REIMAGINING BERGEN COUNTY'S SADDLE RIVER COUNTY PARK:

TRANSFORMING A SUBURBAN OASIS INTO A MODEL OF SUSTAINABILITY

AN INTEGRATIVE CAPSTONE PROJECT
SUSTAINABILITY MANAGEMENT PROGRAM

SUMMER 2025

COLUMBIA UNIVERSITY
School of Professional Studies

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EXECUTIVE SUMMARY

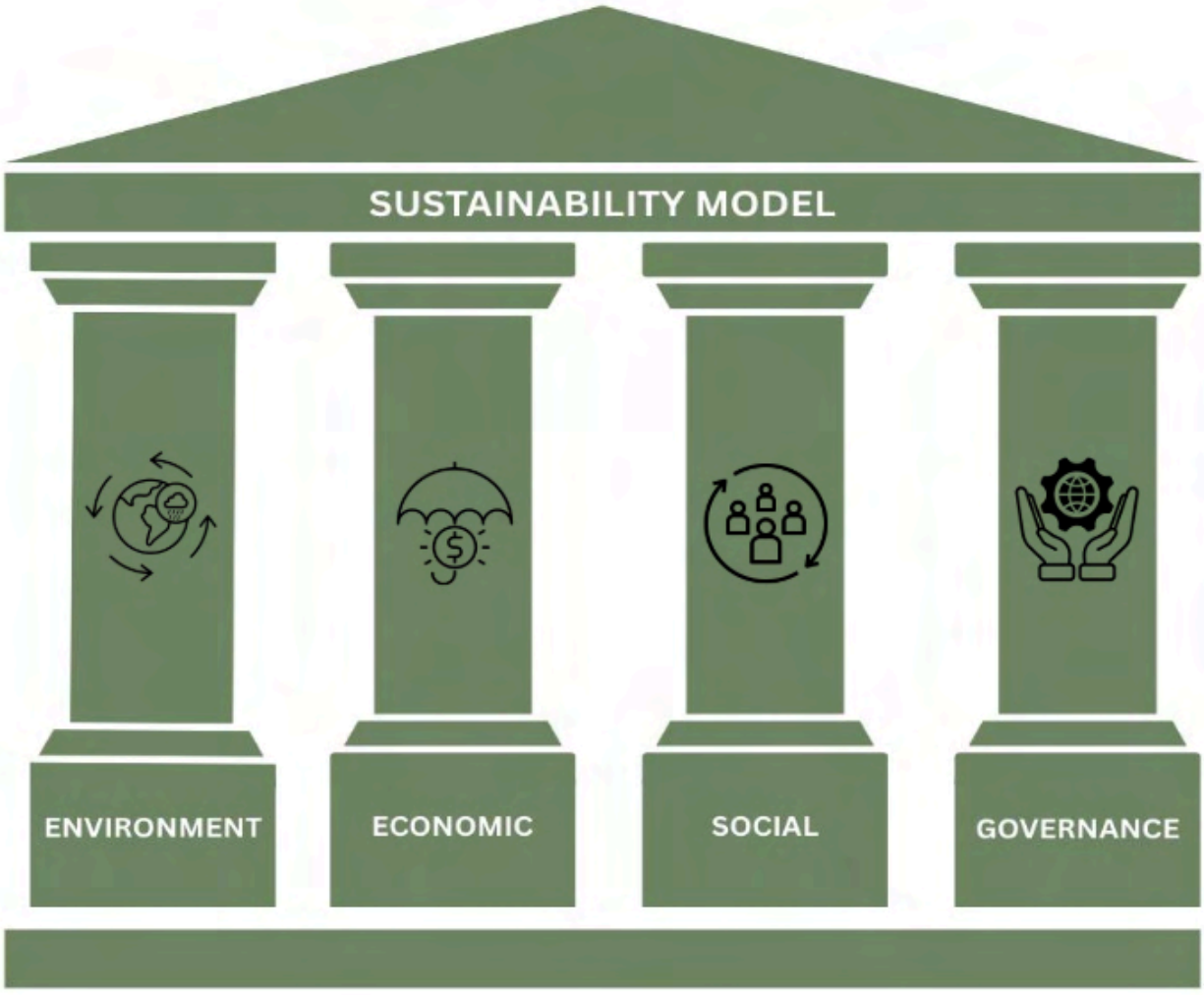
This report presents research and a series of recommendations for the Saddle River County Park in Bergen County, New Jersey. This linear Park spans 587 acres and is adjoined by six surrounding communities. Bergen County, home to nearly one million residents, is now ranked the #1 most vulnerable county for flooding in the entire United States (Magerl, 2025). This threat puts over $7.1 billion of property adjacent to the Park, as well as the lives and well-being of people and communities, at risk. Beyond this, the Park itself has not escaped the impacts of severe flooding. Erosion, added with aging and damaged infrastructure, threatens safety and utility. Ecological health and public use are made more and more vulnerable from rising temperatures and extreme weather.

Over the summer of 2025, a team of graduate students from Columbia University's Master of Science in Sustainability Management Program worked with colleagues from Green Ridgewood, David Refkin (Chair), Alina Mordkovich (Member), and Joan Hubertus (Member) to reimagine the Saddle River County Park as a resilient, sustainable, and accessible urban green space. The Green Ridgewood Team also introduced us to stakeholders from the five other communities that surround the Park: Glen Rock, Paramus, Fair Lawn, Saddle Brook, and Rochelle Park. As part of our research, we were able to interview these stakeholders to deepen our understanding of the individual and collective impacts of flooding. We were also fortunate to speak with local, county, and state officials to round out our knowledge.

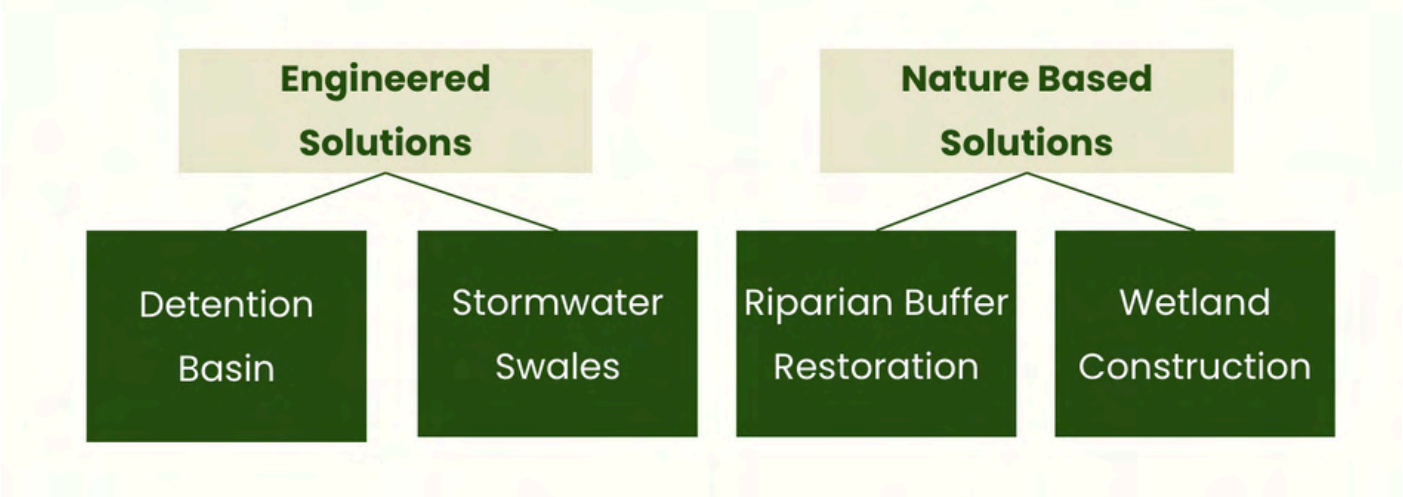
We had one overarching goal, it is to help transform the Saddle River Park into a regional model of resiliency and sustainability.

The project addressed climate-related challenges, especially flooding, the economic impacts from flooding and how to mitigate flood risks. It also addressed a myriad of safety issues, such as deferred maintenance, riverbank erosion, e-bike use, broken pathways for walking and biking, unmaintained trails, and poor lighting, as examples. Finally, the role of the communities in shared decision-making focus on creating opportunities to "voice" concerns and help shape solutions, emerged as a central theme.

We used a holistic approach to analyze our findings across four components: Environmental, economic, social, and governance. Our key findings and suggested recommendations are contextualized through the sustainability model shown below.



For the environmental aspect, we recommend four key interventions at specific locations in the Park. These interventions fall into two categories: Engineered solutions and nature-based solutions. Engineered solutions include detention basins and stormwater swales. Nature-based solutions involve riparian buffers and wetland construction. We pinpoint locations for these interventions and conduct a cost analysis for all four interventions (See page 49). Our review indicates total initial construction cost for new construction projects is $27,000 per acre, and $71,000 per acre for a retrofit project.



Economically, we focused on flood insurance in Bergen County. In many flood-prone areas, property owners are either not able to secure flood coverage through standard homeowners insurance policies, or they have experienced dramatic increases in insurance premiums. Private insurance companies are actually withdrawing from Bergen County, because it is considered a high-risk market. This flood insurance landscape reveals fundamental structural problems that amplify economic vulnerability across the region.

Our overarching recommendation to address these insurance challenges involves FEMA's Community Rating System (CRS) certification program to encourage proactive risk and floodplain management practices. In CRS, flood insurance premium rates are discounted for communities that meet CRS goals to: Reduce and avoid flood damage to insurable property, strengthen and support insurance aspects of the National Flood Insurance Program, and foster comprehensive floodplain management. Currently, only two of the six municipalities surrounding the Saddle River County Park – Ridgewood and Rochelle Park – participate in CRS and are certified. We encourage the four other communities to actively pursue CRS certification.

Our recommendations on social aspects emphasize park safety for the well-being of all individuals who use it for recreation purposes. As previously noted, these concerns cover a wide range of deferred maintenance issues, as well as damaged physical and environmental infrastructure. There is inadequate signage/markings on pathways and lighting in tunnels which pose a safety hazard for pedestrians and cyclists. Creating more effective communication channels within Bergen County Parks, addressing the deferred maintenance in a more centralized manner, and promoting equitable access for all visitors, are among our recommendations.

An important theme that emerged through stakeholder interviews is governance. Throughout our research, we have come to understand the breadth and depth of embedded expertise across all six communities. From green teams, environmental committees and environmental commissions, town engineers, historians and clerks, elected officials, citizen scientists, and teachers, we have discovered an enormous and shared repository of knowledge and skills.

We believe that providing more formal ways to bring together these stakeholders can support collective efforts for mitigation, safety, and park maintenance. The next step is to establish a Task Force that can articulate the shared issues, organize, and prioritize them, while seeking a place at the table for input and authentic co-decision making with county and state agencies, and the NJ state legislature.

It would be essential to have a sponsor for the Task Force, and we would suggest, James J. Tedesco, III, the Bergen County Executive.

Additionally, we advise creating a Consortium of Communities to foster open and effective communication on addressing sustainability issues in the Park and the respective municipalities. One universally held idea is to design and develop an Environmental Living Laboratory to educate the next generation of environmental leaders. The living laboratory model fosters programming that integrates environmental and ecological research, education, and training to develop and test environmental solutions. By design, a living laboratory engages educational institutions, non-profit environmental conservation organizations, and public-private philanthropic partnerships.

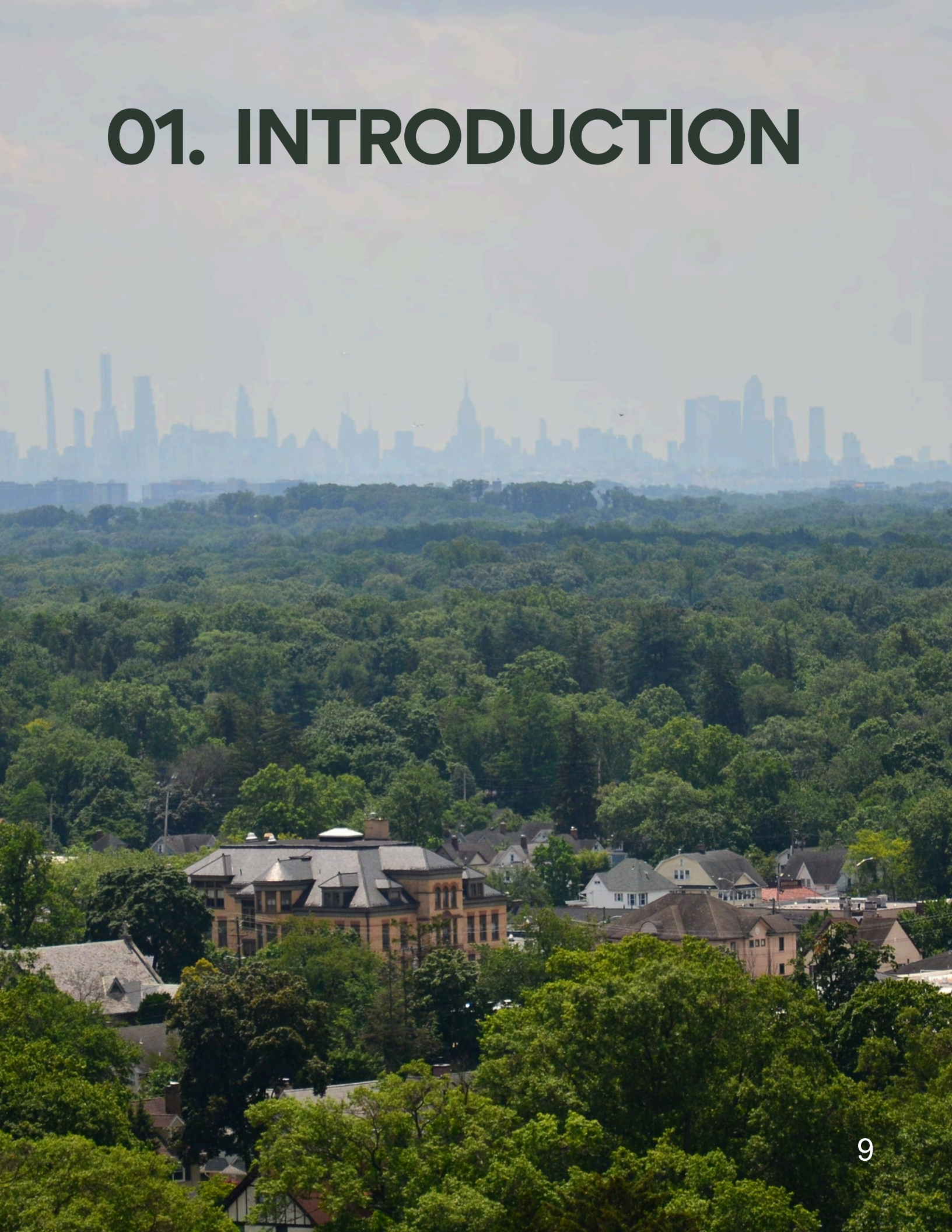
The establishment of The Saddle River Trust is proposed to foster and implement flood mitigation measures, safety and well-being initiatives, and the Living Laboratory. The Trust will manage and disburse funding for these measures. Funding for the Saddle River Trust will come from municipal bonds, tax revenue through the establishment of a Special District, and grants through philanthropic partnerships.

It is essential to stress that our governance recommendations are articulated in the spirit of collaboration with the county and state agencies responsible for the Park and the Saddle River (and its feeder, the Ho-Ho-Kus Brook): The Bergen County Parks Department and the New Jersey Department of Environmental Protection (NJ DEP), respectively. By working together, the communities and agencies are more likely to develop innovative solutions to existing challenges and advance the efforts to secure necessary resources for meeting those challenges. Resources could also be deployed for the County Parks Department professional staffing, such as a full-time naturalist, GIS and data analysts, and information analysts, communication and Safety Specialists.

From a funding perspective, we have identified three viable pathways to finance our recommendations. Each of these solutions should be undertaken in succession. First, increase funding to the Open Space Trust through a referendum. Second, pursue a collective municipal bond issuance, and lastly, establish a Special Purpose District for the long-term planning and capital-intensive projects required to transform Saddle River County Park.

Lastly, we have created a roadmap with a phased approach that we believe is key to successful implementation. Through the holistic review encompassing environmental, economic, social, and governance issues, along with the urgent need for cooperation with Bergen County Parks, NJDEP, and the Army Corps of Engineers, Saddle River County Park can be transformed into a resilient and sustainable greenspace for generations to come.

01. INTRODUCTION



The Master of Science in Sustainability Management Program (SUMA) is one of Columbia University's seventeen graduate programs in the School of Professional Studies. The program is designed for current and aspiring leaders who wish to pursue public, private, and nonprofit careers in sustainability. Within the program, a team of graduate students engages with "real-world" clients to address an urgent and contemporary sustainability issue or problem through SUMA's Integrative Capstone Workshop. The rationale for the Capstone Workshop is that it serves as the integrative educational experience for students in this program, fostering a team-based experience as a pro bono sustainability consulting team. For the client, the team undertakes extensive desktop and expert interview research and analysis to produce findings and recommendations in a final report. This is presented to the client, and the report is also published on the Sustainability Management program's website.

This report represents the effort of our team: Mitchell Lo (Project Manager), Ashmi Kuvera (Deputy Project Manager), Anthea Amalia, Jennifer Ayala Pascasio, Syafitri Firmanputri, Lailah Hall, Ashley Harris, Kierra Holowachuk, Leo Le Moal, Elyssa Pergola, and Anastasya Tioria. With different academic backgrounds and professional expertise, each member contributed a unique perspective to the capstone project for Saddle River County Park.

The Columbia University team would like to express our gratitude to our faculty advisor, Dr. Nancy Degnan. Her guidance, encouragement, and unwavering support were fundamental in shaping our approach and ability to navigate the project with clarity and purpose.

THE TEAM

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CLIENT OVERVIEW

DAVID REFKIN
CHAIRPERSON

JOAN HUBERTUS
MEMBER

ALINA MORDKOVICH
MEMBER

David Refkin (Chair), of Green Ridgewood and colleagues, Alina Mordkovich (Member) and Joan Hubertus (Member), Green Ridgewood, Environmental Committee served as clients for the project. Green Ridgewood assists the Village Council in long-range planning concerning environmental issues, identifies and anticipates environmental challenges, and researches and recommends sustainable solutions. We wish to express our gratitude for their guidance and feedback over the duration of this study. Each has been instrumental in building our understanding of the challenges facing the Saddle River County Park; and their guidance has been essential in addressing the complexities facing the Park and, by extension, the six communities it serves.

We have also engaged with Pamela Perron (Deputy Mayor, Ridgewood, New Jersey and Village Council Liaison) to Green Ridgewood, and Christopher Rutishauser (Village Engineer), and have benefitted by their advice, insights and feedback.

In addition to Green Ridgewood, we would like to acknowledge the five other municipalities that surround Saddle River County Park: Glen Rock, Paramus, Fair Lawn, Saddle Brook and Rochelle Park.

ACKNOWLEDGEMENTS

We would like to express our gratitude to all the individuals who generously shared their time, insights, and experiences with us through interviews and questionnaires conducted by the research team.

Kati Angarone, Chief Strategy Officer, New Jersey Department of Environmental Protection (NJDEP)

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Samuel Bouveron, Member, Team Rochelle Park

Wendy Dabney, Fair Lawn Environmental Committee (FLEC) Chair, Fair Lawn Commission

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Beth Griper, Managing Director, Municipal Bonds at MacKay Shields

Candy Hall, Acting Chair, Glen Rock Environmental Commission

Alexander Heil, Adjunct Lecturer, Columbia University School of Professional Studies

Terry Higgins, Member, Glen Rock Environmental Commission

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Upmanu Lall, Director, The Water Institute at the Julie Ann Wrigley Global Futures Laboratory, Professor, School of Complex Adaptive Systems, College of Global Futures, Arizona State University

Peter Lo Dico, Township Clerk, Saddle Brook

Miles Luo, Teacher, Ridgewood High School

Ben Meyer, Member, Glen Rock Environmental Commission

Ed Morley, Member, Glen Rock Environmental Commission

Jill Orlich, Liaison to Glen Rock Environmental Commission and Council member

Shetal Oza, Administrative Analyst, New Jersey Department of Environmental Protection (NJDEP)

Pamela Perron, Deputy Mayor, Village of Ridgewood, Village Council Liaison to Green Ridgewood

Michael Puma, Professor of Climate; Director in the Center for Climate Systems Research, the Climate School, Columbia University

Chris Rutishauser, P.E., CPWM Village Engineer and Director of the Department of Public Works, Village of Ridgewood

Elaine Silverstein, Member, Glen Rock Environmental Commission

Erika Smull, PhD, Senior Research Analyst, Municipal Bonds at Breckenridge Capital Advisor

Sue Tyrofos, Member, Glen Rock Environmental Commission

Lisa Swain, Assemblywoman, Appropriations Chair, 38th Legislative District in the New Jersey General Assembly

Michael Warren, Chairperson, Team Rochelle Park

OVERVIEW

The Saddle River County Park in Bergen County, New Jersey, faces increasingly severe flooding, driven by a changing climate. The Park spans 587 acres and follows the course of the Saddle River (Bergen County, n.d.). Natural drainage patterns, shaped by the region's geology and glacial history, formed the Saddle River itself. The River originates near Spring Valley, New York, and flows south through Bergen County for approximately 23 miles before joining the Passaic River in Garfield, New Jersey (Conte, 1980). Six communities adjoin Saddle River County Park: Ridgewood, Glen Rock, Fair Lawn, Paramus, Rochelle Park, and Saddle Brook. Within these communities, 13 key groups engage with the Park and river, as shown in Figure A.

The New Jersey Department of Environmental Protection (NJDEP), oversees and regulates the river, and the Bergen County Department of Parks, operates and manages the Park. Their working relationship is cordial, but not notably proactive, particularly for flood risk mitigation, joint visioning, strategic planning, and coordinated community response to issues stemming from deferred maintenance, such as safety concerns, conservation needs, and erosion repairs. Both agencies are responsive only when emergencies take place.

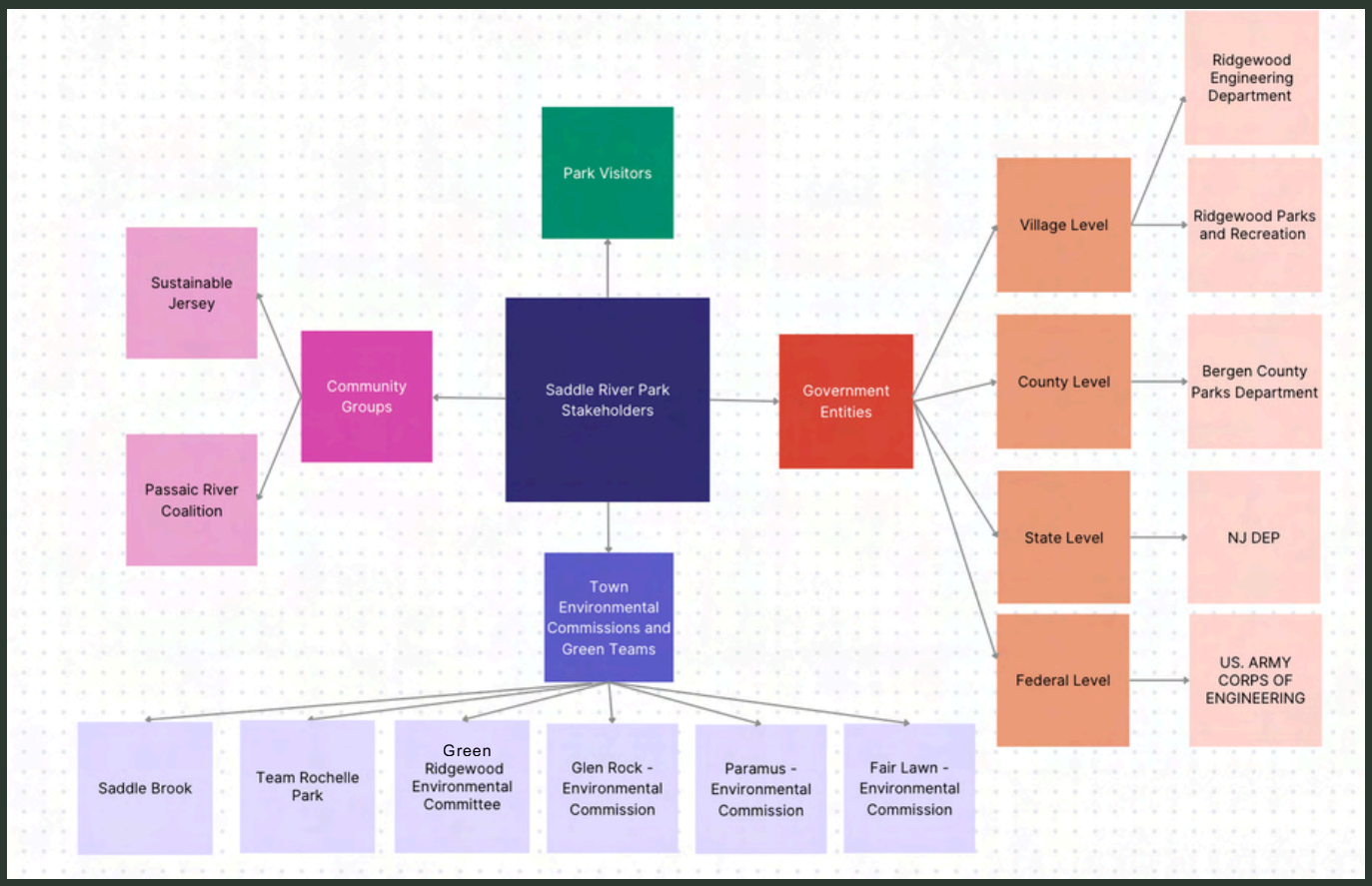


Figure A. Key stakeholders mapping
Source: Created by the team through stakeholder identification process

RESEARCH APPROACH

As part of the Master of Science in Sustainability Management Program at Columbia University, we partnered with Green Ridgewood, Environmental advisory committee.We undertook an assessment of the Park to identify opportunities for enhancing its sustainability and resilience. In this context, resilience refers to the Park's ability to withstand, adapt to, and recover from climate-related challenges.

We conceptualized a "model of sustainability" based on the objectives of: 1.) Flooding and flood risks mitigation; 2.) Park safety, community, and individual wellbeing; and, 3.) Dynamic engagement across the Park's six communities and the jurisdictional governmental agencies at the County and State levels. We also sought to ensure that our model: Informs strategic, actionable recommendations in alignment with the objectives; Provides insights on how to fund necessary infrastructure investment; Drafts a "roadmap" with achievable milestones.

We approached the design and development of a model of sustainability by using a systems thinking that integrates environmental, economic, and social components, while also acknowledging the importance of governance. Governance, particularly from a community-based perspective, is essential for achieving, maintaining, and reinforcing equity. Its function is to support shared decision-making and encourage accountability and transparency.

The team focused on six main work streams:

- Literature Review
- Stakeholder Engagement
- Data Analysis
- GIS Analysis
- Cost Analysis
- Systems Analysis

The six workstreams supported the team in identifying specific, critical information for the Saddle River County Park. All six teams' research propelled the project toward understanding the core issues faced by various stakeholders. Analyzing peer-reviewed articles and reports, interviewing stakeholders, collecting data, conducting GIS and cost analyses, and examining the interconnectedness of different system components and their mutual influences, we uncovered core issues across the environmental, social, economic, and governance regions.

The Literature Review team explored case studies and peer-reviewed articles and reports to identify successful projects with similar characteristics to the Park. The research process involved reviewing best practices, financial models, and implementation frameworks from comparable projects. The aim was to determine which strategies and funding approaches could be adopted for potential implementation.

The Stakeholder Engagement team interviewed 23 experts who gave important insights about the critical and interconnected issues that need structured approaches for flood mitigation and community resilience. The intention was to gain insight into challenges each community faces while also highlighting potential solutions. Our client provided the list of expert stakeholders. These experts comprise members of environmental committees, environmental commissions, and green teams, as well as public sector officials from the municipal, county, and state levels. The team also interviewed Representative Lisa Swain, former mayor of Fair Lawn and current member of the New Jersey State General Assembly. Finally, a number of academics and professionals from the private sector provided environmental and economic recommendations. Each interview lasted approximately one hour and was conducted over Zoom, with one expert opting to submit their responses in writing.

This qualitative approach provided valuable context for the analysis, grounded the recommendations in the lived experience, and established the priorities of those most closely connected to the Park and the surrounding community. For general and specific questions asked in our interviews, please refer to Appendix 6.

The Data Analysis team investigated key datasets to quantify the problem, including flood records, socioeconomic data, topographic maps, and biodiversity data. The list of the data used in the analysis, along with the resource from NJ DEP, is referred to in Appendix 7. The team then met with industry experts to seek guidance on interpreting the data and identifying next steps.

The Geographic Information System (GIS) team analyzed collected data to identify trends and criteria associated with specific land parcels and to determine where interventions would be located.

The Cost Analysis team identified the cost for each intervention by referencing literature or research for dimensions (per acre or foot) and multiplying those values by the total area provided by the GIS team.

The Systems Analysis team mapped and analyzed the four primary regions: Environmental, Economic, Social, and Governance, as shown in Appendices 1 - 4. Because the challenges are complex and interconnected, the team applied a systems thinking approach to understand the broader context, identify key trends, and uncover high-impact opportunities. Systems thinking allowed the team to methodically explore how variables interact with one another, for example, how urban infrastructure contributes to actual flood damage. The output of the systems analysis is a system map composed of several interconnected loops. Key loops will be referenced throughout the report sections to illustrate the dynamics within specific areas of study.

Through the system mapping, the team identified Actual Flood Damage as the key variable to optimize. The analysis involved mapping correlations and causations between contributing factors and visually representing these relationships as part of our analytical process. The team assessed whether feedback loops were reinforcing loops, which amplify current behavior, or conversely balancing loops, which stabilize the system. This structured method provided a clearer understanding of the current landscape previously described and helped frame flood mitigation strategies within a dynamic, interconnected system. By taking a systems thinking approach to the task, the team developed multiple recommendations while recognizing that no silver bullet solution exists when working in systems.

CORE ISSUES

Addressing the challenges facing Saddle River County Park requires looking beyond its boundaries. Protecting the Park depends on help from the surrounding neighborhoods, just as protecting those neighborhoods depends on the Park's capacity to mitigate flooding. This interdependence means that solutions cannot focus solely on park operations. They must also address the broader systems and communities that shape the Park's resilience. Ultimately, the Park and its neighbors will succeed or fail together. The following section outlines the core environmental, economic, social, and governance issues that define this shared challenge.

Environment:

The NJ Climate Overview describes how New Jersey's "geographic location results in the State being influenced by wet, dry, hot, and cold airstreams, making for daily weather that is highly variable" (Rutgers University Climate Lab, n.d.). Although New Jersey is one of the nation's smallest states (land area of 7,836 square miles), it encompasses five distinct climate zones: The Northern Climate Zone, the Central Climate Zone, the Southwest Climate Zone, the Pine Barrens Climate Zone, and the Coastal Climate Zone. These diverse climate zones lead to differences in seasonal patterns, temperature extremes, and precipitation levels in relatively short distances. As a result, communities within New Jersey experience climate-related risks such as flooding, heat waves, and drought at varying intensities. As shown in Appendix 5, Saddle River County Park faces particular vulnerability to extreme weather because it lies between two of these zones : the Northern Climate Zone, which experiences twice as many thunderstorms as the coast, and the Central Climate Zone, which brings frequent heat waves and high pollution levels from industrial activity. The overlap of these two zones exposes the Park and surrounding communities to increasingly volatile weather patterns. Figure B illustrates the increasing instability of precipitation, based on data collected from NOAA. In 2024, rainfall followed an increasingly erratic pattern instead of a predictable seasonal trend. The bars represent actual monthly rainfall in 2024, while the line shows the normal seasonal pattern. Rainfall swung dramatically rather than maintaining a steady trend: On average, eight months recorded precipitation levels over 35% above normal (January 2024 - August 2024), and four months recorded levels 42% below average (September 2024 - December 2024). These monthly extremes illustrate the growing volatility: August was 127% above normal, followed by September at 75% below, and October saw virtually no rainfall at all.

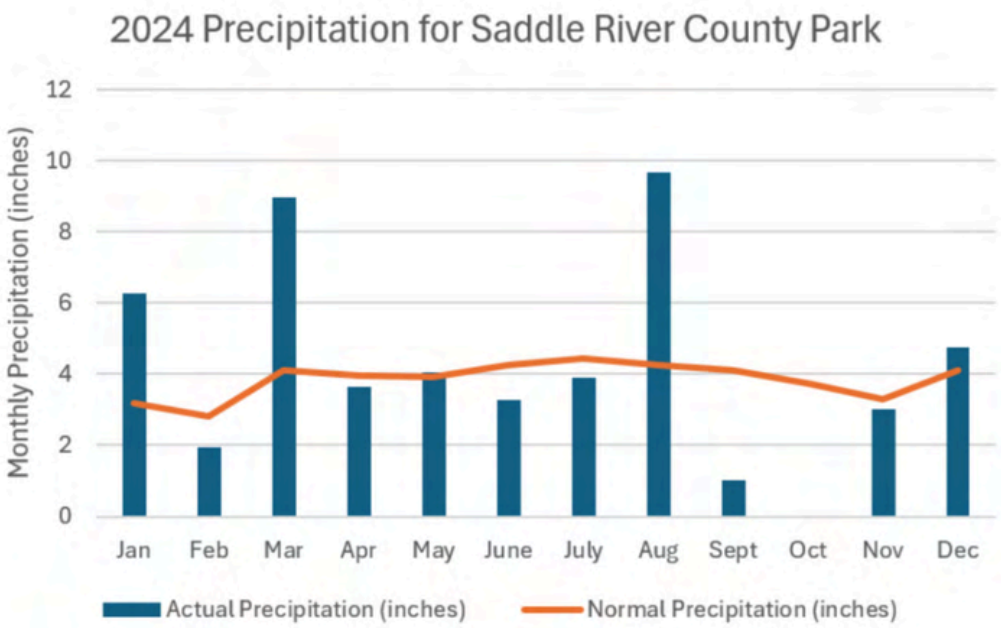


Figure B. 2024 Precipitation for Saddle River County Park
Source: Chart created by the team using NOAA data

These extremes can no longer be viewed as anomalies. They strain already aging local infrastructure, limit the reliability of planning tools, and leave communities more vulnerable to disaster. Our environmental analysis, viewed through a systems thinking lens, revealed a clear pattern of oscillation, shifting from heavy precipitation to intense periods of drought, as illustrated in Figure C with the R1 - Precipitation Loop and the R2 - Heat Waves Loop. Expanding urban development reinforces these fluctuations and drives an increase in actual flood damage. These reinforcing loops suggest the region has entered a cycle increasingly difficult to break without targeted intervention. The region is fluctuating between too much and too little water and Bergen County now ranks as the most flood-impacted area in the United States, highlighting the urgent need for adaptation (Magerl, 2025).

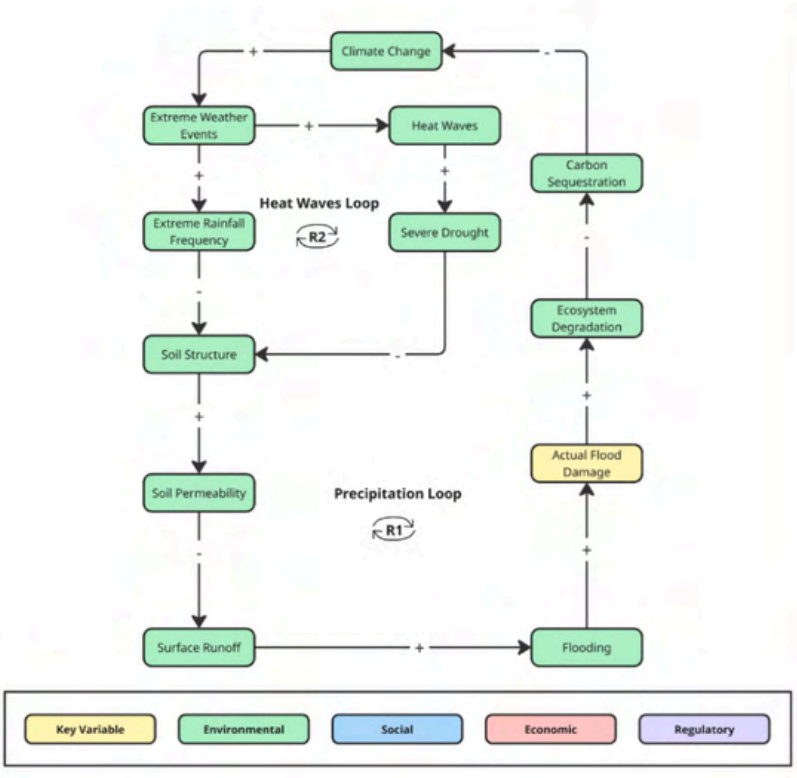


Figure C. Oscillating Environmental Extremes

Economic:

Bergen County faces mounting pressure from a climate-driven insurance crisis that threatens the foundation of municipal finance. Insurance non-renewal rates have increased nearly 70% between 2018 and 2023 across New Jersey (Senate Budget Committee, 2024). This trend reflects a broader market failure where residential properties exposed to flood risk are overvalued by $121-237 billion nationwide (Gourevitch et al., 2023). The implications extend far beyond individual homeowners, as municipalities heavily reliant on property taxes face potential budgetary shortfalls that could destabilize the municipal bond market, responsible for financing over 70% of U.S. infrastructure.

Social:

Throughout our research and stakeholder interviews, we identified several key social issues affecting the Park and the surrounding community. Three major social implications arose from our research. First, recurring flooding threatens citizens' well-being and limits access to the Park, particularly after extreme weather events. Second, safety concerns have emerged, including an absence of sufficient lighting, signs, and the absence of clearly marked lanes for pedestrians and cyclists. One of the tunnels often gets flooded and filled with mud and silt, while two of the tunnels are often closed due to flooding and the risk of drowning.

Broken path edges damaged from flooding pose significant safety risks. These conditions emphasize the urgent need for infrastructure improvements to ensure safe and reliable access for all park visitors.
Moreover, the rise of fast-moving e-bikes and scooters on shared-use paths has emerged as a safety hazard risk. Third, recreational infrastructure is aging and underdeveloped, limiting the quality and accessibility of outdoor experiences for residents.

Governance:

Saddle River County Park is located along the Saddle River, spanning six municipalities. While the communities share common goals around making the Park more sustainable and resilient, formal coordination is limited as the communities act independently with limited coordination. Bergen County and the Bergen County Parks have jurisdiction over the Saddle River County Park. NJDEP has jurisdiction over the Saddle River. From stakeholder interviews, what seems apparent is that the governmental agencies do not effectively coordinate efforts to mitigate flooding and flooding damages; nor do they have information systems to curate community concerns, or management systems to measure effectiveness.

Governance can reverse disjointed planning and management; and, in turn, may comprise immediate and more long-term, system-wide interventions.

For example, the Bergen County Parks operational and capital improvement budgets are not separated out by each county park. The capacity to prioritize improvement projects is impacted. Integrated governance and leadership that can focus on cross-jurisdictional planning, funding, and actions are important for operational integrity. Developing Key Performance Indicators (KPIs) are essential for effective long term management.

Moreover, based on stakeholder interviews, residents feel that their voices go “unheard”, particularly around safety and flood mitigation. Limited public input reduces buy-in for proposed solutions, and slows down implementation and willingness to fund much-needed interventions.

A resilient, inclusive park system can be built with the active participation of the people in surrounding communities. Strengthening cross-town collaboration and creating accessible channels for community involvement are essential steps toward protecting the Park and the neighborhoods it serves.

As a representative noted, now is the time to formalize collaboration through a dedicated Task Force. Such a body could unify local voices, push for integrated planning and investment, and work collaboratively with governmental agencies.

02. FLOODING IMPACTS

Overview

Northern New Jersey is a densely populated area with large concentrations of impervious surfaces, making it vulnerable to climate risks. Specifically, the towns in Bergen County have areas that are densely urban, with few trees or natural water bodies. These large areas of impervious surfaces (buildings and roads) prevent water absorption and retain heat, creating an urban heat island (UHI) effect. UHIs are significantly hotter than their surroundings, with land temperatures higher than air temperatures (United States Environmental Protection Agency, 2014).

Figure D illustrates how Bergen County is affected by this phenomenon, with concentrated red areas indicating land surface temperatures exceeding 100°F. When heavy rains occur, the lack of pervious surfaces only increases the risk of flooding. This is due to three main factors:

1. Intense heat can intensify local convection, leading to heavier rainfall.
2. Prolonged heat waves dry out the soil, reducing its ability to absorb water.
3. Heat weakens infrastructure, making it more vulnerable to flood damage.

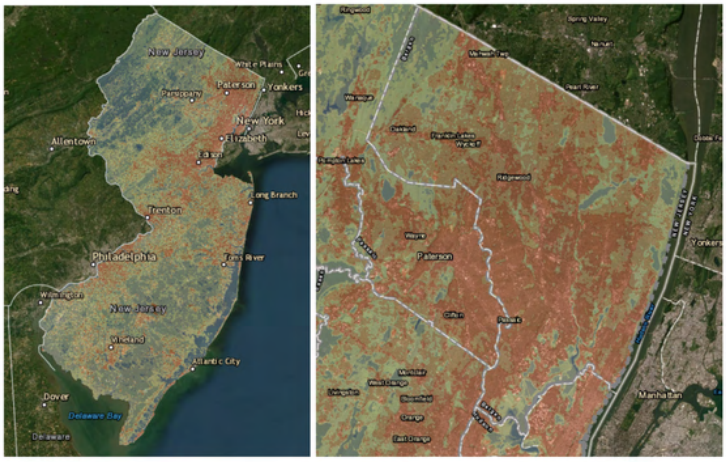


Figure D. Land Surface Temperature for Bergen County, New Jersey, Summer 2022
Source: ArcGIS

Saddle River County Park sits at the western edge of Bergen County, intersected by the Ho-Ho-Kus Brook and the Saddle River, as shown in Figure E. The Park adjoins communities with a population of approximately 120,000 residents and is one of the largest retail shopping areas in the United States.

Stormwater from surrounding communities is funneled into the Saddle River, during heavy rainfall. The flow often exceeds the Park's stormwater capacity, increasing the flood risk. This vulnerability, along with the Park's geographically exposed location, underscores the urgency of addressing flood threats. This Section explores how water flowing through Saddle River County Park may contribute to flooding across six municipalities, FEMA flood maps and risk indices are used. GIS tools help with visualizing the analysis.

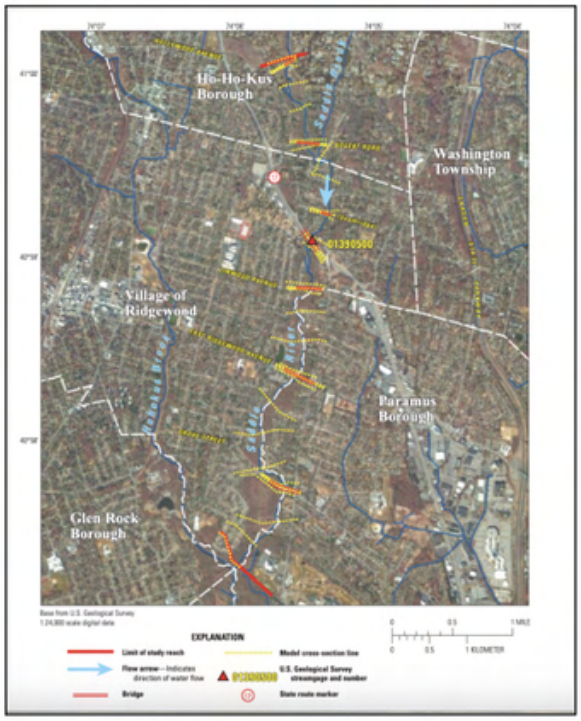


Figure E. Map of Saddle River and Surroundings
Source: U.S. Geological Survey, 2014

Historical Flood Events

Bergen County is highly vulnerable to flooding due to its dense development and proximity to several river networks, including the Saddle River, Hackensack River, and Passaic River. Flooding is one of the most common natural hazards in the county and consistently ranks among the top priorities for municipalities.

Over the last 50 years, Bergen County has experienced numerous severe flood crisis' that caused significant property damage. In August 2011, Hurricane Irene struck areas of New Jersey and recorded up to 11 inches of rainfall in just 24 hours. This caused riverine flooding across Bergen County. Saddle River in Lodi was recorded at its highest peak observed in 87 years of monitoring. Another significant event was during Hurricane Ida in September 2021 as flash floods left homes and vehicles submerged, prompting Bergen County to declare a state of emergency.

Due to the recurring flood hazard risks, we visualize, analyze, and present flooding solutions focusing on areas in proximity of the Saddle River. With local and federal agencies already acknowledging these flood hazard risks, our work aims to support long-term flood resilience as we provide spatial and quantitative data to propose a set of initiatives and prepare for future mitigation strategies.

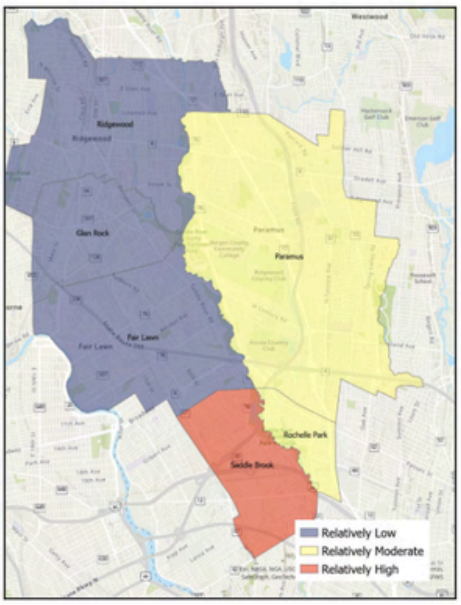


Figure F. Risk Index FEMA

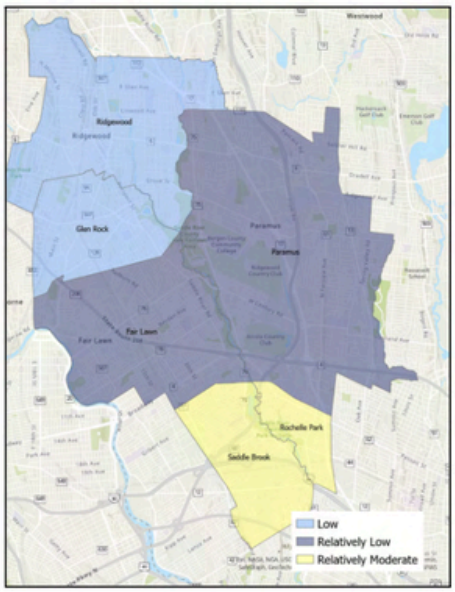


Figure G. Social Vulnerability FEMA

To evaluate hazard exposure in Bergen County, we used FEMA's National Risk Index (NRI). The FEMA NRI is used to quantify the potential impacts of natural hazards and social vulnerability of communities across the United States. Risk Index Scoring, a social vulnerability scoring, was used in our analysis. Using the scoring, we are able to map the vulnerability and risk index as seen in Figure F and G.

Risk Index Scoring was used in our analysis. Below describes how this to defined.

1. Risk Index Scoring

The Risk Index Score is FEMA's metric used to measure overall natural hazard risk exposure across locations. The following formula gives FEMA their score per county census area:

$$\text{Risk Index} = \text{Expected Annual Loss} \times \text{Community Risk Factor}$$

$$\text{where Community Risk Factor} = f\left(\frac{\text{Social Vulnerability}}{\text{Community Resilience}}\right)$$

This Risk Index score is calculated from three components:

- Expected Annual Loss: The dollar value of average annualized losses from natural hazards (property value, population impacts, and agriculture).
- Social Vulnerability: Social factors that may affect a community's ability to respond to and recover from disasters.
- Community Resilience: A score representing community capacity to mitigate, prepare for, and recover from natural hazard risks (based on infrastructure, emergency response, etc.).

Additionally, the Expected Annual loss is determined from an equation that combines values from exposure, annualized frequency, and historic loss across 18 natural hazards.

$$\text{Expected Annual Loss} = \text{Exposure} \times \text{Annualized Frequency} \times \text{Historic Loss Ratio}$$

FEMA then aggregates these components to calculate a Risk Index score from 0-100. In our study, we used the values between individual FEMA reports and averaged the scores for each census tract within the same municipality in order to assign a single risk category.

2. Social Vulnerability Scoring

The Social Vulnerability Score is based on the CDC's Social Vulnerability Index and measures the susceptibility of a population to disasters. FEMA assigns each census tract a score from 0-100, with higher scores indicating greater vulnerability and a lower ability to respond to natural hazards.

This vulnerability score plays two crucial roles: It modifies the Community Risk Factor in the Risk Index formula by increasing the impact of natural hazards in more vulnerable communities and it serves as a sole indicator for natural hazard planning as it identifies the communities with less capacity to respond to such events.

For our analysis, we collected the individual Social Vulnerability scores from all census tracts relevant to each of the municipalities shown in the map (Figure G). Scores were then averaged by municipality to reflect the overall social vulnerability against natural hazards across the Saddle River Park area.

Flood Zone Analysis:

To understand flood risk in our study area, FEMA-designated flood zones across six communities were mapped using census data that helped us define neighborhood extents for our analysis.

The FEMA flood zones include the 1 percent annual chance flood area, commonly referred to as the 100-year flood zone, and the 0.2 percent annual chance flood area, known as the 500-year flood zone. To illustrate, there is a 1 percent annual chance of flooding in any given year. Flood zones were overlapped on neighborhood boundaries to visualize and analyze the extent and impact of potential flooding across the region.

The parcel layers are not displayed on the map to avoid visual overcrowding; they were used to estimate overall exposure to flooding. This included calculating the number of parcels affected by flood zones and the total net value of affected properties, reflecting both land and building value of properties across Bergen County. The figures shown here are only for parcels within six municipalities along the Saddle River County Park. We included only those neighborhoods affected by flooding, whether in the 1% annual chance (100-year) flood zone or the 0.2% annual chance (500-year) flood zone. To better illustrate what a 100-year storm is, a 100-year storm in Bergen County is 11.60 inches of rain in a 24 hour period.

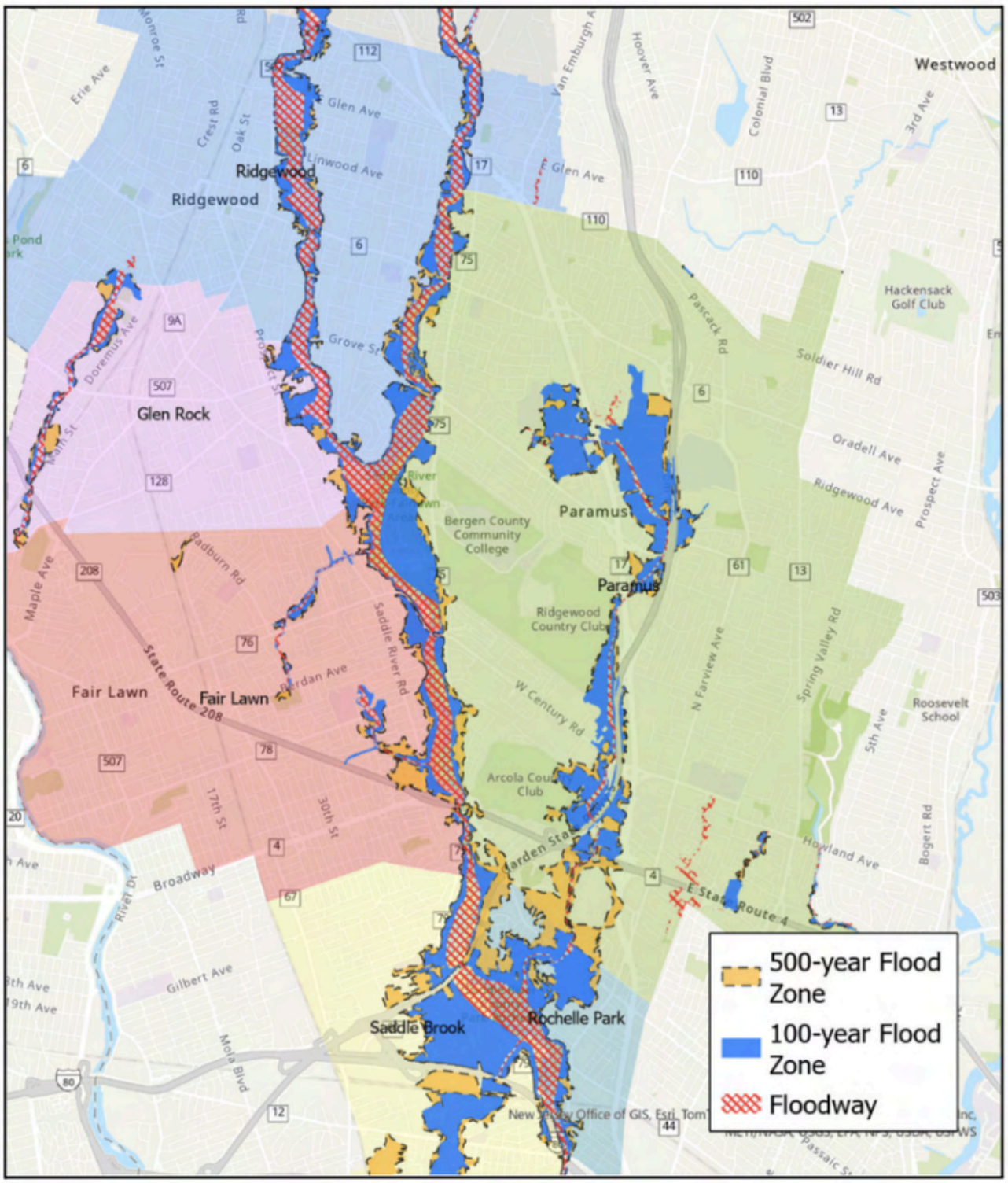


Figure H. Flood zone based on FEMA flood maps

The majority of exposure is in the parcels located in the 1% flood zone, for instance, around 3,200 parcels whose combined net value was more than $4.8 billion were exposed. In contrast, the 0.2% flood zone affects an additional 2,600 parcels valued at $2.2 billion. Residential buildings make up the largest share of both zones, with over $2.2 billion in value across more than 5,000 parcels. Commercial and public properties also show significant exposure, with commercial parcels in the 1% flood zone alone totaling over $3.6 billion in value. These numbers show that a large portion of the built environment is at risk, especially in high-density residential areas and commercial corridors (Figure L).

Parcel Analysis

Building Type	Flood Category	Parcel Count	Total Net Value ($)
Commercial_Industrial	0.2% Annual Chance Flood	155	$963,936,400.00
Commercial_Industrial	1% annual chance flood	290	$2,654,491,500.00
Public_Property	0.2% Annual Chance Flood	114	$296,245,400.00
Public_Property	1% annual chance flood	413	$999,137,000.00
Residential	0.2% Annual Chance Flood	2346	$1,022,019,800.00
Residential	1% annual chance flood	2574	$1,236,788,100.00
	SUM	5892	$7,172,618,200.00

Figure I. Flood zone Analysis per Building Type

Neighborhood Analysis

Neighborhood_Name	Parcel Count	Total Net Value ($)
Fair Lawn	1114	$ 553,419,200.00
Glen Rock	382	$ 364,787,800.00
Paramus	889	$ 3,967,685,500.00
Ridgewood	961	$ 668,597,900.00
Rochelle Park	1298	$ 493,911,500.00
Saddle Brook	1248	$ 1,124,216,300.00
SUM	5892	$ 7,172,618,200.00

Figure J. Flood zone Analysis per Neighborhood

At the neighborhood level, most of the financial exposure is concentrated in Paramus, with about $3.9 billion in at-risk property, followed by Saddle Brook at $1.12 billion and Ridgewood at $668 million. In terms of parcel count, the highest exposure is found in Rochelle Park with 1,298 parcels, Saddle Brook with 1,248 parcels, and Fair Lawn with 1,114 parcels (Figure J).

These numbers indicate that both economic and physical flood risk are unevenly distributed by neighborhood exposure. The greater the exposure, the higher the risk. Some areas like Paramus show higher financial impact, largely due to the presence of high-value commercial and industrial properties. However, the highest number of parcels affected can be found in neighborhoods located in the southern area of the Park, particularly Saddle Brook and Rochelle Park. The total population displacement may be higher, as more homes and residents are directly impacted by flooding.

STAKEHOLDER INTERVIEW INSIGHTS

Stakeholder interviews revealed how flooding has worsened over the years due to climate change and sediment buildup in the Saddle River, reducing its depth from approximately 15 feet to 6–7 feet. This leads to an increase of riverbank overflow that floods Park paths and residential areas. Tree debris and development-related runoff compound the problem. While residents living near the river are directly affected by river flooding, constituents are more concerned about stormwater runoff caused by overdevelopment. The interviews offer important insights into how flooding impacts the lives of community members and the consequences of flooding in the park.

A representative from Rochelle Park explained that the bike path is regularly flooded and unusable. The Park, river, and its river banks are in a state of abandonment. For instance, the continued negligence of maintaining the river banks has caused hundreds of trees to fall into the river, erosion, blockages, sandbars, and changes in the way the river flows.

A representative from Paramus explained that erosion control needs to be monitored and controlled, instead of just reacting and alleviating the situation. They want to be more prepared instead of just cleaning up after a flood or a tree falling down. While the County is quick to clean up issues, there needs to be more planning to avoid this situation.

A representative of Glen Rock, mentioned that the ground is more saturated with water, so when it rains, it floods. Residents have seen an increase in the last few years. Another representative of Glen Rock said that there is an increase in storm intensity and frequency. Also, there has been an increase in perennial flooding just due to buildings and houses. There is also the issue of aging systems in the municipality. Storm drain systems are overloaded. Another representative from Glen Rock mentioned the issue of river erosion.

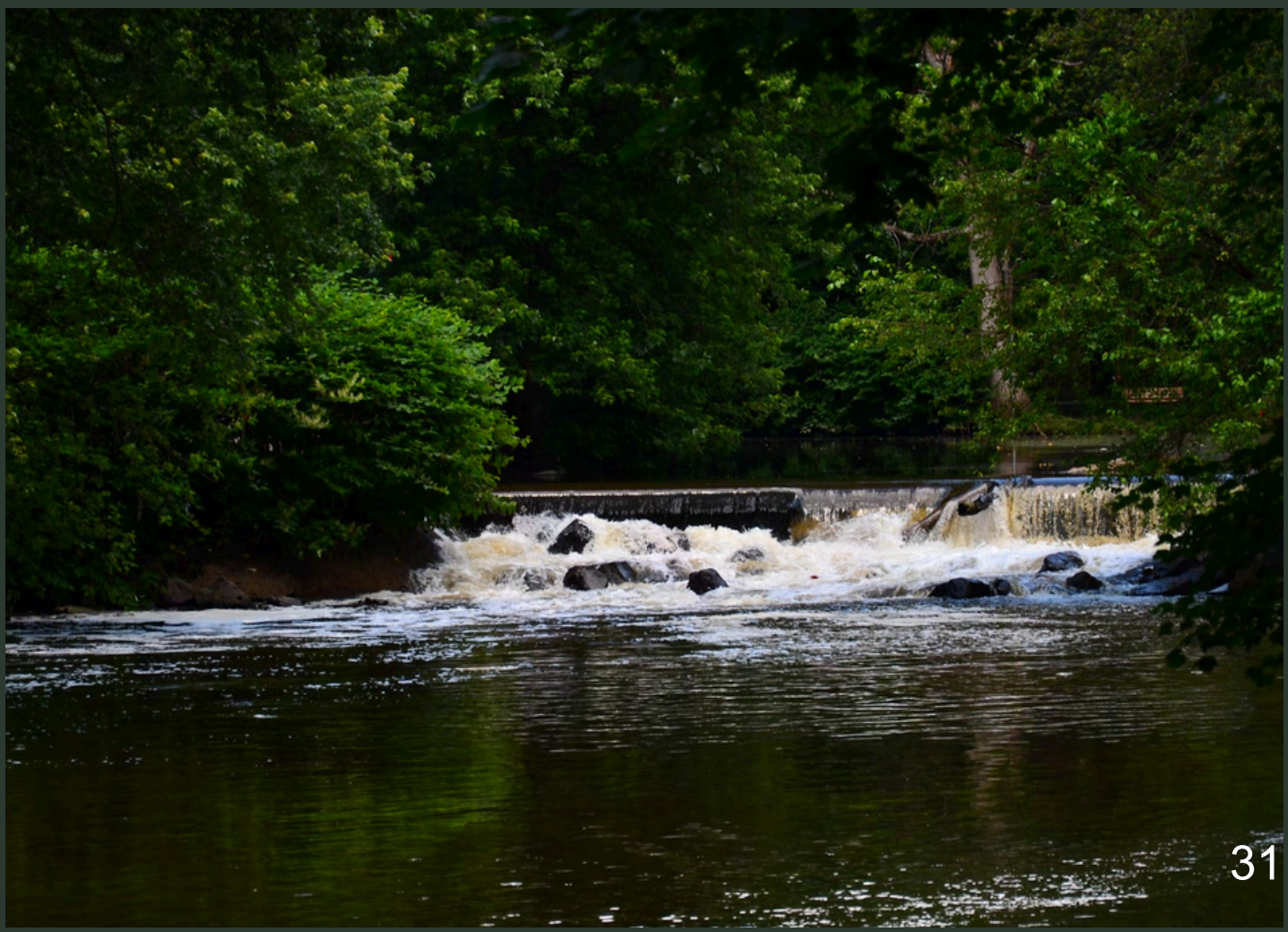
A representative from Ridgewood explained that Ho-Ho-Kus Brook frequently overflows and the water table rises rapidly during rainfall events. Approximately 12 million gallons/day of flow come from nearby wastewater treatment plants, contributing to flooding of the Saddle River.

A representative from Saddle Brook explained that flooding is a concern, especially after heavy rain. There are property damage and safety risks. The banks of the Saddle River in this area show signs of significant riverbank erosion.

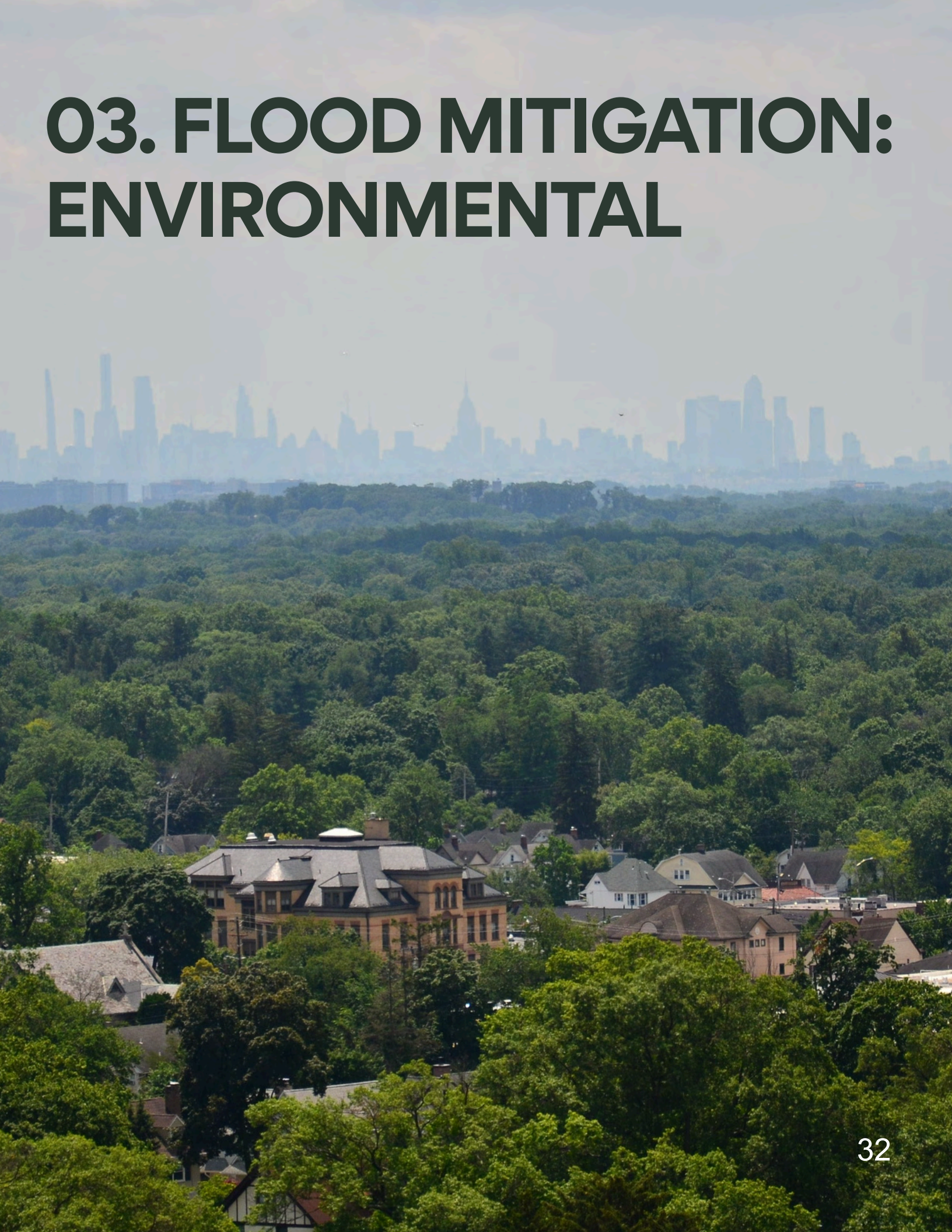
Summary:

Saddle River County Park lies in a region marked by high impervious surface coverage and elevated land surface temperatures, making it especially vulnerable to climate-driven flooding. Stakeholder interviews and data analysis underscore the urgency of these issues. Urban development along the Park's perimeter appears to intensify flood risks, disrupting daily life in surrounding communities.

Financial exposure is particularly highest in Paramus, with nearly $3.94 billion in at-risk property, while Rochelle Park has the highest number of affected households at 1,284. These figures highlight the vulnerability of dense residential areas and commercial corridors across the region. Yet, the Park also offers a unique opportunity to serve as a natural flood buffer. Our analysis shows that the Park holds strong potential to become a sustainable flood mitigation model for Bergen County, especially for the six municipalities it links.



03. FLOOD MITIGATION: ENVIRONMENTAL



Overview

Saddle River County Park is a 587-acre linear park meandering along the Saddle River and its tributary brooks. The Park consists of five areas linked by a multi-use path (Bergen County, n.d.). At the heart of Saddle River County lies a 6.8-mile network of picturesque pathways that wind their way through lush greenery, offering residents and visitors a tranquil escape from urban life. Three popular areas within Saddle River County Park include Ridgewood Wild Duck Pond, Otto C. Pehle Area, and Glen Rock Duck Pond (Snoflo, 2025).

The Ridgewood Wild Duck Pond project in Saddle River Park was a restoration project that focused on restoring ecological function and enhancing the public usage of the existing Wild Duck Pond area. The project began with a proposal solicitation in December 2017 and moved to construction in April 2021. Construction started in July 2021, marked by a groundbreaking ceremony in August 2021, and culminated in a ribbon-cutting ceremony celebrating completion on October 12, 2022. The $1.7 million restoration project included replacing the pond liner, installing fountains and aerators, creating wetland habitats, and implementing stormwater management features (Bergen County, n.d.).

In October 2024, $1 million dollars was allocated through the New Jersey State budget to dredge the wild duck pond in the Otto C. Pehle Area to address flood prevention and promote ecological sustainability in Bergen County (Bergen County Executive Jim Tedesco, 2024). As of the summer 2025, with this report, no explicit deadlines have been set to start the project.

Other than the aforementioned, there are currently no other scheduled flood resilience infrastructure projects.

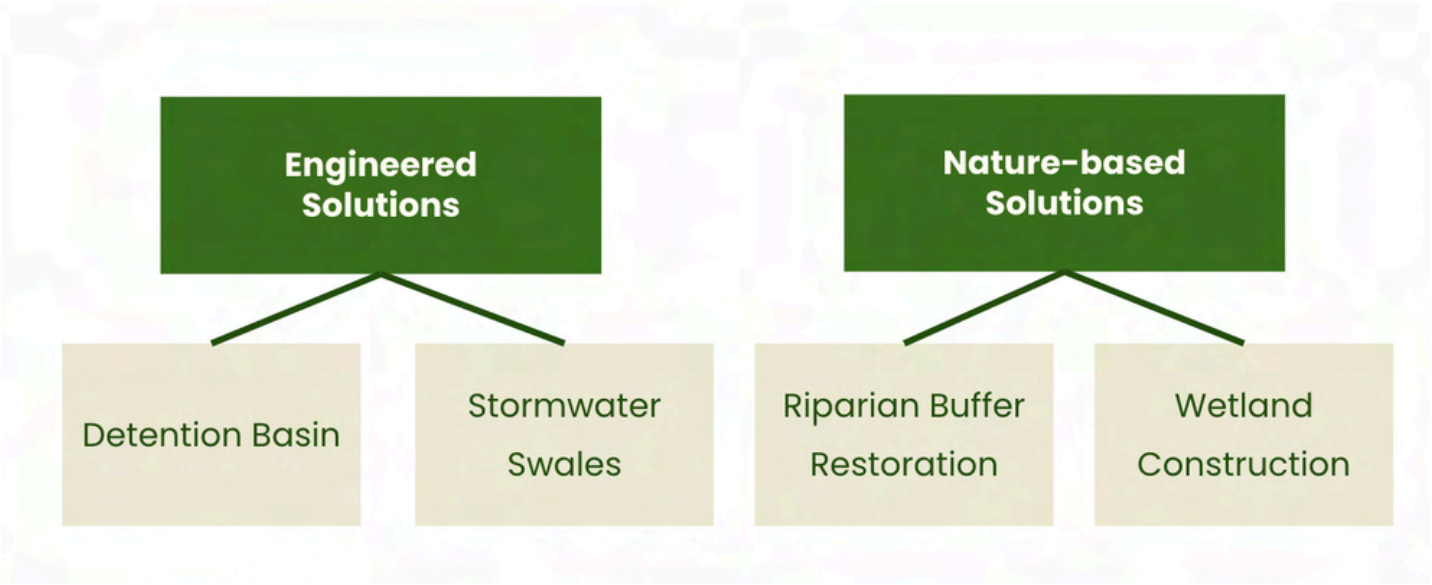
Plants alongside the riverbank must withstand the impact of flooding itself, whereas many trees and their root systems are damaged due to stormwater runoff. This situation is reflected in our environmental system map in the R4 - Riparian Vegetation Loop (Appendix 3), which simultaneously reduces the soil permeability of the ecosystem.

Nature-Based Solutions:

Nature-based solutions are designed to protect, sustainably manage, and restore natural and modified ecosystems, while simultaneously benefiting people and nature (United Nations Environment Programme, n.d.). The article *Nature-based Solutions for Managing Rising Flood Risk and Delivering Multiple Benefits* explains that nature-based solutions can address flood challenges by contributing to a “diversified portfolio,” reducing flood risk and promoting “protection or restoration of riverine ecosystems and their social and environmental benefits” (Opperman & Galloway, 2022). In our recommendation, we are prioritizing nature-based solutions focused on riparian buffers and wetland restoration as effective approaches to mitigate flooding and strengthen ecological resilience.

Most of the locations chosen for the recommended interventions are mainly near the Park. Several measures are selected within the communities to reduce rainwater runoff. Reducing or delaying stormwater runoff decreases the amount of stormwater entering waterways like the Saddle River. The placement of detention systems is key. Targeting commercial zones on Route 17, as well as large impervious surfaces like parking lots, is beneficial for effective stormwater management. For example, the upcoming renovation of Westfield Mall/Garden State Plaza is a potential location to install underground detention systems. With its proximity to Sprout Run, these detention systems can significantly reduce flooding.

Recommendation: Four Interventions



Engineered Solutions:

Engineered solutions refer to interventions for flood mitigation that involve man-made structures and systems aim to reduce the flooding impact (Fiveable, 2024). Examples of engineered solutions include levees, floodwalls, and dams. The engineered solutions discussed in this report consist of two structures: detention basins and stormwater swales.

Intervention I: Detention Basins

I. Introduction

A detention basin is an engineered stormwater management system designed to temporarily store runoff and release it slowly at a controlled rate, reducing the risk of flash flooding by lowering peak flow rates downstream. In Saddle River County Park, this intervention is particularly effective in mitigating flood damage as upstream development and climate change have increased the frequency and severity of flooding. Reduced soil permeability, higher stormwater volumes, and the risk of overwhelming natural waterways make detention basins a strong candidate for local flood mitigation. Detention basins can decrease peak flow rates by 30-83%, depending on the measurement location (Zariello, 1996). These systems can be built as above-ground basins, such as ponds or landscaped depressions, or underground, located beneath parking lots or sports fields, preserving surface use while still providing flood storage.

Figure K : Underground detention basins
Source: Cultect, Inc, 2024

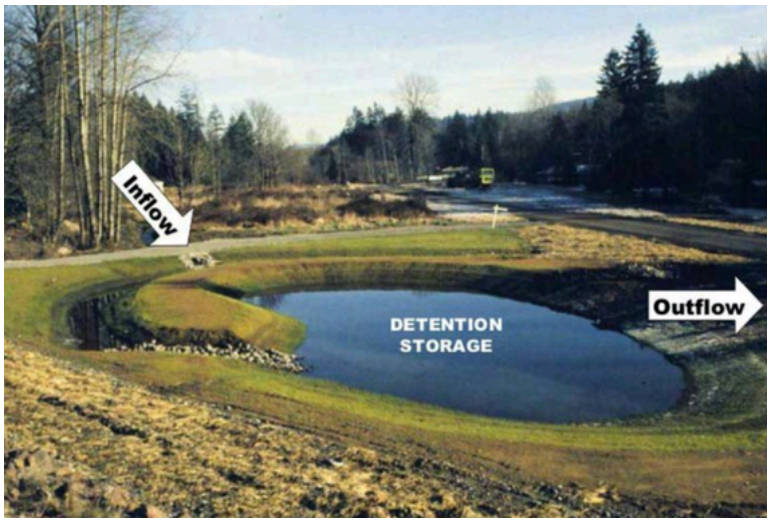


Figure L : Above Ground detention basins
Source: Booth & Bledsoe, 2009

By implementing detention basins, the community can minimize property damage and threats to life during flood events. Furthermore, controlling stormwater runoff helps with reducing downstream erosion and flooding, enhancing groundwater recharge, and protecting the water quality of stream channels. This strategy aligns with the Borough of Saddle River's Municipal Stormwater Management Plan, which identifies detention basins as a key tool for effective and sustainable flood risk management (Spence, 2018).

Figure M on page 37 highlights three areas for detention basins. The area labelled 1 is Otto C. Phele Lake Loop in Saddle Brook, would receive an above-ground detention basin.

Areas 2 and 3 are both parking lots in Paramus and would be appropriate for underground detention basins.

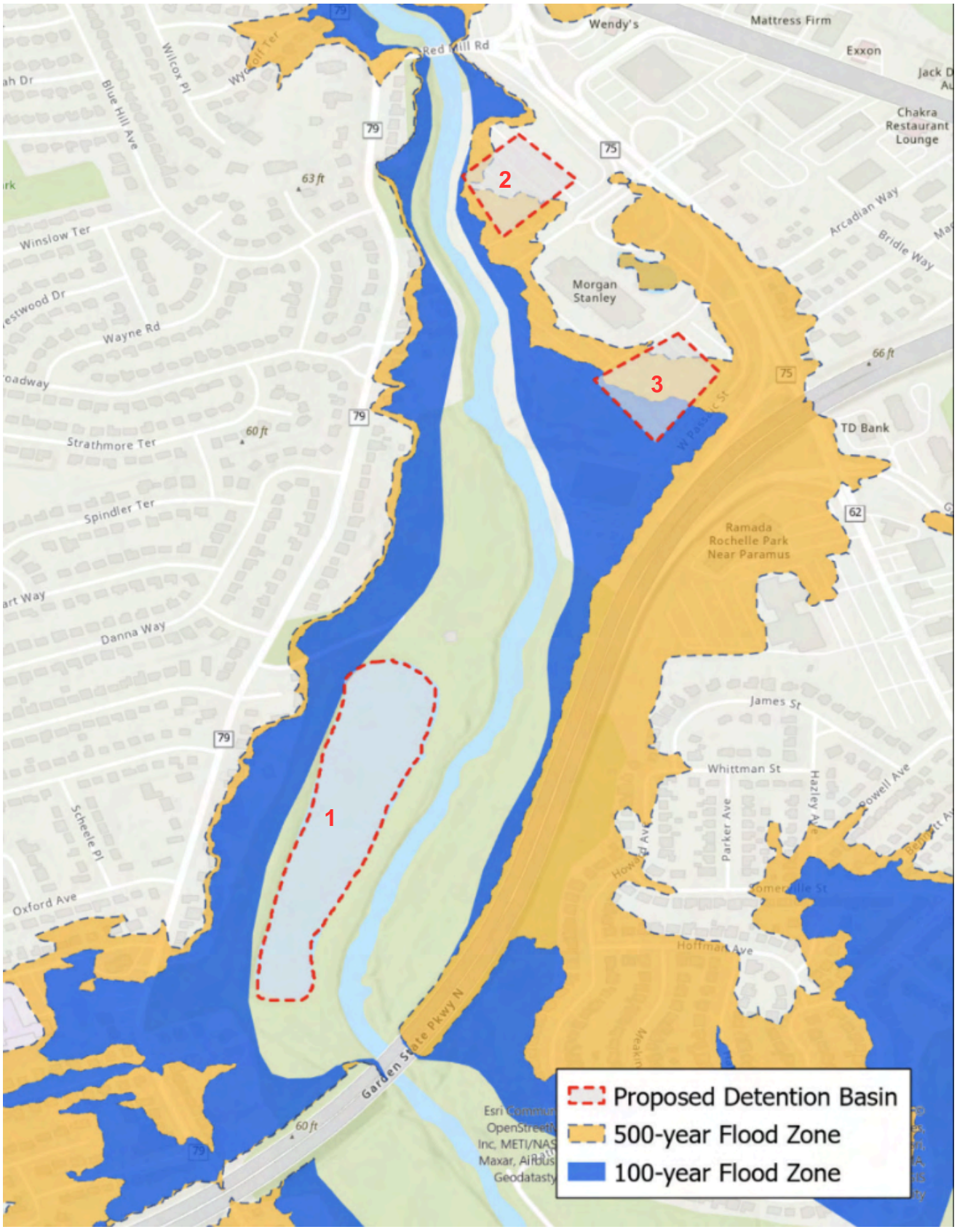


Figure M. Suitable Areas for Detention Basin

IV. Cost Analysis

Cost for developing detention basins can vary considerably. The study by Bron and Schueler evaluated the cost of all pond systems, meaning the entire installation as an integrated set of components, not just the pond excavation itself. Before adjusting for inflation from 1997, the cost of dry extended detention ponds can be estimated with the equation (Pennsylvania Department of Environmental Protection, 2006):

C = 12.4V0.760
Where:
C = Construction, Design, and Permitting Cost
V = Volume needed to control the 10-year storm (cubic feet)

A 10-year storm in Bergen County is defined as 6.24 inches of rainfall over a 24-hour period, and this standard is used as a baseline for sizing detention basin capacity.

Using this equation, a typical construction cost (1997) are:
$ 41,600 for a 1-acre-foot pond
$ 239,000 for a 10-acre-foot pond
$ 1,380,000 for a 100-acre-foot pond
Detention basins employ highly structural design features (rip-rap for erosion control, etc.), more costly than naturalized basins. Long-term maintenance costs are lowered when more naturalized approaches are used due to: 1) the ability of native vegetation to adapt to local weather conditions; and 2) the reduced need for maintenance (ie. mowing and fertilization). Normal maintenance costs range from 3% - 5% of the construction costs annually , excluding the property value (Pennsylvania Department of Environmental Protection, 2006).

Intervention II: Stormwater Swales

I. Introduction

Stormwater swales are a second stormwater management intervention. The primary function is to allow stormwater to flow in the channel, similarly to an open channel ditch. Stormwater swales allow runoff water to flow slowly, enhancing the rate of sedimentation and infiltration through the soil. The feature that distinguishes swales from channels is that swales have greater width and a less inclined slope compared to regular channels, making swales able to infiltrate water slowly and more effectively.

Swale types are distinguished based on the filtration feature (United States Department of Transportation, n.d.). Dry swales provide water quality benefits by allowing stormwater infiltration. Wet swales utilize retained water, treating stormwater before it is discharged to a water body downstream of the channel.The figure depicts a dry stormwater swales.

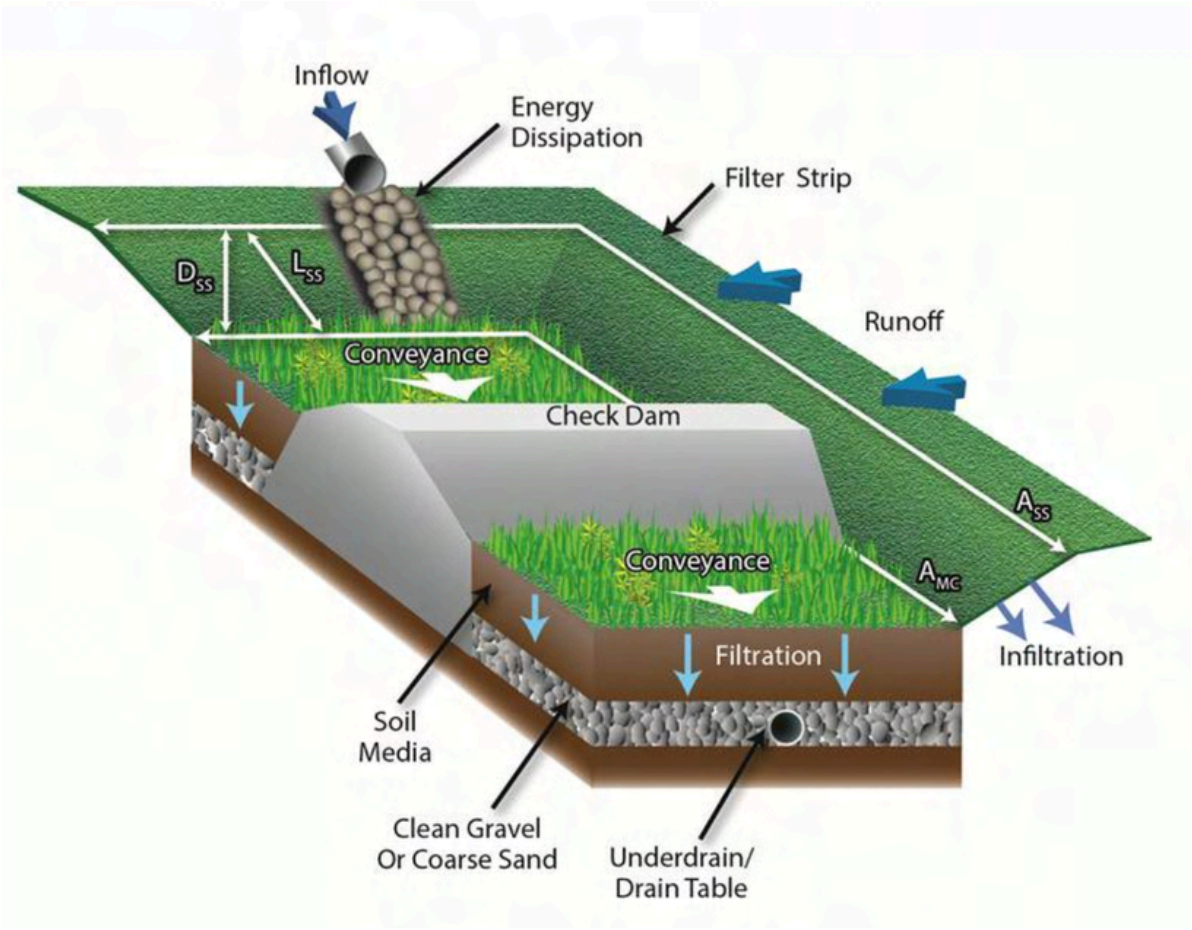


Figure N: Dry Stormwater Swales
Source: Minnesota Stormwater Manual, n.d.

Because swales' functions are to infiltrate water, locations with permeable soils and a low groundwater table are needed to ensure water can seep to the ground effectively. Without these conditions, swales may not perform as expected. In most cases, swales are used alongside highways, residential roads, parking lots, and other similarly developed urban areas. Around Saddle River County Park, where impervious surfaces like pavements contribute to increased runoff, constructing stormwater swales can help capture and absorb excess water. The result should aid in reducing runoff volume, slowing the velocity of stormwater entering the downstream water body or drainage system, and in turn contribute to lower flood risk during heavy rain events. Based on (Rujner et al., 2018), run-off peak flow rates were reduced proportionally to the flow volume reductions, in the range from 4% to 55%.

As part of implementing stormwater swales as a flood intervention, a focused study on soil permeability and groundwater levels, including testing of groundwater and soil permeability, is necessary. This step is critical to ensure the selected sites will support infiltration and maximize the effectiveness of the swale as an intervention.

II. Rationale for Intervention

Stakeholder Interview

A representative from Rochelle Park suggested adding stormwater swales around the Dunkerhook area. Given the amount of impervious surface around Saddle River Park, swales could help reduce surface runoff, reduce peak flow rates, and enhance infiltration, thereby contributing to flood mitigation efforts in the area.

System Map Analysis

Soil structure directly shapes erosion and sedimentation, which in turn intensifies flooding and actual flood damage. These damages drive ecosystem degradation and reduce carbon sequestration, accelerating climate change. The exacerbation of climate change has increased the susceptibility to extreme weather events and rainfall, further weakening soil structure and reinforcing the cycle. At the same time, expanding urban development increases surface runoff, amplifying flooding risks. By introducing stormwater swales, we can intervene to improve soil permeability, reduce surface runoff, and disrupt the reinforcing dynamics of both the R3 - Urbanization Flood Risk Loop and the R8 - Sedimentation Loop, ultimately building greater resilience against flooding and climate impacts.

III. Location of the Intervention

Swale placement was guided by several key criteria: High flood risk zones, proximity to impervious surfaces such as parking areas, and the availability of open space. Stakeholder input also played a role as a representative of Rochelle Park highlighted areas for intervention. The map displays Otto C. Pehle Lake, indicated by 1; and, the Rochelle Park area indicated by 2. The swales were strategically placed parallel to the Saddle River, acting as the primary drainage corridor. By locating the swales near this natural path, the intervention reduces the volume and speed of surface runoff entering the river, achieving both downstream mitigation and localized flooding. To note, there are a few swales that currently exist, but more is needed for greater effectiveness.

Figure O. Suitable Areas for Stormwater Swales

Intervention III: Riparian Buffers Restoration

I. Introduction

Streambank degradation (erosion) is the removal of soil and vegetation from stream banks by flowing water to stream and riverbank (Burnette and Agouridis, 2014). It occurs naturally (for example, on the outside of meander bends) but is greatly accelerated by human activity. Without strong root systems, even moderate flows can strip soil from banks, especially during high flows or storms. When streambanks erode, channels widen and fill with sediment, water quality and habitat suffer, and adjacent land or infrastructure can be undermined.

According to the United States EPA, a forested riparian buffer is an effective measure to reduce peak stormwater flows to riverbodies. In an area with more than 50% development, riparian buffers could reduce peak flow rate velocity by 3% compared to areas with no buffer (Gay et al., 2023). Aside from reducing peak flow, riparian buffers are beneficial for pollutant removal. The riparian buffer's degree of effectiveness depends highly on the slope of the land, soil type, soil structure, and the buffer design itself. The EPA provides a few factors to be incorporated into the buffers design to improve effectiveness: slope degree less than 5%, buffer widths greater than 25 feet, presence of high organic matter, entry stormwater velocity less than 1.5 feet per second, and using prioritizing trees with deep root systems for the vegetation cover (United States Environmental Protection Agency, 2021).

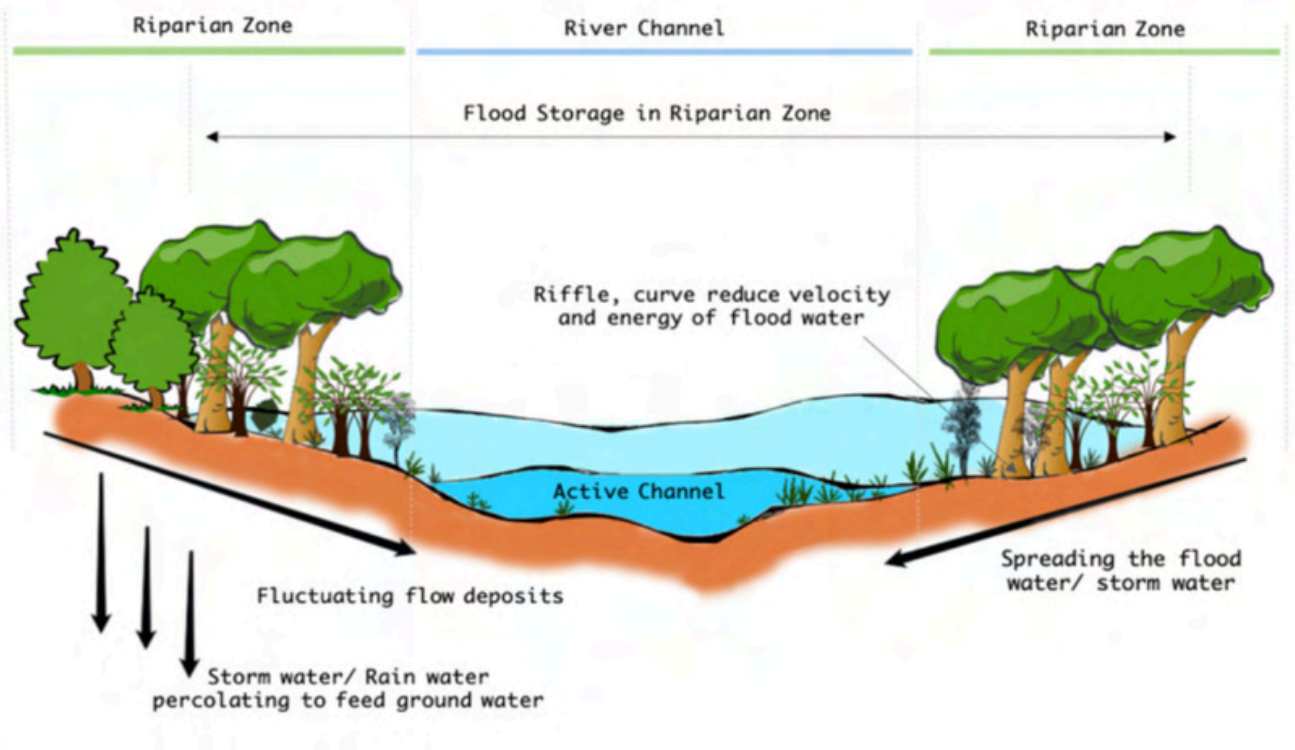


Figure P: Riparian Buffer Restoration
Source: Nair et al., 2024

II. Rationale for Intervention

Stakeholder Interviews:

From our interviews, we learned that flooding worsened over the years due to extreme weather events and sediment buildup in the Saddle River. This leads to streambank overflow of park paths and residential areas. Tree debris and development-related runoff compound the problem. Also, stakeholder interviews revealed the effectiveness of riparian buffers. A representative explained the minimum riparian buffer for streams is usually 50 feet, as set by NJDEP. While NJDEP may consider widening buffers in the future, but this would be difficult in dense areas like North Jersey.

System Map Analysis:

The systems map analysis highlights flood mitigation as a critical leverage point for improving both ecological resilience and community wellbeing in Saddle River County Park. The analysis shows how streambank erosion drives a cycle of worsening flood risk, habitat degradation, and infrastructure damage. Stakeholder interviews reinforced this finding, as several participants noted visible signs of erosion along the Saddle River's banks and expressed concern over the long-term stability of pathways, bridges, and natural areas. Our literature review also identified riverbank restoration as a proven intervention to reduce runoff velocity, improve water absorption, and enhance riparian ecosystems. These insights directly connect to several key feedback loops identified in the environmental systems map, as seen in the Appendix 2, 3, and 4, specifically R4 - Riparian Vegetation Loop, R6 - Aquatic Degradation Loop, and R8 - Sedimentation Loop, which demonstrate how soil structure, erosion, and vegetation interact with one another. These feedback loops illustrate the interconnected nature of riparian vegetation, soil health, and aquatic ecosystems, emphasizing how restoring riparian buffers can break the cycles of degradation and enhance the Park's resilience to flooding and environmental stressors.

III. Location of the Intervention

This map identifies parcels in Bergen County suitable for riparian buffer installation along the Saddle River Park. Parcels with the following key parameters, like 18° slope, elevation between +1 to +100 ft, and soil types that retain moisture, support dense vegetation, have moderate to poor drainage, and high water-holding capacity, were identified for the installation of a riparian buffer. Satisfying these conditions would ensure the riparian buffers could survive and, in return, stabilize the riverbank, reduce erosion, and filter stormwater runoff.

This map is a subsection of Glen Rock. The green-shaded areas represent parcels meeting the aforementioned conditions and as such, are affected by the flooding areas established by FEMA. Both residential and commercial properties are located in the parcels. Riparian buffers would then be placed along the edges of these parcels where they border the flooding areas rather than covering the entire parcel. According to sources, buffers as narrow as 4.6m (15 ft) can be fairly effective in the short term. Given the space constraints for property owners, a micro-buffer 2 ft deep could be installed to slow runoff, trap sediment, and intercept flows from the flood zone while remaining a feasible solution.

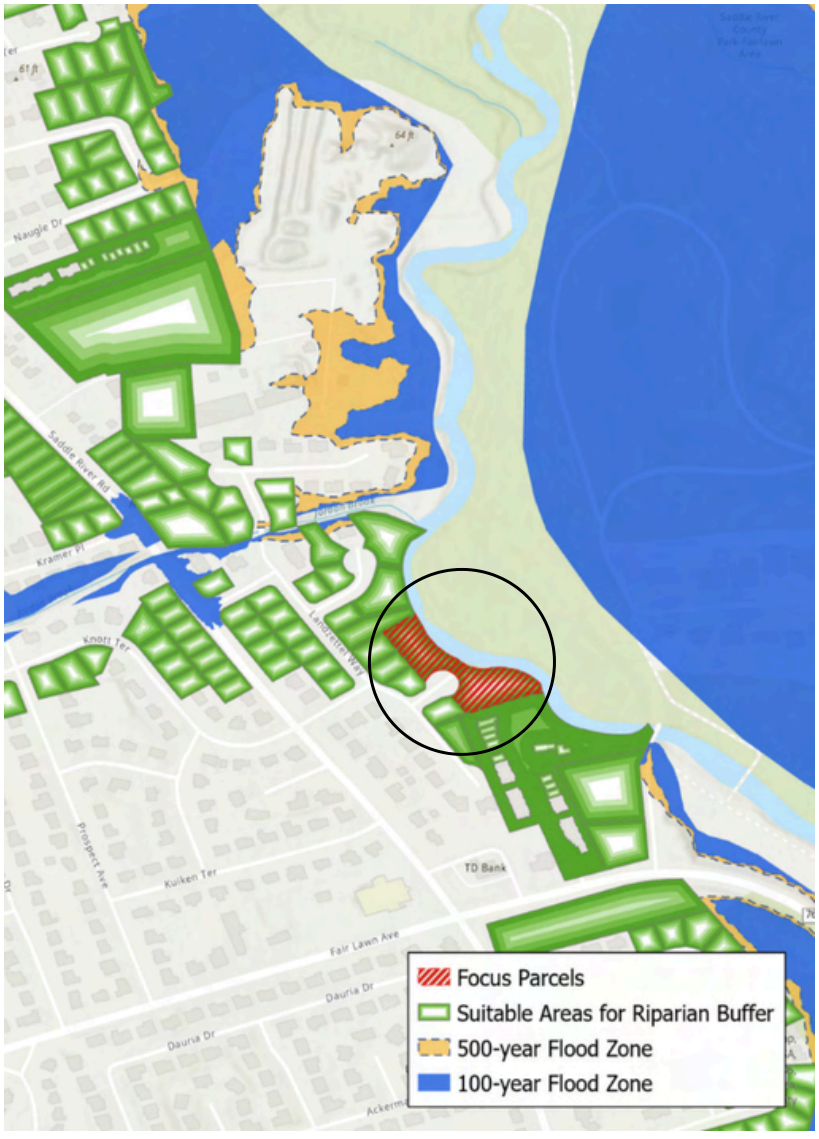


Figure Q. Suitable Areas for Riparian Buffers

IV. Cost Analysis

The cost related to riparian buffer restoration varies according to the specific site condition, namely the soil type and existing slope, and the length of the buffer corridor. The US EPA provides a general cost component that includes design, permitting, grading, planting, and maintenance. The existing condition of the waterway near the buffer also influences the cost. However, a riparian buffer restoration project in Ogden, Utah, totaled $6 million (Frey, 2013). The restoration project addressed around 1.1-mile stretch, with buffer width varying according to the 100-year floodplain, averaging 60 feet. This high cost was partly due to the narrow width of the riparian area and the river's use as a dumping ground. As a result, cleanup costs took a big portion of the pre-construction expenses. A riparian buffer restoration project in the Musconetcong River in New Jersey costs a total of $160,000, covering four restoration projects completed between 2001-2006 (United States Environmental Protection Agency, 2015).

To estimate the cost of riparian buffer restoration in Saddle River County Park, a proxy method based on total acreage served could be applied. A study by King & Hagan (2011) outlined various stormwater best management practices, with costs expressed per acre of impervious area treated. For example, an urban forest buffer would cost $33,000 per acre of impervious area treated. Another report on a riparian forest buffer project in the Willamette Basin, Oregon, estimates the cost of urban riparian planting at approximately $10,543 per acre (Michie, 2010).

Given the highly variable average cost for riparian buffer restoration projects, the pre-construction phase needs to be conducted carefully and diligently, with close attention to site-specific conditions such as soil type, topography, existing vegetation, and the selection of plant species. These factors significantly influence the effectiveness and the cost of riparian buffer restoration effort, and thus must be carefully assessed to ensure a successful and cost-effective implementation.

Intervention IV: Wetland Restoration

I. Introduction

Wetlands often relate to their ecosystem function in controlling excessive water, also known as their capability as a “natural sponge”. The Rutgers Center for Urban Environmental Sustainability reports that significant wetland resources exist throughout Bergen County and its parklands. Tidal wetlands to the floodplains and riparian areas are found along the County’s river systems. Other examples are located within the highland sections of the Ramapos and the vernal pools found in small sections of many parks (Rutgers Center for Urban Environmental Sustainability, 2019). The County parks in the Saddle River watersheds still contain significant wetland acreage. The vegetative species vary greatly, depending on the type of wetland and its hydrogeomorphic location, defined as the landscape position, source of water, direction, and strength of the water flow. For example, the tidal marshes of the Meadowlands are dominated by common reed (Phragmites australis) as well as salt marsh grass (Spartina) species, whereas forested wetlands tend to be dominated by trees such as maples, birches, and willows.

Wetland restoration creates or enhances wetlands by shaping land and planting appropriate vegetation to restore natural functions. It uses the “natural infrastructure” of wetland ecosystems (soil, water, and plants) to improve environmental quality. Beyond water treatment, healthy wetlands provide critical habitat and serve as natural sponges that soak up floodwaters and filter out sediments and chemicals, protecting downstream waterways. As a consequence, earthwork as a form of wetland restoration is recommended.

Earthwork involves re-contouring the land to appropriate elevations for wetlands. Contractors may remove fill or sediment to expose the original wetland soils and depressions. By cutting down to the previous wetland elevation and rebuilding the original contours and low-lying areas, earthwork can help recreate the shallow basins where water can accumulate after storms. The U.S. EPA notes that restoring wetlands can help reduce the height and speed of floodwaters downstream for “moderate stormwater flows” and provide crucial flood protection (U.S. EPA). In the context of Saddle River Park, this kind of intervention would support the Park’s flood resilience while incorporating the natural solution into the natural landscape of the park.

Wetlands can help in flooding mitigation by controlling stormwater runoff, specifically by reducing peak flow velocity (U.S. EPA, 2021). A study in the Midwestern Area, Indiana, shows that wetlands can reduce peak flow rate up to 42%, with deeper areas in wetlands shown to be more effective in reducing stormwater flow (Javaheri & Babbar-Sebens, 2014).

II. Rationale for Intervention

Stakeholder Interviews:

In our stakeholder interview, we learned that a wetland restoration project occurred at Ridgewood Duck Pond. Similar restorations, at other ponds, may be helpful. Ridgewood stakeholders also shared information regarding wetland restoration around Grove Park and Pleasant Park.

System Map Analysis:

Wetlands in Saddle River County Park play an important role as natural sponges that absorb excess water and slow its release into rivers and streams. However, both human and natural pressures degrade their ability to function effectively. These dynamics are reflected in feedback loops from the environmental systems map, specifically R3 - Urbanization Flood Risk (Appendix 1), R6 - Aquatic Degradation Loop (Appendix 4), and R8 - Sedimentation Loop (Appendix 2). The R3 - Urbanization Flood Risk loop shows how urban development increases impervious surfaces, reducing soil permeability and increasing surface runoff, which in turn amplifies flooding and actual flood damage, creating a reinforcing cycle of physical vulnerability. Similarly, the R8 - Sedimentation and R6 - Aquatic Degradation loops illustrate how soil structure degradation leads to erosion and sedimentation, triggering a cascade of ecosystem degradation, water pollution, and impaired aquatic health, all of which further weaken soil integrity and exacerbate flood risks.

III. Location of the Intervention

The map in Figure R is a subsection of Glen Rock, which is the same area suggested for Riparian Buffers (see page 44). Suitable parcels for wetland restoration that include earthwork along Saddle River Park are based on the following parameters: slopes ranging from approximately 14° to 45° and elevations from –1 to +4 ft. Moreover, areas with soil conditions that show low infiltration, hold water well, have moderate erosion risk, and are located in areas that flood often, to ensure earthwork would be effective in restoring wetland and controlling water runoff. In Figure R, the gray-shaded areas represent parcels meeting slope and elevation parameters and reside in FEMA flood zones. Earthwork would focus on the areas of the parcels where water naturally collects and involve land reshaping, such as creating gentle slopes or constructing small berms made from raised soil to hold or redirect water. These features are then placed strategically to slow runoff and maximize the impact of wetland restoration.

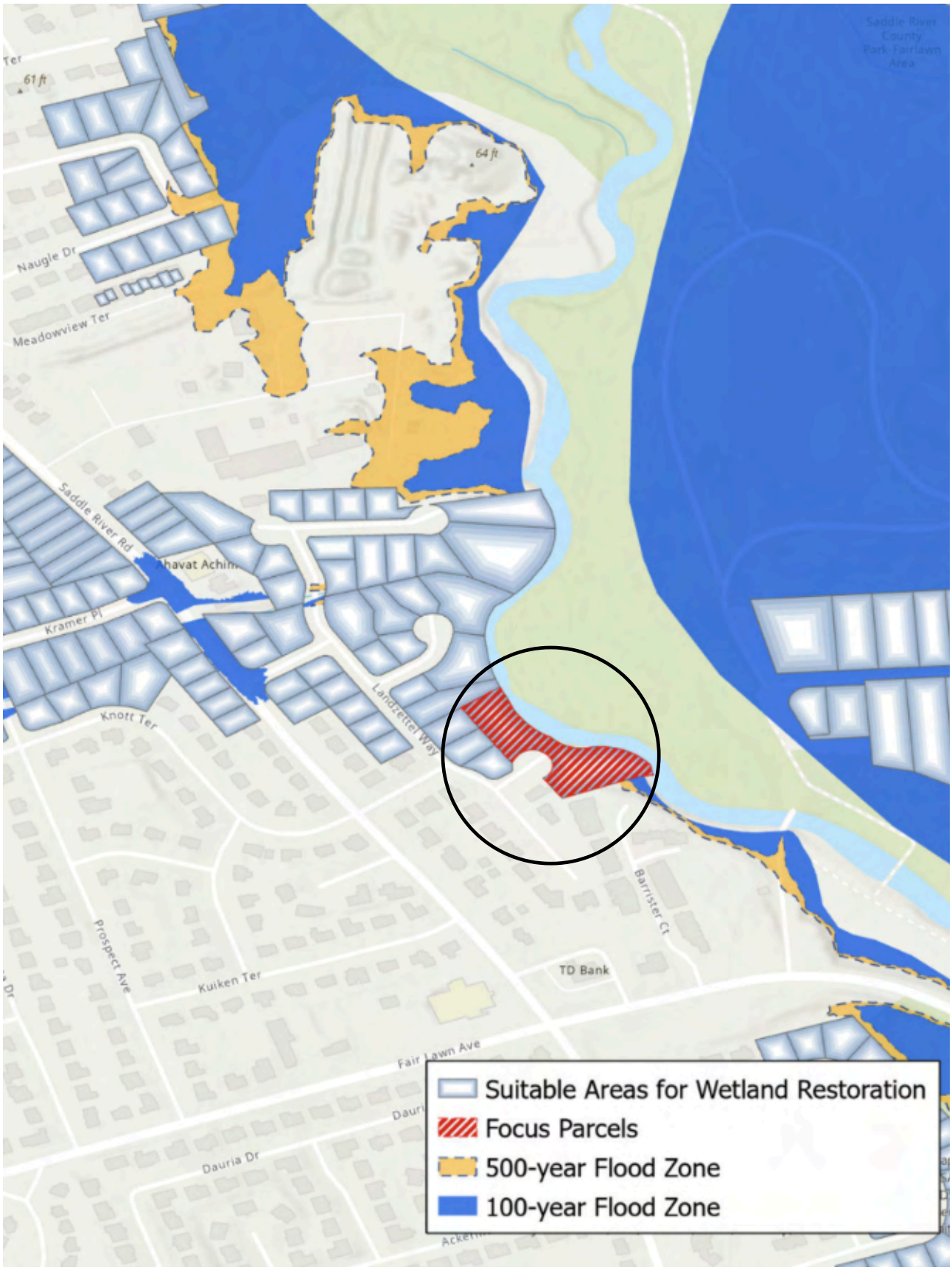


Figure R. Suitable Areas for Wetland Restoration Type: Earthwork

IV. Cost Analysis

Similar to other nature-based solutions, where the exact construction cost depends on the specific site conditions and infrastructure design, the cost components of wetland restoration typically include land, siting, earthwork, liners, media, plants, water control structures and piping, site preparation, other related site work, and human facilities (Kadlec & Wallace, 2009). Kadlec and Wallace also conducted a statistical analysis of wetland restoration in the United States and derived a formula to estimate construction costs based on the wetland area:

C = 479A0.69 ; where C = Cost in thousands of dollars, and a= wetland area (acres)
Other studies by King and Hagan in 2011, examined that the total initial construction cost for new construction projects is $27,000 per acre, and $71,000 per acre for a retrofit project.

Summary

To compare the characteristics of each of the four intervention methods in this section, a comparative analysis was conducted using metrics that include peak flow reduction, stakeholder intervention requirement, cost, and implementation time. This comparative analysis aims to measure how each intervention relates to the other, given the metrics.

The peak flow reduction is used to indicate the effectiveness of each intervention in flood mitigation. Using water storage capacity as a metric can be challenging to apply, especially for stormwater swales and riparian buffers. Therefore, we recommend using peak flow reduction to obtain consistent insights and better assess how each intervention affects flood mitigation. The effectiveness level of peak flow reduction was determined based on values we summarized from the literature review and case studies. To sum up in a range, detention basins, stormwater swales, and wetlands were able to reduce peak flow rate ranging from 30-83%. In contrast, riparian buffers have relatively lower peak flow rate reduction, as they function not as a storage, but mainly to provide bank stabilization. Each of these interventions complements one another resulting in an integrated flood mitigation strategy.

Stakeholder interview captures both the number and the types of parties that need to be involved in the construction process, including for planning, design, permits, and the implementation of the intervention itself.

ArcGIS Story Map

For a detailed GIS analysis of proposed intervention locations, please click here.

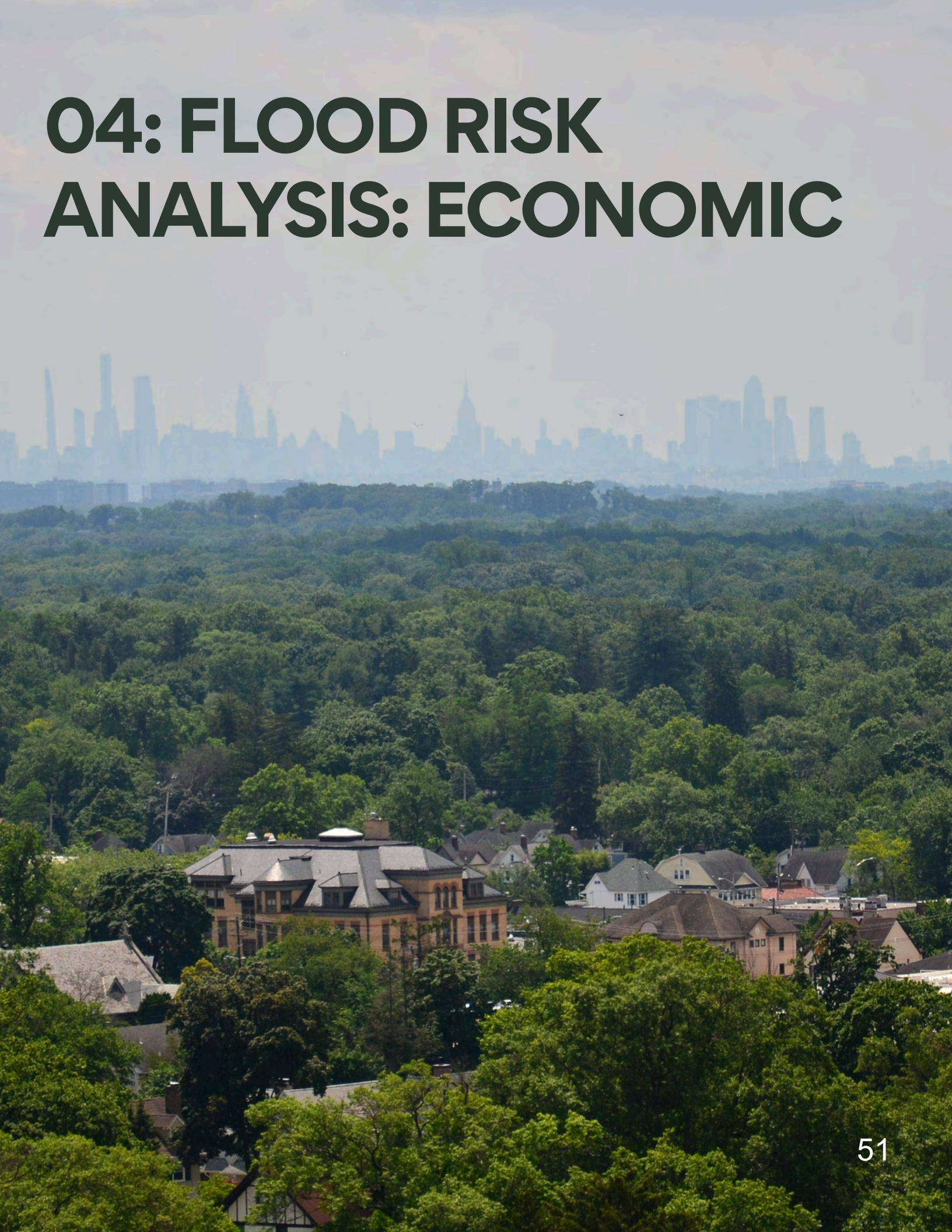
The cost refers to the relative value of construction cost, and we categorized it into Low (≤ $100,000), Medium ($100,000 - $500,000), and High (≥ $500,000). Cost categories are assigned based on relevant literature, case studies, and project reports. We compare the time needed based on an estimate of the duration required for constructing the intervention project, where the timeframe of detailed planning, securing funding, permitting process are not taken into account. The information on the time needed was gathered from general literature reviews. A summary of our intervention analysis is shown in Figure S:

No.	Metrics	Unit	Detention Basin	Stormwater swales	Riparian Buffer	Earthwork
1	Peak flow reduction	percentage	30-83%	4-55%	3%	42%
2	Stakeholder Intervention	#parties involved	5	4	4	5
	NJ DEP		x	x	x	x
	County		x	x	x	x
	Municipality		x	x		x
	Army Corp of Engineers (Federal)		x			x
	Property owners			x	x	
3	Cost	Low/Medium/High	High	Medium	Low	Medium
4	Time Needed	months/years	1-3 months	Several weeks to 3 months	1-5 years (including establishment phase)	2-6 month for <1 acre, or up to 1 year for larger complex sites

Figure S. Summary of Intervention Analysis

Notably, all these metrics remain flexible and may change depending on project-specific factors, such as geographic location and design complexity. This flexibility is crucial when applying our analysis to Saddle River County Park.

04: FLOOD RISK ANALYSIS: ECONOMIC



Insurance Market Crisis and Coverage Gaps

Bergen County faces an unprecedented level of flood risk exposure that threatens both individual property owners and the broader regional economy. According to FEMA, over $72 billion of property value in Bergen County are exposed to flood damage risk (Federal Emergency Management Agency, n.d.). Within the six municipalities alone, $7.1 billion of property values are at risk. This exposure becomes particularly acute in flood-prone corridors like the Saddle River area, where residential properties with median values exceeding $700,000 face increasing frequency and severity of flood events that can cause thousands of dollars in damage from just one inch of floodwater (Federal Emergency Management Agency, n.d.).

The magnitude of this exposure reflects broader national trends where residential properties exposed to flood risk are overvalued by $121-237 billion, as climate risks are not adequately reflected in current property valuations (Gourevitch et al., 2023). In Bergen County, property values have increased 16.1% in the past year alone, further exacerbating this disparity. This overvaluation creates systemic vulnerabilities that extend far beyond individual homeowners to encompass municipal tax bases, which fund local infrastructure, impacting the overall regional economic stability and broader housing market.

The economic implications become more severe when considering the limitations of available flood insurance coverage. Bergen County residents experienced a dramatic 59% increase in flood insurance premiums under the National Flood Insurance Program's Risk Rating 2.0 implementation, with average premiums rising from $1,365 to $2,167 annually (Next To Fall: The Climate-Driven Insurance Crisis Is Here – And Getting Worse, 2024). The flood insurance landscape in Bergen County reveals fundamental structural problems that amplify economic vulnerability across the region.

In many flood-prone areas, including, Saddle River corridor, property owners are not able to secure flood coverage through standard homeowners insurance policies. Instead, they must depend on National Flood Insurance Program, NFIP, policies, which, due to strict coverage limits, can leave individuals, families, and businesses underinsured and financially vulnerable.

The maximum coverage is capped by the NFIP at $250,000 for residential structures and $100,000 for contents. Meanwhile, the average home price in Bergen County is well above $700,000, leaving homeowners with substantial coverage gaps. Further exacerbating this issue, the average NFIP claim payout nationally was only $33,905 in 2024, with approximately 25% of claims being denied entirely, forcing property owners to absorb substantial losses (Federal Emergency Management Agency, n.d.).

This coverage gap reflects a broader $28.7 billion insurance gap between what Americans currently pay for coverage and what they should pay given rising climate risks (Senate Budget Committee, 2024). In New Jersey specifically, this gap has reached a breaking point, with insurance policy non-renewals increasing 69.54% between 2018 and 2023, as displayed in Figure T. This trend leaves approximately $277.7 billion in property and $3.2 billion in tax revenue at risk across the state (NJ Flood Risk = Financial Risk - Rebuild by Design, 2025).

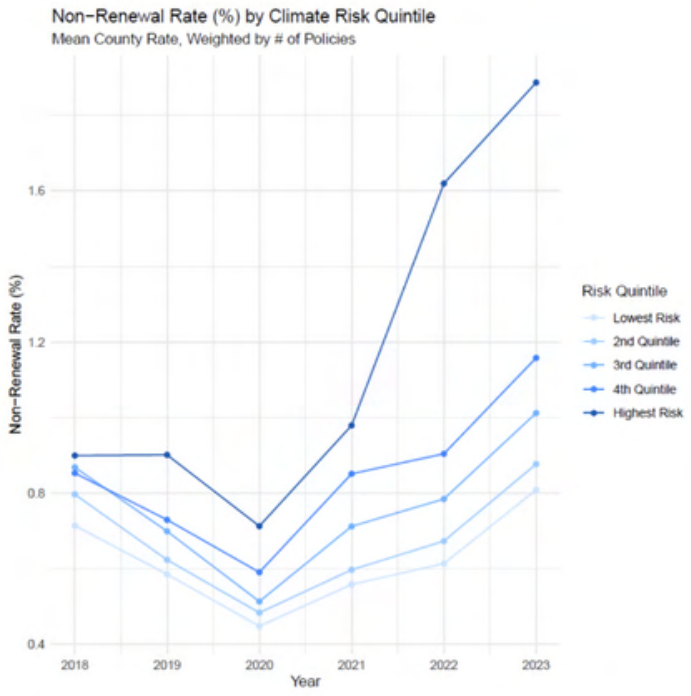


Figure T. Non-renewal rate % by Climate Risk Quintile
Source: Outar, 2025

The withdrawal of private insurers from high-risk markets has fundamentally altered the insurance landscape serving Bergen County communities. Today, national players occupy less than 30% of the overall insurance market in New Jersey.

National Insurer	NJ Market Share	Flood Insurance Approach	Risk Mitigation Services
State Farm	12%	No longer WYO carrier; refers to NFIP	Smart home partnerships, safety device discounts
Allstate	10%	Active WYO carrier using NFIP	Digital risk tools, security system partnerships
Travelers	5-6%	Partners with Neptune Flood for private coverage	Risk consulting, preparedness guides

Figure U: National Insurance Providers in New Jersey

New Jersey's current insurance landscape leads us to another consideration: If the NFIP only covers up to $250,000 will lenders be willing, or even able, to provide mortgages to prospective homeowners? This is an open question, which is critical to address with some urgency. It is not just about the flood insurance, but about the ability to buy a home, and ensure the socioeconomic vitality of communities within Bergen County.

This market structure demonstrates the fundamental challenge facing Bergen County residents: Traditional insurance models cannot adequately price or cover the escalating flood risks associated with climate change. Even innovative private flood insurance options, such as Travelers' partnership with Neptune Flood offering coverage up to $4 million, remain limited in availability and often prohibitively expensive for typical homeowners.
The broader insurance crisis extends beyond coverage gaps to market behavior that threatens long-term economic stability. In 2023, insurance claims totaled over $100 billion while premiums collected totaled approximately $92 billion, creating unsustainable loss deficits that drive continued premium increases and market exits (Internal Investment Committee Memo, 2023). This dynamic suggests that coverage renewal rates will continue to decline while premiums rise, particularly in areas like Bergen County, where flood risks continue to increase.

Municipal Financial Vulnerabilities

The economic impacts of increased flooding extend beyond individual property owners to threaten municipal financial stability across Bergen County. Municipalities heavily reliant on property taxes for revenue face potential budgetary shortfalls as climate risks undermine property values and tax collection capacity (Gourevitch et al., 2023). Research reveals that natural disasters reduce municipal bond returns for at least 20 weeks following an event, with revenue bonds experiencing the most severe impacts while even general obligation bonds from counties with high financial leverage face significant negative price effects (Auh et al., 2023).

This municipal vulnerability becomes particularly concerning given that climate risks are simultaneously making it harder for local governments to service existing bond payments and raise new capital for needed infrastructure investments. The implications threaten the stability of municipal bond markets that finance over 70% of U.S. infrastructure, creating potential feedback loops where climate risks undermine the very financial mechanisms needed to address climate adaptation (Auh et al., 2023).

Federal disaster aid has historically proven crucial for mitigating municipal bond price declines, with counties receiving minimal aid experiencing the largest drops in bond performance (Auh et al., 2023). However, the increasing frequency and severity of flood events, combined with growing federal fiscal constraints, suggest that municipalities can no longer rely on post-disaster federal assistance to maintain financial stability. This shift places greater emphasis on proactive risk management and adaptation investments to prevent economic disruption rather than responding to damage after it occurs. A study by Allstate and the U.S. Chamber of Commerce found that “every $1 spent on climate resilience and preparedness saves communities $13 in damages, cleanup costs, and economic impact.” (Environmental and Energy Study Institute, 2025).

Property Market Implications and Regulatory Changes

The property market implications of increased flooding extend throughout Bergen County, with potential impacts ranging from individual property devaluations to broader market corrections. New Jersey's flood risk notification law, P.L. 2023, c.94, requires all real estate sales beginning March 20, 2024, to acknowledge purchaser awareness if properties are located in FEMA Special Flood Hazard Areas or Moderate Flood Hazard Areas. This regulatory change will likely accelerate market adjustments as buyer awareness increases and pricing begins to reflect actual flood risks rather than historical patterns.

The challenges are compounded by fundamental problems with FEMA flood mapping, which faces significant limitations in accurately representing current and future flood risks. Despite requirements that FEMA assess the need to revise flood maps every five years, 75% of current maps are older than five years, and 11% date back to the 1970s and 1980s (Masters, 2023). A 2017 Department of Homeland Security Inspector General report found that only 42% of flood maps currently reflect accurate flood risk projections, despite the program's goal of maintaining 80% up-to-date coverage (Masters, 2023).

These mapping inadequacies particularly impact inland areas situated near rivers that, despite being located outside FEMA-designated flood zones, are increasingly experiencing frequent flooding events.

Over 26 million U.S. residents live in floodplains not recognized by federal flood maps, creating widespread underinsurance in areas experiencing mounting flood risk (Flores et al., 2025). In Bergen County, this dynamic suggests that current risk assessments may significantly underestimate actual exposure, particularly as climate change intensifies precipitation patterns and flood frequency.

Social Equity and Community Impact

The economic impacts of increased flooding create disproportionate burdens across Bergen County communities, with significant social equity implications that compound the broader economic challenges. Low-income households face a greater risk of losing home equity from climate-driven property value deflation, often lacking the financial resources to fully recover from flood damage or relocate to lower-risk areas (Gourevitch et al., 2023). This vulnerability is particularly acute given that only approximately 27% of homeowners nationally carry flood insurance, with coverage rates likely even lower among lower-income households facing affordability constraints (Burgess, 2024).

The withdrawal of insurance coverage from high-risk areas has led to significant financial exposure for residents and local governments alike. As insurers continue to exit markets repeatedly impacted by flooding, entire communities risk becoming uninsurable, contributing to property value declines ranging between 19% and 40% potentially destabilizing entire communities. These impacts create cascading effects where flood damage leads to incomplete recovery, population loss, and reduced municipal tax revenue, particularly in areas like the Saddle River corridor, where flooding frequency continues to increase.

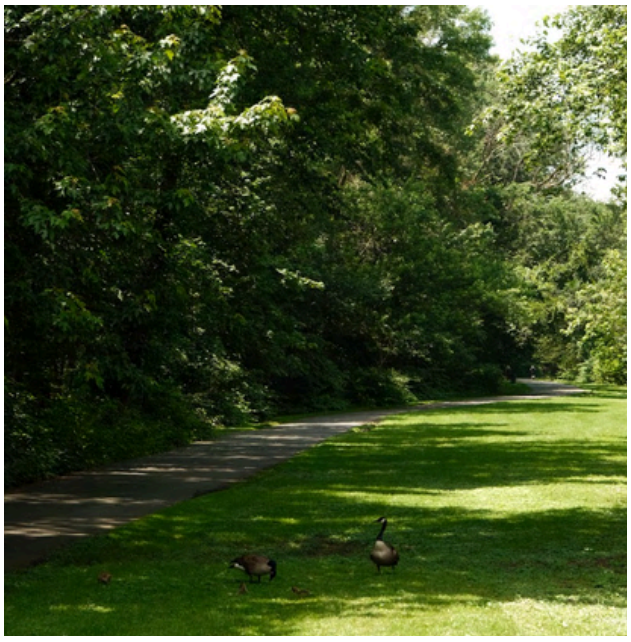
The inadequacy of federal oversight compounds these challenges, as neither Fannie Mae nor Freddie Mac factors climate risk into their mortgage guarantees despite backing 60% of U.S. mortgage debt. This regulatory gap means that mortgage markets continue to finance development and property transactions in high-risk areas without adequate pricing for climate risks, perpetuating the cycle of overvaluation and systemic financial vulnerability.

Economic Imperatives

According to a report by the Joint Economic Committee's Democratic staff, flood damage is projected to cost the United States as much as $496 billion annually (Committee, 2024). And the cost of flooding extends beyond just the financial, leading to the deaths of approximately 140 people in the United States every year (Aliyu et al, 2016).

Not only causing direct damage to the affected areas, major floods also have a cascading effect due to the decrease in property values around the affected areas, disruption of transportation systems, food and water supplies, and other economic damages to local businesses and agriculture.

The scale and scope of flood-related economic impacts in Bergen County demand fundamental changes in how communities approach risk management and economic development. The traditional model of post-disaster recovery, supported by federal disaster aid and insurance payouts, becomes increasingly unsustainable as flood frequency increases and coverage gaps expand. National analysis suggests potential losses of $1.2 trillion across the single-family home market if insurance were properly priced to reflect climate risks, with flooding risk alone accounting for $121-237 billion (Gourevitch et al., 2023).



Recommendations

In response to these challenges, new insurance models are emerging that offer potential pathways for community-based risk management. Community-based catastrophe insurance allows local governments or regional entities to procure group coverage for residents and businesses, helping to lower premium costs and ensure continued access to coverage in areas where traditional insurers are increasingly reluctant to underwrite risk.

The overarching recommendation is to encourage CRS participation for all communities. FEMA offers a Community Rating System (CRS), which is a voluntary incentive program that recognizes and encourages community floodplain management practices that exceed the minimum requirements of the National Flood Insurance Program (NFIP). In CRS communities, flood insurance premium rates are discounted to reflect the reduced flood risk resulting from the community's efforts that address the three goals of the program:

1. Reduce and avoid flood damage to insurable property
2. Strengthen and support the insurance aspects of the National Flood Insurance Program
3. Foster comprehensive floodplain management (Federal Emergency Management Agency, n.d.).

Flood insurance premium discounts in CRS communities range from 5% to 45% and are discounted in increments of 5%. A Class 10 community is not participating in the CRS and receives no discount. A Class 9 community receives a 5% discount for all policies, a Class 8 community receives a 10% discount, all the way to a Class 1 community, which receives a 45% premium discount (FEMA, n.d.). CRS discounts apply to the full-risk premium for all NFIP policies, helping to build a flood-resilient nation and reduce both the personal and financial damage flooding can cause.

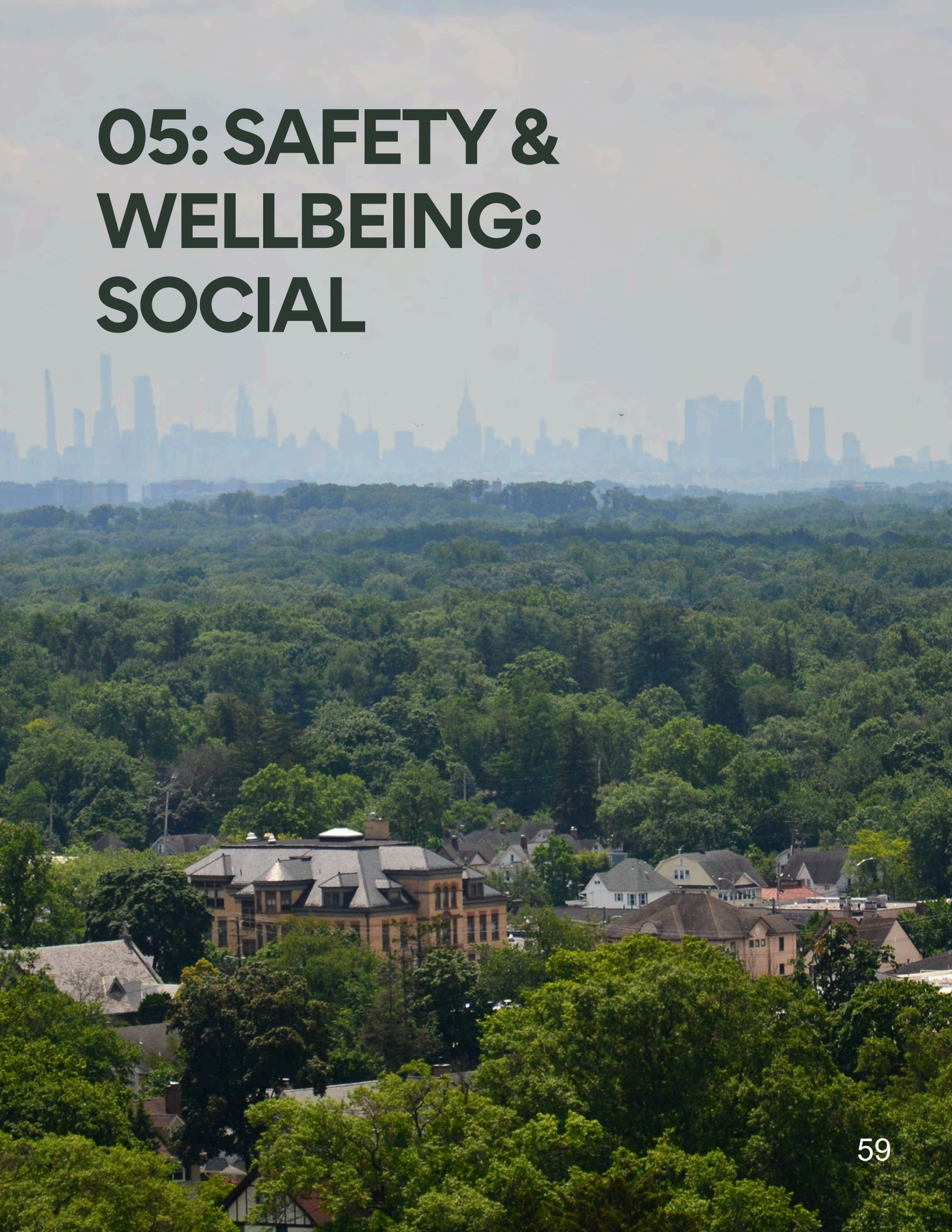
According to the Bergen County 2015 Hazard Mitigation Plan, FEMA has reached out to all six communities to provide information on the benefits of NFIP participation. However, only two out of the six municipalities currently participate: Ridgewood and Rochelle Park. Ridgewood holds a Class 6 rating with a 20% discount, and Rochelle Park is rated Class 7 with a 15% discount (Federal Emergency Management Agency, 2025). Additionally, as illustrated in Figure V, only two municipalities within the study area are enrolled in the community rating system program. This demonstrates a large knowledge gap in risk management between municipalities surrounding Saddle River County Park that we believe can be improved with stronger community engagement.

Municipalities	CRS Class
Ridgewood	6
Rochelle Park	7
Paramus	N/A
Saddle Brook	N/A
Glen Rock	N/A
Fair Lawn	N/A

Figure V. CRS Status of communities surrounding Saddle River Park
Source: Federal Emergency Management Agency, 2025

CRS, with a focus on floodplain management across all six communities represent important innovations in flood risk management. However, long-term effectiveness depends largely on communication, engagement, and voluntary adoption. The economic transformation required extends beyond insurance mechanisms to encompass fundamental changes in land use planning, infrastructure investment, and regional coordination. The concentration in property value exposure across Bergen County creates both unprecedented challenges and opportunities for innovative approaches to flood risk management. Taking collective action now, will determine whether the county can maintain its economic vitality and property values in the face of increasing climate risks or whether it will experience property value declines and municipal financial instability.

05: SAFETY & WELLBEING: SOCIAL



Overview:

Safety and sustainability are deeply intertwined, especially in the context of public parks and green spaces. A safe park encourages a community to consistently foster physical activity, mental well-being, and stronger social ties to their neighborhood. Furthermore, park safety was a key concern for most stakeholders interviewed.

Stakeholders Interview Insights:

All the stakeholders designated “Flooding” to be the biggest concern and risk in the park. The frequent flooding has likewise undermined infrastructure. One community’s representative explained that the bike path is regularly flooded and unusable. The Park, the Saddle River, and its riverbanks are in a state of disrepair. For instance, the continued negligence of maintaining the riverbanks has caused hundreds of trees to fall into the river, along with issues of erosion, blockages, sandbars, and changes to river flow.

In the stakeholder interviews, another recurring concern was that of pedestrian and cyclists’ safety. In particular, tunnels are dark without adequate lighting. Pedestrians and bicyclist pathways are shared, increasing the risk of accidents. Without proper signage and designated lanes, many users, especially children, the elderly, or those with varying abilities, feel unsafe sharing the paths with cyclists.

Finally, community members voiced concerns about the increasing use of e-bikes and electric scooters, both of which have strained the Park’s safety infrastructure.

There need to be clear and updated safety measures to ensure safety for both cyclists and pedestrians through visible ways of reducing collisions and confusion.

Another stakeholder mentioned that the tunnels in the Park are prone to flooding and are a risk to the community. They lack signage that warns visitors to stay away when flooded, especially as the low visibility increases the hazard. Currently, out of 5 tunnels in Saddle River County Park none of them have lighting.

Recommendations:

Preventative maintenance: Issues such as eroded pathways, inadequate lighting in tunnels, or unmaintained paths can create negative environmental and social impacts. The recommendation is to implement a preventative maintenance plan to prioritize repairs with the highest environmental and safety benefit. One possible source of funding is from The Saddle River County Park Trust (see Governance section of report) to allow green repairs such as using permeable materials for pathways, native vegetation restoration, and lighting in low visibility areas. To offset labor costs, a volunteer program could be implemented where community members can come together to plant trees and other vegetation.

Paths: Currently, the paths in the Park are multi-use, except for one section in Otto Pehle Park where there are two paths adjacent to one another. With growing safety concerns due to both cyclists and pedestrians ignoring shared-path etiquette, to shift the cyclists' behavior we recommend the Park to designate a walking trail and a bike path with clear signs labeling the specific use. Having a distinction between the usages of the spaces will encourage cyclists to follow safer routes, reduce conflict with pedestrians, and avoid collisions. Figure W demonstrates how bicycle lanes and walking lanes can help segregate bicyclists and pedestrians.

Figure W. Illustration of the separation between walking and cycling path
Source: Bridget Adolfo, Unsplash

Improve Tunnels Infrastructure: Installing reflective markers to increase visibility and safety during low-light conditions can be an effective way to prevent accidents. Additionally, LED lighting can also help mitigate risk. Adding clear signage and symbols to ensure visibility can prevent accidents and improve awareness of the risks. Moreover, with 4 out of 5 tunnels subject to flooding, it is important to have a real warning system along with clear signage. An example can be seen in Figure X. Currently, when the tunnel's pathways are flooded, the Park often only places a single cone, which is inadequate.

Figure X. Example of a warning sign for flood-prone areas
Source: Amazon

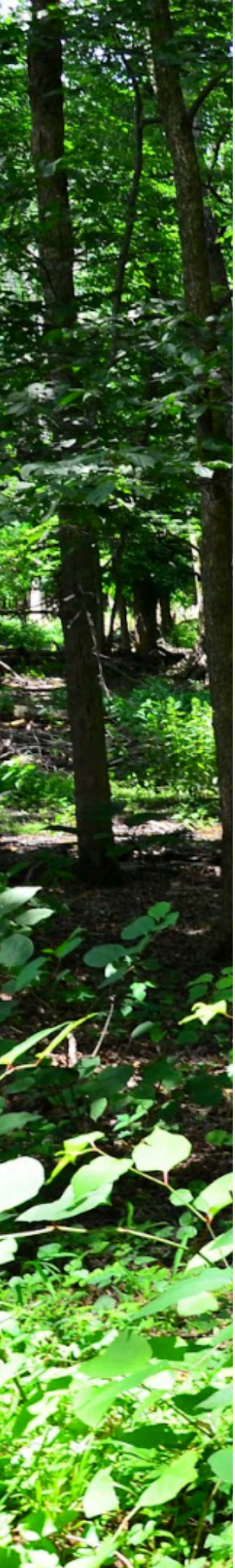
06: COMMUNITY-SHARED SUSTAINABILITY: GOVERNANCE

Overview

An important theme that emerged through stakeholder interviews is Governance. Governance is based on the idea that creating more formal ways to support collective efforts across communities, and, with county and state agencies can advance mitigation, safety, and Park maintenance. In community-shared sustainability, this sharing can become the "glue" that holds communities together while helping to build capacity with and on behalf of the county and the state.

The breadth and depth of expertise across all six communities is notable. Environmental committees, green teams, environmental commissions, town engineers, historians and clerks, elected officials, citizen scientists, and teachers comprise enormous knowledge and skills. These stakeholders "know" the Park, and they "know" the River. Especially for "on-the-ground" knowledge, the stakeholders are professionals who have led global corporations in sustainability, cross-national teams in networked multilayered structures; they understand supply chains, capital and organizational budgeting, hydrology, engineering, the law and environmental biology and ecology. They are communications experts, architects, and marketers, and they are public servants who have held both elective and public office, they have backgrounds in fundraising and grant making.

All of this knowledge and acumen is ready to be used in pursuit of sustainability and resilience objectives for the Park. In practice, Governance functions to give communities a "seat at the table" to actively participate in decision-making about how the River and the Park, for good and for bad, impacts their lives and the lives of their loved ones and neighbors. Our governance recommendations are articulated in the spirit of collaboration with the county and state agencies responsible for the Park and the Saddle River (and its feeder, the Ho-Ho-Kus Brook). By working together, the communities, county, and state agencies are more likely to develop innovative solutions to existing challenges and advance the efforts to secure necessary resources for meeting those challenges. Examples of resources include meeting County Parks Department professional staffing needs like that of full-time naturalists, GIS and data analysts, and information and communication specialists.



The establishment of The Saddle River Trust is proposed to foster and implement flood mitigation measures, safety and well-being initiatives, and the Living Laboratory. The Trust will manage and disburse funding for these measures. Funding for the Saddle River Trust will come from municipal bonds, tax revenue through the establishment of a Special District (see next section), and grants through philanthropic partnerships.

Our recommendations are based primarily on findings from interviews of representatives across the 6 communities. Likewise, supported by case studies that illustrate practices and implementation. This section details: The Living Laboratory as well as The Saddle River County Park Task Force, a Consortium of Saddle River Park, and the establishment of the Saddle River Trust.

Recommendation: Living Laboratory

One universally held idea is to design and develop a Living Laboratory to educate the next generation of environmental leaders. The Living Laboratory is intended to foster programming that integrates environmental and ecological research, education, and training to test out and develop environmental solutions. By design, a living laboratory engages educational institutions, non-profit environmental conservation organizations, and public-private philanthropic partnerships.

The Living Laboratory is a locational and programmatic concept aiming to foster educational learning and engagement opportunities for local K-12 students, as well as colleges, universities, and nonprofit organizations. This model will incorporate inclusionary infrastructure, programming, events, and signage throughout the park to educate patrons on the ecological and environmental systems of Saddle River County Park. In terms of Governance, The Living Laboratory achieves two important objectives, it: 1.) Bridges the kinetic fabric of communities (the schools, libraries, culture, academic practices) with the physical and natural infrastructure of the Park (infrastructure, trail lines, climatic conditions impacts, ecology); and 2.) creates tangible space for the kinds of collaborative and strategic connections needed to advance the Park's objectives of resilience and sustainability.

The Living Lab will utilize funding from the Saddle River County Park Trust to fund projects, such as *the outdoors as a classroom* concept. The Park will incorporate design elements to provide enjoyment for patrons and to foster educational enrichment – planting native flora and fauna to with respective signage explain their characteristics, constructing a brick-and-mortar nature centers displaying monthly installations of various environmental niches, or creating a virtual living laboratory app allowing users to log animal and plant sightings & collaborate with other members in a community forum.

As Saddle River County Park does not have an on-site naturalist or environmental specialist, hiring an expert or experts may be needed. The position can be funded through the Saddle River County Park Trust. This addition will strengthen community engagement, fortify the park's ecological and academic integrity as a regional model for environmental stewardship.

The Living Laboratory, as currently conceived, can be located across community sites near the Park. Some examples include: The James Rose Center, located in the town of Ridgewood and across the street from Ridgewood High School, is an ideal location as the space is already utilized for environmental research and community engagement. Likewise, the Glen Rock Arboretum, with its existing ecological programming, can provide space and programming. In Fair Lawn, the Naugle House could be the site for a Living Laboratory. The Living Laboratory could also collaborate with the Saddle Brook Public Library by co-hosting interactive workshops, tours, and seminars that connect the Library's literary offerings with the Park's ecosystem services. Likewise, the Park can host seasonal programs with private partnerships such as external nature conservancies, sustainability-driven organizations, and local green businesses that amplify the park's environmental and community impact.

As communities consider the full purpose of the Living Laboratory, several key questions can help drive decision-making. Education-based questions might include: How can the Living Laboratory be incorporated into STEM and Literacy curriculum, standards, and skills for elementary, middle, and high school students? How might programming be framed around training and professional development for teachers, particularly for climate change studies, required by the state of New Jersey? Could such training provide professional certification for teachers and potential revenue stream? What would be the role of the Board of Education? What kinds of research about the Park and the impacts of climate change and flood mitigation could benefit mitigation efforts? What universities would be involved? What is the role of the County Parks Department and the NJ DEP, in as much as these agencies can co-develop educational programming?

Recommendation: Living Laboratory (cont.)

For location, questions concerning the use of existing buildings, parking lots, walkways, and roadway access, accommodations for differently-abled learners, will be key to address. Given that all the communities surrounding the Park have unique physical places and buildings, setting up a network of sites may be desirable.

A first step in actualizing the Living Laboratory will be for interested individuals to develop a concept paper that articulates the specifics of the Lab, taking the "nuts and bolts" into consideration. Envisioning the Living Laboratory in iterative phases and building out the mechanisms, timeline, and funding will be essential to success.

Case Study: Living Laboratory

The San Diego River Conservancy has awarded San Diego State University (SDSU) $2M in research funding to build a living laboratory in SDSU Mission Valley River Park, to further the understanding of operative hydrological systems in the San Diego area. The laboratory will serve students at San Diego State University and the community in conducting fieldwork studying water quality, storm, and wastewater treatment. The park will be designed to have a bioretention basin that filters stormwater runoff before it enters the San Diego River and drains into the ocean, while the park's sanitary sewer system holds the runoff water for waste reuse research. The community benefits from a laboratory next to the family-friendly river, which facilitates community learning opportunities for the local K-12 students in the area. The research team in the laboratory wants to introduce unfamiliar technologies to the community to heighten their awareness of PFAS, or forever chemicals' filtration, and microplastics from various water sources. The laboratory is set to open in January 2026 (S.C. Bard, 2024).

Figure Y. SDSU Mission Valley River Park Trail.
Source: R. Brothers, 2023

Case Study: Living Laboratory (cont.)

The City as a Living Laboratory (CALL) is an organization reimagining sustainable development of the built environment through the usage of the arts. Their framework utilizes a place-based approach to connect the local context with larger environmental issues with the assistance of urban designers, policymakers, and community leaders. CALL is currently working on the redevelopment of Tibbetts Brook in Van Cortlandt Park. As the park and nearby neighborhoods have faced serious flooding due to overflow of the Broadway Sewer, the Harlem River becomes infiltrated with contaminated articles and runoff (City of New York Department of Environmental Protection, n.d). The recent hit of Hurricane Ida in 2021 sparked action as the intensity of the storm overloaded the sewage treatment plant and the Major Deegan Expressway, stalling traffic for several hours.

CALL is leading the charge of restoring Tibbettts Brook's back to its normal natural drainage pattern using daylighting. As part of the daylighting project, the organization has current artists' projects uncovering various components of the park (City as Living Laboratory, n.d.). The Buried Brook is an augmented reality sound podcast that traces the geography of Tibbetts Brook through a guided route, educating users on the history of the park.

The second featured project is the Tibbetts Estuary Tapestry created by Ana De La Cueva and Matthew Lopez-Jensen. This creative project was a culmination of one hundred volunteers, all from the local community, to redesign the complexity of the Broadway corridor to improve its ecological progress. The volunteers embroidered flora, fauna, and animals indigenous to the landscape in efforts of dreaming of a more sustainable and flood-resistant landscape.

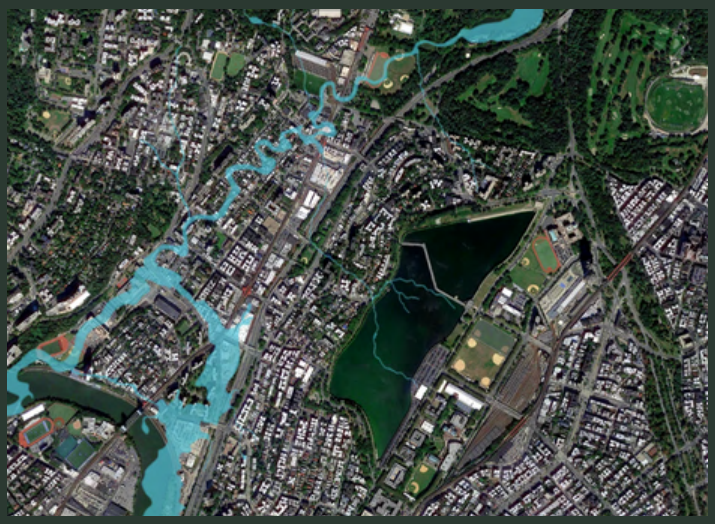
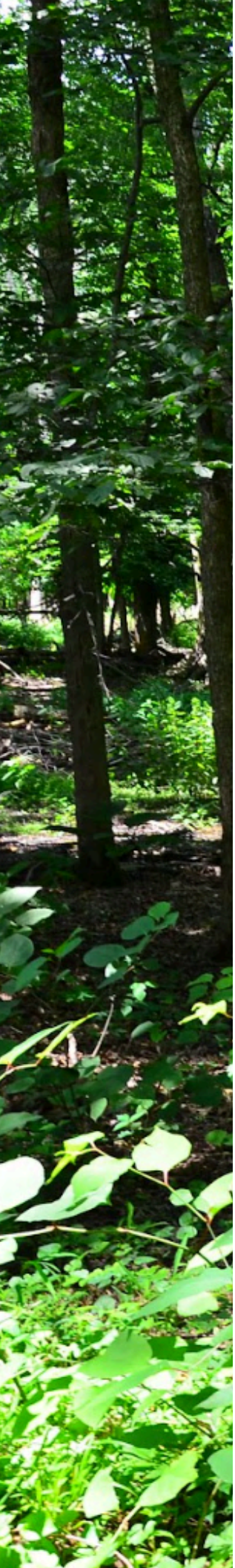


Figure Z. Early concept drawing of Rescuing Tibbetts Brook
Source: City as Living Laboratory, n.d.



Recommendation: Task Force

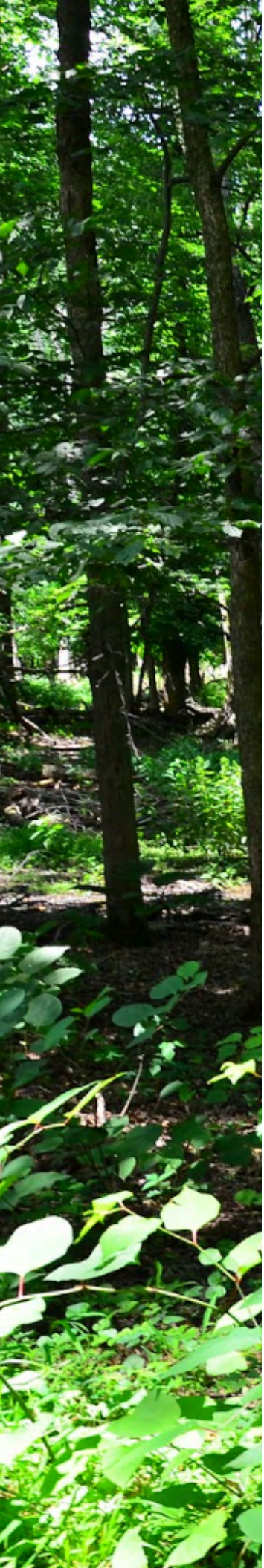
A Task Force that can articulate the shared issues, organize, and prioritize them – whilst seeking a place at the table for input and authentic co-decision making with county and state agencies, and the NJ state legislature, is recommended.

The Task Force comprises representatives from the six communities to conceptualize the most immediate concerns of the Park concerning safety, inclusion, programming, and infrastructure repair and maintenance. Likewise, the Task Force would conceptualize and socialize the Living Laboratory, and define a Consortium of the six communities to implement the findings of the Task Force. The recommendation for the Task Force duration is around six to twelve months. Ensuring the Governance remains core to the Park's sustainability and resiliency will be found in the vision and work of the Consortium.

As a Task Force, safety, inclusion, programming and infrastructure repair and maintenance can be addressed including disability accommodating services in the Park such as Americans with Disability Act (ADA)-accessible sports venues (green field, recreation center, and basketball courts), bathrooms, and hiking trails; and safeguarding addendums to protect the wellbeing of patrons.

Inclusion starts with intentionality, as disabled persons are often overlooked in urban planning decisions. Suggestion of a discounted rate for seasonal activities and programming would be helpful to users requiring ADA-accommodating services, similar to the program by the New York State Office of Parks (New York State Office of Parks, Recreation and Historic Preservation, n.d.).

Additionally, regulations about updated safety features to enhance the Park user's experience are essential. Traditional bikes, electric bikes, and scooters are welcome in the park, but precautionary measures must be put into place to protect both the vehicle users and other park visitors. New biking trails should be introduced, as there is a 45% increase in the use of biking trails from 2019 to 2022 (Rails-to-Trails Conservancy, 2022). Signage is also a priority, as council members have shared incidents with visitors who trespassed a hazardous or construction site without knowledge of its condition. The Park needs to include signage for all Park provisions, and lighting in tunnels needs to be upgraded.

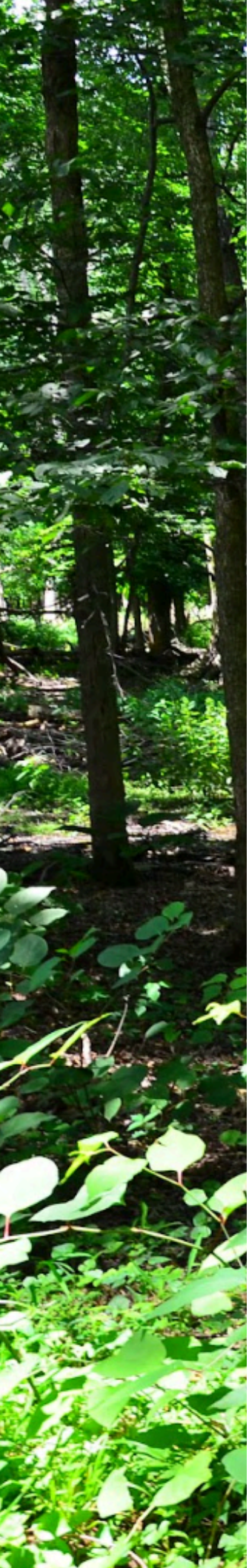


Recommendation: Consortium of Six Communities

The Saddle River County Park Consortium is a collaborative effort among six Bergen County municipalities (Rochelle Park, Saddle Brook, Fair Lawn, Paramus, Glen Rock, and Ridgewood) that are connected by the Saddle River County Park system. Together, with NJDEP, the County and Parks, these communities can collectively work to coordinate on flood mitigation, environmental restoration, stormwater management, and park infrastructure improvements on a Park-wide basis, through a regional lens. In terms of its preliminary work that will be undertaken over a 24-36 month timeframe, the Consortium will need to engage in: Establishing the mission, vision and core values of the Consortium and proposing plans for implementation; socializing the Concept of the Living Laboratory and launching its pilot in 2 to 3 phases; suggesting effective, and ongoing mechanisms for communication, safety and mitigation inventions for the Park; instigating CRS and collective municipal bond discussions and activities; and setting up the Saddle River County Park Trust (see below), as examples.

Best practices and ideas for the Saddle County Park Consortium can be found in another New Jersey organization, The Hackensack River Nation. Taken directly from its website, found at: https://www.nnjcf.org/climate-action-mobilization-project-camp/hackensack-river-nation/: “The Hackensack River Nation, established in 2024 …is dedicated to raising awareness and improving the health of the Hackensack River and its 197-square-mile watershed, which spans northeastern New Jersey and southern New York. … This collaborative effort seeks to underscore the power of unity and set a precedent for community-driven environmental stewardship for problem areas like pollution, flooding, and overdevelopment… and… develop a shared vision for the future of the Hackensack River and the watershed.”

Reviewing the vision and work of the River Nation is important because it embraces a core component of what shared governance represents for the Saddle River County Park: That of creating alliances with “public officials” and “strengthening the influence of its members.” Moreover, their emphasis on collaboration is aspirational and inspirational and is directed at creating better programming, policy, and outcomes. And, finally, the organization is focused on creating cleaner waters and healthier ecosystems, and supporting “environmentally-friendly economic and community development”. All of these elements dovetail, nearly precisely, with the possibilities and opportunities found in Community-shared Governance for the Saddle River County Park constituency, the Bergen County Parks Department, and the NJ DEP.



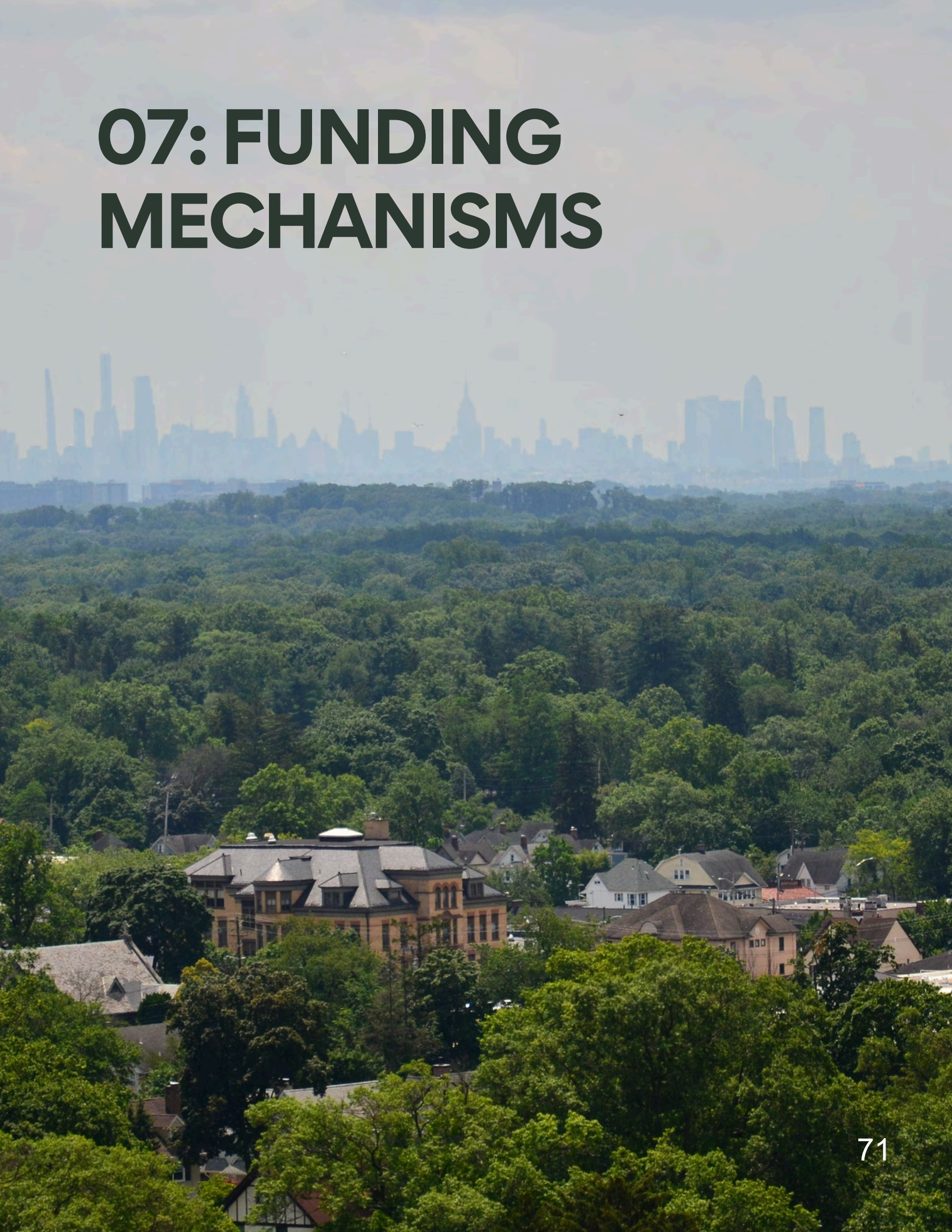
Recommendation: The Saddle River County Park Trust

The Saddle River County Park Trust will be a long-term strategic planning commission that will emerge from the Task Force. The trust will be a consortium of environmental knowledge experts, community leaders, educators in the K-12 school districts, parks officials, policy-makers, and local residents. The Trust will operate as an inclusive forum for subject matter experts, stakeholders, and local constituents to collectively address environmental concerns, align with sustainability and ecological preservation, and fortify precautionary safety measures.

Similar to the Meadowlands Conservation Trust located in Hackensack, New Jersey, the goal of the trust is to preserve the sacred beauty of the natural land and prevent wildlife endangerment. In addition, the environmental commission will serve as an open space for community members to voice their grievances, ideas, or questions.

The environmental commission will host monthly meetings open to the public to foster community engagement and address the relevant needs of local neighbors through an open repository of complaints, perceived hazards, ideas, etc. Community feedback will be collected through meetings, email inbox, and phone line to cater to different backgrounds. The trust will formulate an open space fund designed to receive municipal funding that can be easily accessible for the environmental commission to use towards capital infrastructure projects. The trust will also form a Special Purpose District, which can issue debt on the municipal bond market to finance resilience infrastructure with revenue bonds funded through tax incentives granted by the SPD. The purpose of the trust is to act as a liminal body between the state and municipal government, as local and regional goals, as well as logistical support, will be met under large involvement. The trust’s financial stability will benefit the park in the long run, ensuring consistent programming, facilitating expansion opportunities, and attracting external funding. The Saddle River County Park Trust is more than a funding body, as it is a key driver to advancing the park’s contribution as a sustainable leader within the local community and the world.

07: FUNDING MECHANISMS



Climate Adaptation Financing Analysis: Saddle River County Park Resilience Project

The Saddle River County Park represents a critical opportunity to implement climate resilience infrastructure across all six Bergen County municipalities. With flooding costs across the United States ranging between $179.8 and $496.0 billion annually (U.S. Congress Joint Economic Committee, 2024), the economic imperative for proactive adaptation has never been clearer. Our recommendations to transform Saddle River Park could be financed through various bonding modalities, including a bond financed by the existing open space trust, a collective municipal bond issuance, or the formation of a special purpose district. Research demonstrates that “on average every dollar invested in flood protection can save $5-8 in damages, with some estimates showing that projects protecting water and waste treatment plants can produce $31 in returns per $1 invested,” underscoring the imperative for action (Committee, 2024).

The six municipalities surrounding Saddle River County Park, in particular, demonstrate strong financial capacity to galvanize local action, with three holding AAA credit ratings and combined assessed valuations exceeding $8 billion (S&P Global, n.d.). Amidst the backdrop of widespread discontinuation of federally funded grants for climate-resilient infrastructure and growing investor appetite for municipal bonds that adequately price in severe weather risk, a community bond could be quite attractive. According to Morgan Stanley, the municipal green bond market has ballooned to over $45 billion since 2013, presenting ample opportunity to obtain private financing for adaptation and resiliency projects across Saddle River County Park (Morgan Stanley, 2020). The challenge lies not in financial capacity but in structuring the right kind of financing that can withstand an unpredictable political climate and address the urgent climate risks facing the region.

Special Purpose District Framework

The most promising, albeit difficult, financing mechanism involves creating a Saddle River Flood Management District (“SRFMD”), modeled after successful precedents like the Battery Park City Authority. This approach recognizes that watershed-based flood management transcends municipal boundaries and requires governance structures capable of comprehensive regional coordination. Special-purpose districts have emerged as particularly effective for water management projects, as they possess dedicated bonding authority separate from general municipal debt capacity while maintaining democratic accountability through representative governance (Environmental and Energy Study Institute, 2025).

The Battery Park City Authority provides a compelling precedent, having been granted authority to offer residents and local businesses tax credits in exchange for PILOT payments used to finance debt covering Lower Manhattan's coastal protection infrastructure (E. Smull, personal communication, July 17, 2025). This model demonstrates how special-purpose entities can create revenue streams specifically tied to the benefits they provide, rather than relying solely on general taxation. For the Saddle River project, a similar structure enables the district to capture value from flood protection services while spreading costs equitably across the six participating municipalities based on both their financial capacity and flood risk exposure.

The governance structure would require careful attention to representation and decision-making authority, discussed in further detail under the governance section of this report. Board composition should reflect proportional municipal contribution and flood exposure, ensuring that communities bearing greater risk or contributing larger financial commitments have appropriate influence over project priorities. Professional management with expertise in both water resources engineering and infrastructure finance would be essential, as would the authority to enter into agreements with state and federal agencies for ongoing coordination and potential future funding opportunities.

Revenue Bond Structure and Funding Mechanisms

Unlike general obligation bonds that rely solely on property taxes, revenue bonds can be backed by multiple income streams specifically related to flood management benefits. This diversification reduces financial risk while creating more sustainable funding models that align costs with benefits received. The Hoboken model provides practical guidance, where the Open Space Trust Fund generates revenue through a dedication of $0.03 per $100 of assessed property value, creating approximately $24 million in annual funding for their resiliency park system (Environmental and Energy Study Institute, 2025).
Primary revenue sources for the Saddle River district would include stormwater utility fees, following successful models in communities nationwide where dedicated funding sources generate predictable revenue streams for water management infrastructure. Development impact fees represent another significant revenue opportunity. New construction in flood-prone areas creates additional impermeable surface, further burdening an already overwhelmed stormwater management system and warranting an additional tax to be paid by developers to the SRFMD. These fees can be structured to reflect both the incremental burden new development places on the flood management system and the value developers receive from enhanced flood protection.

Insurance premium savings offer another innovative revenue mechanism. As the project achieves FEMA accreditation and improves flood ratings for the region, participating property owners would realize reduced flood insurance costs. A portion of these savings could be diverted to the SRFMD through special assessments, creating a direct connection between infrastructure investment and the financial benefits it provides. This approach has proven successful in other regions where flood management districts have achieved measurable reductions in insurance costs, creating sustainable revenue streams that grow with the success of the infrastructure investment. Secondary revenue sources expand the financial foundation while supporting broader community benefits.

Enhanced recreational facilities and programming at the park can generate user fees, and environmental service revenue can also be created through the issuance of carbon credits as markets mature. Finally, the special district structure also enhances eligibility for state grants and federal funding opportunities that may become available as climate adaptation policy continues to evolve.

Municipal Financial Capacity and Credit Enhancement

The six municipalities demonstrate exceptionally strong collective financial capacity to support innovative financing approaches. Ridgewood, Glen Rock, Fair Lawn, and Paramus all maintain credit ratings of AA or AAA, reflecting strong fiscal management and low default risk. Even Saddle Brook, with an A rating, maintains adequate financial capacity to participate meaningfully in collective financing arrangements. This credit profile creates opportunities for credit enhancement structures where stronger municipalities can support overall bond performance, potentially reducing borrowing costs for the six municipalities.

The collective assessed valuation of over $8 billion across the six municipalities provides substantial security for revenue bond structures, while median property values ranging from $470,000 to $882,000 demonstrate the significant economic assets at risk from continued flooding. Fair Lawn's large population of 36,489 residents provides demographic diversity, while Ridgewood's high property values and AAA rating anchor the collective credit quality. This combination of population scale, property values, and credit quality creates significant benefits for a collective debt issuance.

In the last year, sources of federal funding, particularly grants issued by the EPA, have been discontinued. Currently, accessing private capital markets at favorable interest rates has become imperative for communities looking to safeguard against systemic risk like flooding.

Using a collective municipal bond issuance in these communities would not only improve the financial attractiveness of the bond through intercreditor agreements where AAA-rated municipalities provide backup support for the collective bond obligations, but also enhance market confidence to further reduce interest rates on the debt. The strong credit profile also positions the district to receive state grants or discounted credit funding from the NJ Infrastructure Bank, which has recently created precedent for resilience funding with a $1.6 million loan to the Bergen County Utilities Authority (New Jersey Infrastructure Bank, 2025).

Green Bond Market Opportunity and ESG Investment Trends

The project aligns strategically with the rapidly growing demand for Environmental, Social, and Governance (ESG) investments, particularly in the municipal green bond market. Since the first municipal green bond in 2013, issuance has grown to more than $45 billion, with appetite continuing to increase among institutional investors, pension funds, and socially responsible investment portfolios. This growth reflects not only investor commitment to environmental outcomes but also recognition that green bonds often provide attractive risk-adjusted returns due to their focus on essential infrastructure serving clear public purposes. According to Beth Griper, Managing Director of Municipal Bonds at MacKay Shields, there is a growing awareness among institutional investors that many municipal bonds now carry unpriced risks due to climate change (B. Griper, interview, June 20, 2025).

Green bond certification requires a rigorous environmental impact assessment, including analysis of protected species, migratory bird populations, and ecosystem services provided by the enhanced park infrastructure (B. Griper, interview, June 20, 2025). These requirements align well with the project's nature-based solutions approach, where tactical physical interventions provide both flood management and habitat benefits. The certification process, while adding initial complexity, creates third-party validation of environmental benefits that enhances market appeal, potentially reducing borrowing costs through ESG investor premiums (B. Griper, interview, June 20, 2025).

Timing considerations favor summer bond issuance when municipal bond supply typically decreases while institutional investor demand remains strong (B. Griper, interview, June 20, 2025). The combination of limited green bond supply and growing investor appetite for sustainable infrastructure creates favorable market conditions for well-structured climate adaptation bonds. Recent successful issuances by entities like the Battery Park City Authority and the city of Hoboken demonstrate continued investor appetite for coastal resilience and flood management bonds, particularly when backed by diverse revenue streams and clear performance metrics.

Proven Implementation Models and Scalable Solution

Case Study: Hoboken's Resiliency Parks

Hoboken's resiliency parks provide the most directly applicable model for the Saddle River project, demonstrating both technical feasibility and financial viability. The city's $230 million investment across four parks achieved an 88% reduction in flooding events while storing 4.2 million gallons of stormwater during major storm events (Environmental and Energy Study Institute, 2025). The Southwest Resiliency Park, built on a one-acre contaminated site, combines passive green space with sophisticated flood mitigation infrastructure, including rain gardens, porous pavers, cisterns for rainwater harvesting, and underground detention systems (Southwest Resiliency Park, 2021).

The financing structure for Hoboken's ResilienCity Park demonstrates the viability of combining federal grants, state infrastructure bank funding, and local revenue sources. While the $10 million BRIC grant component is no longer available due to program discontinuation, the remaining $68 million came from sources that remain accessible: $44 million from the New Jersey Infrastructure Bank through EPA Clean Water State Revolving Loan Fund programs and $24 million from municipal open space funding (Environmental and Energy Study Institute, 2025b). This financing mix provides a template for the Saddle River project, where similar infrastructure bank financing could be combined with the proposed special district revenue and/ or collective municipal bond.

Case Study: The Lower Manhattan Coastal Resiliency Project

The Lower Manhattan Coastal Resiliency project, while much larger in scale at $5-7 billion, demonstrates successful multi-jurisdictional cooperation and special authority financing for flood protection infrastructure. The Battery Park City Authority's $500 million bond issuance shows how special purpose entities can access capital markets effectively when backed by dedicated revenue streams and clear governance structures (Lower Manhattan Coastal Resiliency, n.d.). The project's 6:1 return on investment, where every dollar invested saves six dollars in recovery costs, provides additional validation for the economic benefits of proactive flood management infrastructure (Federal Emergency Management Agency & National Institute of Building Sciences, 2017).

State and Regional Funding Landscape

While federal BRIC funding has been discontinued, state-level opportunities continue to evolve, particularly following successful models like New York's Environmental Bond Act. The $4.2 billion bond act, approved by voters in November 2022, allocated $1.1 billion specifically for restoration and flood risk reduction projects, with $250 million dedicated to municipal stormwater grants, and demonstrates voter appetite for state-administered resilience funding (Hochul & Mahar, 2024). The act prioritizes nature-based solutions wherever possible, aligning perfectly with the integrated park and flood management approach proposed for Saddle River.

New Jersey's potential development of similar bond programs provide crucial state-level support for local climate adaptation projects. The precedent established by successful programs in neighboring New York creates political and technical frameworks that could be adapted for New Jersey's specific needs and regulatory environment. Regional cooperation across state lines also presents opportunities, particularly for watershed-based projects like Saddle River that may have implications for downstream communities in multiple states.

In August 2025, $10 million in funding was made available through NJDEP's Office of Climate Resilience to provide grants of up to $300,000 to municipalities that form regional teams with at least two other municipalities and one community based organization. This funding can be used to develop regional Resilience Action Plans (NJDEP, 2025)

Living Laboratory Financing Strategy

The revolving fund model represents an innovative financing mechanism that diversifies and de-risks debt issuance by pooling private capital with philanthropic funding, creating a hybrid structure particularly effective for projects with both financial returns and social impact objectives. This approach has proven instrumental in financing charter schools, which typically face low credit ratings similar to the challenges confronting novel climate adaptation projects (E. Smull, personal communication, July 17, 2025).

For the Saddle River County Park living laboratory component, a revolving fund structure could address the inherent funding challenges of research and projects that may not generate immediate revenue streams. The model would combine municipal bond proceeds with foundation grants, corporate sustainability investments, and academic research partnerships to support ongoing administration, data collection, and adaptive management activities that are essential for the park's dual objectives to enhance flood infrastructure and serve as an environmental research facility.

The living laboratory's research outputs—including flood mitigation performance data, ecosystem service quantification, biodiversity cataloging, and resilience design frameworks—would provide value to the broader resilience community while justifying philanthropic investment. As the project demonstrates measurable flood reduction and environmental benefits, successful outcomes could attract additional private investment, allowing the fund to revolve and support expansion or replication in other locations. This structure particularly appeals to environmental foundations and corporate ESG programs seeking measurable impact investments in climate adaptation, while providing the municipal partners with reduced financial risk and enhanced technical capacity for long-term project success (E. Smull, personal communication, July 17, 2025).

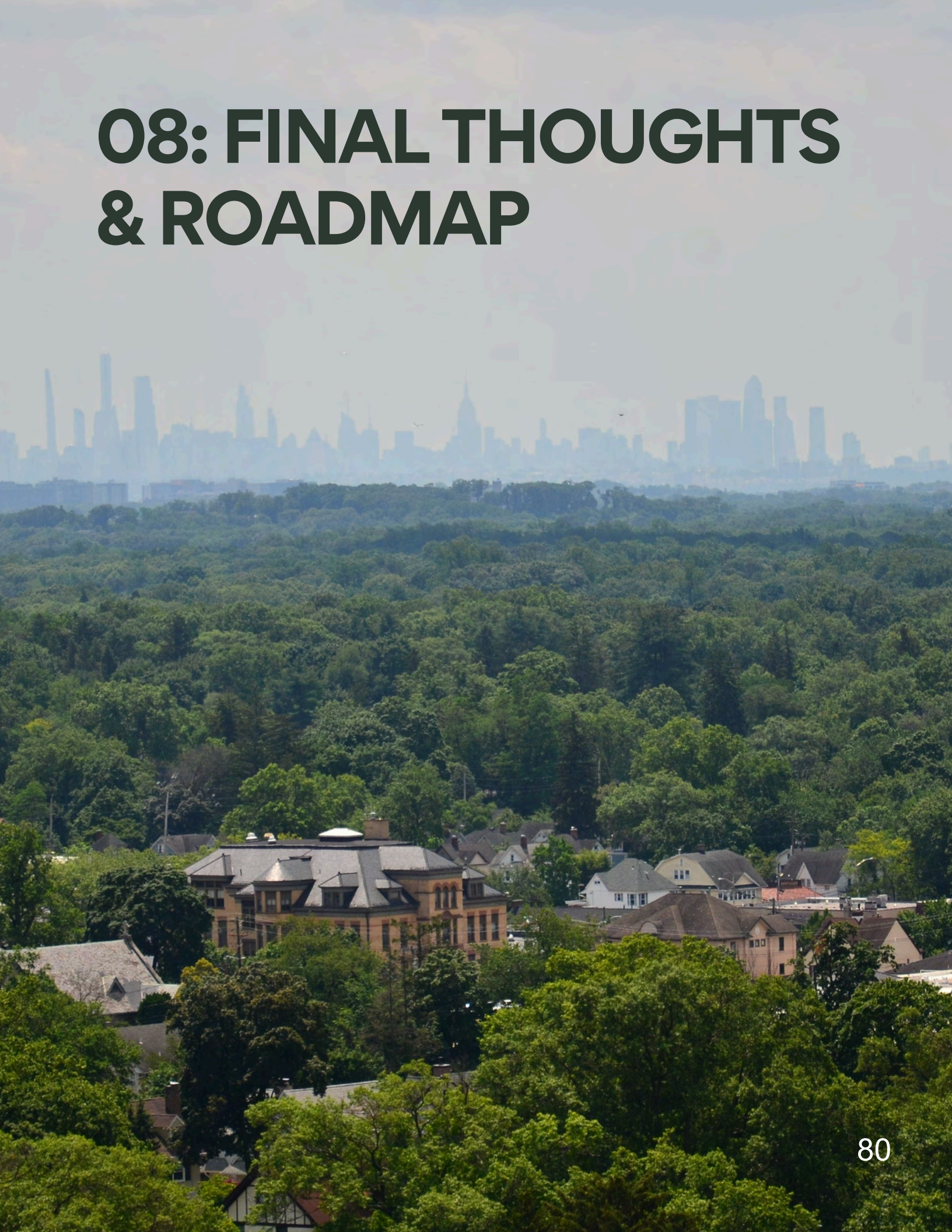
Regional Implications

The Saddle River County Park resilience project represents more than a local flood management initiative; it demonstrates a replicable model for climate adaptation financing that could transform how communities across the region approach infrastructure resilience. The combination of strong municipal credit profiles, proven technical solutions, growing green bond market appetite, and successful precedent projects creates uniquely favorable conditions for implementation despite the challenging federal funding environment.

The project's estimated $1.2- 2.2 million investment requirement aligns well with the collective financial capacity of the participating municipalities, while the demonstrated 1:6 return on resilience investment provides compelling economic justification for immediate action (Federal Emergency Management Agency & National Institute of Building Sciences, 2017). More importantly, success in this pilot project could establish financing mechanisms and governance structures that enable similar initiatives throughout Bergen County and the broader region, positioning these communities as leaders in innovative municipal finance for environmental resilience.

The urgency of climate adaptation, combined with the growing insurance crisis and mounting flood risks, makes the Saddle River project not just financially viable but economically essential. As traditional federal funding sources become less reliable, the innovative financing approaches demonstrated through this project provide a sustainable pathway for communities nationwide to address climate risks proactively rather than reactively. The technical, financial, and governance frameworks developed through this initiative serve as valuable precedents for the broader transformation of municipal finance needed to address the climate challenges facing communities across the United States.

08: FINAL THOUGHTS & ROADMAP



FINAL THOUGHTS

Bergen County, New Jersey is the #1 most vulnerable county for flooding in the US, with over $72 billion at risk. The six communities surrounding Bergen County's Saddle River County Park have been severely affected by repeated flooding events, putting $7.1 billion of property values at risk. Homes along the Saddle River are on the brink of falling apart due to soil erosion. Damaged infrastructure in the tunnels and pathways, and unclear e-bike regulations, pose a dangerous safety threat to communities. Tennis courts in the park are in a state of disrepair and inaccessible to community members. The Bergen County Parks Department could benefit from increased human and financial resources, especially to address Park engineering and natural infrastructure issues and safety concerns. Coordination between the Department and the NJ DEP ought to be enhanced. Strategically and operationally, a more proactive approach to flood mitigation is highly desirable. Finally, climate change and its economic impacts are real and intensifying. Climate change financing offers mechanisms to offset shared risks in a collective way, accruing benefits at a local community level, and, regionally across communities.

To reimagine Saddle River County Park as a model of sustainability, clear and defined governance will help drive integrated environmental, economic, and social solutions, achieving greater adaptability and resilience within and across communities. Governance helps ensure that diverse perspectives are voiced, and that arrived at decisions, policy and actions are better-aligned with community priorities. It would be essential to have a sponsor, and we would suggest, James J. Tedesco, III, the Bergen County Executive. Establishing a "living laboratory" in the Park to educate the next generation of environmental leaders reinforces the role of the Park as a place for learning and innovation as well as for recreation and renewal.

The work of Park transformation is multifaceted and complex. The prospect, though, is a thrilling one: Talented, knowledgeable, deeply committed individuals coming together for the shared purpose of stewarding an urban oasis for current and future generations.

ROADMAP

PHASE 1
FIRST 6 MONTHS

The *Task Force* will:
1. Publish the concept paper for the Living Laboratory.
2. Establish governance for the Consortium of Communities.
3. Work with County Parks to immediately address safety concerns

PHASE 2
7-18 MONTHS AND ONGOING

The *Consortium of Communities* will:

Communities:
1. Build communication plans for CRS certification for municipalities part of the Consortium.

Living Laboratory:
1. Socialize the Living Laboratory concept paper.
2. Establish governance for the Living Laboratory.
3. Establish programming and projects for the community throughout the Saddle River County Park as part of the Living Laboratory.
4. Establish programming and projects through coordination with the Board of Education and local educational institutions as part of the Living Laboratory.
5. Begin initial phase research on locations for the Living Laboratory.

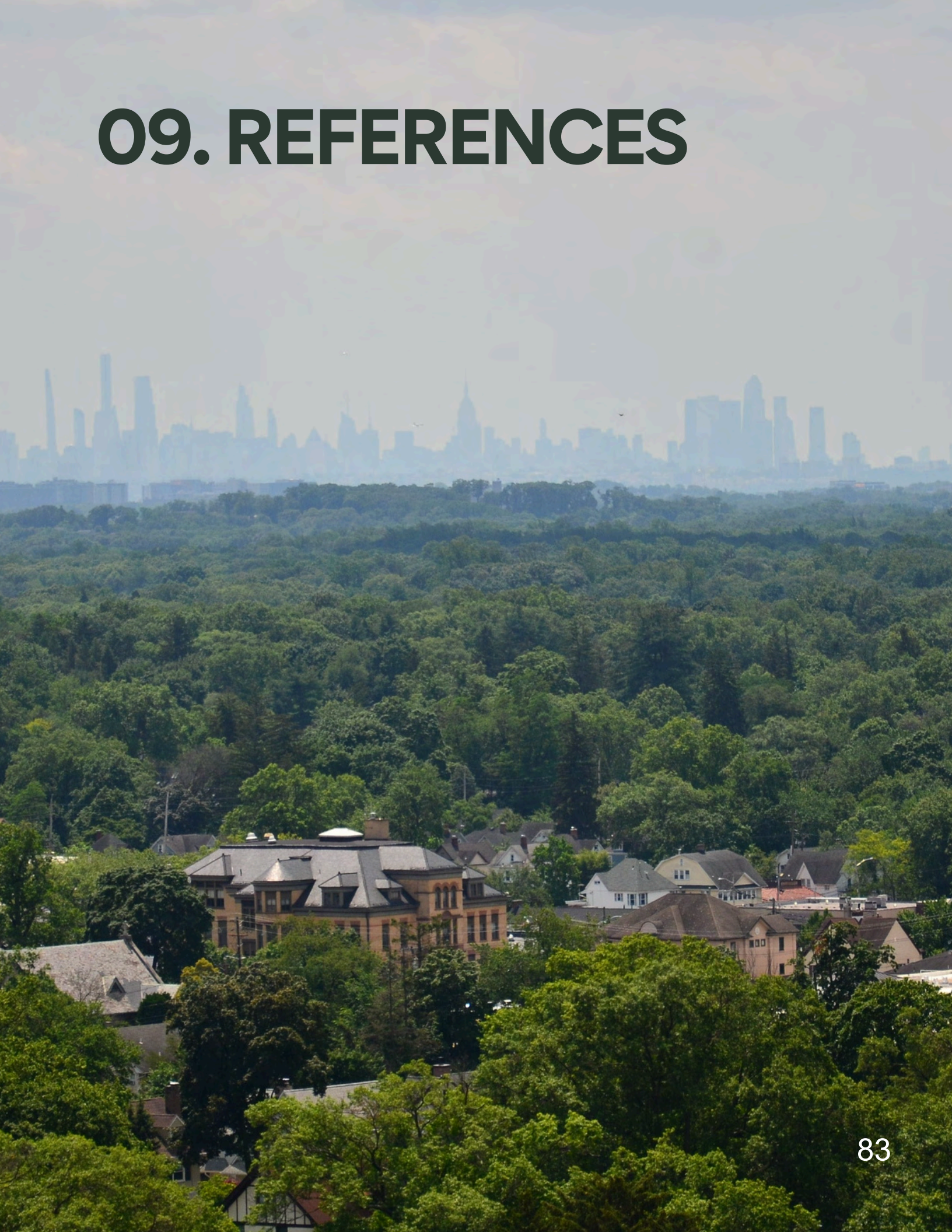
Safety:
1. Establish communication channels with Bergen County Parks and NJ DEP for community members to log issues and provide a clear resolution transparency trail.

Saddle River Trust:
1. Begin initial phase research for funding of the Living Laboratory and Saddle River Trust through grants and municipal bonding.
2. Begin initial phase research on the formation of a Special Purpose District to draw tax revenue for the Living Laboratory and Saddle River Trust.
3. Establish governance for the Saddle River Trust.
4. Identify locations for flood mitigation interventions.

PHASE 3
19-36 MONTHS AND ONGOING

The *Saddle River Trust* will:
1. Coordinate flood mitigation projects based on identified intervention locations.
2. Maintain and continue to seek funding through grants, collective municipal bonding, and tax revenue.
3. Establish locations to house a physical space for the Living Laboratory.

09. REFERENCES



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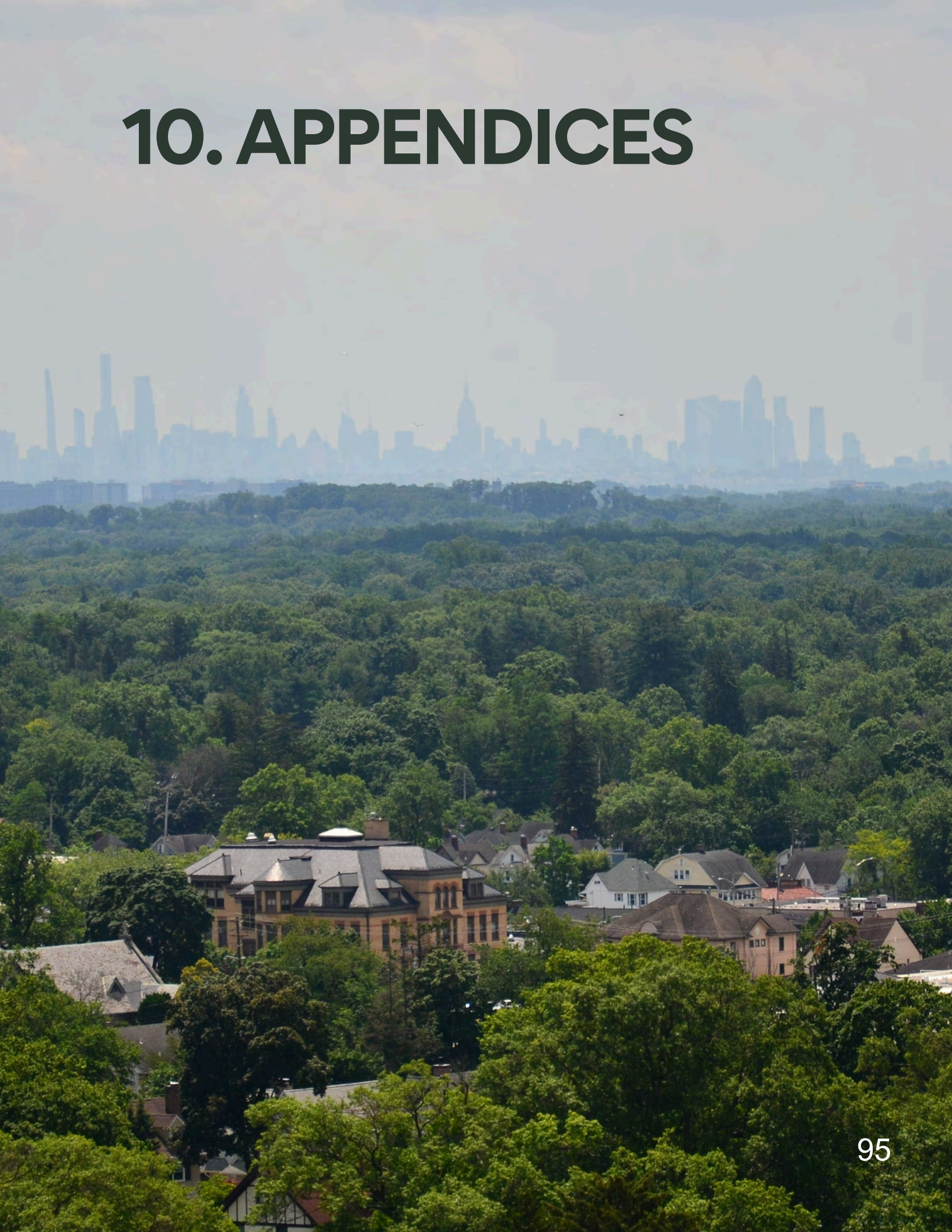
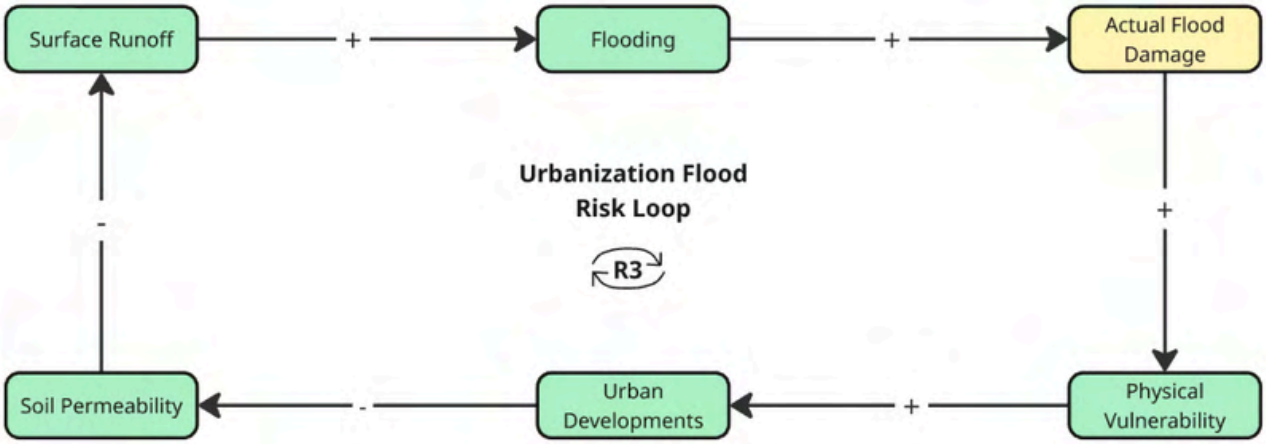
10. APPENDICES

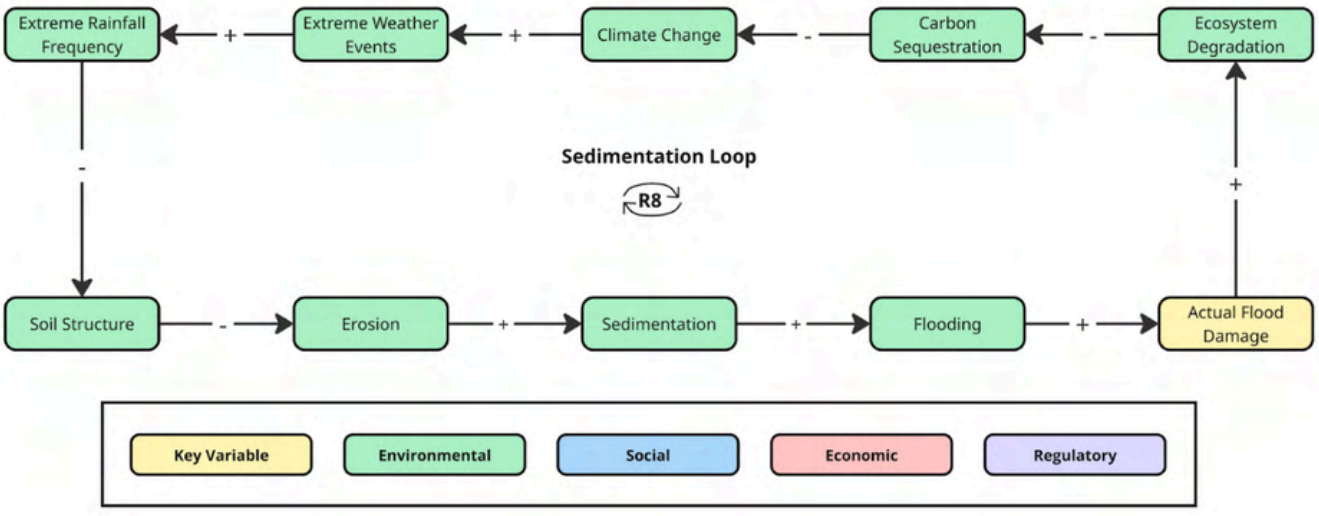


Appendix 1: R3 - Urbanization Flood Risk Loop



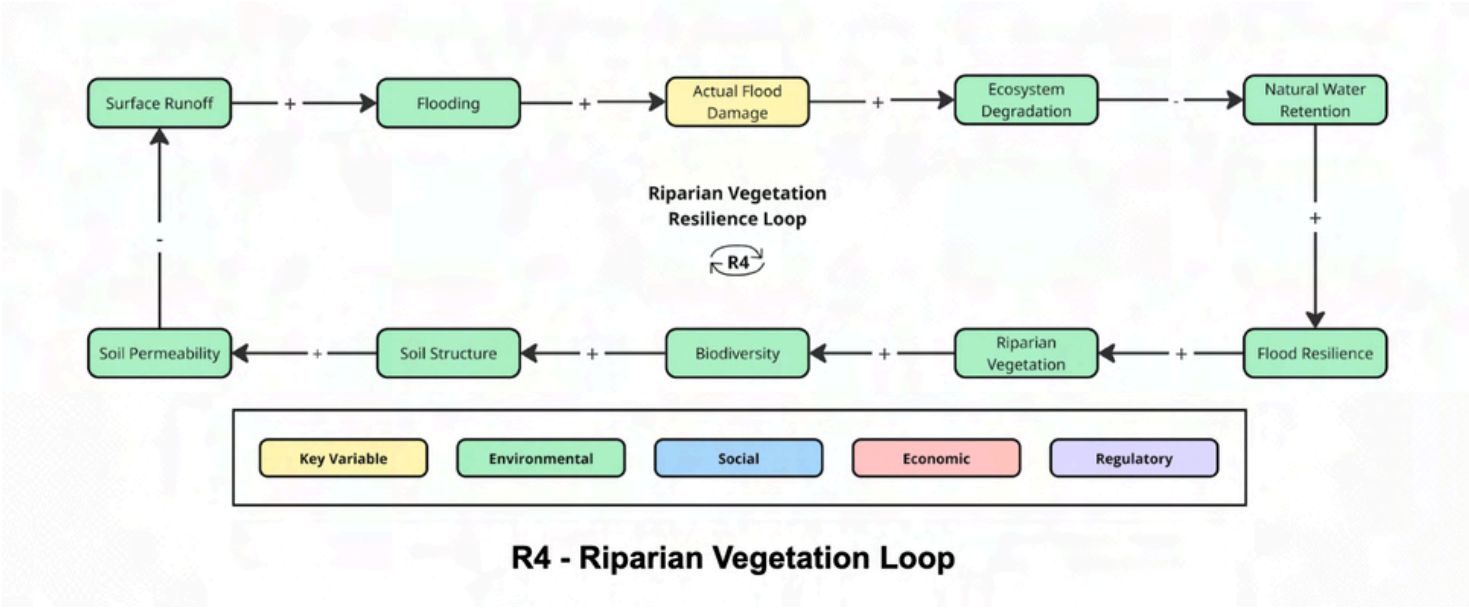
R3 - Urbanization Flood Risk Loop

Appendix 2. R8 - Sedimentation Loop



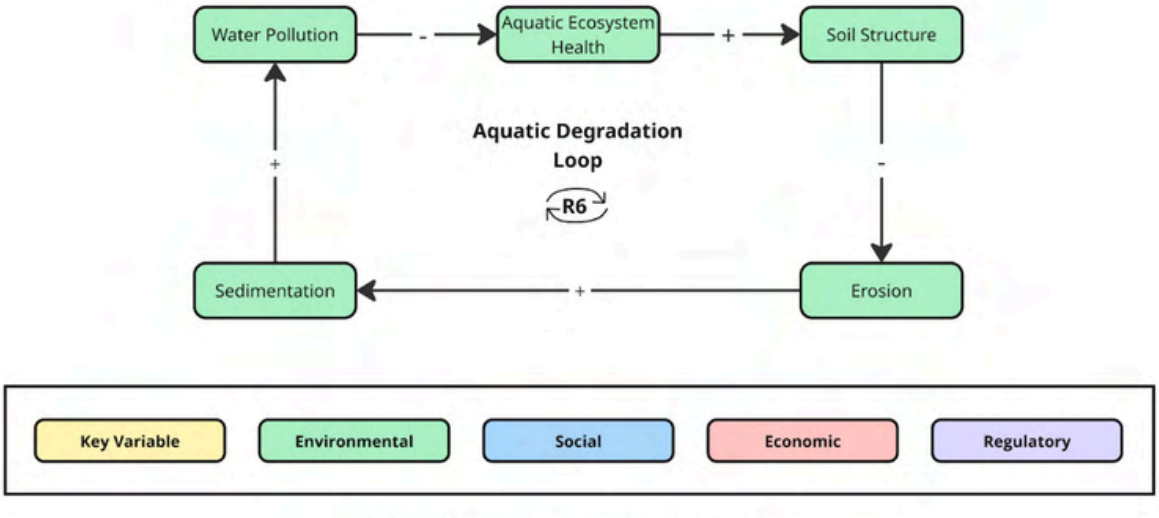
R8 - Sedimentation Loop

Appendix 3. R4 - Riparian Vegetation Loop



R4 - Riparian Vegetation Loop

Appendix 4. R6 - Aquatic Degradation Loop



R6 - Aquatic Degradation Loop

Appendix 5. New Jersey's Different Climate Zones
Source: Rutgers University Climate Lab, n.d.

Appendix 6. Sample Set of Interview Questions

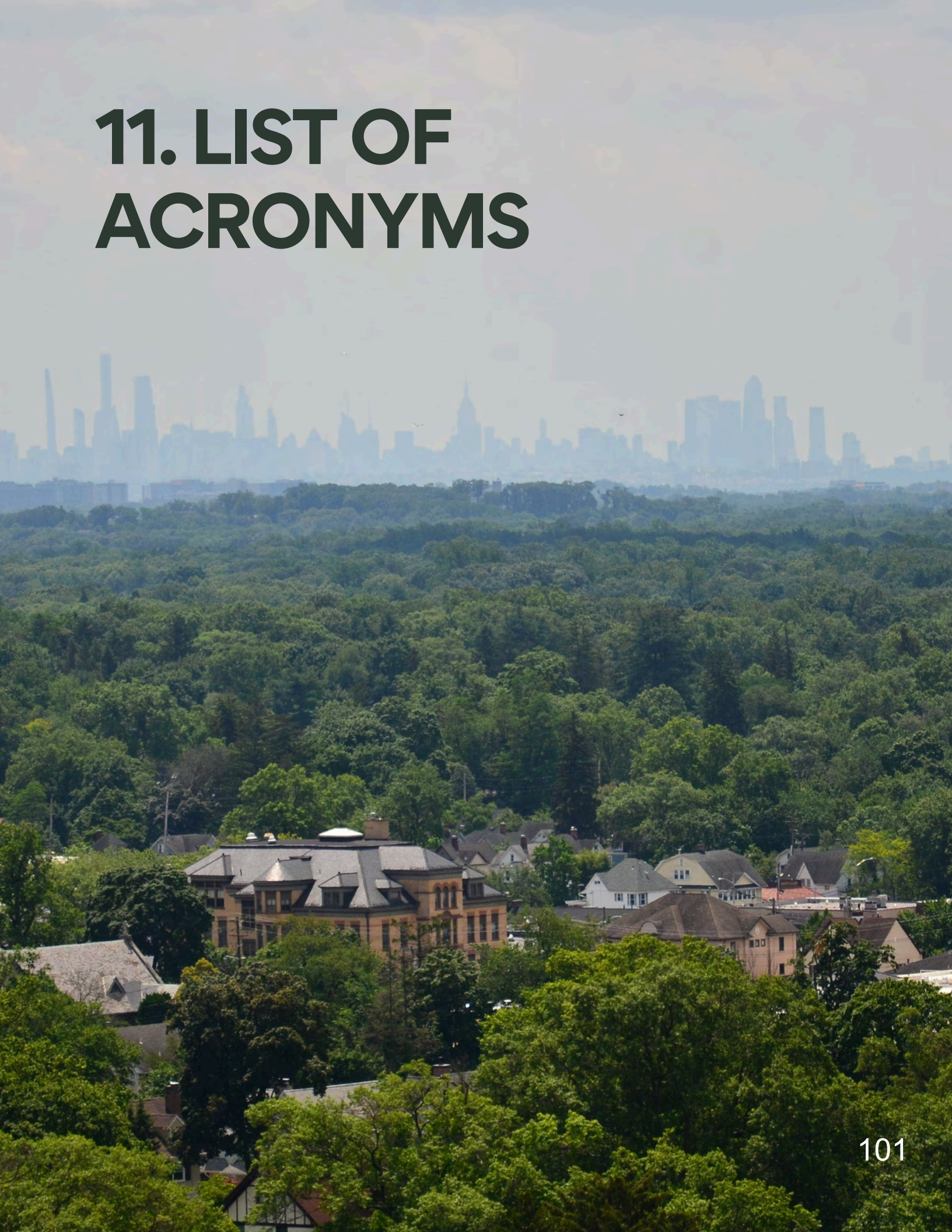
Variations of tailored questions were asked. A sample of typical questions we asked are:

1. Are there specific environmental challenges or opportunities you associate with Saddle River County Park?
2. Do you see any opportunities for collaboration between local schools and the Township to promote flood awareness and preparedness among students and families, possibly through initiatives like community science projects or curriculum tied to a "Living Lab" concept?
3. What improvements, in general, would you like to see regarding flood mitigation? And, the Park, how would this factor in?
4. How do you handle community concerns about safety in the park? For example, concerns about flooding, erosion, pedestrian and bicycle safety, and other safety issues.
5. What are your thoughts on a living lab? What do you think the community's reaction would be to creating a 'living environmental laboratory/education center' in Saddle River Park? Do you think residents and local leaders would support testing and showcasing sustainability projects there?
6. What opportunities and challenges do you see for improving sustainability in the Saddle River County Park?

Appendix 7. Table: GIS Sources

Data Type	Source	URL
Parcel Data	NJDEP ArcGIS Web App Viewer	https://njdep.maps.arcgis.com/apps/webappviewer/index.html?id=e26feba3b4844e5d960d3163b23623f2
Flood Hazard Data	NJDEP ArcGIS Web App Viewer	https://njdep.maps.arcgis.com/apps/webappviewer/index.html?id=e26feba3b4844e5d960d3163b23623f2
DEM Data	USGS National Map Downloader	https://apps.nationalmap.gov/downloader/
Slope Data	NJDEP ArcGIS	https://njdep.maps.arcgis.com/home/item.html?id=a1ba14d09df14f42ad6ca3c4bcebf3b4
Soil Data	USDA NRCS Web Soil Survey	https://websoilsurvey.nrcs.usda.gov/app/WebSoilSurvey.aspx
Census Tract	Bergen County NJ PDF	https://bergencountynj.gov/wp-content/uploads/2023/07/00_BergenCounty_CenTracts2020.pdf

11. LIST OF ACRONYMS



LIST OF ACRONYMS

ADA - Americans with Disability Act

BMP - Best Management Practices

BRIC - Building Resilient Infrastructure and Communities

CALL - City as a Living Laboratory

CRS - Community Rating System

DEP - Department of Environmental Protection

ESG - Environmental, Social, and Governance

FEMA - Federal Emergency Management Agency

GIS - Geographic Information System

NRCS - Natural Resources Conservation Service

NJDEP - New Jersey Department of Environmental Protection

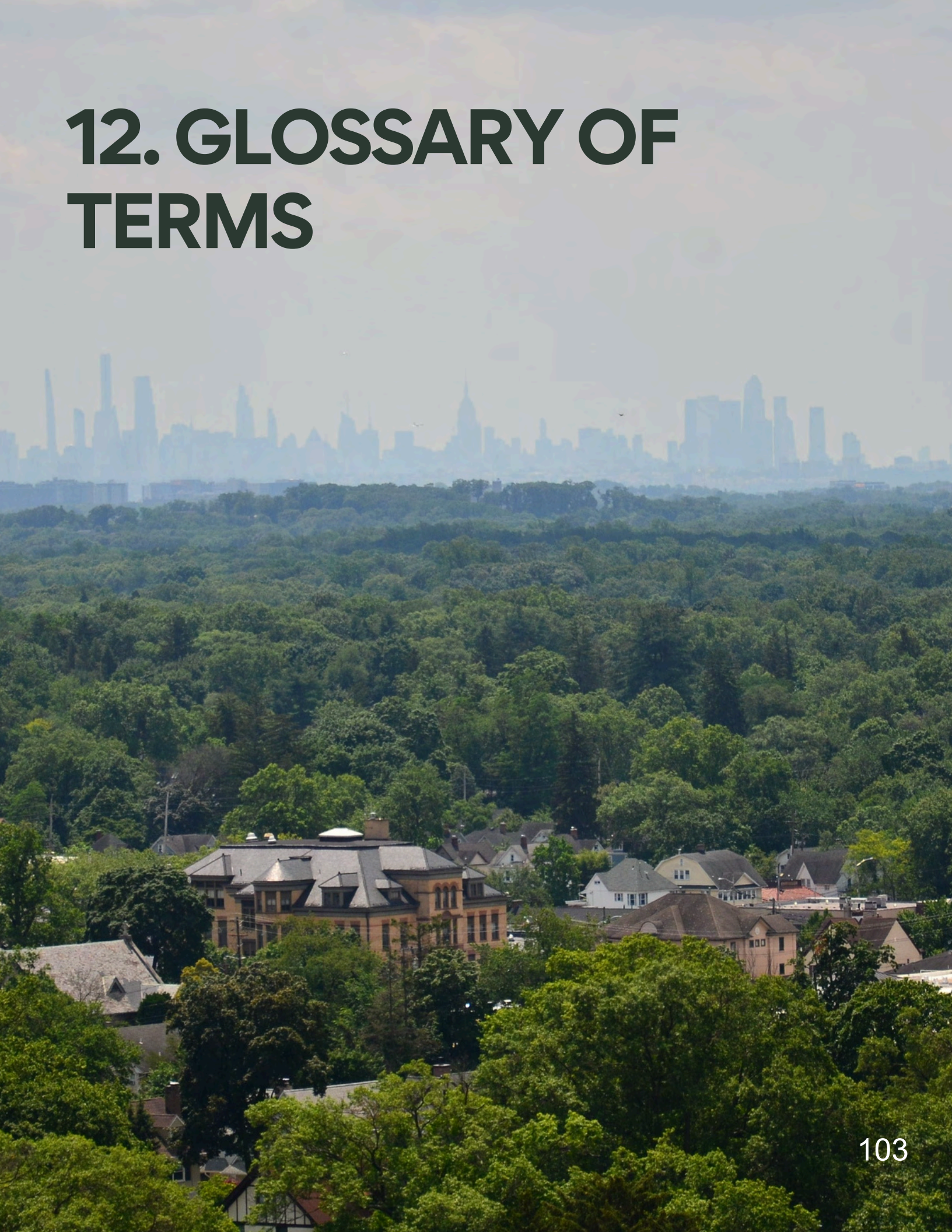
SRFMD - Saddle River Flood Management District

SUMA - Sustainability Management

US EPA - United States Environmental Protection Agency

WYO - Write Your Own

12. GLOSSARY OF TERMS



GLOSSARY OF TERMS

Balancing Loop: In systems thinking, it is a type of loop that is “generally stabilizing or goal-seeking. They resist change in one direction by producing change in the opposite direction” (Wardman, n.d.) In the system map and in the body of this report, a balancing loop is denoted by the letter B.

Earthwork: Earthwork refers to the engineering process of moving, reshaping, and compacting soil, rock, or other ground materials (Procore, 2024)

Elevation: “The vertical distance of a point or object above or below a reference surface or datum (generally mean sea level). Elevation generally refers to the vertical height of land.” (Esri, 2025)

Feedback Loop: “Feedback loops can be thought of as closed loops of interconnection; basically, sequences of mutual causes and effects. The links between each variable show how they are interconnected, while the sign or polarity of each link shows how the variables affect one another” (Wardman, n.d.)

Flood Risk Mitigation: “The overall goal of flood risk mitigation is to reduce or eliminate potential flood damage, in a way that is cost-effective, complies with floodplain regulations, and is acceptable to the homeowner in terms of appearance and livability. Mitigation can help avoid flood damage and, in some cases, may reduce flood insurance premiums. While major mitigation projects can be costly, flood damage is often far more expensive and the affected property remains at risk for future flooding” (National Flood Insurance Program, 2021).

Fluvial Flooding: “Fluvial flooding occurs when rivers and streams break their banks and water flows out onto the adjacent low-lying areas (the natural floodplains). This can arise where the runoff from heavy rain exceeds the natural capacity of the river channel, and can be exacerbated where a channel is blocked or constrained or, in estuarine areas, where high tide levels impede the flow of the river out into the sea” (Office of Public Works, n.d.).

Key Variable: In system mapping, the primary variable that the system aims to optimize or influence. For this project, the key variable is Actual Flood Damage.

Living Laboratory: The Living Laboratory is envisioned as a hub that fosters programming integrating environmental and ecosystems research, education, and training to test and develop environmental solutions. It will be a center for creating the next generation of environmental leaders. Typically, living laboratories engage with higher and secondary education, nonprofit environmental and conservation organizations, and public, private, and philanthropic partnerships (Van den Heuvel et al., 2021).

Model of Sustainability: A holistic approach, encompassing environmental, economic, social and governance issues to manage and mitigate flooding, while enhancing environmental restoration, conservation, and community well-being.

Nature-based Solutions: “Nature-based solutions are actions to protect, sustainably manage, and restore natural and modified ecosystems that address societal challenges effectively and adaptively, simultaneously benefiting people and nature” (United Nations Environment Programme, n.d.)

Negative Polarity: Elements move in the opposite direction (i.e. an increase in ‘x’ causes a decrease in ‘y’ OR a decrease in ‘x’ causes an increase in ‘y’)

Parcel: “Land parcels are boundaries that have associated information such as property owner, land use, value, and location attributes.” (Texas Geographic Information Office, 2019)

Positive Polarity: Elements move in the same direction (i.e. an increase in ‘x’ causes an increase in ‘y’ OR a decrease in ‘x’ causes a decrease in ‘y’)

Precipitation Shield: “On satellite images, an area of clouds, often within a larger cloud shield, that, based upon surface or radar observations, is resulting in precipitation” (American Meteorological Society, 2024)

Rain Garden: “A rain garden is a shallow, landscaped depression that captures, filters, and infiltrates stormwater runoff. In a rain garden, healthy soil and deep-rooted plants move stormwater into the ground and help remove pollutants” (Jersey-Friendly Yards, n.d.)

Reinforcing Loop: In systems thinking, reinforcing loops are “self-reinforcing, which means they compound change in one direction with even more change. Unstopped, they continue to reinforce a particular behavior” (Wardman, n.d.). In the system map and in the body of this report, a reinforcing loop is denoted by the letter R.

Resilience: Refers to the park’s ability to withstand, adapt to, and recover from climate-related challenges, particularly flooding, while continuing to provide essential services to the community.

Rip-rap: Loose stone used to form a foundation for a breakwater

Siting: Siting refers to the process of selecting the most suitable location for an infrastructure. In determining the suitable location, factors that need to be taken into consideration include: topography, location of roads and other infrastructure, type of soil, elevation, and regulatory requirements.

Slope: “Terrain slope refers to the measurement of steepness or incline at any given point on the land surface.”(GIS Navigator 2024)

Special Flood Hazard Area (SFHA): “Special Flood Hazard Area (SFHA) - The SFHA is an area that would be inundated by the flood having a 1-percent chance of being equaled or exceeded in any given year (base flood)” (Federal Emergency Management Agency, 2020)

System Map:
A visual representation that illustrates the interconnected relationships and feedback loops between variables within a system.

Systems Thinking:
A holistic approach that explores how elements within a system are interconnected and influence each other, enabling the identification of leverage points for effective intervention.

Underdrain:
A perforated pipe system installed underground to collect and transport subsurface water to a surface outlet. They can be used in various applications, including road drainage, parking lot construction, and bioretention systems

Variable:
In system analysis, an element within a system that can influence or be influenced by other elements.

Water Control Structure:
“A structure in an irrigation, drainage, or other water management system that conveys water, control the direction or rate of flow, or maintains a desired water surface elevation” (NRCS Ohio, 1991)

Write Your Own (WYO):
“The Write Your Own (WYO) Program, established in 1983, is a partnership between FEMA and private property and casualty insurers. It allows participating companies to issue and service Standard Flood Insurance Policies (SFIPs) under their own names. While the federal government retains responsibility for underwriting losses, companies receive an expense allowance for writing policies and processing claims. The program operates under NFIP rules and regulations.” (The National Flood Insurance Program for Agents: Agents Floodsmart Floodsmart, 2025)

100-Year Flood Zone: “Area that will be inundated by the flood event having a 1-percent chance of being equaled or exceeded in any given year” (Federal Emergency Management Agency, 2020)

500-Year Flood Zone: “Area subject to inundation from a flood having a 0.2 percent chance or greater of being equaled or exceeded in any given year” (HUD exchange, 2024)