Recommended Techniques for Mitigating the Risk of Flooding to Residential Buildings in Carrboro

Tom's Creek, at 118 Carol Street – looking east on December 30, 2015

Acknowledgements

Most of the content of this report has been borrowed or adapted from the Charlotte-Mecklenburg Stormwater Services Flood Risk Assessment and Risk Reduction Plan (2012). In turn, a good deal of information in that plan is provided from this FEMA report.

Homeowner's Guide to Retrofitting Six Ways to Protect Your Home from Flooding. FEMA P-312, 3rd Edition / June 2014. Available athttps://www.fema.gov/sites/default/files/2020-08/FEMA_P-312.pdf

Charlotte-Mecklenburg Stormwater Services is a recognized national leader in flood risk assessment and mitigation. Their full report is available at https://charlottenc.gov/StormWater/Flooding/Documents/Flood_RARR_Plan-Final.pdf

Summary

The purpose of this report is to offer recommendations for reducing flood risk and impacts to residential buildings in Carrboro. It is intended to expand upon previous efforts to minimize the consequences to people and property when a flood occurs. It furthers risk-based mitigation planning and decision making and identifies strategic actions that reduce or eliminate flood risks. It is designed to be a resource to aid in identifying, prioritizing, and planning future flood mitigation projects.

The recommendations are intended to guide flood mitigation activities. Flood mitigation techniques are identified that are deemed to have the highest likelihood of being effective in reducing flood risk for individual properties and buildings. The flood impact factors deemed to be most important for property level risk assessment are: whether the impacts occur to the finished floor/living space, crawl space, mechanical/systems, basement, or outbuilding; frequency of flooding; and location within the floodplain. The following mitigation techniques have been identified and determined to be potentially the most appropriate in Carrboro:

1. Property Acquisition and Structure Demolition or Relocation; Re-sale
2. Structure Elevation
3. Abandon Basement and Fill
4. Wet or Dry Floodproofing of Structures
5. Protecting Service Equipment

Flood insurance through the National Flood Insurance Program (NFIP) remains the most direct financial assistance available to homeowners. Because the Town participates in the NFIP, all residents are eligible to purchase NFIP flood insurance, though only those officially located in the Special Flood Hazard Area (SFHA) are required to purchase it. Most homeowners become aware of NFIP flood insurance only when it becomes a requirement of their home purchase, as mortgages for homes in the SFHA cannot be backed by federal sources without flood insurance. However, other residents can benefit from the insurance. Additionally, the Federal Emergency Management Agency's (FEMA, the administrator of the NFIP) new Risk Rating 2.0 program has recalculated flood insurance rates in part based on distance from flooding source, so it will be an even more affordable and worthwhile investment for those potentially subject to occasional flooding but not located directly in a floodplain.

An opportunity exists to increase the community's awareness of the benefits of floodplains, the natural tendencies and characteristics of streams and creeks, the importance of maintaining riparian buffers, methods of reducing residential stormwater runoff, and the intersection between opportunities for ecosystem enhancement and reduction in flooding potential. Oftentimes, residents consider their backyard streams as "drainage ditches" with a purpose to convey water as quickly and directly as possible. An understanding of the function and benefit of natural stream behavior could lead to increased stewardship of the environment and increased functioning of ecosystem services. Additionally, residents can make changes to their residential properties that not only reduce the impact of intense precipitation events but also reduce their contribution to downstream runoff. In this way, individual lots, blocks, neighborhoods and sub-watersheds can cumulatively reduce their impact.

Prioritizing flood mitigation efforts should account for other community-based benefits and factors not necessarily implicit in flood risk reductions. These include:

- Potential public benefit (e.g., bike and ped facility; recreation; open space)
- Cost effectiveness
- Potential for riparian buffer, floodplain, or stream restoration/enhancement
- Adjacency to publicly owned land
- Ability to bundle multiple properties into one mitigation project.
- Property covered by NFIP policy

This report provides information that can be used to:

- Identify properties at greatest flood risk
- Identify mitigation strategies
- Prioritize projects
- Highlight potential eligibility for FEMA grants

In addition, the information contained herein will help increase the public's awareness of flood mitigation approaches and make more informed decisions that could reduce their individual flood risk. As implementation is pursued, Carrboro will become more flood resilient.

Table of Contents

List of Tables

List of Figures

Section 1 Introduction

1.1 Background

The Town aims to serve its citizens by reducing the potential for flood related damages, while enhancing the natural and beneficial functions of the floodplain. The Town's intention is to support the reduction in flood risk to people and property by enforcing floodplain regulations, maintaining floodplain maps, flood related emergency response, assessing flood risk, mitigation planning, supporting flood hazard mitigation projects when possible, and pursuing green stormwater infrastructure projects and nature based stormwater solutions.

The history of flood mitigation activities in Carrboro including experience with FEMA's grant mitigation program provides the basis for and an opportunity to reevaluate approaches to reduce the flood risk. The recommendations provided herein, therefore, are not necessarily focused on properties that meet FEMA's cost-benefit and other eligibility criteria. Rather, recommendations are offered on how to identify, consider and prioritize future mitigation projects. Note also that this document is a companion to the Flood Resilience Framework report under development.

1.2 Purpose

The purpose of this report is to recommend a comprehensive range of flood mitigation techniques to assist private property owners, Town officials and staff in making informed decisions about flood mitigation. In short, the intention is to assist in identifying, prioritizing, and planning future flood mitigation projects. It is also envisioned that its utility will evolve for specific parcels and need to be updated when new data becomes available. Examples of data that can change over time include property specific data such as Elevation Certificates, parcel information, and building footprints, as well as hazard-specific data such as flood hazard maps

1.3 Goals and Objectives

This report is designed to support dynamic, continuously updated planning. The specific longer term/bigger picture goals are shown in **Figure 1**.

Figure 1: Goals and Objectives Graphic

Section 2 Flood Risk Assessment

2.1 Flood Risk and Impacts

Flood risk is defined as the likelihood of an event occurring (probability) as well as the consequences/impacts (financial, personal, and property damage) that occur. Flood risk has been qualitatively assessed from low risk to highest risk. The ***flood impacts*** are the specific types of damage that could occur as a result of flooding. The flood impacts identified in this plan are the specific consequence that could result from the flood water. Examples of flood impacts include flooding in the living space of a house, flooding of an outdoor heating or air conditioning unit, or damage to personal property such as a car. Not all impacts are directly related to property damage but have equally devastating consequences, such as the closing of a flooded street or the inability of a homeowner to leave a house surrounded by flood water.

There are six categories of residential flood impacts identified and described below. Note that the following discussion is premised on the federal floodplain management program, and by reference, Carrboro's participation in the National Flood Insurance Program. It is not intended to suggest interpretations that extend beyond this program.

A. Flooding Above the Lowest Floor of a Building

Flooding above the lowest floor of a building can cause varying levels of damage to a structure. Even a small amount of flood water inside a house can damage flooring and cabinets. Higher levels of flooding can cause serious damage to sheet rock, doors, and the building's electrical systems. Long-term flooding can also result in mold and mildew that can lead to serious health issues. In practice, the profession of floodplain manage assesses the risk based on the flood water elevation computed using the most up to date HEC-RAS models or Flood Profiles included in the Flood Insurance Study (FIS), and this elevation exceeds the lowest floor elevation of the building as indicated on an Elevation Certificate (see **Figure 2**).

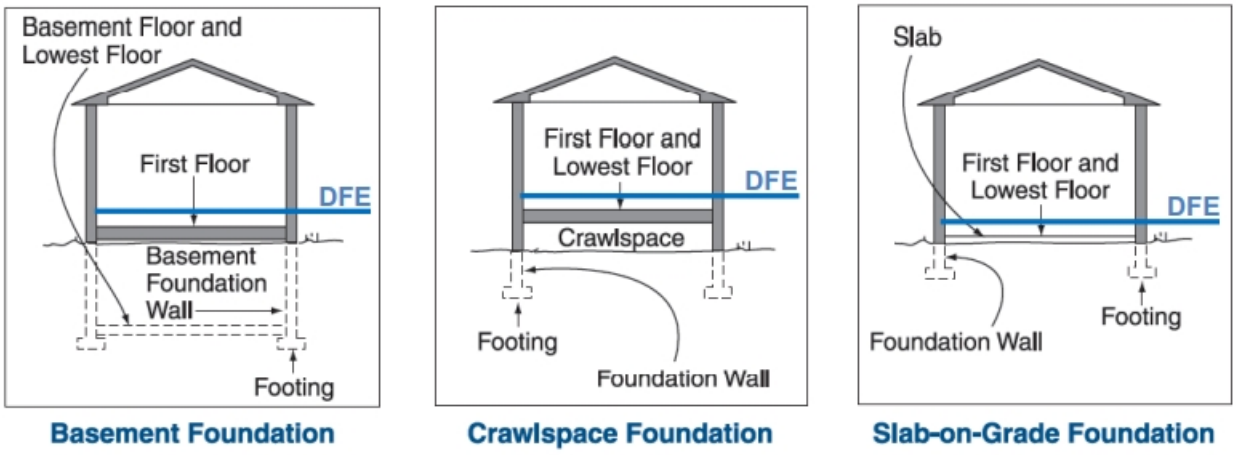


Figure 2: Examples of Flooding Above the Lowest Floor (Source: FEMA P-312)

B. Flooding of Electrical and/or Mechanical Equipment

Flooding of electrical and/or mechanical equipment can lead to costly repairs, render a residence temporarily uninhabitable, pose a fire hazard, and lead to other serious problems for a structure. This type of flooding occurs when the flood water elevation computed using the most up to date HEC-RAS models or Flood Profiles included in the Flood Insurance Study exceeds the elevation of electrical or mechanical equipment but is below the lowest floor elevation as indicated on an Elevation Certificate (see **Figure 3**). In situations where the elevation of the electrical or mechanical equipment is not available, an assumed elevation will be determined based on the foundation type, finished floor elevation, and the elevation of the lowest adjacent grade.

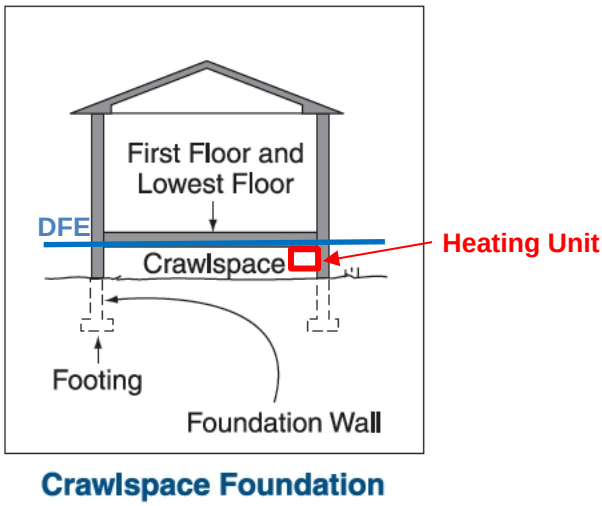


Figure 3: Example of Mechanical Equipment Flooding –
DFE is Design Flood Elevation (Source: FEMA P-312)

C. <u>Flood Water is Touching a Portion of the Building</u>

Flood water, even if touching only a corner or portion of a building, can still cause damage, although to a lesser degree in most cases. This type of flooding occurs when the flood water elevation computed using the adopted HEC-RAS models or Flood Profiles included in the Flood Insurance Study exceeds the elevation of the Lowest Adjacent Grade indicated on an Elevation Certificate, but below the elevation of the electrical and mechanical equipment, and lowest floor (see **Figure 4**).

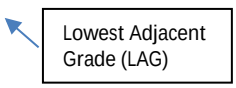
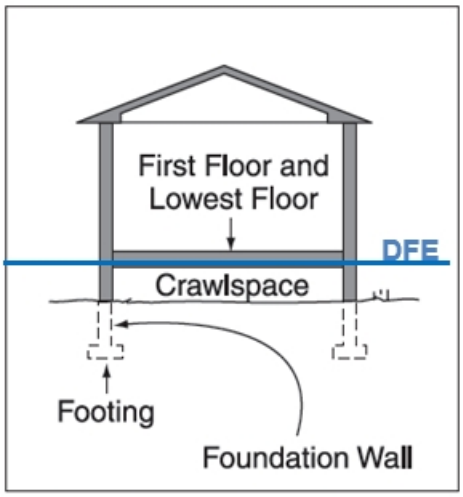
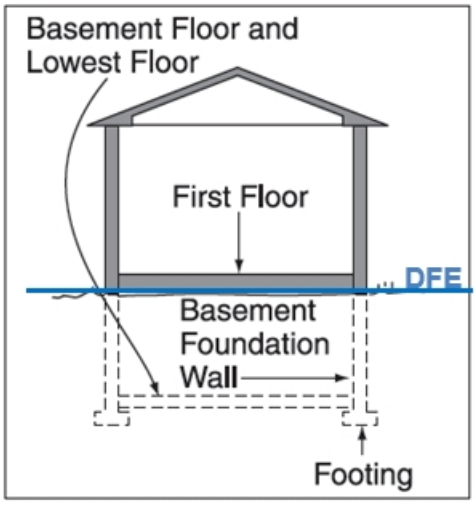


Figure 4: Example of Crawlspace Flooding (left) and Basement Flooding (right) -- DFE
is Design Flood Elevation (Source: FEMA P-312)



Crawlspace Foundation



Basement Foundation

D. <u>Flood Water is Touching a Portion of the Building AND has Structural Damage as a Result of Cumulative Flooding</u>

Repeated flooding of a building can weaken, distort, and compromise the integrity of a structure. It is important to consider the cumulative effects of multiple flood events on a structure even if these effects are not immediately apparent. A property satisfies this condition if the building has reported and verified damage such as cracking or potential damage from subsidence or shifting soil caused by flooding.

E. <u>Flooding of Exterior Property Improvements (Moderate or Significant)</u>

Exterior property improvements can represent substantial investments by property owners. These should be considered when assessing the potential impacts of a flood. This criterion only applies to single-family residential properties and is based on exterior property improvements that are deemed functional necessities to reasonable use of single-family properties.

F. <u>Yard Flooding</u>

Yard flooding is the least severe type of flooding but is worthy of consideration. Flood water on the property could: pose a safety hazard to children and pets; flood water standing for long periods of time can become a habitat for mosquitoes; and yard flooding can hinder access to the structure and cause damage to landscaping and other investments. This type of flooding occurs when the latest adopted Flood Insurance Rate Map (FIRM) indicates that the yard or open space area is flooded, but the flooding does not impact any structures including garages, sheds, or other storage buildings (see **Figure 5**).

Figure 5: Yard Flooding

2.2 Probability of Occurrence

Risk assessment should also account for the likelihood that a particular impact could occur. The estimated flood elevations are founded on a statistical analysis of the likelihood that a watershed will receive enough rain over a certain period of time (24 hours) to produce storm water runoff sufficient to reach a flood level equal to or exceeding a certain elevation in any given year. An example of this concept is the "100-year storm event." The 100-year storm event predicts that in any given year there is a 1 percent chance that there will be enough rain to produce flood levels equal to or exceeding a specified level during a 24-hour time period. The recurrence interval is an annualized probability. There is a 1 percent chance that a 100-year storm will occur during any given year. The storm event recurrence intervals that are typically used to quantify the probability of flood impacts are listed in **Table 1.** It is worth noting that there are active efforts in the profession to determine how to best account for changing precipitation regimes associated with climate change.

Table 1: Storm Event Recurrence Intervals/Annualized Probability

Storm Event	Percent Annual Chance
2-year	50%
5-year	20%
10-year	10%
25-year	4%
50-year	2%
100-year	1%
500-year	0.2%

It is beyond the scope of this report to model, map and present property specific risk associated with each of these storm events.

2.3 Assessing Flood Impacts

As an initial assessment that integrates flood risks, impacts, probabilities, and location as described in the previous sections, qualitative scoring was used to represent the severity of the flood impact. **Table 2** contains the ranking which presumes that lesser impacts are implicit in categories with more severity. For instance, a building with flooding of the living space will also have water touching the

building and yard flooding at a minimum.

Table 2: Flood Severity and Impacts

Severity	Flood Impacts
Most severe	Flooding above the lowest **finished floor** of a building
Severe	Flood water is touching a portion of the building AND has structural damage (subsidence, shifting, cracking) as a result o
Moderately severe	Flooding of electrical and/or mechanical equipment
	Flood water is touching a portion of the building (likely **crawlspace or unfinished basement** being impacted) without structural damage
	Flooding of **SIGNIFICANT exterior property improvements** which are deemed functional necessities to reasonable use of single-family residential property (see separate guidelines)
Less severe	Flooding of **MODERATE exterior property improvements** which are functional necessities to reasonable use of single-family residential property
Least severe	Flooding of **yard** (outdoor area only, any portion of parcel) without impacting property improvements

Section 3 Flood Risk Reduction

3.1 Purpose

Flood risk reduction can be accomplished through "structural" or "engineered" stormwater management approaches related to how runoff moves through a watershed, *and/or* by reducing the consequences/impacts that will result when flooding does occur. The former can also be referred to as "stormwater" measures and the latter as "flood mitigation" measures. In addition and generally speaking, it is rare to find one specific mitigation technique that is appropriate for all flood-prone structures within a community or area of concern. Some techniques, such as acquisition/demolition (buyout), can address the worst-case properties. However, it is also necessary to evaluate a broader range of techniques to arrive at an optimal palette of risk reduction recommendations. For the purposes of this plan, 12 mitigation techniques have been identified and determined to be worth consideration.

Some of these mitigation techniques may provide a complete solution for an individual property by eliminating flood risk, while others may be partial solutions by reducing flood risk. Acquisition/demolition, for example, removes the structure and its inhabitants from that particular hazard area, thus eliminating the flood risk. Elevation, however, simply *reduces* the flood risk because the structure and its inhabitants are still located in the same hazard area.

3.2 Flood Mitigation Techniques

The term ***flood mitigation technique*** is used to describe a specific project type that could be used in a given situation to reduce flood risk. Many properties will have more than one flood hazard mitigation technique that can be employed to reduce or eliminate the flood risk.

It is also important to note that these are *planning level* recommendations and subject to further study for any given property. Twelve mitigation techniques have been deemed most appropriate for Carrboro and are described in detail in the following sections. The actual appropriateness of implementing each technique varies from property to property due to a number of site-specific factors.

3.2.1 Property Acquisition and Structure Demolition (Buyout)

Property acquisition and structure demolition involves the purchase of a flood-prone structure and underlying land and demolition of the structure by a demolition contractor. The flood- prone structure is demolished and the debris is removed from the site. The site is graded to accommodate local runoff and vegetation planted. When FEMA funds are used to purchase the property, the property is deed-restricted in perpetuity as open space to preserve the natural function of the floodplain.

Possible funding sources include:

- FEMA Eligible Activity
- NFIP ICC Fund if eligible

Advantages of this technique include:

- Completely removes people and property from the flood risk
- Property is available for use as open space, greenway, park, water quality project or other similar uses
- Removal of structure and impervious surfaces reduces runoff and improves water quality in

the watershed.

Disadvantages of this technique include:

- Purchase of the land and building and paying for demolition is costly
- Government owned land is removed from the tax base
- A large portion of the demolition debris is taken to a landfill
- If purchased with FEMA funds, land must be used as open space; the property cannot be resold.

Criteria could include:

- Structure is pre-FIRM or post-FIRM with a finished floor elevation lower than the Flood Protection Elevation[1]
- Property is located adjacent to publicly owned land
- Any part of the structure is in a water quality buffer
- Property is located at a potential water quality capital improvement site
- Property is in area needed for planned public use/benefit

Applicability

Buyout opportunities depend on property owner interest, future federal declarations, funding availability, and alignment with other Town interests.

3.2.2 Structure Demolition and Rebuild (Demo Rebuild)

Structure demolition and rebuild involves the demolition of a flood-prone structure and the construction of a floodplain regulatory compliant structure on the same property. The rebuilt structure is either located outside the floodplain on the same parcel or built above the Flood Protection Elevation (FPE) inside the floodplain and is compliant with the Floodplain Ordinance.

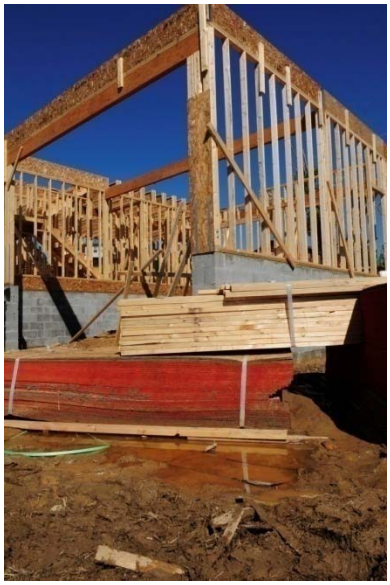


Figure 6: Example of a Demo Rebuild Project

Possible funding sources include:

- FEMA Eligible Activity
- Private/Owner
- Community Development Block Grant

Advantages of this technique include:

- Decreases the flood threat to people and property
- Less expensive than demolition or relocation because the government does not purchase the land and building
- Property remains in the tax base

Disadvantages of this technique include:

- Does not completely eliminate flood risk for people and property

[1] The Flood Protection Elevation, or FPE, is defined as the 100-year flood elevation plus 1 foot of freeboard.

- The property is not available for public uses such as open space, greenway, park, water quality project or other similar uses
- Does not improve water quality by removing impervious surface from the watershed
- A storm event with a flood elevation greater than the FPE would cause damage

Criteria include:

- Land area outside the FEMA Floodway is large enough to accommodate 1.5x the footprint of the structure (to account for setbacks)
- Land area outside the high velocity zone is 1.5x the footprint of the structure
- Land area outside the water quality buffer is large enough to accommodate 1.5x the footprint of the structure
- Building tax value could be chosen below some threshold
- Building grade could be chosen as Below Average
- Land tax value could be chosen as some multiplier of the building tax value
- Property is not surrounded by water during the FEMA Base Flood
- Property is not located in critical needs area of potential land needed for public benefit

Applicability:

- Must be a Severe Repetitive Loss property to be eligible for FEMA funds.

3.2.3 Property Acquisition and Structure Relocation (Relocation)

Property acquisition and structure relocation involves the purchase of the land underlying a flood-prone structure and relocating the structure to a location outside the floodplain. When public funds are available, a local government entity may acquire the land. The structure would be moved to a location outside the floodplain and remains the property of a private owner. The private owner bears the cost of acquiring a new parcel for the structure and the local government entity may bear the structure relocation costs.

When FEMA funds are used to purchase the land, the flood-prone land must be deed-restricted in perpetuity as open space to preserve the natural function of the floodplain.

Possible funding sources include:

- FEMA Eligible Activity
- Private/Owner
- NFIP ICC fund if eligible

Figure 7: Example of House Relocation

Advantages of this technique include:

- Completely removes people and property from the flood risk
- Property is available for use as open space, greenway, park, water quality project or other similar uses
- Relocation is a reuse of the building—no demolition debris for the landfill
- Less costly than acquisition and demolition

Disadvantages of this technique include:

- Government owned land is removed from the tax base
- If purchased with FEMA funds, land must be used as open space—cannot resale land
- Difficulty in transporting building from existing lot to a new lot
- Structure probably needs to be single story (no split levels or multi-story)

Criteria include:

- Structure is pre-FIRM or structure is post-FIRM and has finished floor elevation lower than the Flood Protection Elevation
- Structure foundation is not slab-on-grade
- Structure does not have masonry walls (Cement Block/Split-Face Block, Concrete block, Jumbo/Common Brick, Precast Panel, Reinforced Concrete, or Stone)
- Building tax value needs to meet a minimum threshold
- Structure footprint needs to be below a threshold to be practical, e.g., ≤ 2000 sf

Applicability:

- New building site must be outside the Special Flood Hazard Area.

3.2.4 Property Acquisition, Demolition or Relocation, and Re-sale (Buyout Resale)

Property acquisition, demolition or relocation, and re-sale involves the purchase of a flood-prone structure and underlying land and the demolition or relocation of the structure to a location outside the floodplain. When public funds are available, a local government entity may acquire the land for resale later. There would be no deed restriction on the deed that passes from the private property owner to the government entity. Therefore, the government entity could potentially sell the portion of the property that is outside the floodplain and retain the portion inside the floodplain.

Possible funding sources include:

- Private/Owner
- Community Development Block Grant

Advantages of this technique include:

- Completely removes people and property from the flood risk
- When government is involved, portion of property retained by the government is available for use as open space, greenway, park, water quality project, affordable housing, or other similar uses
- When government is involved, portion of property sold to private owner remains in the tax base
- When government is involved, government recoups some of the expense for purchase and demolition or relocation by the sale of a portion of the property

Disadvantages of this technique include:

- Initial cost is high to purchase the property and demolish or relocate the building
- Demolition produces debris for the landfill
- Relocation requires a willing buyer for the structure
- Cannot obtain a FEMA grant for this type of project
- Government owned portion of the property is removed from the tax base

Applicability:
It is currently uncertain as to if this could be an appropriate measure. See notes also for a simple Buyout without resale.

3.2.5 Structure Elevation (Elevation)

Structure elevation consists of physically raising the lowest finished floor of an existing structure to an elevation above the Flood Protection Elevation (FPE). Elevation may be achieved by a variety of methods including piles, posts, and columns, or elevating on fill. Foundations must be designed to properly withstand all loads. The elevated structure must be properly anchored to the foundation and utilities must be elevated above the FPE.

Figure 8: House During Elevation Process

Possible funding sources include:

- FEMA Eligible Activity
- Private/Owner
- NFIP ICC fund if eligible

Figure 9: Completed Elevation of House

Advantages of this technique include:

- Decreases the flood threat to people and property
- Less expensive than demolition or relocation because the government does not purchase the land and building
- Less disruptive to the property owners
- Does not add debris to the landfill
- Property remains in the tax base

Disadvantages of this technique include:

- Does not completely eliminate flood risk for people and property
- The property is not available for public uses such as open space, greenway, park, water quality project or other similar uses
- Requires more coordination time between the Town staff and property owners
- Does not improve water quality by removing impervious surface from the watershed
- A storm event with a flood elevation greater than the FPE would cause damage

Criteria could include:

- Structure is not located in an area with high-velocity flows
- Structure is outside the FEMA Floodway
- Structure is not a split-level
- Elevation height is 0-9 ft. (FPE - FFE = 0-9 ft.)
- Structure is located outside any water quality buffer
- Structure foundation is not slab-on-grade
- Building tax value is above a minimum threshold
- Land tax value is < some multiplier of the building tax value
- Structure is not surrounded by flood water during the FEMA Base Flood
- Property is not located in critical needs area of planned greenway, park, or other public infrastructure/amenity

Applicability:
There are currently homes with elevation certificates in Carrboro. Most of these are in Weatherhill Point. Several are located adjacent to Toms Creek. It is possible other homes would benefit by being elevated.

3.2.6 Abandon Basement and Fill (Fill Basement)

Abandon basements and fill involves raising the lowest finished floor of an existing structure to an elevation above the Flood Protection Elevation (FPE) by converting the finished basement to crawlspace. This may be achieved by abandoning the basement and filling to create a crawlspace. Fill would be needed around the exterior perimeter of the foundation. The structure must be modified to allow filling in basement and utilities must be elevated above the FPE.

Possible funding sources include:

- FEMA Eligible Activity
- Private/Owner

Advantages of this technique include:

- Decreases the flood threat to people and property
- Less expensive than acquisition, demolition or relocation because the government does not purchase the land and building
- Less disruptive to the property owners
- Does not add debris to the landfill
- Property remains in the tax base

- Results in a fully compliant building

Disadvantages of this technique include:

- Does not completely eliminate flood risk for people and property
- The property is not available for public uses such as open space, greenway, park, sanitary sewer project, water quality project or other similar uses
- Does not improve water quality by removing impervious surface from the watershed
- A storm event with a flood elevation greater than the FPE would cause damage

Criteria include:

- Structure is not located in an area with high-velocity flows
- Structure is outside the FEMA Floodway
- Structure has a basement
- Next Higher Floor is ≥ FPE
- Structure is located outside any water quality buffer
- Property is not surrounded by water during the FEMA Base Flood
- Structure is not surrounded by flood water during the FEMA Base Flood
- Property is not located in critical needs area of planned greenway, park, sanitary sewer line, or water line
- Property is not located at a potential water quality capital improvement site

Applicability:

- Not a typical FEMA technique
- There are several homes with basements in the floodplain.

3.2.7 Dry Floodproofing of Structures (Dry Floodproofing)

Dry floodproofing of a structure involves making any area below the Flood Protection Elevation (FPE) watertight to prevent floodwater from entering the structure. The walls must be made watertight with waterproof coatings, impermeable membranes, and/or supplemental layers of concrete or masonry. Any windows, doors, or other openings must be equipped with permanent or removable shields. Water and sewer lines must be equipped with backflow preventer valves. All mechanical and electrical equipment must be flood protected either by a floodproofing enclosure or by elevating above the FPE.

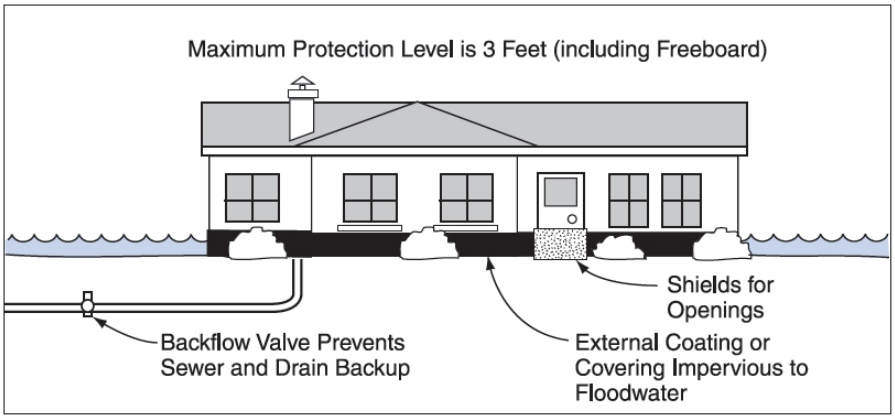


Figure 10: Example of Dry Floodproofing (Source: FEMA P-312)

Possible funding sources include:

- FEMA Eligible Activity
- Private/Owner
- NFIP ICC fund if eligible

Advantages of this technique include:

- Reduces the flood risk to property
- Businesses can remain open providing employment
- Property and building remain in the tax base

Disadvantages of this technique include:

- Does not reduce the flood risk to people
- Reduces but does not eliminate flood risk to property
- Property is not available for use as open space, greenway, park, water quality project or other similar uses
- May be cost prohibitive if foundation modifications are involved
- A storm event with a flood elevation greater that the FPE may cause damage

Criteria include:

- For residential pre-FIRM, the Lowest Floor is not necessarily above the FPE; for residential post-FIRM, the Lowest Floor is above the FPE
- Top of foundation wall is $\leq$ 3 ft above adjacent grade
- Flood depths are $\leq$ 3 ft
- Structure does not have a basement
- Structure has masonry or masonry veneer type walls (Cement Block/Split-Face Block, Concrete Block, Face Brick, Jumbo/Common Brick, Precast Panel, Reinforced Concrete, Stone, Brick, Brick Face)
- Structure is not surrounded by flood water during the FEMA Base Flood
- Structure is located outside any water quality buffer
- Property is not located in critical needs area of planned greenway, park or other public infrastructure or amenity
- Property is not located at a potential water quality capital improvement site

Applicability:

- FEMA funding is limited to non-residential or historic residential buildings
- Does not reduce NFIP insurance premium, and may result in an increase

3.2.8 Wet Floodproofing of Structures (Wet Floodproofing)

Wet floodproofing of a structure is accomplished by modifying the areas of an existing structure to allow water to enter the space, but not cause significant damage. Water is allowed to enter the impacted area such as a crawl space to equalize the hydrostatic pressure. The area that is inundated during the flood event must be made to properly drain when the flood water recedes. All construction and finish materials in the inundated areas must be flood resistant materials.
Another element of wet floodproofing is the relocation of mechanical and electrical equipment above

the Flood Protection Elevation (FPE) or the construction of a floodwall around the equipment for protection during flooding.

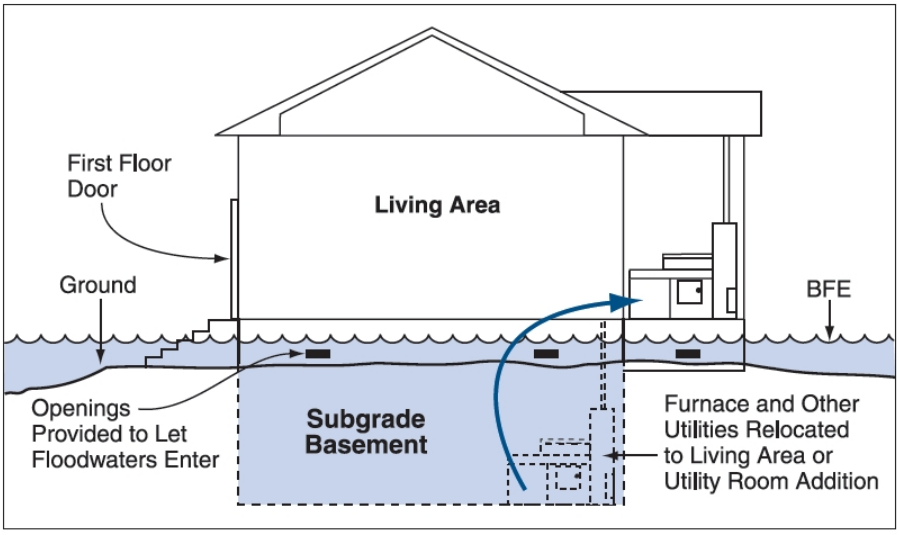


Figure 11: Example of Wet Flo odproofing (Source: FEMA P-312)

Possible funding sources include:

- Private/Owner

Advantages of this technique include:

- Reduces the flood risk to property
- Businesses may remain open providing employment
- Property and building remain in the tax base

Disadvantages of this technique include:

- Does not reduce the flood risk to people
- Reduces but does not eliminate flood risk to property
- Property is not available for use as open space, greenway, park, sanitary sewer project, water quality project or other similar uses
- May be cost prohibitive if foundation modifications are involved
- May not protect personal property such as vehicles in the parking lot are not protected
- A storm event with a flood elevation greater than the FPE would cause damage

Criteria include:

- Structure foundation is not slab-on-grade
- Structures does not have a finished basement
- FEMA Base Flood Elevation is < 8 ft above the Lowest Floor (basement) or LAG (crawlspace)
- Finished Floor Elevation is higher than FEMA Base Flood Elevation
- Structure is not located in an area with high-velocity flows
- Structure is located outside the FEMA floodway
- Structure is surrounded by flood water during the FEMA Base Flood
- Structure is located outside any water quality buffer

- Structure is located outside the Community Encroachment Area
- Any part of the structure is located within the FEMA floodplain
- Property is not located in critical needs area of planned greenway, park, sanitary sewer line, or water line
- Property is not located at a potential water quality capital improvement site

3.2.9 Storm Water Detention Facilities (Detention)

Storm water detention facilities include the installation of basins to detain storm water during large storm events. The detention basin reduces peak flood levels downstream of the basin.
Storage of a large volume of water is necessary to have a significant impact on flood elevations during a large storm event. The detention facilities typically consist of offline storage areas directly adjacent to a stream. The storm water enters the detention facilities during more intense storms and slowly drains out of the basin using gravity operated outlet devices (no mechanical pumping systems). This technique is intended to reduce the potential flood damage to multiple structures and is not intended to benefit a single property. These projects are typically government funded because

Figure 12: Example of Dry Detention Basin

Figure 14: Example of Dry Detention Basin

detention facilities must be very large to reduce flood levels during a large storm event, but this does not preclude a private storm water detention project.

Possible funding sources include:

- FEMA Eligible Activity (however, unlikely)
- Local Government, *if cost-effective and the Town chooses to fund in the future*

Advantages of this technique include:

- Limited disruption to the people and property positively impacted by the detention facility
- Basins provide a water quality benefit by reducing storm water pollutants such as suspended solids

Disadvantages of this technique include:

- There are very limited opportunities available based on the build out/development in

Carrboro. Where these have been studied, they have not been found be effective or cost effective, nor to have a high likelihood of success implementation for multiple reasons

- Detention will reduce but not eliminate the flood risk downstream
- Requires open space adjacent to the stream for the detention basin
- The detention basin must be maintained

Criteria include:

- Area for detention basins must be publicly owned land
- Potential detention area should be located in or adjacent to publicly owned land
- Potential detention area should be located outside the FEMA Floodway
- Potential detention area should be located in area of planned greenway or park

3.2.10 Public Education (Public Education)

This mitigation technique consists of a multi-media public education campaign to inform owners of flood-prone properties of the flood risks and methods for protecting their lives and property. The focus of this effort is to teach the public strategies to protect themselves before, during, and after a flood event. Examples of the educational effort would include encouraging flood-prone property owners to purchase flood insurance, keeping storm drains clear of debris, avoiding flooded roads, etc. The education would be accomplished through broadcast media, the storm water website, flyers, and public meetings.

Figure 13: Example of Flood Safety Brochure

Possible funding sources include:

- Local Government

Advantages of this technique include:

- Engages a large number of people in the flood mitigation process
- Empowers individual property owners to make good decisions about flood risk and flood mitigation
- Builds support necessary to further identify and fund more active type mitigation projects
- Relatively inexpensive

Disadvantages of this technique include:

- This is not an active method of flood mitigation
- Cannot be assured that contact is made with every impacted property owner

Criteria include:

- The property is located in the watershed

3.2.11 Flood Insurance (Flood Insurance)

The goal is the purchase of flood insurance through the National Flood Insurance Program for all flood-prone properties. The Town encourages property owners to purchase flood insurance because it is one of the best methods for limiting the individual economic damage due to flooding. FEMA requires property owners to maintain flood insurance as a requirement of receiving flood mitigation grant funding.

Figure 14: Example of Flood Insurance Promotion Poster

Possible funding sources include:

- Private/Owner

Advantages of this technique include:

- This compensates individuals for economic losses due to flooding
- This is not an expense for the Town

Disadvantages of this technique include:

- This technique does not reduce flood risk to property by structural physical means and does not do anything to reduce risk to life
- Flood insurance may provide a false sense of security

Criteria include:

- None – Any property in Carrboro is eligible to purchase NFIP flood insurance. Homes in the Special Flood Hazard Area are required to purchase it, but it is available to all.

3.2.12 Protecting Service Equipment (HVAC, utilities) (Protecting Equipment)

Protecting service equipment involves elevating, relocating, or protecting them in place. Service equipment installed outside the structure can be raised on pedestals or platforms to an elevation above the Flood Protection Elevation (FPE).
Service equipment located in a basement or other area below the flood level can be relocated to an upper floor, attic, or higher ground. Water and sewer lines can be protected with backflow preventer valves. If elevating and relocation are not possible, protecting service equipment in place may be done with low floodwalls and shields, and anchors and tie downs for aboveground and underground storage tanks.

Figure 15: Example of Elevated Utilities

Possible funding sources include:

- Private/Owner

Advantages of this technique include:

- Reduces the flood risk to property
- Property and building remain in the tax base

Disadvantages of this technique include:

- Does not reduce the flood risk to people
- Reduces but does not eliminate flood risk to property

Criteria include:

- Service equipment elevation is below the FEMA Base Flood Elevation
- FFE of main structure is above the FEMA Base Flood Elevation
- Structure is located outside the FEMA Floodway

Applicability:

- FEMA HMA funding may be available if other mitigation options are evaluated and are not feasible or cost-effective
- Data on equipment elevations for all flood prone properties is not currently available.

Section 4 Flood Mitigation and Risk Reduction Recommendations

The purpose of this section is to synthesize and integrate the information from the previous sections into specific recommendations deemed to be the most relevant for Carrboro.

1) The risk reduction and flood mitigation techniques contained in this report are intended to be used as a guide to the most effective action(s) for reducing or eliminating flood risk to buildings and properties at risk. Some actions may also lead to lower flood insurance premiums and can make properties more valuable.
2) Acquisition is the most expensive option. From a public perspective, any ability to pair an acquisition project with a public benefit could both address the need for a public purpose associated with the expenditure of funds as well as provide a more favorable benefit/cost ratio. "Buyout resale" is a version of acquisition in which costs can be recouped.
3) Demolition/rebuild and relocation are mitigation options that, while not exclusively so, may be able to be pursued more expeditiously and appropriately in the private sector.
4) Floodproofing, whether wet or dry, is generally less expensive than the above options. It is also an approach that does not lend itself as well to public expenditure since only private benefits are realized.
5) For any given flood prone property, one or more of the techniques may be worthy of further evaluation. The applicability of any given technique will depend on factors including but not limited to:
    a. First and foremost, the interest of the property owner in the technique;
    b. Financial considerations such as:
        i. Cost;
        ii. Government funding (availability/timing, ease of pursuing funding, cost sharing, etc.);
    c. Other advantages, disadvantages, criteria, and applicability discussed for each of the techniques.
6) Not all mitigation activities have to be identified, driven, and/or funded by government entities, whether Federal, state, or local. Property owners place large investments in their property and are essentially the primary stakeholder.
7) At the same time, an important barrier for some property owners to further consideration of these techniques has been affordability and access to government financial support. On the government side, the necessary policy and financial instruments need to be in place. In considering Town funding, the ability of a specific mitigation action to create a public benefit will be important.
8) The Center for Neighborhood Technology's RainReady study recommended creation of a new residential assistance program focusing on green infrastructure practices. Town staff have been taking steps that could help support a future program that could potentially both address on property flooding concerns as well as watershed wide interests if enough residents choose to pursue green infrastructure practices. This approach is different from but complimentary to the focus of this report.

Section 5 References

Homeowner's Guide to Retrofitting Six Ways to Protect Your Home from Flooding. FEMA P-312, 3rd Edition / June 2014. Available at https://www.fema.gov/sites/default/files/2020-08/FEMA_P-312.pdf

Appendix A: Acronyms and Definitions

This plan uses terms, phrases, and acronyms that may have different meanings to different readers. The following is a list of terms and definitions that may be useful in understanding key concepts of this document.

Base Flood: A flood having a 1% chance of being equaled or exceeded in any given year.

Base Flood Elevation: The elevation of surface water resulting from a flood that has a 1% chance of equaling or exceeding that level in any given year. The BFE is shown on the Flood Insurance Rate Map (FIRM) for zones AE, AH, A1–A30, AR, AR/A, AR/AE, AR/A1– A30, AR/AH, AR/AO, V1–V30, and VE.

Basement: Any area of the building, having its floor subgrade (below ground level on all sides).

BCA: Benefit-Cost Analysis

BCR: Benefit-Cost Ratio

Building: Any structure built for support, shelter, or enclosure for any occupancy or storage.

CIP: Capital Improvement Program

Community Base Flood: The flood determined using future land use conditions having a 1% chance of being equaled or exceeded in any given year.

Community Base Flood Elevation: The elevation shown on the Flood Insurance Rate Map Flood Hazard Data Table, having a 1% chance of being equaled or exceeded, determined using future land use conditions.

Community Development Block Grant: The Community Development Block Grant (CDBG) program is a flexible program that provides communities with resources to address a wide range of unique community development needs. Beginning in 1974, the CDBG program is one of the longest continuously run programs at HUD. The CDBG program provides annual grants on a formula basis to 1209 general units of local government and States.

Community Encroachment Area: The channel of a stream or other watercourse and the adjacent land areas that must be reserved in order to discharge the FEMA Base Flood without cumulatively increasing the water surface elevation more than 0.1 foot.

Community Floodplain: This shows where flooding is likely to occur in the future, based on expected development upstream.

FEMA: Federal Emergency Management Agency

FEMA Base Flood: The flood determined using land use conditions at the time of the study having a

1% chance of being equaled or exceeded in any given year.

FEMA Base Flood Elevation (BFE): The elevation shown on the Flood Insurance Rate Map and Flood Insurance Study Profile that indicates the water surface elevation resulting from a FEMA Base Flood that has a 1% chance of equaling or exceeding that level in any given year.

FEMA Floodway: The channel of a river or other watercourse and the adjacent land areas that must be reserved in order to discharge the FEMA Base Flood, without cumulatively increasing the water surface elevation more than 0.5 foot. On the Catawba River, and the portions of Six Mile Creek and Rocky River which run along the county boundary line, the FEMA Floodway means the channel of a stream or other watercourse and the adjacent land areas that must be reserved in order to discharge the FEMA Base Flood, without cumulatively increasing the water surface elevation more than 1.0 feet.

First Floor Elevation (FFE): This is the elevation of the top of the lowest finished floor of the structure being studied. Also referred to as Finished Floor Elevation.

Flood or Flooding: A general and temporary condition of partial or complete inundation of normally dry land areas from:

1. The overflow of inland or tidal waters; and/or

2. The unusual and rapid accumulation of run-off of surface waters from any source.

Flood Insurance Rate Map (FIRM): An official map of a community, in both digital and printed format, on which the Federal Emergency Management Agency has delineated the Special Flood Hazard Area and the risk premium zones applicable to the community.

Flood Insurance Study (FIS): A compilation and presentation of flood risk data for specific watercourses, lakes, and coastal flood hazard areas within a community. When a flood study is completed for the NFIP, the information and maps are assembled into an FIS. The FIS report contains detailed flood elevation data in flood profiles and data tables.

Flood Mitigation: Action(s) taken to reduce or eliminate long-term risk to life and property from a flood event.

Flood Mitigation Plan: A plan that identifies flood risks and mitigation actions to reduce or eliminate long-term risk to life and property from flooding.

Flood Protection Elevation (FPE): The elevation to which all structures located within the Community Special Flood Hazard Area must be elevated (or floodproofed if non-residential). Within areas where Base Flood Elevations (BFEs) have been determined, this elevation shall be the Community Base Flood Elevation plus one (1) foot of freeboard (except along the Catawba River where it is the FEMA Base Flood Elevation plus two (2) feet of freeboard). In areas where no BFE has been established, all structures and other development must be elevated (or floodproofed if non-residential), to two (2) feet above the highest adjacent grade. For the purposes of this plan, this will be based on the Community Base Flood Elevation plus one (1) foot of freeboard.

Flood Risk: The likelihood and impacts/consequences (financial, personal, and property damage) resulting from a flood.

Floodplain: Any land area susceptible to being inundated by flood waters from any source.

Floodproofing: Any combination of structural and nonstructural additions, changes, or adjustments to structures, which reduce or eliminate risk of flood damage to real estate or improved real property, water and sanitation facilities, or structures with their contents.

Floodway: Is either the FEMA Floodway or the Community Encroachment Area.

Freeboard: The height added to the Community Base Flood Elevation (BFE) to account for the many unknown factors that could contribute to flood heights greater than the height calculated for a selected size flood and floodway conditions, such as wave action, blockage of bridge openings, and the hydrological effect of urbanization of the watershed. The Community Base Flood Elevation (BFE) plus the freeboard establishes the "Flood Protection Elevation."

Historic Structure: Any structure that is:

1. listed individually in the National Register of Historic Places (a listing maintained by the U.S. Department of Interior) or preliminarily determined by the Secretary of Interior as meeting the requirements for individual listing on the National Register;

2. certified or preliminarily determined by the Secretary of Interior as contributing to the historical significance of a registered historic district or a district preliminarily determined by the Secretary to qualify as a registered historic district;

3. individually listed on a local inventory of historic landmarks in communities with a Certified Local Government (CLG) Program"; or

4. certified as contributing to the historical significance of a historic district designated by a community with a "Certified Local Government (CLG) Program".

Increased Cost of Compliance (ICC): The National Flood Insurance Program (NFIP) includes this coverage for all new and renewed Standard Flood Insurance Policies. Policyholders can get up to $30,000 to help pay the costs to bring their home or business into compliance with their community's floodplain ordinance.

Lowest Floor: The lowest floor of the lowest enclosed area (including the basement). An unfinished or flood-resistant enclosure, usable solely for parking of vehicles, building access or storage in an area other than a basement area, is not considered a building's Lowest Floor provided that such enclosure is not built so as to render the structure in violation of the applicable non-elevation design requirements of this ordinance.

Lowest Mechanical Equipment (LME): The lowest elevation height of mechanical and/or electrical equipment, such as air conditioners, furnaces, hot water heater, etc.

Lowest Adjacent Grade: The elevation of the ground, sidewalk, or patio slab immediately next to a building.

NFIP: National Flood Insurance Program

Repetitive Loss: Flood-related damages sustained by a structure on two (2) separate occasions during any 10-year period for which the cost of repairs at the time of each such flood event, on the average, equals or exceeds 25% of the Market Value of the structure before the damage occurred.

Severe Repetitive Loss (SRL): A residential property that is covered under an NFIP flood insurance policy and: (a) that has at least four NFIP claim payments (including building and contents) over $5,000 each, and the cumulative amount of such claims payments exceeds

$20,000; or (b) for which at least two separate claims payments (building payments only) have been made with the cumulative amount of the building portion of such claims exceeding the market value of the building. For both (a) and (b), at least two of the referenced claims must have occurred within any 10-year period and must be greater than 10 days apart.

Special Flood Hazard Area (SFHA): The 100-year, or 1-percent-annual-chance, flood zone.