



TOWN OF CARRBORO

NORTH CAROLINA

TRANSMITTAL PUBLIC WORKS DEPARTMENT

To: Stormwater Advisory Commission

From: Randy Dodd, Stormwater Utility Manager
Emily Cochran, Stormwater Administrator

Through: Joe Guckavan, Public Works Director

Cc: Heather Holley, Stormwater Specialist
Patricia McGuire, Planning Director
Josh Dalton, Sungate Design

Date: June 2, 2021

Subject: Stormwater Resilience: A Follow Up Memo from the RainReady Carrboro Study

Summary

The purpose of this memo is to supplement the RainReady pilot study provided by the Center for Neighborhood Technology that focused on residential scale resilience and assistance. In broad terms, creating a more flood resilient community will be a function of participation, collaboration, and engagement from a homeowner (especially in light of Carrboro's land use being primarily residential) to federal government scale. Encouraging, expanding, and accelerating resilience efforts can help residents and can also have additional downstream benefits, especially when the recommended practices are more broadly adopted.

Information

Context

Carrboro and many other communities face water resource management challenges that are significant and complex. We are trying to simultaneously manage: the flooding effects of more frequent intense storms, the adverse effects of urbanization on watershed processes, and the impacts to local aquatic ecosystems and water resources. There is a growing recognition that we cannot meet these challenges by working in "silos" - with wastewater, drinking water, groundwater, stormwater, and flooding addressed as separate problems with separate solutions¹. **Multi-faceted problems require multi-faceted solutions.** Communities are now looking for the tools to meet these challenges as efficiently and effectively as possible, with **one overarching goal being increased resiliency.**

For the purposes of this memo, and the previously-completed RainReady pilot study, the intersection of stormwater and floodplain management is particularly relevant. **Floodplain and stormwater management may be distinct disciplines and arenas², but they are hydrologically and**

¹ <http://uswateralliance.org/about/our-work>

functionally connected. The Town’s stormwater management obligations, and its Municipal Separate Storm Sewer System (aka “MS4”), are regulated under an EPA NPDES Phase II stormwater permit, which requires action to address the water quality impacts of stormwater runoff. The Town’s floodplain management approach has been founded upon FEMA’s National Flood Insurance Program, which is primarily motivated by flood mitigation needs for “insurable structures” in federally regulated floodplains. Fundamentally, there is a need to bring these disciplines together to help communities realize the benefits of an integrated approach that will make stormwater management more efficient, effective, and ecologically and economically resilient.

While a major driver for the RainReady pilot study was residents’ experiences of ramped-up, intense storms and associated flooding, it is also essential to understand the focuses of and distinct differences between stormwater and floodplain management, as well as the need to forge a more holistic and synergistic approach. Before discussing what is and could be involved, it is important to provide a synopsis of the history that is the foundation for the current situation.

History

The Carrboro of the mid-1960s was much different than the Carrboro of today; in 1960, about 2000 people lived in Carrboro. Carr Mill was shutting down, while the new public high school, Chapel Hill High, was about to open. The area outside of the current downtown was sparsely populated, with farmland abutting town on three sides. Then, the “baby boomer” movement came to Carrboro along with multifamily housing along Highway 54, in part to house the growing university community. In 1976, the Town joined the National Flood Insurance Program; in 1980, the Land Use Ordinance (LUO) was adopted. The 1980s and 90s were a period of both continued population growth and the associated new flood impacts. The 20th century has brought continued although slower growth, additional amendments to the LUO for improved stormwater and floodplain management, and federal floodplain regulation for the first time. In the past decade, it has also brought an uptick in flooding.

Flooding in Carrboro

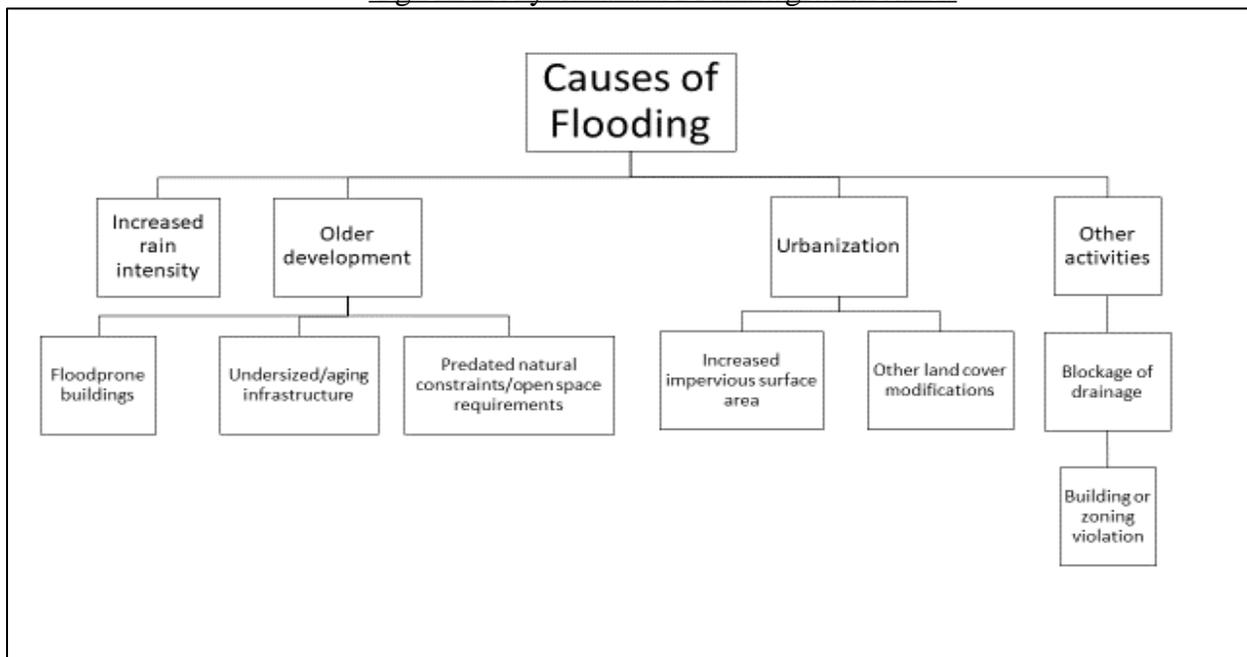
Carrboro’s location provides an inherent degree of flood resilience: towards the headwaters of two creeks (Bolin and Morgan), with much of Carrboro being at the top of the Bolin Creek watershed or along the ridge line between these creeks. Nevertheless, **flooding has become more prevalent** in recent years. **More frequent intense storms is a primary reason.** While it will take some time to tell whether tropical storm occurrence (# storms per year/decade) is changing or remaining about the same, and the location of tropical storm tracks also has a random and complex nature (as determined by atmospheric dynamics and steering currents), it is indisputable that the warming atmosphere holds more energy and water vapor, resulting in more storms at a higher frequency and intensity (inches of precipitation per hour), whether tropical or non-tropical. This increased intensity results in higher rates of local runoff. In addition, there has recently been more rain on an annual basis, which means wetter soils, a higher groundwater table, and less capacity over longer timeframes to absorb rain.

² <https://www.fema.gov/floodplain-management#:~:text=Floodplain%20management%20is%20a%20community,in%20a%20more%20resilient%20community.>
https://swanc.org/index.asp?SEC=75A8192E-23EA-4284-B2C1-ABF0E24D71AC&Type=B_BASIC#:~:text=As%20defined%20by%20the%20U.S.,not%20percolate%20into%20the%20ground.

The first decade of the 21st century was relatively quiet in terms of heavy rains and tropical storms. In fact, water conservation was of more concern than flooding in Carrboro, with repeated droughts. That changed in the second decade. Late June of 2013 brought one of the most intense events in recent years, a non-tropical summer storm that resulted in flooding throughout town, including in some spots not known for flood problems. Two of the wettest years of record (2018 and 2020) also occurred. There has been recurring and repeated floodings.

A major part of the “long term/big picture” solution to this part of the problem is to cool the atmosphere down, a many decades-long endeavor. The other flooding causes (older development, urbanization, and other activities) suggest a variety of approaches and solutions to address flood related challenges, as discussed in the remainder of this memo.

Figure 1: Key Causes of Flooding in Carrboro



A second reason for the flooding problems in Carrboro is the occurrence of some **older and less resilient development in lower lying areas**. This is a multifaceted issue. Some older buildings have been built in flood prone areas that would not be permissible now, or even within a decade of when they were built. In addition, some older buildings were designed in a less “resilient” way—for example, built “below grade” (finished or unfinished basements) or “at grade” (without a crawlspace and elevated finished floor). Less resilient buildings also may not include wet or dry floodproofing, elevation of equipment and ductwork, or other flood resilient measures such as dry wells, dry stream beds or French drains.

Finally, some of the **older stormwater infrastructure (both public and private) predated more recent requirements and standards**. In addition, the conveyance system (swales, ditches, pipes, culverts and associated inlets and catch basins) in some places may be undersized relative to current standards and/or be aging and in need of repair or rehabilitation. A final flooding cause is other **human activities that impede natural drainage**. These activities can involve both public and private properties, and in some cases can be addressed through enforcement of building and zoning

requirements and proper maintenance of the public or private stormwater infrastructure.

Types and Severity of Flooding

The term “flooding” has been generically used in Carrboro to refer to a diversity of events and experiences, but not all flooding is equal in terms of the severity of impacts, source or type of flooding, and potential solutions (Table 1). **In Carrboro, we experience riverine, “overbank” flooding**, which occurs when water overloads a creek channel and is forced to rise out into the floodplain. Federal mitigation funding is available for eligible properties in the regulated Special Flood Hazard Area (1% or 100 year flood) that are impacted by overbank flooding. The Land Use Ordinance includes provisions for stream buffers with a primary purpose of protecting riparian areas along creeks. These areas can also serve as proxies for flood-prone areas beyond the regulated floodplain.

We also experience localized, or “urban flooding”, which occurs when “the inflow of storm water exceeds the capacity of a drainage system to infiltrate water into the soil or to carry it away.”³ It can occur anywhere in the community, generally not in the regulatory floodplain, and therefore garners less federal/state attention and mitigation funding. While localized flooding doesn’t generate as many news headlines, it can pose some of the same risks and damages as overbank flooding, including:

- Safety hazards: drowning or injury, stuck vehicles, electrical shock from downed power lines
- Health concerns: mold and mildew, snakes and rodents driven out of their habitat and into human spaces, pollutants in water, mosquitoes breeding
- Mental health: stress, depression, and anxiety from the constant threat of property damage
- Property damage: carpeting, walls, insulation, furniture, flooring, and foundations
- Disruption: blocked streets, disrupted traffic and hindered access to homes and businesses, lost profits and alterations to normal routines
- Costs to local government: damage to public property, diversion of local staff/resources and additional trash collection and cleanup
- Impacts on the community: dissatisfaction with local government, rapidly aging buildings and infrastructure, longer-term deterioration of a neighborhood, loss of residents and declining property values and tax base for the community.

Flood impacts can be categorized as direct or indirect, and tangible or intangible⁴. Direct impacts are the immediate effect of the disaster, including injury and loss of life, damage to property or infrastructure, and immediate monetary loss; indirect impacts occur in the medium to long term, such as unemployment and reduced income from business interruption, or increased health effects from lack of sanitation facilities. Impacts that have a market value and can be measured in monetary terms are considered tangible, while intangible impacts include the impact to natural resources and human health, and cohesion of a community. Historically, **there has been more focus at all levels of government and society on the easier to identify and mitigate direct, tangible impacts as the result of flooding, while indirect and/or intangible impacts may take longer and be more difficult to identify and value.**

³ National Academies of Sciences, Engineering, and Medicine 2019. Framing the Challenge of Urban Flooding in the United States. Washington, DC: The National Academies Press. <https://doi.org/10.17226/25381>.

⁴ Merz et al., 2010; Zurich Flood Resilience Alliance, 2014

Table 1: Severity of Flood Impacts to Residential Properties

Frequency	Type of Property Impacts		
	Finished/Conditioned Living Space	Basement, Outbuilding, Crawlspace, Equipment, Foundation	Yard, Landscape
Frequent	MOST SEVERE	SEVERE	LESS SEVERE
Occasional	SEVERE	MODERATELY SEVERE	LESS SEVERE
Rare	MODERATELY SEVERE	LESS SEVERE	LEAST SEVERE

In residential properties the **severity of flood impacts is a function, in large part, of the type of impact and frequency of flooding**. The most severe flood impacts, aside from life-threatening events, occur when flood waters enter the living space in a home. This has been reported to the Town by a relatively small number of Carrboro homeowners, several of which have pursued or are pursuing federal flood mitigation grant support. The next most severe impacts occur when an outbuilding, basement, crawl space, equipment (e.g., HVAC), or foundation is impacted. Less severe impacts occur when buildings are not affected but impacts occur to the yard or landscape. Examples include erosion, ponding, mosquito breeding, and impacts to landscape features or plantings. This has occurred for many residents in Carrboro.

The severity of and types of impacts, along with the origin of flood waters (on lot, adjacent lots, from roadside ditches, creek overbanking), are relevant to considering and prioritizing potential solutions. The most severe impacts to buildings in particular suggest a suite of **flood mitigation-oriented approaches**. Less severe impacts can benefit from other tools and practices that are more landscape-oriented and can generally be referred to as **“green stormwater infrastructure”** (more below). These practices can be immediately beneficial at a site scale. When employed in a distributed fashion across a watershed scale, these practices can provide broader runoff reduction, and potentially even trim the peak of the storm hydrograph, thereby providing flood mitigation.

Resilience Solutions

As stated above, flooding challenges have been years in the making and will require time to address. There are a number of steps that Carrboro has already taken or is planning to take toward increased flood resilience and specifically to follow up on the RainReady study, as summarized in Figure 2 and Table 2. **The transition to a community that is more resilient to more frequent intense storms will also require a diversity of tools, new collaborations, and broad participation** (Figure 3). It is likely that the most effective approaches will be synergistic ones with “co-benefits” in consideration of other community interests such as climate action, watershed restoration, social equity, affordability, and livability (Figure 4). An example of a potential synergistic Town/neighborhood scale approach is green infrastructure in the right-of-way that provides both stormwater and traffic calming benefits.

Table 2: Selected Past and Current Flood Resilience Steps

Activity Type	Activity	Timeframe	Notes
Floodplain Management	Participation in National Flood Insurance Program	1976 →	Examples: keeping LUO provisions up to date and enforcing and keeping flood mapping and FIRM panels current.
	Pursuit of flood mitigation grants	2014-2021	For 4 properties in upper Toms Creek watershed
	Engineering studies	1980s; 2013-2020	Both Town and State sponsored studies have been completed. More will need to be pursued moving forward.
	FEMA Public Assistance participation	2019-2021	Hurricane Florence; federal support received for emergency preparedness, damage recovery, administration, mitigation
Stormwater Management	Land Use Ordinance provisions	1983→	Additional flood oriented text amendments being planned for review in FY 22. Non-stormwater specific provisions also relevant (buffers, other natural constraints, open space)
	NPDES Phase II permit (MS4)	2005 →	Relevant efforts include Stormwater Control Measure maintenance and inspections and outreach, education, and public participation
	Jordan Lake Rules compliance	2007→	Compliance with potential new existing development requirements could have synergistic flood resilience benefits.
	Stormwater Utility	2017→	Providing dedicated stormwater revenue and staff
	Stormwater Advisory Commission	2018→	Provides oversight for and citizen participation in stormwater program
	Stormwater/MS4 workflow, condition assessment, asset management, project prioritization	2020 →	Implementing new CityWorks platform including field and office work. Relevant to grey and green infrastructure “4 Rs”: repair, rehab, replace, retrofit.
	Stormwater Capital Improvement Program	2018 →	Using Stormwater Enterprise Fund to pursue MS4 improvements, restoration projects, and plan for future retrofits. Could include future green infrastructure
	Public Works Operations	1970s →	Public right of way, MS4 and facility maintenance; NPDES compliance support. Street sweeping for past 15 years.
Watershed Restoration	Bolin Creek Watershed Team	2007-2013 (& pending)	Pursuit of watershed restoration could have synergistic flood resilience benefits.
Resilience/Assistance	RainReady Pilot Study	2021 →	Any new assistance details to be determined in follow up to study.

Figure 2: Selected and Important Flood Resilience Tools



In the short term, there are several **flood damage reduction activities** that may be employed to address current problems in areas with known recurring issues:

- **Property protection – acquisition and/or relocation.** According to FEMA, “acquisition is the most effective mitigation alternative for addressing repetitive loss properties”⁵ and is a permanent form of mitigation that is especially effective at reducing flood losses, and creating open space in the floodplain, allowing lands to return to their natural functions. While the Town can’t realistically or swiftly convert entire neighborhoods to modern-day best practices, acquisition of individual parcels most vulnerable to flooding can provide some relief for these areas, and for homeowners experiencing recurring flooding. At this time, there are no parcels that have been acquired or relocated by the Town.
- **Property protection – retrofitting and modification.** Elevation, dry or wet floodproofing, and flood barriers for individual structures are all options for redesigning individual properties to become more resilient to flooding, either by allowing water to flow through the property without causing damage, or by preventing water from entering the property at all. These options require considerable time and professional expertise as each solution benefits one property owner and requires individual design. Individual property modification also requires a discussion regarding the public purpose doctrine (see below). There have been several properties modified for flood resilience, but the Town has not directly funded these projects.
- **Structural flood control projects.** The Town’s Capital Improvement Program, along with the relatively recent addition of the Stormwater Enterprise Fund, allows staff to identify larger-scale projects that can mitigate stormwater impacts for more than one property at a time, such as channel modifications, storm drain improvements, diversions, and small reservoirs (such as

⁵ FEMA, “National Flood Insurance Program Community Rating System Coordinator’s Manual”, 2017. OMB No. 1660-0022. Pg. 520-2.

retention or detention basins). The recent culvert replacement project on Broad Street is just one example of a structural project that can alleviate flood impacts. However, as noted above, these projects are not a universal solution and require complex modeling and engineering to determine the potential benefits versus risks.

- **Stormwater system maintenance and improvements.** These solutions include everything from routine maintenance to more extensive repairs, rehabilitation, replacement, and retrofits. The Town's GIS inventory includes approximately 85 miles of stormwater infrastructure (pipes and open channels). The Town also conducts street sweeping on a subset of streets and cleans out clogged infrastructure as necessary. A recent contract with a private firm specializing in stormwater infrastructure is one step towards improved maintenance and planning for future infrastructure projects. Additionally, inspection and maintenance of both public and private Stormwater Control Measures are being increased as part of NPDES permit requirements. Maintenance activities, therefore, are a balance between need, staff capacity, and available funds.

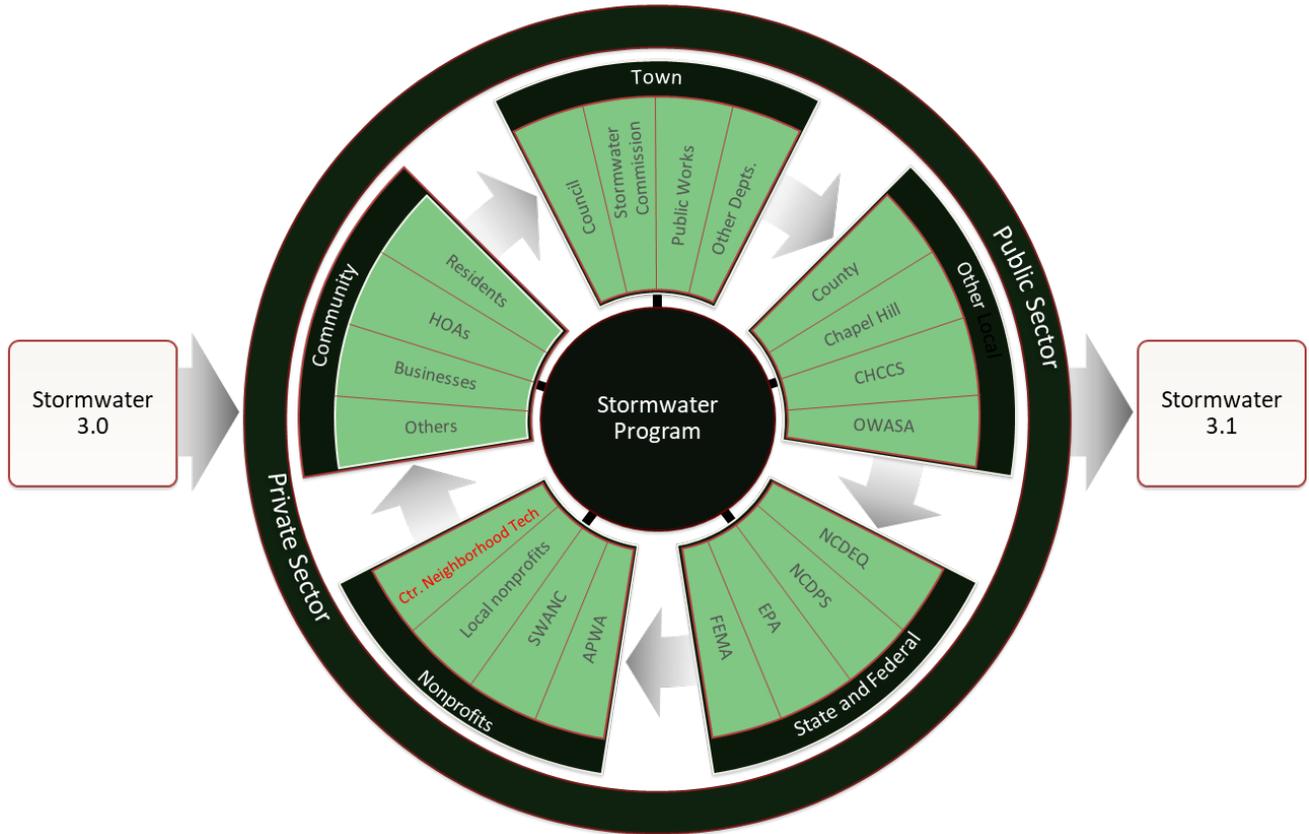
In the bigger picture, there is a necessary paradigmatic and community scale shift for increased flood resilience. The old paradigm of flood management was to “send as much water away as fast as possible”. This begs the question: where is “away”? In reality, “away” means downslope and downstream, where neighbors live amidst ecosystems at risk of flood related impacts. The problem is compounded when more water is coming down more quickly.

The new paradigm for managing stormwater runoff is to “avoid it, sink it, hold it, and send it”, as articulated by the Center for Neighborhood Technology. Other ways that this concept is expressed are through the terms: *stormwater volume control*, *runoff reduction*, *Low Impact Development (LID)*, *hydrograph matching* (meaning an identical rate and amount of runoff before and after development), and *green infrastructure* or *green stormwater infrastructure*. Ultimately, they point to a larger percentage of rainfall being infiltrated into the ground, intercepted by vegetation, evapotranspired, harvested for use, and, if necessary, temporarily stored and slowly released.

These concepts are easiest to implement as part of the planning and design of new development. The process of making modifications to existing development is called “retrofitting”. Examples of the types of retrofits being employed include: removal of existing impervious paving or conversion to permeable pavement; conversion of higher runoff areas to lower runoff areas through landscaping and improvements in soil quality; disconnection of impervious surfaces such as roof drains to allow runoff to soak into the soil and pass through vegetated buffers; rain gardens, also known as bioretention, and similar bioswales that increase infiltration and can also be landscape amenities; and green roofs.

Another necessary shift is a transition from the “someone else’s problem to fix” to a more **collaborative, shared, and community oriented approach**. In particular, the reliance and expectation that government, be it local, state, and/or federal, can solely create a more resilient community does not recognize private property rights, the degree to which private property contributes to increased rates of runoff, nor the reality of government capacity (both workforce and financial). As part of building resilience, and with regard to the potential to extend services from town to residents and their private property, it is important to mention that the Town Attorney provided a memo in 2019 on the legal and financial reasons for **the Town to proceed cautiously** in considering taking on this responsibility. In brief, these reasons include: 1) the constraints of the “public purpose” doctrine; 2) the level of stormwater service that the Town must provide to all similarly situated private property owners; and 3) the liability the Town could assume.

Figure 3. Stormwater Program Level Stakeholder Collaboration and Engagement



Moving Forward

Carrboro’s Stormwater Utility has an important role to play in helping to create a more community based collaboration, and has been and continues to pursue this goal. Carrboro’s initial stormwater program was launched in the late 20th century, and included new stormwater, flood, and water supply watershed protection related elements. The program progressed after the turn of the century with new regulatory requirements, watershed restoration, and floodplain mapping and regulation efforts. The formation of the Stormwater Utility, Enterprise Fund, and Stormwater Advisory Commission in 2018 has provided the foundation to grow additional services.

The Center for Neighborhood Technology’s RainReady study⁶ provided specific, actionable recommendations for the Town moving forward, including that the Town: initiate community education and engagement efforts and develop enhanced communication materials, and design and pilot a small-scale residential assistance program, with an emphasis on green infrastructure. A compilation of the study recommendations and status of pursuing them is provided in Appendix A. While the Town plans to actively pursue these specific recommendations, a resilient future for Carrboro is incumbent on the input and shared responsibility of all community members, leaders, staff and interested parties.

⁶ <http://townofcarrboro.org/1227/Toms-Creek>

Figure 4. Co-Benefits of Green Infrastructure

Benefit	Reduces Stormwater Runoff				Increases Available Water Supply	Increases Groundwater Recharge	Reduces Salt Use	Reduces Energy Use	Improves Air Quality	Reduces Atmospheric CO ₂	Reduces Urban Heat Island	Improves Community Livability					Improves Habitat	Cultivates Public Education Opportunities
	Reduces Water Treatment Needs	Improves Water Quality	Reduces Grey Infrastructure Needs	Reduces Flooding								Improves Aesthetics	Increases Recreational Opportunity	Reduces Noise Pollution	Improves Community Cohesion	Urban Agriculture		
Practice																		
Green Roofs	●	●	●	●	○	○	○	●	●	●	●	●	○	●	○	○	●	●
Tree Planting	●	●	●	●	○	○	○	●	●	●	●	●	●	●	●	○	●	●
Bioretention & Infiltration	●	●	●	●	○	○	○	○	●	●	●	●	●	○	○	○	●	●
Permeable Pavement	●	●	●	●	○	○	○	○	●	●	●	○	○	○	○	○	○	●
Water Harvesting	●	●	●	●	●	○	○	○	○	○	○	○	○	○	○	○	○	●

Yes
 Maybe
 No

Source: Center for Neighborhood Technology 2020 Report:
<http://www.townofcarrboro.org/DocumentCenter/View/7487/RainReady-Final-Report>

Recommendation

It is recommended that the Stormwater Advisory Commission receive this memo and provide feedback regarding development of community resilience efforts.

Appendix A: Rain Ready Study Recommendations and Status

Recommendation	Status
<i>Short-term (1 year)</i>	
<ul style="list-style-type: none"> • Coordinate program activities with the Carrboro Comprehensive Plan Update. • Include residential green infrastructure/runoff reduction program piloting and coordination in new Stormwater staff person job responsibilities • Establish regular cross-departmental meetings to coordinate planning and projects, identify shared funding sources, explore workforce development opportunities, and ensure successful program launch. A quarterly meeting schedule is recommended. • Identify key community public, private, and nonprofit partners, formalize partnerships, and initiate community education and engagement efforts. • Develop enhanced communication materials. • Amend Land Use Ordinance to explicitly exempt native landscaping from “nuisance vegetation” code protocols. • Budget for, design and pilot small-scale residential green infrastructure program. Determine best approach (e.g., by whom, using what available resources, for whom, and with what desired outcomes) for pilot scale program delivery. • For buildings located in known severe flooding areas, such as natural floodplains, continue to support property owners seeking assistance from federal programs. 	<p>Active Complete</p> <p>Planning</p> <p>Planning</p> <p>Ongoing*</p> <p>Planned</p> <p>Planning</p> <p>Ongoing</p>
<i>Mid-term (2 – 4 year)</i>	
<ul style="list-style-type: none"> • Continue enhanced community education and engagement materials. • Investigate financing and funding options. • Use lessons learned from pilot to tune and launch Town-wide residential green infrastructure assistance program. • Continue larger stormwater program development and integrate other efforts with the residential program. • Coordinate stormwater management projects that address federal and state water quality regulatory requirements associated with the Town’s NPDES Phase II permit. • For buildings located in known severe flooding areas, such as natural floodplains, continue to support property owners seeking assistance from federal programs. 	<p>Pending 319 grant/pending Pending</p> <p>Ongoing/planning**</p> <p>Ongoing</p> <p>Ongoing</p>
<i>Long-term (5+ year)</i>	
<ul style="list-style-type: none"> • Evaluate program success, including financing and funding and program sustainability 	<p>Pending</p>

* For example, the new Homeowners Manual. Staff are also working on creating signage.

** For example, outreach planned as part of planned stormwater improvements around Town Hall