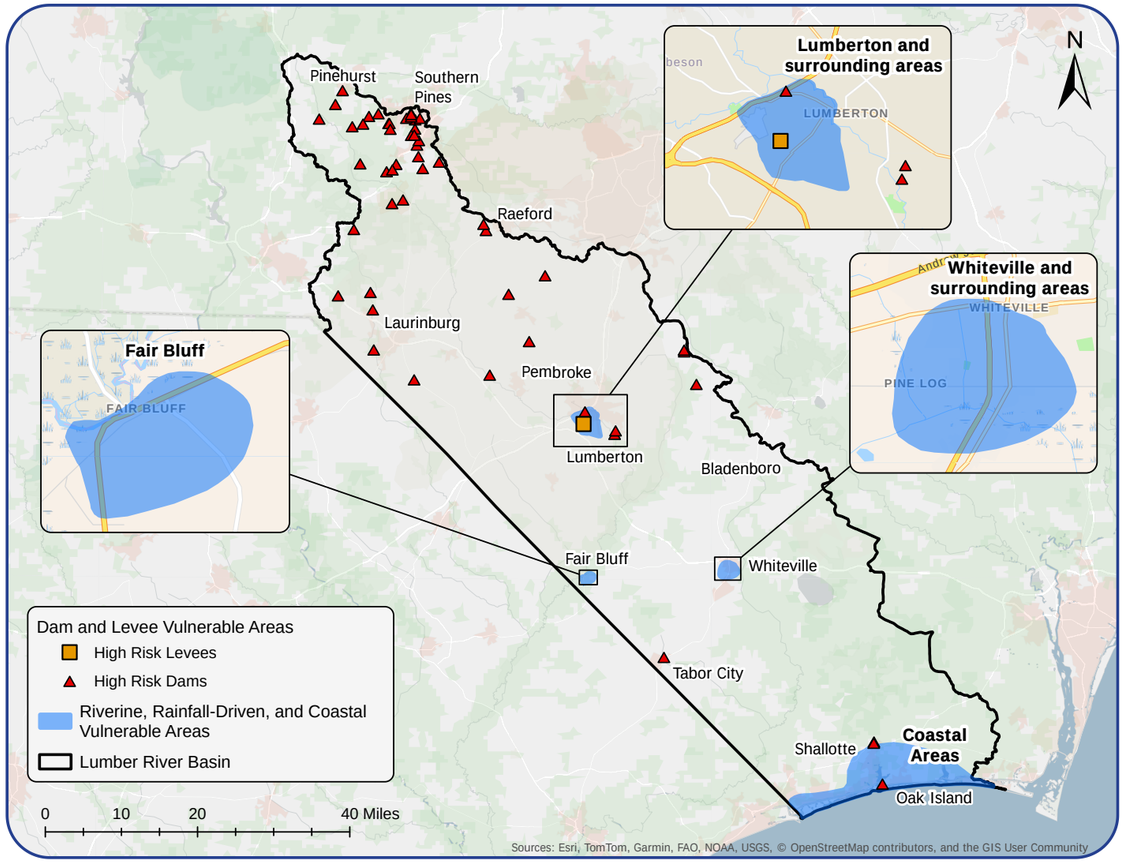
Detailed results of the vulnerability analysis can be found in **Appendix E**.

Flooding from rainfall in an area near the City of Lumberton

Lumber River Basin Flood Vulnerability Overview

The identified vulnerable areas for the Lumber River Basin can be seen in **Figure 13**. The figure depicts the regions within the basin that are currently vulnerable or will become vulnerable to flooding in the future.

Figure 13. Riverine, rainfall-driven, and coastal vulnerable areas to flooding in the Lumber River Basin.



Identification of Regional Resiliency Actions

The vulnerability analysis identified the regions or areas within the Lumber River Basin that exhibit the highest flood risk for both future and current conditions. Regional actions were identified to mitigate flood risk within these vulnerable regions. If one action could not mitigate the flood risk within each vulnerable area, a group of actions was proposed that would mitigate the flood risk when implemented together. However, there were some areas where regional actions could not currently be identified to fully mitigate the identified flood risk. The proposed regional actions are:

1 **City of Lumberton and surrounding areas**

Permanent Pump Station and Floodgate Construction on Jacob Branch to be added to the ongoing construction of the west Lumberton floodgate.

2 **Town of Fair Bluff**

Town of Fair Bluff Acquisition and Park Creation and Levee Construction

3 **City of Whiteville and surrounding areas**

De-Pave Program and Mollie's Branch Stream Restoration

4 **Coastal Areas**

No Identified Regional Actions

5 **Basin-wide Identified Dam Vulnerable Areas**

Regional Dam Inspections, Maintenance, and Modification or Removal

6 **Basin-wide Identified Levee Vulnerable Areas**

Levee System Inspection, Maintenance, Repairs, and Upgrades

7 **Residual Risk Areas**

Building Level Mitigation Program, Cleaning and Clearing Drainage Systems, and Roadway Upgrades

Specific details regarding all identified regional mitigation actions can be found in **Appendix E**.

ACTION REVIEW & SELECTION

This Lumber 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. This RBAS documents a refined and prioritized action set, summarizes the evaluation of actions against metrics to identify high priority actions, and highlights key funding, capacity, and technical assistance needs to help move actions toward implementation.

The actions recommended in this RBAS were identified through two primary approaches: an inductive approach (locally prioritized actions) and a deductive approach (vulnerability assessment based actions).

Locally Prioritized Actions

Locally Prioritized Actions were provided by local governments and delegated authorities who know what specific measures are needed. These actions were inductively collected from direct outreach to local government stakeholders and submitted as part of Local Action Plans in the Blueprint Tool.

Vulnerability Assessment Based Actions

Vulnerability Assessment Based Actions were compiled through a deductive process – they reflect recommended actions to mitigate flood risks identified through the Action Strategy's Vulnerability Assessment results. These actions:

1 Are pre-identified local actions from Hazard Mitigation Plans, North Carolina Resilient Redevelopment Plans, River Basin-wide Water Resources Management Plans, Comprehensive Transportation Plans, State Transportation Planning, and Local Plans & Projects (see **Appendix A**).

2 Are projects with potentially larger scale impacts (regional actions). The regional actions are modifications/adjustments to pre-identified (see **Appendix A**) or proposed conceptual actions.

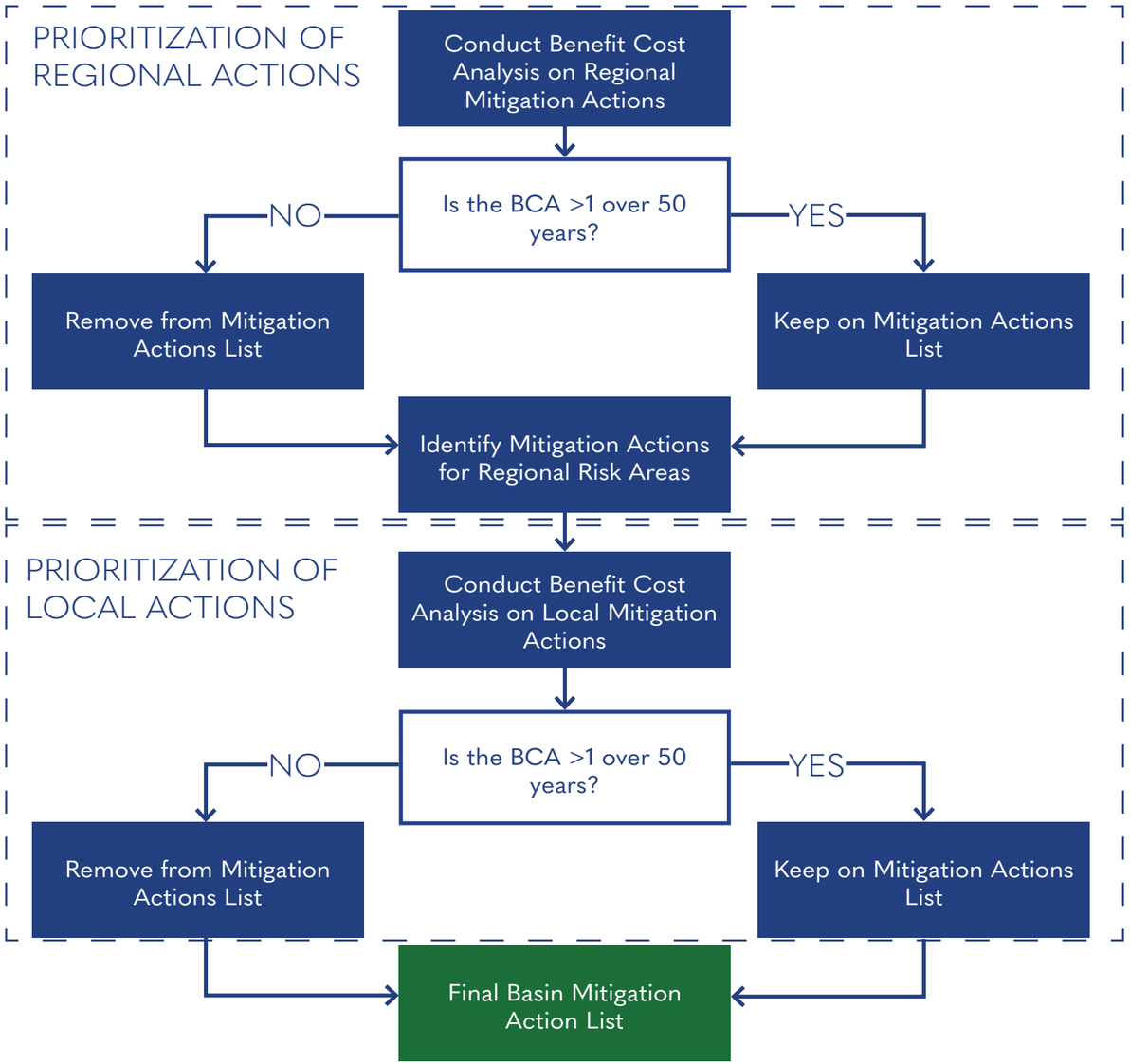
3 May address future vulnerability in addition to current flooding concerns.

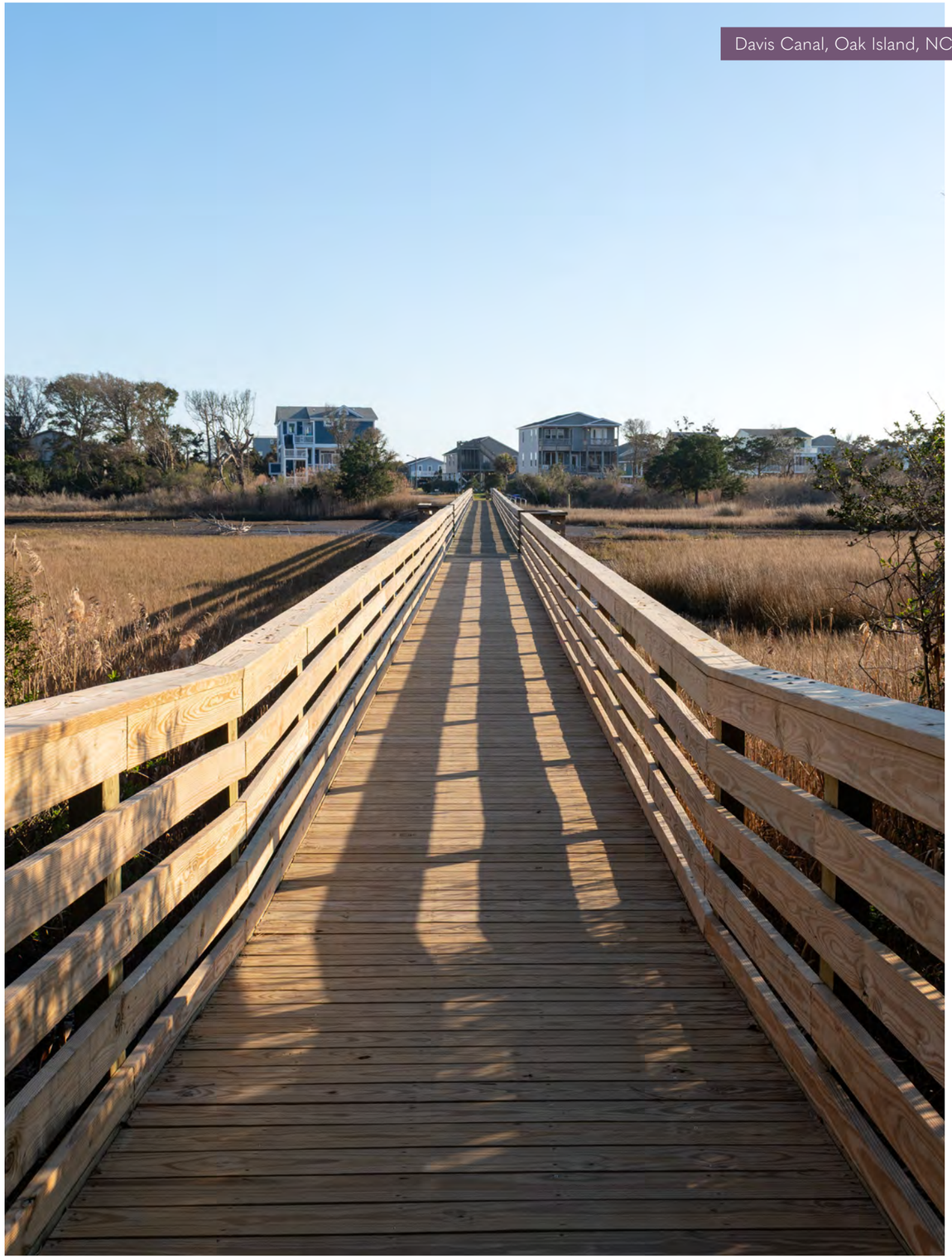
Oak Island Lighthouse, NC

Vulnerability Assessment Based Actions were prioritized based on the workflow shown below. A benefit-cost analysis (BCA) approach was developed to prioritize the regional and pre-identified local resiliency actions. A BCA calculation divides the expected benefit of an action by the cost of an action. To account for the priorities of DEQ, communities, and stakeholders within the basin, a factored BCA was utilized. Actions with a benefit-cost ratio (BCR) of at least 1.0 over 50 years are considered cost-effective and were included in the final prioritized list.

All proposed regional actions and pre-identified local actions were considered for the prioritization workflow. To ensure that multiple actions that protect the same location were not selected, regional actions were analyzed first, followed by local actions. Refer to **Appendix F** for details about the BCA.

The flowchart below outlines the steps used in developing the prioritized mitigation actions list.





Davis Canal, Oak Island, NC

Benefit Cost Analysis Factors

The RBAG provided feedback that was used to develop a list of factors that represented community priorities. Factors are qualities of a resiliency action that were viewed positively (Benefit) or negatively (Cost) by stakeholders. Benefit factors apply a percentage increase to the value of the benefit in the factored BCA, increasing the BCR for a given action, while cost factors apply a percentage increase to the value of the cost, decreasing the BCR. The following factors were incorporated into the BCA for the Lumber River Basin:

Level of Protection (Benefit)

Level of protection is defined as the proportion of the flood risk mitigated by an action in the affected area. The most effective actions, mitigating 90-100% of the flood risk, receive a weight of 30%. An example of a highly effective action would be levee construction. Less effective actions, like wet floodproofing, that mitigate approximately less than 90% of risk receive a 0% weight.

Environmental Benefits (Benefit)

This factor considers the contributions of flood resiliency actions to the health of the environment, which can include improving water quality, increasing biodiversity and ecosystem health, and reducing erosion. Nature-based solutions received the highest weight of 20% due to the core design elements benefiting the environment. The middle tier, receiving a 10% weight, is for non-nature-based solutions that provide secondary environmental benefits. An example could include floodproofing at a wastewater plant that prevents pollutants from entering the environment during a flood event. Actions that do not have an environmental benefit beyond flood resilience are given a weight of 0%.

Future Adaptability (Benefit)

Future adaptability is defined as the ability to build on or change an action once implemented to adapt to future conditions. Uncertainty in the severity of future storms and development patterns places importance on the flexibility of solutions. This factor applies a 20% weight for actions that can be modified or built upon in the future, while those that cannot be modified receive a weight of 0%. An example of an action that can be modified in the future is the creation of a floodplain park, since additional restoration or mitigation measures could be added in the future.

Maintenance Requirements (Cost)

Maintenance requirements include the frequency and cost of the upkeep necessary to ensure the implemented projects mitigate flooding as intended. Projects with a significant level of requirements received a weight of 20%, like floodgate construction, due to the specialized expertise requirement to operate and maintain the structure. Actions with a standard or regular level of maintenance requirements, like roadway upgrades, receive a weight of 10%, because they require consistent maintenance activities that would be more common in a community. A weight of 0% is given to project types with insignificant or minor maintenance requirements, like riparian buffers, which should not need significant additional work following implementation.

Number of Entities Involved (Cost)

This factor considers the increased complexity that comes with coordination between multiple stakeholders that could introduce obstacles to the implementation of an action due to competing priorities and communication challenges. The first tier includes actions with one or two owners listed and receives a 0% cost weight, since two organizations are more likely to be able to work together and resolve conflicts. Actions with three or more owners receive a 20% cost weight due to the increased chances of collaborative issues.

Permitting Requirements (Cost)

Permitting requirements include the application, completion, and approval of any level of permit needed to construct the project. Projects with a significant level of requirements, like levee or floodgate construction, receive a weight of 20% because of the time, cost, and expertise required to obtain necessary permits. Actions with a standard level of permitting requirements, such as roadway upgrades, receive a weight of 10%, since most communities would have experience with these processes. A weight of 0% is given to project types with insignificant or minor permitting requirements, like routine dam inspections and maintenance, which do not require specific permits.

It is important to note that the Benefit-Cost Analysis (BCA) framework used in this study has been specifically tailored to reflect the priorities and objectives of this basin. While it is based on methodologies similar to those used by other agencies, such as FEMA, the customized approach and assumptions applied in this analysis may produce results that differ from those generated using the standard BCA methods employed by those agencies.

Aerial view of the east end of Holden Beach, NC

LUMBER RIVER BASIN PRIORITIZED ACTIONS

What is an Action?

An action is a proactive flood mitigation or resilience measure implemented to minimize an area's vulnerability and risk of flooding and associated disruptions and damages. The Blueprint Tool organizes actions into five main categories: Building Level Mitigation, Channel Modification, Infrastructure & Control Structures, Nature Based Solutions, Policy & Planning, and Other. A selected action may be implemented on a local, regional, or basin-wide scale. The action type will determine the level of coordination required.

Building Level Mitigation

A building level mitigation action focuses on the physical changes that can be implemented on an individual structure to reduce flood risk. Action types within this category include Acquisition/Demolition (purchasing and/or removing flood-prone structures), Dry Floodproofing (making structure watertight to prevent floodwaters from entering), Mitigation Reconstruction (rebuilding or updating a structure to improved standards and codes), Relocation (moving a structure out of flood-prone areas), Structural Elevation (raising the structure first-floor elevation above predicted flood levels), Utility Elevation (raising critical mechanical, electrical, and plumbing systems), and Wet Floodproofing (designing a structure to allow water to enter certain areas while minimizing damage and protecting critical infrastructure).

Building level mitigation allows for small-scale targeted resiliency actions from an individual property to a neighborhood-scale based on specific needs. While implementation only impacts the specific residents and structure, these actions serve to protect property and life. Since these actions operate at the individual structure scale, they can sometimes be faster to implement but may face funding and property ownership challenges. Acquisition of at-risk properties shall be undertaken exclusively on a voluntary, property-by-property basis. Participation by property owners is entirely optional and the State does not intend to pursue involuntary acquisition or the use of eminent domain for these properties.

Action Types

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

Channel Modification

Channel modification actions involve natural or engineered solutions to alter waterways and improve the water storage capacity and functionality. Action types within this category include Channel Dredging, Widening, and Diversion which entails deepening, expanding, or changing the flow path of the channel to increase capacity or Debris Removal where any natural or artificial debris blockages in the channel are removed such that the channel can more closely perform as normal during flooding events. These actions target improving the flow of water through channels which can minimize the risk of flooding to surrounding buildings, roadways, and critical infrastructure. Depending on the waterway and flooding event intensity these actions may need to be repeated to maintain optimal channel performance.

Action Types

- **Channel Dredging**
- **Widening**
- **Diversion**
- **Debris Removal**

Infrastructure & Control Structures

Infrastructure and control structure actions focus on structure implementation to divert water from vulnerable areas. Action types for this category include Critical Infrastructure protection (to protect utilities and essential services), Levee/Dike/Berm construction (to contain, divert, or control water flow), New and Existing Dam Structures (to control water flow and storage), Quarries (repurposed to serve as temporary flood water storage), Roadway Elevation/Road Crossing Modification (raising or modifying roadways to improve accessibility during floods), and Storm Water Management Activities (planning, design, and implementation of stormwater infrastructure to reduce flood risk). These actions are generally implemented within communities and are key to protecting the residents, structures, and critical infrastructure during flooding events and minimizing disruptions to communities.

Action Types

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

Dam at Lake Waccamaw

Nature Based Solutions

Nature based solutions (NBS) actions utilize sustainable planning, design, environmental management, and engineering practices that focus on natural processes and features to reduce flood risk. Action types include Afforestation (planting forest vegetation to reduce flow velocity), Bioretention (using soil and vegetation to promote infiltration and storage of flood waters), Flood Storage Wetlands (engineered or restored wetlands designed to capture, store, and gradually release flood waters), Floodplain Preservation (protecting floodplains to maintain natural ability to absorb and reduce flood waters and mitigate erosion), Floodplain Restoration (rehabilitating degraded floodplains to enhance their ability to perform as intended), Green Roofs (incorporates vegetation on rooftops to intercept rainfall and reduce runoff), Living Shorelines (use of native materials to stabilize a shoreline and enhance wildlife habitat), Permeable Pavement (infiltrate runoff to reduce flood risk in the implemented traffic areas), Raingardens/Sand Filters/Bioswales (engineered green infrastructure to capture runoff and promote infiltration), and Riparian Buffers (areas of healthy vegetation from grasses to woody shrubs that reduce runoff speed and promote infiltration). Implementing an NBS action can assist in flood risk mitigation while also offering additional benefits of promoting biodiversity and wildlife habitat, improved aesthetic value, and public green space.

Action Types

- **Afforestation**
- **Bioretention**
- **Flood Storage Wetlands**
- **Floodplain Preservation**
- **Floodplain Restoration**
- **Green Roofs**
- **Living Shorelines**
- **Permeable Pavement**
- **Raingardens/Sand Filters/ Bioswales**
- **Riparian Buffers**

Policy & Planning

Policy and planning actions focus on regulations that will impact land use, management, and future development to manage and mitigate flood risk. Action types include Advanced Regulations, focusing on GIS capacity building, land use and impervious surface restrictions, and enhanced zoning (adopts stricter standards such as higher freeboard requirements, not allowing certain construction, and stricter rules for critical facilities), Multi-use Floodplains (restored or managed floodplains that provide flood storage and infiltration along with secondary benefits such as community green space or wildlife habitats), and Stormwater, Water Quality, and Floodplain Regulations (polices and regulations to control stormwater volume and flow, reduce pollutants in waterways, and preserve or restore floodplains). The policies and planning will build more long-term flood resilient communities and infrastructure.

Action Types

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

Other

There are some actions that do not fit into the defined categories and designated as 'Other'. These include Beaver Management (allows for the restoration of waterways to remove flood risk from artificial dams), Coastal-Building Mitigation (building level mitigation actions focused on structures impacted by coastal flooding including tidal flooding, storm surge, and sea level rise), and Coastal-Road Elevation/Modification (infrastructure improvements to raise or modify roadways to endure coastal and tidal conditions and sustain transportation). These actions, although more individualized, provide critical flood resilience to communities.

Action Types

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

Where and Why are these Actions Needed?

Resiliency actions are needed to mitigate flooding risk within the basin and to build more long-term resilient communities. Without these actions, the basin and its population will continue to be vulnerable to flood risk. The identified flood hazard type and vulnerability and risk of an identified area along with the area's characteristics including population, properties at risk, geographical limitations, and infrastructure will determine which action category and type is most applicable.

Ocean Isle Beach, NC

PRIORITIZED RESILIENCY ACTIONS

The prioritized or selected resiliency actions for the Lumber River Basin are the vulnerability assessment-based actions with calculated benefit cost ratios (BCR) of at least one over a 50-year project life period, and locally prioritized actions by communities.

As previously noted, locally prioritized actions reflect actions where local governments know that specific actions are needed. These actions were inductively collected from direct outreach to local government stakeholders and submitted as part of Local Action Plans in the Blueprint Tool. BCRs were not calculated for locally prioritized actions as they do not yet have detailed cost estimates.

Local governments are strongly encouraged to maintain current flood resilience actions in their Local Action Plans through the Blueprint Tool. This enables communities to track the status of planned and implemented projects, identify potential co-benefits, and provide DEQ with greater visibility into basin-wide technical and financial needs. Projects identified as priorities in Local Action Plans qualify for consideration for Blueprint funding.

The prioritized resilience actions for the Lumber River basin are shown in **Figure 14** and **Table 2**.

Figure 14. Lumber River Basin prioritized resiliency actions.

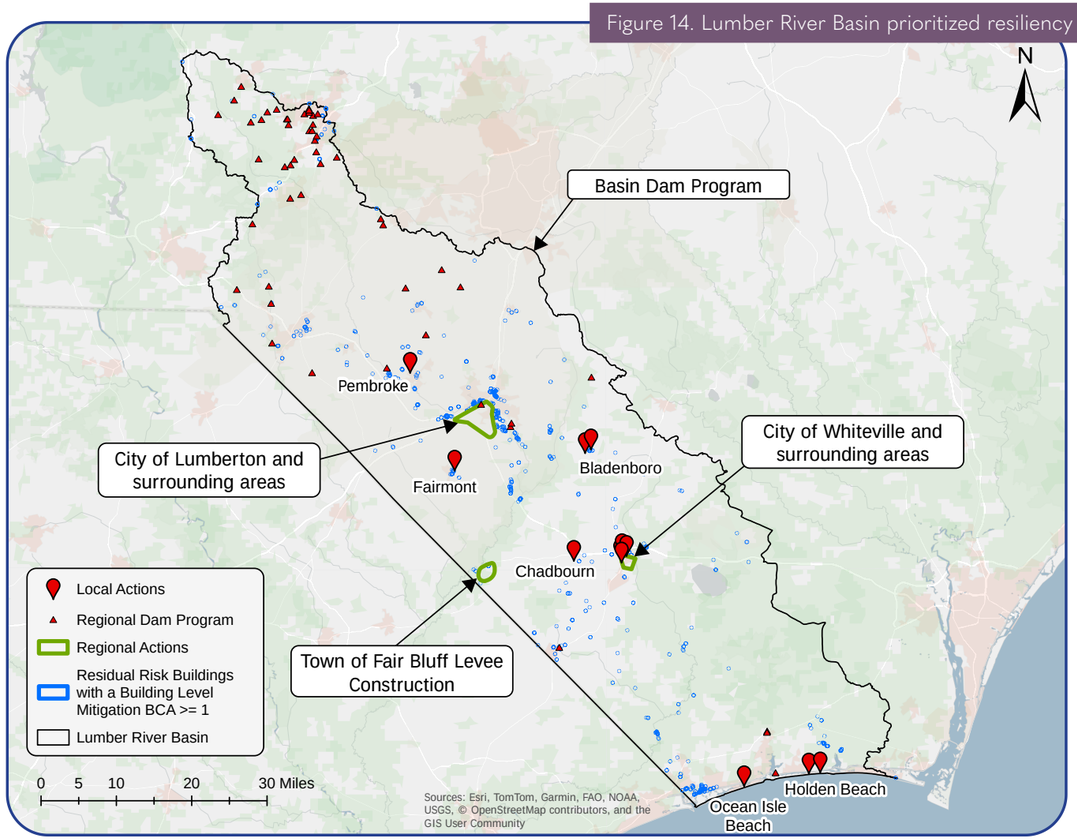


Table 2. Prioritized Resiliency Actions List for the Lumber River Basin

Resiliency Action Name	Jurisdictions	Regional, Local, or Building Level?	Action Descriptions	Action Type(s)	BCR
Stormwater/ Flooding Improvements	Town of Pembroke	Local	This strategy will focus on cleaning and reshaping channels and culverts that carry stormwater away from the campus and town to the larger tributary areas of Watering Hole and Bear Swamp.	Storm Water Management Activities	-
City of Lumberton and surrounding areas Regional Action	City of Lumberton and surrounding areas	Regional	• Lumberton Levee System Inspection, Maintenance, Repair, Upgrades, and Accreditation • Permanent Pump Station • Floodgate Construction on Jacob Branch	Multiple	7.73
Pump Station Relocation	Town of Fairmont	Local	This project involves the relocation of the North Walnut and Happy Hill pump stations to outside the 100-year floodplain. The new stations will have submersible pumps, wet wells, valve vaults, emergency bypass connections, generators, new computer systems, and security fencing.	Critical Infrastructure	-
Town of Fair Bluff Levee Construction	Town of Fair Bluff	Regional	Levee Construction	Levee/Dike/ Berm	4.96

Resiliency Action Name	Jurisdictions	Regional, Local, or Building Level?	Action Descriptions	Action Type(s)	BCR
Stream/Floodplain Restoration and Flood Storage Wetlands	Town of Bladenboro	Local	Approximately 2.59 acres of floodplain restoration will be performed along approximately 2,500 linear feet of confined ditch. The floodplain will also include 2,500 linear feet of base flow stream channel and 2,500 linear feet of riparian buffer restoration. Flood storage wetlands have been coupled with floodplain restoration in lower portions of the 2,000-foot project valley to maximize water storage and release timing within former agricultural lands above the outfall into Bryant Swamp. From a planning level perspective, approximately 1.5 acres of flood storage wetland will be established within the restored floodplain conveyance, providing 11.8 acre feet of flood storage capacity during major storms.	Floodplain Restoration	-
Outlet Rehabilitation	Town of Bladenboro	Local	Outlet improvements at the controlling stormwater discharge boundary to reduce backwater-driven surcharge and roadway flooding duration.	Storm Water Management Activities	-
City of Whiteville and surrounding areas Regional Action	City of Whiteville and surrounding areas	Regional	• De-Pave Program • Mollie's Branch Stream Restoration	Multiple	3.71
Bob White Lane Stormwater Improvements	City of Whiteville	Local	Stormwater infrastructure improvements (feasibility study) to a historically disadvantaged population and access to Whiteville High School and major regional thoroughfare in the City. Alleviating the stormwater issues will improve access and reduce the flooding impacts to residential structures.	Storm Water Management Activities	-

Resiliency Action Name	Jurisdictions	Regional, Local, or Building Level?	Action Descriptions	Action Type(s)	BCR
College Street Stormwater Improvements	City of Whiteville	Local	Improving stormwater infrastructure to resolve existing drainage issues in a high priority area. Feasibility study has been completed and design of the project is underway, nearing completion.	Storm Water Management Activities	-
Baldwin Circle Acquisition	City of Whiteville	Local	Acquire five parcels adjacent to city-owned property. The five parcels are flood-prone and have flooded previously. Public safety staff have had to conduct rescues at these houses. Acquiring the property and restoring it to its natural floodplain functions would mitigate the flood risk for these families and their property.	Acquisition/ Demolition	-

Lighthouse on Oak Island, NC

Resiliency Action Name	Jurisdictions	Regional, Local, or Building Level?	Action Descriptions	Action Type(s)	BCR
Stormwater System Improvements for Flood Mitigation	Town of Chadbourn	Local	Priority Area 1 and 3 Stormwater System Improvements: Proposed project will implement findings from a Stormwater Asset Inventory & Assessment project completed in 2021 to include the replacement of piping in two areas ranging from 12" to 18", and five associated stormwater structures.	Storm Water Management Activities	-
Mollies Branch Acquisition Program	City of Whiteville	Local	Several parcels in this area have been acquired by the city through acquisition programs. The goal of this action is to acquire the remaining parcels that continue to be exposed to flood risk but have not been bought out yet. Some of these properties are vacant and some have existing structures.	Acquisition/ Demolition	-
Ocean Boulevard Stormwater Project East End of Mullett and East End Avenue A	Town of Holden Beach	Local	Stormwater improvements along Ocean Boulevard. Projects include new HPPPs, RCPs, swales, pipe upgrades, and tide gate. The action was proposed as part of the 2024 Holden Beach Stormwater Master Plan. Direct federal funding was appropriated for two project areas in the amount of $2,175,000.	Storm Water Management Activities	-
300 Block of Ocean Boulevard Stormwater Project	Town of Holden Beach	Local	Stormwater improvements along Ocean Boulevard. Projects include new HPPPs, RCPs, swales, pipe upgrades, and tide gate. The action was proposed as part of the 2024 Holden Beach Stormwater Master Plan. Direct federal funding was appropriated for two project areas in the amount of $2,175,000.	Storm Water Management Activities	-

Resiliency Action Name	Jurisdictions	Regional, Local, or Building Level?	Action Descriptions	Action Type(s)	BCR
Elevate & Empower: Resilient Infrastructure Project (Elevate Lift Stations and Transformer Pedestals, Generators for Lift Stations)	Town of Ocean Isle Beach	Local	This project supports the Town of Ocean Isle Beach's infrastructure resilience in three key ways: 1) Elevating sewer lift station control panels in flood-prone areas; 2) Elevating transformer pedestals in flood prone areas, and 3) Purchasing 3 portable generators to operate lift stations during emergency situations with power outages. The town frequently experiences flooding at multiple sites where lift station control panels and transformers are affected.	Storm Water Management Activities	-
Regional Dam Program	Lumber River Basin	Regional	• Basin-Wide Prioritized Dam Inspections • Regular Dam Maintenance • Rehabilitate, Repair, Retrofit, and Remove Dams	Multiple	1.05
Building Level Mitigation	Lumber River Basin Residual Risk Areas	Building Level	Residual Risk building level mitigation.	Multiple	-

Additional details on the prioritized vulnerability assessment-based actions with benefit-cost ratios are provided below. Locally prioritized actions that were submitted to the Blueprint Tool do not necessarily have a BCR due to lack of information. However, they have robust evaluation and descriptions, which are included in the Blueprint Tool outputs in **Appendix H**.

The vulnerability assessment-based actions are either proposed or pre-identified actions. Proposed actions are actions that were developed through Step 3 of the Blueprint Process based on the results of the flood risk and vulnerability analysis. These actions are conceptual and would require future feasibility studies to determine effectiveness. Pre-identified actions are actions that have been identified through the research performed in Step 1 of the Blueprint Process. These actions have been previously proposed in existing studies, plans, and programs.

Aerial of inlet between Holden Beach and Oak Island

Town of Fair Bluff Levee Construction

Jurisdiction:	Town of Fair Bluff
Cost:	$10,779,594
Status:	Pre-Identified

The construction of a levee along the Lumber River would prevent severe riverine flooding from inundating the Town of Fair Bluff (**Figure 15**). The levee system would run along the Lumber riverbank, starting at US-76 near Ice Plant Road on the northern end and ending near the intersection of Main Street and Causey Road. Multiple closures in the form of floodgates would be required at the railroad crossing along Main Street and where NC-904 intersects with Main Street. A levee was previously proposed in both the USACE Lumber River Basin Flood Risk Management Study and the NCEM and North Carolina Department of Transportation (NCDOT) Lumber River Basin Flood Analysis and Mitigation Strategies Study. This proposal builds on the NCEM/NCDOT alternative while updating the alignment to incorporate the new flood risk data.

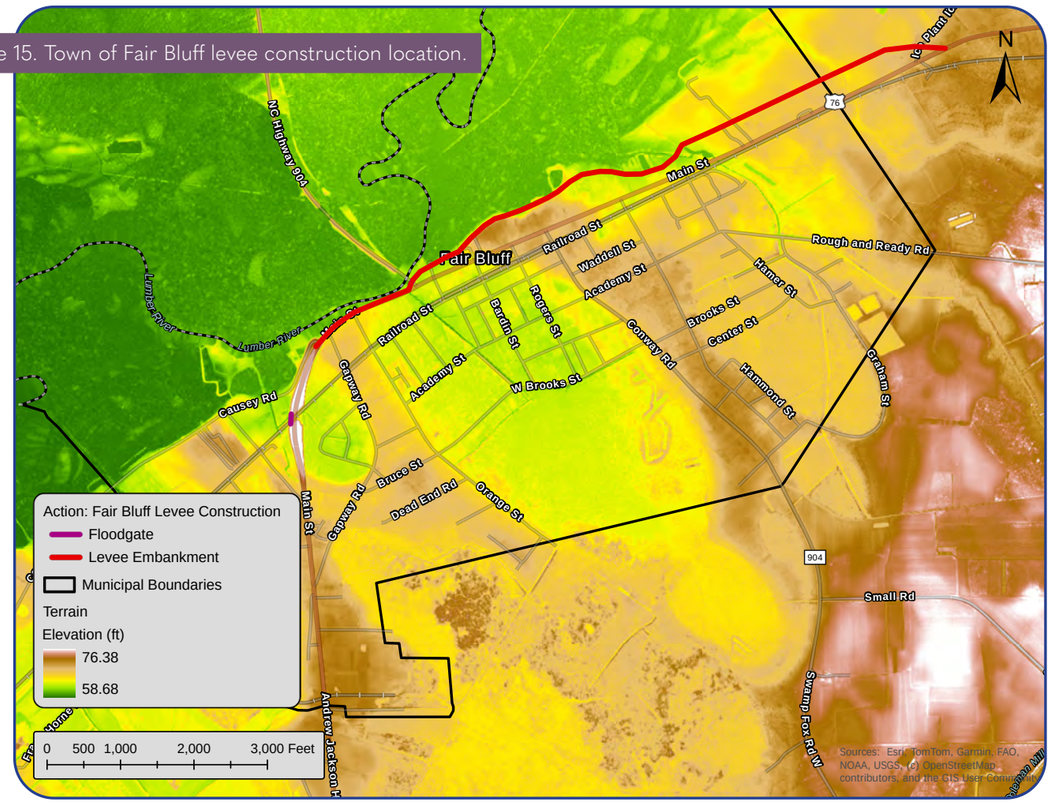


Figure 15. Town of Fair Bluff levee construction location.

City of Lumberton and surrounding areas Regional Action

Jurisdiction:	City of Lumberton and surrounding areas
Cost:	$27,094,427
Status:	Proposed

Lumberton Levee System Inspection, Maintenance, Repair, Upgrades, and Accreditation:

This action involves improvements including raising the height of the levee to protect from future flooding conditions. The functioning of the Lumberton Levee system is key to protecting the southwestern part of the City of Lumberton. This action proposes that the levee should have ongoing support for inspections, maintenance, repairs, and accreditation to ensure that the levee system operates at a high level (**Figure 16**). Regular and routine maintenance should be done on these systems to extend the life cycle. Additionally, attention should be paid particularly after severe flood-loading events to ensure potential overtopping or breaching or any structural deficiencies are identified and addressed early. This could include standard repairs, upgrades, and adaptations to the system to provide protection from future flooding conditions. Finally, as proposed in the 2018 Lumberton Recovery Plan, future levee improvements should ensure that the system meets FEMA requirements for accreditation under the NFIP (Hurricane Matthew Disaster Recovery and Resilience Initiative, 2018). This would verify that the entire system has at least 3 feet of freeboard above the 100-year flood and plans for operations and maintenance (O&M), emergency action, and interior drainage. Accreditation has the added benefit of reducing the flood insurance cost burden on the community within the protected area.

Permanent Pump Station:

The ongoing Lumberton Flood Gate Project (as of May 2026) will protect residents from riverine flooding from the Lumber River. However, this structure limits the flow of water out from behind the floodgate. The construction of a permanent pump station within the protected area on the south side of I-95 near Hester Drive would create the ability convey flow across the levee during a rainfall event while the floodgate is closed (**Figure 17**). A feasibility study has identified specific pump locations.

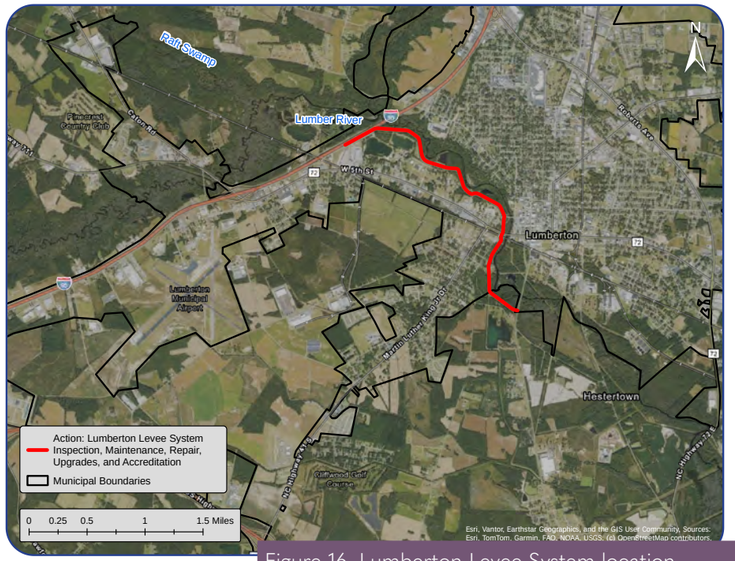


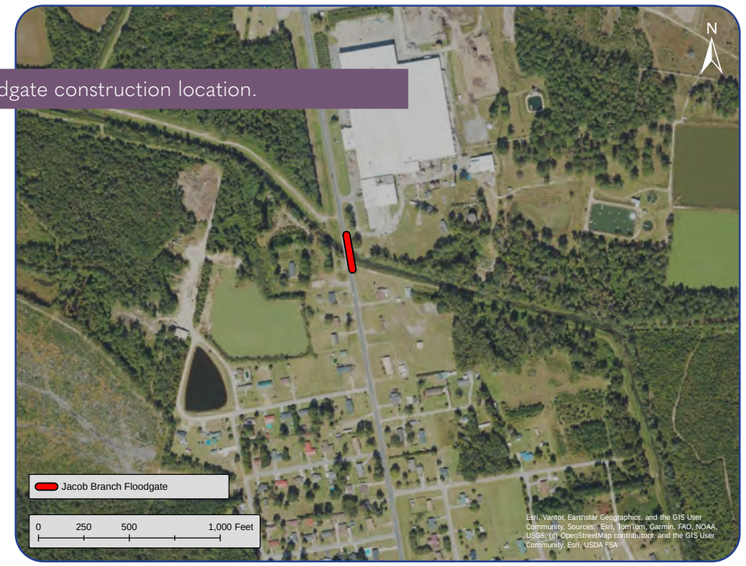
Figure 16. Lumberton Levee System location.

Floodgate Construction on Jacob Branch:

The ongoing flood gate project was designed to mitigate riverine flooding from entering the city through a railway bridge opening on the west side of the city. Through future flood risk analysis, it was determined that flooding from the Lumber River will also impact the area by backing up Jacob Branch through the crossing at Alamac Road on the southeast side of Lumberton (**Figure 18**). This location can benefit from the implementation of a similar flood gate to what is being constructed on the west side of Lumberton to protect the residents from flooding.

Figure 17. Lumberton permanent pump station locations.

Figure 18. Jacob Branch floodgate construction location.



City of Whiteville and surrounding areas Regional Action

Jurisdiction:	City of Lumberton and surrounding areas
Cost:	$27,094,427
Status:	Proposed

De-Pave Program:

Proposed through the Whiteville Community Floodprint, the De-Pave Program creates green stormwater infrastructure where there are underutilized impervious areas of downtown Whiteville such as sidewalks or parking lots (**Figure 19**). Examples of the green infrastructure include planting strips, bulb outs along streets, or floating islands in existing parking lots (Coastal Dynamics Design Lab, 2023). Creating these areas of green infrastructure can allow for increased stormwater absorption and less runoff, further protecting the residents and businesses from current and future flood damage.

Mollie's Branch Stream Restoration:

Proposed through the Whiteville Community Floodprint and city communications, Mollie's Branch Stream Restoration is a nature-based stream restoration project that strives to return the waterway back to its natural state between the confluence with Soules Swamp to US-74 BUS (**Figure 20**). The channel had been straightened to allow for development in the area surrounding it. In addition, the area easily gets blocked with debris during a storm event. The current conditions modeling shows some at-risk buildings due to riverine and rainfall-driven flooding along Mollie's Branch, with risk increasing for the future conditions. Planned implementation was delayed due to developments related to FEMA's Building Resilient Infrastructure and Communities (BRIC) grant, the primary source of funding for this project (Coastal Dynamics Design Lab, 2023). Continuing with this project would protect the residences and development around Mollie's Branch.

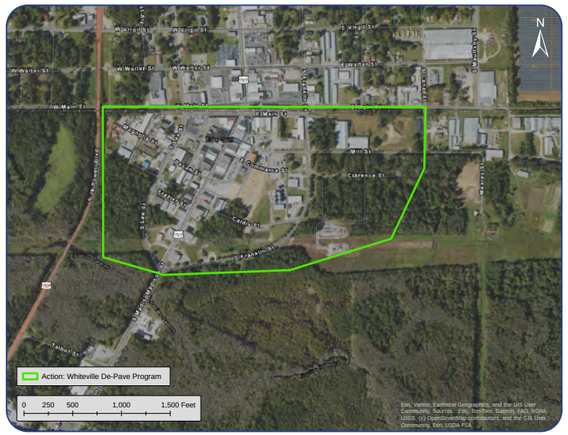


Figure 19. De-Pave Program location.

Figure 20. Mollie's Branch stream restoration location.

Regional Dam Program

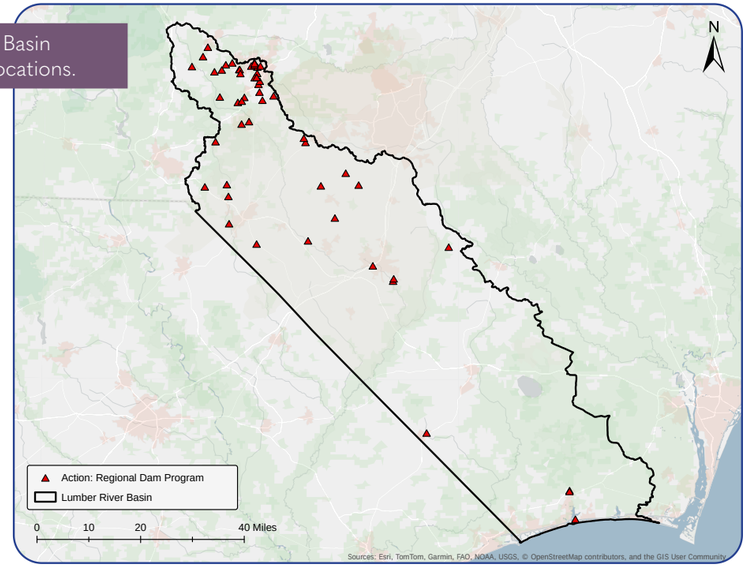
Jurisdiction:	Lumber River Basin High Risk Dams
Cost:	$127,111,895
Status:	Proposed

The dam risk and vulnerability analysis highlights the importance of continued investment in the North Carolina Dam Safety Program since dam failure is a key source of flooding within the basin. The Blueprint would work in close coordination with the Dam Safety Program on any dam or levee action. The following are three actions to address vulnerability to dam breach flooding in the basin. Each of the three components could be implemented individually or jointly, as deemed necessary. **Figure 21** shows the locations of high risk dams that would be prioritized under this program.

Basin-wide Prioritized Dam Inspections:

Identified dams within the basin that have a high risk level should be prioritized for additional inspections to monitor for declining conditions. Dams which are high risk and also have poor or unsatisfactory conditions or are more than 50 years old may be at an elevated risk for failure and should have the highest priority to ensure that corrective actions can be taken as soon as possible. This would allow for quicker interventions on dams deemed to be no longer safe. Inspections and reviews are needed for dams where information is missing or outdated to ensure the identification of high risk dams is accurate. This includes the 12 high risk dams within the Lumber without a recorded condition. Additionally, 14 of the identified high risk dams are classified by DEQ as either low or intermediate hazard dams. These dams should be reviewed to confirm or update the hazard classification. Without this knowledge there could be other areas and populations with increased risk not currently identified. These inspections would assist in determining if there are additional vulnerable areas that need to be addressed.

Figure 21. Lumber River Basin regional dam program locations.



Basin-wide Regular Dam Maintenance:

Another component is conducting regular dam maintenance and minor repairs, which addresses vulnerability by consistently taking small measures to keep dams in good condition. Maintenance activities, as defined by DEQ, include but are not limited to mowing, control of small trees, debris removal, and replacement of gates and riprap. This is necessary for all dams to prevent common issues like embankment stability, erosion, seepage, and cracks that can increase failure risk if unaddressed. While many dam owners may have and follow an O&M plan, dams without these practices are more likely to fall into poor condition and require larger scale action to protect downstream communities.

Basin-wide Rehabilitate, Repair, Retrofit, Remove Dams:

Finally, modification (repair, retrofit, and rehabilitations) or removal should be completed for dams that have been identified to need such repair or removal based on findings from the regular inspections. The longer these dams go without improvements or removal, the greater the continued chances of failure. The specific action will depend on the deficiency identified at a particular dam and may range from patching a structural issue, to increasing the spillway or outfall capacity, to increasing the dam height. Removal could be utilized in cases where there are benefits to restoring natural hydrologic processes.

Bridge in Aberdeen Lake Park, NC

Building Level Mitigation

Jurisdiction:	Residual Risk areas of the Lumber River Basin
Cost:	$17,329,544
Status:	Proposed

Residual Risk Building Level Mitigation:

At-risk buildings outside the areas of impact of the regional mitigation actions were analyzed to determine the cost effectiveness of implementing building level mitigation techniques to combat against riverine and rainfall-driven flooding. The NCEM building BCA methods were used to calculate the building level mitigation technique with the highest BCR between acquisition, relocation, elevation, dry floodproofing, and wet floodproofing. The residual risk buildings with mitigation options with a BCR of at least 1.0 are shown in **Figure 22**.

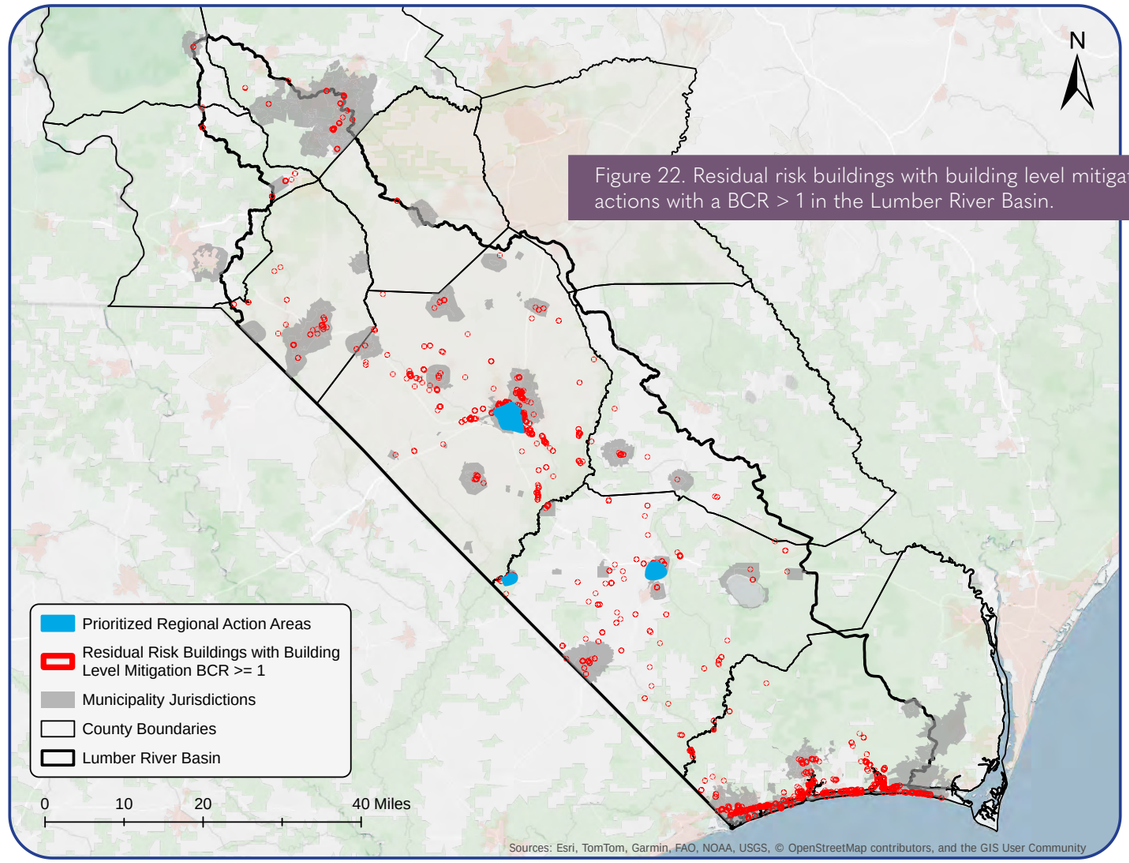
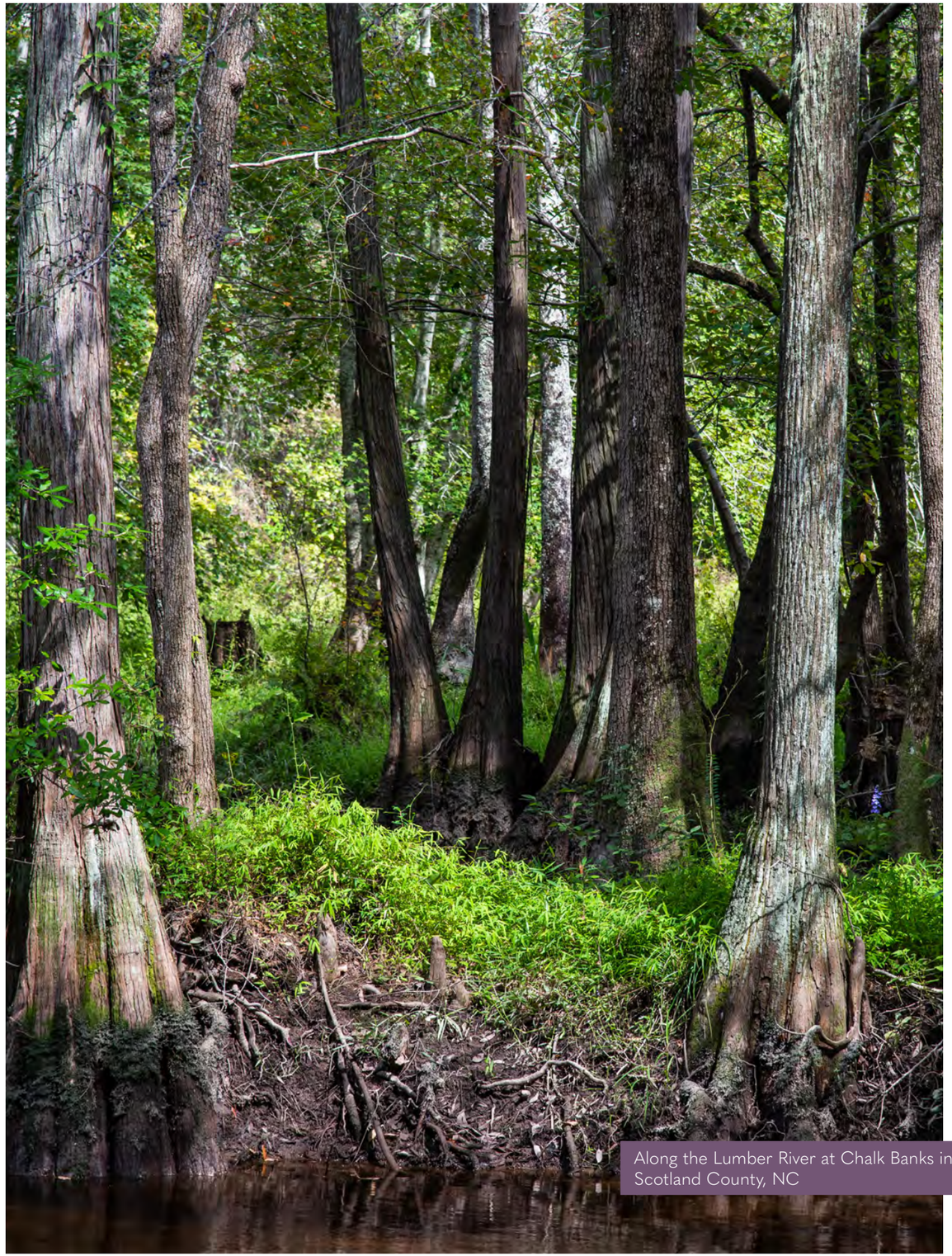


Figure 22. Residual risk buildings with building level mitigation actions with a BCR > 1 in the Lumber River Basin.



Along the Lumber River at Chalk Banks in Scotland County, NC

REVIEW OF FUNDING SOURCES

North Carolina communities face growing challenges from flooding, aging infrastructure, rapid development, and climate driven extreme weather. To address these risks, a wide ecosystem of federal, state, regional, and private funding sources exists—but navigating this landscape is complex. **Appendix G** 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 **Appendix G**, highlighting the 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 aligning resilience needs with the strongest opportunities.

Federal Funding Programs

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)**
  Available after major disasters and supports a wide range of projects such as buyouts, structural mitigation, and infrastructure retrofits.

HUD Community Development Block Grants

HUD administers CDBG Disaster Recovery (CDBG DR) and CDBG Mitigation (CDBG MIT) programs following major disasters. These funds support:

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

USDA Programs

The U.S. Department of Agriculture supports agriculture focused and rural community water infrastructure:

- NRCS Watershed and Flood Prevention Operations (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)
- Water Infrastructure and Innovation Act (WIFIA) Loans for large scale water infrastructure

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

Department of Transportation (DOT) Resilience Programs

DOT's resilience programs—including Promoting Resilient Operations for Transformative, Efficient, and Cost-saving Transportation Program (PROTECT), Rebuilding American Infrastructure with Sustainability and Equity (RAISE), and other discretionary grants—support projects that improve resilience of transportation systems, culverts, roadways, and multimodal networks.

National Oceanic and Atomospheric 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.

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.

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

NC 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)

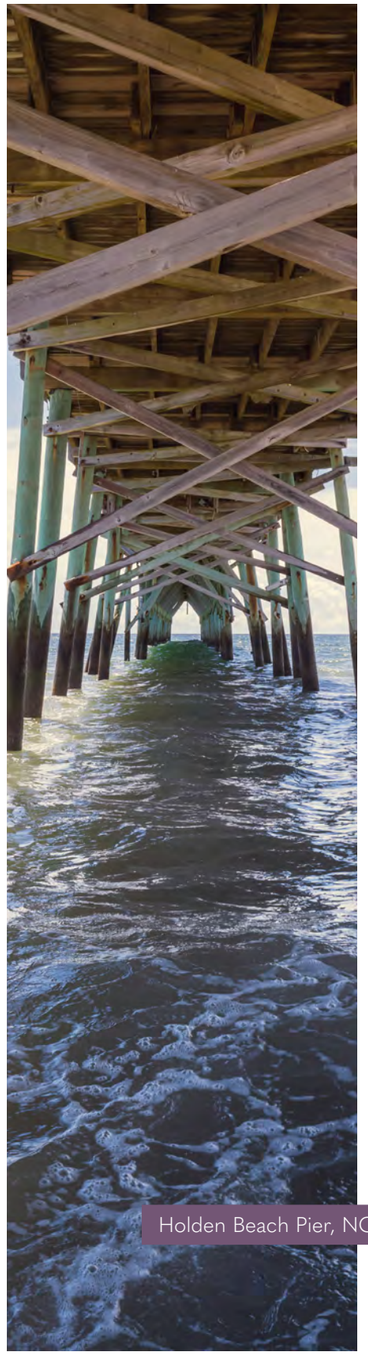
North Carolina administers CWSRF and DWSRF with added benefits for disadvantaged communities. Funds include loan forgiveness, match assistance, and priority scoring for resilience and green infrastructure.

Coastal and Environmental Programs

For coastal communities, the state offers:

- Coastal Storm Damage Mitigation Fund
- Resilient Coastal Communities Program (RCCP)
- Coastal Area Management Act (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.



Holden Beach Pier, NC

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:

- Develop basin specific strategies for major river systems
- Identify priority flood mitigation projects
- Guide implementation of high value, multi-benefit projects
- Support interagency coordination and unified resilience planning

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.

Fishing Pier at Holden Beach, North Carolina

Legislative Appropriations from the NC General Assembly

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

- Biennial state budgets
- Supplemental appropriations bills
- Local, regional, or project specific earmarks

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. 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 Programs

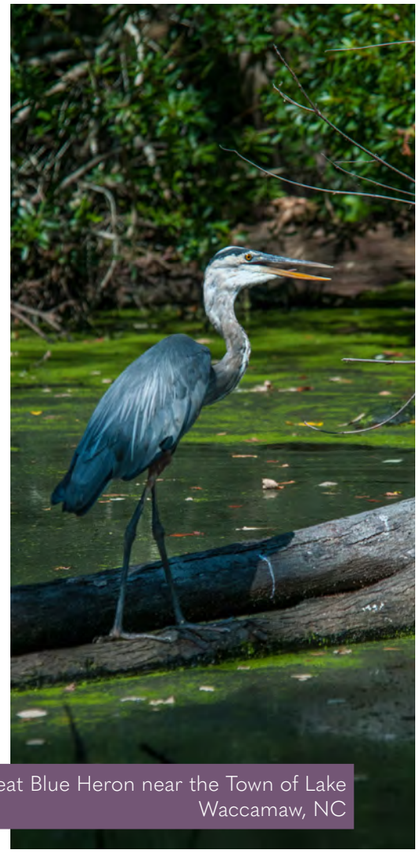
Local governments, regional planning organizations, and nonprofit partners provide essential complementary resources that can fill match requirements, support early-stage planning, or implement smaller scale resilience solutions.

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 capital improvement plans (CIPs)**



Great Blue Heron near the Town of Lake Waccamaw, NC

Regional Transportation Planning Funds

Metropolitan Planning Organizations (MPOs) and Rural Planning Organizations (RPOs) can incorporate resilience components into transportation improvement programs, often unlocking federal dollars for culverts, bridges, greenways, and road related stormwater improvements.

Nongovernmental Organizations (NGOs) and Philanthropy

Nonprofit 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.

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

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.

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 **Appendix G** 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.

Funding Sources for RBAS Process Prioritized Actions

As a final step in developing the RBAS, federal, state, regional, and local funding programs were evaluated for possible fit with the identified Blueprint projects so that these projects can move toward implementation. Information about these programs were gathered in an organized manner and is available in **Appendix G**.

Many of the regional priority projects identified for their impact in mitigating risk were large projects with substantial cost estimates that would need success in large federal grant programs to complete the work. In many instances, the non-federal cost share that would be required of the community was prohibitively high for the small communities in which the action is proposed. To address this need, when the community is under-resourced and the project is large, the strategy also considers sources of cost-match from non-federal sources. For some actions, partnerships with state or federal agencies would likely aid in the success of the project, and these partnerships are identified.

Several factors were considered in making funding program matches, including routing projects to a variety of programs so that basin projects were not in competition for the same funding resources. Other factors included the purpose of the program, award size, previously funded projects, and eligibility. Two funding subject matter experts developed independent funding strategies for the priority basin actions, then met to discuss results to determine the best fit for each project component, the needs for cost-match assistance and the necessary partnerships to implement each project. An overview is available in **Table 3** and discussed below.

Table 3. Priority Project Funding Programs

Project Name	Program Match	Cost Matching Source	Partnerships
Stormwater/Flooding Improvements	North Carolina Land and Water: Restoration Program	-	-
City of Lumberton and surrounding areas: Lumberton Levee System Inspection, Maintenance, Repair, Upgrades and Accreditation	Community Projects Funding	Stormwater Utility Fees	NCEM Floodplain Mapping Program, Charleston USACE
City of Lumberton and surrounding areas: Permanent Pump Station	FEMA Building Resilient Infrastructure and Communities	Stormwater Utility Fees	-
City of Lumberton and surrounding areas: Floodgate Construction on Jacobs Branch	FEMA Pre-Disaster Mitigation	-	-
Pump Station Relocation	FEMA Building Resilient Infrastructure and Communities	Golden LEAF	-

Project Name	Program Match	Cost Matching Source	Partnerships
Town of Fair Bluff Levee Construction	FEMA Flood Mitigation Assistance	Blueprint or Appropriations, NC Community Foundation	NCEM Floodplain Mapping Program, Charleston USACE
Stream/Floodplain Restoration and Flood Storage Wetlands	North Carolina Land and Water: Restoration Program	-	-
Outlet Rehabilitation	Community Development Block Grant: Infrastructure	-	-
City of Whiteville and surrounding areas: De-Pave Program	North Carolina Water Resource Development Grant Program: State and Local Projects	-	-
City of Whiteville and surrounding areas: Mollie's Branch Stream Restoration	USDA Watershed and Flood Preven-tion Operations Program	EPA Clean Water State Re-volving Fund, NRCS-EQIP Water Resources Development Grant: Stream Restoration Projects	-
Bob White Lane Stormwater Improvements	FEMA Flood Mitigation Assistance	-	NCEM
College Street Stormwater Improvements	EPA Sewer Overflow & Stormwater Reuse Municipal Grants Program	-	-
Baldwin Circle Acquisition	North Carolina Land and Water: Land Acquisition Program	-	-
Stormwater System Improvements for Flood Mitigation	North Carolina Water Resources Development Grant: Flood Resiliency Grants	-	-
Mollies Branch Acquisition Program	FEMA Flood Mitigation Assistance	-	NCEM

Project Name	Program Match	Cost Matching Source	Partnerships
Ocean Boulevard Stormwater Project East End of Mullett and East End Avenue A	National Coastal Resilience Fund	-	-
300 Block of Ocean Boulevard Stormwater Project	EPA Sewer Overflow & Stormwater Reuse Municipal Grants Program	North Carolina Water Resource Development Grant Program: State and Local Projects	-
Elevate & Empower: Resilient Infrastructure Project	FEMA Building Resilient Infrastructure and Communities	-	-
Lumber Basin Regional Dam Program: Basin-wide Prioritized Dam Inspections	National Dam Safety Program	Direct Legislative Spending	North Carolina Dam Safety Program
Lumber Basin Regional Dam Program: Regular Dam Maintenance	FEMA High Hazard Potential Dam Program	Rural Infrastructure Program	North Carolina Dam Safety Program
Lumber Basin Regional Dam Program: Rehabilitate, Repair, Retrofit Dams	FEMA BRIC, FEMA Public Assistance Mitigation	National Rural Water Association Revolving Loan Fund	-
Building Level Mitigation	FEMA Flood Mitigation Assistance	-	-

Lumber River at Chalk Banks in Scotland County, NC

Stormwater/Flooding Improvements:

For a project that includes culvert improvements, channel regrading, and other restoration and conveyance improvement activities, the North Carolina Land and Water Fund Restoration Program may be a good fit as it targets projects that improve water quality and support the natural functions of existing tributaries in the area.

City of Lumberton and surrounding area: Lumberton Levee System Inspection, Maintenance, Repair, Upgrades, and Accreditation:

This is a high-cost project that protects more than 400 likely-NFIP properties and several critical facilities and infrastructure assets. The high cost of the project limits certain program fits, as many place price caps. This levee system has already received funding from the EDA and NCDOT which complicates the match. The best funding match for levee upgrades was determined to be Community Projects Funding, which is a federal direct spending program on a wide range of projects that are linked to existing federal programs. This project can support a nexus to existing FEMA programs to qualify for this program. To access this program, Lumberton should reach out to its elected federal representative in the project area who can place the project for funding consideration with Congress.

As this project has also been deemed not in the economic interest of the USACE, it is unlikely to find funding through this additional route. While FEMA programs such as FMA, BRIC, Pre-Disaster Mitigation (PDM), and HMGP may find that this project would qualify, award caps make them funding alternatives for this project.

City of Lumberton and surrounding areas: Permanent Pump Station:

Adding a suitably sized pump to the Lumberton Levee system would protect transportation, wastewater, potable water, and other assets from stormwater flooding by pumping it over the protective levee and into the Lumber River. Given the density of infrastructure protected, FEMA's Building Resilient Infrastructure and

Communities (BRIC) program is deemed to be the best fit for this project. The pump fits well below the $20 million cap for the program and depending on the pump size needed, this project may be eligible for state funding. Similar pumps have been funded through this program.

Other FEMA programs such as HMGP, PDM, and FMA may also be alternative programs to construct the pumping system. The USDA Watershed and Flood Prevention Operations Program is another alternative. Lumberton has an existing Stormwater Utility fee that could be used for cost-match. BRIC and other FEMA programs require that the project be identified in an adopted and approved Hazard Mitigation Plan. If the project is not identified in the existing plan, it should be added in the next update.

City of Lumberton and surrounding areas: Floodgate Construction on Jacobs Branch:

The floodgate is designed to protect several properties and roadways from flooding. The best program fit for this project is the FEMA Pre-Disaster Mitigation program which is accessed through elected representatives at the project location. This program was selected because it appears likely to pass a FEMA BCA. FMA requires that the project be identified in an adopted and approved Hazard Mitigation Plan. If the project is not identified in the existing plan, it should be added in the next update.

The project was not deemed to need a source of match funding. Alternative programs identified for this project are FEMA's FMA program, the DOT's Better Utilizing Investments to Leverage Development (BUILD), and Promoting Resilient Operations for Transformative, Efficient, and Cost-saving Transportation (PROTECT) programs that are designed to invest in improvements that protect transportation assets.

Pump Station Relocation:

The protection of critical infrastructure from natural hazards is the focus of the FEMA Building Resilient Infrastructure and Communities program and thus would be highly competitive in the discretionary program. Golden LEAF has previously invested in the restoration of these facilities and may be interested in supporting their investment with cost-match assistance.

Town of Fair Bluff Levee Construction:

The levee construction project is in a community of fewer than 1,000 residents and was first proposed in a U.S. Army Corps of Engineers Charleston District, where they determined that the levee project would not pass the BCA methodology used by the USACE. It was therefore dropped from consideration for USACE funding. This eliminated traditional levee programs from the USACE. However, when considering the loss of life and property as the primary drivers of benefits, this project scores well. It protects a number of likely NFIP-insured properties which makes the project a good fit for FEMA's Flood Mitigation Assistance (FMA) Program, which has a purpose of reducing claims on NFIP-insured properties.

Since the community is small, it will likely need cost-match assistance to access this federal program. However, if the properties protected have had numerous claims, there is the possibility of reducing cost-match requirements down to nothing. Assuming that there is a need for cost match, there are limited programs for accessing levee funding among non-federal programs. Blueprint, legislative appropriations, and/or the North Carolina Community Foundation are possible sources for match funding.

Since the USACE Charleston District has scoped the project, outreach to the agency for partnership is

recommended. The NCEM Floodplain Mapping Program would also serve as a partner that would assist the community and/or alternative grant application development team to identify the legislative obstacles and processes to getting the levee accredited.

Given the size of the community, Fair Bluff may consider reaching out to the county government or local COG to assist in application development. The North Carolina Water Resources Development Grant: Flood Resiliency Grants is identified as an alternative funding program match for this project. This program was deemed the alternative rather than the best match due to its relatively high 67%/33% cost share and a lack of levee projects funded by the program. FMA requires that the project be identified in an adopted and approved Hazard Mitigation Plan. If the project is not identified in the existing plan, it should be added in the next update.

Similarly to Lumberton, partnerships with the NCEM Floodplain Mapping Program and the USACE Charleston District should be consulted for guidance in developing the scope, budget, and timeline to ensure appropriate time and steps are taken to accredit the levee.

Stream/Floodplain Restoration and Flood Storage Wetlands:

With a complex set of actions in the channel and floodplain, flexible programs such as the North Carolina Land and Water Fund Restoration Program or the state or the federal NRCS-EQIP Water Resources Development Grant: Stream Restoration Projects program would be suitable. Based on the scope, a combination of the two programs can be used as well.

Aerial view of Lumberton, NC

Outlet Rehabilitation:

Outlet upgrades and repairs can be difficult to quantify direct flood benefits for and thus, this project likely needs a non-FEMA program for funding. The Community Development Block Grant-Infrastructure program places prioritization for projects with the community. Other options may be low-interest infrastructure loan programs such as the EPA Water Infrastructure and Innovation Act Program.

City of Whiteville and Surrounding Areas: De-Pave Program:

With benefits for stormwater flooding and water quality and a more affordable cost estimate, there are more alternatives for funding. The project also already has several partners on board. The funding match identified for this program is the North Carolina Water Resource Development Grant Program: State and Local Projects. This state-level program identifies green infrastructure as an eligible activity.

It is a relatively low-cost project, so cost-match assistance was not considered, however, alternative programs may be considered if there is a need. Alternative programs include the Five Star Urban Waters Restoration Grant Program, which could include community implementation activities and is named for its need for five partners.

Additionally, the North Carolina Land and Water Fund: Innovative Stormwater Program, which awards innovative projects in the state would likely find the project competitive.

City of Whiteville and Surrounding Areas: Mollies Branch Stream Restoration:

This project entails the restoration of a stream to a more natural flow adjacent to a wetland, creating water quality benefits along with flood mitigation. It includes culvert upgrades to better pass the restored stream. The project was previously funded through FEMA's BRIC program in the program year that was canceled. Due to recent court rulings, there is the possibility of restoring funding through BRIC to the project, and the project team should reach out to NCEM to pursue this possibility. The best fit for the project is the USDA's Watershed Protection and Flood Prevention Operations Program. Its purpose is to protect and restore watersheds for flood prevention or other purposes. It is accessed through local Natural Resources and Conservation Service offices.

Federal program alternatives include pursuing the culverts through the USDOT PROTECT program and seeking stream restoration funding through the North Carolina Water Resources Development Grant Program: Flood Resiliency. PROTECT focuses on coastal surface transportation assets, and the Flood Resiliency program focuses on nature-based mitigation alternatives in the Lumber River basin among a select few others.

The project was deemed likely to need cost-match assistance. Two programs were identified for this purpose: The EPA Clean Water State Revolving Fund, which provides low- or no-interest loans for projects that support clean water; and the NRCS-EQIP Water Resources Development Grant: Stream Restoration Projects, which provides cost-share support for stream restoration projects.

Bob White Lane Stormwater Improvements:

This is a planning study to better understand what can be done to alleviate stormwater flooding issues in a historically disadvantaged neighborhood. FEMA Flood Mitigation Assistance funds planning studies for flooding in areas where there are NFIP participating structures. Whiteville can reach out to NCEM to determine if they are eligible for this funding.

College Street Stormwater Improvements:

This nearly shovel-ready project will upgrade stormwater infrastructure, which may make it competitive for the EPA Sewer Overflow & Stormwater Reuse Municipal Grants Program.

Baldwin Circle Acquisition:

This project proposes the acquisition of five flood-prone properties, which can be funded through both state and federal programs. The North Carolina Land and Water Fund Land Acquisition Program is a state program that can provide resources for acquisition. At the federal programmatic level, if the properties have NFIP policies and have made significant or multiple claims, FEMA Flood Mitigation Assistance may provide reduced cost-match or no cost-match options for properties meeting claim thresholds.

Stormwater System Improvements for Flood Mitigation:

This project was developed with the results of a state-funded planning project. Keeping the funding source within the state would help to effectively communicate about needs and the development process, so the North Carolina Water Resources Development Grants may be a good source for funding. The program includes stormwater infrastructure as eligible projects and is limited to a few North Carolina basins.

Mollies Branch Acquisition Program:

The FEMA Flood Mitigation Assistance program allows for funding for both the creation of an acquisition program and for providing funds for acquisition. For properties that have had significant or multiple claims to the NFIP, there may be reduced or waived cost-match requirements. NCEM can help identify the eligibility of reduced cost-match for each property.

Ocean Boulevard Stormwater Project East End of Mullett and East End of Avenue A:

This project includes a number of elements, including gray and green infrastructure improvements, and has received federal funding to date. To complete this project, the coastal community of Holden Beach may reach out to the National Coastal Resilience Fund, which is focused is coastal resilience.

300 Block of Ocean Boulevard Stormwater Project:

This project has already received some federal funding to make improvements identified in the stormwater master plan, so any federal funding would likely also need a non-federal match source. This is a relatively large project with several individual actions. The EPA Sewer Overflow & Stormwater Reuse Municipal Grants Program is a federal program that helps upgrade stormwater systems. The North Carolina Water Resource Development Grant Program: State and Local Projects provides nonfederal match for stormwater projects.

Aerial view of waterway at Oak Island, NC

Elevate & Empower: Resilient Infrastructure Project:

This is an infrastructure-focused project that seeks to elevate flood-prone infrastructure and provide secondary power sources for other infrastructure elements. This infrastructure focus makes it an ideal candidate for the FEMA Building Resilient Infrastructure and Communities program, which addresses the risk of natural hazards to infrastructure.

Lumber Basin Regional Dam Program: Basin-wide Prioritized Dam Inspections:

Dam inspections are part of the state's Dam Safety Program responsibilities, making the state the best applicant for this project. The best funding source for increased and emergency inspections would be the National Dam Safety Program, for which increased inspections are an eligible activity. The state program should contact the national program about funding options. Legislative appropriations would be the best source of cost-match or alternative funding source for this project.

Lumber Basin Regional Dam Program: Regular Dam Maintenance:

Identification of dam deficiencies is a likely outcome from success in increased inspections. Each deficient dam is likely to become its own project best directed to the FEMA High Hazard Dam Program, which is designed to address dam deficiencies likely to lead to a loss of life or property in the event of failure. Alternatives include other less-specific FEMA programs such as BRIC, where the target is to protect infrastructure, FMA where the target is to protect NFIP properties, HMGP, and PDM. Where maintenance of dams has the possibility of creating jobs, the Rural Infrastructure Program can provide an alternative. FEMA programs require that the project be identified in an adopted and approved Hazard Mitigation Plan. If the project is not identified in the existing plan, it should be added in the next update.

The State Dam Safety Program should be contacted as a partner for this program, as they are the organization responsible for identifying qualified dams and interfacing with FEMA on this program.

Lumber Basin Regional Dam Program: Rehabilitate, Repair, Retrofit, Remove:

This action could result from the success of the inspection program and could likely become multiple stand-alone projects as deficiencies are identified. Funds for dams can be restrictive, and difficult to access. All of the above-mentioned FEMA Programs: BRIC, FMA, HMGP, PDM, HHPD and Public Assistance Mitigation should be considered for the resulting projects. There are other alternatives as well, including the National Rural Water Association Revolving Loan Fund (which helps protect water utilities), the Fish & Wildlife Service's National Fish Passage Program (if the project can benefit fisheries), and an EPA Water Infrastructure and Innovation Act (WIFIA) loan may be a viable alternative for cost-match assistance. FEMA programs require that the project be identified in an adopted and approved Hazard Mitigation Plan. If the project is not identified in the existing plan, it should be added in the next update.

Building Level Mitigation:

The FEMA Flood Mitigation Assistance program allows for the creation of acquisition and building mitigation programs to be developed. Working together or creating individual county programs could create a pipeline of projects for additional FEMA programs. Structures with multiple claims may be eligible for reduced or no cost-share for building mitigation projects.

ACTION STRATEGY TAKEAWAYS

The Lumber 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 assessments identified several areas of particular concern, including Lumberton, Fair Bluff, Whiteville, and coastal communities, where future modeling indicates expanded flood exposure and increased damages, especially in low-lying areas. 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.

The Lumber RBAS identified 328 resilience actions across the basin, including 17 priority actions selected for focused implementation. These priority actions are distributed throughout the watershed, ranging from stormwater improvements in the Town of Pembroke to enhancements to coastal infrastructure in the Town of Ocean Isle Beach along the coast. The prioritized actions reflect the diverse flood risks, vulnerabilities, and local implementation conditions present across the Lumber River Basin. While some projects are designed to reduce flood damages in more developed and densely populated areas, others focus on protecting critical infrastructure and maintaining access to essential services. Additional actions support long-term adaptation strategies in communities where flooding is extensive, recurring, or expected to persist over time.

Successful implementation of the RBAS will require ongoing collaboration among federal, state, regional, tribal, and local partners. The strategy outlines a variety of potential funding opportunities, including federal hazard mitigation and watershed programs, state grant initiatives, and local financing mechanisms. Given the scope and complexity of many of the recommended projects, successful implementation will depend on coordinating multiple funding sources, cultivating strategic partnerships with agencies such as FEMA, the U.S. Army Corps of Engineers, and state agencies, and helping communities meet local matching fund requirements.

Strengthening local capacity will be essential to ensuring that all communities, particularly those with limited staff and financial resources, can meaningfully participate in and benefit from the Blueprint process. DEQ River Basin Leads, Councils of Governments, and other regional partners can play a critical role in providing technical assistance, fostering collaboration, and helping bridge capacity gaps.

Through coordinated implementation, the Lumber River Basin Action Strategy serves as a long-term framework for reducing flood risk, enhancing community resilience, and supporting sustainable growth throughout the basin. Continued investment, partnership, and institutional support will be necessary to maintain momentum and advance the Blueprint's vision of a more resilient future for the people, communities, and natural resources of the Lumber River Basin.

City of Lumberton's earthen levee system

Current Limitations

The analysis, results, and recommendations in this report are subject to the following limitations:

1. Utilizing existing BLE data as the main source of riverine and rainfall-driven flooding data provides a strong baseline for riverine and rainfall-driven flood extents within the Lumber River Basin. However, the BLE modeling does not incorporate detailed terrain or detailed survey data in the analysis, which can provide refined results. Creating updated hydraulic modeling for the highly vulnerable areas can provide more detailed and accurate data to develop more specific mitigation options per area.

2. The updated BLE modeling data does account for sea level rise (SLR), which gives further insight into coastal flooding, which can be used for mitigation action selection. However, there are many other dynamics involved with coastal modeling including storm surge, wave run-up, overtopping, propagation, storm-induced erosion, and tides, all of which can change the coastal landscape. Currently there are datasets available for only storm surge and overland wave modeling, however these were as early as 2012. Using these potentially out of date datasets can limit the level of actions selected and the potential success of these actions, so updated coastal modeling data is needed for all coastal dynamics.

3. Riverine and rainfall-driven flood risk was only conducted on a building-level. The data used was developed in recent modeling efforts and provided building-level damage across the basin. However, there are many other components with associated risk including transportation infrastructure damage and limited access to critical infrastructure. Data on these systems across the basin could provide refined high risk and vulnerable areas and more detailed actions.

4. There was a lack of dam breach modeling through State Emergency Response Application (SERA) or any other data source for most of the dams within the Lumber River Basin. 156 of the 186 total dams do not have existing breach modeling.

5. The NC Dam Inventory had information missing on the status of some dams about hazard level and structure condition or may not be up to date. It was observed in the data from the NC Dam Inventory that the listed inspection dates for certain dams went back to 1970, with some not having an inspection date listed. Over the period since that listed inspection, the condition and hazard class could have potentially changed based on downstream updates as well as natural degradation. However, without this information accurate risk categorization could not occur.

6. Simplifying assumptions were made for the urban and stormwater, and coastal flooding sources, and compound flooding due to lack of data.

7. Capacity challenges can prevent some local communities from developing local action plans and locally prioritized actions. Further engagement and capacity building are needed to meaningfully prioritize local actions and ensure all are able to participate.

NEXT STEPS & IMPLEMENTATION

DEQ Program and Project Accountability

Through the development of the River Basin Action Strategies, local governments, Councils of Governments, and other partners have used the Blueprint Tool and staff support to develop local resilience plans. River Basin Advisory Groups 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 (later reduced to $76 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 NCEM, the North Carolina Land and Water Fund (NCLWF), the North Carolina Department of Agriculture and Consumer Services (NCDA&CS), the Division of Water Resources (DWR), and the North Carolina Department of Transportation (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. 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.

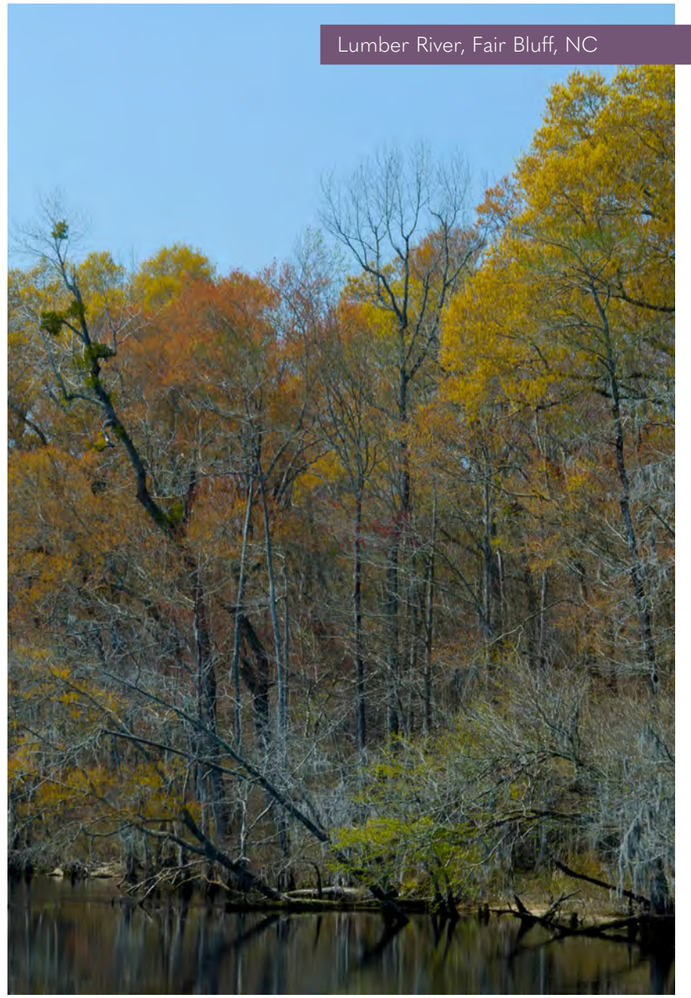
Overall, DEQ is committed to making the state more flood resilient by providing local governments, state agencies, and other partners with the data, tools, and support needed to guide investments that reduce the cost and disruption of future flooding.

Ocean Isle and Shallotte Inlet

Blueprint Tool Next Steps

The Blueprint Tool is available statewide, but its 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.

Blueprint staff and COG partners will continue working with local governments in the initial six basins to identify, evaluate, and prioritize resilience actions using the Blueprint Tool. Developing local action plans through the tool helps communities focus resources on key flood resilience investments and identify and access funding opportunities. This approach will enable local entities and basins to continue applying the Blueprint Process beyond the initial RBAS effort.



Lumber River, Fair Bluff, NC

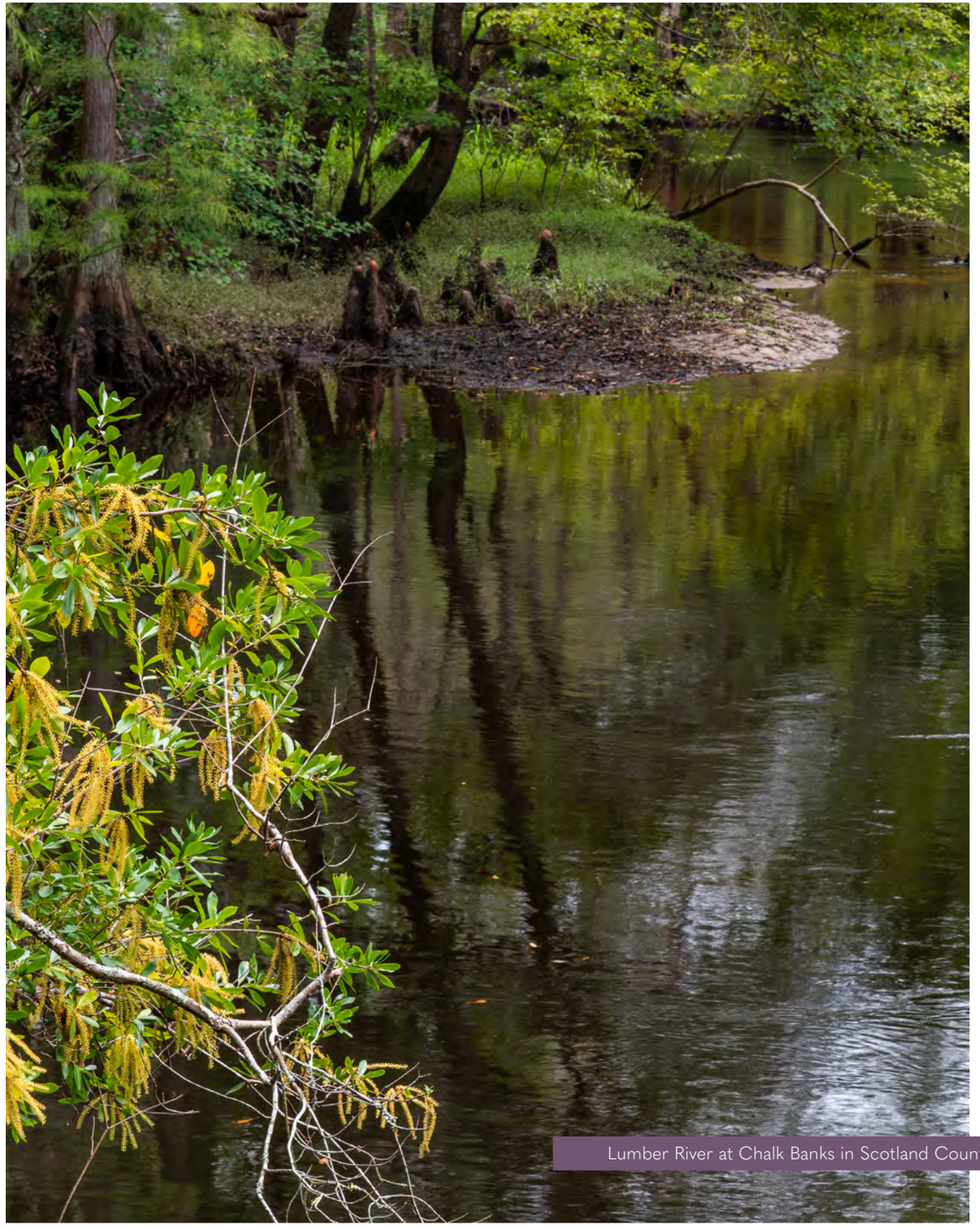
ACKNOWLEDGEMENTS

RBAG MEMBERS

Ashlei Shaw-McFadden
Beshad Norowzi
Bill Tingle
Brandon Love
Brianna Goodwin
Danielle Darkangelo
Darren Currie
Dave McGirt
David Richardson
Guenevere Abernathy
Elizabeth Tucker
Emilie Hart
Ericka Jones Whitaker
Jefferson Currie
Katherine Beatty Hollinger
Kellie Blue
Kerrie Allen
Kurt Golembesky
Linda Oxendine
Mac Legerton
Maksym Bezruchko
Pam Bostic
Pam Cook
Steven Bolyard
Vickie Sasser
Victoria Carter

COLLABORATING ENTITIES

The Association of Mexicans in North Carolina (AMEXCAN)
North Carolina Black Alliance (NCBA)
NC Statewide Independent Living Council (SILC)
Southern Coalition for Social Justice (SCSJ)
The Conservation Fund (TCF)
North Carolina Budget & Tax Center (CB&TC)
North Carolina Conservation Network (NCCN)
North Carolina Inclusive Disaster Recovery Network (NCIDR)
Carolina Wetlands Association (CWA)
Lumber River Council of Governments
Lumber River Conservancy (LRC)
South Carolina Office of Resilience
North Carolina Department of Environmental Quality Division of Coastal Management



Lumber River at Chalk Banks in Scotland County, NC

This report was developed by AtkinsRéalis for DEQ.

REFERENCES

Association of State Dam Safety Officials (ASDSO). (2025, March). The Cost of Rehabilitating Dams in the U.S. https://damsafety.org/content/cost-rehabilitating-dams-us-2025

Centers for Disease Control (CDC). (2024, October 22). Social Vulnerability Index. Place and Health - Geospatial Research, Analysis, and Services Program (GRASP). https://www.atsdr.cdc.gov/place-health/php/svi/index.html

Coastal Dynamics Design Lab. (2023). Whiteville Community Floodprint. https://static1.squarespace.com/static/5ae3403b5ffd20f29c3730d4/t/648083c8309e167666bf618e/1686143951237/Whiteville+Floodprint_FINAL_z_May+2023_compressed.pdf

Federal Emergency Management Agency (FEMA). (n.d.). National Risk Index. https://hazards.fema.gov/nri/

Federal Emergency Management Agency. (2009, June). BCA Reference Guide. https://www.fema.gov/sites/default/files/2020-04/fema_bca_reference-guide.pdf

Federal Emergency Management Agency (FEMA). (2020, March 5). Repetitive Loss Structure. https://www.fema.gov/about/glossary/repetitive-loss-structure

Federal Emergency Management Agency. (2026, April). Benefit-Cost Analysis. https://www.fema.gov/grants/tools/benefit-cost-analysis

GloH2O. (2025). Köppen-Geiger Global 1 km climate classification maps. https://www.gloh2o.org/koppen/

Hurricane Matthew Disaster Recovery and Resilience Initiative. (2018 October). 2018 Lumberton Recovery Plan. https://coastalresiliencecenter.unc.edu/srv/htdocs/wp-content/uploads/sites/845/2018/12/Lumberton-Recovery-Plan.pdf

Multi-Resolution Land Characteristics Consortium (MRLC). (2023). Multi-Resolution Land Characteristics (MRLC) Consortium. https://www.mrlc.gov/data/legends/national-land-cover-database-class-legend-and-description

National Weather Service (NWS). (n.d.-a). Hurricane Hazel: October 15, 1954. NOAA's National Weather Service. https://www.weather.gov/ilm/HurricaneHazel1954

National Weather Service (NWS). (n.d.-b). Hurricane Fran: September 5, 1996. NOAA's National Weather Service. https://www.weather.gov/ilm/HurricaneFran

National Weather Service (NWS). (n.d.-c). Hurricane Floyd: September 16, 1999. NOAA's National Weather Service. https://www.weather.gov/ilm/Floyd

National Weather Service (NWS). (n.d.-d). Hurricane Florence: September 14, 2018. NOAA's National Weather Service. https://www.weather.gov/ilm/hurricaneflorence

National Weather Service (NWS). (n.d.-e). Historic Flooding Rainfall with Potential Tropical Cyclone Eight: September 15-16, 2024. NOAA's National Weather Service. https://www.weather.gov/ilm/2024PTC8

National Weather Service (NWS). (2021, August 26). Hurricane Matthew in the Carolinas: October 8, 2016. https://www.weather.gov/ilm/matthew

National Water Prediction Service (NWPS). (2025, April). Lumber River at Lumberton West 5th Street. https://water.noaa.gov/gauges/LUMN7

North Carolina Climate Institute for Climate Studies (NCICS). (2020, March). North Carolina Climate Science Report. https://ncics.org/wp-content/uploads/2020/10/NC-Climate-Science-Report_Plain_Language_Summary_Final_September2020_smaller.pdf

North Carolina Department of Administration (NCDOA). (n.d.). NC Tribal Communities. https://www.doa.nc.gov/divisions/american-indian-affairs/tribes

North Carolina Department of Environmental Quality. (2024, March). Draft North Carolina Flood Resiliency Blueprint—Appendix A: Definitions Glossary. https://www.deq.nc.gov/mitigation-services/subtask-40-draft-north-carolina-flood-resiliency-blueprint-appendix-definitions-glossary/download?attachment

North Carolina Department of Environmental Quality (DEQ). (2025a, June). Technical Bulletin: Risk Score. https://raleigh01sa.blob.core.windows.net/blueprint-files/1C91B656-A38F-4C2E-BB21-AB564CF3892C

North Carolina Department of Environmental Quality (DEQ). (2025b, December 1). North Carolina Dam Inventory. https://data-ncdenr.opendata.arcgis.com/datasets/ncdenr::north-carolina-dam-inventory/explore

North Carolina Department of Environmental Quality (DEQ). (2026, July, 22). NC Subbasins and Watersheds (8 and 10-Digit HUC). https://www.arcgis.com/home/item.html?id=003a4de213694a2290475512779eb520#overview

North Carolina Department of Transportation (NCDOT). (2025). NCDOT Route Arcs AADT [Dataset]. https://ncdot.maps.arcgis.com/home/index.html

North Carolina Emergency Management (NCEM). (2026). Spatial Data Download. https://sdd.nc.gov/

North Carolina Office of State Budget and Management (OSBM). (2025). Population Overview. https://www.osbm.nc.gov/facts-figures/population-demographics/state-demographer/countystate-population-projections/population-overview

PRISM Climate Group at Oregon State University. (2025). 30-Year Normals. https://prism.oregonstate.edu/normals/

United States Army Corps of Engineers (USACE). (n.d.). National Levee Database. https://levees.sec.usace.army.mil/#/

United States Census Bureau. (2023). 2023 American Community Survey 1-Year Estimates. https://data.census.gov/table?y=2023&d=ACS+1-Year+Supplemental+Estimates

United States Environmental Protection Agency (USEPA). (2025, July 24). About iCLUS. https://www.epa.gov/gcx/about-iclus

APPENDICES

Sunrise at Sunset Beach, NC

APPENDIX A:

LUMBER RIVER BASIN DATA INVENTORY REPORT

LUMBER RIVER BASIN ACTION STRATEGY A-2

APPENDICES

APPENDIX B:

PUBLIC ENGAGEMENT PLAN

APPENDIX C:

BLUEPRINT CAPACITY RESULTS

APPENDICES

APPENDIX D:

GAP ANALYSIS REPORT

APPENDIX E:

FLOOD RISK AND VULNERABILITY ANALYSIS REPORT

LUMBER RIVER BASIN ACTION STRATEGY E-2

APPENDICES

APPENDIX F:

ACTIONS PRIORITIZATION REPORT

APPENDICES

APPENDIX G:
FUNDING DATA SHEETS

APPENDIX H:

BLUEPRINT TOOL REPORTS FOR LOCALLY PRIORITIZED ACTIONS