RESILIENT NJ

PROTECT, RESTORE, TRANSITION

A Resilience Action Plan For The Raritan River And Bay Communities' Region

OCTOBER 2022

SHARE YOUR FEEDBACK ON THIS REPORT

FEEDBACK FORM

PLEASE SHARE YOUR THOUGHTS USING THIS FORM:
https://forms.office.com/r/Df0dFcG0UU

We continually share progress and ask for comments to make sure the project is on the right track. The *About Our Region* report (released spring of 2021) describes key features of the Raritan River and Bay Communities region and its municipalities that are important to understand when planning for higher resilience to flood risk and improved quality of life in the future. The *Vision and Priorities* report (released spring 2022) summarizes what we heard from the community and other stakeholders between December 2020 and January 2022. The *Flood Impact Assessment* (released summer 2022) details the expected impacts of flooding across the region.

This *Action Plan* is the culmination of the three preceding reports. It provides an actionable roadmap that includes clear next steps for the region to reduce risk and improve quality of life by means of thoughtful and targeted resilience actions.

To ensure the *Action Plan* is implementable, the project team welcomes your feedback on:

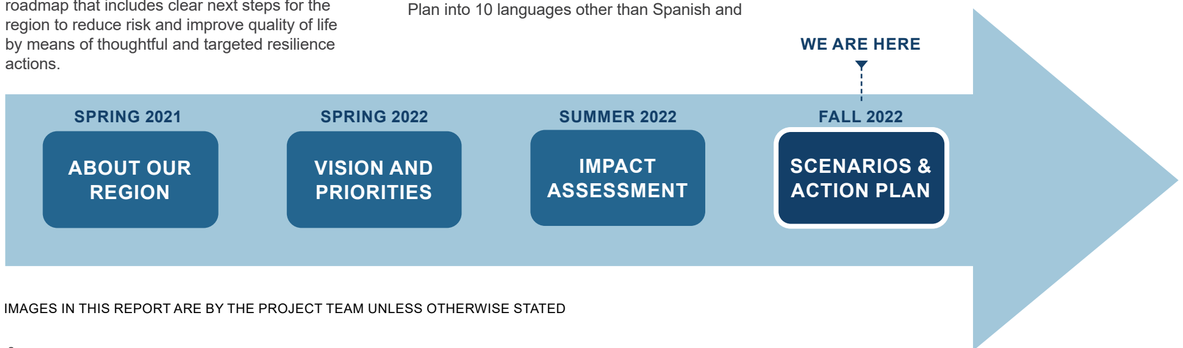
- The specific resilience actions recommended;
- The lead entities and next steps identified for each action; and
- Any additional information you feel is needed to make the plan actionable.

This version incorporates updates based on edits received by October 19th, 2022. Additional public comments are welcome to inform subsequent updates. Please submit comments by March 31, 2023.

The Action Plan will be available in Spanish. You can submit a request for translation of the Action Plan into 10 languages other than Spanish and English. Please follow the instructions in this form to submit a translation request.

We also welcome you to share your thoughts on the broader project:

- By email: ResilientRRBC@dep.nj.gov
- By social media: Twitter and Facebook: @ ResilientRRBC, Instagram: @Resilient_RRBC
- Through our website: www.resilient.nj.gov/rrbc
- Through the Irys app (download through Apple App Store or Google Play Store)



IMAGES IN THIS REPORT ARE BY THE PROJECT TEAM UNLESS OTHERWISE STATED

RESILIENT NJ
RARITAN RIVER AND BAY COMMUNITIES

PROTECT, RESTORE, TRANSITION:
A Resilience and Adaptation Action Plan For The Raritan River And Bay Communities' Region

OCTOBER 2022

LETTER OF SUPPORT

By New Jersey Department of Environmental Protection

Climate change is a global challenge, although its impacts—including flooding from sea-level rise, coastal storms, and extreme precipitation events—are experienced locally. Further, each community's experience of these impacts is distinct and so requires a unique response consistent with, and driven by, the community members who are directly impacted. Integrating a proactive, climate-ready mindset into local and regional planning efforts is imperative to ensure that investments made today are designed to withstand the conditions of tomorrow.

To provide our communities with the assistance and resources to meet these challenges, the NJ Department of Environmental Protection (NJDEP) launched the Resilient NJ program, using funding from the U.S. Department of Housing and Urban Development's National Disaster Resilience Competition. Resilient NJ is the preeminent planning program in the state to support local and regional climate resilience planning and serves as a model for other community resilience planning projects in New Jersey. Using the best available science on precipitation, sea-level rise, and coastal flooding, combined with a whole-community planning approach, Resilient NJ helps communities plan for how the changing climate may affect residents, businesses, and the natural and built environments.

The Resilient Raritan River and Bay Communities region is extremely diverse in both population and development patterns, with a mix of suburban and older urban centers. It is composed of several watersheds whose unique qualities require targeted management, as residents of the region are regularly threatened by flood exposure. This Regional Resilience and Adaptation Action Plan is the result of a nearly two-year, whole community planning process. It presents a suite of innovative and implementable solutions that align with the community vision to increase climate resilience in both the short- and long-term.

New Jersey's Statewide Climate Change Resilience Strategy defines "climate resilience" as the ability of social and ecological systems to absorb and adapt to shocks and stresses resulting from a changing climate, while becoming better positioned to respond in the future. Resilience is not an end-state, but a dynamic state-of-being that will grow more difficult to attain as the climate continues to change. Resilience is perseverance with grace, strength in the face of adversity and hardship, resourcefulness to leverage what is available, and faith in the road that lies ahead. The four initial Resilient NJ regional projects have met those high principles and have established a high bar by which all other resilience initiatives will be measured.

Sincerely,

Nicholas J. Angarone, PP/AICP

New Jersey Chief Climate Resilience Officer

FOREWORD

By the Steering Committee

Resilient NJ Raritan River and Bay Communities (RRBC) is one of four pilot regional planning projects funded through the New Jersey Department of Environmental Protection (NJDEP) that aims to build resilience while improving quality of life in the face of climate change. The program's regional focus is on seven coastal municipalities within Middlesex County, and the program breaks traditional geographic and administrative boundaries to foster collaboration and yield productive change. The region is home to over 300,000 people today. Representatives of each participating municipalities, Middlesex County, and the YMCA sit on a Steering Committee that leads the project and works alongside resilience experts, infrastructure entities, community members and other local, county, and state leaders.

Resilient RRBC launched publicly in the Spring of 2021 with a mandate to develop a regional Resilience and Adaptation Action Plan (*Action Plan*) that outlines a roadmap for addressing current and future flooding. Through community feedback, the process that followed was expanded to consider other climate-related hazards, such as heat, poor air quality, and drought. These hazards interact with each other to create stressors on the region's people, infrastructure, and environment. Stresses are already felt today, as we saw with recent storms such as the remnants of Hurricane Ida in September 2021, less recent storms such as Hurricane Sandy that catalyzed attention to resilience across much of the northeast, and the prevalence of health impacts due to polluted air and heat waves.

The science to understand the complex role that climate change plays in the future of these hazards is constantly evolving through studies led by federal agencies, NJDEP, and other academic and scientific entities. Nonetheless, the science shows that factors such as sea level rise, higher intensity precipitation, invasive species, air quality changes, and increasing temperatures will worsen quality of life in this region unless action is taken. The *Flood Impact Assessment* completed for this project estimates that, considering the effects of climate change, possible losses from severe rainfall and coastal storm surge events could be in the billions of dollars. These hazards compound other challenges faced by this region, including contamination and the legacy of the region's industrial past, aging infrastructure, the need for additional housing, and lack of access to open space and natural areas in some areas within the region.

The Steering Committee is committed to facing these challenges by advancing the recommendations of the *Resilient RRBC Action Plan* and continuing to lead, collaborate, and innovate on these issues. The *Action Plan* outlines clear actions such as policy changes, programs, and capital projects that can be implemented to reduce risk by protecting critical assets and population centers, restoring natural systems, and transitioning to more resilient and sustainable land use patterns. Together, Resilient RRBC partners are already working to advance these recommendations, as shown in the following pages.

The actions aim to advance ongoing efforts in the region and to work alongside the New Jersey Statewide Climate Change Resilience Strategy and other statewide initiatives. As reflected in the *Action Plan*, we can all play a role in increasing resilience, and the plan describes responsibilities at several scales. Community engagement was crucial to the development of the plan to ensure that it aligns with community vision and priorities. Involvement from everyone in our region, especially those who could face the most significant impacts from climate change, will continue to be critical for successful implementation of the plan's recommendations.

This *Action Plan* is not the final step in the process towards achieving increased resilience. By taking the next steps as charted in the roadmap and working iteratively to improve and complete projects, we can collectively build thriving communities.

PROJECT TEAM

ELECTED OFFICIALS

MIDDLESEX COUNTY
Board of County Commissioners: Ronald G. Rios (Director), Shanti Narra (Deputy Director), Claribel Azcona-Barber, Charles Kenny, Leslie Koppel, Chanelle Scott McCullum, Charles E. Tomaro

CARTERET
Mayor: Daniel J. Reiman
Council: Jorge Diaz (President), Vincent Bellion, Susan Naples, Ajmar Johal, and Dennis DiMascio

OLD BRIDGE
Mayor: Owen Henry
Council: Mary Sohor (President), Debbie Walker (VP), Dr. Anita Greenberg-Belli (at-Large), Kevin Garcia (Ward 1), Erik DePalma (Ward 2), Kiran Desai (Ward 3), Jill DeCaro (Ward 4), Tony Paskitti (Ward 5), and John E Murphy III (Ward 6)

PERTH AMBOY
Mayor: Helmin Caba
Council: William A. Petrick (President), Joel Pabon, Sr., Milady Tejeda, Rose B. Morales, and Bienvenido “BJ” Torres

SOUTH AMBOY
Mayor: Fred Henry
Council: Brian McLaughlin (Ward 1), Thomas B. Reilly (Ward 2), Zusette Dato (Ward 3), Christine Noble (at-large), Michael Gross (President)

SAYREVILLE
Mayor: Victoria Kilpatrick
Council: Vincent Conti, Eunice K. Dwumfour, Michele Maher, Mary J,Novak, Christian Onuoha, and Donna Roberts

SOUTH RIVER
Mayor: John M. Krenzel
Council: Tony Ciulla (President), Donna Balazs, Jason Oliveira, Peter Guindi, James Gurchensky, and Julie Meira

WOODBRIDGE
Mayor: John E. McCormac
Council: Howie Bauer (President/Ward 2), Gregg M. Ficarra (VP/at-Large), Sharon McAuliffe (Ward 1), Cory Spillar (Ward 3), Virbhadra N. Patel (Ward 4) Debbie Meehan (Ward 5), Kyle Anderson (at-Large), Lizbeth DeJesus (at-Large), and Brian Small (at-Large)

STEERING COMMITTEE MEMBERS

MIDDLESEX COUNTY
Doug Greenfeld, Mirah Becker, Laurie Sobel, John Ferguson, Lakeasha Carter, Brady Smith

CARTERET
Mike Sica

OLD BRIDGE
Veena Sawant, Damian Gil

PERTH AMBOY
Tashi Vazquez, Larry Cattano, Joel Rosa

SOUTH AMBOY
Glenn Skarzynski

SAYREVILLE
Kirk Miick

SOUTH RIVER
Art Londensky

WOODBRIDGE
Tom Flynn, Mike Gelin, Marta Darden

RARITAN BAY AREA YMCA
Steve Jobin, Lauren Capaci, Brenda Crespo

RARITAN VALLEY YMCA
Gina Stravic

GATEWAY FAMILY YMCA RAHWAY BRANCH
Rodger Koerber

OLD BRIDGE FAMILY YMCA
Christopher Nasta, Jennifer Dunn

YMCA OF METUCHEN EDISON, WOODBRIDGE AND SOUTH AMBOY
Gerry Gessie

CONSULTANTS

ARCADIS

INGROUP, INC.

SCAPE LANDSCAPE ARCHITECTURE

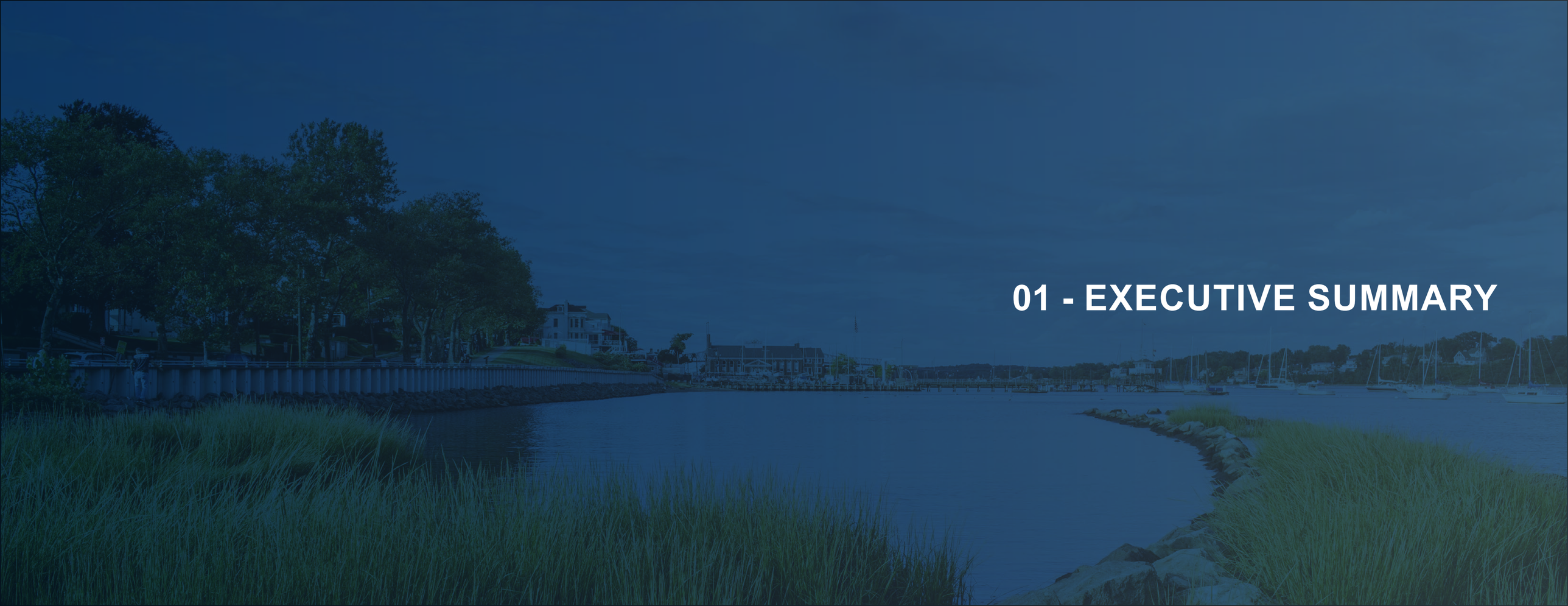
ONE ARCHITECTURE & URBANISM

IRYS

SAM SCHWARTZ ENGINEERING

HEYER, GRUEL & ASSOCIATES

CONTENTS



01 - EXECUTIVE SUMMARY

EXECUTIVE SUMMARY

Resilient NJ is a planning program, administered by the New Jersey Department of Environmental Protection (NJDEP), that supports regional climate resilience planning. Resilient NJ has brought together planners, engineers, designers, and other experts to address flood-related and other hazards at a regional scale in order to develop a targeted set of strategies and actions with clear pathways to implementation, a process fundamentally guided and driven by local community input, particularly from underserved and under-resourced populations.

The mission of Resilient NJ: Raritan River and Bay Communities (RRBC) is to **create a watershed-based plan with a clear vision and roadmap for reducing flood risk, increasing resilience, and achieving environmental restoration to help the multi-municipal region survive and thrive.**

The RRBC region includes seven municipalities in Middlesex County that were impacted by Hurricane Sandy: Carteret, Old Bridge, Perth Amboy, South Amboy, Sayreville, South River, and Woodbridge. The region is home to approximately 310,000 residents of diverse backgrounds, 76,000 jobs, and numerous transportation and environmental assets of regional importance. The region has been shaped geographically and culturally by the Raritan Bay, which serves as an entrance point to the rest of Middlesex County as well as a connection point with New York City and New England. RRBC is heavily interconnected along major transportation networks and waterbodies, home to a wide variety of cultures and industries.

Thousands of residents of RRBC live in areas vulnerable to flooding. These hazards include coastal storms and storm surge, coastal erosion, high tide flooding exacerbated by sea level rise, riverine flooding, flooding from heavy rainfall, and in some areas, combined sewer overflows. In 2012, the region experienced severe flooding during and after Hurricane Sandy. The hurricane caused power outages, damaged businesses and homes, and forced the evacuation of thousands of people. Since then, the region has experienced flooding from other storms, including nor'easters and Hurricanes Irene and Isaias. Many neighborhoods in the region also experience flooding due to heavy rainfall events overwhelming the stormwater system, as seen during Tropical Storm Ida. Climate change will increase these risks as sea levels rise and extreme events become more common.

What is the purpose of this plan?

Through the Resilient NJ program, the Raritan River and Bay Communities region has engaged in a stakeholder-guided process to become more resilient and improve quality of life for its more than 300,000 residents. This action plan is a culmination of these efforts. The plan:

- Summarizes the Resilient NJ program and resilience planning process undertaken in RRBC;
- Shares the outcomes and results of the program and process; and
- Provides a roadmap for reducing flood and other climate risks, and addressing critical issues in the region through identified resilience strategies and actions.

Some Key Terms

The terms introduced here are used throughout the *Action Plan* to define flood risk and resilience in RRBC.

Resilience means the ability to adapt to changing conditions, such as those driven by climate change, and transform in the face of disruption or challenges. Resilience is about creating physical change to prevent flood damage as well as strong civic and governance systems that support inclusive decision-making.

Flooding can be caused by rainfall, overwhelmed sewer systems, overflowing rivers, coastal storms, or high tides. Flooding is more significant at lower elevations (ground levels) and can be exacerbated when drainage systems lack necessary capacity or paved surfaces prevent rainfall from being absorbed. Coastal storms can cause a temporary rise in ocean levels (or storm surge) and strong winds can lead to large waves that overtop bulkheads or coastal barriers. Climate change is causing sea levels to rise and is producing more severe rain events, which will increase flood risk in some areas.

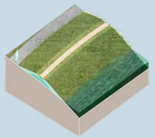
Flood Risk Reduction refers to strategies and actions that reduce the likelihood of flooding and/or build capacity to minimize the consequences of flooding when it occurs. Planning to reduce flood risk helps decrease the number of people and buildings at risk flood impacts.

Nature-based Solutions refers to sustainable planning, design, environmental management, and engineering practices that weave natural features or processes into the built environment to promote adaptation and resilience. These solutions use natural approaches to reduce flood risk, combat climate change, and realize a variety of co-benefits.

A **watershed** is an area of land that drains into a body of water such as a river, lake, stream, or bay.

This preferred scenario will achieve the region's vision by:

PROTECTING
Critical Assets & Economic Centers through

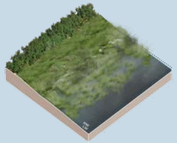


- **Adaptation or protection of critical facilities**
- **Coastal flood barrier systems** to protect from storm surge
- **Adaptation of bulkheads** to protect from sea level rise

- **Expanding stormwater storage** to reduce risks from heavy rainfall

- Increasing **awareness of flood risk and mitigation options** and **increased funding for flood mitigation**

RESTORING
Natural Systems & Minimize Exposure through



- **Protecting and managing tidal wetlands** for sea level rise
- **Protecting and preserving open space**

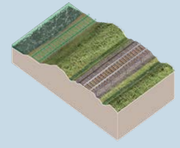
- Improving stormwater management by **restoring riparian corridors** and **eliminating barriers to natural drainage flows**

- Implementing **beach and dune restoration** and building **living breakwaters**

TRANSITIONING
to Smart Growth for a New Economy through

- Limiting development and **reducing density in higher-risk areas** and **creating development opportunities in low-risk areas**

- Incorporating resilience into **redevelopment plans** and **local codes and standards**
- Improving **regional coordination and governance**



- Improving resilience of **mobility systems**

Why this this plan needed?

Flooding is not the only climate hazard this region must worry about, however. Increasing global temperatures, radical shifts in precipitation and weather patterns, sea level rise, and correlated groundwater table rise will interact in complex ways to threaten the region with various additional hazards, including other (non-flooding) types of severe weather, various direct and indirect hazards posed by groundwater rise, increased drought and threats to water supply, extreme heat, worsening air quality, invasive species and vector-borne illnesses, increased risk of wildfire, and ocean acidification. These hazards will increasingly threaten public health, provision of critical services, and the health and integrity of existing ecosystems and habitats the region's population depends on.

While flooding and additional climate hazards will impact people across the region, those with fewer resources or additional vulnerabilities face additional hardships. Indeed, some of the most socially vulnerable communities in the state—and in some cases, the country—reside in Perth Amboy and Carteret. Lower income households with less savings are more vulnerable when faced with losing income. A history of exclusionary policy has inequitably distributed resources so that Black and Latinx communities are disproportionately vulnerable to flooding, high urban heat, air pollution, and proximity to hazardous waste. There are also specific communities such as the elderly and those with disabilities that are at higher risk.

What does this plan recommend?

A broad range of resilience strategies and actions can be leveraged to realize the Raritan River and Bay Communities' vision for the future of: "A thriving region of interconnected watersheds, with complementary environmental, social, economic, and governance systems working together to reduce flood risk of communities and infrastructure, restore natural systems, and adapt to a changing climate." In the process of collaborating with RRBC communities and evaluating three preliminary scenarios, it became clear to the Resilient NJ team that achieving the community vision will require a hybrid strategy that includes a careful balance between the three scenarios.

What will the benefit of this plan be?

This *Action Plan* seeks to reduce current and future risks due to flooding and Additional Climate Hazards , now and into the future. The strategies and actions it proposes are intended to increase adaptive capacity, enable positive transformation, and improve quality of life for the communities who live and depend on the region, even as the impacts of climate change loom larger—especially for the region's most under-resourced communities. Thoughtful implementation of the strategies and actions contained herein could yield a wide variety of benefits for the entire region, including:

- Avoided loss of life, injuries, illnesses, mental stress and anxiety, in addition to other public health benefits
- Protection of structures, contents, and inventories
- A more sustainable economy and avoided impacts to local and regional businesses
- Protection of critical assets and avoided loss of public and essential services
- Multiple ecological benefits, including restoration and expansion of existing open spaces, wetlands, streams, and various habitats
- Expanded access to green space and improved connectivity/mobility

What happens next?

This plan is intended to be an actionable roadmap, providing clear next steps that should be taken to implement the identified resilience actions. It builds off ongoing resilience planning within the region and incorporates the voices and needs of all members of the region, including the most vulnerable, to provide innovative and implementable actions that increase long- and short-term resilience and enhance the value and integrity of the ecological, recreational, and economics resources of the region.

The plan is organized into the following chapters:

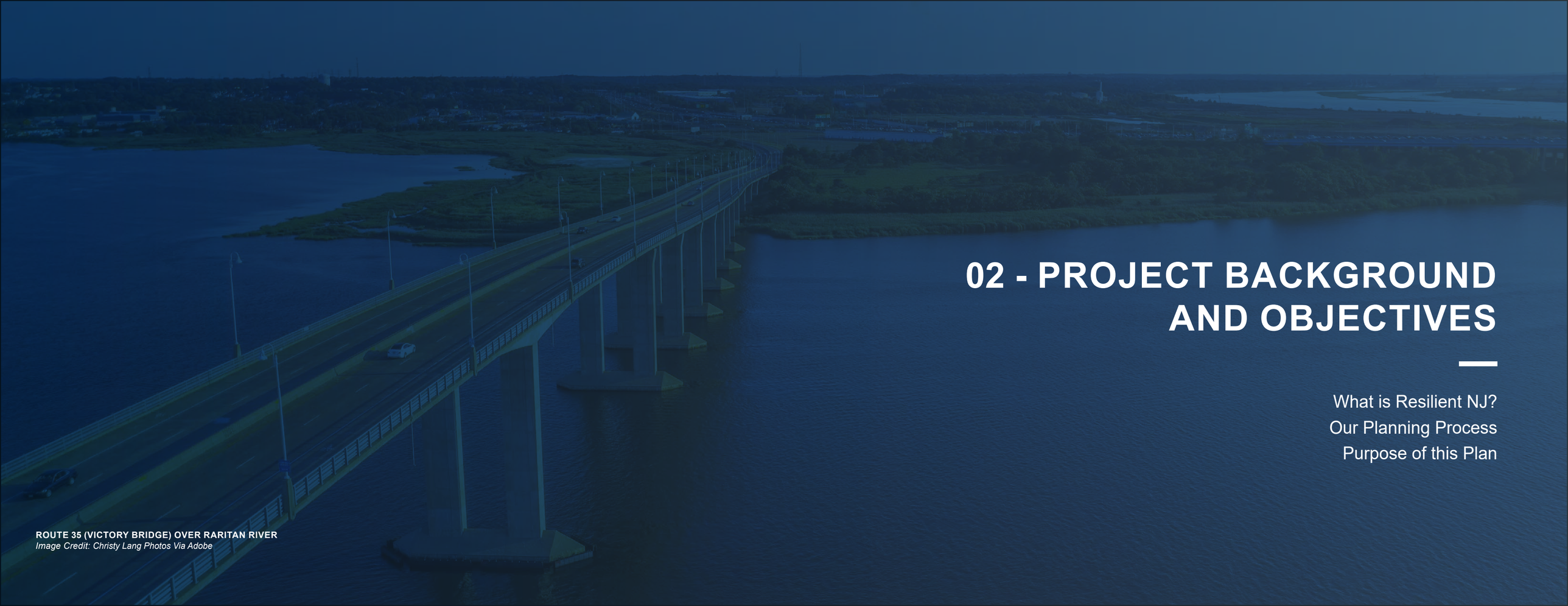
- **Project Background & Objectives** – Provides an overview of the Resilient NJ program, our understanding of the RRBC region and its history, and a summary of the planning process undertaken to complete this plan
- **Summary of Climate Impacts in the Region** – Summarizes key findings of the flood impact and other climate hazard assessments which provided the basis of our understanding of current and future risks in the region
- **Three Pathways to a More Resilient Region: Scenario Development and Evaluation** – Details the scenario development and evaluation process undertaken to weigh the pros and cons of three potential approaches and develop the preferred scenario
  Resilience Action Plan Implementation Framework – Provides an overview of the preferred scenario, details recommended strategies and actions at the regional, sub-watershed, and resilience opportunity area scales, and outlines a roadmap to implement the identified actions

The release of this *Action Plan* is an important step in addressing the flood risks this region faces, but what comes next is even more important.

EVERYONE HAS A ROLE TO PLAY

Everyone has a role to play in reducing flood risk and increasing resilience in the Raritan River and Bay Communities region. The information in the chart below provides additional guidance on next steps for different groups of stakeholders.

IF YOU ARE	WHAT YOU NEED TO KNOW	WHAT YOU CAN DO NEXT
A RESIDENT, BUSINESS OWNER, OR PROPERTY OWNER IN THE REGION	Building resilience in the region depends on you and the actions you take to reduce flood risk to your home, business or property This *Action Plan* includes a variety of actions that may affect the places you care about so review the plan and stay involved in the process as actions are implemented	• Know your risk today and in the future • Purchase and maintain flood insurance and prepare when a flood is in the forecast • Share this plan with your friends, family, and neighbors
A REPRESENTATIVE OF A COMMUNITY-BASED ORGANIZATION	This *Action Plan* recommends a variety of actions that will require partnership and coordination with organizations like yours Implementation of this plan provides an opportunity for actions to realize a number of co-benefits including those that may benefit your organization Effective implementation of this plan will require ongoing conversations with the public	• Carefully review this plan and stay informed about and involved in the implementation process by coordinating with municipal and county staff • Work with municipal and county staff to identify partnership opportunities that further identified resilience actions • Help raise public awareness of flood and Additional Climate Hazards risks and the *Action Plan* through your networks
A MEMBER OF MUNICIPAL STAFF	This plan recommends actions that affect property, infrastructure and services owned and managed by municipalities in the region Municipal staff will lead implementation of some of the actions recommended in this plan Effective implementation of the plan will require active coordination and involvement of staff across municipal departments and functions	• Carefully review this plan and stay informed about and involved in the implementation process • Lead advocating for implementation of priority actions • Lead finding, developing, and overseeing funding opportunities from various sources • Share the *Action Plan* with colleagues
A MEMBER OF COUNTY STAFF	This plan recommends strategies actions that affect property, infrastructure and services owned and managed by Middlesex County County staff will lead implementation of some of the actions recommended in this plan Effective implementation of the plan will require active coordination and involvement of staff across County departments and functions	• Carefully review this plan and stay informed about and involved in the implementation process • Share the *Action Plan* with colleagues
A MEMBER OF STATE STAFF	This plan recommends strategies actions that affect property, infrastructure and services owned and managed by various NJ State Agencies State agency staff will lead implementation of some of the actions recommended in this plan Effective implementation of the plan will require active coordination and involvement of staff across State departments and functions	• Carefully review this plan and stay informed about and involved in the implementation process



ROUTE 35 (VICTORY BRIDGE) OVER RARITAN RIVER
Image Credit: Christy Lang Photos Via Adobe

02 - PROJECT BACKGROUND AND OBJECTIVES

What is Resilient NJ?
Our Planning Process
Purpose of this Plan

WHAT IS RESILIENT NJ?

Resilient NJ is a planning program, administered by the New Jersey Department of Environmental Protection (NJDEP) Bureau of Climate Resilience Planning, that supports regional climate resilience planning.

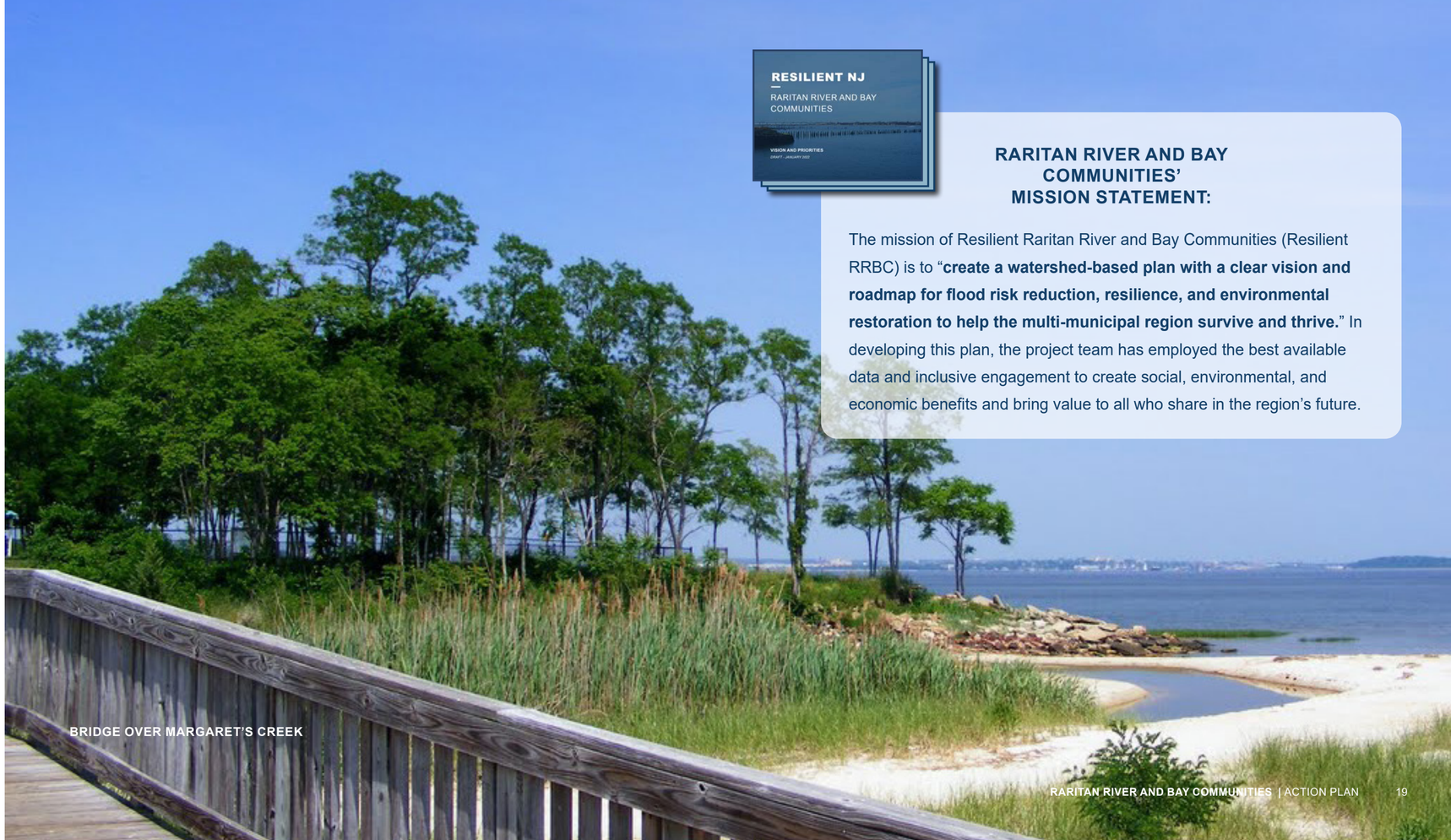
Resilient NJ has brought together planners, engineers, designers, and other experts to address flood-related and other hazards at a regional scale in order to develop a targeted set of strategies and actions with clear pathways to implementation. The process has been fundamentally guided and driven by local community input, particularly from underserved and under-resourced populations.

Resilient NJ was funded through the U.S. Department of Housing and Urban Development (HUD). HUD established the National Disaster Resilience Competition (NDRC) after Hurricane Sandy to help communities impacted by natural disasters plan and implement resilience projects to prepare for future storms. The State of New Jersey was awarded funding as part of the competition in 2016, $10 million of which is being used to fund Resilient NJ and the development of regional resilience action plans. This report focuses on the Raritan River and Bay Communities (RRBC) Region. Similar plans have been developed for Northeastern New Jersey, Long Beach Island, and the Atlantic County Coastal Region.

Why does RRBC need a Resilience Action Plan?

Climate change poses a serious threat to the region and those who live in and depend on it, demanding meaningful, regionwide planning. Already, RRBC is plagued by unpredictable, sometimes severe flood events, in addition to extreme heat and other dangerous hazards. Changes in precipitation, sea level rise, increasing temperatures, and habitat shifts will place increasing stress on the region's infrastructure, natural resources, and social and economic systems. These same impacts directly affect public health and healthcare systems. For many communities—especially those with limited access to resources to prepare for, respond to, and recover from extreme events—the risks these hazards pose to their health, safety, and livelihoods cannot be overstated.

Decisions about zoning, redevelopment, housing, open space, and other investment decisions made by local and regional governments will alter the impacts of climate change on their own and neighboring communities. Integrating climate change considerations into these decisions is imperative to ensure that investments made today are designed to withstand the conditions of tomorrow. This *Action Plan*, guided by input from a diverse range of members of RRBC communities, provides a roadmap for addressing climate hazards in the region while simultaneously meeting other community needs by identifying avenues to integrate flood resilience and climate change considerations into policies, programs, and projects in RRBC.



BRIDGE OVER MARGARET'S CREEK

RARITAN RIVER AND BAY COMMUNITIES' MISSION STATEMENT:

The mission of Resilient Raritan River and Bay Communities (Resilient RRBC) is to "**create a watershed-based plan with a clear vision and roadmap for flood risk reduction, resilience, and environmental restoration to help the multi-municipal region survive and thrive.**" In developing this plan, the project team has employed the best available data and inclusive engagement to create social, environmental, and economic benefits and bring value to all who share in the region's future.

RESILIENT NJ: RARITAN RIVER AND BAY COMMUNITIES

The RRBC region includes seven municipalities in Middlesex County that were impacted by Hurricane Sandy: Carteret, Old Bridge, Perth Amboy, South Amboy, Sayreville, South River, and Woodbridge. The region is home to approximately 310,000 residents, 76,000 jobs, and numerous transportation and environmental assets of regional importance.

The mission of the Resilient NJ RRBC region is to **create a watershed-based plan with a clear vision and roadmap for reducing flood risk, increasing resilience, and achieving environmental restoration to help the multi-municipal region survive and thrive.** In developing this plan, the project team has employed the best-available data and inclusive engagement to identify a actionable roadmap that will yield social, environmental, and economic benefits for all who share in the region's future. Throughout the project, the team has brought together the people who live, work, and play in the area, alongside government, business, infrastructure providers, engineers, scientists, and environmental and community organizations to create a clear and equitable action plan that addresses current and future climate risks while improving quality of life.

Steering Committee

The project has been guided by a Steering Committee that includes representatives from each municipality, as well as Middlesex County and the YMCAs of Middlesex County. The Steering Committee has been meeting regularly over the course of the project to provide feedback on project priorities and public materials.

Multiple local YMCAs, as part of a coalition, serve as community partners on this project, helping to promote additional community input on the *Action Plan*. The Raritan Bay Area YMCA leads this coalition, which also includes the YMCA of Metuchen, Edison, Woodbridge, South Amboy (MEWSA); the Gateway Family YMCA – Rahway Branch (Carteret); the Old Bridge Family YMCA; and the Raritan Valley YMCA.

These Middlesex County YMCAs have been actively involved in the planning process through participation in the Steering Committee and additional efforts to enhance community engagement across the region. These YMCAs have experience working with historically underserved populations in the region and have worked with the project team to represent these populations in the planning process by sharing information about the project with their constituents and ensuring community priorities are clearly reflected in the planning process.

Project Goals

Build off ongoing resilience planning by identifying and addressing gaps and opportunities within the region.

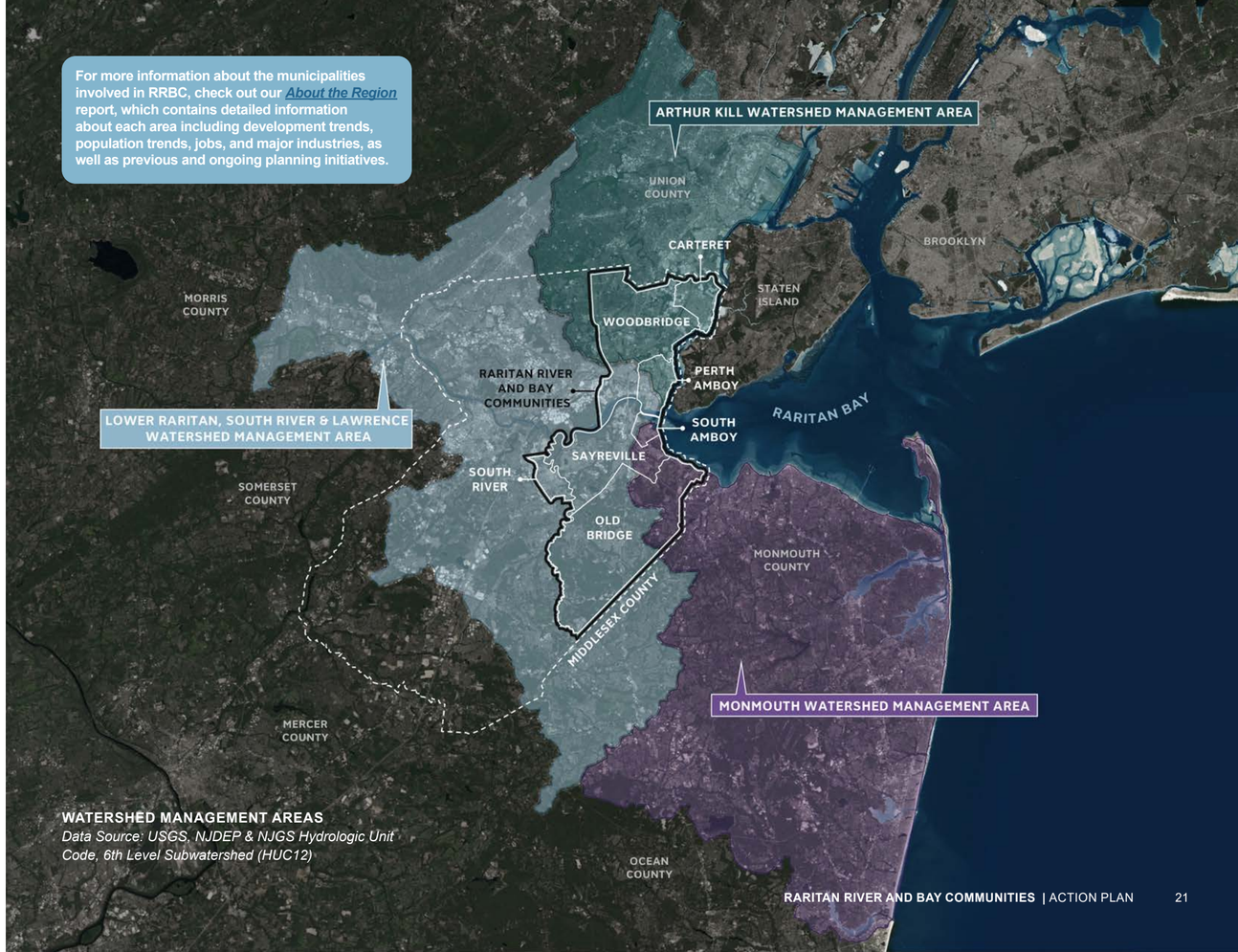
Ensure representation and participation from socially vulnerable populations to address their needs and risks.

Develop innovative and implementable solutions that increase resilience in both the short- and long-term.

Enhance the value and integrity of the ecological, recreational, and economic resources in the region.

Ensure collaboration among a wide variety of stakeholders.

For more information about the municipalities involved in RRBC, check out our *About the Region* report, which contains detailed information about each area including development trends, population trends, jobs, and major industries, as well as previous and ongoing planning initiatives.



WATERSHED MANAGEMENT AREAS
Data Source: USGS, NJDEP & NJGS Hydrologic Unit Code, 6th Level Subwatershed (HUC12)

OUR REGION'S HISTORY

In looking towards the future, the project team first sought to understand how the region has been shaped by its past to provide context on the existing strengths of the region as well as the challenges it currently faces. Located in Middlesex County in central New Jersey between New York City and Philadelphia, the Resilient NJ—Raritan River and Bay Communities region has been shaped geographically and culturally by the Raritan Bay.

The region was first settled 3,000 years ago by the Lenape. The Bay's rich sediment fostered diverse marine ecosystems with plentiful oysters and other shellfish. Its large intertidal zone also made the bay an attractive spot for other food sources that drew people to live and work nearby. The Lenape created an extensive system of trails that later became roads and developed into a major transportation network. The Lenape migrated seasonally and likely practiced small-scale agriculture along with hunting, gathering, and fishing the abundant shellfish in surrounding waters. Dutch colonists arrived in the 17th century, uprooting Lenape livelihoods through armed conflicts and the spread of contagious diseases. Dutch settlers grew Perth Amboy into a prominent port that enabled more commerce and trade in the region.

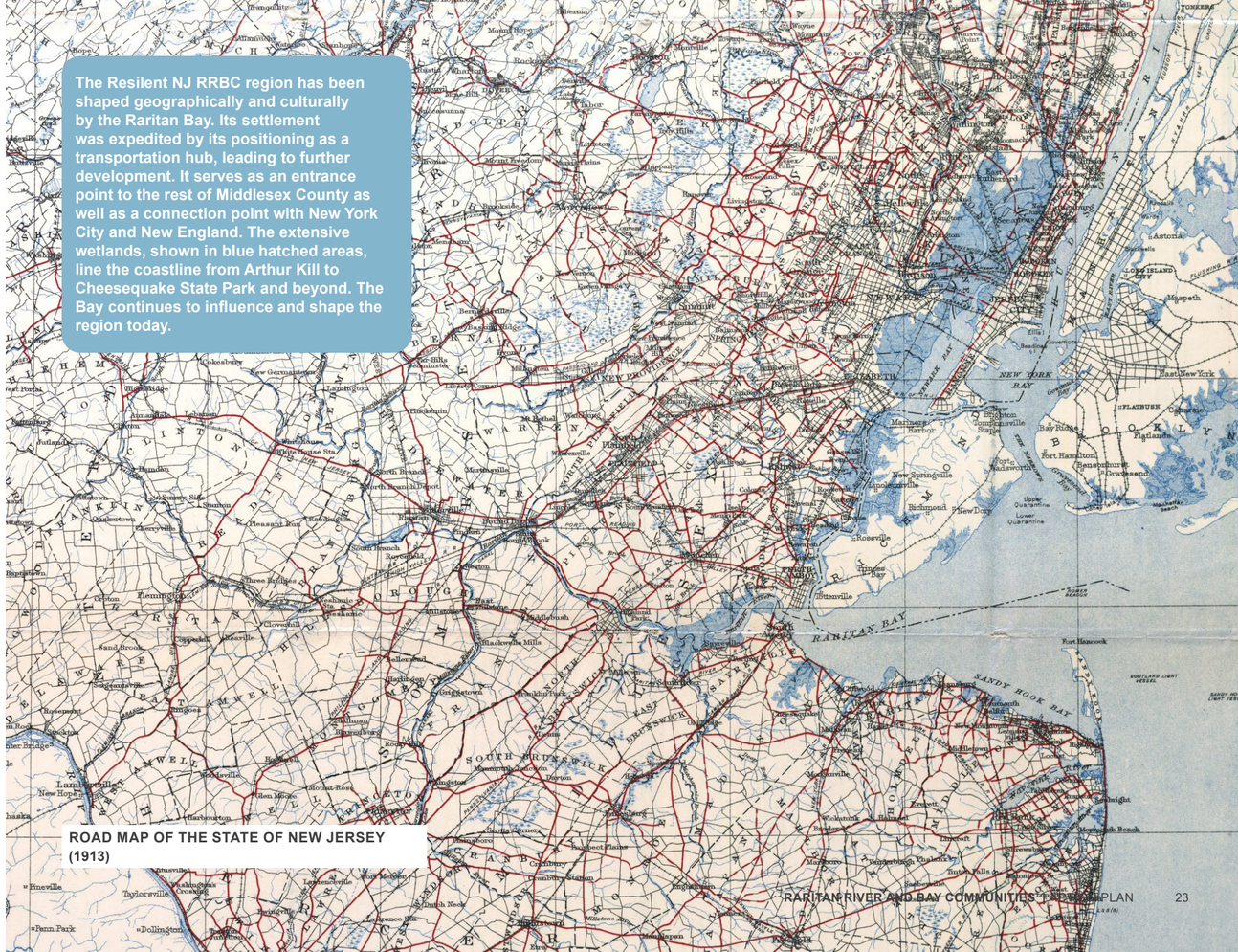
The settlement of this region was expedited by its position as a transportation hub, leading to further development. The Raritan River, which is the area's predominant geographic feature, flows the entire width of the county from west to east. This allowed the area to serve as an entrance point to the rest of Middlesex County, as well as a connection point with New York City and New England. Until the addition of a new rail network through Middlesex County in the 19th century, the area relied mostly on farming. Today, the region is characterized by a transportation network that connects New York City to the Jersey Shore with the North Jersey Coast Line operated by NJ TRANSIT, as well as connections to the Northeast Corridor to travel into Philadelphia on NJ TRANSIT or Amtrak. There are several primary roadways including the New Jersey Turnpike (I-95) and the Garden State Parkway.

As the region grew, the coast was dominated by large scale industrial uses, filling in much of the historic wetlands to make space for development. The RRBC region was a major producer of hosiery, musical strings, playing cards, ice, refrigeration equipment, and horseshoes. Although many of those industries have since left, their legacy of contamination remains. These areas are highly vulnerable to flooding today and contain contaminated soil due to both the fill material and industrial uses. While significant portions of the waterfront are still industrial, especially in Carteret, Perth Amboy, and Woodbridge, many parts of the industrial corridor are now recreation and preservation areas, commercial and residential neighborhoods, or brownfields in the process of being remediated and redeveloped.

The growth of manufacturing over the twentieth century in Middlesex County attracted many immigrants, increasing the size and diversity of the population. In 1900, the county's population reached almost 80,000. By the year 2000, this had expanded to over 750,000. Middlesex is now the second most populous county in New Jersey. The population grew as suburban residential communities proliferated, connected to job centers through regional rail and the Garden State Parkway. More recently, high density housing, mixed-use developments, and new types of industrial uses focused on warehousing and logistics have emerged.

Today, the RRBC region is varied and diverse with a population of over 300,000. The region is heavily interconnected along major transportation networks and waterbodies, home to a wide variety of cultures and industries. There is a mix of land uses, including large areas of residential development, active industrial corridors, greenways, and mid-sized parks. The region's largest employers are in the healthcare, pharmaceutical, financial, and goods distribution industries.

The region lies at the intersection of three major watersheds—the Arthur Kill; the Monmouth; and the Lower Raritan, South River, and Lawrence—which can be subdivided further into smaller watershed areas based on topography. Watersheds often cross municipal and state boundaries, which can present a challenge when planning for flooding and risk reduction. Throughout the process of developing this plan, the project team examined issues and developed strategies at the watershed or regional scale to promote effective flood risk reduction.



The Resilient NJ RRBC region has been shaped geographically and culturally by the Raritan Bay. Its settlement was expedited by its positioning as a transportation hub, leading to further development. It serves as an entrance point to the rest of Middlesex County as well as a connection point with New York City and New England. The extensive wetlands, shown in blue hatched areas, line the coastline from Arthur Kill to Cheesequake State Park and beyond. The Bay continues to influence and shape the region today.

ROAD MAP OF THE STATE OF NEW JERSEY (1913)

PAST AND ONGOING FLOOD RISK

Thousands of residents in RRBC live in areas vulnerable to flooding. Related hazards include tidal flooding from coastal storm surge, coastal erosion, high tide flooding from sea level rise, riverine flooding, flooding from heavy rainfall, and for some areas, combined sewer overflows. The region has been experiencing flooding for decades, much of it caused by flash flooding from heavy rainfall and storm surges, oftentimes originating from tropical storms and hurricanes. Some notable pre-Hurricane Sandy flood events in the region over the past half a century include heavy rainstorm flooding in 1971, 1973, and 1975; Hurricane Gloria in 1985; severe storm and heavy rainfall flooding in 1992 and 1996; Hurricane Floyd in 1999; severe storms causing both inland and coastal flooding in 2007; severe storm flooding in 2010; and Hurricane Irene in 2011. In 2012, municipalities in the region experienced a major flood disaster during and after Hurricane Sandy. Hurricane Sandy caused power outages, damaged businesses and homes, and forced the evacuation of thousands of people. Since then, RRBC has experienced flooding from other storms, including multiple nor'easters in addition to Hurricanes Irene and Isaias. During Hurricane Ida, flash flooding from heavy rainfall overwhelmed the stormwater system. These recent major floods—combined with chronic flooding issues—have sparked more interest in increasing resilience in the region.

There have been numerous resilience-related planning efforts in RRBC since Hurricane Sandy, including the purchase of properties severely and repetitively damaged by storms and flooding through the state's Blue Acres program. Since 2012, there have been more than 70 studies, reports, and action plans focused on the region, covering a wide range of topics. However, many residents, businesses, and community assets remain at high risk of flooding.

Climate change will increase risk as sea levels rise and the frequency and intensity of heavy precipitation events increases. Sea level rise will mean that when a coastal storm comes, the storm will reach further inland with higher flood depths. Increased heavy precipitation, meanwhile, will lead to more flooding in urban areas and the overflowing of rivers. While flooding will impact people of all types across the region, those with fewer resources or additional vulnerabilities face additional hardships. To help address these increasing risks, under the Governor Phil Murphy Administration, New Jersey has taken a proactive approach in preparing for climate change by introducing Executive Orders that create new statewide planning and policy mechanisms and require municipalities to consider climate change and resilience in their state-mandated master planning process. However, there is more work to be done to protect and transform these communities in response to changing climate conditions.

As part of the Resilient NJ program, the project team developed a detailed *Flood Impact Assessment* that summarizes what is likely to happen if nothing is done to protect the region from current and future flooding. This assessment evaluates the exposure of the region and expected impacts due to six different flood events representing a range of flood hazards including heavy rainfall flooding, coastal storm surge flooding, and high tide flooding.

Through the engagement process—detailed in the *Vision and Priorities* report—the project team collected an abundance of information about the region's experiences with flooding. This feedback was integral to the development of this plan in a variety of ways, including by validating the results of the *Flood Impact Assessment* and helping finetune the recommended resilience actions.

Who and What May Be Impacted by Flooding?

Across All Flood Events Evaluated

1 of every 5 residents

14,000 buildings worth $15 B

3,900 acres of park space

17% of daily economic output

WHAT FLOODING LOOKS LIKE IN RRBC: IDA IMPACTS

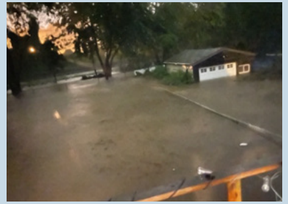
The RRBC region was substantially damaged by Tropical Storm Ida. Middlesex County declared a county-wide state of emergency due to widespread flooding and storm damage to every municipality. Streets were closed and barricades were put in place to ensure safety and monitor traffic. The Raritan River reached new highs that have not been seen in over 50 years. Recovery from the storm and its impacts continues and will take years.

Carteret Flooding

Source: The Lakewood Scoop

Hurricane Ida flooded the Carteret Yeshiva and surrounding areas. The Yeshiva, an important community asset in Carteret, experienced severe basement and first-floor flooding in its Main Building and dormitories. Carteret as a whole experienced 9" of rainfall.

Woodbridge Flooding



Source: News 12

As parts of the Raritan River flooded during Hurricane Ida, this image from Woodbridge shows the rising water levels submerging neighborhood backyards. Nearby in New Brunswick, residents were evacuated.

Source: NJ Spotlight News

In the aftermath of the September flooding devastation that Ida caused in Woodbridge, several flood victims have considered state buyouts of their properties. When Woodbridge asked homeowners there if they would consider selling their flood-prone houses through New Jersey's Blue Acres program, many applied.

South River Flooding

Source: Youtube

In South River, the Causeway area of South River experienced significant flooding during Hurricane Ida. Barricades were placed to close the area to traffic. The road flooding due to the hurricane also limited area evacuation route access.

Middlesex County Flooding

Source: News 12 Bronx | CBS New York

Overall, Hurricane Ida impacted Woodbridge, Carteret, and South River most within the RRBC region. Throughout New Jersey, though, 30 people died as a result of the floods.

OUR PLANNING PROCESS

To develop an actionable roadmap for building resilience in the region, as outlined in the project's mission statement, the project team took a multi-phase approach for the development of this Action Plan.

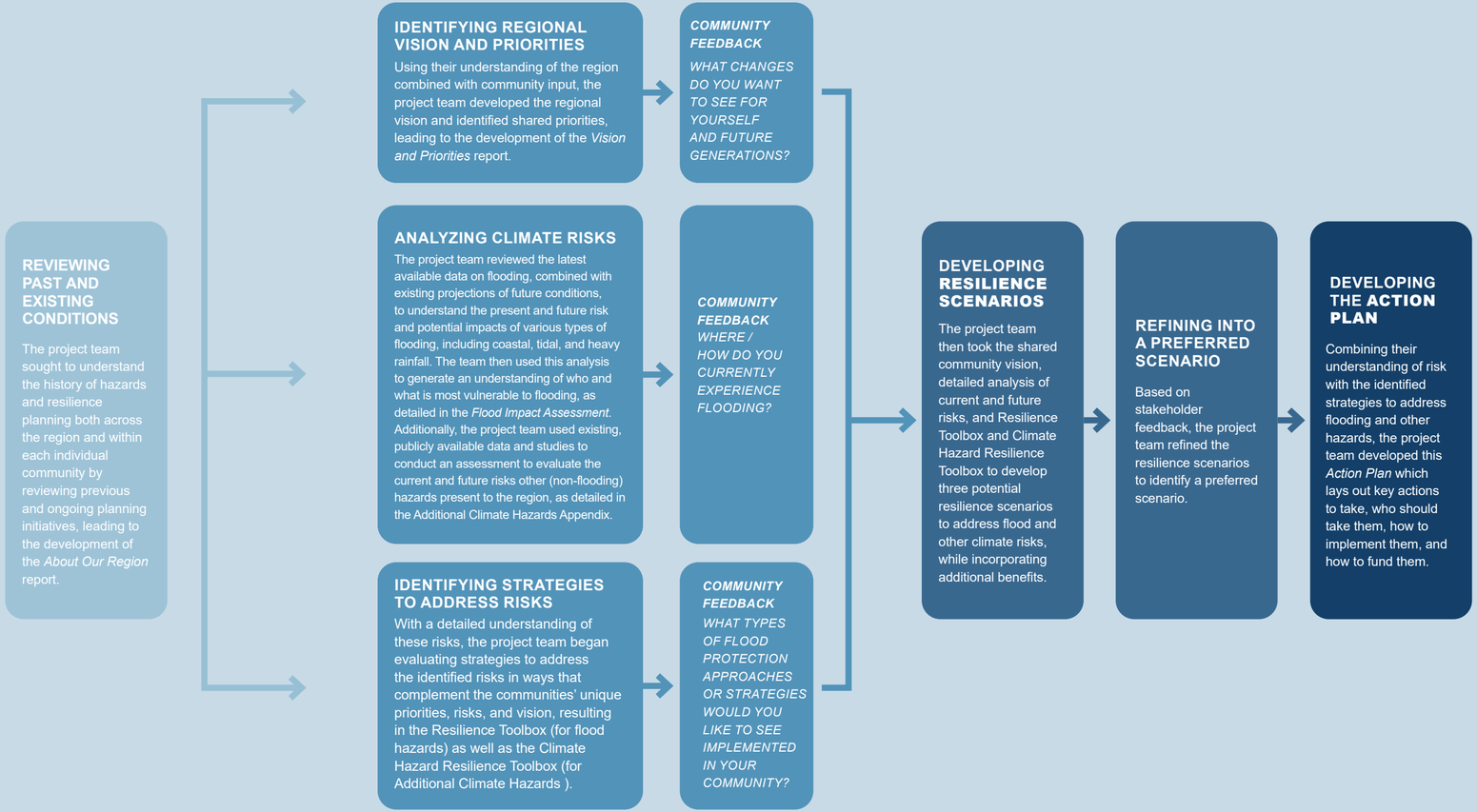
The planning process began in December 2020 with project kick-off, information gathering, and an existing conditions analysis. These steps informed the *Flood Impact Assessment* and the launch of the scenario development and evaluation process. In the spring and summer of 2022, the project team finalized the preferred scenario and recommended actions, with *Action Plan* development concluding the planning process. Throughout the planning process, community and stakeholder engagement guided the incorporation of community preferences, priorities, and values at every stage.

This *Action Plan* focuses in on the development of risk reduction actions and their implementation. Additional details about earlier project phases can be found in the following reports:

- *About Our Region*
- *Vision and Priorities*
- *Flood Impact Assessment*

These reports can be found online at https://resilientnewjersey.com/resource-library.

The RRBC resilience planning process included the steps outlined in the following diagram.

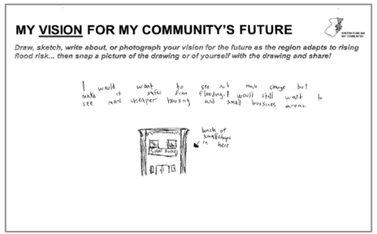


COMMUNITY ENGAGEMENT

Community engagement was an essential part of the planning process described above. Community members, local leaders, business owners, and other stakeholders in the RRBC region are the foremost experts on their communities. The project team actively sought community feedback during every step of developing this *Action Plan*, working to identify, reach out to, and incorporate feedback from diverse groups of people whose voices may have been unheard or undervalued in the past.

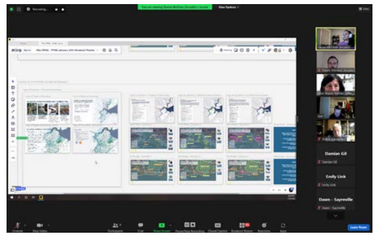
Throughout the RRBC engagement process, the support of the Steering Committee and the Middlesex County YMCAs has been critical for the project team in collecting valuable community feedback. In coordination with the Steering Committee and the YMCAs, the project team reached out to potential partner organizations the ensure the engagement effectively reached and spoke to a broader audience on a basis of mutual trust, collaboration, and joint knowledge production.

Review the *Vision and Priorities* report to learn more about community engagement efforts in the region through January 2022. See page 80 to learn more about community engagement in the region from February through June 2022.

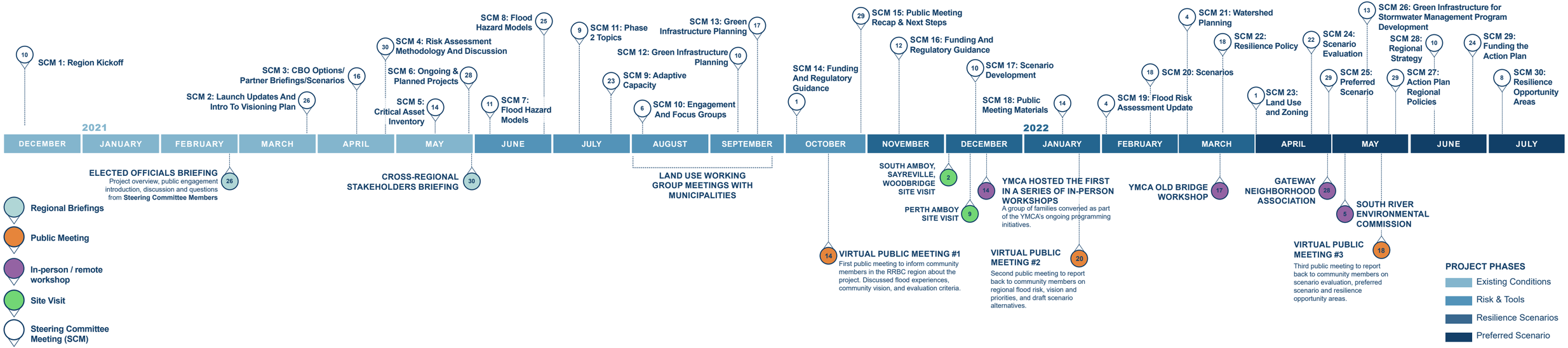


YMCA WORKSHOP WITH STUDENTS
Community-based organization YMCA hosted visioning workshops with students in December 2021.

OLD BRIDGE SCENARIO WORKSHOP
YMCA hosted workshops to discuss scenario alternatives with residents and city planners in March 2022.



VIRTUAL COMMUNITY MEETINGS
The project team organized three virtual community meetings to receive feedback on key project milestones.



To maximize community input and reach a diverse audience, the project team undertook a multi-pronged engagement strategy, which included:

- Hosting virtual community meetings
- Offering opportunities to get and receive information in multiple languages and multiple platforms
- Hosting community conversations at local community centers, like schools and neighborhood associations
- Handing out flyers and playing an informational video series on flood risk in the Raritan River YMCA's lobby
- Partnering with the YMCAs to host workshops with local organizations, including supporting a table at Healthy Kids Day, a presentation to the Weather Club at Perth Amboy Middle School, and a presentation to the Gateway Neighborhood Association in Perth Amboy
- Using Anytime Engagement platforms, which meet people where they are and expand public involvement opportunities beyond public meetings and facilitated conversations. This included an app for people to identify key locations in their communities, a project website with surveys and other information, and a project hotline and email address to submit questions and comments.

Through these engagement opportunities, the project team collaborated with RRBC communities to develop a shared regional vision for the future centered on community priorities. This vision ultimately guided the development of the strategies and actions recommended in this *Action Plan*. Further, much of the information gathered as part of this process was vital to the development of this report. Community members shared their specific experiences with flooding, their concerns about certain flood risk reduction strategies, other community concerns, and their ideas on how to address flooding. The project team learned that RRBC is a diverse region, with a range of cultural, racial, and ethnic groups, as well as a diversity of density, from rural areas to urban spaces. Many communities have strong social networks and deep roots, as many families have lived in the area for generations and developed a strong sense of community connectiveness that they hope to preserve. There are also many spaces that are essential to the communities in the region, including waterfront areas, parks, schools, firehouses, and libraries. These assets provide critical services and play important roles in how the region functions. The community expressed a desire to first and foremost addressing flooding concerns, but also placed strong value on the environment and expressed interest in preserving and expanding green spaces, increasing waterfront access, reducing impervious surfaces, and remediating brownfields. The community also expressed a desire for the waterfront areas to serve as economic drivers with better access, amenities, and resilient development. Underpinning these concerns, the project team heard a desire to address quality of life issues, especially those associated with nearby industrial areas, access to community resources, and engaging and supporting under-resourced and historically marginalized populations.

REGIONAL RESILIENCE VISION

RARITAN RIVER AND BAY COMMUNITIES' VISION FOR THE FUTURE IS:

"A thriving region of interconnected watersheds, with complementary environmental, social, economic, and governance systems working together to reduce flood risk of communities and infrastructure, restore natural systems, and adapt to a changing climate."

FLOODING

- Reduce risk in repetitive loss areas
- Implement resilience strategies that work with natural systems
- Improve communication for existing programs and policies
- Encourage grassroots advocacy and education

ENVIRONMENT

- Restore natural systems, including riparian and tidal zones
- Create more green spaces and conservation zones that support resilience
- Support green infrastructure investment

ECONOMY

- Create high quality green jobs and training opportunities
- Economic diversity and preservation of small businesses

SOCIAL

- Preserve sense of home, community, and cultural diversity
- Better access to parks and public spaces
- Improve environmental quality and well-being

INSTITUTIONAL GOVERNANCE

- Watershed-based planning in the multi-municipal region
- Greater public involvement and investment in relationship between government and community members

PHYSICAL INFRASTRUCTURE

- Flood proof critical utilities
- Improve access to transportation
- Improve pedestrian and biker infrastructure

PURPOSE OF THIS PLAN

Through the Resilient NJ program, the Raritan River and Bay Communities region has engaged in a stakeholder-guided process to become more resilient and improve quality of life for its more than 300,000 residents.

A culmination of these efforts, this *Action Plan*:

1. Summarizes the Resilient NJ program and resilience planning process undertaken in RRBC
2. Shares the outcomes and results of the program and process; and
3. Provides a roadmap for reducing flood and other climate risks and addressing critical issues in the region through identified resilience strategies and actions.

What This Plan Includes

This plan is intended to be an actionable roadmap, providing clear next steps that should be taken to implement the identified resilience actions. It builds off ongoing resilience planning within the region and incorporates the voices and needs of all members of the region, including the most vulnerable, to provide innovative and implementable strategies and actions that increase long- and short-term resilience and enhance the value and integrity of the ecological, recreational, and economic resources of the region.

The plan is organized into the following chapters:

- **Project Background & Objectives** – Provides an overview of the Resilient NJ program, our understanding of the RRBC region and its history, and a summary of the planning process undertaken to complete this plan
- **Summary of Climate Impacts in the Region** Summarizes key findings of the flood impact and additional climate hazards assessment which provided the basis of our understanding of current and future risks in the region
- **Three Pathways to a More Resilient Region Scenario Development and Evaluation** Details the scenario development and evaluation process undertaken to weigh the pros and cons of three potential approaches and develop the preferred scenario
- **Resilience Action Plan Implementation Framework** – Provides an overview of the preferred scenario, details recommended strategies and actions at the regional and sub-watershed scales, and outlines a roadmap to implement the identified actions

CHEESEQUAKE STATE PARK, OLD BRIDGE

To help strengthen RRBC communities' resilience to future storms and other extreme events, this plan equips the public, community-based organizations, RRBC municipalities, Middlesex County, and the State of NJ with targeted strategies and actions. The strategies and actions included in this plan were informed by community feedback solicited throughout the project and are responsive to community priorities by aiming to provide multiple benefits beyond flood risk reduction. Recommended strategies span three broad approaches:

1. Policy and governance
2. Physical and nature-based infrastructure
3. Outreach, education and capacity building

Strategies and actions included in this plan are presented at three scales:

1. **Regional** – Regional strategies are relevant across the region, may be led by a county or state entity, and/or likely benefit from ongoing coordination of various entities within the region. Within the regional strategies included in this *Action Plan*, priority actions have been identified that should be implemented in the near-term. The regional resilience strategies recommended fall under 9 strategy types that have applicability across the region, such as coastal resilience, stormwater management, and zoning and land use. Within the regional strategies, the project team has identified priority actions that should be implemented in the near-term.
2. **Sub-Watershed** – Various combinations of regional strategies can be applied at the sub-watershed scale, based on unique land use characteristics and shared risks within each sub-watershed. Strategies can work together at this scale to address multiple risks and provide additional benefits. Sub-watersheds cross municipal jurisdictional boundaries, demonstrating how collective regional action is necessary to proactively address shared flood risks.
3. **Resilience Opportunity Areas** – Within the sub-watersheds, the project team zoomed in on local Resilience Opportunity Areas as specific geographies where there are significant risks to populations and critical assets. Within these Opportunity Areas, this *Action Plan* recommends a series of targeted actions to be implemented by multiple entities. The intent of these areas is to demonstrate how coordinated actions across jurisdictions can result in improved resilience and other improvements. Taking actions in these areas can also be a catalyst to advancing additional related actions across the region.

The magnitude of flood and other climate risks in the RRBC region both today and in the future demands coordinated action at multiple scales by every level of government. To aid in the implementation of the many actions identified, this plan identifies immediate next steps, lead entities, necessary partners, costs, and potential funding sources for each action.

The strategies and actions included in this plan equip the RRBC region with the projects, programs, and policies needed to build resilience and adapt to a changing climate. As the strategies and actions included in this plan are implemented over the next 3, 5, or 10 years, RRBC will reduce flood and other climate risks to communities and infrastructure, restore natural systems, and realize the vision of a thriving region of interconnected watersheds with environmental, social, economic and governance systems that work together to meet shared goals.

AERIAL VIEW OF RARITAN RIVER AND BAY
Image Credit: Doc Searls Via Flickr

03 - SUMMARY OF CLIMATE IMPACTS IN THE REGION

Flood Impact Assessment

Additional Climate Hazards Assessment

FLOOD IMPACT ASSESSMENT

This *Action Plan* seeks to reduce current and future risks due to flooding and additional climate hazards . Flooding is an ongoing issue in the region and climate change is making it worse.

The project team conducted a detailed flood impact assessment to evaluate the impacts of various types of flooding across the region and identify geographies, populations, and assets that may be vulnerable to flooding and other hazards both today and in the future. The project team used the results of this assessment to inform the development of risk reduction strategies guided by the community vision and priorities.

During the planning process the project team heard interest from stakeholders about the impacts of additional climate hazards and how the region could prepare for other threats. Based on this feedback, the team undertook a second analysis of additional climate hazards to examine how climate threats beyond flooding—such as extreme heat, air pollution, drought, wildfire, and others—are likely to impact the region in the future with climate change.

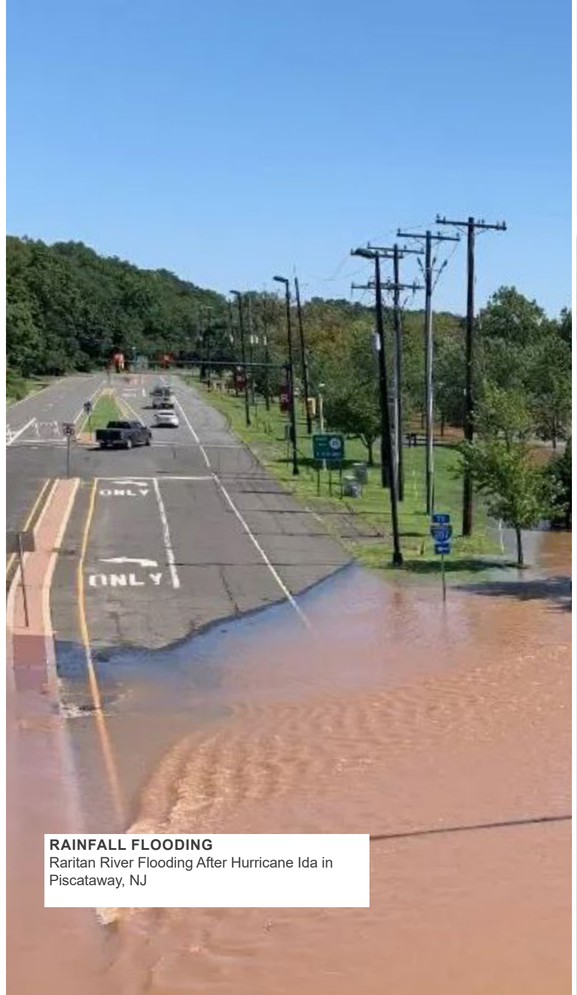
This section summarizes the key findings of the flood impact assessment. Additional information, including data sources and methodologies, is available in the full *Flood Impact Assessment*.

History of Flooding in RRBC

Together, the municipalities of Carteret, Woodbridge, Perth Amboy, South Amboy, Sayreville, South River, and Old Bridge are part of an interconnected and vibrant region that, in many ways, has always been defined by its relationship to the Raritan Bay, the Raritan River, and other waterbodies.

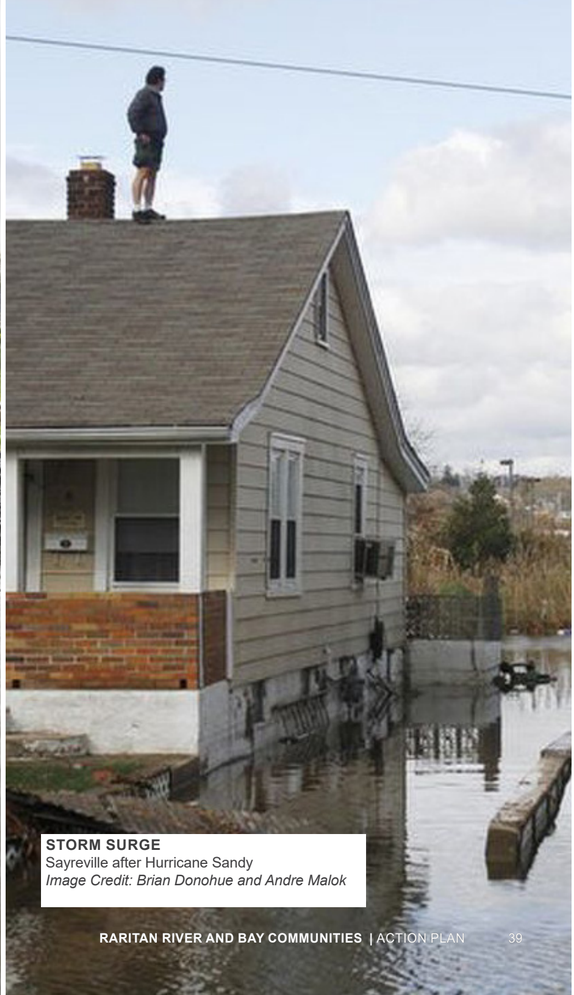
Historically, these waterways provided opportunities for commerce and supported the growth of local manufacturing. More recently, the proximity to water has been seen as a recreational amenity and the region's waterways have attracted new development. However, as Hurricanes Sandy and Irene, as well as the more recent flood events of summer 2021, have demonstrated, the proximity to water also presents a threat—one that is increasing due to climate change.

As the region was developed, many wetlands were filled in, locating development on low elevations susceptible to flooding and blocked natural drainage patterns. Much of the region was also developed prior to codes on stormwater or floodplain management, meaning development did not incorporate drainage elements or buildings designed to be safe from flooding. The stormwater infrastructure that was built out at the time, such as culverts and underground drainage networks, was not designed to manage the intense rainfall events that the region is now regularly facing.



RAINFALL FLOODING
Raritan River Flooding After Hurricane Ida in Piscataway, NJ

TIDAL FLOODING
May 7, 2022 King Tide near Pump Station on South River, Sayreville. *Image Credit: High Water Report by Douglas Baumann via NJ MyCoast*



STORM SURGE
Sayreville after Hurricane Sandy
Image Credit: Brian Donohue and Andre Malok

FLOOD IMPACT SUMMARY

As demonstrated by historic and more recent events—and supported by the most up-to-date climate science—the RRBC region faces high, and increasing, risks from heavy rainfall events, coastal storm surge, and tidal flooding. Each of these presents its own challenge. Many areas in the region face flood risks from multiple sources, demanding solutions that address the ways in which these flooding sources interact in order to provide holistic flood risk reduction.

Social Vulnerability

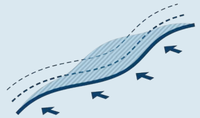
The region is varied and diverse, representing a wide range of social backgrounds, values, opportunities, and challenges. Parts of the region—especially in more heavily urbanized areas, such as parts of Perth Amboy—contain neighborhoods classified by the Centers for Disease Control and Prevention (CDC) as within the highest-ranking categories of "socially vulnerability." Social vulnerability refers to the degree to which a community's individuals and households are challenged when faced with significant disruptions, such as natural disasters or disease. A variety of socio-economic factors play a pivotal role in understanding the degree of impact a community or household may experience because of flooding. For example, lower income households have fewer resources to adapt to changing and dangerous circumstances—whether by moving to areas or homes less exposed to risk, by retrofitting their homes or securing appropriate flood insurance to withstand severe events, by having access to transportation to seek shelter in an emergency, or to financially recover from a destructive flooding event. Historical exclusion and inequitable policies tend to make communities within certain demographics especially susceptible to the most severe impacts of flooding, especially Black, Brown, and Latinx communities, low-income populations, low English-speaking households, and people with disabilities.

An analysis of rates of social vulnerability within RRBC reveals very high rates of social vulnerability concentrated in Perth Amboy, Carteret, the area around Main Street in South River, and pockets of Sayreville. Some neighborhoods with high CDC Social Vulnerability Index (SVI) scores—which aggregates a variety of factors gathered from US Census data including socio-economics, housing composition and disability, minority status and language, and housing type and transportation access—overlap significantly with high concentrations of contaminated sites and overall proximity to hazardous waste, particularly in the northern parts of the region in and around Carteret and Perth Amboy. Residents living within or near current and future flood-prone areas near hazardous waste face serious additional risks, as floodwaters can disrupt these sources of pollution and spread hazardous materials away from the site.

An alternative metric to assessing vulnerability is provided by NJDEP's Office of Environmental Justice, which identifies "overburdened communities" (OBCs) across the state. OBCs are defined as census block groups which meet certain thresholds for rates of low-income households, residents identifying as minorities, and/or households that have limited English proficiency.

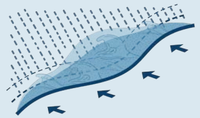
Sources Of Flooding In RRBC

Tidal Flooding



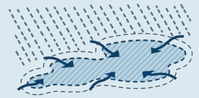
Tidal flooding is the temporary inundation of low-lying areas due to high tides. Sea level rise will cause tides to be higher than they are today, and some areas will flood daily if no actions are taken.

Storm Surge



Tropical storms, hurricanes, and nor'easters can raise water levels along the coast.

Areal Flooding

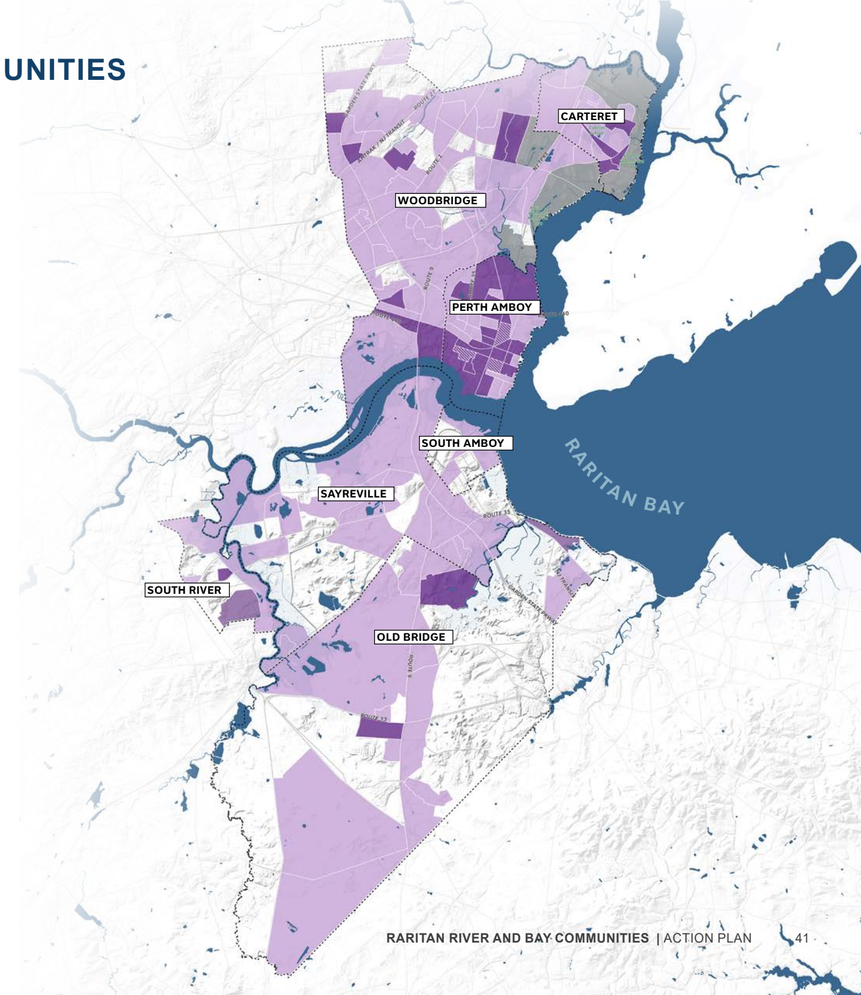


Inches of rain can fall in a few hours during the peak of a storm, causing flooding in low-lying areas. These areas might be along waterways (riverine flooding) or inland where rainfall overwhelms storm drains.

OVERBURDENED COMMUNITIES

These maps corroborate many of the takeaways from the social vulnerability maps, revealing that most census block groups in RRBC are considered overburdened communities given the great number of minority populations who live across the region. However, some communities meet multiple thresholds of OBCs, with many households and residents identified as OBCs both on the basis of low income as well as minority status—with some also on the basis of limited English proficiency—concentrated in and around Perth Amboy.

Lower income households with less savings are more vulnerable when faced with losing income. A history of exclusionary policy has inequitably distributed resources so that Black, Brown, and Latinx communities are disproportionately exposed to flooding and its most dangerous effects. Others, such as the elderly or people with disabilities, also face a higher degree of overall risk, as they tend to have limited ability to evacuate.



LEGEND

RRBC OVERBURDENED COMMUNITIES

- No Population, Adjacent to an OBC
- Minority (40%+)
- Low Income (35%+)
- Low Income (35%+) and Minority (40%+)
- Low Income (35%+), Minority (40%+), and Limited English (40%+)

Data Source: NJDEP Environmental Justice Mapping, Assessment, and Protection Tool (2022)

Summary of Regional Flood Impacts

The RRBC region is home to numerous assets of regional importance, such as the Garden State Parkway, I-95, the North Jersey Coast Line, several power generation plants and wastewater treatment facilities, as well as many regional parks such as Cheesequake State Park. In addition, there are numerous critical assets in every town. These include buildings (such as schools, day care centers, hospitals, or fire stations), infrastructure (such as roads, bridges, and pipelines), or spaces that host community events (like farmer's markets). The *Flood Impact Assessment* identifies critical assets of regional importance that are vulnerable to flooding within each municipality.

The detailed *Flood Impact Assessment* evaluates exposure to current and future flooding and summarizes the potential monetary losses due to physical damages to structures and their contents, human impacts, direct business impacts, and the loss of function of public and essential facilities.

These losses are summarized for each of the flood events assessed. Events assessed include future events that account for climate change: specifically, coastal storm surge and heavy rainfall—the latter of which includes both areal flooding and flash flooding. The future storm surge event is expected to cause the most amount of damage comparatively. While storm surge is expected to affect a smaller area of the region than either areal or flash flooding, the flood depths experienced are expected to be greater, leading to higher damage. However, it is important to note that the storm surge event analyzed is expected to happen much less frequently than flash floods or areal floods caused by heavy rainfall events within the region.

Flood Impact Assessment Damage Categories

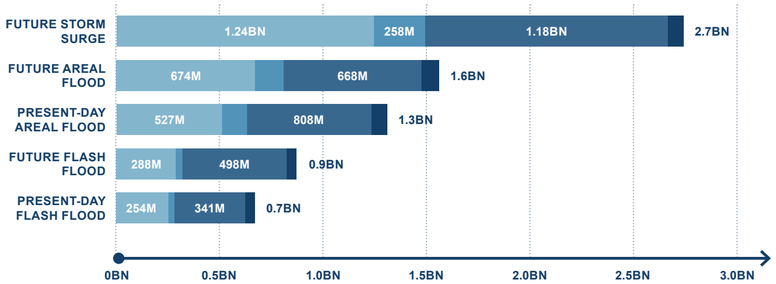
DIRECT PHYSICAL DAMAGE
Damage to Structures, Contents and Inventory Loss

HUMAN IMPACTS
Residential Displacement, Mental Stress and Anxiety, Injuries, Lost Productivity

BUSINESS IMPACTS
Business Relocation, Loss of Employment, Economic Output Loss, Tax Revenue Impacts

LOSS OF FUNCTION
Public and Essential Services Cannot Operate

FLOOD IMPACT ASSESSMENT RESULTS

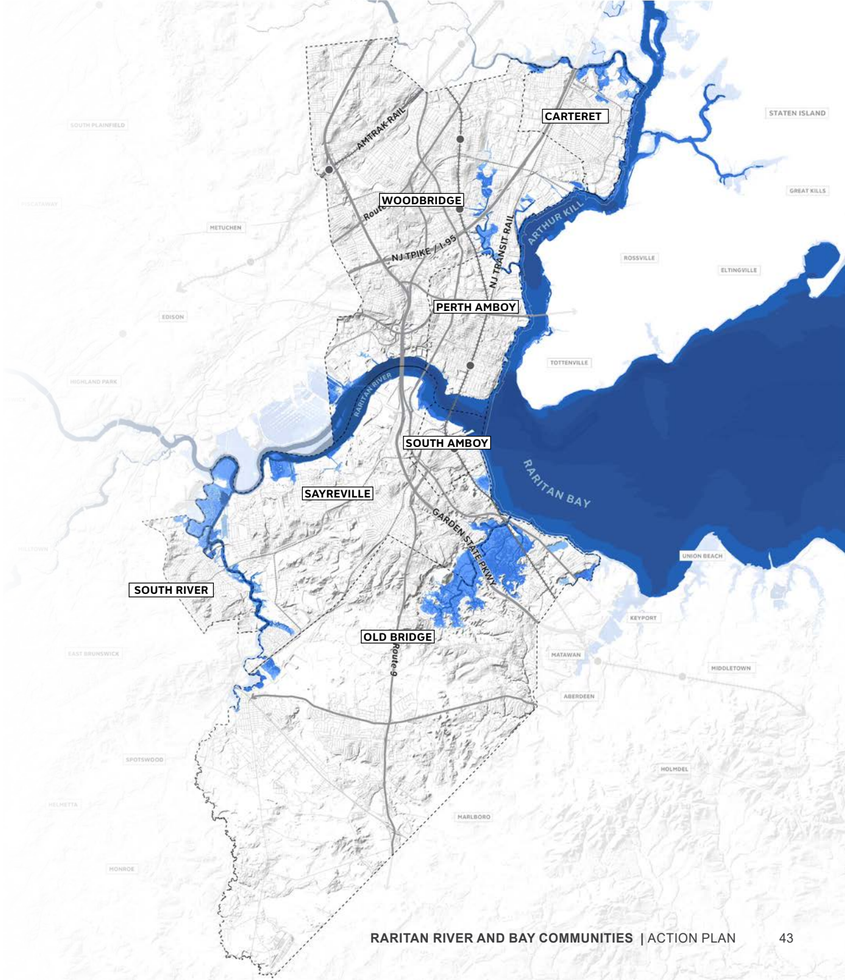


RESIDENTIAL
COMMERCIAL
INDUSTRIAL
OTHER

TIDAL FLOODING

Tidal flooding is the temporary inundation of low-lying areas due to high tides. Sea level rise will cause tides to be higher than they are today, and some areas will flood daily if no actions are taken.

With 2.4 feet of sea level rise, daily high tides will affect 3,000 acres where 32 buildings currently reside. These buildings have $3.8 million in building and contents replacement value and house 44 people. The land value of the affected properties is $110M.



LEGEND

Future Tidal Flooding
Mean High High Water with Sea Level Rise - Flood Depth (feet NAVD88)

- ≤ 2
- ≤ 5
- ≤ 10
- 10 +

Basemap

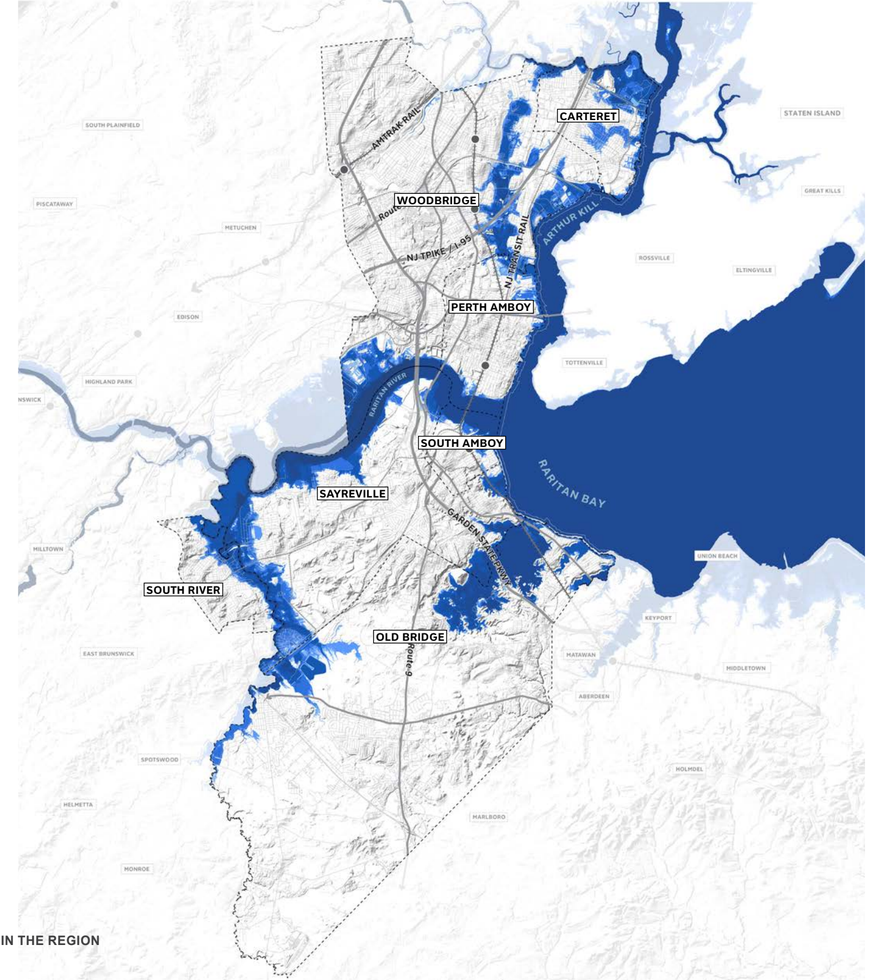
- Rail Network
- Main Roads
- Municipal Boundary

Data Source: RRBC Project Team

STORM SURGE

Tropical storms, hurricanes, and nor'easters can raise water levels along the coast, resulting in storm surge. To understand how coastal flooding could impact the region in the future, the Resilient RRBC team modeled storm surge from Hurricane Sandy as it occurred in 2012, with 2.4 feet of sea level rise.

A similar extreme storm surge event today could flood approximately 3,000 buildings across the region and impact approximately 14,000 residents, causing $1 billion in losses. With an additional 2.4 feet of sea level rise, this coastal flooding could impact approximately 2,000 more buildings with 8,000 more people, and almost tripling the losses.



LEGEND

Future Coastal Storm Surge
with Sea Level Rise (2.4') - Flood Depth (feet NAVD88)

- ≤ 2
- ≤ 5
- ≤ 10
- 10 +

Basemap

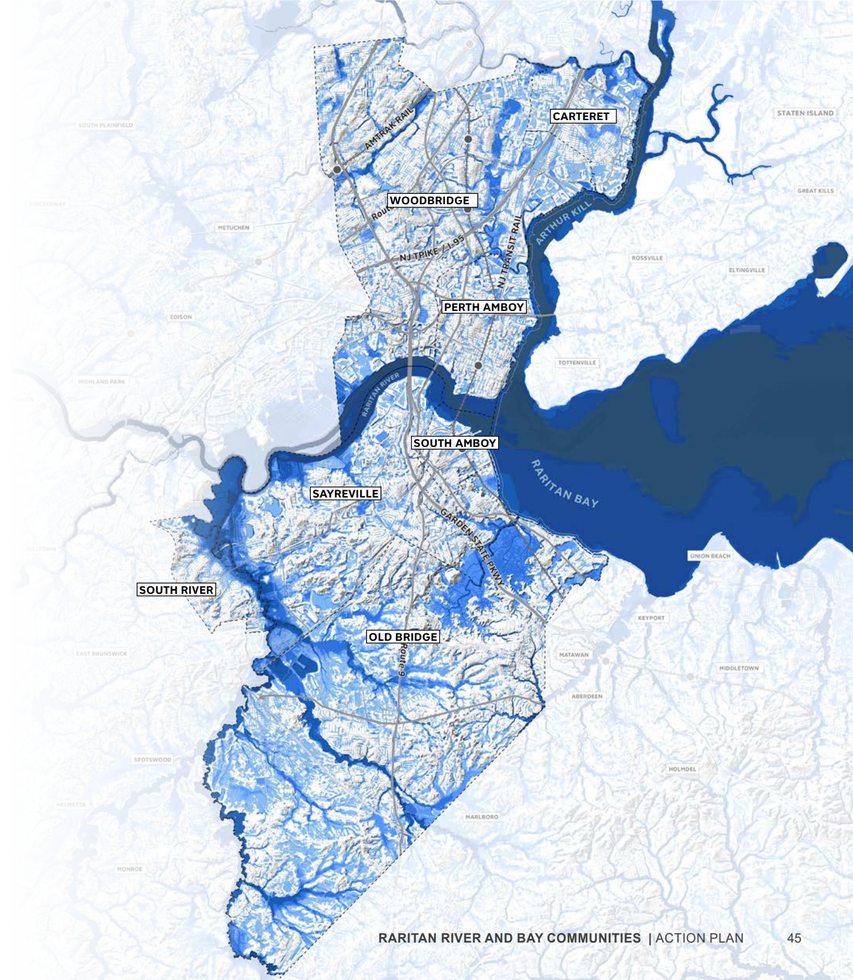
- Rail Network
- Main Roads
- Municipal Boundary

Data Source: RRBC Project Team

AREAL FLOODING

Inches of rain can fall in a few hours during the peak of a storm, causing flooding in low-lying areas. These areas might be along waterways (riverine flooding) or inland where rainfall overwhelms storm drains.

With a 10 percent increase in rainfall expected by 2070, but no change in the built environment or the number and locations of people, areal flooding could impact approximately 1,500 additional buildings and 8,000 additional residents, causing more than $200 million more in damage than from an areal flood event today. Flash flooding could directly impact approximately 800 additional buildings and 4,000 additional residents, causing $200 million more in losses.



LEGEND

Future Areal Flooding
with 10% increase in rainfall (flood depth in NAVD88)

- ≤ 2
- ≤ 5
- ≤ 10
- 10 +

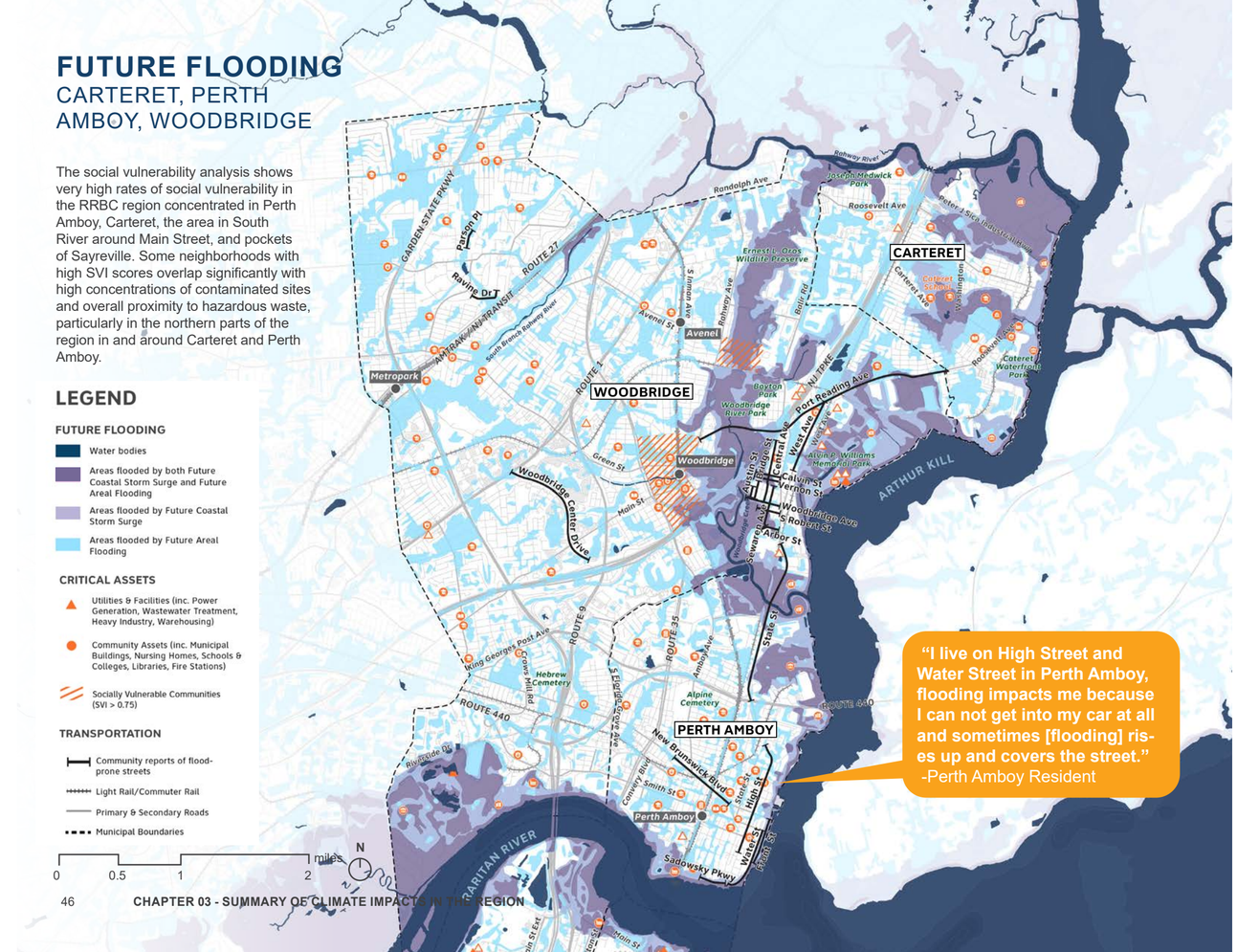
Basemap

- Rail Network
- Main Roads
- Municipal Boundary

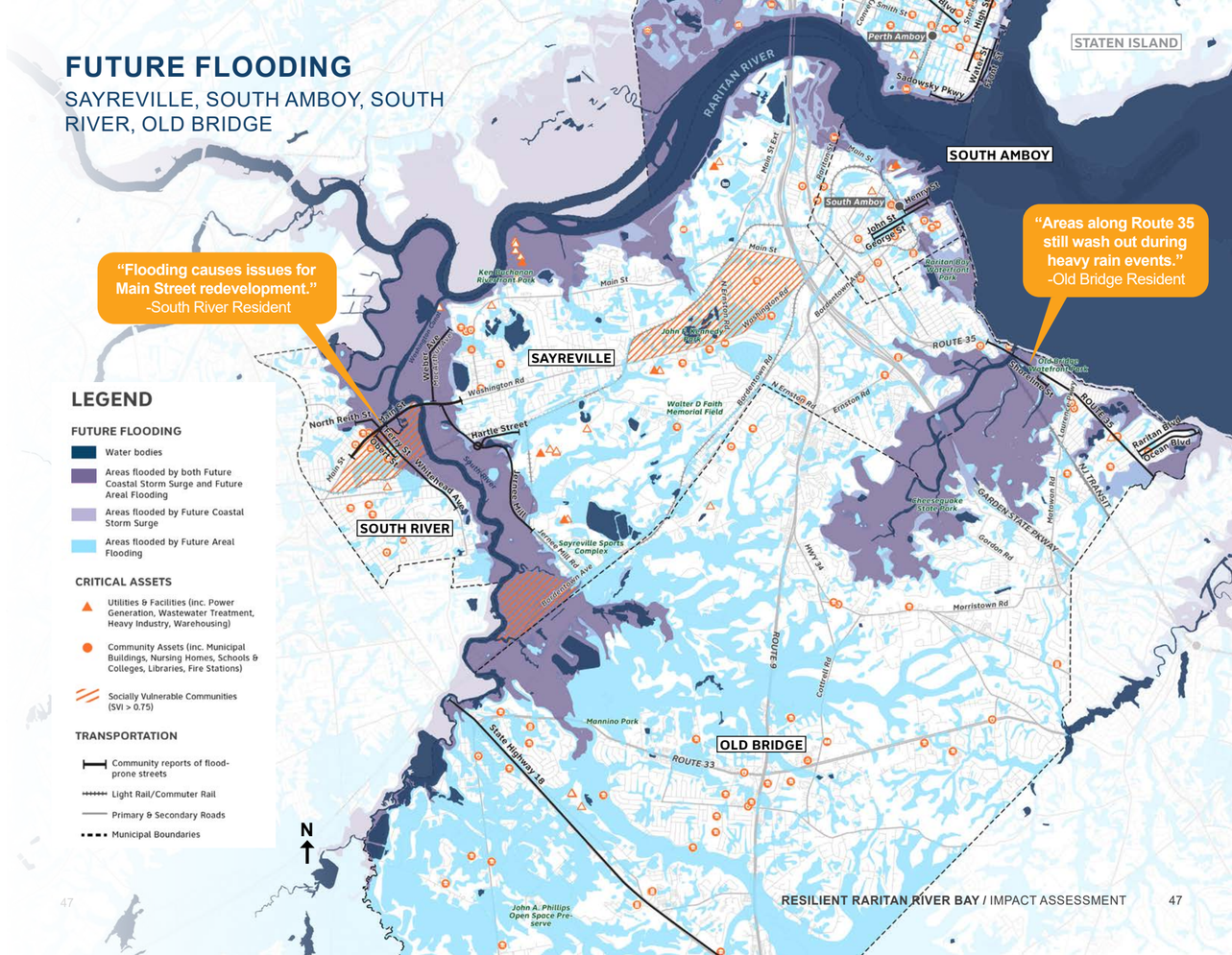
Data Source: RRBC Project Team

FUTURE FLOODING
CARTERET, PERTH AMBOY, WOODBRIDGE

The social vulnerability analysis shows very high rates of social vulnerability in the RRBC region concentrated in Perth Amboy, Carteret, the area in South River around Main Street, and pockets of Sayreville. Some neighborhoods with high SVI scores overlap significantly with high concentrations of contaminated sites and overall proximity to hazardous waste, particularly in the northern parts of the region in and around Carteret and Perth Amboy.



FUTURE FLOODING
SAYREVILLE, SOUTH AMBOY, SOUTH RIVER, OLD BRIDGE



ADDITIONAL CLIMATE HAZARDS ASSESSMENT

Flooding is not the only climate hazard RRBC must worry about as increasing greenhouse gas emissions drive climate change.

This section summarizes the key findings of the Additional Climate Hazards Assessment. Additional information, including data sources and methodologies, is available in the *Additional Climate Hazards Assessment* appendix.

Increasing global temperatures, radical shifts in precipitation and weather patterns, sea level rise, and correlated groundwater table rise will interact in complex ways to threaten the region with various additional hazards. The include other (non-flooding) types of severe weather, various direct and indirect hazards posed by groundwater rise, increased drought and threats to water supply, extreme heat, worsening air quality, invasive species and vector-borne illnesses, increased risk of wildfire, and ocean acidification.

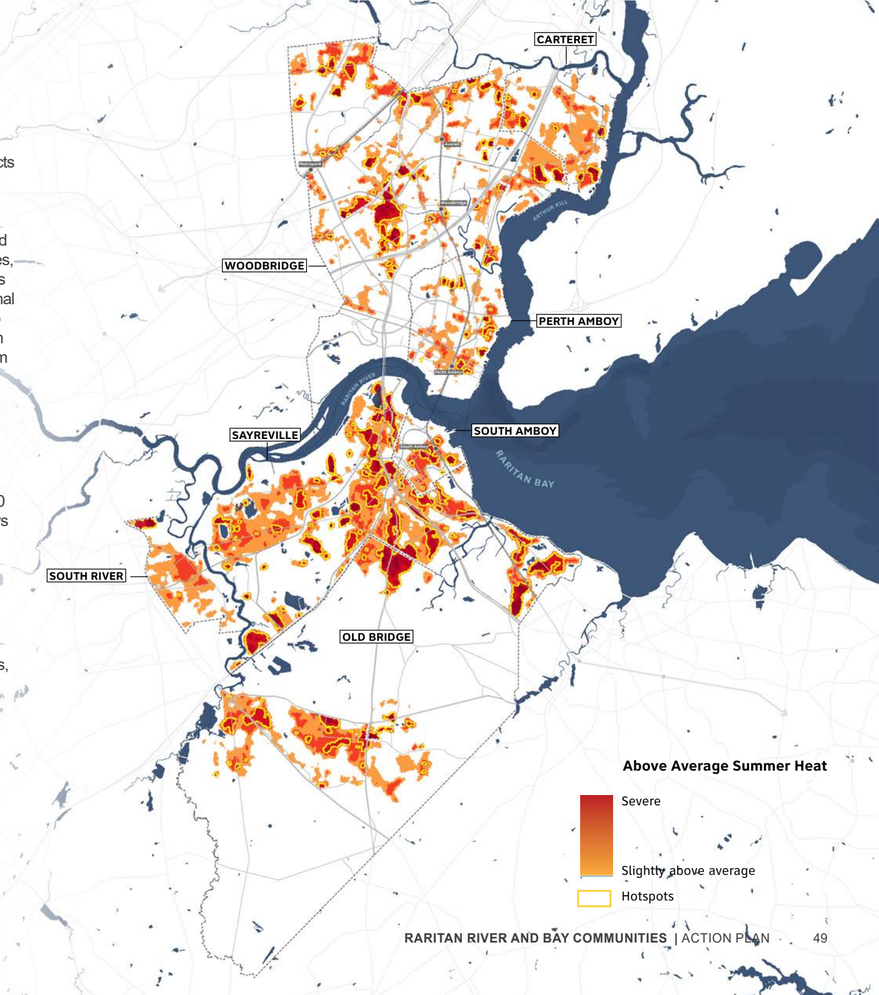
The project team conducted an additional assessment to evaluate the risks these hazards present to the region, how these risks will evolve as climate change progresses into the future, and the types of impacts to be expected to people and places—whether to public health, the provision of critical services, or the health and integrity of existing ecosystems and habitats the region's population depend on. The team relied on existing publicly available data and studies to complete this assessment. Key issues and needs identified through this assessment are detailed below. Recommended strategies to address these needs are discussed in the *Resilience Action Plan Implementation Framework* later in this report.

RISING TEMPERATURE

Rising global temperatures will have an increasingly acute localized effect on the region with serious impacts to public health. Rising temperatures will generate dangerous heat, contribute to worsening air quality, potentially disrupt critical services, threaten water supply and quality, food supply as a result of increased incidence of drought, increase the likelihood of wildfires, and increase the risk of vector-borne illnesses such as Lyme disease and West Nile Virus with longer seasonal periods. In addition, increasing temperatures can also facilitate the introduction of other invasive species with environmental impacts that could have other long-term implications and threaten the region's forests.

Localized urban heat island will be especially acute in the more heavily urbanized parts of the region, such as parts of Carteret and Perth Amboy. For example, by the end of the century, Carteret could see a nearly 300% increase in annual days with heat index equal to or greater than 90°F (compared with the 1971-2000 historical average) —an average of more than 90 days per year.

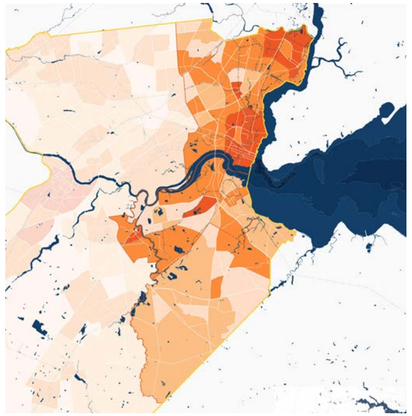
Projected higher temperatures and increased frequency of drought are likely to increase the length of the wildfire season in the region in the future—particularly in the area around Cheesequake State Park in Old Bridge. In addition to potential loss of life as well as the destruction of forests, brush, grasslands, field crops, public and private property, and damage to critical facilities, wildfire smoke can have additional implications for air quality.



SOCIAL VULNERABILITY

Some of the most socially vulnerable communities in the state—and in some cases, the country—reside in Perth Amboy and Carteret. They live in areas of extremely high urban heat, pollution, and proximity to hazardous waste.

The CDC Social Vulnerability Index (SVI) scores aggregates a variety of factors gathered from US Census data including socio-economics, housing composition and disability, minority status and language, and housing type and transportation access



LEGEND

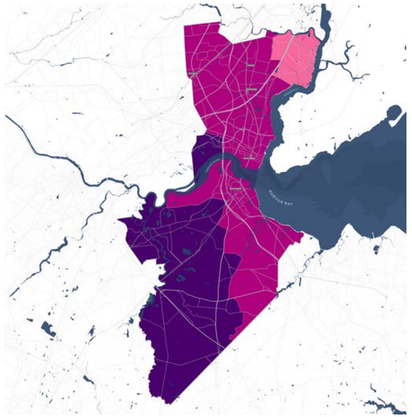
Social Vulnerability Index by Census Tract

- ≤0.25 (Lower Vulnerability)
- ≤0.5
- ≤0.75
- ≤1.00 (High Vulnerability)

Data Source: Centers for Disease Control and Prevention/ Agency for Toxic Substances and Disease Registry Social Vulnerability Index (2018)

AIR QUALITY

The two major sources of climate change-related air pollution—ground-level ozone (haze or smog) and PM2.5 (particulate matter, or aerosols)—are already a serious problem in the region, likely the cause of widespread "invisible" health effects, especially for the elderly and people with pre-existing health conditions, such as asthma. Compared to the rest of the state, the region has extremely high ambient ozone concentrations, especially in the southernmost parts of the region. Nearly the entire region is currently at the highest level of risk (90th to 99th percentile) for cancer due to air toxics, compared to the rest of the state.



LEGEND

Ambient Ozone Concentrations

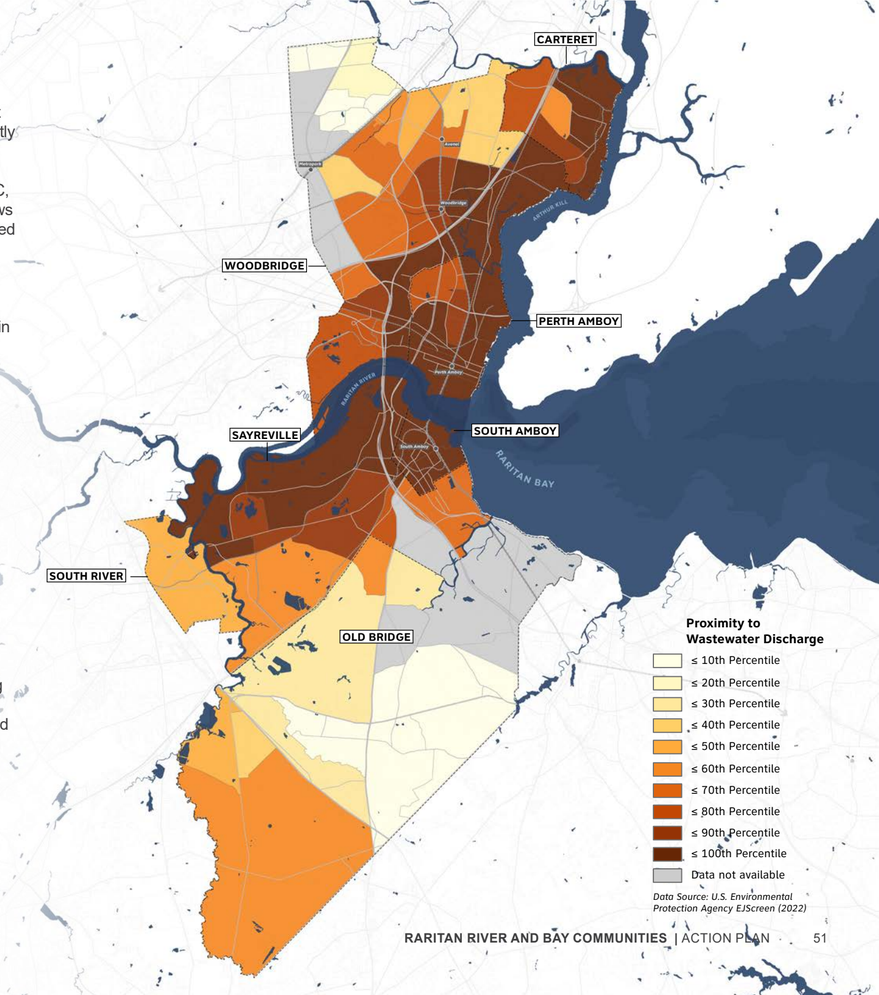
- 40-60th percentile
- 60-80th percentile
- 80-100th percentile

Data Source: U.S. Environmental Protection Agency EJScreen (2022)

WATER QUALITY

Throughout the Northeast U.S., it is anticipated that droughts lasting 3-6 months or longer will significantly increase in frequency under a "business-as-usual" high greenhouse gas emissions scenario and increase slightly in a low emissions scenario. RRBC, being primarily within the Raritan water region, draws its water supply from a mix of surface and unconfined groundwater sources. Municipalities relying more on surface water will feel the impacts of drought more immediately. In the future, the region may turn increasingly toward groundwater for its water supply as surface water sources struggle to maintain necessary capacity. This could lead to higher rates of groundwater pumping with implications for water quality. High concentrations of hazardous materials and wastewater discharge throughout the region can pose a serious risk to public health and safety as groundwater levels rise proportional to sea level rise. Contamination of groundwater aquifers could compromise existing sources of drinking water and limit the ability of other aquifers to serve as supplementary water supply sources in cases of prolonged drought. Remobilized contaminants can lead to contaminant plume spread and decrease water quality at partially remediated sites where contaminant levels in water had previously been improving.

In areas with low depth-to-groundwater, tidal and rainfall conditions combined with sea level rise can lead to risk of groundwater emergence and flooding of basements and underground infrastructure, parks, open spaces, and even streets. If the affected groundwater source is contaminated, this poses an additional risk of sustained exposure to toxic water.



Data Source: U.S. Environmental Protection Agency EJScreen (2022)

CLIMATE HAZARD IMPACTS ON FISHERIES

As the ocean becoming more acidic threatens marine life along the coast, RRBC could experience ecological impacts to its estuarine habitats as well as potential longer-term economic stresses. Although the majority of economic impacts affecting commercial fishing-dependent communities will be concentrated in southern New Jersey, much of coastal Middlesex County is still likely to experience impacts of medium economic severity. Coastal waters in the region could start becoming unfavorable to shellfish by the end of the century.

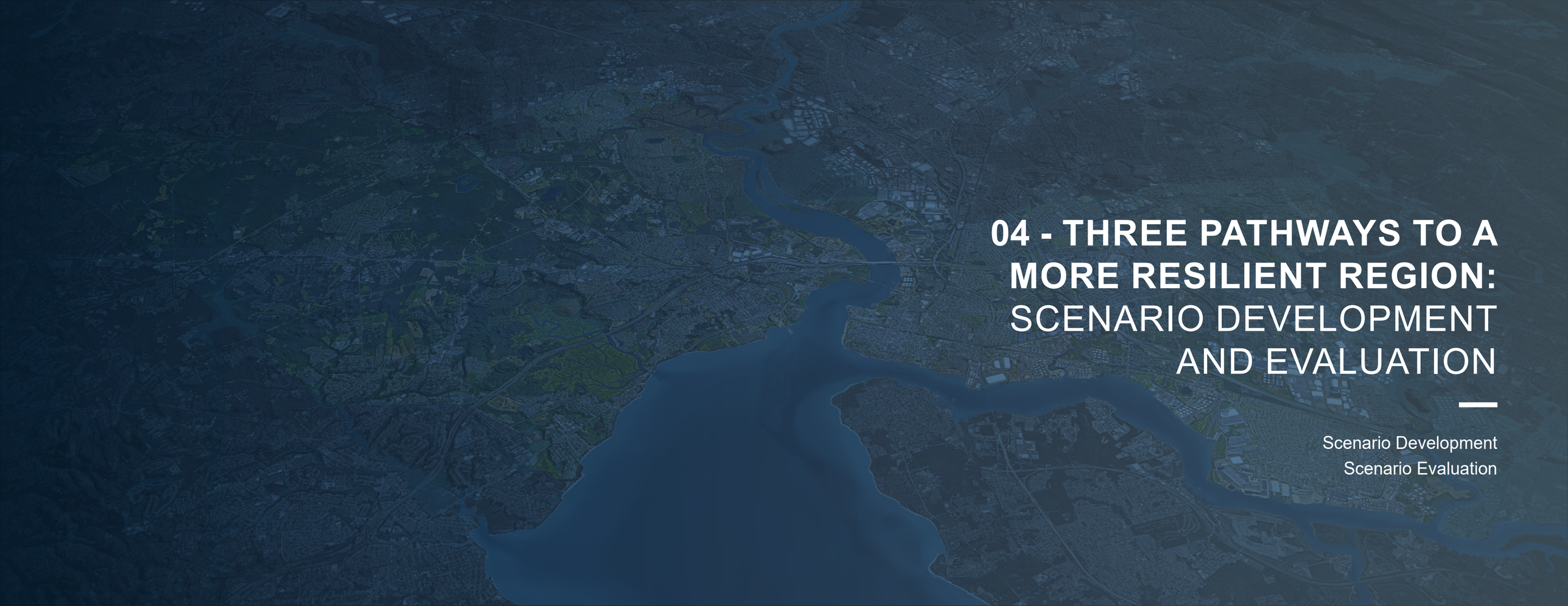
CHEESEQUAKE STATE PARK, OLD BRIDGE
Image Credit: Ungvar Via Adobe

CRITICAL ISSUES

Through the *Flood Impact Assessment*, *Additional Climate Hazards Assessment*, and community engagement efforts described, a number of critical issues, problems, needs, and opportunities related to multiple climate hazards were identified in RRBC. These include:

- Widespread, current flood risk due to both coastal and rainfall events
- Increasing temperatures, urban heat island effects, and related health impacts
- Poor and worsening air quality
- Need for flood mitigation and resilience building resources for private property owners
- Need to incorporate resilience considerations into redevelopment policies and standards
- Need for increased capacity to address resilience issues at the local, county and state level
- Opportunity for continued coordination
- Opportunity to incorporate natural and nature-based strategies
- Aging drainage and coastal infrastructure not designed to manage the severity of heavy rainstorms the region has been experiencing recently, which will grow more frequent with climate change

The scenario development process and evaluation to determine the preferred scenario, as described in the following section, are guided by the region's vision for the future and the desire to begin addressing these critical issues through this *Action Plan*.



04 - THREE PATHWAYS TO A MORE RESILIENT REGION: SCENARIO DEVELOPMENT AND EVALUATION

Scenario Development
Scenario Evaluation

SCENARIO DEVELOPMENT

Scenario development is a key element to the Resilient NJ program and was guided by a methodology developed by NJDEP. The goal of the scenarios is to allow stakeholders and decision-makers to understand various pathways to enhancing resilience, as well as the benefits, challenges, and trade-offs associated with different approaches.

The three scenarios developed for the RRBC region respond to the climate risks the region faces now—which will only increase over the next 50 years—and are consistent with the regional vision developed in collaboration with the communities and the Steering Committee.

A broad range of resilience strategies can be leveraged to realize the Raritan River and Bay Communities' vision for the future of "A thriving region of interconnected watersheds, with complementary environmental, social, economic, and governance systems working together to reduce flood risk of communities and infrastructure, restore natural systems, and adapt to a changing climate." To better understand the pros and cons of different strategies, the project team developed three scenarios, or suites of actions, that illustrate different pathways to achieving this vision.

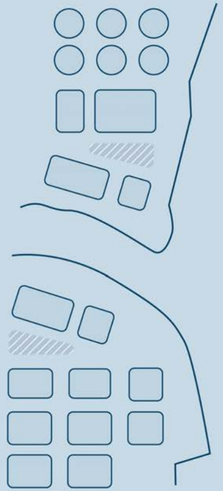
Scenario 1 focuses on protection of critical infrastructure assets, economic centers, and populated areas through a mix of green and grey strategies. Scenario 2 focuses on minimizing exposure to flood risk through reducing the amount of development within the floodplain and restoring natural ecosystems and processes. Scenario 3 focuses on how redevelopment and growth can be directed in a way that reduces flood risk and shapes a more sustainable future.

These scenarios illustrate the pros and cons of different strategies for flood risk reduction and helped facilitate robust stakeholder and community discussion of tradeoffs and priorities. To the extent possible, each of the three scenarios:

- Responds to the region's resilience vision;
- Reduces the anticipated impacts of future flooding and Additional Climate Hazards ;
- Includes actions that address immediate flood concerns;
- Protects or enhances natural resources and ecosystems; and
- Addresses the needs of socially vulnerable and under-resourced populations.

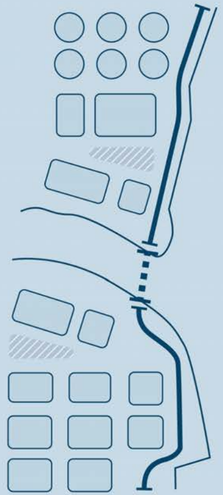
For the purposes of scenario evaluation, the project team developed strategies for all six sub-watersheds under each of the three scenarios. This approach allowed the project team to tailor flood risk reduction and resilience strategies to address the unique characteristics of each sub-watershed. To determine a preferred scenario for the region overall, the team conducted a thorough evaluation of all three scenarios within each sub-watershed. The evaluation process, described in additional detail in the following section, allowed the team to compare the performance of each scenario within sub-watersheds. Unsurprisingly, some scenarios are rated higher or lower in certain sub-watersheds than in others. This highlights the necessity of a regional scenario that would be flexible enough to meet the diverse needs of this large region while also working towards a shared vision of the future.

SCENARIO 0: BASELINE



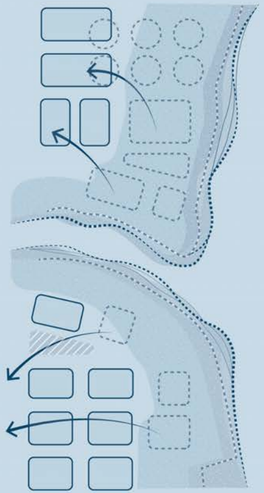
Scenario 0 (the baseline scenario) assumes continuation of ongoing and planned projects in the region.

SCENARIO 1: PROTECT
Critical Assets & Economic Centers



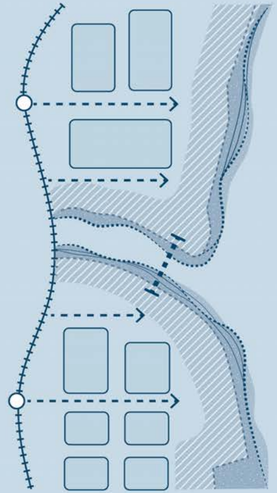
Scenario 1 focuses on protection of critical infrastructure assets, economic centers, and populated areas through a mix of green and grey strategies.

SCENARIO 2: RESTORE
Natural Systems & Minimize Exposure



Scenario 2 focuses on minimizing exposure to flood risk by reducing the amount of development within the floodplain and restoring natural ecosystems and processes.

SCENARIO 3: TRANSITION
Smart Growth for a New Economy



Scenario 3 focuses on redirecting redevelopment and growth to reduce flood risk, and invest in mobility systems to shape a more sustainable future.

SCENARIO 0: BASELINE

In recognition of the numerous and ongoing resilience activities across the state and in the region, the project team started with the development of a baseline scenario, dubbed "scenario 0," that imagines a continuation of the projects and activities going on the region now. This includes actions at the statewide level on policy and governance, planning work within the region at the county or municipal level, as well as initiatives by regional non-profit organizations.

Statewide Initiatives

Under the Governor Phil Murphy Administration, New Jersey has taken a proactive approach in preparing for climate change by introducing Executive Orders that create new statewide planning and policy mechanisms as well as requiring municipalities to consider climate change and resilience in their state-mandated master planning process. Existing statewide initiatives include the following:

- Executive Order 89, which requires the state to develop a Statewide Climate Change Resilience Strategy and created an Interagency Council on Climate Resilience
- Executive Order 100, which launched New Jersey Protecting Against Climate Threats (NJPACT), an initiative aimed at modernizing land use requirements to incorporate climate change. Administrative Order 2020-01 implements EO 100 and set deadlines for NJDEP rule changes
- NJDEP initiated a regulatory program in 2015 requiring utilities operating combined sewer systems to develop Long-Term Control Plans (LTCP) that identify projects to be implemented in the coming decades to reduce combined sewer overflows
- In March 2019, the Stormwater Utility Law, officially known as the "Clean Stormwater and Flood Reduction Act," was signed into law. This law authorizes local and county governments and certain utilities the ability to create stormwater utilities that can assess fees and use the revenue to maintain stormwater management infrastructure
- The State has also begun tackling its legacy of pollution and environmental racism through the Environmental Justice Bill (S232, September 2020), which requires NJDEP review of new construction, expansions, or permit renewals at facilities causing pollution in overburdened communities

New legislation passed in the State Assembly (New Jersey Assembly Bill 2785) requires the land use plan element of municipal master plans to include climate change-related hazard vulnerability assessments

Regional Initiatives

Regionally, there have been numerous resilience-related planning initiatives in the RRBC region over the last two decades, but the bulk of resilience planning began after Hurricane Sandy. The region was impacted especially hard by flooding during Sandy, and the storm motivated additional resilience planning and climate-related initiatives. There have been more than 70 studies, reports, and action plans focused on the region since 2012, covering a wide range of topics. In addition to resilience, planning in the region has addressed riverfront activation, watershed management, and open space.

County Initiatives and Resilience Projects

Other recent and ongoing resilience-related initiatives currently being undertaken by Middlesex County include:

- **The Middlesex County Hazard Mitigation Plan:** To stay up to date with Federal Emergency Management Agency (FEMA) requirements, Middlesex County released an updated Multi-Jurisdictional All-Hazards Mitigation Plan in January 2022.
- **Destination 2040:** In 2018, Middlesex County began development of a new strategic plan titled Destination 2040, which will serve as a business plan for county operations. The plan will outline a 20-year outlook and strategic initiatives to undertake over the next 3-5 years. The plan will cover economic and workforce development; healthy, safe, and inclusive communities; land use, development, and housing; sustainability and community

In addition to the planning initiatives discussed above, there are many additional resilience projects that have already been completed, are currently in design or construction, or are being planned by the RRBC municipalities, Middlesex County, state and federal agencies, and regional infrastructure entities.

List Of Ongoing And Planned Projects

Ongoing and planned municipal projects include a subset of projects closely related to resilience and reducing the impacts of climate change. The list included here may not capture related efforts.

Carteret
CA1. Rahway River Basin, New Jersey Coastal Storm Risk Management Feasibility Study
CA2. Tremley Point Connector Road
CA3. DuPont Chemical Site Brownfield Remediation
CA4. Noe Street Park
CA5. Carteret Ferry Terminal
CA6. Carteret Marina Renovation
CA7. Carteret Riverwalk

Woodbridge
WB1. Stream Bank Stabilization of the Pumpkin Patch Brook
WB2. Woodbridge Marina Expansion
WB3. Reconstruction of Cove Creek Culvert
WB4. Reconstruction of Route 35 Culvert
WB5.Valley Road Streambank Restoration
WB6. Lyman Creek Streambank Restoration
WB7. Metuchen Ave Creek Streambank Restoration
WB8. CPV Woodbridge Energy Center
WB9. Woodbridge Waterfront Park
Woodbridge Town Center Advanced Microgrid (municipality-wide)
Township Drainage Improvement (municipality-wide)

Perth Amboy
PA1. Perth Amboy High School (Emergency Shelter)
PA2. Rudyk Park Semi-permeable Plaza
PA3. Harbortown Infrastructure and Walkway
PA4. Route 35 Road Diet
PA5. Middlesex County Park
PA6. NYNJHAT Study Alternatives 3A & 3B – Arthur Kill Gate
PA7. Bulkhead Repair and Beach Nourishment
PA8. Perth Amboy Station Renovation
PA9. Borinqueneer Park
PA10. Raritan River Bridge Replacement
PA11. Middlesex Greenway Waterfront Spur
PA12. Route 9 and 35 Victory Circle Elimination Project
Perth Amboy CSO Mandate (municipality-wide)

South Amboy
SA1. South Amboy Ferry Terminal
SA2. Outerbridge Renewable Connector (planned)

Sayreville
SY1. MCUA Flood Mitigation and Permanent Restoration of the Sayreville Pump Station

South River
SR1. South River Ecosystem Restoration and Flood Resiliency Enhancement Project

Old Bridge
OB1. Laurence Harbor Beach Replenishment
OB2. Raritan Bay Slag Superfund Site (planned)

SCENARIO 0: BASELINE

LEGEND

Resilience Projects

- Completed
- Planning / Construction
- Conceptual / Unknown

Redevelopment Areas

Open space conservation/ recreation zones

Watershed Boundary

Municipal Boundary

Study Area Boundary

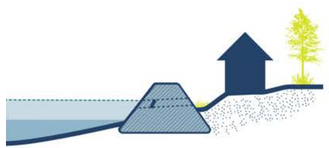
RESILIENCE TOOLBOX

There are many possible solutions that can be implemented to address flooding. As a first step in developing scenarios, the project team developed a Resilience Toolbox of potential options and asked for feedback from the Steering Committee and broader public.

The toolbox includes physical and nature-based solutions, policy and governance solutions, and individual and community-based actions. Physical and nature-based solutions include projects that change the built environment to address flood risk. Policy and governance related solutions are solutions that affect what decisions related to flooding are made, how, and by whom. Individual and community-based solutions are solutions that increase the social resilience of a community.

The toolbox is also an ongoing resource to provide information to stakeholders about potential strategies. The document summarizes key information about each solution including:

- Types of hazards the solution addresses
- The types of areas in which the solution could be applied
- Scale of the intervention (individual site, multiple sites, etc.)
- Possible co-benefits (benefits other than reduced flooding)
- Level of potential disruption from construction or implementation
- Other constraints and considerations



Reduce flood hazards through water management infrastructure or policy and building practices that work to either keep water out or reduce the force of flood waters.

- Coastal or riverine barriers
- Elevation of land

Reduce impacts of flooding by improving adaptive capacity through education, policy, and changes in community and personal behavior, or through adapting buildings, infrastructure, and other assets.

- Floodproofing of buildings
- Riparian management
- Shoreline restoration
- Improved stormwater management

Reduce exposure to flood risk by managing growth or investment in areas exposed to flood hazards and moving highly at-risk communities or assets.

- Relocation
- Increasing density outside the floodplain

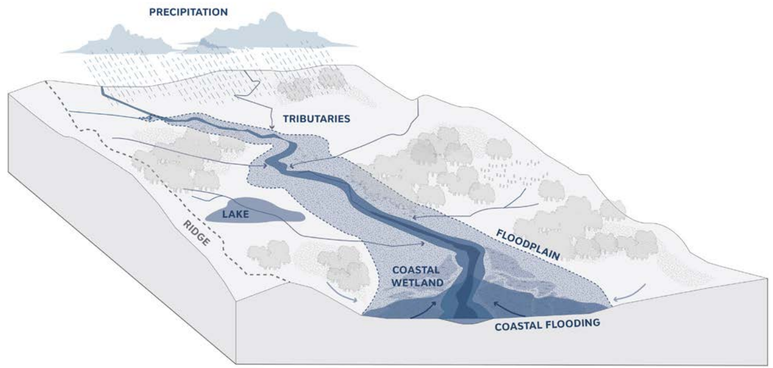
RESILIENCE TOOLBOX EXAMPLE

APPLYING A WATERSHED-BASED PLANNING APPROACH

The RRBC region lies at the intersection of three major watersheds: the Arthur Kill; the Monmouth; and the Lower Raritan, South River, and Lawrence. A watershed can most easily be thought of as an area within which, wherever water falls, it will all eventually flow to the same place. Watersheds can cross municipal and state boundaries, which can present a challenge when planning for flooding and risk reduction. To address this challenge, the project team adopted a watershed-based planning approach in scenario development. A watershed-based approach can lead to more effective outcomes in reducing flood risk and institutionalizes coordination to address shared risks within sub-watershed boundaries.

To facilitate this watershed-based approach, the project team created several sub-geographies based on hydrologic unit code 14 (HUC14) watershed boundaries and the shared flood risks and land use patterns within each. This report refers to these areas as sub-watersheds. They are:

- Arthur Kill Waterfront
- Woodbridge Creek
- Raritan Riverfront and Bay
- South River/ Washington Canal
- Cheesequake/ Laurence Harbor
- Rahway River and Tributaries



WHAT IS A WATERSHED?
A watershed can most easily be thought of as an area within which, wherever water falls, it will all eventually flow to the same place. As watersheds can cross municipal and state boundaries, a watershed-based approach to planning instead of a municipality-based approach will lead to more effective outcomes in reducing flood risk.

SUB-WATERSHEDS

Rahway River and Tributaries is bounded by the Woodbridge Creek subwatershed to the east, Raritan River subwatershed to the south and the Woodbridge municipal boundary to the north.

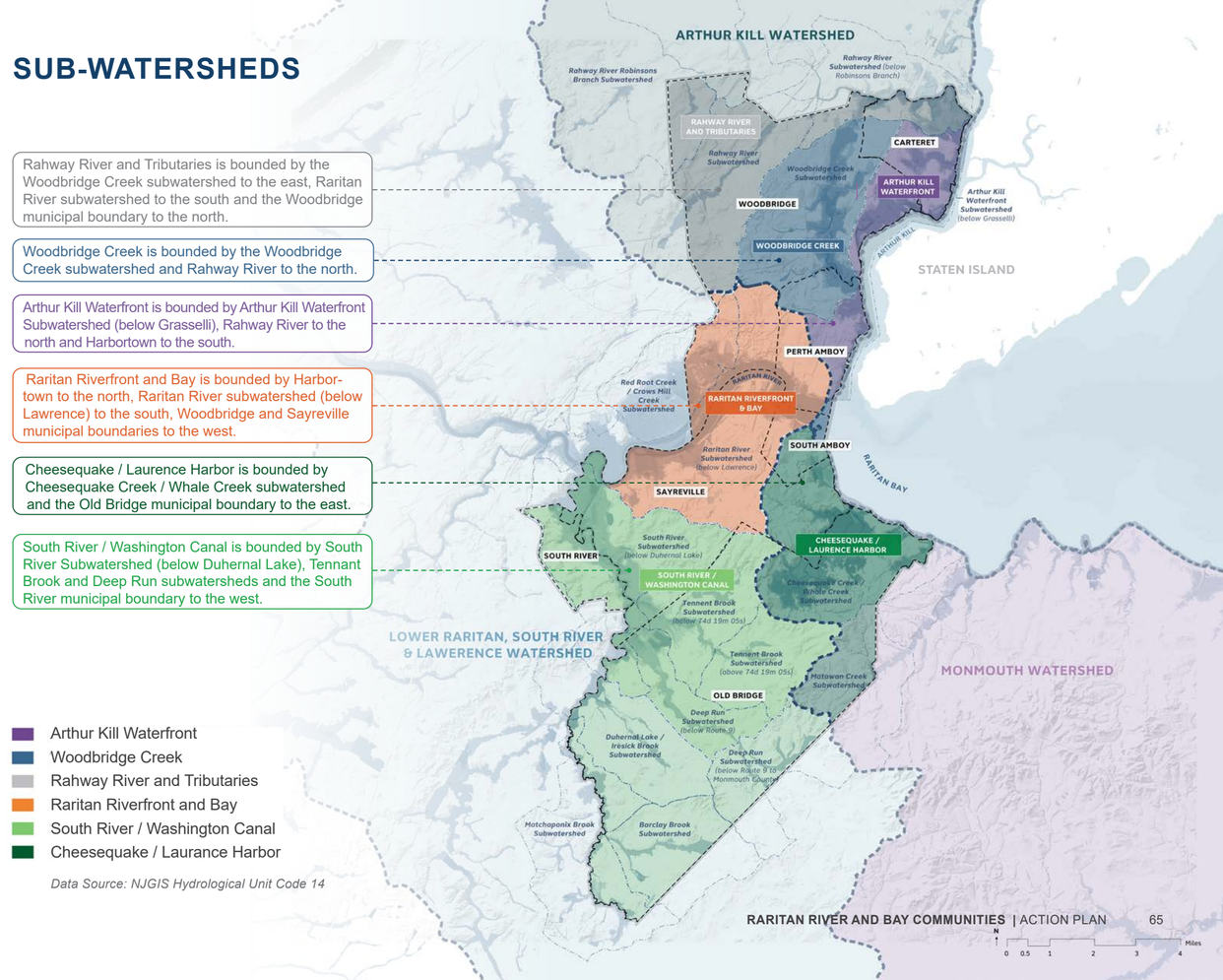
Woodbridge Creek is bounded by the Woodbridge Creek subwatershed and Rahway River to the north.

Arthur Kill Waterfront is bounded by Arthur Kill Waterfront Subwatershed (below Grasselli), Rahway River to the north and Harbortown to the south.

Raritan Riverfront and Bay is bounded by Harbor-town to the north, Raritan River subwatershed (below Lawrence) to the south, Woodbridge and Sayreville municipal boundaries to the west.

Cheesequake / Laurence Harbor is bounded by Cheesequake Creek / Whale Creek subwatershed and the Old Bridge municipal boundary to the east.

South River / Washington Canal is bounded by South River Subwatershed (below Duhernal Lake), Tennant Brook and Deep Run subwatersheds and the South River municipal boundary to the west.



Data Source: NJGIS Hydrological Unit Code 14

SCENARIO 1:
PROTECT CRITICAL ASSETS AND ECONOMIC CENTERS

This scenario focuses on protection of critical infrastructure assets, economic centers, and populated areas through a mix of green and grey strategies. In this scenario, the existing patterns of development are not significantly modified, and assets are protected in their current location and configuration. It also includes shoreline barriers to protect from coastal and tidal flooding, improved capacity of stormwater management systems to manage heavy rainfall, and site- and building-scale adaptation of critical infrastructure.

Example strategies under this scenario include:

- Shoreline barriers to protect low-lying areas from coastal and tidal flooding
- Increasing capacity of stormwater systems to manage heavy rainfall
- Building- and site-scale adaptation of critical infrastructure

Community Feedback

This scenario responds directly to feedback the project team heard across the region from community members and other stakeholders, who are concerned about damage from future flood events. The project team received positive feedback on how this scenario prioritizes risk reduction. The project team also heard skepticism from some members of the community regarding the feasibility of some of the proposed strategies due to their high costs, extensive permitting requirements, and/or the need for significant ongoing agency coordination to implement.

Example Strategies by Sub-Watershed

Arthur Kill Waterfront

- Site-specific adaptation of critical utilities
- Site-specific adaptation of oil and gas terminals
- Installation of berm/floodwall with multi-use paths along the waterfront for public access

Woodbridge Creek

- Increased resilience of transportation systems, specifically flood-prone roadways
- Culvert modification and enlargement
- Building-scale adaptation of pump station

Raritan Riverfront and Bay

- Increased storm sewer capacity in Perth Amboy and incorporation of underground water storage in Washington Park and other open spaces
- Site-specific adaptation of critical facilities
- Installation of berm/floodwall with multi-use paths along the waterfront from Sadowski Parkway to Woodbridge Riverfront Park for public access

South River/ Washington Canal

- Elevation of Jernee Mill Road and site-specific protection of adjacent industrial sites
- Development of strategic evacuation plan for Winding Woods Apartment Complex for implementation in advance of major flood events
- Increased temporary impoundment along the South River

Cheesequake/ Laurence Harbor

- Flood risk mitigation along Garden State Parkway
- Surge barrier/tide gate and pump station at mouth of Cheesequake Creek
- Permanent stabilization for Shoreland Circle to prevent future road collapse due to coastal storms

Rahway River and Tributaries

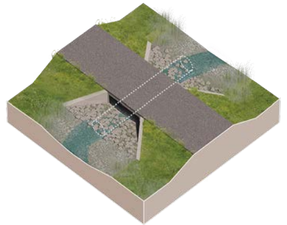
- Culvert modification and enlargement
- Increased flood storage capacity on publicly owned lands through hybrid and structural solutions
- Flood risk mitigation of oil and gas terminals

Examples of Strategies in Scenario 1

Flood Barriers

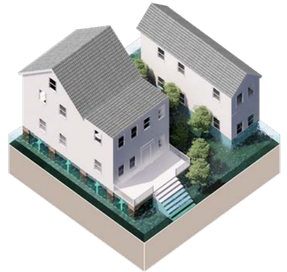
Shoreline barriers, like berms and levees, protect low-lying areas from coastal and tidal flooding.

Stormwater Management



Increasing capacity of stormwater systems helps manage heavy rainfall.

Floodproof / Harden



Building- and site-scale adaptation of critical infrastructure can include floodproofing, hardening or perimeter protection strategies.

WATERFRONT BULKHEAD REPAIR
Perth Amboy, NJ

WOODBRIDGE CENTER DR INTERSECTION IMPROVEMENTS
Woodbridge, NJ

SAYREVILLE PUMP STATION
Sayreville, NJ

PROTECT
CARTERET, PERTH AMBOY, WOODBRIDGE

LEGEND

STRATEGIES

- Site or building level adaptation of critical facilities
- Create floodable spaces on publicly owned lands
- Increase stormwater system capacity or diversion upstream
- Protect / adapt critical transportation infrastructure
- Multi-purpose coastal flood barrier
- Tide / Surge Gate
- Culvert modification
- Construct new pump station / retrofit existing pump station

CRITICAL UTILITIES

- Power Generation & Substations
- Wastewater Treatment
- Oil & Gas Storage
- Warehouse

BASEMAP

- Water bodies
- Future Sandy (2070), 24-hour 100-year storm with 10% rainfall increase (2070)
- Existing Wetlands
- Municipal Boundary

0 0.5 1 2 miles

N

Tide gate and coastal protection of Noe's Creek

Multi-purpose coastal flood barrier with multi-use paths along the waterfront for public access

Site or building-level adaptation of critical facilities and industrial areas

PROTECT
SAYREVILLE, SOUTH AMBOY, SOUTH RIVER, OLD BRIDGE

Perimeter flood protection of substation in South Amboy

Surge barrier at Noe's Creek inlet

Study additional impoundment and upstream diversion along South River

SCENARIO 2:
RESTORE NATURAL SYSTEMS AND MINIMIZE EXPOSURE

This scenario focuses on minimizing exposure to flood risk through reducing the amount of development within the floodplain and restoring natural ecosystems and processes. Strategies seek to work with and augment existing networks of open spaces, wetlands, and streams to manage stormwater and provide buffers, and there is a greater reliance on acquisitions and reducing density in flood-prone areas. Specific strategies include restoring riparian zones to provide additional space for stormwater management, restoring tidal wetlands to improve stormwater management and buffer coastal flooding, and relocation of vulnerable uses to minimize exposure.

Example strategies under this scenario include:

- Restoration of tidal wetlands to buffer coastal flooding and providing space for marsh migration
- Restoration and expansion of riparian zones for flood storage
- Relocation of vulnerable land uses out of flood-prone areas

Community Feedback

Community members expressed a great deal of interest in preservation of open space, ecosystem improvements, and increased implementation of green infrastructure across the region. In some areas, however, the project team heard a general concern that Scenario 2's focus on restoration of natural systems, strategic acquisition of homes, and redevelopment of industrial sites may not be feasible given the existing interests of property owners and ongoing development trends. The project team also heard concern that green infrastructure alone would not adequately reduce the high degree of risk posed by severe flooding of comparable magnitude to some of the most recent events.

Example Strategies by Sub-Watershed

Arthur Kill Waterfront

- Implementation of tide gate at and daylighting of Noe's Creek
- Technical assistance and targeted outreach to industrial property owners to promote building flood risk mitigation.
- Incorporation of brownfield and wetland restoration in low-lying industrial areas.

Woodbridge Creek

- Riparian zone restoration along Heards Brook Creek to create additional capacity for flood storage
- Additional targeted buyouts in Watson Crampton neighborhood

Raritan Riverfront and Bay

- Wetland restoration in Sayreville along Raritan River
- Right-of-way flood storage along rail easements that are no longer active
- Beach replenishment in Perth Amboy to protect waterfront park and recreational assets

South River/ Washington Canal

- Additional buyouts in low-lying areas of South River, including industrial and commercial properties at risk
- Riparian zone and wetlands restoration along South River

Cheesequake/ Laurence Harbor

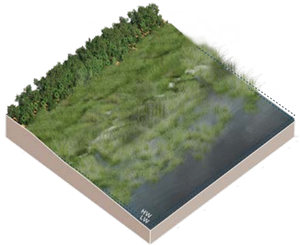
- Beach replenishment to protect recreational asset and dune restoration to reduce wave impacts in Laurence Harbor
- Wetland restoration in Cheesequake Park to serve as buffer from coastal storms and generate additional stormwater capacity

Rahway River and Tributaries

- Identification of brownfield sites suitable for wetland restoration
- Riparian zone restoration and stream bank stabilization along South Branch of Rahway River to create additional capacity for flood storage and minimize erosion

Examples of Strategies in Scenario 2

Wetland Restoration



Restoration of tidal wetlands and riparian zones help buffer coastal flooding and provide space for marsh migration and coastal habitats.

CHEVRON WETLAND RESTORATION
Perth Amboy, NJ

Stream Restoration / Riparian Zone Expansion

Restoration and expansion of riparian zones, such as stream daylighting or construction of wet ponds, can help increase flood storage capacity on publicly owned open spaces and parks.

NOE'S CREEK PARK RETENTION POND
Carteret, NJ

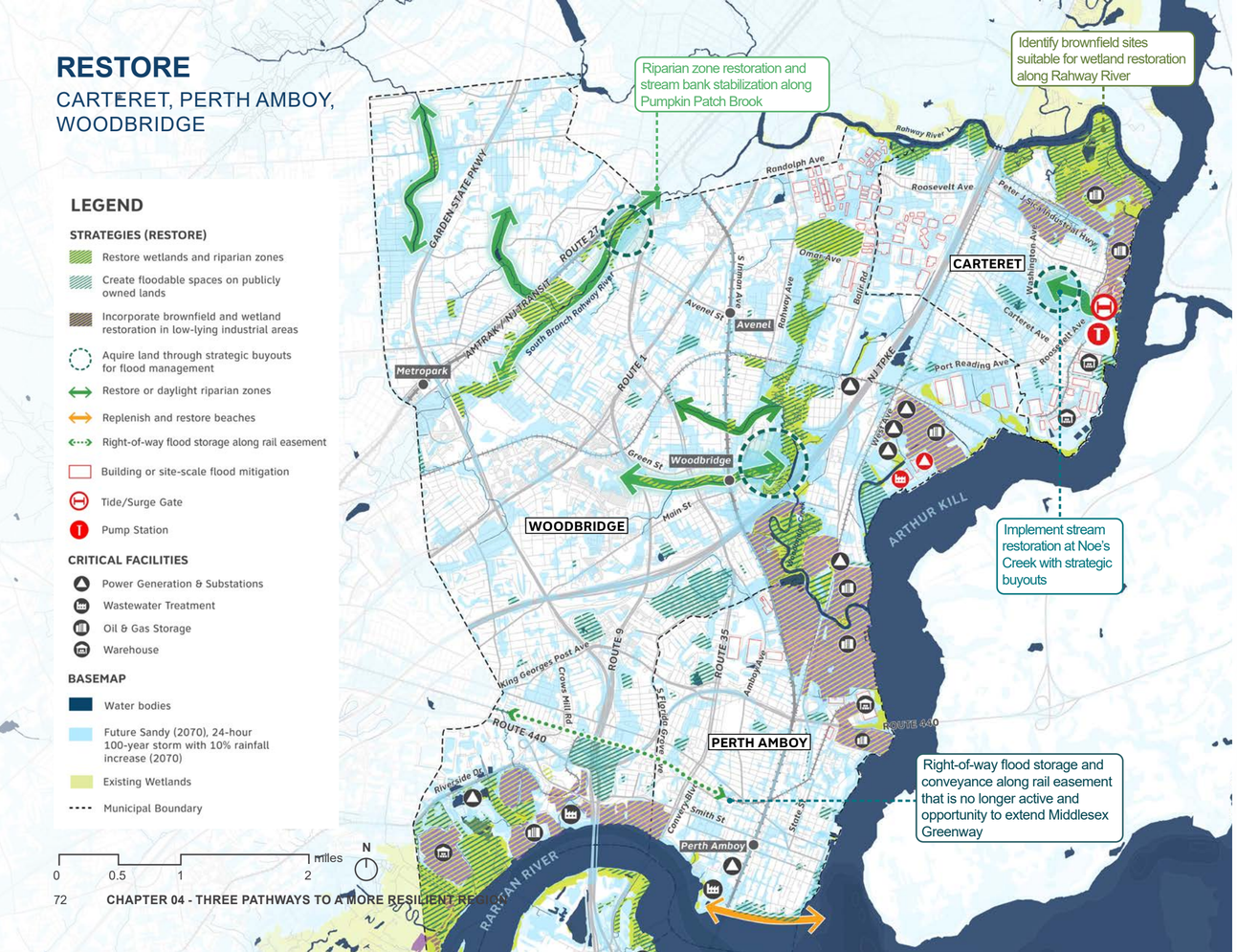
Relocation

Relocation of vulnerable land uses out of flood-prone areas can redirect growth to reduce flood exposure and preserve open space.

WATSON CRAMPTON BUYOUT AND RESTORATION PROJECT
Woodbridge, NJ

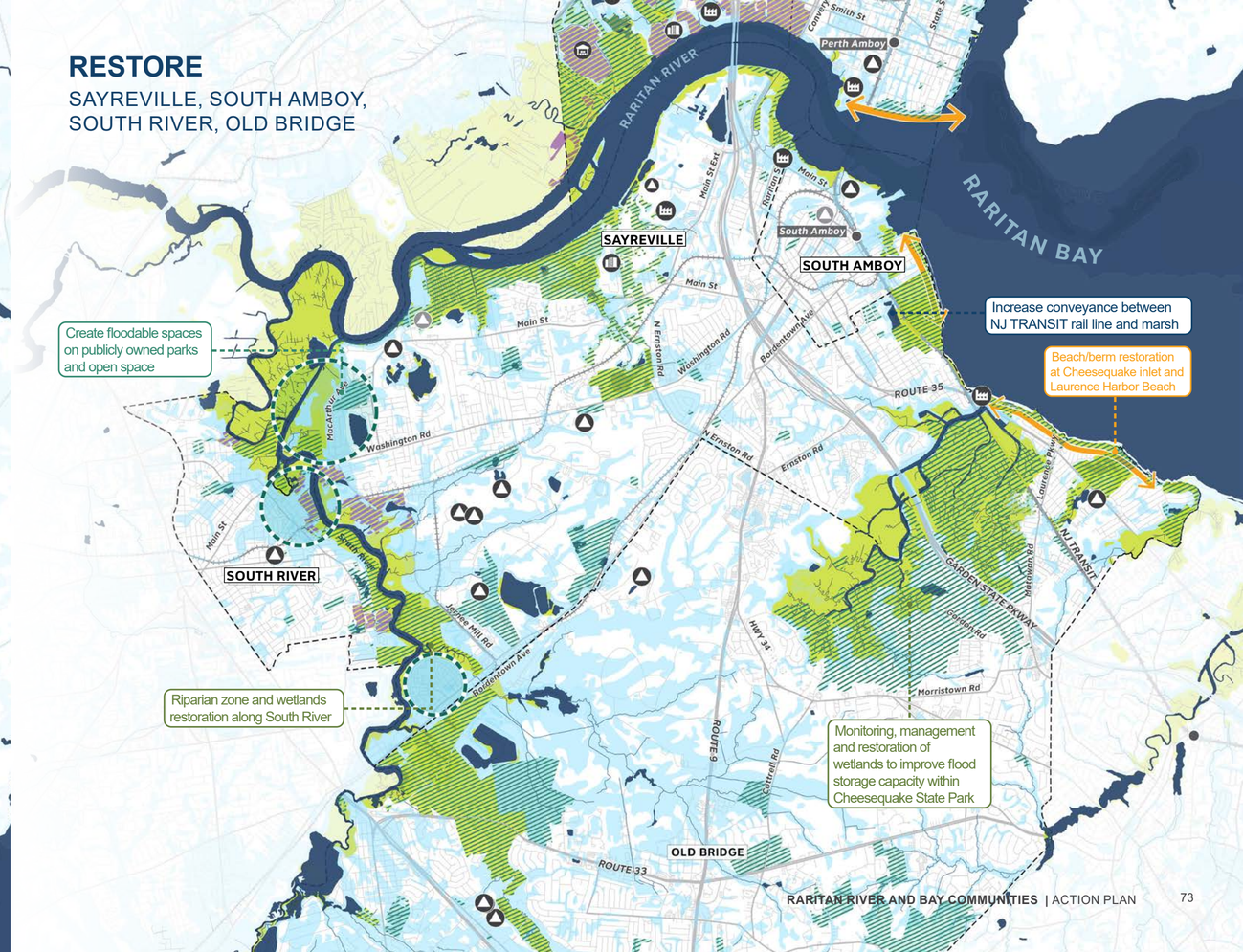
RESTORE

CARTERET, PERTH AMBOY, WOODBRIDGE



RESTORE

SAYREVILLE, SOUTH AMBOY, SOUTH RIVER, OLD BRIDGE



SCENARIO 3:
TRANSITION TO SMART GROWTH FOR A NEW ECONOMY

This scenario focuses on how redevelopment and growth can be directed in a way that reduces flood risk and helps shape a more sustainable future. It draws on flood risk reduction strategies included in the other two scenarios—incorporating protective features into redevelopment in some areas and focusing protection in densely built-up areas, while also reducing density in areas that are less densely populated and with fewer options for protection. Additionally, this scenario seeks to transition industrial uses away from oil and gas, strengthen developed areas outside of the floodplain, and enhance the resiliency of mobility systems.

Example strategies under this scenario include:

- Transitioning industrial uses away from oil and gas and towards new resilient economic drivers
- Strengthening and enabling growth in well-connected developed areas outside of the floodplain
- Enhancing resiliency of mobility systems

Community Feedback

This scenario was generally the most positively received by community members and other stakeholders, as it combines elements of Scenarios 1 and 2. Members of the community also appreciated that it provides opportunities for integrating resiliency improvements into other goals, such as improving public waterfront access or developing the waterfront.

Example Strategies by Sub-Watershed

Arthur Kill Waterfront

- Increased flood storage capacity on publicly owned lands through hybrid and structural solutions
- Installation of berm/floodwall with multi-use paths along the waterfront for public access
- Transition of oil and gas facilities to renewable energy sources
- Redevelopment of industrial areas with new forms of industry and mixed-use centers

Woodbridge Creek

- Encouragement of mixed-use development outside floodplain near transit
- Additional buyouts and extension of open space network in Watson Crampton neighborhood
- Riparian zone restoration along Heards Brook Creek to create additional capacity for flood storage

Raritan Riverfront and Bay

- Redevelopment of decommissioned power plant in Sayreville as green energy campus, with wetland restoration
- Increased storm sewer capacity in Perth Amboy and incorporation of underground water storage in open spaces
- Encouragement of mixed-use development outside floodplain near transit

South River/ Washington Canal

- Elevation of critical roadways
- Additional buyouts in low-lying areas of South River and Sayreville
- Incentivized relocation away from extremely flood-prone areas including Winding Woods

Cheesequake/ Laurence Harbor

- Elevation of critical systems to protect South Amboy Pump Station
- Beach restoration and setback of new beachfront development
- Increased flood storage capacity within Cheesequake State Park through restoring wetlands and improving flow across infrastructure impediments

Rahway River and Tributaries

- Strategic land acquisition in flood prone areas
- Redevelopment of oil and gas terminals as mixed-use centers
- Encouragement of mixed-use development outside floodplain near transit

Examples of Strategies in Scenario 3

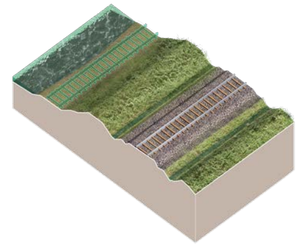
Resilient Redevelopment

Redevelopment of vulnerable waterfront legacy industrial areas into light industry or mixed-use residential should incorporate resilience standards.

Strengthen Low Risk Centers

Enabling growth and additional density in well-connected areas outside of the floodplain can also support transit-oriented development.

Resilient Transportation Infrastructure



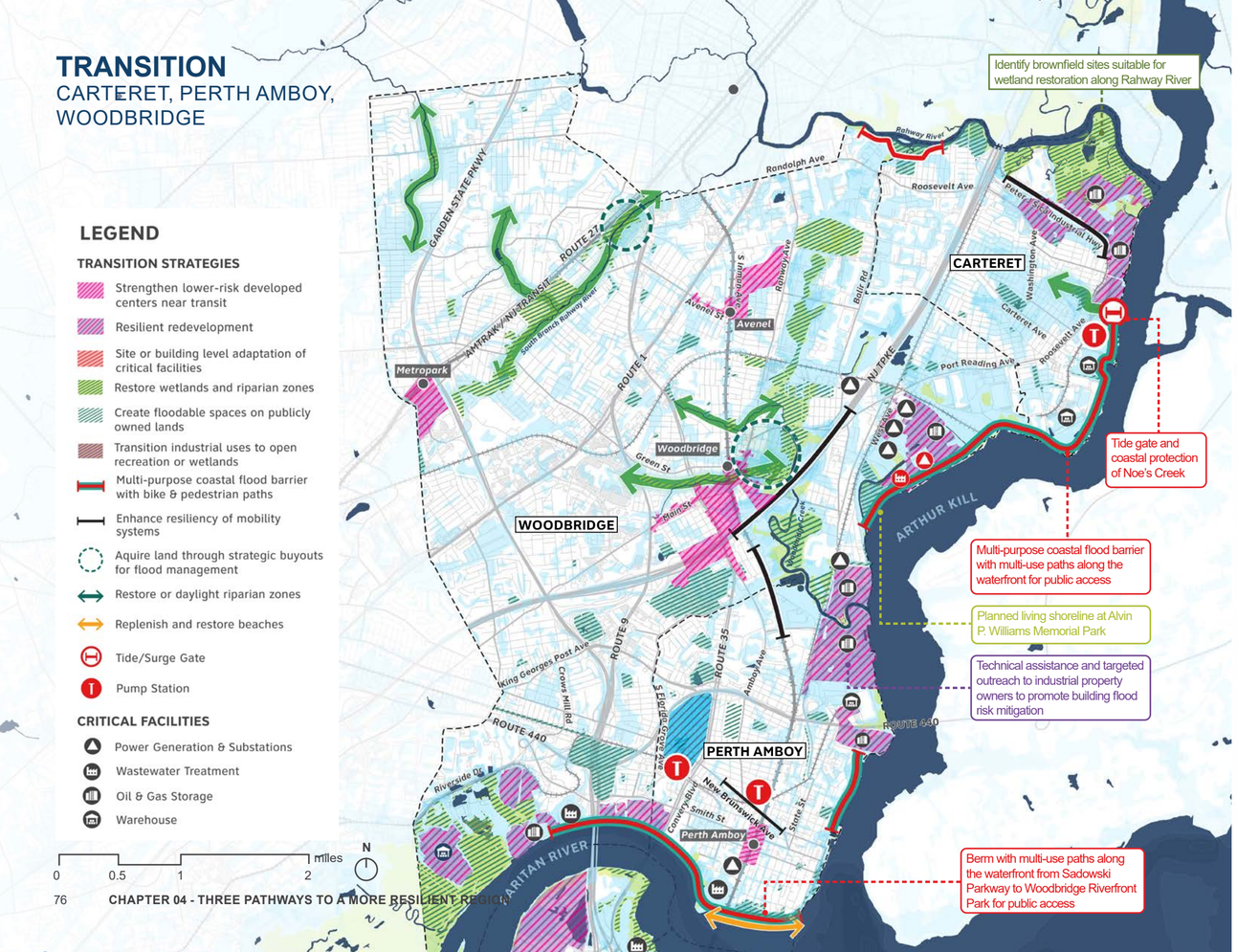
Mobility systems should be designed to be resilient to future flooding, taking into account sea level rise and future precipitation.

PROPOSED FERRY TERMINAL
South Amboy, NJ

AVENUE & GREEN TRANSIT-ORIENTED DEVELOPMENT
Woodbridge, NJ

NJ TRANSIT RARITAN BRIDGE REPLACEMENT
Middlesex County, NJ

TRANSITION
CARTERET, PERTH AMBOY, WOODBRIDGE



TRANSITION
SAYREVILLE, SOUTH AMBOY, SOUTH RIVER, OLD BRIDGE

SCENARIO EVALUATION

To determine a preferred scenario, the project team evaluated the scenarios within each sub-watershed according to a set of criteria designed to capture the benefits and drawbacks of each. The project team developed these evaluation criteria based on NJDEP's guidance with refinement from the Steering Committee and public feedback.

The scenarios also received feedback from stakeholders during Steering Committee meetings and feedback from the community during virtual public meetings. These two components—community/stakeholder feedback and evaluation criteria—allowed the project team to select an actionable scenario that is feasible, appropriate for the region, and supported by the public and key stakeholders.

The evaluation criteria covered the following topics:

- **Design Life / Adaptability:** Strategies should be designed to be adaptable to accommodate changing future risk and community preferences.
- **Cost and Feasibility**: Cost is a major factor that needs to be considered as projects with too high of a price tag relative to benefits are difficult to fund and implement. Scenarios must also be feasible given the permitting and regulatory environment and community's support, among other considerations.
- **Risk Reduction / Effectiveness:** Projects need to effectively reduce the risk of all types of future flooding and effectively protect community assets.
- **Environment:** Protection of the environment and improvement of natural systems is vital to the region and projects must not have negative environmental impacts.
- **Community and Health:** Preserving existing community values and places is essential. Projects should expand community benefits and go beyond just reducing flood impacts to provide additional benefits.
- **Partnership and Equity:** Strategies must consider all members of the region, especially socially vulnerable populations. Community leaders and members should be involved in decision-making and past inequities should be considered in all strategies.

Evaluation Criteria	Feedback from the Community	How Feedback is Incorporated in the Preferred Scenario
Design Life / Adaptability	**DESIGN LIFE / ADAPTABILITY** *Community members and stakeholders expressed concern about how current problems will only get worse with climate change.*	• The preferred scenario includes a of mix of short-, medium-, and long-term strategies to address near-term risks while also planning for long-term potential impacts of climate change.
Cost and Feasibility	**COST AND FEASIBILITY** *Community members and stakeholders were concerned about costs, including where project funding comes from and how will it be secured.* *Community members and stakeholders expressed a desire to see action quickly; in other words, that it is important that recommended actions be feasible.*	• The preferred scenario focuses on feasible and cost-effective strategies to reduce risk. Some infrastructure elements from the protect scenario were determined to be too costly and challenging to implement, and thus were not incorporated into the preferred scenario.
Risk Reduction / Effectiveness	**RISK REDUCTION / EFFECTIVENESS** *Community members and stakeholders expressed concerns about how effective certain strategies would be given the unique conditions of the region.* *Community members and stakeholders expressed concern over how new development could impact flooding.*	• To effectively reduce flood risk, the preferred scenario includes action on both policy and governance, as well as outreach, capacity building, and the construction of physical and nature-based infrastructure. • The preferred scenario includes recommendations for how development ordinances and zoning can be used to promote more resilient forms of and locations for development.
Environment	**ENVIRONMENT** *Access to the waterfront, increased park, open space, and recreation opportunities are priorities for many community members and stakeholders.*	• The preferred scenario includes ways in which flood mitigation projects, such as coastal protection, stormwater management, and riparian zone restoration, can be used to increase waterfront access and improve open space amenities.
Community and Health Benefits	**COMMUNITY AND HEALTH BENEFITS** *Community members and stakeholders expressed concern over public health impacts of flooding on contaminated sites.* *Community members and stakeholders expressed concern over public health impacts of Additional Climate Hazards , such as extreme heat.*	• The preferred scenario includes specific, prioritized recommendations for remediation of brownfields and other contaminated sites. • The preferred scenario includes strategies to reduce the health impacts of Additional Climate Hazards , including extreme heat.
Partnership and Equity	**PARTNERSHIP AND EQUITY** *Residents expressed a desire to be involved in the creation of the Action Plan.* *Community members and stakeholders expressed that all members of the region should be able to see themselves represented in this plan.* *Community members and stakeholders expressed a need for the project team to build on work already being done in the region and to leverage existing community networks and organizations.*	• The preferred scenario includes actions to broaden outreach, education, and capacity building. • The preferred scenario includes recommendations for how community organizations and non-governmental organizations can support the region's resilience. • The preferred scenario leverages ongoing and planned projects to efficiently build resilience.

EVALUATION CRITERIA AND COMMUNITY FEEDBACK

In order to be consistent with other regions participating in RNJ, the project team also evaluated the scenarios using standardized evaluation criteria developed by NJDEP. Criteria developed by NJDEP align well with those refined to meet the needs of the RRBC region. Evaluation of the scenarios through NJDEP's methodology is documented in *Appendix E*.

Throughout the community engagement process, the project team received feedback relating to each of the evaluation criteria, summarized in the table below. The preferred scenario, described in detail in the next section, aims to address this feedback and related concerns.

Building on the community engagement and outreach activities described in the *Vision and Priorities* report, additional engagement took place between February and June 2022. The goal of these engagement efforts was to seek feedback on the scenarios described above and to refine the preferred scenario through the lens of the evaluation criteria. Specific engagement and outreach activities the project team conducted included:

- Community Meeting #3 in May: a virtual community meeting held to gather feedback on the preferred scenario
- Presentation to the South River Environmental Committee: a presentation on the three scenarios and preliminary preferred scenario
- YMCA Old Bridge Workshop: an in-person workshop with community members and Old Bridge Township on scenario alternatives and feedback to inform the preferred scenario
- Presentation to Weather Club at McGinnis Middle School in Perth Amboy: a presentation to middle school students in Perth Amboy, introducing them to the project, flood risk, and potential ways to address flooding
- Presentation to the Gateway Neighborhood Association: a presentation to a local neighborhood association on the project to gather residents' input
- Healthy Kids Day with the YMCAs: engagement with community youth on climate change and flooding with activities and shared information on the project
- Tabling, handing out flyers, and leading activities demonstrating impacts of flooding and climate change for kids at numerous events, including South River Day

In undertaking the evaluation and engagement process, the project team determined that the preferred scenario must combine elements of each of the three preliminary scenarios. Given the great diversity of types of flooding, land use and density, feasible strategies, and community priorities across RRBC, selected elements from each scenario must be applicable to the region at large. Therefore, the preferred scenario combines key elements of Scenarios 1, 2, and 3 in different geographies and at varying scales to recommend concrete strategies and actions designed to address existing flood and other climate risks while bolstering long-term resilience throughout the region.

> "We cannot think of flood risk in isolation, the action plan needs to goes beyond flooding too. Projects that have other community benefits, like access to green and open space, but also don't compromise economic development are a priority."
>
> *– PUBLIC MEETING 2*

> "All communities should work together and analyze how their development goals impact the coastlines of other communities."
>
> *– SOUTH AMBOY RESIDENT*

> "Major goal is to make the waterfront more accessible and help it become a destination."
>
> *– OLD BRIDGE RESIDENT*

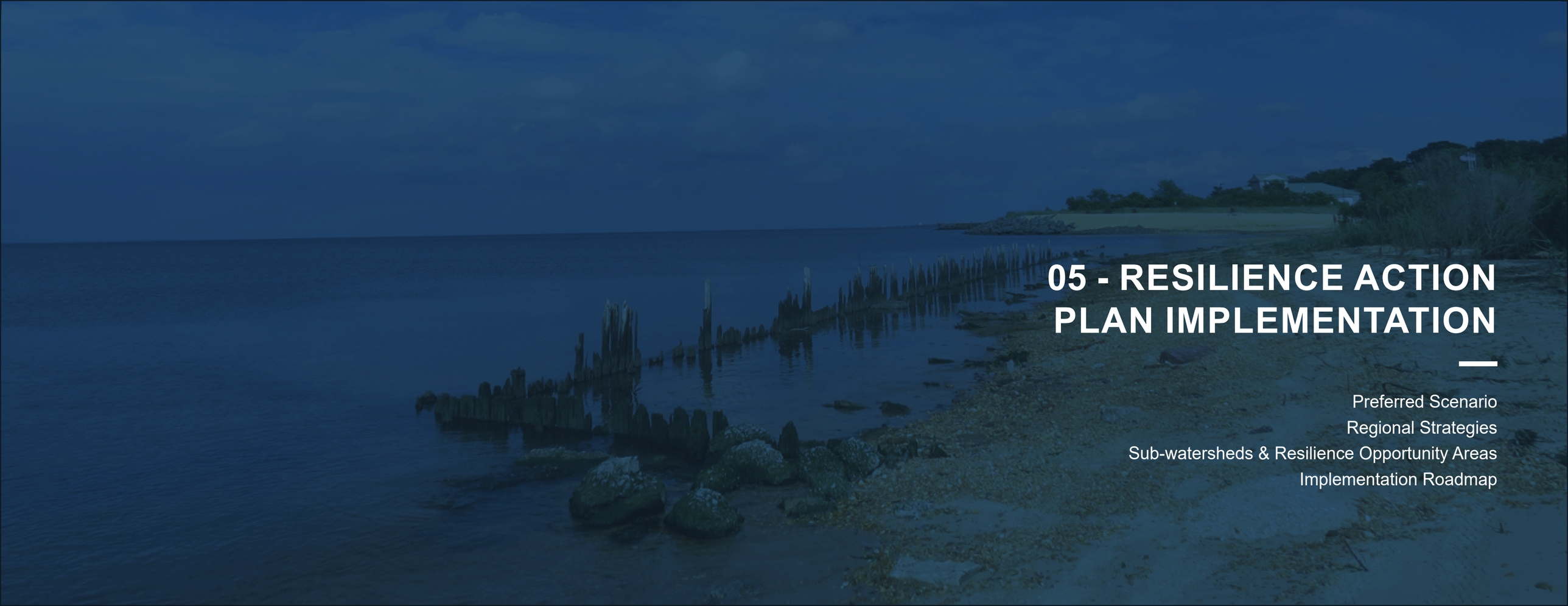
> "We need to prepare for more frequent rainfall events as well, not just 100-year storms. We need to think of community's needs now and plan for the future."
>
> *– STEERING COMMITTEE MEMBER*

CITY OF WATER DAY
Project staff hosting a promotional table to discuss flood risk with attendees and organizers of Perth Amboy's City of Water Day, July 16, 2022.

WORKSHOP AT OLD BRIDGE YMCA
Community members, steering committe members, and project staff gathered in person to discuss flood risk and risk reduction strategies.

WEATHER CLUB AT MCGINNIS MIDDLE SCHOOL
Educating middle school students on flood risk and climate change and hearing how they would like to address flooding issues in their community.

HEALTHY KIDS DAY
Healthy Kids Day, organized by the Raritan Bay YMCA, provided an opportunity to hand out flyers and share project details with the local community.



05 - RESILIENCE ACTION PLAN IMPLEMENTATION

Preferred Scenario
Regional Strategies
Sub-watersheds & Resilience Opportunity Areas
Implementation Roadmap

PREFERRED SCENARIO: PROTECT, RESTORE, AND TRANSITION

In the process of collaborating with RRBC communities and evaluating the preliminary scenarios based on the process described above, it became clear to the project team that achieving the community vision will likely require a hybrid strategy that includes a careful balance between protecting, restoring, and transitioning.

The preferred scenario, which serves as the foundation of this *Action Plan*, combines elements of all three preliminary scenarios to generate a long-term plan that synthesizes more resilient development patterns, feasible flood mitigation projects, and transformational open space and ecological improvements into a cohesive plan for a more resilient region. It seeks to achieve this by simultaneously implementing physical and nature-based infrastructure strategies (e.g., flood barriers, stormwater infrastructure, and wetland restoration); policy and governance actions to promote more resilient development and improve coordination across multiple levels of government; and outreach, education, and capacity building programs to improve flood risk awareness and promote community adaptation.

In addition to reducing flood risk, this scenario provides secondary benefits, called "co-benefits," that will improve quality of life in the region, such as:

- Additional access to open space, improved waterfront access, and recreational opportunities, which provide a multitude of benefits for both people and the environment—from public health benefits to increased biodiversity and reduced urban heat islands
- Building local capacity for resilience planning, which strengthens community ties and improves overall community resilience, connecting communities with the resources they need and improving social cohesion
- Remediation of brownfield sites, thereby reducing pollution
- Improving mobility and concentrating density, which can reduce greenhouse gas emissions and improve air quality.
- Restoring wetlands and riparian areas, which can improve water quality, result in cleaner water for recreation, and improved habitat quality

By taking a multi-pronged approach, the preferred scenario aims to protect the most vulnerable while achieving a variety of co-benefits for all. The preferred scenario also seeks to bolster the adaptive capacity of communities across the region while also leveraging these initiatives to promote the substantive and transformative civic and governance changes required to achieve long-term, sustainable outcomes. The following section describes the categories of actions included in the preferred scenario in more detail.

RESILIENCE STRATEGIES

ZONING AND LAND USE

- Preserve existing Open Space/ Conservation Zones, Green & Blue Acres properties
- Expand local conservation/ open space zones & ordinances
- Strategic buyouts in high risk areas
- Resilient Waterfront Redevelopment (light industrial / warehousing)
- Resilient Waterfront Redevelopment (mixed-use residential)
- Enable greater density/ floor area in low flood risk areas near transit

PROTECTION OF CRITICAL FACILITIES

- Site or building level adaptation of critical facilities
- Retrofit and protect existing pump station

RESILIENCE OF MOBILITY SYSTEMS

- Elevate or harden roadways in flood- prone areas
- Elevate or harden rail lines in flood- prone areas

STORMWATER MANAGEMENT

- Restore natural features for stormwater storage and infiltration
- Retrofit parks & open space for stormwater management
- Opportunity for regional consolidated conveyance along publicly owned corridors
- Stream corridor restoration and riparian zone expansion
- Increase stormwater system capacity or diversion upstream
- Culvert enlargements
- New Pump Station
- Increase stormsewer capacity - deep storage tunnel
- Stormsewer separation (study & prioritize)

COASTAL RESILIENCE

- Construct multi-purpose coastal flood barrier (with bike & pedestrian paths)
- Integrate coastal flood defense into new waterfront redevelopment (tide/surge gate)
- Construct Living Shorelines or Vegetated Berms to enhance shoreline ecology
- Protect and manage tidal wetlands for sea level rise
- Implement beach and dune restoration and renourishment
- Living breakwaters

PREFERRED SCENARIO

REGIONAL BIRD'S EYE VIEW OF PREFERRED SCENARIO
See pages 84-85 for keystone actions legend.

IMPLEMENTING THE PREFERRED SCENARIO

The magnitude of flood risk in the RRBC region both today and in the future demands coordinated action at multiple scales by every level of government. Successful implementation of the preferred scenario will require a range of strategies with action on multiple scales and recognition that resilience building in the region is truly a shared responsibility.

To guide the implementation of the preferred scenario, this *Action Plan* details risk reduction and resilience building strategies that can be undertaken by various entities at both regional and sub-watershed scales. Within the sub-watershed, more detailed strategies can also be implemented within specific Resilience Opportunity Areas. Recommended strategies span three broad approaches:

1. Policy and governance
2. Physical and nature-based infrastructure
3. Outreach, education, and capacity building

Regional strategies are relevant across the region, may be led by a county or state entity, and/or likely benefit from ongoing coordination of various entities within the region. Within the regional strategies included in this *Action Plan*, priority actions have been identified that should be implemented in the near-term.

Various combinations of regional strategies can be applied at the **sub-watershed** scale, based on unique land use characteristics, and shared risks within each sub-watershed. These strategies address the fact that flooding does not stop at municipal boundaries and encourage coordination to proactively reduce flood risks.

Within the sub-watersheds, the project team zoomed in on local **Resilience Opportunity Areas** as specific geographies where there are significant risks to the populations and critical assets. Within these Opportunity Areas, this *Action Plan* recommends a series of targeted actions to be implemented by multiple entities. The intent of these areas is to demonstrate how coordinated actions across jurisdictions can result in improved resilience and other improvements. Taking actions in these areas can also be a catalyst to advancing additional related actions across the region.

Regional Strategies

Sub-Watersheds

Resilience Opportunity Areas

The regional resilience strategies recommended fall under nine strategy types, based on the broad approach:

Policy and Governance

1. Governance and continued coordination
2. Zoning and land use policy

Physical and Nature-Based Infrastructure

3. Adapt or protect critical facilities
4. Resilient mobility systems
5. Stormwater management
6. Coastal resilience
7. Resilient transformation of contaminated sites and brownfields

Outreach, Education, and Capacity Building

8. Flood awareness outreach campaigns
9. Technical support for property owners

The sub-watersheds include the following:

- Arthur Kill Waterfront
- Woodbridge Creek
- Raritan Riverfront and Bay
- South River / Washington Canal
- Cheesequake / Laurence Harbor
- Rahway River and Tributaries

Resilience Opportunity Areas include the following:

- Noe's Creek *(Arthur Kill Waterfront)*
- Heards Brook *(Woodbridge Creek)*
- Middlesex County Greenway Extension *(Raritan Riverfront and Bay)*
- South River and Sayreville Main Street *(South River / Washington Canal)*
- Cheesequake Inlet *(Cheesequake / Laurence Harbor)*

The Implementation Roadmap lists every strategy identified within the action plan and includes additional detail about specific recommended locations, lead entities, immediate next steps, partners, and costs.

REGIONAL STRATEGIES

Regional strategies are applicable across the region, may be led by a county or state entity, and/or likely benefit from ongoing coordination of different entities within the region. Within the regional strategies, the project team has identified priority actions that should be implemented in the near-term.

The strategies identified within the preferred scenario span three overarching approaches, which each entail one or more strategy type:

Policy and governance actions to promote more resilient development and improve coordination across levels of government. Relevant strategy types include:

- Governance and continued coordination
- Zoning and land use policy

Implementable **physical and nature-based infrastructure strategies** such as flood barriers, stormwater infrastructure, and wetland restoration. Relevant strategy types include:

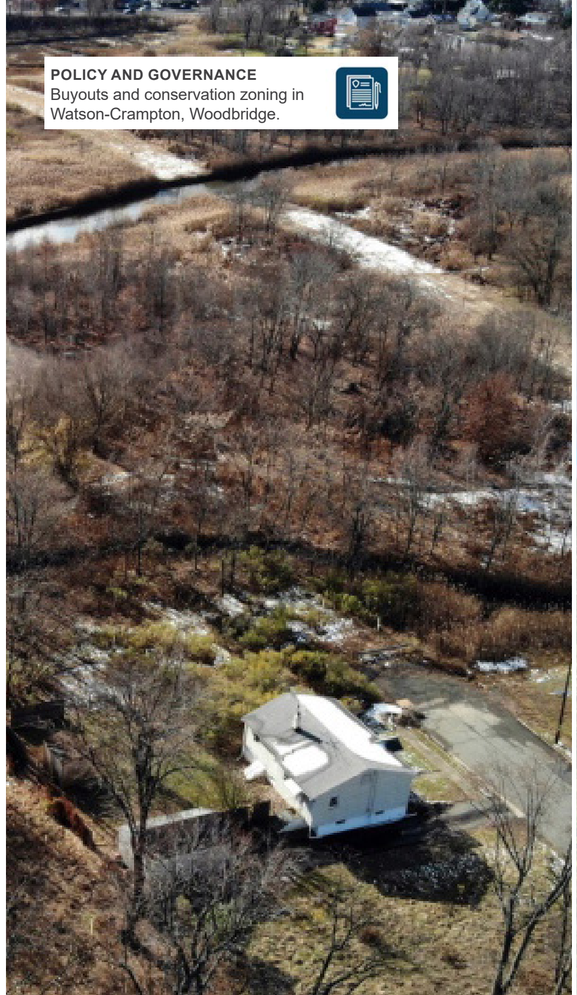
- Adapt or protect critical facilities
- Resilient mobility systems
- Stormwater management
- Coastal resilience
- Resilient transformation of contaminated sites and brownfields

Outreach, education, and capacity building programs to improve flood risk awareness and promote community adaptation. Relevant strategy types include:

- Flood awareness outreach campaigns
- Technical support for property owners

For each strategy type, this Action Plan details the following:

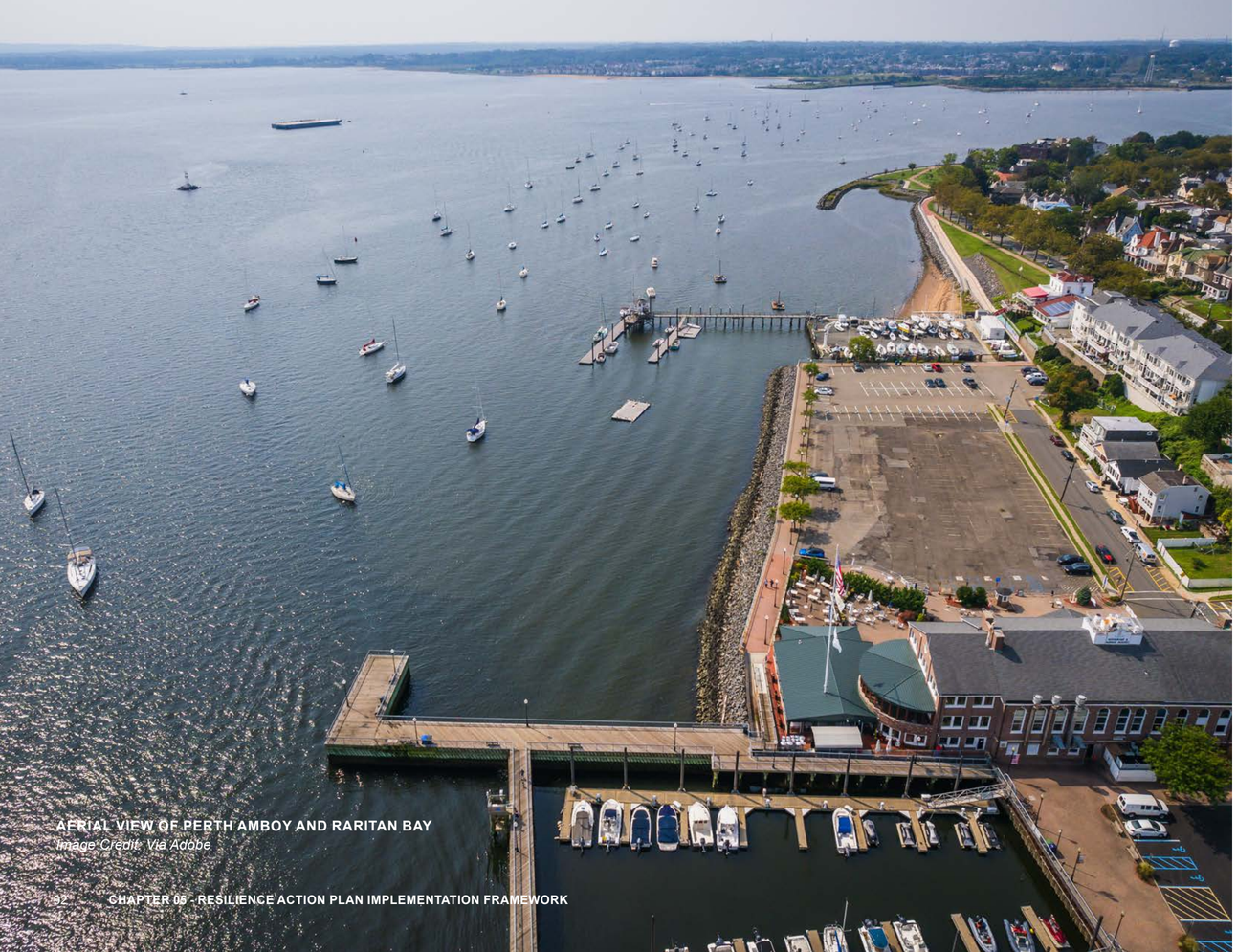
- **Connection to Resilience** – Describes the issues it seeks to address and how strategies of this type generally work towards the regional vision and realize specific protections, risk reductions, and resilience building for flooding and other hazards once implemented
- **Strategies** – Describes specific, actionable strategies within the strategy type and how they can be applied throughout the region
- **Key Considerations** – Provides an overview of environmental, maintenance, regulatory, and other feasibility considerations
- **Co-Benefits** – Describes elements of the strategy type that complement and improve the effectiveness of other strategies and/or realize benefits in addition to flood risk reduction
- **Funding Opportunities** – Lists likely funding and financing sources. *Appendix G* provides a full description of potential funding sources
- **Priority Actions by Lead Entity** – Identifies priority actions and who would be responsible for the implementation and maintenance of each. Priority actions were identified based on stakeholder feedback and immediate resilience needs in the region.



POLICY AND GOVERNANCE
Buyouts and conservation zoning in Watson-Crampton, Woodbridge.

PHYSICAL AND NATURE-BASED INFRASTRUCTURE
Ernest L. Oros Preserve, Woodbridge

OUTREACH, EDUCATION AND CAPACITY BUILDING PROGRAMS
YMCA Perth Amboy



AERIAL VIEW OF PERTH AMBOY AND RARITAN BAY
Image Credit: Via Adobe

POLICY AND GOVERNANCE

A suite of regional policy and governance actions will play a vital role in helping the region transition toward a more resilient and sustainable future, while enabling implementation of coordinated large-scale protect, restore, and transition strategies well into the future.

These types of strategies can serve to minimize growth in highly at-risk areas through strategic buyouts and zoning changes; promote resilient development through updating codes and policies; strengthen lower-risk areas near transit through zoning changes; and promote regional watershed coordination among municipalities and the county. Many of these strategies respond to the concern expressed by residents and other stakeholders about how new development should be consistent with an approach to flood risk management. Policy and governance offer many co-benefits, such as improving public spaces and ecosystems, while also setting a foundation for a more resilient and sustainable long-term growth trajectory.

GOVERNANCE AND CONTINUED COORDINATION

Policy & Governance

Connection to Resilience

Within the RRBC region, the vast majority of floodplain management and flood risk reduction is done at the local level. However, flooding does not stop at municipal boundaries. Currently, policies, programs, and projects are led by individual municipalities, are often reactive instead of proactive, and often do not address cross-jurisdictional floodplain management and resilience needs. Community feedback collected throughout the planning process indicated a desire for increased coordination to proactively build resilience across the region. By recognizing and addressing the interdependence of actions across municipalities, the management of floodplains and resilience could be improved. The table below provides examples of potential benefits of coordination at the regional or watershed scale.

The region currently lacks an organized governance framework for advancing policies, programs, and projects that effectively, proactively manage flood risk at a watershed or regional scale. The strategies described below explore ways that various levels of government within RRBC can work together to implement the *Action Plan* effectively and efficiently.

ACTIVITY	POSSIBLE BENEFITS
COORDINATED DEVELOPMENT OF POLICIES AND PROGRAMS	• Consistent application and benefit of floodplain management and resilience policies and practices • Planning and zoning for equitable upstream and downstream distribution of flood risk • Cumulative assessment of flood impact of proposed development or rezoning • Floodplain ordinance higher standards coordinated across jurisdictions
FLOOD PROTECTION PLANNING AND DESIGN	• Coordinated/participatory planning of federal and state flood management projects and programs • Negotiation of cost sharing agreements • Equitable sharing of benefits of floodplain management policies and programs
MAINTENANCE OF FLOOD PROTECTION AND REGIONALLY SIGNIFICANT INFRASTRUCTURE	• Equitable and efficient distribution of costs across benefitting parties • Joint financing of maintenance and improvement projects
WATERSHED/RIVER BASIN FLOOD ANALYSIS AND MAPPING	• Consistent assumptions across and within watersheds for future-condition analysis and mapping • Greater certainty related to the effects and benefits of actions in the watershed • Greater prediction capability • Ability to leverage information to improve flood risk reduction

Strategies

Governance is the system by which public entities are directed and controlled. In the RRBC region, governance structures and processes can be optimized to help implement all strategies included in the preferred scenario and proactively reduce risk.

There are several ways different levels of government (local, county, state, regional) can work together within a shared governance structure. In New Jersey, like elsewhere in the country, resilience is a shared responsibility across multiple levels of government. Decisions around floodplain management, land use, and resilience are subject to a hierarchy of rules and regulations at various scales of jurisdiction. The table on page 101 summarizes current responsibilities as they relate to floodplain management, land use, and resilience.

To better understand how alternative governance frameworks could be leveraged to support implementation of the preferred scenario, the project team explored four different courses of action. These courses of action are largely based off case studies of watershed-based planning approaches implemented in other places. They vary in terms of level of effort to implement and allocation of responsibilities among participating entities. *Appendix* K includes a summary of the process undertaken to develop the strategies described below and provides additional detail about each potential course of action.

GOVERNANCE FRAMEWORKS FOR FLOODPLAIN MANAGEMENT

Level Of Effort To Implement

#0 NEW ENTITY — *Raritan River and Bay Resilience Commission*

- Delaware River Basin Commission – like approach
- Continuation and expansion of RNJ initiative
- Established through legislation, new regulatory authority

#1 STATE-LED — *NJDEP*

- Louisiana Watershed Initiative – like approach
- Existing and/or expanded regulatory authority

#2 COUNTY-LED — *Middlesex County Flood Resilience District*

- King County Flood Control District – like approach
- Special purpose district established through county ordinance

#3 MUNICIPAL-LED — *Assorted Approaches*

- Formal inter-municipal cooperation
- Memorandum of Understanding, Inter-municipal Agreement, Joint Service Agreement, etc

Although this planning process did not lead to consensus around which course of action should be pursued in RRBC, it did identify broad goals for coordinated regional or watershed-scale governance moving forward. These goals are focused on reducing flood risk, improving resilience through enhanced coordination, building capacity, and empowering communities. Priority actions identified later in this section are near-term steps that can be taken to increase opportunities for coordination and work towards these goals while the discussion around regional or watershed scale governance continues to evolve.

Key Considerations

Each potential course of action has different benefits and challenges. Regardless of the course of action ultimately pursued, the following should be considered to fully realize the potential benefits of a regional or watershed scale governance approach:

- **Political Will** – Political will is critical to the success of any watershed or regional scale governance or coordination. Committed support is required of each participating entity.
- **Core Floodplain Management Responsibilities** – The approach must account for all existing core floodplain management responsibilities. Floodplain management is broadly applied in this context to reflect efforts that reduce flood risk, manage water, and build resilience. These include funding, planning, flood insurance coordination, regulatory authority, technical support & capacity building, project execution, analysis, data and information management, outreach and engagement, and monitoring and evaluation. The approach should also consider new or expanded floodplain management responsibilities necessary to build resilience in the region.
- **Stormwater Management** – A regional or watershed-scale governance approach may also yield a number of benefits for stormwater management including existing water quantity issues, existing water quality issues, or water quality and quantity issues that may be caused by future development. Regional stormwater management and planning can result in regulations and recommendations that are tailored to meet the needs of a region, watershed, or drainage area. NJDEP developed guidance for regional stormwater management planning which is available here. The guidance emphasizes the importance of collaboration in the development of a successful regional approach. Regional or watershed-scale governance in RRBC could be leveraged to address floodplain management, stormwater management, or both.
- **Implementation** – There should be a clear rationale or impetus for entities to participate. Goals and metrics for success should be developed to guide the watershed or regional approach. The structure of the governance framework applied should follow its desired function and efficiently distribute the identified floodplain management responsibilities. There should be a robust understanding of how the new framework either supports or supersedes existing roles and responsibilities.
- **Enforcement and Compliance** – Action on the watershed or regional scale may require enabling legislation or policy. There should be a clear understanding of which entity or entities are responsible for enforcement and compliance. Penalties for non-compliance and benefits for compliance can be used to encourage active participation.
- **Accountability and Authority** – A single entity should be identified as responsible for coordination on the watershed or regional approach. Responsibilities for each participating entity should be clearly defined and reflect an established hierarchy of authority.
- **Resources and Funding** – Established source(s) for funding, resources, staff, and staff time should be identified. Allocation of funding and other resources among participating entities should be transparent.
- **Maintenance** – As the needs of the region and understanding of future hazards evolve, coordination efforts and governance frameworks should as well. Coordination efforts and related policies should be regularly evaluated and updated to ensure that they are meeting the needs of the region.

Co-benefits

There is the potential for coordination to benefit all subsequent strategies recommended in this plan. Further, there is a benefit to continued coordination of the Resilient NJ RRBC Steering Committee, regardless of whether a formal watershed or regional scale governance approach is undertaken. Co-benefits, or benefits that are not directly related to flood risk reduction, include:

- Tackling flood risk at a regional scale can realize efficiencies of scale. This may result in more funding and other resources to address other issues within the region
- Enhanced open space networks and improved water quality
- Capacity building and information and resource sharing between entities
- A watershed or regional scale governance approach can be leveraged to meet ongoing data needs to advance resilience. This may include improved mapping of inland creeks not covered by FEMA or NJDEP and/or development of regional future-condition analysis and mapping

Funding Opportunities

- **Federal Emergency Management Agency (FEMA) Building Resilient Infrastructure & Communities (BRIC)** – FEMA's annual grant program funds capability and capacity building activities such as evaluating and adopting updated building codes, partnership network analysis, partnership development activities, and other planning activities.
- **NJDEP Water Quality Restoration Grants, Nonpoint Source Pollution** – State funding is available for water quality and watershed planning.

Priority Actions

Actions below are priority actions that can be taken in the near- or MID TERM to advance governance and coordination. For a full list of recommended actions, see the *Implementation Roadmap* section.

STATE	• Regular follow-up regarding implementation progress and opportunities for State support • Expanded resilience resources available to counties and municipalities • Coordinate with State agencies on implementing projects identified in the plan • Track progress of recommendations to state agencies • Communicate flood risk and evolving climate science, in partnership with NGOs
RESILIENT RRBC	• Prioritize *Action Plan* recommendations • Identification of priority collective action to demonstrate proof of concept and benefits of coordination • Track progress of recommendations for county and municipal actions • Support ongoing regional coordination on plan implementation
LOCAL- ALL MUNICIPALITIES	• Provide comments on NJPACT rules • Provide updates on implementation of projects recommended in the plan • Identify opportunities for inter-municipal agreements
YMCAs / OTHER NGOs	• Partner with the academic community and community-based organizations to conduct localized studies and public health screenings of present-day vulnerabilities to and impacts of extreme heat and poor air quality

HOW TO INTEGRATE ADDITIONAL CLIMATE HAZARDS INTO GOVERNANCE

Depending on the governance framework and course of action undertaken for a watershed-based approach, there are many ways to build additional climate hazards into these structures. Most of the below strategies would benefit most from implementation at a statewide or regional scale, though many could also be implemented at a county or municipal level. Some of these solutions also include partnerships with regional environmental and community-based organizations and/or academic and research organizations.

- **Enhance regional planning and coordination around additional hazards.** This could include regional coordination around large-scale ecosystem-based adaptation projects; regional goals to support local planning for accessible, equitable public and multi-modal transportation infrastructure; programs associated with reclaimed water for beneficial reuse (RWBR); development of a regional drought early warning system (DEWS) that includes New Jersey; updating the Strategic Management Plan for Invasive Species to reflect best-available data on climate change-related impacts; and identifying key stakeholders and advancing ocean acidification initiatives.

- **Partner with the research community to gather best-available, publicly accessible regional data and develop models and projections of future risk for additional hazards to aid in decision-making.** High priority data gathering needs include a current water table elevation map for the region, a comprehensive contaminant source inventory that details depth and water-solubility of contaminants, a database of household access to and lack of air conditioning data, asthma prevalence data (in coordination with the CDC), an inventory of wildfire fuel sources, and data on water losses and efficiency (i.e., via physical and financial audits). High priority regional modeling and projections needs include projected future changes in depth-to-groundwater with sea level rise, additional groundwater modeling where high-risk conditions exist to help forecast contamination plumes, projections of future high-risk Lyme disease contraction areas and West Nile Virus risk areas, High Resolution Rapid refresh 48-hour severe weather and PM2.5 transport plume forecasting, and ocean acidification monitoring with projected changes in ocean carbon cycles and changes in regional marine species populations and habitat.

- **Work with environmental justice groups to initiate an accessible, regional program to incentivize mitigating and sustainable practices.** Such programs can be used to incentivize widespread private action to address a multitude of additional climate hazards, ranging from large businesses and landowners to small residential property owners. These programs can include incentives for heat-mitigating strategies, such as green roofs, cool (high albedo) roofs, façades and glass glazing with low U-values (e.g., triple-pane or triple-glazed glass), and sun control and exterior shading features; outdoor heat mitigation and landscaping features; actions that would reduce vehicular emissions, such as car-sharing and private investment in vehicle charging stations; residential and commercial indoor and outdoor water conservation retrofits and practices, such as water audits, low-flow fixture and plumbing retrofits, limitations on irrigable acreage, and water-efficient appliances; encouraging rainwater collection practices; hazardous site remediation efforts that include elimination of stagnant water sources and/or maintenance and drainage of surface water to prevent development of adult mosquitoes; cost-sharing and technical assistance to private landowners for forest stand improvement practices and wildlife habitat improvements; and installation of noncombustible screens (e.g., over attic vents), safe storage of propane tanks, and access to water for firefighters to address wildfire risk.

- **Initiate universal public programs to distribute risk-mitigating resources and technical assistance.** This could involve distribution of air conditioners; clean energy technology and transportation subsidies; distribution of residential water quality test kits and emergency at-home water filtration systems; provision of soil moisture or rain sensors and smart controllers for irrigation efficiency for agricultural workers; distribution of bug sprays, window and door screen protections, and tickscape resources; and installation assistance. Minimizing barriers to access by implementing unconditional programs ensures such programs will reach the highest-priority populations—environmental justice communities and other under-resourced populations. This could be paired with a public health hotline for extreme heat, poor air quality, and poor water quality.

- **Investigate tying water conservation rate structures to water utilities.** Water conservation rate structures would be tied to public water utilities based on the amount of water volume consumed as a method of reducing water demand during (or preempting) droughts to mitigate the risk of water shortages. This could be seasonal and be based on allowances/thresholds or involve decoupling water utility sales from earnings/profits, as recommended in the 2017-2022 NJ Water Supply Plan. Any such structure must be equitable and be designed to not burden low-income households.

GARDEN STATE PARKWAY OVER RARITAN RIVER
Image Credit: Ungvar Via Adobe

ZONING AND LAND USE POLICY

Connection to Resilience

There are many ways in which land use tools, such as zoning, planning, and development ordinances can be used to promote resilience to flooding. One of the most important tools is to incorporate consideration of climate change into existing standards and codes at the federal, state, and local scale. These standards are important to promote the design of new construction that is safe for residents, minimize flood damage to property, and minimize flood impacts on adjacent sites.

The Federal Emergency Management Agency (FEMA) sets national minimum floodplain construction standards for communities that participate in the National Flood Insurance Program, however the maps these standards are based on do not incorporate climate change, nor do they include mapping of smaller inland waterbodies, or urban stormwater flooding. FEMA also administers the Community Rating System (CRS), which provides insurance discounts in communities that adopt higher floodplain management standards.

At the state level, the Department of Environmental Protection (NJDEP) develops and enforces rules relating to permitting regulated activity in environmentally sensitive areas, including floodplains. NJDEP promulgates model stormwater management and flood damage prevention ordinances and develops statewide floodplain construction standards. These are incorporated into statewide construction codes. NJDEP is in the process of reviewing these standards to incorporate consideration of climate change—an important step in promoting more resilient new construction.

Local municipalities are required to adopt local floodplain management and stormwater management ordinances. While each municipality must comply with statewide standards, municipalities can also go above and beyond statewide standards to promote more resilient development and receive lower flood insurance rates through the CRS, as described above. Land use is regulated by local municipalities through development of master plans, zoning, and redevelopment plans.

In addition to codes and standards that apply to all new construction regardless of location, land use policies and tools like zoning can be used to manage the location and use of new development to align with resilience goals. The suitable approach for each area will vary depending on land use and environmental characteristics, as well as community desires and goals. Zoning can be used to direct growth away from areas of high flood risk and towards areas of lower flood risk. Limiting density in high hazard areas can lead to less risky future development, which reduces the impact of future flood events. Limiting density may not always be feasible or desirable in some areas at-risk that are already substantially built up and have existing infrastructure—and in fact concentrating growth in areas where there is good transit access can have a positive impact on mitigating climate change. In areas where there is substantial flood risk, particularly from future inundation from daily tides, and where it is consistent with other land use goals, limiting future density through zoning and other tools is an important tool to promote more resilient land use patterns over time. This strategy is particularly effective when paired with buyouts and the reuse of buyout properties for open space and passive recreation—as shown by the case study of the Watson and Crampton neighborhood in Woodbridge.

After Hurricane Sandy, hundreds of properties in the region were bought out through the NJDEP Blue Acres Program. The program was particularly popular in the South River Watershed and Woodbridge. Feedback from South River and Sayreville has been that many of the homes that were most vulnerable were bought out with a few remaining. Post-Hurricane Sandy, the scale of the devastation made property buyouts politically feasible. However, absent the reactive disaster response situation, buyouts may be more difficult to execute and may not have robust political support. In a proactive situation where the flood risk is seen as more hypothetical than actual, it may be difficult to even consider substantial property buyouts. The modeling work that the Resilient NJ team has done shows that additional properties will likely be subject to inundation in the future with rising sea levels and changing precipitation patterns. Some of these properties may not have a history of flood damage and may not appear to be in danger today. However, with a longer time horizon, it may be beneficial to consider proactive approaches to easing structures and development out of the future inundation zones.

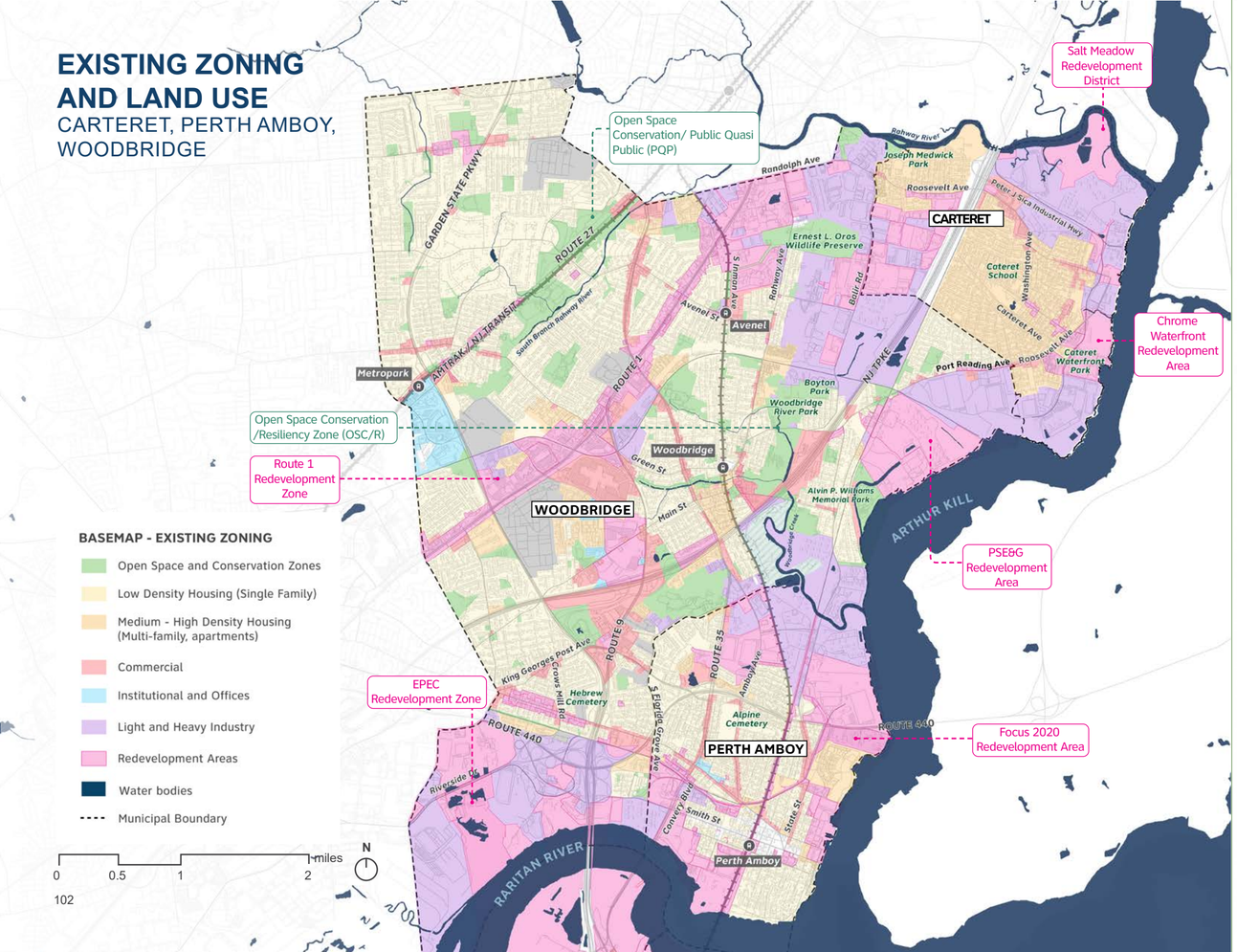
For other areas within the region at-risk from flooding, a resilient land use strategy can include the use of redevelopment to set higher standards for new development and incorporate resilience infrastructure into the redevelopment areas for the benefit of the new development as well as surrounding neighborhoods.

Before developing new local ordinances to restrict development, incorporating resilience into a redevelopment plan, or increasing density outside the floodplain, municipalities should explore these issues as part of a Master Plan Reexamination Report and a Land Use Element update with the required climate change and resilience assessments. The Master Plan process can establish a basis for rezonings, and the new climate change assessment requirements can potentially support zoning recommendations.

AGENCY	CURRENT RESPONSIBILITIES
FEMA	• Creates maps of current flood risk and sets national minimum floodplain construction standards • Administers the National Flood Insurance Program (NFIP), through which people in participating municipalities can purchase flood insurance. Reduced rates are available through the Community Rating System (CRS) for municipalities that adopt higher construction standards
STATE	• Develops floodplain construction standards and stormwater management model local ordinances • Develops and enforces statewide construction codes • Maps watershed management areas • In process of updating rules and regulations to address climate change (NJPACT)
COUNTY	• Site plan and subdivision standards for development that impacts County assets
LOCAL	• Local zoning and ordinances • Master plans • Redevelopment plans • Required to have Flood Damage Prevention Ordinances and Municipal Separate Storm System (MS4) “Stormwater Management” plans

EXISTING ZONING AND LAND USE

CARTERET, PERTH AMBOY, WOODBRIDGE



BASEMAP - EXISTING ZONING

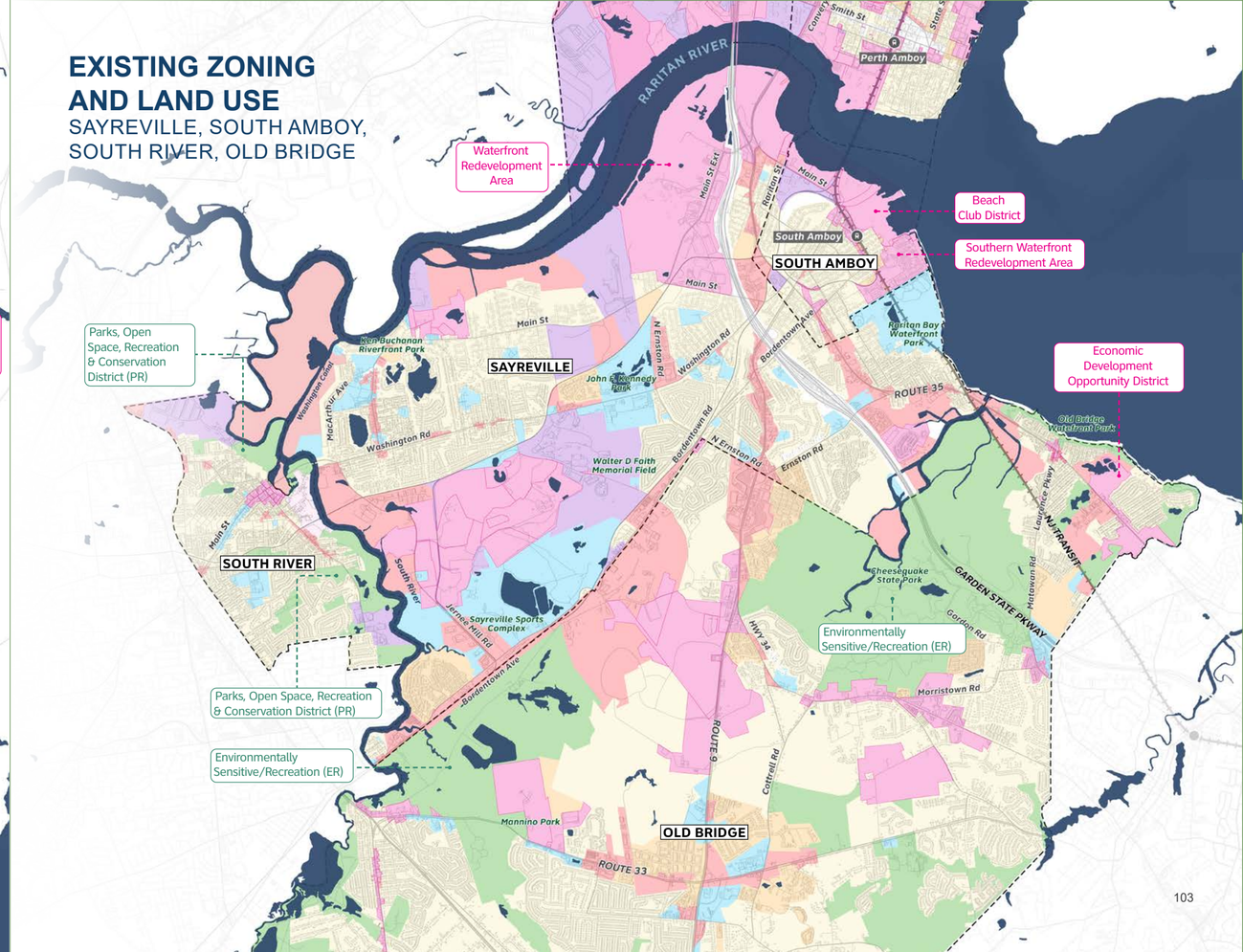
- Open Space and Conservation Zones
- Low Density Housing (Single Family)
- Medium - High Density Housing (Multi-family, apartments)
- Commercial
- Institutional and Offices
- Light and Heavy Industry
- Redevelopment Areas
- Water bodies
- Municipal Boundary

0 0.5 1 2 miles

N

EXISTING ZONING AND LAND USE

SAYREVILLE, SOUTH AMBOY, SOUTH RIVER, OLD BRIDGE



Strategies

There are many opportunities, some complex and some straightforward, to use zoning and land use policy tools to promote a more resilient region over the long-term. This includes continuation of existing tools to preserve natural systems and features that contribute to reducing regional flood risk, offering additional voluntary buyouts in areas of high flood risk, and using zoning and redevelopment tools to direct growth as part of a strategy to increase resilience.

» Protect and preserve open space

While many sections of the region are substantially built out, the RRBC region still possesses undeveloped open space, including forests and wetlands, that should continue to be preserved into the future. Wetlands serve as important buffers to coastal storms and serve as critical habitats. Green spaces in general can also help offset urban heat island effects.

Open space can be preserved through zoning ordinances (as discussed below), as well as through the acquisition of privately owned properties. The NJ Green Acres program managed by NJDEP provides funding for municipalities to acquire and improve open space for preservation purposes.

» Limit Development and Reduce Density in High Risk Areas

Zoning designations, such as Woodbridge's Open Space Conservation/Resiliency Zoning (OSC/R), can be expanded into other areas throughout the region to reduce density in areas with high flood risk, and where there is community support for growth limitations.

In South River, a patchwork of properties was bought out through the Blue Acres program following Hurricane Sandy, though there are a few pockets of properties remaining south of Causeway St. near the South River, as well as along Maple St. north of Reid Street. Existing zoning in these areas leaves some potential for future development and redevelopment. Portions of these neighborhoods will be impacted by future daily tidal flooding and are at risk from storm surge and heavy rainfall flooding. Extension of OSC/R zoning into these areas can help limit future growth. The area near Causeway St. and along the South River should also allow for marinas and other small or temporary structures to promote waterfront access.

On the Sayreville side of the South River, dozens of homes were also bought out through the Blue Acres program along MacArthur and Weber. While there is not significant interest in additional buyouts in the area at this time, future buyouts may make sense in this area. Extension of OSC/R zoning into this neighborhood can help limit future growth on sites that were not bought out but have a similar risk profile to those that were.

In both Sayreville and South River, sites that were bought out through Blue Acres have had minimal improvements beyond regular mowing. Pursuing grants to improve these areas as passive recreational space or community gardens could enhance the sites as amenities for residents and visitors.

Critical Area Ordinance

Another zoning tool to limit density to reduce flood risk and preserve natural features is the use of critical area ordinances. Critical area ordinances define sensitive environmental features as critical areas and exclude them from density, building coverage, impervious coverage, and other calculations. Critical areas may include wetlands, wetland transition areas, steep slopes of 15% or greater, threatened and endangered species habitat, flood hazard areas, riparian areas, and other locally significant measures.

An example in practice: A 10-acre parcel is encumbered by 2 acres of flood hazard area. In the zoning district 50% impervious coverage is permitted, and 25% building coverage is permitted. Rather than calculate the permissible coverage based on the entire 10-acre parcel, the 2 acres of "critical areas" are removed and the calculations are conducted using the remaining 8 unencumbered acres (10 acres x 50% Impervious coverage = a maximum impervious coverage of 5 acres; when the critical area ordinance is applied, 8 acres x 50% = a maximum impervious coverage of 4 acres).

In addition, portions of Woodbridge near the South Branch of the Rahway River and the Pumpkin Patch Brook may benefit from extensions of the Township's OSC/R Zoning in response to recent flooding events.

» Incorporate resilience into redevelopment plans

Redevelopment plans are powerful tools that municipalities can use to set specific design controls within an area experiencing redevelopment. They can be used to incorporate higher standards for floodplain construction and/or stormwater management and require the construction of resilience infrastructure such as stormwater storage, green infrastructure, and coastal protection.

The waterfront portions of South Amboy, Perth Amboy, Woodbridge, and Carteret are largely occupied by redevelopment areas. Portions of the Arthur Kill area have been built-out with new redevelopment projects, many of which have incorporated resilience measures. For the areas across the region that have not yet been redeveloped, including properties that may become future redevelopment areas, the following should be considered:

Incorporation of coastal protection and drainage improvement into all redevelopment projects. Where area-wide projects are planned, dedication of land and pro-rata contributions from redevelopers should be considered to facilitate these efforts.

- Perth Amboy currently requires that property be provided as part of redevelopment projects to create a contiguous waterfront walkway along the Arthur Kill. Where feasible, similar requirements can be incorporated into other redevelopment plans within the region.
- In some areas, particularly in Woodbridge, there may be security or safety concerns about providing waterfront public access, so a walkway may not be appropriate. However, requiring that space be set-aside for future infrastructure improvements may be a beneficial tool in the redevelopment process.
- In Old Bridge, potential redevelopment planning for the Laurence Harbor Area should consider ensuring that sufficient space is provided for flood storage, and that more intense land uses, such as higher density residential, are concentrated outside the flood hazard area.
- The Chrome Waterfront Redevelopment Area in Carteret may benefit from review and amendment to provide space around the mouth of Noe's Creek for flood mitigation and resilience projects.

» Create development opportunities in low-risk areas

This region is growing as demand for new housing and commercial spaces, especially warehousing, is high. Directing this growth as much as possible to areas with lower flood risk will improve the long-term safety and resilience of the region. Areas identified below are outside of the areas identified as exposed to a future coastal storm and with minimal localized flooding from a future heavy rainfall event, with some specific vulnerabilities noted below.

In Carteret, there are existing development opportunities available through the Federal Boulevard Redevelopment Plan which encompasses a mix of parcels that have been redeveloped for warehousing, distribution, or light industrial uses, and parcels that still have redevelopment potential. This area can support additional development in lower risk areas.

In Old Bridge, there are existing development opportunities available under existing zoning in the Browntown/Brownville Town Center Districts at the junction of County Routes 516 and 687 near Route 9. A tributary of Tennent Brook runs through this area, and any new development should be located on higher ground set back from the brook. There are additional opportunities for growth under existing zoning north along Route 9 with minimal flood risk, such as near Perrine and Poor Farm Roads, and at Schulmeister Road. There are also longer-term opportunities that would require zoning changes along Route 9—redevelopment of the Park and Ride at Ivernerness Road to structured parking with additional uses, and full or partial redevelopment of the Acme Shopping Center at Route 9 and Ferry Road. Depending on the long-term vitality of the commercial office market, portions of the existing office and retail developments may be appropriate for mixed-use redevelopment near exit 120 of the Garden State Parkway.

In Sayreville, the Riverton development represents the largest current development opportunity within the Borough. While portions of the development site are vulnerable to coastal flooding, the site is being significantly elevated. Preliminary approvals are in place. There are longer-term opportunities for growth along the Route 35 Corridor north of the Cheesequake Creek outside the flood hazard area—the current B-3 Zoning and development patterns have created a patchwork of uses and lot sizes along the corridor. Several new development projects have been approved, but future targeted redevelopment and potential lot consolidation could

provide additional development potential along the highway and relatively close to the South Amboy train station.

In Perth Amboy, the 2nd Street Corridor represents an opportunity for transformation from auto-oriented and light-industrial uses to mixed-use or residential development near the train station. The zone was identified in the Focus 2020 Redevelopment Plan. Longer term, there are potential opportunities for growth around the train station, including the several substantial surface parking lots and under-utilized parcels in the C-2 Business District. The C-1 Business District on the west side of the train tracks may be able to support additional transit-oriented development potential.

In Woodbridge, there are existing development opportunities under existing zoning in the Rehabilitation Areas near the Woodbridge Train Station. Redevelopment planning is also underway for the Metro Park Area. Introducing a mix of uses can capitalize on the train station and improve the overall vitality of the area. Long-term, office market trends may lead to additional redevelopment possibilities. Development here, however, should be set back as much as possible from the tributary of the South Branch of the Rahway River that intersects the area, and development should be elevated above projected flood levels. The Route 1 corridor in Woodbridge is also a potential opportunity for increased density over the long term. Large commercial and office strips may become appropriate for mixed-use redevelopment as trends evolve. Residential uses have been introduced at Woodbridge Center Mall and behind some of the Route 1-fronting commercial properties near the Garden State Parkway. Evolution of the corridor may reveal additional redevelopment opportunities.

» Update local codes and standards

Local and state codes should be updated to increase design standards for both floodplain management and stormwater management. New development in flood-prone areas should be required to mitigate and minimize flood risk.

All municipalities in the region should amend their flood damage prevention ordinances to reflect the 2021 release of the new “code compliant” model. Municipalities should also explore incorporating higher standards such as:

- Requiring elevation certificate prior to issuing a Certificate of Occupancy.
- Requiring disclosure of flood hazard to renters as part of property registration.
- Requiring disclosure of flood hazard during property transfer through a recorded deed notice.
- Limiting outdoor storage of materials in flood hazard areas (unenclosed and/or hazardous materials)
- Setting specific standards for cumulative substantial improvements, and/or lower substantial improvement threshold.
- Requiring application of the standards in the 0.2% annual chance, or 500-year, floodplain.

Each municipality’s stormwater management ordinance is up to date with the most recent state model code. However, municipalities should explore incorporating higher standards such as:

- Lowering the threshold for “major development.” Major developments are currently defined as the disturbance of one or more acres, the creation of one-quarter acre or more of “regulated impervious surface,” the creation of one-quarter acre or more of “regulated motor vehicle surface” or a combination of regulated surfaces that totals one-quarter acre or more. The thresholds could be modified at the local level to require stormwater management for smaller projects such as one-half acre of disturbance (instead of one acre) or 5,000 square feet of regulated impervious surface (instead of one-quarter acre, which equals 10,890 square feet).
- Creating minor development definition to help mitigate the cumulative impacts of smaller developments
- Modifying the water quality or water quantity criteria to require additional treatment and/or storage
- Redefining pre-construction condition to recognize historical green spaces
- Implementing a green-first best management practice (BMP) hierarchy. A BMP hierarchy could be created to specify certain practices that must be used to the maximum extent practicable prior to using other types of practices. For example, a green-first hierarchy would have vegetated practices in the first tier, while other non-vegetated practices are in lower tiers. The practice hierarchy should be accompanied by detailed criteria on how applicants demonstrate that practices in higher tiers were used to the maximum extent.

In addition, zoning tools could be explored to improve stormwater management, such as minimum green area ratios, requirements for green/solar roofs, or blue roofs. Sewer connection permits can also be used to set maximum allowable discharge rates along with requirements for green infrastructure to meet requirements.

TRANSFER OF DEVELOPMENT RIGHTS (TDR)

A Transfer of Development Rights (TDR) program is one strategy that can be used to distribute growth away from one area and towards another. The Municipal Land Use Law authorizes municipalities to establish TDR programs. The law states: the State is “faced with the challenge of accommodating vital growth while maintaining environmental integrity [and] preserving natural resources.”

Municipalities can create a TDR program within their borders that establishes sending areas (sensitive environmental or natural areas where land will be conserved, and development rights “sent” elsewhere) and receiving areas (locations that can accommodate additional growth or density of development that can “receive” the development potential from the sending areas.) Inter-municipal programs are also authorized whereby multiple towns can jointly establish TDR sending and receiving areas.

The only inter-municipal TDR programs in effect in NJ today are in the Pinelands and Highlands regions. Separate regional bodies administer the programs and facilitate the transfer of development credits and the accompanying preservation and density increases. An inter-municipal program outside of these established planning regions will have governance challenges. Another regional entity, such as the County could be assist with facilitation, but there is no formal statutory basis for such a governance model. The most logical approach could be coordination through a state-level agency to facilitate the synchronization of various municipal plans and the structure of the TDR model. While such a program could be beneficial to this region as way to direct growth away from higher risk areas and towards lower risk areas; there are several challenges to implementing such a program:

- Resources to undertake the foundational work. A great deal of planning and analysis needs to be undertaken to implement a TDR program.
- Difficulty identifying appropriate receiving zones within the municipalities. Generally, towns are already zoned for a mix of growth and conservation.
- A region-wide approach would be best for the program, as TDR is easier to implement over a larger area, but the distribution of tax ratables and the potential shifting of affordable housing obligations would make the program difficult to design and likely hard to support politically.
- Statewide, the best example of a mature and active TDR program is in the Pinelands where 50+ towns are involved, there are established sending and receiving zones, a bank structure facilitates the transfer, and municipalities cannot opt-out of the regional Comprehensive Management Plan. The mandated participation and region-wide level of control present in the Pinelands does not currently exist elsewhere.
- A regional TDR program was discussed as potential tool with the steering committee but more discussion and analysis is needed to determine sending and receiving zones.

Case Study: Pinelands Region

The TDR program within the Pinelands Region is a mandatory part of the Comprehensive Management Plan that defines region-wide sending and receiving areas. The Pinelands Development Credit program has preserved over 55,000 acres of land as of mid-2021. The Pinelands Development Credit Bank, a separate entity with offices at the Pinelands Commission headquarters is responsible for administering the program. From January 2021 through April 14, 2022, 156 “development rights” were sold with a total value of $2,517,200. The program remains a viable means to preserve land and allocated development in areas that can support it throughout the Pinelands Region.

WOODBRIDGE CREEK & WATSON CRAMPTON NEIGHBORHOOD, WOODBRIDGE NJ
Image Credit: Associated Press

Case Study: Woodbridge Watson-Crampton Neighborhood Buyouts and Rezoning

Woodbridge, NJ

Following the devastation from Hurricane Sandy in 2012, the Woodbridge of Township was designated a community in need of Blue Acres Program assistance. The Blue Acres Program provides an option for willing homeowners to sell their Sandy-damaged homes. The homes are demolished, and the land is permanently preserved as open space. Within the Watson-Crampton neighborhood, nearly 150 homeowners participated in the program and the township has been in the process of removing roads and restoring the land to provide open space and habitat. The township has planted native grasses and trees and developed a walking trail throughout the area.

Woodbridge rezoned the area from residential to an open space conservation/resiliency zone, where the only permitted uses are unimproved open space and existing residential structures. New construction is not permitted. The intent is to encourage the removal of all structures from the area and to return the zone to a natural state with resilience enhancements. The following building design standards apply whenever demolition, addition, reconstruction, renovation, sale, or conveyance of the property, or change in tenancy takes place, with exemptions for “ordinary maintenance” as defined in the Zoning Ordinance.

1. Structures shall be elevated to FEMA standards. The top of the lowest floor must be elevated at least one foot above the base flood elevation.
2. All structures must be properly anchored to resist collapse, flotation, and lateral movement.
3. Homes can be elevated on perimeter foundation walls, or on piles, piers, or columns.
4. Valves shall be placed on the building’s sewage line to prevent backflow during storm events.
5. Flood vents are required for foundation walls.
6. Utilities including mechanical equipment such as generators, HVAC systems, electrical, heating, air-conditioning equipment, plumbing, etc. shall be located above the base flood elevation.
7. Basements are not permitted. Enclosed areas below elevated structures (below lowest floor) are permitted to be used only for parking, building access, and storage.
8. Flood damage-resistant construction materials shall be used below the base flood elevation.

The Ordinance also includes requirements to reduce the width of existing roadways in the open space conservation/resiliency zone, landscaping according to the Floodplain Restoration Plan, and registration of properties with the Township.

Buyouts and conservation zoning in Watson-Crampton neighborhood, Woodbridge.

Key Considerations

The zoning and land use policy proposals in this *Action Plan* are based on assessment of flood risk, investigation of existing land uses, and input from local officials and residents. However, any zoning or policy change requires additional investigation and stakeholder outreach. Land use changes specifically should be considered as part of a master planning process that takes into account a wide array of land use concerns and integrates input from involved stakeholders and residents who will be impacted. Beyond flood risk, the following considerations should be part of any decision on policy changes.

- **Implementation Process** – Regulatory changes require adoption by state or local legislative bodies. Before adoption, it is necessary to develop proposed rules, get stakeholder feedback, and, if necessary, make modifications. This process can be time consuming and politically challenging, particularly if there is resistance to proposed changes. Doing outreach to explain the intent behind the changes and how they will work in practice is important to offset any concerns.
- **Ease of Interpretation and Enforcement** – Regulations need to be clearly understandable to those responsible for meeting them, and for those enforcing them. Information on applicable standards needs to be readily available to practitioners. There must also be mechanisms for enforcing all aspects of a regulation.
- **Costs of Higher Standards** – Research has shown that higher standards do not present significant incremental costs to development.

Co-benefits

- Increasing density outside of the floodplain can have numerous co-benefits including economic development and meeting housing demand.
- Limiting density and buying out properties also has numerous co-benefits including improving ecology, protecting habitats, improving water quality, and creating recreational opportunities. Increased green space can also reduce the impact of urban heat island.
- Incorporating higher standards into development can reduce flood insurance premiums for property owners and adopting higher standards can qualify municipalities for increased rating under the Community Rating System. Through this system, municipalities can lower the flood insurance rates for property owners within their town.

Funding Opportunities

- **NJDEP Blue Acres** – State-run, voluntary buyout program of homes subject to repeated flooding or heavily. Homes are demolished and the property can be used as open space or flood storage
- **NJDEP Green Acres** – State administered program dedicated to protecting open space and providing outdoor recreational facilities through land acquisition and funding to local governments and nonprofits.
- **Federal Emergency Management Agency (FEMA) Building Resilient Infrastructure & Communities (BRIC)** – Through NJOEM, FEMA offers grants for building code updates that enhance resilience
- **Garden State Commercial Property Assessed Clean Energy (C-PACE)** – with guidance expected in Summer 2022, this program will provide financing of eligible commercial renewable energy, water efficiency projects in participating municipalities
- **US Department of Energy, Energy Efficiency and Renewable Energy** – Bipartisan Infrastructure Law funded competitive grant program to enable States or regional partnerships to provide sustained, cost-effective implementation of updated building energy codes to save customers money on their energy bills.

Priority Actions

Actions below are priority actions that can be taken in the near- or MID TERM to advance implementation of more resilient zoning and land use. For a full list of recommended actions, see the *Implementation Roadmap* section.

STATE	• Update state codes and standards to reflect climate change (NJPACT) • Communicate code changes to municipalities, developers, and residents • Expand State technical assistance to support local code changes and Community Rating System (CRS) participation • Advocate for improved flood disclosure laws statewide
RESILIENT RRBC	• Provide expanded technical assistance to support local code changes and CRS participation (e.g., continuation of CRS user group) • Provide comments on NJPACT rules
LOCAL (ALL MUNICIPALITIES)	• Provide comments on NJPACT rules • Update the Flood Hazard/ Flood Damage prevention ordinance to incorporate best practices in the latest NJDEP Model Ordinances. Explore opportunities to include higher standards such as requirement of an elevation certificate, limited outdoor storage of materials in flood hazard areas, standards for cumulative substantial improvements and/or lower substantial improvement threshold, and/or application of standards in the 0.2% annual chance floodplain. • Incorporate higher standards into stormwater management ordinance including lowering the threshold for “major development,” defining “minor development” to mitigate the impacts of smaller projects, redefine “regulated impervious surface,” require more distribution of stormwater management best management practices throughout developments by lowering maximum contributory drainage areas, require enhanced on-site groundwater recharge

RESILIENT ZONING AND LAND USE

CARTERET, PERTH AMBOY, WOODBRIDGE

See Summary Table of Recommended Actions starting on page 223 for additional details on all actions.

LEGEND

POTENTIAL ZONING AND LAND USE

1. Protect and preserve open space and natural features that reduce flood risk

- Preserve existing Open Space / Conservation Zones, Green and Blue Acres properties)

2. Manage growth & limit development in flood-prone areas

- Expand local conservation/open space zones and ordinances (ER, OSCR, OS-C/OS-R, PR)*
- Strategic buyouts in high risk areas

3. Set resilient redevelopment standards in flood-prone areas

- Resilient waterfront redevelopment areas - light industrial use and warehousing
- Resilient waterfront redevelopment areas - mixed-use residential

4. Create development opportunities in low flood risk areas

- Enable greater density/floor area in low flood risk areas near transit

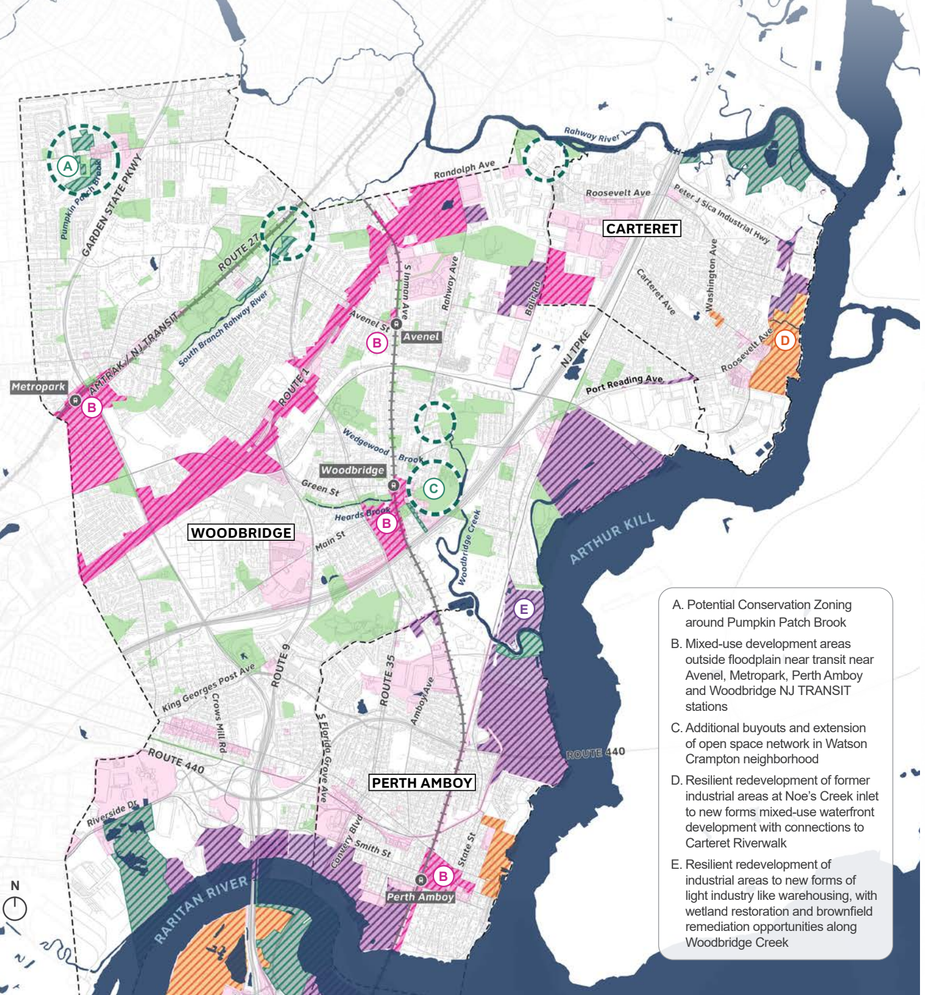
** ER - Environmentally Sensitive/Recreation*
OSC/R - Open Space Conservation/Resiliency Zone
PQP - Open Space Conservation/Public Quasi Public
PR- Parks, Open Space, Recreation & Conservation

BASEMAP - EXISTING ZONING

- Open Space and Conservation Zones
- Redevelopment Areas
- Water bodies
- Municipal Boundary

0 0.5 1 2 miles

N



A. Potential Conservation Zoning around Pumpkin Patch Brook

B. Mixed-use development areas outside floodplain near transit near Avenel, Metropark, Perth Amboy and Woodbridge NJ TRANSIT stations

C. Additional buyouts and extension of open space network in Watson Crampton neighborhood

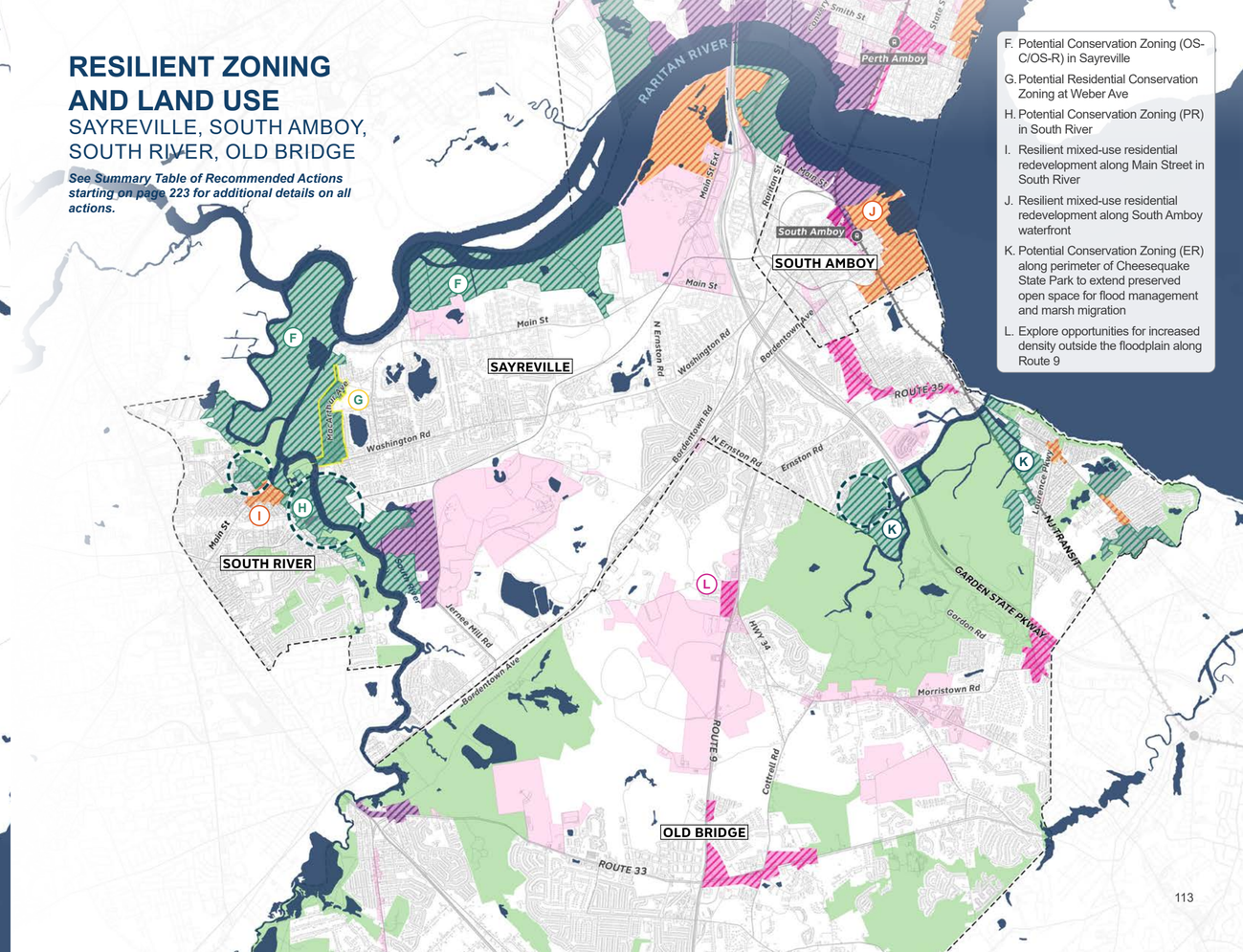
D. Resilient redevelopment of former industrial areas at Noe's Creek inlet to new forms mixed-use waterfront development with connections to Carteret Riverwalk

E. Resilient redevelopment of industrial areas to new forms of light industry like warehousing, with wetland restoration and brownfield remediation opportunities along Woodbridge Creek

RESILIENT ZONING AND LAND USE

SAYREVILLE, SOUTH AMBOY, SOUTH RIVER, OLD BRIDGE

See Summary Table of Recommended Actions starting on page 223 for additional details on all actions.



F. Potential Conservation Zoning (OS-C/OS-R) in Sayreville

G. Potential Residential Conservation Zoning at Weber Ave

H. Potential Conservation Zoning (PR) in South River

I. Resilient mixed-use residential redevelopment along Main Street in South River

J. Resilient mixed-use residential redevelopment along South Amboy waterfront

K. Potential Conservation Zoning (ER) along perimeter of Cheesequake State Park to extend preserved open space for flood management and marsh migration

L. Explore opportunities for increased density outside the floodplain along Route 9

HOW TO INTEGRATE ADDITIONAL CLIMATE HAZARDS INTO POLICY AND ZONING

As with flooding, climate change is rapidly affecting the nature of various Additional Climate Hazards , such as extreme heat, air pollution, groundwater rise, drought, and wildfires. As the region advances its understanding of these evolving risks and their complex interactions, it must ensure that policies, regulations, and ordinances are continually updated to prepare for the future, mitigate the sources and consequences of these hazards, and reflect the highest national and international standards.

- **Adopt ordinances and building codes to state, national, and international models and guidance and consider higher standards.** Standards to look to include 2021 federal U.S. Department of Labor Occupational Safety and Health Administration (OSHA) standards, including inspection guidance for heat-related hazards, in line with the National Emphasis Program (NEP) on heat inspections (effective April 2022); 2021 International Energy Conservation Code (IECC) on energy efficiency and performance as well as spot-ventilation, isolation, and insulation of electrical and mechanical heat systems; federal U.S. Environmental Protection Agency (EPA) air quality standards; World Health Organization (WHO) Global Air Quality Guidelines; 2018 International Residential and Plumbing Codes water conservation and efficiency standards; and 2018 International Green Construction Code water conservation and efficiency standards. Could also include conservation subdivision ordinances to ensure water-efficient landscaping, e.g., requiring retainment of wooded areas or requiring a certain percentage of low water-use plants be used in design.

- **Pursue a statewide requirement, paired with a model ordinance, for municipalities to adopt regulations specific to environmental justice issues and cumulative impacts.** For example, look to the Newark Environmental Justice/Cumulative Impacts ordinance. Develop a streamlined standard operating procedure for integrating review of all potentially impactful development activity.

- **Enhance enforcement of existing local and state regulations**, including the 2021 NJ Stormwater Rule that requires municipalities to update their Stormwater Control Ordinances (SCOs) to require green infrastructure be included with new development (model ordinances provided); State Emission Statement rule which establishes regulations for the annual reporting of air contaminant emissions from stationary sources to help with the monitoring of the state's progress toward the mandatory emissions reduction protocols; NJ Air Quality State Implementation Plan regulations; New Jersey's existing statewide water quality standards, assessments, monitoring, and watershed-based plans and programs to reduce total maximum daily loads; landlord regulations for provision of window and door screen protections to tenants (for mosquito protection); regulations on design of water conveyance and holding structures to minimize potential for mosquito habitats; and others.

- **Explore zoning overlays, restrictions, and/or buffers to address groundwater contamination and wildfire risk.** Implement groundwater protection zoning overlay districts that protect any water within the 1-, 5-, or 10-year Time of Travel zones for contaminants, or buffer distances around groundwater intakes (e.g., a 1-year Time of Travel zone describes the radius around a well within which it would take 1 year for contaminants to reach the well). Develop specific zoning restrictions to address fire risk (e.g., adequate buffers for industrial-residential uses and wildland-urban interfaces, restricting development in the latter).

AERIAL VIEW OF THE WASHINGTON CANAL AND RARITAN RIVER IN SAYREVILLE
Image Credit: Wirestock Creators Via Adobe

PERRINE ROAD TRAIL AT CHEESEQUAKE STATE PARK
Image Credit: Demetrios Via Adobe

PHYSICAL & NATURE-BASED INFRASTRUCTURE

Across the region, the preferred scenario incorporates physical and nature-based infrastructure strategies such as:

- Site- or building-level adaptation of critical facilities
- Restoring wetlands and riparian zones
- Creating floodable spaces on publicly owned lands
- Increasing stormwater system capacity
- Restoring or daylighting riparian zones
- Replenishing and restoring beaches
- Implementing multi-purpose coastal flood barriers
- Enhancing resiliency of mobility systems
- Implementing tide and surge gates
- Retrofitting existing pump stations and modifying culverts

This set of strategies addresses the desire of residents and other stakeholders to both prevent damage and disruption from flooding and incorporate nature-based strategies. In addition to flood risk reduction, additional benefits of these strategies include new public spaces and community amenities as well as improved open space networks and ecosystem processes. Many nature-based solutions also have the potential to address additional climate hazards as well, including extreme heat (especially urban heat), poor air quality, stressed water supply and quality, invasive species, wildfires, and the threats posed to marine species by ocean acidification.

ADAPT OR PROTECT CRITICAL FACILITIES

Physical & Nature-Based Infrastructure

Connection to Resilience

A wide variety of critical facilities in the RRBC region are at risk from rainfall and/or coastal flooding. The *Flood Impact Assessment* includes additional information about priority critical facilities within each municipality that may be exposed to flooding. Critical facilities were prioritized based on the breadth of impact--how wide-reaching losses of the asset might be felt--as well as the magnitude of exposure--approximated as the depth of flooding experienced across all flood events evaluated. For the purposes of this *Action Plan*, strategies to adapt or protect critical facilities are limited to prioritized, publicly-owned critical facilities with structures. These include utilities, community assets, and emergency response facilities across the region. Strategies for transportation infrastructure are recommended in the following section, Resiliency of Mobility Systems. Strategies for parks and open spaces are largely addressed in the Coastal Resilience and Stormwater Management sections.

Flooding of critical facilities in the region can have widespread and cascading impacts, such as the following:

- Utilities including power plants, substations, pump stations, cell towers, and wastewater treatment plants across the region are vulnerable to flooding. Cell towers may be flooded, resulting in service outages that can put citizens at risk during a storm event. Flooding of wastewater treatment plants can cause disruptions to sewage treatment and lead to the disposal of untreated water into river systems.
- Community assets including schools, libraries, and recreational centers across the region are vulnerable to flooding. Flooding of these assets disrupts community services, including education and care of school-aged children. School closures can impact the ability of parents to work further disrupting the economy in the aftermath of a flood.
- Emergency response facilities such as shelters, fire, and police stations in the region are vulnerable to flooding. Flooding of fire and police stations can delay emergency response times. Flooding of emergency shelters can result in shelters being inaccessible or unsafe and unable to provide their intended services during a disaster.

Strategies

Depending on the type of critical facility and type and extent of flood exposure, appropriate site or building scale adaptation measures vary. Opportunities to reduce the risk of critical facilities should be evaluated on a site-by-site or building-by-building basis.

Implement site- or building-level adaptation measures

Site- or building-level adaptation may include:

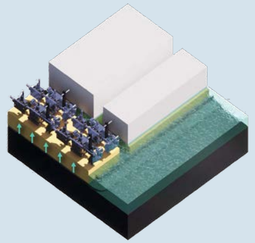
- Elevating critical mechanical systems, including emergency and backup generators
- Dry floodproofing which involves constructing flood barriers and/or shields around critical equipment, systems, or areas
- Retrofitting pump stations
- Relocating critical facilities should effective mitigation interfere with operations

Additional asset-specific study will be required to determine the most appropriate and cost-effective way of reducing risk at each priority asset.

While some critical facilities may be protected from coastal flooding by regional coastal protection strategies, as discussed later in this section, many facilities are outside the areas that would be protected by any proposed coastal protection.

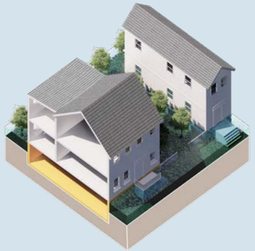
Implement Site- or Building-level Adaptation Measures

Elevate Critical Mechanical Systems



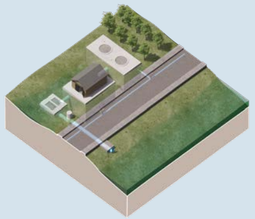
Relocating critical systems to higher floors or elevations reduces the impacts of flooding on critical services and reduces recovery times. This tool increases the resilience of essential services.

Dry Floodproof



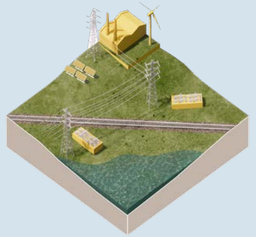
Dry floodproofing below flood levels involves fully blocking out floodwaters with both permanent and deployable structures. This tool retains usability of floors below grade for permanent and temporary uses. It allows for assets and utilities to remain below Design Flood Elevation (DFE) with a lessened chance of flooding.

Retrofit Pump Stations



Pumping is a crucial method to convey water out of areas vulnerable to inundation, where natural and gravity fed drainage is insufficient or not possible.

Relocate Critical Facilities



Where mitigation options interfere with operations, relocating critical facilities can reduce impacts of flooding on critical services. Additionally, creating decentralized and redundant energy generators and developing micro-grid systems can also ensure recovery of critical systems in case of failure within the wider network.

ADAPT OR PROTECT CRITICAL FACILITIES

Key Considerations

- **Level of protection:** The appropriate level of protection for critical facilities should be higher than other, non-critical facilities. However, flood mitigation cannot impact the ability of the facility to provide services. If effective mitigation would interfere with the facility's ability to provide services, relocation of the facility to a lower risk area should be considered.
- **Implementation**: Flood mitigation of critical facilities may pose implementation challenges including identification of and coordination with entities with jurisdiction, permitting, construction, and maintenance, etc.
- **Maintenance**: In order to be resilient, critical facilities must be regularly maintained. The same applies to emergency and backup generators and dry floodproofing. All facilities should consider how they will fund the cost of regular, ongoing maintenance in their operating budgets as well as who will be responsible for maintenance. Additionally, facilities should regularly practice deployment of any 'just-in-time' flood protection measures such as deployable flood barriers and doorway flood shields.
- **Environmental impacts**: Flooding of critical facilities can lead to a number of environmental impacts including contamination of flood water with raw sewage and other hazardous or toxic substances. This highlights the importance of effectively reducing risk for these facilities.
- **Permitting:** Permitting will vary based on the type, location, and ownership of each facility. Relocation of existing facilities will likely encounter additional permitting needs than adaptation to existing facilities. Any work on the waterfront or near wetlands will require additional state and federal permits.

Co-Benefits

Protecting critical facilities from flood risk will allow services to be maintained following a flood event. This can prevent cascading impacts as the impacts to one facility (such as power generation) can have significant downstream impacts on other facilities that depend on them.Additionally, protecting critical facilities has several benefits to public health including, but not limited to, avoiding contamination of flood water with raw sewage, maintaining access to clean drinking water, ensuring availability of emergency services and more. Other facility needs, like improving services or addressing maintenance needs, could be pursued at the same time as the resilience improvements.

Funding Opportunities

- **Federal Emergency Management Agency (FEMA) FEMA Public Assistance (PA):** Grants that provides reimbursement for disaster related expenses. Often used for repairs, restorations, reconstruction or replacement of public facilities or infrastructure damaged or destroyed by a disaster
- **Federal Emergency Management Agency (FEMA) Hazard Mitigation Grant Program (HMGP):** Funding to state, local, tribal, and territorial governments to develop hazard mitigation plans and rebuild in a way that reduces, or mitigates, future disaster losses in their communities. Dependent on presidentially declared disaster
- **Federal Emergency Management Agency (FEMA) Building Resilient Infrastructure & Communities (BRIC):** Competitive grants of up to $50 M for hazard mitigation projects, reducing or eliminating the risks from future disasters and natural hazards.

Priority Actions

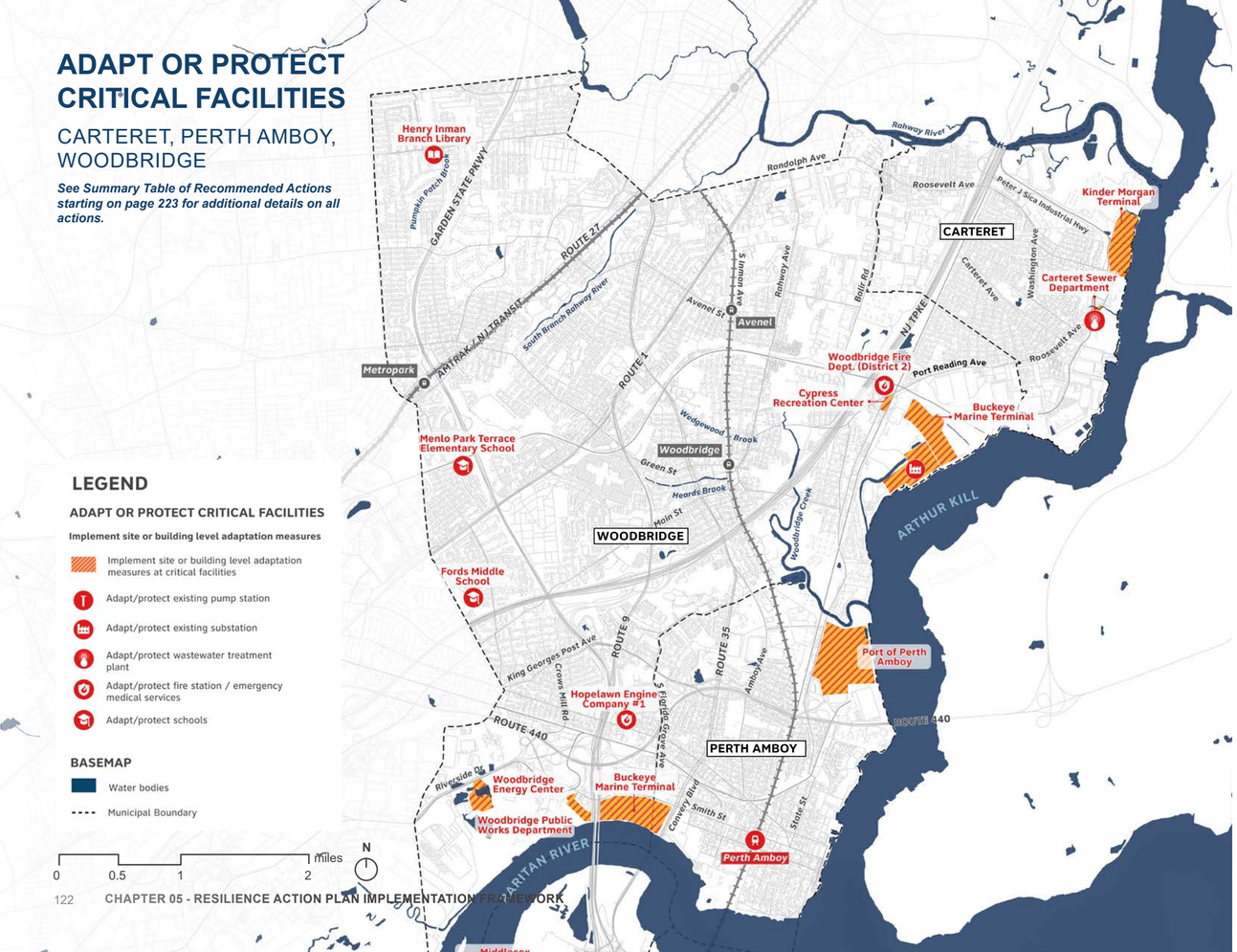
Actions below are priority actions that can be taken in the near- or mid-term to adapt or protect critical facilities. For a full list of recommended actions, see the *Implementation Roadmap* section.

STATE	• Develop guidance for State and Local agencies on design standards and climate projections
LOCAL- ALL MUNICIPALITIES	• Consider relocation of flood-prone shelters to lower risk areas
LOCAL - WOODBRIDGE	• Site-specific mitigation of flood-prone assets at Henry Inman Elementary

ADAPT OR PROTECT CRITICAL FACILITIES

CARTERET, PERTH AMBOY, WOODBRIDGE

See Summary Table of Recommended Actions starting on page 223 for additional details on all actions.



LEGEND

ADAPT OR PROTECT CRITICAL FACILITIES

Implement site or building level adaptation measures

- Implement site or building level adaptation measures at critical facilities
- Adapt/protect existing pump station
- Adapt/protect existing substation
- Adapt/protect wastewater treatment plant
- Adapt/protect fire station / emergency medical services
- Adapt/protect schools

BASEMAP

- Water bodies
- Municipal Boundary

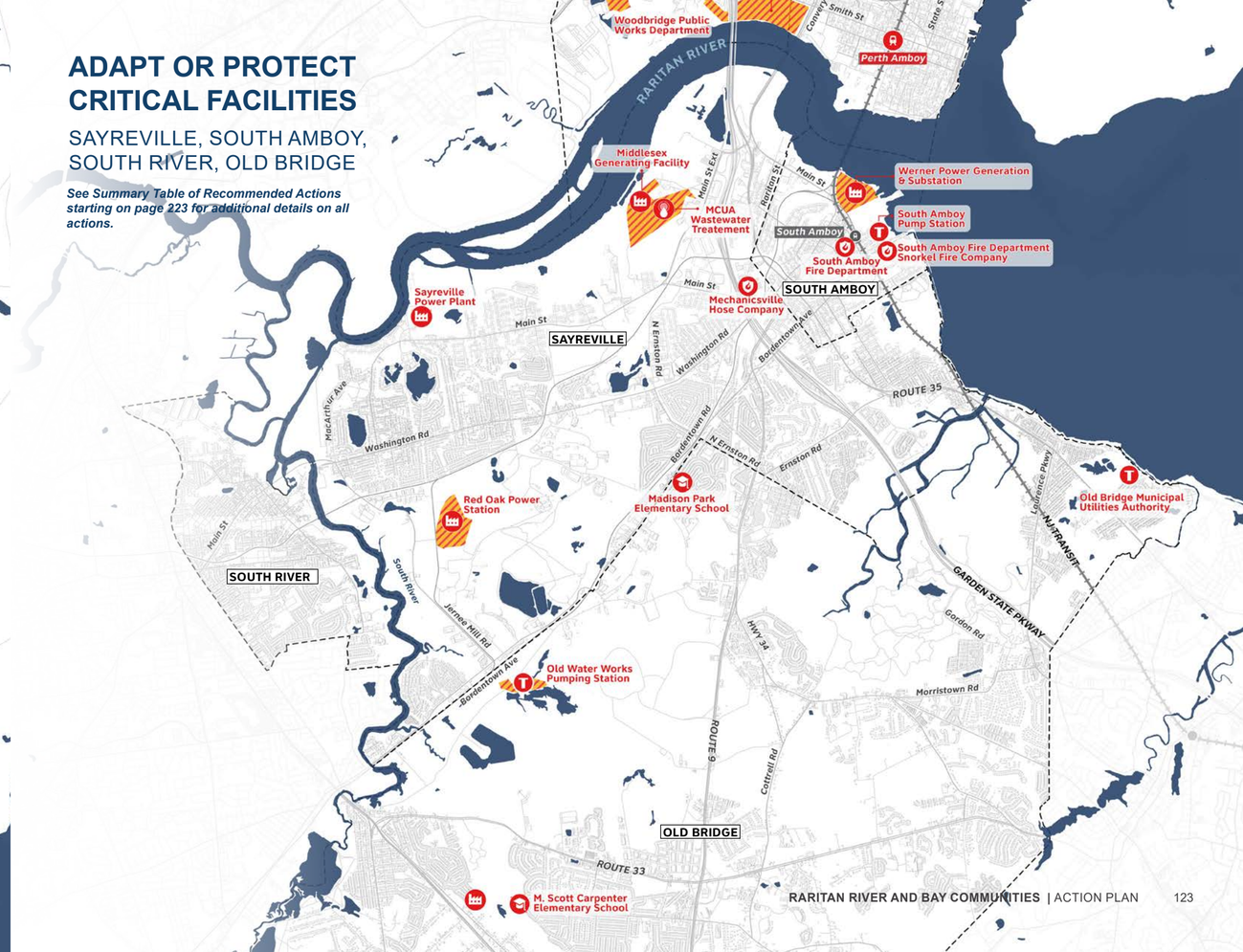
0 0.5 1 2 miles

N

ADAPT OR PROTECT CRITICAL FACILITIES

SAYREVILLE, SOUTH AMBOY, SOUTH RIVER, OLD BRIDGE

See Summary Table of Recommended Actions starting on page 223 for additional details on all actions.



ADAPTING CRITICAL FACILITIES TO ADDITIONAL CLIMATE HAZARDS

Adapting critical facilities to additional climate hazards could mean many things depending on the specific type of hazard. Among the most urgent threats are drought and water quality, with their implications for water supply infrastructure, and the threat of heat-related public health impacts at outdoor public spaces.

- **Prioritize capital improvement projects to replace and/or renew deteriorating and inefficient pipelines and water supply assets.** In accordance with the 2018 American Water Infrastructure Act, this would involve developing risk and resilience assessments for drinking water systems that consider climate change impacts. Could also involve partnering with the Lead Service Line Replacement program. Consider exploring a state mandate for routine water supply asset management planning, with consideration of future water demand and availability conditions. May involve creation of standardized metrics and reporting of conditions to support prioritization of Drinking Water State Revolving Fund.

- **Require specific mitigations on publicly owned properties.** For example, require outdoor heat mitigation, which may include measures such as canopy cover or photovoltaic (PV) shade canopies, water-based cooling stations, or cool pavements.

KEASBEY BROWNFIELD DEVELOPMENT AREA AND WOODBRIDGE ENERGY CENTER AND FACING RARITAN RIVER
Image Credit: PS&S

RESILIENCY OF MOBILITY SYSTEMS

Physical & Nature-Based Infrastructure

Connection to Resilience

The RRBC region is rich with a large variety of transportation systems, and elements of all these systems are vulnerable to flooding.

- Portions of each of the major highways that intersect the region—the **Garden State Parkway and New Jersey Turnpike (I-95)**—are exposed to rainfall and storm surge. Closures and flooding of these key corridors have the potential to cause major disruption to goods, services, and people. Additional key roadways include Route 35, Route 1, Route 9, and CR535. Many of the roadways also serve as bus lines that many commuters and socially vulnerable populations depend upon.
- The **North Jersey Coast Line** commuter rail line connects the Jersey Shore region to the metropolitan area in Northeastern New Jersey and New York City. With more than 24,000 daily riders, there is potential for flooding to greatly impact the region and its commuting population. Additionally, the rail line uses five moveable bridges that are vulnerable to high winds and storm surges during coastal storms, and sea level rise. Vulnerable stations in the RRBC region include Woodbridge, Perth Amboy, and South Amboy (however, the Woodbridge and South Amboy stations are elevated, resulting in a lower risk of flooding).
- The **Northeast Corridor Line** is a rail line that runs through Woodbridge and is vulnerable to rainfall flooding. This line connects the Trenton Transit Center to New York Penn Station and is a major line for commuters. In addition to these individual assets, many roadways across the region are vulnerable to flooding. In addition to supporting vehicular travel, these roadways include critical bus routes, bike lanes, and sidewalks that support public transit and non-motorized transportation.

Increasing the resilience of these mobility systems is key to supporting the ongoing and continuous operation of these assets and maintaining a vibrant and connected region. The region's economy depends upon the movement of goods, and hundreds of thousands of commuters travel through this region every day in cars, buses, and trains.

Strategies

Many transportation agencies have begun to address the resiliency of their assets, but additional analysis of key threats and examination of the feasibility of different approaches to protect vulnerable roadways, rail lines, and stations.

» Protect vulnerable rail lines, train stations, and roadways

Rail lines and roadways can be protected from flooding through either elevating them above projected flood levels or constructing barriers alongside them. Elevating rail lines can be challenging due to space constraints and limitations on grades than can be safely traveled. Barriers must also be designed to manage stormwater and not trap floodwaters behind the barrier. Barriers can include permanent floodwalls or deployable systems that are put in place before a storm.

Roadways identified as evacuation routes, such as the Garden State Parkway, NJ Turnpike (I-95), Route 35 and Route 1, should be prioritized for protection to ensure those roadways are accessible before an evacuation. In addition, roadways that serve as critical bus routes should be protected from flooding.

While there are several train stations in the region exposed to flooding, the Perth Amboy Train Station is the most vulnerable to flooding as the station is at-grade and the tracks run in a depressed trench. Stations can be protected through elevation of critical mechanical systems or flood protection around the facility. Potential options should be further studied and evaluated.

» Integrate resilience infrastructure into proposed greenways

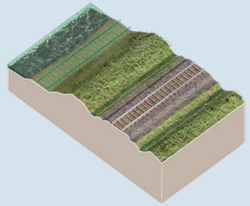
Greenways along the waterfront can be integrated into coastal protection projects, as discussed in Coastal Resilience. Stormwater management features can also be integrated, such as in the proposed Middlesex County Greenway Extension (see Page 190).

» Incorporate future flooding conditions into the design of transportation infrastructure

As new transportation infrastructure is designed and built, design standards are needed to ensure that those systems are built to be resilient to future flooding, taking into account sea level rise and future precipitation. While individual agencies have developed design standards, such as NJ TRANSIT, consistency across additional relevant agencies would help ensure resiliency of systems during future flood events.

Protect Vulnerable Rail Lines, Train Stations, And Roadways

Elevate or harden rail lines in flood prone areas



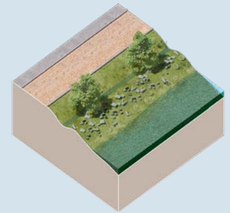
Rail lines and roadways can be protected from flooding through either elevating them above projected flood levels or constructing barriers alongside them. Barriers must also be designed to manage stormwater and not trap floodwaters behind the barrier.

Elevate or harden roadways in flood prone areas

As new transportation infrastructure is designed and built, design standards are needed to ensure that those systems are designed to be resilient to future flooding, taking into account sea level rise and future precipitation.

Integrate Resilience Infrastructure into Proposed Greenways

Integrate berms or setback levees into proposed waterfront greenways



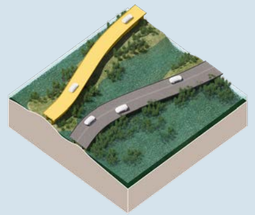
Berms and or setback levees are raised earthen structures erected to protect from flooding. They can be integrated with recreational boardwalks, walkways and bike paths. Their natural sloped sides can be used for plantings or recreational features and be integrated into coastal protection projects.

Integrate stormwater management into proposed greenways

Bioswales are vegetated drainage courses that can capture, detain, and infiltrate runoff allowing any excess rain water along right-of-ways to enter the piped stormwater system.

Incorporate Future Flooding Conditions into The Design of Transportation Infrastructure

Ensure resilient evacuation routes



By creating redundant routes, residents and emergency services can have mobility options when other, more susceptible routes are impassible. This tool applies to instances where critical emergency routes are often compromised by floodwaters.

Key Considerations

Criticality, risk tolerance and level of protection: It may not be feasible to elevate or protect all roadways or rail lines from all storm events. All roadways and rail lines should be protected from future high tide and other frequent flood events, and the most critical roadways and rail lines should be protected from rare, extreme events. Agencies should evaluate the level of protection needed for a route based on the implications of being flooded. Roadways that serve as evacuation routes, have high traffic, or connect to key critical facilities should be considered more critical that small roadways.

Maintenance: To be resilient, mobility systems must be regularly maintained. Strategies recommended to improve the resilience of mobility systems vary in terms of maintenance requirements.

Permitting: Permitting needs will vary based on the asset and location. Rail lines and roadways near the waterfront or wetlands may be more challenging and time consuming to permit. In some instances, there may be a need to acquire property along a rail or roadway corridor to have the space to implement flood mitigation.

Co-Benefits

Reconstruction of transportation assets to protect from flooding can also be an opportunity to improve the asset in other ways. This could include improving visitor waiting areas at a train station, improving traffic flow on a highway, or adding a bike lane to a bridge.

Case Study: NJ TRANSIT Raritan River Bridge Project

NJ TRANSIT is in the process of constructing a new bridge on the Raritan River between Perth Amboy and South Amboy which would replace the existing swing bridges that carry the NJ TRANSIT North Jersey Coastal Line. The bridges were damaged by Hurricane Sandy and the replacement project is funded through a Federal Transit Administration Emergency Relief Program. The new bridge will integrate resilient structural designs and materials to withstand future storm surges and be significantly less vulnerable to severe weather events.

Aerial view of NJ TRANSIT Raritan River Bridge connecting South Amboy and Perth Amboy over Raritan Bay

Image Credit: Wirestock via Adobe

Funding Opportunities

- **U.S. Department of Transportation (USDOT) Promoting Resilient Operations for Transformative, Efficient, and Cost-saving Transportation (PROTECT):** Funded through the bipartisan infrastructure law, USDOT PROTECT provides formula funding to states and national competitive grants that local governments can apply to for resilience improvements to surface transportation assets, including making transportation resilient to future weather and natural disasters, assess vulnerability and plan emergency response strategies, and protecting coastal infrastructure at risk from sea level rise.
- **USDOT Transportation Alternatives Program (TAP):** Funded through proportional set-aside of funds under the bipartisan infrastructure bill, administered by NJDOT, in partnership with the NJTPA, DVRPC and SJTPO, this program provides federal funds for community based “non-traditional” surface transportation projects, such as conversion and use of abandoned railroad corridors for trails for pedestrians, bicyclists, and other non-motorized transportation users and environmental mitigation to address stormwater management due to highway runoff.

Priority Actions

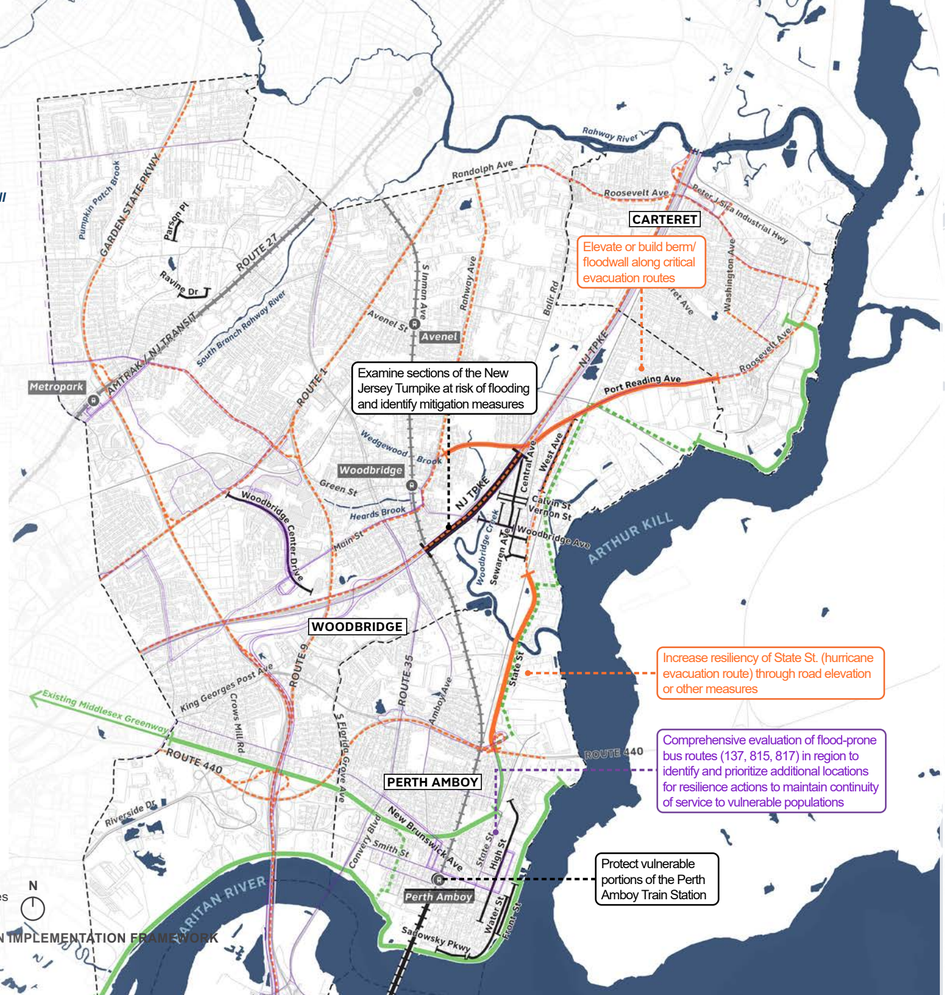
Actions below are priority actions that can be taken in the near- or mid-term to promote the resiliency of mobility systems. For a full list of recommended actions, see the *Implementation Roadmap* section.

NJDEP	• Develop guidance for State Transportation agencies on design standards and climate projections
NJ Turnpike Authority	• Examine sections of the Garden State Parkway at risk of future flooding and identify mitigation measures, such as the stretches within Cheesequake State Park and near Woodbridge Creek
NJ TRANSIT	• Study and develop alternatives to reduce flood risk to the NJ TRANSIT Coast Line, including the section in Old Bridge at Cheesequake Creek
NJDOT	• Review flood risk to vulnerable sections of State Route 35 in Laurence Harbor and integrate considerations for how to reduce flood risk into future capital plans to the extent feasible • Update the statewide evacuation plan, with input from Local and Regional stakeholders
Resilient RRBC	• Examine opportunities to protect vulnerable sections of State St. (CR 611) and Port Reading Ave near the Arthur Kill

RESILIENCY OF MOBILITY SYSTEMS

CARTERET, PERTH AMBOY, WOODBRIDGE

See Summary Table of Recommended Actions starting on page 223 for additional details on all actions.



LEGEND

RESILIENT MOBILITY SYSTEMS

- Elevate or harden roadways
- Elevate or harden rail lines
- Integrate resilience infrastructure into proposed greenways
- Ensure resilient evacuation routes
- Ensure resilient bus routes

BASEMAP

- Hurricane Evacuation Routes
- Existing Greenways and Trails
- Proposed Greenways and Trails (L-Plan Middlesex County Greenway Opportunities, 2022)
- Water bodies
- Municipal Boundary

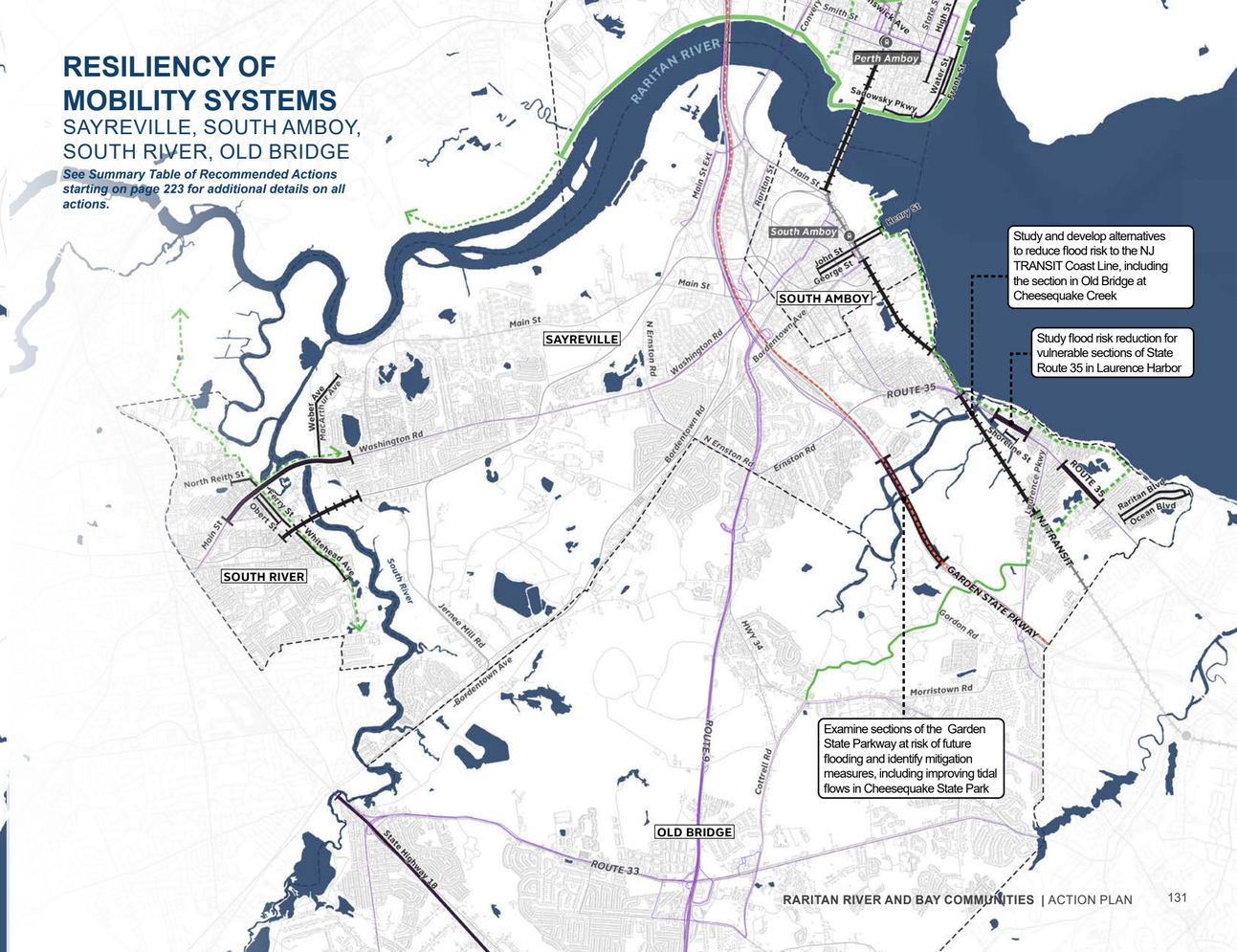
0 0.5 1 2 miles

N

RESILIENCY OF MOBILITY SYSTEMS

SAYREVILLE, SOUTH AMBOY, SOUTH RIVER, OLD BRIDGE

See Summary Table of Recommended Actions starting on page 223 for additional details on all actions.



MOBILITY AND ADDITIONAL CLIMATE HAZARDS

In addition to policy-related approaches to protecting roadways and other transportation assets from the impacts of extreme heat (i.e., implementing load restrictions for older roads, bridges, and railways), broader transportation planning efforts can be leveraged to mitigate the severity of extreme heat and poor air quality. The types of solutions included in this strategy pair well with sustainability initiatives, as they could also lead to greater energy efficiency and lower greenhouse gas emissions.

- **Plan for accessible, equitable public, multi-modal transportation infrastructure.** Establish regional goals and undertake coordination to encourage local and regional planning for more accessible and equitable public and multi-modal transportation infrastructure to reduce emissions from cars. May include greater emphasis on sidewalk improvements, bicycle infrastructure, and pedestrian connectivity; expanding and enhancing public transit; encouraging mixed-use zoning; investing in electric and zero-emissions buses; investing in public electric vehicle charging stations; and establishing clear goals to convert 20% or more of the car fleet to electric by the end of the decade. This can be paired with other improvements such as PV canopies and/or green infrastructure at bus stops, as well as public-private partnerships to limit vehicular heat and pollution by starting or expanding bike share programs and exploring opportunities for streets to shut down to vehicular traffic and create a pedestrian-only experience.

OPPORTUNITIES TO IMPROVE EVACUATION PLANNING

Evacuation planning requires coordination across levels of government and consistent and clear communication with the public and community organizations.

The Federal Highway Administration provides national guidance on best practices and structures. The New Jersey Office of Emergency Management (NJOEM) coordinates the statewide evacuation plan and makes the determination of when a state evacuation order is needed and communicates that to the County level. The NJ Department of Transportation (NJDOT) identifies evacuation routes and zones and communicates messaging on state highways. Middlesex County coordinates with NJOEM and NJDOT on evacuation planning needs within the County, and coordinates with surrounding counties as needed. Each municipality communicates evacuation orders with their residents.

Opportunities to improve the coordination of evacuation planning across the region include:

- Municipalities can identify local evacuation routes to complement the existing County and Statewide evacuation routes.
- The State, Municipalities, and the County can continue their efforts to reach residents, particularly those at high-risk, in disadvantaged communities, or with disabilities. The recently launched NJ511 system allows geotargeted communications to drivers' cell phones. Additional communication strategies include websites, television, social media, door to door and other methods.

The State will be updating the Statewide Evacuation Routing plan and Counties will have the opportunity to provide their input on updates. Counties and Municipalities should be involved in this process to ensure that their residents needs are heard, and disadvantaged communities are considered during the evacuation route planning process.

Through the Resilient NJ planning process, several specific areas with high concentrations of residents in areas vulnerable to flooding were identified that would benefit from more targeted evacuation planning and communication. These include the public housing complex in Carteret and the Winding Woods apartment complex in Sayreville. Both areas are also predominantly low-income and house many residents of color.

ROUTE 35 (VICTORY BRIDGE) OVER THE RARITAN RIVER
Image Credit: *Christy Lang Photos Via Adobe*

STORMWATER MANAGEMENT

Physical & Nature-Based Infrastructure

Connection to Resilience

The Raritan River drains an area of more than 1,000 square miles, which covers a broad range of land uses and environmental resources. Development has greatly increased the amount of impervious surfaces within the region and has altered traditional drainage patterns. Storm sewer systems within the region are not sized to manage the extreme storms experienced more frequently over the past few years. The effectiveness of these systems will continue to degrade, as climate change is expected to lead to increased sea levels and rainfall intensities, reducing the capacity of catch basins, pipes, and outfalls to drain areas throughout the region. By 2070, a heavy rainfall event could cause $4.9 billion in losses. Woodbridge and Perth Amboy face the highest risk with $1.5 billion and $700 million in losses respectively. Tidal flooding and high groundwater tables will also reduce the effectiveness of existing stormwater management infrastructure.

Strategies

Effective management of stormwater to reduce flood risk within the Raritan River and Bay communities requires a watershed approach. Strategies have been identified that improve management from the headwaters to the mouth of rivers with the goal of re-establishing natural drainage functions. Specifically, the strategies recommended here include those that expand capacity to store stormwater and improve the conveyance or movement of stormwater through the system. Strategies are overlapped to provide redundancy and flexibility, allowing systems to adapt to changing environmental conditions. This watershed approach is most evident in several of the inland tributaries within the region, such as the Raritan River, South River, Woodbridge Creek, Rahway River, and their tributaries. These waterways cut through the heart of communities in the region. Integrating multiple storage and conveyance techniques will reduce risk by mimicking pre-development conditions and protect against local stormwater flooding impacts.

» Expand storage on publicly owned land

Paved surfaces prevent rainfall from soaking into the soil, resulting in more stormwater runoff leaving sites more quickly. If large portions of the watershed are paved, an intense storm event can transform a downpour into flash flooding by quickly consolidating runoff from multiple sites. Providing areas for stormwater storage helps delay runoff and can reduce peak flows downstream. A distributed approach can counteract the impact of impervious surfaces.

Protecting and restoring natural features, such as wetlands and riparian zones, can improve stormwater storage and infiltration. There are also opportunities across the region to retrofit parks and other open spaces for stormwater management by adding stormwater storage through both green and grey infrastructure techniques. The map later in this section identifies some areas that have been identified on a preliminary analysis that should be further refined and prioritized. Utilizing existing corridors, such as the inactive rail line through Perth Amboy, provides opportunities to distribute green infrastructure while capturing additional benefits to public space and connectivity.

Partnering these distributed techniques with regional stormwater storage takes advantage of large publicly owned properties, where practices can be cost-effective to implement. When placed in conjunction with distributed techniques, these practices can manage larger stormwater stressors within the watershed and safely manage localized flood risk.

Matching stormwater management needs with publicly owned opportunity areas is a way to prioritize implementation of these techniques.

While limited in areas, voluntary buyouts of properties can create additional room to divert flows into storage areas to reduce peak flows downstream. While more study is needed to model the effectiveness of these approaches, areas of the South River can be prioritized for river management through upstream diversions and off-channel storage.

» Increase capacity of riparian corridors

In certain areas of the region, the storm sewer system effectively conveys flows to riparian corridors but development along these corridors has choked the ability to move these flows to Raritan Bay. Evaluating and eliminating these constraints can ensure that stormwater flows unimpeded through the watershed, limiting flood impacts.

Heards Brook and Wedgewood Brook are examples of stream corridors that have been significantly restrained due to the urban development that has occurred in Woodbridge. Infrastructure along this corridor, specifically the number of culverts associated with road crossings, pinches the corridor causing flooding in this area.

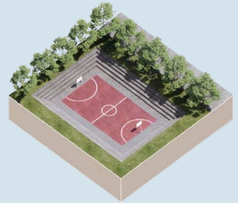
Expanding and restoring riparian zones, along stream corridors helps to convey larger storm events and provides additional space to safely manage flood events. Stream restoration has numerous additional benefits to water quality and habitat for fish and other species, and the new floodable green space along these corridors can provide accessible public open space that can be a popular amenity during non-storm events that provides numerous benefits for the health and wellbeing of residents.

Expand Storage on Publicly-owned land

Restore wetlands and riparian areas for stormwater storage and infiltration

Wetland restoration involves returning the natural functions of former or degraded wetlands that have been filled, drained, or impounded to promote stable water exchanges into and out of the wetland.

Retrofit parks and open space for stormwater management



Retroffitting parks and open space can capture and store stormwater collected from impervious areas. Stored water is then released directly through an outlet pipe back into natural waters at rates designed to reduce peak water flows during storms.

Create upstream diversions and stormwater storage on flood-prone rivers

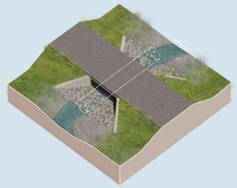
Capturing runoff and diverting water upstream can help reduce downstream or localized flooding and enable groundwater recharge. Retention ponds, for example, are artificial basins used to manage stormwater runoff and promote infiltration.

Increase Capacity of Riparian Corridors

Stream corridor restoration and riparian zone expansion

Stream daylighting is the exposure of some or all of the flow of waterways covered by pipes or culverts. Stream daylighting and restoration of natural drainage systems can help eliminate flooding issues by re-creating a functioning floodplain and riparian area.

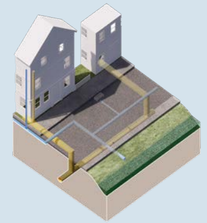
Culvert enlargements



Enlargement of culverts that are not able to manage large flow surges during heavy rain events or spring thaw can help reduce the likelihood of localized flooding upstream of the culverts, assuming additional floodwater doesn't exacerbate flooding issues downstream.

Eliminate Barriers Caused by Existing Infrastructure

Increase stormsewer capacity



Breakwaters are partially or fully emergent structures that extend above mean high water. They are built with armor units to help attenuate storm waves to improve safety and prevent damage to buildings and infrastructure.

This can be coupled with culvert enlargements to reduce or eliminate "pinch points" and help effectively convey runoff from larger storm events. This is particularly critical at road and rail crossings.

» Eliminate barriers caused by existing infrastructure

As the Raritan River basin developed, overlapping infrastructure and conflicting priorities have altered natural drainage pathways. These barriers restrict stormwater flows and exacerbate localized flooding problems. Reversing these barriers without impacting the conflicting infrastructure can be difficult, requiring creative strategies to effectively manage stormwater. Highways or railways are a common source of these constraints, cutting across riparian corridors and cutting off drainage pathways. In the Hopelawn neighborhood of Woodbridge, natural drainage pathways flow south towards the Raritan River. These flows need to travel past an abandoned rail embankment, the complicated interchange of NJ-440 and the Garden State Parkway, and residential, commercial, and industrial properties. Publicly owned corridors can be an opportunity for regional consolidated conveyance of stormwater. This infrastructure can be leveraged to help consolidate stormwater, by collecting drainage along the abandoned railway, and sent past the other barriers in a more efficient and effective location.

Additional challenges with existing drainage infrastructure may arise as climate change increase the severity of storm events. This infrastructure was designed based on historic records of rainfall and sea level – already dated for today's design conditions but even more for systems that have been built more than 50 years ago. Expanding the existing sewer system, separating stormwater, adding pump stations, and/or high-level storm sewers in the combined sewer areas of Perth Amboy, can address these localized barriers in sewer infrastructure. Another alternative is to capture and store combined sewer overflow (CSO) discharges in a deep storage tunnel during a storm event and pump the overflow back into the sewer system when conveyance and/or treatment capacity is available. Adding tide gates and pump stations, as proposed for the mouth of Noe's Creek, overcomes the barriers caused by sea level rise inundating existing sewer outfalls. Connecting these projects with the combined sewer overflow long term control plan for Perth Amboy can help to achieve increased resiliency along with the planned water quality benefits.

» Incorporate climate considerations into Long Term Control Plans

NJDEP requires utilities that operate combined sewer systems (CSS) to develop Long-Term Control Plans (LTCPs) that outline steps they will take to reduce combined sewer overflows to improve water quality. Within the RRBC region, Perth Amboy is the only municipality with a combined sewer system. While the primary goal of the LTCPs is to address water quality issues, they can also provide resilience benefits. Strategies to reduce CSO events by increasing storage capacity can also alleviate flooding. The current standards set by NJDEP that LTCPs must follow use historic rainfall data, not including future projections, despite them being long-term plans. Incorporating climate projections into the process for developing LTCPs would ensure that they better address near and long-term resilience and water quality issues.

Key Considerations

Level of protection: Agencies should evaluate the level of protection or service needed to be provided by stormwater infrastructure. For example, agencies can require green infrastructure to manage a 2-year storm event and all new gray infrastructure to manage a 10-year storm event. Before enlargement of any culverts in the study area, additional study will be required to demonstrate that culvert enlargement will not exacerbate flood risks elsewhere. In areas vulnerable to coastal storm surge, the potential for enlarged culverts to allow more storm surge to propagate inland must also be considered.

Land use changes: Stormwater improvements should account for land use changes, such as increased impervious areas and changes to drainage patterns.

Costs: Stormwater management costs will initially increase to account for increased rainfall intensity and additional stormwater infrastructure capacity. Proper planning and implementation moving forward will produce cost savings.

Potential community disruption: Construction impacts may disrupt the community but will be followed by reduced local flooding.

Maintenance: In order to be resilient, stormwater management assets must be regularly maintained. All stormwater management assets require routine maintenance to maximize their operational performance, but each has unique maintenance requirements. Green infrastructure will require varied and specific maintenance per practice type, and inspections should be prioritized in critical areas and following rain events.

Permitting: Most stormwater improvements will require permits from local, state, and federal agencies, which can be time-consuming and expensive. All the permitting needs for a project permitting should be examined early in the process to identify necessary regulatory agencies to engage, and to minimize implementation challenges later in the process. Some project may also require land acquisitions or easements to be coordinated with private property owners.

Co-Benefits

Stormwater improvements can have numerous co-benefits to surrounding areas, such as:

- Increased green space
- Improved water quality
- Reduction of urban heat island effects

Funding Opportunities

NJDEP Natural Climate Solutions Grant: Offered through NJDEP and funded through Regional Greenhouse Gas Initiative. Provides grant funding for on-the-ground implementation of projects that create, restore, and enhance New Jersey's natural carbon sinks, such as salt marshes, seagrass beds, forests, urban parks and woodlands, and street trees

National Fish & Wildlife Foundation (NFWF) America the Beautiful Grant: The goal of this program is to connect and restore the lands, waters, and wildlife of the US through cooperative agreements with other federal agencies. Funding is focused on mitigating flooding and storm threats and improve resilience to wildfire and drought

New Jersey Infrastructure Bank (I-Bank): Independent state financing authority responsible for providing and administering low interest rate loans to qualified municipalities, counties, regional authorities, and water purveyors in NJ. Eligible projects include green infrastructure and stormwater management

NJDEP Stormwater Competitive Grant Program: $7 million grant program providing funds to improve water quality and quantity through implementation of green infrastructure, retrofits and redesigns of existing stormwater management basins, restoration activities resulting in the removal or reduction of impervious surfaces, and planning and analysis activities associated with the implementation of the aforementioned activities.

NJDEP Stormwater Utility Feasibility Study Technical Assistance /Stormwater Resilience Planning: Funding for municipalities, counties, and public authorities to conduct feasibility studies for forming stormwater utilities.

Priority Actions

Actions below are priority actions that can be taken in the near- or mid-term to improve stormwater management. For a full list of recommended actions, see the Implementation Roadmap section.

STATE	• Explore opportunities for expanded stormwater storage on State facilities
RESILIENT RRBC	• Continue to explore a regional stormwater utility in partnership with municipalities • Explore opportunities for expanded stormwater storage on County facilities • Assess opportunities for incorporating flood storage and conveyance into an extension of the Middlesex County Greenway
LOCAL - ALL MUNICIPALITIES	• Explore opportunities for expanded stormwater storage on municipal-owned facilities • Incorporate higher standards into stormwater management (see page 111)
LOCAL - PERTH AMBOY	• Implement the Long-Term Control Plan to reduce CSOs

REGIONAL STORMWATER UTILITY

The Middlesex County region experiences localized flooding and additional stormwater-related problems such as sedimentation build up. A dedicated stormwater funding source, such as a stormwater utility, could be used to solve this issue by implementing capital improvement projects and best management practices, paying for administration and operations services, meeting permit-required minimum control measures, and performing ongoing operations and maintenance activities.

Reliable stormwater funding helps increase resilience by allowing municipal agencies to address issues related to aging infrastructure, increasing flooding problems, and increasing regulatory requirements for stormwater management and pollution reduction. Creating a dedicated funding source for stormwater management provides a stable revenue source for stormwater and resilience programs

Funding Methods

There are numerous funding methods available to municipalities and utilities for the development and implementation of stormwater and resilience programs. The following table presents the funding methods that typically form part of stormwater financing strategies.

Importance of dedicated funding. Stormwater can be used as a dedicated source to fund stormwater programs to leverage other funding methods presented in the table above. Stormwater utility fees reduce the pressure to raise taxes and reduce reliance on an entity's general fund. In 2019, New Jersey signed into law the Clean Stormwater and Flood Reduction Act, allowing the governing body of any county, municipality, or municipal authority to establish stormwater utilities.

Traditional Funding Sources	Innovative Funding Sources
Stormwater utilities	Cost sharing programs
Grant and loan programs	Public-private partnerships
Municipal bonds	Private and non-profit sources
Taxes (General Fund)	Capital markets
Fee in-lieu-of programs	Mitigation banking programs
Developer funding (plan review and inspections)	Credit trading programs

What is a Stormwater Utility?

A stormwater utility creates the ability to assess fees, based on a fair and equitable approximation of the contribution of stormwater runoff from a real property, which can then be used to fund stormwater programs within the governing body. A stormwater utility operates similarly to any other utility, such as a water or electric utility. This is an especially valuable tool as part of a watershed approach for flood resilience, as it facilitates implementation of stormwater management practices for new and redeveloped areas, creates incentives for retrofits on private property, and provides dedicated funding for beneficial public stormwater projects and maintenance activities.

There are different types of stormwater utilities and varying strategies to calculating stormwater fees. It is up to the governing body to select a method most suitable for their community. The majority of stormwater fees are based on the impervious footprint of a property. While property taxes are solely based on the value of a property, the Clean Stormwater and Flood Reduction Act requires stormwater fees to be based on a fair and equitable approximation of the proportionate contribution of stormwater runoff. Properties with more impervious area and thus those that contribute the most to stormwater runoff will pay higher fees than properties with minimal impervious area.

Credits can be used to provide incentives to implement best management practices and reduce a property's stormwater fee. These credits can improve equity during implementation and reward properties that manage stormwater on their own property or minimize impervious areas. The maximum credit for a property is typically capped. Stormwater utility revenue projections will account for the impact of credits to assure revenue sufficiency.

Stormwater utility fees reduce the pressure to raise taxes, provide a dedicated funding source for stormwater management, create a more equitable allocation of costs because higher property values do not necessarily contribute higher amounts of stormwater runoff. Furthermore, tax-exempt properties are responsible for paying stormwater fees based on their contributing runoff, making stormwater utilities more equitable. Stormwater fee credit policies can incentivize improved private stormwater facility maintenance as well as facility upgrades.

Local vs. Regional Stormwater Utilities

The state of New Jersey has over 560 jurisdictions, many which have similar stormwater challenges and a lack of dedicated funding to address all their stormwater needs. A regional approach to implementing a stormwater utility may be a logical approach to addressing resilience and stormwater problems that span beyond municipal boundaries.

A regional approach could consist of an existing regional authority or county agency providing stormwater services or consist of several communities pooling together to form a new stormwater utility. This regional approach can create economies of scale where administrative, compliance and project costs can be shared. This regional approach also works for other utilities such as water, wastewater, or electricity. The table below, presents advantages and challenges of local and regional stormwater utilities.

	Advantages	Challenges
Local Stormwater Utility	+ Local control of policies + Dedicated funding at the local level	x Stormwater problems do not follow municipal boundaries
Regional Stormwater Utility	+ Address stormwater problems that span beyond municipal boundaries + Cost savings through economies of scale and shared resources + Increase access to grants and innovate funding sources + Opportunities to share technical expertise + Able to adapt rate structure to support regional goals + Streamline implementation to regulatory compliance and O&M costs + Dedicated funding for regional implementation	x Potential loss of local control of certain operational or project decisions, hiring, etc. x Project prioritization requires regional procedures agreed by participants in the regional stormwater utility

Given the local stormwater and resilience needs, the region should establish a dedicated funding source, potentially including a regional stormwater utility in coordination with municipalities within the county boundary.

The recommended process to establish a stormwater utility includes the following steps laid out by NJDEP:

1. **Discuss the concept:** assess the pros and cons of a regional stormwater utility.
2. **Conduct a preliminary feasibility study:** obtain an inventory of all current stormwater facilities and define the services to be provided.
3. **Engage management:** gather support from local government.
4. **Conducting a comprehensive feasibility study:** identify the project team and process, take inventory, identify needs and expenses (i.e., program revenue needs for capital, operation and maintenance, administrative, and compliance), analyze impervious and pervious surfaces, develop level of service options, define billing procedures and administrative policies, and establish fee and credit structures.
5. **Engage stakeholders:** have transparent and ongoing public education and outreach programs that will extend throughout the duration of the feasibility study and into implementation, if approved. Consider the formation of a Stormwater Advisory Committee (SAC) that includes representatives from stakeholder groups and represent a cross section of the community that uses or benefits from the County's stormwater services. This SAC allows the County and municipalities team to build a knowledge base among leaders in the community, provides a resource for understanding the stormwater requirements and problems facing community members, and provides a sounding board for developing tools and approaches that will appeal to the broader public as the stormwater utility moves toward implementation.
6. **Engage the public:** gather general public support to draft an ordinance to establish the stormwater utility. Consider the use of workshops, watershed tours, public meetings, social media, mailings, etc.
7. **Implement the stormwater utility**: establish an implementation team to set up the utility and move towards launch and implementation, including being ready to deliver the identified stormwater services.

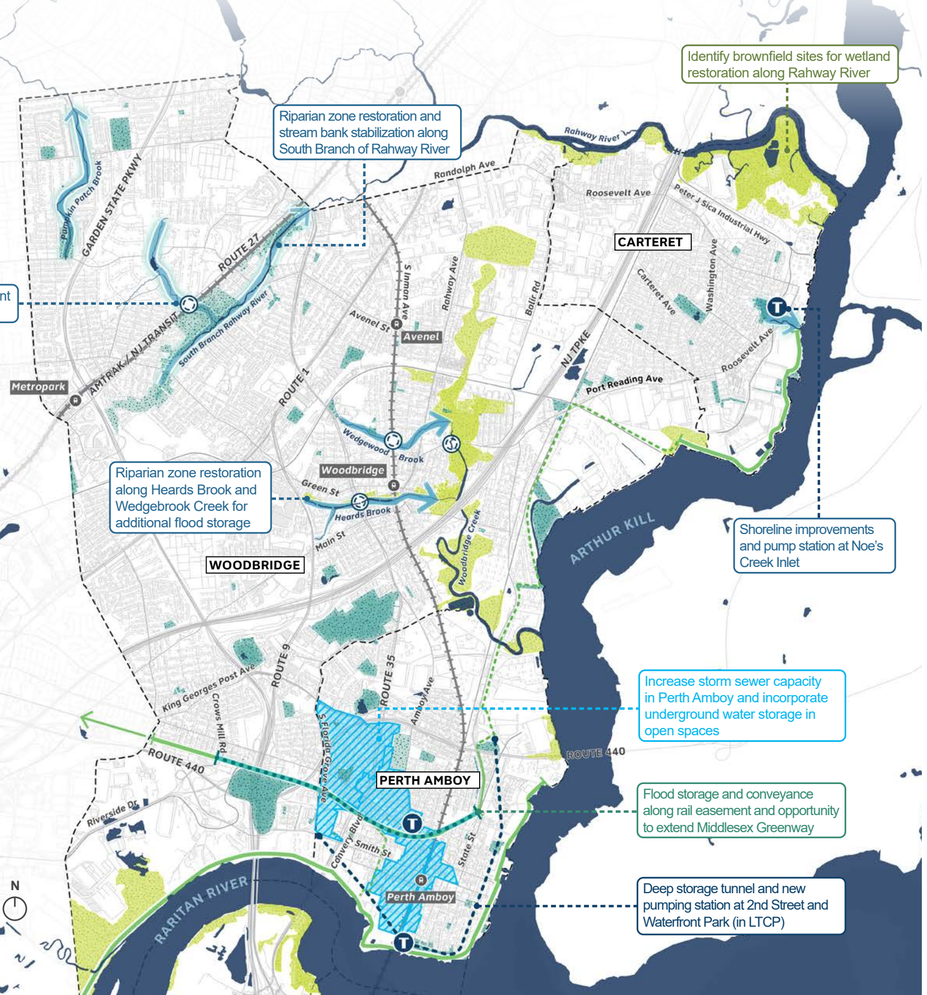
Middlesex County and the participating municipalities must first ensure there is leadership and commitment to evaluate the feasibility of a regional stormwater utility among the interested member communities and then develop a regional concept or model for funding. This concept or model will describe the overall framework on how stormwater services would be provided and will refine the benefits of the regional approach to the county and interested municipalities. Community engagement will be essential for receiving buy-in and public acceptance. It is recommended that after performing initial outreach to establish a list of interested member communities that Middlesex County conduct a feasibility study with those communities to further define the services to be provided by the regional stormwater utility, develop procedures for project prioritization, analyze applicable rate structure, and estimate potential stormwater fees before developing an implementation plan.

For additional information on establishing a stormwater utility see *Appendix L* and NJDEP provided guidance on establishing fees and credits, developing an asset management program for stormwater management systems, and develop guidance for stormwater management related public education and outreach available here.

STORMWATER MANAGEMENT

CARTERET, PERTH AMBOY, WOODBRIDGE

See Summary Table of Recommended Actions starting on page 223 for additional details on all actions.



LEGEND

STORMWATER STRATEGIES

Expand Storage On Publicly Owned Land

- Protect and restore natural features for stormwater storage and infiltration
- Retrofit parks and open space for storm-water management (study & prioritize)
- Create upstream diversions and off-channel storage on flood-prone rivers (South River only)

Increase Capacity Of Riparian Corridors

- Expand and restore riparian zones
- Culvert enlargements

Eliminate Barriers Caused by Existing Infrastructure

- Opportunity for regional consolidated conveyance along publicly owned corridors
- Stormsewer separation (study & prioritize)
- Increase stormsewer capacity - deep storage tunnel (Long Term Control Plan)
- New Pump Station

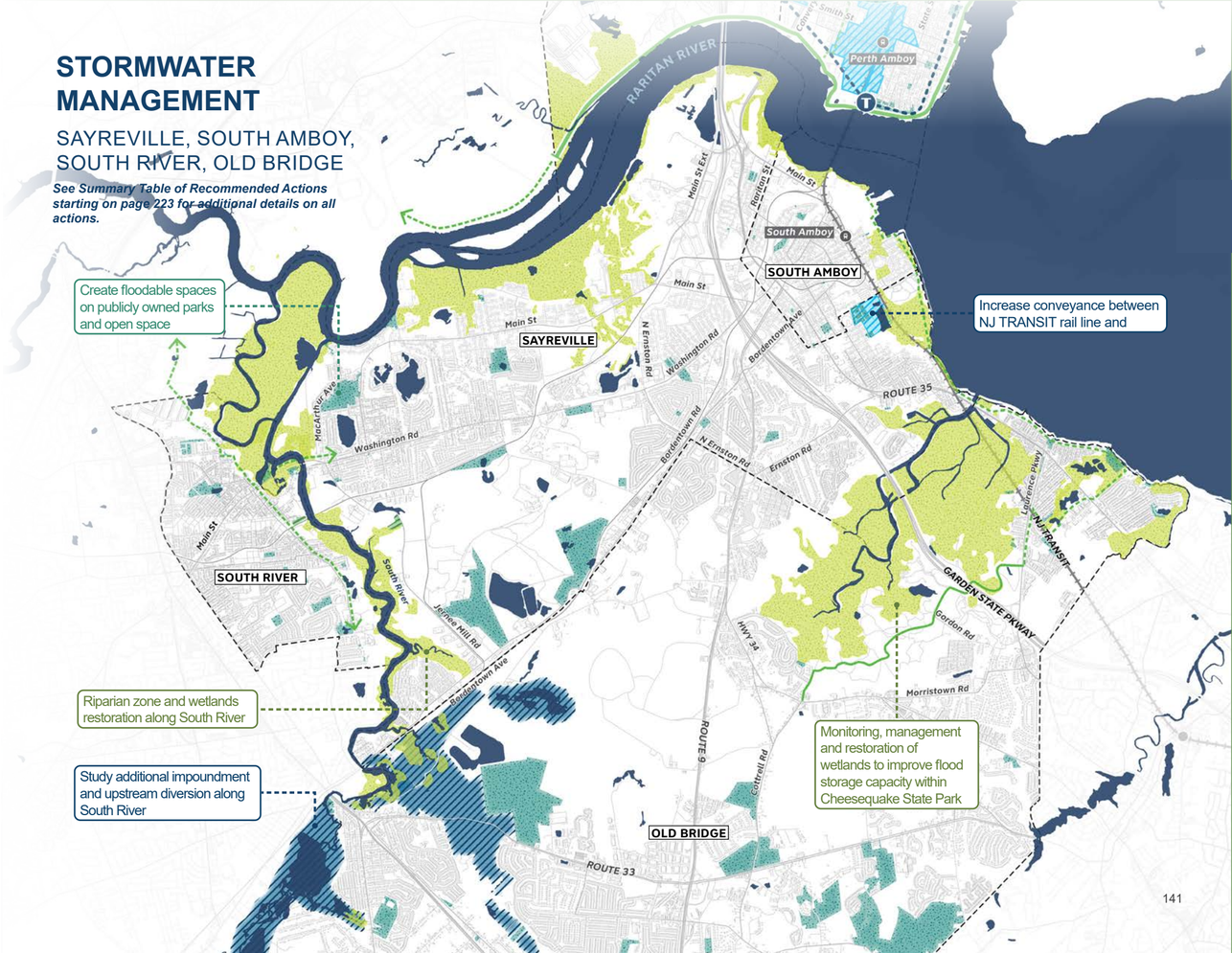
0 0.5 1 2 miles

N

STORMWATER MANAGEMENT

SAYREVILLE, SOUTH AMBOY, SOUTH RIVER, OLD BRIDGE

See Summary Table of Recommended Actions starting on page 223 for additional details on all actions.



COASTAL RESILIENCE

Connection to Resilience

As evidenced by Hurricane Sandy in 2012, much of the Raritan River and Bay Communities region is vulnerable to coastal flooding. With 2.4 feet of sea level rise, a storm like Sandy could flood approximately 5,000 buildings across the region, impact approximately 22,000 residents, and cause $2.8 billion in damage. Areas along the Raritan Bay coast in Old Bridge, South Amboy and Perth Amboy are vulnerable to coastal storm surge, in addition to the waterfront up the Arthur Kill, along Woodbridge Creek and Rahway River, as well as along the Raritan River and South Rivers.

In addition to storm surge, low lying areas along the coast will also be flooded more regularly by high tides due to sea level rise. With 2.4 feet of sea level rise, 32 structures that house 44 residents will be impacted by daily tidal flooding. If no actions are taken, some areas along the coast, particularly along the South River, will no longer be safe places for people to live.

Strategies

To reduce these risks, the region's coasts and waterfronts will need to be adapted to provide a "first line of defense" against storm surge and sea level rise. This includes strategies that prevent erosion of land, like bulkheads, those that serve as a barrier to flooding, such as floodwalls, berms, and levees, as well as strategies that serve to buffer wave action, like breakwaters. There are also strategies to preserve or adapt natureal systems, such as beaches, dunes, or coastal wetlands, to enhance the ability of these landscapes to buffer storms and adapt them to sea level rise.

» Coastal Flood Barriers

Adapt existing bulkheads

Much of the region's coast has been heavily altered by development and bulkheads have been constructed along the shoreline, particularly along the Arthur Kill. As sea levels rise, these structures will need to be adapted to maintain functionality. Standards and guidance statewide are needed to provide a consistent methodology for how property owners should determine a suitable elevation as structures require improvements.

Construct multi-purpose coastal flood barriers

In areas with significant coastal flood risk and where there is available land under largely public ownership, coastal barriers are an effective way to address flood risk. In addition to providing protection from coastal flooding, flood barriers can be designed to provide pedestrian and bike pathways along the waterfront. In Carteret, there is an opportunity to incorporate a coastal barrier into the planned greenway along the Arthur Kill. This could tie into an elevated redevelopment site north of Noe's Creek, connected by a tide gate across the creek. For more on the Noe's Creek proposal, see Chapter 5.3.1. Further south in Perth Amboy, a similar approach could be used to provide a waterfront greenway along the Harbortown development as well as along the Sadowski Parkway and connecting into Woodbridge Riverfront Park to provide contiguous public access and coastal storm surge protection.

Along the Rahway River in Carteret and Woodbridge, the U.S. Army Corps of Engineers (USACE) has developed a proposed design for a levee and floodwall to provide coastal flood protection to the West Carteret neighborhood and industrial properties in the Avenel section of Woodbridge (Rahway River Basin (Tidal) Flood Risk Management Project). This project has been authorized for construction and awaits funding allocation. By incorporating public access to this project, the proposal can also improve waterfront public access along this waterway and connect into Joseph Medwick Park.

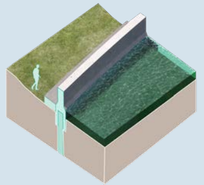
Along the South River, there are targeted opportunities to protect areas of high flood risk and substantial density, such as the Main Street section of South River, that should be further studied as priority areas for coastal protection. Sections of this potential alignment may be achieved through deployable flood protection measures, and through development of a berm or floodwall along the roadway or on land acquired through voluntary buyouts.

Tide or surge gates deployed along drainage and waterways keep out floodwaters during high tides or storm events. In Carteret, adding a tide gate at the mouth of Noe's Creek can block this flood pathway and prevent flooding due to coastal storm surge and also ensure the existing sewer outfalls do not get inundated due to sea level rise. The USACE is also studying regional coastal protection strategies as part of the New York and New Jersey Harbor and Tributaries Study. This includes examination of a storm surge barrier across the Lower New York Bay from Sandy Hook to Breezy Point, which would protect the entire RRBC region, as well as more localized surge barriers such as across the Arthur Kill at Perth Amboy, which in combination with a barrier at the Narrows would protect the northern portion of the region.

In areas where coastal barriers are not feasible

Coastal Flood Barriers

Adapt existing bulkheads



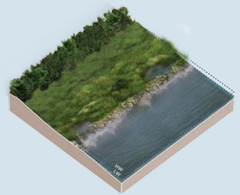
Bulkheads are concrete structures along shorelines of large bodies of water that protect from flooding, wave action and erosion. They can be integrated into recreational greenways and provide waterfront access to users.

Construct multi-purpose coastal flood barriers

Berms and levees are raised earthen structures erected to protect from flooding. They can be integrated with recreational boardwalks, walkways, and bike paths, and their sloped sides can be populated with vegetation and plantings.

Natural and Nature-based Features

Living Shorelines



Living shorelines stabilize and protect estuarine coasts, sheltered coastlines, and tributaries by incorporating natural features, vegetation, or submerged aquatic vegetation. Hybrid systems also integrate harder shoreline structures for stability such as stone, sand fill, rock sills, and other structural and organic materials.

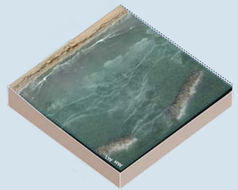
Protect and manage tidal wetlands for sea level rise

Low-lying tidal wetland ecosystems are among the most vulnerable environments to sea level rise. The resilience of tidal wetlands to sea level rise depends on the potential for horizontal migration to upland areas and the vertical accretion rate of the wetland, which can be supported through restoration and expansion.

Implement beach and dune restoration and renourishment

Dunes are landforms that occur with sufficient transportation of sand or sediment, and rely on a healthy and extensive root system of dune grasses and other vegetation to maintain their shape. Dunes act as a buffer, reducing damage to communities by attenuating ocean waves.

Living Breakwaters



Breakwaters are partially or fully emergent structures that extend above mean high water. They are built with armor units to help attenuate storm waves to improve safety and prevent damage to buildings and infrastructure.

due to a mix of property ownership and land use considerations, there will need to be outreach to property owners to promote protection on individual sites, particularly critical facilities owned and operated by industrial business and utilities. For more on this strategy see the sections on Adapt or Protect Critical Facilities and Technical Support for Property Owners. Coastal barriers can serve as impediments to natural drainage patterns, so planning for inland drainage storage and conveyance is a critical part of implementing these strategies.

» Natural and Nature-based Features

Protect and manage tidal wetlands for sea level rise

Tidal wetlands provide important habitats for numerous species. Large, contiguous tidal wetland areas can also reduce the impacts of coastal storms by buffering wave action. Much of the wetlands across the region are compromised by invasive species, fill, and poor water quality. Sea level rise will present an additional threat if sediment supply is not adequate. Existing wetlands should be preserved and protected from development through zoning and other regulations (see Land Use and Zoning section above) and wetlands in poor health should be restored to improve ecological quality and promote adaption to sea level rise.

Construct living shorelines

Living shorelines are an alternative to bulkheads that create space for tidal wetlands to manage erosion, provide some wave attenuation benefit, and create and preserve intertidal habitats. There are numerous opportunities to incorporate living shorelines throughout the region—as part of waterfront development projects like the Riverton in Sayreville, coastal restoration projects like the South River Ecosystem Restoration and Flood Resilience Enhancement Project, and park projects like Alvin P. Williams Memorial Park in Woodbridge.

Implement beach and dune restoration and renourishment

Beaches and dunes can buffer upland areas from coastal waves but can also be eroded by major storms. They also provide habitat and recreational spaces. There are existing beaches along the Raritan Bay in Perth Amboy, South Amboy, and Old Bridge. Renourishment of these beaches can provide resilience benefits, while additional structures like breakwaters and jetties can manage sediment transport to protect beaches from erosion and maintain key navigational channels.

Build living breakwaters

Breakwaters are offshore structures that reduce wave action, thereby protecting shorelines from erosion. Breakwaters can be completely or partially submerged and can be designed with a variety of materials. A living breakwater is a structure that mimics the function of coastal reefs to break waves and support marine life.

Key Considerations

Costs and maintenance: Coastal resilience strategies vary in terms of their costs. Coastal barrier systems are generally the most expensive as these projects involve significant construction. Nature-based solutions are often less expensive, but may require more extensive on-going maintenance, such as ongoing beach nourishment. Coastal barrier systems also require maintenance, with greater maintenance needed for any gates or closure elements.

Level of protection: The level of protection for coastal resilience projects will vary based on the specific risks the project is addressing and the type of strategy. Bulkheads are typically designed to protect land from erosion and daily high tide flooding, but not from coastal storm surge events. Coastal barrier strategies, give their high costs are typically designed to protect against relatively infrequent events, such as the event that will have a one percent annual chance of occurring. Nature-based strategies may be designed to protect against a lower storm event that those specific techniques are most able to address.

Potential community disruption: Construction impacts may disrupt the community but will be followed by reduced flooding.

Permitting: Most coastal resilience projects will require permits from local, state, and federal agencies, which can be time-consuming and expensive. Coastal areas are regulated by the U.S. Army Corps of Engineers as well as the NJDEP. Specific projects may require review by additional agencies based on the project scope and location. All the permitting needs for a project should be examined early in the process to identify necessary regulatory agencies to engage, and to minimize implementation challenges later on in the process. Some projects may also require land acquisitions or easements to be coordinated with private property owners.

Co-benefits

Coastal resilience projects can advance multiple goals beyond flood risk reduction, including:

- Waterfront access
- Habitat creation

Funding Opportunities

FEMA Public Assistance (PA): These grants provide reimbursement for disaster related expenses and are often used for repairs, restorations, reconstruction or replacement of public facilities or infrastructure damaged or destroyed by a disaster.

United States Army Corps of Engineers (USACE): The USACE funds large, coastal resilience projects throughout the county and received significant funding from the Bipartisan Infrastructure Bill for future studies and projects. The process for identifying prioritizing and designing civil works projects through the USCAE can be lengthy.

National Oceanic and Atmospheric Administration (NOAA) National Fish and Wildlife Foundation (NFWF) National Coastal Resilience Fund: This grant program funds the planning, design, and restoration of natural and nature-based solutions to help protect coastal communities from impacts of storms, floods, and other natural hazards and enable them to recover more quickly and enhance habitat for fish and wildlife.

Priority Actions

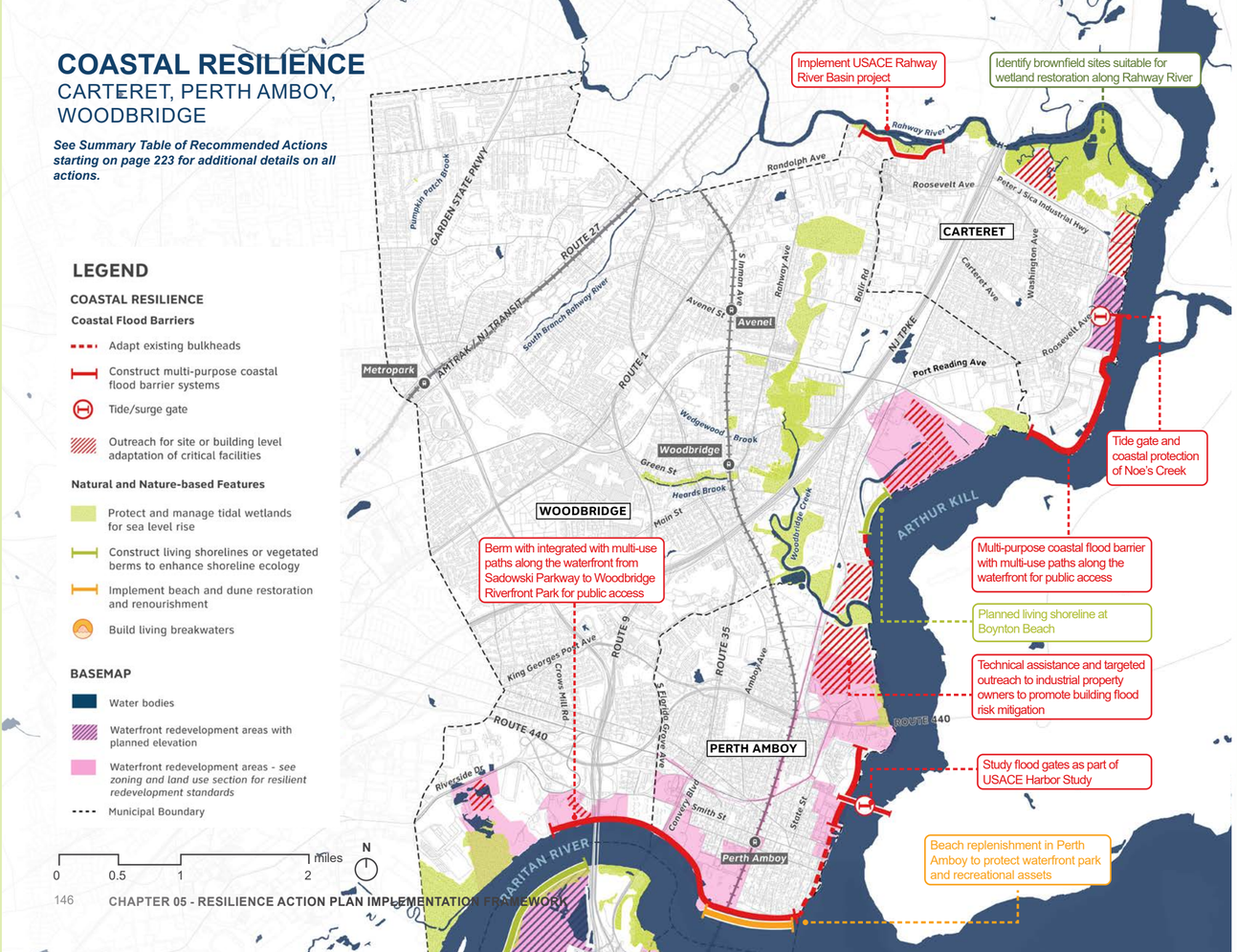
Actions below are priority actions that can be taken in the near- or mid-term to improve coastal resilience. For a full list of recommended actions, see the Implementation Roadmap section.

USACE	• Rehabilitation of Cheesequake Creek Jetty • Implement Rahway River Basin project • Study regional and local coastal protection strategies through the NYNJ HATS study
LOCAL - SAYREVILLE	• Work with Riverton developer to incorporate nature-based solutions along the shoreline, such as a living shoreline/ into redevelopment plan
NGOs	• Study resilience of existing wetland systems and identify opportunities for restoration and improvements
LOWER RARITAN RIVER WATERSHED PARTNERSHIP	• Implement the South River Ecosystem Restoration & Flood Resiliency Enhancement Project and study opportunities for additional improvements along the South River

COASTAL RESILIENCE

CARTERET, PERTH AMBOY, WOODBRIDGE

See Summary Table of Recommended Actions starting on page 223 for additional details on all actions.



LEGEND

COASTAL RESILIENCE

Coastal Flood Barriers

- Adapt existing bulkheads
- Construct multi-purpose coastal flood barrier systems
- Tide/surge gate
- Outreach for site or building level adaptation of critical facilities

Natural and Nature-based Features

- Protect and manage tidal wetlands for sea level rise
- Construct living shorelines or vegetated berms to enhance shoreline ecology
- Implement beach and dune restoration and renourishment
- Build living breakwaters

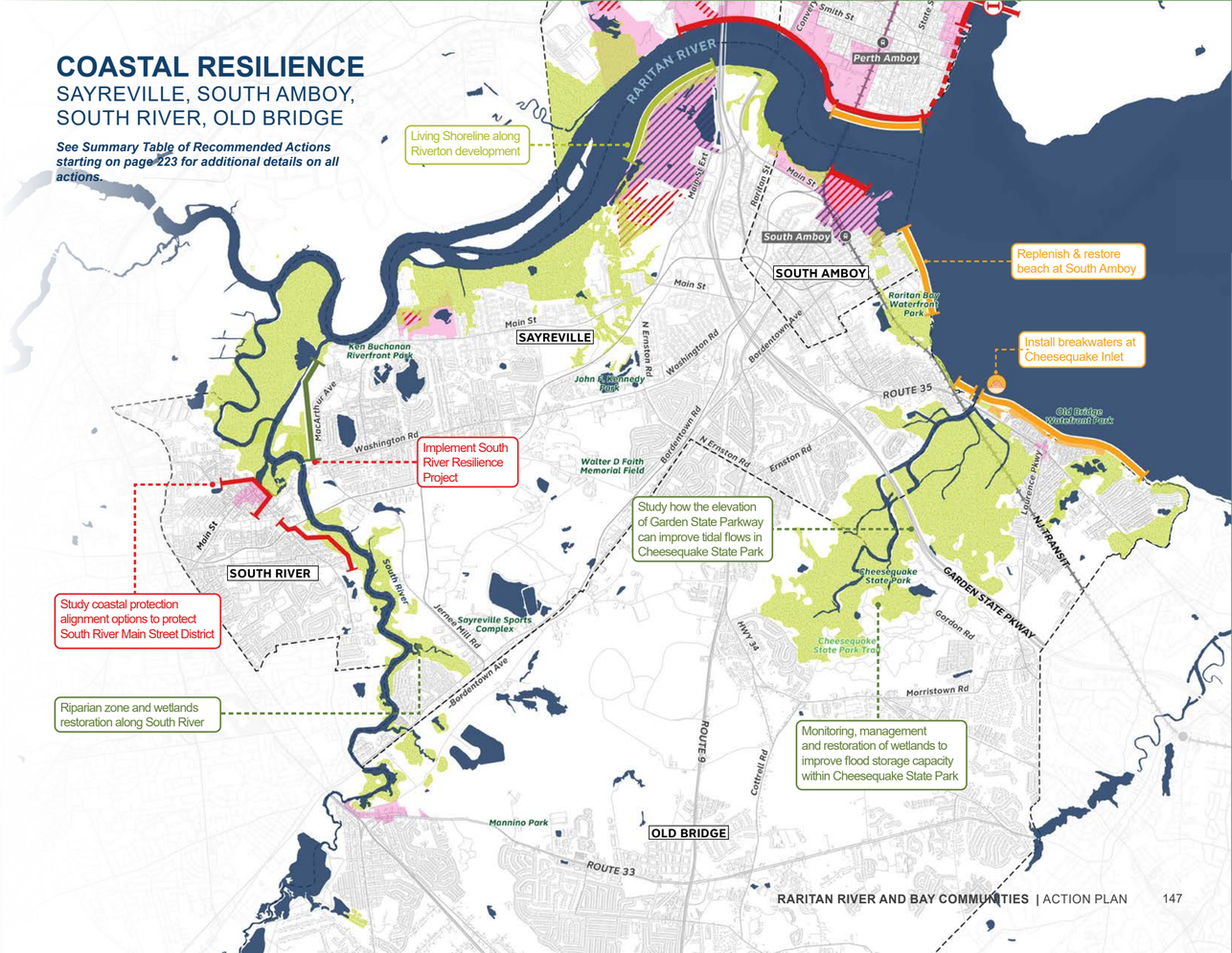
BASEMAP

- Water bodies
- Waterfront redevelopment areas with planned elevation
- Waterfront redevelopment areas - *see zoning and land use section for resilient redevelopment standards*
- Municipal Boundary

COASTAL RESILIENCE

SAYREVILLE, SOUTH AMBOY, SOUTH RIVER, OLD BRIDGE

See Summary Table of Recommended Actions starting on page 223 for additional details on all actions.



BENEFITS FOR ADDITIONAL CLIMATE HAZARDS

At a regional scale, the shifting dynamics of natural processes driven by climate change form a nexus between hydrologic processes, increasing temperatures, habitat shifts, and other processes. While presenting a sticky challenge, this also presents an opportunity at a regional scale to implement large-scale, holistic, and innovative projects that can tackle multiple hazards at once.

Invest in regional ecosystem-based adaptation projects to address multiple climate hazards. Projects founded on principles of large-scale watershed-based management, habitat restoration, and sustainable agroforestry practices can not only reduce greenhouse gas emissions but also reduce local heat; improve regional air quality; protect water supply sources; increase natural filtration; improve groundwater recharge; keep surface water systems, such as wetlands and lakes, in good health to minimize risk of contaminants; promote native plants that require fewer fertilizers while keeping out invasive species; manage freshwater inflows into estuaries with implications for coastal ecosystems already experiencing stress from ocean acidification; minimize tick presence; and minimize wildfire risk.

Regional integrated water resources management practices should be implemented as part of these processes to develop holistic approaches to managing future water supply, such as through conjunctive seasonal use of surface water and groundwater. Other types of projects to consider include large-scale forest stand improvement projects including enhancing native habitats, removal of additional brush and debris, and monitored localized burnings, as well as large-scale projects to conserve and protect marine life vulnerable to ocean acidification.

LIVING SHORELINE PLANNING & DESIGN RESOURCES IN NJ

A living shoreline is "a shoreline management practice that addresses the loss of vegetated shorelines, beaches, and habitat in the littoral zone by providing for the protection, restoration or enhancement of these habitats." (Coastal Zone Management Rules at N.J.A.C. 7:7-1.5)

When properly designed, living shorelines can mitigate the effects of erosion and sea level rise while also providing habitat for endangered and threatened species. In 2013, the State of New Jersey adopted Coastal General Permit 24 (also referred to as the Living Shorelines General Permit) to encourage the use of living shorelines along the coastline. To support this effort, the NJDEP Office of Policy and Coastal Management has compiled a variety of resources on their Living Shorelines website. These resources include:

- **Planning and design resources on living shorelines.** *The Living Shorelines Engineering Guidelines* was developed byNJDEP and the Stevens Institute of Technology in 2015 to help engineering consultants, regulators, and private property owners ensure that living shorelines in the state are designed, permitted, and constructed in a way that leverages the best available information. An update of these guidelines is forthcoming.
- **Resources and information on permits and regulations** that apply to implementing living shoreline include New Jersey coastal zone management regulations and applicable state and federal permits.
- **Case studies** of successful living shoreline projects from around the state.

SOUTH RIVER ECOSYSTEM RESTORATION & FLOOD RESILIENCY ENHANCEMENT PROJECT SITE
Image Credit: LRWP

Case Study: South River Ecosystem Restoration And Flood Resilience Enhancement Project, Sayreville, NJ

The Lower Raritan Watershed Partnership, along with Princeton Hydro, Rutgers University, Middlesex County, and other partners received funding in 2018 from the National Fish and Wildlife Foundation to develop an "eco-park" which combines a vegetated berm along with wetland restoration strategies to provide coastal flood protection as well as ecosystem enhancements. For more information on the South River Ecosystem Restoration & Flood Resiliency Enhancement Project, visit their website.

RESILIENT TRANSFORMATION OF CONTAMINATED SITES AND BROWNFIELDS

Physical & Nature-Based Infrastructure

Connection to Resilience

The region contains many contaminated sites due to its indsutrial history. Many of these sites are located along the Arthur Kill and the Raritan River, where many industrial sites were once clustered. The presence of hazardous substances associated with these sites poses risks to human health and ecosystems due to possible exposure. Contaminated sites in areas vulnerable to flooding from both heavy rainfall and storm surge present possible additional risks from spreading of surface-level contamination in floodwaters, spreading of subsurface contamination with groundwater rise, or damage to engineered controls due to storms or other climate events. Climate change may exacerbate these risks in the futurel; the level of risk is also related to a variety of other factors, including the type and extent of contamination.

The sites also present an opportunity to remediate and transform these industrial areas into open space or develop them to meet demand for new uses and economic growth, while incorporating stormwater management and resilience components. Redevelopment of these sites can also support the residential redevelopment strategies recommended in the *Zoning and Land Use Policy* section. Transformation of these sites can reduce a potential threat from flooding, in addition to meeting other community goals. For example, the Dupont site on the Carteret waterfront is in the process of being cleaned-up and transformed into a waterfront greenway, while the upland portion will be redeveloped with new uses.

According to the NJDEP Known Contaminated Site List dataset, there are approximately 500 contaminated sites within the RRBC region. The team conducted an analysis of these sites to identify priority sites based on the following factors using currently available data:

- Exposure to flooding based on the six modeled flood scenarios developed for the Resilient NJ program
- Density of population living within a half-mile of the contaminated site
- Social and economic demographics of the adjacent population using the CDC Social Vulnerability Index
- Site remediation status (Pending or Active)
- Contaminant type
- Distance from existing green space
- Whether or not the site was in a redevelopment area
- Inclusion in the NJDEP brownfields inventory
- Presence in a U.S. Department of Treasury Opportunity Zone
- Presence in an Urban Enterprise Zone

Other information, such as the concentration and extent of contamination, might be useful to understand the capacity for a site to be transformed, but is not widely available. Further analyses, including consideration of desired end use of each site, can help identify specific sites for transformation. More details on this prioritization methodology and results can be found in *Appendix I.*

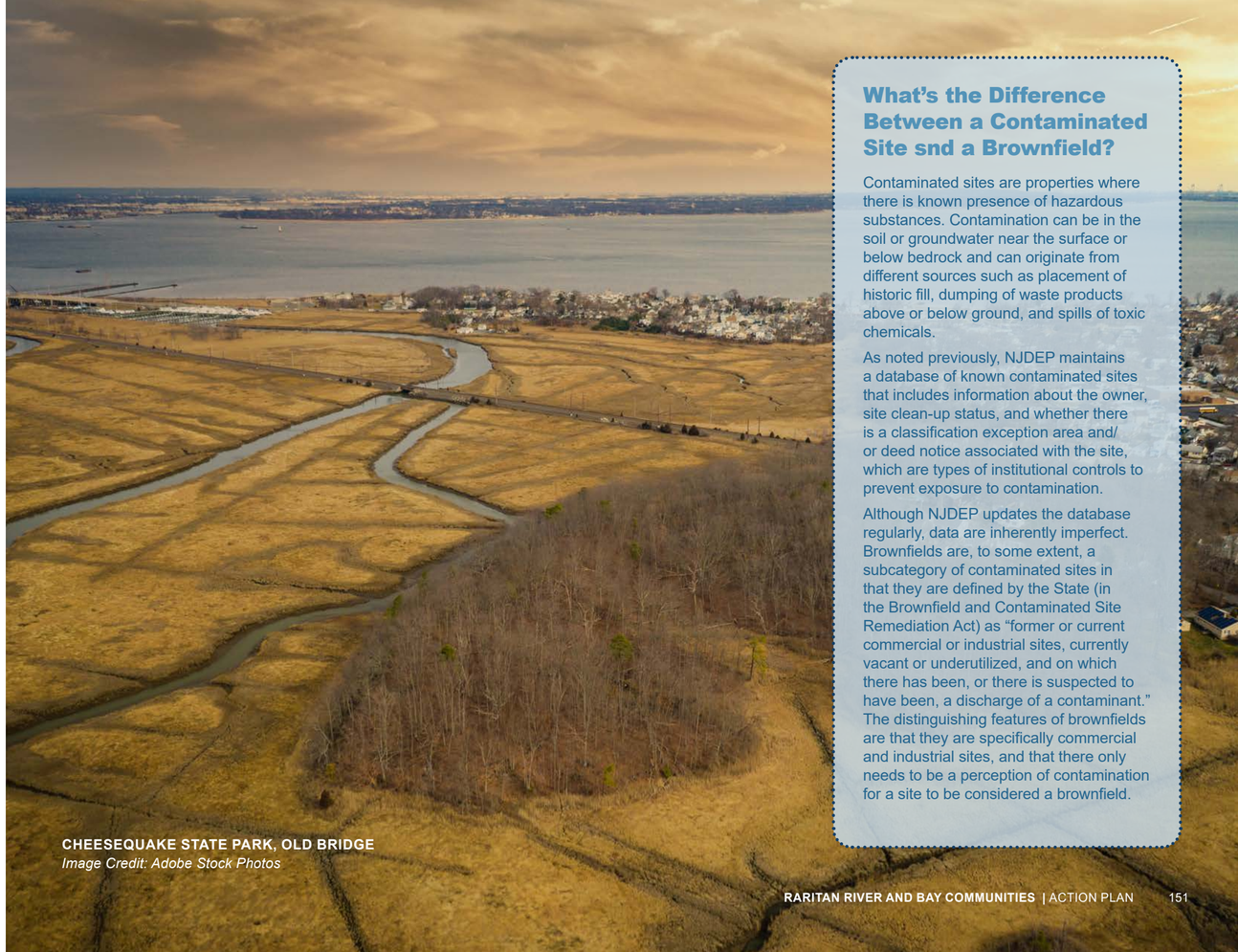
Strategies

Developing a pipeline of contaminated sites and brownfields that can be prioritized for remediation can expedite the clean-up of potentially hazardous sites within areas prone to flooding, as well as create additional benefits for the region.

» Promote remediation and redevelopment of brownfields and contaminated sites in areas exposed to flooding

Developing a prioritized set of sites could facilitate the alignment of potential funding sources. The preliminary priority list developed by the Resilient NJ team can serve as a starting place for additional collaboration with municipalities, the county, and the state to develop a pipeline of sites. The state could further support this process by collaborating on the development of a set of guidelines and requirements for how a site can flow through the process of clean-up and enhancement.

Many of the contaminated sites in the region are owned by municipalities, who could fund and advance projects to transform these sites. Other sites are owned by private entities, and outreach and engagement could foster advancement of resilience projects.



CHEESEQUAKE STATE PARK, OLD BRIDGE
Image Credit: Adobe Stock Photos

What's the Difference Between a Contaminated Site snd a Brownfield?

Contaminated sites are properties where there is known presence of hazardous substances. Contamination can be in the soil or groundwater near the surface or below bedrock and can originate from different sources such as placement of historic fill, dumping of waste products above or below ground, and spills of toxic chemicals.

As noted previously, NJDEP maintains a database of known contaminated sites that includes information about the owner, site clean-up status, and whether there is a classification exception area and/or deed notice associated with the site, which are types of institutional controls to prevent exposure to contamination.

Although NJDEP updates the database regularly, data are inherently imperfect. Brownfields are, to some extent, a subcategory of contaminated sites in that they are defined by the State (in the Brownfield and Contaminated Site Remediation Act) as "former or current commercial or industrial sites, currently vacant or underutilized, and on which there has been, or there is suspected to have been, a discharge of a contaminant." The distinguishing features of brownfields are that they are specifically commercial and industrial sites, and that there only needs to be a perception of contamination for a site to be considered a brownfield.

RESILIENT TRANSFORMATION OF CONTAMINATED SITES AND BROWNFIELDS

» Improve data collection

NJDEP's Brownfield Inventory, which was used in the preliminary prioritization process developed by Resilient NJ, only includes Community Collaborative Initiative (CCI) municipalities, which means it only covers Perth Amboy in this region. Expansion of this dataset statewide would support additional municipalities in developing plans to remediate brownfields.

Additional data improvements to the Known Contaminated Site List and other state-managed databases to provide more complete information on resilience-related factors is also needed. For instance, there is a need for expanding the available information or accuracy on contaminant type and extents, remedial design type, and site status.

» Incorporate climate considerations into remediation

A statewide climate-related risk assessment of contaminated and remediated sites would be beneficial to fully understand the magnitude of risk these sites could present if flooded and make the potential case for further investment. This should include a specific study of the impacts of climate-related hazards such as groundwater rise on risks posed by various types of site contamination.

In addition, there is a need to explore higher standards for contaminated sites to consider climate change impacts in remedial design.

Key Considerations

Data and science gaps: Preliminary prioritized sites identified in this plan should be reviewed in more detail, as the process was based on the data sets currently available which have their limitations, as noted above. In addition, there is limited scientific knowledge around the potential dangers to public health when contaminated sites are flooded, or the long-term implications of sea level rise.

Implementation: Remediation and redevelopment of contaminated sites and brownfields is a lengthy process that will require concerted action at many levels of government, and in close coordination with the private sector.

Co-Benefits

Remediation and re-used of contaminated sites and brownfields can result in the provision of open space in areas that currently lack open space and contribute to reducing the urban-heat island effect. Redevelopment of sites can also contribute to economic development.

Resilient Transformation of Contaminated Sites for Additional Climate Hazards

High concentrations of hazardous materials and wastewater discharge throughout the region can pose a serious risk to public health and safety as groundwater levels rise proportional to sea level rise. The following strategies can help mitigate these risks.

Develop site-specific plans for contaminated sites near wellhead protection areas, especially those located in environmental justice communities. This strategy would likely require extensive engagement and partnerships with private property owners and other key stakeholders. As groundwater levels rise, it will also be increasingly essential to develop site-specific plans to remediate contaminated plumes, which could include full soil removal replaced with new topsoil.

Identify high opportunity contaminated sites for urban green space placement in underutilized and non-municipal land. See page 134 on Stormwater Management.

Funding Opportunities

- **U.S. Environmental Protection Agency (EPA) Brownfields Job Training Program:** This is a program to recruit, train, and place unemployed and under-employed residents from communities impacted by brownfield. Funding can be used for hazardous waste training, green remediation technologies, stormwater management training, emergency response training, enhanced environmental health & safety related to site remediation, energy efficiency and alternative energy technologies
- **New Jersey Economic Development Authority (NJEDA) Brownfields Impact Fund:** This fund provides loans and grant on a first come, first serve basis to assist with cleanup of brownfield sites throughout New Jersey
- **NJDEP / NJEDA Hazardous Discharge Site Remediation Fund (HDSRF):** The fund provides loans or grants for remediation and / or cleanup of contaminated and underutilized sites. Funding can cover preliminary assessments, site investigation, remedial investigation and remedial action

Priority Actions

Actions below are priority actions that can be taken in the near- or mid-term to promote transformation of contaminated sites. For a full list of recommended actions, see the *Implementation Roadmap* section.

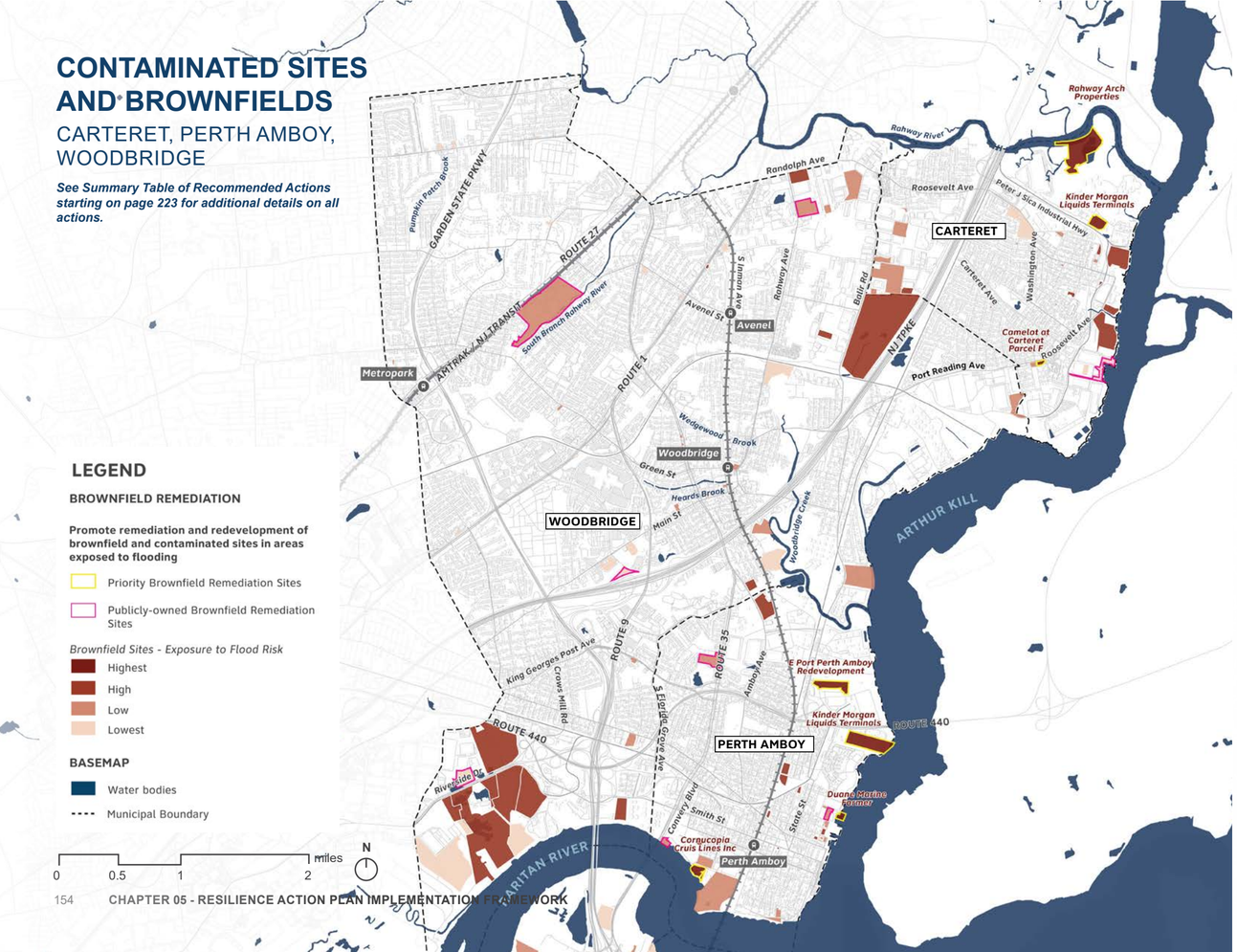
STATE	• Expand the brownfields inventory across the state, beyond CCI municipalities (which are the only municipalities included as of June 2022)
	• Continue data improvements to Known Contaminated Site List and other state-managed databases to provide more complete information on resilience-related factors (e.g., expanding available information or accuracy on contaminant type and extents, remedial design type, site status)
	• Coordinate and align state funding programs to accelerate resilient transformation of contaminated sites. Consider:
	  ◦ Collaborating in the development of guidelines and requirements a site might follow to flow through the process
	  ◦ Funding and supporting resilient transformation of high priority sites under RNJ banner

RESILIENT RRBC	• Support refinement of the prioritization methodologies presented herein and support municipalities in confirming high risk and high opportunity sites for action
LOCAL- ALL MUNICIPALITIES	• Support refinement of the prioritization methodologies presented herein and confirm high risk / opportunity sites • Advance catalyst resilient transformation projects at high risk / opportunity publicly owned contaminated sites / brownfields

CONTAMINATED SITES AND BROWNFIELDS

CARTERET, PERTH AMBOY, WOODBRIDGE

See Summary Table of Recommended Actions starting on page 223 for additional details on all actions.



LEGEND

BROWNFIELD REMEDIATION

Promote remediation and redevelopment of brownfield and contaminated sites in areas exposed to flooding

- Priority Brownfield Remediation Sites
- Publicly-owned Brownfield Remediation Sites

Brownfield Sites - Exposure to Flood Risk

- Highest
- High
- Low
- Lowest

BASEMAP

- Water bodies
- Municipal Boundary

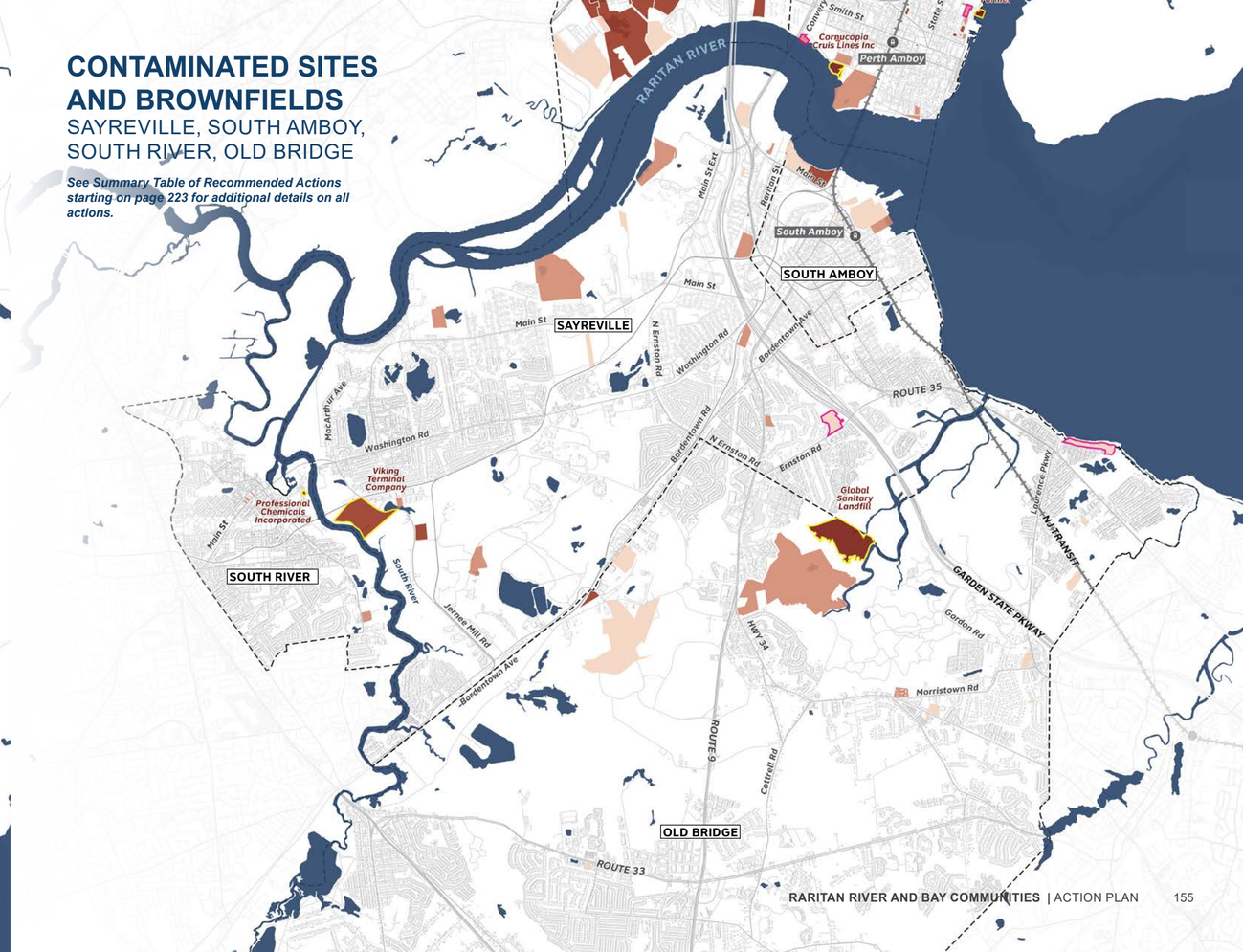
0 0.5 1 2 miles

N

CONTAMINATED SITES AND BROWNFIELDS

SAYREVILLE, SOUTH AMBOY, SOUTH RIVER, OLD BRIDGE

See Summary Table of Recommended Actions starting on page 223 for additional details on all actions.



YMCA OLD BRIDGE WORKSHOP

OUTREACH, EDUCATION, AND CAPACITY BUILDING

A wide range of strategies focused on outreach, education, and capacity building can serve as a strong foundation for any physical, nature-based, or policy and governance projects and decision-making processes.

The preferred scenario includes actions that serve to:

- Increase awareness of flood risk through public outreach
- Provide technical assistance and targeted outreach to property owners to promote building mitigation and flood insurance uptake
- Develop a funding program for flood mitigation and green infrastructure for private property owners
- Conduct targeted outreach to incentivize relocation of residences and businesses away from the most flood-prone areas.

Many of these strategies can also be adapted or leveraged for non-flooding hazards. This suite of actions responds to communities' expressed desire for greater public involvement and investment in relationships between the government and community members as well as the need to ensure all actions undertaken work to preserve a sense of home, community, and cultural diversity.

FLOOD AWARENESS RESEARCH CAMPAIGN

Connection to Resilience

The region faces flood risk from multiple sources of flooding. Flooding can damage property and put lives in danger, as evidenced during Hurricane Ida. It is essential that those who live, work, and play in the region have a strong awareness of flooding. This includes knowing how your property or home is exposed to flooding and what to do before, during and after a flood. Throughout the development of this plan, Resilient NJ RRBC has led an outreach campaign to ensure community members understand the causes and sources of flooding. We have developed and shared a video series explaining flooding hazards and spoken of flood risk at community events and public meetings. Communicating flood awareness helps to ensure a resilient community that is prepared for flooding. By providing community members with the tools and knowledge to understand flood risk, we hope to ensure preparedness for future flooding.

Strategies

There are several ways to increase flood awareness throughout the RRBC region. Components of an outreach campaign may include post-cards or other mailers, informational videos, and permanent signage. These activities should be ongoing and evolve over time to meet the changing needs and flood risk awareness of the community.

» Postcard Mailing Campaign

Sharing information on flood risk in community mailings to ensure all members of the community are equally knowledgeable on flood risk. Using flood maps, particular focus will be given to raising awareness in those areas most at risk.

» Video Series

Campaign of local municipal officials, community leaders, and experts explaining the project and flood risk to ensure understanding of flooding. This will be shared across digital media platforms.

» Permanent Signage

Install signs in popular areas that are prone to flooding or have experienced flooding in the past. In both English and Spanish, these signs can show high water marks from previous flooding events and expected high water marks from future events. This is a powerful tool to convey future flood risk and visualize how impactful flood waters can be on a neighborhood.

» Social Media

Continue to share flood awareness information on social media.

» Meeting-in-a-Box

Adapt the successful “meeting-in-a-box” materials, which provide an overview of the project, flood risks, and potential solutions, to continue to meet with community groups and further spread awareness.

Key Considerations

Flooding can happen quickly and with little warning to prepare. It is important for individuals to understand their risk and have a plan in place to be able to respond quickly. Knowing how one’s home and travel can be impacted by flooding is important to ensuring safety and preventing damage.

Co-Benefits

- Community resilience from informed and prepared residents
- Potentially reduce need for emergency services and likelihood of property damage and injury since residents are prepared for flood events

Funding Opportunities

The Funders Network (TFN) and Urban Sustainability Directors Network, Partners for Places Mini Grants: Helps local governments, place-based funders, and frontline community groups build relationships, align around project ideas, and ideally develop a proposal that centers racial equity in water, sustainability, and/or climate action work to develop a full Partners for Places matching grant proposal

NJDEP Community-Based Art Grant Program: Grants for 5 community-based organizations (CBOs) to be paired with an artist team and then hosting/promoting art installations through the community they serve. Purpose of grants is to increase public awareness of how individuals will be impacted by climate change and what they can do about it.

FEMA Building Resilient Infrastructure & Communities (BRIC), Capability and Capacity Building: FEMA, through NJOEM, offers grants to help communities build whole community resilience. This could include hosting a forum to share best practices and lessons learned or conducting mitigation-related tabletop exercises to build relationships or pursuing opportunities for knowledge transfer between partners

Sustainable Jersey, Sustainable Communities Grant Program: The Environmental Stewardship Grants are intended to help municipalities plan for, protect and improve public spaces such as local parks, natural areas, and recreation resources. In addition, grants can be used in combination with other funding sources to cover a portion of the expenses associated with developing and/or supporting their open space programs not otherwise covered by state or county programs. Resiliency Grants support projects that enhance a municipality’s capacity to prevent and respond to catastrophic events and emergencies.

Priority Actions

Priority outreach and awareness actions should:

- Translate flood awareness information into consumable forms and share broadly with the community, in both English and Spanish.
- Establish readily available flooding resources and empower municipalities and community partners to share this information
- Include targeted outreach to communities in high-risk areas on evacuation planning, such as the Winding Woods apartment complex in Sayreville and Jeanette Smith Village in Carteret
- Train municipalities to understand flood risk, educate their community, and take action

Actions in the table are priority actions that can be taken in the near- or mid-term to increase awareness of flooding. For a full list of recommended actions, see the *Implementation Roadmap* section.

STATE	• Explore opportunities for additional funding to continue community outreach and awareness building developed through Resilient NJ
RESILIENT RRBC	• Support ongoing outreach and awareness in partnership with the YMCAs and municipalities
LOCAL- ALL MUNICIPALITIES	• Support ongoing outreach and awareness in partnership with the YMCAs and the County
YMCAs/ OTHER NGOs	• Integrate flood awareness into community programming using materials developed by Resilient NJ

TECHNICAL SUPPORT TO PROPERTY OWNERS

Connection to Resilience

Throughout RRBC, privately-owned industrial, commercial, and residential properties are vulnerable to current and future flood hazards. To build resilience in the region, it is essential that private property owners are both aware of their flood risks and have access to resources to help them reduce that risk. The flood risk awareness outreach campaign will provide property owners with the tools and knowledge to understand their flood risk. This strategy supports the awareness campaign by then providing property owners with the technical support needed to identify and fund potential mitigation options.

Though there are existing educational resources available to property owners at the federal, state, and local levels, property owners may not know how to access them. Additionally, there is a growing demand for funding to implement flood mitigation strategies on privately owned properties. In RRBC, stakeholders indicated the need for targeted outreach to promote building-scale mitigation in flood-prone areas, funding to implement buyouts of commercial, industrial, and multi-family housing structures, and funding to install green infrastructure on private properties.

Strategies

Encouraging flood mitigation on privately owned properties will require a two-pronged approach. First, property owners must be aware of their flood risk and the options available to help reduce it. Second, funding and other implementation resources should be made available to encourage floodproofing, elevation and other mitigation actions.

Increasing Awareness of Flood Risk and Mitigation Options

The first step to reducing flood risk is understanding flood risk. Private properties across the region may be vulnerable to flooding from one or multiple sources. Knowing both the type of flooding that may impact a property and the severity of expected impacts can help property owners make decisions about the best flood risk reduction options for their property.

Additionally, to make informed decisions about which flood risk reduction options may work for their property, property owners need access to information about the wide variety of mitigation approaches including floodproofing, elevations, buyouts, and green infrastructure. To help private property owners understand how to reduce their flood risk, this strategy includes the development of both educational resources and technical capacity.

Outreach and coordination with private owners and operators of critical facilities including oil and gas terminals (operated by Buckeye Global Marine Terminal and Kinder Morgan) and power plants (run by PSE&G, Next Era, and CPV Woodbridge) is also recommended. Flooding at these facilities can have a major impact on community health and safety both during and after a flood event. Coordination is key to ensuring owners and operators understand risks and the opportunities available to mitigate them.

Entities at the state, county and local level all play a role in developing and providing resources on flood risk and mitigation options for private properties. At the state level, additional information about flood mitigation options can be developed and disseminated to counties and municipalities.

Case Study: PSE&G Sewaren Power Plant

Woodbridge, NJ

Some privately owned critical facilities, such as the PSE&G run power plant in Sewaren, have already taken steps to protect their facilities. The PSE&G power plant was flooded during Hurricane Sandy, prompting the facility to act. Mitigation actions taken on the site to harden and upgrade the Sewaren Switching Station include elevating electric distribution equipment above levels required by FEMA, installing new, elevated transmission facilities to maintain a reliable electric system. In making the facility more resilient to flooding, PSE&G also incorporated upgrades to make the power station more energy efficient.

The state may also consider expanding training opportunities available to county and municipal officials on topics related to resilience and flood risk reduction. Such trainings could be released in support of recently released and forthcoming NJPACT regulations.

At the county level, technical support can be provided through staff time to help municipalities understand where to target outreach and how to access and use informational resources available from the state. Municipalities can look for opportunities to engage private property owners in targeted, highly vulnerable areas to discuss flood mitigation options. Informational resources developed by the county and state can inform these conversations.

Increasing Funding for Implementing Building Scale Flood Mitigation

Increasing awareness of flood risk and the increasing frequency of flood events throughout the region will continue to increase demand for funding to implement building scale flood mitigation on private properties. To meet this need, the state should develop funding programs, including both loans and grants, that can be provided to a variety of property owners to implement floodproofing, elevation, buyouts and green infrastructure retrofits. Priority funding opportunities include:

- Increased buyouts for commercial and industrial properties through the NJDEP Blue Acres Program
- Buyouts for multi-family housing properties through the NJDEP Blue Acres Program
- Green infrastructure retrofits for residential and commercial properties
- Building-scale mitigation of industrial properties that have the potential to contaminate surrounding areas during flood events

Key Considerations

- Flood risk awareness and education about mitigation options must be an ongoing process, including sharing information about Risk Rating 2.0
- This work must be tied into a larger awareness of climate change so homeowners understand that risk will continue to grow in the future
- Community members should be educated on nuisance flooding as well, so they understand just because flooding hasn't happened before, does not mean it won't happen in future
- Developing and sharing materials will require dedicated funding and staffing resources
- Regular follow up should be conducted following the development and sharing of materials. State and county staffing resources should be made available to answer questions and direct property owners to additional resources. Stakeholder feedback on materials should be collected periodically and used to make materials more useful and user friendly.
- Increased funding for building scale flood mitigation will require increased staff capacity to administer and manage funding streams
- Funding should have a dedicated source and be made available on a regular basis in perpetuity
- All building scale flood mitigation funded through these strategies should be held to a standard higher than minimum resilience requirements
- All buyout programs should include relocation assistance to encourage property owners to relocate to areas of lower risk

Co-Benefits

- Economic benefits associated with reduction in repetitive loss achieved through building-scale mitigation and buyouts
- Expanded staff capacity at local, county and state level to address resilience challenges
- Increased opportunities for coordination between local, county, and state levels of government
- Remediation and/or environmental restoration of acquired industrial and commercial sites

TECHNICAL SUPPORT TO PROPERTY OWNERS

Funding Opportunities

- **NJDEP Community-Based Art Grant Program:** Grants for 5 community-based organizations to be paired with an artist team and then host/promote art installations in the community they serve; Purpose of grants is to increase public awareness of how individuals will be impacted by climate change and what they can do about it.
- **FEMA FMA:** The Flood Mitigation Assistance Program is a competitive grant program that provides funding to states, local communities, federally recognized tribes and territories. Funds can be used for projects that reduce or eliminate the risk of repetitive flood damage to buildings insured by the NFIP.
- **Garden State C-PACE:** Program will finance eligible commercial clean and renewable energy projects in participating municipalities. The program pays for the up-front costs of the project. Eligible uses include energy efficiency improvement, renewable energy system, stormwater management system, electric vehicle charging infrastructure, flood resistant construction improvement, or hurricane resistant construction improvement.

Priority Actions

Actions below are priority actions that can be taken in the near- or mid-term to promote the resiliency of mobility systems. For a full list of recommended actions, see the *Implementation Roadmap* section.

STATE / NJDEP	• Develop funding programs including loans and grants that can be provided to property owners (residential, multi-family, and commercial) to support building scale mitigation through floodproofing, elevations, buyouts, and green infrastructure retrofits
RESILIENT RRBC	• Enhance staff capacity to support dissemination of state resources and support municipalities in building-scale mitigation • Enhance coordination and relationship betwen the County and municipalities
LOCAL- ALL MUNICIPALITIES	• Share information on flood risk with property owners to empower them to take action and advocate for additional support

EXPANDING OUTREACH TO ADDITIONAL CLIMATE HAZARDS

Start a regional education campaign with resources for individual mitigation and to promote advocacy related to additional hazards. This campaign should take a two-pronged approach of pointing people to the right resources to minimize their own risk while collaborating with community-based organization to educate on how to organize for collective action and advocacy around these issues. Should involve developing and distributing accessible, multilingual information and educational materials designed to reach as many communities as possible, especially environmental justice communities.

Work with community-based organizations to conduct public health studies of localized current-day "invisible" effects of air quality. Poor air quality in the region is not merely a future issue. The RRBC population is currently at extremely high risk, relative to the rest of the state, for air toxics-related cancer impacts. As such, it is highly likely that communities are already experiencing these effects, especially communities with higher rates of elderly people, people with existing health conditions (such as asthma), low-income households with limited access to health care, and communities in areas with little access to green space and high urban heat island effect.

Conduct targeted community outreach with agricultural and fishery workers. Work with trusted local and regional organizations to develop relationships with agricultural producers and communities that depend on marine species for their livelihoods. Outreach should be focused on understanding future needs and localized social and economic impacts of ocean acidification and changes to water supply levels and projected future demand to help shape decision making.

SUB-WATERSHEDS AND RESILIENCE OPPORTUNITY AREAS

The regional strategies described in the preceding section will advance resilience to flooding and other climate impacts throughout the region.

Taken together, these strategies have the potential to advance targeted improvements to watersheds, communities, and individual sites across RRBC. This section will illustrate how the combination of regional strategies described in the preceding section could result in actions at the watershed and neighborhood scales to address flooding and generate additional opportunities for community amenities, economic development, and ecosystem enhancement.

Sub-Watersheds are sub-geographies within the region identified based on hydrologic unit code 14 (HUC14) watershed boundaries as well as the shared flood risks and land use patterns within each. For more information on how and why these were defined, see “Applying a Watershed-Based Planning Approach” in *Chapter 04*.

These sub-watersheds are:

- Arthur Kill Waterfront
- Woodbridge Creek
- Raritan Riverfront and Bay
- South River / Washington Canal
- Cheesequake / Laurence Harbor
- Rahway River and Tributaries

Resilience Opportunity Areas are a specific selection of smaller, localized areas within the sub-watersheds, identified based on their significant flood risk and stakeholder priorities, for which a suite of resilience-building strategies were developed in more detail. The intent of these resilience opportunity areas is to show how regional strategies can be designed and implemented in combination locally to address resilience needs and how coordinated actions across jurisdictions can result in improved resilience and other community benefits. Taking action in these areas can also be a catalyst to advancing additional related actions across the region. Activities in these areas should be prioritized not only because they address urgent flood risks, but because they can serve as a demonstration of the potential for a range of different types of physical and non-physical interventions to reduce flood risk and create additional benefits.

The Resilience Opportunity Areas are:

- Noe’s Creek
- Heards Brook
- Middlesex County Greenway Extension
- South River and Sayreville Main Street
- Cheesequake Inlet

SUBWATERSHEDS

RESILIENCE OPPORTUNITY AREAS

Arthur Kill Waterfront

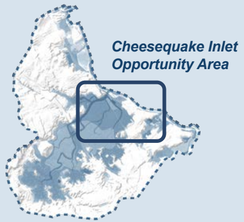
Woodbridge Creek

Rahway River and Tributaries

Raritan Riverfront and Bay

South River / Washington Canal

Cheesequake / Laurence Harbor



SUB-WATERSHED: ARTHUR KILL WATERFRONT

CARTERET, PERTH AMBOY, WOODBRIDGE

The Arthur Kill Waterfront sub-watershed includes industrial areas along the Arthur Kill coast in Carteret, Woodbridge, Perth Amboy, and the surrounding residential areas. The area is exposed to flooding from both heavy rainfall and storm surge, with some sites directly on the coast also vulnerable to future sea level rise. The waterfront in this area is characterized by oil and gas terminals, many brownfield sites, and critical infrastructure, in addition to more recent warehousing and distribution facilities.

Recently, new investments in waterfront parks and residential and mixed-use development have opened portions of the waterfront to public access and a broader mix of uses. Inland of the waterfront are more residential neighborhoods, including the center of Carteret, a diverse community with many people identifying as Hispanic or Latinx, as well as a large Sikh community. The poverty rates in some neighborhoods in Carteret are among the highest in the region, and there are several public housing complexes in area prone to flooding. The center of Carteret also includes many publicly owned sites, including parks, schools, and municipal buildings.

To address coastal flooding risks in this area, coastal protection can be integrated into the buildout of the planned waterfront greenway along the Arthur Kill in Carteret by **constructing a multi-purpose flood barrier** with bike and pedestrian paths. This alignment should cross Noe's Creek and tie-in to redeveloped waterfront sites (as discussed in the next section).

Additional inland strategies are needed to manage heavy rainfall events, such as **increasing flood storage capacity on publicly owned lands**.

RECOMMENDED ACTIONS	ID*	LEAD ENTITY
A. Review and amend Chrome Waterfront Redevelopment Area to accommodate proposed Noe's Creek flood mitigation and resilience projects.	C1	Carteret
B. Multi-purpose coastal flood barrier and tide gate along Arthur Kill as part of the Noe's Creek project	C4, C5	Carteret
C. Explore opportunities for expanded stormwater storage on facilities and right of ways owned by Carteret	C7, C8	Carteret
D. A pump station at Noe's Creek inlet for improved coastal and inland flood management	C9	Carteret
E. Outreach to private owners and operators of industrial facilities and critical utilities (PSE&G)	NJ33	NJDEP
F. Implement living shoreline at Boynton Beach	W23	Woodbridge
G. Promote redevelopment of waterfront industrial properties and brownfields along the Arthur Kill and Woodbridge Creek to new forms of light industry like warehousing and incorporate resilience standards and wetland restoration	W1	Woodbridge
H. Multi-purpose coastal flood barrier with bike and pedestrian paths along Perth Amboy shoreline from Armstrong Lane to Perth Amboy Harborside Marina	P4	Perth Amboy

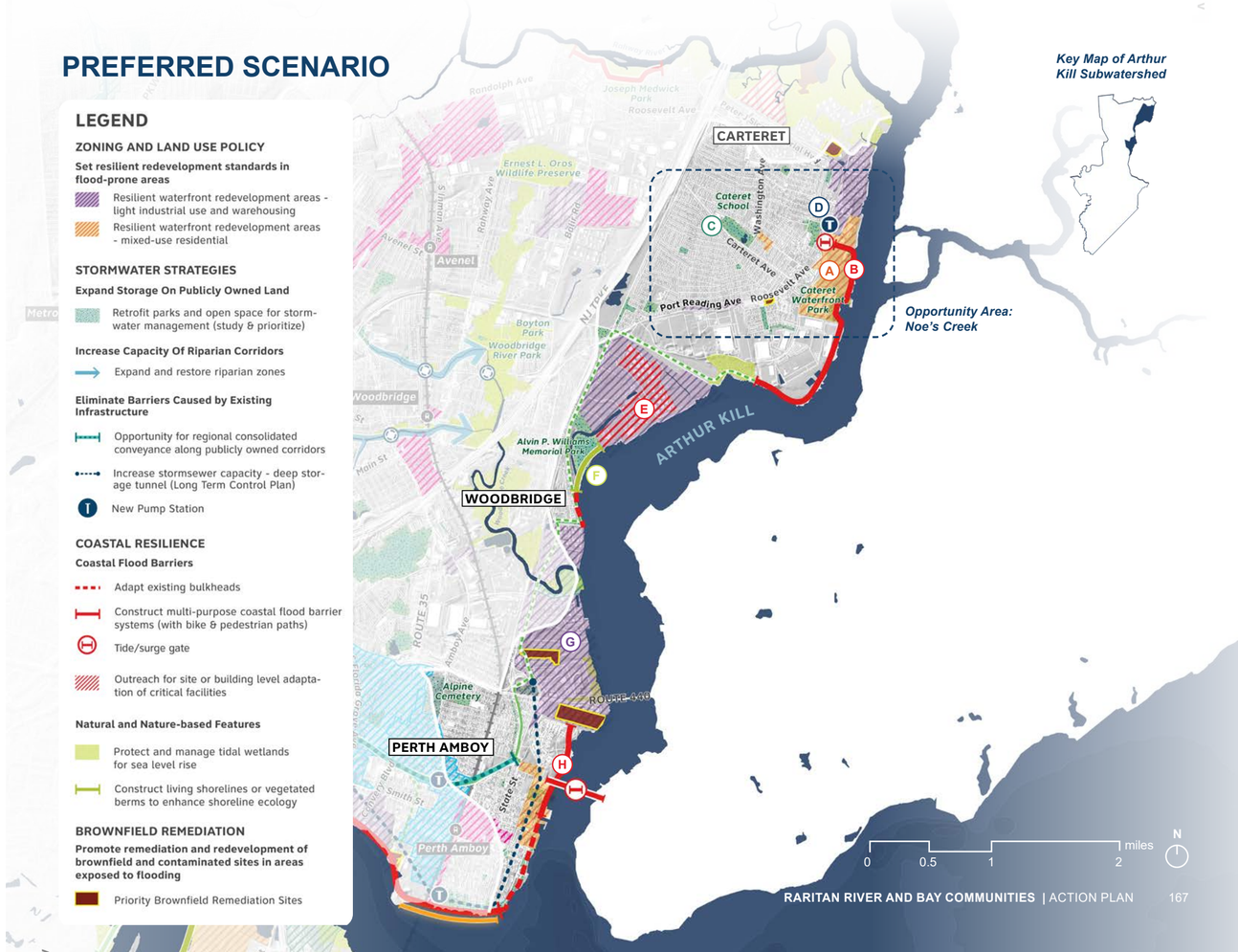
See Summary Table of Recommended Actions starting on page 223 for additional details.

Park improvements to provide flood storage can also serve to enhance neighborhood recreational amenities.

Waterfront industrial sites, such as oil and gas terminals and the PSE&G power station in Sewaren, are also exposed to flooding. Since Hurricane Sandy, some facilities have made resiliency improvements (including PSE&G), but further coordination is needed with these property owners to promote **site-specific adaptation to address future flooding risks.**

Many industrial uses along the waterfront have recently transitioned to warehouse and logistics uses. Incorporating resiliency strategies, such as stormwater storage, coastal protection, and site elevation, can promote the safety of these uses as through **resilient redevelopment.**

PREFERRED SCENARIO



ARTHUR KILL WATERFRONT OPPORTUNITY AREA: NOE'S CREEK

Flood Risk and Impacts

Noe's Creek is a tidal inlet in Carteret that was once a much more extensive waterway. The creek and surrounding wetlands were filled in to enable the urban development of the borough. Today, the culverted creek is a major pathway for coastal flooding and the surrounding watershed is low-lying, leading to frequent ponding and flooding from heavy rain events, particularly at high tide.

With climate change, the risk of flooding in this area is expected to increase. If no action is taken to reduce risk, the potential for damage and disruption is significant. Potential monetary losses due to physical damages to structures and their contents, human impacts, direct business impacts, and the loss of function of public and essential facilities add up to **$496M** in damages due to a future storm surge event and **$159M** in damages due to a future heavy rainfall event. Flood events in this area have the potential to damage many critical and community assets including places of worship, stores, parks, municipal buildings, and more.

Densely populated residential areas in this area are also vulnerable to the impacts of flooding. The area has a high concentration of people of color—especially Hispanic, Latinx and Sikh populations—many of whom are also in low-income households. Notably, this area also has a very high concentration of low-income households with limited broadband internet access and low food access within 1 mile, with many characterized by the U.S. EPA Environmental Justice Screening and Mapping Tool as linguistically isolated. These neighborhoods are therefore less likely to have easy access to the resources and information needed to prepare for and respond to major flood events and are more likely to experience negative impacts from events—ranging from serious financial difficulty stemming from direct damages to homes and contents, to further restricted access to already scarce essential resources such as food.

Coastal Storm Surge

Areal Rainfall Flooding

Case Study: Noe Street Waterfall Park

The recently rebuilt Noe Street Waterfall Park features a detention basin used to collect stormwater from new and additional catch basins on the street. Once the water exceeds a certain level, a new stormwater pump station moves excess water to upgraded outflows off of Peter J. Sica highway to Noe's Creek which then drains into the Arthur Kill. The park also serves as an all-season multipurpose recreational amenity with fountains, vegetation, ice-skating, and interpretive signage.

Noe Street Park, Carteret, NJ

Image Credit: Google Streetview

Overview of Strategies

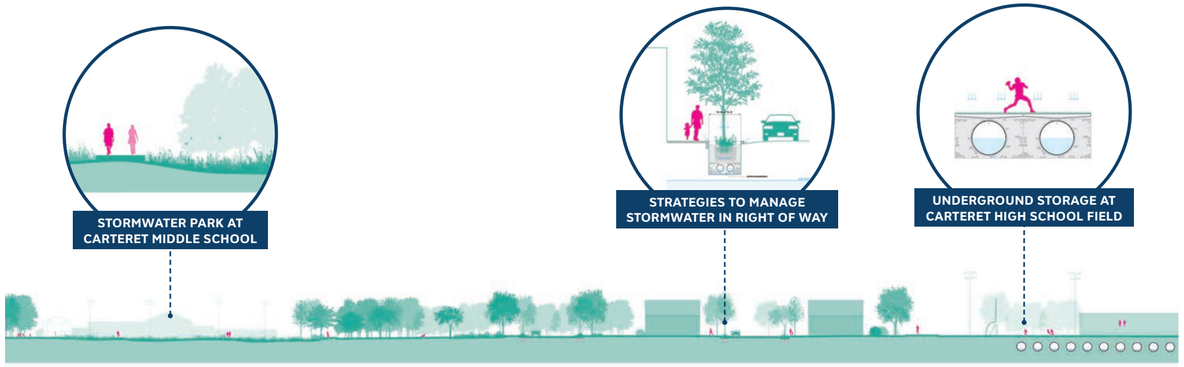
The resilience strategies at Noe's Creek combine coastal flood barriers, resilient redevelopment, and multi-benefit stormwater storage on publicly owned land. They not only reduce flood risk to existing residents, community facilities, and important commercial assets, but also enhance recreational amenities, increase multi-model connectivity, and provide economic development opportunities for this entire small watershed.

To reduce coastal flood risks, a **multi-purpose flood barrier system** in the form of an elevated waterfront greenway integrated into redevelopment sites on either side of Noe's Creek is proposed. This is combined with a tide gate across the creek to block coastal storm surge when closed but allow for continued tidal exchange under day-to-day conditions. The alignment shown here is a potential pathway for the coastal protection system, but further study is needed to identify a design flood elevation, assess site-specific constraints, and develop a preferred alignment and design. Waterfront redevelopment parcels are elevated and **incorporate resilience into their redevelopment plans** as they are developed to tie into the new coastal defense system and ensure that new development is resilient whether it is constructed before or after the complete flood defense system. A **pump station** is needed to manage stormwater on the inland side of this coastal protection system.

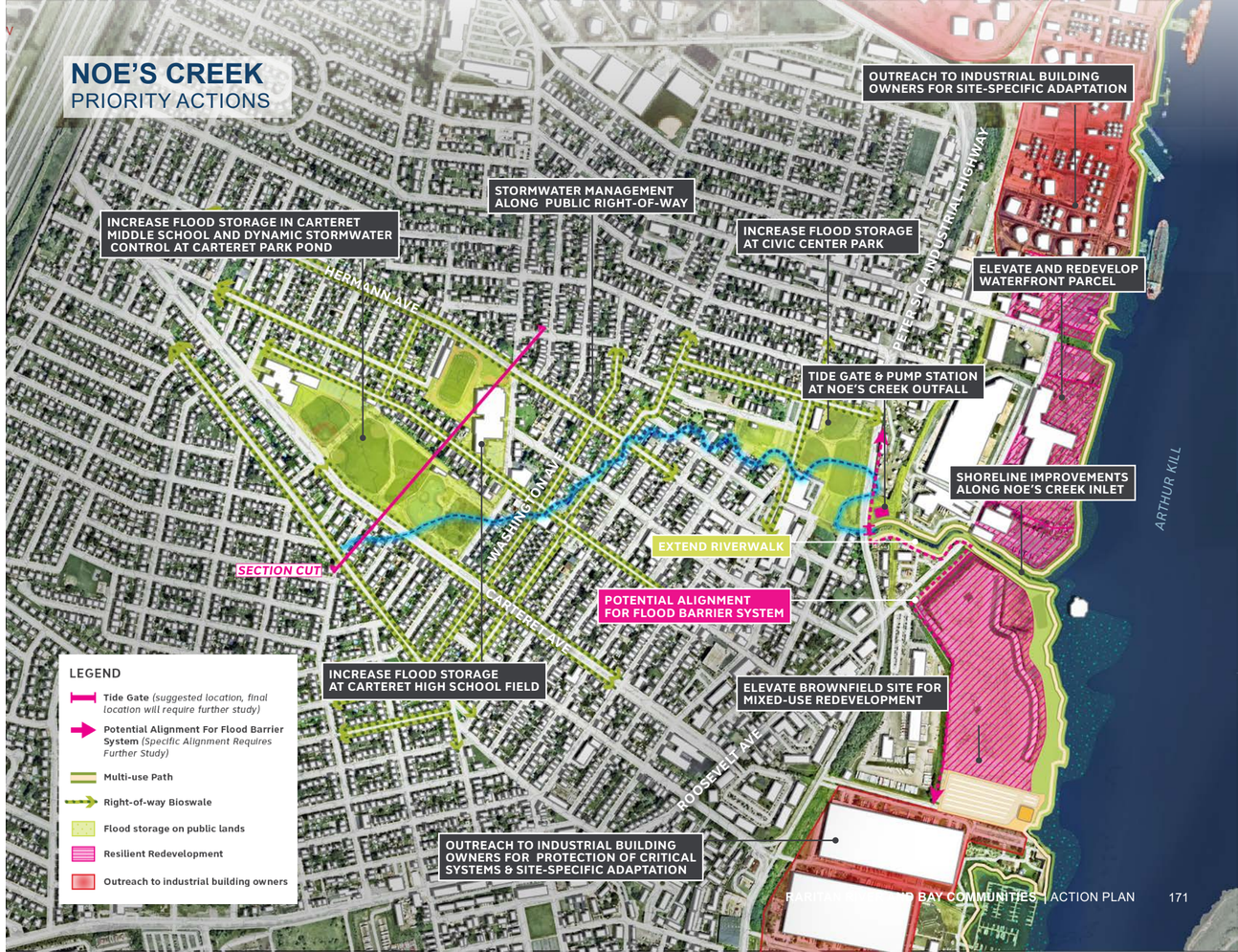
To address risk from heavy rainfall, an extensive system of stormwater storage improvements are included, building on the recent Noe Street Waterfall Park improvements. These consist of multiple actions to expand storage capacity on publicly owned land including: integrating green infrastructure into public right-of –ways, specifically streets, in the form of bioswales and raingardens; and retrofitting parks and open space for stormwater management at sites like Civic Center Park, Carteret High School, Carteret Middle School, and Carteret Pond Park.

Implementation of these projects should involve close collaboration with residents and include partnerships with the schools to incorporate educational opportunities.

There is also interest in buyouts in this area from property owners who were impacted heavily by Hurricane Ida. Re-use of bought-out properties may include additional opportunities for stormwater management.



Increase flood storage in Carteret Middle School through a stormwater park, dynamic stormwater control at Carteret Park Pond, and underground storage at Carteret High School football field



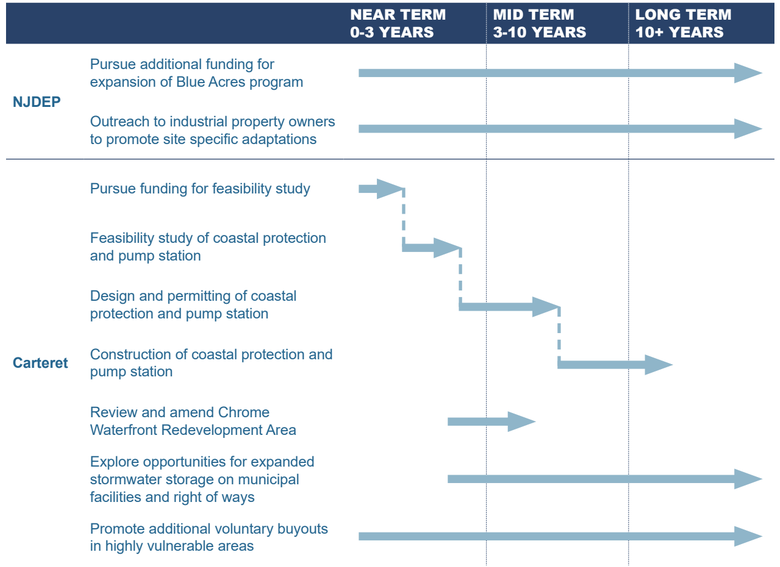
NOE'S CREEK INLET TODAY FROM ROOSEVELT AVE BRIDGE

Implementation Roadmap

Both NJDEP and Carteret should play key roles in the implementation of actions within the Noe's Creek Resilience Opportunity Area. Primary responsibilities of NJDEP include pursuing additional funding to expand the Blue Acres program, making buyouts available to property owners impacted by Ida. NJDEP should also play a role in facilitating outreach to industrial private property owners along the Arthur Kill in order to promote site-specific adaptation. NJDEP could pilot outreach programs in Noe's Creek and other Resilience Opportunity Areas before expanding regionally or statewide.

Carteret should serve as the lead entity for the Noe's Creek Resilience Opportunity Area. Responsibilities may include pursuing funding for further study, facilitating further study, and all activities related to design, permitting, and construction of the coastal protection and pump station. Additionally, Carteret should explore amendment of the Chrome Waterfront Redevelopment Area to accommodate proposed Noe's Creek flood mitigation and resilience projects. Exploring and pursuing opportunities to expand stormwater storage on municipal-owned facilities and right of ways will be essential to increase storage capacity in the area.

.



Implementation roadmap for Noe's Creek Resilience Opportunity Area

NOE'S CREEK


ELEVATED REDEVELOPMENT
(INDUSTRIAL / LOGISTICS)
ELEVATED OPEN SPACE
ELEVATED PATH - CARTERET RIVERWALK EXTENSION
ELEVATED MIXED-USE DEVELOPMENT
BULKHEAD / LIVING SHORELINE FOR FUTURE DEVELOPMENT
LIVING SHORELINE/ REMEDIATION

SUB-WATERSHED: WOODBRIDGE CREEK

CARTERET, PERTH AMBOY, WOODBRIDGE

The Woodbridge Creek watershed drains a large urban area with residential and commercial uses in Woodbridge Township. Downtown Woodbridge, which has been a focus for recent mixed-use and affordable housing redevelopment, as well as the Avenel community, are within this sub-watershed. Woodbridge Creek extends from the Arthur Kill north to where it nearly meets the Rahway River. Along the creek are extensive wetlands, with several recent restoration projects at Heards Brook and the Ernest L. Oros Wildlife Preserve. There are many creeks that feed into Woodbridge Creek, some of which have been channelized. These creeks are a frequent source of flooding during heavy rain events, particularly in areas where flood waters back up behind culverts.

During a major coastal storm, storm surge can enter the area through the Rahway River as well as up the Woodbridge Creek, resulting in extensive flooding on either side of the Creek. During heavy rainfall events, floodwaters can overwhelm the inland creeks, causing flooding along their banks, as well as ponding in low-lying areas.

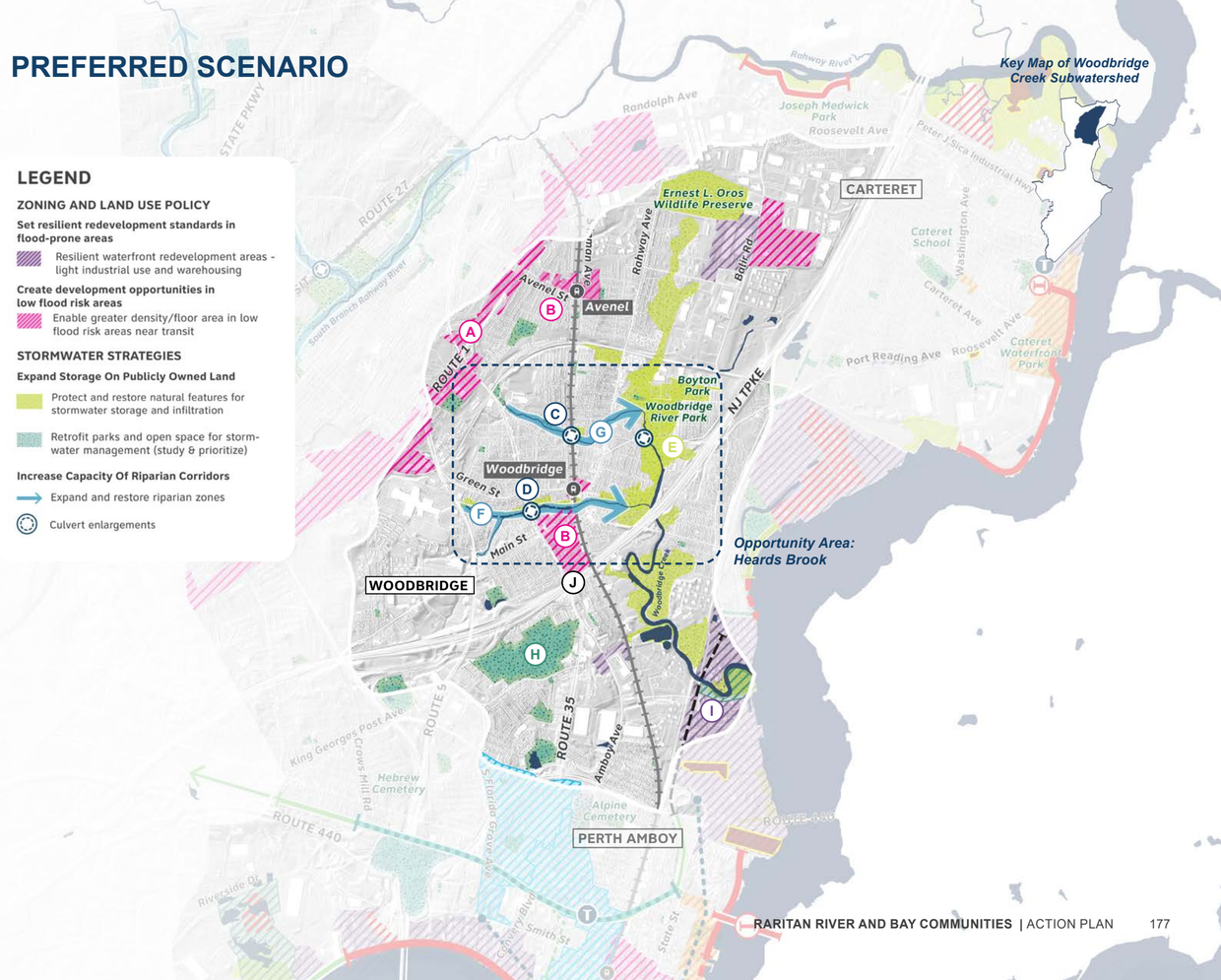
Increasing the capacity of the riparian corridors along Heards Brook, Wedgewood Brook, and other tributaries of Woodbridge Creek can reduce flood impacts from heavy rainfall. This includes expanding the riparian area, or zone along the river, along with expanding the capacity of culverts under road and rail crossings, to help convey water and provide additional space to manage floodwaters. While there have been some buyouts in this area post-Hurricane Sandy, **additional buyouts** can create more space along the stream corridors for these improvements. Buyouts can also reduce risks from future coastal flooding in the area.

RECOMMENDED ACTIONS	ID*	LEAD ENTITY
A. Exploration of long-term opportunities for increased density outside the floodplain, such as along the Route 1 corridors	W2	Woodbridge
B. Encourage mixed-use development outside floodplain near Avenel and Woodbridge train stations	W4	Woodbridge
C. Wedgewood Brook and NJ TRANSIT Line Culvert Expansion	NJ17	NJ TRANSIT
D. Heards Brook and Route 35 Culvert Expansion	NJ30	NJDOT
E. Protect and manage tidal wetlands along Woodbridge Creek for sea level rise	W15	Woodbridge
F. Increase the storage and conveyance capacity of Heards Brook along with ecological restoration	W19	Woodbridge
G. Increase the storage and conveyance capacity of Wedgewood Brook along with ecological restoration	W21	Woodbridge
H. Explore opportunities for expanded stormwater storage on municipal-owned facilities and right of ways.	W16	Woodbridge
I. Promote redevelopment of waterfront industrial properties and brownfields along the Arthur Kill and Woodbridge Creek to new forms of light industry like warehousing and incorporate resilience standards and wetland restoration.	W1	Woodbridge
J. Examine sections of the NJ Turnpike (I95) at risk of future flooding and identify mitigation measures	NJ12	NJ Turnpike Authority

See Summary Table of Recommended Actions starting on page 223 for additional details.

While portions of this area are vulnerable to flooding, the areas adjacent to the Woodbridge and Avenel train stations are well-poised to meet the demand for new housing in the region. Areas on higher ground with less risk from flooding should be prioritized for increased density though **zoning and land use** approaches. When it is necessary to site development in flood prone areas, resiliency improvements should be incorporated.

PREFERRED SCENARIO



OPPORTUNITY AREA: HEARDS BROOK

Flood Risk and Impacts

Coastal flooding extends up Woodbridge Creek and its tributaries, Heards Brook and Wedgewood Brook, to the rail corridor. Heavy rainfall can cause flooding in areas on the banks of the waterways, as well as other low-lying areas. Outdated and undersized drainage infrastructure and culverts contribute to back-ups and localized flooding from heavy rainfall.

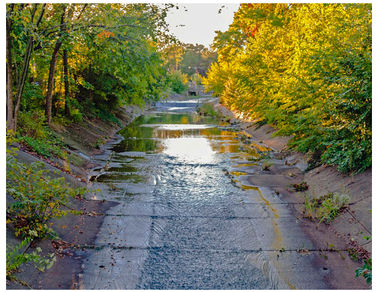
With climate change, the risk of flooding in this area is only expected to increase. If **no action is taken** to reduce risk, the potential for damage and disruption is significant. Potential monetary losses due to physical damages to structures and their contents, human impacts, direct business impacts, and the loss of function of public and essential facilities add up to $100M in damages due to a future storm surge event and $14M in damages due to a future heavy rainfall event. Flood events in this area have the potential to prevent ingress and egress via critical mobility routes including the NJ Turnpike (I-95) and the NJ TRANSIT line. Residential areas in the vicinity of Heards Brook and Wedgewood Brook may experience increased flooding with more water backing up behind undersized culverts due to more frequent and more severe precipitation events. High concentrations of hazardous waste and wastewater discharge in the area may also pose dangerous public health impacts if they interact with flood waters, threats that are especially acute for environmental justice communities and low-income households in the area. Parts of the area around Heards Brook rank as high as the 90th to 95th national percentile for environmental justice indices (U.S. EPA EJScreen) that account for hazardous waste proximity and wastewater discharge exposure, respectively.

Coastal Storm Surge

$100 Million in expected losses

Areal Rainfall Flooding

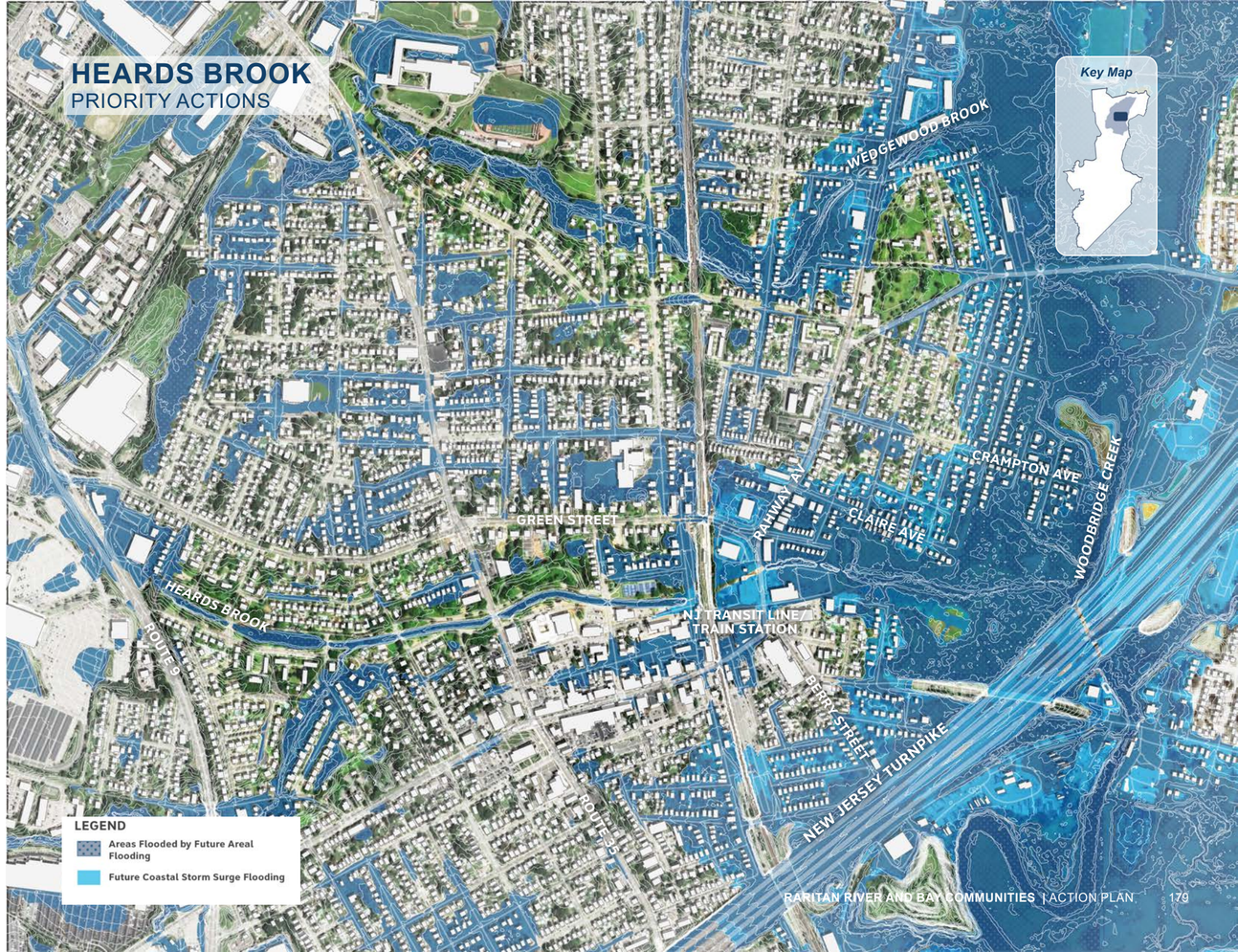
$14 Million in expected losses



HEARDS BROOK
Seen from the Pearl Street bridge near Woodbridge Train Station, Heards Brook is channelized from Route 9 downstream to Woodbrigde Creek.

Image Credit: Daniel Case

WEDGEWOOD BROOK
Seen from Barron Ave Bridge, Wedgewood Brook is a channelized stream that drains to Woodbridge Creek



Overview of Strategies

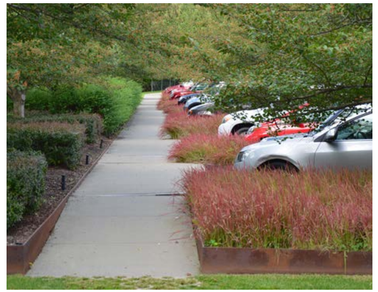
This area requires a watershed-scale stormwater management strategy that starts with further modeling and study to assess and clearly identify where drainage improvements are needed to be most effective. Thus, although the specific interventions and locations shown here are preliminary, they nevertheless represent the range of layered actions that will be necessary to reduce flood risk along these flood-prone creeks while illustrating the variety of non-flood related benefits that such measures could yield for residents, businesses, infrastructure, and community amenities.

These actions consist of measures to **increase the capacity of riparian corridors** by **expanding and restoring riparian zones** along both Heards Brook and Wedgewood Brook and **culvert enlargements** at road and rail crossings where existing culverts constrain these creeks and contribute to upstream flooding.These measures can be supplemented with restoration of these stream corridors that provides additional ecosystem and recreational benefits. The **protection and restoration of natural features** and the **retrofitting of parks and open space** (and even parking lots) for stormwater management along both creeks will further expand the stormwater management capacity of these watersheds and provide additional co-benefits.

In addition to these physical and nature-based strategies, **zoning and land use** changes to promote smart and resilient re-development and ensure the incorporation of stormwater management requirements into redevelopment and new development will be key to ensuring long-term effective flood risk reduction here. **Protecting and preserving open space** where these restoration and stormwater management strategies can be implemented will be key. Creating development opportunities in lower risk areas—like the area south of Heards Brook between Route 35 and the rail line can be incorporated into resilient redevelopment plans.

Additionally, sections of the NJ Turnpike (I-95) at risk of future flooding should be evaluated to identify mitigation measures near Woodbridge Creek. Potential actions may include **elevation or building a berm/floodwall along the roadway**. These physical and nature-based infrastructure strategies can be complemented by policy strategies to **encourage resilient development through higher redevelopment standards** and expanding access to voluntary buyouts in highly vulnerable areas.

STREAM RESTORATION
Muddy River stream restoration and bank stabilization, Boston, MA



STORMWATER RETROFITS IN PARKING LOTS
Dia Beacon Parking Lot, Beacon NY

CHANNELIZED HEARDS BROOK TODAY
FROM ROUTE 35 CULVERT BRIDGE

Implementation Roadmap

NJDEP, Woodbridge and various transportation authorities should play key roles in the implementation of actions within the Heards Brook Resilience Opportunity Area. The primary responsibility of NJDEP in this area is pursuing additional funding to expand the Blue Acres program, making buyouts available to property owners in higher risk areas. To encourage resilient, transit-oriented development in lower risk areas near the Woodbridge train station, Woodbridge should lead efforts to incorporate resiliency standards into redevelopment. This action should take priority as redevelopment is already underway in this area. Additionally, Woodbridge should be the lead entity in pursuing funding, conducting feasibility assessments and implementing restoration projects along tributaries of Woodbridge Creek in order to expand available area for flood management. Monitoring and restoration of tidal wetlands is recommended to complement these riparian areas and reduce coastal flooding impacts inland. Transportation agencies including NJ TRANSIT, NJDOT, and NJ Turnpike Authority should coordinate efforts to assess potential culvert improvements to their assets in the area and identify opportunities for mitigating flood risk to critical transportation corridors.

		NEAR TERM 0-3 YEARS	MID TERM 3-10 YEARS	LONG TERM 10+ YEARS
NJDEP	Pursue additional funding for expansion of Blue Acres program	→	→	→
	Incorporate resiliency standards into redevelopment	→		
	Promote additional voluntary buyouts in highly vulnerable areas	→	→	→
	Develop monitoring program for tidal wetlands along Woodbridge Creek	→	⇢	
	Identify restoration needs for resiliency and health of tidal wetlands		→	
Woodbridge	Pursue funding for further study of Wedgewood Brook and Heards Brook stormwater improvements	→	⇢	
	Assessment of feasibility and benefits of stream restoration and culvert improvements		→	⇢
	Implement stream restoration projects along Wedgewood Brook and Heards Brook		→	→
	Site-specific assessment and improvements of Heards Brook culverts at Elmwood Ave and School St		→	⇢
NJ TRANSIT	Site-specific assessment and improvements of culvert at Wedgewood Brook and Rail line		→	⇢
NJDOT	Site-specific assessment and improvements of culvert at Heards Brook and Route 35		→	⇢
NJ Turnpike Authority	Examine sections of the NJ Turnpike (I95) at risk of future flooding and identify mitigation measures	→		

Implementation roadmap for Heards Brook Resilience Opportunity Area

HEARDS BROOK

SUB-WATERSHED: RAHWAY RIVER & TRIBUTARIES

CARTERET, WOODBRIDGE

The Rahway River and Tributaries sub-watershed is bounded by the Woodbridge Creek sub-watershed to the east, Raritan River sub-watershed to the south, and the Woodbridge municipal boundary to the north. Rahway River and Tributaries represents part of the Arthur Kill Watershed and includes the northeast portion of Woodbridge. This area is not expected to experience significant coastal flooding, because it is further inland and at a higher elevation above sea level, which protects it from storm surge. Most buildings in this sub-watershed are residential. A heavy rainfall event is expected to cause the highest damages, specifically to commercial and residential structures.

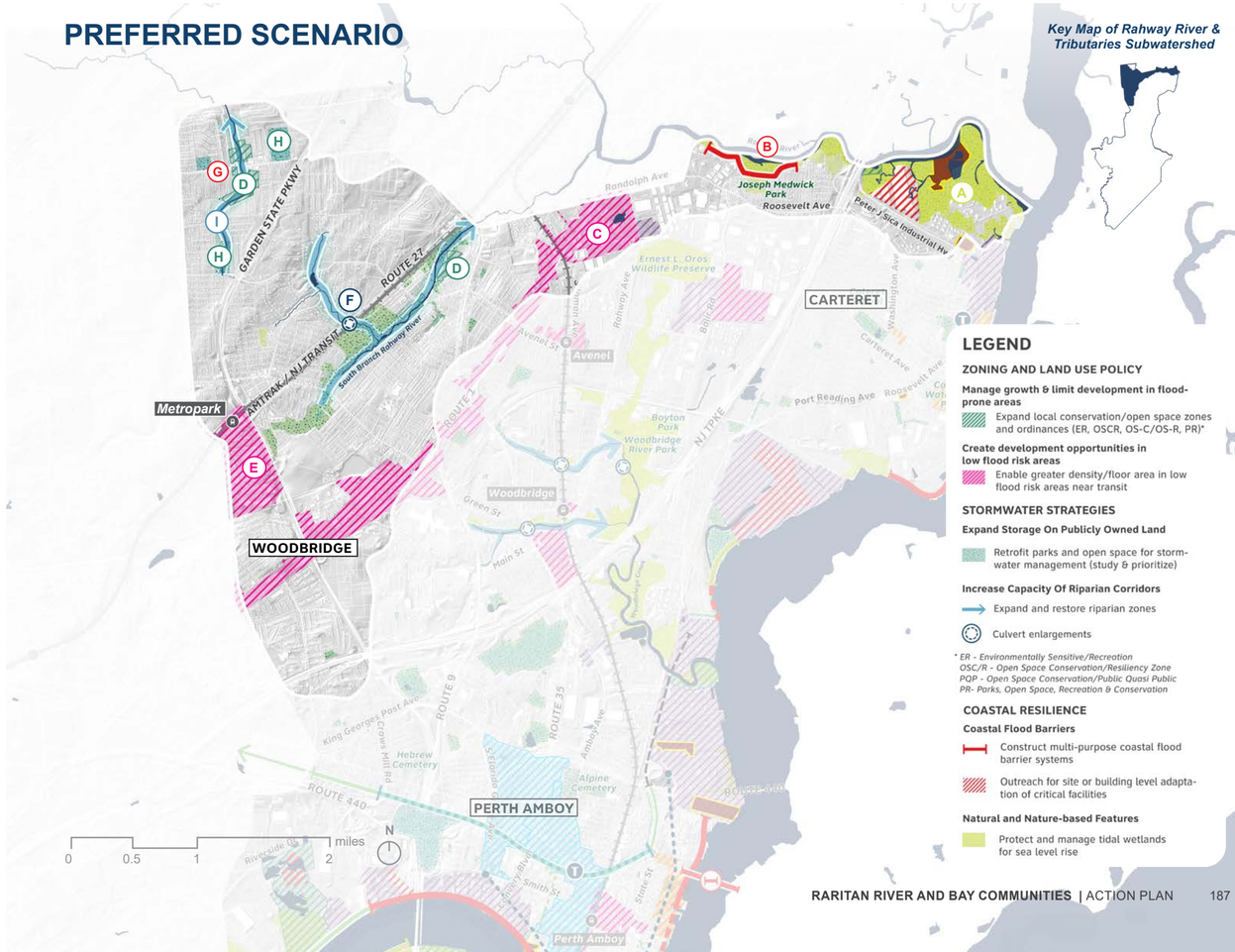
Strategies in this region focus on reducing flood risk due to widespread heavy rainfall events and limited coastal flooding impacts near Peter J Sica Industrial Highway through a variety of approaches. These include:

- Targeted outreach on mitigation options to homeowners throughout the region flooded by Ida (including along Pumpkin Patch Brook, Avenel, and other areas of Woodbridge)
- Encouraging mixed-use development outside floodplain near Metropark train station through zoning and land use changes
- South Rahway River at Route 27 Culvert expansion
- Increasing the storage and conveyance capacity of Pumpkin Patch Brook riparian corridor
- Identifying brownfield sites north of Peter J Sica Industrial Highway that are suitable for wetland restoration
- Outreach to industrial building owners for protection of critical systems and site-specific adaptation north of Peter J Sica Industrial Highway
- Implementation of the USACE Rahway River Basin project

RECOMMENDED ACTIONS	ID*	LEAD ENTITY
A. Identify brownfield sites north of Peter J Sica Industrial Highway that are suitable for wetland restoration	C6	Carteret
B. Implement Rahway River Basin project along the south bank of the Rahway River along with road raising	US6	USACE
C. Exploration of long-term opportunities for increased density outside the floodplain, such as along the Route 1 corridors	W2	Woodbridge
D. Use zoning to limit development potential of highly vulnerable areas along Pumpkin Patch Brook and the South Branch of the Rahway River, promote additional voluntary buyouts in highly vulnerable areas and targeted outreach on mitigation options to Ida impacted homeowners	W3, W6, W22	Woodbridge
E. Encourage mixed-use development outside floodplain near Metropark train station. Development should avoid portions of the area vulnerable to flooding from the South Branch of the Rahway River.	W5	Woodbridge
F. South Rahway River Under Northeast Corridor Rail Line Culvert Expansion	NJ16	NJ TRANSIT
G. Site-specific mitigation of flood-prone assets at Henry Inman Library	W10	Woodbridge
H. Explore opportunities for expanded stormwater storage on municipal-owned facilities and right of ways, such as Lynn Elementary School and Colonia Middle School	W16	Woodbridge
I. Increase the storage and conveyance capacity of Pumpkin Patch Brook riparian corridor along with ecological restoration	W20	Woodbridge

See Summary Table of Recommended Actions starting on page 223 for additional details.

PREFERRED SCENARIO



SUB-WATERSHED: RARITAN RIVERFRONT AND BAY

PERTH AMBOY, SAYREVILLE, SOUTH AMBOY, WOODBRIDGE

The Raritan Riverfront and Bay sub-watershed is characterized by the historic downtowns of South Amboy and Perth Amboy, which are both situated on higher ground just inland from the coast, as well as the area of Sayreville close to Raritan Bay. Recently, new developments in all three municipalities have introduced new housing and open spaces along the waterfront.

Coastal flooding has the potential to impact low-lying areas along the Raritan River and Bay, including the waterfront of Perth and South Amboy, and areas of Woodbridge and Sayreville along the Raritan River. Heavy rainfall flooding can cause ponding in low-lying areas across the area. Perth Amboy is the most densely populated municipality in Middlesex County, with a majority of residents identifying as Hispanic or Latinx. The city is one of the oldest settlements in the region, and has a combined sewer system, which means that under heavy rain events, untreated sewage can be released into the area's waterbodies, posing a major threat to public health.

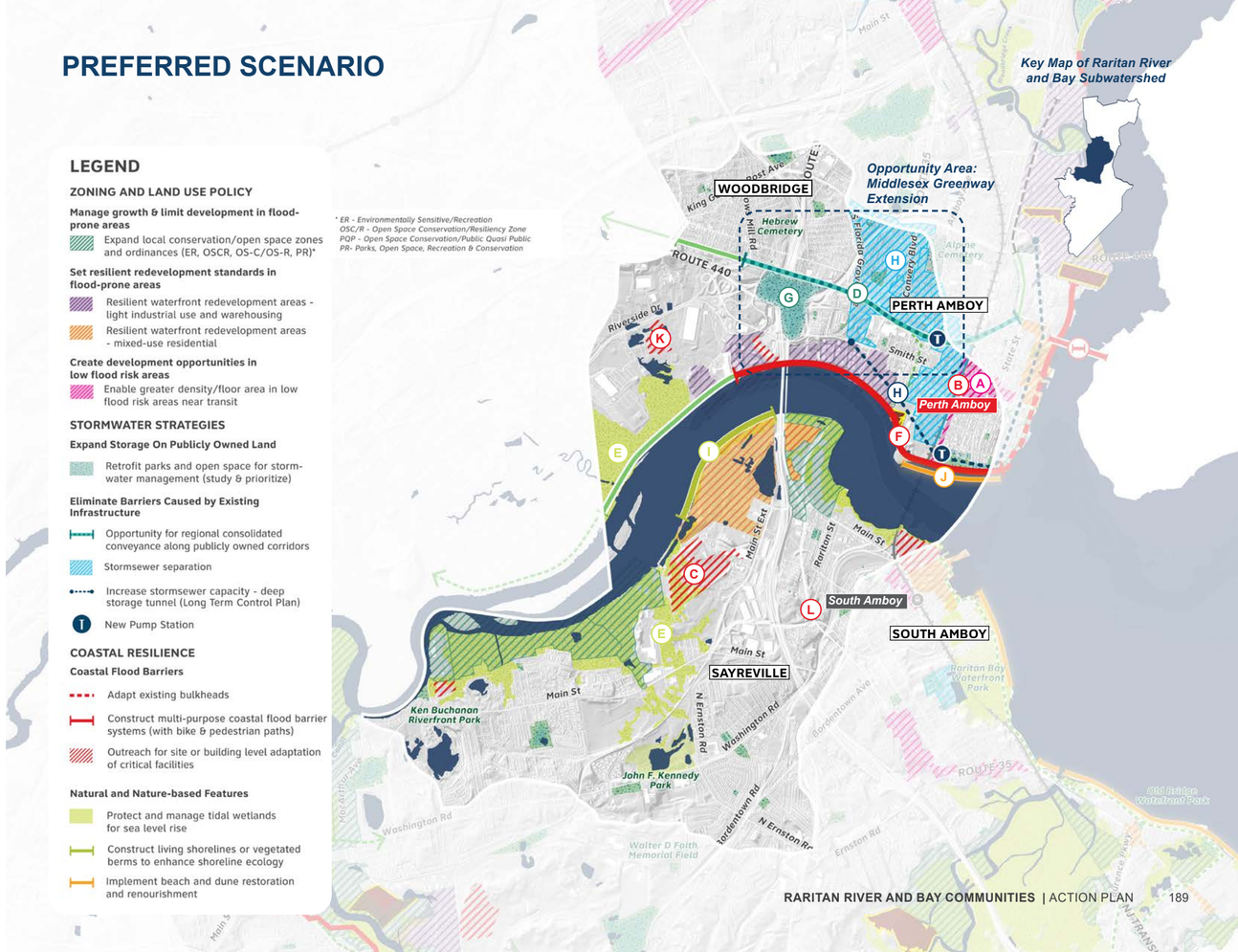
Resilience strategies in this area work together to address both heavy rainfall flooding and coastal flooding. Strategies include **increasing storm sewer capacity** in Perth Amboy and **expanding storage on publicly owned lands** including Washington Park and 440 Connector. Expansion of the Middlesex County Greenway, explained in more detail below, increases **right-of-way flood storage** along an inactive rail easement and allows for better conveyance of flood waters.

Zoning strategies such as **encouraging mixed use development outside the floodplain near transit** and conservation zoning along the Raritan River **limit development and reduce density in high risk areas**. **Coastal flood barriers** including a **berm with integrated multi-use pathways, a living shoreline** along the Riverton development and **beach replenishment** in Perth Amboy work together to reduce the impacts of coastal flooding while expanding public access to the coast.

RECOMMENDED ACTIONS	ID*	LEAD ENTITY
A. Exploration of opportunities for increased density outside the floodplain, such as near the train station and along 2nd street	P1	Perth Amboy
B. Protect vulnerable portions of the Perth Amboy Train Station	NJ14	NJ TRANSIT
C. Site-specific mitigation of flood-prone assets at MCUA Wastewater Treatment Plant and Middlesex Generating Facility	MC2	MCUA
D. Assess opportunities for incorporating flood storage and conveyance into an extension of the Middlesex County Greenway	RRBC7	Resilient RRBC
E. Restore wetlands and riparian areas along the Raritan River	NG3	Rutgers
F. Floodwall and elevated harborwalk on Sadowski Parkway	P3, W14	Perth Amboy, Woodbridge
G. Explore opportunities for expanded stormwater storage on facilities and right of ways owned by Perth Amboy	P5, P6	Perth Amboy
H. Implement the Long-Term Control Plan to reduce CSOs and improve drainage (Improvements include deep storage, new pumping station at 2nd street and beach, additional storage and treatment strategies, sewer separation, and green infrastructure)	P7	Perth Amboy
I. Work with Riverton developer to incorporate nature-based solutions along the shoreline, such as a living shoreline/ into redevelopment plan	SV4	Sayreville
J. Beach replenishment in Perth Amboy to protect waterfront park and recreational assets	US3	USACE
K. Site-specific mitigation of flood-prone assets at Woodbridge Recycling Center	W12	Woodbridge
L. Site-specific flood mitigation of South Amboy Fire Mechanicsville Hose Company	SA3	Sayreville

See Summary Table of Recommended Actions starting on page 223 for additional details.

PREFERRED SCENARIO



OPPORTUNITY AREA: MIDDLESEX GREENWAY EXTENSION

Flood Risk and Impacts

Flooding from heavy rainfall in the Hopelawn neighborhood of Woodbridge and in the Washington Park area of Perth Amboy is exacerbated by the highway and rail corridor, which cut off natural drainage pathways. These flows need to travel past an abandoned rail embankment, the complicated interchange of NJ-440 and the Garden State Parkway, and residential, commercial, and industrial properties.

With climate change, the risk of flooding in this area is only expected to increase. If no action is taken to reduce risk, the potential for damage is significant. Potential monetary losses due to physical damages to structures and their contents, human impacts, direct business impacts, and the loss of function of public and essential facilities add up to $87M in damages due to a future heavy rainfall event. Hopelawn Engine Company #1 is within this opportunity area and may be impacted by heavy rainfall events today and in the future. Flooding of this critical facility would impact its ability to provide vital services to the community. Very high concentrations of wastewater discharge and hazardous waste in the area may also pose dangerous public health impacts if they interact with flood waters, threats that are especially acute for environmental justice communities and low-income households in the area. Parts of the area around Hopelawn rank as high as the 95th to 100th national percentile for environmental justice indices (U.S. EPA EJScreen) that account for wastewater discharge exposure and hazardous waste proximity, respectively. Notably, this area also has a very high concentration households without broadband internet access. These neighborhoods are less likely to have easy access to the resources and information needed to prepare for and respond to major flood events.

Areal Rainfall Flooding

$87 Million in expected losses

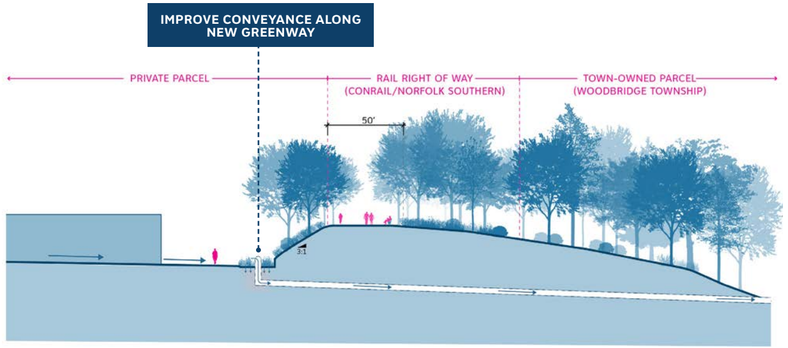
LEHIGH FREIGHT RAIL LINE IN PERTH AMBOY
View of underutilized rail right of way near YMCA Perth Amboy

LEHIGH FREIGHT RAIL LINE IN HOPELAWN, WOODBRIDGE
View of underutilized rail right of way near Quincy Heights Apartments

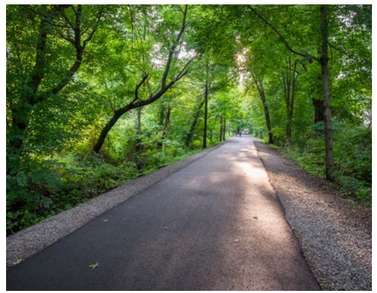
Overview of Strategies

Portions of this abandoned, former freight rail line have been repurposed into the Middlesex County Greenway, a bike and pedestrian trail which connects the Hopelawn neighborhood to Metuchen. As part of an extension of the trail into Perth Amboy, the rail embankment can be leveraged to help consolidate stormwater by collecting drainage through **right-of-way flood storage** along the abandoned railway. This allows floodwater in the area to be sent past the other barriers in a more efficient and effective location. Additional study of drainage pathways to convey water to existing channels and ultimately to the Raritan River may be needed.

Drainage can also be improved through improvements to Washington Park to increase **stormwater storage** and increasing the capacity of the city's storm sewer infrastructure.



Improve conveyance along new greenway extension with green and grey infrustructure and study drainage pathways to convey stormwater to existing waterways or the Raritan River



MIDDLESEX GREENWAY
Middlesex Greenway Trail at New Jersey Turnpike Mac Arthur Drive Liddle Avenue Gross Avenue LVRR Perth Amboy Branch

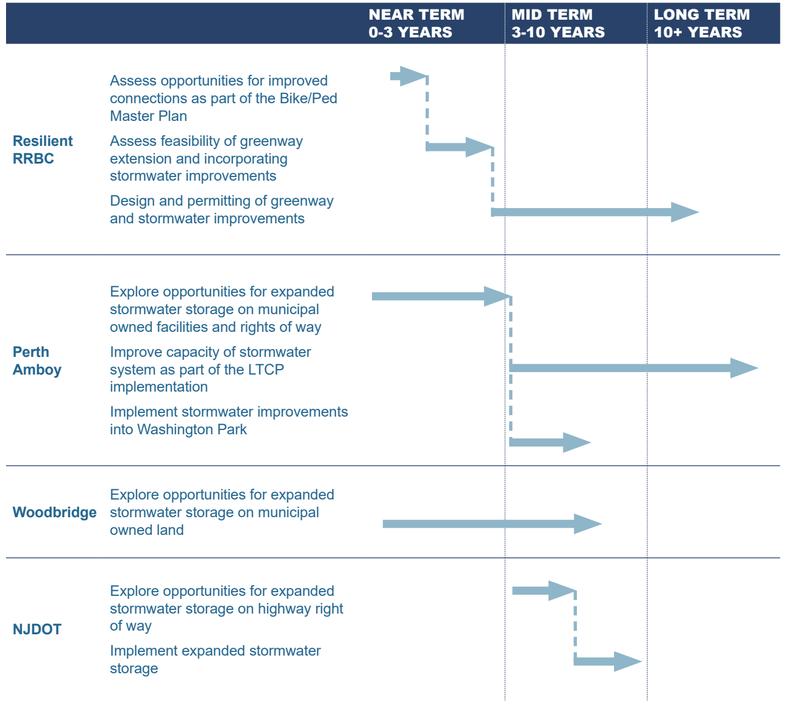
RIGHT-OF-WAY BIOSWALE
Whittier Greenway Trail integrates bioswales with greenways, Los Angeles CA

Image Credit: Whittier Daily News

LEHIGH RAILWAY EASEMENT FOR MIDDLESEX GREENWAY EXTENSION

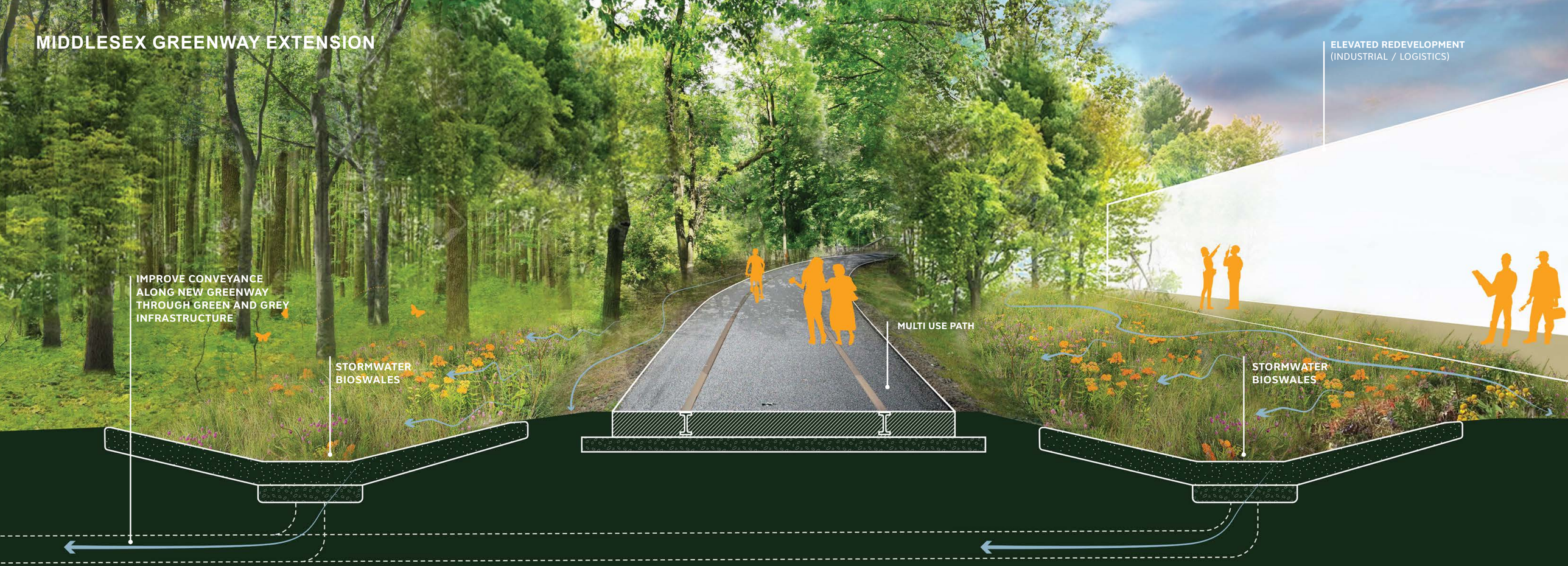
Implementation Roadmap

Middlesex County, Perth Amboy, Woodbridge, and NJDEP should play key roles in the implementation of actions within the Middlesex County Greenway Extension Resilience Opportunity Area. As part of the County's Bike/Pedestrian Master Plan, the County is examining the potential extension of the greenway, and additional analysis of the feasibility of this extension, and opportunities to incorporate stormwater improvements could be pursued as a follow-up study. Both Perth Amboy and Woodbridge should pursue opportunities to expand stormwater storage on municipal-owned facilities and rights of way. Perth Amboy should also look for opportunities to improve capacity of the stormwater system through implementation of their LTCP. NJDOT should also lead identification of opportunities for stormwater storage on the highway right of way and implementation of these opportunities.



Implementation roadmap for Middlesex Greenway Extension Resilience Opportunity Area

MIDDLESEX GREENWAY EXTENSION



SUB-WATERSHED: SOUTH RIVER & WASHINGTON CANAL

OLD BRIDGE, SAYREVILLE, SOUTH RIVER

The South River / Washington Canal sub-watershed is bounded by the South River sub-watershed (below Duhernal Lake), Tennent Brook and Deep Run sub-watersheds, and the South River municipal boundary to the west. It includes portions of Old Bridge, Sayreville, and South River. The sub-watershed includes the mixed-use downtown of South River, in addition to residential and industrial areas along the river in all the municipalities.

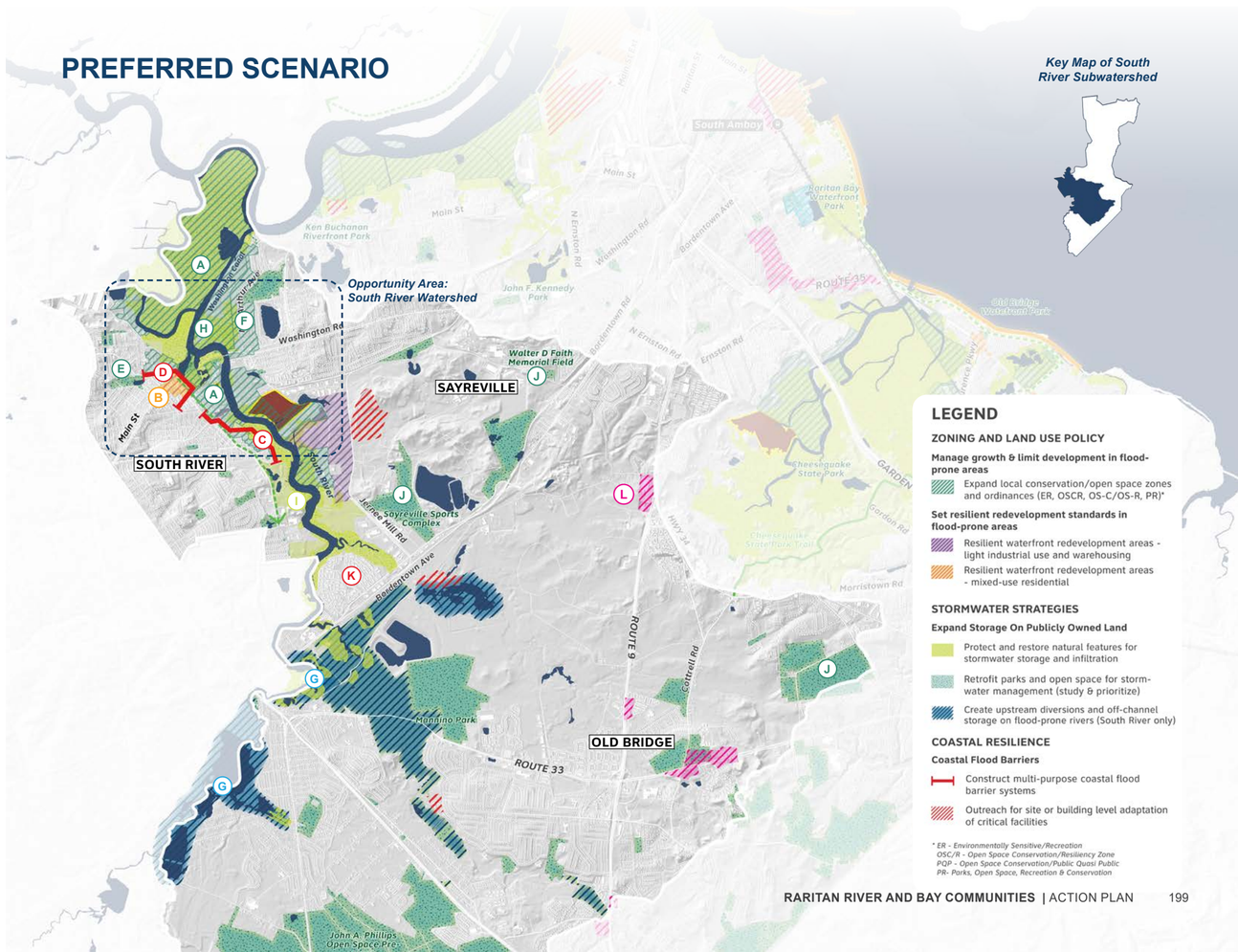
In this sub-watershed, coastal flooding from the Raritan Bay and Raritan River is expected to extend inland for great distances along the South River. Coastal flooding in this sub-watershed is compounded by riverine flooding from upstream tributaries including Tennent Brook and Deep Run and rainfall flooding which has widespread impacts throughout the area.

A watershed-based management strategy is needed to look at opportunities to **increase flood storage in the upper tributaries** to reduce downstream flooding from heavy rainfall events. This can be done in combination with opportunities for **wetland restoration**. Additional **buyouts**, particularly in South River, can reduce impacts from future flood events and transition areas vulnerable to sea level rise to open space. Targeted **outreach** to property owners on flood protection options is needed, along with development of new funding sources to support adaptation of existing buildings. In densely populated areas, like the Winding Woods apartment complex, additional outreach on evacuation is needed.

RECOMMENDED ACTIONS	ID*	LEAD ENTITY
A. Use zoning to limit development potential of sites that have not been bought out along the South River by expanding parks, open space and conservation zones to encompass more of the flood hazard area and promote additional voluntary buyouts in highly vulnerable areas	SR1, SR3	South River
B. Promote resilient redevelopment along Main Street and incorporate resiliency standards, such as elevating first floors and streetscape standards, into redevelopment plans	SR2	South River
C. Coastal flooding protection along the South River (evaluate flood protection alternatives for riverfront from the railroad crossing at Whitehead Avenue south to Bissetts Recreational Area)	SR4	South River
D. Coastal flooding protection of South River downtown core	SR5	South River
E. Explore opportunities for expanded stormwater storage on municipal-owned facilities and right of ways (potential sites include Dailey's Pond Recreation Area, Burton Ave and Louis Street Baseball Field)	SR6	South River
F. Use zoning to limit development potential of sites that have not been bought out along the South River (Expand the OS-C Zone within the SED Zones and remaining residential neighborhoods along MacArthur Avenue)	SV2	Sayreville
G. Study opportunities and potential benefits of upstream storage and diversion within the South River watershed	RRBC11	Resilient RRBC
H. Implement the South River Ecosystem Restoration & Flood Resiliency Enhancement Project and explore additional coastal resilience opportunities along the South River	NG1, NG2	Lower Raritan Watershed Partnership
I. Restore wetlands and riparian areas along the Raritan River	NG3	Rutgers
J. Explore opportunities for expanded stormwater storage on municipal-owned facilities and right of ways (Potential sites include the Sayreville Sports Complex, Walter D. Faith Memorial Fields, Veterans Park)	SV5	Sayreville
K. Promote flood awareness campaign and evacuation for Winding Woods apartment complex	SV6	Sayreville
L. Exploration of opportunities for increased density outside the floodplain, such as along Route 9 to accommodate growth	O2	Old Bridge

See Summary Table of Recommended Actions starting on page 223 for additional details.

PREFERRED SCENARIO



OPPORTUNITY AREA: SOUTH RIVER AND SAYREVILLE MAIN STREET

Flood Risk and Impacts

Within the South River and Sayreville Main Street Resilience Opportunity Area, both rainfall and coastal flooding are expected to have widespread impacts. In both South River and Sayreville, development on either end of Veterans Memorial Bridge and along the banks of the South River are vulnerable to flooding. Areas of downtown South River face chronic flooding during high tide events today and this is expected to become even more frequent with sea level rise. Following extensive damage in the area caused by Hurricane Sandy, a number of properties were bought out within both municipalities.

With climate change, the risk of flooding in this area is only expected to increase. If **no action is taken** to reduce risk, the potential for damage is significant. Potential monetary losses due to physical damages to structures and their contents, human impacts, direct business impacts, and the loss of function of public and essential facilities add up to $224M in damages due to a future storm surge event and $88M in damages due to a future heavy rainfall event. Notably, parts of this Opportunity Area—especially in eastern South River—have some of the highest rates of unemployment in the country. The consequences of a major flood event for unemployed individuals and their households could be especially dire. Conversely, many of the strategies proposed for this Opportunity Area could help spur economic revitalization in the neighborhood, if implemented thoughtfully and equitably in close collaboration with the community.

Coastal Storm Surge

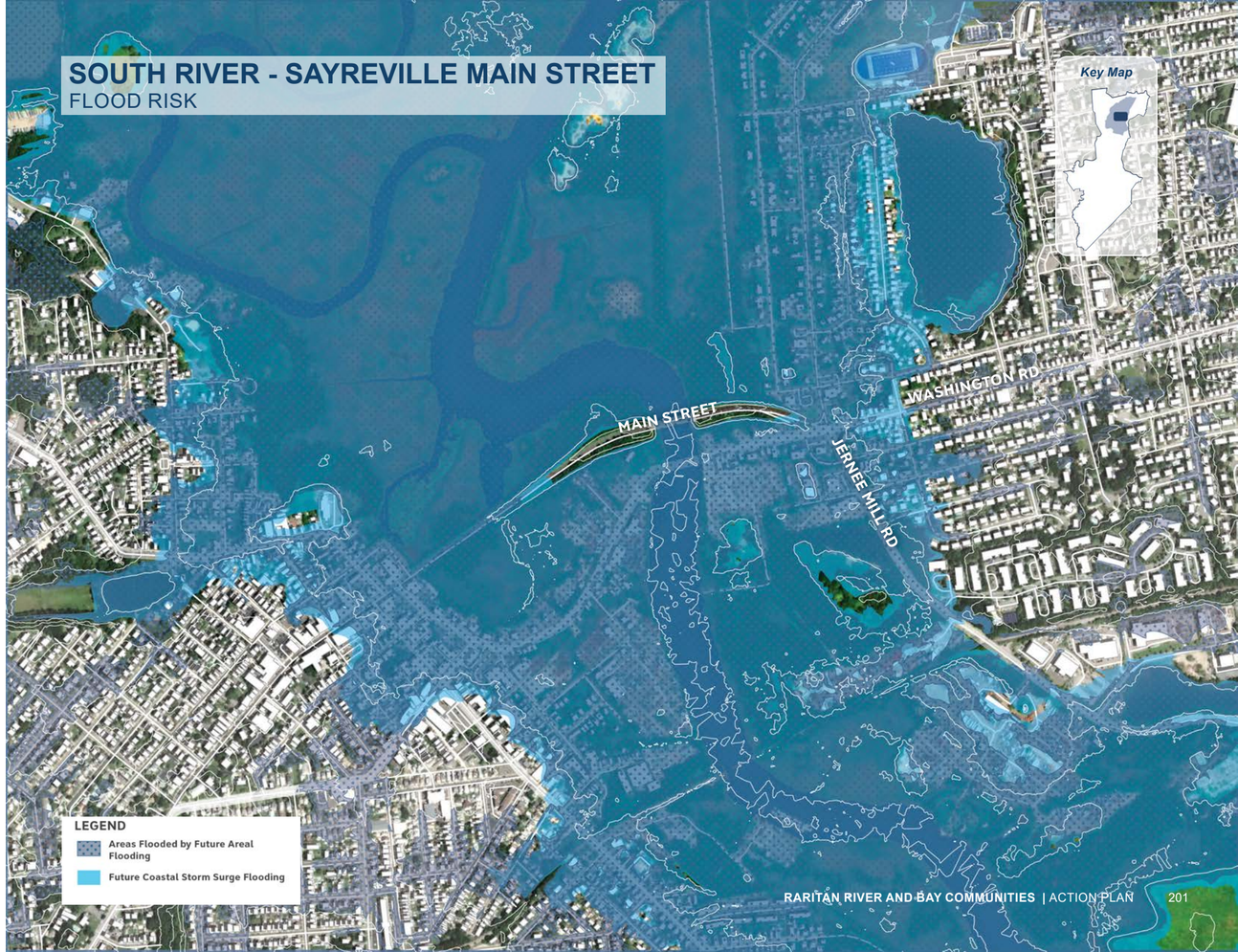
$224 Million in expected losses

Areal Rainfall Flooding

$88 Million in expected losses

WATER STREET AFTER HURRICANE IRENE
South River, NJ on Aug 28, 2011.

MAIN STREET AFTER HURRICANE IRENE
Sayreville Bridge and the Causeway in South River, NJ on Aug 28, 2011.



Overview of Strategies

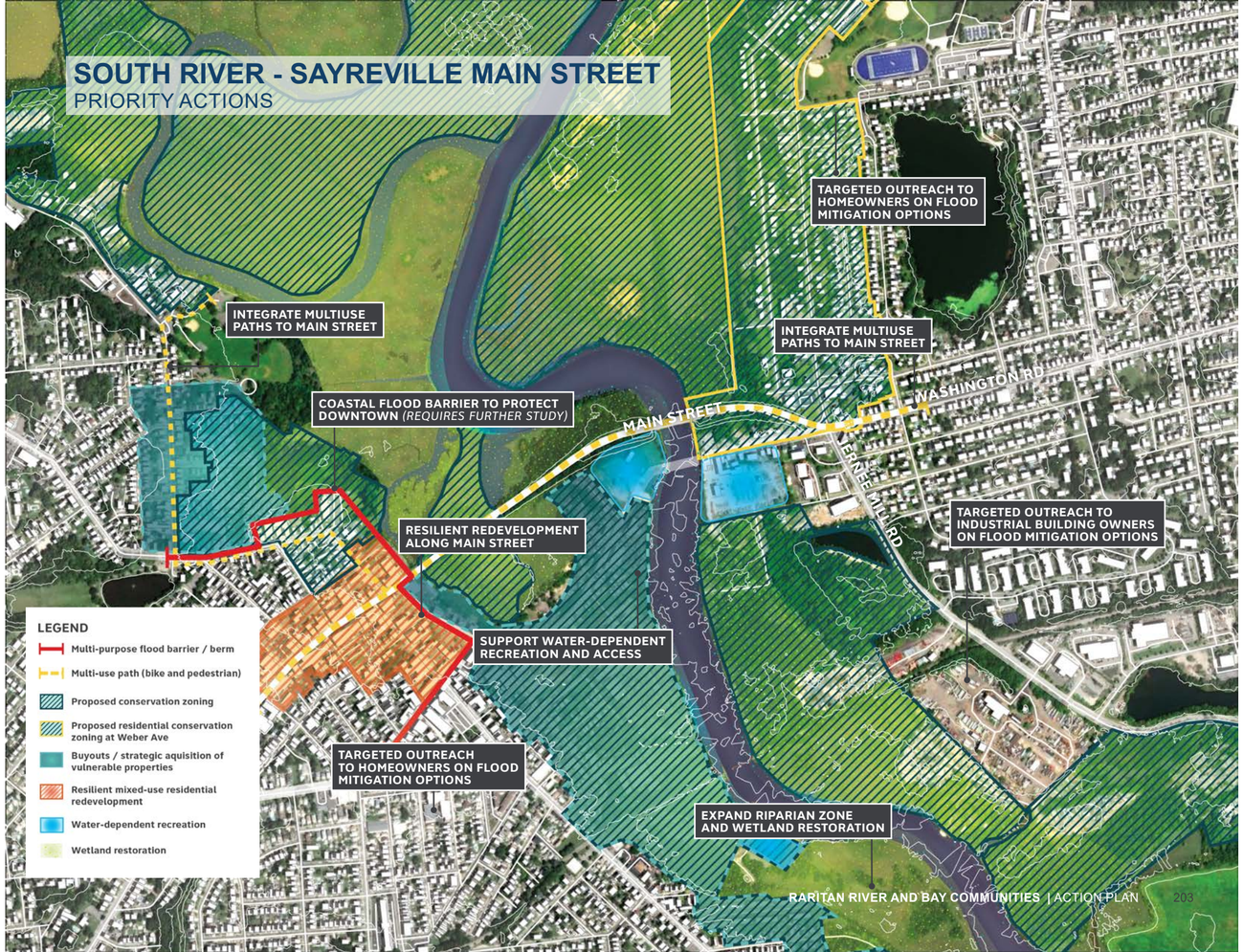
In South River, an exploration of a **coastal protection** alignment to protect the town's Main Street district is needed. This area is a priority for redevelopment with a mix of uses including ground floor retail. The area closet to the South River has experienced flooding and is projected to increase in the future. A coastal protection system could be a mix of permanent floodwalls, as well as temporary deployable measures. The proposed alignment shown here is one potential route that should be further explored and confirmed for feasibility. Stormwater drainage inland of the protection system will also need to be evaluated and developed.

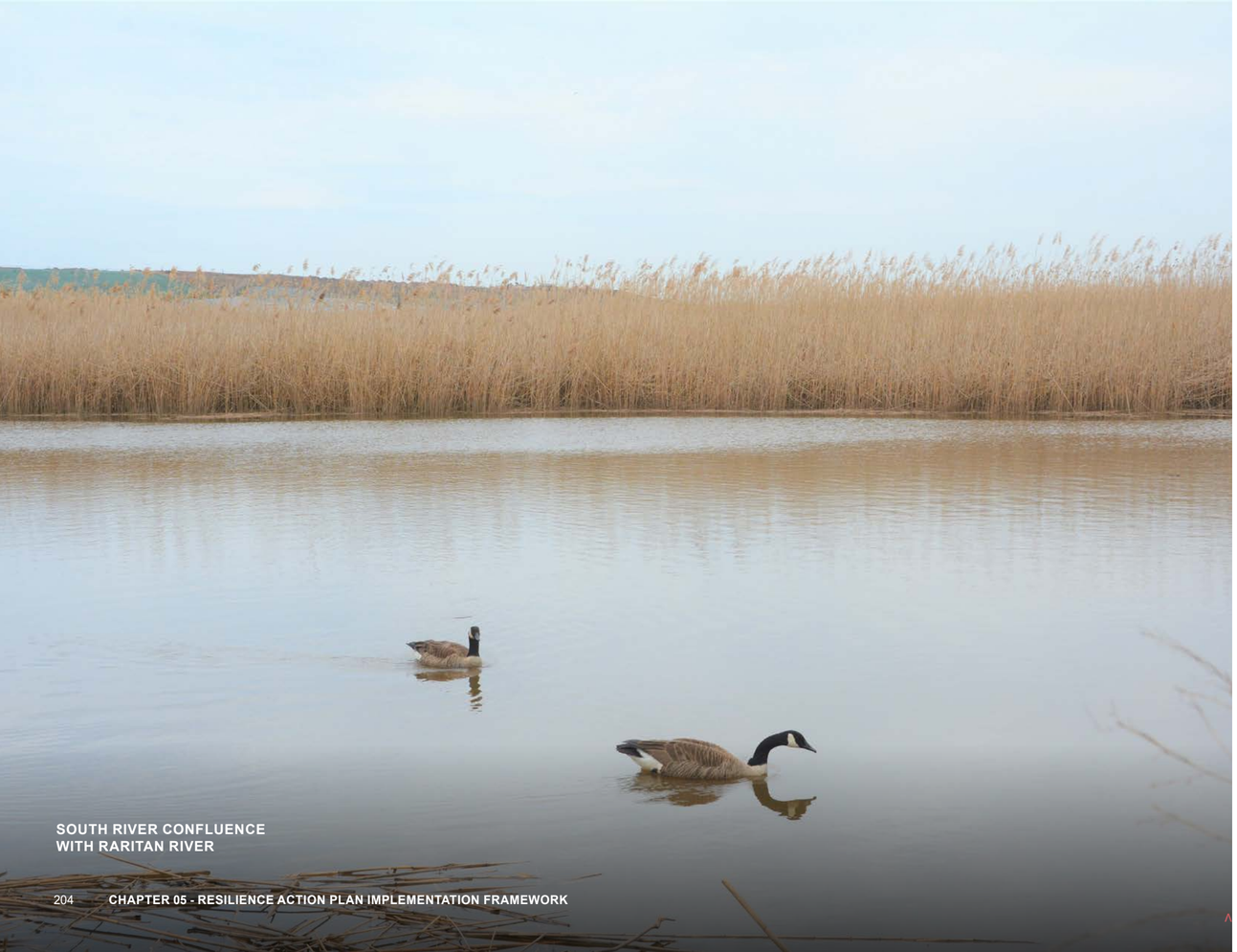
Areas close to South River and north and south of Main Street where there have been extensive buyouts should be prioritized for **additional buyouts** and **reuse of land** for open space and waterfront access. Outreach to property owners in needed in these areas, to communicate ongoing flood risk and provide information on potential mitigation options, including buyouts. The zoning in these areas should also be examined and are good candidates for the extension of conservation zoning to reduce the development potential of properties that have not yet been bought out. For those areas along the South River, including acquired open spaces could be repurposes for marinas and boating opportunities, and the zoning should be sure to allow such uses.

MARSH RESTORATION
In Avalon, NJ, thin layer placement of sediment across low-lying and degraded sections of the salt marsh helped restore native plants to keep pace with sea level rise

Image Credit: The Nature Conservancy

BUYOUTS
In the Watson-Crampton neighborhood of Woodbridge, properties bought out after Hurricane Sandy have been transformed into public open space

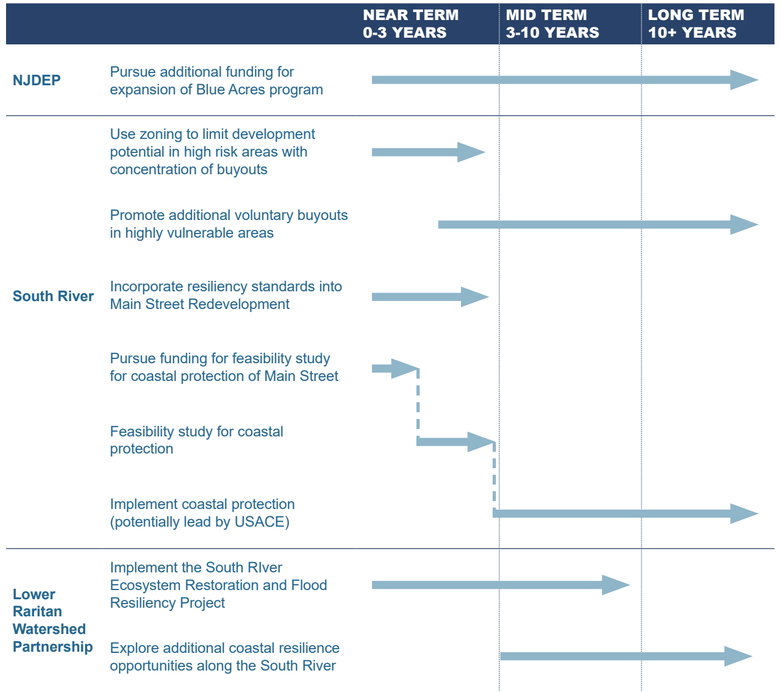




SOUTH RIVER CONFLUENCE
WITH RARITAN RIVER

Implementation Roadmap

NJDEP, South River, Sayreville, and the Lower Raritan River Watershed Partnership should play key roles in the implementation of actions within the South River and Sayreville Main Street Resilience Opportunity Area. The primary responsibility of NJDEP in this area is pursuing additional funding to expand the Blue Acres program, making buyouts available to property owners in higher risk areas. Sayreville should lead efforts to limit development in higher risk areas through zoning. In South River primary responsibilities should include using zoning to limit development in higher risk areas, promoting additional buyouts in higher risk areas, incorporating resiliency standards into redevelopment and pursuing funding to study the feasibility of installing coastal protection for Main Street. Implementation of the South River Ecosystem Restoration & Flood Resiliency Enhancement Project by the Lower Raritan Watershed Partnership will round out efforts in this opportunity area by reducing flood risk near Washington Canal.



Implementation roadmap for South River and Sayreville Main Street Resilience Opportunity Area

SUB-WATERSHED: CHEESEQUAKE & LAURENCE HARBOR

OLD BRIDGE, SAYREVILLE, SOUTH AMBOY

The Cheesquake / Laurence Harbor sub-watershed is bounded by Cheesequake Creek / Whale Creek sub-watershed and the Old Bridge municipal boundary to the east. Cheesequake and Laurence Harbor include expansive wetland areas, including Cheesequake State Park, and coastal beaches across parts of Sayreville, South Amboy, and Old Bridge. The South Amboy waterfront has been the focus of recent waterfront developments, located in proximity to a walkable town center and train station.

The Laurence Harbor section of Old Bridge was developed as a beachfront resort and bungalow colony in the early 20th century. The community was damaged badly from Hurricane Sandy, resulting in damaged homes and some buyouts.

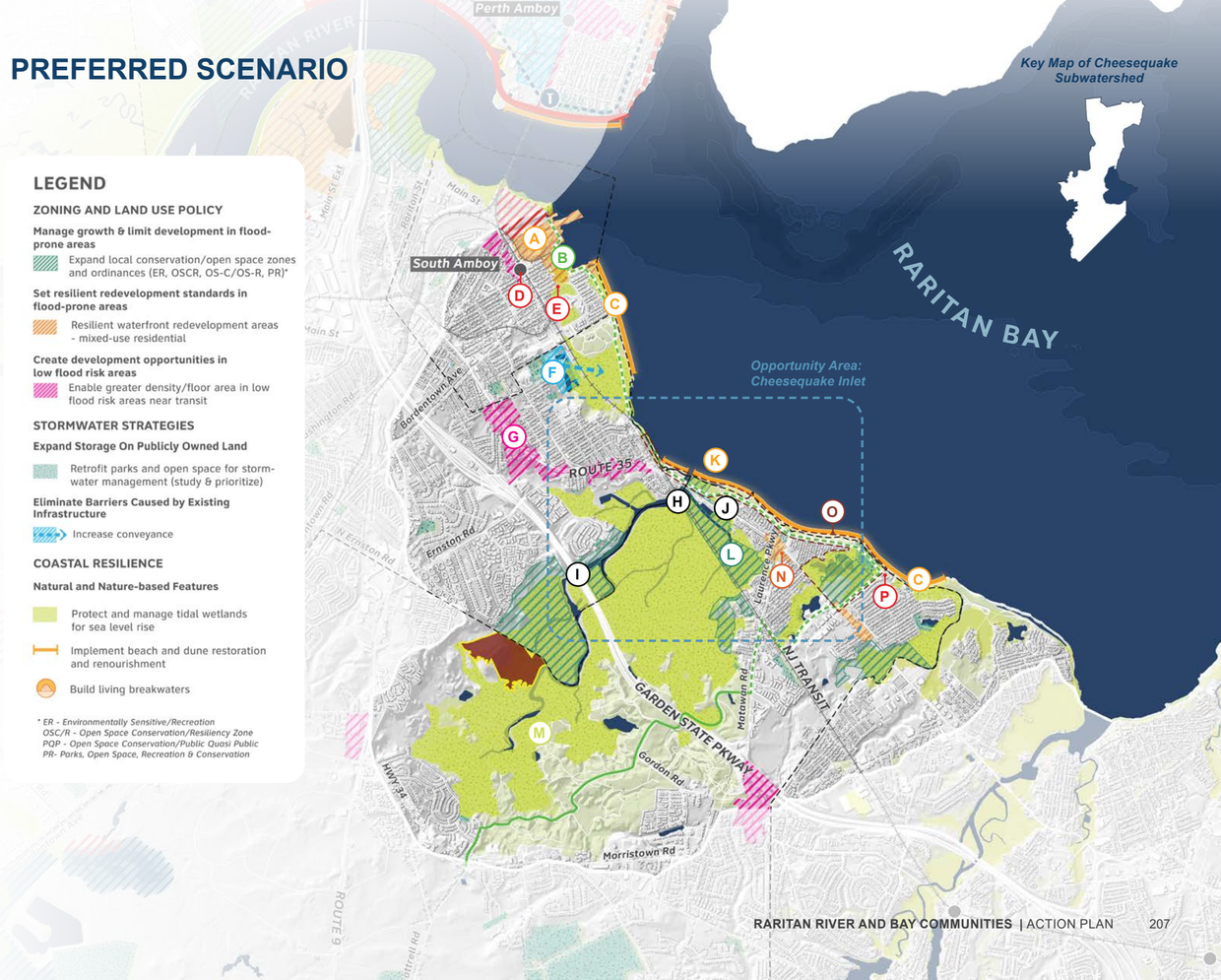
Cheesequake State Park, just inland from the coast, includes a mix of ecosystems, from saltwater marsh and a tidal estuary near the mouth of Cheesequake Creek on the Raritan Bay to hills of northeastern hardwood forest, open fields, a white cedarswamp, and a small portion of Atlantic coastal pine barrens. Monitoring, management, and restoration of the wetlands to improve flood storage capacity should be pursued. There are also sections along the edge of the park that should be examined for additional buyouts and limitations on future development.

Resilience strategies in this area include **beach and dune nourishment** along the coast, and **protection of key transportation corridors**, including the New Jersey Coast Line, Route 35, and the Garden State Parkway.

RECOMMENDED ACTIONS	ID*	LEAD ENTITY
A. Promote resilient redevelopment along the South Amboy waterfront	SA1	South Amboy
B. Require contiguous waterfront walkway during redevelopment for future coastal protection infrastructure and waterfront access	A2	All Municipalities
C. Beach Nourishment along Raritan Bay	US2, US5	USACE
D. Protect or adapt South Amboy Pump Station	MC1	MCUA
E. Site-specific flood mitigation of South Amboy Fire Department Snorkel Fire Company	SA2	South Amboy
F. Increase conveyance between rail line and marsh inland of Raritan Bay Waterfront	NJ15	NJ TRANSIT
G. Exploration of opportunities for increased density outside the floodplain, such as along Route 35 to accommodate growth	SV3	Sayreville
H. Study and develop alternatives to reduce flood risk to NJ TRANSIT Coast Line	NJ13	NJ TRANSIT
I. Examine sections of the Garden State Parkway at risk of future flooding and identify mitigation measures	NJ 11	NJ Turnpike Authority
J. Examine opportunities to protect vulnerable sections of Route 35 in Old Bridge	NJ27	NJDOT
K. Installation of breakwaters along the coast could serve to buffer storm waves and reduce erosion of the beach	US8	USACE
L. Coordinate with the NJDEP Blue Acres program to identify suitable buyout properties in areas of high risk, such as area surrounding Cheesequake State Park that are prone to coastal flooding from Cheesequake Creek	O3	Old Bridge
M. Monitoring, management, and restoration of wetlands to improve flood storage capacity within and around the edges of Cheesequake State Park	NJ19	NJDEP
N. Explore zoning changes and other tools to promote resilient redevelopment of waterfront along Laurence Parkway	O1	Old Bridge
O. Remediation of Slag superfund site	US1	US EPA
P. Site-specific mitigation of Laurence Harbor Pump Station	O7	Old Bridge Municipal Utilities Authority

See Summary Table of Recommended Actions starting on page 223 for additional details.

PREFERRED SCENARIO



OPPORTUNITY AREA: CHEESEQUAKE INLET & LAURENCE HARBOR

Flood Risk and Impacts

The Laurence Harbor beachfront is highly vulnerable to coastal flooding. Cheesequake inlet serves as a major flood pathway to coastal flooding further inland. Low-lying portions of the area are also vulnerable to ponding from heavy rainfall.

The beachfront is part of the Raritan Bay Slag superfund site that is being examined by the U.S. Environmental Protection Agency. Due to the lead content in the area, public access at the beach has been limited.

With climate change, the risk of flooding in this area is only expected to increase. If no action is taken to reduce risk, the potential for damage is significant. Potential monetary losses due to physical damages to structures and their contents, human impacts, direct business impacts, and the loss of function of public and essential facilities add up to $29M in damages due to a future storm surge event and $16M in damages due to a future heavy rainfall event. In addition to providing flood risk mitigation for the surrounding communities, the strategies proposed below could provide substantial ecosystem benefits while increasing open space and waterfront access for nearby populations, improving overall quality of life and potentially mitigating the risks of Additional Climate Hazards.

Coastal Storm Surge

$29 Million in expected losses

Areal Rainfall Flooding

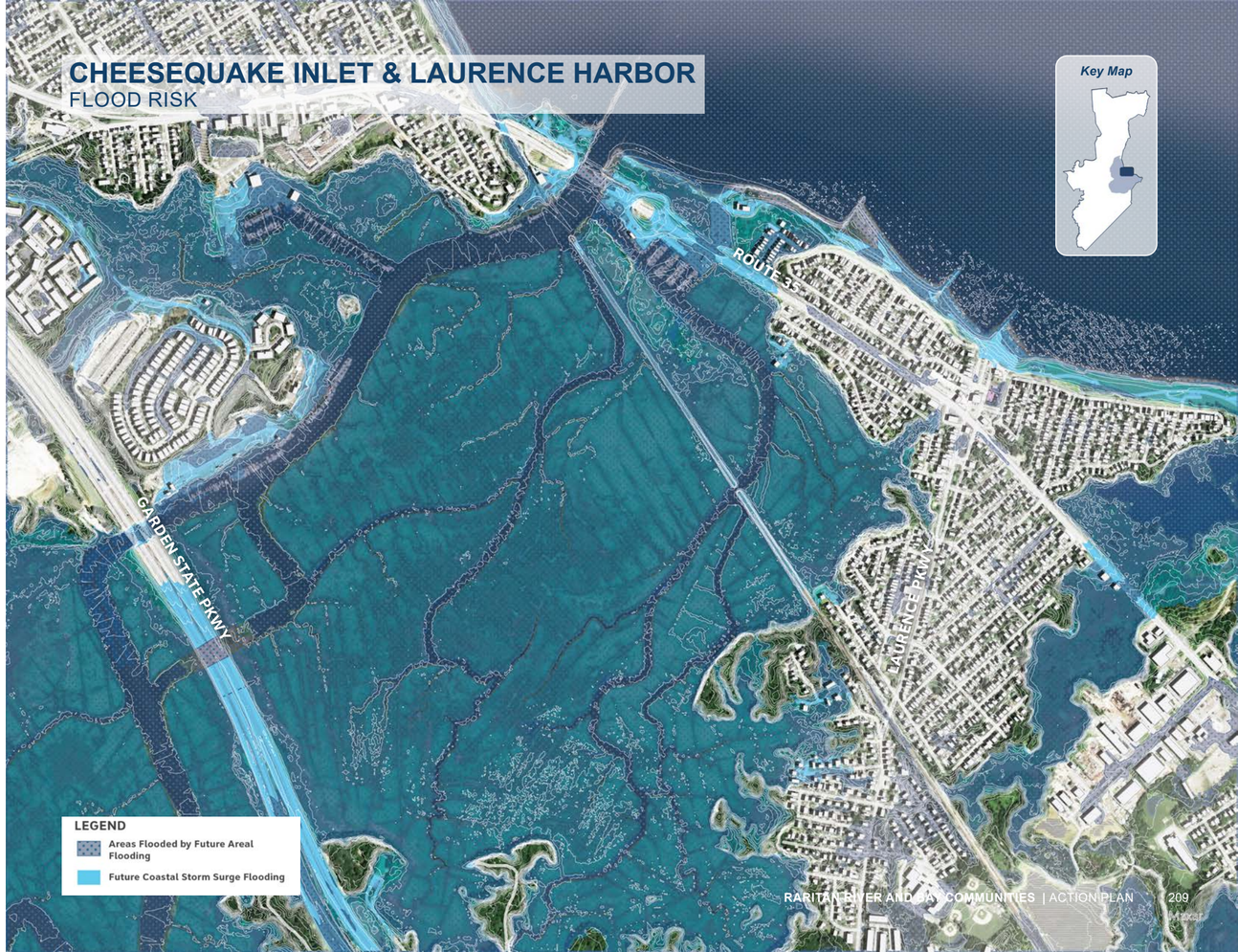
$16 Million in expected losses

MORGAN MARINA AT CHEESEQUAKE CREEK
Parlin, NJ

Image Credit: Marinas.com

LAURENCE HARBOR BEACH BOARDWALK
Laurence Harbor, NJ

Image Credit: Mapio



Overview of Strategies

Proposed flood risk reduction strategies in this area focus on coastal resilience measures along the waterfront including **beach and dune restoration** and **living breakwaters** in addition to **protection of key regional transportation corridors** that cross through this area.

In the 1960's the U.S. Army Corps of Engineers (USACE) built a beach berm in Laurence Harbor. After Hurricane Sandy the stretch was replenished again. Additional future replenishment may be needed, which could include additional dune habitat creation and an offshore breakwater to attenuate storm waves and reduce beach erosion.

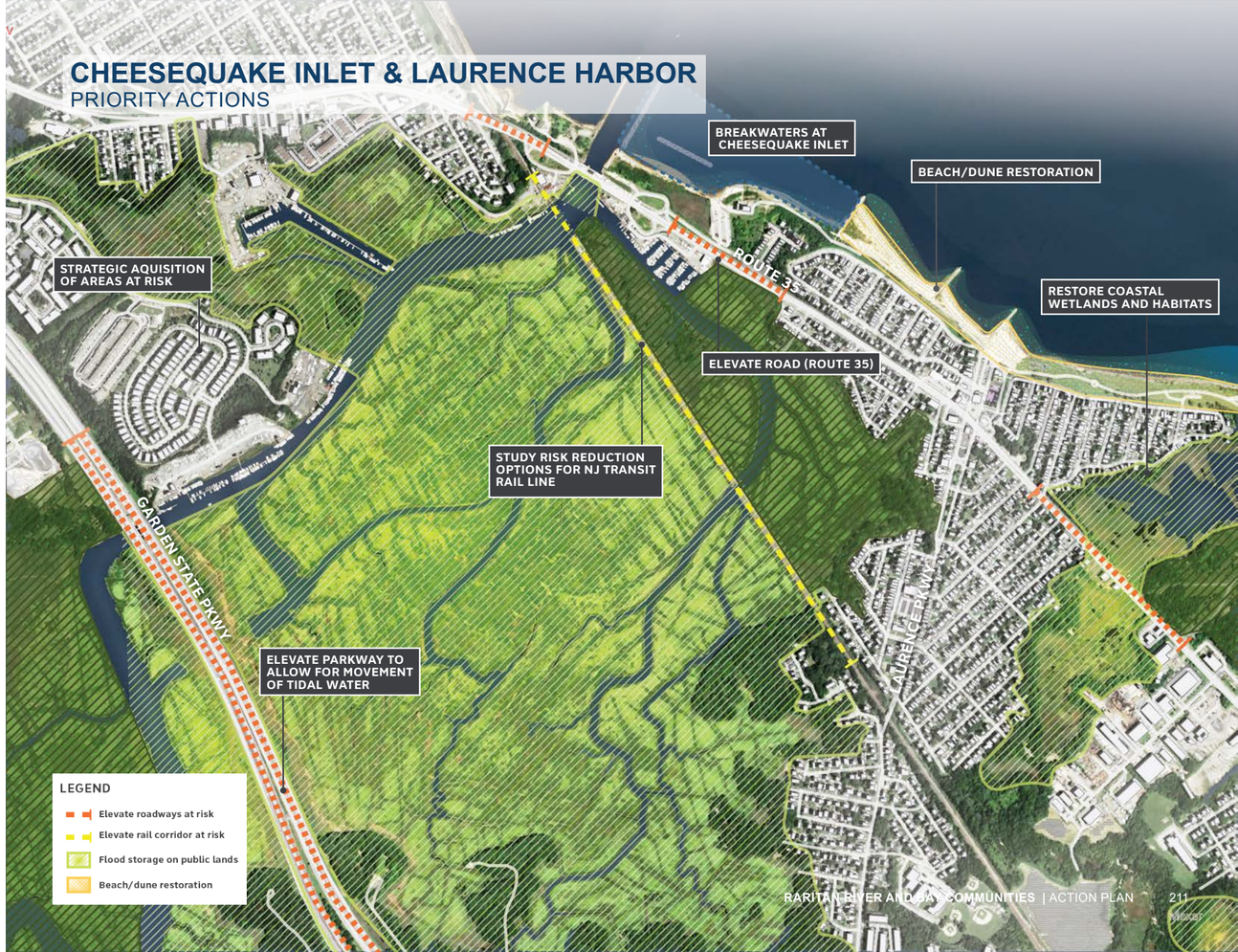
With funding from the recent Federal Bipartisan Infrastructure Bill, the USACE will be rebuilding the jetty at Cheesequake Inlet, which will maintain the navigation of the creek for recreational boats.

Elevation of Route 35 will protect the key evacuation route from future flood events. Potential flood mitigation opportunities for the vulnerable New Jersey Coast Line and Garden State Parkway should also be examined, in addition to looking at how additional tidal exchange can improve the health of the tidal wetlands in the park.

DUNE RESTORATION
Dunes in Midway Beach, South Seaside Park, New Jersey

MARSH RESTORATION
In Avalon, NJ, thin layer placement of sediment across low-lying and degraded sections of the salt marsh helped restore native plants to keep pace with sea level rise *(Image Credit: TNC)*

LIVING BREAKWATERS
Just across Raritan Bay in Tottenville, Staten Island (NY), living breakwaters are being constructed to reduce long-term beach erosion, knock down storm waves, and provide structured habitat for a variety of aquatic species. *(Image Credit: SCAPE)*



CHEESEQUAKE INLET TODAY
Image Credit: Marinas.com

Implementation Roadmap

NJDEP, EPA, USACE, NJDOT, NJ Turnpike Authority / NJ TRANSIT, and Old Bridge should play key roles in the implementation of actions within the Cheesequake Inlet Resilience Opportunity Area. Federal Agencies including EPA and USACE should continue leading ongoing projects in the area to remediate the Slag superfund site and rehabilitate the Cheesequake Creek Jetty, respectively. USACE should also consider pursuing a feasibility study to explore additional mitigation opportunities to reduce flood risk and maintain the inlet. Transportation agencies, including NJDOT, NJ Turnpike Authority, and NJ TRANSIT, should lead efforts to conduct vulnerability assessments and mitigation of risks to their key assets in this opportunity area. The primary responsibility of NJDEP in this area is pursuing additional funding to expand the Blue Acres program, making buyouts available to property owners in higher risk areas bordering Cheesequake State Park. Old Bridge should take the lead in exploring zoning changes and other opportunities to promote resilient redevelopment along the waterfront and promote buyouts in higher risk areas.

LEAD ENTITY	ACTION	NEAR TERM 0-3 YEARS	MID TERM 3-10 YEARS	LONG TERM 10+ YEARS
NJDEP	Pursue additional funding for expansion of Blue Acres program	→	→	→
EPA	Remediation of slag superfund site	→	→	
USACE	Rehabilitation of Cheesequake Creek jetty	→		
	Feasibility study of additional beach nourishment, dune restoration, and breakwaters		→	
	Implement coastal resiliency measures		→	→
NJDOT	Conduct vulnerability and mitigation assessment of Route 35	→		
	Implement resiliency improvements to vulnerable section of Route 35	→	→	
New Jersey Turnpike Authority / NJ TRANSIT	Conduct vulnerability and mitigation assessment of Garden State Parkway and NJ Coast Line	→		
	Implement resiliency improvements to vulnerable section of parkway and rail line	→	→	
Old Bridge	Explore zoning changes and other tools to promote resilient redevelopment of waterfront	→	→	
	Promote additional voluntary buyouts in vulnerable areas	→	→	→

Implementation roadmap for Cheesequake Inlet & Laurence Harbor Resilience Opportunity Area


CHEESEQUAKE INLET
STUDY FLOOD-PRONE SECTIONS OF ROUTE 35
PUBLIC BEACH ACCESS
EXISTING ROUTE 35
DUNE RESTORATION
REVETMENT UPGRADE
LIVING BREAKWATERS
REBUILD JETTY (ONGOING SUPERFUND REMEDIATION)
PRESERVE & RESTORE WETLANDS
STUDY RISK REDUCTION OPTIONS FOR NJ TRANSIT RAIL LINE
PUBLIC BEACH ACCESS

IMPLEMENTATION ROADMAP

The magnitude of flood risk in the Raritan River and Bay Communities region both today and in the future demands coordinated action at multiple scales by every level of government. Successful implementation of the preferred scenario will require action on multiple scales and recognition that resilience building in the region is truly a shared responsibility.

The Implementation Roadmap lists every institutional action identified within this plan and includes additional detail about specific recommended locations, lead entities, immediate next steps, partners, and costs. The actions recommended in this plan complement and reinforce one another at the resilience opportunity area, sub-watershed, and regional scale. Many of the policy and governance strategies that are applicable regionwide may be necessary or highly desirable to support actions at the sub-watershed or resilience opportunity area scale. Coordination of local, county, state and federal entities, as described in *Governance and Continued Coordination* section, will be necessary to implement this plan and track progress.

What does it take to implement the actions identified in this plan?

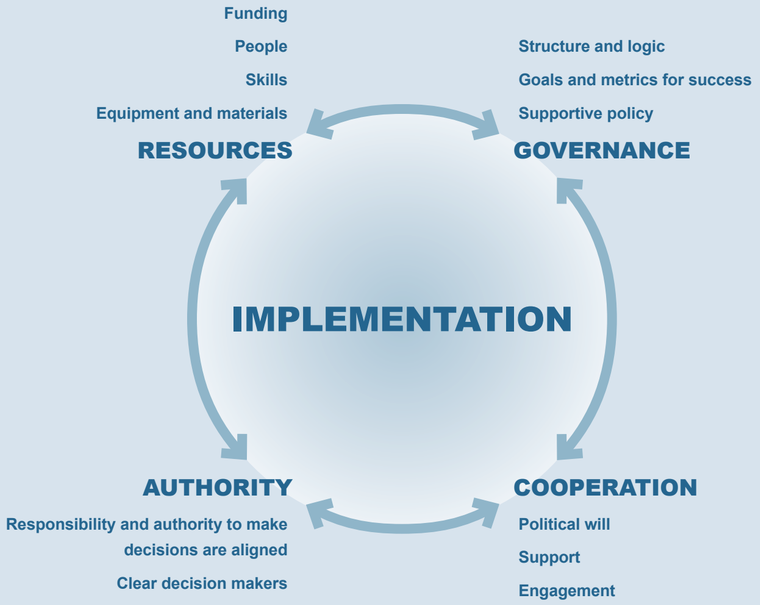
The implementation process for flood resilience and other climate hazard strategies and actions is complex and takes time. Depending on the technical complexity of the specific action, additional implementation planning such as project phasing analyses and permitting assessments may be required to advance the strategy. Each action and strategy type will necessitate a different timetable for bringing this *Action Plan* from concept, through design and development, to ultimate delivery. Implementation of all recommended actions must include ongoing stakeholder engagement, including those who will need to play a role in strategy implementation and those who will be affected by its outcome.

What can I do?

The following pages include actions that can be taken at both the individual and institutional scales. Actions for individuals includes steps that residents and property and business owners can take at the scale of individual properties and buildings to reduce flood risk and build resilience to additional hazards. These actions include better understanding their risk, preparing for disaster, and adapting their properties through a variety of site-specific approaches.

The **implementation roadmap** includes **160 actions** in total, including 19 actions addressing additional climate hazards beyond flooding.

- Of the **141 actions addressing flooding**, 44 are policy and governance strategies, 86 are physical and nature-based infrastructure strategies, and 11 are outreach, education, and capacity building strategies.
- **59 actions** are to be advanced across the region **over the next 3 years**. These are actions that require less resources and time to implement and can be advanced today.
- **72 actions** are to be advanced **over the next 3-10 years**. These actions are those that require some additional time and resources and may need some additional study and concept development before they can be implemented.
- **29 actions** are to be advanced in the **next 10+ years**. These are actions that will require additional time and resources to assess feasibility, identify and pursue funding, and coordinate with involved stakeholders.



Implementation needs depend on many factors, including action type, scale, and complexity, as well as the stage of implementation we're in, but all actions will require the same essential components identified above.

FUNDING

Cost Estimation

The project team used information from prior studies and construction projects around the United States to develop planning-level costs estimates for all actions. The resulting estimates are presented within the implementation roadmap on the following pages. The following scale is used for all actions:

$ = <$2M

$$ = $2-10M

$$$ = $10-49M

$$$$ = $50-100M

$$$$$ = >$100M

More refined costs were developed for select physical and nature-based infrastructure actions, including stormwater management and coastal resilience approaches, for which the necessary information was available. These costs are based on readily available data and do not reflect detailed design-level considerations for the project area, such as existing underground utilities or geotechnical information. Further, these estimates must account for the numerous uncertainties that exist at this stage of preliminary planning. Given this, these estimates can be used for planning purposes to understand the magnitude of anticipated project costs. Subsequent stages of design and engineering will help collect additional information to enable more detailed cost estimation for each strategy. Note that detailed cost estimates are representative of the ultimate proposed action, not interim planning steps.

Overview of Funding Sources

In developing this *Action Plan*, it was important to consider the ways in which recommended actions could be matched with funding sources to facilitate implementation. Funds are available for implementing the *Action Plan* from various sources. Public funding can come from grant and loan programs, as well as through revenue generation – such as taxes and fees. The federal government provides funding through grant programs funded by congressional allocations. There are also state grants and loans, local government sources, and even private or non-for-profit organizations that provide funding through grants, bonds, or loans. Leveraging grant funding reduces the burden on local municipalities and allows for the implementation of this these beneficial actions in a timely manner. Each source of funding has a specific focus, eligibility criteria, and amount of funding available. Grant funding is often available through annual funding cycles and is often awarded through a competitive process.

When considering funding for actions recommended in this *Action Plan*, it's helpful to break the plan down into specific funding categories. These categories help to discern applicable funding sources to pursue. The table below provides upcoming, potential funding opportunities in each of the identified funding categories that could be competitively pursued to begin implementation the *Action Plan*. There are numerous other funding opportunities available from a variety of sources that are not included in this table. For a more in-depth look at potential funding opportunities, refer to *Appendix G.*

The summary of all recommended action starting on page 223 identifies all actions recommended in this *Action Plan* and identifies potential funding sources. We have identified multiple local, state, and federal funding sources that are used to fund everything from coastal resilience projects to stormwater projects, planning studies, transportation improvements, and capacity building, among many others. Many of these funding sources are available now and can be actively pursued to begin implementing these important actions. Additionally, the Infrastructure Investment and Jobs Act, also known as the Bipartisan Infrastructure Law, passed by the Biden administration in the fall of 2021, will be providing $550 billion in new federal funding over the next five years for resilience projects, which Resilient NJ hopes to leverage.

OVERVIEW OF FUNDING SOURCES

The chart below shows some but not all of the funding sources that could be used to support implementation. Note that some funding sources can fund projects in more than one category.

Funding Category		Source	Program	Description
	**Policy & Governance**	NJEDA	Garden State Commercial Property Assessed Clean Energy (C-PACE)	Financing of eligible commercial renewable energy, water efficiency projects in participating municipalities
	**Physical and Nature-Based Infrastructure**	NJDEP	Natural Climate Solutions Grant	Grant funding for implementation of projects that create, restore, and enhance New Jersey's natural carbon sinks, such as salt marshes, seagrass beds, forests, urban parks and woodlands, and street trees.
		NOAA	Transformational Habitat Restoration and Coastal Resilience Grants	Grant funding for projects to restore habitat for fisheries and protected resources while also strengthening the resilience of coastal communities and ecosystems.
		FEMA	Building Resilient Infrastructure and Communities (BRIC)	Competitive grants of up to $50 million for hazard mitigation projects, reducing risks from disasters and natural hazards
		USDOT	Promoting Resilient Operations for Transformative, Efficient, and Cost-saving Transportation (PROTECT)	Grant funding to make transportation infrastructure more resilient to natural disasters, including planning grants to assess vulnerability and plan emergency response strategies
	**Outreach, Education, & Capacity Building**	FEMA	Building Resilient Infrastructure and Communities (BRIC), Capability & Capacity Building	Annual grant program funds capability and capacity building activities such as evaluating and adopting updated building codes, partnership network analysis, partnership development activities, and other planning activities.

ACTIONS FOR INDIVIDUALS

Complementing collective and institutional actions, individuals—particularly landowners—may also play an important role in advancing resilience in the region. Individuals' actions generally fall into one of three types: understanding risk, personal disaster preparation, and physical adaptation and resilience.

Understanding Risk

Taking action on climate change begins with understanding the ways and extent to which you are at risk. Flooding is perhaps the most significant climate impact in our region. This flooding is caused both by global climate change and the unique land use history of this region. In addition to sea level rise from melting glaciers, a warmer atmosphere and ocean waters also create more favorable conditions for severe coastal storms and extreme precipitation events

One of the best ways to understand how increasingly intense and frequent flooding could impact you is by looking at the Flood Insurance Rate Maps (FIRMs) created by the Federal Emergency Management Agency (FEMA). Pay special attention to whether you live in a Special Flood Hazard Area (SFHA), which means you could be affected by a 1% annual chance flood today

You can access information on your own flood risk through resources offered by the NJDEP here. Understanding your future flood risk will help you effectively implement risk reduction measures on your property.

Personal Disaster Preparation

Flood Insurance

- Most standard home and business insurance policies do not cover flood damage. This means that the financial impact of a flood disaster could make it even more devastating
- You can purchase flood insurance through FEMA's National Flood Insurance Program or a private insurer
- All properties in the SFHA that have a federally-backed mortgage are required to have flood insurance. However, you should still consider purchasing flood insurance even if you are not in the SFHA. Your property may still be at risk of flooding even if it has not experienced a flood in the past or is not located right along the coastline. Properties in lower risk areas are eligible for flood insurance coverage at lower rates

Put together a flood preparedness kit

- Store valuable items, important documents, and things like family heirlooms in a safe location. Ideally, this would be on an upper floor or even in a watertight container. Additionally, store copies of important documents online.
- Create a list of your belongings, which can help with processing insurance claims.
- Create a plan to secure outdoor objects like lawn furniture, external fuel tanks, grills, bicycles, and children's toys.
- Assemble a basic disaster supplies kit. Ready.gov is the best source of information for the items you should include.

Physical Adaptation And Resilience

Install a backflow valve and/or sump pump

- During flood events, sewage can back up through drainage pipes on your property. In addition to being unpleasant, this is a public health hazard. A sewer backflow valve can prevent this. Similarly, a sump pump works by pumping groundwater away from your property to prevent basement flooding. These devices should be installed by a licensed plumber, who will ensure they comply with local regulations.
- Protect doors and windows
- Windows and doors are a common point of failure during flood events and coastal storms. When they break, it can cause serious damage by allowing wind, water, and debris to enter a structure.
- There are a variety of options to prevent windows and doors from failing during storm events.
  - » High-impact windows have stronger glass than standard windows and are carefully engineered to withstand more extreme storm events.
  - » Storm shutters cover windows and doors to protect them from wind, water, and debris during a storm event.
  - » Sandbags are a low cost option that can be deployed ahead of an expected extreme storm event.
  - » More expensive deployable flood barriers such as sliding gates, inflatable floodwalls, and portable flood gates may also help to protect your property from damage during a flood or storm event.

Other risk reduction approaches

- Simpler flood risk reduction approaches include elevating appliances and utilities above expected flood levels, sealing the foundation and basement walls of structures, using flood resistant building materials as much as possible, reducing impervious surfaces and installing flood vents.
- More expensive, complex flood risk reduction approaches include raising the entire first floor of the structure, dry-floodproofing non-residential structures, and relocation.

Addressing climate impacts beyond flooding

- Although flooding is the most significant and apparent climate threat in the RRBC area, other climate impacts may also pose a risk. These include extreme heat, drought, wildfires, and vector-borne illnesses.
- Property owners can take steps to mitigate these risks:
  - » Extreme heat can be mitigated through strategies including green roofs, facades that have low rates of heat transference, exterior shading features, and tailored ground and landscaping features.
  - » Water efficient appliances, low-flow plumbing fixtures, residential rainwater harvesting, and the use of efficient irrigation practices in agricultural contexts can help to mitigate drought events.
  - » Eliminating stagnant water, ensuring proper site drainage, and window and door screens can help to prevent vector-borne illnesses.
  - » In areas where wildfires are a significant concern, the safe storage of combustible materials, ensure access to water for firefighting on site, and smart landscaping practices can help to reduce risk.

RARITAN BAY WATERFRONT. SOUTH AMBOY
Image Credit: TripAdvisor

SUMMARY OF RECOMMENDED ACTIONS

The roadmap below organizes these actions by regional action category (policy and governance, physical and nature-based infrastructure, outreach, education, and capacity building, and all hazards) for each identified lead entity. Lead entities are those primarily responsible for shepherding actions through the identified next steps and all subsequent steps through implementation. Lead entities should take ownership over identifying and securing funding for projects, identifying project partners and ensuring the recommendation is ultimately implemented. Lead entities have been identified based on their jurisdiction and capacity to implement the action.

Regional Action Category:

Policy & Governance

Physical & Nature-Based Infrastructure

Outreach & Capacity Building

Additional Climate Hazards

Timeframe for Implementation:

Near (<3 years)

Mid (3-10 years)

Long (>10 years)

***Guide to ID numbering**:*

A = All Municipalities
US = Federal Agencies
NJ = State Agencies
MC = Middlesex County Utilities Authority
NG = Non-governmental agencies
C = Carteret
O = Old Bridge
P = Perth Amboy
RRBC = Resilient RRBC
SA = South Amboy
SV = Sayreville
SR = South River
W = Woodbridge

Guide to Costs:

$ = <$2M
$$ = $2-10M
$$$ = $10-49M
$$$$ = $50-100M
$$$$$ = >$100M

***Note:** Costs are reflective of outreach to property owners, not the buyouts themselves.*

POLICY AND GOVERNANCE

** (Near <3 years, Mid 3-10, Long >10)*

LEAD ENTITY	ID	REGIONAL STRATEGY	ACTION	DESCRIPTION	SUBWATERSHED	NEXT STEP	INVOLVED ENTITIES	COST	POTENTIAL FUNDING SOURCES	TIMEFRAME*
All Municipalities	**A1**	Governance and Coordination	Explore opportunities for inter-municipal agreements which further resilience goals	Inter-municipal agreements are one potential strategy municipalities can coordinate across jurisdictions on issues and needs at the regional or watershed scale.	All	Identify potential needs	All municipalities	$	FEMA BRIC; NJDEP Water Quality Restoration Grants, Nonpoint Source Pollution, FEMA Regional Catastrophic Preparedness Grant Program	**Mid**
All Municipalities	**A2**	Zoning and Land Use Policy	Incorporate resiliency into all waterfront redevelopment projects	Require that property is provided for contiguous waterfront walkway during redevelopment that could also provide space for future coastal protection infrastructure, where appropriate given location and land uses.	All	Explore within specific redevelopment plans	Local property owners and developers local residents and stakeholders	$	FEMA BRIC	**Long**
All Municipalities	**A3**	Zoning and Land Use Policy	Incorporate higher standards into local stormwater management ordinances	Incorporate higher standards into stormwater management ordinance including lowering the threshold for "major development," defining "minor development" to mitigate the impacts of smaller projects, redefine "regulated impervious surface," require more distribution of stormwater management best management practices throughout developments by lowering maximum contributory drainage areas, require enhanced on-site groundwater recharge.	All	Research potential code improvements	Middlesex County, NJDEP	$	FEMA BRIC	**Near**
All Municipalities	**A4**	Governance and Coordination	Continue regional coordination around implementation of Action Plan	Participate in ongoing Steering Committee meetings and provide updates on implementation of projects recommended in the plan.	All	Join ongoing Steering Committee meetings hosted by the County	Middlesex County	$	FEMA BRIC Capacity Building	**Near**
All Municipalities	**A5**	Zoning and Land Use Policy	Update the Flood Hazard/ Flood Damage prevention ordinance to incorporate best practices in the latest NJDEP Model Ordinances and explore opportunities to include higher standards	All municipalities need to update local codes to be up to date with the latest model statewide code. Municipalities should also explore opportunities to include higher standards such as requirement of an elevation certificate, limited outdoor storage of materials in flood hazard areas, standards for cumulative substantial improvements and/or lower substantial improvement threshold, and/or application of standards in the 0.2% floodplain.	All	Research potential code improvements	Middlesex County	$	FEMA BRIC	**Near**
All Municipalities	**A6**	Zoning and Land Use Policy	Explore zoning and building code improvements to improve stormwater management	Explore minimum green area ratios, require green/solar roof and/or blue roof tops within zoning and building codes.	All	Research potential code improvements	All Municipalities	$	FEMA BRIC	**Near**
All Municipalities	**A7**	Zoning and Land Use Policy	Explore sewer connection permits	Require permit for connection to City sewer, set maximum allowable discharge rate, allow use of green infrastructure to meet requirements.	All	Research potential permit requirements	All Municipalities	$	FEMA BRIC	**Near**
All Municipalities	**A8**	Zoning and Land Use Policy	Explore the concept of a critical area ordinance	Explore the concept of a critical area ordinance that excludes wetlands, flood hazard areas, and other defined environmental features throughout the municipality.	All	Explore as part of local master plan updates	All Municipalities	$	FEMA BRIC	**Mid**
All Municipalities	**A9**	Zoning and Land Use Policy	Incorporate resiliency into all redevelopment projects	Incorporate resiliency into redevelopment plans by including higher standards for flood elevations, requirements for provision of coastal protection and drainage requirements, as appropriate, and site specific urban design requirements to minimize impacts of higher elevations on the public realm.	All	Explore within specific redevelopment plans	Local property owners and developers, local residents and stakeholders	$	FEMA BRIC, FEMA Regional Catastrophic Preparedness Grant Program	**Mid**
All Municipalities	**A10**	Governance and Coordination	Coordinated municipal comment on NJPACT rules	As NJPACT regulatory reforms are developed, jointly commenting on the proposed rules could increase the collective voice of individual municipalities.	All	Discuss common priorities	All municipalities	$	N/A	**Near**

LEAD ENTITY	ID	REGIONAL STRATEGY	ACTION	DESCRIPTION	SUBWATERSHED	NEXT STEP	INVOLVED ENTITIES	COST	POTENTIAL FUNDING SOURCES	TIMEFRAME*
Carteret	**C1**	Zoning and Land Use Policy	Review and amend Chrome Waterfront Redevelopment Area	Review and amend Chrome Waterfront Redevelopment Area to accommodate proposed Noe's Creek flood mitigation and resilience projects.	Arthur Kill Waterfront	Assess necessary amendments	Local property owners and developers, local residents and stakeholders	$	FEMA BRIC	**Mid**
Carteret	**C2**	Zoning and Land Use Policy	Promote additional voluntary buyouts in highly vulnerable areas	Coordinate with the NJDEP Blue Acres program to identify suitable buyout properties in areas of high risk, such as the area near Louis St./Washington Ave./Cypress St. which is prone to flooding from heavy rainfall and coastal flooding.	Arthur Kill Waterfront	Conduct outreach to property owners and connect them with NJDEP resources	Property owners	$ (see note on page 223)	NJDEP Blue Acres	**Long**
NJDEP	**NJ1**	Zoning and Land Use Policy	Advocate for improved flood disclosure laws statewide	While there are some flood disclosure laws already on the books in New Jersey, there is a need to strengthen these laws and enforce them. Adequate flood disclosure is needed to make sure that prospective buyers and renters are aware of flood risk.	All	Review existing laws and enforcement and coordinate with legislators on addressing gaps	State Legislature	$	N/A	**Near**
NJDEP	**NJ2**	Governance and Coordination	Communicate flood risk and evolving climate science	There is a need for a consolidated online portal that provides guidance on what is the official source for flood risk and climate change projections. As the scientific understanding of the extent and nature climate threats changes over time, those changes should be communicated to local officials and other stakeholders.	All	Develop statewide communications strategy	Rutgers and other NGOs, Middlesex County, all Municipalities	$	NJDEP Community-Based Art Grant Program	**Near**
NJDEP	**NJ3**	Governance and Coordination	Communicate evolving code changes and regulatory requirements	There is a need for greater awareness at the local level of statewide efforts to update codes and standards to account for climate change.	All	Develop statewide communications strategy	Middlesex County, all Municipalities	$	N/A	**Near**
NJDEP	**NJ4**	Governance and Coordination	Coordinate with State and Federal agencies on implementing projects identified in the plan	There is a need for NJDEP to continue coordination with state agencies with responsibilities identified in this plan, and track progress of implementation.	All	Set up follow-up meetings with State Agencies on recommendations after plan release	NJDOT, NJ TRANSIT, NJOEM, USACE, US Coast Guard	$	N/A	**Near**
NJDEP	**NJ5**	Governance and Coordination	Ongoing technical assistance to municipalities and Counties	Expand State resilience technical assistance resources available to municipalities and counties, including support for local code changes, Community Rating System participation, and improved availability of flood data.	All	Coordinate with Middlesex County and municipalities on needs	Middlesex County, all Municipalities	$	N/A	**Near**
NJDEP	**NJ6**	Zoning and Land Use Policy	Update state codes and standards to reflect climate change	Continue to review and develop proposed regulatory changes to incorporate climate change projections into state codes and standards.	All	Release Emergency Stormwater Rules	All Municipalities, Middlesex County	$	FEMA BRIC Capability & Capacity Building	**Near**
NJDEP	**NJ7**	Governance and Coordination	Coordination of regional water and transportation infrastructure	Water and transportation infrastructure is owned and maintained by various municipal, county, and state agencies. There is a need to coordinate these actors so that impacts and issues that cross jurisdictional boundaries can be understood and managed.	All	As part of Interagency Council on Climate Change, discuss specific regional coordination needs	Middlesex County, NJ TRANSIT, NJDOT, All Municipalities	$	N/A	**Mid**
NJDEP	**NJ8**	Governance and Coordination	Guidance on re-use of properties in the Blue Acres Program	Within the goal of the Blue Acres program is to return land to a natural state, there is an opportunity to develop guidance on acceptable uses and improvements that meet flood risk reduction, environmental, and community goals.	All	Consult with municapities and other stakeholder on challenges and desires	All municipalities, but especially Sayreville and South River	$	N/A	**Near**

LEAD ENTITY	ID	REGIONAL STRATEGY	ACTION	DESCRIPTION	SUBWATERSHED	NEXT STEP	INVOLVED ENTITIES	COST	POTENTIAL FUNDING SOURCES	TIMEFRAME*
NJDEP	**NJ9**	Zoning and Land Use Policy	Expand state Blue Acres program	Expand state Blue Acres program to provide funding for additional properties, including commercial and multifamily properties.	All	Pursue additional federal funding	Middlesex County, all municipalities	$$$$$	FEMA or CDBG-DR Funding	**Mid**
Old Bridge	**O1**	Zoning and Land Use Policy	Explore zoning changes and other tools to promote resilient redevelopment of waterfront	Promote resilient redevelopment with a mix of uses along Laurence Parkway in Laurence Harbor.	Cheesequake/Laurence Harbor	Explore as part of a master plan update	Local property owners and developers, local residents and stakeholders	$	FEMA BRIC Capability & Capacity Building	**Near**
Old Bridge	**O2**	Zoning and Land Use Policy	Exploration of opportunities for increased density outside the floodplain	Exploration of opportunities for increased density outside the floodplain, such as along Route 9 and near the Garden State Parkway, to accommodate growth.	South River/Washington Canal	Explore as part of a master plan update	Middlesex County, Local property owners and developers, local residents and stakeholders	$	N/A	**Mid**
Old Bridge	**O3**	Zoning and Land Use Policy	Promote additional voluntary buyouts in highly vulnerable areas and / or promote resilient redevelopment.	Coordinate with the NJDEP Blue Acres program to identify suitable buyout properties in areas of high risk, such as area surrounding Cheesequake State Park that are prone to coastal flooding from Cheesequake Creek.	Cheesequake/Laurence Harbor	Conduct outreach to property owners and connect them with NJDEP resources	Property owners	$ (see note on page 223)	NJDEP Blue Acres	**Long**
Perth Amboy	**P1**	Zoning and Land Use Policy	Exploration of opportunities for increased density outside the floodplain	Exploration of opportunities for increased density outside the floodplain, such as near the train station and along 2nd street.	Raritan Riverfront and Bay	Explore as part of a master plan update	Local property owners and developers, local residents and stakeholders	$	N/A	**Mid**
Perth Amboy	**P2**	Zoning and Land Use Policy	Explore zoning changes and other tools to promote resilient redevelopment of waterfront industrial properties	Promote redevelopment of waterfront industrial properties and brownfields along the Arthur Kill and Woodbridge Creek to new forms of light industry like warehousing and incorporate resilience standards and wetland restoration.	Raritan Riverfront and Bay	Explore as part of a master plan update	Local property owners and developers, local residents and stakeholders	$	FEMA BRIC Capability & Capacity Building	**Long**
Resilient RRBC	**RRBC1**	Governance and Coordination	Prioritize Action Plan recommendations	The Steering Committee should identify priority recommendations to advance implementation in the near-term.	All	Develop a prioritization framework	NJDEP	$	Resilient NJ	**Near**
Resilient RRBC	**RRBC2**	Governance and Coordination	Support ongoing regional coordination on plan implementation	The Steering Committee should continue to meet and discuss ways regional coordination can advance resilience goals and enhance coordination and relationship between the Coutny and municipalities.	All	Determine who should continue hosting of regular Steering Committee meetings	NJDEP	$	FEMA BRIC	**Near**
Resilient RRBC	**RRBC3**	Governance and Coordination	Ongoing technical assistance to municipalities	Enhance staff capacity to support dissemination of state resources and support municipalities in building-scale mitigation. Expand upon existing County resilience technical assistance resources available to municipalities such as the MS4/CRS User Group to include additional resources connecting municipalities to guidance on updating local codes, pursuing federal funding opportunities, and best practices for floodplain management, stormwater management, and climate resiliency.	All	Coordinate with NJDEP on needs and potential funding sources	All municipalities, NJDEP	$	FEMA BRIC	**Near**
Resilient RRBC	**RRBC4**	Governance and Coordination	Identification of priority collective action to demonstrate proof of concept and benefits of ongoing coordination in the region	Additional actions can serve as a proof of concept of the benefits of regional coordination. As NJPACT regulatory reforms are developed, jointly commenting on the proposed rules could increase the collective voice of individual municipalities.	All	Continue participation in regular Steering Committee meetings	All municipalities	$	N/A	**Near**
Resilient RRBC	**RRBC5**	Zoning and Land Use Policy	Explore potential and structure of a regional Transfer of Development rights	Explore potential and structure of a regional Transfer of Development rights program to manage increases in density outside the floodplain and lowered density in areas at high risk.	All	Explore goals and concepts	All municipalities	$	N/A	**Long**

LEAD ENTITY	ID	REGIONAL STRATEGY	ACTION	DESCRIPTION	SUBWATERSHED	NEXT STEP	INVOLVED ENTITIES	COST	POTENTIAL FUNDING SOURCES	TIMEFRAME*
South Amboy	**SA1**	Zoning and Land Use Policy	Promote resilient redevelopment along the waterfront	Incorporate resiliency standards, such as elevating first floors and streetscape standards, into redevelopment plans. Should incorporate standards that go beyond the mapped FEMA floodplain to account for future climate change.	Raritan Riverfront and Bay	Incorporate into redevelopment plans	Middlesex County, Local property owners and developers, local residents and stakeholders	$	FEMA BRIC Capability & Capacity Building	**Mid**
South River	**SR1**	Zoning and Land Use Policy	Use zoning to limit development potential of sites that have not been bought out along the South River	Expand parks, open space and conservation zone to encompass more of the flood hazard area. Conservation zone provisions can prevent new construction and require improvements to adhere to higher design standards. Zone could include a cumulative damage or improvement provision. Allow maritime uses along waterfront.	South River/Washington Canal	Explore as part of a master plan update	Sayreville, local residents and stakeholders	$	N/A	**Mid**
South River	**SR2**	Zoning and Land Use Policy	Promote resilient redevelopment along Main Street	Incorporate resiliency standards, such as elevating first floors and streetscape standards, into redevelopment plans. Should incorporate standards that go beyond the mapped FEMA floodplain to account for future climate change.	South River/Washington Canal	Explore as part of a master plan update	Local property owners and developers, local residents and stakeholders	$	N/A	**Mid**
South River	**SR3**	Zoning and Land Use Policy	Promote additional voluntary buyouts in highly vulnerable areas	Coordinate with the NJDEP Blue Acres program to identify suitable buyout properties in areas of high risk, such as industrial and commercial areas along the South River.	South River/Washington Canal	Conduct outreach to property owners and connect them with NJDEP resources	Property owners	$ (see note on page 223)	NJDEP Blue Acres	**Long**
Sayreville	**SV1**	Zoning and Land Use Policy	Incorporate resiliency into Riverton Development	Incorporate resiliency standards, such as elevating first floors and streetscape standards, into redevelopment plans. Should incorporate standards that go beyond the mapped FEMA floodplain to account for future climate change.	South River/Washington Canal	Incorporate into redevelopment plans	Local property owners and developers, local residents and stakeholders	$	FEMA BRIC Capability & Capacity Building	**Near**
Sayreville	**SV2**	Zoning and Land Use Policy	Use zoning to limit development potential of sites that have not been bought out along the South River	Expand the OS-C Zone within the SED Zones and remaining residential neighborhoods along MacArthur Avenue. Consider including provisions like the Woodbridge OSC/R Ordinance to limit future development and require enhanced design for any change of use, change of tenancy, and major improvements.	South River/Washington Canal	Explore as part of a master plan update	South River, local residents and stakeholders	$	N/A	**Mid**
Sayreville	**SV3**	Zoning and Land Use Policy	Exploration of opportunities for increased density outside the floodplain	Exploration of opportunities for increased density outside the floodplain, such as along Route 35 to accommodate growth.	South River/Washington Canal	Explore as part of a master plan update	Middlesex County, Local property owners and developers, local residents and stakeholders	$	N/A	**Mid**
Woodbridge	**W1**	Zoning and Land Use Policy	Explore zoning changes and other tools to promote resilient redevelopment of waterfront industrial properties	Promote redevelopment of waterfront industrial properties and brownfields along the Arthur Kill and Woodbridge Creek to new forms of light industry like warehousing and incorporate resilience standards and wetland restoration.	Arthur Kill Waterfront, Woodbridge Creek	Explore as part of a master plan update	Local property owners and developers, local residents and stakeholders	$	FEMA BRIC Capability & Capacity Building	**Long**
Woodbridge	**W2**	Zoning and Land Use Policy	Exploration of opportunities for increased density outside the floodplain	Exploration of long-term opportunities for increased density outside the floodplain, such as along the Route 1 corridors.	Rahway River and Tributaries, Woodbridge Creek	Explore as part of a master plan update	Middlesex County, Local property owners and developers, local residents and stakeholders	$	N/A	**Long**
Woodbridge	**W3**	Zoning and Land Use Policy	Use zoning to limit development potential of highly vulnerable areas along Pumpkin Patch Brook and the South Branch of the Rahway River	Expand the OSC/R Zone or the PQP Zone to encompass the most recently substantially flooded areas.	Rahway River and Tributaries	Explore as part of a master plan update	Local property owners and developers, local residents and stakeholders	$	N/A	**Mid**
Woodbridge	**W4**	Zoning and Land Use Policy	Explore opportunities for increased density outside the floodplain	Encourage mixed-use development outside floodplain near Avenel and Woodbridge train stations.	Woodbridge Creek	Explore as part of a master plan update	NJ TRANSIT, Local property owners and developers, local residents and stakeholders	$	N/A	**Mid**

LEAD ENTITY	ID	REGIONAL STRATEGY	ACTION	DESCRIPTION	SUBWATERSHED	NEXT STEP	INVOLVED ENTITIES	COST	POTENTIAL FUNDING SOURCES	TIMEFRAME*
Woodbridge	**W5**	Zoning and Land Use Policy	Explore opportunities for increased density outside the floodplain	Encourage mixed-use development outside floodplain near Metropark train station. Development should avoid portions of the area vulnerable to flooding from the South Branch of the Rahway River.	Rahway River and Tributaries, Woodbridge Creek	Coordinate with NJ TRANSIT on development plan	NJ TRANSIT	$	N/A	**Mid**
Woodbridge	**W6**	Zoning and Land Use Policy	Promote additional voluntary buyouts in highly vulnerable areas	Coordinate with the NJDEP Blue Acres program to identify suitable buyout properties in areas of high risk, such as the homes along Wedgewood Brook, Heards Brook, Woodbridge Creek, the South Branch of the Rahway River, and Pumpkin Patch Brook.	Arthur Kill, Rahway River and Tributaries, Woodbridge Creek	Conduct outreach to property owners and connect them with NJDEP resources	Property owners	$ (see note on page 223)	NJDEP Blue Acres	**Long**

PHYSICAL AND NATURE-BASED INFRASTRUCTURE

LEAD ENTITY	ID	REGIONAL STRATEGY	ACTION	DESCRIPTION	SUBWATERSHED	NEXT STEP	INVOLVED ENTITIES	COST	POTENTIAL FUNDING SOURCES	TIMEFRAME*
All Municipalities	**A11**	Adapt or Protect Critical Facilities	Relocation of vulnerable emergency shelters	Consider relocation of flood-prone shelters to less flood-prone areas (First Reformed Church of South River, Madison Park Elementary School, Fords Middle School, others as appropriate).	All	Identify alternate evacuation shelters in less prone locations	All Municipalities	$	TBD	**Mid**
All Municipalities	**A12**	Contaminated Sites and Brownfields	Advance remediation of priority sites	Support refinement of the prioritization methodologies presented herein and confirm high risk / opportunity sites and advance catalyst resilient transformation projects at high risk / opportunity publicly owned contaminated sites / brownfields.	All	Review preliminary prioritized list and methodology	NJDEP, Middlesex County	$	NJEDA Brownfields Impact Fund, NJDEPA / NJEDA Hazardous Discharge SIte Remediation Fund (HDSRF)	**Mid**
Carteret	**C3**	Adapt or Protect Critical Facilities	Site-specific flood mitigation of Carteret Sewer Department and Recycling	According to the flood models developed by Resilient NJ, this facility is vulnerable to flooding from coastal storm surge and heavy rainfall. While in the long-term there is a coastal protection project proposed to protect this site, near-term improvements to protect or adapt this facility, including wet and dry floodproofing and elevation of critical systems, should be explored.	Arthur Kill Waterfront	Pursue site-specific study of mitigation options.		$$	FEMA BRIC	**Mid**
Carteret	**C4**	Coastal Resilience	Multi-purpose coastal flood barrier and tide gate along Arthur Kill as part of the Noe's Creek project - North Portion	Floodwall and a recreational harborwalk along the Arthur Kill from Noe's Creek to the Carteret Waterfront Park, with a tide gate across the Noe's Creek inlet.	Arthur Kill Waterfront	Pursue funding for a feasibility study	Middlesex County	$$$$$	FEMA BRIC, USACE	**Long**
Carteret	**C5**	Coastal Resilience	Multi-purpose coastal flood barrier for public access along Arthur Kill - South Portion	Floodwall and a recreational harborwalk along the Arthur Kill from the Carteret Waterfront Park to Tufts Point.	Arthur Kill Waterfront	Pursue funding for a feasibility study	Middlesex County, Woodbridge	$$$$$	FEMA BRIC, USACE	**Long**
Carteret	**C6**	Contaminated Sites and Brownfields	Identify brownfield sites north of Peter J. Sica Industrial Highway that are suitable for wetland restoration	Contaminated sites vulnerable to flooding can be remediated and prioritized for ecosystem restoration with resiliency benefits.	Rahway River and Tributaries	Pursue funding for a feasibility study	Middlesex County, Woodbridge	$	NJEDA Brownfields Impact Fund, NJDEPA / NJEDA Hazardous Discharge SIte Remediation Fund (HDSRF)	**Mid**
Carteret	**C7**	Stormwater Management	Explore opportunities for expanded stormwater storage on facilities and right of ways owned by Carteret (Noe's Creek Resilience Opportunity Area)	Potential sites include Carteret High School, Carteret Park, Sycamore St and Solted Ave Park, and more. See map on pages 140-141.	Arthur Kill Waterfront	Examine feasibility of preliminary suggested sites	Local parks, public works, and education departments.	$$$$$	FEMA BRIC	**Mid**
Carteret	**C8**	Stormwater Management	Explore opportunities for expanded stormwater storage on municipal-owned facilities and right of ways	Potential stormwater storage sites include Chrome Park and Contrell Rd/ Colonial Dr Open Space.	Arthur Kill Waterfront, Raritan Riverfront and Bay	Examine feasibility of preliminary suggested sites.	Local parks, public works, and education departments.	$$$$$	FEMA BRIC, NJ I-Bank	**Mid**
Carteret	**C9**	Stormwater Management	Noe's Creek Pump Station	A pump station for improved coastal and inland flood management is needed to complement proposed tide gate and coastal protection in this area.	Arthur Kill Waterfront	Pursue funding for a feasibility study	Middlesex County	$$$$	FEMA BRIC	**Long**

LEAD ENTITY	ID	REGIONAL STRATEGY	ACTION	DESCRIPTION	SUBWATERSHED	NEXT STEP	INVOLVED ENTITIES	COST	POTENTIAL FUNDING SOURCES	TIMEFRAME*
MCUA	**MC1**	Adapt or Protect Critical Facilities	Elevation of critical systems to protect South Amboy Pump Station	This pump station was impacted during Sandy and remain vulnerable to flooding from coastal storm surge and heavy rainfall according to the flood models developed by Resilient NJ. MCUA is already working to develop strategies to protect adapt this facility.	Cheesequake/Laurence Harbor	Pursue site-specific study of mitigation options.	South Amboy	$$	FEMA BRIC, NJ I-Bank	**Near**
MCUA	**MC2**	Adapt or Protect Critical Facilities	Site-specific mitigation of flood-prone assets at MCUA Wastewater Treatment Plant and Middlesex Generating Facility	According to the flood models developed by Resilient NJ, this facility is vulnerable to flooding from heavy rainfall. Strategies to protect or adapt this facility, including wet and dry floodproofing and elevation of critical systems, should be explored.	Raritan Riverfront and Bay	Pursue site-specific study of mitigation options.	Sayreville	$$$$$	FEMA BRIC, NJ I-Bank	**Mid**
Lower Raritan Watershed Partnership	**NG1**	Coastal Resilience	Explore additional coastal resilience opportunities along the South River	Explore opportunities to expand South River Ecosystem Restoration & Flood Resiliency Enhancement Project to protect residential and commercial properties north of Tyska Avenue.	South River/Washington Canal	Pursue funding for an additional study of nature-based resilience strategies	South River, Sayreville, Middlesex County, Rutgers	$	FEMA BRIC, NFWF America the Beautiful Grant, NOAA National Coastal Resilience Fund, NJDEP Natural Climate Solutions Grant	**Mid**
Lower Raritan Watershed Partnership	**NG2**	Coastal Resilience	Implement the South River Ecosystem Restoration & Flood Resiliency Enhancement Project	Continued partnership with South River and Sayreville communities in implementation of South River Ecosystem Restoration & Flood Resiliency Enhancement Project.	South River/Washington Canal	Advance design and permitting	South River, Sayreville, Middlesex County, Rutgers	TBD	FEMA BRIC, NFWF America the Beautiful Grant, NOAA National Coastal Resilience Fund, NJDEP Natural Climate Solutions Grant	**Near**
Rutgers	**NG3**	Coastal Resilience	Restore wetlands and riparian areas along the Raritan River	There are opportunities for wetland restoration along the Raritan River and increase its resilience to sea level rise.	Raritan Riverfront and Bay	Pursue funding and partnerships	Middlesex County, Sayreville	$$	NJDEP Natural Climate Solutions Grant, EPA Wetland Program Development Grants, NOAA National Coastal Zone Management Grant, NFWF America the Beautiful Grant, NOAA Transformational Habitat Restoration and Coastal Resilience Grants	**Mid**
Rutgers	**NG4**	Coastal Resilience	Study resilience of existing wetland systems and identify opportunities for restoration and improvements	There is a need for a regional assessment of wetland resources to assess ecosystem health and resiliency needs.	All	Pursue funding and partnerships	NJDEP, Middlesex County	$	NJDEP Natural Climate Solutions Grant, EPA Wetland Program Development Grants, NOAA National Coastal Zone Management Grant, NFWF America the Beautiful Grant, NOAA Transformational Habitat Restoration and Coastal Resilience Grants	**Mid**
NJDEP	**NJ10**	Adapt or Protect Critical Facilities	Develop guidance for State and Local agencies on design standards and climate projections	While many individual agencies have incorporated climate change into their own guidelines, there is a need to establish and coordinate a common set of guidelines to promote design and rehabilitation of critical infrastructure.	All	Explore as part of the Interagency Council on Climate Resilience	Interagency Council on Climate Resilience	$	USDOT	**Near**
New Jersey Turnpike Authority	**NJ11**	Resilient Mobility Systems	Examine sections of the Garden State Parkway at risk of future flooding and identify mitigation measures	Examine sections of the Garden State Parkway at risk of future flooding and identify mitigation measures, such as the stretches within Cheesequake State Park. Potential strategies include elevation or building a berm/floodwall along the roadway.	Cheesequake/Laurence Harbor	Pursue statewide assessment of flood risks	NJDOT, NJDEP, Middlesex County, Municipalities	$$$$$	USDOT PROTECT, USDOT RAISE, USDOT Transportation Alternatives Program (TAP)	**Mid**
New Jersey Turnpike Authority	**NJ12**	Resilient Mobility Systems	Examine sections of the NJ Turnpike (I95) at risk of future flooding and identify mitigation measures	Examine sections of the New Jersey Turnpike at risk of future flooding and identify mitigation measures near Woodbridge Creek. Potential strategies include elevation or building a berm/floodwall along the roadway.	Arthur Kill, Woodbridge Creek	Pursue statewide assessment of flood risks	NJDOT, NJDEP, Middlesex County, Municipalities	$$$$$	USDOT PROTECT, USDOT RAISE, USDOT Transportation Alternatives Program (TAP)	**Mid**

LEAD ENTITY	ID	REGIONAL STRATEGY	ACTION	DESCRIPTION	SUBWATERSHED	NEXT STEP	INVOLVED ENTITIES	COST	POTENTIAL FUNDING SOURCES	TIMEFRAME*
NJ TRANSIT	**NJ13**	Resilient Mobility Systems	Assess and improve resilience of vulnerable sections of NJ Coast Line	Study and develop alternatives to reduce flood risk to the NJ TRANSIT Coast Line, including the section in Old Bridge at Cheesequake Creek.	Cheesequake/Laurence Harbor	Further analysis to identify priority areas	Municipalities	$	FEMA, USACE	**Mid**
NJ TRANSIT	**NJ14**	Resilient Mobility Systems	Protect vulnerable portions of the Perth Amboy Train Station	According to the flood models developed by Resilient NJ, this facility is vulnerable to flooding from heavy rainfall. Strategies to protect or adapt this facility, including wet and dry floodproofing, elevation of critical systems, and floodwalls, should be explored.	Raritan Riverfront and Bay	Pursue site-specific study of mitigation options.	Perth Amboy	$$$$$	USDOT PROTECT, USDOT RAISE, USDOT Transportation Alternatives Program (TAP)	**Mid**
NJ TRANSIT	**NJ15**	Stormwater Management	Increase conveyance between rail line and marsh inland of Raritan Bay Waterfront	The NJ Coast Line cuts between two wetlands in this location and is vulnerable to flooding. Increasing conveyance between the marshes through additional culverts could alleviate flooding and improve ecological functions.	Cheesequake/Laurence Harbor	Pursue funding for a feasibility study		$$	USDOT PROTECT, USDOT RAISE, USDOT Transportation Alternatives Program (TAP)	**Long**
NJ TRANSIT	**NJ16**	Stormwater Management	South Rahway River Under Northeast Corridor Rail Line Culvert Expansion	This site has been identified as a potential opportunity to reduce flooding through increasing the size of this culvert. Additional analysis is needed to assess potential flood risks and benefits.	Rahway River and Tributaries	Pursue site specific investigation of capacity and future needs	Middlesex County, Woodbridge	$	USDOT PROTECT, USDOT RAISE, USDOT Transportation Alternatives Program (TAP)	**Mid**
NJ TRANSIT	**NJ17**	Stormwater Management	Wedgewood Brook and NJ TRANSIT Line Culvert Expansion	This site has been identified as a potential opportunity to reduce flooding through increasing the size of this culvert. Additional analysis is needed to assess potential flood risks and benefits.	Woodbridge Creek	Pursue site specific investigation of capacity and future needs	Woodbridge	$	USDOT PROTECT, USDOT RAISE, USDOT Transportation Alternatives Program (TAP)	**Mid**
NJDEP	**NJ18**	Coastal Resilience	Adapt existing bulkheads	Standards and guidance for the elevation of bulkheads is needed so that as bulkheads are replaced, they are elevated to maintain functionality with sea level rise.	All	Pursue as part of NJPACT	Interagency Council on Climate Resilience	$	NJDEP Shore Protection Grants and Loans	**Mid**
NJDEP	**NJ19**	Coastal Resilience	Monitoring, management, and restoration of wetlands to improve flood storage capacity within and around the edges of Cheesequake State Park	Wetlands within the park should be evaluated and monitored for resiliency to sea level rise and other stressors. Evaluation of the potential to restore wetlands in ways that also create flood resiliency benefits.	Cheesequake/Laurence Harbor	Pursue funding for a feasibility study	NJ Parks	$	NJDEP Natural Climate Solutions Grant, EPA Wetland Program Development Grants, NOAA National Coastal Zone Management Grant, NFWF America the Beautiful Grant, NOAA Transformational Habitat Restoration and Coastal Resilience Grants	**Long**
NJDEP	**NJ20**	Contaminated Sites and Brownfields	Coordinate and align state funding programs to accelerate resilient transformation of contaminated sites	Consider collaborating on the development of guidelines and requirements a site might follow to flow through the process and funding and supporting resilient transformation of high priority sites under RNJ banner.	All	Coordinate with relevant departments to advance the concept	All Municipalities, Middlesex County	$	EPA	**Near**
NJDEP	**NJ21**	Contaminated Sites and Brownfields	Expand the brownfields inventory	Expand the brownfields inventory across the state, beyond CCI municipalities (which are the only municipalities included as of June 2022).	All	Identify resources		$	EPA, NJEDA	**Near**
NJDEP	**NJ22**	Contaminated Sites and Brownfields	Improve the Known Contaminated Site List	Continue data improvements to Known Contaminated Site List and other state-managed databases to provide more complete information on resilience-related factors (e.g., expanding available information or accuracy on contaminant type and extents, remedial design type, site status).	All	Identify resources		$	EPA, NJEDA	**Near**
NJDEP	**NJ23**	Contaminated Sites and Brownfields	Incorporate climate considerations into brownfield remediation planning	Explore a statewide climate risk assessment of contaminated and remediation sites and explore integration of climate risks into remedial design.	All	Identify resources		$$	EPA, NJEDA	**Mid**

LEAD ENTITY	ID	REGIONAL STRATEGY	ACTION	DESCRIPTION	SUBWATERSHED	NEXT STEP	INVOLVED ENTITIES	COST	POTENTIAL FUNDING SOURCES	TIMEFRAME*
NJDEP	**NJ24**	Resilient Mobility Systems	Develop guidance for State Transportation agencies on design standards and climate projections	While many individual agencies have incorporated climate change into their own guidelines, there is a need to establish and coordinate a common set of guidelines to promote design and rehabilitation of infrastructure.	All	Explore as part of the Interagency Council on Climate Resilience	Interagency Council on Climate Resilience	$	USDOT	**Near**
NJDEP	**NJ25**	Stormwater Management	Provide guidance to municipalities and utilities on incorporating climate change into the standards for Long Term Control Plans	The current standards set by NJDEP that LTCPs must follow use historic rainfall data, not including future projections, despite them being long-term plans. Incorporating climate projections into the process for developing LTCPs would ensure that they better address near and long-term resilience and water quality issues.	All	Develop standards and guidance		$	N/A	**Near**
NJDOT	**NJ26**	Resilient Mobility Systems	Assess and improve resilience of hurricane evacuation routes	As part of statewide assessment of climate vulnerabilities, prioritize hurricane and all-hazard evacuation routes	All	Continue assessment of flood risks	NJOEM	$	USDOT PROTECT	**Near**
NJDOT	**NJ27**	Resilient Mobility Systems	Examine opportunities to protect vulnerable sections of Route 35 in Old Bridge	Review flood risk to vulnerable sections of State Route 35 in Laurence Harbor and integrate considerations for how to reduce flood risk into future capital plans to the extent feasible.	Cheesequake/Laurence Harbor	Continue assessment of flood risks	Old Bridge	$$$$$	USDOT PROTECT, USDOT RAISE, USDOT Transportation Alternatives Program (TAP)	**Mid**
NJDOT	**NJ28**	Stormwater Management	Explore opportunities for expanded stormwater storage on facilities and right of ways owned by NJ DOT (Middlesex County Greenway Extension Resilience Opportunity Area)	Explore enhancement of drainage capabilities through improved maintenance of existing drainage features. Explore expanded stormwater features as part of a larger regional or statewide watershed/drainage basin analysis. Potential sites identified include Rt 9 and GSP on and off ramps. See map on page 136-137.	Raritan Riverfront and Bay	Examine feasibility of preliminary suggested sites	Local parks, public works, and education departments.	$$$$$	FEMA BRIC	**Mid**
NJDOT	**NJ29**	Stormwater Management	Explore opportunities for expanded stormwater storage on State facilities	There are potential opportunities for stormwater management in the Open Space along Route 1 and Route 35. Review opportunities presented and integrate into capital planning process to the extent feasible.	All	Examine feasibility of preliminary suggested sites.	Municipalities	$$$$	FEMA BRIC, NJ I-Bank	**Mid**
NJDOT	**NJ30**	Stormwater Management	Examine Heards Brook and Route 35 Culvert Expansion	This site has been identified as a potential opportunity to reduce flooding through increasing the size of this culvert. Increasing the size of the culvert could potentially result in additional flood risks downstream, further analysis is required that could lead to other recommendations to reduce flood risks. Review opportunities for flood risk reduction into capital planning process to the extent feasible.	Woodbridge Creek	Pursue site specific investigation of capacity and future needs	Woodbridge	$	USDOT PROTECT, USDOT RAISE, USDOT Transportation Alternatives Program (TAP)	**Mid**
NJDOT	**NJ31**	Stormwater Management	Examine South Rahway River under Route 27 culvert expansion	This site has been identified as a potential opportunity to reduce flooding through increasing the size of this culvert. Increasing the size of the culvert could potentially result in additional flood risks downstream, further analysis is required that could lead to other recommendations to reduce flood risks. Review opportunities for flood risk reduction into capital planning process to the extent feasible.	Rahway River and Tributaries	Pursue site specific investigation of capacity and future needs	NJ TRANSIT, Woodbridge	$	USDOT PROTECT, USDOT RAISE, USDOT Transportation Alternatives Program (TAP)	**Near**
NJDOT	**NJ32**	Resilient Mobility Systems	Improve coordination around evacuation planning	Update the statewide evacuation plan, with input from local and county stakeholders..	All	Continue work on updating the statewide evacuation plan	NJOEM, All Municipalities, Middlesex County, NJTPA, NJTRANSIT	$	USDOT PROTECT	**Mid**

LEAD ENTITY	ID	REGIONAL STRATEGY	ACTION	DESCRIPTION	SUBWATERSHED	NEXT STEP	INVOLVED ENTITIES	COST	POTENTIAL FUNDING SOURCES	TIMEFRAME*
North Jersey Transportation Planning Authority	**NJ33**	Resilient Mobility Systems	Assess and improve resilience of bus routes	Comprehensive evaluation of flood-prone bus routes (137, 815, 817) in region	All	Pursue statewide assessment of flood risks	NJDOT, NJ TRANSIT	$	USDOT PROTECT	**Mid**
Old Bridge	**O4**	Adapt or Protect Critical Facilities	Site-specific mitigation of flood-prone assets at Madison Park Elementary School	According to the flood models developed by Resilient NJ, this facility is vulnerable to flooding from heavy rainfall. Strategies to protect or adapt this facility, including wet and dry floodproofing and elevation of critical systems, should be explored.	South River/Washington Canal	Pursue site-specific study of mitigation options.		$$$	FEMA BRIC	**Mid**
Old Bridge	**O5**	Stormwater Management	Explore opportunities for expanded stormwater storage on municipal-owned facilities and right of ways	Potential stormwater storage sites include Veterans Park, Open Space Along Tennent Brook and William Way, Tenant Brook Tributary Baseball Fields.	South River/Washington Canal	Examine feasibility of preliminary suggested sites.	Local parks, public works, and education departments.	$$$$$	FEMA BRIC	**Mid**
Old Bridge Municipal Utilities Authority	**O6**	Adapt or Protect Critical Facilities	Site-specific mitigation of flood-prone assets at Old Water Works Pumping Station	According to the flood models developed by Resilient NJ, this facility is vulnerable to flooding from heavy rainfall. Strategies to protect or adapt this facility, including wet and dry floodproofing and elevation of critical systems, should be explored.	South River/Washington Canal	Pursue site-specific study of mitigation options.		$$$	FEMA BRIC	**Mid**
Old Bridge Municipal Utilities Authority	**O7**	Adapt or Protect Critical Facilities	Site-specific mitigation of Laurence Harbor Pump Station	According to the flood models developed by Resilient NJ, this facility is vulnerable to flooding from heavy rainfall. Strategies to protect or adapt this facility, including wet and dry floodproofing and elevation of critical systems, should be explored.	Cheesequake/Laurence Harbor	Pursue site-specific study of local flood risk and mitigation options.	Old Bridge	$$$	FEMA BRIC	**Mid**
Perth Amboy	**P3**	Coastal Resilience	Floodwall on Sadowski Parkway - Peth Amboy Portion	Elevated Harborwalk on New Seawall.	Raritan Riverfront and Bay	Pursue funding for a feasibility study		$$$$$	NJDEP Shore Protection Grants and Loans	**Mid**
Perth Amboy	**P4**	Coastal Resilience	Multi-purpose coastal flood barrier along the Arthur Kill	Multi-purpose coastal flood barrier with bike and pedestrian paths along Perth Amboy shoreline from Armstrong Lane to Perth Amboy Harborside Marina.	Arthur Kill Waterfront	Pursue funding for a feasibility study	Middlesex County	$$$$$	USACE	**Long**
Perth Amboy	**P5**	Stormwater Management	Explore opportunities for expanded stormwater storage on facilities and right of ways owned by Perth Amboy (Middlesex County Greenway Extension Resilience Opportunity Area)	Potential sites include Seaman Street Playground and Sports Fields and Lake Between Pfeiffer Blvd and Dorothy Ave, and more. See map on page 140-141.	Raritan Riverfront and Bay	Examine feasibility of preliminary suggested sites	Local parks, public works, and education departments.	$$$$$	FEMA BRIC	**Mid**
Perth Amboy	**P6**	Stormwater Management	Explore opportunities for expanded stormwater storage on municipal-owned facilities and right of ways	Potential stormwater storage sites include along Sadowski Parkway, Franklin Drive Sports Fields and Washington Road and Lakeview Drive Baseball Fields.	Raritan Riverfront and Bay	Examine feasibility of preliminary suggested sites.	Local parks, public works, and education departments.	$$$$	FEMA BRIC	**Mid**
Perth Amboy	**P7**	Stormwater Management	Implement the Long-Term Control Plan to reduce CSOs and improve drainage	Improvements include deep storage, new pumping station at 2nd street and beach, additional storage and treatment strategies, sewer separation, and green infrastructure.	Raritan Riverfront and Bay	Formally approve long-term control plan.	NJDEP, MCUA	Varies	NJ I-Bank	**Near**
Resilient RRBC	**RRBC6**	Contaminated Sites and Brownfields	Coordinate with municipalities to identify priority brownfield and contaminated sites for remediation	Support refinement of the prioritization methodologies presented herein and support municipalities in confirming high risk and high opportunity sites for action.	All	Review preliminary prioritized list and methodology	All Municipalities, NJDEP	$	NJEDA Brownfields Impact Fund, NJDEPA / NJEDA Hazardous Discharge SIte Remediation Fund (HDSRF)	**Near**

LEAD ENTITY	ID	REGIONAL STRATEGY	ACTION	DESCRIPTION	SUBWATERSHED	NEXT STEP	INVOLVED ENTITIES	COST	POTENTIAL FUNDING SOURCES	TIMEFRAME*
Resilient RRBC	**RRBC7**	Resilient Mobility Systems	Examine opportunities to protect vulnerable sections of State St. (CR 611) and Port Reading Ave. near the Arthur Kill	Study and develop alternatives to reduce flood risk to State St. (CR 611) and Port Reading Ave. through road elevation or other measures. The roads flood frequently leading to many disruptions and is an evacuation route.	Woodbridge Creek	Pursue funding for a study to assess risks and mitigation options	Woodbridge, Perth Amboy	$$$$$	USDOT PROTECT, USDOT RAISE, USDOT Transportation Alternatives Program (TAP)	**Mid**
Resilient RRBC	**RRBC8**	Stormwater Management	Assess opportunities for incorporating flood storage and conveyance into an extension of the Middlesex County Greenway	Extension of the Middlesex County Greenway further into Woodbridge and into Perth Amboy could increase recreation and mobility. It also presents an opportunity to overcome drainage impediments formed by the rail embankment.	Raritan Riverfront and Bay	Examine feasibility of incorporating stormwater improvements into the proposed greenway extension.	CSQ/Norfolk Southern, Woodbridge, Perth Amboy	$$$$	USDOT PROTECT, USDOT RAISE, USDOT Transportation Alternatives Program (TAP)	**Long**
Resilient RRBC	**RRBC9**	Stormwater Management	Continue to explore a regional stormwater utility in partnership with municipalities	A stormwater utility creates the ability to assess fees, based on a fair and equitable approximation of the contribution of stormwater runoff from a real property, which can then be used to fund stormwater programs.	All	Coordinate with municipalities to understand interest in a stormwater utility at various scales.	All Municipalities	$	N/A	**Near**
Resilient RRBC	**RRBC10**	Stormwater Management	Culvert Expansion at Port Reading Ave and Woodbridge Creek	This site has been identified as a potential opportunity to reduce flooding through increasing the size of this culvert. Additional analysis is needed to assess potential flood risks and benefits.	Woodbridge Creek	Pursue site specific investigation of capacity and future needs	Woodbridge	$	USDOT PROTECT, USDOT RAISE, USDOT Transportation Alternatives Program (TAP)	**Mid**
Resilient RRBC	**RRBC11**	Stormwater Management	Explore opportunities for expanded stormwater storage on County facilities and rights of way	Potential sites include Merrill Park, Alvin P. Williams Memorial Park, William Warren Park, and more. See map on page 140-141.	All	Examine feasibility of preliminary suggested sites.	County parks department; municipalities.	$$$$$	FEMA BRIC	**Mid**
Resilient RRBC	**RRBC12**	Stormwater Management	Study opportunities and potential benefits of upstream storage and diversion within the South River watershed	Existing water bodies within the upstream tributaries of the South River can be managed to increase the storage of stormwater upstream and reduce peak flows downstream. Additional study is needed to model the effectiveness of this approach.	South River/Washington Canal	Pursue funding and partnerships for a study of this concept	South River, Sayreville, Old Bridge, USACE	$$$$$	USACE	**Long**
South Amboy	**SA2**	Adapt or Protect Critical Facilities	Site-specific flood mitigation of South Amboy Fire Department Snorkel Fire Company	According to the flood models developed by Resilient NJ, this facility is vulnerable to flooding from coastal storm surge and heavy rainfall. Strategies to protect or adapt this facility, including wet and dry floodproofing and elevation of critical systems, should be explored.	Cheesequake/Laurence Harbor	Pursue site-specific study of mitigation options.		$$	FEMA BRIC, NJ I-Bank	**Mid**
South Amboy	**SA3**	Adapt or Protect Critical Facilities	Site-specific flood mitigation of South Amboy Fire Mechanicsville Hose Company	According to the flood models developed by Resilient NJ, this facility is vulnerable to flooding from heavy rainfall. Strategies to protect or adapt this facility, including wet and dry floodproofing and elevation of critical systems, should be explored.	Raritan Riverfront and Bay	Pursue site-specific study of mitigation options.		$	FEMA BRIC, NJ I-Bank	**Mid**
South Amboy	**SA4**	Stormwater Management	Explore opportunities for expanded stormwater storage on municipal-owned facilities and right of ways	Potential stormwater sites include John Zdanewicz Park, South Amboy Elementary School, and more. See map on page 140-141.	Cheesequake/Laurence Harbor	Examine feasibility of preliminary suggested sites.	Local parks, public works, and education departments.	$$$$$	FEMA BRIC, NJ I-Bank	**Mid**
South River	**SR4**	Coastal Resilience	Coastal flooding protection along the South River	Evaluate flood protection alternatives for riverfront from the railroad crossing at Whitehead Avenue south to Bissetts Recreational Area.	South River/Washington Canal	Pursue funding for a feasibility study of potential options	Middlesex County	$$$$$	FEMA BRIC, USACE	**Long**
South River	**SR5**	Coastal Resilience	Coastal flooding protection of South River downtown core	Evaluate potential alignments for protection of South River downtown core.	South River/Washington Canal	Pursue funding for a feasibility study of potential options	Middlesex County	$$$$$	FEMA BRIC, USACE	**Long**

LEAD ENTITY	ID	REGIONAL STRATEGY	ACTION	DESCRIPTION	SUBWATERSHED	NEXT STEP	INVOLVED ENTITIES	COST	POTENTIAL FUNDING SOURCES	TIMEFRAME*
South River	**SR6**	Stormwater Management	Explore opportunities for expanded stormwater storage on municipal-owned facilities and right of ways	Potential sites include Dailey's Pond Recreation Area, Burton Ave and Louis Street Baseball Field, and more. See map on page 140-141.	South River/Washington Canal	Examine feasibility of preliminary suggested sites.	Local parks, public works, and education departments.	$$$$$	NJDEP Natural Climate Solutions Grant, NOAA National Coastal Zone Management Grant, NFWF America the Beautiful Grant, NOAA Transformational Habitat Restoration and Coastal Resilience Grants, FEMA BRIC	**Mid**
Sayreville	**SV4**	Coastal Resilience	Work with Riverton developer to incorporate nature-based solutions along the shoreline, such as a living shoreline/ into redevelopment plan	Incorporation of nature-based solutions, such as a living shoreline, can create additional habitat opportunities and allow for inland migration of wetlands with sea level rise.	Raritan Riverfront and Bay	Incorporate into development phases	NJDEP, Developers	$	FEMA BRIC, NJDEP Natural Climate Solutions Grants	**Near**
Sayreville	**SV5**	Stormwater Management	Explore opportunities for expanded stormwater storage on municipal-owned facilities and right of ways	Potential sites include the Sayreville Sports Complex, Walter D. Faith Memorial Fields, Veterans Park, and more. See map on page 140-141.	Raritan Riverfront and Bay, South River / Washington Canal	Examine feasibility of preliminary suggested sites.	Local parks, public works, and education departments.	$$$$$	FEMA BRIC, NJ I-Bank	**Mid**
U.S. EPA	**US1**	Contaminated Sites and Brownfields	Remediation of Slag superfund site	EPA has issued a record of design for the site's clean-up which includes excavating and dredging contaminated material.	Cheesequake/Laurence Harbor	Complete design plans for site remediation	Old Bridge, USACE, NL Industries	$$	EPA	**Near**
USACE	**US2**	Coastal Resilience	Beach Nourishment along Ocean Boulevard	Restoring the eroding beach along the Atlantic Ocean by adding more sand and height to dunes along the shoreline.	Cheesequake/Laurence Harbor	Examine options as part of the Laurence Harbor project.	NJDEP, Old Bridge	$$	NJDEP Shore Protection Grants and Loans	**Long**
USACE	**US3**	Coastal Resilience	Beach replenishment in Perth Amboy to protect waterfront park and recreational assets	Restoring the eroding beach along the Arthur Kill River by adding more sand and height to dunes along the shoreline.	Raritan Riverfront and Bay	Examine options as part of the NYNJ HATS Project	NJDEP, Perth Amboy	$$$	NJDEP Shore Protection Grants and Loans	**Long**
USACE	**US4**	Coastal Resilience	Rehabilitation of Cheesequake Creek jetty	Improvement of the jetty.	Cheesequake/Laurence Harbor	Pursue design and permitting	NJDEP, Middlesex County, Old Bridge	$$$	Water Resources Development Act	**Near**
USACE	**US5**	Coastal Resilience	Beach Nourishment along Raritan Bay	Restoring the eroding beach along the Raritan Bay by adding more sand and height to dunes along the shoreline.	Cheesequake/Laurence Harbor	Examine options as part of the NYNJ HATS Project	NJDEP, South Amboy	$$$	FEMA BRIC, USACE, NJDEP Shore Protection Grants and Loans	**Long**
USACE	**US6**	Coastal Resilience	Implement Rahway River Basin project	The project includes a levee/floodwall along the south bank of the Rahway River along with road raising. It will provide benefits to vulnerable properties in Carteret and Woodbridge.	Rahway River and Tributaries	Allocate funding for construction	NJDEP, Carteret, Woodbridge	$$$$	Water Resources Development Act	**Long**
USACE	**US7**	Coastal Resilience	Study regional and local coastal protection solutions through the NY/NJ Harbor and Tributaries Study	This study is examining several alternatives to coastal flood risk reduction, including examining a storm surge barrier across the Lower New York Bay as well as more localized surge barriers such as across the Arthur Kill at Perth Amboy.	All	Issue a report on a tentatively selected plan	NJDEP, Perth Amboy	$$$$$	Water Resources Development Act	**Long**
USACE	**US8**	Coastal Resilience	Installation of breakwaters at Cheesequake Inlet	Breakwaters along the coast could serve to buffer storm waves and reduce erosion of the beach.	Cheesequake/Laurence Harbor	Examine options as part of the Laurence Harbor project.	NJDEP, Middlesex County, Old Bridge	$$$$	FEMA BRIC, USACE, NJDEP Shore Protection Grants and Loans	**Mid**
Woodbridge	**W7**	Adapt or Protect Critical Facilities	Site-specific flood mitigation of Hopelawn Engine Company 1	According to the flood models developed by Resilient NJ, this facility is vulnerable to flooding from coastal storm surge and heavy rainfall. Strategies to protect or adapt this facility, including wet and dry floodproofing and elevation of critical systems, should be explored.	Raritan Riverfront and Bay	Pursue site-specific study of mitigation options.		$$	FEMA BRIC, I-Bank	**Mid**

LEAD ENTITY	ID	REGIONAL STRATEGY	ACTION	DESCRIPTION	SUBWATERSHED	NEXT STEP	INVOLVED ENTITIES	COST	POTENTIAL FUNDING SOURCES	TIMEFRAME*
Woodbridge	**W8**	Adapt or Protect Critical Facilities	Site-specific mitigation of flood-prone assets at Cypress Recreation Center	According to the flood models developed by Resilient NJ, this facility is vulnerable to flooding from heavy rainfall. Strategies to protect or adapt this facility, including wet and dry floodproofing and elevation of critical systems, should be explored.	Woodbridge Creek	Pursue site-specific study of mitigation options.		$$	FEMA BRIC, I-Bank	**Mid**
Woodbridge	**W9**	Adapt or Protect Critical Facilities	Site-specific mitigation of flood-prone assets at Fords Middle School	According to the flood models developed by Resilient NJ, this facility is vulnerable to flooding from heavy rainfall. Strategies to protect or adapt this facility, including wet and dry floodproofing and elevation of critical systems, should be explored.	Woodbridge Creek	Pursue site-specific study of mitigation options.		$$$$	FEMA BRIC, NJ I-Bank	**Mid**
Woodbridge	**W10**	Adapt or Protect Critical Facilities	Site-specific mitigation of flood-prone assets at Henry Inman Library	This library was flooded by Hurricane Ida, leading to the library's temporary closure. Strategies to protect or adapt this facility, including wet and dry floodproofing and elevation of critical systems, should be explored.	Rahway River and Tributaries	Pursue site-specific study of mitigation options.		$$	FEMA BRIC, NJ I-Bank	**Mid**
Woodbridge	**W11**	Adapt or Protect Critical Facilities	Site-specific mitigation of flood-prone assets at Menlo Park Terrace Elementary School	According to the flood models developed by Resilient NJ, this school is vulnerable to flooding from heavy rainfall. Strategies to protect or adapt this facility, including wet and dry floodproofing and elevation of critical systems, should be explored.	Woodbridge Creek	Pursue site-specific study of local flood risk and mitigation options.		$$$	FEMA BRIC, NJ I-Bank	**Mid**
Woodbridge	**W12**	Adapt or Protect Critical Facilities	Site-specific mitigation of flood-prone assets at Woodbridge Recycling Center	According to the flood models developed by Resilient NJ, this facility is vulnerable to flooding from heavy rainfall. Strategies to protect or adapt this facility, including wet and dry floodproofing and elevation of critical systems, should be explored.	Raritan Riverfront and Bay	Pursue site-specific study of mitigation options.		$$$$	FEMA BRIC, I-Bank	**Mid**
Woodbridge	**W13**	Adapt or Protect Critical Facilities	Site-specific mitigation of flood-prone assets at Woodbridge Township Fire District 2 Port Reading	According to the flood models developed by Resilient NJ, this facility is vulnerable to flooding from heavy rainfall. Strategies to protect or adapt this facility, including wet and dry floodproofing and elevation of critical systems, should be explored.	Woodbridge Creek	Pursue site-specific study of mitigation options.		$$	FEMA BRIC, I-Bank	**Mid**
Woodbridge	**W14**	Coastal Resilience	Floodwall on Sadowski Parkway - Woodbridge Portion	Elevated Harborwalk on New Seawall.	Raritan Riverfront and Bay	Pursue funding for a feasibility study		$$$$$	FEMA BRIC, USACE, NJDEP Shore Protection Grants and Loans	**Mid**
Woodbridge	**W15**	Coastal Resilience	Protect and manage tidal wetlands along Woodbridge Creek for sea level rise	Monitor and evaluate coastal wetlands and identify opportunities to restore wetlands and address resiliency to sea level rise.	Woodbridge Creek	Identify partners and pursue funding opportunities	Middlesex County, NJDEP, Rutgers	$$$	NJDEP Natural Climate Solutions Grant, NOAA National Coastal Zone Management Grant, NFWF America the Beautiful Grant, NOAA Transformational Habitat Restoration and Coastal Resilience Grants, FEMA BRIC	**Long**
Woodbridge	**W16**	Stormwater Management	Explore opportunities for expanded stormwater storage on municipal-owned facilities and right of ways	Potential sites include Lynn Crest Elementary School, Cypress Recreation Center, and more. See map on page 140-141.	Arthur Kill, Rahway River and Tributaries, Woodbridge Creek	Examine feasibility of preliminary suggested sites	Local parks, public works, and education departments.	$$$$$	FEMA BRIC	**Mid**
Woodbridge	**W17**	Stormwater Management	Heards Brook and Elmwood Ave Culvert Expansion	This site has been identified as a potential opportunity to reduce flooding through increasing the size of this culvert. Additional analysis is needed to assess potential flood risks and benefits.	Woodbridge Creek	Pursue site specific investigation of capacity and future needs		$	USDOT RAISE Grant Program	**Mid**

LEAD ENTITY	ID	REGIONAL STRATEGY	ACTION	DESCRIPTION	SUBWATERSHED	NEXT STEP	INVOLVED ENTITIES	COST	POTENTIAL FUNDING SOURCES	TIMEFRAME*
Woodbridge	**W18**	Stormwater Management	Heards Brook and School St Culvert Expansion	This site has been identified as a potential opportunity to reduce flooding through increasing the size of this culvert. Additional analysis is needed to assess potential flood risks and benefits.	Woodbridge Creek	Pursue site specific investigation of capacity and future needs		$	USDOT RAISE Grant Program	**Mid**
Woodbridge	**W19**	Stormwater Management	Increase the storage and conveyance capacity of Heards Brook	Examine strategies to increase storage and conveyance along the stream along with ecological restoration.	Woodbridge Creek	Pursue funding for a feasibility study	NJDEP	$$	NJDEP Natural Climate Solutions Grant, NOAA National Coastal Zone Management Grant, NFWF America the Beautiful Grant, NOAA Transformational Habitat Restoration and Coastal Resilience Grants, FEMA BRIC	**Long**
Woodbridge	**W20**	Stormwater Management	Increase the storage and conveyance capacity of Pumpkin Patch Brook riparian corridor	Examine strategies to increase storage and conveyance along the stream along with ecological restoration.	Rahway River and Tributaries	Pursue funding for a feasibility study	NJDEP	$	FEMA BRIC	**Long**
Woodbridge	**W21**	Stormwater Management	Increase the storage and conveyance capacity of Wedgewood Brook	Examine strategies to increase storage and conveyance along the stream along with ecological restoration.	Woodbridge Creek	Pursue funding for a feasibility study	NJDEP	$$	NJDEP Natural Climate Solutions Grant, NOAA National Coastal Zone Management Grant, NFWF America the Beautiful Grant, NOAA Transformational Habitat Restoration and Coastal Resilience Grants, FEMA BRIC	**Long**
Woodbridge	**W22**	Coastal Resilience	Implement living shoreline at Boynton Beach	A living shoreline provides for improved intertidal habitat and creates opportunities for inland wetland migration as sea levels rise.	Arthur Kill Waterfront	Pursue design and permitting	NJDEP	$$$	NJDEP Natural Climate Solutions Grant	**Mid**
All Municipalities	**A13**	Flood Awareness Outreach Campaign	Support ongoing Flood Awareness Outreach Campaign	Support ongoing outreach and awareness in partnership with the YMCA and the County. Share information on flood risk with property owners to empower them to take action and advocate for additional support.	All	Pursue funding opportunities	NJDEP, Middlesex County, YMCA	$	Watershed Institute Grants	**Near**

OUTREACH AND CAPACITY BUILDING

LEAD ENTITY	ID	REGIONAL STRATEGY	ACTION	DESCRIPTION	SUBWATERSHED	NEXT STEP	INVOLVED ENTITIES	COST	POTENTIAL FUNDING SOURCES	TIMEFRAME*
Carteret	**C10**	Flood Awareness Outreach Campaign	Develop evacuation plan for flood-prone public housing including Jeanette Smith Village	Promote communication and awareness of flood risk and what to do when there is a severe storm forecast with residents of public housing in areas vulnerable to flooding.	Arthur Kill Waterfront	Coordinate with Carteret Housing Agency to understand existing emergency operations and needs	Middlesex County, NJOEM, NJ TRANSIT	$	NJDEP Community-Based Art Grant Program	**Near**
Carteret	**C11**	Technical Support for Property Owners	Targeted outreach on mitigation options to Ida impacted homeowners.	Share information about resiliency investments they can make to their homes, or interest in buyouts.	Arthur Kill, Rahway River and Tributaries	Gather informational materials about options to share with property owners and community organizations	Middlesex County, NJDEP, Community Organizations	$	N/A	**Near**
YMCAs/ Other NGOs	**NG5**	Flood Awareness Outreach Campaign	Support ongoing Flood Awareness Outreach Campaign	Integrate flood awareness into community programming using materials developed by Resilient NJ.	All	Pursue funding opportunities	NJDEP, Middlesex County, all municipalities	$	NJDEP Community-Based Art Grant Program	**Near**
NJDEP	**NJ34**	Technical Support for Property Owners	Outreach to private owners and operators of industrial facilities and critical utilities	Major critical facilities like oil and gas terminals, and power stations, as well as cell towers, are located in vulnerable areas throughout the region. While some assets have made some resiliency improvements, there is a need for further coordination and outreach to promote adaptation.	Arthur Kill Waterfront, Rahway River and Tributaries	Reach out to property owners to understand what improvements have been made and what needs remain.	PSEG, Buckeye Global Marine Terminal, Kinder Morgan, NextEra Energy Resources, CPV, AT&T	$	FEMA BRIC Capability & Capacity Building	**Near**
NJDEP	**NJ35**	Technical Support for Property Owners	Develop funding programs to property owners for floodproofing, elevations, buyouts, and green infrastructure retrofits	Funding programs can include loans and grants and should be developed to supporting a range of property types including residential, multi-family, and commercial.	All	Identify funding opportunities		$$$$$	HUD CDBG-DR Ida, FEMA Swift Current	**Near**
NJDEP	**NJ36**	Flood Awareness Outreach Campaign	Explore opportunities for additional funding for ongoing Flood Awareness Outreach Campaign	Additional funding and technical support is needed to continue Resilient NJ outreach and awareness building led by the County, municipalities, and the YMCAs.	All	Identify funding opportunities	Middlesex County, all Municipalities, YMCA	$	Watershed Institute Grants, Sustainable New Jersey Grants, FEMA Regional Catastrophic Preparedness Grant Program	**Near**
Perth Amboy	**P8**	Technical Support for Property Owners	Targeted outreach on mitigation options to Ida impacted homeowners	Share information about resiliency investments they can make to their homes, or interest in buyouts.	Arthur Kill, Raritan Riverfront and Bay	Gather informational materials about options to share with property owners and community organizations	Middlesex County, NJDEP, Community Organizations	$	N/A	**Near**
Resilient RRBC	**RRBC13**	Flood Awareness Outreach Campaign	Support ongoing Flood Awareness Outreach Campaign as identified by the County All Hazard mitigation plan	Support ongoing outreach and awareness in partnership with the YMCA and municipalities and enhance staff capacity to support dissemination of state resources and support municipalities in building-scale mitigation.	All	Pursue funding and partnership opportunities	NJDEP, all Municipalities, YMCA	$	FEMA BRIC Capability & Capacity Building, FEMA Regional Catastrophic Preparedness Grant Program	**Near**
Sayreville	**SV6**	Flood Awareness Outreach Campaign	Promote flood awareness campaign and evacuation for Winding Woods apartment complex	Promote communication and awareness of flood risk and what to do when there is a severe storm forecast with residents of Winding Woods Apartment Complex.	South River/Washington Canal	Reach out to property owners to understand opportunities	Private property owners, residents	$	Sustainable New Jersey Grants	**Near**
Woodbridge	**W23**	Technical Support for Property Owners	Targeted outreach on mitigation options to Ida impacted homeowners, particularly along Pumpkin Patch Brook and the South Branch of the Rahway River	Share information about resiliency investments they can make to their homes, or interest in buyouts.	Rahway River and Tributaries	Gather informational materials about options to share with property owners and community organizations	Middlesex County, NJDEP, Community Organizations	$	N/A	**Near**
All Municipalities	**A14**	Additional Climate Hazards	Enhance enforcement of existing local and state regulations relating to hazards other than flood	Existing regulations including the 2021 NJ Stormwater Rule, State Emission Statement rule, NJ Air Quality State Implementation plan regulations, Statewide water quality standards, and others may be leveraged to increase green infrastructure, monitor state progress towards emissions reductions, improve water quality and more.	All	Conduct a review of key regulations in coordination with NJDEP and develop a strategy for equitable enforcement	NJDEP	$$	N/A	**Near**

ADDITIONAL CLIMATE HAZARDS

LEAD ENTITY	ID	REGIONAL STRATEGY	ACTION	DESCRIPTION	SUBWATERSHED	NEXT STEP	INVOLVED ENTITIES	COST	POTENTIAL FUNDING SOURCES	TIMEFRAME*
All Municipalities	**A15**	Additional Climate Hazards	Explore zoning overlays, restrictions, and/or buffers to address groundwater contamination and wildfire risk	Implement groundwater protection zoning overlays to protect water within potential contamination zones or buffer distances around groundwater intakes. Develop zoning restrictions to address fire risk.	All	Conduct an initial investigation and convene with other entities across the country that have successfully implemented such structures on best practices/ lessons learned	NJDEP	$	N/A	**Near**
All Municipalities	**A16**	Zoning and Land Use Policy	Develop site-specific plans for contaminated sites, especially those located in environmental justice communities	Incorporate considerations of hazards beyond flooding and needs of environmental justice communities in remediation of contaminated sites.	All	Work with NJEJA and existing partners to identify and conduct outreach with key CBOs to identify high priority needs and low-hanging fruit	Local community-based organizations, NJ Environmental Justice Alliance	$	EPA	**Near**
All Municipalities	**A17**	Additional Climate Hazards	Conduct targeted community outreach with agricultural and fishery workers	Outreach should be focused on understanding future needs and localized social and economic impacts of ocean acidification and changes to water supply levels and projected future demand to help shape decision making.	All	Identify key stakeholders for outreach	NJ Department of Agriculture, NJ Fish and Wildlife, NJDEP, Middlesex County	$	FEMA Regional Catastrophic Preparedness Grant	**Near**
All relevant public water utilities	**A18**	Additional Climate Hazards	Prioritize capital improvement projects to replace and/or renew deteriorating and inefficient pipelines and water supply assets	In accordance with the 2018 American Water Infrastructure Act, this would involve developing risk and resilience assessments for drinking water systems that consider climate change impacts. Could also involve partnering with the Lead Service Line Replacement program and others.	All	Conduct a comprehensive review of existing data and identify any critical information gaps	All municipalities	$	NJ I-Bank, WIFIA	**Near**
YMCAs/ Other NGOs	**NG6**	Additional Climate Hazards	Study present-day vulnerabilities to and impacts of extreme heat and poor air quality	Partner with the academic community and community-based organizations to conduct localized studies and public health screenings of present-day vulnerabilities to and impacts of extreme heat and poor air quality.	All	Pursue funding and partnerships	Rutgers and other NGOs	$	NOAA Climate Program Office (CPO) Extreme Heat Risk Initiative Competition, EPA Environmental Justice Grants	**Near**
NJ Board of Public Utilities: Division of Water	**NJ37**	Additional Climate Hazards	Investigate tying water conservation rate structures to water utilities	Water conservation rate structures would be tied to public water utilities based on the amount of water volume consumed to mitigate the risk of water shortages. This could be seasonal and be based on metrics as recommended in the 2017-2022 NJ Water Supply Plan. Any such structure must be equitable and be designed to not burden low-income households.	All	Conduct an initial investigation and convene with other entities across the country that have successfully implemented such structures on best practices/ lessons learned	NJDEP Division of Water Supply and Governance, municipal public water utility authorities	$	N/A	**Mid**
NJ Department of Health	**NJ38**	Additional Climate Hazards	Work with community-based organizations to conduct public health studies of localized current-day “invisible” effects of air quality	Poor air quality in the region is not merely a future issue. The RRBC population is currently at extremely high risk, relative to the rest of the state, for air toxics-related cancer impacts.	All	Assess existing data gaps and identify key CBOs at the municipal scale to help ground-truth initial assumptions	Middlesex County, NJDEP, local community-based organizations, all municipalities	$	EPA Environmental Justice Grants	**Near**
NJDEP	**NJ39**	Additional Climate Hazards	Enhance regional planning and coordination around additional hazards	Efforts may include goals to support local planning for accessible, equitable public and multi-modal transportation infrastructure, and others. These efforts should complement watershed scale or regional planning to address flood risk.	All	Convene with Resilient RRBC stakeholders to identify regional goals on additional climate hazards	All municipalities, Middlesex County, NJDOT, NJ Fish and Wildlife	$	USDOT PROTECT	**Mid**

LEAD ENTITY	ID	REGIONAL STRATEGY	ACTION	DESCRIPTION	SUBWATERSHED	NEXT STEP	INVOLVED ENTITIES	COST	POTENTIAL FUNDING SOURCES	TIMEFRAME*
NJDEP	**NJ40**	Additional Climate Hazards	Work with environmental justice groups to initiate an accessible, regional program to incentivize mitigating and sustainable practices	This strategy can be complemented by the recommended individual actions and outreach, education and capacity building for private property owners.	All	Conduct outreach with key environmental justice organizations, develop program goals and identify funding sources	NJ Environmental Justice Alliance, local community-based organizations, all municipalities	$$	EPA Environmental Justice Grants	**Mid**
NJDEP	**NJ41**	Additional Climate Hazards	Identify high-opportunity contaminated sites for urban green space placement in underutilized and non-municipal land	Contaminated sites or brownfields, vacant land, and existing publicly owned impervious surfaces in environmental justice communities experiencing high urban heat and/or poor air quality should be identified and prioritized for green space placement.	All	Develop evaluation criteria for high-priority, high-opportunity sites, identify funding opportunities	All municipalities, Middlesex County	$	NJDEP Green Acres, NJDEP Natural Climate Solutions Grant	**Mid**
NJDEP	**NJ42**	Additional Climate Hazards	Invest in regional ecosystem-based adaptation projects to address multiple climate hazards	Like flooding and other flood resilience issues, ecosystem-scale adaptation can be leveraged to build resilience to Additional Hazards through habitat restoration and sustainable agroforestry.	All	Convene with Resilient RRBC stakeholders to identify regional goals on additional climate hazards	Key regional environmental organizations, NJ Fish and Wildlife, NJ Board of Public Utilities: Division of Water, all municipalities	$$	N/A	**Long**
NJDEP	**NJ43**	Additional Climate Hazards	Initiate universal public programs to distribute risk-mitigating resources and technical assistance	This program could involve distribution of air conditioners, clean energy technology and transportation subsidies, emergency at-home water filtration systems and other mitigation resources.	All	Work with NJEJA and existing partners to identify and conduct outreach with key CBOs to identify high priority needs and low-hanging fruit	NJ Environmental Justice Alliance, local community-based organizations, all municipalities	$$	FEMA Regional Catastrophic Preparedness Grant	**Near**
NJDEP	**NJ44**	Additional Climate Hazards	Adopt ordinances and building codes to state, national, and international models and guidance and consider higher standards	Higher standards including the 2021 US Department of Labor Occupational Safety and Health Administration standards, 2021 International Energy Conservation Code, US Environmental Protection Agency air quality standards, World Health Organization Air Quality Guidelines and others should be evaluated to determine which should be adopted to meet resilience goals and improve quality of life.	All	Leverage Resilient RRBC to convene a working group/action committee focused on identifying low-hanging fruit and conducting outreach with elected officials	All municipalities, Middlesex County, NJ Department of Labor & Workforce Development, NJ Office of Planning Advocacy	$	FEMA BRIC Capability & Capacity Building	**Near**
NJDEP	**NJ45**	Additional Climate Hazards	Require specific mitigations on publicly owned properties	For example, require outdoor heat mitigation, which may include measures such as canopy cover or photovoltaic (PV) shade canopies, water-based cooling stations, or cool pavements.	All	Conduct an initial investigation and convene with other entities across the country that have successfully implemented such structures on best practices/ lessons learned	All municipalities, NJDOT, Middlesex County	$	Garden State C-PACE	**Near**
NJDEP Office of Environmental Justice	**NJ46**	Additional Climate Hazards	Pursue local regulations specific to environmental justice issues and cumulative impacts	For example, look to the Newark Environmental Justice/Cumulative Impacts ordinance. Develop a streamlined standard operating procedure for integrating review of all potentially impactful development activity.	All	Meet with the City of Newark to discuss best practices, undertake investigation of identifying a clear pathway to including amendment to the New Jersey Administrative Codes (NJAC), similar to the process undertaken for the Stormwater Management Rule	All municipalities, NJ Environmental Justice Alliance	$	EPA Environmental Justice Grants	**Near**

LEAD ENTITY	ID	REGIONAL STRATEGY	ACTION	DESCRIPTION	SUBWATERSHED	NEXT STEP	INVOLVED ENTITIES	COST	POTENTIAL FUNDING SOURCES	TIMEFRAME*
NJDOT (to be confirmed)	**NJ47**	Additional Climate Hazards	Plan for accessible, equitable public, multi-modal transportation infrastructure	Establish regional goals and undertake coordination to encourage local and regional planning for more accessible and equitable public and multi-modal transportation infrastructure to reduce emissions from cars.	All	Convene with Resilient RRBC stakeholders to identify regional goals	All municipality planning departments, NJ Office of Planning Advocacy, NJDEP, local community-based organizations	$	USDOT PROTECT	**Mid**
Office of the New Jersey State Climatologist	**NJ48**	Additional Climate Hazards	Partner with the research community to gather best-available, publicly accessible regional data and develop models and projections of future risk for additional hazards to aid in decision-making	High priority data gathering needs include a current water table elevation map for the region, a comprehensive contaminant source inventory that details depth and water-solubility of contaminants, and others. High priority regional modeling and projections needs include projected future changes in depth-to-groundwater with sea level rise, additional groundwater modeling where high-risk conditions exist to help forecast contamination plumes, and others.	All	Secure funding and partnerships for identified data gathering and modeling needs	NJDEP, Rutgers Center for Remote Sensing and Spatial Analysis, Consortium for Climate Risk in the Urban Northeast (CCRUN), U.S. CDC	$	FEMA CTP	**Near**
Resilient RRBC	**RRBC14**	Additional Climate Hazards	Start a regional education campaign with resources for individual mitigation and to promote advocacy related to additional hazards	Develop an educational campaign to point people to the right resources for minimizing their own risk while also collaborating with community-based organizations that may educate communities on how to organize for collective action on Additional Hazards issues.	All	Convene with Resilient RRBC stakeholders to identify regional goals on additional climate hazards	NJDEP	$	EPA Environmental Justice Grants	**Near**

NEXT STEPS

The release of this action plan is an important step in addressing the flood risks this region faces, but what comes next is even more important. This plan builds on many prior planning efforts at the local, county, and regional scale and is intended to serve as a launching pad for what comes next.

This plan:

- Assesses the risk and costs of inaction
- Identifies critical issues that need to be addressed
- Identifies key strategies applicable across the region
- Makes recommendations on specific next steps for key actors to take
- Focuses on specific project concepts within the identified Resilience Opportunity Areas as priorities for concerted action

The next steps include:

- Pursuing funding to advance the development of concepts identified in the plan
- Additional coordination across levels of governance on the implementation of actions recommended in the plan and tracking of the plan's progress
- Ongoing outreach and engagement with key stakeholders and communities on strategies presented in this plan

PERTH AMBOY WATERFRONT, NJ
Image Credit: Adobe Stock Photos

CHEESEQUAKE STATE PARK, OLD BRIDGE

06 - REFERENCES

REFERENCES

Centers for Disease Control and Prevention/ Agency for Toxic Substances and Disease Registry Social Vulnerability Index (2018) https://www.atsdr.cdc.gov/placeandhealth/svi/index,

FEMA, 2008 Supplement to the 2006 Evaluation of the National Flood Insurance Program's Building Standards, https://www.fema.gov/sites/default/files/2020-07/fema_nfip_2008_freeboard_report_0.pdf

FEMA, Flood Risk Disclosure: Model State Requirements for Disclosing Flood Risk During Real Estate Transactions, https://www.fema.gov/sites/default/files/documents/fema_state-flood-risk-disclosure-best-practices_07142022.pdf

Lower Raritan River Watershed Partnership: Designing and Eco-Park Along the South River, https://lowerraritanwatershed.org/2022/01/24/

NJDEP Environmental Justice Mapping, Assessment, and Protection Tool, https://experience.arcgis.com/experience/548632a2351b41b8a0443cfc3a9f4ef6

Pinelands Development Credit Bank 2021 Annual Report, https://www.nj.gov/pinelands/pdcbank/reports/PDC%20Bank%20Annual%20Report%202021%20(Final).pdf

South River Ecosystem Restoration & Flood Resiliency Enhancement Project, https://lowerraritanwatershed.org/2022/01/24/designing-an-eco-park-along-the-south-river/

USACE New York and New Jersey Harbor and Tributaries study, https://www.nan.usace.army.mil/Missions/Civil-Works/Projects-in-New-York/New-York-New-Jersey-Harbor-Tributaries-Focus-Area-Feasibility-Study/

U.S. Environmental Protection Agency Environmental Justice Screening Tool, https://ejscreen.epa.gov/mapper/

ACRONYMS

BRIC – Building Resilient Infrastructure and Communities, a FEMA program

CBO – community-based organization

CCI – Community Collaborative Initiative

CDC – Centers for Disease Control and Prevention

CEA – classification exception area

C-PACE – Commercial Property Assessed Clean Energy

CPV – Competitive Power Ventures

CRS – Community Rating System, a FEMA program

CSO – combined sewer overflow

CSS – combined sewer system

DEWS – drought early warning system

DVRPC – Delaware Valley Regional Planning Commission

EJScreen – USEPA Environmental Justice Screening and Mapping Tool

EO – executive order

EPA – United States Environmental Protection Agency

FEMA – Federal Emergency Management Agency

FIRM – Flood Insurance Rate Map, a part of FEMA's NFIP

FMA – Flood Mitigation Assistance, a FEMA program

GI – Green Infrastructure

HDSRF – Hazardous Discharge Site Remediation Fund

HMGP – Hazard Mitigation Grant Program, a FEMA program

HUC – Hydrologic Unit Code

HUD – United States Department of Housing and Urban Development

HVAC – heating, ventilation, and air conditioning

I-Bank – New Jersey Infrastructure Bank

IECC – International Energy Conservation Code

LTCP - Long-Term Control Plans

MS4 – municipal separate storm sewer system

NDRC - National Disaster Resilience Competition

NEP – National Emphasis Program

NFIP – National Flood Insurance Program, a FEMA program

NFWF – National Fish and Wildlife Foundation

NJ – New Jersey

NJAC – New Jersey Administrative Codes

NJDEP – New Jersey Department of Environmental Protection

NJDOT – New Jersey Department of Transportation

NJEDA – New Jersey Economic Development Authority

NJOEM - New Jersey Office of Emergency Management

NJPACT – New Jersey Protecting Against Climate Threats

NJTPA – New Jersey Transportation Planning Authority

NOAA – National Oceanic and Atmospheric Administration

OSC/R – open space conservation/resiliency

OSHA – Occupational Safety and Health Administration

PA – Public Assistance, a FEMA program

pH – potential of hydrogen, a measure of the acidity or alkalinity of something

PM2.5 – fine particulate matter

PROTECT - Promoting Resilient Operations for Transformative, Efficient, and Cost-saving Transportation, a USDOT program

PSE&G - Public Service Electric and Gas

PV – photovoltaic

RNJ – Resilient NJ

RRBC – Raritan River and Bay Communities

RWBR – reclaimed water for beneficial reuse

SAC – Stormwater Advisory Committee

SCO – stormwater control ordinance

SFHA – Special Flood Hazard Area

SJTPO – South Jersey Planning Organization

SVI – social vulnerability index

07- LIST OF APPENDICES

LIST OF APPENDICES

A . About Our Region Report (Planning Context Report)

B. Vision and Priorities Report (Visioning Report)

C. Flood Impact Assessment Report

D. Asset Profile Tables

E. Scenario Evaluation (Resilience and Adaptation Scenario Evaluation Tool and Action Sheet for the three preliminary scenarios and the preferred scenario)

F. Cost Estimation Approach and Workbook

G. Funding Strategy and Sources

H. Review of Long-Term Control Plan

I. Resilient Transformation of Contaminated Sites

J. Engagement and Capacity Building

K. Watershed Planning and Governance

L. Stormwater Management and Green Infrastructure

- Memo
- Presentation

M. Regional Coordination of Evacuation Planning

N. Risk Rating 2.0 Outreach Campaign

O. Additional Climate Hazards

- Assessment
- Toolkit

Note: Scenario Development Memo, Scenario Visualization Products, and Resilience and Adaptation Scenario Report are covered in Chapter 4 of this report.