



**AMT**



# CITY OF ROANOKE

## Flood Resilience Plan



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# CITY OF ROANOKE FLOOD RESILIENCE PLAN

## EXECUTIVE SUMMARY

The City of Roanoke's geography and history are intertwined with the abundant water resources that flow through the Roanoke Valley – the Roanoke River, its tributaries and the salt marsh now hidden below Roanoke's Downtown. These water resources were critical during the City's early development, and the Roanoke River and tributaries continue to be an important natural asset for those that live, work, learn and play in its watershed. The challenge of living in proximity to these waterways is the periodic flooding that disrupts community life and the local economy. Flooding has become an increasingly important issue with the continued need for community growth, the related housing and commercial development, and the increase in rainstorm severity due to climate change. While these are important issues for Roanoke, they are not unique as urban flooding has one of the greatest social and economic impact of any natural hazard in the United States. To mitigate the growing risk of urban flooding, adoption of the principle of "flood resilience" has become a prominent strategy in communities nationwide.

The plan is organized as follows: Section 1 defines scope and purpose, Section 2 summarizes Roanoke's flood history, Section 3 characterizes Roanoke's demographics and vulnerabilities in the context of social equity and Section 4 adds to this knowledge based on the results of the public engagement process performed for this Plan. Section 5 is the culmination of the Plan into five key principles of flood resilience:

1. Climate Change – Does the effort internalize climate change impacts (increased rainfall intensity and temperature) into design and implementation of efforts?
2. Social Equity – Does the effort acknowledge community vulnerabilities and work towards equitable outcomes in its conception? Will the effort improve or strengthen the social fabric in vulnerable parts of the community?
3. Community Scale Benefits – Will the effort render benefits at a U.S. Census Block scale or larger? Will at least 10% of the City's population benefit from the project? Is the effort consistent with regional efforts?
4. Economy and Land Use – Does the effort acknowledge fiscal realities and focus on cost-effectiveness? Does the effort encourage the usage and development of land that internalizes present and future flood risk? Is it consistent with best practice for floodplain management?
5. Nature-Based Approach – Will the effort leverage environmental processes and natural systems to minimize mitigate flood impacts and reduce pollutants of concern including fine sediment, pathogens and organic chemicals?

These five principles are then used to evaluate existing City efforts in Section 6 and propose future flood resilience projects in Section 7. The flood resilience efforts proposed in Section 7 are consistent with existing City efforts, and provide specific, actionable work items that will assure that long-range resilience concepts are embedded in the City's decision-making processes with respect to floodplain management and flood-related infrastructure planning. Overall, it is anticipated that adoption and implementation of the five key flood resilience principles and the specific project proposals will further support the City Plan 2040 vision of a strong, livable, economically resilient community that exists in harmony with nature while ensuring that programs and actions are equitable for all members of the community.

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# 1. INTRODUCTION

## 1.1 STATEMENT OF PURPOSE

The term “resilience” is defined as the capability to anticipate, prepare for, respond to, and recover from significant multi-hazard threats with minimum damage to social well-being, health the economy and the environment<sup>1</sup>. Resilience is a concept of major significance for communities in a rapidly changing world. In the context of flooding, resilience focuses both on minimizing the impacts of flooding and equipping a community to respond to and rebound from the impacts of flood events. This includes both the direct, short-term shocks related to a specific flood event, as well as the longer-term issues that flood risk can create in a community. The Commonwealth of Virginia recognized this challenge when it created the Community Flood Preparedness Fund in 2020.

### Flood Resilience

The capability to anticipate, prepare for, respond to and recover from a significant flood-related disruption or shock with minimum damage to social well-being, health, the economy and the environment

The City is growing and its vision, as expressed through our Comprehensive Plan, is to be a strong, livable, economically resilient community that exists in harmony with nature while ensuring that programs and actions are equitable for all members of the community. This is a particular challenge in an urban environment where there is a need to provide additional housing and related infrastructure. This development to support growth can occur, while understanding the needs of a diverse community, and incorporating flood resilience principles in a manner that supports community growth. This vision is consistent with the State’s vision for creating strong, resilient communities.

With an acknowledgement of the present and future flood risk in the community, and a desire to apply resilience principles to the long-range mitigation of and response to this risk, the City of Roanoke has developed this Flood Resilience Plan to identify a path to a more flood resilient Roanoke. As such, **the purpose of this document is to define the City’s principles of flood resilience, to identify gaps in existing City efforts with respect to these principles, and to provide specific action items that can be performed to make progress towards these principles.**

The plan follows the principles of the Community Flood Preparedness Fund as defined by the Department of Conservation and Recreation (DCR) and the elements and direction of City Plan 2040. Appendix A includes a cross references between DCR’s criteria for resilience plans with the contents of this document.

## 1.2 OVERARCHING THEMES AND PRINCIPLES

There are three overarching themes that apply to the City’s flood resilience:

- Roanoke is a growing city with an urban development pattern. Policy, programs and actions need to creatively account for the balance of a growing community that is becoming more resilient.
- Achieving a high level of resilience cannot be achieved by the City alone. It is a collective, community effort with the City playing a critical role in developing programs and policy as well as implementing projects.

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<sup>1</sup> From U.S. Global Change Research Program - <https://www.globalchange.gov/climate-change/glossary>

- With limited resources, being good stewards of our land and capital resources is critical and is based on an understanding of community needs.

These themes are applied to flood resilience planning principles. These principles recognize:

- The changing climate and how it will affect rainfall and flood risk for our community.
- Nature based solutions are preferred as the most sustainable options for flood resilience and can offer other community benefits beyond reducing flood risk.

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*Nature-based solutions are sustainable practices that weave natural features and processes into the built environment to promote adaptation and resilience.*

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This plan's three flood resilience themes and resilience planning principles are tied to the five key principles of flood resilience:

1. Climate Change
2. Social Equity
3. Community Scale Benefits
4. Economy and Land Use
5. Nature-Based Approach

These themes and principles support the plan's objective of providing a blueprint for the City's flood future efforts to build upon and expand on considerable stormwater and floodplain management plans, policies and projects to guide the City towards greater resilience to flood risk.

### **1.3 METHODS AND SCOPE**

In order to form a Plan that applies resilience-thinking appropriately to the City's specific context, the following document structure is used: first an introduction is provided that clarifies the purpose, methodology and scope of this Resilience Plan in Section 1. Next, Section 2 provides a summary of how Roanoke's history and hydrology shapes the present-day context for flood resilience, with a summary of other related vulnerabilities. Section 3 is focused on characterizing Roanoke's demographics and vulnerabilities in the context of social equity and Section 4 adds to this knowledge base using the public engagement process for this Plan. Section 5 assimilates the previous sections into five key flood resilience principles, which are used to evaluate existing City efforts in Section 6 and propose future flood resilience projects and programs in Section 7.

The planning team consisted of City staff from the Departments of Public Works, Planning, Building and Development, and Parks and Recreation and a consultant team from A. Morton Thomas, Inc. (AMT) and Wetland Studies and Solutions Inc. (WSSI). Public outreach for the plan was conducted from January 2023 to March 2023. The plan was reviewed by pertinent City leadership prior to presentation to and adoption by City Council. While this document memorializes the resilience-thinking and public outreach completed to date, it is acknowledged that community engagement is an ongoing, project specific process that will continue as the proposed ideas in this plan make their way to implementation. This plan is therefore subject to future revisions, as concepts of flood resilience and community perspectives evolve.

Finally, it is important to understand that the focus of this plan is flood resilience and not resilience more broadly (e.g. economic, health, energy) as a broader evaluation of other known threats and hazards and the complex interdependencies between the different types of critical infrastructure during emergency events is outside of the scope of this work. Notwithstanding, the methods, analysis, findings and recommendations in this plan are carefully crafted to support a broader application of resilience thinking across these domains.

## **2. BACKGROUND**

### **2.1 HISTORY AND HYDROLOGY**

The City of Roanoke is a mid-sized locality (population ~100K, 43 mi<sup>2</sup>) in southwest Virginia located near the bottom (i.e. downstream terminus) of a 513 mi<sup>2</sup> watershed known as the “Upper Roanoke River Watershed” (Figure 1). The watershed is comprised of steep Appalachian and Blue Ridge Mountain slopes, with relatively thin soils that drain into flatter river floodplains as the Roanoke River flows into Roanoke County, City of Salem, City of Roanoke and subsequently into Smith Mountain Lake and the Virginia Piedmont. In addition to the approximately 10 miles of Roanoke River within the City, drainage within the City’s service area is comprised of 13 smaller tributary waterways amounting to 63 stream miles and an additional 450 miles of storm drainpipe and nearly twenty-two thousand related drainage structures (manholes, inlets, outfalls, etc.).







The abundant availability of water resources was an important aspect of the settlement of the Roanoke Valley, and in particular the position of the City at the bottomlands of the river valley is due in part to the availability of three critical water resources at the time Roanoke (formerly Big Lick) was settled around the turn of the 20<sup>th</sup> century: (1) fresh drinking water springs, (2) a number of salt marshes near present-day Downtown Roanoke that provided hunting grounds, and (3) the ability to dispose of sewage via the multitude of streams in the area. Early settlement followed this pattern in numerous locales on the eastern seaboard, and while the proximity to water resources was critical to the City's early survival and continues to be a critical element of water resilience context in the Roanoke Valley, this proximity has become problematic as the City has expanded in footprint and population and because the City is the downstream recipient of runoff from most of the developed and developing land in the remainder of the Upper Roanoke River Watershed.

As of the date of this plan, it is estimated that the Upper Roanoke River Watershed is on average 24% developed and that the City's service area is 87% developed land and 38% impervious cover. As a result of this changing land cover and the related removal of vegetation and grading/compaction of soils, the hydrology of the Roanoke River and its tributaries has changed considerably from the early days of its settlement, and Roanoke is now subject to two separate but related flooding processes: riverine and pluvial. In general, riverine flooding is caused by longer duration rainfall (tropical storms or frontal systems) while pluvial flooding is caused by shorter duration but very intense rainfall (convective or "burst" storms) – the impacts of these two processes are further expanded in the following subsections.

### 2.1.1 Riverine Flooding

Riverine flooding occurs during longer duration precipitation events that exceed the infiltration limits of the soils in the Upper Roanoke River Watershed and cause flooding along the Roanoke River corridor. The most well-known example of riverine flooding is the flood of record in the Roanoke Valley - commonly known as the Election Day Flood of 1985, or simply the "**Flood of '85**". In this significant historical event, the remnants of Hurricane Juan moved slowly up the eastern seaboard and then stalled in the mid-Atlantic by a cold front from the west, resulting in five consecutive days of heavy rainfall. On November 4, the system produced a record-breaking 6.61 inches of rainfall over a 24-hour period, resulting in major flooding of the Roanoke River and its tributaries and causing ten deaths and an estimated \$225M (1985 USD) in property damages in Roanoke alone<sup>2</sup>. While the Flood of '85 was the largest flood to date, riverine flooding is not unusual along the Roanoke River as the River has exceeded the National Weather Service's (NWS) "Major Flood Stage" of 16 ft. seven times in recorded history, with the most recent event related to the remnants of Hurricane Michael on October 11, 2018 (Figure 2).

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<sup>2</sup> For further reading on the Flood of '85, see: Corrigan, P. (2020). *The Floods of November, 1985: Then and Now* (pp. 1–13). NOAA Central Region Headquarters.  
[https://www.weather.gov/media/rnk/past\\_events/Flood%20of%201985\\_Then-Now\\_2020.pdf](https://www.weather.gov/media/rnk/past_events/Flood%20of%201985_Then-Now_2020.pdf)



**Figure 2 – The Roanoke River at S. Jefferson St. and Carillion Roanoke Memorial Hospital on October 11, 2018. Flooding resulted from the remnants of Hurricane Michael as it passed through southwest Virginia.**

One issue of particular importance that was identified during the Flood of '85 was the impact of flooding on **critical facilities** along the Roanoke River and tributaries – namely the flooding of the basement and first floor of Roanoke Memorial Hospital (now Carillion Roanoke Memorial Hospital, CRMH). A critical facility is one that functions as a community lifeline, and a disruption in service may lead to health and public safety issues – this includes hospitals, fire stations, police stations, storage of critical records, etc. While CRMH has implemented several flood-proofing measures since the Flood of '85, there are still 22 critical facilities within the City's SFHA that present a particular risk during Riverine flooding events and would benefit from additional flood protection efforts and well- documented/rehearsed flood-day operations manuals.

The extent and impacts of riverine flooding can generally be summarized using FEMA's mapped floodplain – known as the "Special Flood Hazard Areas" (SFHAs, Figure 1) – as these areas portray the inundation extent along streams and rivers with drainage areas greater than approximately 1 mi<sup>2</sup>. However, there are smaller tributaries that may experience flooding that are not mapped as a SFHA, including Horton's Branch in the Loudon-Melrose, Shenandoah West and Villa Heights neighborhoods, and the western portion of Trout Run in the Gilmer neighborhood. Along with the SFHA, there are areas of repetitive loss and damage from flooding across the City that may or may not be in the SFHA (Figure 1). There are 67 repetitive loss properties in the City of Roanoke and 10 severe repetitive loss properties.

The floodplain boundaries are based on the extent of inundation during the 0.2% and 1% Annual Chance<sup>3</sup> floods (Previously known as the 500-year and 100-year floods) and the regulatory Floodway, which is the zone of highest flood risk. Most of the City's known flooding issues – referred to as "repetitive loss" or "severe repetitive loss" areas are subject to riverine flooding and are therefore located in a mapped FEMA

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<sup>3</sup> The 0.2% and 1% Annual Chance floods have historically been referred to as the 500-year and 100-year floods respectively,

SFHA. However, there are known flood prone locations throughout the City that are not adjacent to a stream or river, but nonetheless experience flooding during brief, intense rainfall.

### **2.1.2 Pluvial Flooding**

In comparison to the long duration rainfall systems that cause riverine flooding, pluvial flooding is generally caused by short duration, localized, intense bursts of rainfall over more highly developed land. This type of flooding generally impacts the storm drain system and smaller tributaries as excess runoff generated from urbanized sub-watersheds exceeds their capacity and causes brief periods (5 minutes – 30 minutes) of surface flooding. While pluvial flooding is a different process from riverine flooding, the impacts of pluvial flooding can sometime be exacerbated if the river is at flood stage and therefore a downstream impedance to drainage of the tributaries. The impacts of pluvial flooding were especially notable in 2018 as the City's rainfall surpassed the average annual rainfall accumulation of 41.25 inches by over 20 inches, achieving a new historical record of 62.45 inches.

In particular, the Trout Run watershed which drains the City's Downtown is subject to recurring pluvial flooding, as are certain sections of the smaller tributaries and storm drain system. When intense rainfall occurs over the Trout Run watershed, the pipes and tunnel systems draining through the Downtown are overwhelmed with runoff because of (1) the intensity of precipitation; (2) the position of the Downtown atop a historical salt marsh and (3) the undersized tunnels that drain the Downtown dating back to the 1880's. Various other areas of the City are subject to pluvial flooding issues related to intense precipitation and legacy infrastructure that was not designed to modern day engineering standards.

## **2.2 LEGACY INFRASTRUCTURE AND STANDARDS**

The City dates to the late 1880s with much of the City's growth occurring before the 1960s. The age of drainage infrastructure generally reflects the age of the development of the various areas of the City. Among other issues, this means that a large proportion of the City's flood-related infrastructure:

- May be undersized because it pre-dates modern-day (or any) hydraulic engineering methods or because it was sized based on a now-dated rainfall atlas.
- Was built using materials (e.g. vitrified clay, corrugated metal) that are susceptible to damage/at the end of their service life or methods (e.g. unsuitable backfill material, poorly formed connections, no maintenance access) that present significant maintenance burdens.
- Did not consider impacts on downstream channel erosion or surface water quality.

As of the date of this Plan, the City's Stormwater Capital Improvement Program (CIP) has a list of over 200 projects valued at over \$150M that would address some of the flooding related to the issues listed above. In addition, a recent technical report proposed an additional \$80-90M of projects to address Downtown flooding, beyond those listed in the CIP. Furthermore, the City's estimated capital outlay to build the required water quality projects (as required by the TMDLs, see Section 6.3.2) is in the \$150M range amounting to a total estimated capital investment of approximately \$380M – note that this does not include the substantial cost of maintaining existing storm drain infrastructure throughout the City. While the City has been working to address these legacy infrastructure issues, it is important to understand that the age, scale and right-of-way needed to address these issues means that the volume and rate of depreciation of aging infrastructure will continue to surpass the City's replacement capabilities (funding, staff, equipment, etc.) for the foreseeable future as the annual project delivery capability is in the \$7 - 9M

range. This gap is further widened by the rapid inflation in the cost of construction products<sup>4</sup> and the potential impacts of climate change on pipe sizing calculations (see Section 2.3). These factors suggest that while traditional drainage improvement projects are still beneficial in certain circumstances, community-wide flood resilience cannot be achieved by simply replacing and updating legacy infrastructure - a more diverse portfolio of strategies will be needed.

The City's age also means that the development in much of the service area pre-dates modern day flooding-related development standards. A few examples of this are:

- Construction of buildings or other capital assets in the floodplain or floodway prior to the availability of floodplain maps (i.e. Flood Insurance Rate Maps, FIRMs) and prior to the National Flood Insurance Program (NFIP) in the 1970s.
- Land development prior to modern-day stormwater and erosion/sediment control regulations resulting in unmitigated discharges of runoff from developed land applying to development since the 1980s.

While the City has adopted floodplain, stormwater, erosion and sediment control regulations and other development standards to control runoff and/or reduce flood risk, older developments do represent a risk. That risk may be associated with buildings and structures on the immediate property or the effect of that development on downstream properties. As properties are redeveloped and modified over time, there is the opportunity to retrofit improvements to reduce runoff from properties and/or make the properties more resilient related to flooding. Over time some, but not all risk can be managed through redevelopment and renovation. The City actively works to reduce this risk through floodplain acquisition of highly flood prone properties, including demolition of flood prone structures.

In summary, the age of the City's infrastructure presents a particular challenge because of the complexity and cost of retrofitting legacy developed land to a disposition that reflects modern-day standards. An additional complication is that modern-day standards assume that historical rainfall and hydrology patterns are representative of present and future patterns. However, it is likely that this is not actually the case, and the specter of a warming climate further exacerbates the issues outlined in this Section.

## 2.3 CLIMATE CHANGE

In general, climate forecasts suggest that average temperatures in Virginia will increase by 4°F by the year 2100 and Roanoke's climate will feel more like the present-day climate in Tuscaloosa, Alabama<sup>5</sup>. These higher temperatures and corresponding moisture holding capacity of the atmosphere will likely cause more frequent and intense rainfall and flood events<sup>6</sup>. Expert guidance suggests that the City of Roanoke should expect an estimated 5% increase in average annual precipitation by 2035 and an 11%

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<sup>4</sup> Concrete pipe (for example) has increased in unit cost by 13% since July 2022, 37% since July 2021 and 40% since July 2020 nationally. See U.S. Bureau of Labor Statistics [WPU1332](#)

<sup>5</sup> For more detailed information on temperature impacts in Virginia, see the [National Climate Assessment, Southeast Region](#), the [Climate Impact Lab](#) and University of Maryland's [Climate Analog Tool](#).

<sup>6</sup> See Intergovernmental Panel on Climate Change (IPCC) [2022 Report](#)

increase by 2060, potentially increasing streamflow (i.e. the volume of water flowing through the City's streams during flood events) by 1.5 times present day streamflow<sup>7</sup>.

While the total annual rainfall increase is substantial, the greatest impact to flood resilience is the increasing intensity and frequency of individual storm and rainfall events. To quantify this impact, the National Oceanographic and Atmospheric Administration's (NOAA's) Mid-Atlantic Regional Integrated Sciences and Assessments (MARISA) Team has developed a tool to predict rainfall intensities of future storm events. This tool can be used to predict rainfall for future design storms in Roanoke based on planning horizons (year 2070 or 2100) and two scenarios for level of action taken to reduce the effects of climate change (steady state RCP 8.5 or optimistic reductions RCP 4.5) and several storm events pertinent to hydraulic engineering are summarized in Table 1.

As the table shows, predictions can be complicated based on a range of factors. However, the projected increase in precipitation and storm events necessitates a new vision for managing stormwater and flood adaptation. Two highlights are:

- The 10-year storm (or 10% Annual Chance): This rainfall event is typically used for storm drain and culvert sizing, will increase in size by 14% - 19% by 2070 and by as much as 23% - 28% by 2100, making it more like the present day 25-year rainfall. This means that in fifty years, storm drainpipes that are sized to present day standards will no longer achieve the designed level-of-service and may flood on a more frequent basis than anticipated. (note, that because of the City's age, much of the City's drainage infrastructure was not even designed to a 10-year storm event, see Section 2.2).
- The 100-year storm (or 1% Annual Chance): Rainfall is projected to increase by 20-25% from present-day estimates, making it more like the present day 200 – 500-year rainfall event. While these storms may be infrequent, it means that major riverine floods would be larger and more frequent, and that flood risk would increase for floodplain properties.

**Table 1 - Estimated Impacts of Climate Change on Rainfall Amounts**

Rainfall Duration	Current Rainfall (in)	Projected 2070		Projected 2100	
		Rainfall (in)	Change from Current (in)	Rainfall (in)	Change from Current (in)
10-Year Return Period (10-Year Storm)					
10 min.	0.81	0.92	+ 0.11	1.04	+ 0.23
1 hr.	1.94	2.21	+ 0.27	2.48	+ 0.54
24 hr.	4.70	5.36	+ 0.66	6.02	+ 1.32
25-Year Return Period (25-Year Storm)					
10 min.	0.92	1.08	+ 0.16	1.23	+ 0.31
1 hr.	2.30	2.69	+ 0.39	3.08	+ 0.78
24 hr.	5.72	6.69	+ 0.97	7.66	+ 1.94

<sup>7</sup> See EPA's [Streamflow Projections Map](#)



Rainfall Duration	Current	Projected 2070		Projected 2100	
	Rainfall (in)	Rainfall (in)	Change from Current (in)	Rainfall (in)	Change from Current (in)
100-Year Return Period (100-Year Storm)					
10 min.	1.07	1.31	+ 0.24	1.35	+ 0.28
1 hr.	2.85	3.48	+ 0.63	3.59	+ 0.74
24 hr.	7.50	9.15	+ 1.65	9.45	+ 1.95
Notes:					
<div>1. Estimates for Roanoke Regional Airport for time periods 2020 – 2070 and 2050 – 2100 from NOAA’s Mid-Atlantic Regional Integrated Sciences and Assessments Team.</div> <div>2. Rainfall estimates based on a low emission scenario, RCP 4.5, are shown in this table. This assumes that was used for this table, RCP 4.5 is a moderate scenario in which greenhouse gas emissions peak around 2040 and then begin to decline.</div>					

While the estimated changes to precipitation patterns are now available, it is more difficult to translate changes in precipitation patterns to impacts on infrastructure cost and floodplain structures. This is because the relationship between rainfall intensity and corresponding runoff, stream flows and flood depths are non-linear (i.e. a 14% increase in rainfall does not necessarily lead to a 14% increase in runoff or streamflow) and the cost of infrastructure and impacts to floodplain structures varies, depending on a wide number of factors. The complexity involved in understanding how changes in precipitation result in on-the-ground impacts means that the formulation of policies and protocols aimed at these long-term changes requires additional study. Recommendations with respect to hydraulic engineering calculations and floodplain management that address this complexity are provided in Section 7, though the reader should understand that the field of climate change adaptation for local flood resilience is still relatively new, and that best practice will evolve rapidly as communities experiment with different adaptation strategies.

In general, the best available practice that has formed around hydraulic engineering design for climate change is to shift from a principle of “protection” to that of “adaptation”. While these concepts may sound similar, protection is focused on repelling and diverting flood waters, while adaptation acknowledges the eventuality and increasing probability of flooding with climate change and focuses on replacing risk with natural assets. Levees and concrete floodwalls are a simple example of a flood protection structure, as they are built to repel floodwaters from developed land up to their design flood; though the major issue is that when they overtop (which they are more likely to do in the context of climate change), the failure is typically catastrophic. The adaptive alternative to levees and floodwalls is called a riparian buffer, which replaces flood risk along the river with trees and other vegetation that will not be subject to damages if flooded. As previously mentioned, there is an economic tradeoff from the use of adaptive solutions, and their implementation requires careful weighing of benefits and costs – though it is critical that these types of adaptive, nature-based solutions be considered as a viable project alternative in the context of drainage improvements and other flood-related projects. This is discussed further in Section 5 and 7 of this Plan.

## **2.4 RELATED HAZARDS**

A flood resilience plan would not be complete without addressing flood-related hazards. There are several flood-related hazards pertinent to the City that are considered here with respect to flood resilience. The proposed efforts in this Plan will also work towards City objectives related to water quality, dam safety and landslides.

### **2.4.1 Water Quality**

It is well known that hydrology – the volume, rate, energy and frequency of flow – is a master variable that drives water quality. While the focus of this plan is flood resilience, it is anticipated that the principles and projects outlined here would also support the City’s efforts to improve water quality in the Roanoke River and its tributary streams. In particular, the Roanoke River and several tributaries have been designated as “impaired” by the Virginia Department of Environmental Quality (DEQ) for aquatic life, bacteria and a category of organic chemicals known as polychlorinated biphenyls (PCBs). The DEQ has designated regulatory pollutant reduction requirements for all three of these impairments, known as “total maximum daily loads” (TMDLs), and as such, the City is required to demonstrate progress towards mitigation of these water quality impairments. A more thorough summary of these impairments and mitigation efforts are provided in the City’s TMDL Action Plan documents<sup>8</sup>.

More specifically, the aquatic life impairment results from long-term assessment of aquatic insects indicating an unhealthy lack of diversity. Excessive fine sediment from urban runoff is a primary cause of this issue. In general, efforts to mitigate the volume and rate of urban runoff that flows into the City’s waterways will make the City more resilient to flooding and will improve the health of streams. Similarly, issues related to bacteria in the Roanoke River are multi-faceted, but at least part of this issue can be mitigated by controlling excess runoff during storm events. This is because excess runoff can infiltrate the sewer system during periods of heavy rainfall leading to overflows and contamination of downstream waterways.

### **2.4.2 Landslides**

Another hazard related to severe rainfall and localized flooding is that excessive water can induce landslides in the high slope topography in and around Roanoke. While this hazard is more prominent in the areas surrounding Roanoke that have a significant amount of high slope land, the area around Mill Mountain and other parts of the City where the landscape has been steeply graded are also subject to this potential hazard. The risk of landslides can be reduced by minimizing disturbance and grading on existing steep slopes, and by establishment of suitable soil and slope stabilization methods where necessary.

### **2.4.3 Dam Safety**

There are two ‘High Hazard’ dams upstream from the City of Roanoke that present the possibility of probable loss of life or serious economic damage in the event of dam failure. Both impoundments are owned and operated by the Western Virginia Water Authority.

The Carvins Cove Dam (1946) is located on Tinker Creek, a tributary of the Roanoke River, in Botetourt and Roanoke counties. The Clifford D. Craig Memorial Dam (1993) at the Spring Hollow Reservoir is

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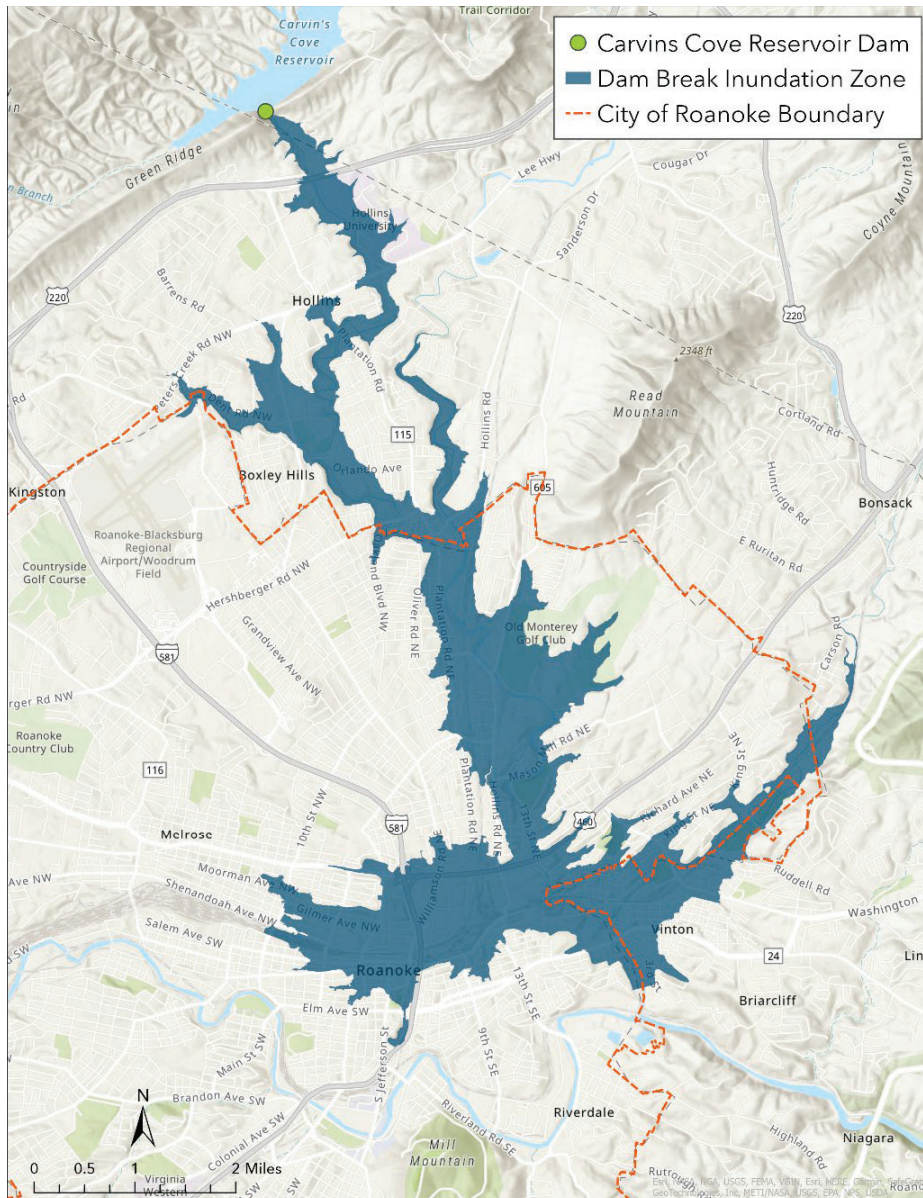
<sup>8</sup> The TMDL Action Plans are available at: <https://www.roanokeva.gov/2275/Municipal-Separate-Storm-Sewer-System-MS>

located in the Glenvar area of Roanoke County, adjacent to the Roanoke River. The dam at Spring Hollow is of a type that has never experienced a structural failure and is unaffected by rainfall or peak mean flow of any rivers or streams. However, if the dam would fail, inundation would significantly raise the Roanoke River levels in the City.



**Figure 3 - The Spring Hollow Dam Break Inundation Zone and City of Roanoke Boundary. Zone boundary from the Virginia Department of Conservation and Recreation (DCR) Virginia Dam Safety and Inventory System (DSIS).**





**Figure 4 - The Carvins Cove Dam Break Inundation Zone and City of Roanoke Boundary. Zone boundary from the Virginia Department of Conservation and Recreation (DCR) Virginia Dam Safety and Inventory System (DSIS).**

In addition, there are two smaller privately held dams within the City of Roanoke. Windsor Lake Dam (1960, with modifications in 2007) and Spring Valley Lake (1960) are both considered ‘Significant Hazard’ dams that, upon failure, might cause loss of life or appreciable economic damage. Dam owners are responsible for:

- Proper design, construction, operation, maintenance, and safety of their dams
- Reporting abnormal conditions at the dam to the Police Department, the City Manager, and the Coordinator of Emergency Management
- Recommending evacuation of the public below the dam if it appears necessary.

Owners of dams that exceed 25 feet in height and impound more than 50 acre-feet (100 acre-feet for agricultural purposes) of water must develop and maintain an Emergency Action Plan.

Procedures are in place between the City of Roanoke and respective Dam Owner/Operators to ensure timely notification of changes in dam condition or threat of failure. There are established procedures during different alert levels and the public will be notified of conditions at an affected dam. More information can be found in the Dam Safety Support Annex to the City Emergency Operations Plan.

Increased frequencies and durations of storm events create additional dam safety risk in a variety of ways. The increased volume of water that accumulates behind impounding structures puts more frequent and greater pressure on these structures, impacting the integrity of such structures, particularly for earthen structures or those that have not been properly maintained. The region has a number of dams on private property where responsibility for maintenance falls on the homeowner; these expenses can be difficult for such owners and maintenance is often postponed. Additionally, many impounding structures were designed and built before current day engineering requirements were in place and may have difficulty withstanding these effects. Increased storm events due to climate change and their hydrologic impacts result in additional dam safety risk.

## 2.5 SUMMARY OF VULNERABILITIES

The following table summarizes potential risks and vulnerabilities associated with flooding and related hazards.

<b>High Likelihood</b>		
<i>Type of Hazard</i>	<i>Vulnerability</i>	<i>Potential Actions/Adaptations</i>
Riverine Flooding	High along Roanoke River and tributaries	The City has little ability to reduce floodwaters themselves but can adapt development regulations and the physical floodplain.  Acquisition/restoration of flood prone land to contain flood waters and remove highly vulnerable structures.  Adequately elevate or flood proof structures per development regulations/retrofits.
Pluvial Flooding	High for tributaries vulnerable to flash flooding and for development along former natural drainage.	Effects of pluvial flooding are localized, reducing direct discharges from impervious surfaces may reduce some flood risk.  Acquisition/restoration of flood prone land to contain flood waters and remove highly vulnerable structures.  Adequately elevate or flood proof structures per development regulations/retrofits.



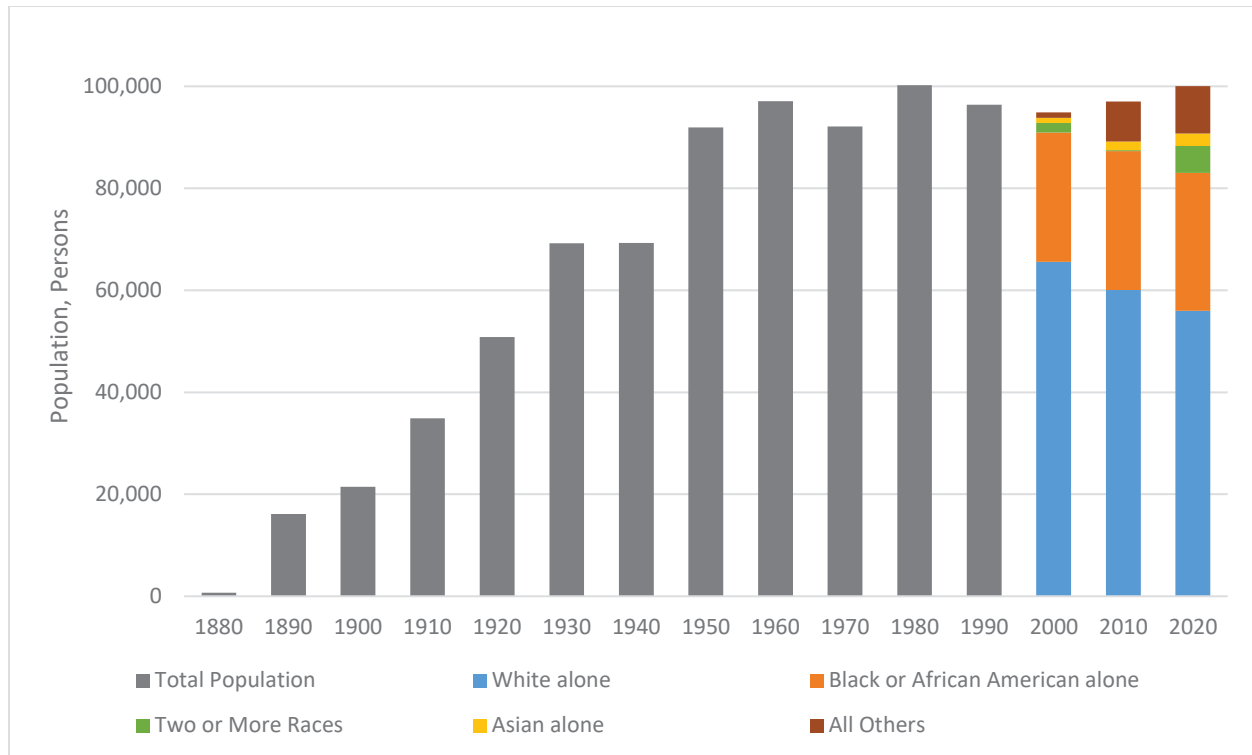
<b>Moderate Likelihood</b>		
<i>Type of Hazard</i>	<i>Vulnerability</i>	<i>Potential Actions/Adaptations</i>
Aging Infrastructure	Moderate across the City but high in areas with aging or undersized infrastructure.	<p>Green infrastructure/ infiltration and detention practices to reduce runoff.</p> <p>Upsizing pipes/culverts where bottle necks exist.</p> <p>Update design practices to account for future precipitation. Infrastructure can be adapted to handle larger flows based on available funds and impacts on other parts of the system (improvements in one area can create issues downstream).</p>
<b>Low Likelihood</b>		
<i>Type of Hazard</i>	<i>Vulnerability</i>	<i>Potential Actions/Adaptations</i>
Dam Safety	High, similar to large scale flood event.	<p>Monitor through state safety programs.</p> <p>The City does not own any of the dams and does not control inspection or maintenance.</p>
Land Slides	Low	<p>Periodically review standards/ regulations for best practices related to development on slopes.</p> <p>Slope issues on new developments can be evaluated as part of plan review process</p>

### **3. PEOPLE, LAND, ECONOMY AND EQUITY**

In addition to the City's history of development and hydrology, the community's character is a fundamental element of resilience planning including assessment of vulnerabilities. Residents' goals, issues, demographics, and economic situations all provide the context for project planning, funding and delivery. The purpose of this section is to contextualize any assessment of flood resilience and all proposed solutions with regards to Roanoke's local community – people, land and economy. While community information that is pertinent to flood resilience is presented in this section, this is not a comprehensive summary, and the reader is referred to the City's demographics analysis in City Plan 2040 and various resources noted in this section.

From the City's incorporation in the 1880s through the 1950s, Roanoke experienced rapid growth from a small community to a city of over 90,000 people. Recently, the population of the City has since been steady with a population ranging between 90,000 – 100,000 (Figure 5). From the 1960s to the 1980s, population growth was driven largely by land annexation, with actual population density decreasing. Since 2000, the City's population has gradually increased along with the desire for walkable neighborhoods and urban amenities, leading to slow but steady growth, and this moderate growth is expected to continue in the future.

The City is the most diverse in the region with a population as of the 2020 census that is 56% White, 27% African American, 5% two or more races, 2.5% Asian and 9% all others with 8.5% ethnic Hispanic/Latino. In general, the City's population is increasing in racial and ethnic diversity (Figure 5). Table 2 shows general socio-economic and demographic information for the City, region and the state for comparison, indicating that the City is diverse from racial, ethnic, and socioeconomic perspectives. The City has lower levels of educational attainment and lower household incomes compared to the Roanoke Region (i.e. metropolitan statistical area), and the entire City of Roanoke is designated as a low-income geographic area by DCR.



**Figure 5 – The City of Roanoke’s total population from 1880-2020 with demographic data generalized for available years 2000-2020. Note that the “All Others” category contains three additional categories that were aggregated because of their small size for visibility. Data abstracted from the following U.S. Census Bureau publication or data sources: “Census of Population: 1950” (1880-1950); “Census of Population: 1980” (1960-1980); Census Table PHC-T4 (1990); Census Table DP1 (2000); Census Table P9 (2010-2020).**

**Table 2 – Demographic characteristics of Roanoke City as compared to the Roanoke Metropolitan Statistical Area (MSA) and the Commonwealth of Virginia. Data from U.S. Census Bureau QuickFacts and from American Community Survey (ACS) via CensusReporter.org. Note that Roanoke City data are slightly different than that presented in Figure 3 and narrative, as ACS data is dated July 1, 2022.**

U.S. Census Bureau Statistic	City of Roanoke	Roanoke Region	Virginia
Total Population	97,847	315,442	8,683,619
<i>Racial/Hispanic Origin</i>			
White alone, percent	60.1%	76%	68.5%
Black or African American alone, percent	29.3%	13%	20.0%
Asian alone, percent	3.2%	2%	7.3%
All Others, percent	7.4%	9%	4.2%
Hispanic or Latino, percent	6.6%	4%	10.5%
<i>Educational Attainment</i>			
High School Degree or higher	88.3%	91.2%	90.8%
Bachelor’s Degree or higher	26.8%	30.8%	40.3%
<i>Income and Poverty</i>			
Per Capita Income	\$30,379	\$34,652	\$43,267
Median Household Income	\$48,476	\$59,630	\$80,615
% Below Poverty Level	18.4%	12.5%	10.2%

This increasing diversity along with the increasing immigrant and refugee population likely corresponds with a greater proportion of the City's population that is non-English speaking. With respect to flood resilience, this means that a language barrier may inhibit access to flooding information and resources (i.e. grant funding, technical support, post-disaster support). This is further exacerbated by a lack of internet connectivity, as approximately 16% of the City's population does not have internet access; three census tracts have 30-40% without access, and one tract has approximately 50% without access<sup>9</sup>. A number of recommendations are provided in Section 7 that would improve equitable delivery of flood resilience services to an increasingly diverse community that may not otherwise have access to these resources.

In general, the City's population is characterized by a wide variability of wealth, education, and employment indicators that factor into a community's social and economic vulnerability. A number of indices now exist that compile socioeconomic factors into a single index of vulnerability to hazardous events. For this plan, the Center for Disease Control's (CDC's) "Social Vulnerability Index" (SVI) is used, which scores vulnerability on a 0 (low) to 1 (high) vulnerability scale<sup>10</sup>. The City's overall SVI is 0.92 (high), and within the City, there are three census tracts with low vulnerability, nine with moderate and thirteen with high vulnerability. This means that in general, the community's ability to respond to and recover from a hazardous event (flooding, for the purposes of this plan) are affected by several social conditions, such as poverty, mobility, health, etc. The community's vulnerability is of particular importance to flood resilience where high SVI overlaps with flood prone areas; this is manifest in several examples, listed below:

- Low-income households are less likely to have income or savings that could be used to recover from flood damage<sup>11</sup>
- Areas with high unemployment may have less access to paid time off or health insurance that would help cover costs during the time needed to recover from a flood<sup>12</sup>
- Lower educational attainment can mean that the practical and bureaucratic hurdles to cope with and recover from a flood would be more challenging<sup>13</sup>
- Households with a larger number of dependent children or elderly, single parent households and households with disabled persons would likely require additional financial support, transportation, medical care during and after a flood disaster<sup>14</sup>

In the City, areas of high social vulnerability intersect with flood prone areas along Peters Creek, Lick Run and limited parts of Hortons Branch and Trout Run (Figure 1); with this in mind, some

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<sup>9</sup> See American Community Survey – Internet Access by Income Variables - <https://hub.arcgis.com/maps/9edc0cbeeb2a4259910e158dfba01881/about>

<sup>10</sup> <https://www.atsdr.cdc.gov/placeandhealth/svi/index.html>

<sup>11</sup> See Morrow (1999) and Cutter et al. (2003)

<sup>12</sup> See Brodie et al. (2006)

<sup>13</sup> See Morrow (1999)

<sup>14</sup> Flanagan et al. (2011)

recommendations on how to incorporate social vulnerability in flood resilience projects are provided in Section 7.5.

An equitable distribution of flood resilience investment in Roanoke should also consider the pertinent issues in the local housing market and business economy; these issues are generally summarized as follows. First, the availability and affordability of housing in the City appears to be a significant issue, with greater than one third of Roanoke’s households categorized as “cost-burdened” with respect to mortgage or rent payments<sup>15</sup>. While this housing disparity may be due to a number of factors, a shortage in housing stock appears to be at least one major driver of this issue. An important aspect of the housing shortage that is pertinent to flood resilience is that 1,511 residential properties, or approximately 5% of all residential properties in the City are in one of the FEMA designated Special Flood Hazard Areas (SFHAs, i.e. “floodplains”, Table 3). This suggests that the already at-risk local residential real-estate economy is subject to potential damages from flooding which could further exacerbate the housing shortage issue. Several recommendations to this end are provided in Section 7.4 of this Plan.

**Table 3 – Summary of properties in the City within FEMA Special Flood Hazard Areas (SFHAs) by property type. Table was generated using July 1, 2022 parcel layer and PROPERTYDESC field.**

Property Type	Citywide	Within Any SFHA	% of Citywide
Residential	31,422	1,511	4.8%
Commercial/Industrial	3,239	624	19.3%
Vacant or Other	9,644	1,492	15.5%
<i>TOTAL</i>	<i>44,305</i>	<i>3,627</i>	<i>8.2%</i>

Similar considerations apply to commercial and industrial real estate in the City, as 19% of all commercial/industrial parcels lie within a SFHA – which suggests that a major flood event would likely have significant impacts on the local economy by way of business damages, closures, foregone revenue, lost wages, etc. Inversely, reduction of flood risk at commercial/industrial properties would reinforce the local economy’s ability to continue operations during and after a major flood event. Strategies for protection of commercial real estate depend on site-specific variables (e.g. topography, business model, development type, etc.), though in general, elevation of assets above flood elevations, relocating out of the floodplain, or flood-proofing are the three primary methods that can be used. With respect to equity, implementation of commercial flood-proofing can require a significant amount of capital and technical expertise that is probably not widely achievable for small or mid-sized businesses – although these businesses bring an important measure of adaptability to the local economy.

Finally, the age of the City means that most of the readily developable land has already been used in some fashion, and the housing shortage and commercial development needs mean that the remaining land will be needed to support the necessary growth of the local economy. This context and demand create a land issue for flood resilience, as most types of flood resilience projects require a significant land footprint to provide a material reduction in flooding (e.g. acquisition/demolition projects, land conservation, retention ponds, riparian buffer). On the one hand, there is a need to create additional housing units and working spaces, but the addition of more developed land could lead to more runoff and flooding, further diminishing the land needed to provide flood resilience projects. As such, the pathway to flood resilience

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<sup>15</sup> <https://housingforwardva.org/toolkits/sourcebook/affordability-costburden/>



in Roanoke will likely need to integrate flood-resilient design into land development – the development of some technical resources is proposed in Section 7.4.

## 4. COMMUNITY ENGAGEMENT

The social, economic and demographic summary provided in Section 3 provides helpful high-level community context for this Plan, but it was imperative that the perspectives of individual community members be collected as part of this planning effort. As such, an extensive community engagement effort was performed that included both a survey and in-person meetings, to further develop the community's perspective on flooding and resilience. This section summarizes the methods and findings of the Resilience Plan Community Engagement effort and discusses how this new information supplements the significant engagement, education and outreach programs that already existed prior to this planning effort; these existing efforts are summarized in Section 6.2.4 .



Figure 6 – Images of public outreach events during community engagement efforts, March 2023.

### 4.1 METHODS

Public outreach for the 2023 Roanoke Flood Resilience Plan was done primarily with public survey followed by in person public meetings. A 10 minute survey on flooding was created by the City, available in English and Spanish, on a dedicated Resilience Plan website. The survey was promoted through social media, five local news segments (television, radio, and RVTV filmed videos), local partners and non-profit groups, and with signs with QR codes placed in public areas such as the greenways and parks. Additionally, a flyer was created to promote the in person meetings, which was mailed with the City's annual Repetitive Loss Area outreach letter to 345 residents.

The public survey received 146 responses. Of the survey respondents a majority were under 65 and over 18 (33% 18-39, 43% 40-65), white (84%, 6% African American, 7% did not say), City residents (88% live in City of Roanoke), and half live in the southwest quadrant of the City (55.5% in either 24014, 24015, or 24016 zip codes). The most common occupational status was full time employment (62%) followed by retired (24%).

In person public meetings were held at 5 of the City libraries in March 2023 along with one virtual Zoom meeting option. At these meetings, a brief presentation was given providing general information about flooding and flood resilience, followed by an open forum for the community to ask questions, express concern, and discuss flooding with staff and consultants. Public meetings garnered a total of 12 participants, however the level of interaction of the participants was high and beneficial. Follow up public outreach is planned to allow for dissemination of plan results and to answer community questions after adoption of the plan document. Future feedback will inform plan updates.

## 4.2 SUPPLEMENTAL OUTREACH

The project team also developed a custom GIS-based online survey and mapping application. This GIS mapping application was designed to facilitate automated capture of basic flood occurrence data and visualization of issues in a geographical context. The application employed a crowdsourcing workflow to create an accessible and easy to use survey application to obtain flooding occurrences from City residents. The tool offers a means for residents to provide basic information and attach photos documenting areas of concern. The public facing interface allows residents to see where issues are occurring, while allowing City staff to catalogue and archive reports of flooding while controlling access to detailed source information. The tool was provided on the project website and also brought to the public through radio and television, including a brief segment on the local evening news.

During this Resilience Plan outreach it received 14 reports of flooding issues from the public. Reports included street flooding, local drainage issues, and stream or river flooding. The reports were largely from the North and southwest areas of the City. A few responses were from outside of City boundaries at Smith Mountain Lake, these were passed along to appropriate organizations as necessary; they also illustrate downstream flooding impacts. The mapping application will be kept open beyond the plan development phase to allow for ongoing reporting.

## 4.3 SUMMARY OF RESPONSES

This section provides a summary of the findings of the Resilience Plan Community Engagement effort, though the full survey results are included in Appendix E of this Plan. Over two thirds of respondents felt flooding currently poses a moderate (55%) or serious (24%) challenge to their community with only 5% feeling it is an extreme challenge. When looking at the risk flooding poses in the next 20-40 years, 17% felt flooding will pose an extreme challenge.

About one quarter of respondents' homes have flooded (27%) while only a minority reported flooding of a business (7%). The most common commentary on flooding experienced was basement or land (backyard or street/driveway/sidewalk) due to either large storms, drainage issues, or stream overbanking. One third have not experienced any type of property damage from flooding, but when damage occurred, the most common damage was to basements (38%) followed by street flooding (34%) and debris/trash deposits (26%). Relatedly, the most common negative impact reported was damage to transportation (62%) as well as trash and debris (41%).

Most respondents are not interested or concerned about moving due to flooding; however, 21% are considering relocation due to flooding issues and 7% of those have issues that prevent them from relocation. For those that have put in mitigation measures on their homes, the most common is a sump pump (24%), french-drains (21%), or elevation of property/utilities (19%). About an equal number do not have any mitigation measures on their homes (27%).

As far as solutions, the most popular suggestion was the persevering/creating natural space for flood water storage (80%). Other options such as buy-outs, changing design standards, increasing capacity for drainage, funding for flood-proofing, increased outreach, and real estate disclosures for flood prone properties were all equally popular.

The main discussions at in the in person meetings were regarding existing, long term flooding issues from residents and how they might find solutions or be helped by the Resilience Plan. There was overall excitement for a focus on flooding and resilience but disappointment in the length of time for meaningful

solutions to be implemented for complex flooding issues. Additional understanding of specific flooding problems were relayed to City staff as well as the emotional and financial burden on those residents.

Even though somewhat limited in responses, this feedback from the community survey supports the City's Resilience Planning efforts, as flooding is clearly expressed as a real threat to its residents and nature based solutions are positively received. The responses also help this plan to focus on local solutions for property damage and street flooding that residents commonly experience. Using community feedback helps align this plan with the community's needs and desires.

While responses to this initial outreach effort were limited, past efforts at engagement and outreach also support the City's understanding of the community. Robust educational and engagement efforts, outlined in 6.2.4, help guide the City's plan for flooding resilience. The City highly values incorporating education, engagement, and outreach with the community as a fundamental part of building resilience. Direct community engagement encourages accountability, creates connectedness between city and citizen and instills a sense of ownership and pride in one's community.

## 5. PRINCIPLES OF FLOOD RESILIENCE

In this section, the background context related to flooding, community vulnerabilities and equity provided in Sections 2 and 3 are combined with the information gained from the Community Engagement survey for this Resilience Plan effort in Section 4 to support Roanoke’s five basic principles of flood resilience. These principles acknowledge and internalize the nature of flooding in Roanoke (i.e. a combination of pluvial and riverine), with the challenge of retrofitting legacy land with modern day infrastructure and standards in the face of a changing climate. The principles also acknowledge the large variability in social vulnerability in the City and incorporate social equity as one of the principles. The principles are derived from parameters given in DCR’s 2023 Community Flood Prevention Fund Grant Manual but are adapted to Roanoke City’s specific context based on the extensive work performed in the previous Sections of this Plan. The five key principles are described as follows; note that in each principle the term “effort” is used, as it includes any type of planning document, internal protocol or program, policy or technical/construction project that the City may perform.

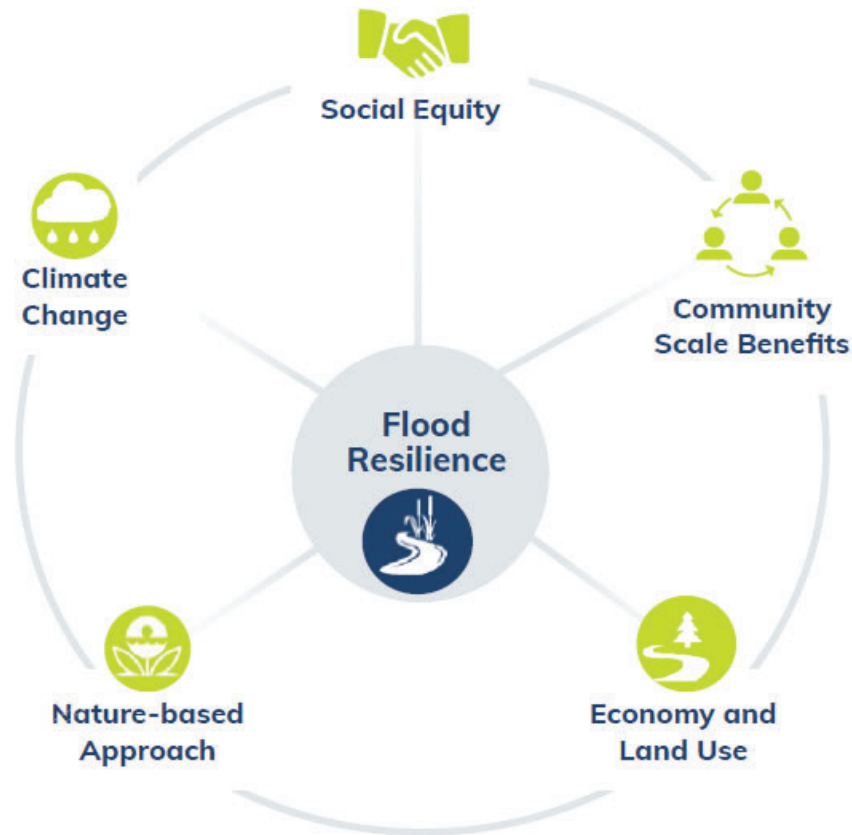
1. **Climate Change** – Does the effort internalize the potential impacts of climate change, such as increased rainfall intensity and temperature into planning, design and implementation of efforts?
2. **Social Equity** – Does the effort acknowledge community vulnerabilities and work towards equitable outcomes in its conception? Will the effort improve or strengthen the social fabric in vulnerable parts of the community?
3. **Community Scale Benefits** – Will the effort render benefits at a U.S. Census Block scale or larger? Will at least 10% of the City’s population benefit from the project? Is the effort consistent with regional efforts?
4. **Economy and Land Use** – Does the effort acknowledge fiscal realities and focus on cost-effectiveness? Does the effort encourage the usage and development of land that internalizes present and future flood risk? Is it consistent with best practice for floodplain management?
5. **Nature-Based Approach** – Will the effort use or leverage environmental processes and natural systems including (but not limited to) vegetation, soil, biota to minimize flooding and mitigate flood impacts? Will the effort encourage a reduction in key pollutants of concern for Roanoke’s waterways, including fine sediment, pathogens and organic chemicals?

Resilience Principle	CFPF Program Perspective	Related City Vision
Climate Change	Potential impacts of climate change, such as increased rainfall intensity and temperature into planning, design and implementation of efforts	The City Plan 2040 and the City’s Climate Action Plan recognize that our climate is changing, and action is needed. This plan lays out the provision for the City to adapt to and mitigate impacts of climate change as they relate to increases in rainfall and potential for flooding.



<b>Resilience Principle</b>	<b>CFPF Program Perspective</b>	<b>Related City Vision</b>
Social Equity	Efforts acknowledge community vulnerabilities and work towards equitable outcomes in their conception. Efforts will improve or strengthen the social fabric in vulnerable parts of the community.	City Plan 2040 recognizes that equitable outcomes need to be evaluated in all City Actions. The Department of Public Works Equity Action Plan further recognizes the need to understand community needs as projects are planned, developed and implemented.
Community Scale Benefits	Will the effort render benefit at a U.S. Census Block scale or larger? Will at least 10% of the City's population benefit from the project? Is the effort consistent with regional efforts?	The Stormwater Utility recognizes that stormwater and flood projects need to be evaluated within the overall context of the watershed and community they are planned in. Projects need to account for the watershed so that a project does not create upstream or downstream issues. More importantly, projects need to be assessed holistically based on the community and how a resilience project can be part of broader community development efforts.
Economy and Land Use	Does the effort acknowledge fiscal realities and focus on cost-effectiveness? Does the effort encourage the usage and development of land that internalizes present and future flood risk? Is it consistent with best practice for floodplain management?	City Plan 2040 recognizes the need to adapt to climate change will creating a more resilient community. Resilience efforts will focus on effective use of City and leveraged resources and other community resources to adapt to a changing climate. Efforts will include land use practices including preservation and restoration of highly flood prone areas, reduction of flood risk through appropriate projects, and adapting to climate change through appropriate development standards.
Nature-Based Approach	Will the effort use or leverage environmental processes and natural systems including (but not limited to) vegetation, soil, biota to minimize flooding and mitigate flood impacts? Will the effort encourage a reduction in key pollutants of concern for Roanoke's waterways, including fine sediment, pathogens and organic chemicals?	City Plan 2040, Stormwater Utility monitoring efforts and general best practices for flood resilience all point to the value of flood plains and use of natural process, such as infiltration, to help reduce the impacts of flooding and increased rainfall/runoff. Use of nature-based solutions, at least in part, are preferred for projects. It is recognized that in a compact urban environment, traditional engineering practices are still necessary as part of a holistic process to be resilient community.

It is important to understand that these principles are focused on flood resilience – the scope of this plan. While these principles do not explicitly internalize other known threats and hazards or the complex interdependencies between different types of critical infrastructure during an emergency event, they are crafted carefully to support a broader application of resilience thinking across these domains.



**Figure 7 - The Five Principles of Flood Resilience**

The following Sections use these principles to evaluate efforts to date related to flooding (Section 6) and to propose recommendations that would further advance Roanoke as a flood resilient community (Section 7). While these principles represent knowledge of the community and best practice with respect to flood resilience as of the date of this plan, it is anticipated that these principles could be revised in future versions of this plan, as community dynamics shift and flood resilience practice evolves.

## **6. EFFORTS TO DATE**

In this section, the five principles of flood resilience are used to evaluate existing City efforts to date related to flooding and flood resilience. City efforts are organized into the categories of planning documents, internal protocols and programs, external facing policies, and engineering/construction projects. Each section contains a summary of the effort, a description of how the effort relates to flood resilience, and an analysis of the degree to which each effort incorporates the five key principles of flood resilience. As existing efforts are evaluated, a gap analysis is performed to identify if and how the key principles of flood resilience may be missing from individual efforts or from the collection of effort. As gaps are identified, future work is proposed in the following Recommendations Section (Section 7) and links to specific recommendations are provided throughout.

Efforts to address flood resilience can be broken into five categories:

- Plans - Documents that outline issues and establish policies and propose actions to address those issues.
- Practices and Programs – Represent best practices, studies or programs that the City implements to reduce flood risk and increase resilience and/or to help prioritize efforts.
- Regulations – Specific requirements that the City is required to follow or that the City requires of its residents/businesses.
- Projects – Actions to address flooding issues and increase resilience
- Funding – Providing monetary resources to execute work.

This section concludes with a gap analysis of current efforts and the City’s vision to become more flood resilient.

### **6.1 PLANS**

There are existing City planning documents that have undergone extensive authorship, editing, review and approval processes that have a bearing on flood resilience. The universe of documents evaluated in this section include only those documents that have been approved by City Council for adoption; other planning-type documents that have not been approved by Council are found in Section 6.2 - Practices and Programs, as these documents are primarily for internal use and prioritization of projects and are subsidiary to any Council-approved Plan.

#### **6.1.1 City Plan 2040**

The City Plan 2040<sup>16</sup> is the City’s Comprehensive Plan adopted in 2020 and provides a broad vision for the ideal future for Roanoke with recommendations for implementation over the next 20 years. The City Plan enumerates ideas, themes, design principles and land use principles at a high level and provides a pathway for implementation.

With respect to flood resilience, one of the themes that Roanoke’s City Plan for 2040 promotes is “Harmony with Nature”, described as “resilient practices for a resilient environment that nurtures

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<sup>16</sup> <https://planroanoke.org/city-plan-2040/>

community health and protects natural resources.” Some of the practices mentioned in this City Plan that directly relate to flooding are:

- Adapt the City’s approach to stormwater management with climate change in mind.
- Promote regional collaboration for stormwater and flooding goals and develop a comprehensive approach to floodplain management.
- Promote green infrastructure.
- Improve stormwater management for all development projects.
- Improve conditions of the Roanoke River.
- Promote tree stewardship by increasing tree care, increasing the percentage of tree canopy, and community education in the city.
- Sustainable land development involving policies and codes to support green building, incentivize pre-existing development to adapt green features, and reduce impervious surfaces.

Another key theme is “Interwoven Equity” and also corresponds with this plan’s focus on addressing flood resilience needs of all parts of the locality, especially underserved populations. Practices identified within the plan are:

- Equity involves the fair distribution of investments and services and the removal of institutional or structural policies that can be barriers to success.
- It is crucial that services are provided equitably and in ways that are accessible to all residents.
- Provide financial resources in neighborhoods that were formerly redlined.
- Provide quality education for all residents.
- Provide supportive interventions strategically.

Overall, the ideas, themes and action items enumerated in the City Plan are highly consistent with the five key principles of flood resilience in this Resilience Plan.

### **6.1.2 Downtown Roanoke Plan**

The Downtown Plan (2017) was created to enhance and direct public and private sector investments in Roanoke’s downtown area and to identify policy and actions towards those goals. The plan recognizes that Downtown was built above a channelized stream (Trout Run) and springs/marshland. Policies to make Downtown more flood resilient are like those in City Plan 2040 and are as follows:

- “POLICY 2-G: Support appropriate floodplain management”.
- “POLICY 2-H: Reduce flooding by encouraging stormwater and green infrastructure projects in downtown”.
- “POLICY 2-B: Repair voids in the streetscape and improve the pedestrian realm, while supporting infill development”.

A more detailed flood study has been completed since the adoption of Downtown Plan 2017 and that information is currently being adapted into new FEMA maps expected in 2025. Downtown is an area where flood resilience can best be improved through public and private initiatives. Projects identified in the flood study can remove bottle necks and achieve some detention to help manage the current 25-year storm event. Private property owners can further enhance their resilience with adaptations and protections such as flood shields that can be deployed during large storm events.

### **6.1.3 Climate Action Plan**

The City's Climate Action Plan for 2015-2020 (n.d.) identifies a broad range of policies to reduce the City's emissions of greenhouse gasses and reduce the impacts of climate change on the City. This document included the current status summary and recommended goals and targets to:

- "Promote and strengthen green infrastructure and natural systems".
- "Sustain and enhance the integrity of the Roanoke Valley water resources and waterways through innovative water management practices".
- "Work to ensure sustainable land use and urban development".
- "Continue to expand the urban tree canopy and achieve an equitable percentage of tree canopy across residential neighborhoods, City parks, street medians, school properties".

### **6.1.4 TMDL Action Plan (revised September 2022)**

The Action Plan speaks to the City's MS4 permit and provides information on the effects of sediment loading caused in part by stormwater runoff. It also outlines the City's processes to address pollution in its impaired streams. Water quality efforts focus on reducing the volume of stormwater runoff from smaller storms affecting sediment load. Reducing runoff and sediment deposition reduces risk from flooding, at least during smaller storm events, and potentially larger storms if sediment block stormdrain systems.

### **6.1.5 Urban Forestry Plan (2003)**

This document provides a more in-depth look into the City's urban canopy and discusses how trees and vegetation can help to mitigate flooding.

### **6.1.6 Parks and Recreation Master Plan**

The **Parks and Recreation Master Plan (2019)** – With plans to be updated sometime this year, this master plan report highlights the current and planned park systems, which includes green spaces, greenways and trails. The City works with planners, consultants, and residents to improve tree canopy, innovative use of impervious surfaces and natural vegetation, and promotes a more fostering relationship to local rivers with sustainably designed access (City of Roanoke, 2019). All of these factors can help to inform the current and future direction of flood planning within the City.

### **6.1.7 Neighborhood Plans**

A helpful resource in conceptualizing future urbanization, neighborhood and area plans have been written and are at various stages of implementation since 2002 (City of Roanoke, 2020). These plans depict finer details of the greater land use vision of the City as a whole and can give us a glimpse of future resiliency measures in the form of stormwater improvements, streetscape improvements (involving the use of more street trees), and recommendations of more green space.

### **6.1.8 City-Wide Brownfield Redevelopment Plan**

City-Wide Brownfield Redevelopment Plan (2008) – Adopted by the City in 2008, this plan informs the Roanoke River Corridor, amongst others, on implementation of green space development and promotes more efficient land use in areas that likely contain brownfield sites. A brownfield is a property,



redevelopment or reuse of land which may be complicated by the presence or potential presence of a hazardous substance, pollutant, or contaminant (EPA, n.d.).

### **6.1.9 Roanoke Valley Greenway Plan (2018)**

This plan incorporates surrounding municipalities and localities that assess the current interconnected greenway routes of the Roanoke Valley and reports progress on goals for development and improvements, compared with the originally Conceptual Greenway Plan from 2007 (Roanoke Valley Greenways, 2018). The improvement of greenways and trails within the City helps to inform progress of new green space and natural trail innovation against the challenges of development.

### **6.1.10 Various Flooding Impact Documents**

Helpful research and analysis pertaining to the preparation of flooding events is the City's Repetitive Loss Area Analysis, issued in 2021. This analysis provides community members with information about the National Flood Insurance Program's Repetitive Loss Areas per FEMA criteria, the Community Rating System (CRS), and project recommendations to help reduce the effects of these Repetitive Loss flooding areas. Similarly, Roanoke Valley's Alleghany Regional Hazard Mitigation Plan, issued September 16, 2019, captures past flood events, provides CRS and Repetitive Loss statistics, provides past flooding data, and provides a comparison of this data to Roanoke County and several neighboring counties.

The City of Roanoke not only informs the public of how to stay prepared for flooding events but has its own internal and-state approved procedures in place when a hazardous flooding event occurs. In 2022, Roanoke approved an updated "Basic Plan" Emergency Operations Plan that describes the City's hazard vulnerabilities, including flash flooding, and the distribution of City and agency-based responsibilities in case of an event. Like the Basic Plan, two annex documents were issued by the City relating specifically to flood emergency response. The Flood Incident Annex was aimed at describing public health and safety measures in the event of flooding such as training, equipment, and technology involved in an emergency process. For dam flooding or failure emergencies, the Dam Safety Support Annex determines procedures for evacuation of downstream residents if there is imminent or impending dam failure. The Western Virginia Water Authority is also responsible for preparing an Emergency Action Plan applicable to dams throughout the Western Virginia Region.

### **6.1.11 Summary**

The existing planning documents summarized in this Section represent a significant body of work directing the City's efforts towards major themes, ideas and principles. Together the results of the City's flood resilience planning and study cover the entirety of the City's watersheds.

In general, the five key principles of flood resilience presented in Section 5 of this plan already appear in existing planning documents in various forms. However, as the scope and level of specificity of these other plans varies widely, the value of this Resilience Plan is that it collates flood related ideas that are already enumerated in other existing documents into a single document which can then provide helpful categories to scope and direct specific projects to make progress towards the high-level goals and ideas. With that in mind, several construction projects and technical studies are proposed in Section 7 to advance the themes that were already approved in other planning documents but are repackaged here with a focus on flood resilience.

## **6.2 PRACTICES AND PROGRAMS**

Protocols and programs help to create structure for City staff for implementation of flood prevention and mitigation strategies and also provide guidance when flooding and the associated hazard of an event

impacts the community. Roanoke continues to advance flood resilience through the issuance of these various procedures, protocols and policies as seen in the City’s development procedures, and their flood-related protocols. This continuously evolving process demonstrates that stormwater management and flood prevention remain high priorities for Roanoke.

### **6.2.1 Flooding Assistance Protocols**

The City has established flooding assistance protocols to safeguard its residents during flood events. The first step of flooding assistance is keeping the community informed of the flooding event. The City has provided public information and outreach to the community regarding severe weather preparedness and preparation, in addition to more in-depth hazard information that can be found in the Roanoke Valley-Alleghany Regional Hazard Mitigation Plan. The City maintains several flood warning gauges throughout the City – known as the Stream Hydrology and Rainfall Knowledge System (SHARKS, see also Section 6.2.4) – and uses the Star City Alerts system to issue important warnings<sup>17</sup> Additionally, information on evacuations and designated shelters for displaced individuals have been published on the City’s website. After a flood has occurred, federal flood relief support for the City has been established through the City’s participation in the National Flood Insurance Program (NFIP) and Community Rating System Program (see next section for more details).

### **6.2.2 FEMA Community Rating System Program**

FEMA provides flood mitigation and flood event relief assistance through federal grants and programs, one of these is the National Flood Insurance Program’s (NFIP’s) Community Rating System (CRS). The CRS is a national flood readiness rating system that identifies various best practices that a locality can implement to improve responsiveness to flood events and reduce the impacts of floods when they occur. Based on the City’s participation in this program, property owners receive discounts for NFIP insurance premiums. A few examples of flood risk reduction activities that contribute to a community’s CRS score are:

- Requiring permits that assess if new development is located within flood-prone areas
- Requiring that new or improved developments are elevated above “base flood level”
- Ensuring proper flood-proofing measures are in place for new or improved development within certain zones
- Ensuring the “prohibition of encroachments” for any kind of development within a floodway (with a few exceptions)
- Ensuring that the central portion of a riverine floodplain carries deep and fast-moving water
- Enforcing requirements to protect buildings from intense rainfall and storm surges
- Ensuring that all other permits associated with new development have been approved

The CRS ranks participating communities on a 1-10 scale, with 1 designating the highest level of effort with respect to floodplain management and risk mitigation. As of October 1, 2023, the City will advance from a Class 7 to a Class 6 community, which will provide a 20% discount for properties within the

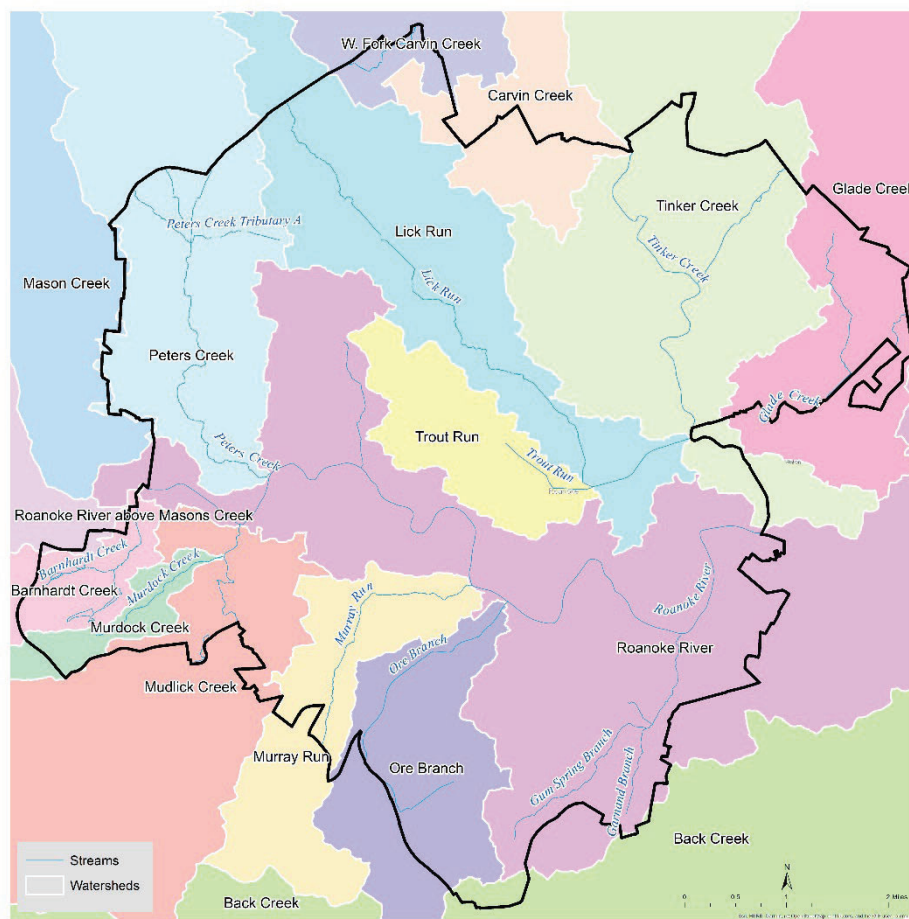
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<sup>17</sup> <https://www.roanokeva.gov/2788/Star-City-Alerts>

SFHA and a 10% discount for properties outside of the SFHA<sup>18</sup>. This advancement was the result of improved floodplain management activity and the documentation thereof by City staff.

### 6.2.3 Watershed Master Plans

The City's Stormwater Division was formed in 2014 to address issues related to flooding and water quality in the City, and at the time of its inception a strategic plan was needed to (1) summarize the numerous regulatory requirements related to stormwater; (2) characterize the City's streams and watersheds based on data to-date; (3) propose a portfolio of projects that would lead to improved water quality and reduce flooding. As such, the Division funded Watershed Master Plan (WMP) documents that provided guidance to this end, though it is important to note that these documents are internal strategy documents only and have not been through a public engagement or Council review process.



**Figure 8 - City of Roanoke Watershed Map.**

<sup>18</sup> The City had been a Class 7 community since 2008, which provide 15% and 5% discount for properties within and outside the SFHA respectively.

These plans focused on individual watersheds or groups of watersheds, and thus far plans for Lick Run, Trout Run, Carvins Creek, Tinker Creek, Glade Creek and Peters Creek have been completed. More recently, staff have changed the strategy to evaluate projects across all watersheds in a single plan, as this would allow for a comprehensive City-wide project identification and ranking system. In general, the principles and objectives of the WMP documents are consistent with the five key flood resilience principles in this Plan; the WMP goals are copied verbatim below for reference:

- 1. Maximize watershed resiliency and sustainability**
  - A. Restore more natural surface water processes (abiotic hydrology, geomorphology, and chemistry)
  - B. Revitalize ecosystem health (biotic species habitat and diversity)
  - C. Augment capacity to endure and recover from short term hazards (drought and flood)
  - D. Enhance adaptability to long-term hazards (land development and climate change)
- 2. Minimize watershed hazard to public health, safety, and property**
  - A. Prioritize and construct Capital Improvement Projects that both mitigate neighborhood flood hazards and improve downstream water quality (ISI Envision checklist)
  - B. Increase Community Rating System (CRS) ratings for progressive floodplain management activities
  - C. Delist from the 303(d) report all impairments including bacteria, sediment, PCBs, and Mercury in fish tissue
- 3. Connect residents, businesses, students, and other stakeholders to their watershed**
  - A. Provide the community with life-long learning opportunities about their watershed (natural processes, ecosystem health, and pollution prevention)
  - B. Engage the community in revitalizing watershed ecosystem health (BMPs, green infrastructure, and low impact design)
  - C. Coach the community to participate in outdoor recreation and stewardship opportunities within their watershed

As the goals of the WMP are similar to and consistent with the principles enumerated here, the projects that were proposed in the WMPs are also generally consistent with the principles here. However, one important gap in the WMPs is that the proposed projects were identified and prioritized based on hydrologic and water quality assessments and the WMPs did not explicitly consider social vulnerabilities or equity in the planning scheme. Another shortcoming of the WMPs is that they use GIS analysis to identify potential projects, but do not leverage hydraulic/water quality modeling or structural condition assessment information as these data were not available at the time the WMPs were written.

## **6.2.4 Flood-Related Community Education, Outreach and Engagement**

The City prioritizes community engagement, education and outreach as part of building a resilient City for those that live, work, learn, and play in the City of Roanoke. This Resilience Plan is only part of the ongoing efforts the City has undertaken for community engagement. A variety of engagement tools or strategies are utilized to help residents connect with and help shape their own community including councils and committees, educational events or programs, and curated outreach materials. See Appendix C for a more detailed summary of the City's outreach and educational efforts.

## **6.3 REGULATIONS**

Like all municipalities and localities, the City of Roanoke is subject to regulatory measures that aim to protect, and improve the well-being of its residents, infrastructure, and the environment. Fortunately, local, state and federal regulations are intersecting with flood resiliency objectives increasingly as our society begins to see the importance of natural events amidst the built environment.

The City's Zoning Code (Section 36.2 of the City code) plays a major role in how land is developed in Roanoke and includes provisions to promote flood resilience and the conservation of open space along the Roanoke River and its tributaries. This is strongly demonstrated in Roanoke's Floodplain Overlay District and River and Creek Corridors District ordinances, as well as in general development standards that apply to all projects.

### **6.3.1 Floodplain Management**

As previously described, Community Rating System and NFIP are two federal programs under FEMA that assists Roanoke through federally back flood insurance and discounted rates based on applying best practices. While participation in these programs is voluntary, they are important as they:

- Provide a significant risk-management tool for property owners in the floodplain through flood insurance
- And significant cost savings on that insurance based on the federal backing and CRS discounts.

The NFIP Community Rating System Repetitive Loss Area (RLA) Analysis has been instrumental in visually depicting the City's RLAs and providing recommended property owner actions to mitigate flood risk. Although this analysis directly targets these RLA regions, flooding or mitigation measures in the form of specific project recommendations were not specified. Generalized recommendations include redeveloping structures with higher elevation, utilizing flood proofing techniques, improving road drainage, and planning additional stormwater infrastructure within certain RLA regions (Roanoke Stormwater, 2021). The City of Roanoke has extracted these recommendations and assessed the logistical feasibility of implementation within certain RLA regions.

By participating in the NFIP, the City uses the FEMA Flood Insurance Rate Maps (FIRMs) as the primary tool to assess flood zones and flood elevations. The FEMA regulations associated with the NFIP includes minimum standards related to development in flood zones, such as building elevation and flood proofing standards. It should be noted that the Uniform Statewide Building Code requires construction consistent with FEMA and related standard. FEMA regulations are administered at the state level by the Virginia Department of Conservation and Recreation (DCR) and at the local level through the City's Zoning Ordinance at Section 36.2-333. - Floodplain Overlay District.

The Floodplain Overlay District (i.e. the "floodplain ordinance") reinforces the basic principles of FEMA's NFIP federal program, defining flood zones based on the applicable FIRMs designating how often a flood may occur in that area, what kind of flooding may occur, and to what extent. The section outlines the minimum standards of the NFIP including:

- Standards for flood proofing and/or elevating new structures.
- Requirements for improvements to existing structures (to bring those structures into NFIP compliance or closer to compliance).



- Criteria to limit filling/encroachments in the floodway.
- Requires that decisions related to development are based on the height of a 1-percent chance storm (100-year storm).
- Requirements for substantial improvements to structures in the floodplain.

The Floodplain Overlay District includes provisions that are more conservative than the NFIP program such as:

- Requires structures be elevated or flood proofed to two feet above base flood elevation (free board).
- Restricts permitted uses in the floodway, the most flood prone portion of the flood plain with typically the highest flow velocity.
- Requires substantial improvement determinations be evaluated based on work over a five-year period.

These more restrictive regulations help to reduce the potential for a rise in flood elevation from placing fill in the floodway and the free board requirement provides some safety to structures should fill occur and allows some factor of safety for increases in rainfall or storm events that are larger than the current 1-percent chance storm.

A permit from the Zoning Administrator is required for all development occurring within a flood zone. These permits require various types of information including site plans, flood elevation data, and sometimes verification from a licensed surveyor or engineer in order to be accepted. The permit is then reviewed and approved by the City before the development can proceed. Detailed procedures for floodplain review including substantial improvements are enclosed as Appendix B.

### **6.3.2 Stormwater Management**

The City of Roanoke's stormwater management program is regulated and implemented through programs that are derived from the federal Clean Water Act and administered through the Virginia Department of Environmental Quality (DEQ). These programs include:

- Municipal Separate Storm Sewer System (MS4) - regulates City owned and operated stormwater infrastructure and permits discharge from the City's MS4 into the Roanoke River and its tributaries.
- Virginia Stormwater Management Program (VSMP) - provides standards for managing stormwater quantity and quality at land development sites once construction is complete
- Total Maximum Daily Load (TMDL) - designates specific pollutants of concern and requires the City to report steps taken to reduce transport of these pollutants into waters of the United States in the City's annual MS4 permit report and TMDL Action Plan.

The MS4 program is a water quality program and is not specifically focused on flooding, though it is well understood that a reduction in stormwater runoff magnitude, volume and frequency improves both water quality and reduces flooding. The City's MS4 permit requires demonstration of progress towards six programmatic Minimum Control Measures (MCMs) designed to reduce stormwater pollutant loads into the MS4. Three of these MCM are largely requirements of the City to Provide public education and outreach (MCM #1), public participation (MCM #2) and to carry out good housekeeping in municipal operations (MCM #6).

The other three MCMs are outward facing. MCM #3 relates to illicit discharge detection and elimination. This is regulated through Chapter 11.3 - Stormwater Discharge Requirements of City code. This section restricts non-stormwater discharges into the City's MS4 and provides penalties for violations. While illicit discharges may be associated more with pollution (e.g., allowing chemical to flow into a drain), dumping debris and trash into drains can create flooding issues. Such debris, sediment or material can clog drains that leads to flooding conditions.

MCM #4 and #5 relate to managing runoff from construction activities and then maintaining and installing stormwater management facilities at new and re-development sites. This is administered through the City's adoption of the VSMP (Chapter 11.6 - Stormwater Management of City code). The most important element of the VSMP with respect to flood resilience, is the requirement that downstream channel adequacy be evaluated, and that detention is provided to manage downstream erosion and flooding. These requirements apply to development sites that disturb more than 10,000 square feet of area. These facilities are periodically inspected to make sure they are properly maintained. Reducing runoff from property as it is developed or redeveloped is an important element of the City flood resilience.

The final pertinent stormwater management program is the TMDL program which limits the amount of sediment, bacteria and an organic chemical known as polychlorinated biphenyls (PCBs) that can be discharged to the Roanoke River and its tributaries. The City is required to reduce the presence of sediment, bacteria, and PCBs and to annually report progress towards meeting these goals in an annual MS4 report. As previously noted, efforts to improve water quality align with flood resilience goals of reducing the amount of runoff.

### **6.3.3 Erosion and Sediment Control**

City Ordinance, Chapter 11.7 - Erosion and Sediment Control focuses on the control of soil erosion and sediment transport during construction and related activities that disturb more than 2,500 square feet of land. As with the City's stormwater management regulations, this program derives from state and federal regulations. The disturbance of land leaves exposed or stockpiled soil and similar materials exposed to runoff that can carry the material into the storm drain system and on to the Roanoke River or its tributaries. Sedimentation can affect water quality (impair habitat for fish and insects) and can also accumulate and create clogs or flow constrictions that can create or exacerbate flooding conditions.

### **6.3.4 Riparian Buffer Standards**

The City's Zoning Ordinance, Section 36.2-335 - River and Creek Corridors District (RCC) establishes development standards for the protection/re-establishment of riparian buffers along the Roanoke River and its tributaries, where mapped (not all tributaries are mapped as part of this district). This section contains rules that establishes riparian buffers in mapped areas where the district applies. The intent is to primarily protect water quality and has the benefit of limiting fill and disturbance in buffers that typically coincide with the floodplain. This provision serves to maintain or reestablish natural functions along the Roanoke River and its tributaries and helps reduce flooding through natural vegetation and buffers and encourages proper soil drainage and decreased impervious surface cover through limited and strategic land use.

## **6.4 PROJECTS**

This section presents the five broad categories of flood resilience projects that the City currently undertakes and is likely to continue to implement under this plan. These types of projects are listed in the following Table with brief description of the type of work and examples of recent completed projects.

It is important to note that project scopes can be broad and can fit into more than one category. An example is the recent acquisition and demolition of the former Ramada Inn on Franklin Road. That project falls into the acquisition and demolition category. The project also includes restrictions on land use and a future phase of work to further enlarge the flood plain on the property. That part of the work falls into the land preservation and restoration category. There are other instances where projects could fall into multiple categories, such as:

- Acquisition of a highly flood prone property with the intent that the flood prone structure could be removed and the property redeveloped in a more resilient fashion (Acquisition and Demolition and Adaptation).
- Constructing traditional storm drain systems that include bioretention area, vegetated swales, etc. to reduce runoff (Gray and Green Infrastructure)

<b>Acquisition and Demolition</b>	
<i>Description</i>	<i>Recent Examples</i>
Acquisition of highly flood prone property, typically repetitive loss, and the demolition or removal of structures form the property to remove flood risk.	<ul style="list-style-type: none"> <li>• Ramada Inn property acquisition</li> <li>• Cee Breeze property acquisition</li> <li>• Property acquisition along Garnand Branch, Peters Creek and Mud Lick Creek.</li> </ul>
<b>Land Preservation and Restoration</b>	
<p>Acquisition of property or easements to protect open space that is valuable for future flood resilience. Typically, this is flood plain and riparian areas along the Roanoke River or a tributary.</p> <p>The intent is to remove obstructions, high-risk structures, and restore flood storage capacity, thereby reducing flood risk.</p>	<ul style="list-style-type: none"> <li>• Stream restoration on Lick Run at Washington Park, Highland Farms and Blacksburg Roanoke Regional Airport</li> <li>• Glade Creek Stream Restoration</li> <li>• Peters Creek Constructed Wetland</li> <li>• Roanoke River Flood Reduction Project (property acquisition and bench cuts)</li> <li>• Property acquisition along Garnand Branch, Peters Creek and Mud Lick Creek.</li> <li>• Cee Breeze and Ramada Inn property acquisitions and restorations.</li> </ul>
<b>Adaptation</b>	
Includes a range of measures to protect new or existing structures from flooding or reduce the risk from flooding	<ul style="list-style-type: none"> <li>• Flood proofing measures at the City Market Building</li> <li>• Roanoke River Flood Reduction Project – berms/training walls</li> </ul>

<b>Green Infrastructure</b>	
A wide range of practices for encouraging infiltration and/or collection and reuse of stormwater. Measures can range from a rain barrel to park land that functions as a stormwater facility.	<ul style="list-style-type: none"> <li>• Permeable pavement/paving systems on Bullitt Avenue at Elmwood Park, Norfolk Avenue at the Amtrak platform, Raleigh Court Library parking, Garden City Greenway</li> <li>• Bioretention/bioswales at Williamson Road Library, and Fire Station 3</li> <li>• Green Roof at Municipal Building</li> <li>• Narrows Lane channel improvements</li> <li>• 24<sup>th</sup> Street drainage improvements (permeable pavement)</li> </ul>
<b>Gray Infrastructure/Traditional Engineering Practices</b>	
Traditional storm drainage facilities such as pipes, ditches and basins.	<ul style="list-style-type: none"> <li>• Sample/Crown Point, Westover Avenue, Templeton Ave, and Sweetbriar Ave drainage improvements</li> <li>• Deyerle Road drainage improvements (hybrid, includes a natural channel along with a piped conveyance)</li> <li>• Chapman and 19<sup>th</sup> Drainage Improvements (include bioretention area along with traditional drainage measures)</li> </ul>

Special considerations apply when the City considers acquisition of property for flood mitigation purposes, either for demolition or for preservation purposes. Broadly, there are two mechanisms the City can use. One would be an involuntary acquisition through a condemnation process. It is unlikely that the City would take such an approach and determining the acquisition price would be subject to federal and state requirements to ensure that compensation is fair and equitable.

Generally, the City acquires flood prone property through voluntary acquisition working with property owners who are willing to sell. In developing an offer for such property, the City evaluates the property including land area, type of structures and condition of the property and structures to assess the value. From there, a price is negotiated with the owner. If the City and owner come to a mutually agreeable price, the acquisition can move forward. If a property is occupied by a tenant, federal relocation practices are followed to make sure the tenant has access to equivalent, safe housing.

Voluntary acquisition at a mutually agreed price is consistent with the City's vision of interwoven equity and being fair in our processes. Appendix D contains the Stormwater Division's standard procedures for property acquisition.

## **6.5 FUNDING**

To create a sustainable funding source to address issues related to stormwater management and flooding, the City created a Stormwater Utility. The utility is funded by a dedicated stormwater utility fee as outlined in Chapter 11.5 - Stormwater Utility of City code. The Stormwater Utility is a Division of the City's Department of Public Works and the fee provides the utility with a dedicated funding source to carry out its work which generally includes mitigation of flooding, improvement of water quality and maintenance of the storm drain system. The fee provides operating budget that allows for progress

towards these three goals, compliance with regulations described in this Section, equipment, planning and research, etc.

It is important to understand that the fee only provides a small amount of funding for capital construction projects – these are typically funded using bonds leveraged with external grant funding. The Stormwater Utility’s current budget for capital projects includes \$3,500,000 in cash and bonds with a goal to match that with grant funds for a targeted capital budget of \$7,000,000/ year. Typical grant programs include:

- Virginia Department of Transportation Revenue Sharing – improvement related to City streets and runoff to/from streets (addresses localized flooding issues)
- DEQ Stormwater Local Assistance Fund – Water quality projects including stream restoration that can preserve and restore floodplain areas and provide for other improvements.
- FEMA Hazard Mitigation Grant Program – Allows for acquisition of highly flood prone property and other related projects to reduce flood hazards.
- FEMA Building Resilient Infrastructure and Communities program – Allows for various projects that reduce flood risk through a wide range of project types.
- DCR CFPF grants - Allows for a wide range of projects to reduce flooding and increase resilience.

The fee itself is based on the total amount of impervious cover on a given parcel and the fee structure also includes a credit system which allows fee payers to reduce their annual fee by implementing flooding or water quality best practices on their parcel. The credit program and outreach and education efforts can lead to reductions in runoff that can become significant as these practices become accepted/adopted in the community.

In general, the structure of the fee and the operations of the Stormwater Utility is consistent with the five key principles provided in this document, and it is likely that most of the proposed flood resilience work will be carried out by staff in the Utility. The Utility’s operating budget is reviewed as part of the City’s annual budget adoption process. The operating budget is based on expected revenues and services needed to meet regulatory requirements, debt service and overarching City goals.

The Utility’s capital improvement program identifies large construction type projects, such as those listed in Section 6.4, that will be undertaken in a five-year window. The CIP outlines expected capital expenditures over the five-year window and the projects that are expected to be executed. The operating budget and CIP are both reviewed and approved by City Council.



As noted earlier in this plan, the backlog of stormwater related projects is substantial. To advance the City’s vision of flood resilience. A holistic approach to managing stormwater runoff and improving flood resilience must be holistic. Projects, to the extent possible need to address multiple facets of stormwater management/flood resilience and be developed in a way that supports broader community growth as illustrated in the figure below. This mindset recognizes that there are often multiple engineering solutions to a problem. The methods that best addresses broad community objectives should be pursued.

## Holistic Approach to Project Delivery

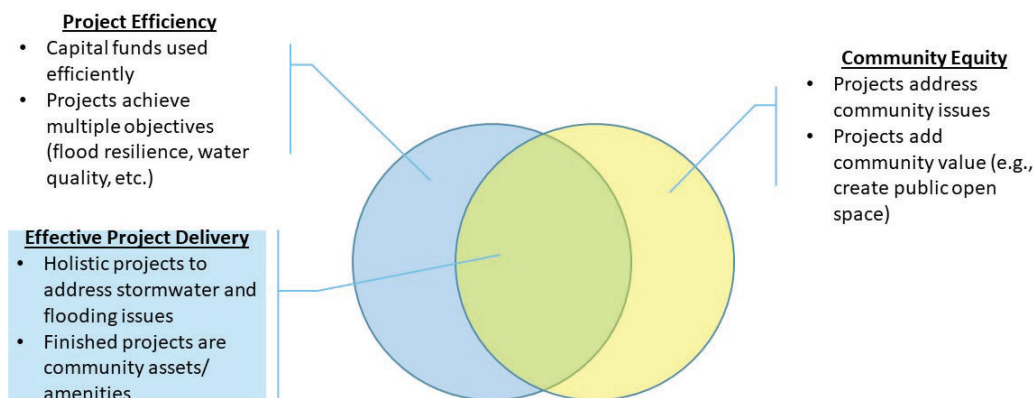


Figure 9 – City of Roanoke approach to Project Delivery.

### 6.6 GAP ANALYSIS

Based on the City’s vision and current efforts there are some logical next steps that can be considered. These efforts are outlined in the Table below with more specific recommendations in the following section. Generally, these gaps and next steps are logical extensions of implementing the recently adopted City Plan 2040, continuing to assess likely impacts of climate change and how that influences City programs and continuing to move forward with holistic stormwater projects to reduce flood risk.

Current Efforts	Gaps	Potential Actions
Plans	<ul style="list-style-type: none"> <li>City Plan 2040 and related planning documents outline broad strategies to increase flood resilience. Specific implementation steps need to be developed.</li> </ul>	<ul style="list-style-type: none"> <li>Studies to define mechanisms to balance floodplain and riparian area preservation/restoration with urban development patterns and identify programmatic updates.</li> </ul>

Current Efforts	Gaps	Potential Actions
Practices and Programs	<ul style="list-style-type: none"> <li>Monitoring efforts are ongoing with USGS and others. Identify means to use data for local predictions and decision making.</li> <li>Watershed master plans completed for some watersheds, not all and currently do not incorporate climate change.</li> <li>Assess outreach efforts for usefulness for all segments of the community.</li> </ul>	<ul style="list-style-type: none"> <li>Continue working with partners (USGS, etc.) on predictive data tools and tailored decision making based on local data.</li> <li>Continue to evaluate flood resilience best practices through the CRS program and programs of other localities and agencies.</li> <li>Complete watershed master planning process for the City including assessment of climate change impacts.</li> <li>Continue outreach efforts that maximize impact and usefulness for all segments of the community.</li> </ul>
Regulations	<ul style="list-style-type: none"> <li>Regulations generally derive from state code requirements. These state codes currently do not account for climate change/increased rainfall/flooding.</li> </ul>	<ul style="list-style-type: none"> <li>Assess options for accounting for climate change in regulatory programs balancing current and future costs and impacts.</li> </ul>
Projects	<ul style="list-style-type: none"> <li>The City implements a wide range of infrastructure and other projects that can benefit flood resilience, ensure strategies are in place to program work in the Capital Improvement Program and have flexibility to take advantage of unexpected opportunities.</li> </ul>	<ul style="list-style-type: none"> <li>Continuous assessment of ranking and selection criteria to ensure projects that have the most impact are implemented (multiple benefits for flooding, water quality, etc. And for impact on vulnerable communities)</li> <li>Develop CIP to allow some flexibility to adapt to opportunities to address resilience (need funding sources, opportunities to partner with other entities, etc.)</li> </ul>
Funding	<ul style="list-style-type: none"> <li>The backlog of stormwater management and flood resilience work is substantial compared the City's annual maintenance and capital budgets.</li> </ul>	<ul style="list-style-type: none"> <li>Continue to assess project selection and scoping to maximize project value.</li> <li>Assess a variety of funding sources to leverage City funds.</li> <li>Look at programs and partnerships to ensure that development activities and day-to-day maintenance of property aligns with City efforts.</li> </ul>

## **7. RECOMMENDED PROJECTS FOR FLOOD RESILIENCE**

In this final section, studies, planning efforts and capital projects are proposed that will advance the City's existing efforts towards flood resilience consistent with the five key principles designated in this plan.

### **7.1 IDENTIFIED PLANS STUDIES AND PROJECTS**

Several studies, plans and projects to improve the City's flood resilience are already identified and are listed in the summary table of projects describing the project and flood resilience benefits in general terms. Each project is evaluated against the five key resilience principles from this plan, and a cost opinion and estimated timeframe for each project is provided.

Proposed studies and planning efforts are based on broad recommendations from existing City policy, largely from City Plan 2040, that can be further developed into actionable measures. These studies and planning efforts may be funded through annual operating budget with potential support funds from grant sources.

Proposed projects include those specifically identified in the current Capital Improvement Plan (CIP) as well as other efforts that are more general. These general items include funds that are programmed for acquisition of flood prone properties and for green infrastructure work that can be incorporated as part of the City's annual street paving program (repaving), streetscape projects (construction of new curb, gutter and sidewalk), or other capital projects (e.g., new building construction).

### **7.2 INCORPORATING NEW PROJECTS, PLANS AND STUDIES**

Much of resilience relates to being best prepared for events that can happen unexpectedly. While the City carefully plans its funding, unexpected opportunities do present themselves that need responses. Such items could include new project priorities identified in watershed plans, unexpected issues that arise that are not programmed into a capital program, an owner of a highly flood prone property that is willing to sell, or simply an opportunity to build flood resilience efforts into another effort or project. In these instances, the City needs to be prepared to assess these opportunities and act as appropriate. The following tables provide decision trees for assessing the type of work that may make sense and determining if the work is urgent or represents an opportunity that warrants a timely action or if the project should be ranked and programmed with other capital projects.

The following graphics provide guidance on how a new project can be assessed for programming into the City's CIP or considered for a quicker action when the opportunity to address an issue arises unexpectedly. The first tool (Figure 10) is decision tree for project screening and the second tool helps define when different approaches to a project can be considered.

## Flood Resilience Project Decision Tree: Evaluation of Potential Projects

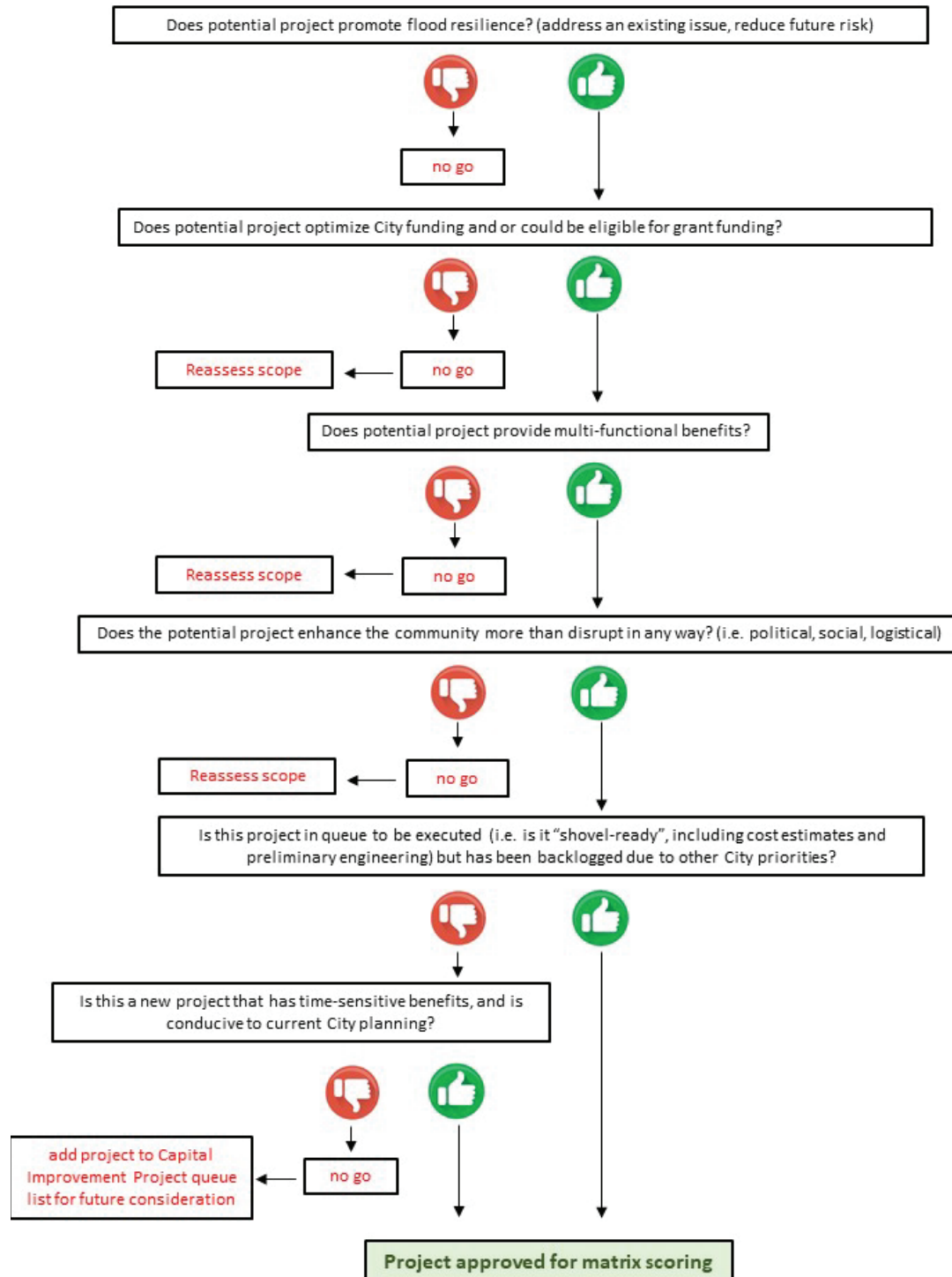


Figure 10 – Decision tree for guidance on how projects could be assessed for programming and City action.

### Potential Project Scoping Decision Tree for Flood Resilience

Project Type	Evaluation Criteria	Descriptors
<b>Acquisition and Demolition</b>	Description	<ul style="list-style-type: none"> <li>Acquisition of property with the intent of demolishing existing structures</li> </ul>
	Applicability	<ul style="list-style-type: none"> <li>Typically for areas of riverine flooding, may apply to other property with major drainage issues</li> <li>Highly flood prone, protection/adaptation not feasible</li> </ul>
	Other factors	<ul style="list-style-type: none"> <li>Potential for use of site after demolition – open space or possible reuse</li> </ul>
	Who initiates Description	<ul style="list-style-type: none"> <li>Property owner or City may initiate a request</li> <li>Acquisition likely by City when use is for open space</li> <li>City or a private entity may initiate acquisition if there is a reuse option.</li> </ul>
<b>Land Preservation and/or Restoration</b>	Description	<ul style="list-style-type: none"> <li>Acquisition of property or easement to protect open space that is valuable for future flood resilience</li> </ul>
	Applicability	<ul style="list-style-type: none"> <li>Typically for areas of riverine flooding</li> <li>Highly flood prone</li> <li>High environmental value (flood plain or riparian area)</li> <li>Low development/economic value (high risk)</li> </ul>
	Other factors	<ul style="list-style-type: none"> <li>If structures are present, consider demolition if high risk or possible preservation if adaptation or protection is feasible.</li> <li>Hybrid option could allow for preservation of high risk/high environmentally valuable areas while the balance of the property remains available for appropriate development.</li> <li>Availability of nearby land to support community needs</li> </ul>
	Who initiates	<ul style="list-style-type: none"> <li>Acquisition likely by City</li> <li>Easement would be initiated by a land holder through the City or a third party.</li> </ul>
<b>Adaptation and Protection</b>	Description	<ul style="list-style-type: none"> <li>Includes a range of measures to protect new or existing structures from flooding/reduce the risk from flooding</li> </ul>
	Applicability	<ul style="list-style-type: none"> <li>Existing flood prone structures that have historic, economic or cultural value.</li> <li>New facilities that are constructed in flood prone areas in a manner to minimize risk</li> <li>Other structures that can be reasonably adapted to reduce flood risk.</li> </ul>



Project Type	Evaluation Criteria	Descriptors
	Other factors	<ul style="list-style-type: none"> <li>• Incorporation of protections that consider historic characteristics of a building</li> <li>• Maintaining neighborhood character/appeal</li> </ul>
	Who initiates	<ul style="list-style-type: none"> <li>• Typically building owner or developer to comply with development regulations, to reduce risk, and/or reduce insurance costs.</li> </ul>
<b>Green Infrastructure</b>	Description	<ul style="list-style-type: none"> <li>• A wide range of practices for encouraging infiltration and/or collection and reuse of stormwater. Measures can range from a rain barrel to park land that functions as a stormwater facility</li> </ul>
	Applicability	<ul style="list-style-type: none"> <li>• Scalable based on the space available and intended result</li> <li>• Work well in a compact, urban areas where space is at a premium</li> <li>• Protect existing infrastructure from increasing flows/reduce pollutant loads</li> </ul>
	Other Factors	<ul style="list-style-type: none"> <li>• Can be incorporated as part of most development projects when planned</li> <li>• Details of implementation can be tailored to preferences of immediate neighbors/community</li> <li>• Routine maintenance required to maintain function.</li> <li>• Can be designed to serve multiple functions (e.g., public space, landscape/aesthetics)</li> </ul>
	Who initiates	<ul style="list-style-type: none"> <li>• City as part of public infrastructure and public facilities</li> <li>• Property owners as part of development projects or retrofits</li> </ul>
<b>Grey Infrastructure / Traditional Civil Engineering Practices</b>	Description	<ul style="list-style-type: none"> <li>• Traditional storm drainage facilities such as pipes, ditches and basins.</li> </ul>
	Applicability	<ul style="list-style-type: none"> <li>• Issues related primarily to capacity and volume.</li> <li>• Drainage problem that can be readily solved by connecting to an existing storm drain system (e.g., adding an inlet along an existing drain)</li> <li>• Undersized infrastructure causing property damage</li> <li>• Tight spaces limit other options.</li> </ul>
	Other Factors	<ul style="list-style-type: none"> <li>• Upsizing infrastructure can exacerbate downstream drainage issues/flooding</li> </ul>
	Who initiates	<ul style="list-style-type: none"> <li>• Generally, city initiated to address drainage issues.</li> <li>• Can be part of development or redevelopment projects</li> </ul>

Table 4: Summary of Recommended Projects – LF = linear feet, ac = acre

Project	Description and Flood Resilience Benefits	Flood Resilience Principles	Cost Opinion	Estimated Timeframe	Priority
<b>Capital Projects</b>					
<b>Acquisition and Demolition</b>					
Peters Creek Rd. NW & North Rd. NW (PC-4)	Mitigate floodway structures through acquisition and demolition or relocation. Acquisition, abatement, and demolition of 7 structures and 1 outbuilding. All floodway properties. Large scale floodplain benching and riparian planting in the 3.5-acre open space.	1, 2, 3, 4, 5	\$1,481,385	Potential	Score: 65
<b>Land Preservation and Restoration</b>					
Ore Branch Stream and Site Restoration	350 LF of stream restoration using natural channel design; 2.4 acres of pollinator meadow, tree plantings. Increase floodplain storage capacity; improve green space, tree canopy, stream ecology	1, 2, 3, 4, 5	\$830,000	FY 2025	Score: 65
Garnand Branch Stream Restoration	1,000 LF of stream restoration using natural channel design; Increase floodplain storage capacity; improve green space, tree canopy, stream ecology; reduce stream bank erosion	1, 2, 3, 4, 5	\$1,305,000	FY 2025	Score: 70
Peters Creek at Strauss Park Stream Restoration	2,100 LF of stream restoration using natural channel design; Increase floodplain storage capacity; improve green space, tree canopy, stream ecology; reduce stream bank erosion	1, 2, 3, 4, 5	\$2,600,000	FY 2028	Score: 75
Countryside Riparian Buffer	1,200 LF of riparian buffer invasive species removal and tree planting along Lick Run within City-owned Countryside property, consistent with Countryside Master Plan	1, 2, 3, 4, 5	\$75,000	Early Concept	Score: 70
<b>Green Infrastructure</b>					
Campbell Avenue Upper Watershed Improvements	Identify, design and build a combination of small detention storage, bioretention, permeable pavement, underground storage along Campbell Ave. west of Downtown to mitigate Downtown flooding at 25-yr. flood.	1, 2, 5	\$9.5M	2030	
Luck Avenue Upper Watershed Improvements	Identify, design and build a combination of small detention storage, bioretention, permeable pavement, underground storage along Luck Ave. and Franklin Rd. south of Downtown to mitigate Downtown flooding at 25-yr. flood	1, 2, 5	\$21M	2035	
Melrose Avenue Crossing Improvements	Study flooding at Melrose Ave @ Forest Park Blvd; design and build combination of detention storage, culvert upsizing, stream restoration to reduce roadway flooding and structure damages	1, 2, 3, 5	\$3M	FY 2026	Score: 75
Moorman Avenue/Trout Run Green Infrastructure	Work with Gilmer and Harrison neighborhoods to identify projects along Trout Run to complement an upcoming streetscape project along Moorman Avenue. The streetscape itself will include bioretention areas and new trees. Additional work could include day lighting parts of Trout Run and restoring portions of the floodplain/creating public spaces.	1, 5	\$2-5M	2030	
Annual Green Infrastructure Projects	Install bioretention bump-outs; tree lawns and other green infrastructure coincident with annual street paving and streetscape projects; increase flood storage, improve water quality	1, 2, 3, 5	\$500K/yr.	Annual	Score: 75
<b>Gray Infrastructure/Traditional Engineering Practices</b>					
Salem Ave. & 1st Street "L-Tunnel"	Upsize 15 – 36" storm drain to 4'H x 6'W rectangular tunnel to reduce flooding in Downtown at 25-yr flood. Improve maintenance access; move primary drainage from present location underneath existing building.	1, 5	\$2.0M	FY2024	Score: 60
Trout Run Watershed Detention Storage	Identify, design and build approximately 81 acre-ft of detention storage in Trout Run watershed; project will significantly mitigate Downtown risk at 25-yr flood; improve water quality; incorporate nature-based strategies	1, 5	\$45M	2030 - 2050	
Shenandoah/Jefferson Diversion Tunnel	Divert runoff around core of Downtown by constructing 1,000 LF of new storm drain tunnel and repurposing existing pedestrian tunnel; mitigate Downtown risk at 25-yr. flood	1, 5	\$12M	2025-2030	
Downtown Tunnel Operations Upgrades	Install nine oversized maintenance access vaults with sump pits at key hydraulic locations in Downtown tunnels to allow for safe entry and periodic removal of sediment, trash and other debris.	1, 5	\$4.2M	2030	
Peters Creek Rd. NW & North Rd. NW (PC-4)	Mitigate floodway structures through acquisition and demolition or relocation. Acquisition, abatement, and demolition of 7 structures and 1 outbuilding. All floodway properties. Large scale floodplain benching and riparian planting in the 3.5-acre open space.	1, 2, 3, 4, 5	\$1.5M	Potential	Score: 65
<b>Technical Studies and Programmatic Approaches</b>					
Watershed Master Plans	City wide master planning to replace original, individual watershed planning. City-wide master planning takes in account USGS and Virginia Tech research. Focusing on processes and project types that can applied to all watersheds. Effort may be coordinated with Neighborhood Planning efforts to evaluate land use, etc.	2, 3, 5	\$80,000	Potential	Score: 75
Evaluation of Floodplain, Riparian Buffer and Other Land Preservation Practices	Evaluate flood prone lands across the City including floodplains and associated riparian buffers to assess a range of practices to preserve and/or restore such areas, where possible. The study would consider various economic impacts and land use and development practices to support flood reduction through the beneficial effects of managed flood plains and buffers and balanced needs of our urban community. Evaluate the economic, social, and environmental impacts and potential hydrologic effects of applying different land conservation policies.	2, 3, 5		Potential	Score: 75
Evaluate Predicted Precipitation and Design Practices and Standards	Evaluate predicted rainfall and determine how that impacts our current design standards, practices and regulatory programs. Identify options to consider for how those standards, practices and programs can be updated so that planning efforts, infrastructure and development is resilient considering future rainfall and flood potential. The effort could include a review of the City's infrastructure to assess bottlenecks and flood potential under increased	5			Score: 70

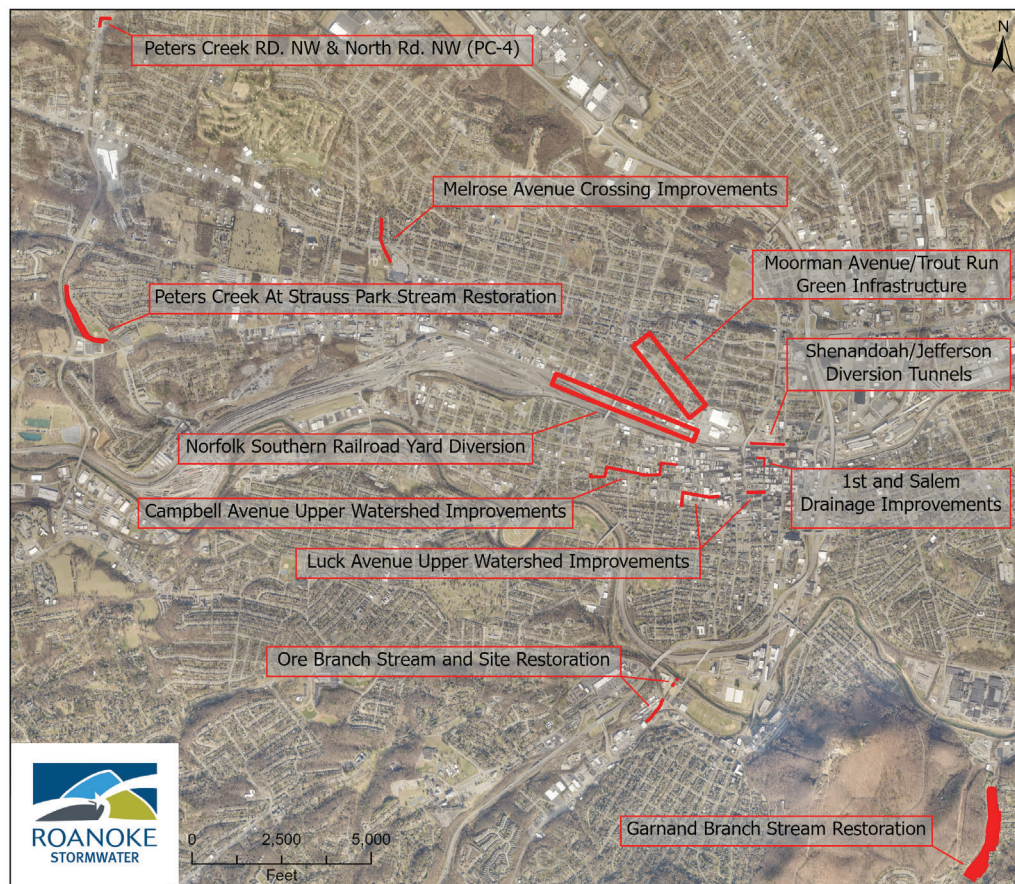
	rainfall to further assist in decision making with infrastructure and development. The study could provide an economic evaluation of short-term cost of improvements compared to long-term costs associated with increased rainfall and flooding.				
Evaluate Land Management/Green Infrastructure Strategies	Evaluate the costs and benefits of strategies that can be used to minimize impervious surface while encouraging resilient, compact urban development in the City. The evaluation would look at options to encourage use of applicable practices and would cover a wide range of actions from increasing tree canopy to various urban BMPs based on natural processes or collection and reuse of harvested water. The study would look at example programs in other jurisdictions and how they were implemented.	2, 3, 5			Score: 70
Review Stormwater Utility Fee Credit Program	Evaluate the utility fee structure to determine if the credits reward efforts that provide the most benefits for water quality and runoff reduction. In particular credits for the protection/restoration of riparian buffers or conversion of paved surfaces and manicured lawns to natural cover (land cover conversion).	2			Score: 70

\*DCR Criteria: (1) Project-based, focused on flood control and resilience; (2) Incorporates nature-based infrastructure; (3) Enhances social equity; (4) Includes local and inter-jurisdictional coordination and a schedule; (5) Based on climate change science.

\*\*In Progress indicates a project has already been approved by the City and is in various stages of completion: planning, design, or construction.

### 7.3 CONSTRUCTION PROJECTS

There are several specific construction projects evaluated in this plan. These projects advance the City's flood resilience goals and are already identified in the Stormwater Utility's capital improvement program and/or in watershed master plans. New projects are regularly identified based on watershed studies, resident complaints, opportunities to collaborate on other City projects etc. This section provides more detail on currently identified resilience projects and further describes how future projects will be assessed for feasibility/inclusion in the Resilience Plan and the City's capital improvement program/processes.



**Figure 11 – Map of projects currently identified for resilience. Summary of each project in Section 7.1.1.**

#### 7.1.1 Existing Construction Projects that Advance Resilience Objectives

##### **Demolition/Acquisition**

###### *Peters Creek Rd. NW & North Rd. NW (PC-4)*

Peters Creek is subject to flash floods and repetitive losses at Peters Creek Road, NW and North Road, NW, an area with moderate to high social vulnerability. Peters Creek has 26.9% tree canopy and very few parks and greenways to help absorb floodwaters. There are 9 commercial structures, including a car repair business, located in the 100-year floodplain (1% annual chance flood), and at least one business has closed due to flooding in this

area. At least one privately owned building has a connected structure that is dangerously close to an eroding stream bank. A nearby City-owned Fire/EMS facility is also affected by flooding.

The City plans to seek funding to mitigate floodway structures through acquisition and demolition or relocation. Acquisition would allow for future floodplain benching and riparian planting in a 3.5-acre open space. A gray infrastructure project is proposed at the 1600 block of Peters Creek and North Road to upsize the existing drainage system and relocate new inlets at ponding locations and recreate the roadside ditch along North Road to maximize runoff capture. This project is in the preliminary design phase and no project date has been established yet. Note - The City is currently underway on a project just upstream of this area which will increase floodplain storage capacity and ecological function in the area north of the confluence of Peters creek and Tributary B.

## **Preservation and Restoration**

### *Ore Branch Stream and Site Restoration*

Ore Branch is a flood-prone river, and Wiley Drive is a flood-prone road in an area with low to moderate social vulnerability. Stream and site restoration on Ore Branch, upstream of Wiley Drive, will support flood protection efforts, reversing some of the negative effects of development on biodiversity and downstream receiving waters. The riparian corridor improvements will add additional tree canopy, greenspace, and improved habitat for terrestrial and aquatic species. To help reduce repetitive flooding, the project includes the purchase and demolition of the former Ramada Inn. The project will cost \$830,000 and is planned for Fiscal Year 2025.

### *Garnand Branch Stream Restoration*

Garnand Branch is a flood-prone river in the Roanoke River watershed in an area with moderate social vulnerability. The stream restoration project will repair current and reduce future channel erosion, eliminate slope failures of the stream banks, reestablish native vegetation along the riparian edge, and restore floodplain connection to the previously acquired floodplain lots. The project will help alleviate the frequent flooding in Garden City Park and along the Garden City Greenway, both located along Garnand Branch. The current project will cost \$1,305,000 and is planned for Fiscal Year 2024-2025.

### *Peters Creek At Strauss Park Stream Restoration*

Peters Creek is a flood-prone river with a repetitive loss area located just downstream of Strauss Park. The stream restoration project will increase flood capacity and help alleviate flooding in an area with medium to high social vulnerability. The project helps achieve the recommendations in the Peters Creek watershed management plan, which call for stream projects that provide flood mitigation and water quality benefit to add flood storage and mitigate flash flooding, reduce bank erosion, and improve overall stream function. This project will restore and protect important environmental assets in a watershed that has only 26.9% tree canopy and is somewhat lacking in greenways and parks other than Strauss. Construction on this project is planned for Fiscal Year 2028.

## **Green Infrastructure:**

### *Campbell Avenue Upper Watershed Improvements*

In this project, “green streets” are proposed in the West End Neighborhood extending into Downtown. This upper watershed project will alleviate localized flooding in West Ene (10<sup>th</sup> and Campbell), detain runoff and then tie into an existing 36” RCP along Rorer Avenue SW. This potentially includes a detention basin (7.0 acre-feet) in the vicinity of the former fire station at Rorer Avenue SW and 6<sup>th</sup> Street SW, and a smaller detention basin (2.6 acre-feet) at the intersection of Patterson Avenue NW and 8<sup>th</sup> Street SW. The combination of “Green



Streets” from 10<sup>th</sup> Street SW to 6<sup>th</sup> Street SW includes permeable pavement, curb extensions with bioretention, and street trees with check dams under the pavement to detain peak discharges from the upper watershed for Campbell Avenue, thereby reducing peak discharges in the Roanoke CBD downstream. This project also provides substantial water quality and runoff reduction benefits as a demonstration project for Green Streets in the City of Roanoke, and it can be integrated into planned corridor enhancements for this neighborhood plan. The project budget is estimated at \$9.5M

#### *Luck Avenue Upper Watershed Improvements*

In this project, detention of stormwater runoff is proposed in three locations identified as flood prone areas within the upper watershed for Luck Avenue. This includes detention (5.6 acre-feet) centered on the city parking lot across the street from the YMCA and along 5<sup>th</sup> Street between Luck Avenue and Marshall Avenue, where detention is provided by permeable pavement with a series of concrete vaults underneath. It also includes detention in two private parking lots and 2<sup>nd</sup> Street, centered on Luck Avenue, where detention (13.25 acre-feet) is provided by permeable pavement with a series of concrete vaults underneath. It also includes detention near Elmwood Park on S. Jefferson Street, where storage is provided by underground vaults and by converting a turf grass plaza into a combination of bioretention basin and pervious concrete sidewalks (4.07 acre-feet). Details will need to be evaluated based on availability of property, need for phasing and adapting to site specific details. The primary benefit of this project is to detain peak discharges from the upper watershed for Luck Avenue, thereby reducing peak discharges into Downtown itself. This project also provides water quality and runoff reduction benefits through permeable pavement and bioretention areas for treating local runoff. The project budget is estimated at \$20.1M.

#### *Melrose Avenue Crossing Improvements*

This previously identified project aims to reduce repetitive flooding in areas with medium to high social vulnerability by increasing culvert size and improving channel conditions up and down stream of Melrose Avenue at Hortons Branch. Specifically, this Capital Improvement Project will increase flow capacity under Melrose Ave. The existing 6' x 3' concrete box culvert and upstream and downstream channels are not adequate to convey stormwater that concentrates in these areas. There are signs of bank erosion and undercutting. Several homes experience flooding upstream of Melrose Avenue due to the backwater from the undersized culvert. Any culvert capacity modifications associated with this project should include a careful assessment of the capacity at the downstream end of the open channel section of Horton Branch to ensure that flooding of the neighboring development (Goodwill, library, etc.) is not exacerbated. This project may also provide a unique opportunity for enhanced education and outreach due to the advocacy and participation by a local Kiwanis club.

#### *Moorman Avenue/Trout Run Green Infrastructure*

Short-term work with the with Gilmer and Harrison neighborhoods to include green infrastructure elements in the Moorman Avenue streetscape project such as bioretention areas and new trees. Longer-term effort includes working with the communities to look at flood reduction effort s along Trout Run, which generally parallels Moorman Avenue. Additional wok could include day lighting parts of Trout Run and restoring portions of the floodplain/creating public spaces.

#### *Annual Green Infrastructure Projects*

This activity involves assessing annual streetscape (additions of sidewalk, curb and gutter to existing streets) and repaving programs to identify opportunities for green infrastructure elements such as bioretention bump-outs, tree lawns, bioswales and other urban infiltration practices. These measures can be installed cost-effectively as part of large street projects. In addition to providing flood storage and improved water quality, they can also provide public gathering spaces.



## **Gray Infrastructure**

### *1<sup>st</sup> and Salem Drainage Improvements*

The 1<sup>st</sup> and Salem Drainage Improvements project is the first of several proposed projects designed to reduce flooding in Downtown Roanoke. The project includes upsizing existing 15 – 36” diameter storm drainpipes to 4’ H x 6’ W tunnels, using an alignment that is more hydraulically efficient and that directs flow away from existing structures. The project, by itself, is designed to reduce flood depths in the area by approximately 6” during the 25-year flood and will also improve maintenance access to the downtown stormwater tunnels to assure that the pipes continue to flow as designed. (Future projects will detain and/or divert water upstream to further reduce flooding as they are implemented.) The proposed work will also include improvements to the aging water mains within the project footprint in order to provide additional benefits to the community with a single project.

### *Shenandoah/Jefferson Diversion Tunnels*

The primary benefit of this project is to divert flow from the Trout Run watershed away from the Norfolk Tunnel at the Warehouse Row diagonal tunnel and convey runoff further downstream in the new tunnel before tying back into the Norfolk Tunnel at N. Jefferson Street. The new diversion tunnel will tie into the tunnel that was previously used by the Hotel Roanoke to provide pedestrian access downtown, below the Norfolk Southern railroad tracks. The second part of this project includes a new 20’ x 16’ junction box over the Norfolk Tunnel in the alley behind Warehouse Row for improved access to the existing Norfolk Tunnel. The work will remove accumulated sediment and debris from the tunnels in that area and plug a broken weir wall that previously restricted runoff into the diagonal tunnel going towards Salem Avenue. The project is anticipated to be built entirely within city rights of way (city streets) except where it crosses under the NS railroad yard. In order to coordinate the shared use of the existing pedestrian tunnel at N. Jefferson Street to convey stormwater runoff, an access agreement will need to be acquired from the WVWA outlining construction modifications to the tunnel and long-term maintenance responsibilities for each party. The project budget is estimated at \$4.6M.

### *Norfolk Southern Railroad Yard Diversion*

In this project, two sediment basins are proposed to be constructed on railroad property to help collect runoff from the surrounding tracks in the railroad yard. The primary benefit of this project is to divert flow from the railroad yard to the CCBC detention basin. The sediment traps in the railroad yard at the upstream end of the pipe diversion will help reduce downstream maintenance needs in the 66” RCP and the CCBC detention basin from the railroad runoff. The project budget is estimated at \$4.3M.

### *Maintenance Access Upgrades*

In this project, nine (9) new junction boxes are proposed to provide the city with better access to the existing tunnels for inspections and maintenance work. These junction boxes range in size from 8’x8’ to 20’x20’, and are proposed within city rights-of-way, where they were positioned initially to minimize potential utility conflicts. In some cases, associated traffic impacts might require the junction boxes to be offset into sidewalk areas, side streets or on-street parking spaces to allow to the city to best maintain traffic during construction. The primary benefit of this project is to provide the city safer and easier access into their existing stormwater system. The project budget is estimated at \$4.2M.

## 7.4 TECHNICAL STUDIES AND PROGRAMMATIC APPROACHES

### *Watershed Master Plans*

Watershed Master Plans (WMPs) have been developed for the Lick Run, Tinker Creek & Tributaries (Carvin Creek, Glade Creek, and Lick Run-Norfolk Southern), Trout Run, and Peters Creek watersheds. The City plans on seeking funding to help complete WMPs for the remaining watersheds that will include Roanoke River, Back Creek, Ore Branch, Murray Run, Mudlick Creek, Murdock Creek, Barnhardt Creek, and Mason Creek watersheds. WMPs should ensure watershed boundaries are consistent (e.g., Lick Run, Lick Run – Norfolk Southern) in future analyses.

The City would conduct the GIS mapping and asset inventory necessary for determining:

- Where the critical environmental assets are and the linkages to stormwater infrastructure.
- Determine where bottle necks currently exist in drain systems or where they may exist in the future.

A complete set of WMPs would enable the City to take a more comprehensive look at environmental assets at the watershed scale and identify opportunities for mitigation and protection, particularly in areas with high social vulnerability. As more WMPs are developed, the findings and recommendations should be incorporated into this Resilience Plan.

The City's process of prioritizing flood resilience projects could incorporate the SVI or other similar metrics, as projects in this area would likely yield a larger improvement in flood recovery capability per dollar of investment than the same project in a less vulnerable area. **This principle is consistent with the City's definition of Equity – that different groups have different needs and should be provided services determined by their needs<sup>19</sup>.**

### *Evaluation of Floodplain, Riparian Buffer and Other Land Preservation Practices*

This project would evaluate floodplains, riparian buffers and other land preservation practices throughout the City to determine their potential for preserving or improving natural and beneficial effects of floodplains and buffers. The resulting baseline would help the City prioritize enhancement and restoration projects, aimed at improving the ability of floodplains to spread out and slow down floodwaters during heavy precipitation and storm events, thus reducing downstream erosion. This is one of the least expensive and most effective ways to increase flood resiliency. The data would also be used to focus floodplain improvements in areas with repetitive flood loss and socially vulnerable areas.

This effort could also assess the potential property and economic, social, and environmental impacts of the expanding the River and Creek Corridor (RCC) Overlay District in the City's Zoning ordinance. The RCC requires preservation of riparian buffers along the Roanoke River and certain portions of some tributaries. The study would evaluate the number and extent of impacts to existing properties, including the extent of the drainage network that would be affected. The study would evaluate the costs and benefits of extending protections of the RCC and could explore policy changes or incentives to offset economic effects.

The City could also seek funding to evaluate the economic, social, and environmental impacts and potential hydrologic effects of applying other land conservation policies. The City would identify various models implemented in other localities and consider the impacts of applying them to the City of Roanoke.

### *Evaluate Predicted Precipitation and Design Practices and Standards*

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<sup>19</sup> See City Plan 2040 | Themes: Interwoven Equity - <https://planroanoke.org/interwoven-equity/>

The City understands the upward trend in the severity of precipitation events and the associated impacts that such storms will likely have in exacerbating flooding problems. The NOAA MARISA (Miro et al., 2021) updated IDF Curve Data Tool provides the City with an opportunity to evaluate the impacts of using this new tool on stormwater management and design. The City would use future funding to evaluate the cost of implementation on existing infrastructure versus maintenance upgrades and assess potential impacts to downstream channel stability. This work would also assess how to use and/or supplement or monitoring networks to support decision making. The study could also include a review of the City's infrastructure to assess bottlenecks and flood potential under increased rainfall to further assist in decision making with infrastructure and development. The study could provide an economic evaluation of short-term cost of improvements compared to long-term costs associated with increased rainfall and flooding.

#### *Evaluate Land Management and Green Infrastructure Practices*

Evaluate the costs and benefits of strategies that can be used to minimize impervious surface while encouraging resilient, compact urban development in the City. The evaluation would look at a range of practices that can be used to reduce runoff and that can be incorporated into various City standards and programs. These could range from increasing tree canopy to various BMPs based on natural processes or harvesting of rainwater for collection and reuse. The study would look at example programs in other jurisdictions and how they were implemented.

This effort would consider two factors in how the existing housing stock or commercial properties could be further protected from flood risk

1. Assess how future development of residential land can incorporate flood resilience into development plans.
2. Balance land use and development policy between acquisition of highly flood prone property for conservation while encouraging development in other areas to provide needed housing.

#### *Review Stormwater Utility Fee Credit Program*

The City recognizes the importance of native meadow and forested tracts to flood resilience. Research has quantified the decreased level of absorption and filtering associated with turfgrass relative to native meadow or forested conditions. The City may consider adoption of a stormwater utility credit for land conversion in order to maximize the potential benefits to flooding and stormwater system performance. The City would seek funding to evaluate the utility fee structure impacts and hydrologic effects of such measures

#### *Evaluate Land Preservation Protections*

The City's current credit manual was developed in 2014 and 2015 leading up to the creation of the Stormwater Utility. There have been no substantive changes since that time. As flood resilience strategies are developed, it is appropriate to review the types of work that should be eligible for fee credits – making sure the City incentivizes/rewards the most valuable activities. These credits should focus on runoff reduction and preservation of critical spaces (floodplains and riparian areas). In particular credits for the protection/restoration of riparian buffers or conversion of paved surfaces and manicured lawns to natural cover (land cover conversion).

## **7.5 ADDITIONAL CONSIDERATIONS**

#### *Robust Measurement of Social Vulnerability*

Realizing the variability in social vulnerability findings, greater equity may be achieved by using a more robust social vulnerability model to determine priority in the scoring matrix. The Resilience Plan presents a model combining data from three different models (Social Vulnerability Index, EPA EJSCREEN, FEMA National Risk

Index) to determine the overall level of social vulnerability, whereas the DCR's Adopt VA Social Vulnerability Index used to ascertain a score in the ranking matrix relies on a modified version of one model (Social Vulnerability Index). Though the DCR model is valid, incorporating all available data sets into a single model strengthens findings and minimizes those weaknesses inherent to a single dataset. Therefore, when determining the level of social vulnerability and corresponding weight in the future, the City recommends a shift toward using the model applied in **Section 3** of this Resilience Plan.

#### *Enhance Project Selection Tools*

To create equal evaluation and ranking for resilience projects, the Resilience Plan relies on established criteria and suggested weighting for the project selection matrix. Future efforts may find that additional local constraints or criteria would be beneficial to include in the project selection process. As the City continues to advance resilience efforts, staff would periodically consider the need for Resilience Plan updates and modifications to the project selection matrix to more effectively evaluate and rank projects in a way that prioritizes broader resilience, going beyond flooding and drainage to incorporate other social, economic, and environmental factors.

#### *Increase Inter-departmental Coordination*

For nearly a decade the City of Roanoke has had a designated funding stream for stormwater-related projects. Though funding allocations are now more predictable, the need for coordination between City staff remains critical. Often storm drainage improvement projects create opportunities for improvement in other facets of City management. For example, neighborhood drainage improvements made to reduce localized flooding may also allow for road resurfacing. The opposite is also true. Road improvements may create opportunities for enhanced stormwater management (e.g. the addition of street trees, roadside water quality treatment areas, etc.). Quarterly meetings between department management where upcoming project schedules and scope are discussed could help avoid misaligned implementation (i.e. damage to recently installed infrastructure by work from another department) and promote mutually beneficial projects.

#### *Consider Programs to Incentivize Improvements to Increase Flood Resilience*

City Plan 2040 promotes the idea of green convenience, making it easy for residents and businesses to take actions that improve our environment. The City's Repetitive Loss Area Analysis contemplates creating a program to assist residents with making improvements to make their homes or businesses more resilient. As public infrastructure projects will not quickly address flood resilience for the entire community, flood resilience efforts should work to furnish flood prone small and mid-sized local businesses with resources to reduce risk and improve recovery, particularly in areas of high social vulnerability.

The City could assess options for assisting homeowners and businesses in evaluating and supporting projects that improve flood resilience and reduce flood risk in the community. Ideally, such a program would leverage state or federal funding to support resilience efforts of residents and business owners and work to furnish flood prone small and mid-sized local businesses with resources necessary to sustain operations during and after flood events. This strategy is especially important for businesses that lie in areas of high social vulnerability.

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## APPENDIX A – DCR CROSSWALK

This crosswalk is developed to assist with review of this flood resilience plan for completeness with the City's grant application. The plan elements included in the below table are based on the grant application submitted in the 2021 Community Flood Preparedness Fund grant round.

Plan Element	Plan Location	Notes
Acknowledge climate change and its consequences, and base decision making on the best available science	Section 2.3 Climate Change  Chapter 5 Principles of Flood Resilience	The plan focuses on 5 key principles, one of which is climate change.
Identify and address socioeconomic inequities and work to enhance equity through adaptation and protection efforts	Chapter 3 People, Land, Economy, Equity  Chapter 5 Principles of Flood Resilience	The plan focuses on 5 key principles, one of which is equity.
Utilize community and regional scale planning to maximum extent possible, seeking region-specific approaches tailored to the needs of individual communities	Chapter 4 Community Engagement  Chapter 6 Efforts to Date	The plan focuses on 5 key principles, one of which is community scale benefits. The plan builds on City-wide and watershed specific planning efforts and included a robust public outreach campaign.
Understand the fiscal realities and focus on the most cost-effective solutions for the protection and adaptation of our communities, businesses, and critical infrastructure. The solutions will to the extent possible, prioritize effective natural solutions.	Section 6.5 Funding  Chapter 7 Recommended Projects for Flood Resilience	The plan focuses on 5 key principles, one of which is economy and land use.  Cost-effectiveness of projects is a major component in project evaluation in the plan.  Nature-based solutions/green infrastructure is also major component in project evaluation in the plan.
Recognize the importance of protecting and enhancing nature-based solutions in all regions, natural	Chapters 5 Principles of Flood Resilience	The plan focuses on 5 key principles, one of which is nature-based approach.

coastal barriers and fish and wildlife habitat by prioritizing nature-based solutions.	<p>Section 6.4, Projects</p> <p>Chapter 7 Recommended Projects for Flood Resilience</p>	Nature-based solutions/green infrastructure is a major component in project evaluation in the plan.
The plan is project-based with projects focused on flood control and resilience.	<p>Chapters 5 Principles of Flood Resilience</p> <p>Section 6.4, Projects</p> <p>Chapter 7 Recommended Projects for Flood Resilience</p>	The plan focuses on flood resilience throughout and has 5 key resilience principles.
The plan will incorporate nature-based infrastructure to the maximum extent possible.	<p>Chapters 5 Principles of Flood Resilience</p> <p>Section 6.4, Projects</p> <p>Chapter 7 Recommended Projects for Flood Resilience</p>	The plan focuses on 5 key principles, one of which is nature-based approach. Nature-based solutions/green infrastructure is a major component in project evaluation in the plan.

## **APPENDIX B – FLOODPLAIN REVIEW**

Floodplain Review (Residential and Commercial) SOP attached in the following pages.



Procedure Name:  
***Floodplain Review  
(Residential and Commercial)***

Procedure #: FP-001  
Revision #: 0  
Implementation Date:  
Last Review/Update Date:  
Approval:

Procedure Owner:

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## 1. Purpose

Describe the overall process for reviewing permits that are located on parcels that are at least partially within the Special Flood Hazard Area or Floodplain.

## 2. Scope

The scope of this procedure is based on the development, partial development or redevelopment of a parcel for commercial or residential purposes.

The development is subject to the requirements of Section 36.2-333, Floodplain Overlay District (F). This review will take place concurrently with other relevant reviews for the development (zoning, building, E&S, etc.)

This procedure applies to the Permit Center, Zoning Administration, Zoning Review, Building Review, and Planning and Building Inspections function in the department.

## 3. Permit Types/Subtypes

This procedure applies to the following permit types and the associated subtypes.

- Residential New (RNEW)
- Residential Addition (RADD)
- Residential Repair/Remodel (RMRP)
- Residential Deck Porch (RDKP)
- Residential Accessory Structure (RACC)
- Commercial New (CNEW)
- Commercial Addition (CADD)
- Commercial Repair/Remodel (CMRP)
- Commercial Deck/Porch (CDKP)
- Commercial accessory Structure (CACC)
- Subdivision (SU)
- Comprehensive Plan (CP)

This procedure will not apply to any trade permits that are in-kind replacements of existing system unless the upgrade is determined to be a substantial improvement or part of a substantial improvement to the building. However, all **NEW** trade permits must meet the NFIP requirements which mean elevating those systems 2 feet above the BFE.





Procedure Name:  
***Floodplain Review  
(Residential and Commercial)***

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#### 4. Prerequisites

- A signed and sealed elevation certificate has been provided with the permit application.
- A site plan, with floodplain/floodway boundaries shown on the site plan, has been submitted with the application.
- Any flood-proofing certifications have been signed and sealed certifying that dry or wet flood-proofing that is proposed meets Building Code Standards for the floodplain.

#### 5. Initialized from:

Building and Zoning permits are typically initialized from an address. However, some permits may be appropriate to initialize from a building. This is particularly important for floodplain review. If multiple buildings under one address are located within a floodplain and are on the same parcel, it is important to make clear which one of the building/s the permit is for.

#### 6. Responsibilities

- Permit Technicians – Permit initialization, assignment of reviews, document management (ensures that elevation certificate has been provided upon initialization).
- Zoning Floodplain Reviewer/Administrator – Review project sites to ensure compliance with Section 36.2 -333 Floodplain Overlay District (F). Checks to verify accuracy of the Elevation Certificate. In some instances, checks to see if the permit constitutes a substantial improvement to a building. Determines whether an as-built survey or a post-construction elevation certificate is on file before issuance of a CO.
- Building Floodplain Reviewer/Inspector – Review of building plans for flood proofing/elevation data accuracy. Determines that the Flood proofing Certificate is accurate and that the flood proofing was installed correctly.

#### 7. Procedure

The floodplain review process must **ALWAYS** begin with a zoning determination of the use of the new structure, addition, or any other type of development associated with the permit application. This informs reviewers as to changes of use and also allows reviewers to determine if new proposed uses are allowed within certain areas of the floodplain overlay. Certain uses are non-starters for permitting approval in developments or re-developments within the Floodway. Changes of uses within the floodway may require a Special Exception to change from one non-conforming use to another.

After use has been deemed to be compliant, see attached flow chart for the rest of the review process. This procedure is an assembly procedure, based on other defined, detailed procedures for specific tasks.

#### 8. References

- Zoning Ordinance, Chapter 36.2 of the Code of the City of Roanoke (1979), as amended.
- Section 36.2 -333 Floodplain Overlay District (F)
- Stormwater Management Ordinance, Chapter 11.6 of the Code of the City of Roanoke (1979), as amended.
- Uniform Statewide Building Code.



Procedure Name:  
***Floodplain Review  
(Residential and Commercial)***

Procedure #: FP-001  
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Approval:

Procedure Owner:

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## 9. Definitions

***Substantial Improvement*** – Any reconstruction, rehabilitation, addition, or other improvement of a structure, the cost of which equals or exceeds fifty (50) percent of the market value of the structure before the start of construction of the improvement. The term does not, however, include either:

1. Any project for improvement of a structure to correct existing violations of state or local health, sanitary, or safety code specifications which have been identified by the local code enforcement official and which are the minimum necessary to assure safe living conditions, or
2. Any alteration of a historic structure, provided that the alteration will not preclude the structure's continued designation as a historic structure.
3. Historic structures undergoing repair or rehabilitation that would constitute a substantial improvement as defined above, must comply with all section requirements that do not preclude the structure's continued designation as a historic structure. Documentation that a specific section requirement will cause removal of the structure from the National Register of Historic Places or the State Inventory of Historic places must be obtained from the Secretary of the Interior or the State Historic Preservation Officer. Any exemption from section requirements will be the minimum necessary to preserve the historic character and design of the structure

***Base Flood Elevation*** - The water surface elevations of the base flood, that is, the flood level that has a one (1) percent or greater chance of occurrence in any given year. The water surface elevation of the base flood in relation to the datum specified on the community's flood insurance rate map.

Add more based on current projects – encroachment, etc

## 10. Time Limits

- Intake, initialization and scanning of documents – Completed at counter, within next business day for electronic submissions.
- Initial Zoning/Site Reviews – Complete and provide comments within 10 days of initialization.
- Initial Building Plan Review – Complete and provide comments within 10 days of initialization (5 days for residential permits).

## 11. Revisions

Date	Description of Revision



## Procedure Flow Chart:

### ***Zoning Floodplain Review - Commercial***

Procedure #: FP-001

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#### **Required Submittals**

- Applicable permit application form
- Site plan with floodplain/floodway indicated on the site plan
- Building plan (with sealed drawing confirming dry/wet flood-proofing if proposed – only allowed on non-residential structures)
- Signed and sealed elevation certificate with date
- Total valuation of the proposed project

C

#### **Plan Revision/Resubmission** Applicant

Plans revised to address comments

#### **Resubmission Processing** Permit Technician

- Check for scope change
- Add reviews
- scan and/or upload
- If hard copy, add resubmission to file

**Start**  
Customer submits Building and Zoning permit application

#### **Permit Initialization** Permit Technician

- Identify project scope, permit type/subtype
- Check/link prerequisites
- Assign reviews
- Use/number of units
- Assess fees
- Scan and/or upload documents
- Note document location

#### **Zoning Use Determination** Zoning Floodplain Reviewer

- Identify zoning use of the property
- Identify if development is occurring in regulatory floodway
- Identify any change of use
- Determine if use is permitted in the floodway
- If new development in floodway, any use not permitted will result in permit denial.
- If change of use in floodway, applicant will need to submit application to BZA, prior to permit review

Zoning Floodplain Review

Building Floodplain Review

A

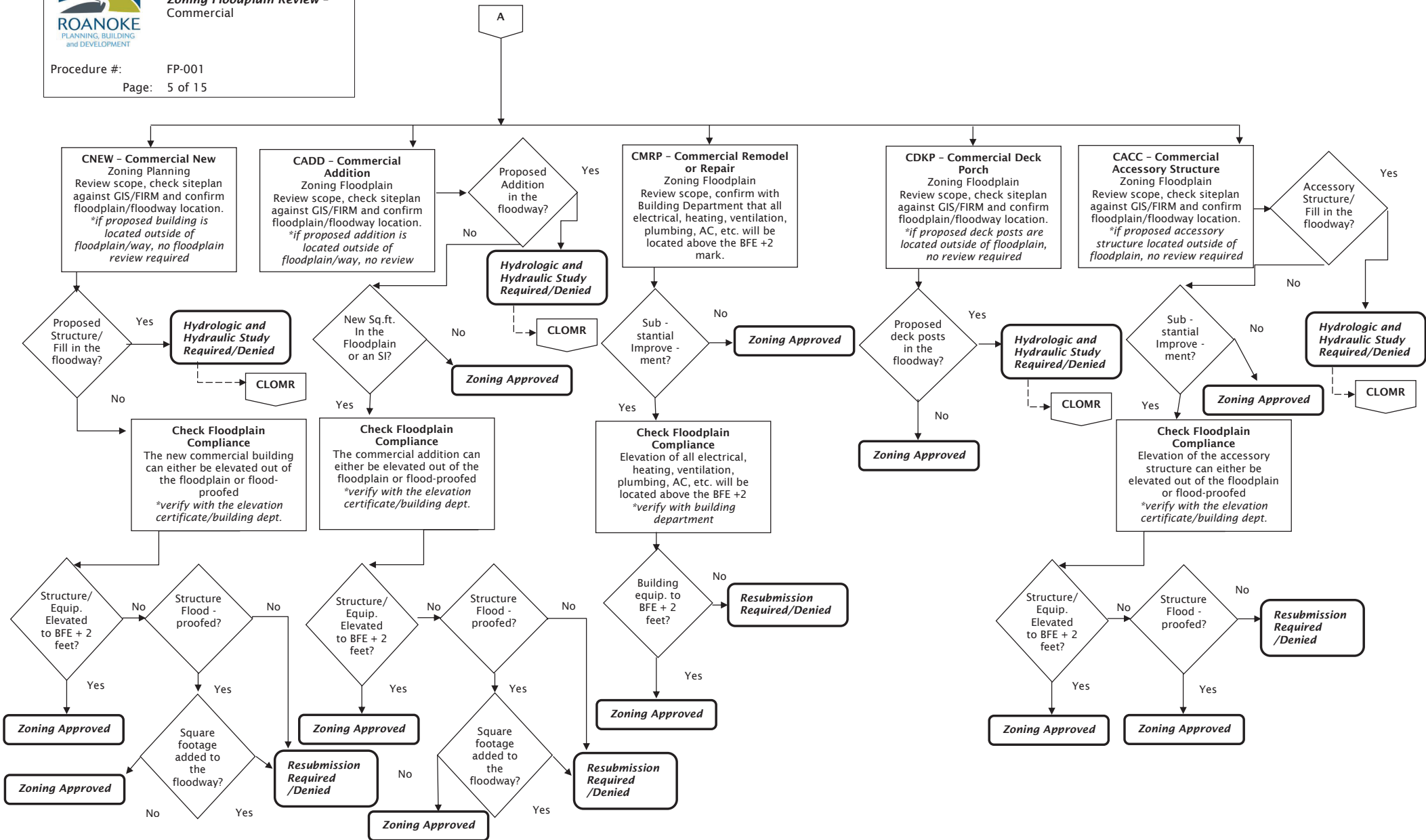
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Procedure Flow Chart:

**Zoning Floodplain Review - Commercial**

Procedure #: FP-001  
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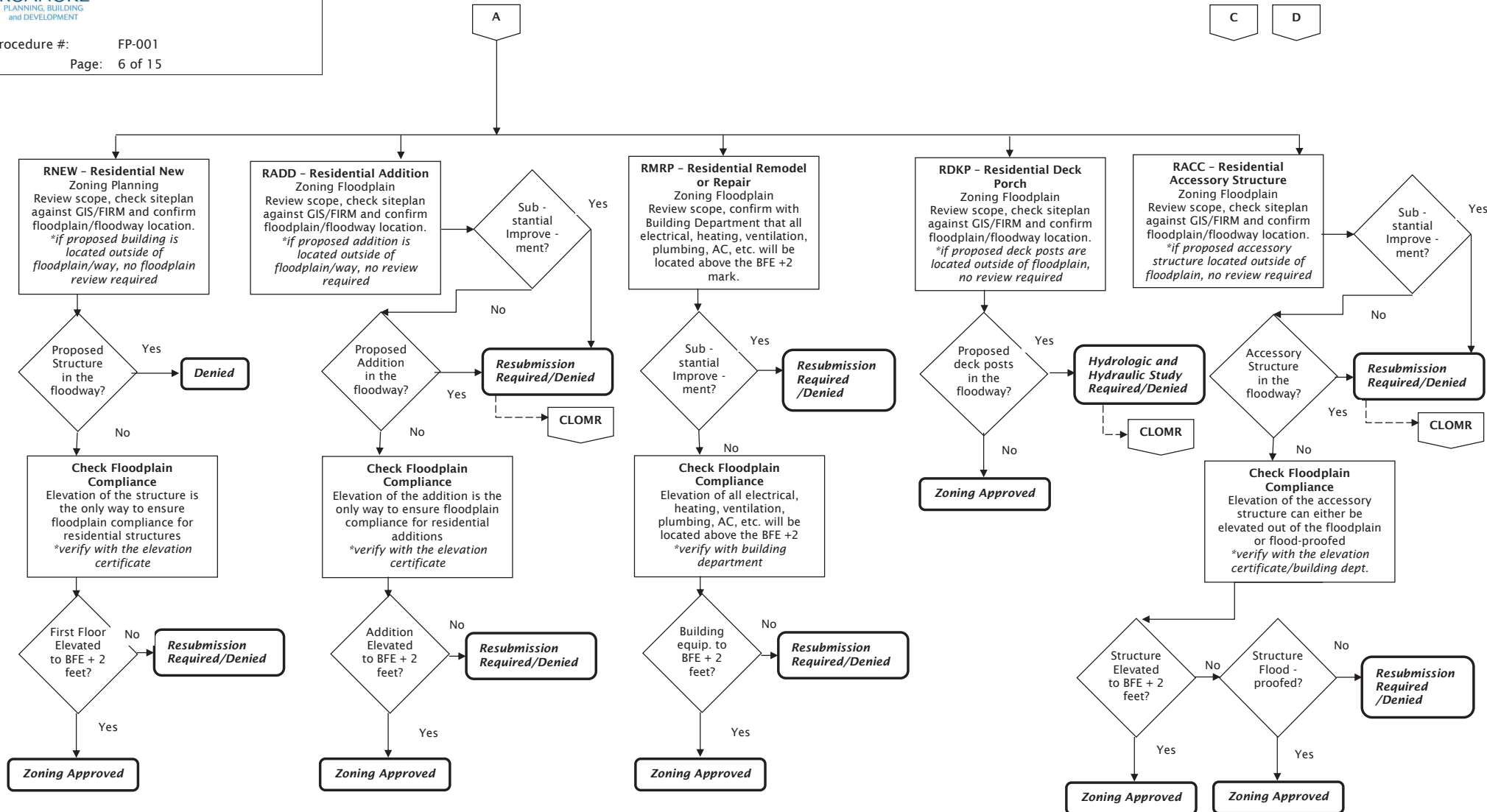




Procedure Flow Chart:

**Zoning Floodplain Review -**  
Subdivisions and Comp Plans

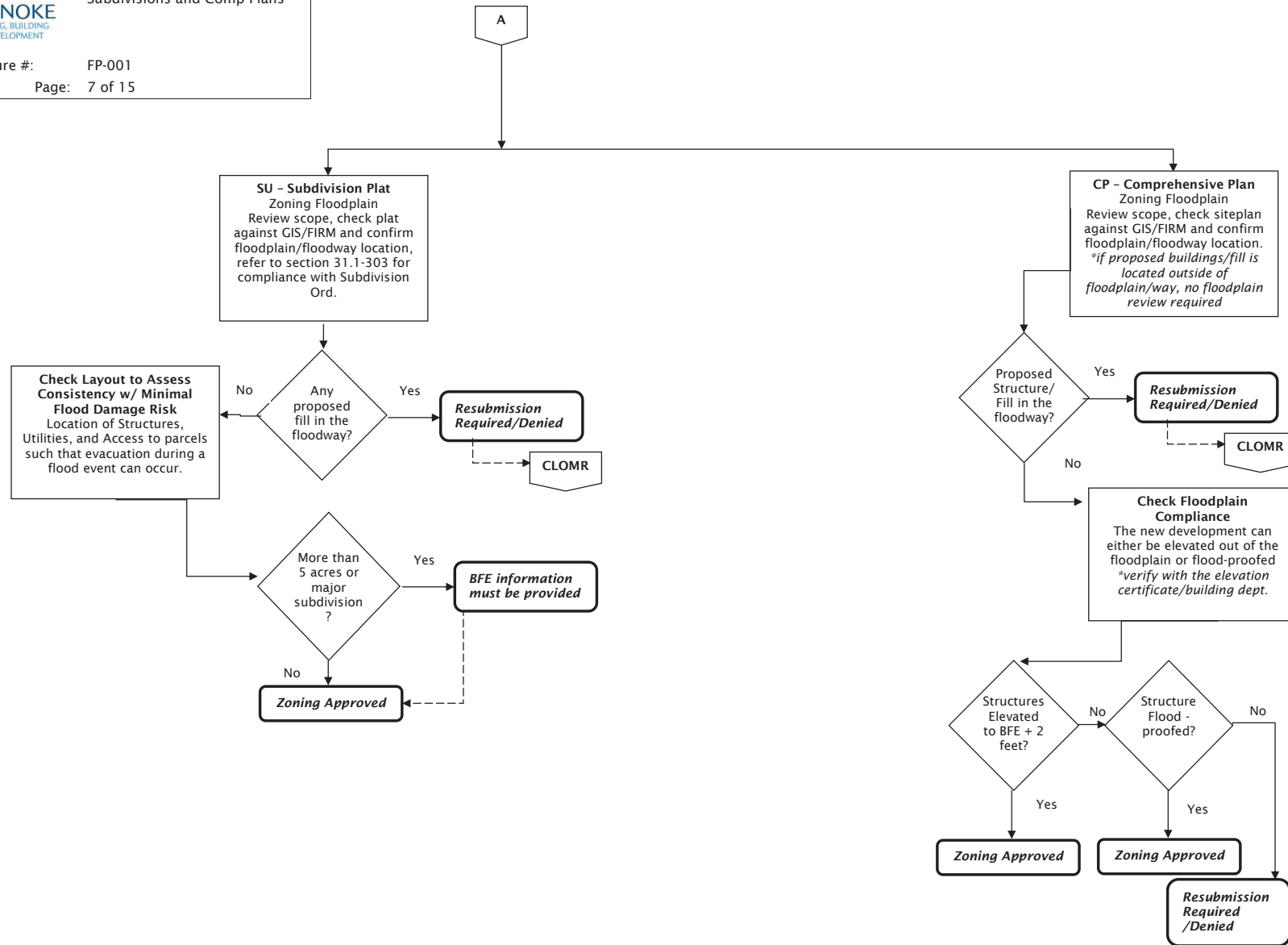
Procedure #: FP-001  
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Procedure Flow Chart:  
**Zoning Floodplain Review –**  
Subdivisions and Comp Plans

Procedure #: FP-001  
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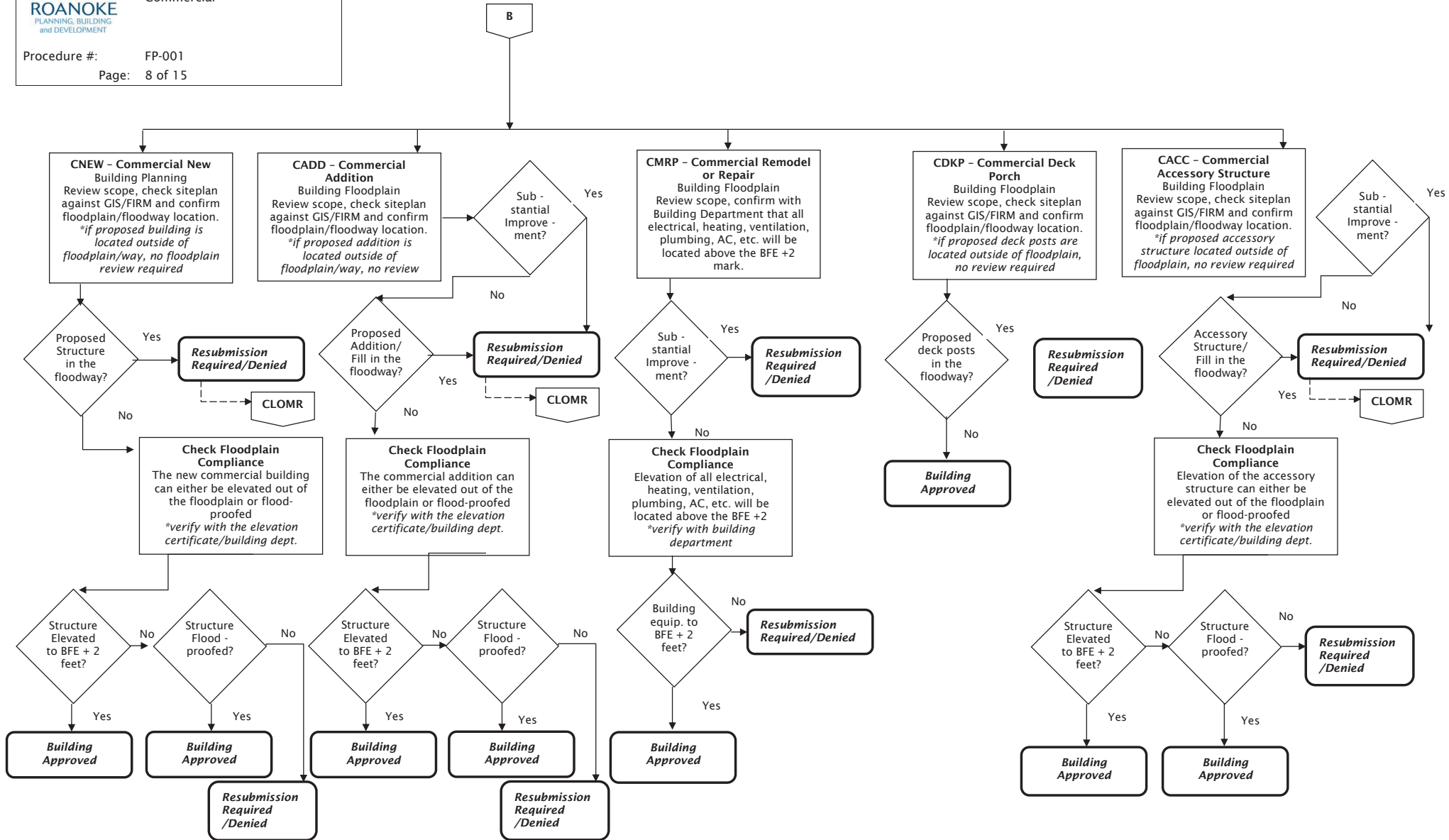




Procedure Flow Chart:

**Building Floodplain Review - Commercial**

Procedure #: FP-001  
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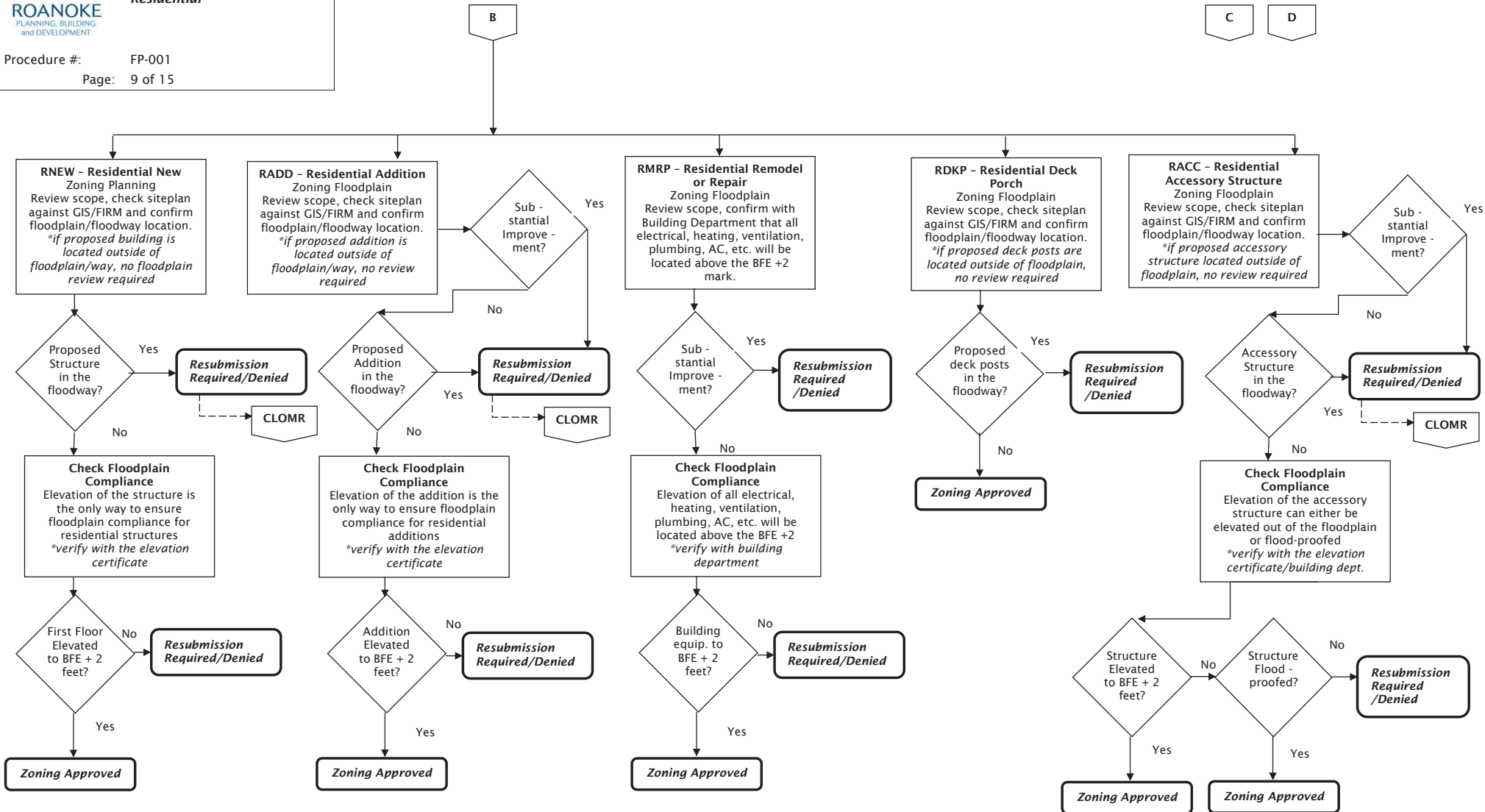




Procedure Flow Chart:

**Building Floodplain Review Residential**

Procedure #: FP-001  
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Procedure Flow Chart:

***Conditional Letter of Map  
Revision Review Process***

Procedure #: FP-001

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CLOMR

44 CFR 65.12:

"When a community proposes to permit encroachments upon an adopted regulatory floodway which will cause base flood elevation increases in excess of...(0.00 ft in a floodway) and/or [0.1 ft in a floodplain]...the community shall apply to the Administrator for conditional approval of such actions prior to permitting the encroachments to occur..."

44 CFR 60.3(d)(3):

"In the regulatory floodway, communities must prohibit encroachments, including fill, new construction, substantial improvements, and other development within the adopted regulatory floodway unless it has been demonstrated through hydrologic and hydraulic analyses performed in accordance with standard engineering practice that the proposed encroachment would not result in any increase in flood levels within the community during the occurrence of the base flood discharge."

Requirements:

1. Applicant must submit a MT-2 Form from FEMA
  - a. Describes data requirements for request
  - b. Helps applicant organize submittal
  - c. Allows for community involvement early on in the revision process
2. Include "No-Rise" Certification
  - a. Floodplain Manager will require that the applicant's engineer certify that there will be no rise in flood heights due to any development within the floodplain.
  - b. The Community is required to review and approve the encroachment review ("no-rise" certification), however may request technical assistance and review from the FEMA Regional Office or state NFIP Coordinator. If this alternative is chosen, the Community must review the technical submittal package and verify that all supporting data are included in the package before sending it to FEMA.

Minor projects: Some projects are too small to warrant an engineering study and the certification. Many of these can be determined with logic: a sign post or telephone pole will not block flood flows. A driveway, road or parking lot at grade (without any filling) won't cause a problem, either.

Building additions, accessory buildings, and similar small projects can be located in the conveyance shadow. This is the area upstream and downstream of an existing building or other obstruction to flood flows. Flood water is already flowing around the larger obstruction, so the addition of a new structure will not change existing flood flow. Upstream is measured at an angle of 1-to-1, downstream is measured at an angle of 4-to-1.

- c. To support a "No-Rise / No-Impact" certification for proposed developments encroaching onto the regulatory floodway, a community will require that the following procedures be followed:
  - i. Currently Effective Model Furnish a written request for the step-backwater hydraulic model for the specified stream and community, identifying the limits of the requested



Procedure Flow Chart:

***Conditional Letter of Map  
Revision Review Process***

Procedure #: FP-001

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data. A fee will be assessed for providing the data. Send data requests to: Federal Emergency Management Agency [http://www.fema.gov/fhm/st\\_order.shtml](http://www.fema.gov/fhm/st_order.shtml) or to: MOD RMC Region 4 Faxed to (678) 459-1030 to the attention of: "Back-up Technical Data Request"

- ii. Duplicate Effective Model Upon receipt of the step-backwater hydraulic model, the engineer should run the effective hydraulic model to duplicate the data in the effective FIS.
- iii. Existing Conditions Model Revise the duplicate effective model to reflect site-specific existing conditions by adding new cross-sections (two or more) in the area of the proposed development, without the proposed development in place. Regulatory floodway limits should be manually set at the new cross-section locations by measuring from the effective FIRM or FBFM. The cumulative reach lengths of the waterway should remain unchanged. The results of these analyses will indicate the base flood elevations and the regulatory floodway elevations for the effective hydraulic model revised to incorporate existing conditions at the proposed project site.
- iv. Proposed Conditions Model Modify the existing conditions models to reflect the proposed development using the new cross-sections, while retaining the currently adopted regulatory floodway widths. The overbank roughness parameters should remain the same unless a valid explanation of how the proposed development will impact the roughness parameters is included with the supporting data. The results of this floodway hydraulic model will indicate the regulatory floodway elevations for proposed conditions at the project site. These results must indicate NO impact on the base flood elevations, regulatory floodway elevations, or regulatory floodway widths shown in the duplicate Effective Model or in the Existing Conditions Model (items ii and iii above, respectively). The "no-impact" analysis along with supporting data and the original engineering certification must be reviewed by the appropriate community official prior to issuing a development permit. The original effective FIS model, the duplicate effective FIS model, the Existing Conditions Model, and the Proposed Conditions Model should be reviewed for any changes in the base flood elevations, regulatory floodway elevations and floodway widths. The "No-Rise / No-Impact" supporting data should include, but may not be limited to:
  1. Copy of the currently effective FIS hydraulic models (legible hard copy and a disc (if available))
  2. Duplicate effective FIS hydraulic models (hard copy and a disc).
  3. Existing conditions hydraulic models (hard copy and a disc).
  4. Proposed conditions hydraulics models (hard copy and a disc)
  5. Annotated effective FIRM or FBFM and topographic map, showing regulatory floodplain and floodway boundaries, the additional cross-sections, and the site location along with the proposed topographic modifications.
  6. Documentation clearly stating analysis procedures. All modifications made to the duplicate effective hydraulic models to correctly represent existing conditions, as well as those made to the existing conditions models to represent proposed conditions should be well documented and submitted with all supporting data.
  7. Annotated effective Floodway Data Table (from the FIS report).
  8. Statement defining source of additional cross-sections, topographic data, and other supporting information.
  9. Cross-section plots of the additional cross sections for existing and proposed conditions hydraulic models.



Procedure Flow Chart:

***Conditional Letter of Map  
Revision Review Process***

Procedure #: FP-001

Page: 12 of 15

10. Certified planimetric (boundary survey) information indicating the location of structures on the property.
11. Hard copy of all output files.
12. Clear explanation of how roughness parameters were obtained (if different from those used in the effective hydraulic models).
13. Engineering certification (sample attached).
- v. The engineering "No-Rise / No-Impact" certification and supporting technical data must stipulate NO impact or NO changes to the base flood elevations, regulatory floodway elevations, or regulatory floodway widths at the new cross-sections and at all existing cross-sections anywhere in the model. Therefore, the revised computer model should be run for a sufficient distance upstream and downstream of the development site to insure proper "No-Rise / No-Impact" certifications.



Procedure Flow Chart:

***Substantial Improvement /  
Damage***

Procedure #: FP-001

Page: 13 of 15

*Substantial Improvement* – Any reconstruction, rehabilitation, addition, or other improvement of a structure, the cost of which equals or exceeds fifty (50) percent of the market value of the structure before the start of construction of the improvement. The term does not, however, include either:

1. Any project for improvement of a structure to correct existing violations of state or local health, sanitary, or safety code specifications which have been identified by the local code enforcement official and which are the minimum necessary to assure safe living conditions, or
2. Any alteration of a historic structure provided that the alteration will not preclude the structure's continued designation as a historic structure.
3. Historic structures undergoing repair or rehabilitation that would constitute a substantial improvement as defined above, must comply with all section requirements that do not preclude the structure's continued designation as a historic structure. Documentation that a specific section requirement will cause removal of the structure from the National Register of Historic Places or the State Inventory of Historic places must be obtained from the Secretary of the Interior or the State Historic Preservation Officer. Any exemption from section requirements will be the minimum necessary to preserve the historic character and design of the structure





## Procedure Flow Chart:

### ***Substantial Improvement / Damage***

Procedure #: FP-001

Page: 14 of 15

## Process for determining Substantial Improvement/ Substantial Damage

1. If any of the three (3) items listed on the previous page match the description of the project, the project is not subject to the substantial improvements review process.
2. Determine the “Improvement Value” on the property (assessed value of the building). This can be done through the GIS website. An example of how to determine the improvement value can be seen below. If there is a discrepancy between the applicant’s valuation of the building and the valuation as prescribed by the Tax Assessor’s office, the applicant will be informed that an appraisal made by a licensed appraiser according to appraisal laws and regulations could be an option for them to raise this assessed valuation of the building, thereby allowing for potentially more improvements to be made before reaching the “substantial improvement/damage” threshold. It is important to note that the appraisal should only be accepted if the study was done prior to any improvement/damage.

The screenshot shows the Roanoke GIS website interface. The 'Assessments' tab is selected, displaying a table of valuation data for the property at 2921 SHENANDOAH AVE NW. The table includes columns for Valuation Date, Land Value, Improvement Value, and Total Value. The 'Improvement Value' column is highlighted in yellow.

Valuation Date	Land Value	Improvement Value	Total Value
2017-01-01	\$49,200	\$17,500	\$116,800
2016-01-01	\$49,200	\$60,400	\$109,600
2015-01-01	\$49,200	\$60,400	\$109,600
2014-01-01	\$49,200	\$60,400	\$109,600
2013-01-01	\$49,200	\$60,400	\$109,600

2. Open Trak-It and search under the parcel for all building permits, trade permits, or other permits that pertain to improvements to the specified building within the past 5 years. Tally the sum of all of the building costs related to those permits. If there are more than 5 permits that were completed during this time, create an excel spreadsheet that tabulates the cumulative cost and save it under attachments at the address level. Additional information about what should and should not be included in the costs associated with an improvement/damage project can be found in the FEMA Floodplain Management Handbook.
3. Divide the sum total cost of all permits over the past 5 years found in Step 2, in addition to the current project’s cost of improvement/damage, by the assessed value of the structure in Step 1. If this value is more than .50, then the applicant will need to improve



Procedure Flow Chart:

***Substantial Improvement /  
Damage***

Procedure #: FP-001

Page: 15 of 15

the structure to FEMA floodplain compliance. For residential structures, this means elevating the bottom of the first floor to the Base Flood Elevation, plus two feet. For Commercial buildings, the structure shall either be elevated or flood-proofed to the Base Flood Elevation, plus two feet.

4. Whenever our Department initiates a substantial improvement request, the applicant will be made aware that the improvement will be considered a substantial improvement. If the applicant moves forward, a note will be created on the parcel that indicates that a substantial improvement is being sought. The floodplain manager will also be made aware so that they can report to FEMA about the resulting substantial improvements and a log of the review process will be saved in TrakIt, the City permitting software database.

## APPENDIX C – EDUCATION AND OUTREACH

### Breakdown of Education and Outreach

#### **Regional Working Groups and Committees**

The City works with statewide agencies, other localities/municipalities, and stakeholders in the form of Committees to stay informed on regional water resource management topics, issues and goals, which include flooding and stormwater improvement initiatives. Once organized, these initiatives can then be passed onto residents to inform, and sometimes take action with preventative or enhanced water-related measures.

##### *Roanoke River Blueway Committee*

Formed in 2013 to promote planning, tourism, and outreach affairs in relation to the Roanoke River, and now a formal Committee with voting members under the Roanoke Valley Area Regional Commission. The group combines the City of Roanoke, Roanoke County, surrounding cities and counties, the National Park Services and others. The committee helps to organize events that promote awareness, stewardship, and education about the Roanoke River.

##### *Stormwater Advisory Committee (RCSWAC)*

The group combines the City of Roanoke, Roanoke County, surrounding counties, agencies, and continues to grow. This committee discusses current needs for floodplain management and infrastructure projects related to stormwater in conjunction with state and federally mandated stormwater requirements (City of Roanoke, 2018).

##### *Regional Pre-Disaster Mitigation Planning Committee*

The City of Roanoke, the County of Roanoke and several other localities participate in this committee to keep their residents informed and prepared for natural disasters through hazard mitigation planning such as the 2019 Regional Hazard Mitigation Plan which provides critically important information about flooding (Roanoke Valley-Alleghany Regional Commission, 2019).

##### *Citizen Advisory Committees*

Citizen advisory committees are utilized as needed for Citywide planning projects. Committees are comprised of a diversity of professionals and city residents and are established to review and provide feedback on the City's planning goals. As an example, this was utilized in City downtown planning of 2013-2017.

#### **Public Education Events**

The City also participates in, as well as sponsors, educational events to both educate and engage the community in local water quality and flooding issues. Often this occurs in partnership with local organizations or non-profits, such as the Clean Valley Council. These events span a wide range of formats to reach diverse community interests.

*Clean Valley Days* - Roanoke Clean Valley Council (CVC) organizes "Clean Valley Days" twice each year where local roads and water ways are cleaned up by volunteers.

*Green Academy* - Every year, the City joins forces with the Western Virginia Water Authority and Clean Valley Council to hosts a 5-week Green Academy with specific sessions that address water quality, conservation, stormwater management and BMPs.

*Environmental Summits* - Environmental Summits have been organized to educate the public on environmental issues and engage the community with planning of environmental outreach efforts. As a result of the 2018 summit, “Roanoke Clean and Green” was formed. This group of volunteers help to spread the word on “green initiatives” and best practices within the community.

*Roanoke Prepareathon* - Event hosted by the City during National Preparedness Month, in partnership with Emergency Management and Fire-EMS, to highlight local topics on floodplain management and flood mitigation for the community.

*Stormdrain Stenciling* - CVC helps lead a storm drain stencil marking program where volunteers are trained to do hands-on stenciling work on drainage inlets. Accompanied with this training is education not only about storm sewer inlets, but about water quality as a whole: local streams and rivers, and watersheds.

*Citizen Science* - Partnering with CVC, Stormwater sponsors a citizen science program to monitor water quality and benthic macroinvertebrates. Residents learn about local water quality at the stream, river and watershed level.

*Stormwater Workshops* - Partnering with CVC, Stormwater sponsors workshops on water quality and stormwater management and offers rain barrel workshops during certain times throughout the year

*Public Art Projects* - Partnering with the Roanoke Regional Arts commission, Stormwater sponsors public art projects to engage the public creatively to learn about and help creatively communicate water quality and other stormwater issues. Examples include inlet art, murals, photography, and jingle competitions.

### **Public Educational Outreach (Mail Delivery, Virtual and Other)**

A regular part of City functioning is informing and educating residents with pertinent information. This is done in a variety of formats as necessary according to the information and relevant audience, including taking accessibility and inclusivity into consideration. Interpretation and translations services and resources are available to City residents and visitors regardless of the language they speak. It is the policy of the City of Roanoke to ensure that limited English proficiency individuals have meaningful access to all services, programs, and activities.

#### *Notifications*

- Repetitive Loss Area - Repetitive Loss Area Analysis has been introduced to the City public in a letter mailed out last year to residents that are located within Repetitive Loss Areas. Additionally, this letter describes the NFIP, CRS program, and provides resources such as flood preparation steps, online flood plan maps, and the suggestion for permanent protection measures against floods. This letter also leads recipients to a Repetitive Loss survey that can be taken to evaluate possible Repetitive Loss properties. This survey helps the City to further identify Repetitive Loss Areas, which can then result in specifically tailored mitigation projects and/or more grant funding provided by FEMA for various flooding solutions.
- Special Flood Hazard Area – Annual mailer to approximately 360 real estate agents, lenders and insurance agents. Post card titled “Are you aware of the flood hazards?”, which provides resources for agents and lenders to share with property owners that possess properties within Special Flood Hazard Areas.

#### *Publications*

- Flooding in Roanoke – Annual brochure mailed to all residents and businesses located within the Special Flood Hazard area and/or a Repetitive Loss Area. The brochure promotes flood insurance, provides flood protection information, tips for flood preparedness including actions to take to reduce

flood damage to a home or business, flood map information services, and information about the natural drainage system and the importance of protecting natural floodplain functions.

- State of Our Waters – Mailed to all Stormwater fee payers, about 32,300 addresses, and available in public at City libraries and the City Municipal Building. Information includes local and national data on water pollution and climate change; new projects that relate to water quality such as stream restoration and infrastructure projects; floodplain preparedness information, and ways that the local community can help.
- Flood Preparedness and Recovery Guide – Brochure containing Disaster Response Resource Information, and important messaging such as “Turn Around, Don’t Drown”. The brochure provides a list of important resource phone numbers for emergencies and non-emergencies, as well as links to resources about flood response, residential flooding, special needs, and recovery after a flood.

#### *Virtual Tools*

- Social Media - City’s social media platforms include Facebook, Instagram, X (formerly Twitter) and Nextdoor. Through these platforms, information about specific floodplain and resilience issues including flood hazards; insuring property against flooding incidents; how to protect people and property from flooding hazards; responsible flood resistant development; and the importance of protecting natural floodplain functions is shared with the public.
- Website – The City maintains a public facing website with information on flood zones and insurance, flood safety, preventing flood damage, flood warnings, flood management, emergency preparedness, City events, and staff directories.
- SHARKS App - The City has funded a public information web-based application known as Stream Hydrology and Rainfall Knowledge System (SHARKS). Sharks relies on a system of rain gauges, USGS data, and automated computations incorporated into a website that allows you to determine past rainfall data and/or can determine areas that are experiencing a flood event in real time. This information is available to the public and can advise locals on what roads to avoid during storm events. This rainfall data can also be instrumental in further research to show hotspots of flood-prone areas.

## **APPENDIX D – PROPERTY ACQUISITION**

### **Property Acquisition SOP**

The City of Roanoke, must at times acquire certain real property rights from private owners to achieve annual and long-term program objectives of varying master plans and capital projects. These rights include the acquisition of vacant properties, and the acquisition and demolition of structures. This outlines the procedure for City staff to engage private property owners in voluntary sales of their property, ensure full transparency in the acquisition process, leverage resources for fair and equitable treatment of property owners and their tenants, and adhere to land preservation requirements of all properties acquired.

#### **1. Letters of Interest and Voluntary Participation**

Once a property has been identified as high priority to achieve overall objectives of a project or program, the Department Manager or Project Manager shall coordinate with their Economic Development Department representative to initiate contact with the property owner. This “Letter of Interest” should give an overview of the need for the property, the future use of the site, and listed source of funding. This LOI will not include a certified offer, City projects must gain City Council approval to obtain all property rights from private owners. The goal of the LOI is to gauge interest from the owner(s), that would warrant submission to Council. This also provides a personal approach to owner engagement on each project.

For projects funded by the Virginia Department of Emergency Management, FEMA, or other state agencies that are federal backed, a Voluntary Participation Agreement must be signed by each property owner for grant application submittal. This agreement demonstrates interest of the property owners, serves as support for readiness to proceed on the project, waives the rights of relocation for owners, protects the rights of the tenant, and reinforces the voluntary nature of each acquisition. The Voluntary Participation Agreement for FEMA’s FMA, PDM, and HMGP grants is attached as Exhibit A.

#### **2. Appraisals, Offers and Negotiations, and Sales Agreement**

If a property owner responds positively to the Letter of Interest, a submittal to City Council for approval of acquisition is required. Pending the project schedule, owner expectations, and time of Council approval; the project manager may also concurrently work with the Economic Development Department to hire a third-party appraiser to ensure fair and objective value estimation of the property. The third-party appraiser coordinates a visit to the property, and provides a detailed report to the City and property owner at no cost to the owner.

The appraised value reflects the current fair market value for the property, and is the basis for the offer letter. As this is a voluntary agreement, the property owners have the right to negotiate a different purchase price, and it is the City’s right to accept, decline, or renegotiate this counter-offer. It should be noted, the City is required to purchase each property at either the tax assessed or appraised value, whichever is higher. If the acquisition is funded through a grant, the appraised value is the amount in which can be reimbursed. If a property owner exercises their right to negotiate for a higher purchase price, the City must determine if paying 100% of the difference between appraised value and final offer meets cost/benefit.

Once a final price is agreed, City attorney’s office will prepare closing documents and sales agreement.

#### **3. Uniform Relocation Act**



If there are active renters at the property, the Federal Uniform Relocation Act may apply. Form II-3 URA Relocation Assistance for Tenants Fact Sheet is included as Exhibit B to assist in determining when a tenant may be eligible. 49 CFR 24.402 (part of the federal regulations governing the Uniform Relocation Act), requires the City to provide relocation funds for the tenant and ensure their new dwelling is decent, safe, and sanitary in addition to being comparable to their current rental.

Working closely with the tenants in their relocation, assisting in identifying a new dwelling that meets all federal grant requirements, and ensuring the new dwelling is decent, safe, and sanitary aligns with the City's goals of equitable treatment of both property owner and tenant. All of the tenant's rights are outlined in the Federal Uniform Relocation Act.

#### 4. Land Preservation and Deed Restrictions

In the sales agreement for each acquisition, an exhibit is included that furthermore restricts the deed from sale, development; maintaining the parcel as open space. An example of the deed restrictive language is included as Exhibit C, with an excerpt as follows:

"Federal program requirements consistent with 44 C.F.R. Part 80, the Grant Agreement, and the State-local Agreement, the following conditions and restrictions shall apply in perpetuity to the Property described in the attached deed and acquired by the Grantee pursuant to FEMA program requirements concerning the acquisition of property for open space:

a. Compatible uses. The Property shall be dedicated and maintained in perpetuity as open space for the conservation of natural floodplain functions. Such uses may include: parks for outdoor recreational activities; wetlands management; nature 1 PG )29b.; ~18 22 reserves; cultivation; grazing; camping (except where adequate warning time is not available to allow evacuation); unimproved, unpaved parking lots; buffer zones; and other uses consistent with FEMA guidance for open space acquisition, Hazard Mitigation Assistance, Requirements for Property Acquisition and Relocation for Open Space.

b. Structures. No new structures or improvements shall be erected on the Property other than:

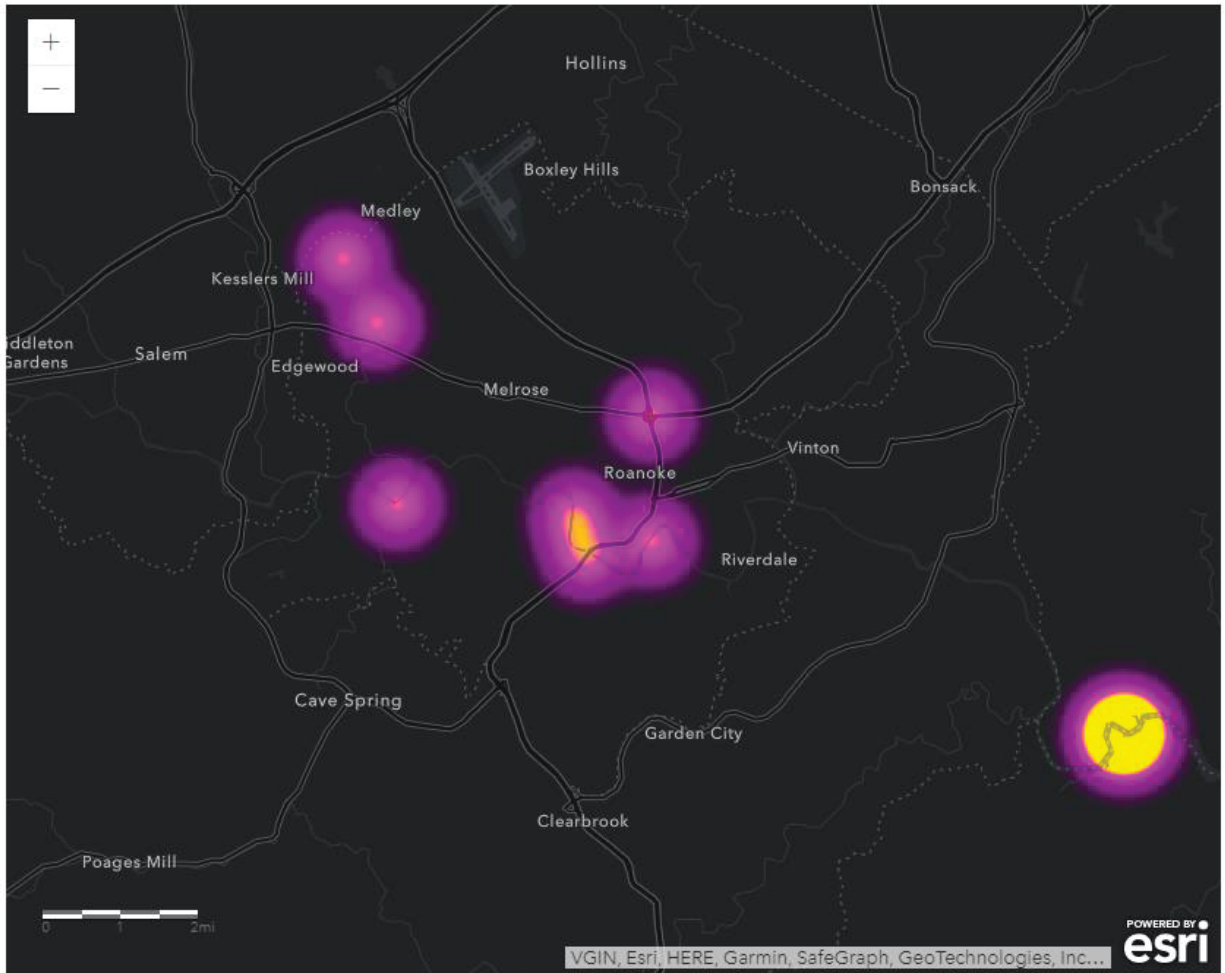
i. A public facility that is open on all sides and functionally related to a designated open space or recreational use;

ii. A public rest room; or

iii. A structure that is compatible with open space and conserves the natural function of the floodplain, including the uses described in Paragraph 1.a., above, and approved by the FEMA Administrator in writing before construction of the structure begins."

## APPENDIX E – COMMUNITY SURVEY

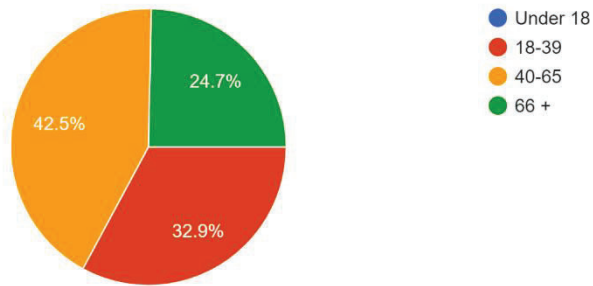
This Appendix contains Figures that portray the results of the community survey and map that were open from January 2023 through March 2023 for public input and resulted in 160 responses.



Resilience Plan Survey Responses

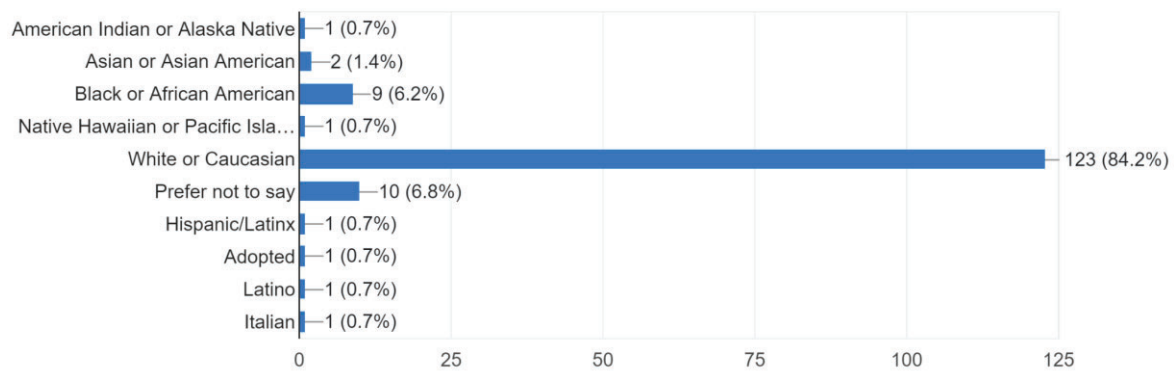
Please identify your age bracket.

146 responses



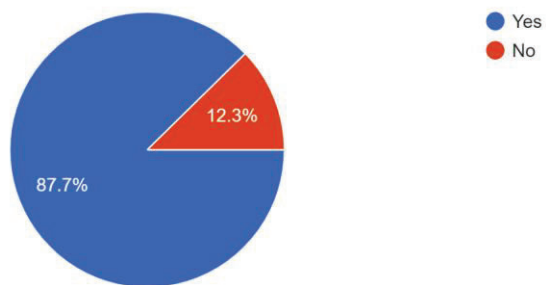
Please identify your race (select all that apply).

146 responses



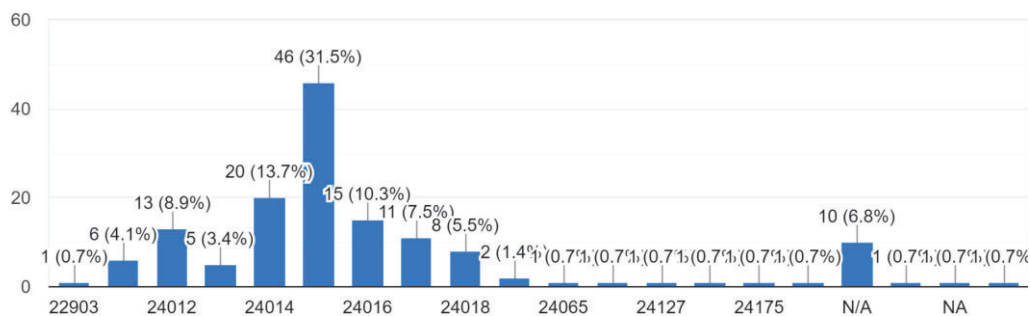
Do you live in the City of Roanoke?

146 responses



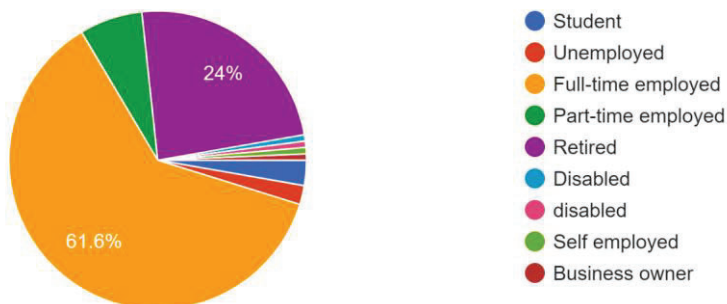
If you live in the City please provide your zip code. If this does not apply, please type "N/A".

146 responses



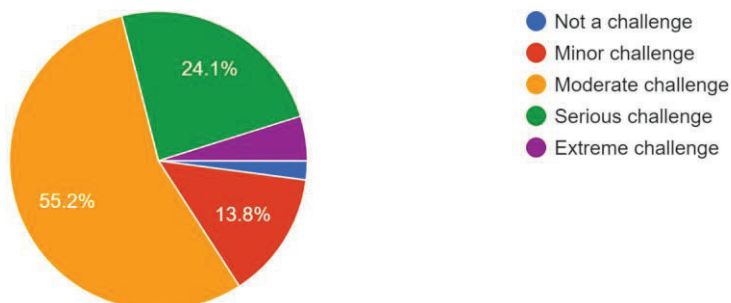
Please identify your occupational status.

146 responses



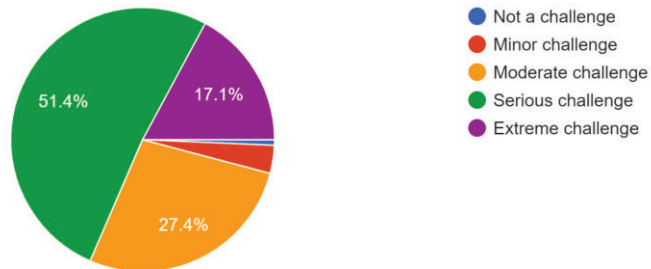
How much of a challenge do you feel flooding poses to your community currently?

145 responses



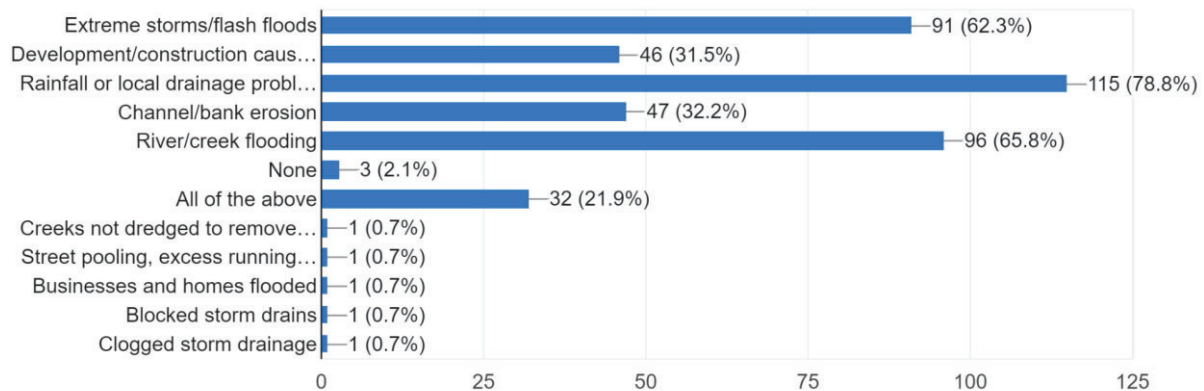
How much of a challenge do you feel flooding poses to your community in the next 20-40 years, given climate change?

146 responses



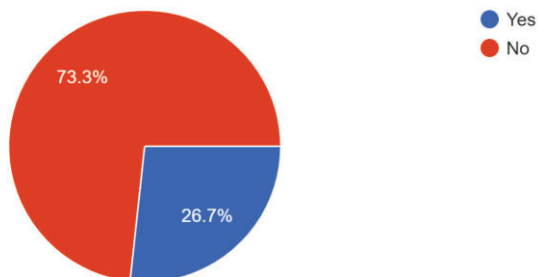
What type of flooding hazards have you witnessed in your community? Select all that apply.

146 responses



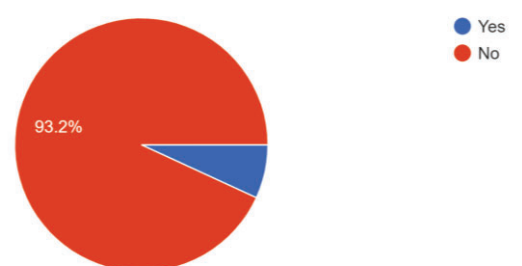
Has your home ever flooded?

146 responses



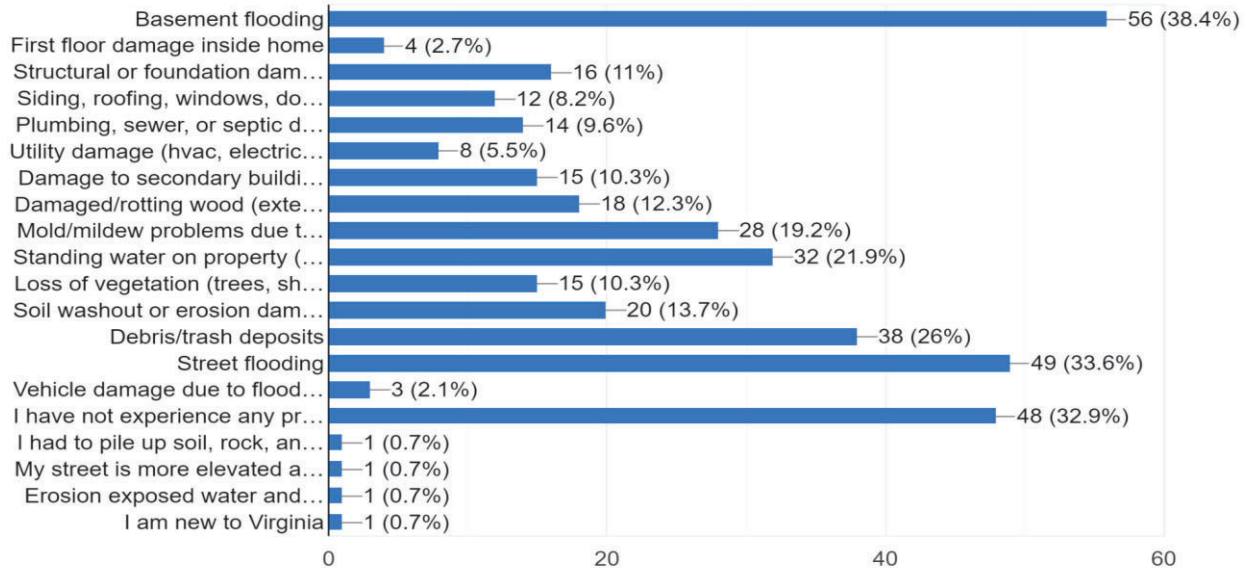
Has your business ever flooded?

146 responses



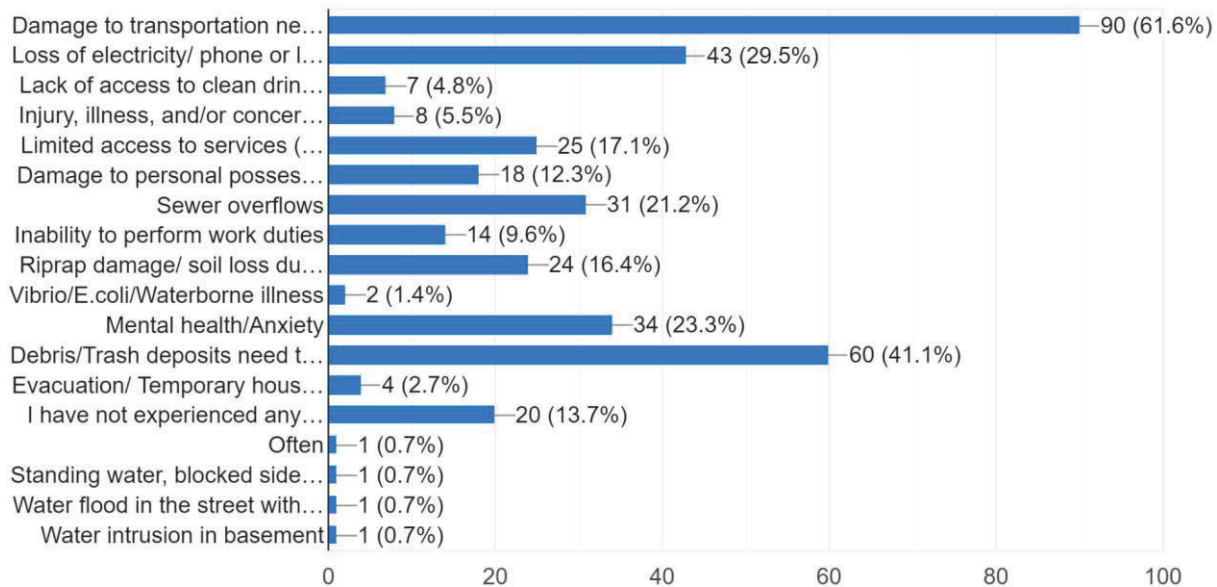
What type of property damage have you experienced resulting from a flood event? (select all that apply)

146 responses



What type of negative impacts have you experienced resulting from a flood event? (select all that apply)

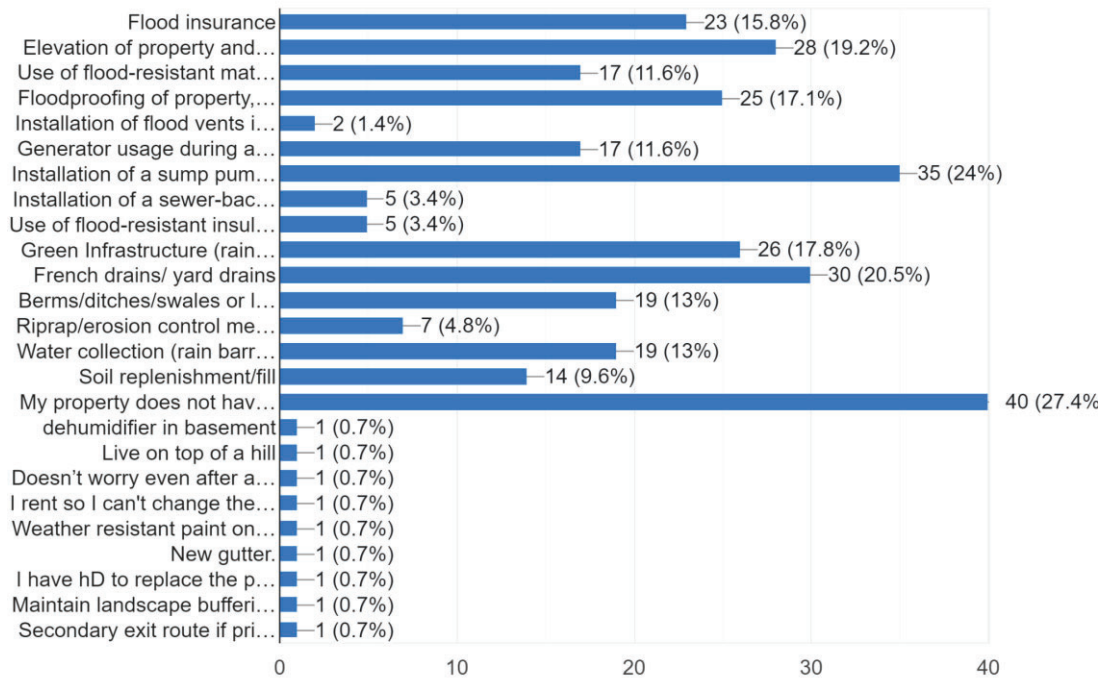
146 responses





Do you currently have any prevention or mitigation measures in place on your property(ies)? (select all that apply)

146 responses



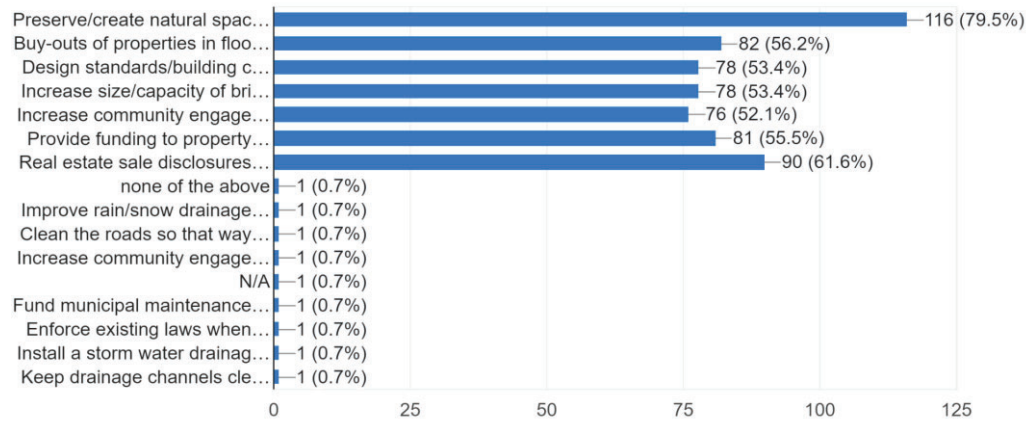
Have you ever considered moving to another location (inside or outside the City of Roanoke) to avoid future flood losses, impacts, or damage?

146 responses



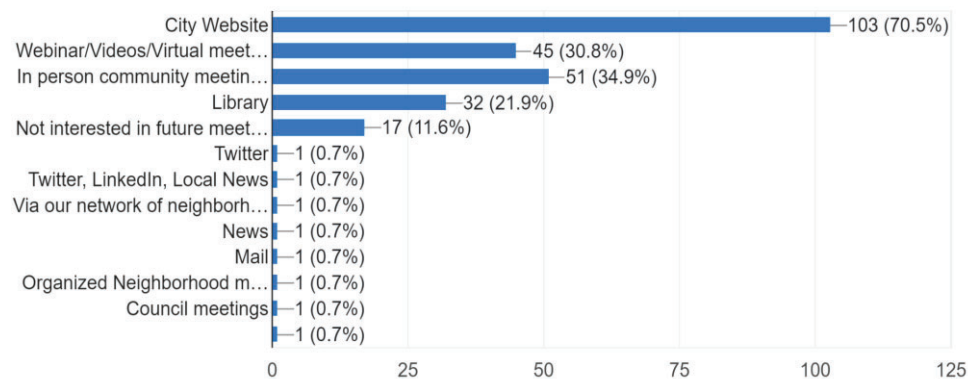
Do you believe any of the project types listed below would provide benefits to your community?  
(select all that apply)

146 responses



Other communication options for follow up (select all that apply)

146 responses



Social Media, select which social media platform you prefer for updates or select none.

146 responses

