



Draft North Carolina Flood Resiliency Blueprint

Executive Summary & Key Findings

January 2024



This document serves as the executive summary for the **Draft North Carolina Flood Resiliency Blueprint**, the most significant statewide flood mitigation investment in North Carolina’s history. The Blueprint is designed to bring together all flood-related resources and knowledge in the state into one unified platform. It will offer decision-makers at all levels an online support tool, a standardized methodology for flood planning, and river basin-specific strategies to address flooding in North Carolina communities. The Blueprint will allow the state to make targeted decisions about where to allocate resources for the most significant impact. The Draft Blueprint will continue to be refined based on advisory group feedback, community engagement, the pilot Neuse River Basin Action Strategy, and the creation of the Flood Resiliency Blueprint Tool.

1 Introduction

North Carolina communities have experienced catastrophic flooding in recent years, with some counties seeing multiple flooding disasters. Within the last ten years, major hurricanes, tropical storms, and other severe rain events have highlighted a flood-risk crisis that threatens North Carolina's communities, businesses, and people. Since 1977, North Carolina has received federal aid for 29 major flooding events. Hurricanes Matthew and Florence in 2016 and 2018 caused \$27 billion in damage and resulted in 76 storm-related fatalities across the state. As of April 2020, the state and federal governments have spent over \$3.5 billion as a result of these two storms alone, and recovery needs continue to exist for communities.¹ The current flood risk experienced by communities is expected to increase in frequency and intensity based on forecasting of future weather patterns and the state's population growth, highlighting the need for enhanced community flood resilience (Figure 1).

There are many types and sources of flooding that have negative impacts on human safety, homes and businesses, rural lands, infrastructure, and the environment. These sources of flooding may occur independently but often occur concurrently with each other. In addition to major riverine, coastal, and flash flooding caused by extreme weather events, nuisance flooding is on the rise and disrupts the day-to-day activities of North Carolinians. Nuisance flooding refers to lower levels of inundation that can occur more frequently in urban, suburban, and rural areas and poses additional costly challenges to taxpayers and governments, as well as public safety risks. As recently as Fall 2023, many regions of the state experienced severe drought followed by intensive rain and flash flooding that restricted road access to neighborhoods and vital community services like hospitals, caused strain on transportation infrastructure, and tested the limits of stormwater infrastructure.

Many jurisdictions face challenges related to current levels of flooding, even as the state continues to grow, attracting new businesses and residents. The state population has increased from 9,535,483 in 2010 to 10,439,388 in 2020, marking a 9.5 percent increase in the last decade, and is projected to reach 11.6 million by 2030.²

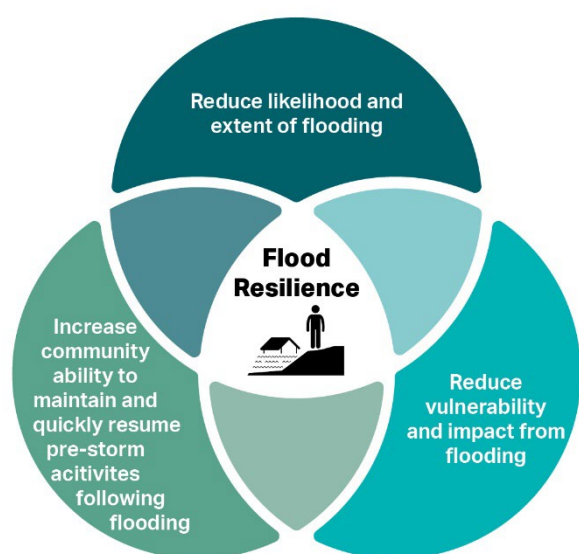


Figure 1. Flood Resilience

¹ <https://www.ncdps.gov/news/press-releases/2020/04/30/hud-approves-nc-plan-spending-hurricane-florence-recovery-funds-0>

² <https://www.osbm.nc.gov/facts-figures/population-demographics/state-demographer/countystate-population-projections>

While North Carolina’s growing economy and population are an overall positive trend for many communities, this growth is often accompanied by an increase in the amount of impervious surface area. Increasing the impervious surface area reduces the ground’s ability to absorb rainwater, increasing water flow into rivers and worsening local and downstream flooding. The state’s growth has also led to structures and infrastructure being built within areas that are beginning to experience flooding beyond historical patterns or may be susceptible to flooding in the future.

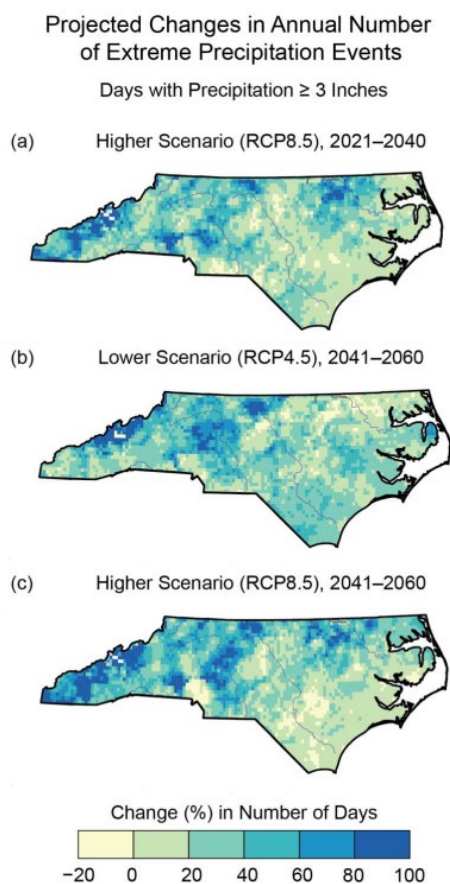


Figure 2.³

In highlighting the current flood risk that threatens North Carolina, it is important to consider the role of a changing climate and its potential to worsen the crisis. According to leading science, including recent analyses completed through the North Carolina Climate Risk Assessment, the state has witnessed escalating flooding occurrences. North Carolina is expected to experience further amplification, partly attributed to rising precipitation levels and heightened flooding intensity (Figure 2).³ While all North Carolinians will experience these effects in the future, resource-limited communities are disproportionately located in flood-prone areas, meaning these communities may bear a greater share of the increased flood risk.⁴

To better equip the state and its communities to manage current and future flood risk, the North Carolina General Assembly passed Section 5.9(c) of Session Law 2021-180 in 2021, which directed the North Carolina Department of Environmental Quality (NCDEQ) to develop a Flood Resiliency Blueprint (Blueprint)⁵. The Legislature provided additional guidance on the Blueprint’s development in 2022 in Section 22 of Session Law 2022-75⁶.

Session Law, 2021-180 Section 5.9(c), lays out the General Assembly’s intentions for the Blueprint by stating it should “identify the major watersheds affected by flooding and direct these funds toward the activities which are central to the creation of an actionable blueprint, namely flood risk assessment, identification of data gaps, and

recommendations to reduce flood risk for each target watershed.” The subsequent Session Law 2022-75 expands on this vision with the addition of several key elements stating that the Blueprint should “(1) Set up a standardized method to create requirements and guidelines for major flood risk modeling datasets with statewide application, including the collection, updating, and storing of GIS data. (2) Develop consistent guidelines to ensure common standard hydrology and hydraulic

³ <https://ncics.org/programs/nccsr/>

⁴ <https://doi.org/10.1038/s43247-023-01165-x>

⁵ <https://ncfloodblueprint.com/documents/SL2021-180.pdf>

⁶ <https://ncfloodblueprint.com/documents/SL2022-75.pdf>

watershed models can be used for regional studies. (3) Create and maintain a publicly accessible repository for data and modeling outputs and technical reports to allow local government units and other organizations to access the information.”

The North Carolina Flood Resiliency Blueprint is a first-of-its-kind program in the country and represents North Carolina's largest statewide flood mitigation investment. It is designed to bring together and build upon all the relevant existing resources and knowledge in the state to create one unified initiative to realize a resilient North Carolina. The vision for this effort was developed through state legislation and extensive communication with state agencies, other states involved in robust flood mitigation and resiliency, communities on the front line of flood events, academics, nonprofits, climate and flood resiliency experts, legislators, and other stakeholders. The Blueprint provides a statewide flood planning framework and decision-support tool that enables state, tribal, regional, and local entities and their stakeholders to identify, prioritize, and direct resources to implement effective flood resilience strategies based on the best available science and understanding likely future conditions. The Blueprint will serve as the backbone of North Carolina’s flood planning process, increasing community resiliency to flooding. By investing in a more flood-resilient state now, we will secure and build upon our thriving economy, expand tourism, support farming and agriculture businesses, fortify our transportation infrastructure, protect critical aspects of the military mission, and steward our natural resources.

The Blueprint planning framework and the decision support tool are not envisioned as a static set of plans or tools but rather as a dynamic process incorporating new information as it becomes available. The effort will provide multi-scale flood modeling, scenario exploration systems, guidance documents, and an iterative and interactive online planning tool to increase decision-makers’ ability to understand flood risk and prioritize and implement flood resilience actions to protect communities, economies, and the environment. It will help to link and build on existing data, strategies, projects, plans, and efforts underway by local, state, and federal entities, academia, businesses, and nonprofits, as well as capitalize on lessons learned from similar programs in peer states.

The Blueprint's unique nature and scope require its development to emphasize an adaptive learning and management approach that encourages flexibility to continuously leverage the expertise of relevant stakeholders, incorporate existing and ongoing flood resiliency efforts, and take advantage of technological advancements as they mature. Moreover, the Blueprint aims to identify and address gaps in ongoing flood resiliency efforts in the state, foster regional collaboration, and strengthen local programs by incorporating community and stakeholder knowledge as a primary foundation for its efforts.

The development of the Blueprint to date has been divided into three phases (Figure 3). Phase 1, Develop the Draft Blueprint, began in late 2022 and was primarily focused on generating foundational research and gap analysis for the development of a framework document, the Draft North Carolina Flood Resiliency Blueprint, a preliminary Draft Neuse River Basin Action Strategy, and requirements for a Blueprint Tool. To build a knowledge base to support the development of the Draft Blueprint and Neuse River Basin Action Strategy, over 30 documents and reports were drafted based on extensive research covering diverse topics related to flood resiliency and the successful development and implementation of the Blueprint.



Figure 3. *The start date for Phase III is approximate.

Phase II, Develop the Flood Resiliency Blueprint Tool, launched in late 2023 to design, construct, and evaluate an online decision-support tool by 2024. Phase III, Apply to Targeted Basins Statewide, is estimated to begin in the Spring of 2024 and will involve NCDEQ and coordinating stakeholders applying the Blueprint’s planning framework and the Flood Resiliency Blueprint Tool to additional targeted river basins (Figure 4).

In addition to Blueprint’s initial funding, which is being used to develop the Blueprint and priority River Basin Action Strategies, the General Assembly appropriated \$96M for the implementation of flood resiliency projects. The 2021 budget bill and money report (S.L. 2021-180 2021) authorized, set the requirements, and allocated the funds to NCDEQ, while legislation in 2022 amended the requirements (S.L. 2022-43). NCDEQ is developing the spending strategy for these funds and will implement on-the-ground projects in parallel to the continued development of the tool and action strategies.

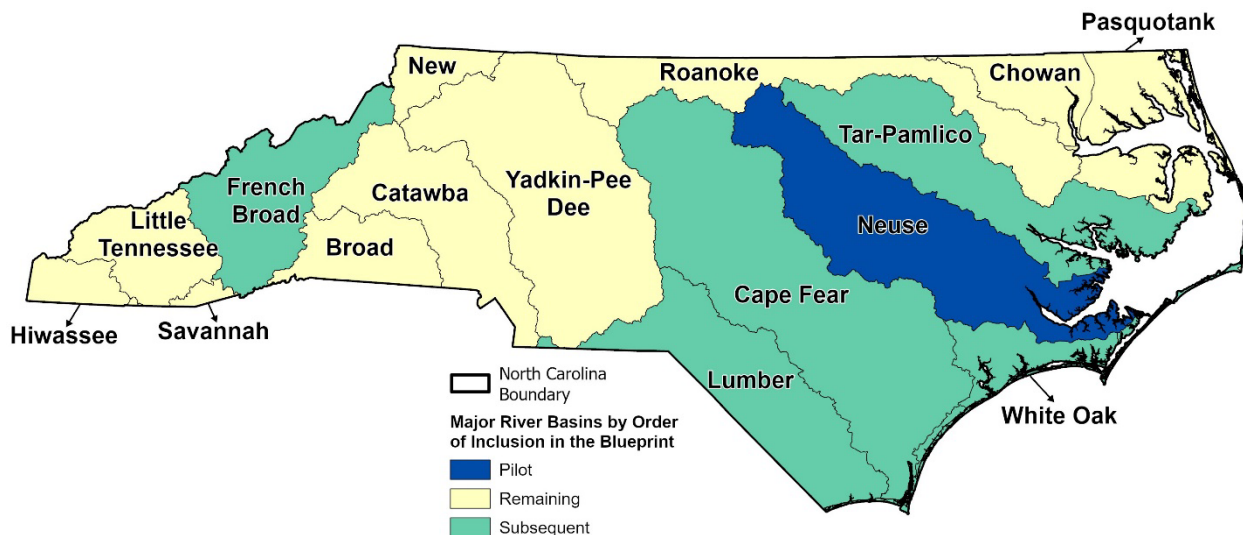


Figure 4. North Carolina Major River Basins by Order of Inclusion in Blueprint

The Neuse River Basin Action Strategy, which serves as the Blueprint’s river basin pilot, was developed parallel to the Blueprint framework during Phase I. This ensured the timely incorporation of lessons learned from the development of the Blueprint and vice versa. As their titles suggest, the Preliminary

Draft Neuse River Basin Action Strategy and the Draft North Carolina Flood Resiliency Blueprint are considered draft versions, subject to change based on continuous engagement and feedback from stakeholders as well as new and refined key findings and recommendations that arise during Phase II of the Blueprint. As Phase I ends, stakeholder engagement will continue to play a critical role in the Blueprint’s development process. For example, NCDEQ has invited a smaller group of stakeholders to inform the creation of the Flood Resiliency Blueprint Tool during Phase II. A larger group of potential users will be engaged for beta testing once the preliminary tool has been created. Additionally, further stakeholder engagement and community outreach is planned for the Neuse River Basin as the preliminary Action Strategy is refined.

From the beginning, it was clear that input from external stakeholders would be critical to the success of the Blueprint (Figure 5). Every step of the development process included feedback and collaboration from a diverse set of stakeholders. NCDEQ took the proactive step of involving outside entities in crafting a work plan for Phase I. The work plan was informed by several one-on-one meetings and workshops that brought together NCDEQ staff, flood resiliency experts, key stakeholders, and potential Blueprint end-users from various sectors. These included other state agencies, academic institutions, local government representatives, and nonprofits.

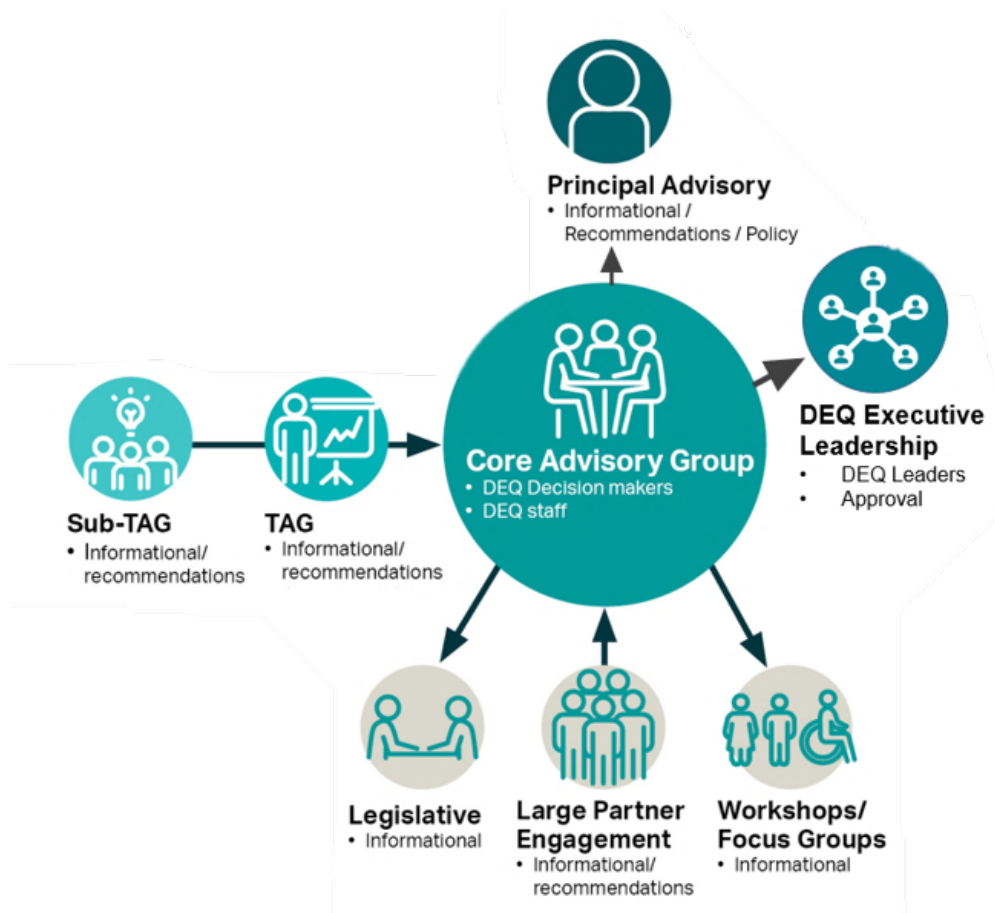


Figure 5. Blueprint's Phase I Stakeholder Engagement Design

At the outset of Phase I, NCDEQ engaged more than 150 subject matter experts and key stakeholders to participate across six Technical Advisory Groups (TAG), a Neuse Regional Advisory Group, and a Principal Advisory Group (PAG). These groups served as the foundation for stakeholder involvement

by providing valuable input on each component of Phase I across seven rounds of TAG and Neuse Regional Advisory Group meetings, as well as five PAG meetings. In addition, NCDEQ hosted 14 open house-style public meetings and workshops with local and regional decision-makers.

The stakeholder groups and NCDEQ worked together to create and review foundational documents during Phase 1 that were divided into four tasks covering Stakeholder Outreach/Facilitation, Gap Analysis, Recommendations and Decision Framework, and the drafts of the North Carolina Flood Resiliency Blueprint and Preliminary Draft Neuse River Basin Flood Resiliency Action Strategy (Figure 6).

With Phase I ending, Phase II already underway, and Phase III on the horizon, it is essential to take stock of the progress made, the relationships built, and the next steps the Blueprint will take to realize the General Assembly's vision and increase community resiliency to flooding. The following sections provide a high-level summary of Blueprint's Phase I results, focusing on the Blueprint's Planning and Implementation Workflow and Recommendations, which are described in more detail in the Draft Blueprint. As directed by the Legislature and indicated by their titles, the Draft North Carolina Flood Resiliency Blueprint and Preliminary Draft Neuse River Basin Action Strategy are in draft form as of January 2024. Designating these documents as drafts allows for greater flexibility in their development and incorporating lessons learned from Phase I and peer states. The Blueprint can be updated and strengthened as new information arises through the development of the Decision-Support Tool, new future conditions modeling, further river basin action strategy development, and continuous stakeholder collaboration.

2 Recommendations

The Draft North Carolina Flood Resiliency Blueprint includes three primary sections: a Planning and Implementation Workflow, Case Studies, and Program Recommendations that directly apply to the program’s long-term vision for a statewide flood resiliency planning framework. The Workflow is an 8-step process that the state and communities participating in the Blueprint undertake on a 5-year cycle for a river basin (Figure 6). Case Studies are used to demonstrate the Workflow implementation, highlighting the adaptability built into the Workflow that assists the Blueprint in addressing the unique flooding challenges and distinct goals of each participating community and region within a river basin. In addition, a set of recommendations for program implementation covering diverse topics is proposed in the Draft Blueprint, informed by the supporting research and documentation from Phase I. These are intended to guide the Blueprint development through Phases II, III, and beyond as well as flood resiliency project implementation. The Draft Blueprint and related contents provide a clear direction for how the Blueprint can serve as the central platform for flood resiliency planning and implementation at the state, regional, and local levels to achieve a more resilient North Carolina.

The Draft Blueprint includes guidelines to ensure consistent practices and procedures statewide yet remains sufficiently flexible to account for different physiographic settings, development intensity, regional differences, and other types of variability. The Workflow is designed as a continuous 5-year cycle for each river basin, where each iterative planning cycle builds on the efforts of the previous planning cycle. The Workflow is adaptable and forward-thinking as it necessitates that all resiliency investments made through the Blueprint consider future conditions during project planning, implementation, and maintenance phases. The implementation of these projects, described in more detail below, is balanced between shovel-ready projects and action plans that focus on the need for additional analysis.

Steps 1 through 6 of Blueprint’s Workflow focus on flood risk and vulnerability assessments and identifying flood resilience actions through collaboration between state agencies, regional planning groups, and local communities. The Flood Resiliency Blueprint Tool supports the planning process throughout the workflow. These steps culminate in a Flood Resiliency River Basin Action Strategy with a ranked collection of local and regional actions and potential funding sources. The implementation of actions commences in step 7 of the Workflow, overseen by NCDEQ in collaboration with a local, state, or regional sponsor for on-the-ground execution of flood resiliency projects. Step 8, the final piece of the Blueprint’s Workflow, ensures program and project accountability. Through the Flood Resiliency Blueprint Tool, users can access and share information from a dashboard communicating metrics on spending, risk reduction, and milestone completion in a highly visual format. The Draft North Carolina Flood Resiliency Blueprint details the entire Blueprint Workflow and incorporates theoretical case studies, illustrating the adaptable nature of Workflow approaches in practical scenarios.

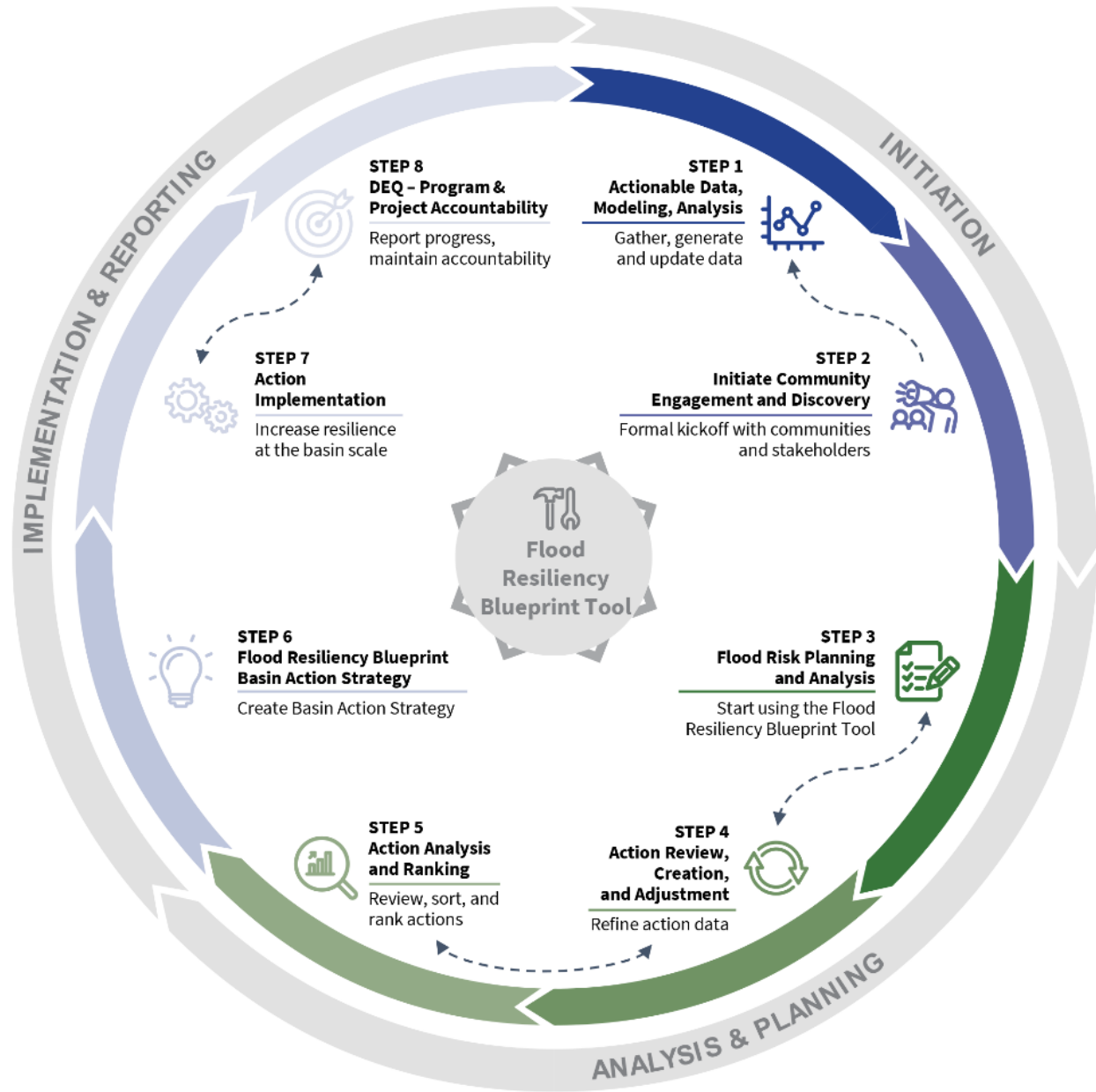


Figure 6. The North Carolina Flood Resiliency Blueprint's Workflow

The North Carolina Flood Resiliency Blueprint draws upon a strong foundation of prior flood resiliency work in the state. Analysis during Phase I revealed that at least 54 flood resiliency or flood reduction plans and programs exist across the state, in addition to federal efforts. NCDEQ developed the Blueprint Workflow to build upon and fill gaps in existing plans and programs rather than replace them. As noted earlier, the increase in flood risk due to a variety of factors underscores the need for enhanced resiliency planning and project implementation based on future conditions modeling—a task Blueprint is designed to accomplish.

Phase I of the Blueprint identified several gaps in North Carolina’s current flood resilience planning, policy, and programming. These include, for example, flood modeling limitations, outdated data, the absence of a river basin-level administrative or advisory body, and gaps in Nature-Based Solutions (NBS) policy and data. On average, hydrologic and hydraulic modeling in North Carolina is over 15 years old, requires two-dimensional updates, and does not consider future climate conditions. Several key statewide datasets identified as crucial to Blueprint's success must be updated to reflect current conditions. Additionally, the creation of the Blueprint Workflow revealed a gap in river basin-level administration. Blueprint’s basin-wide action strategies will require an advisory and/or decision-making body to help shape final actions. Lastly, the gap analysis revealed the absence of a comprehensive summary and analysis of North Carolina policies and practices related to NBS. Such a platform would help to minimize barriers for implementation and provide a central location for communities and others to collect and share data valuable to NBS flood resilience efforts, including funding sources.

The Draft Blueprint outlines recommendations to remedy these gaps as well as what actions the State must take to implement the North Carolina Flood Resiliency Blueprint and continuously improve it between 5-year cycles. Through a collaborative effort, TAG and PAG members, NCDEQ, and the consultant team drafted recommendations to provide actionable steps to implement the program as it moves into future phases of work. These recommendations span eight primary categories: Implementation of the Blueprint, Characterizing Flood Issues, Maintaining the Blueprint’s Workflow, Create Project Ranking and Metrics, Funding, Financing, Policy and Governance, and Pilot Project Implementation. The following table includes a brief description of each recommendation along with its associated category (Table 1). More detailed information, including a description, justification, cost consideration, link to Blueprint’s Workflow, alternatives considered, and estimated timeline for each recommendation, can be reviewed in the Draft North Carolina Flood Resiliency Blueprint.

Table 1. Recommendations to Implement the North Carolina Flood Resiliency Blueprint

| Category | Recommendation |
|---|---|
| Implementation of Blueprint | • Create River Basin Advisory Groups for Each River Basin |
| | • Integrate Other Flood Resiliency Strategies into Blueprint's Implementation Process and Flood Resiliency Blueprint Tool |
| | • Create and Administer Robust Stakeholder Engagement Programming |
| | • Build the Blueprint's Team and Hire Staff |
| | • Conduct Basin-Specific Financial and Technical Capacity Needs Assessments |
| | • Integrate Lessons Learned from Peer State Programs into the Blueprint |
| | • Implement Lessons Learned from Existing Online Flood Mitigation Decision Support Tools |
| | • Provide Support to Under-Resourced Communities Throughout the Implementation of the Blueprint |
| Characterizing Flood Issues | • Conduct 2-D Flood, Future Conditions Modeling |
| | • Use a Two-Tier Approach in Flood Modeling |
| | • Update Statewide Datasets Relevant to the Blueprint |
| | • Study the Benefits of Natural Assets for Flood Reduction, Flood Storage, and Flood Dispersion |
| Maintaining Blueprint's Workflow | • Implement a 5-Year Program Lifecycle for Action Strategies |
| | • Develop and Implement a Data Quality Review Process |
| | • Update Resiliency Action Plans Annually |
| | • Use the Best Available Data for the Flood Resiliency Blueprint Tool |
| Create Project Ranking and Metrics | • Develop a Resiliency Project Ranking Methodology |
| | • Use Advanced Technologies Where Appropriate |
| | • Incorporate Local Values into Project Ranking |
| Funding | • Integrate Identified Funding Sources |
| | • Develop a State Funding Policy |
| Financing | • Develop a Compensation Program for the Agricultural Community Based on the Use of Farmland for Flood Storage and Reduction |
| | • Develop Standard Finance Methods for Stormwater Initiatives |
| | • Provide Grant Opportunities to Establish Stormwater Programs |
| Policy and Governance | • Create a Blueprint Oversight Group |
| | • Create a Nature-Based Solutions Policy Digest |
| | • Incentivize the Use of Nature-Based Solutions |
| | • Coordinate State-Funded Projects Through the Flood Resiliency Blueprint Tool |
| | • Incentivize Stronger Flood Protection Efforts |
| Pilot Project Implementation | • Prioritize completion of current Stoney Creek pilot project and explore agency partnerships for implementation such as the Department of Agriculture and Consumer Services. |
| | • Implement pilot flood resiliency projects prioritizing those identified in the Neuse River Basin Action Strategy in the near term followed by pilot projects in the Phase III river basins. |

The Draft North Carolina Flood Resiliency Blueprint is the first significant step in achieving the legislature's long-term vision for the Blueprint, which is stated as “...The backbone of a State flood planning process that increases community resiliency to flooding, shall be a resource for riverine and stream management to reduce flooding, and should support the establishment and furtherance of local government stormwater maintenance programs” (S.L. 2021-180, Section 5.9(c)). The dynamic nature of the Blueprint, highlighted in the Workflow and Case Studies, leverages and builds upon the robust array of existing and ongoing flood resiliency efforts across the state. Analyzing comparable initiatives in other states allows the Blueprint to enhance and leverage peer programs. Blueprint’s adaptable Workflow approach ensures that stakeholder collaboration is the foundation for River Basin Action Strategies, which address the unique flooding challenges of each river basin, region, and community.

Phase II of the Blueprint process will focus on developing the Flood Resiliency Blueprint Tool and refining the Draft Blueprint and Preliminary Draft Neuse Action Strategy. Local decision-makers and residents will participate in several workshops in the Neuse River Basin at the beginning of 2024 to review and provide feedback on the preliminary draft. Further stakeholder engagement will be conducted to inform the development of the decision-support tool. Commencing in Spring 2024, Phase III of Blueprint will incorporate insights from Phase I, coupled with the Tool crafted in Phase II, and strategically implement the Blueprint planning process across additional targeted major river basins.

The individual communities that make up each of North Carolina’s 17 river basins have unique needs, a wealth of expertise, and a desire to find solutions to the challenges of flooding. As the state grapples with the impacts of future change and the potential of increased flooding, the Blueprint serves as a central decision-support and implementation platform that acts as a “connective tissue” for numerous resiliency efforts and guides stakeholders and communities toward more resilient futures. The Blueprint will offer state and local leaders an online decision support tool, a standardized methodology for flood planning, and river basin-specific strategies to holistically address flooding for communities in North Carolina. The Blueprint's tools and processes, which let science drive flood mitigation decisions, will ultimately assist decision-makers in making more informed choices for why, where, and how to deal with flooding in ways that support a resilient and vibrant state. Implementation of this program will be an ongoing and iterative process, evolving as more data and information are collected and actions within the River Basin Action Strategies are implemented.

While basin-specific strategies are being developed, NCDEQ will be implementing projects on the ground using the \$96M in funding provided by the Legislature so that some of the most impacted communities can be helped sooner rather than later. As additional flood solutions are developed in collaboration with affected communities and included in River Basin Action Strategies, updates to the Blueprint will build on these initial efforts and incorporate lessons learned.

As the North Carolina Flood Resiliency Blueprint continues to advance and flood projects begin to take shape on the ground, every community in the state will be needed to help shape how we grow the state’s resilience to future floods. By working together and using the Blueprint as our common platform, we can build a more resilient North Carolina.

Acknowledgments

NCDEQ would like to acknowledge and thank the following individuals for their time and effort in contributing to Blueprint’s Phase I development. These acknowledgments highlight NCDEQ’s core Blueprint team, relevant contractors, and stakeholders who assisted with developing a work plan for Phase I and/or participated in TAG/PAG activities. The following acknowledgments include stakeholders' names and relevant organizations (during their contributions to Blueprint). It is important to note that the organizations associated with some individuals may have changed as some contributors have since retired or moved on to different organizations.

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Peer States

Louisiana

Louisiana Coastal Master Plan | Louisiana Coastal Protection and Restoration Authority
Louisiana Watershed Initiative | Louisiana Council on Watershed Management

South Carolina

Strategic Statewide Resilience and Risk Reduction Plan | South Carolina Office of Resilience

Texas

Texas State Flood Plan | Texas Water Development Board
Texas Coastal Resiliency Master Plan | Texas General Land Office

Virginia

Virginia Coastal Resilience Master Plan | Virginia Department of Conservation and Recreation

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