NORTHERN VIRGINIA HAZARD MITIGATION PLAN

2017

Arlington County
Fairfax County
Loudoun County
Prince William County
City of Alexandria
City of Fairfax
City of Falls Church
City of Manassas
City of Manassas Park
Town of Dumfries
Town of Haymarket
Town of Herndon
Town of Leesburg
Town of Lovettsville
Town of Middleburg
Town of Purcellville
Town of Occoquan
Town of Round Hill
Town of Vienna

Appendix:
Appendix A – Crosswalk
Appendix B – Adoption Resolution
Appendix C – Meeting Documentation
Appendix D – HIRA Documentation
Appendix E – 2010 Mitigation Actions Update
Appendix F – Outreach Screenshots
Appendix G – NFIP Survey

Executive Summary

Mitigation is commonly defined as sustained actions taken to reduce or eliminate long-term risk to people and property from hazards and their effects. Hazard mitigation focuses attention and resources on community policies and actions that will produce successive benefits over time. A mitigation plan states the aspirations and specific courses of action that a community intends to follow to reduce vulnerability and exposure to future hazard events. These plans are formulated through a systematic process centered on the participation of citizens, businesses, public officials, and other community stakeholders.

The area covered by this plan includes:

Participating Communities	
Counties	**Towns**
Arlington County	Town of Dumfries
Fairfax County	Town of Haymarket
Loudoun County	Town of Herndon
Prince William County	Town of Leesburg
Cities	Town of Lovettsville
City of Alexandria	Town of Middleburg
City of Fairfax	Town of Purcellville
City of Falls Church	Town of Occoquan
City of Manassas	Town of Round Hill
City of Manassas Park	Town of Vienna

The additional contents of this Plan are designed and organized to be as reader-friendly and functional as possible. While significant background information is included on the processes used and studies completed (e.g., risk assessment, capability assessment), this information is separated from the more meaningful planning outcomes or actions (e.g., mitigation strategy, mitigation action plans).

Chapter 2, Planning Process, provides a complete narrative description of the process used to prepare the Plan. This includes the identification of who was involved, who participated on the planning team, and how the public and other stakeholders were involved. It also includes a detailed summary for each of the key meetings held along with any associated outcomes.

Chapter 3, Regional Information, describes the general makeup of the Northern Virginia region, including prevalent geographic, demographic, and economic characteristics. In addition, transportation, housing, and land-use patterns are discussed. This baseline information provides a snapshot of the regional planning area and thereby assists county and municipal officials to recognize those social, environmental, and economic factors that ultimately play a role in determining community vulnerability to natural hazards.

The Regional Hazard Identification and Risk Assessment (HIRA) is presented in Chapter 4. This section serves to identify, analyze, and assess the Northern Virginia region's overall risk to natural hazards. The risk assessment also attempts to define any hazard risks that may uniquely or exclusively affect the individual municipal jurisdictions.

The Risk Assessment builds on available historical data from past hazard occurrences, establishes detailed profiles for each hazard, and culminates in a hazard risk ranking based on conclusions about the frequency of occurrence, spatial extent, and potential impact of each hazard. FEMA's HAZUS^{MH} loss estimation methodology was also used in evaluating known hazard risks by their relative long-term cost in expected damages. In essence, the information generated through the risk assessment serves a critical function as communities seek to determine the most appropriate mitigation actions to pursue and implement — enabling communities to prioritize and focus their efforts on those hazards of greatest concern and those structures or planning areas facing the greatest risk(s). For the purposes of compliance with the Disaster Mitigation Act as further specified by Interim Final Rule 44 CFR Section 206.401(c)(2)(i), this Plan addresses in full only the following hazards: Flood, High Wind, Tornadoes, Winter Storms, Drought, Earthquakes, Landslides, Wildfire, Sinkholes, Dam Failure, and Extreme Temperatures. For the 2017 Plan update, extreme cold was removed from Winter Storms, and extreme heat was removed from Drought. Extreme Temperatures was examined as its own hazard.

The Capability Assessment, found in Chapter 5, provides a comprehensive examination of each participating jurisdiction's capacity to implement meaningful mitigation strategies and identifies existing opportunities to increase and enhance that capacity. Specific capabilities addressed in this section include planning and regulatory capability, staff and organizational (administrative) capability, technical capability, fiscal capability, and political capability. Information was obtained through a survey for local officials and an inventory and analysis of existing plans, ordinances, and relevant documents. The purpose of this assessment is to identify any existing gaps, weaknesses, or conflicts in programs or activities that may hinder mitigation efforts, and to identify those activities that should be built upon to establish a successful and sustainable regional hazard mitigation program.

The Regional Information, Risk Assessment, and Capability Assessment sections collectively serve as a basis for determining the goals for the Hazard Mitigation Plan; each contributing to the development, adoption, and implementation of a meaningful Mitigation Strategy that is based on accurate background information.

The Mitigation Strategy, found in Chapter 6, consists of broad regional goal and strategies. The regional mitigation actions were removed from the 2017 Plan and have been incorporated into the jurisdictional Mitigation Action Plans. The strategy provides the foundation for detailed jurisdictional Mitigation Action Plans, found in Chapter 7, that link specific mitigation actions for each jurisdiction to locally-assigned implementation mechanisms and target completion dates. Together, these sections are designed to make the Plan both strategic (through the identification of long-term goals), but also functional through the identification of short-term and immediate actions that will guide day-to-day decision-making and project implementation.

In addition to the identification and prioritization of possible mitigation projects, emphasis is placed on the use of program and policy alternatives to help make the communities of the

Northern Virginia region less vulnerable to the damaging forces of nature while improving the economic, social, and environmental health of the community. The concept of multi-objective planning was emphasized throughout the planning process, particularly in identifying ways to link hazard mitigation policies and programs with complimentary community goals related to housing, economic development, downtown revitalization, recreational opportunities, transportation improvements, environmental quality, land development, and public health and safety.

The Plan Maintenance Procedures, found in Chapter 8, include the measures that the Mitigation Advisory Committee and participating jurisdictions will take to ensure the Plan's continuous long-term implementation. The procedures also include the manner in which the Plan will be regularly evaluated and updated to remain a current and meaningful planning document.

Chapter 1: Introduction

Mitigation is commonly defined as sustained actions taken to reduce or eliminate long-term risk to people and property from hazards and their effects. Hazard mitigation focuses attention and resources on community policies and actions that will produce successive benefits over time. A mitigation plan states the aspirations and specific courses of action that a community intends to follow to reduce vulnerability and exposure to future hazard events. These plans are formulated through a systematic process centered on the participation of citizens, businesses, public officials, and other community stakeholders.

A local mitigation plan is the physical representation of a jurisdiction's commitment to reduce risks from natural hazards. Local officials can refer to the plan in their day-to-day activities and in decisions regarding regulations and ordinances, granting permits, and in funding capital improvements and other community initiatives. Additionally, these local plans will serve as the basis for States to prioritize future grant funding as it becomes available.

It is hoped that the Northern Virginia Hazard Mitigation Plan will be a useful tool for all community stakeholders by increasing public awareness about local hazards and risks, while at the same time providing information about options and resources available to reduce those risks. Teaching the public about potential hazards will help each of the area's jurisdictions protect itself against the effects of the hazards, and will enable informed decision making on where to live, purchase property, or locate businesses.

The areas covered by this plan include:

Table 1.1. Participating Communities

Counties	Towns
Fairfax County	Town of Dumfries
Loudoun County	Town of Haymarket
Prince William County	Town of Herndon
	Town of Leesburg
	Town of Lovettsville
Cities	Town of Middleburg
City of Alexandria	Town of Purcellville
City of Fairfax	Town of Occoquan
City of Manassas	Town of Round Hill
City of Manassas Park	Town of Vienna

I. Background

Natural hazards, such as floods, tornadoes, and severe winter storms are a part of the world around us. Their occurrence is natural and inevitable, and there is little we can do to control their force and intensity.

The Northern Virginia region is vulnerable to a wide range of natural hazards, including flooding, tornadoes, hurricanes, and winter storms. These hazards threaten the safety of residents and have the potential to damage or destroy both public and private property, disrupt the local economy, and impact the overall quality of life of individuals who live, work, and play in the Northern Virginia region.

While we cannot eliminate natural hazards, there is much we can do to lessen their potential impacts upon our community and our citizens. The effective reduction of a hazard's impact can decrease the likelihood that such events will result in a disaster. The concept and practice of reducing risks to people and property from known hazards is generally referred to as hazard mitigation.

Hazard mitigation techniques include both structural measures, such as strengthening or protecting buildings and infrastructure from the destructive forces of potential hazards; and non-structural measures, such as the adoption of sound land-use policies or the creation of public awareness programs. Some of the most effective mitigation measures are implemented at the local government level where decisions on the regulation and control of development are made. A comprehensive mitigation strategy addresses hazard vulnerabilities that exist today and in the foreseeable future. Therefore it is essential that projected patterns of development are evaluated and considered in terms of how that growth will increase or decrease a community's overall hazard vulnerability. Land use is a particularly important topic in the Northern Virginia region, where many communities are facing rapid growth and redevelopment rates. Now is the time to effectively guide development away from identified hazard areas and environmentally sensitive locations, before unsound development patterns emerge and people and property are placed in harm's way.

One of the most effective tools a community can use to reduce hazard vulnerability is to develop, adopt, and update as needed, a local hazard mitigation plan. A hazard mitigation plan establishes the broad community vision and guiding principles for addressing hazard risk, including the development of specific mitigation actions designed to eliminate or reduce identified vulnerabilities. The Northern Virginia Hazard Mitigation Plan (hereinafter "Hazard Mitigation Plan" or "Plan") is a logical first step toward incorporating hazard mitigation principles and practices into the routine activities and functions of local government within the Northern Virginia region.

The mitigation actions noted in this Plan go beyond recommending structural solutions to reduce existing vulnerability. Local policies addressing community growth, incentives to protect natural resources, and public awareness and outreach campaigns are examples of other measures that can be used to reduce the future vulnerability of the Northern Virginia region to identified hazards. The Plan has been designed to be a living document, with implementation and evaluation procedures included to help achieve meaningful objectives and successful outcomes.

A. Disaster Mitigation Act of 2000

In an effort to reduce the Nation's mounting natural disaster losses, the U.S. Congress passed the Disaster Mitigation Act of 2000 (DMA 2000) in order to amend the Robert T. Stafford Disaster Relief and Emergency Assistance Act. Section 322 of DMA 2000 emphasizes the need for State and local government entities to closely coordinate on mitigation planning activities, and makes the development of a hazard mitigation plan a specific eligibility requirement for any local government applying for Federal mitigation grant funds. These funds include the Hazard Mitigation Grant Program (HMGP) and the Pre-Disaster Mitigation (PDM) program, both of which are administered by the Federal Emergency Management Agency (FEMA) under the Department of Homeland Security. Communities with an adopted and federally-approved hazard mitigation plan thereby become pre-positioned and more apt to receive available mitigation funds before and after the next disaster strikes.

The Plan has been prepared in coordination with FEMA Region III and the Virginia Division of Emergency Management (VDEM) to ensure that the Plan meets all applicable DMA 2000 and State requirements. A Local Mitigation Plan Crosswalk, found in Appendix A, provides a summary of Federal and State minimum standards and notes the location where each requirement is met within the Plan.

II. Overview of Hazard Mitigation Planning

Local hazard mitigation planning is the process of organizing community resources, identifying and assessing hazard risks, and determining how to best minimize or manage those risks. This process results in a hazard mitigation plan that identifies specific mitigation actions, each designed to achieve both short-term planning objectives and a long-term community vision. To ensure the functionality of each mitigation action, responsibility is assigned to a specific individual, department, or agency along with a schedule for its implementation. Plan maintenance procedures are established for the routine monitoring of implementation progress, as well as the evaluation and enhancement of the mitigation plan itself. These plan maintenance procedures ensure that the plan remains a current, dynamic, and effective planning document over time.

Mitigation planning offers many benefits, including:

- saving lives and property;
- saving money;
- speeding recovery following disasters;
- reducing future vulnerability through wise development and post-disaster recovery and reconstruction;
- expediting the receipt of pre-disaster and post-disaster grant funding; and
- demonstrating a firm commitment to improving community health and safety.

Typically, mitigation planning is described as having the potential to produce long-term and recurring benefits by breaking the repetitive cycle of disaster loss. A core assumption of hazard mitigation is that pre-disaster investments will significantly reduce the demand for post-disaster assistance by lessening the need for emergency response, repair, recovery, and reconstruction. Furthermore, mitigation practices will enable local residents, businesses, and industries to re-establish themselves in the wake of a disaster, getting the community economy back on track sooner and with less interruption.

The benefits of mitigation planning go beyond solely reducing hazard vulnerability. Measures such as the acquisition or regulation of land in known hazard areas can help achieve multiple community goals, such as preserving open space, maintaining environmental health, and enhancing recreational opportunities. Thus, it is vitally important that any local mitigation planning process be integrated with other concurrent local planning efforts, and any proposed mitigation strategies must take into account other existing community goals or initiatives that will help complement or hinder their future implementation.

III. Purpose of Plan

The purpose of the Plan is to:

- Protect life, safety, and property by reducing the potential for future damages and economic losses that result from **natural** hazards;
- Make communities safer places to live, work, and play;
- Qualify for grant funding in both the pre-disaster and post-disaster environment;
- Speed recovery and redevelopment following future disaster events;
- Demonstrate a firm local commitment to hazard mitigation principles; and
- Comply with State and Federal legislative requirements for local multi-jurisdictional hazard mitigation plans.

IV. Authority

Following conditional approval of the plan by both VDEM and FEMA, the plan will be brought forth to each participating jurisdiction to be formally adopted.

The Plan, developed in accordance with current State and Federal rules and regulations governing local hazard mitigation plans, will be adopted by the four counties, five cities, and 10 participating municipalities in accordance with the authority and police powers granted to counties, cities, and municipalities under §15.2-2223 through §15.2-2231 of the Virginia State Code. Copies of local adoption resolutions are provided in Appendix B (to be completed after adoption). The Plan shall be routinely monitored and revised to maintain compliance with the following provisions, rules, and legislation:

- Section 322, Mitigation Planning, of the Robert T. Stafford Disaster Relief and Emergency Assistance Act, as enacted by Section 104 of the Disaster Mitigation Act of 2000 (P.L. 106-390); and

- FEMA's Interim Final Rule published in the Federal Register on February 26, 2002, at 44 CFR Part 201.

V. Summary of Plan Contents

The additional contents of this Plan are designed and organized to be as reader-friendly and functional as possible. While significant background information is included on the processes used and studies completed (e.g., risk assessment, capability assessment), this information is separated from the more meaningful planning outcomes or actions (e.g., mitigation strategy, mitigation action plans).

Chapter 2, Planning Process, provides a complete narrative description of the process used to prepare the Plan. This includes the identification of who was involved, who participated on the planning team, and how the public and other stakeholders were involved. It also includes a detailed summary for each of the key meetings held along with any associated outcomes.

Chapter 3, Regional Information, describes the general makeup of the Northern Virginia region, including prevalent geographic, demographic, and economic characteristics. In addition, transportation, housing, and land-use patterns are discussed. This baseline information provides a snapshot of the regional planning area and thereby assists county and municipal officials to recognize those social, environmental, and economic factors that ultimately play a role in determining community vulnerability to natural hazards.

The Regional Hazard Identification and Risk Assessment (HIRA) is presented in Chapter 4. This section serves to identify, analyze, and assess the Northern Virginia region's overall risk to natural hazards. The risk assessment also attempts to define any hazard risks that may uniquely or exclusively affect the individual municipal jurisdictions.

The Risk Assessment builds on available historical data from past hazard occurrences, establishes detailed profiles for each hazard, and culminates in a hazard risk ranking based on conclusions about the frequency of occurrence, spatial extent, and potential impact of each hazard. FEMA's HAZUS^{MH} loss estimation methodology was also used in evaluating known hazard risks by their relative long-term cost in expected damages. In essence, the information generated through the risk assessment serves a critical function as communities seek to determine the most appropriate mitigation actions to pursue and implement — enabling communities to prioritize and focus their efforts on those hazards of greatest concern and those structures or planning areas facing the greatest risk(s). For the purposes of compliance with the Disaster Mitigation Act as further specified by Interim Final Rule 44 CFR Section 206.401(c)(2)(i), this Plan addresses in full only the following hazards: Flood, High Wind, Tornadoes, Winter Storms, Drought, Earthquakes, Landslides, Wildfire, Sinkholes, Dam Failure, and Extreme Temperatures. For the 2017 Plan update, extreme cold was removed from Winter Storms, and extreme heat was removed from Drought. Extreme Temperatures was examined as its own hazard.

The Capability Assessment, found in Chapter 5, provides a comprehensive examination of each participating jurisdiction's capacity to implement meaningful mitigation strategies and identifies existing opportunities to increase and enhance that capacity. Specific capabilities addressed in this section include planning and regulatory capability, staff and organizational (administrative) capability, technical capability, fiscal capability, and political capability. Information was obtained through a survey for local officials and an inventory and analysis of existing plans, ordinances, and relevant documents. The purpose of this assessment is to identify any existing gaps, weaknesses, or conflicts in programs or activities that may hinder mitigation efforts, and to identify those activities that should be built upon to establish a successful and sustainable regional hazard mitigation program.

The Regional Information, Risk Assessment, and Capability Assessment sections collectively serve as a basis for determining the goals for the Hazard Mitigation Plan; each contributing to the development, adoption, and implementation of a meaningful Mitigation Strategy that is based on accurate background information.

The Mitigation Strategy, found in Chapter 6, consists of broad regional goal and strategies. The regional mitigation actions were removed from the 2017 Plan and have been incorporated into the jurisdictional Mitigation Action Plans. The strategy provides the foundation for detailed jurisdictional Mitigation Action Plans, found in Chapter 7, that link specific mitigation actions for each jurisdiction to locally-assigned implementation mechanisms and target completion dates. Together, these sections are designed to make the Plan both strategic (through the identification of long-term goals), but also functional through the identification of short-term and immediate actions that will guide day-to-day decision-making and project implementation.

In addition to the identification and prioritization of possible mitigation projects, emphasis is placed on the use of program and policy alternatives to help make the communities of the Northern Virginia region less vulnerable to the damaging forces of nature while improving the economic, social, and environmental health of the community. The concept of multi-objective planning was emphasized throughout the planning process, particularly in identifying ways to link hazard mitigation policies and programs with complimentary community goals related to housing, economic development, downtown revitalization, recreational opportunities, transportation improvements, environmental quality, land development, and public health and safety.

The Plan Maintenance Procedures, found in Chapter 8, include the measures that the Mitigation Advisory Committee and participating jurisdictions will take to ensure the Plan’s continuous long-term implementation. The procedures also include the manner in which the Plan will be regularly evaluated and updated to remain a current and meaningful planning document.

Chapter 2: Planning Process

For the 2017 plan update, the Mitigation Advisory Committee (MAC) held monthly meetings during the plan update process. Meetings were held in person, but committee members were given the option to call in due to the large geographic area covered by the plan. The dates and the description of the activities at these meetings are found below. Meeting sign-in sheets and notes are located in Appendix C. As many of the participants called into meetings, the sign-in sheets do not accurately represent the attendees for each meeting. The call-in attendees were documented and a full list of attendees for each meeting is found in the meeting notes located in Appendix C.

Table 2.1. 2017 Meeting Schedule

Date	Meeting Purpose
December 1, 2015	Project Kickoff Meeting
January 12, 2016	Hazard Identification and Risk Assessment
February 9, 2016	Status Update
March 8, 2016	Outreach Plan Development
May 10, 2016	Hazard Identification and Risk Assessment and Regional Mitigation Strategy
May-July 2016	Jurisdictional Meetings
June 14, 2016	Outreach Plan Discussion and Project Update
July 12, 2016	Status Update
August 9, 2016	Status Update
September 13, 2016	Outreach Plan Discussion and Project Update
December 13, 2016	Status Update
January 10, 2017	Project Update
February 14, 2017	Project Update

Kickoff Meeting

The update of the 2010 Northern Virginia Hazard Mitigation plan began establishing a project plan. A kick-off meeting was held on December 1, 2015, with representatives from various counties and cities in the planning region in attendance. A list of participants for each committee meeting can found in Appendix C. At the kickoff meeting, the planning process was discussed in detail, along with the proposed schedule of deliverables and meetings.

The project scope and responsibilities were also discussed at length at the kickoff meeting. At the November meeting of the Northern Virginia Emergency Managers, the Mitigation Advisory Committee Chairman was given the direction to perform the update to the 2010 plan with limited contractor support. Witt O'Brien's was selected to support the update to the 2010 plan by performing the Hazard Identification and Risk Assessment, and updating that section of the plan.

Additionally, the committee was asked to review the list of hazards in the 2006 plan and determine if the list should carry over as-is to the 2010 plan, or if changes were necessary.

Hazard Identification and Risk Assessment Meeting

A second meeting was held on January 12, 2016, to discuss the goals and vision of the plan's HIRA section. The HIRA process involved analyzing the region's greatest hazard threats and determining its most significant vulnerabilities with respect to natural hazards. Additionally, the committee was asked to review the list of hazards in the 2010 plan and determine if the list should carry over as-is to the 2017 plan, or if changes were necessary. The hazards were kept largely the same, but Extreme Temperatures was added as its own hazard, removing extreme cold from Winter Storm, and extreme heat from Drought. Risk was determined by looking at the total threat and vulnerability for all of the jurisdictions for each hazard identified by the MAC. The HIRA was performed in large part using GIS data from the participating jurisdictions, HAZUS^{MH} (a GIS-based FEMA loss estimation software), and State sources. At the HIRA results meeting in May 2016, the MAC reviewed the draft HIRA. Witt O'Brien's hosted the January meeting and was responsible for performing the HIRA. A full description of the HIRA methodology can be found in the HIRA section of this plan.

February 9, 2016 Meeting

The February 9, 2016 meeting provided MAC members an opportunity to provide an update on their progress in providing data for inclusion in the HIRA. It also provided an opportunity for the MAC to ask any questions about the update of the plan.

March 8, 2016 Meeting

The focus of the March 8, 2016 meeting was a discussion of the plan to conduct outreach on the plan and to gain the input of the public and key stakeholders. The MAC determined that we would conduct two rounds of outreach on the plan. The first round would give stakeholders an opportunity to comment on the HIRA and would be conducted in June. The second round of outreach was conducted in the summer of 2016 and gave stakeholders an opportunity to comment on the complete plan.

Committee members were also assigned the task of updating their jurisdiction Capability Assessment at the March meeting. The results of this are included in Chapter 5 of the plan. The MAC was also asked to begin reviewing their jurisdiction's Mitigation Action Plan. The April MAC meeting was cancelled.

Hazard Identification and Risk Assessment Results Meeting

Witt O'Brien's hosted the May 10, 2016 HIRA Results meeting. During the HIRA Results Meeting, Witt O'Brien's presented the results of the HIRA to the MAC. Prior to the May 10 meeting, the MAC was given an opportunity to review the HIRA and any concerns were discussed at the meeting.

The MAC was also given the assignment of updating their individual executive summary and mitigation action plan found in Chapter 7. The due date for this assignment was July 15, 2016.

In addition, the MAC reviewed the Regional Mitigation Strategy, Chapter 6 of the plan. The committee reaffirmed the regional strategy with only minor changes. The MAC chose to remove the regional mitigation actions from the plan. The regional mitigation actions found in the 2010 plan were incorporated into the jurisdictional mitigation action plans found in Chapter 7, where appropriate. A full description of these changes can be found in Appendix C.

May-July Jurisdictional Meetings
Following the HIRA Results meeting on May 10, each jurisdiction held a meeting to develop jurisdiction-specific mitigation actions. The content and attendees for these meetings varied greatly between jurisdictions, but the result was an updated jurisdictional action plan.

June 14, 2016 Meeting
The June 14 meeting provided committee members an opportunity to provide status updates on the work that they were doing on their action plans. The outreach period was also discussed.

July 12, 2016 Meeting
The July 12 meeting provided committee members an opportunity to provide status updates on the work that they were doing on their action plans. The outreach period was also discussed.

August 9, 2016 Meeting
The August 9 meeting provided committee members an opportunity to provide status updates on the work that they were doing on their action plans. The outreach period was also discussed.

September 13, 2016 Meeting
The September 13 meeting provided committee members an opportunity to provide status updates on the work that they were doing on their action plans. The outreach period and draft plan submission was also discussed.

October, 2016 Meeting
This meeting was cancelled as the draft plan was out for public review and comment.

November, 2016 Meeting
This meeting was cancelled as many jurisdictions were preparing for the 2016 Presidential election.

December 13, 2016 Meeting
This meeting was held to advise jurisdictions that the plan was reviewed by the state and was submitted to FEMA Region III for their review.

January 10, 2017 Meeting
This meeting was held to advise jurisdictions that the plan was reviewed by FEMA Region III and that FEMA returned their comments and required changes. The committee was asked to review the list of comments and to complete the National Flood Insurance Program survey.

February 14, 2017 Meeting

This meeting was held to advise jurisdictions that their NFIP surveys were due and that a few jurisdictions needed to complete the survey. When all surveys are completed the plan will go back to FEMA to obtain approved pending adoption status.

I. Mitigation Advisory Committee

The Northern Virginia Emergency Managers convened an advisory committee comprised of representatives from various participating jurisdictions. The Mitigation Advisory Committee was responsible for the update of the plan and management of Witt O'Brien's as they updated the HIRA.

The following members were a part of the MAC and were chosen by their respective jurisdictions to participate in the development of this plan:

Table 2.2. Committee Members

Member	Jurisdiction
David Morrison	Arlington County
Cara Howard, Adam Kelly and Gregory Zebrowski	Fairfax County
Kevin Johnson	Loudoun County
Alexa Lenhart	Prince William County
Aaron Hope and Blake Stave, and Ray Whatley	City of Alexandria
Walter English	City of Fairfax
Tom Polera	City of Falls Church
Amelia Gagnon	City of Manassas
Robert Hoffower	City of Manassas Park
Amanda Christman	Town of Clifton
Tiawana Barnes	Town of Dumfries
Holly Montague and Brian Henshaw	Town of Haymarket
Stephen Thompson	Town of Herndon
Kirstyn Jovanovich	Town of Occoquan
Dan Janickey	Town of Vienna
Rita Frazier	Town of Quantico

Throughout the planning process the Town of Clifton and the Town of Quantico withdrew from the process. They are still included in the Regional Profile and the Hazard Identification and Risk Assessment as they withdraw after these chapters were completed. The decision was made to include their information as they till fall within the Northern Virginia Region and will be covered by Fairfax and Prince William County.

II. Public Involvement and Citizen Input

An important component of this planning process is the opportunity for the general public to provide input. Individual citizen and community-based input provided the planning team with a greater understanding of local concerns and increased the likelihood of successfully implementing mitigation actions by developing community "buy-in" from those directly affected by the decisions of public officials. As citizens become more involved in decisions that affect their safety, they are more likely to gain a greater appreciation of the natural hazards present in their community and take the steps necessary to reduce their impact. Public awareness is a key component of any community's overall mitigation strategy aimed at making a home, neighborhood, school, business, or city safer from the potential effects of natural hazards. This public outreach effort was also an opportunity for neighboring jurisdictions, agencies, businesses, academia, nonprofits, and other interested parties to be involved in the planning process. Local jurisdictions included Community Emergency Response Teams (CERTs), the American Red Cross, and Citizen Corp groups in planning meetings and presentations for this plan update. A complete list of public outreach initiatives can be found below; however, it should be noted that many jurisdictions chose to have public outreach meetings following conditional approval of this plan.

The following lists include an explanation of the public outreach efforts accomplished by each participating jurisdiction. This section is considered a work-in-progress and will be completed by formal adoption.

Arlington County

- The Plan has been posted for review and comment on the county's website and social media.
- The Plan project has been presented to the county commission which addresses emergency management issues

Fairfax County (including the Towns of Herndon, and Vienna)

- The County and Towns posted the draft plan at www.fairfaxcounty.gov for public comment and review. Please see Appendix F for a screenshot example.
- The County also posted a link to the Plan on their Twitter and Facebook pages, advertising that public review and comments were welcome.
- Fairfax County additionally sent out a newsletter to a group of businesses and non-profits that are part of the Emergency Support Function-15 Council of Governments group, advertising that the Plan was being updated and it could be accessed on the county website.
- The Office of Emergency Management (OEM) also included the link to the Plan in a monthly newsletter that is distributed to all county agencies and partner agencies.

- OEM's Outreach Coordinator also included the Plan update information in a monthly newsletter which is distributed to groups such as Fairfax County Citizen Corp Groups.

Loudoun County (Including the Towns of Leesburg, Middleburg, Purcellville, and Round Hill)

- A link to the draft plan will be posted to the OEM website, which is www.loudoun.gov/oem, in October 2016.
- County Administrator will make an announcement during his "Administrator's Comments" portion of the Board of Supervisors Business Meeting, which is scheduled for Tuesday, October 4, 2016.
- OEM will coordinate with the Loudoun County Public Information Office to distribute messages on Twitter and Facebook announcing the project and directing residents to the website.

Prince William County (including the Towns of Dumfries, Haymarket, Occoquan, and Quantico)

- A link to the draft plan will be posted on the county website for review and comment by the public during the fall of 2016.
- The County posted information about the plan being available for review by the public on their county website and social media.

City of Alexandria

- The City will post a link to the draft plan on their Emergency Management website, and social media requesting that the public review and comment on the plan during the fall of 2016.

City of Fairfax

- The City posted a link to the draft plan on their Emergency Management website, and social media requesting that the public review and comment on the plan. A screenshot can be found in Appendix H.

City of Falls Church

- Upon receiving the final document the City will provide public outreach via the City website, Facebook, and eFocus (newsletter).

City of Manassas

- The City posted the Plan to the City website, and social media during the summer of 2016.

City of Manassas Park

- The City posted the plan on its website and social media. A screenshot of this website can be found in Appendix H.

In addition, neighboring jurisdictions and additional stakeholders were asked via email on June 14, 2016 to review the document and provide any feedback by June 26, 2016. The distribution list consisted of:

- Clarke County
- Fauquier County
- Stafford County
- DC HSEMA
- Prince George's County
- Montgomery County
- George Mason University
- Northern Virginia Community College
- Northern Virginia Chamber of Commerce
- Volunteer Fairfax
- American Red Cross
- Fairfax County Public Schools
- INOVA Health System (INOVA Fairfax)
- HCA Healthcare (Reston Hospital Center)
- MICRON Technology, Inc.

III. Incorporation of Existing Plans and Studies

The Plan incorporates information from a number of other previously produced plans, studies, articles, exhibits, graphics, and reports. The various plans and documents were used to identify hazards and risks, assess vulnerabilities, develop trends, and align mitigation strategies throughout the Northern Virginia Hazard Mitigation Plan. These documents and sources include:

- Commonwealth of Virginia Hazard Mitigation Plan, 2010
- Critical Infrastructure Protection in the National Capital Region, 2005
- National Capital Region Hazard Identification and Risk Assessment, 2007
- National Capital Region Strategic Hazard Identification and Evaluation for Leadership Decisions (NCR SHIELD), 2008
- National Climatic Data Center Storm Events Database
- National Weather Service / National Oceanic and Atmospheric Administration
- Commonwealth of Virginia Emergency Operations Plan
- *Science* Magazine
- National Flood Insurance Program
- HAZUS-MH™
- Federal Emergency Management Agency
- Intergovernmental Panel on Climate Change
- North Carolina Division of Emergency Management
- American Society of Civil Engineers
- National Drought Mitigation Center
- US Geological Survey
- Virginia Department of Forestry
- Esri
- US Census Bureau
- Virginia Department of Mines, Minerals, and Energy

- US Army Corps of Engineers National Inventory of Dams
- Loudoun County Building and Development

Chapter 3: Regional Information

I. Northern Virginia Overview

A. Planning Region

The Northern Virginia planning region includes Arlington, Fairfax, Loudoun, and Prince William counties, as well as the cities and towns located within these counties (19 jurisdictions). For this plan update, two additional towns in Loudoun County participated, Round Hill and Lovettsville. The communities participating in the 2017 hazard mitigation plan update are summarized in Table 3.1 and graphically in Figure 3.1.

Table 3.1. 2017 Planning Jurisdictions
Jurisdictions Included
Arlington County
Fairfax County
City of Alexandria
City of Fairfax
City of Falls Church
Town of Herndon
Town of Vienna
Loudoun County
Town of Leesburg
Town of Lovettsville
Town of Purcellville
Town of Round Hill
Town of Middleburg
Prince William County
City of Manassas
City of Manassas Park
Town of Dumfries
Town of Occoquan
Town of Haymarket

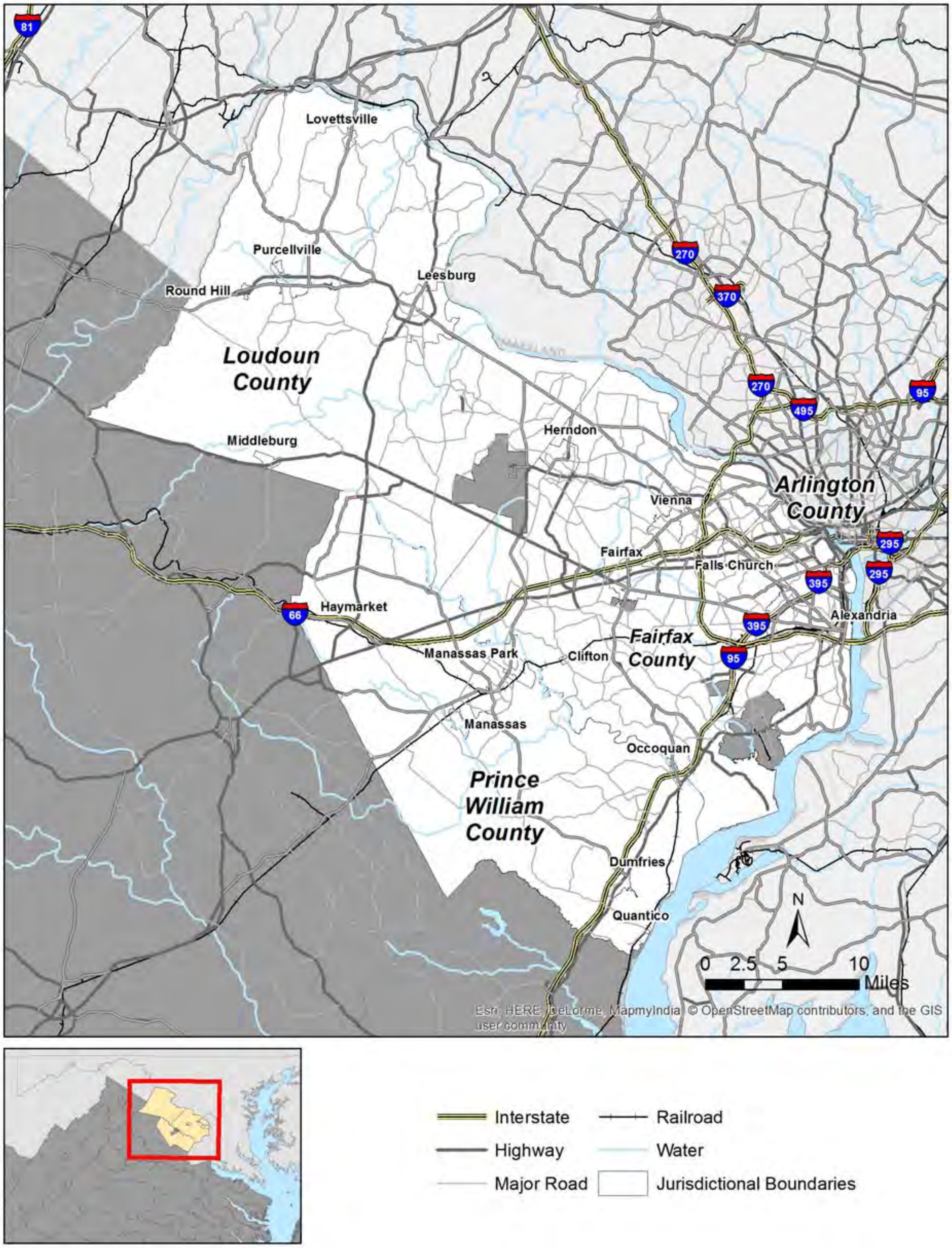


Figure 3.1. Northern Virginia 2017 Hazard Mitigation Plan Update Region

1. County Profiles

Arlington County

The area that encompasses present-day Arlington County was first settled as part of the British Colony of Virginia in the late 1690s. In 1791, George Washington surveyed the area in what was to become the District of Columbia. Congress returned the area to the Commonwealth of Virginia in 1842 as the County of Alexandria. In 1870, the City of Alexandria became independent of Alexandria County, and the county portion was officially renamed Arlington County in 1920. The 2014 census estimate for the county is 226,908, an approximately 9% increase since 2010.

Arlington is an urban county of about 26 square miles located directly across the Potomac River from Washington, D.C. Arlington's central location in the Washington DC metropolitan area, its ease of access by car and public transportation, and its highly skilled labor force have attracted an increasingly varied residential and commercial mix. Arlington is one of the most densely populated communities in the nation with more than 8,727 persons per square mile.

Arlington's high population density and its location along the banks of the Potomac River, increase the county's vulnerability to a variety of hazards, most notably flooding. In addition to snow melt and rain-related river flooding episodes, Arlington is also subjected to tidal and storm surge flooding. As sea levels rise, permanent inundation of low-lying areas along and near the river shoreline is also a threat. It should be noted that most of the Arlington river bank along the Potomac is Federal Land (National Park Service). During the 1960s and 1970s, Four Mile Run experienced significant flooding events as the watershed became more urbanized. In 1974, Congress authorized the United States Army Corps of Engineers (USACE) to design and construct a flood control channel that would contain the increased flows. Since its completion over twenty years ago, the channel has safely conveyed the high storm flows through Arlington County and the City of Alexandria. The channel will be undergoing a significant restoration project to last through the Fall of 2017. Additionally, winter storms pose significant threats, as evidenced during the 2015 – 2016 winter season.

Fairfax County

The land that is now Fairfax County was part of the Northern Neck Proprietary granted by King Charles II in 1660 and inherited by Thomas Fairfax, Sixth Lord Fairfax of Cameron, in 1719. The county itself was formed in 1742 from Prince William County. The 2014 census population estimate for the county is 1,137,538, an approximately 5% increase since 2010.

Fairfax County comprises about 407 square miles located directly across the Potomac River from Washington, D.C. The county's location in the Washington metropolitan area, its ease of access by car and public transportation, and its highly skilled labor force have attracted an increasingly varied residential and commercial mix. Much of the commercial development in Fairfax County is centered around the Metrorail's

Silver line with stations in Reston and Tysons. Tysons alone has 26 million square feet of office space, 6 million square feet of retail space, and more than 100,000 people work there.

Due to its location on both the Virginia piedmont and the Atlantic coastal plain, the County experiences a variety of weather. The diversity of Fairfax County's landscape increases the County's vulnerability to a variety of hazards, most notably flooding and severe storms. In addition to snow melt and rain-related river flooding episodes, low-lying areas of Fairfax County along the Potomac River are also subject to tidal and storm surge flooding. As sea levels rise, permanent inundation of low lying areas along and near the river shoreline is also a threat. Additionally, winter storms pose significant threats, as evidenced during the 2015 – 2016 winter season.

Loudoun County

Loudoun County was established in 1757 and was formerly part of Fairfax County. It was named after John Campbell, Fourth Earl of Loudoun and past Governor of the Commonwealth of Virginia. It was the most populous Virginia county during the time of the American Revolution. Since 1757, the county seat has always been the Town of Leesburg. In 2014, Loudoun County was ranked by Forbes as America's second wealthiest county. The County has a total area of 521 square miles, of which one square mile is water. As of the 2014 Census estimate, it has a population density of 696 per square mile. The population was estimated to be approximately 363,050 in 2014 by the U.S. Census Bureau, a nearly 16% increase over the 2010 population of 312,311.

Geographically, Loudoun County is bounded to the North by the Potomac River, to the south are Prince William and Fauquier counties, and on the west by the watershed of the Blue Ridge Mountains. The Bull Run Mountains and Catoctin Mountain run through the County. There are seven incorporated.

Risk factors for the county are in part due to its proximity to the Nation's capital and its growth rate. The county has a risk of flooding due to low lying areas surrounding the Potomac River and other natural hazards and risks, such as storm damage and winter weather. Winter storms pose significant threats, as evidenced during the 2015 – 2016 winter season.

Prince William County

Prince William County was formed in 1730, and was named by the Virginia General Assembly to honor the son of King George II. The county seat is the City of Manassas. Prince William County has a total area of 338 square miles, of which 11 square miles are water. It has a population density of 1,364 per square mile. In 2014, the population was estimated at 446,094, an approximately 11% increase over the 2010 census.

Prince William County has been an incredibly fast growing community for decades. This is because of its central location to the Washington, D.C., metropolitan area. The population growth rate poses a risk; as open land is developed flood management must be addressed with the increasing amounts of impervious surfaces. Its flood risk is also due to low lying areas surrounding the Potomac River. Other natural hazards and risks are storm damage and winter weather. Winter storms pose significant threats, as evidenced during the 2015 – 2016 winter season.

2. City Profiles

City of Alexandria

What is now the City of Alexandria was first settled as part of the British Colony of Virginia in the late 1690s. In 1791, George Washington included portions of the City of Alexandria in what was to become the District of Columbia. That portion was given back to Virginia in 1846 and the City of Alexandria was re-chartered in 1852. In 1870, the City of Alexandria became independent of Alexandria County, with the remainder of the County changing its name to Arlington County in 1920. In 2014 the population was estimated to be 150,575, an increase of nearly 8% since the 2010 Census.

Alexandria's high population density and its location along the banks of the Potomac River, increase the city's vulnerability to a variety of hazards, most notably flooding. In addition to snow melt and rain-related river flooding episodes, Alexandria is also subjected to tidal and storm surge flooding. As sea levels rise, permanent inundation of low lying areas along and near the river shoreline is also a concern. Winter weather and high wind events also pose a significant threat to the city as the 2015 – 2016 winter and summer seasons have proven.

City of Fairfax

Named after Thomas Fairfax, Sixth Lord Fairfax of Cameron, what is now known as the City of Fairfax became an independent city in 1961. This occurred only after having been previously known as Earp's Corner, then Town of Providence, and eventually Town of Fairfax. In 2014 the population was estimated to be 24,483, an increase of 8% since 2010.

The city's location on the eastern edge of the Virginia Piedmont make it susceptible to natural hazards and risks, such as storm damage and winter weather, as evidenced during the 2015 – 2016 winter season.

City of Falls Church

It is believed that the area was first settled by Europeans in 1699. The city takes its name from what was coined The Falls Church, a building that was built in 1757. In 2014, the population was estimated to be 13,601, an increase of 10% since 2010.

The City of Falls Church comprises about 2.2 square miles located approximately 10 miles west of Washington, D.C. The City's proximity to the Washington metropolitan area and its ease of access by car and public transportation have allowed increasingly-varied residential and commercial development. In 2014, Falls Church was ranked by Forbes as America's wealthiest municipality. Falls Church is densely populated with more than 6,182 persons per square mile.

The City of Falls Church experiences significant flood threats due to the presence of Four Mile Run and Tripps Run. The City's location on the eastern edge of the Virginia Piedmont make it susceptible to other natural hazards and risks, such as damage from severe storms and winter weather, as evidenced during the 2015 – 2016 winter and summer seasons.

City of Manassas

The City of Manassas played an important role during the American Civil War. The First Battle of Bull Run (also called First Battle of Manassas) was fought in the vicinity in 1861. It was the first land battle of the Civil War. The Second Battle of Bull Run took place August 28-30, 1862. The Town of Manassas was incorporated in 1873 and became an independent city in 1975. In 2014 the population was estimated to be 42,081, an increase of 11% since 2010.

Manassas is subject to high wind events, winter weather, and flooding. Winter storms pose significant threats, as evidenced during the 2015 – 2016 winter season.

City of Manassas Park

The City of Manassas Park was incorporated in 1957 and became an independent city in 1975. It was the last town in Virginia to become a city before a moratorium was placed on other towns achieving similar status. In 2014 the population was estimated to be 15,174, an increase of 10% since 2010.

3. Town Profiles

Town of Dumfries

Dumfries was chartered on May 11, 1749, and is Virginia's oldest continuously chartered town. John Graham gave the land on which the town was founded and is named after his birthplace, Dumfrieshire, Scotland. The population of the town was 4,961 as of the 2010 Census and was estimated by the Census Bureau to be 5,192 in 2014.

Town of Herndon

Incorporated in 1879, the area on which the town was built was originally granted to Thomas Culpeper by King Charles II of England in 1688. Much of the downtown was destroyed on March 22, 1917, by a fire but was rebuilt with brick instead of wood. The population of the town was 23,292 as of the 2010 Census and was estimated by the Census Bureau to be 24,554 in 2014, an increase of 5%.

Town of Leesburg

Steeped in history, Leesburg is the county seat of Loudoun County. Leesburg was established in 1758, and formally became a town by signed act of the Virginia General Assembly on February 18, 1813. It is located just over 30 miles west-northwest of Washington, DC, at the base of Catoctin Mountain and adjacent to the Potomac River. The principal drainage for the town is Tuscarora Creek and its northern "Town Branch," which empties into Goose Creek to the east of town.

European settlement began in the late 1730s. After its founding, it was the location of the post office and regional courthouse. The town was originally established on 60 acres of land. The population of the town was 242,616 as of the 2010 Census and was estimated by the Census Bureau to be 49,496 in 2014, an increase of 16%.

Town of Vienna

Originally called Ayr Hill, the village agreed in the 1850s to change its name to Vienna at the request of William Hendrick, a medical doctor who grew up in Vienna, New York. Vienna was incorporated as a town in 1890. The population of the town was 15,687 as of the 2010 Census and was estimated by the Census Bureau to be 16,459 in 2014, an increase of 5%.

Town of Purcellville

Settled in the mid-1700s, the village was first known as Purcell's Store. The village renamed to Purcellville on July 9, 1852, and was incorporated in 1908. Many present structures in the town reflect the Victorian architecture of the turn of the century. Located in the western portion of Loudoun County, the town has a total area of 2.6 square miles. Wine production is a thriving industry in this area, with approximately 30 wineries in the region. The Blue Ridge Mountains are just to the west and in good weather are usually visible from town. Recreation includes the WO&D bike trail, the western portion of which ends here. The population of the town was 7,727 as of the 2010 Census and was estimated by the Census Bureau to be 8,929 in 2014, an increase of over 15%.

Town of Lovettsville

Originally known as the German Settlement, Lovettsville was officially established in 1820, incorporated in 1842. Its location at the intersection of the Berlin Turnpike and Lovettsville Road, and its proximity to an important Potomac River crossing allowed the town to grow and prosper well into the 20th Century. The population of the town was 1,613 as of the 2010 Census and was estimated by the Census Bureau to be 1,869 in 2014, an increase of 16%.

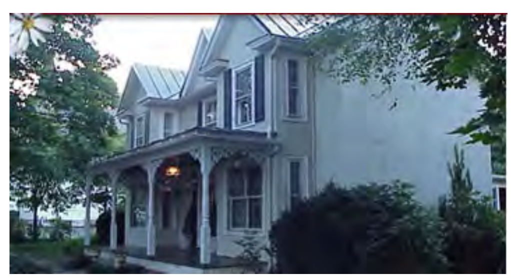
Town of Clifton

Formerly known as Devereux Station, Clifton became the first town in Fairfax County when it incorporated on March 9, 1902. The population of the town was 282 as of the 2010 Census and was estimated by the Census Bureau to be 295 in 2014.

Town of Middleburg

The population of the Town was 673 as of the 2010 Census and was estimated by the Census Bureau to be 781 in 2014. Middleburg is located in Loudoun County and covers approximately 0.6 square miles of land. The population density of the town is 1,083 people per square mile.

Town of Round Hill



Named after the 910 foot hill located just southwest of the town center, and part of the foothills of the Blue Ridge Mountains, Round Hill was incorporated in 1900. The population of the town was 539 as of the 2010 Census and was estimated by the Census Bureau to be 621 in 2014.

Town of Haymarket

Chartered in 1799 by the Virginia General Assembly, the Town of Haymarket was incorporated in 1882. The population of the town was 1,782 as of the 2010 Census and was estimated by the Census Bureau to be 1,973 in 2014, an increase of nearly 11%.

Since the 1900s it has been popular for fox hunting and steeple chasing and is also known for its wineries. The town covers 0.5 square miles of land and is located in Prince William County.

Town of Occoquan

Derived from a Dogue Indian word meaning 'at the end of the water,' Occoquan was divided into lots and streets were laid out in 1804 by Nathaniel Ellicott, James Campbell, and Luke Wheeler. The population of the town was 934 as of the 2010 Census and was estimated by the Census Bureau to be 1,013 in 2014.

Town of Quantico

Located in Prince William County and surrounded by the Marine Corps Base Quantico, the population of the town was 480 as of the 2010 Census and was estimated by the Census Bureau to be 531 in 2014.

B. Geography, Hydrology, and Climate

1. Geography

The Northern Virginia planning region is located at the north-east corner of the Commonwealth of Virginia, lies across the Potomac River from the Nation's Capital, Washington, DC, and is part of the Washington, DC-Maryland-Virginia-West Virginia Primary Metropolitan Statistical Area. Figure 3.1 above is an overview map for the Northern Virginia region including all counties, cities, and towns within the region.

Northern Virginia is made up of the counties of Arlington, Fairfax, Loudoun, and Prince William; the independent cities of Alexandria, Falls Church, Fairfax, Manassas, and Manassas Park; the towns of Clifton Herndon, and Vienna (Fairfax County), Leesburg, Purcellville, Lovettsville, Middleburg and Round Hill (Loudoun County), and Dumfries, Haymarket Occoquan, and Quantico (Prince William County). Figure 3.2 is a base map overview of the Northern Virginia region including all participating county, city, and town jurisdictions, as well as the identification of interstate highways, major roads, major water bodies, and lands outside the authority of participating jurisdictions such as Dulles Airport and U.S. government property.

Northern Virginia is home to numerous Federal government facilities such as the Pentagon, CIA, and U.S. Geological Survey. Historic and cultural resources include George Washington's historic home on the Potomac, Mount Vernon; Arlington National Cemetery; and the Udvar-Hazy Center of the Smithsonian Institution's National Air and Space Museum at Washington-Dulles International Airport.

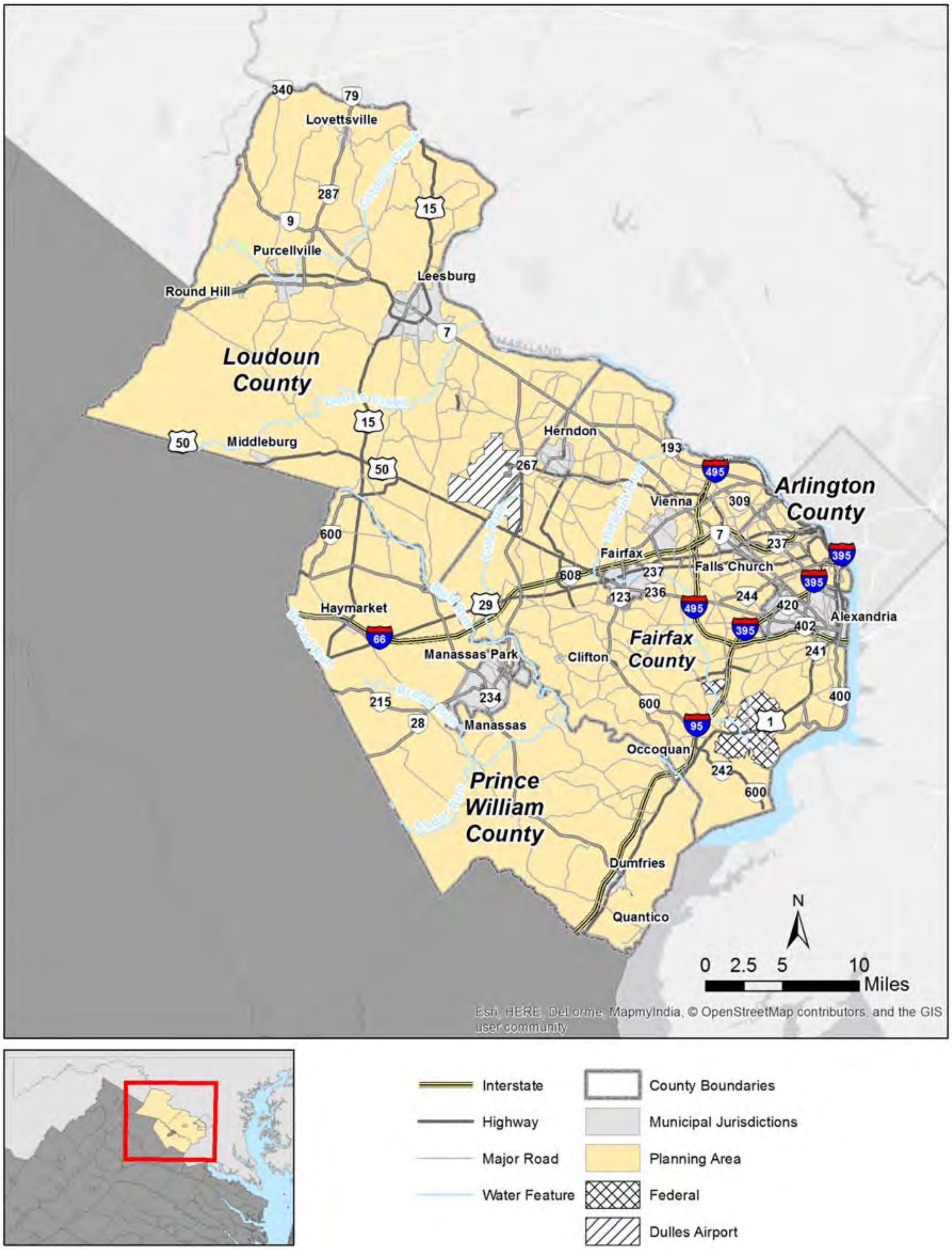


Figure 3.2. Major Features in Northern Virginia

2. Hydrology

The Northern Virginia Planning District is divided by three physiographic provinces of Virginia: the Coastal Plain, the Northern Piedmont, and the Blue Ridge (Figure 3.3). The Coastal Plain lies roughly east of Interstate 95/395 including the eastern portions of the City of Alexandria, and Fairfax and Prince William Counties. The Northern Piedmont province lies roughly between I-95 and US Highway 15 in central Loudoun and western Prince William counties. It is bounded by the Blue Ridge Mountains on the west with ridges, foothills, and hollows rolling down to the Potomac River to the east. Elevations range from more than 1,950 feet above sea level in the Blue Ridge Mountains in western Loudoun County to sea level in eastern Prince William County on the Potomac River. The total land area is 1,304 square miles.

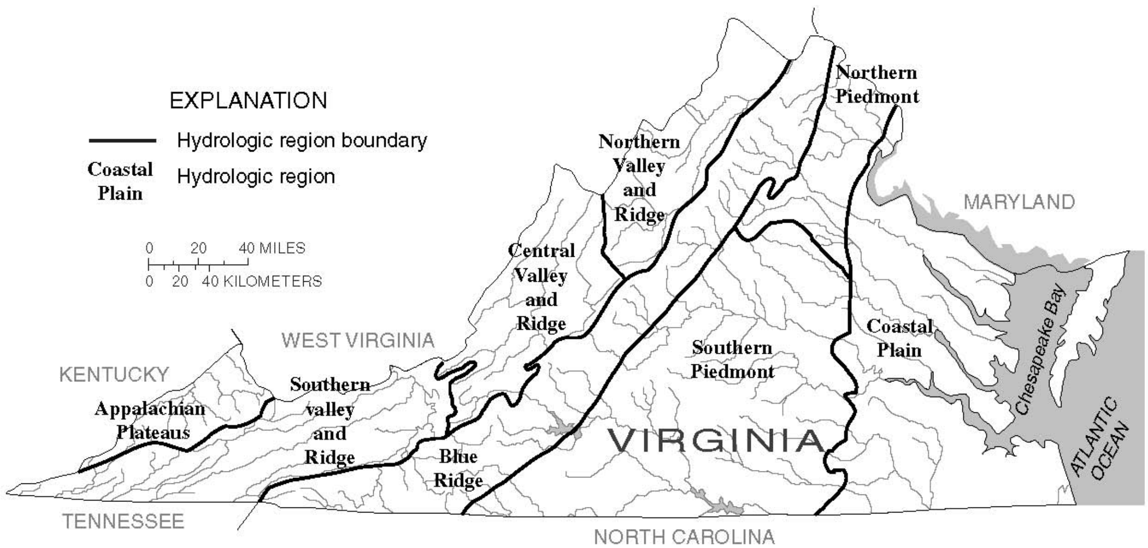


Figure 3.3 Hydrologic Regions of Virginia
Source: U.S. Department of the Interior, U.S. Geological Survey, Fact Sheet 023-01

Northern Virginia lies entirely within the Potomac River watershed. After passing Harper's Ferry, WV, the Potomac forms the border between Maryland and Virginia, flowing in a southeasterly direction. Figure 3.4 provides a general overview of the watersheds in Virginia. The topography of the upper reaches of the basin is characterized by gently sloping hills and valleys. At Great Falls, the stream elevation rapidly descends from over 200 feet to sea level. Eastward of Great Falls, the Basin enters into the Coastal Plain physiographic province. Figure 3.5 illustrates the major physiographic features of Virginia.

3. Climate

The area has a moderate climate. Average temperatures are approximately 50 degrees, and range from January lows in the mid-20s to July highs in the high-80s. Annual rainfall averages above 40 inches the average snowfall in the region ranges from approximately 15 inches at Reagan National Airport to 22 inches at Dulles International Airport.

Climate change is both a present threat and a slow-onset disaster. It acts as an amplifier of existing hazards. Extreme weather events have become more frequent over the past 40 to 50 years and this trend is projected to continue.[1] Rising sea levels, coupled with potentially higher hurricane wind speeds, rainfall intensity, and storm surges are expected to have a significant impact on coastal communities, including those in northern Virginia. More intense heat waves may mean more heat-related illnesses, droughts, and wildfires. As climate science evolves and improves, future updates to this plan might consider including climate change as a parameter in the ranking or scoring of natural hazards.

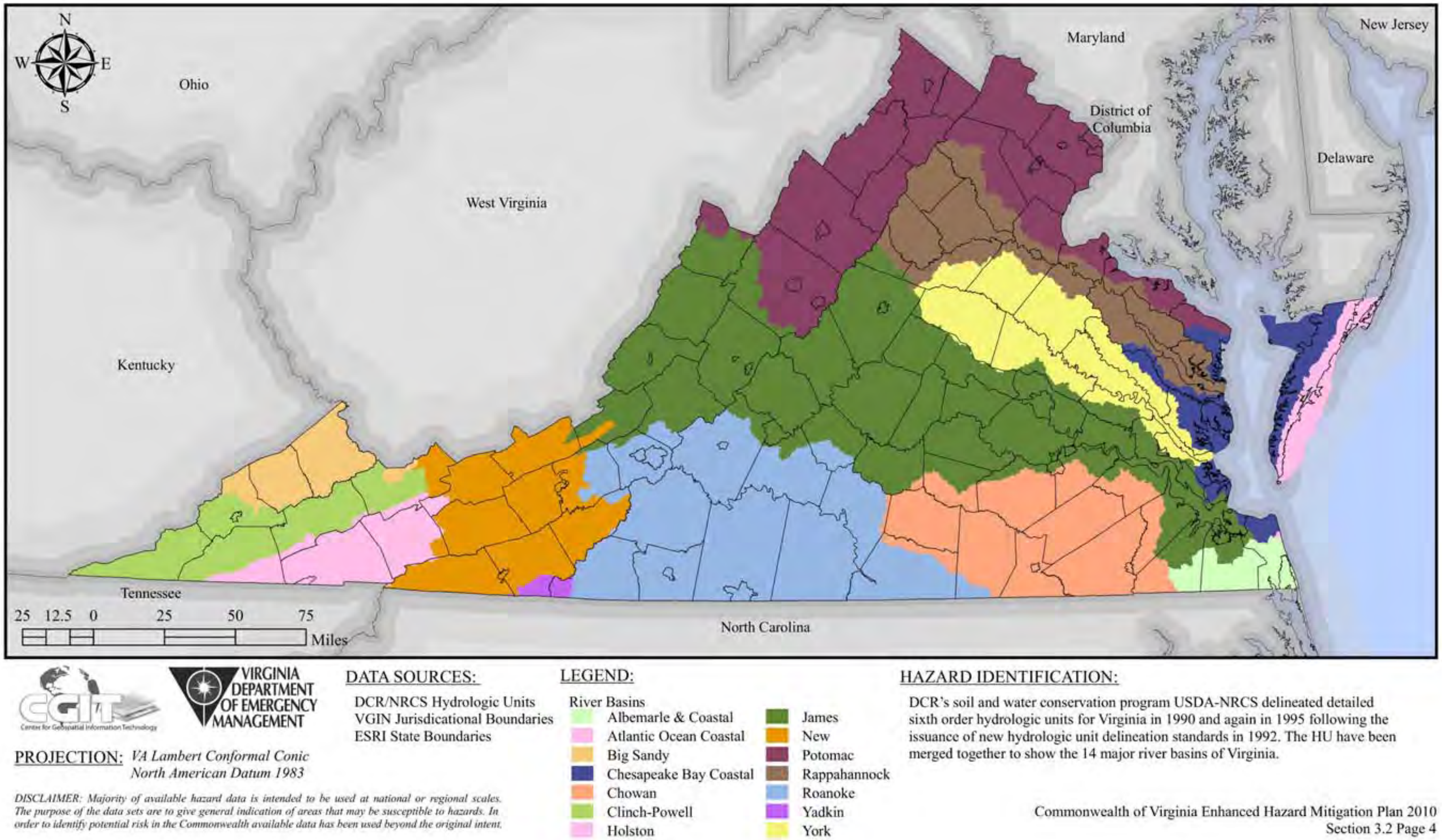


Figure 3.4. Watersheds of Virginia (*Source: Commonwealth of Virginia Emergency Operations Plan HIRA Figure 3.2-2)*

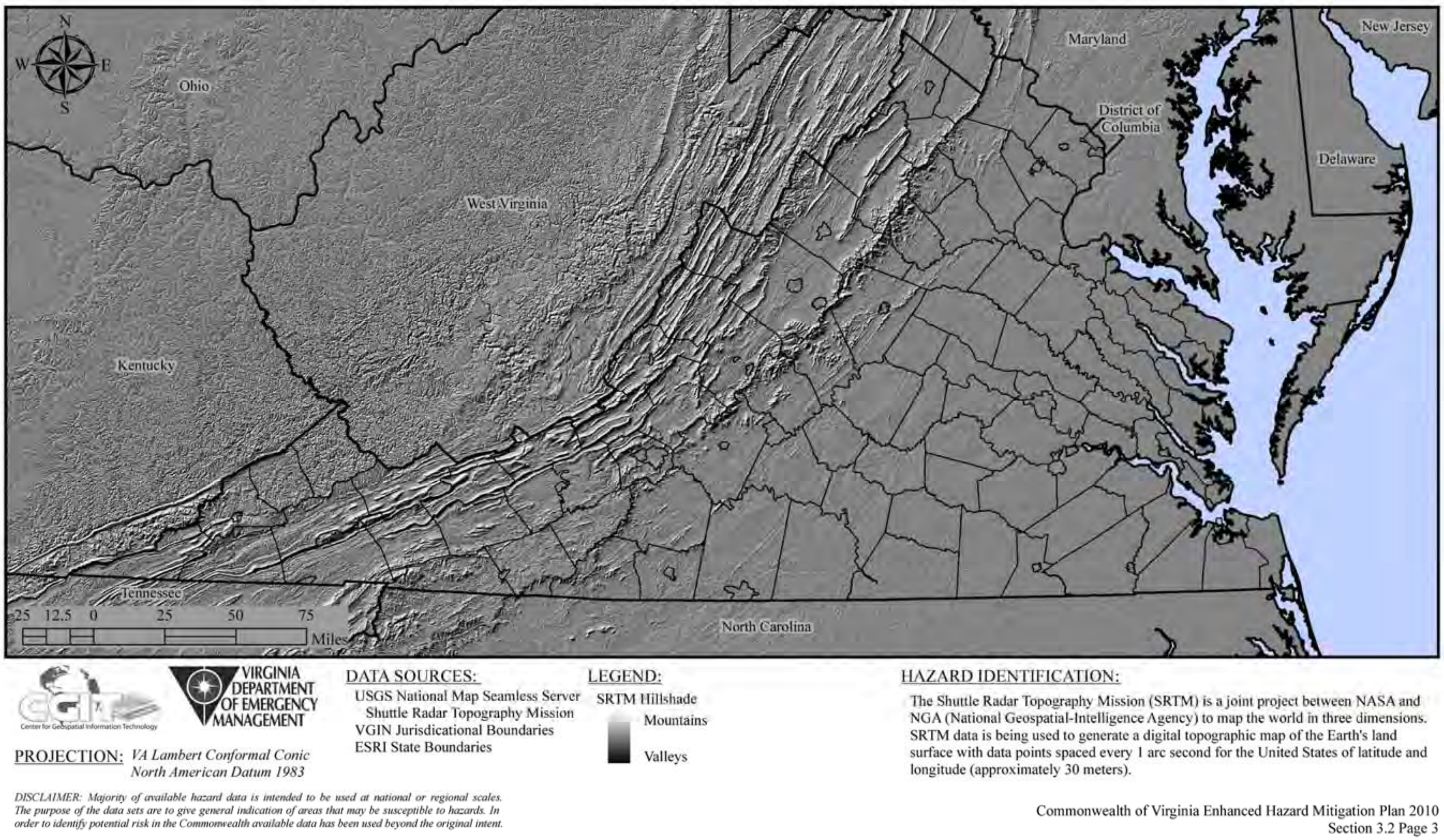


Figure 3.5. Shaded Relief of Virginia

(Source: Commonwealth of Virginia Emergency Operations Plan HIRA Figure 3.2-1.)

C. Demographics, Population & Economic Growth

The Washington metropolitan area is projected to experience substantial growth in population, employment, and output over the next 20 years. Proximity to the Nation's capital has been fueling population growth in Northern Virginia for more than 60 years. Since the mid-1930s, when large numbers of Federal workers moved to Washington, D.C., during the New Deal and began spilling out into adjoining suburbs, people have been moving into Northern Virginia at an accelerated rate.

Today, Northern Virginia is home to over 2 million people. As seen in Table 3.2, demographers are projecting on average, nearly 30,000 newcomers per year through the end of this decade, and approximately 28,000 per year the decade after. The latest population numbers from the Metropolitan Washington Council of Governments were grouped as shown in the table below. Numbers were not available for each city and county individually. By 2020, the population will approach 2.5 million.

The population of Northern Virginia is incredibly diverse and transient. According to the Census Bureau Report from November 3, 2015, there are 168 languages spoken at home. 26% of the metro area population age 5 and over speak a language other than English at home. Individual jurisdictions have even higher totals, for example, Fairfax County Public Schools data shows that 34% of the Fairfax-Falls Church Area population speaks a language other than English at home. The population in the Washington, D.C. area is also very transient, and there are large numbers of visitors to the region. These population characteristics present unique challenges for the Northern Virginia jurisdictions as outreach efforts are not possible in all of the languages spoken in Northern Virginia homes. These characteristics also present challenges in terms of residents' familiarity with the local alerting systems.

Table 3.2 Projected Population Growth in Northern Virginia, 2010-2040

Jurisdiction	2010	2025	2040	Percent Change
Alexandria	140,012	171,292	191,405	26.9%
Arlington County	207,627	247,357	282,998	26.6%
City of Fairfax, Fairfax County and Falls Church	1,116,549	1,255,627	1,406,187	20.6%
Loudoun County	312,310	452,242	484,498	35.5%
Prince William County, Manassas and Manassas Park	454,094	557,549	617,427	26.5%
Northern Virginia	**2,230,592**	**2,684,067**	**2,982,515**	**25.2%**

Source: Metropolitan Washington Council of Governments, Cooperative Forecasts

The locus of population growth, inexorably pushing outward, is now sweeping across the broad expanse of the outer rim of the Northern Virginia region. This is where the pressure to absorb new metropolitan growth is most intense, Loudoun County in particular is predicted to see substantial population growth. There is substantial population growth across the region, with large population increases in every jurisdiction through redevelopment.

At the beginning of the 1960s, Northern Virginia was a suburban bedroom community of predominantly middle-class families with children, not dissimilar demographically from hundreds of other places. By the end of the century, it had evolved into a complex blend of urban and suburban influences, an intricate demographic composite formed by the economic growth, transformation, and prosperity of the Washington metropolitan economy, by a rising tide of immigration, aging of the baby boom generation, and other powerful agents of social and demographic change.

A second salient feature of Northern Virginia's demography is the degree of urbanization etched in locality profiles. In many ways, American suburbs have become more urban, as traffic congestion, overcrowding, immigrants, and more diverse homes and lifestyles work their way into suburbia. But urban pressures and forms, while present everywhere, have not impacted suburbia equally. The pressures are more intense, as a general rule, in neighborhoods settled by the first wave of post-war suburbanization, as they age and become part of an expanding urban core.

In Northern Virginia, impacts of urbanization can be observed in the contrasting demographic profiles of close-in and outer-fringe localities. The differences can be traced, primarily, to variations in the affordability, age, and composition of local housing inventories. As types of housing are unevenly distributed across regional and local landscapes, so too is the flow of different population streams as they seek a home in a location and at a price range suitable to their lifestyle, thereby stamping sections of the region with a distinctive demographic coloration. Listed below are some of the major demographic differences found in the close-in and outer-ring suburbs of Northern Virginia.

Northern Virginia Suburbs closest to Washington, D.C.:
(Primarily in Alexandria, Arlington County, and some inside-the-beltway Fairfax neighborhoods)

- are communities that have changed during the past three decades from conventional family-centered suburbs into new-urban enclaves that, demographically, have become similar to downtown Manhattan, San Francisco, and other U.S. cities
- have become "first-stop" immigrant gateways
- are approaching minority-majority status
- are distinctive and stand out nationally for their high percentage of non-family households, single-person households, childless households, renters, and multi-unit apartment and hi-rise housing (of 50 or more units)
- have among the smallest percentage of school age children, and among the largest percentage of young adults (20 to 35 year old), found anywhere in the U.S.
- have high population turnover, people continually moving in and out, with about half of the population replaced every five years
- exhibit evidence of a widening gap between have and have-nots with large numbers at the high end of the income ladder; and large numbers, mainly immigrants and minorities, at

the low with very few in the middle.

Outer-ring suburbs of Northern Virginia:
(Primarily in Prince William and Loudoun Counties and parts of Fairfax County)

- are communities that are more traditionally suburban in character
- dominated by families with school-age children, and homeowners who are living in detached single-family houses and townhouses
- have large average household sizes
- have growing foreign-born populations but with socio-economic backgrounds different from those pouring into the inner core. Outer suburban immigrants, generally, have lived in the U.S. longer, are better educated, are more affluent, and are more likely to live in homes they own
- many homes with affluent, and well educated people; with some pockets of lower income communities but less prevalent than the jurisdictions closer to Washington, D.C.

The Region at a Glance

The population of Northern Virginia is incredibly diverse and transient adding to the region's vulnerability. According to the Census Bureau Report from November 3, 2015, there are 168 languages spoken at home. 26% of the metro area population age 5 and over speak a language other than English at home. Individual jurisdictions have even higher totals, for example, Fairfax County Public Schools data shows that 34% of the Fairfax-Falls Church Area population speaks a language other than English at home. The population in the Washington, D.C. area is also very transient, and there are large numbers of visitors to the region. These population characteristics present unique challenges for the Northern Virginia jurisdictions as outreach efforts are not possible in all of the languages spoken in Northern Virginia homes. These characteristics also present challenges in terms of residents' familiarity with the local alerting systems.

The Northern Virginia MAC and participating jurisdictions were mindful of these challenges when creating new strategies. Some actions that were examined to address this vulnerability include:

- Expand code requirements to require redundant mechanical systems, especially in communities targeted at retirees.
- Design and build new schools to serve as community shelters.
- Assess if an under-assessed Hispanic service and farm labor force is at risk due to limited communication pathways.
- Determine whether school systems that rapidly expanded during the past 20 years have adequate natural hazard monitoring systems (tornado, winter storm, severe storm); are plans in place and exercised to ensure appropriate school closures or sheltering-in-place.
- Consider new multi-household housing units, especially for elderly, to have on-site generators for power redundancy.
- Work with Cooperative Extensive Service/USDA agencies and Loudoun and Prince William Soil and Water Conservation Districts to determine if agricultural land owners have special hazard mitigation challenges regarding power outages and livestock feeding, access, etc.

- Determine most effective emergency management and hazard mitigation notification communication networks to reach military and immigrant communities who are not familiar with the area.
- Verify that targeted elderly populations can be reached through redundant communication networks.
- Work with advocates for elderly populations to consider education and outreach for seniors to facilitate personal disaster preparedness plans.
- Develop and distribute homeowner hazard mitigation tool kits to property owners that focus on easy mitigation actions homeowners can take.
- Provide multi-language hazard mitigation tool kits through community churches and other organizations.
- Work with landlords to distribute multi-cultural hazard mitigation information to renters, as appropriate, regarding renter's insurance, what to do in an emergency, etc.

1. Projected Economic Growth

While still relatively strong, the recent downturn has had significant impact on the area's economy. The performance of the Washington metropolitan area economy is lagging behind the national economy and that of similar metropolitan areas, a five-year trend dating back to 2010. The Department of Labor Statistics reported an unemployment rate of 3.9% for the region in December 2015, as compared to 5.1% in December 2013. Even with the slumping economy, the region's unemployment rate remains considerably lower than the national rate of 4.8%. George Mason University's Center for Regional Analysis projects the Washington Metropolitan Area economy (Gross Regional Product) to grow from $433.24 billion in 2010 to $683.7 billion in 2030.

A few quick facts underscore the strength, performance, and unique structure of its economy, of which Northern Virginia is an important sub-component. Greater Washington:

- is home to the Federal government, the largest purchaser of goods and services in the world. The total value of Federal procurement outlays received by businesses in the National Capital region during fiscal year 2014 was $71.2 billion, up from $29.3 billion in 2000. The 2014 figure is a decrease from the peak in federal procurement in 2010, when $82.4 billion was received by businesses in the NCR.
- 5th largest increase in jobs among the 15 largest job markets in the United States, with 68,500 additional jobs between December 2014 and December 2015
- has one of the lowest unemployment rates in the country (3.9% in December 2015).
- A total of 297 Fortune 500 companies operate in the Washington, D.C. area
- 11 of the 19 Fortune 500 Companies categorized as federal contractors are headquartered in the Washington Area
- While many of the Fortune 500 companies located in the Washington area, 43 are located here for reasons other than access to the federal market. Data processing and analysis is the Washington area's biggest industry strength.
- is a top U.S. tourist destination, serving as host to 19 million domestic and international visitors in 2013 according to Destination DC

- is home to a growing list of industries and advanced technologies on the vanguard of innovation. Many IT services and computer support firms have facilities here including NETAPP, Level-3 Communications, CenturyLink, IBM, CISCO, Oracle, Microsoft, 3M, and Google.
- The biggest industries in Northern Virginia are Professional, Scientific and Technical services and Government.

Northern Virginia is a strong sub-regional component of the larger Washington economy, as are suburban Maryland and the District of Columbia. Major employers for manufacturing and non-manufacturing jobs in the Northern Virginia region are shown in Table 3.3.

Table 3.3. Major Employers in Northern Virginia. Source: Virginia Employment Commission

Manufacturing		
Company	*Product/Service*	*Estimated Employment*
BAE Systems	Aerospace electronic systems	100 - 299
Lockheed Martin Corporation	Electronic components	5,000 - 9,999
Non-Manufacturing		
Booz, Allen & Hamilton	Management & technology consulting	10,000+
Computer Sciences Corporation	Information technology services	10,000+
Department of Defense	National security	10,000+
Department of Homeland Security	National Security	10,000+
Federal Home Loan Mortgage Corp.	Financial services	2,500 - 4,999
George Mason University	Higher education	2,500 - 4,999
INOVA Health System	Health care	10,000+
Northrop Grumman	Professional, scientific, and technical services	5,000 - 9,999
Science Applications International Corp. (SAIC)	Information technology services	5,000 - 9,999
Wal-Mart Stores, Inc.	Discount retail	2,500 - 4,999
Washington Metro Area Transit Authority	Transit system	1,500 - 2,499

2. Population

According to the U.S. Census Bureau, the population of the Northern Virginia region in 2014 was approximately 2.4 million. The average number of persons per square mile was 1,735, making the region one of the most densely populated in the United States. Table 3.4 shows the total population and population density per square mile, by jurisdiction. As can be seen in the table, the City of Alexandria is the densest jurisdiction while Loudoun County is the least dense. However, when the land comprising Arlington National Cemetery and Reagan National Airport are considered, Arlington County is even denser than Alexandria. Figure 3.6 illustrates the distribution of population density, using 2014 estimates, across the region according to census tracts.

Table 3.4. Population Statistics in the Northern Virginia Region, by Jurisdiction
Source: U.S. Census Bureau

Jurisdiction	2005 Population Estimate	2005 Population Density (Square Mile)	2010 Population	2010 Population Density (Square Mile)	2014 Census Population Estimate	2014 Population Density (Square Mile)
Arlington County	197,806	7,573	207,627	7,993	226,908	8,737
Fairfax County	1,036,578	2,550	1,081,726	2,767	1,137,538	2,909
Loudoun County	257,240	494	312,311	515	363,050	599
Prince William County	354,039	1,016	402,002	1,195	446,094	1,326
City of Alexandria	138,004	8,955	139,966	9,314	150,575	10,018
City of Fairfax	23,059	3,626	22,565	3,616	24,483	3,923
City of Falls Church	10,648	5,324	12,332	6,170	13,601	6,835
City of Manassas	37,423	3,742	37,821	3,828	442,081	4,259
City of Manassas Park	12,561	5,106	14,273	5,633	15,174	5,998
Northern Virginia Total	**2,067,358**	**1,545**	**2,230,623**	**1,599**	**2,419,504**	**1,735**

Development Trends, described in the following section, summarize population change for the region. The Risk Assessment Methodology section summarizes the population parameters used in ranking the hazards presented in this report.

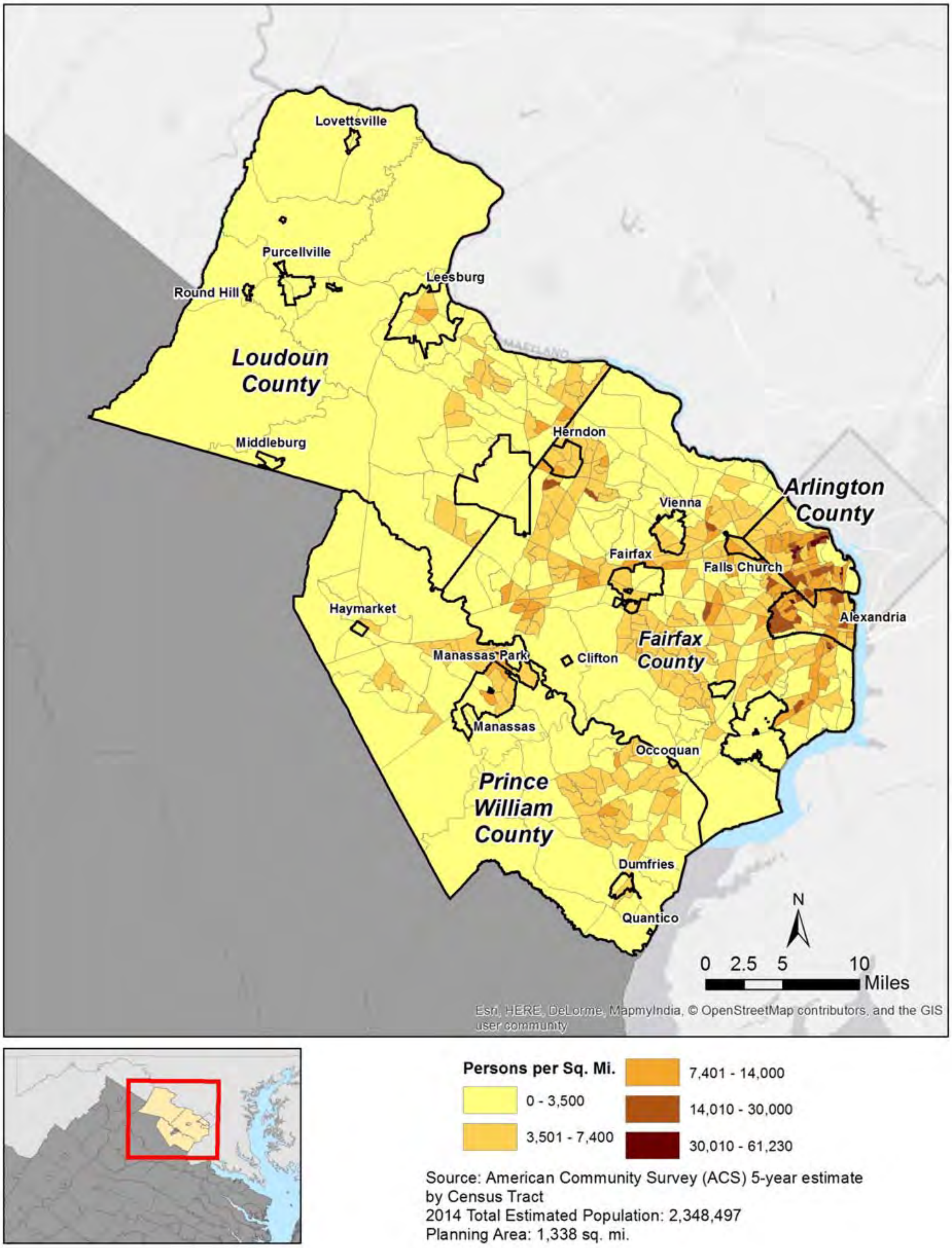


Figure 3.6 Population Density (2014).

3. Housing

A general market inventory of housing in Northern Virginia shows that there is a continual demand for affordable housing, with low vacancy rates throughout the region. Housing demand is being propelled by job growth.

As tracked by George Mason University, the median sales price of housing in December 2014 was $408,000 an increase of 4.3% since December 2013. Incomes have not been keeping pace with rising housing prices. The Urban Institute estimates that 69% of Washington area households are paying less than 30% of their income in housing costs in 2011. Additionally, in 2011, the Urban Institute estimates that nearly half of all renters in the region are paying more than 30% of their salary on housing. Housing construction has continued to be strong in the outer-ring suburban jurisdictions.
http://cra.gmu.edu/pdfs/Washington_Metro_Housing_Market_Update.pdf

D. Land Use, Development, & Zoning

1. Land Use

FEMA requires that State and local mitigation plans evaluate land use and development trends so that mitigation options can be considered in future land-use decisions. Changes in urban and agricultural land cover may help to highlight areas within the State that should be considered in long-term comprehensive plans.

To identify these areas, land cover change was assessed using the National Land Cover Dataset. This dataset is produced by the Multi-Resolution Land Characteristics Consortium (MRLC), a collection of Federal agencies that pool resources to map land cover across the Nation. Using satellite imagery, the MRLC produced datasets for 2001 and 2011 that include land cover classes for various types of urban, agricultural, forested, and other natural areas. These two datasets were compared in order to map land cover changes during that 10 year period.

The majority of change in Northern Virginia has occurred in forested lands and urban areas shown in Table 3.5. From 2001 through 2011, forest land cover has decreased and urban area has increased across the region. With the exception of several towns, which saw no change, every jurisdiction saw an increase in urban area and a decrease in forested land. Loudoun County, however, has witnessed the most urban growth, increasing by 11,945 acres. Agricultural land cover has also shown significant decrease in both Loudoun and Prince William Counties as population growth moves out. Figures 3.7 and 3.8 show the distribution of land cover for Northern Virginia.

Table 3.5. National Land Cover Changes 2001 to 2011.				
Jurisdiction	**Urban Change (Acres)**	**Forest Change (Acres)**	**Agricultural Change (Acres)**	**Wetland Change (Acres)**
Arlington County	65.8	-65.4	0	-1.1
Fairfax County	4,965	-4,212	-751	-116
Town of Herndon	33	-30	-3.6	0
Town of Vienna	6.4	-6.4	0	0
Town of Clifton	0	0	0	0
Loudoun County	11,945	-6,361	-6,158	-220
Town of Leesburg	918	-307	-585	-14
Town of Lovettsville	84	-7.8	-74.9	-1.1
Town of Purcellville	404	-127	-287	0
Town of Middleburg	0	0	0	0
Town of Round Hill	0	0	0	0
Prince William	12,440	-9,771	-2,813	-960
Town of Dumfries	42.5	-37.1	0	-7.3
Town of Haymarket	15.8	-10.5	-2.9	-2.4
Town of Occoquan	0	0	0	0
Town of Quantico	1.8	0	0	-1.8
Alexandria	87	-59	0	-18
Fairfax City	60	-53	-6	0
Falls Church	8	-8	0	0
Manassas	123	-111	-11	-8.2
Manassas Park	182	-126	-24	0
Total	***31,381***	***-21,293***	***-10,715***	***-1,350***

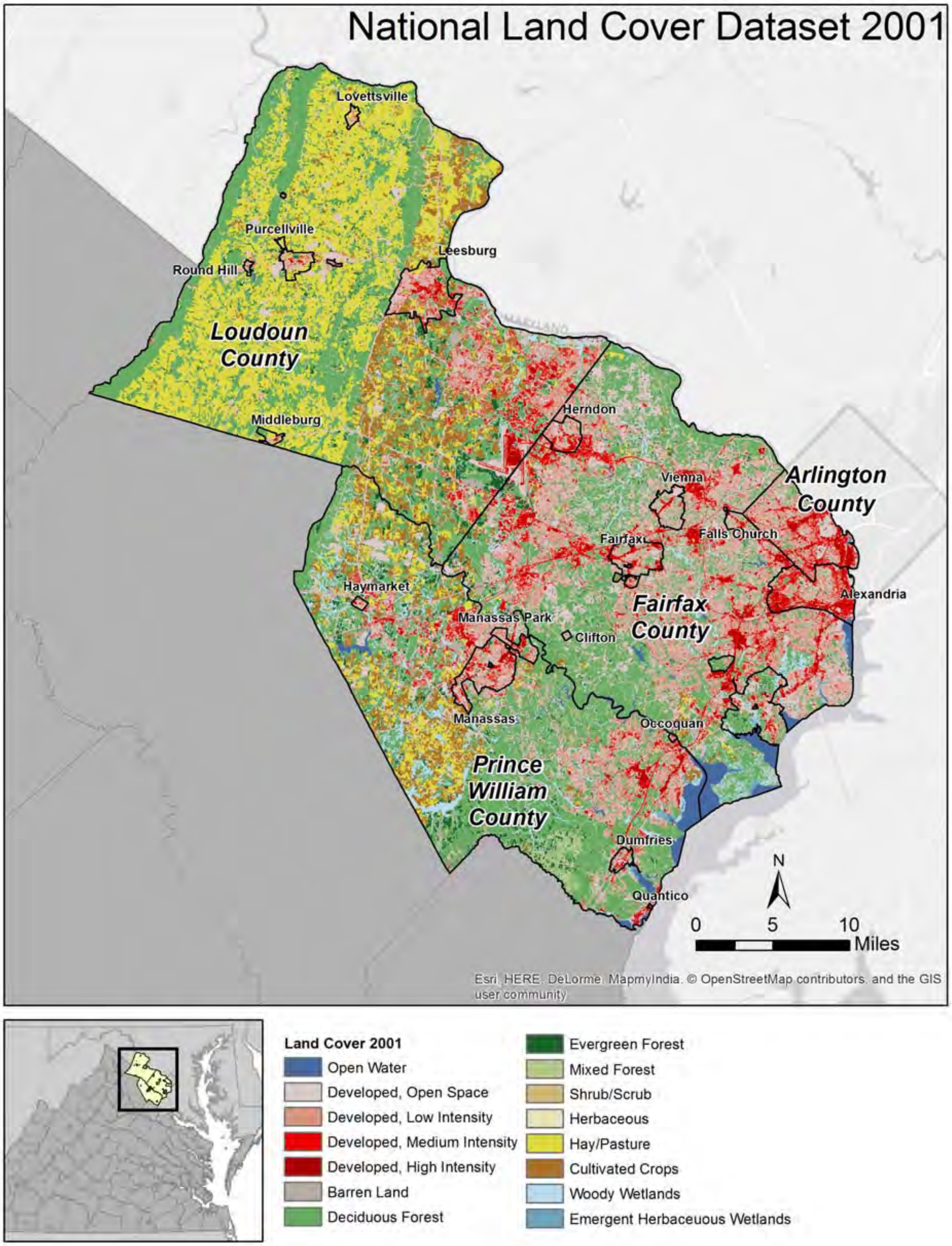


Figure 3.7. 2001 Land Cover categories.

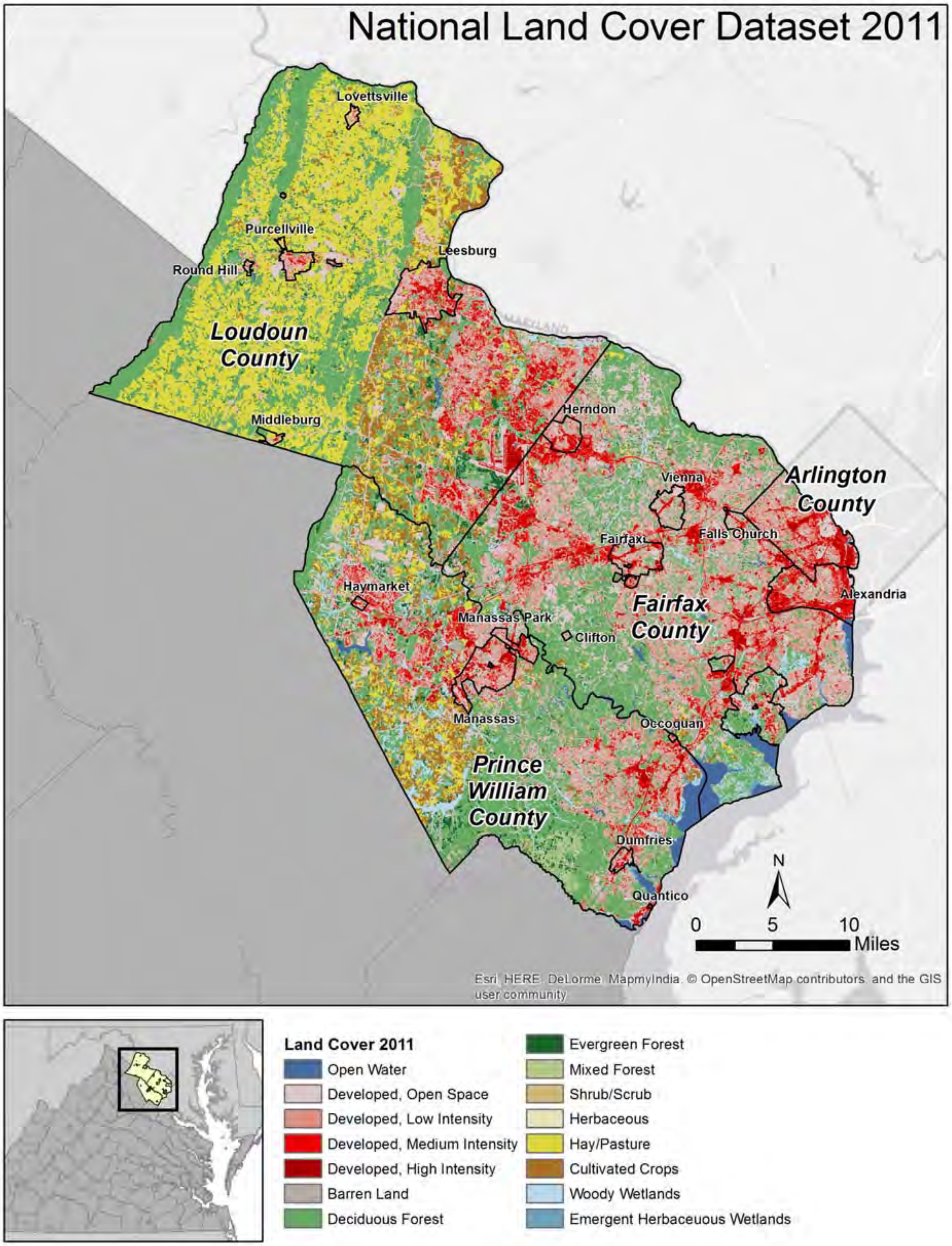


Figure 3.8. 2011 Land Cover categories.

2. Development Trends

A general analysis of land uses, development trends, and zoning within the planning area is an important factor in formulating mitigation options that influence future land use and development decisions. In many cases, local development policies greatly influence the degree of future vulnerability in communities across the region. The vulnerability of future buildings, infrastructure, and critical facilities is a great concern to community leaders across the Northern Virginia region and, as discussed in the Capability Assessment section, many of the day-to-day activities in local governments in the region are designed to deal with these challenges.

One of the most critical indicators to review in considering local development trends is population growth. The rate of population change in the Northern Virginia region from 2010 to 2014 was 8.58 percent, which is more than double the average growth rate for the State of Virginia during this same time period (4.07 percent). Table 3.6 shows the breakdown of population growth rates, by jurisdiction. As can be seen in the table, Fairfax County has the highest population in the region (1,137,538 people) while Loudoun County experienced the highest growth rate based upon percent change (16.25%). The region as a whole has experienced an 8.58% growth in the past nine years and accounts for over a quarter of the Commonwealth's total population.

Total population and population density have been used in the risk assessment ranking methodology. Refer to the Risk Assessment and Methodology section for more details on these ranking parameters.

Table 3.6. Northern Virginia Population Change (2010 – 2014).

Jurisdiction*	2010 Census	Estimated 2014	Percent Change
Arlington County	207,627	226,908	9.2%
Fairfax County	1,081,726	1,137,538	5.15%
Town of Herndon	23,292	24,554	5.42%
Town of Vienna	15,687	16,459	4.92%
Town of Clifton	282	295	4.61%
Loudoun County	312,311	363,050	16.25%
Town of Leesburg	42,616	49,496	16.14%
Town of Lovettsville	1,613	1,869	15.87
Town of Purcellville	7,727	8,929	15.56%
Town of Middleburg	673	781	16.05%
Town of Round Hill	539	621	15.21%
Prince William County	402,002	446,094	10.97

Table 3.6. Northern Virginia Population Change (2010 – 2014).			
Jurisdiction*	**2010 Census**	**Estimated 2014**	**Percent Change**
Town of Dumfries	4,961	5,192	4.66%
Town of Haymarket	1,782	1,973	10.72%
Town of Occoquan	934	1,013	8.46%
Town of Quantico	480	531	10.63%
City of Alexandria	139,966	150,575	7.58%
City of Fairfax	22,565	24,483	8.50%
City of Falls Church	12,332	13,601	10.29
City of Manassas	37,821	42,081	11.26%
City of Manassas Park	14,273	15,174	6.31%
Northern Virginia Total	**2,331,209**	**2,531,217**	**8.58%**
VIRGINIA TOTAL	**7,079,030**	**7,882,590**	**11.35%**

*Town estimates are accounted for in County Totals.

3. Zoning

Zoning is also a critical indicator to review in considering local development trends. Zoning Geographic Information Systems (GIS) data was provided by the majority of the jurisdictions participating in the plan update. The following section summarizes the results of this data. In some cases, zoning generalizations were made in order to compare the jurisdictions to each other. In all of the jurisdictions, residential zoning is by far the largest classification, often followed by commercial.

Fairfax County has 46 zoning classifications that can be grouped into several large categories; residential zoning occupies approximately 79.8% of the total area of the county followed by planned units (10.9%). Commercial and Industrial make up 3% of the county land area.

Loudoun County's zoning categories were grouped to allow them to be compared to the other jurisdictions. Loudoun County is made up of 86% residential, 4% commercial, 4% industrial, and 6% mixed use zoning.

Prince William County has 7 zoning categories. Agricultural zoning occupies approximately 46.68% of the land within the county. 22.09% of the county is within the borders, but does not belong to the County (including towns, independent cities, and federally owned property), Residential makes up 13.63% of the land area, Mixed use is 12%, industrial is 3.23%, business is 2.13%, and office makes up 0.23% of the land area.

Arlington County has 30 zoning classifications. Over 47% of the land area zones are considered One-Family Dwelling Districts. In order to compare to the other jurisdictions, the classifications were grouped into commercial, industrial, residential, and other. This resulted in 60% residential, 31% other, 8% commercial, and less than 1% is industrial based on land area.

The City of Alexandria has 32 zoning classifications. In order to compare to the other jurisdictions, the classifications were grouped into commercial, industrial, residential, and other. This resulted in 57% residential, 25% commercial, 15% other, and less than 3% industrial based on land area.

The City of Falls Church has 13 zoning classifications; low density residential represents the largest category with 51% of the land area of the city. In order to compare to the other jurisdictions, the classifications were grouped into commercial, industrial, residential, and other. This resulted in 79% residential, 14% commercial, 5% industry, and less than 2% other (or transitional) based on land area.

The City of Fairfax has 16 existing land use classifications; "Residential-Single Detached" represents the largest category with 45.6% of the land area of the city not including right of ways (or 39% of the total 4061.89 acres of the City). The second largest land use category is "Open Space – Recreation & Historic" which represents 12% of the land uses (10.3% of total area). Public right of way makes up 14.4% of the total area of the City. In order to compare to the other jurisdictions, the classifications were grouped into residential, commercial, industrial, institutional, and other. This resulted in 55.1% residential, 16.8% commercial, 8.5% institutional, 3.8% industrial and approximately 15.7% other based on land area not including the public right of way.

The City of Fairfax also provided Future Land Use categories. Based on this information, the city has 14 future land use classifications; "Residential – Low" is the largest category with 33.6% of the land area of the city not including public right of way. The second largest category, "Business – Commercial", represents 12%. In order to compare to the other jurisdictions (and existing land uses of the city), the classifications were grouped similarly to the summarized existing land uses. This resulted in 54.2% residential, 13.3% commercial, 7.5% institutional, 6.2% mixed use, 3.0% industrial and 15.7% other based on land area not including right of way. "Mixed Use" is not a category used in the existing land use analysis. The category, which makes up 6% of the future land uses, is a mix of all other existing land uses (64% commercial, 27% residential, 4% industrial, 2% institutional, 3% other).

The City of Manassas has 17 Zoning Districts, as of April 2015, 54% of the land area is residential, 34% is industrial, 9% is commercial, and 3% is mixed-use/downtown.

4. Transportation

Northern Virginia and the Washington, D.C., metropolitan area is served by an extensive transportation network. There are 12 interstates and 42 highways in the Northern Virginia region. Transportation within the Northern Virginia region is primarily dependent upon a network of major highways (VA Rt. 7, I-66, US50, US29/211, I-95/395, and US1) that radiate out from the urban core (Washington, D.C., Arlington, and Alexandria); one major circumferential highway (I-495/95, the Capital Beltway); and other primary cross-county roads such as the Fairfax County Parkway and the Prince William Parkway. Figure 3.1 above provides the major overview of the highways and interstates in the planning region.

The Washington Area's Metro Rail System primarily serves the inner localities with 11 stations in Arlington County, four stations in the City of Alexandria, and 10 stations in Fairfax County. There is a major expansion underway on the Metro Rail system, with the "Silver Line" extending service along I-267 into Fairfax and Loudoun Counties. Five of the stations in Fairfax County opened in June of 2014, and construction is underway to extend service to Dulles Airport and farther into Loudoun County. The Virginia Railway Express (VRE) commuter rail system serves communities to the west, cutting through central Fairfax County to the cities of Manassas and Manassas Park, and to the south in eastern Prince William County continuing to the City of Fredericksburg. Several bus systems (Metrobus, Alexandria's DASH, Arlington's ART, Falls Church's George, Fairfax County's Connector, Fairfax City's CUE, and Prince William's PRTC/Omniride) provide service throughout the region.

Commercial air service includes the Ronald Reagan Washington National Airport and Washington Dulles International Airport. Figure 3.2 shows the location of the airports in the planning region.

Nevertheless, these transportation systems are being strained by the growing population, housing, and employment patterns. In 2015, the travel time index for the Washington, D.C. area was 1.34. Travel time index is a comparison of travel time during the peak period to travel time with free flow. In other words, a trip will take 34% longer during rush hour then with no traffic. In 2014, the region experienced 5.4 hours of "rush hour" per day. This is a new measure and cannot be compared to previous years. According to the Census Bureau and Texas Transportation Institute, the average commute in the Washington, D.C. area is 34.5 minutes, up from 31.7 minutes in 2000. Workers are leaving home earlier and coming home later to make up the time that it takes to get where they need to go.

The Texas Transportation Institute 2014 Urban Mobility Report shows the Metropolitan Washington region ranks as follows:

- Number 1 in average hours lost sitting in traffic (82 hours).
- Number 1 in congestion cost per commuter ($1,834).
- Number 1 in excess fuel consumed per commuter due to congestion (35 gallons/year).
- Number 6 in total excess gallons of fuel consumed due to congestion (88 million gallons)
- Number 5 total regional congestion cost ($4.56 billion/year).
- Number 4 in total delay due to congestion (204 million hours/year)

Transportation systems are key in providing effective emergency response, but can also influence the impact of natural disasters. This can be a particularly crucial issue in Northern Virginia due to the high levels of traffic congestion. In addition to more immediate needs, businesses and employees suffer economic consequences when roads are closed due to natural disasters.

Day to day traffic reports frequently report accidents or simply high volume levels that may bring a particular highway to a standstill. The attack on the Pentagon on September 11, 2001, Hurricane Isabel in 2004, and normal winter storms bring the regional highway system to a stop and taxes the transit system to the limits.

Northern Virginia, the Commonwealth of Virginia, and the metropolitan area as a whole are actively addressing transportation through significant updates in regional plans; expansion of transit to areas such as Tysons Corner, Reston, and Dulles Airport; and introduction of operational measures such as HOT (high occupancy toll) lanes (charging tolls on high occupancy vehicle lanes) to address congestion. In fact, HOT lanes have been added to I-95, I-395, and I-495.

[1] Gutowski, W.J., G.C. Hegerl, G.J. Holland, T.R. Knutson, L.O. Mearns, R.J. Stouffer, P.J. Webster, M.F. Wehner, and F.W. Zwiers, 2008: Causes of observed changes in extremes and projections of future changes. In: *Weather and Climate Extremes in a Changing Climate: Regions of Focus: North America, Hawaii, Caribbean, and U.S. Pacific Islands* [Karl, T.R., G.A. Meehl, C.D. Miller, S.J. Hassol, A.M. Waple, and W.L. Murray (eds.)]. Synthesis and Assessment Product 3.3. U.S. Climate Change Science Program, Washington, DC, pp. 81-116.

Chapter 4: Regional Hazard Identification and Risk Assessment (HIRA)

Requirement §*201.6(c)(2): (The plan shall include) …a risk assessment that provides the factual basis for activities proposed in the strategy to reduce losses from identified hazards. Local risk assessments must provide sufficient information to enable the jurisdiction to identify and prioritize appropriate mitigation actions to reduce losses from identified hazards. The risk assessment shall include:*

- *(i) A description of the type, location, and extent of all natural hazards that can affect the jurisdiction. The plan shall include information on previous occurrences of hazard events and on the probability of future hazard events.*
- *(ii) A description of the jurisdiction's vulnerability to the hazards described in paragraph (c)(2)(i) of this section. This description shall include an overall summary of each hazard and its impact on the community. All plans approved after October 1, 2008 must also address NFIP insured structures that have been repetitively damaged by floods. The plan should describe vulnerability in terms of:*
  - *a. The types and numbers of existing and future buildings, infrastructure, and critical facilities located in the identified hazard areas;*
  - *b. An estimate of the potential dollar losses to vulnerable structures identified in paragraph (c)(2)(ii)(A) of this section and a description of the methodology used to prepare the estimate;*
  - *c. Providing a general description of land uses and development trends within the community so that mitigation options can be considered in future land use decisions.*
- *(iii) For multi-jurisdictional plans, the risk assessment must assess each jurisdiction's risks where they vary from the risks facing the entire planning area.*

I. Introduction

The 2016 update to the Northern Virginia Hazard Mitigation Plan includes the following participating jurisdictions:

Counties
Arlington County
Fairfax County
Loudoun County
Prince William County

Cities
City of Alexandria
City of Fairfax
City of Falls Church
City of Manassas
City of Manassas Park

Towns
Town of Clifton
Town of Dumfries
Town of Haymarket
Town of Herndon
Town of Leesburg
Town of Lovettsville
Town of Middleburg
Town of Purcellville
Town of Occoquan
Town of Quantico
Town of Round Hill
Town of Vienna

Although some anecdotal information may be included regarding the towns located within these counties, these areas may not be fully included in this assessment due to the lack of data available. Where available, location-specific data is incorporated into the 2016 update. Where it was not available, it is assumed that adjacent county or municipal data includes or otherwise accounts for the town. For the purpose of simplicity, the study area will be referred to as the Northern Virginia planning area throughout the remainder of this chapter.

Efforts to involve county, city, and town departments and community organizations that might have a role in the implementation of mitigation actions or policies included invitations to attend meetings and assist with the development process, e-mails of minutes and updates, and opportunities for input and comment on all draft deliverables. Additional information on how this chapter was developed is available in the Planning Process Chapter.

The purpose of this section of the plan is to:

1) Identify the natural hazards that could affect the Northern Virginia planning area;
2) Assess the extent to which the area is vulnerable to the effects of these hazards; and
3) Prioritize the potential risks to the planning area.

The first step, identifying hazards, assessed and ranked all the potential natural hazards in terms of probability of occurrence and potential impacts. It also identified those hazards with the highest likelihood of significantly impacting the community. This section was completed based on a detailed review of the planning area hazard history. The 2010 update evaluated and reviewed the 2006 ranking and it was determined by the steering committee to expand the ranking and better align it with the Commonwealth of Virginia's methodologies. For the 2016 update, it was determined to continue the same methodology and hazards, with one minor change – rather than include extreme temperatures with other hazards, extreme temperatures is included in the 2016 update as an independent hazard.

Prior to the beginning of work to update the HIRA, the planning committee determined that the 2016 plan update would focus on natural hazards, and that no man-made or technological hazards would be included in this update, even in a redacted appendix.

The hazards determined to be of the highest risk were analyzed further to determine the magnitude of potential events, and to characterize the location, type, and extent of potential impacts. This included an assessment of what types of development are at risk, including critical facilities and community infrastructure. Finally, a prioritization of the risk to the planning area was compiled, to serve as an overall guide for the communities when planning development, implementing policy, and identifying potential mitigation measures.

II. Data Availability and Limitations

This study includes data collected from a variety of resources including local, state, and national datasets. Whenever possible and practical, data has been incorporated into GIS products to aid in analysis and to develop area-wide maps for depicting historical hazard events, hazard areas, and vulnerable infrastructure. Critical facility data has been collected from the FEMA loss-estimating module, Hazards U.S. (HAZUS^{MH}), and has been supplemented, to the extent possible, by local data. The local data provided is summarized below in the Building Inventory & Local Critical Facility Data section. In accordance with FEMA mitigation planning guidance, the results of this study are based on the best available data. In most cases, detailed data regarding the structural characteristics of facilities does not exist in a usable format at the local level.

Local Critical Facility and Building Data

Building inventories were provided by the jurisdictions participating in this plan. In most cases, the building inventory captures only the location and estimated value of structures. Characteristics such as structure and construction type, (i.e., residential wood frame home) are not always recorded. This data was utilized to determine the risk to buildings based on the extent of known hazard areas that can be spatially defined through GIS technology. Hazards without known recurrence probabilities or mapped hazard extents are not deemed unique enough to make definitive risk and vulnerability assessments for potentially at-risk buildings or facilities that differentiate them from other areas of the region. The hazard-specific sections provide the analysis, if relevant, for the critical facilities, historic structures, and buildings at risk. Table 4.1 summarizes estimated building inventories per jurisdiction, estimated from both local inventories and HAZUS^{MH}.

Table 4.1. Local Building Inventory per Jurisdiction, from Local Inventories and HAZUS^{MH}

Jurisdiction	Estimated Number of Buildings per HAZUS^{MH}	Jurisdiction Estimated Number of Critical and Historic Assets
Arlington County	40,847	380
Fairfax County	328,867	448
Town of Clifton	*included*	58
Town of Herndon	*included*	37
Town of Vienna	*included*	19
Loudoun County	99,182	176
Town of Leesburg	*included*	171
Town of Lovettsville	*included*	7
Town of Purcellville	*included*	7
Town of Middleburg	*included*	6
Town of Round Hill	*included*	5
Prince William County	128,867	171
Town of Dumfries	*included*	NA
Town of Haymarket	*included*	8
Town of Occoquan	*included*	11
Town of Quantico	*included*	NA
City of Alexandria	41,158	21
City of Fairfax	7,986	16
City of Falls Church	4,602	9
City of Manassas	8,024	85

Table 4.1. Local Building Inventory per Jurisdiction, from Local Inventories and HAZUS^{MH}		
Jurisdiction	**Estimated Number of Buildings per HAZUS^{MH}**	**Jurisdiction Estimated Number of Critical and Historic Assets**
City of Manassas Park	4,152	19

Local historic asset, critical facility, and infrastructure data were provided in some form by most jurisdictions. However, a comprehensive inventory consistent across jurisdictions does not exist because there is no universally accepted definition of what constitutes critical facilities and infrastructure, nor is one associated with FEMA and DMA 2000 planning requirements. For purposes of this plan, critical facilities and infrastructure are identified as "*those facilities or systems that are owned/operated/maintained by the jurisdiction whose incapacity or destruction would present an immediate threat to life, public health, and safety, or have a debilitating effect on the economic security of the region*." This includes the following facilities and systems based on their high relative importance for the delivery of vital services, the protection of special populations, and other important functions in the Northern Virginia region:

- Emergency Operations Centers (EOCs);
- Hospitals and medical care facilities;
- Police stations;
- Fire stations;
- Schools (particularly those designated as shelters);
- Hazardous material facilities;
- Potable water facilities;
- Wastewater facilities;
- Energy facilities (electric, oil, and natural gas); and
- Communication facilities.

Because of their significance to many of the participating jurisdictions, historic assets were also included in this critical asset inventory for many jurisdictions.

In preparing the inventory of critical facilities for the Northern Virginia region, each participating jurisdiction was asked to submit best available GIS data for their primary critical facilities to be used in combination with HAZUS^{MH} inventory data. This resulted in the identification of hundreds of critical facilities for the Northern Virginia region. It is understood that this listing is incomplete due to data limitations associated with both the local GIS and HAZUS^{MH} inventories, but that further enhancements to the data will be made over time and incorporated during future plan updates. When analysis for critical facilities was performed, both the local and HAZUS^{MH} summary results are presented in the hazard specific sections, with clear notations as to which data set was utilized for that particular portion of the assessment.

During the 2016 update, each of the localities was provided a data matrix to assist them in compiling local data. The Data Matrix found in Appendix D contains the populated data matrices for localities that provided data during the data collection phase of this update. Figures 4.1

through 4.19 show the provided critical facility and historic asset locations within each of the participating jurisdictions.

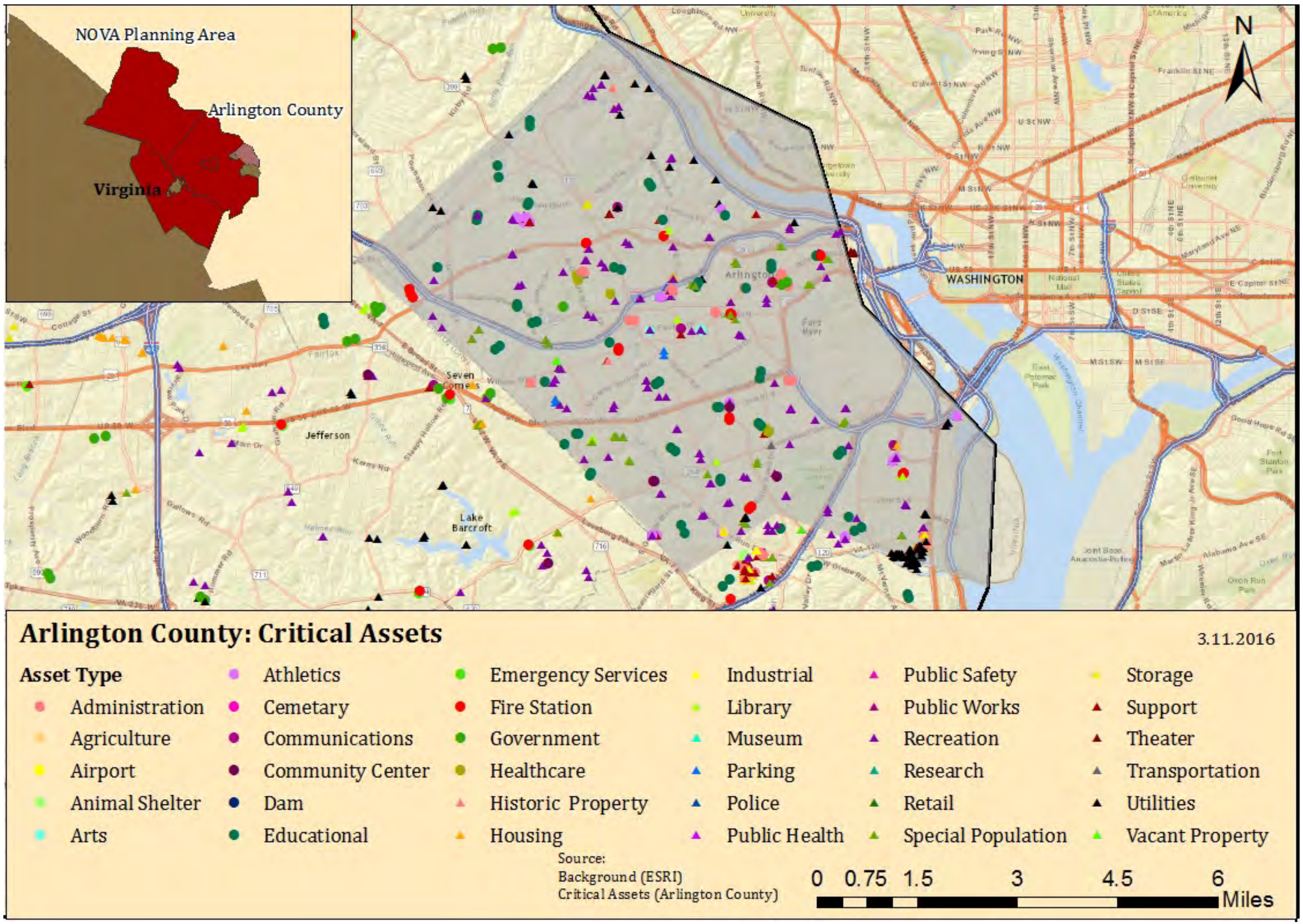


Figure 4.1. Arlington County local critical assets and historic structures.

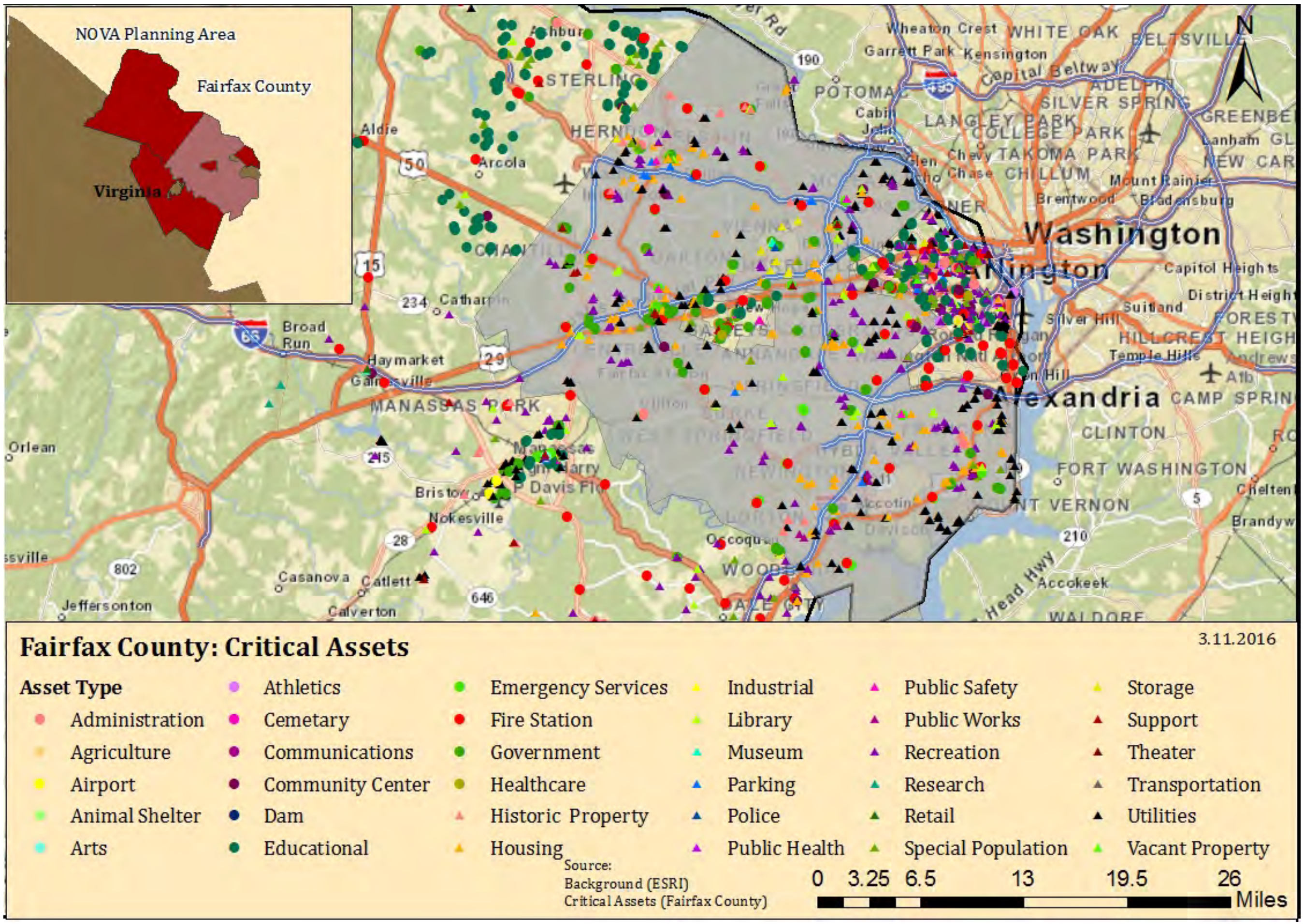


Figure 4.2. Fairfax County local critical assets and historic structures.

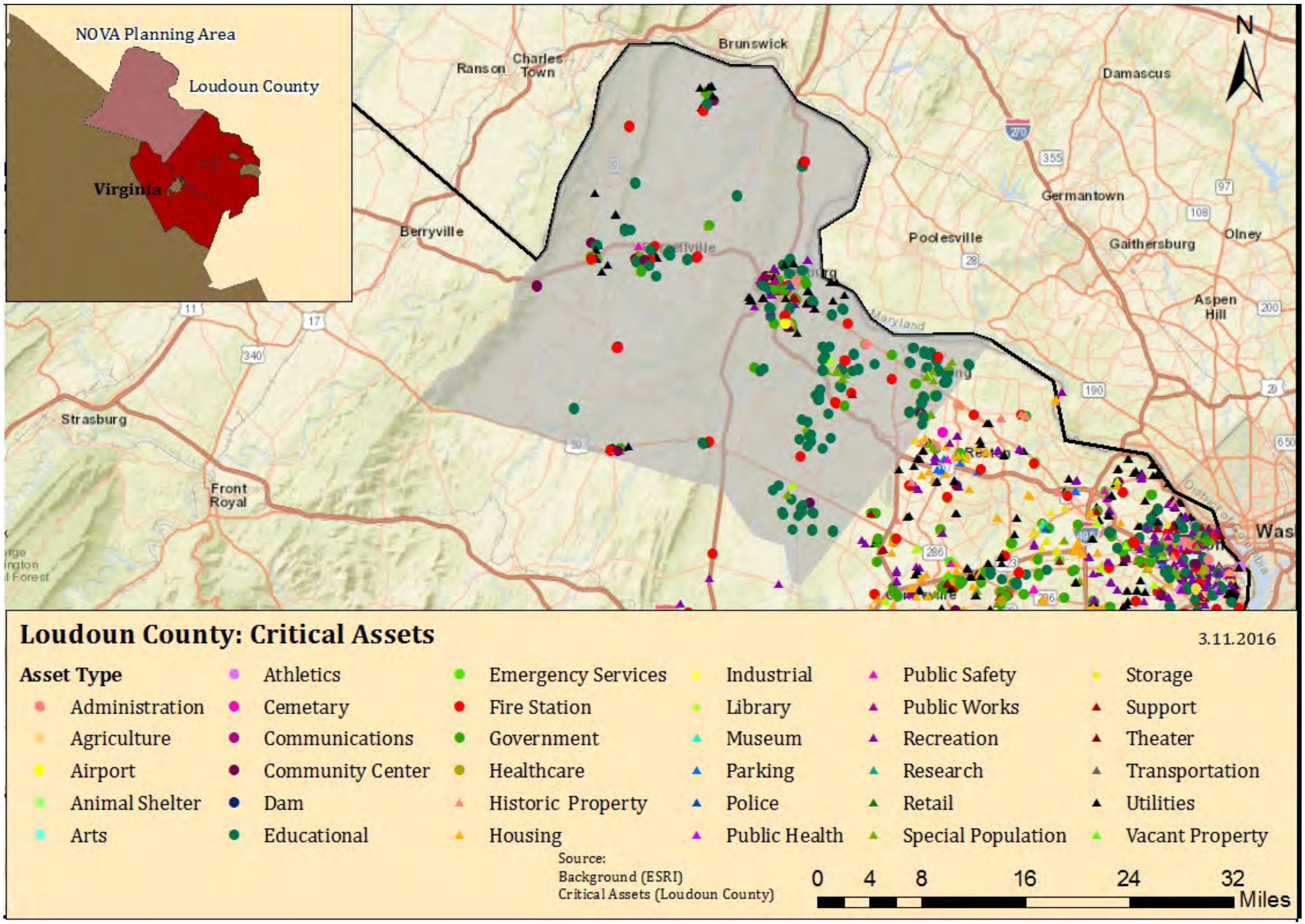


Figure 4.3. Loudoun County local critical assets and historic structures.

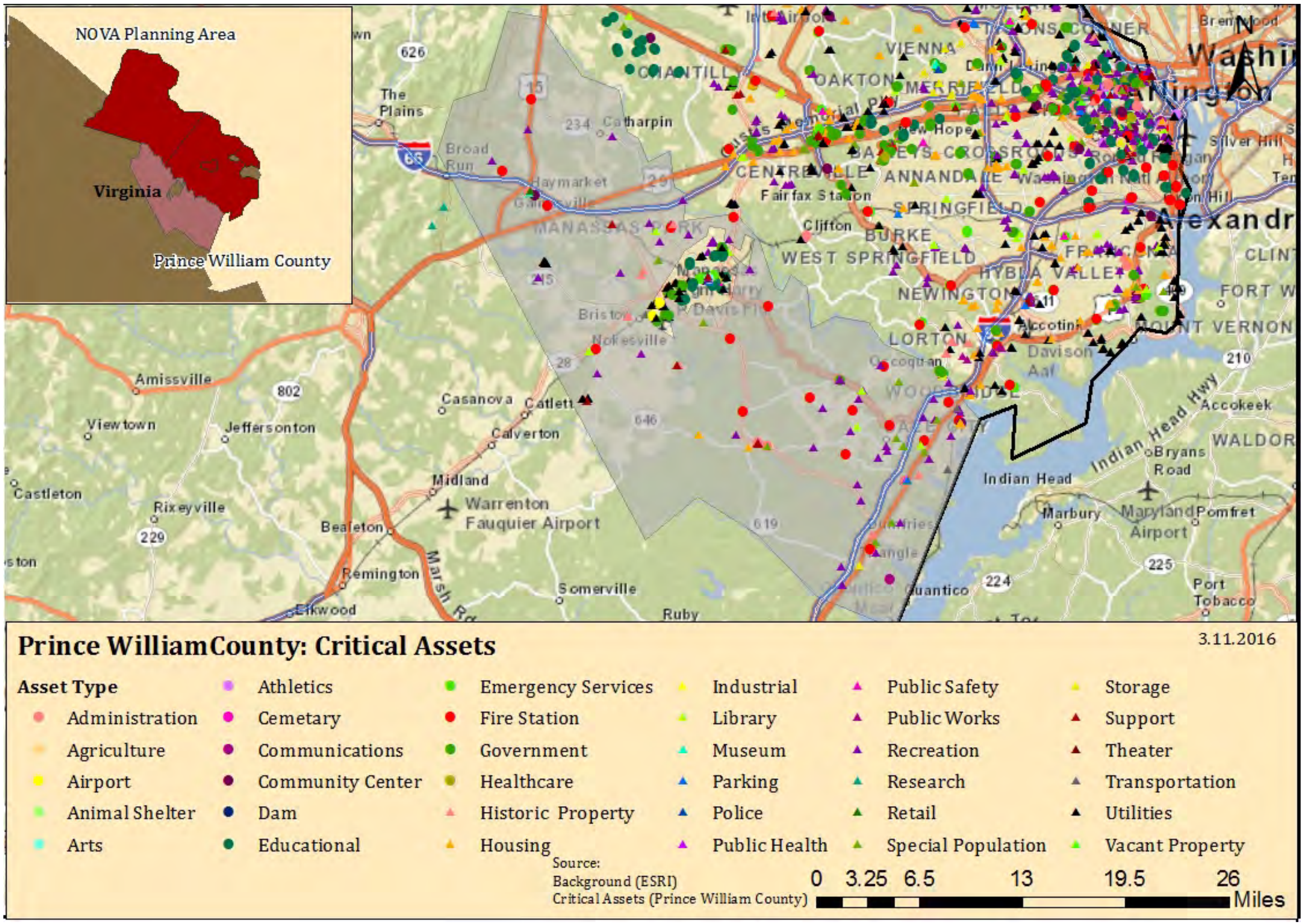


Figure 4.4. Prince William County local critical assets and historic structures.

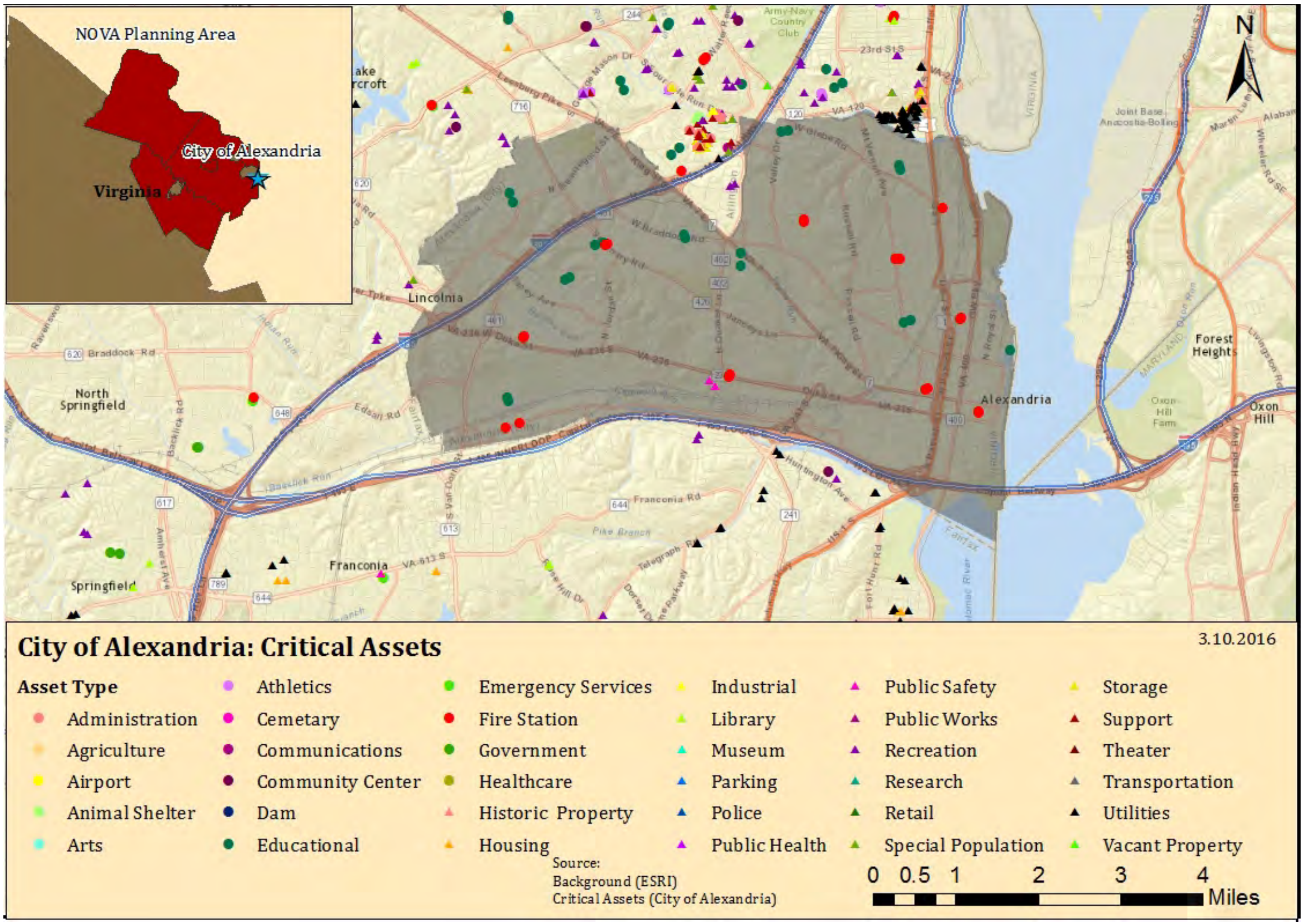


Figure 4.5. City of Alexandria local critical assets and historic structures.

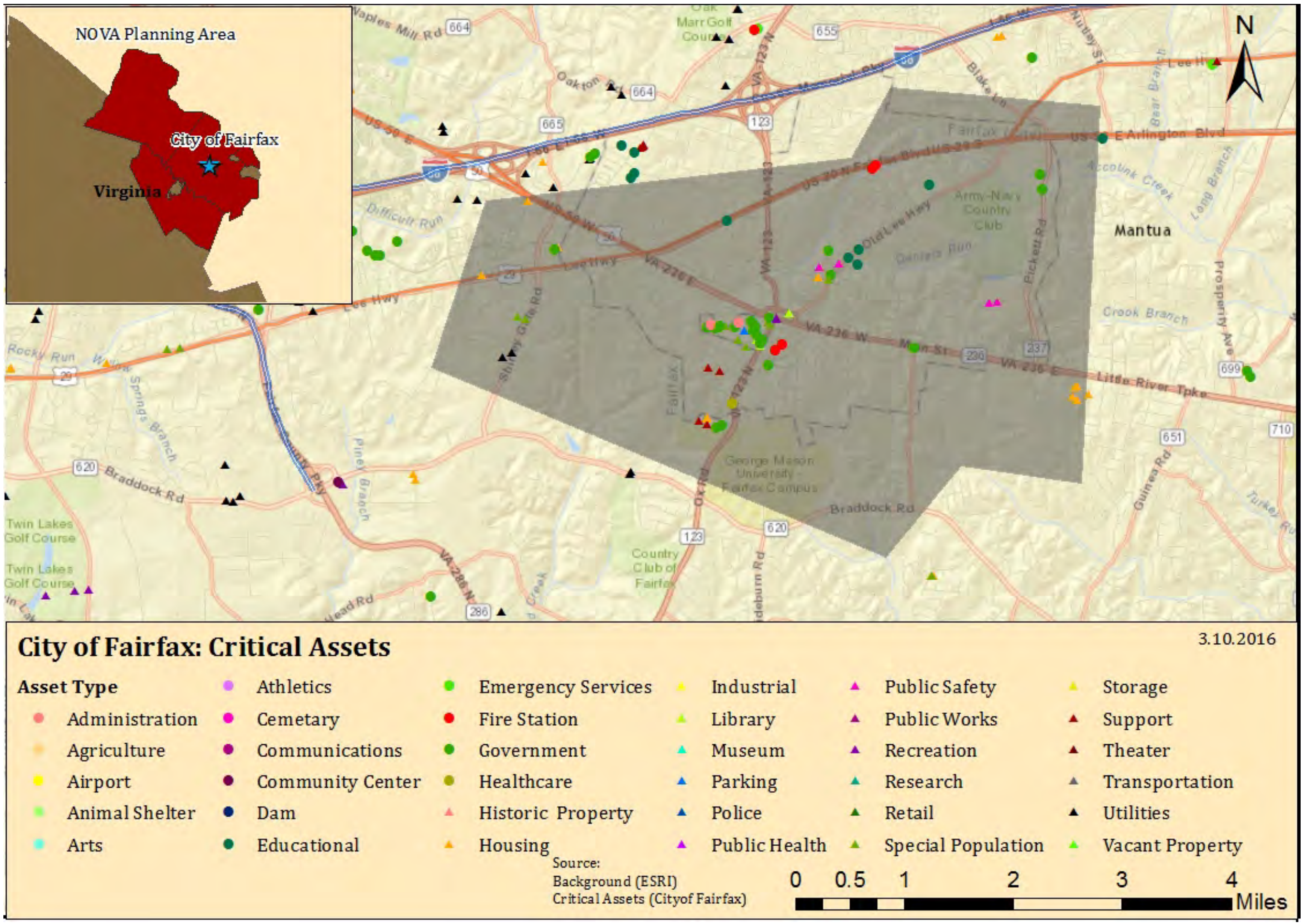


Figure 4.6. City of Fairfax local critical assets and historic structures.

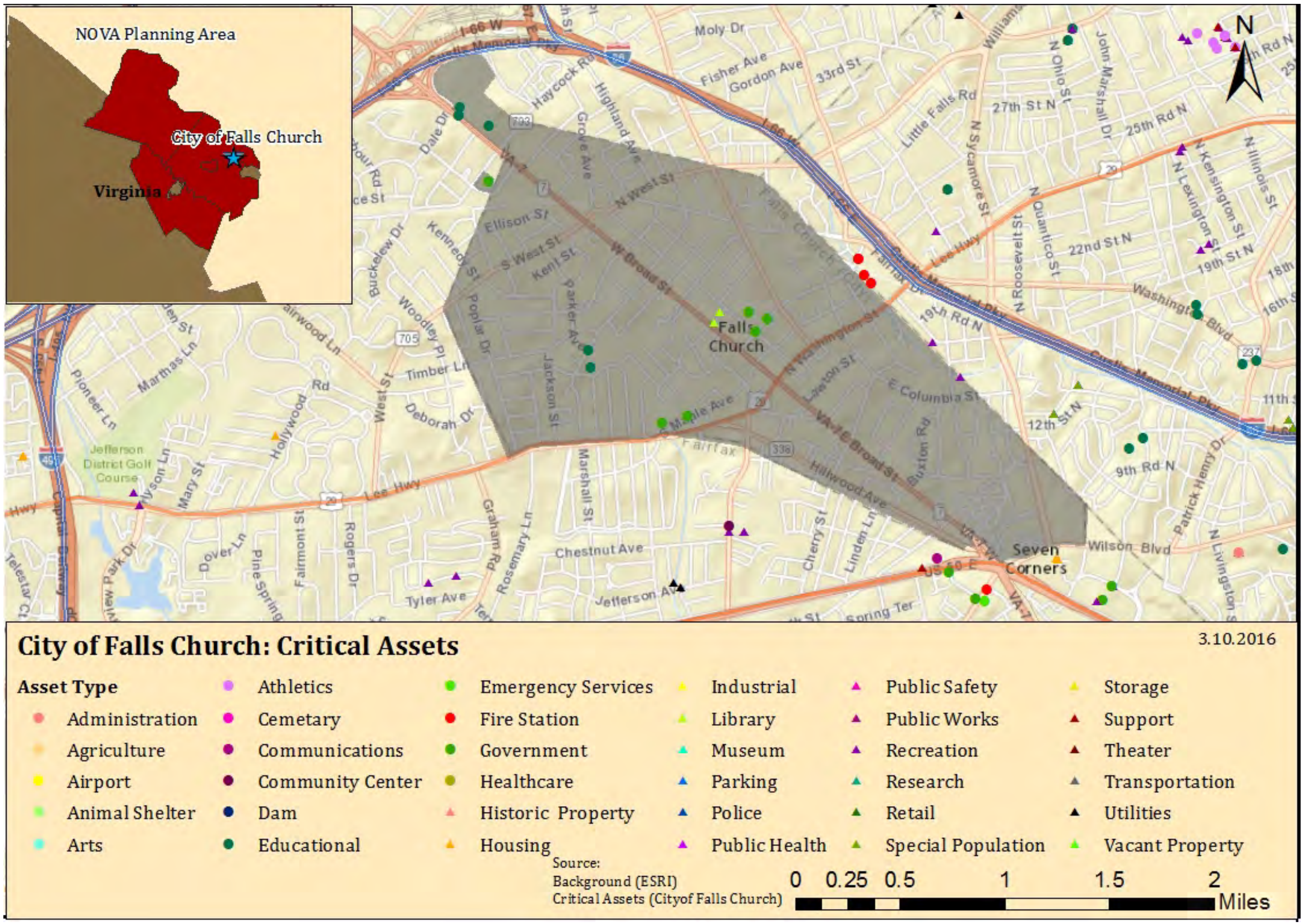


Figure 4.7. City of Falls Church local critical assets and historic structures.

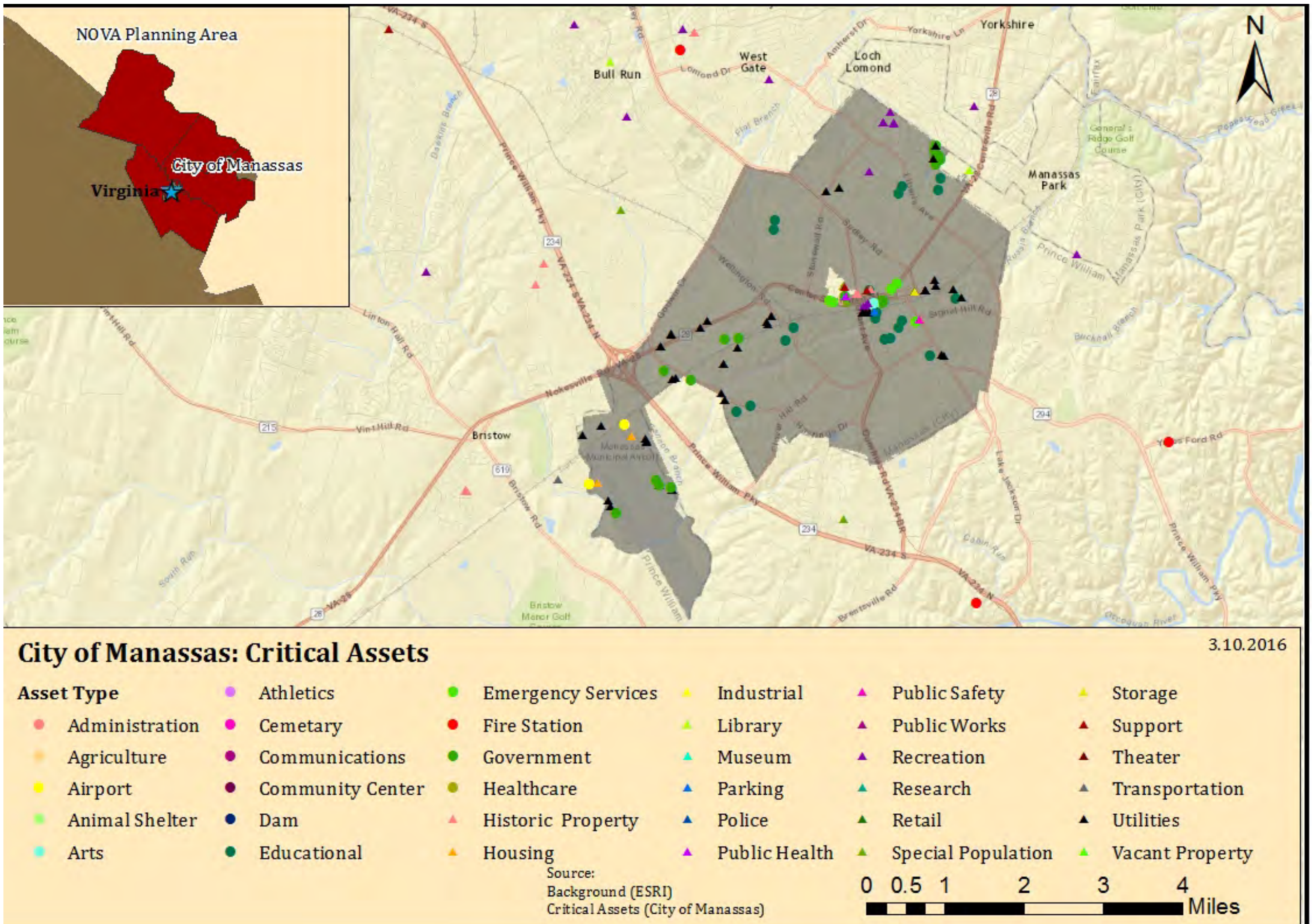


Figure 4.8. City of Manassas local critical assets and historic structures.

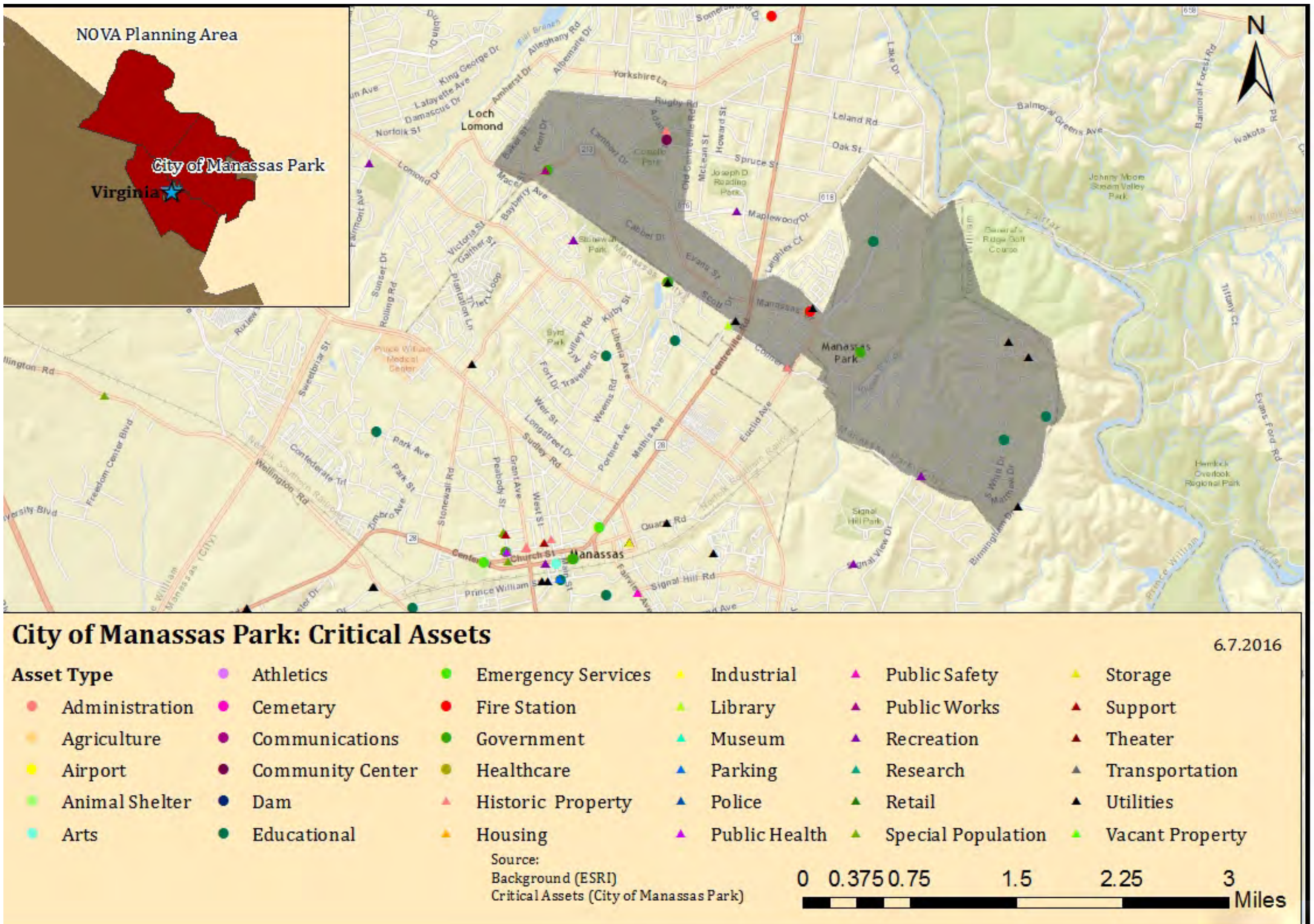


Figure 4.9. City of Manassas Park local critical assets and historic structures.

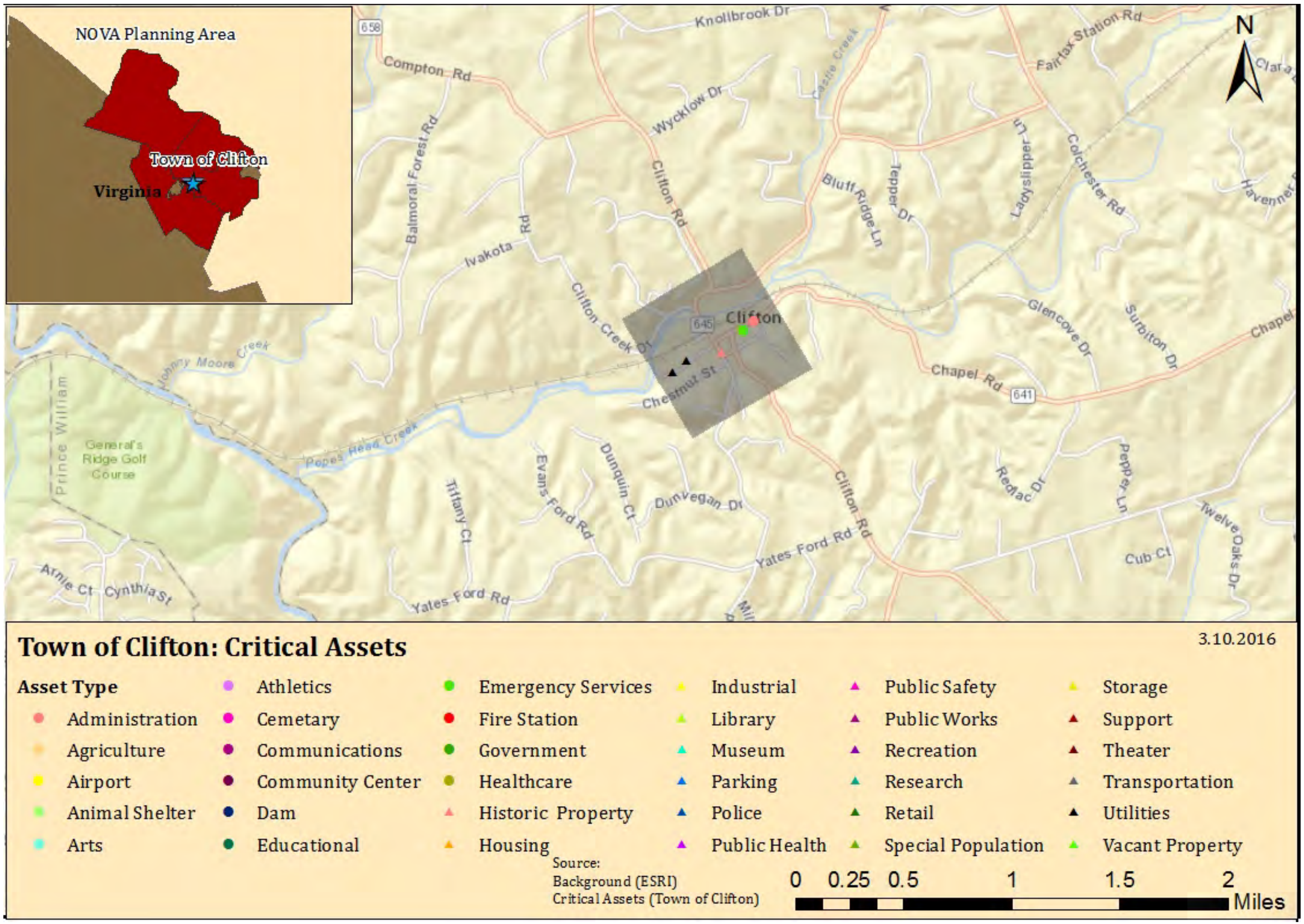


Figure 4.10. Town of Clifton local critical assets and historic structures.

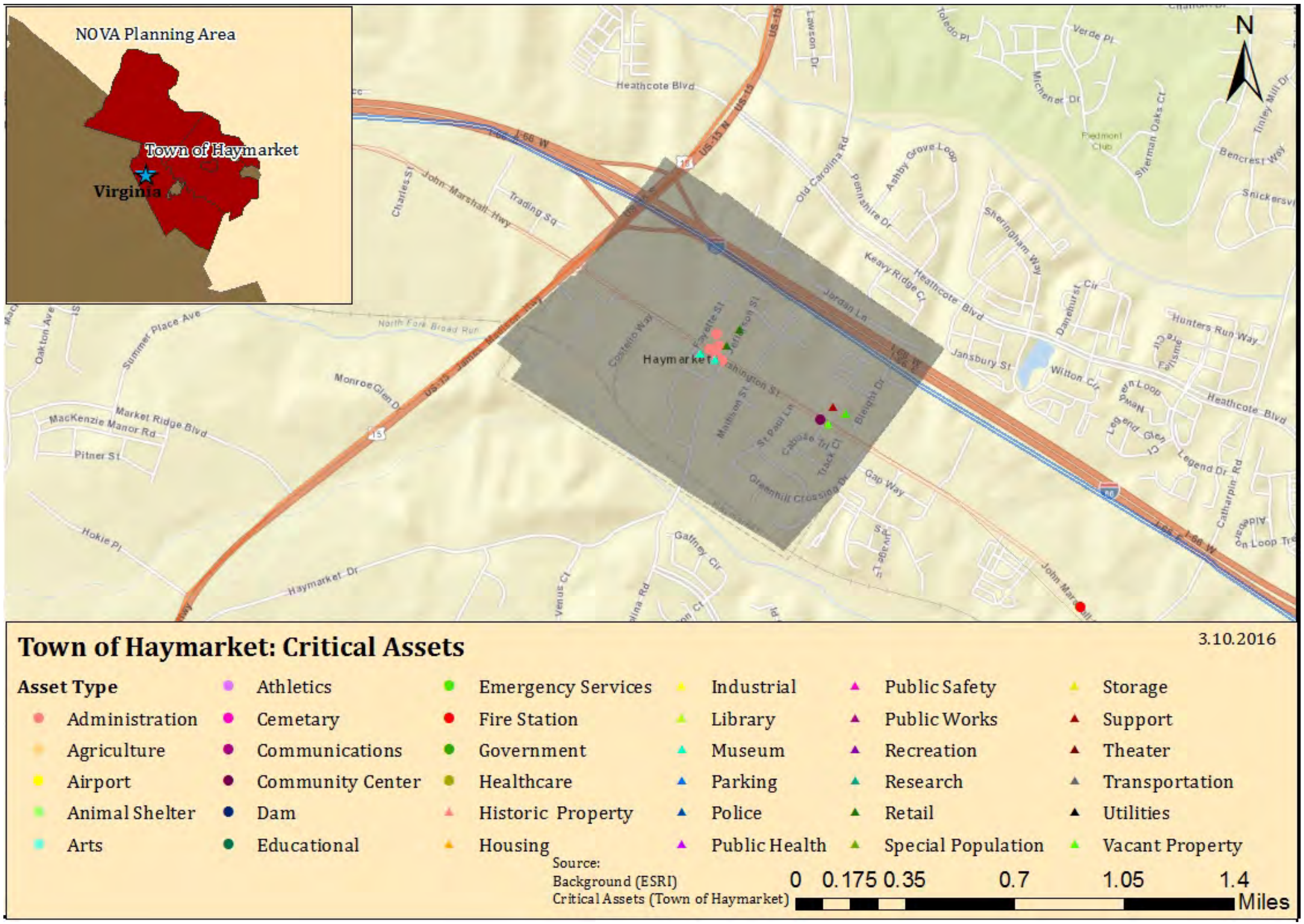


Figure 4.11. Town of Haymarket local critical assets and historic structures.

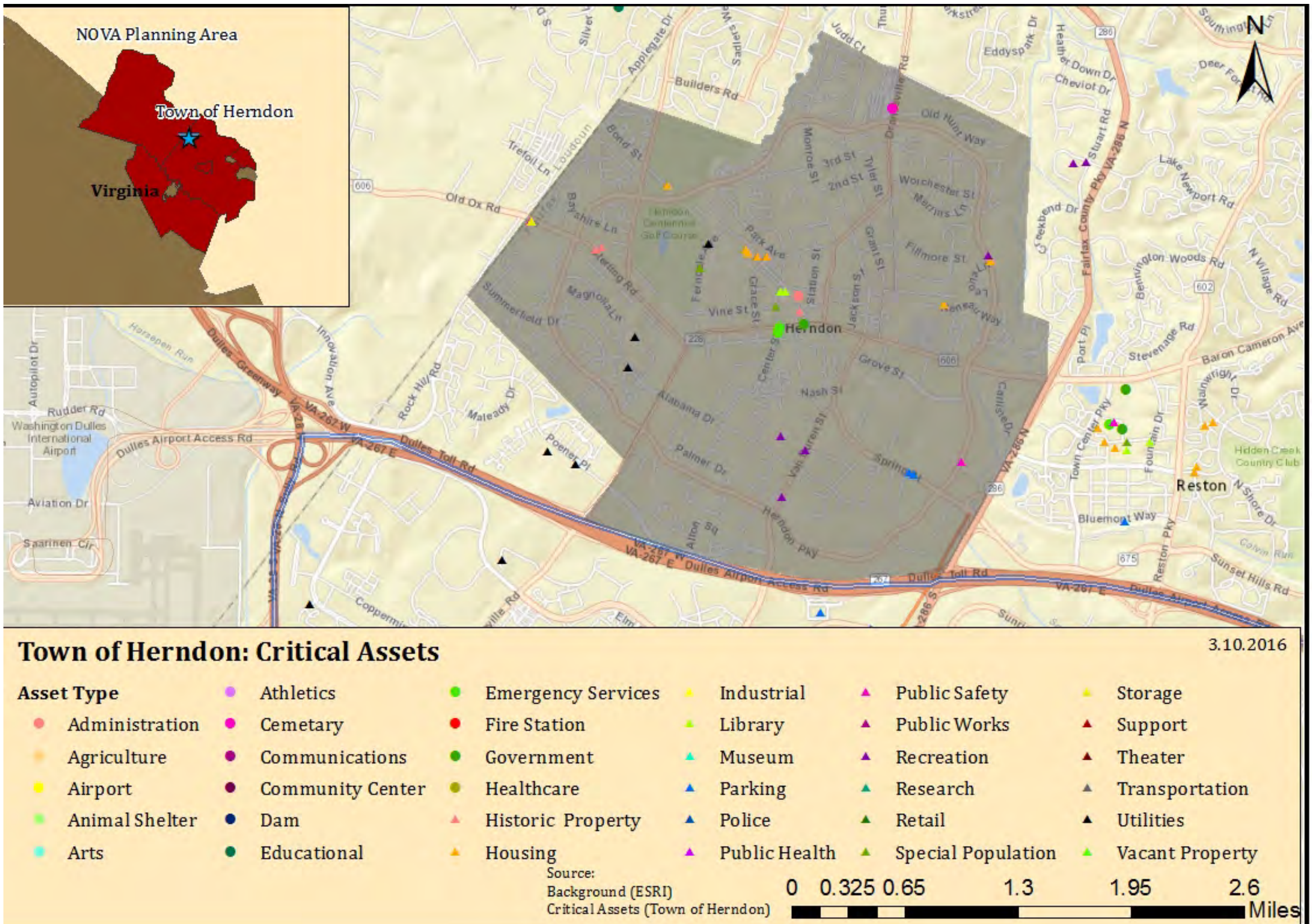


Figure 4.12. Town of Herndon local critical assets and historic structures.

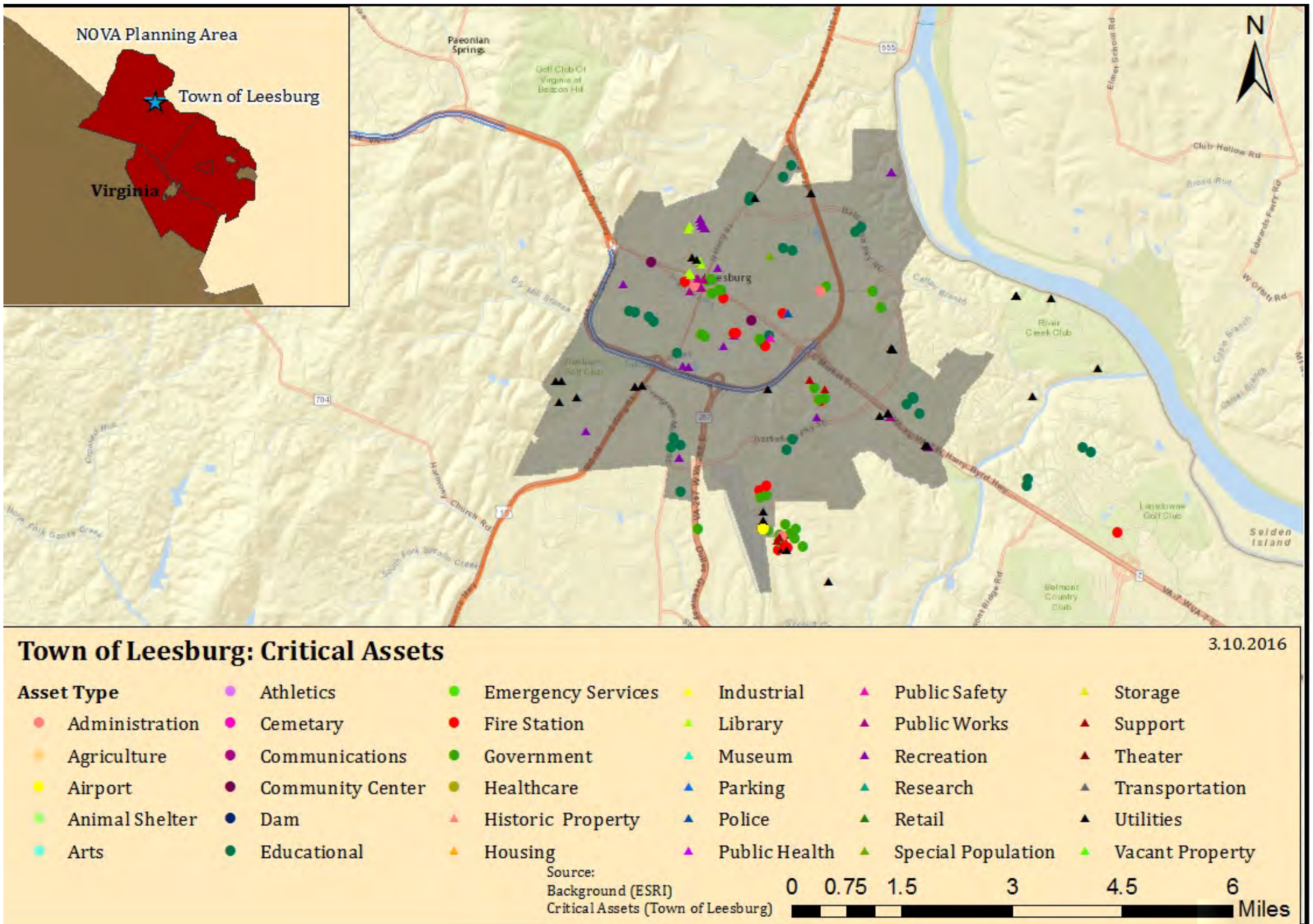


Figure 4.13. Town of Leesburg local critical assets and historic structures.

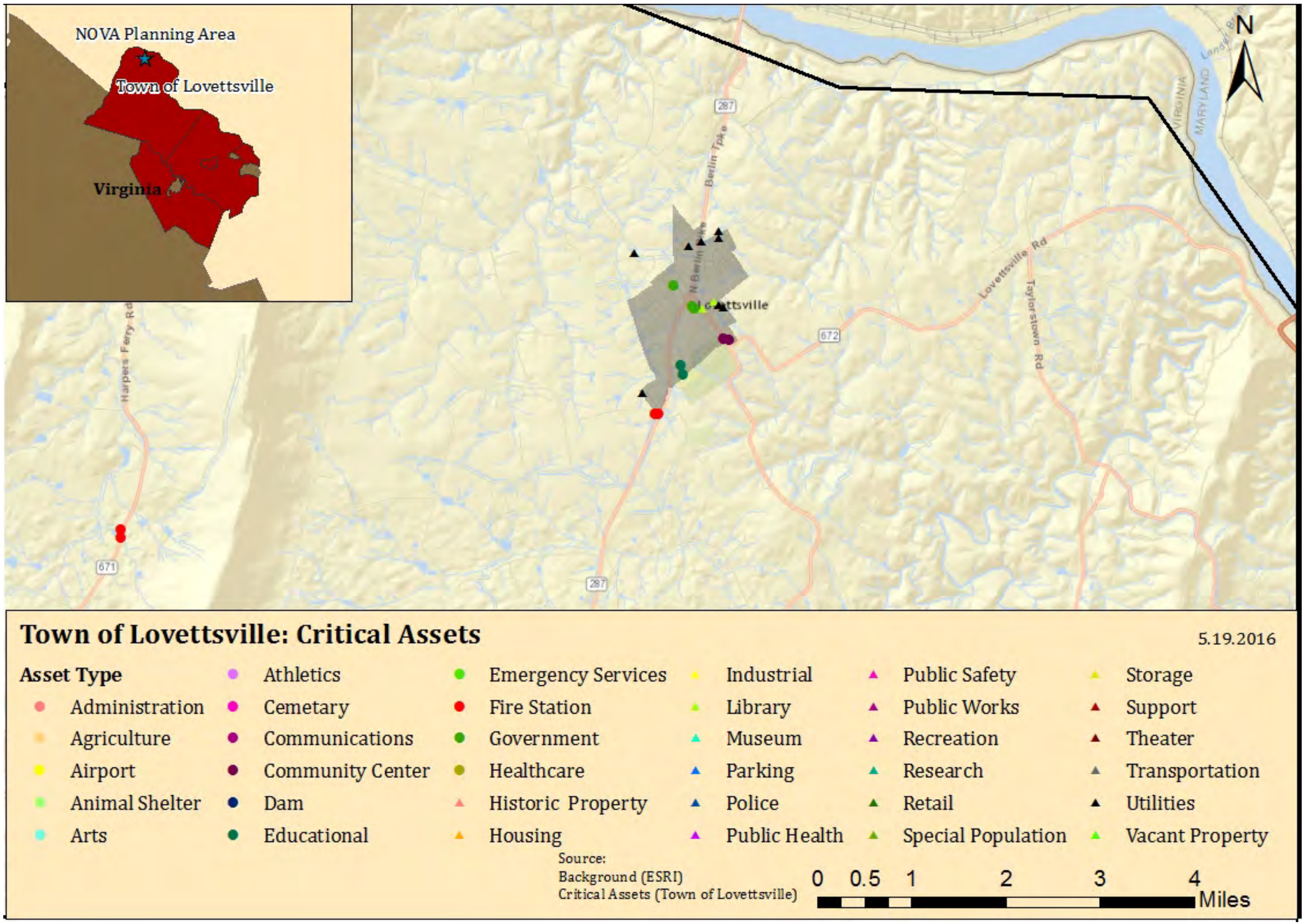


Figure 4.14. Town of Lovettsville local critical assets and historic structures.

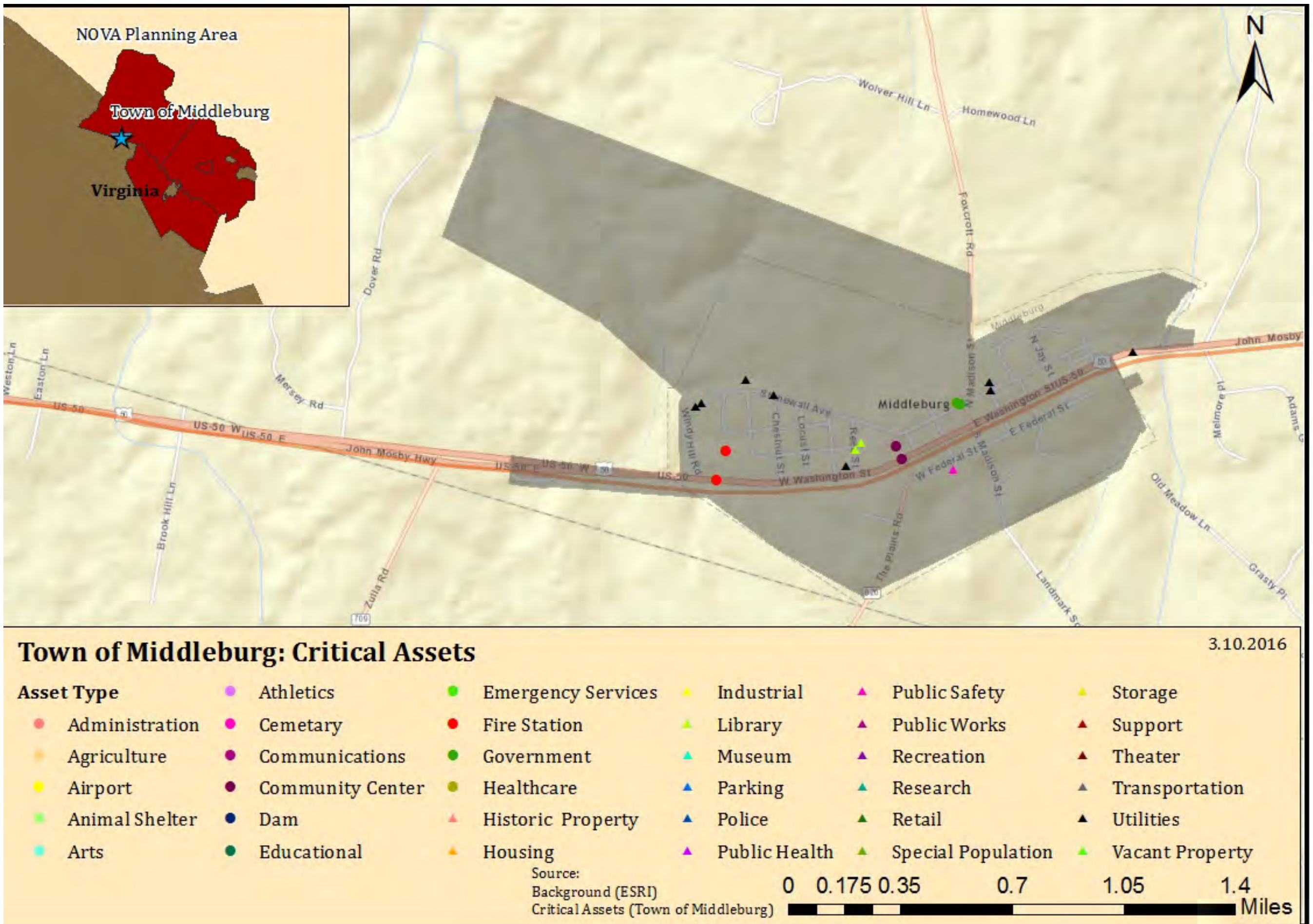


Figure 4.15. Town of Middleburg local critical assets and historic structures.

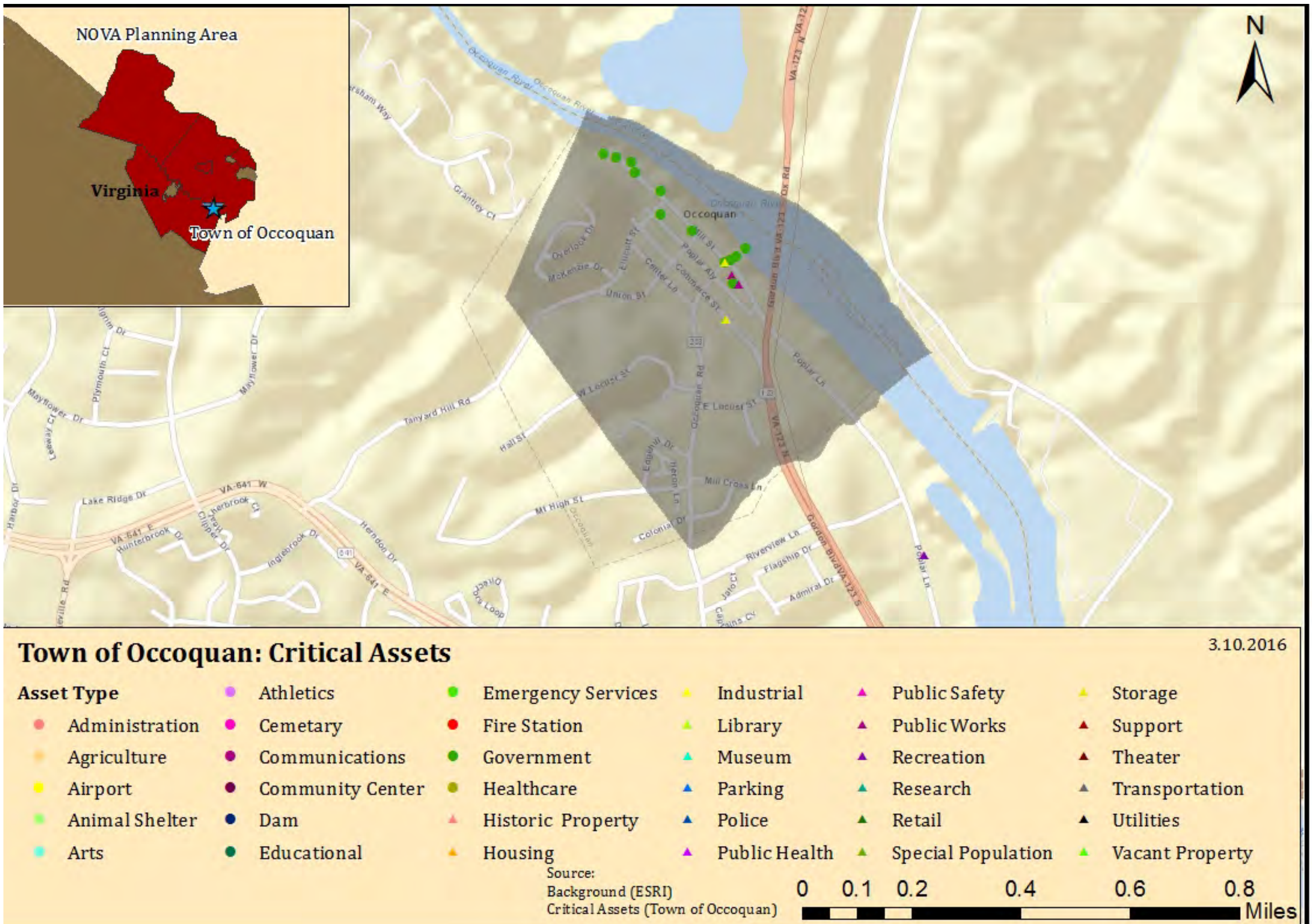


Figure 4.16. Town of Occoquan local critical assets and historic structures.

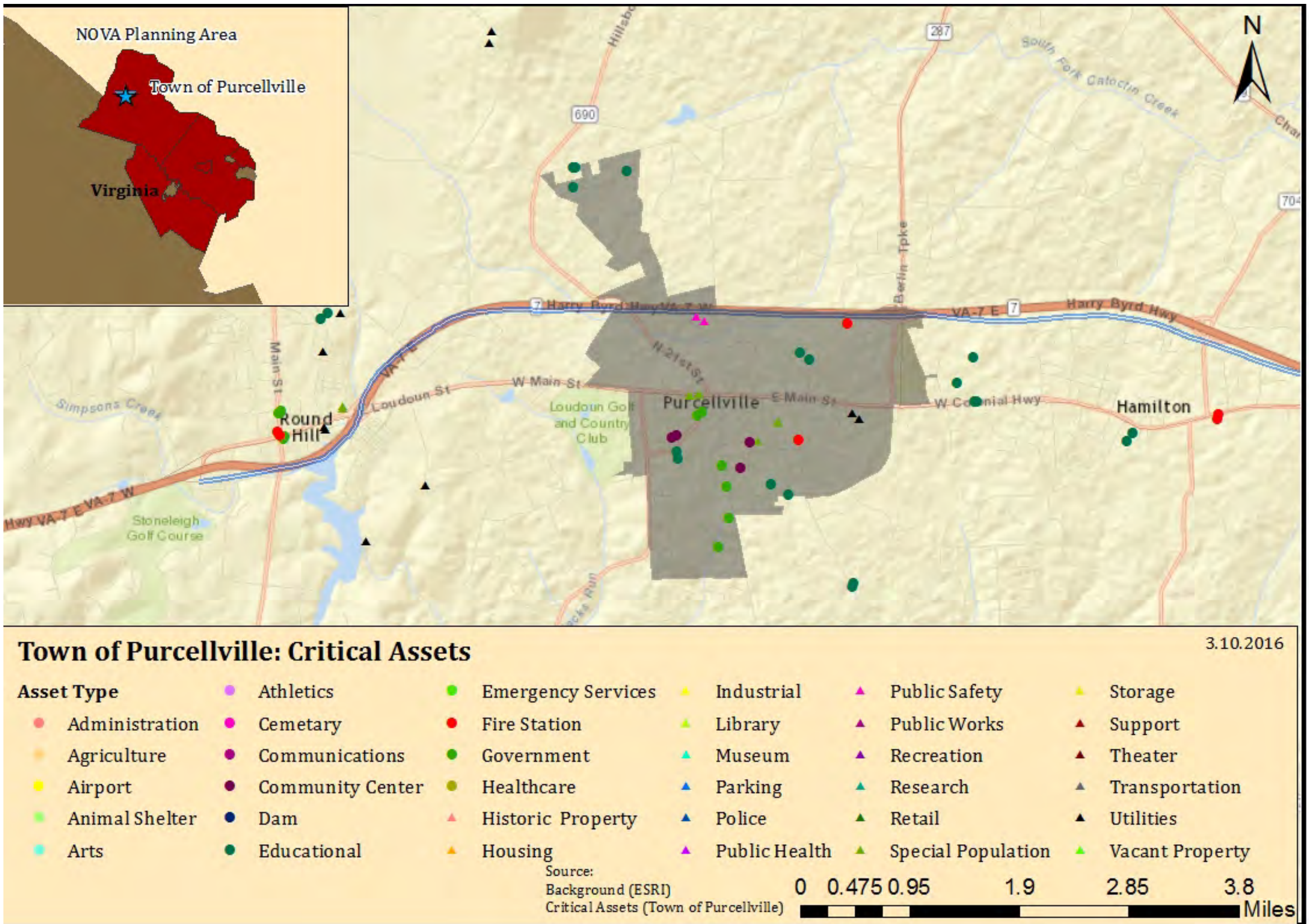


Figure 4.17. Town of Purcellville local critical assets and historic structures.

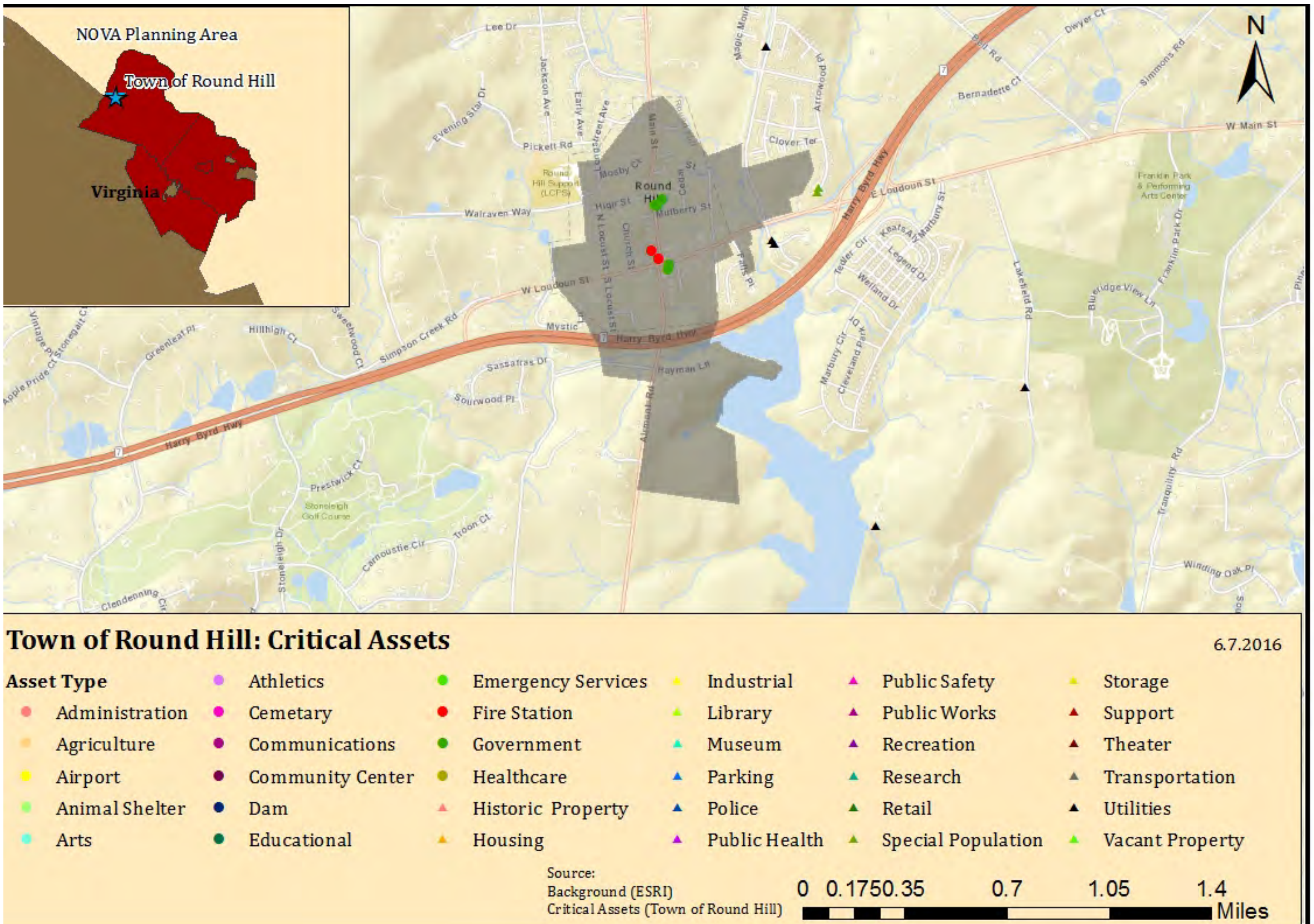


Figure 4.18. Town of Round Hill local critical assets and historic structures.

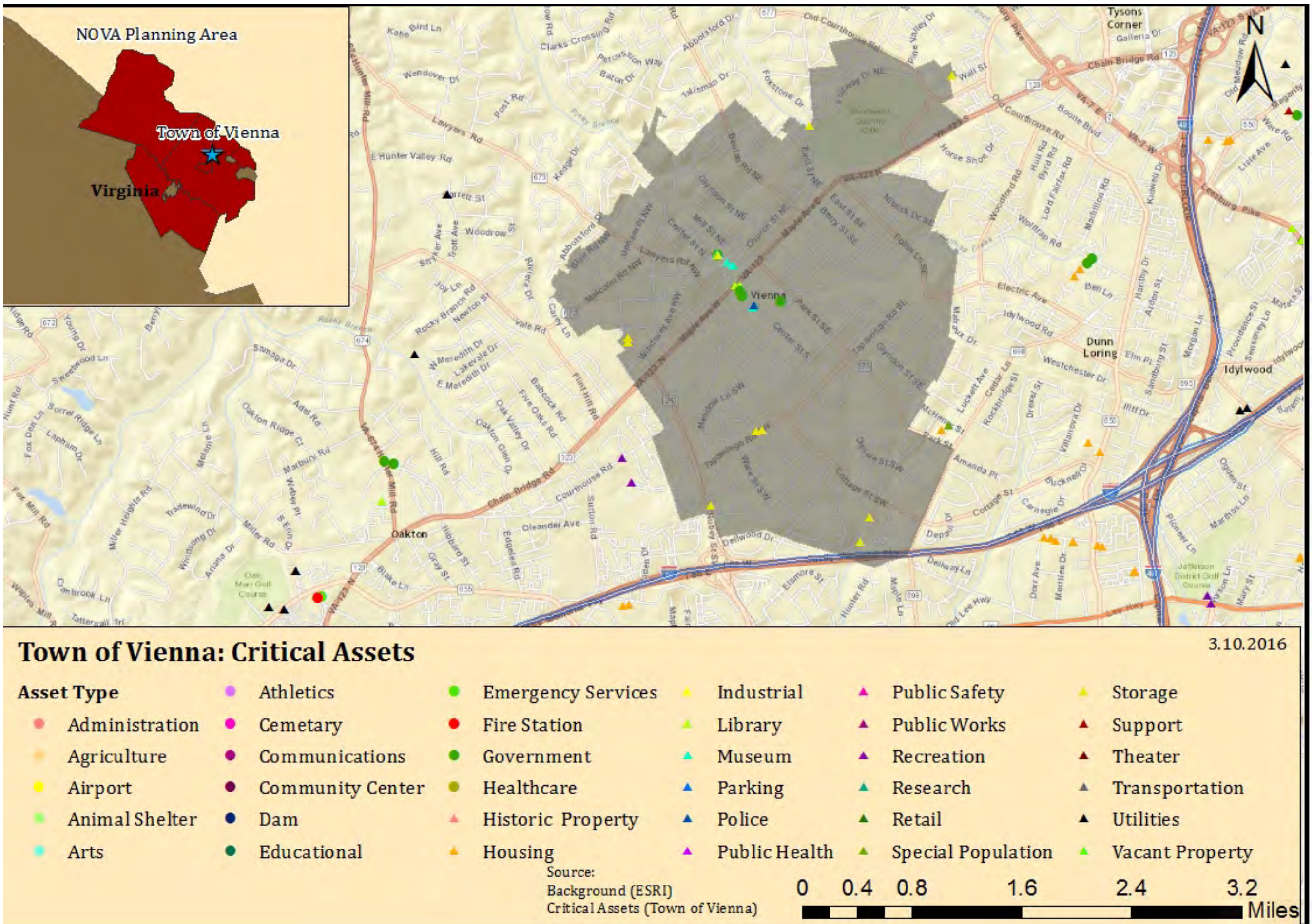


Figure 4.19. Town of Vienna local critical assets and historic structures.

No local critical assets were identified for the towns of Dumfries or Quantico; therefore, no maps were created for these jurisdictions, and no locally-identified assets were included in any risk assessment for these jurisdictions.

HAZUS^{MH} Version 3.1

HAZUS^{MH} facilities data was used to supplement the hazard-specific analysis. The HAZUS^{MH} inventory serves as the default when a user does not have better data available. This data provides a uniform look at building stock in the region. There are approximately 663,685 buildings in the region as estimated by HAZUS, categorized as residential, commercial, industrial, agricultural, religious, government, and education.

HAZUS^{MH} essential facilities are facilities vital to emergency response and recovery following a disaster, including medical care facilities, emergency response facilities, and schools. School buildings are included in this category because of the key role they often play in housing people displaced from damaged homes. With the Northern Virginia planning area, HAZUS^{MH} estimates there are approximately 762 essential facilities.

Note: For estimation purposes, building stock and essential facilities data from HAZUS^{MH} was obtained through the hurricane module. Runs for this module were completed at a smaller regional level. HAZUS^{MH} outputs do not easily differentiate counties from independent cities, and so will often combine independent cities into county data, and cannot always distinguish the boundaries of towns and villages from counties. In most cases, aggregate building stock and essential facilities counts are provided at a 'county' level, and incorporate municipal and other entity building counts.

Fairfax County and the City of Fairfax have the largest number of essential facilities, 401, with almost 85% of those facilities labeled as schools. Table 4.2 below shows the number of facilities in each of the HAZUS^{MH} essential facility classes. With many national datasets, accuracy and completeness leave much to be desired.

<table>
<tr><th colspan="7">Table 4.2 HAZUS-MH Essential Facilities for Northern Virginia planning area.</th></tr>
<tr><th>Jurisdiction</th><th>EOC</th><th>Fire Station</th><th>Hospitals</th><th>Police Stations</th><th>Schools</th><th>Total</th></tr>
<tr><td>Arlington County, The City of Alexandria, and The City of Falls Church</td><td>-</td><td>4</td><td>4</td><td>4</td><td>79</td><td>91</td></tr>
<tr><td>Fairfax County and The City of Fairfax</td><td>-</td><td>42</td><td>8</td><td>15</td><td>336</td><td>401</td></tr>
<tr><td>Town of Herndon</td><td colspan="6" rowspan="3">Included in Fairfax County essential facilities count</td></tr>
<tr><td>Town of Vienna</td></tr>
<tr><td>Town of Clifton</td></tr>
<tr><td>Loudoun County</td><td>1</td><td>11</td><td>3</td><td>7</td><td>83</td><td>105</td></tr>
<tr><td>Town of Leesburg</td><td colspan="6" rowspan="5">Included in Loudoun County essential facilities count</td></tr>
<tr><td>Town of Lovettsville</td></tr>
<tr><td>Town of Purcellville</td></tr>
<tr><td>Town of Middleburg</td></tr>
<tr><td>Town of Round Hill</td></tr>
<tr><td>Prince William County, The City of Manassas, and The City of Manassas Park</td><td>-</td><td>11</td><td>2</td><td>14</td><td>138</td><td>165</td></tr>
<tr><td>Town of Dumfries</td><td colspan="6" rowspan="4">Included in Prince William County essential facilities count</td></tr>
<tr><td>Town of Haymarket</td></tr>
<tr><td>Town of Occoquan</td></tr>
<tr><td>Town of Quantico</td></tr>
<tr><td>Total</td><td>1</td><td>68</td><td>17</td><td>40</td><td>636</td><td>762</td></tr>
</table>

The HAZUS^{MH} stock inventory for the jurisdiction often differs from reality. The table above reflects only those structures contained within the HAZUS dataset, and may not accurately reflect actual assets for each jurisdiction.

Data

The HAZUS^{MH} building stock for Northern Virginia contains 663,685 structures with an estimated exposure value of approximately $384 million (2015 dollars). HAZUS^{MH} estimates 84% of the region's general occupancy is categorized as residential, which represents 83.62% of the building value for the region. Fairfax County and the City of Fairfax represent approximately 50% of the region's total building value summarized in Table 4.3.

Table 4.3 Total Building Value per HAZUS^{MH} area (2015 dollars).				
Jurisdiction	**Residential**	**Non-Residential**	**Total**	**% Total**
Arlington County, the City of Alexandria, and the City of Falls Church	$54,402,048,000	$14,354,494,000	$68,756,542,000	**17.89%**
Fairfax County and the City of Fairfax	$161,437,502,000	$32,603,535,000	$194,041,037,000	**50.49%**
Loudoun County	$46,169,251,000	$7,131,665,000	$53,300,916,000	**13.87%**
Prince William County	$59,393,279,000	$8,845,863,000	$68,239,142,000	**17.75%**
Total	**$321,402,080,000**	**$62,935,557,000**	**$384,337,637,000**	**100%**

Table 4.4 shows the estimated total exposure values by jurisdiction. Residential housing represents 84% of the building value in the region, followed by commercial properties representing 11.5%. The remaining occupancy types account for the remaining 4.5% of the region.

Table 4.4. Building stock exposure for general occupancy type by jurisdiction (2015 dollars).								
Jurisdiction	**Residential**	**Commercial**	**Industrial**	**Agriculture**	**Religious**	**Government**	**Education**	**Total**
Arlington County, the City of Alexandria, & the City of Falls Church	$54,402,048,000	$10,027,368,000	$786,596,000	$57,929,000	$1,408,243,000	$565,297,000	$1,509,061,000	**$68,756,542,000**
Fairfax County, the City of Fairfax, the Town of Clifton, the Town of Herndon, & the Town of Vienna	$161,437,502,000	$25,013,495,000	$2,930,598,000	$302,667,000	$2,189,134,000	$653,199,000	$1,514,442,000	**$194,041,037,000**

Table 4.4. Building stock exposure for general occupancy type by jurisdiction (2015 dollars).								
Jurisdiction	**Residential**	**Commercial**	**Industrial**	**Agriculture**	**Religious**	**Government**	**Education**	**Total**
Loudoun County, the Town of Leesburg, the Town of Lovettsville, the Town of Middleburg, & the Town of Round Hill	$49,169,251,000	$5,027,525,000	$1,021,465,000	$172,981,000	$440,995,000	$151,487,000	$317,212,000	**$53,300,916,000**
Prince William County, the City of Manassas, the City of Manassas Park, the Town of Dumfries, the Town of Haymarket, the Town of Occoquan, & the Town of Quantico	$59,393,279,000	$6,248,644,000	$1,223,616,000	$209,192,000	$540,415,000	$182663,000	$441,333,000	**$68,239,142,000**
Total	**$321,402,080,000**	**$46,317,032,000**	**$5,962,275,000**	**$742,769,000**	**$4,578,787,000**	**$1,552,646,000**	**$3,72,048,000**	**$384,337,637,000**

Building stock exposure is also classified by building type. General Building Types have been developed as a means to classify different building construction types. This provides an ability to differentiate between buildings with substantially different damage and loss characteristics. Model building types represent the average characteristics of buildings in a class. The damage and loss prediction models are developed for model building types and the estimated performance is based upon the "average characteristics" of the total population of buildings within each class. Five general classifications have been established, including wood, masonry, concrete, steel, and manufactured homes (MH). A brief description of the building types is available in Table 4.5.

Table 4.5. HAZUS-MH General Building Type Classes.	
General Building Type	**Description**
Wood	Wood frame construction
Masonry	Reinforced or unreinforced masonry construction
Steel	Steel frame construction
Concrete	Cast-in-place or pre-cast reinforced concrete construction
MH	Factory-built residential construction

Wood construction represents the majority (60%) of building types in the region, followed by masonry, which represents 27% of building stock exposure. The remaining percentage is distributed among other building types. Table 4.6 below provides building stock exposure for the five main building types. The differences in the building stock tables are a result of aggregation by HAZUS^{MH} and rounding. HAZUS^{MH} only provides building stock for the counties and cities in Northern Virginia. Towns participating in this plan are represented in their respective county totals.

Table 4.6: Building stock exposure for general building type by jurisdiction (2015 dollars).

Jurisdiction	Wood	Masonry	Concrete	Steel	MH	Total
City of Alexandria	$15,742,702,000	$7,883,135,000	$1,177,964,000	$2,953,902,000	$10,899,000	**$27,768,602,000**
Arlington County	$22,903,960,000	$10,739,683,000	$1,393,360,000	$3,269,160,000	$20,238,000	**$38,326,401,000**
Fairfax County and The City of Fairfax	$123,744,041,000	$51,405,986,000	$4,412,824,000	$14,332,720,000	$145,461,000	**$194,041,032,000**
City of Falls Church	$1,561,833,000	$724,271,000	$78,296,000	$297,211,000	$0	**$2,661,611,000**
Loudoun County	$25,465,190,000	$13,776,791,000	$866,772,000	$3,170,583,000	$21,457,000	**$53,500,916,000**
City of Manassas	$3,363,297,000	$1,516,280,000	$189,293,000	$705,525,000	$11,970,000	**$5,786,365,000**
City of Manassas Park	$1,182,103,000	$475,657,000	$34,789,000	$145,600,000	$428,000	**$1,838,586,000**
Prince William County	$40,804,413,000	$15,628,024,000	$916,267,000	$3,200,275,000	$65,208,000	**$60,614,187,000**
Total	**$244,767,539,000**	**$102,149,827,000**	**$9,069,574,000**	**$28,074,976,000**	**$275,662,000**	**$384,337,577,000**

III. Hazard Identification

While there are many different natural hazards that could potentially affect the Northern Virginia planning area, some hazards are more likely to cause significant impacts and damages than others. This analysis will quantify these potential impacts and identify the hazards that pose the greatest possible risk.

The potential hazards that could affect the Northern Virginia planning area include: flooding, winter storms, high winds, tornadoes, droughts, earthquakes, landslides, wildfires, landslides, dam failures, and extreme temperatures. Some of these hazards are interrelated (i.e., hurricanes can cause flooding and tornadoes), and some consist of hazardous elements that are not listed separately (i.e., severe thunderstorms can cause lightning; hurricanes can cause coastal erosion). Some hazards, such as severe winter storms, may impact a large area yet cause little damage; other hazards, such as a tornado, may impact a small area yet cause extensive damage. Several of these hazards have been included together (i.e. high winds/thunderstorms/hurricane winds). The hazard description in each hazard section provides a general description for each of the hazards listed above, along with their hazardous elements.

Depending on the severity, location, and timing of the specific events, each of these hazards could have devastating effects on houses, businesses, agricultural lands, infrastructure, and ultimately residents of the planning area. In order to gain a full understanding of the history of these hazards in the planning area, detailed data related to the hazard history was compiled and available in each of the hazard sections. Appendix D contains the National Climactic Data Center (NCDC) storm events database used in the 2016 analysis.

Information was collected from meetings with local community officials, existing reports and studies, state and national data sets, and local newspaper clippings, among others sources; the assessment is largely based on the NCDC databased whenever possible and practical.

The historical data collected includes accounts of all the hazard types listed above. However, some have occurred much more frequently than others with a wide range of impacts. By analyzing the historical frequency of each hazard, along with the associated impacts, the hazards that pose the most significant risks to the Northern Virginia planning area can be identified. This analysis will allow the jurisdictions included in this study to focus their hazard mitigation plans on those hazards that are most likely to cause significant impacts to their community.

To a large extent, historical records are used to identify the level of risk within the Northern Virginia region with the assumption that the data sources cited are reliable and accurate. Unless otherwise cited, all data on historical weather-related events is based on information made available through the Storm Event Database by the NWS NCDC[1]. From a regional planning perspective, it is important to use a consistent source for hazard-related data such as the NCDC. That being said, descriptions of historical hazard events and numerical damage data are based on the collection of information reported by local offices of the NWS and other local users, such as emergency management officials, and should only be considered approximate figures for general analysis and planning purposes.

To complete the risk assessment, best available data was collected from a variety of sources, including local, state and federal agencies, and multiple analyses were performed qualitatively and quantitatively (further described below). Additional work will be done on an ongoing basis to enhance, expand, and further improve the accuracy of the baseline established here, and it is expected that this assessment will continue to be refined through future plan updates as new data and loss estimation methods or tools become available to the participating jurisdictions.

The findings presented in the hazard risk assessments and in the overall results were developed using best available data, and the methodologies applied have resulted in an approximation of risk. These estimates should be used to understand relative risk from hazards and the potential losses that may be incurred. However, uncertainties are inherent in any loss estimation methodology, arising in part from incomplete scientific knowledge concerning specific hazards and their effects on the built environment, as well as incomplete data sets and approximations and simplifications that are necessary in order to provide a meaningful analysis. Further, most data sets used in this assessment contain relatively short periods of records which increases the uncertainty of any statistically-based analysis.

Federally Declared Disasters

Presidential Disaster Declarations are issued for county (including towns) or independent city jurisdictions when an event has been determined to be beyond the capabilities of State and local governments to respond. There have been a total of 62 declared disasters in Virginia, and 17 of those disasters have been declared in at least one community in the Northern Virginia planning area since 1965. The City of Alexandria has been declared in 13 of these events, and Arlington and Fairfax Counties have been declared in 10 and 11 of the disasters, respectively. Prior to January 1, 1965, presidential disaster declarations did not have county or independent city designations. The region has also experienced a significant number of additional emergencies and disasters that were not severe enough to require Federal disaster relief through a presidential declaration. Table 4.7 summarizes the disasters and the localities that were included in the declaration.

Wind-related events (severe storms, tornadoes, and flooding) dominate the Northern Virginia declared hazards, followed by winter storms events.

Table 4.7. Major disaster declarations for Northern Virginia planning area (1965-December 2015), based on FEMA records.

Date of Declaration	Disaster	Declared Jurisdiction								
		Arlington County	Fairfax County	Loudoun County	Prince William County	Alexandria, City of	Fairfax, City of	Falls Church, City of	Manassas, City of	Manassas Park, City of
7/27/2012	Severe Storms and Straight-line Winds	✓	✓				✓	✓		✓
11/17/11	Remnants of Tropical Storm Lee		✓		✓	✓				
9/3/2011	Hurricane Irene					✓				
4/27/2010	Severe Winter Storms and Snowstorms	✓	✓	✓	✓	✓	✓	✓	✓	✓
2/16/2010	Severe Winter Storm and Snowstorm	✓	✓		✓	✓	✓	✓	✓	✓
7/13/2006	Severe Storms, Tornadoes, and Flooding	✓	✓			✓				
9/18/2003	Hurricane Isabel	✓	✓	✓	✓	✓	✓	✓	✓	✓
3/27/2003	Severe Winter Storm	✓	✓	✓	✓	✓	✓	✓	✓	✓
9/11/2001	Terrorism	✓								
2/28/2000	Severe Winter Storm	✓	✓	✓	✓	✓	✓		✓	
10/12/1999	Hurricane Floyd		✓				✓			
10/23/1996	Hurricane Fran				✓					
2/2/1996	Blizzard of 1996	✓	✓	✓	✓	✓	✓	✓	✓	✓
11/10/1985	Severe Storms & Flooding					✓				
10/10/1972	Severe Storms & Flooding					✓				
10/7/1972	Severe Storms & Flooding					✓				
6/29/1972	Tropical Storm Agnes	✓	✓	✓	✓	✓	✓	✓		

NCDC Storm Events Database

NCDC Storm Data is published by the National Oceanic and Atmospheric Administration (NOAA), part of the U.S. Department of Commerce. The Storm Events Database contains information on storms and weather phenomena that have caused loss of life, injuries, significant property damage, and/or disruption to commerce. Efforts are made to collect the best available information, but because of time and resource constraints, information may be unverified by the NWS. The NWS does not guarantee the accuracy or validity of the information. Although the historical records in the database often vary widely in their level of detail, the NWS does have a set of guidelines used in the preparation of event descriptions.[2]

The NCDC is well known for having limited records of geological hazards (i.e., earthquake, landslide, and karst). In the absence of better data, it was decided to proceed with the records available in NCDC for these events, in all cases. NCDC records for these events are severe under-representations of what has happened in Northern Virginia's history. To date, no comprehensive digital databases exist for these hazards[3].

In 2012, shortly after the completion of the previous plan update, major changes were made to the records in the NCDC database. These changes resulted in revisions to historic records in the database, as well as additional data being added to the database. Since this 2012 change, periodic additions of new data and revisions of existing data have been accomplished by NOAA, all with the goal of creating a better data set for general use. Because of these changes, however, the data set available from NCDC during the development of the 2016 plan update was significantly different from the data set available during previous plan activities. As a result, all previous NCDC data has been removed from the 2016 plan update, and has been replaced with the data available during the plan update process. This has resulted in different calculations and findings – in some cases significantly different – than were contained in previous versions of this plan. However, the NCDC data contained in the 2016 plan update is the best available version of the best available data.

Event records from January 1, 1950, through December 31, 2015, have been used for the HIRA analysis. There are approximately 6,101 events recorded in the NCDC storm events database for the Northern Virginia planning area spanning 1950 through 2015; approximately 2,153 of those events have not been included in the analysis – comprised of drought, winter storm, and extreme temperature events – as it is assumed the records are duplicative, as records for towns cannot be reliably separated from records for the corresponding county. Given the widespread spatial nature of those three hazards, it is reasonable to assume that a winter storm event that impacts a county would also impact the towns within the county; the same is true for extreme temperature events and drought events.

Table 4.8 shows the number of NCDC events for each county, city, and town by hazard type.

Table 4.8. Number of Storm Events in the NCDC database (1950-2015).

Jurisdiction	Drought	Flood	High Wind	Tornado	Winter Storm	Extreme Temperatures	Total
Arlington County	9	45	144	2	97	59	**356**
Fairfax County	10	34	63	0	123	67	**297**
Loudoun County	12	130	434	25	131	66	**798**
Prince William County	12	84	191	17	110	74	**488**
City of Alexandria	9	33	90	2	97	59	**290**
City of Fairfax	10	34	63	0	123	67	**297**

Table 4.8. Number of Storm Events in the NCDC database (1950-2015).							
Jurisdiction	**Drought**	**Flood**	**High Wind**	**Tornado**	**Winter Storm**	**Extreme Temperatures**	**Total**
City of Falls Church	9	36	54	1	97	9	**206**
City of Manassas	12	28	52	2	110	74	**278**
City of Manassas Park	12	18	31	1	110	74	**246**
Town of Clifton	10	0	1	0	123	67	**201**
Town of Dumfries	12	7	27	2	110	74	**232**
Town of Haymarket	12	9	26	0	110	74	**231**
Town of Herndon	10	9	12	0	123	67	**221**
Town of Leesburg	12	38	70	5	131	66	**322**
Town of Lovettsville	12	1	33	6	131	66	**249**
Town of Middleburg	12	13	29	3	131	66	**254**
Town of Occoquan	12	1	1	0	110	74	**198**
Town of Purcellville	12	16	38	0	131	66	**263**
Town of Quantico	12	6	17	3	110	74	**222**
Town of Round Hill	12	4	21	1	131	66	**235**
Town of Vienna	10	7	10	0	123	67	**217**
Total	**233**	**553**	**1,407**	**70**	**2,462**	**1,376**	**6,101**

To use the NCDC data in the same fashion as it was used in the *Commonwealth of Virginia Hazard Mitigation Plan* Risk Assessment, the data had to be processed. The following excerpt on processing the NCDC data has been taken from Virginia's hazard mitigation plan.

NCDC Normalizing Data

Information for specific hazard events is sometimes reported by the NWS and found in the NCDC database only at a zonal level. This is particularly true for events that impact a wide area, such as winter storm and drought events. Each zone may contain one or many political jurisdictions. These zonal events may include information regarding deaths, injuries, and damages caused by the event, but may not break these down by individual jurisdiction. To accurately count the number of events occurring in a single county or city, the zonal data records were expanded into a set of individual city/county records, based on NCDC records. To the extent possible, determinations were made as to if a specific event impacted a particular town or jurisdiction. Those records that could be reliably tied to a particular jurisdiction remained in the assessment. Other records were excluded. The exceptions to this are records for winter weather, drought, and extreme temperatures. Given the widespread spatial nature of these three hazards, it can be reliably assumed that reports of incidents that impacted the greater county also impacted the towns. Therefore, only reports for the counties and cities were included in the final assessment for droughts, winter weather, and extreme temperatures.

Injuries and fatalities are counted exactly as recorded from those reports that remain in the assessment.

For most hazards for which NCDC data was utilized, the period of record used for the assessment was 1950 through 2015, a total of 65 years. The exceptions are winter weather and extreme temperatures. NCDC began maintaining separate records for these hazards in 1996. Therefore, the period of record for these hazards used for the assessment was 1996 to 2015, a total of 19 years.

NCDC Damages

The damages entered into the NCDC Storm Events database portray how much damage was incurred in the year of the event. These damages are approximations or estimates only, and may not reflect the actual or final calculations of damages from other sources.

NCDC Annualizing Data

After the data was normalized, the data was annualized in order to be able to compare the results on a common system (i.e., ranking the hazards). In general, this was completed by taking the parameter of interest and dividing by the length of record for each hazard. The annualized value should only be utilized as an estimate of what can be expected in a given year. Deaths/injuries, property and crop damage, and events were all annualized in this fashion, on a per-jurisdiction basis, where data was available.

NCDC Data Compilation

The NCDC Storm Events database uses very detailed event categories. The reported storm events were summarized in simplified classifications to correspond to the major hazard types considered in this plan. Table 4.9 shows how the NCDC categories were grouped into the HIRA hazard categories. The ranking methodologies, explained later in this section, summarize how the NCDC data was used in ranking the hazards.

Table 4.9. HIRA and NCDC Event Category Classifications	
HIRA Category	**NCDC Event Categories**
Drought	Drought
Flood	Coastal flood
	Flash Flood
	Flood
	Heavy Rain
	High Surf
	Lakeshore Flood
	Storm Surge/Tide
High Wind	Hurricane (Typhoon)
	Marine High Wind
	Marine Strong Wind
	Marine Thunderstorm Wind
	Strong Wind
	Thunderstorm Wind
	Tropical Depression
	Tropical Storm
	Thunderstorm Wind
Tornado	Funnel Cloud
	Tornado
	Water Spout
Winter Storm	Blizzard
	Heavy Snow
	Ice Storm
	Sleet
	Winter Storm
	Winter Weather
Extreme Temperatures	Cold/Wind Chill
	Extreme Cold/Wind Chill
	Excessive Heat
	Frost/Freeze
	Heat
Not Included	Agricultural Freeze
	Avalanche
	Black Ice
	Dense Fog
	Dust Devil

Table 4.9. HIRA and NCDC Event Category Classifications	
HIRA Category	**NCDC Event Categories**
	Freezing Fog
	Hail
	Lake-effect Snow
	Rip Current
	Lightning

IV. Ranking and Analysis Methodologies

HAZUS^{MH} Methodology

HAZUS^{MH} is FEMA's nationwide standardized loss estimation software package, built upon an integrated GIS platform with a national inventory of baseline geographic data (including information on the Northern Virginia region's general building stock and dollar exposure). Originally designed for the analysis of earthquake risks, FEMA has expanded the program to allow for the analysis of multiple hazards including flood and wind events. By providing estimates on potential losses, HAZUS^{MH} facilitates quantitative comparisons among hazards and may assist in the prioritization of hazard mitigation activities.

HAZUS^{MH} uses a statistical approach and mathematical modeling of risk to predict a hazard's frequency of occurrence and estimated impacts based on recorded or historic damage information. The HAZUS^{MH} risk assessment methodology includes distinct hazard and inventory parameters. For example, wind speed and building type were modeled using the HAZUS^{MH} software to determine the impact (damages and losses) on structures. Figure 4.20 shows a conceptual model of HAZUS^{MH} methodology.

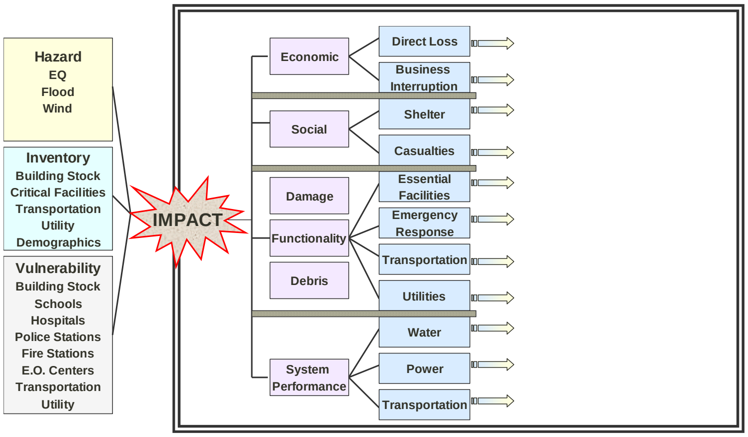


Figure 4.20. Conceptual Model of HAZUS^{MH} Methodology

As with the 2006 and 2010 update of the risk assessment, the 2016 update utilized HAZUS^{MH} to produce regional profiles and estimated losses for hazards addressed in this section: hurricane winds, earthquake, and flood. For each of these hazards, HAZUS^{MH} was used to generate probabilistic "worst case scenario" events to show the maximum potential extent of damages. It is understood that those events of less severe magnitude which could occur would likely result in fewer losses than those calculated here. During the update additional scenarios were completed for flood and earthquake to further define the region's risk.

Supplemental Annualized Loss Estimate Methodology

The first step in conducting supplemental annualized loss calculations and risk assessment included the collection of relevant GIS data from local, state, and national sources. This began with the collection of local data from each participating jurisdiction, then continued up to best available data at the national inventory level (considered least accurate). The data determined to be "best available" was then used for purposes of this assessment. Data matrices were compiled based on the data provided by each of the localities; these may be found in Appendix D.

In order to generate hazard loss estimates beyond hurricane wind, flood, and earthquake, the following steps were conducted independent of the HAZUS^{MH} analysis:

- For the drought, severe storm, tornado, wildfire, and winter storm hazards, best available data on historical hazard occurrences (limited to NOAA NCDC and Virginia Department of Forestry [VDOF] records) was used to produce estimate of potential damages. Using this data, loss estimates were generated by totaling the amount of property damage over the period of time for which records were available, and calculating the average annual loss. In addition, for appropriate hazards, scenarios were also created to allow for additional estimation of potential losses.
- For the hazards of extreme temperatures, erosion, sinkholes, landslides, and dam failure, meaningful historical data (meaning data which would have included past property damages and other essential indicators) was virtually non-existent, and therefore potential losses for these hazards could not be calculated. For these hazard, a qualitative analysis was performed based on what limited data is available for the participating jurisdictions.

All conclusions of the HIRA completed for the Northern Virginia region are presented at the end of each of the hazard specific sections.

Critical Facility and Building Risk

In addition to generating loss estimates for particular hazards, GIS technology was further utilized to identify, quantify, and analyze potentially at-risk community assets such as public buildings, critical facilities, and infrastructure. This analysis was completed for hazards that can be spatially defined in a meaningful manner (i.e., hazards with a determined geographic extent) and for which digital GIS data layers are readily available. The analysis resulted in the identification of potentially at-risk community assets based upon their location in relation to identified hazard areas. Results of this analysis are contained within each of the hazard specific sections; the actual GIS products are found in Appendix D.

For the flood hazard, GIS was used to further assess risk utilizing the FEMA Digital Flood Insurance Risk Maps (DFIRMs) in combination with locally-available GIS data layers. Primary data layers used include local building footprints and tax parcel data. Exposure values do not include any estimated values for building contents.

Ranking Methodology

During the 2010 HIRA update kick-off meeting, committee members liked the NCDC ranking methods developed for the Commonwealth of Virginia's HIRA. It was agreed that this approach would be used in the update to the Northern Virginia plan update. During the January 2016 HIRA update kick-off meeting, committee members determined that the same methodologies used in the 2010 update should be applied to the 2016 update, to the extent possible and practicable, to ensure that there was a means of comparison across plans, and that progress could be measured over time.

Since the methodology for the update was to mirror the State plan, with updated storm event records, the following has been taken from the Commonwealth of Virginia Emergency Operations Plan Annex 3 (Volume II) of the Standard and Enhanced Hazard Mitigation Plan Ranking Methodology.

To compare the risk of different hazards, and prioritize which are more significant, requires a system for equalizing the units of analysis. Under ideal conditions, this common unit of analysis would be "annualized dollars." However, such an analysis requires reliable probability and impact data for all the hazards to be compared. As this is often not the case, many hazard prioritization methods are based on scoring systems, which allow greater flexibility and more room for expert judgment.

The Virginia Tech Center for Geospatial Information and Technology's (CGIT) and VDEM have developed a standardized methodology to compare different hazard's risk on a jurisdictional basis. As some of the hazards assessed in this plan did not have precisely quantifiable probability or impact data, a semi-quantitative scoring system was used to compare all of the hazards. This method prioritizes hazard risk based on a blend of quantitative factors from the available data. A number of parameters have been considered in this methodology, all of which could be derived from the NCDC database:

- History of occurrence;
- Vulnerability of people in the hazard area;
- Probable geographic extent of the hazard area; and
- Historical impact, in terms of human lives and property.

The ranking methodology tries to balance these factors, whose reliability varies from hazard to hazard due to the nature of the underlying data. Each parameter was rated on a scale of one (1) through four (4). The exact weights were highly debated, but the final conclusion was that the population vulnerability and density would each be weighted at 0.5 with a geographic extent at 1.5, relative to the other parameters. These scores are summed at a jurisdictional level for each hazard separately, permitting comparison between jurisdictions for each hazard type. A summation of all the scores from all hazards in each jurisdiction provides an overall "all-hazards" risk prioritization. The following sections provide an overview of the six parameters that were used in ranking the hazards that impact Virginia.

The NCDC data, as described above, is far from a complete data source. This data was used for the ranking because of its standardized collection of many of the hazards of interest. The data only partially represents the geological hazards, and as a result, the ranking can only characterize the current form of the data. As other data sources become available, the ranking will need to be reassessed to make sure the parameters are still valid for ranking the hazards.

Population Vulnerability and Density

Population vulnerability and density are simple, yet important factors in the risk ranking assigned to a jurisdiction. In general, a hazard event that occurs in a highly populated area has a much higher impact than a comparable event that occurs in a remote, unpopulated area. Two population parameters were used, accounting for jurisdictions with high populations and jurisdictions with densely populated areas. Each parameter was given a weighting of 0.5 in an effort to avoid overwhelming the overall ranking methodology with pure population data.

Population vulnerability was calculated as a percent of the total population of Virginia present in each jurisdiction. The 2010 U.S. Census population calculation for each jurisdiction were divided by the total population for the State and a value between one and four was assigned based on a geometric breaks pattern. By ranking jurisdictions this way, those cities and counties with significantly larger populations have effectively been given extra weight. For the purposes of this planning effort, it is assumed that the higher the population density, the higher the vulnerability of that population, as there are simply more people in the path of the hazard. Table 4.10 describes the breaks and assigned scores for population vulnerability for the individual jurisdictions of the planning area.

Table 4.10. Population Vulnerability as the percentage of people that will be affected by the occurrence of the hazard.

Population Vulnerability	
Rank	***Definition***
1	<= 0.229 % of the total population of the State
2	0.230% - 0.749% of the total population of the State
3	0.750% - 2.099% of the total population of the State
4	> = 2.100% of the total population of the State

Population density was based on the population per square mile for each jurisdiction. The 2010 Census population calculation for each jurisdiction were divided by the total area for the jurisdiction; a value between one and four was assigned based on geometric intervals. By ranking jurisdictions this way, those cities and counties with densely populated areas have effectively been given extra weight. Table 4.11 describes the breaks and assigned scores for population density for the individual jurisdictions of the planning area.

Table 4.11. Population Density as the number of people per square mile that will be affected by the occurrence of the hazard.	
Population Density	
Rank	***Definition***
1	<= 60.92 people/sq. mi
2	60.93 – 339.10 people/sq. mi
3	339.11 - 1,743.35 people/sq. mi
4	>= 1,743.36 people/sq. mi

Geographic Extent

Probable geographic extent (GE) would ideally be measured consistently for each hazard; however, the available data sources vary widely in their depiction of hazard geography. As a result, one uniform ranking system could not be accomplished at this time. In this version of the plan each hazard has been assigned individual category break points based on the available hazard data. In the overall scoring system, geographic extent was given a 1.5 weighting relative to the other parameters, as geographic extent was deemed to be critically important, and more reliable than some of the other parameters. GE data sources, ranking criteria, and category breaks for the individual jurisdictions of the planning area are summarized in Table 4.12.

Table 4.12. Geographic Extent as the percentage of a jurisdiction impacted by the hazard.			
Geographic Extent			
Hazard	***Description***	***Category Breaks***	
		Rank	*Definition*
Flood	Percent of a jurisdiction that falls within FEMA Special Flood Hazard Area (SFHA). Data: FEMA Floodplains (DFIRMs)	*1*	*<=2.99%*
		2	*3.00-4.99%*
		3	*5.00 -9.99%*
		4	*>=10.00%*
High Wind	Average maximum wind speed throughout the entire jurisdiction. Data: HAZUS^{MH} 3-second Peak Gust Wind Speeds	*1*	*<= 59.9*
		2	*60.0 - 73.9*
		3	*74.0 - 94.9*
		4	*>= 95.0*
Wildfire	Percent of jurisdiction that falls within a “high” risk. Data: VDOF Wildfire Risk Assessment	*1*	*<= 9.9%*
		2	*10.0% - 19.9%*
		3	*20.0% - 49.9%*
		4	*>= 50.0%*
Karst	Percent of jurisdiction where the risk is “high” for karst related events. Data: USGS Engineering Aspects of Karst	*1*	*<= 24.9%*
		2	*25.0% - 49.9%*
		3	*50.0% - 74.9%*
		4	*>= 75.0%*
Landslide	Percent of jurisdiction where a high landslide risk exists.	*1*	*<= 24.9%*
		2	*25.0% - 49.9%*

Table 4.12. Geographic Extent as the percentage of a jurisdiction impacted by the hazard.			
Geographic Extent			
Hazard	***Description***	***Category Breaks***	
		Rank	*Definition*
	Data: USGS Landslide Incidence & Susceptibility	*3*	*50.0% - 74.9%*
		4	*>= 75.0%*
Earthquake	Average 2,500-year return period max percent of gravitational acceleration (PGA). Data: HAZUS^{MH} 2,500-year PGA	*1*	*<= 0.069*
		2	*0.070 - 0.159*
		3	*0.160 - 0.299*
		4	*>= 0.300*
Winter Storm	Average annual number of days receiving at least 3 inches of snow, calculated as an area-weighted average for each jurisdiction. Data: NWS snowfall statistics	*1*	*<= 1.49*
		2	*1.50 - 1.99*
		3	*2.00 - 2.99*
		4	*>= 3.0*
Tornado	Annual tornado hazard frequency (times 1 million), calculated as an area-weighted average for each jurisdiction. Data: NCDC tornado frequency statistics	*1*	*<= 1.24*
		2	*1.25 - 9.99*
		3	*10.00 - 99.9*
		4	*>= 100.00*

Annualizing the Data for Analysis

Data from the NCDC database was annualized in order to compare the results on a common system. In general, this was completed by taking the parameter of interest and dividing by the length of record for each hazard. The annualized value should only be utilized as an estimate of what can be expected in a given year.

Annualized Deaths and Injuries

Deaths and injuries are also an important factor to evaluate when determining risk ranking. Using NCDC data, past deaths and injuries were computed for drought, flood, high wind, tornado, wildfire, and winter storm. The remaining hazards have no reported deaths or injuries in this database and as a result were assigned a ranking of one (1). Table 4.13 describes the breaks and assigned scores for annualized deaths and injuries for the individual jurisdictions of the planning area.

Table 4.13. Annualized Deaths and Injuries as the number of deaths or injuries that a hazard event would likely cause in a given year.	
Annualized Deaths and Injuries	
Rank	*Definition*
1	<= 1.019 deaths and/or injuries per year
2	1.020 – 6.279 deaths and/or injuries per year

Table 4.13. Annualized Deaths and Injuries as the number of deaths or injuries that a hazard event would likely cause in a given year.	
Annualized Deaths and Injuries	
Rank	*Definition*
3	6.280 – 13.199 deaths and/or injuries per year
4	>= 13,200 deaths and/or injuries per year

Annualized Crop and Property Damage

Crop damage and property damage were also analyzed separately in order to give each jurisdiction a score of one (1) to four (4). This data was obtained from the NCDC storm events database and annualized according to the period of record for each event category. Table 4.14 describes the breaks and assigned scores for annualized crop and property damages for the individual jurisdictions of the planning area.

Table 4.14. Annualized Crop and Property Damage as the estimated damages that a hazard event will likely cause in a given year.		
Annualized Crop and Property Damage		
Rank	*Definition: Crop Damage*	*Definition: Property Damage*
1	*<= $25,711 per year*	*<= $ 136,129 per year*
2	*$25,712 – $100,270 per year*	*$136,130 - $432,555 per year*
3	*$100,271 - $291,384 per year*	*$432,556 - $1,111,067 per year*
4	*>= $291,385 per year*	*>= $1,111,068 per year*

Annualized Events

While each hazard may not have a comprehensive database of past historical occurrences, the record of historical occurrences is still an important factor in determining where hazards are likely to occur in the future. Annualizing the NCDC storm events data yields a rough estimate of the number of times a jurisdiction might experience a similar hazard event in any given year. To do this, the total number of events in the NCDC database, for each specific hazard in each jurisdiction, was divided by the total years of record for that hazard to calculate an "annualized events" value.

There were no significant events reported for land subsidence (karst), earthquake, and landslide in NCDC; as a result, the events for these hazards all received a rank of one (1). Table 4.15 describes the annual frequency breaks for events for the individual jurisdictions of the planning area.

Table 4.15. Annualized Events as the number of times that a hazard event would likely happen in a given year.	
Annualized Events	
Rank	*Definition*
1	<= 0.09 events per year
2	0.10 – 0.99 events per year
3	1.00 – 4.99 events per year
4	>= 5.00 events per year

Overall Hazard Ranking

The scores from each of these categories were added together for each hazard to estimate the total jurisdictional risk due to that hazard. As discussed previously, the population parameters were each given a weighting of 0.5 (for a total of 1.0 for all population parameters), and Geographic Extent was given a weighting of 1.5 relative to the other factors. The total scores were broken into five categories to better illustrate the distribution of risk scores. Those jurisdictions with scores from 0 to 8.49 were determined to have a low risk in that hazard category; scores 8.50 through 9.99 were considered medium-low risk; between 10.0 and 11.49, medium risk; between 11.50 and 12.99 were considered medium-high risk; and jurisdictional hazard scores greater than 13.00 were given a high rating.

In order to assess the total risk of a county or city across all hazard categories, each of the previous categories were summed across the different hazard types. Overall, all-hazards ranking counties with a low risk have a score less than 86.00; those with a medium-low risk between 86.01 and 93.50; medium risk between 95.51 and 100.00; medium-high risk between 100.01 and 108.00; and those with a high risk have a score greater than or equal to 108.01.

Comparison of Methodologies

Differences in 2010 and 2016 annualized loss estimates can be attributed to several factors:

- Time frame of storm events database and/or data sources;
- Inflation of storm events database;
- Methodologies used for analysis (i.e., HAZUS^{MH}); and
- Differences in versions of HAZUS available for use.

Additional Risk Assessments Completed for the Northern Virginia Region

The Northern Virginia Planning region, as discussed in other sections of this plan, has numerous plans that document different aspects of the risk to natural and man-made hazards. Some of these plans are briefly outlined below:

December 2015 National Capital Region THIRA *National Capital Region Threat and Hazard Identification and Risk Assessment:* This THIRA discusses natural and human-caused hazards and provides risk summaries for each of the hazards. Threats and hazards were identified based on the likelihood of an incident and the significance of the threat/hazard's effects to the area.

Threats/Hazards considered in the THIRA:

- Pandemic
- Severe Weather Event (hurricane/winter weather)
- CBRNE
- Cyber attack
- Terrorism
- Earthquake

Limitations of Data

The data sources used in the hazard ranking and loss estimation are varied in their degree of completeness, accuracy, and precision as the ability to accurately prioritize some of the hazards would be improved by better information (e.g., landslide, karst, etc.). The participating jurisdictions should consider their internal and cooperative abilities to gather and maintain additional data for future updates to this plan.

V. Overall Hazard Results

The preceding sub-sections discuss the probability, impacts, vulnerability, and risks for each of the natural hazards that have been determined to have a significant impact on the Northern Virginia planning region. The final section of the HIRA provides an overall assessment, summary, and comparison of the overall hazard ranking and estimated losses. Risk to critical facilities has been discussed, to the extent possible, in each of the hazard sub-sections. These sections highlight the results of the analysis completed during the 2010 and 2016 plan updates. Refer to the tables in these sections to determine what facilities or facility types are at greater risk for each hazard. This information is ideal for determining structural mitigation strategies. The names and information for the HAZUS^{MH} and local critical facilities in the assessments are available in Appendix D.

Refer to the Risk Assessment Methodology section of the HIRA for a full description of the methodology and the limitations of the data used for ranking the hazards and loss estimation. For most natural hazards, the NCDC data, although somewhat limited, provides the most comprehensive historical record of events and damages available. This analysis is only representative of the NCDC data and other data that was used. It is known that the time period of this data is small in comparison to the known historical events. The data does not fully represent geological hazards, but in the absence of better data, NCDC was used to represent the risk.

Comparison of 2010 and 2016 Results

Table 4.16 provides a comparison of the 2010 and 2016 hazard rankings, by jurisdiction. Note that the list of jurisdictions that participated in the plan in 2010 is slightly different from the list of jurisdictions that participated in 2016; therefore, the rankings do not line up exactly. In addition, the configuration of the hazards included, while substantively the same, is slightly different between the 2010 and 2016 plans.

Following Table 4.16, tables are provided that show select results from the HIRA for the most probable hazards likely to impact the Northern Virginia planning area – floods, high wind, earthquake, and winter weather – by participating jurisdiction.

Table 4.16. Hazard Vulnerability Comparison, 2010 and 2016 Plans, by Jurisdiction and Hazard.

Jurisdiction	Flood		Winter Storm		High Wind		Tornado		Drought		Earthquake		Landslide		Wildfire		Geologic		Extreme Temperatures	
	2010	2016	2010	2016	2010	2016	2010	2016	2010	2016	2010	2016	2010	2016	2010	2016	2010	2016	2010	2016
Arlington County	H	H	H	H	H	H	H	H	MH	L	M	M	M	L	ML	L	ML	L		H
Fairfax County	H	H	H	H	H	H	H	H	MH	L	M	M	ML	L	M	L	ML	L		H
Loudoun County	H	H	H	H	H	H	H	H	H	M	M	M	MH	L	ML	M	ML	M		H
Prince William County	H	H	H	H	H	H	H	H	H	M	M	M	ML	L	M	M	ML	L		H
City of Alexandria	H	H	H	H	H	H	H	H	MH	L	M	M	M	L	L	L	ML	L		H
City of Fairfax	H	H	H	H	H	H	H	H	MH	L	M	M	M	L	ML	L	L	L		H
City of Falls Church	H	H	H	H	H	H	MH	H	M	L	ML	M	ML	L	L	L	ML	L		H
City of Manassas	H	H	H	H	H	H	H	H	MH	L	M	M	M	L	ML	L	ML	L		H
City of Manassas Park	H	M	H	H	H	H	MH	H	L	L	ML	M	ML	L	L	L	L	L		H
Town of Clifton	H	L	H	H	H	H	H	H	MH	L	M	M	ML	L	M	L	ML	L		H
Town of Dumfries	H	M	H	H	H	H	H	H	H	M	M	M	ML	L	M	M	ML	L		H
Town of Haymarket	H	M	H	H	H	H	H	H	H	M	M	M	ML	L	M	M	ML	L		H
Town of Herndon	H	M	H	H	H	H	H	H	MH	L	M	M	ML	L	M	L	ML	L		H
Town of Leesburg	H	H	H	H	H	H	H	H	H	M	M	M	MH	L	ML	M	ML	M		H
Town of Lovettsville		L		H		H		H		M		M		L		M		L		H
Town of Middleburg	H	H	H	H	H	H	H	H	H	M	M	M	MH	L	ML	M	ML	L		H
Town of Occoquan	H	L	H	H	H	H	H	H	H	M	M	M	ML	L	M	M	ML	L		H
Town of Purcellville	H	H	H	H	H	H	H	H	H	M	M	M	MH	L	ML	M	ML	L		H
Town of Quantico	H	M	H	H	H	H	H	H	H	M	M	M	ML	L	M	M	ML	L		H
Town of Round Hill	H	M	H	H	H	H	H	H	H	M	M	M	MH	L	ML	M	ML	L		H
Town of Vienna	H	M	H	H	H	H	H	H	MH	L	M	M	ML	L	M	L	ML	L		H

Table 4.17. Flood Events and Damages in the Northern Virginia Region, 1950–2015.				
Jurisdiction	**# of Flood Events**	**Property Damage**	**Crop Damage**	**Total**
Arlington County	45	$4,123,000	$0	$4,123,000
Fairfax County	34	$2,506,000	$0	$2,506,000
Loudoun County	130	$2,138,000	$180,000	$2,318,000
Prince William County	84	$775,000	$50,000	$825,000
City of Alexandria	33	$718,000	$0	$718,000
City of Fairfax	34	$2,506,000	$0	$2,506,000
City of Falls Church	36	$620,000	$0	$620,000
City of Manassas	28	$31,000	$0	$31,000
City of Manassas Park	18	$11,000	$0	$11,000
Town of Clifton	0	$0	$0	$0
Town of Dumfries	7	$500,000	$0	$500,000
Town of Haymarket	9	$173,000	$50,000	$223,000
Town of Herndon	9	$0	$0	$0
Town of Leesburg	38	$718,000	$0	$718,000
Town of Lovettsville	1	$0	$0	$0
Town of Middleburg	13	$500,000	$0	$500,000
Town of Occoquan	1	$0	$0	$0
Town of Purcellville	16	$500,000	$0	$500,000
Town of Quantico	6	$507,000	$0	$507,000
Town of Round Hill	4	$0	$0	$0
Town of Vienna	7	$0	$0	$0
Total	**553**	**$16,326,000**	**$280,000**	**$16,606,000**

Based on the data in the table above, the planning area should expect to experience flood damages in the amount of $255,477 annually.

Table 4.18. Annualized Loss Estimates Due to Severe Storms and High Winds, 1950-2015.		
Jurisdiction(s)	Annualized Property and Crop Damage	Total Property and Crop Damage
Arlington County	$158,827	$10,323,750
Fairfax County & the City of Fairfax (including Town of Clifton, Town of Herndon, and Town of Vienna)	$315,508	$20,508,000
Loudoun County (including Town of Leesburg, Town of Lovettsville, Town of Middleburg, Town of Purcellville, and Town of Round Hill)	$49,732	$3,232,600
Prince William County (including Town of Dumfries, Town of Haymarket, Town of Occoquan, and Town of Quantico)	$268,412	$17,446,750
City of Alexandria	$149,538	$9,720,000
City of Fairfax	--	--
City of Falls Church	$149,692	$9,730,000
City of Manassas	240,538	$15,635,000
City of Manassas Park	$231,261	$15,032,000
Total	**$1,563,509**	**$101,628,100**

Table 4.19. HAZUS[MH] Estimated Damages from Probabilistic Scenario 2500-year Return Interval.				
Jurisdiction	**Building Stock**	**Transportation Infrastructure**	**Utility Infrastructure**	**Total**
Arlington County	$343,903,000	$4,726,000	$3,172,000	$347,551,000
Fairfax County	$1,794,989,000	$12,702,000	$20,528,000	$1,828,219,000
Loudoun County	$430,261,000	$1,985,000	$8,280,000	$440,526,000
Prince William County	$679,957,000	$4,027,000	$15,648,000	$699,632,000
City of Alexandria	$274,089,000	$3,011,000	$4,038,000	$281,238,000
City of Fairfax	$63,431,000	$28,000	$286,000	$63,745,000
City of Falls Church	$274,089,000	$0	$154,000	$274,243,000
City of Manassas	$74,521,000	$854,000	$5,412,000	$80,787,000
City of Manassas Park	$20,296,000	$131,000	$165,000	$20,592,000
Total	**$3,708,422,000**	**$27,464,000**	**$57,684,000**	**$3,793,570,000**

Table 4.20. Winter Storm Events and Damages in the Northern Virginia Region, 1996–2015.				
Jurisdiction	**# of Winter Storm Events**	**Property Damage**	**Crop Damage**	**Total**
Arlington County (includes the Cities of Alexandria and Falls Church)	97	$460,000	$0	$460,000
Fairfax County (includes the City of Fairfax and the Towns of Clifton, Herndon, and Vienna)	123	$335,000	$0	$335,000
Loudoun County (includes the Towns of Leesburg, Lovettsville, Middleburg, Purcellville, and Round Hill)	131	$135,000	$100,000	$235,000

Table 4.20. Winter Storm Events and Damages in the Northern Virginia Region, 1996–2015.				
Jurisdiction	**# of Winter Storm Events**	**Property Damage**	**Crop Damage**	**Total**
Prince William County (includes the Cities of Manassas and Manassas Park and the Towns of Dumfries, Haymarket, Occoquan, and Quantico)	110	$55,000	$0	$55,000
Total	**461**	**$985,000**	**$100,000**	**$1,085,000**

Based on the data in the table above, the planning area should expect to experience winter storm damages in the amount of $57,105 annually.

VI. Flood

NOTE: As part of the 2016 plan update, the flood hazard was reexamined and a new analysis performed. This new analysis included, but was not limited to: 1) refreshing the hazard profile; 2) updating the previous occurrences; 3) determining number of hazard events and losses by jurisdiction using NCDC and other data sources where available; 4) updating the assessment of risk by jurisdiction based on new data; and 5) ranking of the hazard by jurisdiction using the methodology described in detail in the HIRA Introduction section. In addition, each section of the plan was also reformatted to improve clarity, and new maps and imagery, when available and appropriate, were inserted.

A. Hazard Profile

1. Description

Flooding - Flooding is the most frequent and costly natural hazard in the United States; a hazard that has caused more than 10,000 fatalities since 1900. Nearly 90% of presidential disaster declarations result from natural events where flooding was a major component.

Floods are the result of excessive precipitation, and can be classified under two categories: general floods, precipitation over a given river basin for a long period of time; and flash floods, the product of heavy, localized precipitation in a short time period over a given location. The severity of a flooding event is determined by the following: 1) a combination of stream and river basin topography and physiography; 2) precipitation and weather patterns; 3) recent soil moisture conditions; and 4) the degree of vegetative clearing.

Floods are events that may last for several days. The primary types of flooding include riverine, coastal, and urban. Riverine flooding is a function of excessive precipitation levels and water runoff volumes within the watershed of a stream or river. Coastal flooding is typically a result of storm surge, wind-driven waves, and heavy rainfall produced by hurricanes, tropical storms, nor'easters, and other large coastal storms. Urban flooding occurs where man-made development has obstructed the natural flow of water and decreased the ability of natural groundcover to absorb and retain surface water runoff.

Flash Flooding - Flash flooding events can occur from a dam or levee failure within minutes or hours of heavy amounts of rainfall, or from a sudden release of water held by an ice jam. Most flash flooding is caused by slow-moving thunderstorms in a local area or by heavy rains associated with hurricanes and tropical storms. Although flash flooding occurs often along mountain streams, it is also common in urbanized areas where much of the ground is covered by impervious surfaces. Flash flood waters move at very high speeds— "walls" of water can reach heights of 10 to 20 feet. Flash flood waters and the accompanying debris can uproot trees, roll boulders, and damage or destroy buildings, bridges, and roads.

The average global sea level has been rising at the rate of about 3.1 mm per year (data from 1993 to 2003)[4]. This same trend is apparent in the historical gage records for Washington, DC, (Station 8594900) along the tidally-influenced Potomac River where rates have averaged about 3.2 mm/year.

Sea Level Rise

Sea level rise is expected to continue and possibly accelerate as the planet warms. Based on output from multiple computer models, a low sea level rise scenario is one with a sea level rise of 7 to 15 inches by 2100. A high scenario would include a sea level rise of 10 to 23 inches by 2100. Neither scenario includes the possibility of ice sheet melting contributing to sea level rise. Some scientists suggest that should the Greenland and West Antarctic ice sheets collapse; sea level rise will be on the order of several feet higher than the high scenario shown here. [5]

Using the high Intergovernmental Panel on Climate Change (IPCC) emissions growth scenario and overlaying corresponding projected sea levels expected with that scenario, it is anticipated that significant portions of the eastern sections of Old Town Alexandria, including the eastern portions of King Street will be at risk of inundation (Figure 4.21). A study being conducted by NVRC as part of Sustainable Shorelines & Community Management indicates that approximately 49 buildings may be inundated under a high sea-level rise scenario.

Also at risk of inundation under projected rises in sea-level is Ronald Reagan Washington National Airport. Situated along the banks of the Potomac, the airport opened in 1941. The site had originally been mostly underwater and was built up by sand and gravel fill. Approximately 200 acres of the airport are within the 100-year floodplain which is 11.4 feet above mean sea level. Under the high emissions scenario, permanent inundation of portions of taxiways and access roadways is possible (See Figure 4.22).

Other low-lying areas in Northern Virginia are also at risk for sea level rise inundation. Portions of Four Mile Run in Arlington and Alexandria, Dangerfield Island, Jones Point, Huntington, Belle Haven/New Alexandria, Dyke Marsh, Hallowing Point, Occoquan NWR, Town of Quantico, the Occoquan River and various tidal embayments may be impacted.

In addition to producing high resolution sea level rise and storm surge inundation mapping for Northern Virginia, the NVRC study, completed in late 2010, also quantified specific elements vulnerable for both the built and natural environments and developed strategies to protect, adapt or retreat communities located in areas at risk.

Figure 4.21. Projected ‘high scenario’ sea level rise for Old Town, Alexandria, 2100. *Source: NVRC, 2010.*

Figure 4.22. Projected “high-scenario” sea-level rise for Ronald Reagan Washington National Airport Year 2100.
Source: NVRC, 2010

Erosion

Erosion is the gradual breakdown and movement of land due to both physical and chemical processes of water, wind, and general meteorological conditions. Natural, or geologic, erosion has occurred since the Earth’s formation and continues at a very slow and uniform rate each year.

There are two general causes of soil erosion: wind and water. Both can cause significant soil loss. Winds blowing across sparsely vegetated or disturbed land can pick up soil particles and transport them to another location. Water flowing over land also transports soil particles to other locations. Wind erosion generally impacts wider, less well defined areas than water erosion, but water erosion is capable of transporting larger particles than wind. Major storms such as hurricanes may cause significant erosion by combining the impacts of high winds and high velocity water flow over large flood areas, including storm surges that significantly impact the shoreline.

Wind erosion is the result of lateral and uplift wind forces separating individual soil particles from the soil mass and transporting them until the wind speed and resulting forces decrease to where they are insufficient to support and transport the particles. Generally, individual wind erosion events in areas of exposed silt and clay are relatively minor. However, if the exposed soil consists of sand, and the sand becomes airborne, the rate of erosion can increase by a factor of 10. Airborne sand acts as an abrasive as it is blown across the surface, which acts to dislodge significantly more soil that the wind alone.

The main causes of water erosion are stream or overland flow, and wave action. Stream or overland flow erosion is the result of mechanical or chemical removal, and transportation of soil particles to a new location. Mechanical erosion is caused by hydrodynamic forces pushing particles down-gradient; hydraulic drag forces pulling particles down-gradient, and/or hydraulic uplift. Susceptibility of an area to stream or overland flow erosion is a function of soil characteristics, vegetative cover, water quality, topography, and climate. Soils weathered from calcareous carbonate rock (i.e., limestone and dolomite), are more susceptible to chemical erosion by dissolution than other soils. Vegetative cover can be very helpful in controlling erosion by shielding the soil surface from direct water contact and reinforcing the soil, with the foliage serving as an energy dissipater and the root mat reinforcing the near surface soils. Water quality impacts both chemical and mechanical erosion; water with relatively a high concentration of carbon dioxide, oxygen, and organic acids accelerates dissolving minerals from calcareous carbonate soils. Sand and gravel that are transported during periods of high velocity flow increase mechanical erosion through abrasion of the flow bed. Topography of the area, including size, shape, and slope is a key variable in determining water flow velocity which in turn is a key variable in the magnitude of the hydraulic forces producing erosion. The greater the slope length and gradient, the more potential an area has for erosion. Climate can also affect the amount of runoff, especially the frequency, intensity, and duration of rainfall and storms. When rainstorms are frequent, intense, or of long duration, erosion risks are high. Seasonal changes in temperature and rainfall amounts define the period of highest erosion risk for the year.

During the mid to late 1960s, the importance of erosion control gained increased public attention. Implementation of erosion control measures consistent with sound agricultural and construction operations was needed to minimize the adverse effects associated with increasing settling out of the soil particles due to water or wind. The increase in government regulatory programs and public concern has resulted in a wide range of erosion control products, techniques, and analytical methodologies in the United States. The preferred method of erosion control in recent years has been the restoration of vegetation. These measures are addressed in the Northern Virginia region through local sedimentation and erosion control programs. While local erosion hazard areas are not identified, the areas of greatest concern are typically those areas consisting of steep slopes and fast running stream channels, as well as large construction sites involved in the excavation and disturbance of their natural state.

There is no known database of historic erosion events in the Northern Virginia region. Erosion events are often extremely localized in nature and often go unreported unless they damage infrastructure or the resulting topography presents a new hazard.

As far as coastal and tidal erosion, Prince William, Fairfax, and Arlington Counties and the City of Alexandria all have tidal shorelines along the Potomac River and its associated embayments and tributaries. The accretion and erosion of these shorelines are greatly influenced by wind-induced waves, littoral currents, tidal currents, sea-level rise, boat wake, and storm water runoff. Other contributing factors include the physical characteristics of the shoreline (e.g., topography, soil), as well as human activities (e.g., land use, dredging, and shoreline stabilization).

In September 1992, NVRC prepared a study entitled "Tidal Shoreline Erosion in Northern Virginia" which discusses the erosion situation for various segments of the shoreline in the Northern Virginia region, as well as identifies the locations of "priority" erosion concern. The report is intended to serve as a valuable resource document for State and local officials to assist them in planning for shoreline and erosion control throughout Northern Virginia, and is hereby incorporated by reference. In addition, the report augments a DBase IV computer data file also created by NVRC that contains the names, mailing addresses, and tax parcel numbers of tidal Potomac shoreline property owners. This data is distributed to the Shoreline Erosion Advisory Service and Northern Virginia local governments. Combined with the set of approximately 360 low altitude aerial photographs, these work products serve as an excellent historical record for current planning efforts, and also future research.

According to the report, 20% of the Northern Virginia shoreline has been artificially stabilized with 32 miles of hard structures. Prince William County has approximately 48 miles of shoreline with 8.7 miles of artificial shoreline stabilization structures. Fairfax has the most tidal shoreline in Northern Virginia (87 miles), and the most artificial stabilization (13.3 miles), but the smallest percent of stabilized shoreline (15%). The City of Alexandria has the shortest shoreline length (8.8 miles), with the largest percent stabilized (58%, or 5.1 miles). Arlington County has 13.3 miles of tidal shoreline, with 4.9 miles of hardened shoreline (37%). This information has not been updated since the 2006 plan creation, and remains the best available data for the 2016 update to this plan.

The probability of future erosion events remains likely in localized areas throughout the Northern Virginia region. According to projects researching the changing climate, including sea-level risk and increased storm events, erosion would be expected to increase.

Erosion vulnerability for the region is difficult to determine because there are no historical records for previous occurrences of erosion events. The Northern Virginia region's vulnerability to erosion is limited to those immediate areas along rivers, creeks, and streams and to areas of loose soils with steep slopes. In most cases where erosion poses an imminent threat to property, erosion control techniques are typically applied before damages occur. Therefore, future structural damages caused by long-term erosion and associated dollar losses are expected to be negligible.

As discussed in the Hazard Analysis section, NVRC prepared a study titled "Tidal Shoreline Erosion in Northern Virginia," which discusses the erosion situation for various segments of the shoreline in the Northern Virginia region, as well as identifies the locations of "priority" erosion concern. This publication is hereby incorporated by reference, as will be future updates to shoreline erosion studies in the Northern Virginia region.

2. Geographic Location / Extent

There are numerous rivers and streams flowing through the Northern Virginia region. When heavy or prolonged rainfall events occur, these rivers and streams are susceptible to some degree of flooding. The most notable of these water bodies is the Potomac River, which in the past has been the source for significant storm surge and tidal flooding – particularly in waterfront communities such as Arlington and Alexandria.

The entire Northern Virginia region falls within the Potomac River Basin, which serves as the border between Maryland and Virginia and flows in a southeasterly direction. The topography of the upper reaches of the basin is characterized by gently sloping hills and valleys.

At Great Falls in Maryland, the Potomac River starts its rapid descent to sea level by plunging 76 feet through a deep gorge in less than one mile. Eastward of Great Falls, the Potomac flows between Washington, DC, Arlington, and Alexandria. Here the river dramatically broadens and is flanked by low marshes in many places along the eastern side of Prince William County, where tides further influence the river. The Potomac then continues on through the coastal plain and eventually grows to more than 11 miles wide as it reaches the Chesapeake Bay.

While some of the most dramatic flooding events in Northern Virginia are associated with the tidal flooding of the Potomac River during hurricanes or tropical storms, other more frequent inland flood hazards exist throughout the region. Too much rainfall or snowmelt in too little time causes serious flooding problems along even the smallest of tributaries or storm drainage systems. The low-lying areas prone to this type of flooding are known as floodplains or SFHAs. These locations, which are more commonly referred to as the "100-year floodplain" (areas with a one-percent-annual-chance of flooding), are routinely surveyed and mapped by FEMA as part of a Flood Insurance Study (FIS) sponsored by the NFIP. These studies and associated maps are then provided to local communities in order to regulate the development of land within these hazard areas.

Figure 4.23 shows the potential flood hazard areas throughout the Northern Virginia region based on the FEMA National Flood Hazard Layer (NFHL). Jurisdiction-specific flood maps that show the FEMA floodplain in relation to boundaries and assets in the region can be found in Appendix D.

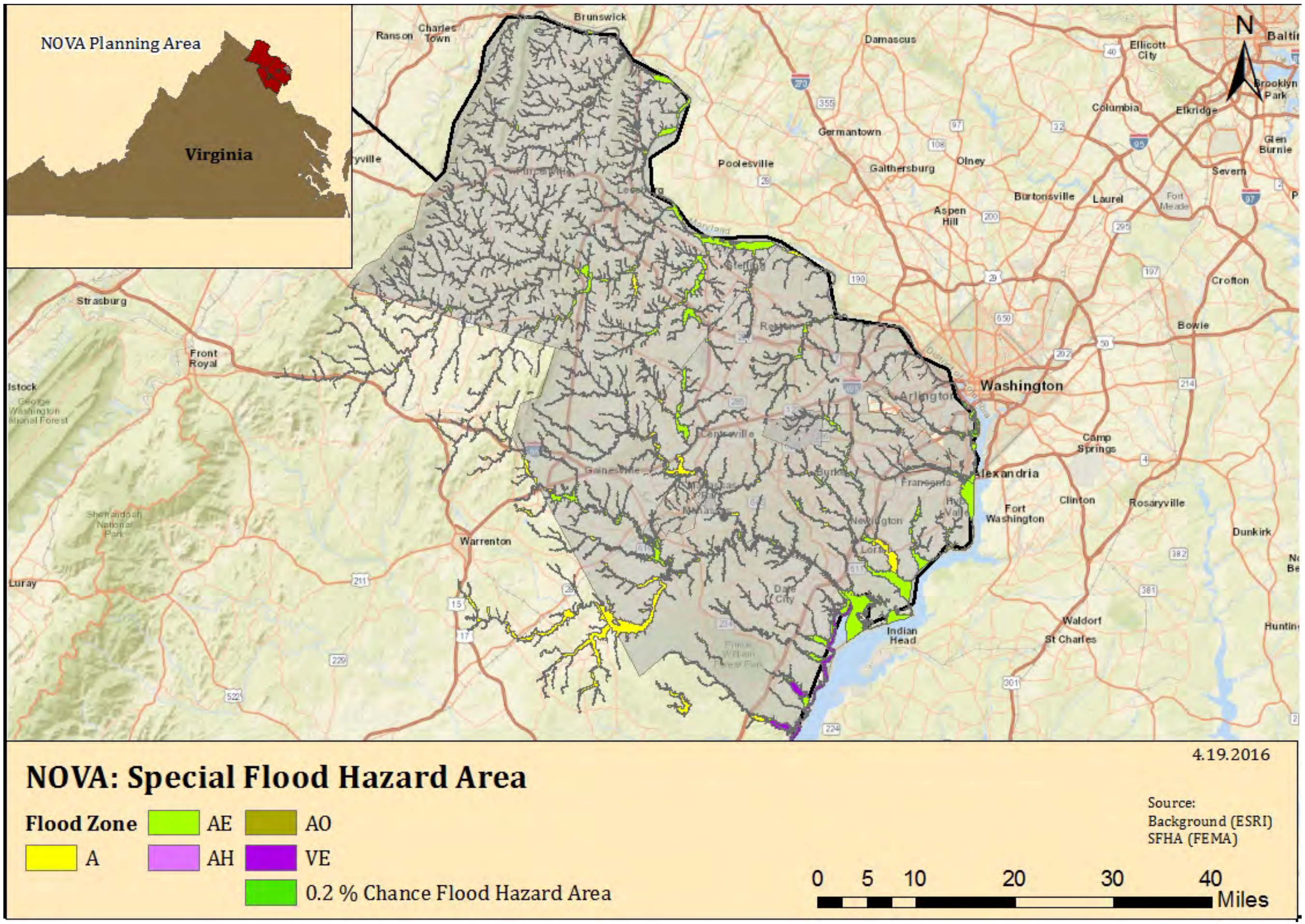


Figure 4.23 FEMA Special Flood Hazard Area Map (National Flood Hazard Layer data).

There have been a number of past flooding events throughout the region, ranging widely in terms of location, magnitude, and impact. The most frequent flooding events are quite localized in nature, resulting from heavy rains in a short period of time over urbanized areas that are not able to appropriately handle storm water runoff. These events typically do not threaten lives or property and will not result in emergency or disaster declarations, thus historical data is difficult to obtain. Table 4.21 summarizes the number of flood events (by participating jurisdiction) since 1950 which have caused a notable impact on the Northern Virginia region as recorded by the NCDC. This includes 553 flood events that have caused approximately $16.6 million in property and crop damages.

Table 4.21. Flood Events in the Northern Virginia Region, 1950–2015 based on NCDC data.

Jurisdiction	# of Flood Events	Property Damage	Crop Damage	Total
Arlington County	45	$4,123,000	$0	**$4,123,000**
Fairfax County	34	$2,506,000	$0	**$2,506,000**
Loudoun County	130	$2,138,000	$180,000	**$2,318,000**

Table 4.21. Flood Events in the Northern Virginia Region, 1950–2015 based on NCDC data.				
Jurisdiction	**# of Flood Events**	**Property Damage**	**Crop Damage**	**Total**
Prince William County	84	$775,000	$50,000	**$825,000**
City of Alexandria	33	$718,000	$0	**$718,000**
City of Fairfax	34	$2,506,000	$0	**$2,506,000**
City of Falls Church	36	$620,000	$0	**$620,000**
City of Manassas	28	$31,000	$0	**$31,000**
City of Manassas Park	18	$11,000	$0	**$11,000**
Town of Clifton	0	$0	$0	**$0**
Town of Dumfries	7	$500,000	$0	**$500,000**
Town of Haymarket	9	$173,000	$50,000	**$223,000**
Town of Herndon	9	$0	$0	**$0**
Town of Leesburg	38	$718,000	$0	**$718,000**
Town of Lovettsville	1	$0	$0	**$0**
Town of Middleburg	13	$500,000	$0	**$500,000**
Town of Occoquan	1	$0	$0	**$0**
Town of Purcellville	16	$500,000	$0	**$500,000**
Town of Quantico	6	$507,000	$0	**$507,000**
Town of Round Hill	4	$0	$0	**$0**
Town of Vienna	7	$0	$0	**$0**
Total	**553**	**$16,326,000**	**$280,000**	**$16,606,000**

*Prior to the 2016 Plan Update, previous damages were inflated to current values. As of the 2016 plan update, damages are presented in year of occurrence values, as reported by the NCDC.

3. Magnitude or Severity

Flooding only impacts a community to the degree that it affects the lives of its citizens and the community functions overall. Therefore, the most vulnerable areas of a community will be those most affected by floodwaters in terms of potential loss of life, damages to homes and businesses, and disruption of community services and utilities. For example, an area with a highly developed floodplain is significantly more vulnerable to the impacts of flooding than a rural or undeveloped floodplain where potential floodwaters would have little impact on the community.

The severity of a flood on a community can be magnified to the degree floodwaters affect special needs populations and critical facilities. Special needs populations are those that may require special assistance during a flood event, may not be able to protect themselves prior to an event, or may not be able to understand potential risks. These can include non-English speaking populations, elderly populations, or those in a lower socioeconomic group. Tourists and visitors to the area also have increased vulnerability, as they are less familiar with the geography of the area and the typical means of warning residents regarding dangerous conditions.

The impacts of floodwaters on critical facilities, such as police and fire stations, hospitals, and water or wastewater treatment facilities can greatly increase the overall effect of a flood event on a community. In general, relatively few of these facilities are located in areas with a high risk from flooding.

As discussed above, relative sea-level rise due to land subsidence and global sea level changes that are projected to occur in association with climate change and the possibility of more intense precipitation events, which may translate into greater storm water run-off into the future, are expected to exacerbate flooding hazards.

4. Previous Occurrences

Arlington County

From 1950 through 2015, NCDC recorded 45 flood events in Arlington County. Of these events, 11 were designated as coastal flood/storm surge, 12 were coded as flash floods, 11 were attributed to heavy rain, and the remaining were categorized as flood.

Arlington County was included in DR 1655, which occurred June 23-July 6, 2006. A nearly stationary front draped across the area combined with several low pressure systems and produced several waves of heavy rainfall across Northern Virginia over this 5-day stretch. Rainfall totals over this period were in the double digits at several locations. The pinnacle of the flooding occurred on June 26th. The VRE commuter line ceased operations and flooding in underground tunnels forced much of the Washington Metro rail service to close. Numerous roadways across the region were also underwater. Water rescues were needed for motorists that became trapped in floodwaters. In Huntington, flooding-related damages lead to 158 homes being declared uninhabitable due to contamination and lack of utilities.

On August 11, 2001, showers and thunderstorms with very heavy rainfall and frequent lightning moved across Northern Virginia during the afternoon of the 11th. In Arlington County, heavy rainfall washed out a culvert and created a sinkhole. Trees were downed along streams when the waterways overflowed their banks. Flooded roads and downed power lines were reported in North Arlington where a total of 5½ inches of rain was recorded.

Fairfax County

From 1950 through 2015, NCDC received reports of 34 flood events in Fairfax County. Of these events, two were categorized as coastal flood/storm surge events, six as flash flood events, 11 were attributed to heavy rain, and the remaining 15 as flood.

Fairfax County was included in DR 1655, which occurred June 23-July 6, 2006. A nearly stationary front draped across the area combined with several low pressure systems and produced several waves of heavy rainfall across Northern Virginia over this 5-day stretch. Rainfall totals over this period were in the double digits at several locations. The pinnacle of the flooding occurred on June 26th. The VRE commuter line ceased operations and flooding in underground tunnels forced much of the Washington Metro rail service to close. Numerous roadways across the region were also underwater. Water rescues were needed for motorists that became trapped in floodwaters. In Huntington, flooding-related damages lead to 158 homes being declared uninhabitable due to contamination and lack of utilities.

On June 21-24, 1972, Hurricane Agnes entered Virginia as a tropical depression that produced widespread severe flooding. Sixteen inches of rain were recorded in Chantilly in Fairfax County resulting in major flooding of the Potomac River. Peak flows in the Potomac River basin ranged from two to six times previously known maximums. The Potomac River crested at 15.5 feet, 8.5 feet above flood stage.

Loudoun County
From 1950 through 2015, NCDC recorded 130 flood events in Loudoun County. Of the recorded events, 57 were categorized as flash flood events, 16 were attributed to heavy rain, and the remaining 57 as flood events.

On September 23, 2003, six inches of rain in four hours caused major flooding across the region, but particularly in Loudoun County. During the morning of the 23rd, heavy rain fell on top of already saturated ground from Hurricane Isabel, which struck a few days before. This led to widespread flooding of roads, waterways, and other low lying areas. Widespread flooding was reported, especially in the Leesburg, Purcellville, Bluemont, Aldie, and Middleburg areas. Across the county, over 50 roads were affected by flooding. Lime Kiln Road, Evergreen Mills Road, and Route 15 were underwater for over 24 hours after Goose Creek surged nearly 11 feet above bank full stage. The Little River flooded the Oatlands Mill area and five people had to be rescued from their homes by boat. One farmhouse along Oatlands Mills Road had water up to its second story, and in Aldie the local firehouse sustained significant flood damage. St. Louis Road was completely washed away. In Leesburg, Tuscarora Creek and Town Branch overflowed into yards, basements, and parking lots. Two vans in a parking lot along Town Branch were washed downstream and residents along Shenandoah Street had to be evacuated. The Sheriff's Office administrative building was heavily damaged after the heavy rain collecting on the roof caused the ceiling to collapse. Across the county, 60 basements were flooded.

On August 11, 2001, showers and thunderstorms with very heavy rainfall and frequent lightning moved across Northern Virginia during the afternoon of the 11th. In Loudoun County, high water stranded motorists in Sterling and the bridge at Lawson Road in Leesburg was impassible after a stream overflowed its banks.

Loudoun County was included in DR 1098, which occurred January 19-February 1, 1996. Snowmelt, combined with one to three inches of rain (some locations received nearly five inches), caused the worst regional flooding in over 10 years. Warming temperatures melted most of the snow on the ground within 12 hours. The snow pack had a liquid equivalent of between two to three inches. River flooding began along the headwaters of all basins and continued downstream through the 22nd, with crests ranging from three to 21 feet above flood stage. High water caused millions of dollars in damage, closed roads, destroyed homes and businesses, and forced the evacuation of several towns.

Prince William County

From 1950 to 2015, NCDC recorded 84 flood events in Prince William County. Of these events, two were recorded as storm surge, 59 were categorized as flash floods, and the remaining 23 as flood events.

On August 11, 2001, showers and thunderstorms with very heavy rainfall and frequent lightning moved across Northern Virginia during the afternoon of the 11th. In Prince William County, side roads were flooded by heavy downpours in Manassas. Four homes and two cars were damaged by flood waters.

City of Alexandria

From 1950 through 2015, NCDC recorded 33 flood events as impacting the City of Alexandria. Of these events, 13 were attributed to coastal flooding/storm surge, nine were categorized as flash floods, and 11 as floods.

Alexandria was included in DR 1655, which occurred June 23-July 6, 2006. A nearly stationary front draped across the area combined with several low pressure systems and produced several waves of heavy rainfall across Northern Virginia over this 5-day stretch. Rainfall totals over this period were in the double digits at several locations. The pinnacle of the flooding occurred on June 26. The VRE commuter line ceased operations and flooding in underground tunnels forced much of the Washington Metro rail service to close. Numerous roadways across the region were also underwater. Water rescues were needed for motorists that became trapped in floodwaters. In Huntington, flooding-related damages lead to 158 homes being declared uninhabitable due to contamination and lack of utilities.

On January 19-February 1, 1996, Alexandria was affected by snowmelt, combined with one to three inches of rain (some locations received nearly five inches), caused the worst regional flooding in over 10 years. Warming temperatures melted most of the snow on the ground within 12 hours. The snow pack had a liquid equivalent of between two to three inches. River flooding began along the headwaters of all basins and continued downstream through the 22nd, with crests ranging from three to 21 feet above flood stage. High water caused millions of dollars in damage, closed roads, destroyed homes and businesses, and forced the evacuation of several towns. Several kayakers were also rescued while trying to navigate the rough waters. Flood waters covered Union Street and the lower part of King Street along the river in Old Town Alexandria, and affected Washington National Airport, but not the runways.

City of Fairfax

From 1950 through 2015, NCDC recorded 34 flood events for the City of Fairfax. Five events were categorized as flash floods, three as coastal flood/storm surge, 11 were attributed to heavy rain, and the remaining 15 events were flood events.

On August 11, 2001, showers and thunderstorms with very heavy rainfall and frequent lightning moved across Northern Virginia during the afternoon of the 11th. Water covered roads in the City of Fairfax.

City of Falls Church
NCDC recorded 36 flood events as impacting the City of Falls Church from 1950 through 2015. Ten of these events were categorized as coastal flood/storm surge, 13 were attributed to heavy rain, six were noted as flash floods, and the remaining seven were described as flood events.

On August 11, 2001, showers and thunderstorms with very heavy rainfall and frequent lightning moved across Northern Virginia during the afternoon of the 11th. In Falls Church, more than three inches of rain fell in two to three hours. The Red Cross Chapter Headquarters was damaged when water flooded a portion of the building.

City of Manassas
NCDC recorded 28 flood events for the City of Manassas from 1950 through 2015. Of these, eight were recorded as flash floods, one was attributed to storm surge, nine were described as heavy rain, and the remaining 10 were described as flood events.

In July 2013, the City experienced torrential rain that resulted in significant flooding at the corner or Portner and Battle Streets. Several private residences were flooded. The City's storm water system was also damaged, resulting in cleanup costs estimated at $1.2 million, some of which was due to the age of the storm water system.

City of Manassas Park
From 1950 through 2015, NCDC recorded 18 flood events for the City of Manassas Park. Of these events, one was storm surge, two were flash floods, eight were attributed to heavy rain, and the remaining seven were described as flood events.

Town of Clifton
The Town of Clifton reported no events or damages from flooding, and none were recorded by NCDC from 1950 through 2015.

Town of Dumfries
NCDC recorded seven flood events for the Town of Dumfries from 1950 through 2015. Of these, one was recorded as storm surge, two were flood events, and the remaining four were described as flood events.

Town of Haymarket
NCDC recorded nine flood events for the Town of Haymarket from 1950 through 2015. Of these, two were flood events, and the remaining seven were described as flash flood events.

Town of Herndon
NCDC recorded nine flood events for the Town of Herndon from 1950 through 2015. Of these, three were flood events, three were heavy rain events, and the remaining three were described as flash flood events.

Town of Leesburg
NCDC recorded 38 flood events for the Town of Leesburg from 1950 through 2015. 17 events were described as flash floods, six were attributed to heavy rain, and the remaining 15 were recorded as flood events.

Town of Lovettsville
NCDC recorded one flood event impacting the Town of Lovettsville from 1950 through 2015. This event was recorded as a flash flood event in 1996.

Town of Middleburg
NCDC recorded 13 flood events for the Town of Middleburg from 1950 through 2015. Seven events were described as flash floods, two were attributed to heavy rain, and the remaining four were recorded as flood events.

Town of Occoquan
NCDC recorded one flood event impacting the Town of Occoquan from 1950 through 2015. This event was recorded as a flash flood event in 1996.

Town of Purcellville
NCDC recorded 16 flood events for the Town of Purcellville from 1950 through 2015. Nine events were described as flash floods, and the remaining seven were recorded as flood events.

Town of Quantico
NCDC recorded six flood events for the Town of Quantico from 1950 through 2015. Of these, two were flood events, one was attributed to storm surge, and the other three were described as flash flood events.

Town of Round Hill
NCDC recorded four flood events for the Town of Round Hill from 1950 through 2015 – two flash floods and two flood events.

Town of Vienna
NCDC recorded seven flood events for the Town of Vienna from 1950 through 2015. Two events were described as flash floods, three were attributed to heavy rain, and the remaining two were recorded as flood events.

National Flood Insurance Program (NFIP)
The Flood Insurance and Mitigation Administration, a component of FEMA, manages the NFIP. The three components of the NFIP are:

1. Flood Insurance;
2. Floodplain Management; and
3. Flood Hazard Mapping.

Nearly 20,000 communities across the United States and its territories participate in the NFIP by adopting and enforcing floodplain management ordinances to reduce future flood damage. In exchange, the NFIP makes federally backed flood insurance available to homeowners, renters, and business owners in these communities. Community participation in the NFIP is voluntary.

Flood insurance is designed to provide an alternative to disaster assistance to reduce the escalating costs of repairing damage to buildings and their contents caused by floods. Flood damage is reduced by nearly $1 billion a year through communities implementing sound floodplain management requirements and property owners purchasing flood insurance. Additionally, buildings constructed in compliance with NFIP building standards suffer approximately 80% less damage annually than those not built in compliance.

In addition to providing flood insurance and reducing flood damages through floodplain management regulations, the NFIP identifies and maps the Nation's floodplains. Mapping flood hazards creates broad-based awareness of flood hazards, and provides the data needed for floodplain management programs and to actuarially rate new construction for flood insurance.

Table 4.22 shows the dates each of the jurisdictions were identified with Flood Hazard Boundary Maps (FHBMs), when the first FIRM became effective, the date of the current FIRMs used for insurance purposes, and the date the community entered into the NFIP.

Table 4.22. Communities Participating in the NFIP.

Community Name	Init FHBM Identified	Init FIRM Identified	Current Effective Map Date	Reg-Emer Date
Arlington County	--	10/1/1969	8/19/13	12/31/1976
Fairfax County	5/5/1970	3/5/1990	9/17/2010	1/7/1972
Town of Herndon	6/14/1974	8/1/1979	9/17/2010	8/1/1979
Town of Vienna	8/2/1974	2/3/1982	9/17/2010	2/3/1982
Town of Clifton	3/28/1975	5/2/1977	9/17/2010	5/2/1977
Loudoun County[1]	4/25/1975	1/5/1978	7/5/2001	1/5/1978
Town of Leesburg	8/30/1974	9/30/1982	7/5/2001	9/30/1982
Town of Purcellville	7/11/1975	11/15/1989	7/5/2001	11/15/1989
Town of Middleburg	--	7/5/2001	7/5/2001	7/31/2001
Town of Round Hill	5/13/1977	7/5/2001	7/5/2001	1/10/2006
Prince William County	1/10/1975	12/1/1981	8/3/2015	12/1/1981
Town of Dumfries	6/18/1976	5/15/1980	8/3/2015	5/15/1980
Town of Haymarket	8/9/1974	1/17/1990	1/5/1995	1/31/1990
Town of Occoquan	7/19/1974	9/1/1978	1/5/1995	9/1/1978
Town of Quantico	11/1/1974	8/15/1978	8/3/2015	8/15/1978
City of Alexandria	8/22/1969	8/22/1969	6/16/2011	5/8/1970

[1] Loudoun County is currently participating in RiskMAP; map effective dates are expected to change during the lifecycle of the 2016 plan update.

Table 4.22. Communities Participating in the NFIP.				
Community Name	**Init FHBM Identified**	**Init FIRM Identified**	**Current Effective Map Date**	**Reg-Emer Date**
City of Fairfax	5/5/1970	12/23/1971	6/2/2006	12/17/1971
City of Falls Church	9/6/1974	2/3/1982	7/16/2004	2/3/1982
City of Manassas	5/31/1974	1/3/1979	1/5/1995	1/3/1979
City of Manassas Park	3/11/1977	9/29/1978	1/5/1995	9/29/1978

as of 3/29/16 http://www.fema.gov/cis/VA.html

As of October 31, 2015, there was a total of 9,626 flood insurance policies in-force in the Northern Virginia region. These policies amounted to more than $6.6 million in flood insurance premiums paid in the region. Approximately 2,058 claims have been filed, accounting for more than $23 million in payments. Table 4.23 shows the NFIP policy statistics for each of the participating jurisdictions of the Northern Virginia region.

Table 4.23. NFIP policy and claim statistics.					
		Policy Statistics (as of 10/31/2015)		**Claim Statistics 1/1/1978 – 10/31/2015**	
County	**Community Name**	**Policies In-Force**	**Premiums Paid**	**Total Claims**	**Total Payment**
Arlington County	Arlington County	650	$346,450	129	$372,316
	Total	*650*	*$346,450*	*129*	*$372,316*
Fairfax County	Fairfax County	4,849	$3,060,806	1,028	$10,554,103
	Town of Herndon	80	$55,705	12	$19,356
	Town of Vienna	120	$82,120	19	$222,630
	Town of Clifton	8	$8,176	3	$48,969
	Total	*5,057*	*$3,206,807*	*1,062*	*$10,835,058*
Loudoun County	Loudoun County	741	$402,773	129	$1,659,242
	Town of Leesburg	124	$90,571	8	$140,160
	Town of Lovettsville	6	$2,497	-	-
	Town of Purcellville	9	$3,283	-	-
	Town of Middleburg	19	$4,691	-	-

Table 4.23. NFIP policy and claim statistics.					
County	**Community Name**	**Policy Statistics (as of 10/31/2015)**		**Claim Statistics 1/1/1978 – 10/31/2015**	
		Policies In-Force	**Premiums Paid**	**Total Claims**	**Total Payment**
	Town of Round Hill	2	$872	-	-
	Total	*901*	*$504,687*	*137*	*$1799,402*
Prince William County	Prince William County	1,351	$856,788	150	$4,630,540
	Town of Dumfries	16	$20,703	9	$34,842
	Town of Haymarket	4	$1,803	1	$0
	Town of Occoquan	34	$57,025	19	$65,187
	Town of Quantico	4	$2,364	-	-
	Total	*1,409*	*$1,877,366*	*179*	*$4,730,569*
City of Alexandria	City of Alexandria	1,155	$1,112,202	266	$3,762,441
	Total	1,155	$1,112,202	266	$3,762,441
City of Fairfax	City of Fairfax	172	$301,415	50	$885,955
	Total	172	$301,415	50	$885,955
City of Falls Church	City of Falls Church	172	$181,571	45	$399.413
	Total	172	$181,571	45	$399413
City of Manassas	City of Manassas	90	$64,445	30	$215,536
	Total	90	$64,445	30	$215,536
City of Manassas Park	City of Manassas Park	20	$17,927	7	$94,804
	Total	20	$17,927	7	$94,804
NOVA Total:		9,626	$6,674,187	2,057	$23,105,494

Floodplain management regulations are the cornerstone of NFIP participation. Communities that participate in the NFIP are expected to adopt and enforce floodplain management regulations. These regulations apply to all types of floodplain development and ensure that development activities will not cause an increase in future flood damages. Buildings are required to be elevated at or above the BFE.

Repetitive Loss Properties

A Repetitive Loss Property is a property that is insured under the NFIP and has filed two or more claims in excess of $1,000 each, within a 10-year period. Nationwide, Repetitive Loss properties constitute 2% of all NFIP insured properties, but are responsible for 40% of all NFIP claims. Mitigation for Repetitive Loss properties is a high priority for FEMA, and the areas in which these properties are located typically represent the most flood prone areas of a community.

The identification of Repetitive Loss properties is an important element to conducting a local flood risk assessment, as the inherent characteristics of properties with multiple flood losses strongly suggest that they will be threatened by continual losses. Repetitive Loss properties are also important to the NFIP, since structures that flood frequently put a strain on the National Flood Insurance Fund. Under the NFIP, FEMA defines a Repetitive Loss property as "any NFIP-insured property that, since 1978 and regardless of any change(s) of ownership during that period, has experienced: a) four or more paid flood losses; or b) two paid flood losses within a 10-year period that equal or exceed the current value of the insured property; or c) three or more paid losses that equal or exceed the current value of the insured property."

A second category of Repetitive Loss properties has been identified, for those properties that have sustained the highest levels of damages and claims; these are known as Severe Repetitive Loss properties. Severe Repetitive Loss properties are defined as any building that is covered under a Standard Flood Insurance Policy (SFIP) and has sustained flood damage for which: (a) four or more separate claim payments have been made under a SFIP, with the amount of each claim exceeds $5,000, and with the cumulative amount of such claims exceeding $20,000; or (b) at least two separate claims payments have been main under a SFIP, with the cumulative amount of those payments exceeding the fair market value of the insured structure as of the day before the loss.

A primary goal of FEMA is to reduce the number of structures that meet these criteria, whether through elevation, acquisition, relocation, or a flood-control project that lessens the potential for continual losses.

According to FEMA, there are currently 135 Repetitive Loss properties and three Severe Repetitive Loss properties within the Northern Virginia region. The specific addresses of the properties are maintained by FEMA, VDEM, and local jurisdictions, but are deliberately not included in this Plan as required by law.[6] All of these properties are unmitigated; 35 of them are also uninsured. The insured properties have been paid more than $9.3 million from 332 payable claims. Table 4.24 shows the total number of properties, total number of losses experienced, and losses paid for all of the communities within the planning region that have Repetitive Loss or Severe Repetitive Loss properties, according to data obtained from the NFIP through the State Floodplain Coordinator.

Table 4.24 Repetitive Loss and Severe Repetitive Loss Properties, as of October 2015.

Jurisdiction	Number of Repetitive Loss Properties			Total Number of Losses	Total Building Payment	Total Contents Payment	Total Payment
	Residential	Non-Residential	Total				
Arlington County	2	0	2	4	$102,468	$16,827	$119,295
Fairfax County	76	1	77	160	$3,015,231	$200,340	$3,215,571
Town of Herndon	1	0	1	2	$5,928	$0	$5,928
Town of Clifton	1	0	1	2	$18,983	$24,750	$42,733
Loudoun County	13	1	14	46	$1,097,410	$336,513	$1,433,922
Prince William County	17	1	18	61	$1,478,608	$285,097	$1,763,705
City of Alexandria	6	6	12	30	$1,312,222	$559,065	$1,871,287
City of Fairfax	5	0	5	12	$519,284	$71,864	$591,148
City of Falls Church	1	0	1	3	$166,432	$13,836	$180,268
City of Manassas	3	1	4	10	$46,664	$23,845	$70,509
City of Manassas Park	1	0	1	2	$78,647	$9,654	$88,301
TOTAL	125	10	138	332	$7,841,875	$1,541,792	$9,383,667

B. Risk Assessment

1. Probability of Future Occurrences

Periodic flooding of lands adjacent to rivers, streams, and shorelines (land known as floodplain) is a natural occurrence that can be expected to take place based upon established recurrence intervals. The recurrence interval of a flood is defined as the average time interval, in years, expected between a flood event of a particular magnitude and an equal or larger flood. Flood magnitude increases with increasing recurrence interval.

A 100-year flood is not a flood that occurs every 100 years. In fact, the 100-year flood has a 26 percent chance of occurring during a 30-year period, the typical length of many mortgages. The 100-year flood is a regulatory standard used by Federal agencies, States, and NFIP-participating communities to administer and enforce floodplain management programs. The 100-year flood is also used by the NFIP as the basis for insurance requirements nationwide[7]. The main recurrence intervals used on the FIRMs are shown in the table below (Table 4.25).

Table 4.25. Annual probability based on flood recurrence intervals.

Flood Recurrence Interval	Annual Chance of Occurrence
10 –year	10.0%
50–year	2.0%
100–year	1.0%
500–year	0.2%

Flooding remains a highly likely occurrence throughout the identified flood hazard areas of the Northern Virginia region. Smaller floods caused by heavy rains and inadequate drainage capacity in urbanized areas will be more frequent, but not as costly as the large-scale floods which may occur at much less frequent intervals.

2. Impact & Vulnerability

A number of factors contribute to the relative vulnerabilities of certain areas in the floodplain. Development, or the presence of people and property in the hazardous areas, is a critical factor in determining vulnerability to flooding. Additional factors that contribute to flood vulnerability range from specific characteristics of the floodplain to characteristics of the structures located within the floodplain.

The following is a brief discussion of some of these factors and how they may relate to the Northern Virginia planning region.

- Flood depth: The greater the depth of flooding, the higher the potential for significant damages.
- Flood duration: The longer duration of time that floodwaters are in contact with building components, such as structural members, interior finishes, and mechanical equipment, the greater the potential for damage.
- Velocity: Flowing water exerts forces on the structural members of a building, increasing the likelihood of significant damage.

- Elevation: The lowest possible point where floodwaters may enter a structure is the most significant factor contributing to its vulnerability to damage due to flooding.
- Construction Type: Certain types of construction are more resistant to the effects of floodwaters than others. Typically, masonry buildings, constructed of brick or concrete blocks, are the most resistant to damages simply because masonry materials can be in contact with limited depths of flooding without sustaining significant damage. Wood frame structures are more susceptible to damage because the construction materials used are easily damaged when inundated with water.

3. Risk

Riverine HAZUS^{MH} analysis was completed for the 2016 revision using 100-year scenarios. The following section summarizes the module and highlights the results and differences of the HAZUS^{MH} runs. The detailed reports of the HAZUS^{MH} run results can be found in Appendix D.

HAZUS^{MH} is a regional multi-hazard loss estimation model that was developed by FEMA and the National Institute of Building Sciences. The primary purpose of HAZUS^{MH} is to provide methodology and software application to develop multi-hazard losses at a regional scale. The loss estimates are used primarily by local, State, and regional officials to plan and stimulate efforts to reduce risk from multi-hazards and prepare for emergency response and recovery[8].

Potential loss estimates analyzed in HAZUS^{MH} include:

- Physical damage to residential and commercial buildings, schools, essential facilities, and infrastructure; and
- Economic loss including lost jobs, business interruptions, repair and reconstruction costs.

The HAZUS^{MH} Flood Model analyzes both riverine and coastal flood hazards. Flood hazard is defined by a relationship between depth of flooding and the annual chance of inundation to that depth. Hazard analysis of the 100-year return interval was performed in order to assess risk to essential facilities.

Depth, duration, and velocity of water in the floodplain are the primary factors contributing to flood losses. Other hazards associated with flooding that contribute to flood losses include channel erosion and migration, sediment deposition, bridge scour and the impact of flood-born debris. The HAZUS^{MH} Flood Model allows users to estimate flood losses due to flood velocity to the general building stock. The agricultural component will allow the user to estimate a range of losses to account for flood duration. The flood model does not estimate losses due to high velocity flash floods at this time. Building stock exposure is discussed in detail in the HAZUS^{MH} building stock portion of the HIRA.

The flood analysis for the HIRA was completed using the FEMA HAZUS^{MH} software for riverine flood hazards. This assessment has been completed for streams and reaches within the identified study region with a drainage area of ten square miles. The flood depth grid was developed for the 100-year return period.

Loss estimation for this HAZUS^{MH} module is based on specific input data. The first type of data includes square footage of buildings for specified types or population. The second type of data includes information on the local economy that is used in estimating losses. Table 4.26 displays the economic loss categories used to calculate annualized losses by HAZUS^{MH}. Data for this analysis has been provided at the census block level.

Table 4.26. HAZUS^{MH} direct economic loss categories and descriptions.		
Category Name	**Description of Data Input into Model**	**HAZUS Output**
Building	Cost per sq. ft. to repair damage by structural type and occupancy for each level of damage	Cost of building repair or replacement of damaged and destroyed buildings
Contents	Replacement value by occupancy	Cost of damage to building contents
Inventory	Annual gross sales in $ per sq. ft.	Loss of building inventory as contents related to business activities
Relocation	Rental costs per month per sq. ft. by occupancy	Relocation expenses (for businesses and institutions)
Income	Income in $ per sq. ft. per month by occupancy	Capital-related incomes losses as a measure of the loss of productivity, services, or sales
Rental	Rental costs per month per sq. ft. by occupancy	Loss of rental income to building owners
Wage	Wages in $ per sq. ft. per month by occupancy	Employee wage loss as described in income loss

Annualized loss is one way to determine the maximum potential annual loss. This is useful for creating a common denominator by which different types of hazards can be compared. Annualized losses are the summation of losses over all return periods multiplied by the probability of occurrence.

The HAZUS^{MH} flood analysis predicts that the Northern Virginia region can expect, annually, $1,061,851,000 in damages due to flood events. Property or “capital stock” losses make up about $1,059,291,000 of the damages 99.7%. This includes the values for building, content, and inventory. Business interruption accounts for 0.3% of the annualized losses and includes income, rental, wage, and relocation costs.

Table 4.27 illustrates the expected annualized losses. The majority of the expected damages for all jurisdictions can be attributed to building and content value. The flood model incorporates NFIP entry dates to distinguish pre-FIRM and post-FIRM census blocks.

The stream threshold used to delineate stream reaches included a 10 mi^2 threshold. The stream threshold influenced a lack of stream delineation within two communities: the City of Fairfax and City of Falls Church. This does not mean streams or floodplains do not exist in these communities, however it does mean that the automated, GIS-based method used to define a sub-watershed and the number of grid cells flowing through the community was less than the 10 mi^2 threshold. In order to try and compensate for the lack of data for these two communities, coupled with the need to quantify other flood-related loss estimates, additional flood model work was performed using the 100-year scenario.

For the flood scenario models, the built-in default inventory of assets - known as the Comprehensive Data Management System (CDMS) - was utilized. No adjustments were made to the inventory to account for any locally-reporting critical assets. Therefore, discrepancies may appear related to critical assets between self-reported data, such as historic occurrences, and HAZUS-generated data, such as the data in this section. See Appendix D for a description of the methodology used for the flood scenarios described in this section, and the grouping of counties, cities, and towns in each model.

Table 4.27. HAZUS[MH] Flood Module Annualized Building Loss (2015 dollars)								
Jurisdiction	**Building Loss**	**Content Loss**	**Inventory Loss**	**Relocation Loss**	**Income Loss**	**Rental Loss**	**Wage Loss**	**Total Loss**
Arlington County & the City of Falls Church	$60,000	$70,000	$34,000	$0	$0	$0	$0	$131,000
Fairfax County, the City of Fairfax, & the Towns of Clifton, Herndon, & Vienna	$163,482,000	$116,257,000	$1,802,000	$179,000	$115,000	$30,000	$239,000	$282,104,000
Loudoun County & the Towns of Leesburg, Lovettsville, Purcellville, Middleburg, & Round Hill	$216,864,000	$150,661,000	$1,089,000	$284,000	$181,000	$92,000	$448,000	$369,619,000
Prince William County, the City of Manassas Park, & the Towns of Dumfries, Haymarket, Occoquan, & Quantico	$216,772,000	$160,654,000	$2,953,000	$227,000	$256,000	$60,000	$343,000	$380,893,000
City of Alexandria	$12,895,000	$9,852,000	$33,000	$18,000	$12,000	$6,000	$9,000	$22,825,000
City of Manassas	$2,362,000	$3,846,000	$10,000	$7,000	$37,000	$5,000	$12,000	$6,279,000
Total	$612,435,000	$441,340,000	$5,921,000	$715,000	$601,000	$193,000	$1,051,000	$1,061,851,000

Essential Facilities Risk

The vulnerability of the region's building stock was assessed using GIS analysis by comparing the physical location with the extent of known hazard areas that can be spatially defined through GIS technology. Tables 4.28 and 4.29 summarize the number of potentially at-risk essential facilities in the region to flood by jurisdiction and facility type. These determinations are based solely on best available data for critical facility locations and delineable hazard areas for. The actual level of risk for each facility may only be determined by further on-site assessments.

Table 4.28. Number of HAZUS^{MH} Critical Facilities Potentially At-Risk to Flood.

Jurisdiction	Fire Stations	Hospitals	Police Stations	Schools	EOCs
Arlington County	0	0	0	0	0
Fairfax County	0	0	0	0	0
Town of Herndon	0	0	0	0	0
Town of Vienna	0	0	0	0	0
Town of Clifton	0	0	0	0	0
Loudoun County	0	0	0	0	0
Town of Leesburg	0	0	0	0	0
Town of Lovettsville	0	0	0	0	0
Town of Purcellville	0	0	0	0	0
Town of Middleburg	0	0	0	0	0
Town of Round Hill	0	0	0	0	0
Prince William County	0	0	1	0	0
Town of Dumfries	0	0	0	0	0
Town of Haymarket	0	0	0	0	0
Town of Occoquan	0	0	0	0	0
Town of Quantico	0	0	0	0	0
City of Alexandria	0	0	0	0	0
City of Fairfax	0	0	0	0	0
City of Falls Church	0	0	0	0	0
City of Manassas	0	0	0	0	0
City of Manassas Park	0	0	0	0	0

Table 4.29. HAZUS^{MH} Estimate: Shelter Requirements.		
Jurisdiction	**# of Displaced People**	**# of People Needing Short-Term Sheltering**
Arlington County	0	0
Fairfax County	3,065	2,016
Town of Herndon	0	0
Town of Vienna	0	0
Town of Clifton	0	0
Loudoun County	3,641	2,961
Town of Leesburg	0	0
Town of Lovettsville	0	0
Town of Purcellville	0	0
Town of Middleburg	0	0
Town of Round Hill	0	0
Prince William County	4,601	3,329
Town of Dumfries	0	0
Town of Haymarket	0	0
Town of Occoquan	0	0
Town of Quantico	0	0
City of Alexandria	685	627
City of Fairfax	0	0
City of Falls Church	0	0
City of Manassas	0	2
City of Manassas Park	0	0

Information for the HAZUS^{MH} identified critical facilities in the flood zones is available in Appendix D, as is information regarding the potential flood risk for locally-identified critical assets for each jurisdiction.

The most vulnerable properties to flooding in the Northern Virginia region are located in SFHAs identified by FEMA through the completion of detailed Flood Insurance Studies. The DFIRMs depicting the SFHAs in Appendix D illustrate the location of these areas for each jurisdiction based upon the most up-to-date digital floodplain data as provided by the FEMA Map Service

Center. Digital data was available for all of the localities within the Northern Virginia planning region.

4. Overall Loss Estimates and Ranking

The loss estimates and ranking results for the flood hazard in the Northern Virginia region is principally based on the results of the detailed GIS and HAZUS^{MH} analysis, NCDC storm events, and the Commonwealth of Virginia's 2013 HIRA.

There have been a number of past flooding events throughout the region, ranging widely in terms of location, magnitude, and impact. The most frequent flooding events are quite localized in nature, resulting from heavy rains in a short period of time over urbanized areas that are not able to appropriately handle storm water runoff. These events typically do not threaten lives or property and will not result in emergency or disaster declarations, thus historical data is difficult to obtain. Table 4.21 (earlier in this section) summarizes the number of flood events since 1950 which have caused a notable impact on the Northern Virginia region as recorded by the NCDC. This includes 553 flood events that have caused approximately $16.6 million in property and crop damages.

The Commonwealth of Virginia's 2013 hazard mitigation plan ranking was based on the NCDC database. This update to the Northern Virginia plan used this same framework to establish a common system for evaluating and ranking hazards. The geographic extent score for each jurisdiction is based on the percent of the jurisdiction that falls within the SFHA, as defined by FEMA.

For the 2016 plan update, the qualitative assessment was organized by participating jurisdiction. Jurisdictions with a determined probability of 'Highly Likely' were determined to have 'High' vulnerability to the flood hazard. Those with 'Likely' probabilities were determined to have 'Moderate' vulnerability. Those with 'Unlikely' probability were determined to have 'Low' vulnerability.

Arlington County

Table 4.30. 2016 Qualitative Assessment for Flood.

	Probability	Impact	Spatial Extent	Warning Time	Duration
Risk Level	Highly Likely	Critical	Moderate	6 to 12 hours	Less than one week

Table 4.31. 2016 Qualitative Assessment for Erosion.

	Probability	Impact	Spatial Extent	Warning Time	Duration
Risk Level	Likely	Minor	Negligible	More than 24 hours	More than one week

Fairfax County

Table 4.32. 2016 Qualitative Assessment for Flood.

	Probability	Impact	Spatial Extent	Warning Time	Duration
Risk Level	Highly Likely	Critical	Moderate	6 to 12 hours	Less than one week

Table 4.33. 2016 Qualitative Assessment for Erosion.

	Probability	Impact	Spatial Extent	Warning Time	Duration
Risk Level	Likely	Minor	Negligible	More than 24 hours	More than one week

Town of Clifton

Table 4.34. 2016 Qualitative Assessment for Flood.

	Probability	Impact	Spatial Extent	Warning Time	Duration
Risk Level	Unlikely	Minor	Negligible	6 to 12 hours	Less than one week

Table 4.35. 2016 Qualitative Assessment for Erosion.

	Probability	Impact	Spatial Extent	Warning Time	Duration
Risk Level	Likely	Minor	Negligible	More than 24 hours	More than one week

Town of Herndon

Table 4.36. 2016 Qualitative Assessment for Flood.

	Probability	Impact	Spatial Extent	Warning Time	Duration
Risk Level	Likely	Critical	Moderate	6 to 12 hours	Less than one week

Table 4.37. 2016 Qualitative Assessment for Erosion.

	Probability	Impact	Spatial Extent	Warning Time	Duration
Risk Level	Likely	Minor	Negligible	More than 24 hours	More than one week

Town of Vienna

Table 4.38. 2016 Qualitative Assessment for Flood.					
	Probability	Impact	Spatial Extent	Warning Time	Duration
Risk Level	Likely	Critical	Moderate	6 to 12 hours	Less than one week

Table 4.39. 2016 Qualitative Assessment for Erosion.					
	Probability	Impact	Spatial Extent	Warning Time	Duration
Risk Level	Likely	Minor	Negligible	More than 24 hours	More than one week

Loudoun County

Table 4.40. 2016 Qualitative Assessment for Flood.					
	Probability	Impact	Spatial Extent	Warning Time	Duration
Risk Level	Highly Likely	Critical	Moderate	6 to 12 hours	Less than one week

Table 4.41. 2016 Qualitative Assessment for Erosion.					
	Probability	Impact	Spatial Extent	Warning Time	Duration
Risk Level	Likely	Minor	Negligible	More than 24 hours	More than one week

Town of Leesburg

Table 4.42. 2016 Qualitative Assessment for Flood.					
	Probability	Impact	Spatial Extent	Warning Time	Duration
Risk Level	Highly Likely	Critical	Moderate	6 to 12 hours	Less than one week

Table 4.43. 2016 Qualitative Assessment for Erosion.					
	Probability	Impact	Spatial Extent	Warning Time	Duration
Risk Level	Likely	Minor	Negligible	More than 24 hours	More than one week

Town of Lovettsville

Table 4.44. 2016 Qualitative Assessment for Flood.

	Probability	Impact	Spatial Extent	Warning Time	Duration
Risk Level	Unlikely	Moderate	Moderate	6 to 12 hours	Less than one week

Table 4.45. 2016 Qualitative Assessment for Erosion.

	Probability	Impact	Spatial Extent	Warning Time	Duration
Risk Level	Unlikely	Minor	Negligible	More than 24 hours	More than one week

Town of Middleburg

Table 4.46. 2016 Qualitative Assessment for Flood.

	Probability	Impact	Spatial Extent	Warning Time	Duration
Risk Level	Highly Likely	Critical	Moderate	6 to 12 hours	Less than one week

Table 4.47. 2016 Qualitative Assessment for Erosion.

	Probability	Impact	Spatial Extent	Warning Time	Duration
Risk Level	Likely	Minor	Negligible	More than 24 hours	More than one week

Town of Purcellville

Table 4.48. 2016 Qualitative Assessment for Flood.

	Probability	Impact	Spatial Extent	Warning Time	Duration
Risk Level	Highly Likely	Critical	Moderate	6 to 12 hours	Less than one week

Table 4.49. 2016 Qualitative Assessment for Erosion.

	Probability	Impact	Spatial Extent	Warning Time	Duration
Risk Level	Likely	Minor	Negligible	More than 24 hours	More than one week

Town of Round Hill

Table 4.50. 2016 Qualitative Assessment for Flood.

	Probability	Impact	Spatial Extent	Warning Time	Duration
Risk Level	Likely	Moderate	Moderate	6 to 12 hours	Less than one week

Table 4.51. 2016 Qualitative Assessment for Erosion.

	Probability	Impact	Spatial Extent	Warning Time	Duration
Risk Level	Unlikely	Minor	Negligible	More than 24 hours	More than one week

Prince William County

Table 4.52. 2016 Qualitative Assessment for Flood.

	Probability	Impact	Spatial Extent	Warning Time	Duration
Risk Level	Highly Likely	Critical	Moderate	6 to 12 hours	Less than one week

Table 4.53. 2016 Qualitative Assessment for Erosion.

	Probability	Impact	Spatial Extent	Warning Time	Duration
Risk Level	Likely	Minor	Negligible	More than 24 hours	More than one week

Town of Dumfries

Table 4.54. 2016 Qualitative Assessment for Flood.

	Probability	Impact	Spatial Extent	Warning Time	Duration
Risk Level	Likely	Critical	Moderate	6 to 12 hours	Less than one week

Table 4.55. 2016 Qualitative Assessment for Erosion.

	Probability	Impact	Spatial Extent	Warning Time	Duration
Risk Level	Likely	Minor	Negligible	More than 24 hours	More than one week

Town of Haymarket

Table 4.56. 2016 Qualitative Assessment for Flood.

	Probability	Impact	Spatial Extent	Warning Time	Duration
Risk Level	Likely	Critical	Moderate	6 to 12 hours	Less than one week

Table 4.57. 2016 Qualitative Assessment for Erosion.

	Probability	Impact	Spatial Extent	Warning Time	Duration
Risk Level	Likely	Minor	Negligible	More than 24 hours	More than one week

Town of Occoquan

Table 4.58. 2016 Qualitative Assessment for Flood.

	Probability	Impact	Spatial Extent	Warning Time	Duration
Risk Level	Unlikely	Minor	Moderate	6 to 12 hours	Less than one week

Table 4.59. 2016 Qualitative Assessment for Erosion.

	Probability	Impact	Spatial Extent	Warning Time	Duration
Risk Level	Unlikely	Minor	Negligible	More than 24 hours	More than one week

Town of Quantico

Table 4.60. 2016 Qualitative Assessment for Flood.

	Probability	Impact	Spatial Extent	Warning Time	Duration
Risk Level	Likely	Critical	Moderate	6 to 12 hours	Less than one week

Table 4.61. 2016 Qualitative Assessment for Erosion.

	Probability	Impact	Spatial Extent	Warning Time	Duration
Risk Level	Likely	Minor	Negligible	More than 24 hours	More than one week

City of Alexandria

Table 4.62. 2016 Qualitative Assessment for Flood.					
	Probability	**Impact**	**Spatial Extent**	**Warning Time**	**Duration**
Risk Level	Highly Likely	Critical	Moderate	6 to 12 hours	Less than one week

Table 4.63. 2016 Qualitative Assessment for Erosion.					
	Probability	**Impact**	**Spatial Extent**	**Warning Time**	**Duration**
Risk Level	Likely	Minor	Negligible	More than 24 hours	More than one week

City of Fairfax

Table 4.64. 2016 Qualitative Assessment for Flood.					
	Probability	**Impact**	**Spatial Extent**	**Warning Time**	**Duration**
Risk Level	Highly Likely	Critical	Moderate	6 to 12 hours	Less than one week

Table 4.65. 2016 Qualitative Assessment for Erosion.					
	Probability	**Impact**	**Spatial Extent**	**Warning Time**	**Duration**
Risk Level	Likely	Minor	Negligible	More than 24 hours	More than one week

City of Falls Church

Table 4.66. 2016 Qualitative Assessment for Flood.					
	Probability	**Impact**	**Spatial Extent**	**Warning Time**	**Duration**
Risk Level	Highly Likely	Critical	Moderate	6 to 12 hours	Less than one week

Table 4.67. 2016 Qualitative Assessment for Erosion.					
	Probability	**Impact**	**Spatial Extent**	**Warning Time**	**Duration**
Risk Level	Likely	Minor	Negligible	More than 24 hours	More than one week

City of Manassas

Table 4.68. 2016 Qualitative Assessment for Flood.					
	Probability	Impact	Spatial Extent	Warning Time	Duration
Risk Level	Highly Likely	Critical	Moderate	6 to 12 hours	Less than one week

Table 4.69. 2016 Qualitative Assessment for Erosion.					
	Probability	Impact	Spatial Extent	Warning Time	Duration
Risk Level	Likely	Minor	Negligible	More than 24 hours	More than one week

City of Manassas Park

Table 4.70. 2016 Qualitative Assessment for Flood.					
	Probability	Impact	Spatial Extent	Warning Time	Duration
Risk Level	Likely	Critical	Moderate	6 to 12 hours	Less than one week

Table 4.71. 2016 Qualitative Assessment for Erosion.					
	Probability	Impact	Spatial Extent	Warning Time	Duration
Risk Level	Likely	Minor	Negligible	More than 24 hours	More than one week

VII. Winter Storm

NOTE: As part of the 2016 plan update, the Winter Storm hazard was reexamined and new analyses performed. This new analyses included, but was not limited to: 1) refreshing the hazard profile; 2) updating the previous occurrences; 3) determining the number of hazard events and losses by jurisdiction using NCDC and other data sources (where available); 4) updating the assessment of risk by jurisdiction based on new data; and 5) ranking of the hazard by jurisdiction using the methodology described in detail in Chapter 4 Section IV Ranking and Analysis Methodologies. Extreme Cold was separated from the winter storm section for the 2016 plan update, and included in the Extreme Temperatures section. Each section of the plan was also reformatted for improved clarity, and new maps and imagery, when available and appropriate, were inserted.

A. Hazard Profile

1. Description

A winter storm can range from a moderate snow over a period of a few hours to blizzard conditions with blinding wind-driven snow that lasts for several days. Some winter storms impact multi-State regions. Winter storms may be accompanied by low temperatures, ice, and heavy and/or blowing snow, which can severely impair visibility.

Winter storms may include snow, sleet, freezing rain, or a mix of these wintry forms of precipitation. Sleet – raindrops that freeze into ice pellets before reaching the ground – usually bounce when hitting a surface and do not stick to objects; however, sleet can accumulate like snow and cause a hazard to motorists. Freezing rain is rain that falls onto a surface with a temperature below freezing, forming a glaze of ice. Even small accumulations of ice can cause a significant hazard, especially on power lines and trees. An ice storm occurs when freezing rain falls and freezes immediately upon impact. Communications and power can be disrupted for days, and even small accumulations of ice may cause extreme hazards to motorists and pedestrians.

A freeze is weather marked by low temperatures, especially when below the freezing point (zero degrees Celsius or 32 degrees Fahrenheit). House fires and carbon monoxide poisoning are possible as people use supplemental heating devices (wood, kerosene, etc.) and fuel burning lanterns or candles for emergency lighting.

2. Geographic Location / Extent

The Northern Virginia region is located in a part of the country that experiences hazardous winter weather conditions, including severe winter storms that bring heavy accumulations of snow, sleet, and freezing rain. On average, the region receives approximately 15 to 21 inches of snow annually. The region's biggest winter storms are typically associated with Nor'easters. During these events, winds around the storm's center can become intense, building waves that erode the Potomac shoreline and sometimes pile water inland causing extensive coastal flooding and severe erosion. These systems may also produce blinding snowfall that can accumulate to a foot or more or mixed precipitation that may leave a coating of ice. Other types of winter weather systems are more of a nuisance and generally do not cause major damage. Weather systems such as the "Alberta Clipper" (a fast moving storm from the Alberta, Canada region), or a cold front sweeping through from the west, generally do not bring more than a few inches of snow in a narrow 50 to 60-mile-wide band. Figures 4.24 and 4.25 (later in this chapter) show the average number of days in Virginia with at least 3 and 6 inches of snowfall, as calculated by VDEM.

3. Magnitude or Severity

The Northeast Snowfall Impact Scale (NESIS) developed by Paul Kocin and Louis Uccellini attempts to rank Northeast snowstorms based on the impacts these systems have on society. The scale is broken into five categories ranging from Category 1 which is considered a "Notable" event, to a Category 5 which is considered "Extreme." The amount of snowfall for a particular storm and the population impacted are the factors used in assigning NESIS values. This scale is mentioned here as background information for the reader and is infrequently referenced by the media or the NWS in describing significant snowfall events.

4. Previous Occurrences

Since 1996, there have been 461 winter storm event reports recorded by the NCDC for the Northern Virginia region, causing more than $1 million in crop and property damage. (Most storm damages are attributable to traffic accidents and roof or other structural collapses. It is important to note that the considerable costs associated with lost wages and business opportunities, lowered productivity, and snow and ice removal are not factored into NCDC loss estimates, and are therefore not accounted for here.) Table 4.72 illustrates the distribution of these events. Note that the NCDC records winter storm events at a geographic county level, and because of this, all towns and cities within the same geographic area are included in the storm and damage estimates for that area. This is because of the typically widespread spatial nature of winter storm events. Therefore, the table below illustrates the data in the same manner, by geographic area, with specific jurisdictions included noted.

Table 4.72. Winter Storm Events in the Northern Virginia Region, 1996–2015, based on NCDC data.

Jurisdiction	# of Winter Storm Events	Property Damage	Crop Damage	Total
Arlington County, the City of Alexandria, & the City of Falls Church	97	$460,000	$0	$460,000
Fairfax County, the City of Fairfax, & the Towns of Clifton, Herndon, and Vienna	123	$335,000	$0	$335,000
Loudoun County & the Towns of Leesburg, Lovettsville, Middleburg, Purcellville, and Round Hill	131	$135,000	$100,000	$235,000
Prince William County, the City of Manassas, the City of Manassas Park, & the Towns of Dumfries, Haymarket, Occoquan, and Quantico	110	$55,000	$0	$55,000
Total	**461**	**$985,000**	**$100,000**	**$1,085,000**

Planning Area Occurrences

The winter of 2014 was particularly harsh in the planning area. In January, four separate storms moved through the area, each dumping ice or snow in the area. The January 21st event was particularly harsh, with the majority of the planning area receiving in excess of five inches of snow. The City of Manassas reported receiving 6-10 inches of snow, and partially activating their EOC for the event. February 12-13 saw the next round of snow, with more than two inches falling on the 12th and another six inches or more falling the next day. March 3rd saw yet another round of significant snowfall throughout the area, with more than five inches recorded throughout the area; some area, such as the City of Manassas, reported accumulations of 6-10 inches.

Arlington County, Fairfax County, Loudoun County, Prince William County, the City of Alexandria, the City of Fairfax, the City of Falls Church, the City of Manassas, and the City of Manassas Park were all included in DR 1905, which occurred February 5-11, 2010. This event was declared as a result of severe winter storms and snowstorms. Record-breaking snowfall fell over Northern Virginia and much of the Mid-Atlantic. A storm system moving through the Midwest phased with another system moving across the South, growing more powerful off the Carolina coast. The system then tracked northeast and then east along the Mid-Atlantic coast before heading out to sea. Snow began during the afternoon hours of February 5 and continued into the early evening of February 6. As much as 32.4 inches fell over the two-day period at the NWS Forecast Office in Sterling, Virginia near Dulles International Airport, with 17.8 inches at Ronald Reagan Washington National Airport. Whether by air, rail, or roadway, travel became nearly impossible, as winds gusting over 35 mph whipped snow into drifts of up to four feet deep. This storm was the second paralyzing snowstorm of the season for what would turn out to be (according to NWS data) northern Virginia's snowiest winter on record. The storm was nicknamed 'Snowpocalypse' and 'Snowmageddon' by local media and others. The snow forced the shutdown of the Federal government for four and a half consecutive days.

A dry, powdery snow accompanied by wind gusts of 40 to 50 mph caused white-out conditions across a considerable portion of northern Virginia, particularly on the morning of February 10. Snow drifts up to four feet high leftover from the storm of February 5-6 and up to a foot of additional accumulation from this storm brought travel in the area to a standstill once again. Conditions were so fierce that at 7am, the Virginia Department of Transportation ceased snowplow operations citing visibility of less than 100 feet at times. Total accumulations from this storm were greatest over the eastern and northern sections of the region where 10 to 14 inches was common near the borders with the District of Columbia and Maryland. Lighter amounts of generally 5 to 9 inches fell over the rest of the region.

Arlington County, Fairfax County, Prince William County, the City of Alexandria, the City of Fairfax, the City of Falls Church, the City of Manassas, and the City of Manassas Park were also included in DR 1874, which occurred December 18-20, 2009. A storm system that formed over the Gulf of Mexico gathered strength as it tracked to a position off the Carolina coast and then along the Eastern Seaboard. Snow began over northern Virginia during the evening of Friday, December 18, and continued into much of the following day. The storm caused travel to ground to a halt as roads, railways, and runways became snow covered and in some cases impassable. The initial heavy, wet nature of the snow combined with winds that gusted to over 35 mph at times left thousands in the Mid-Atlantic without power. Ronald Reagan Washington National Airport recorded 15 inches of snow on December 19, for a two-day storm total of 16.4 inches.

Slightly higher amounts fell just to the west and south with Dulles International Airport receiving 19.3 inches.

B. Risk Assessment

1. Probability of Future Occurrences

The probability of future winter weather events is usually determined based on an examination of the historical frequency of occurrence of such events. The NCDC Storm Events database contains winter weather events and damages dating back to 1996, but it does not systematically document the magnitude or intensity of each event. The NCDC database also records these events at a geographic county level, with individual accounts from municipalities or unincorporated areas of the county included in the reports. Long-term weather station observation data provides more detailed information on event magnitude (as measured by snowfall depth, precipitation types, and temperature), but does not provide any information regarding historical impacts.

Rather than relying solely on existing climatology information, independent analyses of weather station data were performed for the Commonwealth of Virginia Emergency Operations Plan to estimate the probability of specific winter weather occurrences.

Using daily weather station data involves decisions about which weather stations to include in the analysis and how to handle any gaps in the data record. In deciding which weather stations to use, the location, period of record, and data variables reported are the key considerations. Virginia stations with substantially complete data from 1960 through 2000 were chosen for the Virginia Hazard Mitigation Plan analysis. Small interruptions or gaps exist in these stations' data records, which may indicate periods when the station was not operational. Entire years with no data were removed from consideration when conducting the analyses in this report, but smaller data gaps were ignored. As a result, the statistics generated from this data may slightly underestimate the frequency or intensity of winter weather phenomena. Future plan updates might consider more involved techniques, which could potentially improve this area of the analysis.

As part of the analysis for the State plan, weather station data was downloaded from the NCDC archives. A selection of cooperative weather stations operating between 1960 and 2000 was loaded into a Microsoft Access database in order to determine the annual frequency of occurrence of certain conditions. The daily station data variables relevant to this investigation include 24-hour snowfall depth, minimum temperature, and daily weather type codes.

The NCDC archives, and specifically the Daily Surface Data records (DS3200 / 3210 / 3205 / 3206), provide data in comma-delimited text files, which must be transformed in order to create a database table as a single daily record. This transformation was accomplished using a macro written with Visual Basic for Applications in Access. This macro converts the data from its original format, with all days of a month in one record, to a format containing only one day per record. With the daily data thus transformed, a second macro calculated and reported the annual frequency of occurrence for user-specified conditions. In this instance, the probability that a given year would contain at least three days with three inches of snowfall was examined.

Figures 4.24 and 4.25 are a selection of results from CGIT analysis of the daily snowfall and temperature weather station data from the Virginia Hazard Mitigation Plan. These figures illustrate a general trend towards more frequent and more intense winter weather at higher elevations and at higher latitudes. In these figures, the station-specific statistics have been used as the basis for a seamless statewide estimate based on multiple linear regressions between the weather statistics (dependent variable) and elevation and latitude (independent variables). The analysis shows that the average number of days with at least three inches of snowfall varies from approximately two to almost seven days in western portions of Loudoun County, to two to three days throughout the remainder of Northern Virginia. The average number of days with at least six inches of snowfall was between one and 1.5 over western sections of Loudoun County and generally one day or fewer in the remainder of Northern Virginia. This data was validated for this plan update, and found to be accurate.

Based on this analysis and the historical record, winter storms will remain a highly likely occurrence for the entire Northern Virginia region. If history continues to hold true, western sections of Loudoun County can expect a slightly higher likelihood of experiencing accumulating snowfall relative to the remainder of Northern Virginia.

Long range climate modeling suggests that as the planet warms, a trend of more winter precipitation taking the form of liquid precipitation, rather than snowfall would result.[9] Future hazard mitigation plan updates might consider factoring the latest climate science as part of a quantitative method for determining the probability of future occurrence of wintry weather.

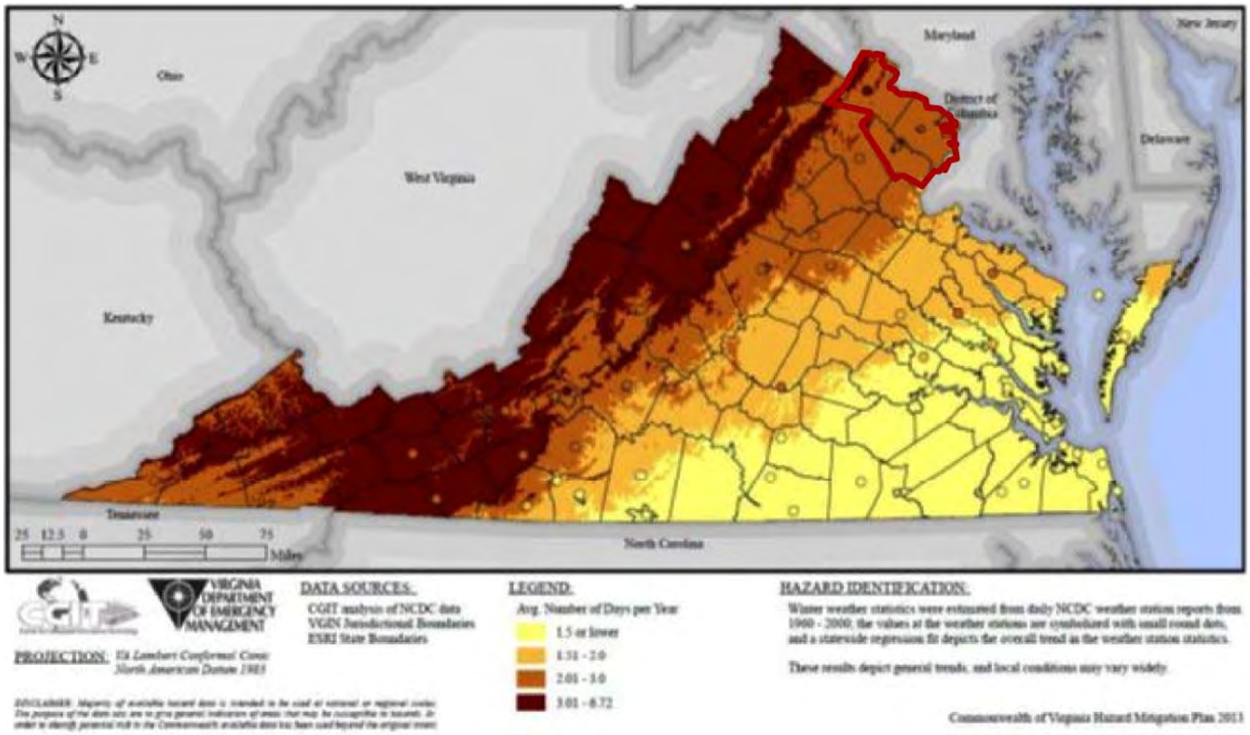


Figure 4.24. Average Number of Days with at Least Three Inches of Snow.

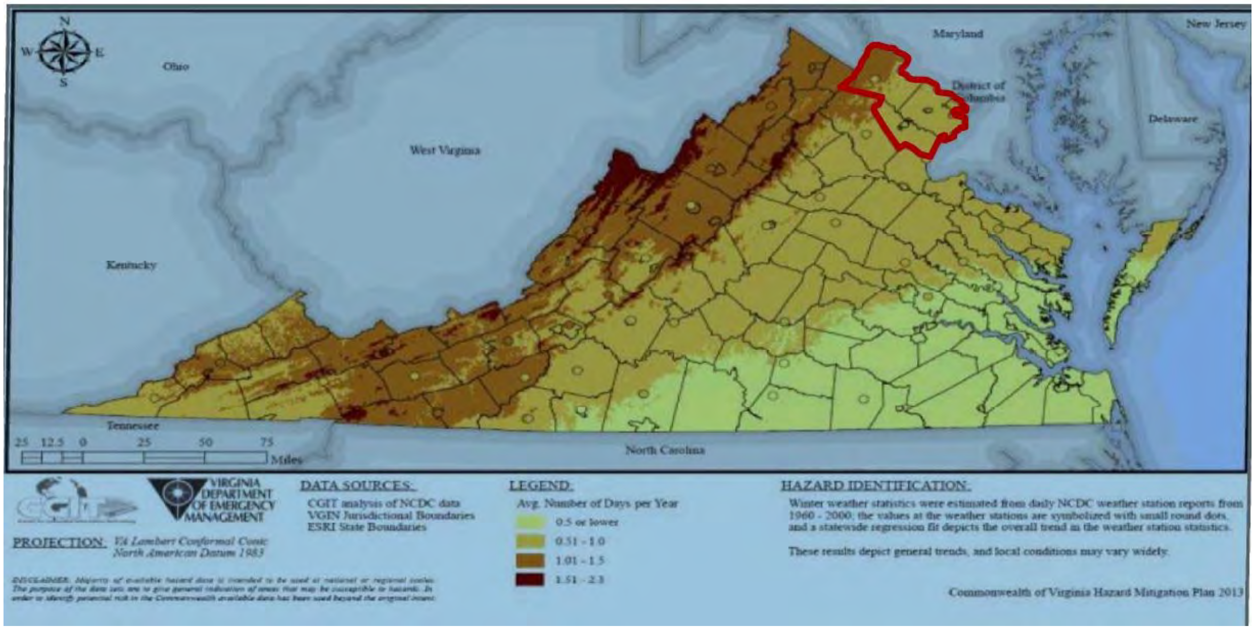


Figure 4.25. Average Numbers of Days with at Least Six Inches of Snow.

2. Impact & Vulnerability

Winter storm vulnerability can be thought of in terms of individual, property, and societal elements. For example, the exposure of individuals to extreme cold, falling on ice-covered walkways, and automobile accidents is heightened during winter weather events. Property damage due to winter storms includes damage done by and to trees, water pipe breakage, structural failure due to snow loads, and injury to livestock and other animals. The disruption of utilities and transportation systems, as well as lost business and decreased productivity are vulnerabilities of society as a whole. The vulnerability to these damages varies in large part due to specific factors; for example, proactive measures such as regular tree maintenance and utility system winterization can minimize property vulnerability. Localities accustomed to winter weather events are typically more prepared to deal with them and therefore less vulnerable than localities that rarely experience winter weather.

The impacts of winter storms are primarily quantified in terms of the financial cost associated with preparing for, response during, and recovering from them. The primary source of data providing some measurement of winter storm impacts is the NCDC Storm Events database. The database includes winter event data back to 1993, but is not necessarily complete or consistent from event to event. Although a more comprehensive, labor-intensive analysis consisting of using weather station data, NCDC damages, and other data sources could possibly produce an intensity-damage relationship between winter weather occurrences and resultant damages, this type of analysis was not performed for the update of this or the State Plan. The branches of government most often affected by winter storms include the Virginia Department of Transportation and local public works and transportation departments. Roadway treatment operations often begin in advance of a winter storm, and continue for as long as necessary.

3. Risk

Risk, as defined as probability multiplied by impact, cannot be fully estimated for winter storms due to the lack of intensity-damage models for this hazard. Instead, estimates of the financial impacts of winter storms can be developed based on NCDC winter weather event data that runs from January 1996 to December 2015. Examination of NCDC data shows that there were at least 461 winter weather events in the database, producing an estimated annualized loss of $57,105, based on total estimated losses of more than $1 million for the 19-year period of record.

The winter weather frequency data from the Commonwealth shows a strong trend toward more winter weather occurring in areas at higher latitudes and at higher elevations. The mountainous western portion of the State and the northern portions of the State, including Northern Virginia, experience winter weather more often and with greater severity than other portions of Virginia. While the magnitude of damages from winter storms are perhaps not typically as great as experienced in association with extreme flooding or a severe earthquake, winter storms occur much more frequently and usually over broader areas. In addition, storm events with relatively low intensity can nevertheless cause significant impacts, especially in areas unaccustomed to such events.

Losses associated with winter storms are typically related to snow removal and business interruption, although power failure is also a significant secondary hazard commonly associated with winter storms, and particularly ice events. In addition to the impacts on transportation, power transmission, and communications, severe winter storms in the Northern Virginia region have at times cause severe property damage due to roof collapses. According to FEMA, most injuries and fatalities related to winter storms are caused by vehicle accidents and hypothermia. The entire Northern Virginia region is generally equally susceptible to winter storms, and has experienced similar numbers of events and levels of damage. Due to higher residential and commercial densities, Arlington and Fairfax counties may be more severely impacted by winter storms in terms of interruption to services (transportation, communication, etc.), but are not considered significantly more vulnerable.

Critical Facility Risk

Quantitative assessment of critical facilities for winter storm risk was not feasible for this update. Even so, it is apparent that transportation structures are at greater risk from winter storms. In addition, building construction type – particularly roof span and construction method, are factors that determine the ability of a building to perform under severe stress weights from snow. Finally, not all critical facilities have redundant power sources and may not even be wired to accept a generator for auxiliary heat. Future plan updates should consider including a more comprehensive examination of critical facility vulnerability to winter storms.

Existing Buildings and Infrastructure Risk

Risk to existing buildings and infrastructure is largely determined by building construction type – particularly roof span and construction method. Both are factors that determine the ability of a building to perform under severe stress weights from snow.

Overall Loss Estimates and Ranking

The Commonwealth of Virginia's 2013 HIRA ranking was based largely on the NCDC storm events database. The 2016 update to the Northern Virginia plan used this same framework to establish a common system for evaluating and ranking hazards. In determining a score and ranking for winter storm, the geographic extent score for each jurisdiction is based on the analysis of the average annual number of days receiving at least three inches of snow (Figure 4.24, calculated as an area weighted average for each jurisdiction.) The methodology for the scoring and ranking of hazards is described in detail in the Risk Assessment and Methodology section. Based on this methodology, all of Northern Virginia is considered at 'High' risk for winter storms and winter weather.

For the 2016 plan update the qualitative assessment was performed by jurisdiction. Given the widespread nature of the hazard, however, all counties, cities, and towns were determined to have the same qualitative risk to the hazard. Therefore, to avoid repetition, Table 4.73 provides the results of the qualitative assessment for all participating jurisdictions, as all jurisdictions were found to have the same results.

Table 4.73. 2016 Qualitative Assessment for Winter Storm.

	Probability	Impact	Spatial Extent	Warning Time	Duration
Risk Level	Highly Likely	Critical	Moderate	6 to 12 hours	Less than one week

VIII. High Wind / Severe Storms
(Including thunderstorms and hurricanes)

NOTE: As part of the 2016 plan update, the High Wind/Severe Storm hazard was reexamined and a new analysis performed. This new analysis included, but was not limited to: 1) refreshing the hazard profiles; 2) updating the previous occurrences; 3) determining number of hazard events and losses by jurisdiction using NCDC and other data sources where available; 4) updating the assessment of risk by jurisdiction based on new data; and 5) ranking of the hazard by jurisdiction using the methodology described in detail in Chapter 4, Section IV Ranking and Analysis Methodologies. Each section of the plan was also reformatted for improved clarity and new maps and imagery, when available and appropriate, were inserted.

a. Hazard Profile

i. Description

Wind is the motion of air past a given point caused by a difference in pressure from one place to another. Wind poses a threat to Northern Virginia in many forms, including wind produced by severe thunderstorms and tropical weather systems. The effects can include blowing debris, interruptions in elevated power and communications utilities, and intensified effects of winter weather. Harm to people and animals as well as damage to property and infrastructure may result.

Severe Thunderstorms

According to the NWS, more than 100,000 thunderstorms occur each year in the United States, though only about 10% of these storms are classified as *severe*. A thunderstorm with wind gusts in excess of 58 miles per hour (50 knots) and/or hail with a diameter of 3/4" or more is classified as a severe thunderstorm. Although thunderstorms generally affect a small area, they are dangerous because of their ability to generate tornadoes, hail, strong winds, flash flooding, and lightning. While thunderstorms can occur in all regions of the United States, they are most common in the central and southern states because atmospheric conditions in those areas are ideal for generating and feeding these powerful storms.

Multiple cloud-to-ground and cloud-to-cloud lightning strikes observed during a nighttime thunderstorm. (Photo courtesy of NOAA Photo Library, NOAA Central Library; OAR/ERL/ National Severe Storms Laboratory)

Thunderstorms are caused when air masses of varying temperatures and moisture content meet. Rapidly rising warm moist air serves as the driving force for thunderstorms. These storms can occur singularly, in lines, or in clusters. They can move through an area very quickly or linger for several hours.

Lightning is a discharge of electrical energy resulting from the buildup of positive and negative charges within a thunderstorm, creating a bolt when the buildup of charges becomes strong enough. This flash of light usually occurs within the clouds or between the clouds and the ground. A bolt of lightning can reach temperatures approaching

50,000 degrees Fahrenheit. Lightning rapidly heats the sky as it flashes, but the surrounding air cools following the bolt. This rapid heating and cooling of the surrounding air causes thunder. On average, 89 people are killed each year by lightning strikes in the United States.

Some storms produce a particular type of high wind called a derecho. Derechos are widespread, long-lived, straight-line wind storms associated with severe thunderstorms. They can cause hurricane-force winds, tornadoes, heavy rains, and flooding. Derechos travel quickly, with sustained winds that often exceed hurricane-force. They typically occur in the summer months, though they can occur any time of year and ant any time of the day or night.

ii. Geographic Location / Extent

Although most frequent in the Southeast and parts of the Midwest, thunderstorms are a relatively common occurrence across Northern Virginia and have been known to occur in all calendar months. The NWS collected data for thunderstorm days, number and duration of thunder events, and lightning strike density for the 30-year period from 1948 to 1977. The analysis of this data determined that on average, 50 to 60 thunderstorm events occur annually in Northern Virginia. No one portion of Northern Virginia is deemed to be more likely to experience thunderstorms than another portion of the region.

Figure 4.26 illustrates thunderstorm hazard severity based on the annual average number of thunder events from 1948 to 1977. The planning area is highlighted in green on the map.

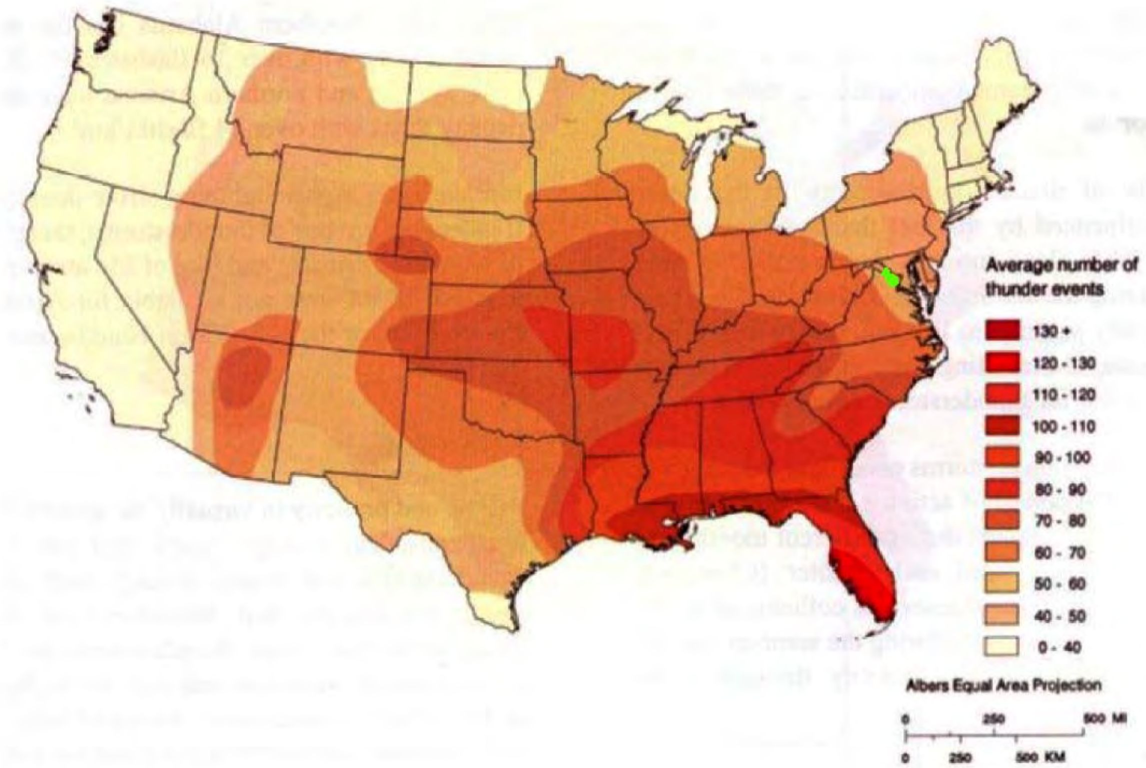


Figure 4.26. Annual Average Number of Thunder Events.
Source: Federal Emergency Management Agency

iii. Magnitude or Severity

Straight-line winds, which in extreme cases have the potential to cause wind gusts that exceed 100 miles per hour, are responsible for most thunderstorm wind damage. One type of straight-line wind, the downburst, can cause damage equivalent to a strong tornado and can be extremely dangerous to aviation. Figure 4.27 shows how the frequency and strength of extreme windstorms vary across the United States. The map was produced by FEMA and is based on 40 years of tornado history and over 100 years of hurricane history. Zone IV, the darkest area on the map, has experienced both the greatest number of tornadoes and the strongest tornadoes. As shown by the map key, wind speeds in Zone IV can be as high as 250 MPH. As depicted in this figure, the planning area is highlighted in green and falls within Zone II, a hurricane-susceptible region where winds can be as high as 160 MPH.

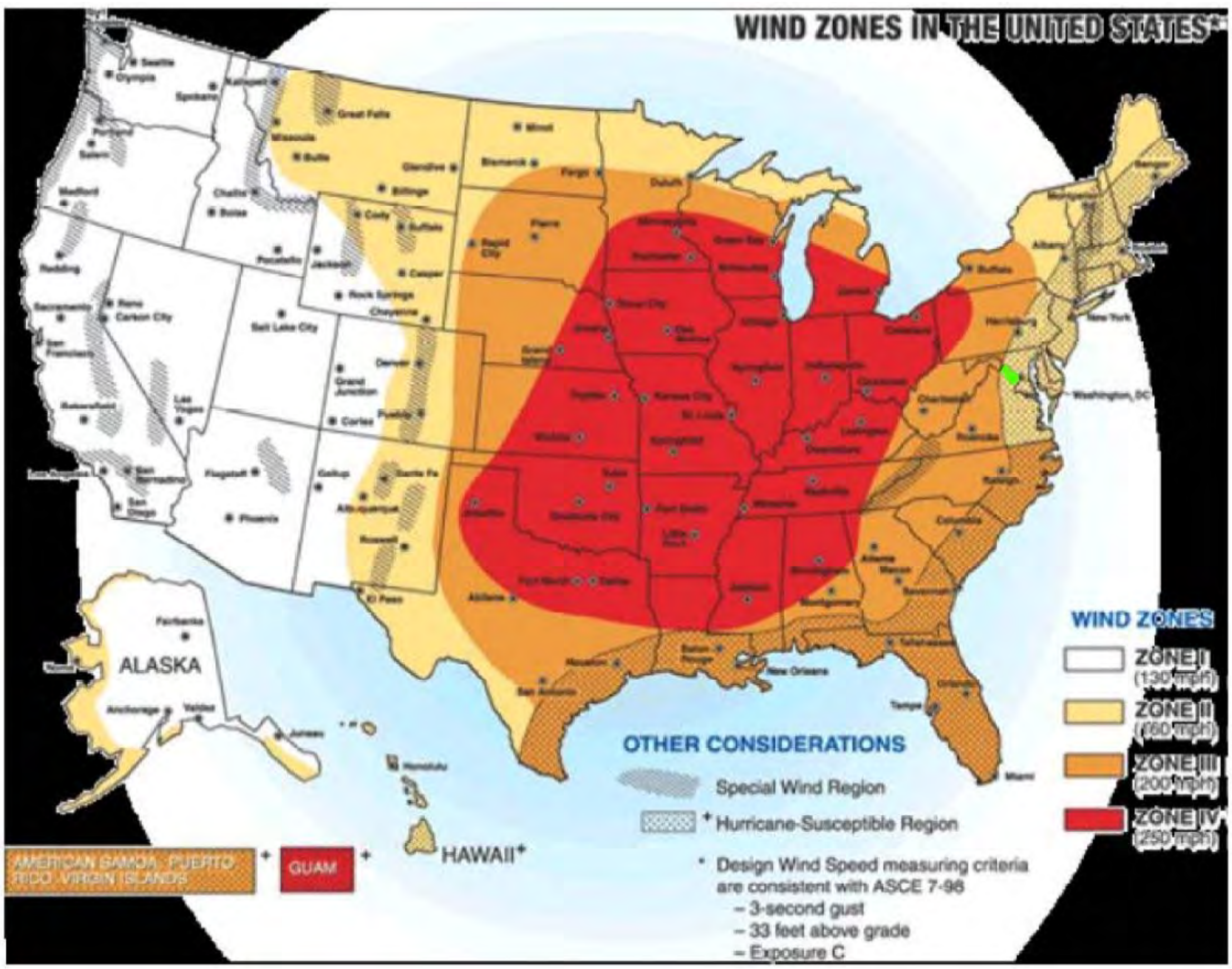


Figure 4.27. Wind Zones in the United States.
Source: Federal Emergency Management Agency

Hailstorms are another potential damaging outgrowth of severe thunderstorms. Early in the developmental stages of a hailstorm, ice crystals form within a low-pressure front due to the rapid rising of warm air into the upper atmosphere and the subsequent cooling of the air mass. Frozen droplets gradually accumulate on the ice crystals until, having developed sufficient weight, they fall as precipitation — as balls or irregularly shaped masses of ice greater than 0.75 in. (1.91 cm) in diameter. The size of hailstones is a direct function of the size and severity of the storm. High velocity updraft winds are required to keep hail in suspension in thunderclouds. The strength of the updraft is a function of the intensity of heating at the Earth's surface. Higher temperature gradients relative to elevation above the surface result in increased suspension time and hailstone size. Figure 4.28 shows the annual frequency of hailstorms in the United States. The planning area is highlighted in green on the map.

Large hail collects on streets and grass during a severe thunderstorm. Larger stones appear to be nearly two to three inches in diameter. (NOAA Photo Library, NOAA Central Library; OAR/ERL/National Severe Storms Laboratory)

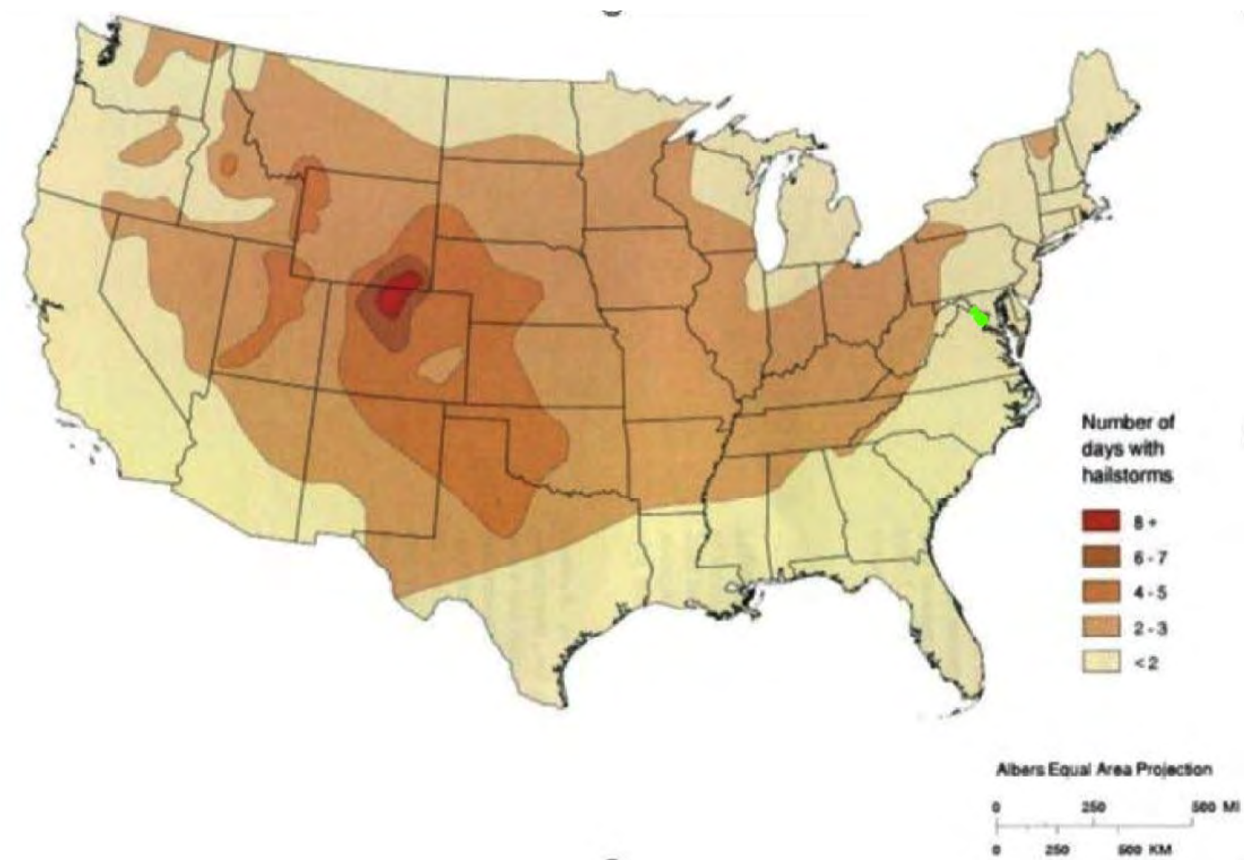


Figure 4.28. Annual Frequency of Hailstorms in the United States
Source: Federal Emergency Management Agency

Though more frequent in the Mississippi River Valley, derechos occur often enough in the eastern United States for the National Weather Service to map their typical frequency of occurrence. Figure 4.29 illustrates the typical distribution of occurrences, as determined by the NWS. Based on this data, the planning area, which is highlighted in green, could expect to experience at least one derecho every 2-4 years, on average.

Figure 4.29. Derecho Climatology in the United States.
Source: The National Weather Service Forecast Office, Cleveland, Ohio.

In addition to high winds and hail associated with these events, severe storms can also bring dangerous lightning that can cause fires, property damage, and death or serious injury to humans.

iv. Previous Occurrences

There have been a number of past severe storm and high wind events throughout the region, ranging widely in terms of location, magnitude, and impact; these events are captured and reported by the NCDC. Where possible, NCDC tracks reports separately by impacted jurisdiction; it is not always possible, however, to estimate damages below a county or city level. In most cases, therefore, damages that were reported for counties and cities include damages that occurred within towns. Therefore, Table 4.74 illustrates the number of events reported by participating jurisdiction, and the number of injuries reported, but assumes that all reported damage estimates are captures at the county and city level. To avoid duplication, no damages are reported in the table following for towns. This table summarizes the number of severe storm and high wind events (by participating jurisdiction) since 1950 which have caused a notable impact on the Northern Virginia region as recorded by the NCDC. This includes 1,344 events that have caused approximately $101.6 million in property and crop damages and have resulted in approximately 87 injuries. In addition, at least four fatalities were recorded by NDCD – two each in Fairfax and Loudoun Counties.

Note: In the case of Fairfax County and the City of Fairfax, the number of events reported, the number of fatalities and injuries, and the approximate dollar amount of damages reported were identical, leading to the conclusion that the reports for each jurisdiction are duplicates. Therefore, for the purposes of this calculation, the jurisdictions were combined into a single line item, to avoid over-estimation of occurrences and damages.

Table 4.74. Severe Storm & High Wind Events in the Northern Virginia Region, 1950–2015 based on NCDC data.

Jurisdiction	# of Severe Storm & High Wind Events	Property Damage	Crop Damage	Total
Arlington County	144	$10,318,000	$5,750	$10,323,750
Fairfax County & the City of Fairfax	63	$20,468,000	$40,000	$20,508,000
Loudoun County	434	$2,943,000	$289,600	$3,232,600
Prince William County	191	$17,365,000	$81,750	$17,446,750
City of Alexandria	90	$9,720,000	$0	$9,720,000
City of Fairfax	--	--	--	--
City of Falls Church	54	$9,730,000	$0	$9,730,000
City of Manassas	52	$15,556,000	$79,000	$15,635,000
City of Manassas Park	31	$14,955,000	$77,000	$15,032,000
Town of Clifton	1	--	--	--
Town of Dumfries	27	--	--	--
Town of Haymarket	26	--	--	--
Town of Herndon	12	--	--	--
Town of Leesburg	70	--	--	--
Town of Lovettsville	33	--	--	--
Town of Middleburg	29	--	--	--
Town of Occoquan	1	--	--	--
Town of Purcellville	38	--	--	--
Town of Quantico	17	--	--	--
Town of Round Hill	21	--	--	--
Town of Vienna	10	--	--	--
Total	**1344**	**$101,055,000**	**$573,100**	**$101,628,100**

Arlington County
In late June and early July of 2012, the planning area experienced a number of severe storms and straight-line winds, including a derecho – a phenomenon that previously had not been recorded in the planning area. These storms resulted in DR-4072, issued on July 27, 2012.

Fairfax County - including the Town of Clifton, the Town of Herndon, and the Town of Vienna
In late June and early July of 2012, the planning area experienced a number of severe storms and straight-line winds, including a derecho – a phenomenon that previously had not been recorded in the planning area. These storms resulted in DR-4072, issued on July 27, 2012.

Loudoun County - including the Town of Leesburg, the Town of Lovettsville, the Town of Middleburg, the Town of Purcellville, and the Town of Round Hill
In late June and early July of 2012, the planning area experienced a number of severe storms and straight-line winds, including a derecho – a phenomenon that previously had not been recorded in the planning area. These storms resulted in DR-4072, issued on July 27, 2012.

On July 25, 2010, severe thunderstorms raked the area during the late afternoon producing damaging winds in excess of 60 mph that brought down trees and power lines. Torrential rainfall caused flash flooding of low-lying and poorly drained areas. A large tree struck and killed a child in Claude Moore Park near Sterling Park in Loudoun County. Numerous trees were also downed in Leesburg. A roof collapsed on a parking garage near Reston where wind gusts were estimated at 75 mph.

Prince William County - including the Town of Dumfries, the Town of Haymarket, the Town of Occoquan, and the Town of Quantico
In late June and early July of 2012, the planning area experienced a number of severe storms and straight-line winds, including a derecho – a phenomenon that previously had not been recorded in the planning area. These storms resulted in DR-4072, issued on July 27, 2012. In Prince William County, the derecho caused power outages and wind damages to the Public Safety Communications Center, resulting in the temporary loss of 911 service to the area.

City of Alexandria
On August 5, 2010, thunderstorm outflow winds of between 70 and 90 mph tore through parts of Northern Virginia knocking down hundreds of trees and power lines and causing extensive damage to homes, businesses, and vehicles. The mid-afternoon storms hit Arlington and Alexandria particularly hard and resulted in the closure of major roadways including the George Washington Parkway near Slaters Lane, and the loss of power to thousands of residents for several days. Damage from the storms also halted Metrorail service at Alexandria's King Street station for a time.

City of Fairfax
In late June and early July of 2012, the planning area experienced a number of severe storms and straight-line winds, including a derecho – a phenomenon that previously had not been recorded in the planning area. These storms resulted in DR-4072, issued on July 27, 2012.

City of Falls Church
In late June and early July of 2012, the planning area experienced a number of severe storms and straight-line winds, including a derecho – a phenomenon that previously had not been recorded in the planning area. These storms resulted in DR-4072, issued on July 27, 2012.

City of Manassas
The City of Manassas reported derecho winds of 60-80 MPH on June 29, 2012, with periodic gusts in excess of 50 MPH lasting for another 15-20 minutes. Because of these winds, the 911 call center was inoperable for approximately 36 hours, causing emergency services to rely on ham radio operators throughout the City.

City of Manassas Park
In late June and early July of 2012, the planning area experienced a number of severe storms and straight-line winds, including a derecho – a phenomenon that previously had not been recorded in the planning area. These storms resulted in DR-4072, issued on July 27, 2012. As a result of this derecho, the city experienced power outages.

b. Risk Assessment

i. Probability of Future Occurrences

Since severe storms are difficult to predict, it is extremely difficult to determine probability of future occurrence with any degree of accuracy. It can, however, with considerable confidence, based on historical record, be projected that Northern Virginia will continue to experience severe thunderstorms with great frequency – several times a year, in most cases. Based on analysis of previous events in the NCDC database, it appears that those events causing injury, death or damage have occurred on a seemingly random basis with no particular portion of Northern Virginia more likely to experience them than any other.

Climate change is projected to increase the frequency and intensity of extreme weather events, including severe thunderstorms. Using global climate models and a high-resolution regional climate model, one study that investigated the link between severe thunderstorms and global warming found a net increase in the number of days with environmental conditions that foster the development of severe thunderstorms. This was true for much of the United States, including northern Virginia.[10]

ii. Impact & Vulnerability

The Northern Virginia region faces uniform susceptibility to the effects of severe thunderstorms, including high winds, lightning, and hail.

Similar to hurricane and tropical storm force-winds, the most at-risk buildings to thunderstorm winds are assumed to include manufactured homes and older residential structures (see discussion under *Hurricanes and Tropical Storms*). Another great concern for the Northern Virginia region with regard to high winds is damage to electric power lines which regularly cause power outages for residents and businesses across the area, and have disrupted the availability of emergency services, including 911. During past events, storm winds have downed trees across power lines, snapped utility poles and even blown down transformers resulting in widespread outages. Downed power lines create a dangerous threat to public safety; while difficult to quantify, long-term power outages can result in significant hardship for residents and major economic impacts for local businesses.

Lightning presents a significant threat to human safety and has historically caused injuries and death in the Northern Virginia region. Lightning has also been known to cause structural fires that can destroy property and present further life/safety issues. According to the Virginia State Climatology Office, most lightning related deaths and injuries in Virginia have been males between the ages of 20 and 40 years old who were caught outdoors on golf courses, ball fields, near open water or under trees.

Hail, while not a major threat to human safety, can be extremely destructive to crops and personal property (particularly vehicles, as well as roofs, siding, and windows of buildings). Most hail damage recorded for the Northern Virginia region has been in Fairfax and Loudoun counties, though all areas are considered to be equally at risk.

iii. Risk

Risk, as defined as probability multiplied by impact, cannot be fully estimated for damaging thunderstorm wind, hail, and lightning events due to the lack of intensity-damage models for these hazards. Instead, financial impacts of damaging thunderstorm events can be developed based on NCDC Storm Events data. Using this data, property and crop damage related to severe storm and high wind events totaled more than $101 million.

Critical Facility Risk

Quantitative assessment of critical facilities for thunderstorm wind risk was not feasible for this update. Even so, the type and age of construction plays a role in vulnerability of facilities to thunderstorm winds. In general, concrete, brick, and steel-framed structures tend to fare better in thunderstorm wind events than older, wood-framed structures. Finally, it is important to note that not all critical facilities have redundant power sources and may not even be wired to accept a generator. Future plan updates should consider including a more comprehensive examination of critical facility vulnerability to thunderstorm winds.

Existing Buildings and Infrastructure Risk

Risk to existing buildings and infrastructure is largely determined by building construction type. As explained in Critical Facility Risk, concrete, brick, and steel-framed structures tend to fare better in thunderstorm wind events than older, wood-framed structures.

Overall Loss Estimates and Ranking

Based on data obtained from the NCDC Storm Event database (presented earlier in Table 4.74), severe storm and high wind events have produced a total of approximately $101.6 million in property and crop damages for the region. Table 4.75 (following) provides a breakdown of these damages in both real estimates and an annualized format, by participating jurisdiction.

Table 4.75. Loss Estimates Due to Severe Storms and High Winds.		
Jurisdiction(s)	Annualized Property and Crop Damage	Total Property and Crop Damage
Arlington County	$158,827	$10,323,750
Fairfax County & the City of Fairfax (including Town of Clifton, Town of Herndon, and Town of Vienna)	$315,508	$20,508,000
Loudoun County (including Town of Leesburg, Town of Lovettsville, Town of Middleburg, Town of Purcellville, and Town of Round Hill)	$49,732	$3,232,600
Prince William County (including Town of Dumfries, Town of Haymarket, Town of Occoquan, and Town of Quantico)	$268,412	$17,446,750
City of Alexandria	$149,538	$9,720,000
City of Fairfax	--	--
City of Falls Church	$149,692	$9,730,000
City of Manassas	240,538	$15,635,000
City of Manassas Park	$231,261	$15,032,000
Total	**$1,563,509**	**$101,628,100**

For the 2016 plan update the qualitative assessment was organized by jurisdiction. Given the widespread nature of the hazard, however, all counties, cities, and towns were determined to have the same qualitative risk to the hazard, and a vulnerability of 'High'. Therefore, to avoid repetition, Table 4.76 provides the results of the qualitative assessment for all participating jurisdictions, as all jurisdictions were found to have the same results.

Table 4.76. 2016 Qualitative Assessment for High Wind & Severe Storms.					
	Probability	**Impact**	**Spatial Extent**	**Warning Time**	**Duration**
Risk Level	Highly Likely	Critical	Moderate	6 to 12 hours	Less than one week

c. Hurricanes and Tropical Storms

Hurricanes and tropical storms, as well as nor'easters and typhoons, are classified as cyclones and defined as a closed circulation developing around a low-pressure center in which the winds rotate counter-clockwise in the Northern Hemisphere (or clockwise in the Southern Hemisphere) and whose diameter averages 10 to 30 miles across. A tropical cyclone refers to any such circulation that develops over tropical waters. Tropical cyclones act as a safety-valve, limiting the continued build-up of heat and energy in tropical regions by maintaining the atmospheric heat and moisture balance between the tropics and the pole-ward latitudes. The primary damaging forces associated with these storms are high-level sustained winds, heavy precipitation, and tornadoes. Coastal areas are also vulnerable to the additional forces of storm surge, wind-driven waves, and tidal flooding which can be more destructive than cyclone wind.

The key energy source for a tropical cyclone is the release of latent heat from the condensation of warm water. Their formation requires a low-pressure disturbance, warm sea surface temperature, rotational force created by the earth's rotation, and the absence of significant wind shear in the lowest 50,000 feet of the atmosphere. The majority of hurricanes and tropical storms form in the Atlantic Ocean, Caribbean Sea, or Gulf of Mexico during the official Atlantic hurricane season, which encompasses the months of June through November. The peak of the Atlantic hurricane season is in early to mid-September.

i. Geographic Location / Extent

Although the Northern Virginia region rarely experiences the wrath of a direct land falling hurricane, it is located in an area quite susceptible to the remnants of such storms. This includes the perils of hurricane and tropical storm force winds, heavy rains, and significant storm surge and tidal flooding. These events can be extremely dangerous and costly across a large geographic area, as was learned during Hurricane Isabel in 2003 when the region suffered approximately $32 million in damages (nearly $2 billion statewide). In 2011, the remnants of Tropical Storm Lee impacted Fairfax and Prince William Counties, and the City of Alexandria. The storm dropped between five and seven inches of rain over the Northern Virginia area. In Fairfax County, VDOT estimated the storm caused approximately $10 million in damages to roads and bridges throughout the county. In late October 2012, Hurricane Sandy blanketed the region with heavy rain and high winds, resulting in downed trees, debris issues, and transportation interruptions.

Figure 4.30 shows the probability of a named tropical storm or hurricane affecting any single area during a June to November Atlantic hurricane season. The figure was created by the NOAA's Hurricane Research Division using data from 1944 to 1999 and counting hits when a storm or hurricane was within approximately 100 miles (165 km) of each location.

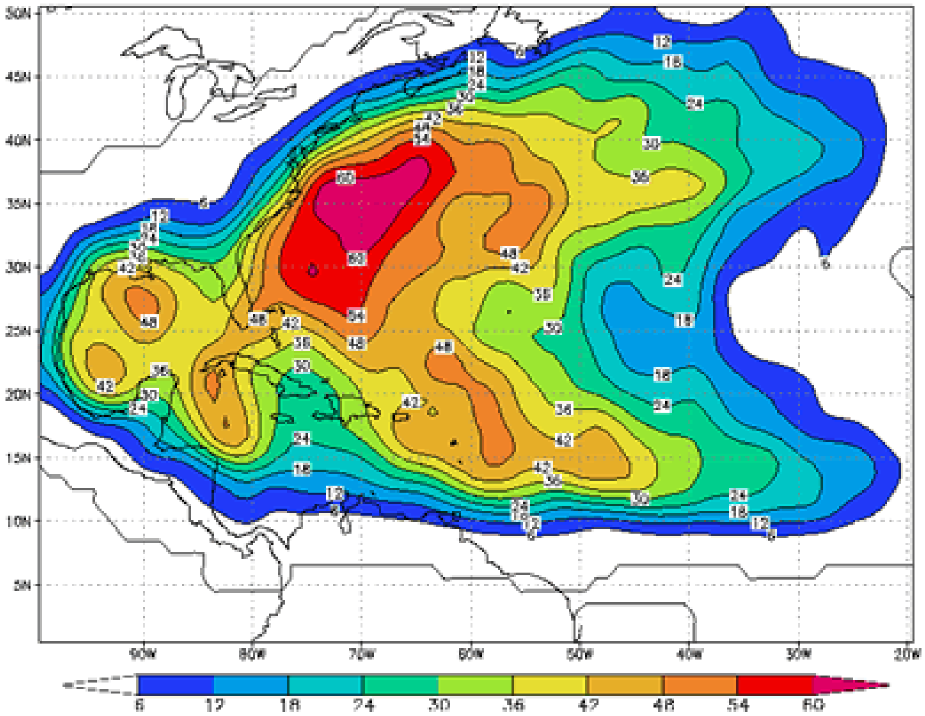


Figure 4.30. Empirical Probability of a Named Storm.
Source: National Oceanic and Atmospheric Administration, Hurricane Research Division

ii. Magnitude or Severity

As an incipient hurricane develops, barometric pressure (measured in millibars or inches) at its center falls and winds increase. If the atmospheric and oceanic conditions are favorable, it can intensify into a tropical depression. When maximum sustained winds reach or exceed 39 miles per hour, the system is designated a tropical storm, given a name, and is closely monitored by the National Hurricane Center in Miami, Florida. When sustained winds reach or exceed 74 miles per hour the storm is deemed a hurricane. Hurricane intensity is further classified by the Saffir-Simpson Scale currently in use by NOAA's National Hurricane Center (see Table 4.77), which rates hurricane intensity on a scale of 1 to 5, with 5 being the most intense.

Table 4.77. Saffir-Simpson Scale.

Category	Maximum Sustained Wind Speed (MPH)	Minimum Surface Pressure (Millibars)
1	74—95	Greater than 980
2	96—110	979—965
3	111—130	964—945
4	131—155	944—920
5	155+	Less than 920

The Saffir-Simpson Scale categorizes hurricane intensity based upon maximum sustained winds and barometric pressure which are combined to estimate potential damage. Categories 3, 4, and 5 are classified as "major" hurricanes, and while hurricanes within this range comprise only 20% of total tropical cyclone landfalls, they cause 70% of the damage in the United States. Table 4.78 describes expected damage per hurricane category.

Table 4.78. Hurricane Damage Classification.

Category	Damage Level	Description
1	Minimal	No real damage to building structures. Damage primarily to unanchored mobile homes, shrubbery, and trees. Also, some coastal flooding and minor pier damage.
2	Moderate	Some roofing material, door, and window damage. Considerable damage to vegetation, mobile homes, etc. Flooding damages piers and small craft in unprotected moorings may break their moorings.
3	Extensive	Some structural damage to small residences and utility buildings, with a minor amount of curtain wall failures. Mobile homes are destroyed. Flooding near the coast destroys smaller structures with larger structures damaged by floating debris. Terrain may be flooded well inland.
4	Extreme	More extensive curtain wall failures with some complete roof structure failure on small residences. Major erosion of beach areas. Terrain may be flooded well inland.
5	Catastrophic	Complete roof failure on many residences and industrial buildings. Some complete building failures with small utility buildings blown over or away. Flooding causes major damage to lower floors of all structures near the shoreline. Massive evacuation of residential areas may be required.

Source: National Hurricane Center

A storm surge is a large dome of water often 50 to 100 miles wide and rising anywhere from four to five feet in a Category 1 hurricane, up to 20 feet or more in a Category 5 storm. The storm surge arrives ahead of the storm's eye making landfall and the more intense the hurricane is, the sooner the surge arrives. Water rise can be very rapid, posing a serious threat to those who have not yet evacuated flood prone areas. A storm surge is a wave that has outrun its generating source and become a long period swell. The surge is highest in the right-front quadrant of the direction in which the hurricane is moving. As the storm approaches shore, the greatest storm surge will be to the north of the hurricane eye. Such a surge and associated breaking waves can be devastating to coastal regions, causing severe beach erosion and property damage along the immediate coast.

Storm surge heights, and associated waves, are dependent upon the shape of the continental shelf (narrow or wide) and the depth of the ocean bottom (bathymetry). A narrow shelf, or one that drops steeply from the shoreline and subsequently produces deep water close to the shoreline, tends to produce a lower surge but higher and more powerful storm waves. Damage during hurricanes may also result from spawned tornadoes and inland flooding associated with heavy rainfall that usually accompanies these storms. Hurricane Floyd, as an example, was at one time a Category 4 hurricane racing towards the North Carolina coast. As far inland as Raleigh, the State capital located more than 100 miles from the coast, communities were preparing for extremely damaging winds exceeding 100 miles per hour. However, Floyd made landfall as a Category 2 hurricane and will be remembered for causing the worst inland flooding disaster in North Carolina's history. In Virginia, Floyd dropped 10-20 inches of rain over southeast Virginia, causing the closure of more than 300 roads from flooding and downed trees. A total of 64 jurisdictions were affected by the more $255 million in storm damages.

Similar to hurricanes, nor'easters are ocean storms capable of causing substantial damage to coastal areas in the eastern United States due to their associated strong winds and heavy surf. Nor'easters are named for the winds that blow in from the northeast. These storms track up the East Coast along the Gulf Stream, a band of warm water that lies off the Atlantic coast. They are caused by the interaction of the jet stream with horizontal temperature gradients and generally occur during the fall and winter months when moisture and cold air are plentiful.

Nor'easters are known for dumping heavy amounts of rain and snow, producing hurricane-force winds, and creating high surfs that cause severe beach erosion and coastal flooding. There are two main components to a nor'easter: (1) a Gulf Stream low-pressure system (counter-clockwise winds) generated off the southeastern coast, gathering warm air and moisture from the Atlantic, and pulled up the East Coast generating strong northeasterly winds along the western forward quadrant of the storm; and (2) an Arctic high-pressure system (clockwise winds) which meets the low-pressure system with cold, arctic air blowing down from Canada. When the two systems collide, the moisture and cold air produce a mix of precipitation and have the potential for creating dangerously high winds and heavy seas. As the low-pressure system deepens, the intensity of the winds and waves will increase and cause serious damage to coastal areas as the storm moves northeast. Table 4.79 shows an intensity scale proposed for nor'easters that is based on levels of coastal degradation.

Table 4.79. Dolan-Davis Nor'easter Intensity Scale.

Storm Class	Beach Erosion	Dune Erosion	Over wash	Property Damage
1 (Weak)	Minor changes	None	No	No
2 (Moderate)	Modest; mostly to lower beach	Minor	No	Modest
3 (Significant)	Erosion extends across beach	Can be significant	No	Loss of many structures at local level
4 (Severe)	Severe beach erosion and recession	Severe dune erosion or destruction	On low beaches	Loss of structures at community-scale
5 (Extreme)	Extreme beach erosion	Dunes destroyed over extensive areas	Massive in sheets and channels	Extensive at regional-scale; millions of dollars

Source: North Carolina Division of Emergency Management

iii. Previous Occurrences

Most hurricanes and tropical storms that have affected Virginia have originated in the Atlantic Ocean. Since 1851, there have been a total of 32 storms to come within 75 miles of the Northern Virginia region. Other notable storms, including hurricanes Floyd (1999), Fran (1996), and Agnes (1972) are discussed herein, but were beyond the 75-mile radius used for this analysis. A chosen distance of 75 miles was used for this analysis in order to focus on those storms that came through areas closest to the Northern Virginia region. However, the effects of large hurricanes and tropical storms may be felt up to 200 miles away from the center of circulation. Six of these storms were classified as hurricanes (including Isabel in 2003 and Irene in 2011), and 25 as tropical storms as they impacted the region. These events are listed in Table 4.80 with a graphical depiction of historical hurricane tracks between 1851 and 2012 shown in Figure 4.31.

Table 4.80. Historical Hurricane and Tropical Storms in the Northern Virginia Region, 1851–2015.

Year	Month	Name	Wind Speed (MPH)	Intensity
1872	October	Not named	45	Tropical Storm
1874	September	Not named	60	Tropical Storm
1876	September	Not named	80	Category 1
1878	October	“Gale of ‘78”	105	Category 2
1882	September	Not named	45	Tropical Storm
1883	September	Not named	45	Tropical Storm
1888	September	Not named	50	Tropical Storm
1888	September	Not named	40	Tropical Storm
1893	August	Not named	70	Tropical Storm
1893	October	Not named	90	Category 1
1893	October	Not named	50	Tropical Storm
1896	September	Not named	80	Category 1
1899	October	Not named	65	Tropical Storm
1904	September	Not named	65	Tropical Storm
1928	September	Not named	45	Tropical Storm
1933	August	Not named	60	Tropical Storm
1943	October	Not named	40	Tropical Storm
1944	August	Not named	50	Tropical Storm
1945	September	Not named	40	Tropical Storm
1949	August	Not named	45	Tropical Storm
1952	September	Able	45	Tropical Storm
1954	October	Hazel	78	Tropical Storm
1955	August	Connie	60	Tropical Storm
1955	August	Diane	65	Tropical Storm
1979	September	David	45	Tropical Storm
1983	September	Dean	45	Tropical Storm
1992	September	Danielle	45	Tropical Storm
1996	July	Bertha	70	Tropical Storm
2003	September	Isabel	75	Category 1
2008	September	Hanna	40	Tropical Storm

Table 4.80. Historical Hurricane and Tropical Storms in the Northern Virginia Region, 1851–2015.				
Year	**Month**	**Name**	**Wind Speed (MPH)**	**Intensity**
2011	September	Irene	120	Category 1
2011	September	Lee (remnants)	60	Tropical Storm
2012	October	Sandy[2]	80	Category 1

Of these, eight storm tracks made direct paths through the region. This includes the "Gale of '78," a category 2 hurricane which is further described under Previous Occurrences. An additional 25 storm tracks for tropical depressions and extratropical systems came within 75 miles of the region.

Although some good narrative information has been gathered on the impacts of these events (see Previous Occurrences), data on estimated property damages could only be accessed through the NCDC since the mid-1990s. Table 4.81 summarizes estimated damage figures caused by hurricane and tropical storm events since 1993 as recorded by the NCDC, and includes all damages recorded for all participating jurisdictions. These events have amounted to more than $45 million in property damages, most of which is attributable to effects of storm surge and tidal flooding resulting from the storms. More detailed information on historical hurricane and tropical storm events can be obtained through the NCDC Storm Event database, referenced earlier in this section.

Table 4.81. Historical Hurricane and Tropical Storm Damages in the Northern Virginia Region, 1993–2015, Based on NCDC Data.	
Estimated Property Damage	
Total	**$45,204,000**

[2] Note that the Northern Virginia area was not included in the designated disaster area for the federal disaster declaration, but did receive some impacts from the storm as it passed by the area.

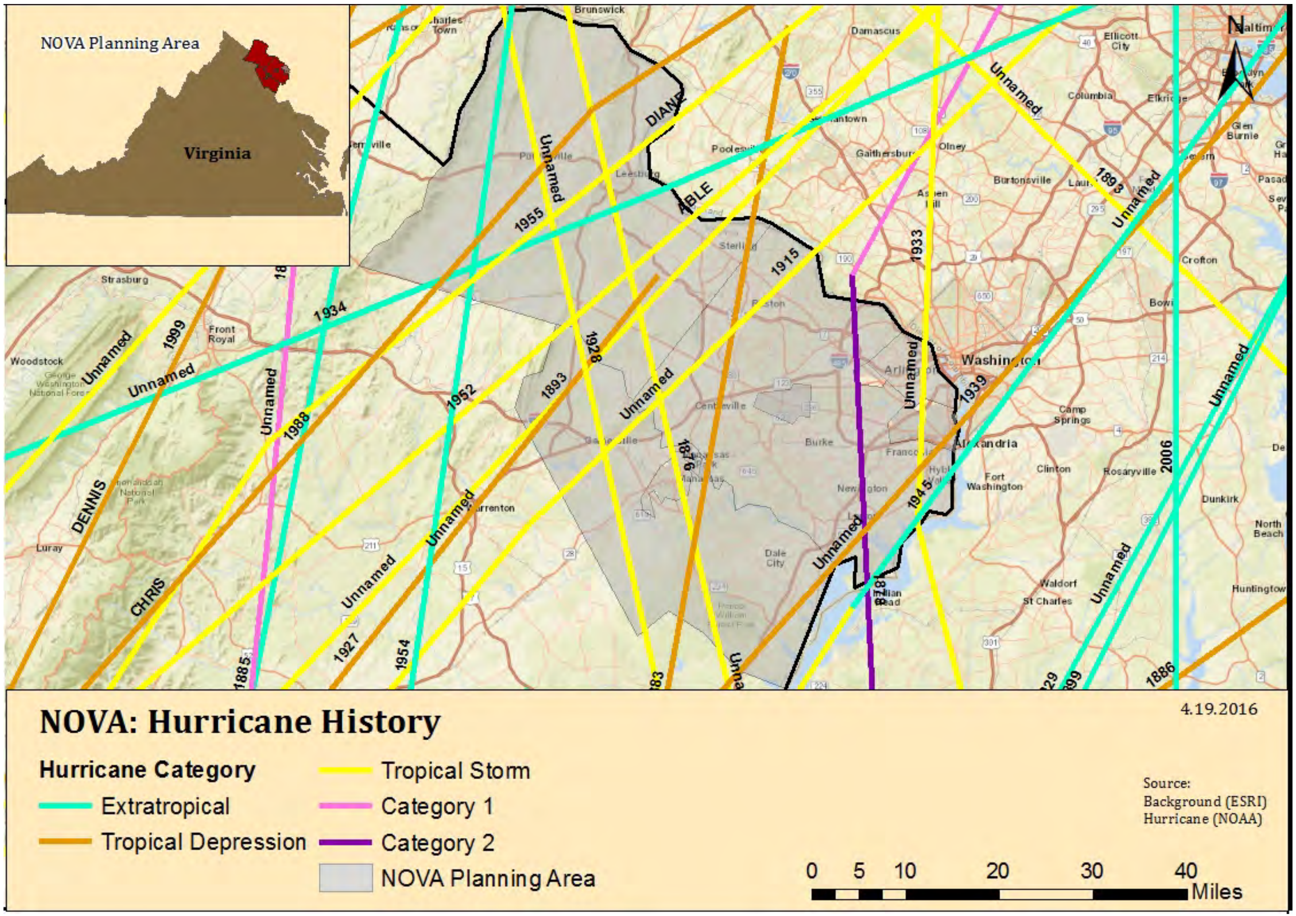


Figure 4.31. Historic Hurricane Tracks, 1851-2012

Significant Historical Events

Planning Area

On October 29, 2012, Hurricane Sandy passed by Northern Virginia on her way up the Atlantic Coast, before she turned northwest and made landfall northeast of Maryland. On her way, she brought high winds and heavy rains to the Northern Virginia regions, resulting in tropical storm force winds throughout the area, downed trees and power lines, river flooding, and some isolated flash flooding. Some structures were damaged throughout the area, mostly due to falling trees, which displaced some residents.

On September 4, 2011, Tropical Storm Lee made landfall in southern Louisiana. Several days later, the remnants of Lee arrived in Northern Virginia. Record rainfall, coming on the heels of Hurricane Irene a few days before, resulted in flooding of most of the creeks and waterways throughout Northern Virginia, leading to an estimated four fatalities, all from drowning. In Manassas Park, one home was displaced in a dry creek bed on the west side of the city.

On August 27-28, 2011, Hurricane Irene impacted the entire Northern Virginia area. Widespread power outages impacted utility production and distribution throughout the area, resulting in several utility service providers being offline and tens of thousands of residents and businesses without electrical service. Trees were also downed throughout the area, and some minor flooding was reported, including basement flooding.

On September 6-7, 2008, Tropical Storm Hanna made landfall between North and South Carolina on September 6, 2008, with maximum sustained winds of near 70 mph. The storm tracked north and then northeast through eastern Virginia, traveling just to the east of Northern Virginia through the Chesapeake Bay, before moving into the Northeast and New England. Slowly weakening, maximum sustained winds were between 40 and 50 mph at the time of the center's closest proximity to Northern Virginia. Peak winds across Northern Virginia gusted to between 35 and 45 mph and the storm produced rainfall amount of three to eight inches across the area. Weak or decaying trees were downed and flooding of low-lying areas was reported.

On September 18-19, 2003, Hurricane Isabel made landfall on the North Carolina coast. Its huge wind field was already piling water up into the southern Chesapeake Bay. By the time Isabel moved into central Virginia, it had weakened and was downgraded to a tropical storm. Isabel's eye tracked well west of the bay, but the storm's 40 to 60 mph sustained winds pushed a bulge of water northward up the bay and its tributaries producing a record storm surge. The Virginia western shore counties of the Chesapeake Bay and the tidal tributaries of the Potomac, Rappahannock, and other smaller rivers, experienced a storm surge which reached five to nine feet above normal tides.

Arlington County had two homes destroyed and 46 with major damage, while another 146 residences had minor damage. Costs of flooding and damage from falling trees were estimated at $2.5 million. In Fairfax County, 160 homes and 60 condominiums were flooded in the Belleview area south of Alexandria. Over 2,000 units had minor to moderate damage from storm surge flooding. In addition, many trees fell causing additional property damage across the county. In Prince William County, seven homes were destroyed and 24 homes and three businesses had major damage. Scattered trees and wires were down causing roads to be closed. The storm surge washed away 20 feet of embankment along the Potomac which caused one of the CSX tracks to collapse along the Cherry Hill Peninsula. Damages at Quantico Marine Base were significant. Quantico's weather station recorded a two-minute sustained wind of 54 miles per hour with a peak gust of 78 miles per hour between 11 pm and Midnight on the 18th. Damages to the base included buildings, houses, and vehicles hit by fallen trees and flooding destroyed their marina. Total damages were reported to be $9.5 million.

In Alexandria, the water level in Old Town reached 9.5 feet above sea level. Numerous businesses were flooded and the marinas were hard hit. Winds also knocked trees down around the city. Damages totaled $2 million. Storm surge water flooded the employee parking lot of Ronald Reagan Washington National Airport. In the City of Fairfax, 15 homes had major damage from trees. Fairfax County damages came to $18 million.

On September 16, 1999, Hurricane Floyd made landfall just east of Cape Fear, North Carolina, in the early morning hours of the 16th and moved north-northeast across extreme southeast Virginia to near Ocean City, Maryland, by evening on the 16th. Rain bands on the outer edge of the hurricane began to affect Northern Virginia shortly after 8:00 AM on the 15th and continued to cross the area through afternoon on the 16th. Winds and rain combined to topple 130 trees in Arlington County and the City of Alexandria. One tree damaged a home and 4,500 power outages were reported. In Fairfax County, a 61-year-old woman was killed when a tree fell onto her car and crushed it on Fair Lakes Drive. In Loudoun County, a handful of trees were downed and a road was blocked near Mt. Weather. Siding was also torn from a few homes. In Prince William County, 17 trees came down on roads and power lines, and two homes were slightly damaged by fallen trees. One business was destroyed by fallen trees and another in Falls Church was damaged. A 70-foot oak tree fell onto a home and tore a hole in the 2nd floor, shattering windows and tearing off rain gutters. The tree also damaged a detached garage and a swing set. A few trees were downed in the Manassas area.

On September 6, 1996, the rapid runoff produced by the heavy rains from Hurricane Fran caused substantial, damaging, and in some cases record river flooding across much of the Northern Virginia watershed from late on the 6th until early on the 10th. Flash flooding on the 6th rapidly became river flooding late on the 6th along the headwaters of the Potomac, Shenandoah, and Rappahannock River basins, and continued throughout the basins over the weekend and into early the following week. Crests at gauging points in these basins were similar to those in January 1996 across the Lower Main Stem of the Potomac. Levels were one to five feet higher across the Upper Main Stem Potomac and Rappahannock Rivers. The Shenandoah Basin had levels similar to the October 1942 flood with three points reaching record levels (Lynnwood, Cootes Store, and Strasburg). There were numerous road closures, rescues, evacuations, washed out and damaged bridges, and culverts; the flood also produced major agricultural damage. Debris covered pasture and farmland, and filled small creeks and streams to levels higher than surrounding roads, which redirected the natural stream flow. River sand and mud covered streets and multiple levels of homes and businesses. There were several electric and phone outages. Three deaths occurred in the northern half of Virginia due to flash flooding.

Washington National Airport in southern Arlington County had damage with the river crest late Sunday into Monday morning. Flooding tore out security fence and flooded boat houses where rescue equipment is kept, while mud and debris had to be removed from the grounds.

In June 1972, Hurricane Agnes, in its tropical storm stage, caused torrential rains over Virginia and the Mid-Atlantic States. All rivers in Virginia were affected. Ten inches of rain fell over Northern Virginia resulting in widespread flash flooding and major flooding on the Potomac River.

On October 22-23, 1878, Hurricane Gale’s eye made landfall at Cape Fear, NC and moved north across Richmond and Washington, DC, and seemed to lose little strength. The storm was thought to resemble that of Hurricane Hazel in 1954. Winds downed trees and fences and unroofed homes, and very high tides occurred on the coast. Fields of corn were submerged in the ensuing flood around Washington, DC. Rock Creek became a raging river, but produced little damage. Many young shade trees in the area were leveled. Telegraph lines fell between Baltimore and New York. Flooding from the Potomac inundated many basements and county roads crossing the Stickfoot Branch of the Anacostia River were washed out.

Arlington County
From 1950 through 2015, NCDC recorded four tropical storm events as impacting Arlington County, resulting in more than $4.6 million in property damages and 26 injuries.

Fairfax County
From 1950 through 2015, NCDC reports describe six occurrences of tropical storms impacting Fairfax County. These tropical storms caused more than $18 million in property and crop damages, one fatality, and one injury.

Loudoun County
NCDC recorded two tropical storms that impacted NCDC from 1950 through 2015. These events resulted in approximately $5,000 in damages.

Prince William County
NCDC recorded impacts to Prince William County from three tropical storms between 1950 and 2015, resulting in more than $14.5 million in property damages and approximately $50,000 in crop damages. No injuries or fatalities were attributed to these events.

City of Alexandria
From 1950 through 2015, NDCD recorded four occurrences of tropical storms impacting the City of Alexandria. Damage reports for these occurrences are captured in the reports for larger geographic areas, cannot be reliably separated to account for specific damages to the City of Alexandria.

City of Fairfax
NDCD reports verify that the City of Fairfax experienced six tropical storms from 1950 through 2015. Damage reports for these occurrences are captured in the reports for larger geographic areas, cannot be reliably separated to account for specific damages to the City of Fairfax.

City of Falls Church
For the City of Falls Church, NCDC reports verify that four tropical storms impacted the City between 1950 and 2015. Damage reports for these occurrences are captured in the reports for larger geographic areas, cannot be reliably separated to account for specific damages to the City of Falls Church.

City of Manassas
NCDC reports indicate that three tropical storms impacted the City of Manassas from 1950 through 2015. Damage reports for these occurrences are captured in the reports for larger geographic areas, cannot be reliably separated to account for specific damages to the City of Manassas.

City of Manassas Park
NCDC reports indicate that three tropical storms impacted the City of Manassas Park from 1950 through 2015. Damage reports for these occurrences are captured in the reports for larger geographic areas, cannot be reliably separated to account for specific damages to the City of Manassas Park.

Town of Clifton
NCDC reports indicate that no tropical storms impacted the Town of Clifton from 1950 through 2015.

Town of Dumfries
NCDC reports indicate that two tropical storms impacted the Town of Dumfries from 1950 through 2015. Damage reports for these occurrences are captured in the reports for larger geographic areas, cannot be reliably separated to account for specific damages to the Town of Dumfries.

Town of Haymarket
NCDC reports indicate that one tropical storm impacted the Town of Haymarket from 1950 through 2015. Damage reports for these occurrences are captured in the reports for larger geographic areas, cannot be reliably separated to account for specific damages to the Town of Haymarket.

Town of Herndon
NCDC reports indicate that two tropical storms impacted the Town of Herndon from 1950 through 2015. Damage reports for these occurrences are captured in the reports for larger geographic areas, cannot be reliably separated to account for specific damages to the Town of Herndon.

Town of Leesburg
NCDC reports indicate that one tropical storm impacted the Town of Leesburg from 1950 through 2015. Damage reports for these occurrences are captured in the reports for larger geographic areas, cannot be reliably separated to account for specific damages to the Town of Leesburg.

Town of Lovettsville
NCDC reports indicate that no tropical storms impacted the Town of Lovettsville from 1950 through 2015.

Town of Middleburg
NCDC reports indicate that no tropical storms impacted the Town of Middleburg from 1950 through 2015.

Town of Occoquan
NCDC reports indicate that no tropical storms impacted the Town of Occoquan from 1950 through 2015.

Town of Purcellville
NCDC reports indicate that no tropical storms impacted the Town of Purcellville from 1950 through 2015.

Town of Quantico
NCDC reports indicate that one tropical storm impacted the Town of Quantico from 1950 through 2015. Damage reports for these occurrences are captured in the reports for larger geographic areas, cannot be reliably separated to account for specific damages to the Town of Quantico.

Town of Round Hill
NCDC reports indicate that no tropical storms impacted the Town of Round Hill from 1950 through 2015.

Town of Vienna
NCDC reports indicate that one tropical storm impacted the Town of Vienna from 1950 through 2015. Damage reports for these occurrences are captured in the reports for larger geographic areas, cannot be reliably separated to account for specific damages to the Town of Vienna.

d. Risk Assessment

i. Probability of Future Occurrences

Although not likely to experience a direct hit from a Category 4 or Category 5 hurricane, the Northern Virginia region remains susceptible to the effects from such storms making landfall along the Atlantic coast of the United States. According to HAZUS^{MH}, the Northern Virginia region can expect to see hurricane force winds (with peak gust wind speeds of up to 89 miles per hour) at least once every 50 years. The effects of tropical storms will be more frequent, particularly from those storms making landfall further south and proceeding up the Atlantic seaboard.

ii. Impact & Vulnerability

Based on a range of long-term global climate models under IPCC warming scenarios, it is likely that hurricanes will become more intense, with stronger winds and heavier precipitation throughout the 21st century. Using an ensemble-mean of 18 climate models, IPCC A1B emissions scenario[11], and operational hurricane forecast models, one study[12] showed a decrease in the total number of tropical storms and hurricanes, but an increase in the number of intense hurricanes, particularly Category 4 or 5 hurricanes.

Historical evidence shows that the Northern Virginia region is vulnerable to damaging hurricane and tropical storms. For purposes of this assessment, vulnerability is quantified for hurricane and tropical storm-force winds. For the most part, the Northern Virginia region faces a uniform susceptibility to hurricanes and tropical storm winds. Though historical data and computer models indicate that Fairfax County may on average face higher wind speeds than other areas, the difference in peak gusts is not deemed significant (less than 20 miles per hour). However, based on the higher amount of residential and commercial exposure, Fairfax and Arlington counties are considered to be slightly more vulnerable to these winds.

iii. Risk

The hurricane wind analysis for the HIRA was completed using HAZUS^{MH}. The model uses state of the art wind field models, calibrated and validated hurricane data. Wind speed has been calculated as a function of central pressure, translation speed, and surface roughness. This assessment is based on a Level 1 analysis. A Level 1 analysis involves using the HAZUS^{MH} provided data with no local data adjustments. This is an acceptable level of information for mitigation planning; future versions of this plan can be enhanced with Level 2 and 3 analyses. Dollar values shown in this report should only be used to represent cost of large aggregations of building types. Highly detailed, building specific, loss estimations have not been completed for this analysis as they require additional local data inputs, which could not be accomplished for this update. Note that storm surge and waves have not been implemented in the present version of the Hurricane Model[13].

Additional information generated by HAZUS^{MH} for the planning area can be found in Appendix D, including additional imagery of wind fields for the area, presented by participating jurisdiction.

Loss estimation for this HAZUS^{MH} module is based on specific input data. The first type of data includes square footage of buildings for specified types or population. The second type of data includes information on the local economy that is used in estimating losses. Table 4.82 displays the economic loss categories used to calculate annualized losses by HAZUS^{MH}.

Table 4.82. HAZUS^{MH} direct economic loss categories and descriptions.

Category Name	Description of Data Input into Model	HAZUS^{MH} Output
Building	Cost per sq. ft. to repair damage by structural type and occupancy for each level of damage	Cost of building repair or replacement of damaged and destroyed buildings
Contents	Replacement value by occupancy	Cost of damage to building contents
Inventory	Annual gross sales in $ per sq. ft.	Loss of building inventory as contents related to business activities
Relocation	Rental costs per month per sq. ft. by occupancy	Relocation expenses (for businesses and institutions)
Income	Income in $ per sq. ft. per month by occupancy	Capital-related incomes losses as a measure of the loss of productivity, services, or sales
Rental	Rental costs per month per sq. ft. by occupancy	Loss of rental income to building owners
Wage	Wages in $ per sq. ft. per month by occupancy	Employee wage loss as described in income loss

For the hurricane wind scenario models, the built-in default inventory of assets - known as the Comprehensive Data Management System (CDMS) - was utilized. No adjustments were made to the inventory to account for any locally-reporting critical assets. Therefore, discrepancies may appear related to critical assets between self-reported data, such as historic occurrences, and HAZUS-generated data, such as the data in this section. See Appendix D for a description of the methodology used for the hurricane wind scenarios, and the grouping of counties, cities, and towns in each model.

Annualized loss is defined as the expected value of loss in any one year, and is developed by aggregating the losses and exceedance probabilities for the 10-, 20-, 50-, 100-, 200-, 500-, and

1000-year return periods. HAZUS^{MH} estimates direct and indirect economic losses due to hurricane wind speeds that include:

- Damage to buildings and contents
- Economic loss (business interruptions)
- Social Impacts

The figures contained in Appendix D illustrate the 3-second peak wind gust speeds for the 100- and 1000-year return periods. Wind speeds are based on estimated 3-second gusts in open terrain at 10 meters above ground at the centroid of each census track. Buildings that must be designed for a 100-year mean recurrence interval wind event include[14]:

- Buildings where more than 300 people congregate in one area
- Buildings that will be used for hurricane or other emergency shelter
- Buildings housing a day care center with capacity greater than 150 occupants
- Buildings designed for emergency preparedness, communication, or emergency operation center or response
- Buildings housing critical national defense functions
- Buildings containing sufficient quantities of hazardous materials

For Northern Virginia, HAZUS^{MH} wind gust data for the 1000-year and 100-year return period events indicate that the southeastern portions of Northern Virginia are generally more likely to experience the highest wind gusts in both scenarios. This corresponds to the strongest winds associated with hurricanes typically occurring in the storm's right front quadrant (relative to the direction of the storm's movement). For a 1000-year event, southeastern sections of both Fairfax and Prince William counties can expect to see gusts topping 90 mph. Although slightly lower wind gusts are expected in this scenario in western Loudoun County and far western Prince William County, gusts may still exceed 80 mph in both locations. For a 100-year event, wind gusts of slightly greater than 70 mph may impinge on portions of Fairfax and Arlington counties, with gusts of between 50 and 70 mph expected elsewhere in Northern Virginia.

Critical Facility Risk

HAZUS^{MH} estimates very minor expected damage to critical facilities for the different return periods.

- The expected loss of use for the 100-year event is less than one day for the planning area as a whole. EOCs and hospitals for all the modeled return periods result in 100% functionality.
- For the 1000-year event, hospitals in the areas of Arlington and Fairfax counties may experience a least moderate damage, resulting in at least 50% functionality. Hospitals in the Loudoun and Prince William counties areas may expect to retain full functionality even in a 1000-year hurricane.
- Fire stations, police stations, and schools throughout the planning area may expect to retain the vast majority of their functionality even during a 1000-year hurricane event, and would have less than a day of loss of function.

The HAZUS^{MH} model also estimates the number of households that are expected to be displaced from their homes due to the hurricane and the number of displaced people that will require accommodations in temporary public shelters. Based on the probabilistic analysis, one household in Alexandria and two in Arlington County would be displaced and seek shelter from a 1000-

year event, though no people would be expected to require short-term sheltering. In Fairfax County and the City of Fairfax, 46 households would be displaced, with five persons requiring short-term sheltering from a 1000-year event. For Loudoun County and its associated townships, even a 1000-year event would not displace any households or persons, and no one would require short-term sheltering; the same is the case for Prince William County, its associated towns, the City of Manassas, and the City of Manassas Park.

Existing Buildings and Infrastructure Risk

The most at-risk buildings to high wind events are assumed to include manufactured homes, along with residential structures that were built many years ago (due to probable deterioration and less stringent building code enforcement during original construction).

Table 4.83 summarizes the HAZUS^{MH} information for the Northern Virginia region. Residential buildings make up the majority of damages due to hurricane winds. The more frequent return periods result in fewer damages that fall within the moderate to destruction classifications. The 500- and 100-year return periods result in severe damage and destruction to buildings in the Northern Virginia region.

Table 4.83. HAZUS^{MH} Estimate: Number of buildings damaged.

Return Period	Minor		Moderate		Severe		Destruction		Total	
	Residential	Total	Residential	Total	Residential	Total	Residential	Total	Residential	Total
10	0	0	0	0	0	0	0	0	0	0
20	0	0	0	0	0	0	0	0	0	0
50	92	134	0	0	0	0	0	0	92	134
100	426	564	8	11	0	0	0	0	434	575
200	517	2,050	81	84	0	0	0	0	598	2,134
500	10,277	10,906	705	736	1	2	0	0	10,983	11,644
1000	22,999	24,228	2,111	2,212	4	11	8	8	25,122	26,459

In the case of a 100-year hurricane event, HAZUS^{MH} estimates the building loss for Northern Virginia to be approximately \$77.9 million. Should the region experience a 1000-year hurricane event, the model estimates the building loss for the region would be approximately \$1.2 billion. Tables 4.84, 4.85, and 4.86 provide summaries of losses by jurisdiction.

Note that details for some of the participating jurisdictions were included with other jurisdictions by the model, and could not be reliably separated out in this Level 1 assessment.

Table 4.84. HAZUS^{MH} Estimate: Total Annualized Building Loss by Jurisdiction.

Jurisdiction	Building Loss	Content Loss	Inventory Loss	Relocation Loss	Income Loss	Rental Loss	Wage Loss	Total Loss
Arlington County	$613,000	$77,000	$0	$26,000	$2,000	$17,000	$3,000	**$738,000**
Fairfax County and the City of Fairfax	$2,632,000	$388,000	$1,000	$78,000	$5,000	$33,000	$6,000	**$3,143,000**

Table 4.84. HAZUS^MH Estimate: Total Annualized Building Loss by Jurisdiction.								
Jurisdiction	**Building Loss**	**Content Loss**	**Inventory Loss**	**Relocation Loss**	**Income Loss**	**Rental Loss**	**Wage Loss**	**Total Loss**
Town of Herndon	*Included*	*Included*	*Included*	*Included*	*Included*	*Included*	*Included*	*Included*
Town of Vienna	*Included*	*Included*	*Included*	*Included*	*Included*	*Included*	*Included*	*Included*
Town of Clifton	*Included*	*Included*	*Included*	*Included*	*Included*	*Included*	*Included*	*Included*
Loudoun County	$684,000	$104,000	$0	$24,000	$1,000	$8,000	$1,000	**$822,000**
Town of Leesburg	*Included*	*Included*	*Included*	*Included*	*Included*	*Included*	*Included*	*Included*
Town of Lovettsville	*Included*	*Included*	*Included*	*Included*	*Included*	*Included*	*Included*	*Included*
Town of Purcellville	*Included*	*Included*	*Included*	*Included*	*Included*	*Included*	*Included*	*Included*
Town of Middleburg	*Included*	*Included*	*Included*	*Included*	*Included*	*Included*	*Included*	*Included*
Town of Round Hill	*Included*	*Included*	*Included*	*Included*	*Included*	*Included*	*Included*	*Included*
Prince William County	$779,000	$140,000	$0	$0	$0	$0	$0	**$919,000**
Town of Dumfries	*Included*	*Included*	*Included*	*Included*	*Included*	*Included*	*Included*	*Included*
Town of Haymarket	*Included*	*Included*	*Included*	*Included*	*Included*	*Included*	*Included*	*Included*
Town of Occoquan	*Included*	*Included*	*Included*	*Included*	*Included*	*Included*	*Included*	*Included*
Town of Quantico	*Included*	*Included*	*Included*	*Included*	*Included*	*Included*	*Included*	*Included*
City of Alexandria	$451,000	$65,000	$0,000	$20,000	$2,000	$12,000	$3,000	**$553,000**
City of Falls Church	$42,000	$7,000	$0	$2,000	$0	$1,000	$0	**$51**,000
City of Manassas	$0	$0	$0	$0	$0	$0	$0	**$0**
City of Manassas Park	$0	$0	$0	$0	$0	$0	$0	**$0**
Total	**$5,201**,000	**$781**,000	**$1**,000	**$150**,000	**$10**,000	**$71**,000	**$137**,000	**$5,398**,000

Table 4.85. HAZUS^MH Estimate: 100-Year Hurricane Building Loss by Jurisdiction.								
Jurisdiction	**Building Loss**	**Content Loss**	**Inventory Loss**	**Relocation Loss**	**Income Loss**	**Rental Loss**	**Wage Loss**	**Total Loss**
Arlington County	$6,358,000	$505,000	$0	$12,000	$0	$0	$0	**$6,875**,000
Fairfax County and the City of Fairfax	$34,415,000	$4,434,000	$0	$9,000	$0	$0	$0	**$38,858,000**
Town of Herndon	Included	Included	Included	Included	Included	Included	Included	Included
Town of Vienna	Included	Included	Included	Included	Included	Included	Included	Included
Town of Clifton	Included	Included	Included	Included	Included	Included	Included	Included
Loudoun County	$7,662,000	$1,044,000	$0	$0	$0	$0	$0	**$8,706**,000
Town of Leesburg	Included	Included	Included	Included	Included	Included	Included	Included
Town of Lovettsville	Included	Included	Included	Included	Included	Included	Included	Included
Town of Purcellville	Included	Included	Included	Included	Included	Included	Included	Included
Town of Middleburg	Included	Included	Included	Included	Included	Included	Included	Included
Town of Round Hill	Included	Included	Included	Included	Included	Included	Included	Included

Table 4.85. HAZUS^{MH} Estimate: 100-Year Hurricane Building Loss by Jurisdiction.								
Jurisdiction	**Building Loss**	**Content Loss**	**Inventory Loss**	**Relocation Loss**	**Income Loss**	**Rental Loss**	**Wage Loss**	**Total Loss**
Prince William County	$14,481,000	$1,333,000	$0	$6,000	$0	$0	$0	**$15,820**,000
Town of Dumfries	Included	Included	Included	Included	Included	Included	Included	Included
Town of Haymarket	Included	Included	Included	Included	Included	Included	Included	Included
Town of Occoquan	Included	Included	Included	Included	Included	Included	Included	Included
Town of Quantico	Included	Included	Included	Included	Included	Included	Included	Included
City of Alexandria	$5,409,000	$590,000	$0	$8,000	$0	$0	$0	**$6,007**,000
City of Falls Church	$465,000	$258,000	$0	$0	$0	$0	$0	**$723**,000
City of Manassas	$723,000	$57,000	$0	$0	$0	$0	$0	**$780**,000
City of Manassas Park	$243,000	$1,000	$0	$0	$0	$0	$0	**$244**,000
Total	**$69,756**,000	**$8,222**,000	**$0**	**$35**,000	**$0**	**$0**	**$0**	**$42,914**,000
								78,004,000

Table 4.86 HAZUS^{MH} Estimate: 1000-Year Hurricane Building Loss by Jurisdiction								
Jurisdiction	**Building Loss**	**Content Loss**	**Inventory Loss**	**Relocation Loss**	**Income Loss**	**Rental Loss**	**Wage Loss**	**Total Loss**
Arlington County	$129,966,000	$11,858,000	$15,000	$5,533,000	$216,000	$3,955,000	$78,000	**$151,620**,000
Fairfax County and the City of Fairfax	$529,472,000	$64,624,000	$69,000	$15,476,000	$729,000	$7,663,000	$264,000	**$618,298**,000
Town of Herndon	Included	Included	Included	Included	Included	Included	Included	Included
Town of Vienna	Included	Included	Included	Included	Included	Included	Included	Included
Town of Clifton	Included	Included	Included	Included	Included	Included	Included	Included
Loudoun County	$134,753,000	$14,012,000	$18,000	$4,632,000	$0	$1,687,000	$0	**$155,102**,000
Town of Leesburg	Included	Included	Included	Included	Included	Included	Included	Included
Town of Lovettsville	Included	Included	Included	Included	Included	Included	Included	Included
Town of Purcellville	Included	Included	Included	Included	Included	Included	Included	Included
Town of Middleburg	Included	Included	Included	Included	Included	Included	Included	Included
Town of Round Hill	Included	Included	Included	Included	Included	Included	Included	Included
Prince William County	$184,839,000	$18,273,000	$26,000	$5,690,000	$74,000	$44,000	$2,196,000	**$211,142**,000
Town of Dumfries	Included	Included	Included	Included	Included	Included	Included	Included
Town of Haymarket	Included	Included	Included	Included	Included	Included	Included	Included
Town of Occoquan	Included	Included	Included	Included	Included	Included	Included	Included
Town of Quantico	Included	Included	Included	Included	Included	Included	Included	Included
City of Alexandria	$100,724,000	$11,129,000	$18,000	$4,096,000	$429,000	$2,886,000	$155,000	**$119,437**,000

Table 4.86 HAZUS^{MH} Estimate: 1000-Year Hurricane Building Loss by Jurisdiction								
Jurisdiction	**Building Loss**	**Content Loss**	**Inventory Loss**	**Relocation Loss**	**Income Loss**	**Rental Loss**	**Wage Loss**	**Total Loss**
City of Falls Church	$7,482,000	$927,000	$1,000	$254,000	$0	$127,000	$0	**$8,790,000**
City of Manassas	$14,600,000	$1,181,000	$3,000	$553,000	$0	$234,000	$0	**$16,571,000**
City of Manassas Park	$5,346,000	$180,000	$26,000	$5,690,000	$74,000	$2,196,000	$44,000	**$5,817,000**
Total	**$1,107,479,000**	**$122,184,000**	**$196,000**	**$41,924,000**	**$1,522,000**	**$18,792,000**	**$2,737,000**	**$1,286,777,000**

Overall Loss Estimates and Ranking

Based on the HAZUS^{MH} models, the annualized losses due to hurricanes in Northern Virginia total approximately $6.5 million. The models used the HAZUS^{MH} probabilistic hurricane scenario to compute loss which takes into the expected value of loss in any one year, and is developed by aggregating the losses and exceedance probabilities for the 10-, 20-, 50-, 100-, 200-, 500-, and 1000-year return periods.

On an annual basis, NCDC records estimate property and crop losses in Northern Virginia due to severe storm and high wind events, including tropical storms and hurricanes, totals an estimated $1.5 million. Actual losses for the period of record (1950-2015) total more than $101.6 million. The details of these estimates, by participating jurisdiction, were presented earlier in this section, in Table 4.75.

The Commonwealth of Virginia's 2013 Hazard Mitigation Plan ranking was based largely on the NCDC database. The update to the Northern Virginia plan used this same framework to establish a common system for evaluating and ranking hazards. In determining a score and ranking for high wind, the geographic extent score for each jurisdiction is based on the average maximum wind speed throughout the entire jurisdiction as determined through GIS analysis of HAZUS^{MH} generated data. The high wind hazard ranking factors damaging wind events that include severe thunderstorms, hurricanes, and non-thunderstorm related wind events.

Based on this analysis and available data, the high wind/severe storm hazard is ranked as being 'High' for all jurisdictions in Northern Virginia.

Although a separate ranking was not made for hurricanes, historical damage due to hurricane wind is included in the 2016 ranking assessment for severe storms/high wind below. The high wind/severe storm hazard incorporates both thunderstorm wind and hurricane/tropical storm winds along with non-thunderstorm related wind damage.

Refer to the Risk Assessment Methodology section of the HIRA for a full description of the methodology and the limitations of the data used for ranking the hazards. NCDC data, although somewhat limited, provides a comprehensive historical record of natural hazard events and damages.

For the 2016 plan update, the qualitative assessment was performed by jurisdiction. Given the widespread nature of the hazard, however, all counties, cities, and towns were determined to have the same qualitative risk to the hazard. Therefore, to avoid repetition, Table 4.87 provides the results of the qualitative assessment for all participating jurisdictions, as all jurisdictions were found to have the same results.

Table 4.87. 2016 Qualitative Assessment for Hurricane & Tropical Storm-Force Winds.

	Probability	Impact	Spatial Extent	Warning Time	Duration
Risk Level	Highly Likely	Critical	Moderate	12 to 24 hours	Less than one week

IX. Tornadoes

NOTE: As part of the 2016 plan update, the Tornado hazard was reexamined and new analyses performed. These new analyses included, but was not limited to: 1) refreshing the hazard profile; 2) updating the previous occurrences; 3) determining number of hazard events and losses by jurisdiction using NCDC and other data sources where available; 4) updating the assessment of risk by jurisdiction based on new data; 5) ranking of the hazard by jurisdiction using the methodology described in detail in Chapter 4 Section IV Ranking and Analysis Methodologies. Each section of the plan was also reformatted for improved clarity and new maps and imagery, when available and appropriate, were inserted.

A. Hazard Profile

1. Description

A tornado is a violent windstorm characterized by a twisting, funnel-shaped cloud extending to the ground. Tornadoes are most often generated by thunderstorm activity (but sometimes result from hurricanes and other tropical storms) when cool, dry air intersects and overrides a layer of warm, moist air forcing the warm air to rise rapidly. The damage caused by a tornado is a result of the high wind velocity and wind-blown debris, also accompanied by lightning or large hail. According to the NWS, tornado wind speeds normally range from 40 to more than 300 miles per hour. The most violent tornadoes have rotating winds of 250 miles per hour or more and are capable of causing extreme destruction and turning normally harmless objects into deadly missiles.

According to NOAA, each year an average of over 800 tornadoes is reported nationwide, resulting in 80 deaths and 1,500 injuries, on average. They are more likely to occur during the spring and early summer months of March through June and can occur at any time of day, but are more likely to form in the late afternoon and early evening. Most tornadoes are a few dozen yards wide and only touchdown briefly, but even small, short-lived tornadoes can inflict tremendous damage. Highly destructive tornadoes may carve out a path over a mile wide and several miles long.

Waterspouts are weak tornadoes that form over warm water and are most common along the Gulf Coast and southeastern states. Waterspouts occasionally move inland, becoming tornadoes that cause damage and injury. However, most waterspouts dissipate over the open water causing threats only to marine and boating interests. Typically, a waterspout is weak and short-lived, and because they are so common, most go unreported unless they cause damage.

The destruction caused by tornadoes ranges from light to devastating depending on the intensity, size, and duration of the storm. Typically, tornadoes cause the greatest damage to structures of light construction such as residential homes (particularly mobile homes), and tend to remain localized in impact. The Fujita-Pearson Scale for Tornadoes (F Scale) was developed in 1971 to rate tornado intensity based on associated damages. An Enhanced Fujita Scale (EF Scale) was developed and implemented operationally in 2007 and is shown in Table 4.88, along with a comparison of the original F Scale.

Table 4.88. Enhanced Fujita Scale for Tornadoes Vs. Fujita Scale.

Fujita Scale			Enhanced Fujita Scale	
F Number	**Fastest 1/4-mile (mph)**	**3 Second Gust (mph)**	**EF Number**	**3 Second Gust (mph)**
0	40-72	45-78	0	65-85
1	73-112	79-117	1	86-110
2	113-157	118-161	2	111-135
3	158-207	162-209	3	136-165
4	208-260	210-261	4	166-200
5	261-318	262-317	5	Over 200

2. Geographic Location/Extent

According to the NOAA Storm Prediction Center (SPC), the highest concentration of tornadoes in the United States has been in Oklahoma, Texas, Kansas and Florida respectively. Although the Great Plains region of the central United States does favor the development of the largest and most dangerous tornadoes (earning the designation of 'tornado alley'), Florida experiences the greatest number of tornadoes per square mile of all states (SPC, 2002). Although the region is located outside of "tornado alley" and does not experience as many tornadoes as Florida, there are many examples of tornadoes tracking through Northern Virginia. Figure 4.32 shows tornado activity in the United States based on the number of recorded tornadoes per 1,000 square miles.

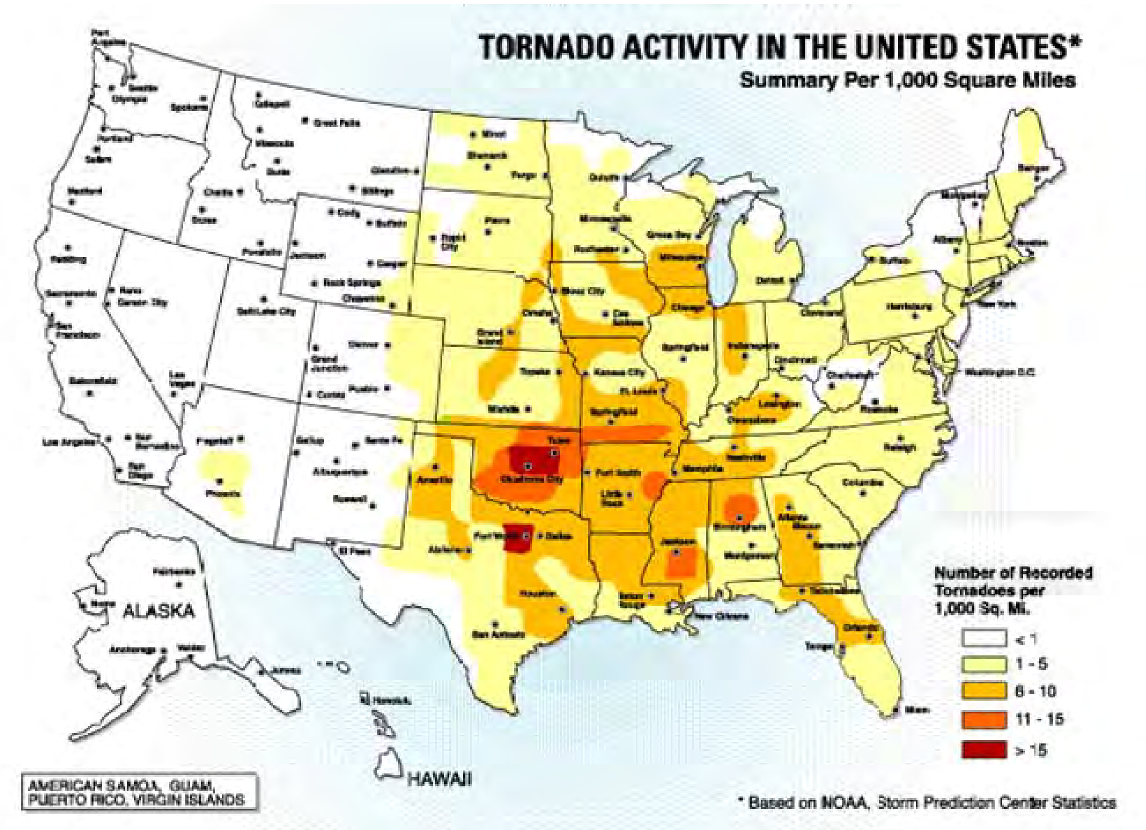


Figure 4.32. Tornado Activity in the United States
Source: American Society of Civil Engineers

The tornadoes associated with tropical cyclones are most frequent in September and October when the incidence of tropical storm systems is greatest. This type of tornado usually occurs around the perimeter of the storm, and most often in the northeast quadrant and ahead of the storm path or the storm center as it comes ashore. These tornadoes commonly occur as part of large outbreaks and generally move in an easterly direction.

3. Magnitude or Severity

When compared with other states, Virginia ranks 29th in the nation in number of tornado events, 25th in tornado deaths, 26th in tornado injuries, and 28th in damages. These rankings are based upon data collected for all states and territories for tornado events between 1950 and 1994 by NOAA’s SPC. Most tornadoes that occur in Virginia are less intense (F0 through F2 on the Fujita-Pearson Scale) than those that occur elsewhere in the country, but occasionally they are of significant magnitude causing major damage and destruction.

From 1950 through the year 2001, 376 tornadoes were documented in Virginia (an average of seven tornadoes per year). Nationally, statistics have suggested that prior to 1990, only a third of all tornadoes were actually recorded. Many occurred in unpopulated areas or caused little property damage and therefore are not reported to the NWS, while others may have been recorded separately as high wind events instead of tornadoes. Thus, the actual average number of tornadoes that Virginia experiences in a given year is likely higher than historical NOAA records indicate. Tornado fatality records began in 1916.

According to NCDC records, the Northern Virginia region experienced approximately 70 funnel cloud and tornado events from 1950 through 2015. Figure 4.33 graphically depicts the touchdown points and tracks of the tornadoes, as well as the Fujita scale rating for each of those events. As can be seen in the figure, most of these events were recorded as either F0 or F1 events although there have also been some stronger F2 and F3 events.

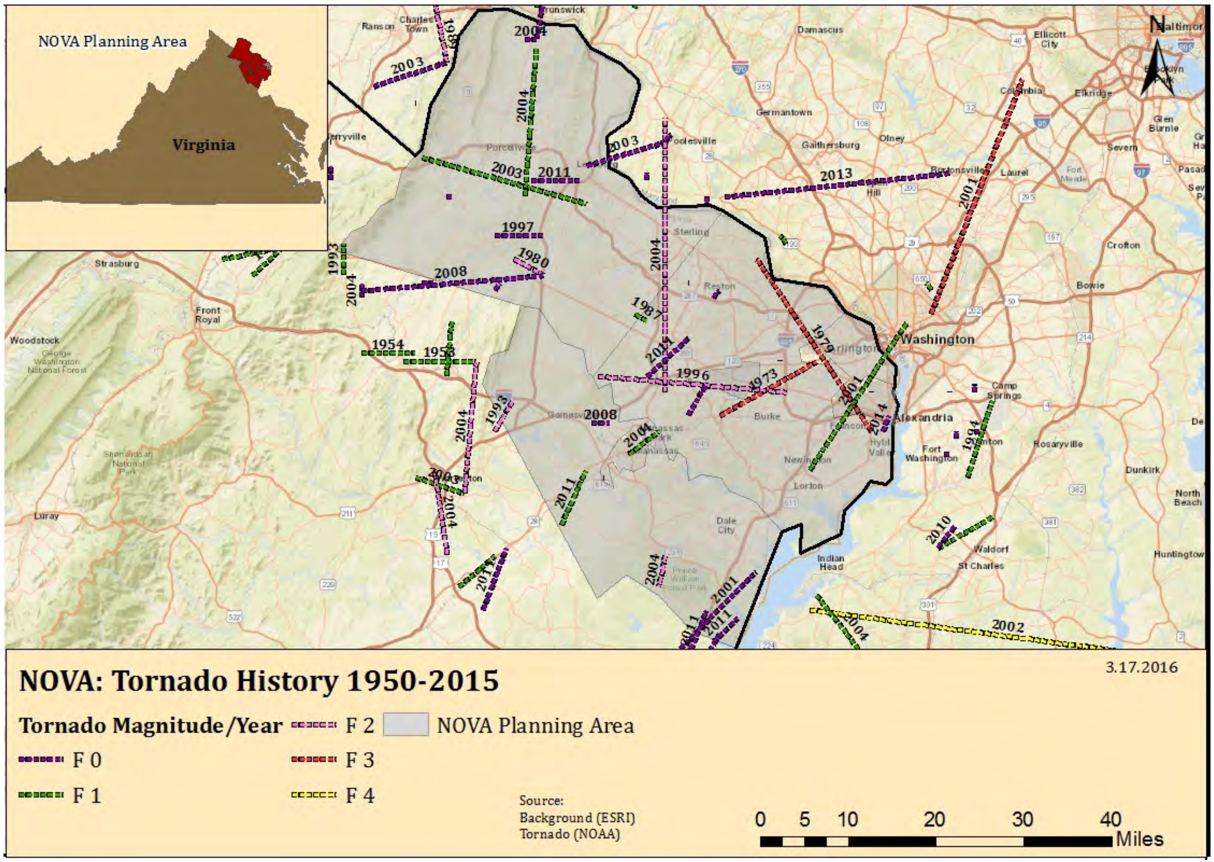


Figure 4.33. Historic Tornado Tracks, 1950 to 2015.

In total, these tornado events are reported to have caused approximately four fatalities, 12 injuries and approximately $13.6 million in property and crop damages as summarized by jurisdiction in Table 4.89. More detailed information on each of these historical tornado events can be obtained through the NCDC Storm Event database.

Table 4.89. NCDC Tornado Events in the Northern Virginia Region, 1950–2015, Based on NCDC Data.					
Tornado Events in Northern Virginia					
Years of Record: 1950 - 2015	**Annualized Property and Crop Damage**	**Total Property and Crop Damage**	**Injuries**	**Fatalities**	**Number of Events**
Arlington County	$16,923	$1,100,000	0	2	2
Fairfax County	0	0	0	0	0
Loudoun County	$78,200	$5,083,000	2	0	25
Prince William County	$60,185	$3,912,000	0	1	17
City of Alexandria	0	0	0	0	0
City of Fairfax**	0	0	0	0	0
City of Falls Church	$38,462	$2,500,000	0	0	1
City of Manassas*	$0	$0	0	0	2
City of Manassas Park*	$0	$0	0	0	1
Town of Clifton	$0	$0	0	0	0
Town of Dumfries	$0	$0	0	0	2
Town of Haymarket	$0	$0	0	0	0
Town of Herndon	$0	$0	0	0	0
Town of Leesburg	$6,215	$404,000	0	0	5
Town of Lovettsville	$9,054	$588,500	0	0	6
Town of Middleburg	$123	$8,000	0	0	3
Town of Occoquan	$0	$0	0	0	0
Town of Purcellville	$0	$0	0	0	0
Town of Quantico	$385	$25,000	10	1	3
Town of Round Hill	$0	$0	0	0	1
Town of Vienna	$0	$0	0	0	0
Total	$209,662	$13,628,000	12	4	70

*NCDC database does not contain damage data for the September 17, 2004 tornado events that impacted Manassas and Manassas Park

**NCDC has no record of any tornado events having impacted the City of Fairfax since 1950; this conflicts with other sources indicating that tornadoes did impact the City, causing damage on September 5, 1979 as a result of Hurricane David.

4. Previous Occurrences

Supplemental to the previous occurrences recorded by NCDC (shown in Table 4.89), the following events are notable within the planning area.

On June 20, 2015, an EF-0 tornado produced a 2.1-mile path of damage that was approximately 100 yards wide. The bulk of the damage occurred at the Broad Run golf training center in Prince William County, where about a half-dozen softwood trees between 12 and 18 inches in diameter were snapped approximately 4 feet above the ground. The damage at the baseball fields at the intersection of Route 28 and Godwin Road included a scoreboard secured by 4x4s being snapped, along with baseball dugout roofs lifted and blown away. The damage was sporadic along the 2.1-mile path.

On October 15, 2014, severe thunderstorms produced a confirmed EF-0 tornado near Belle Haven in Eastern Fairfax County. The tornado created a path of vegetative damage for approximately 1.5 miles. The tornado continued north across the Belle Haven Country Club where larger tree limbs were snapped. The tornado then briefly moved into the City of Alexandria, likely lifting across Interstate 495 at the intersection of George Washington Parkway, where large tree branches were also downed. Several large tree branches were snapped in the immediate adjacent neighborhood to the north before the radar couplet signature weakened after 12:26 pm. Estimated maximum winds were 55-65 mph.

On May 16, 2014, a tornado touched down near Sunny Bank in Loudoun County. A large tree was uprooted, and other trees and large branches were found uprooted and collapsed in different directions, along with branches snapped or twisted at various points along Light Horse Court.

On April 27, 2011, an EF-1 tornado snapped numerous trees along Carriage Ford Road, Aden Road and Garman Drive in Prince William County. Siding and shingles were removed from several homes in the area. Horse run-ins and sheds were also damaged. Garage doors were blown in on a detached garage. A fence was also damaged along with some signs and small trees in the parking lot of a shopping center. A few trees were snapped along Linton Hall Road before the tornado lifted.

On October 13, 2011, thunderstorms developed that contained strong aloft winds. Thunderstorms developed behind the front produced damaging wind gusts. Rapidly changing winds in both direction and speed caused some of the stronger thunderstorms to produce tornadoes near the warm front. Trees were sporadically uprooted and snapped for about a three-mile path, starting near Clifton to just west of Fairfax City.

On July 23, 2008, a weak tornado touched down in Prince William County in an industrial park near Wellington at 6:43PM. The tornado produced siding and roof damage to homes and toppled trees. The twister damaged the roof of a retail home center in Sudley Towne Plaza before lifting after crossing Sudley Road near Route 234.

On June 4, 2008, strong upper level thunderstorms developed over the area, resulting in several severe thunderstorms. An EF-1 tornado crossed into south central Loudoun County, producing a damage path near the town of Aldie.

On July 4, 2007, a funnel cloud was spotted near Pickett Road in Fairfax by Department of Public Works and Environmental Services. Severe weather in the area caused the need for sheltering those attending Fourth of July celebrations. No reports of damage or injuries were received as a result of this particular funnel cloud, but a man was killed when a tree fell onto his car in Annandale during storms earlier in the afternoon.

On September 17, 2004, a tornadic thunderstorm entered western Fairfax County from Prince William County. The storm had a path of approximately seven miles. Beginning on Old Centerville Road, the storm produced scattered tree damage and minor roof damage in the Loudoun Town area. A line of damage was carved from Lee Highway northward into the Centerville and Chantilly areas. The tornado destroyed one estate and damaged approximately 50 other structures, and was responsible for downed trees and powerlines. The parent thunderstorm produced another tornado on the east side of the City of Manassas causing structural and tree damage before continuing on into Manassas Park where several dwellings were damaged in the Yorkshire subdivision. At its strongest, this tornado produced F2 damage estimated at approximately $1 million.

On September 24, 2001, five tornadoes touched down in Northern Virginia during the afternoon and early evening of the 24th. A tornado, which remained on the ground for 15 miles, passed through densely populated areas of Eastern Fairfax County, the western portion of the City of Alexandria, and Arlington County causing minor injuries and significant damage to trees, residences, and businesses. Its strength varied between F0 and F1 as it crossed the Interstates three times during rush hour traffic. Cars were hit with flying debris and some windows were blown out. Hundreds of homes and numerous parked vehicles were also damaged. Most of the damage was minor to the exterior and roofs of homes. A few homes suffered more significant damage, mainly in the Shirlington area of Arlington County. Total damages were estimated at $1 million. Only two people are known to have been injured. Before the tornado moved into Washington, DC, it passed right by the Pentagon City Mall and the Pentagon itself. Numerous recovery workers at the Pentagon in the aftermath of the 9-11 attack had to take cover from the tornado in underground tunnels. One of the tornadoes touched down in Prince William County where it downed some trees in Prince William Forest Park area. The tornado moved north into the Lake Montclair community where it took down a few trees, broke branches, and bent siding up on homes. The weak tornado lifted shortly after.

On May 25, 1997, a small, brief tornado, packing winds up to 70 miles per hour, knocked down between 75 and 100 trees and limbs, some of which fell onto residences, vehicles, and other property in South Arlington. Scattered structural damage included aluminum siding, gutters, shingles, and plastic fascia.

On June 24, 1996, a tornado, associated with the mesocyclone of a heavy-precipitation super cell, touched down in extreme southeastern Loudoun County near the Bull Run, then proceeded east-southeast for 20 miles knocking down over 1,000 trees and causing substantial property damage, especially in western Fairfax County, before lifting along the Capital Beltway at the Braddock Road interchange less than two miles west of Annandale. The most significant damage occurred along Tree Line Drive, where 11 of 17 homes incurred moderate to major damage. The combined effort of several agencies produced property damage estimates along the track (not including flora) totaling $2.9 million. Included in that total are 323 homes which sustained minor damage. An estimated 80,000 homes lost power along the track of the tornado in Fairfax County, with some homes not receiving power until several days after the event.

On April 16, 1993, a tornado touched down approximately a 0.5 mile southwest of Saint Louis in the southern part of Loudoun County, and moved east northeast for about 1.7 miles. The storm knocked down and damaged hundreds of trees. Roofs of two barns were blown off, windows were blown out, and fences were ripped up.

On September 5, 1979, Hurricane David spawned six tornadoes across Virginia. A strong F3 tornado struck Fairfax County tracking 18 miles, killing one and injuring six people. It struck the same school hit by a tornado on April 1, 1973, this time causing $150,000 damage. Numerous cars were demolished, 90 homes were damaged, and trees and debris blocked roads. Damages in Fairfax County reached $2.5 million dollars.

On April 1, 1973, a strong F3 tornado struck a populated area of Northern Virginia. It touched down in Prince William County and traveled 15 miles northeast through Fairfax and into Falls Church. Extensive damage occurred along a six-mile stretch in Fairfax. A high school, two shopping centers, an apartment complex, and 226 homes were damaged. Thirty-seven people were injured. It could have been much worse, but it was Sunday and "Blue Laws" were still in effect--the normally busy shopping center which had extensive damage was closed and school was not in session. Damage totaled an estimated $14 million.

On May 2, 1929, on a day known as "Virginia's Deadliest Tornado Outbreak," the town of Hamilton in Loudoun County (six miles northwest of Leesburg) experienced one of the five tornadoes that caused widespread destruction across the state. The tornado path was reportedly 200 yards across and two miles long. It destroyed a house, barn, and some smaller buildings at one farm. It caused several injuries but no deaths. Other nearby farms were damaged, as well as a brick church.

On November 17, 1927, a tornado touched down in a rural part of Fairfax County and moved northeast across the western part of Alexandria, across the Potomac River and Washington, DC, and into Maryland. Over 100 people were injured in Alexandria and over 200 homes were unroofed and torn apart.

B. Risk Assessment

1. Probability of Future Occurrences

The probability of future occurrences of tornadoes was examined through analysis of the NCDC historical data and in consideration of data developed for the 2013 Commonwealth of Virginia Hazard Mitigation Plan. For the Commonwealth's plan, an extensive frequency analysis was performed on the historical tornado record (including touchdown points and tornado tracks) using GIS techniques. Results of this analysis (see Figure 4.34) pinpoint areas that have experienced slightly higher frequency of tornadoes based on past occurrences. It should be noted that what is determined to be 'High' in the figure is relative to tornado frequency in the entire

Commonwealth of Virginia. This ‘High’ designation is still low in comparison with frequencies experienced in ‘tornado alley’ and throughout the southern States. An examination of the NCDC data shows that Loudoun County has experienced 25 tornado events since 1950, more than any other jurisdiction in Northern Virginia. Prince William County is not too far behind having recorded 17 such events during that same period of time.

Based on this analysis, it is likely that the Northern Virginia region will continue to experience weak to moderately intense tornadoes. It is unlikely that very strong tornadoes (F4 or F5) will strike the area, though it does remain a possibility. Climate change is projected to increase the frequency and intensity of extreme weather events[15], including severe thunderstorms. At this time, it remains uncertain if this might also translate into an increased frequency of tornadoes.

2. Impact & Vulnerability

Tornadoes are high-impact, low-probability hazards. A tornado’s impact is dependent on its intensity and the vulnerability of development in its path. Qualification of tornado impact has not been performed for this analysis. Future plan updates might investigate the feasibility of methods for doing so. Tornado vulnerability is based on building construction and standards, the availability of shelters or safe rooms, and advanced warning capabilities. Even well-constructed buildings are vulnerable to the effects of a stronger (generally EF2 or higher) tornado.

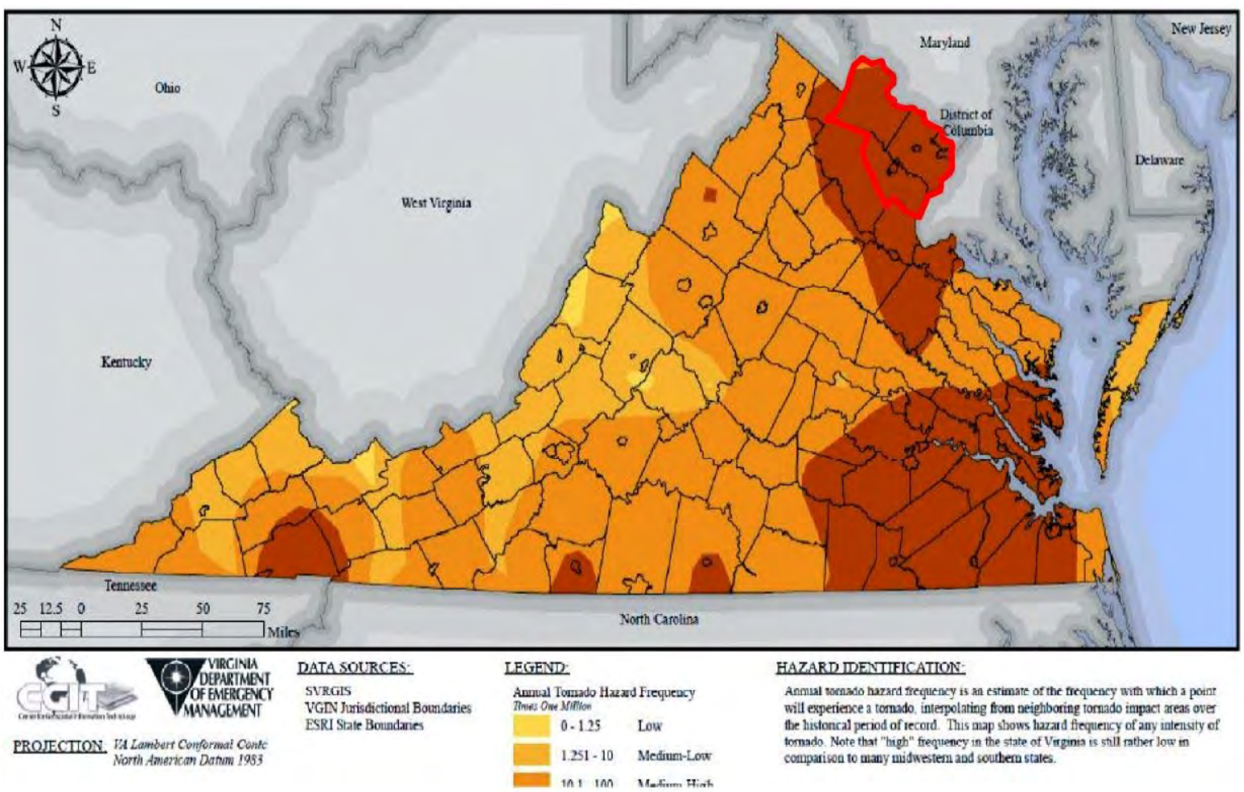


Figure 4.34 Tornado Hazard Frequency. *Source: Commonwealth of Virginia Hazard Mitigation Plan.*

3. Risk

Risk, defined as probability multiplied by impact, cannot be fully estimated for tornadoes due to the lack of intensity-damage models for this hazard. Instead, estimates of the financial impacts of tornadoes can be developed based on historical data contained within the NCDC storm event data. Examination of NCDC data shows that there were 70 tornado events in Northern Virginia between 1950 and December 2015 that caused approximately $13.6 million in property and crop damages. Loudoun County has recorded more damage than other Northern Virginia jurisdictions due to tornadoes. NCDC data shows that the county experienced more than $5 million in property and crop damages since 1950.

Critical Facility Risk

Quantitative assessment of critical facilities for tornado risk was completed for this update using a scenario developed for each participating jurisdiction. The track of a historic tornado in the jurisdiction or an adjacent area was relocated to insect with the participating jurisdiction. Locally-identified critical assets were mapped in relation to the tornado track. Images were created for each scenario; those images can be found in Appendix D.

Table 4.90 provides details of the critical assets that were determined to be damaged in each scenario. For the purposes of this assessment, no assumption was made as to the level of damage that the asset would sustain; therefore, the values displayed represent the entire value of the asset and its contents.

The type and age of construction plays a role in vulnerability of facilities to tornadoes. In general, concrete, brick, and steel-framed structures tend to fare better in tornadoes than older, wood-framed structures or manufactured homes. Finally, not all critical facilities have redundant power sources and may not even be wired to accept a generator. Future plan updates should consider closer examination of critical facilities risk by looking at construction type of critical facilities in jurisdictions considered to be at higher risk of tornadoes.

Table 4.90. Scenario Assessment for Tornadoes by Jurisdiction.

Jurisdiction	Number of Assets Damaged	Value of Assets	Value of Contents	Total
Arlington County	83	$488,255,187	$27,000,723	$515,255,910
Fairfax County	61	$511,768,862	$78,281,693	$590,050,555
Loudoun County	22	$245,335,780	$245,335,780	$490,671,560
Prince William County	0	$0	$0	$0
City of Alexandria	6	$55,873,350	$50,000,000	$105,873,350
City of Fairfax	0	$0	$0	$0
City of Falls Church	3	$18,662,700	$0	$18,662,700
City of Manassas	7	$10,191,160	$796,050	$10,987,210

Table 4.90. Scenario Assessment for Tornadoes by Jurisdiction.				
Jurisdiction	**Number of Assets Damaged**	**Value of Assets**	**Value of Contents**	**Total**
City of Manassas Park	6	$40,408,100	$0	$40,408,100
Town of Dumfries	0	$0	$0	$0
Town of Haymarket	6	$3,187,813	$205,877	$3,393,690
Town of Herndon	8	$18,762,385	$2,514,029	$21,276,414
Town of Leesburg	14	$26,397,517	$1,517,642	$27,915,159
Town of Lovettsville	$0	$0	$0	$0
Town of Middleburg	4	$297,620	$297,620	$595,240
Town of Purcellville	2	$28,030	$28,030	$56,060
Town of Quantico	0	$0	$0	$0
Town of Round Hill	0	$0	$0	$0
Town of Vienna	6	$13,250,000	$700,000	$13,950,000

Existing Buildings and Infrastructure Risk

Risk to existing buildings and infrastructure is largely determined by building construction type including construction method, materials and roof span. As mentioned previously, concrete, brick, and steel-framed structures tend to fare better in tornadoes than older, wood-framed structures

Overall Loss Estimates and Ranking

As detailed in Table 4.89 (earlier in this section), the annualized losses due to tornadoes in Northern Virginia totals approximately $209,662. Based on historical occurrences, tornado events in the Northern Virginia region are more common in Loudoun County, with Prince William County coming in a close second. However, it is expected that susceptibility for tornado occurrences is relatively uniform across the region. Historical data indicates that Loudoun County is by far the most vulnerable of the four counties in terms of property damages, fatalities, and injuries.

Similar to hurricane and tropical storm force-winds, the most at-risk buildings to tornadoes are assumed to include manufactured homes and older residential structures (see discussion under *Hurricanes and Tropical Storms*). Even small F1 tornadoes can cause severe damage to these buildings. For more intense tornadoes (F2 and higher), all buildings are considered at-risk with the exception of those specifically built to withstand wind speeds of more than 120-150 miles per hour (such as designated shelters, EOCs, etc.).

The Commonwealth of Virginia's 2013 Hazard Mitigation Plan ranking was based largely on the NCDC database. The update to the Northern Virginia plan used this same framework to establish a common system for evaluating and ranking hazards. In determining a score and ranking for tornadoes, the geographic extent score for each jurisdiction is based on a frequency analysis of historical tornado events completed for the 2013 Commonwealth plan.

Based on this analysis and the available data, the tornado hazard is ranked as being 'High' for all jurisdictions in Northern Virginia (See Figure 4.34). Refer to the Risk Assessment Methodology section of the HIRA for a full description of the methodology and the limitations of the data used for ranking the hazards. NCDC data, although somewhat limited, provides a comprehensive historical record of natural hazard events and damages.

For the 2016 plan update, the qualitative assessment was performed by jurisdiction. Given the widespread nature of the hazard, however, all counties, cities, and towns were determined to have the same qualitative risk to the hazard. Therefore, to avoid repetition, Table 4.91 provides the results of the qualitative assessment for all participating jurisdictions, as all jurisdictions were found to have the same result.

Table 4.91. 2016 Qualitative Assessment for Tornadoes.

	Probability	Impact	Spatial Extent	Warning Time	Duration
Risk Level	Highly Likely	Critical	Moderate	0 to 12 hours	Less than one week

X. Drought

NOTE: As part of the 2016 plan update, the Drought hazard was reexamined and a new analysis performed. This new analysis included, but was not limited to: 1) refreshing the hazard profile; 2) updating the previous occurrences; 3) determining number of hazard events and losses by jurisdiction using NCDC and other data sources where available; 4) updating the assessment of risk by jurisdiction based on new data; and 5) ranking of the hazard by jurisdiction using the methodology described in detail in Chapter 4, Section IV Ranking and Analysis Methodologies. Though Drought and Extreme Heat are often interrelated hazards, they can and do occur independent of each other. Though the 2010 plan update consolidated their analysis into one section, the 2016 plan update separated them into different hazards. In addition, each section of the plan was also reformatted for improved clarity, and new maps and imagery, when available and appropriate, were inserted.

A. Hazard Profile

1. Description

Drought is generally defined as a persistent and abnormal moisture deficiency having adverse impacts on vegetation, people, or animals. High temperatures, high winds, and low humidity can worsen drought conditions and make areas more susceptible to wildfire. Human demands and actions can also hasten drought-related impacts. Droughts are frequently classified as one of following four types:

- Meteorological;
- Agricultural;
- Hydrological; or
- Socio-economic.

Meteorological droughts are typically defined by the level of "dryness" when compared to an average, or normal, amount of precipitation over a given period of time. Agricultural droughts relate common characteristics of drought to their specific agricultural-related impacts. Emphasis tends to be placed on factors such as soil/water deficits, water needs based on differing stages of crop development, and water reservoir levels. Hydrological drought is directly related to the effect of precipitation shortfalls on surface and groundwater supplies. Human factors, particularly changes in land use, can alter the hydrologic characteristics of a basin. Socio-economic drought is the result of water shortages that limit the ability to supply water-dependent products in the marketplace.

Figure 4.35 shows the Palmer Drought Severity Index (PDSI) summary map for the United States from 1895 to 1995 with the planning area highlighted in green. The PDSI is a meteorological index that is based on temperature, precipitation, and Available Water Content of the soil data. The PDSI drought classifications are based on observed drought conditions and range from -0.5 (incipient dry spell) to -4.0 (extreme drought). As can be seen, the Eastern United States has historically not seen as many significant long-term droughts as the Central and Western regions of the country.

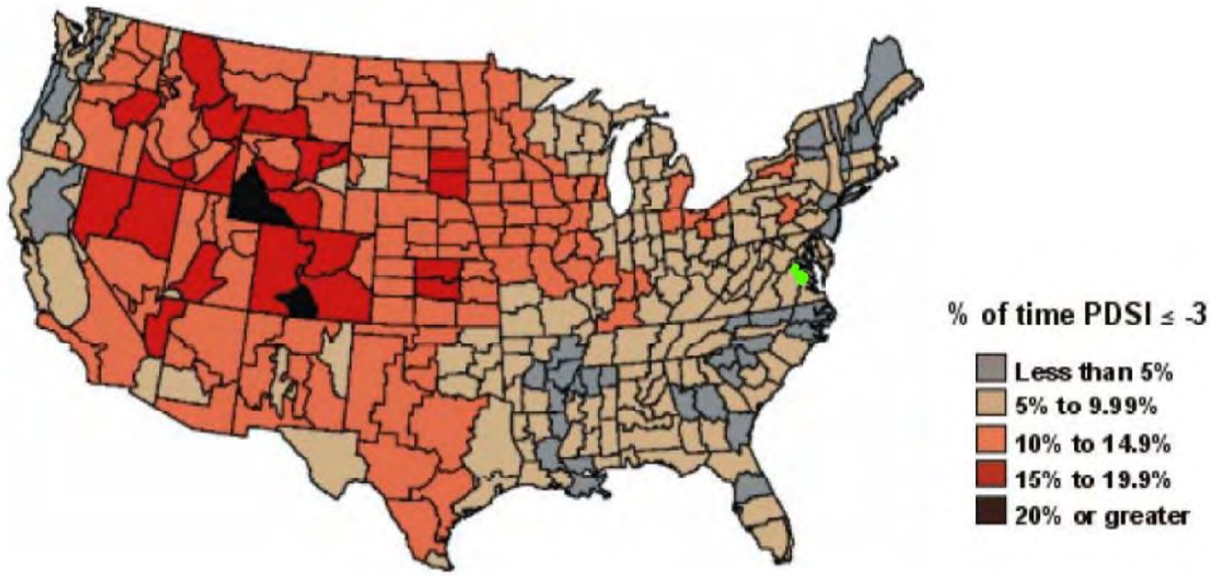


Figure 4.35. Palmer Drought Severity Index, 1895-1995 Percent of Time in Severe and Extreme Drought. *Source: National Drought Mitigation Center*

2. Geographic Location / Extent

The Northern Virginia region is susceptible to drought conditions, although these are typically not nearly as severe as in other regions of the country. According to historical PDSI records for the years 1895 to 1995, the Northern Virginia region was in severe to extreme drought conditions for only 5 to 10 percent of the time (See Figure 4.35), as compared with areas in the western portion of the United States that experienced severe to extreme drought conditions for more than 20% of the time.

According to the U.S. Department of Commerce, Bureau of Economic Analysis, less than one percent of the Northern Virginia region's civilian workforce is involved in the farm or agriculture sector. Those that are tend to be most involved in hay production, which is grown primarily to feed livestock populations, and viticulture. Other vulnerable crops include corn, alfalfa, and soybeans. According to the USDA's Census of Agriculture, Loudoun County leads the Northern Virginia region with more than 1,400 active farms on 142,452 acres of farmland, with the average farm size being approximately 100 acres.

3. Magnitude or Severity

There are 95 records of drought events contained within the NCDC database. (See Table 4.92) Many of these instances are considered overlapping (counted twice or possibly more), as adjacent jurisdictions experiencing the same drought were considered separate instances. Data regarding the impact or occurrence of drought on the towns is contained within the estimates for the counties. Also, unlike the very distinct beginning and end to other hazards (e.g., tornado), the period of a drought occurrence is not clear because multiple instances may be recorded for the same long-term drought. More detailed information on historical drought events can be obtained through the NCDC Storm Event Database.

Table 4.92. Annualized Property and Crop Loss Due to Drought, Based on NCDC Data.

Number of Events	**151**
Years of Record: 1950-2015	**Annualized Property and Crop Damage**
Arlington County	$22,315
Fairfax County	$22,315
Loudoun County	$317,304
Prince William County	$28,160
City of Alexandria	$22,315
City of Fairfax	$0
City of Falls Church	$22,315
City of Manassas	$28,160
City of Manassas Park	$0
Town of Clifton	Included in Loudoun County estimate
Town of Dumfries	Included in Prince William County estimate
Town of Herndon	Included in Fairfax County estimate
Town of Haymarket	Included in Prince William County estimate
Town of Leesburg	Included in Loudoun County estimate
Town of Lovettsville	Included in Loudoun County estimate
Town of Middleburg	Included in Loudoun County estimate
Town of Occoquan	Included in Prince William County estimate
Town of Purcellville	Included in Loudoun County estimate
Town of Quantico	Included in Prince William County estimate
Town of Round Hill	Included in Loudoun County estimate
Town of Vienna	Included in Loudoun County estimate
Total	**$462,886**

Lack of rainfall during drought conditions will affect water levels along the Potomac River, the main water source for the Northern Virginia region. Many of the major reservoirs serving the Northern Virginia region, including the Occoquan (Fairfax County) and the Beaverdam (Loudoun County), have experienced dangerously low levels in the past due to ongoing drought periods. During these periods, many locations are forced to begin water restrictions, which could lead to potential economic impacts for the region. The most vulnerable residents during these dry periods are those who live in the more rural areas located away from the larger cities and populated suburbs of the region (many of whom draw their water supply from wells).

4. Previous Occurrences

Because of the widespread geographic nature of the hazard, droughts typically impact large geographic areas, such as the entire Northern Virginia region. To avoid repetition, descriptions of the occurrences of drought in Northern Virginia have been consolidated to cover the entire planning area.

Planning Area

From October 1, 2007 – October 30, 2007, rainfall deficits of nearly 10 inches were common across northern Virginia at the beginning of the month. All counties and independent cities in the Commonwealth, with the exception of Arlington County and the independent cities of Alexandria and Falls Church, were declared primary disaster areas by the State. Many jurisdictions instituted water restrictions (both voluntary and mandatory) during this particularly dry stretch. Much of Northern Virginia was categorized as experiencing Extreme Drought by the National Drought Monitor during the later portions of the month. Several storm systems brought much-needed rainfall as the month ended, alleviating drought conditions.

In August 1998-August 1999, the PDSI indicated Northern Virginia was in an extreme drought. July was the 10th month in the previous 12 that precipitation was below normal. During this period, precipitation was a staggering 10 to 16 inches below average, the second driest 12 months on record.

The lack of rainfall affected water levels along the Potomac River, the main water source for the region. Many upstream tributaries also reported extremely low water levels. For the first time, water was released from the Randolph and Little Seneca reservoirs near the Potomac headwaters to help maintain a safe water level for wildlife and human consumption. By July 31st, the Randolph Reservoir was 13.8 percent below capacity and the Little Seneca Reservoir was down four inches.

Across Northern Virginia, several crops such as corn and soybeans never reached maturity, trees prematurely shed leaves and fruit in orchards, pasture land became nearly non-existent, and watering holes and irrigation sources dried up.

These instances of drought came to an end in September 1999 as the remnants of two hurricanes brought significant rainfall to the region. Following these storms, most areas recorded a major increase in water supplies and upgraded their condition from an extreme drought to a mild drought.

July 1997 was a very dry month that included one seven-day heat wave, and exacerbated drought-like conditions across much of the fertile farmland of Northern Virginia. The weather in July resulted in the failure of several crops, including corn, hay, alfalfa, and soybeans. Counties in the Northern Virginia region reported damage via local farms, though no formal declarations of Federal emergency were received from them.

B. Risk Assessment

1. Probability of Future Occurrences

The future incidence of drought is highly unpredictable and may be localized, which makes it difficult to assess the probability of drought. No sources of information on long-term historic frequency of drought or future probability were identified for inclusion in this plan. This may be a result of many different definitions resulting in spotty reporting. Based on past events, it certainly remains possible over the long-term that the Northern Virginia region will experience recurring drought conditions, the severity of which cannot be quantified.

2. Impact & Vulnerability

Short-term droughts can impact agricultural productivity, while longer term droughts are more likely to impact not only agriculture, but also water supply. Jurisdictions that have invested in water supply and distribution infrastructure are generally less vulnerable to drought. Short and long-term drought may lead to an increase in the incidence of wildfires which might in turn lead to increased potential for landslides or mudflows once rain does fall.

There is no standardized methodology for estimating vulnerability to the drought hazard. As opposed to posing a direct threat to life and property, drought impact is primarily measured by its potential and actual economic effect on the agricultural sector as well as municipal and industrial water supplies. This economic effect can also be expected to affect related sectors, such as wholesale and retail trade.

3. Risk

The risk associated with drought in Northern Virginia has not been formally quantified, due to the difficulty in assessing the rate of incidence, and the lack of complete data on drought impacts. There is low risk of human injury/death due to drought in Northern Virginia, and low risk of property damage. Crop damages due to drought are uncertain, as agricultural productivity often varies with growing conditions from year to year. However, the NCDC Storm Events database does report crop losses due to drought of approximately $463,000 annually (see Table 4.92). Future updates to this plan should consider methods for quantifying annual drought losses in sectors outside of agriculture. This might include defining losses related to maintaining water supply, hydropower, tourism, and recreation and would require data sources outside of NCDC storm events data – including detailed local reports of both occurrences and associated damages.

Critical Facility Risk

Risk associated with drought has not been quantified in terms of geographic extent for this revision; as a result, critical facility risk has not been calculated. The majority of drought related damages do not impact buildings or infrastructure.

As discussed previously, the entire Northern Virginia region is vulnerable to drought and historically suffers drought conditions between five and 10 percent of the time. Since 1950, the region has been severely impacted by numerous instances of a long-term drought with damages totaling approximately $25 million (most of which was attributed to agricultural losses in Loudoun and Prince William counties). Prior to this period of record, very little historical data exists on past drought events.

The Commonwealth of Virginia's 2013 HIRA ranking was based largely on the NCDC database. The update to the Northern Virginia plan used this same framework to establish a common system for evaluating and ranking hazards. No geographic extent data was available for drought probability. Based on this analysis and the available data, the drought hazard is considered to be 'Moderate' for Loudoun County, Prince William County, and the Towns of Leesburg, Lovettsville, Purcellville, Middleburg, Round Hill, Dumfries, Haymarket, Occoquan, and Quantico, and 'Low' for all other jurisdictions.

For the 2016 plan update the qualitative assessment was performed by jurisdiction. Given the widespread nature of the hazard, however, all counties, cities, and towns were determined to have the same qualitative risk to the hazard. Therefore, to avoid repetition, Tables 4.93 and 4.94 provides the results of the qualitative assessment for all participating jurisdictions.

Arlington County, Fairfax County, the City of Arlington, the City of Fairfax, the City of Falls Church, the Town of Clifton, the Town of Herndon, and the Town of Vienna

Table 4.93. 2016 Qualitative Assessment for Drought.

	Probability	Impact	Spatial Extent	Warning Time	Duration
Risk Level	Unlikely	Low	Moderate	3 to 6 months	More than one month

Loudoun County, Prince William County, the City of Manassas, the City of Manassas Park, the Town of Dumfries, the Town of Haymarket, the Town of Leesburg, the Town of Lovettsville, the Town of Middleburg, the Town of Occoquan, the Town of Purcellville, the Town of Quantico, and the Town of Round Hill

Table 4.94. 2016 Qualitative Assessment for Drought.

	Probability	Impact	Spatial Extent	Warning Time	Duration
Risk Level	Likely	Moderate	Moderate	3 to 6 months	More than one month

XI. Earthquake

NOTE: As part of the 2016 plan update, the Earthquake hazard was reexamined and a new analysis performed. This new analysis included, but was not limited to: 1) refreshing the hazard profile; 2) updating the previous occurrences; 3) determining number of hazard events and losses by jurisdiction using NCDC and other data sources where available; 4) updating the assessment of risk by jurisdiction based on new data; and 5) ranking of the hazard by jurisdiction using the methodology described in detail in Chapter 4, Section IV Ranking and Analysis Methodologies. Each section of the Plan was also reformatted for improved clarity, and new maps and imagery, when available and appropriate, were inserted.

A. Hazard Profile

1. Description

An earthquake is the motion or trembling of the ground produced by sudden displacement of rock in the Earth's crust. Earthquakes result from crustal strain, volcanism, landslides, or the collapse of caverns. Earthquakes can affect hundreds of thousands of square miles; cause damage to property measured in the tens of billions of dollars; result in loss of life and injury to hundreds of thousands of persons; and disrupt the social and economic functioning of the affected area.

Most earthquakes are caused by the release of stresses accumulated as a result of the rupture of rocks along opposing fault planes in the Earth’s outer crust. These fault planes are typically found along borders of the Earth's 10 tectonic plates. These plate borders generally follow the outlines of the continents, with the North American plate following the continental border with the Pacific Ocean in the west, but following the mid-Atlantic trench in the east. As earthquakes occurring in the mid-Atlantic trench usually pose little danger to humans, the greatest earthquake threat in North America is along the Pacific Coast.

The areas of greatest tectonic instability occur at the perimeters of the slowly moving plates, as these locations are subjected to the greatest strains from plates traveling in opposite directions and at different speeds. Deformation along plate boundaries causes strain in the rock and the consequent buildup of stored energy. When the built-up stress exceeds the rocks' strength, a rupture occurs. The rock on both sides of the fracture is snapped, releasing the stored energy and producing seismic waves, generating an earthquake.

2. Geographic Location / Extent

Figures 4.36 and 4.37 show the probability that ground motion will reach a certain level during an earthquake. The data show peak horizontal ground acceleration (the fastest measured change in speed, for a particle at ground level that is moving horizontally due to an earthquake) with a 10 percent and 2 percent probability of exceedance in 50 years, respectively. The maps were compiled by the USGS Geologic Hazards Team, which conducts global investigations of earthquake, geomagnetic, and landslide hazards.

Figure 4.38 from the Commonwealth of Virginia’s Hazard Mitigation Plan shows the epicenter locations of historical earthquakes and the two main zones in Virginia that are more susceptible to earthquakes. These zones, as mapped by the USGS, are believed to be sources of most Magnitude 6 or greater earthquakes during the past 1.6 million years around Virginia.

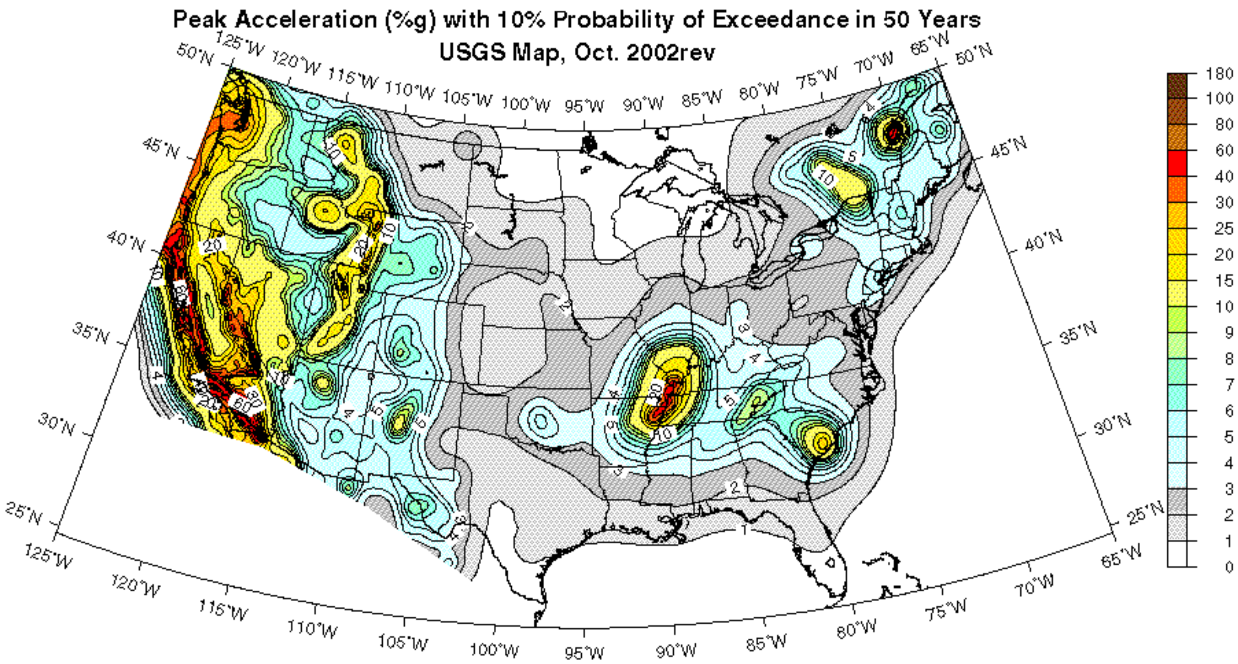


Figure 4.36. Peak Acceleration with 10 Percent Probability of Exceedance in 50 Years.
Source: USGS

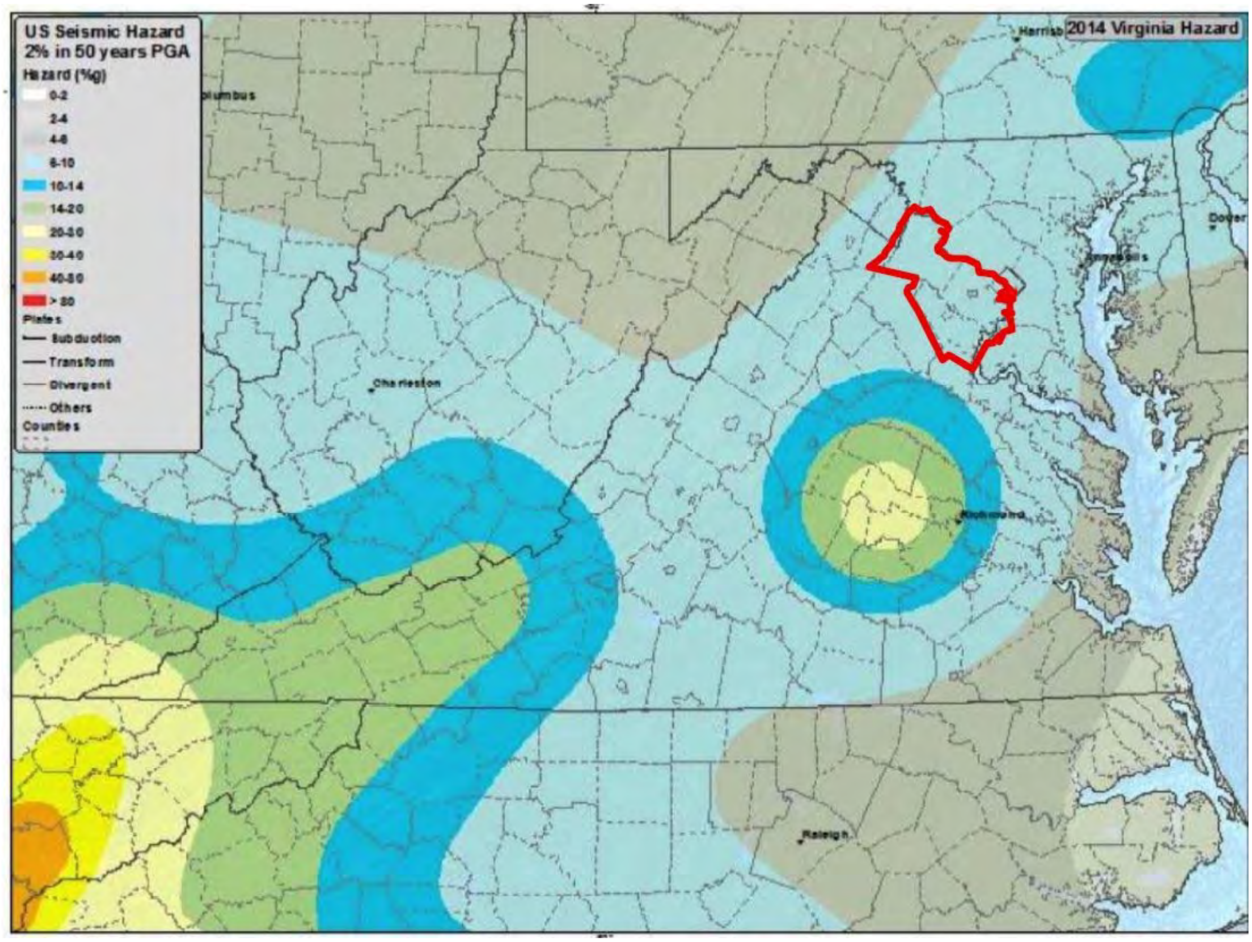


Figure 4.37. Peak Acceleration with 2 Percent Probability of Exceedance in 50 Years.
Source: USGS

3. Magnitude or Severity

Ground shaking can lead to the collapse of buildings and bridges and disrupt gas lines, electricity, and phone service. Death, injuries, and extensive property damage are possible vulnerabilities from this hazard. Some secondary hazards caused by earthquakes may include fire, hazardous material release, landslides, flash flooding, avalanches, tsunamis, and dam failure.

Most property damage and earthquake-related deaths are caused by the failure and collapse of structures due to ground shaking. The level of damage depends upon the amplitude and duration of the shaking, which are directly related to the earthquake size, distance from the fault, site, and regional geology. Other damaging earthquake effects include landslides, the down-slope movement of soil and rock (mountain regions and along hillsides), and liquefaction, in which ground soil loses shear strength and the ability to support foundation loads. In the case of liquefaction, anything relying on the substrata for support can shift, tilt, rupture, or collapse.

Earthquakes are measured in terms of their magnitude and intensity. Magnitude is measured using the Richter Scale, an open-ended logarithmic scale that describes the energy release of an earthquake through a measure of shock wave amplitude (see Table 4.95). Each unit increase in magnitude on the Richter Scale corresponds to a 10-fold increase in wave amplitude, or a 32-fold increase in energy. Intensity is most commonly measured using the Modified Mercalli Intensity (MMI) Scale based on direct and indirect measurements of seismic effects. The scale levels are typically described using roman numerals, with a I corresponding to imperceptible (instrumental) events, IV corresponding to moderate (felt by people awake), to XII for catastrophic (total destruction). A detailed description of the MMI Scale of earthquake intensity and its correspondence to the Richter Scale is given in Table 4.96.

Table 4.95, The Richter Magnitude Scale.

Richter Magnitudes	Earthquake Effects
Less than 3.5	Generally not felt, but recorded.
3.5-5.4	Often felt, but rarely causes damage.
Under 6.0	At most slight damage to well-designed buildings. Can cause major damage to poorly constructed buildings over small regions.
6.1-6.9	Can be destructive in areas up to about 100 kilometers across where people live.
7.0-7.9	Major earthquake. Can cause serious damage over larger areas.
8 or greater	Great earthquake. Can cause serious damage in areas several hundred kilometers across.

Table 4.96. Modified Mercalli Intensity Scale for Earthquakes.

Scale	Intensity	Description of Effects	Corresponding Richter Scale Magnitude
I	Instrumental	Detected only on seismographs	
II	Feeble	Some people feel it	<4.2
III	Slight	Felt by people resting; like a truck rumbling by	
IV	Moderate	Felt by people walking	
V	Slightly Strong	Sleepers awake; church bells ring	<4.8
VI	Strong	Trees sway; suspended objects swing, objects fall off shelves	<5.4
VII	Very Strong	Mild Alarm; walls crack; plaster falls	<6.1
VIII	Destructive	Moving cars uncontrollable; masonry fractures, poorly constructed buildings damaged	
IX	Ruinous	Some houses collapse; ground cracks; pipes break open	<6.9

Table 4.96. Modified Mercalli Intensity Scale for Earthquakes.			
Scale	**Intensity**	**Description of Effects**	**Corresponding Richter Scale Magnitude**
X	Disastrous	Ground cracks profusely; many buildings destroyed; liquefaction and landslides widespread	<7.3
XI	Very Disastrous	Most buildings and bridges collapse; roads, railways, pipes and cables destroyed; general triggering of other hazards	<8.1
XII	Catastrophic	Total destruction; trees fall; ground rises and falls in waves	>8.1

4. Previous Occurrences

The first recorded earthquake in Virginia occurred in 1774. Since then, more than 300 earthquakes have occurred in the State, with 18 having a magnitude of 4.5 or higher on the Richter Scale. The largest of these events occurred in Giles County in 1897 with a magnitude of 5.8. Most earthquake events have resulted in very little property damage, if any, and there are no historical records of any earthquake-related damages in the Northern Virginia region. Historical event information for earthquakes in Virginia occurrences is based on information made available through the USGS Earthquake Hazards Program. There have been no Federally Declared Disasters or NCDC recorded events in the Northern Virginia region for earthquakes.

According to the USGS, there have been 62 significant earthquake events to occur within 300 miles of the Northern Virginia region (including those centered outside of Virginia). The epicenter locations of these events are shown in Figure 4.38[16] along with the year in which they occurred for the larger events. There are no reported casualties or significant property damages for the Northern Virginia region as a result of these events. Below is a summary of significant events that impacted the Northern Virginia region. It is assumed that these events were experienced across the planning region, though it is possible that there were no specific reports of damages in specific geographic areas.

On August 23, 2011, a magnitude 5.8 earthquake struck the Piedmont region of Virginia. Its epicenter was in Louisa County, and was one of the highest magnitude earthquakes to occur east of the Rocky Mountains. The earthquake was felt in approximately a dozen states and well into Canada. No fatalities from the event were recorded, though some injuries were reported; however, damage was widespread and estimated at hundreds of millions of dollars, much of which was uninsured. The earthquake caused the automatic shutdown of the North Anna Nuclear Power Station in Mineral, Virginia, located approximately 11 miles west-southwest of the station. In Arlington County, a pipe ruptured in the Pentagon, resulting in flooding of at least two corridors. Damage was also reported at a theater in Arlington County and several structures in the City of Arlington; the City of Manassas reported slight damage to City Hall and the Fire and Rescue Headquarters for the City. In Prince William County, the earthquake was blamed for damage to a dam and slight damage to several county facilities. A Federal Disaster Declaration was issued for the event in Virginia, though no part of the Northern Virginia planning area was included in the declaration.

On July 16, 2010, a magnitude 3.4 occurred near Gaithersburg, Maryland. The earthquake was felt in the Potomac-Shenandoah Region of Virginia. An hour after the quake, more than 5,500 people reported feeling it across Maryland, Washington, DC, West Virginia, Virginia, and Delaware[17]. No injuries or property damages were reported. The earthquake occurred in a part of the Eastern Seaboard that is less seismically active than central Virginia, New England, and the area surrounding New York City. Since 1980, 14 earthquakes have been felt within 80 km (about 50 miles) of the July 16th earthquake. All were smaller than this event. Other earthquakes have been reported in that area as far back as at least 1758[18].

On May 6, 2008, a minor earthquake (2.0 magnitude) occurred near Annandale, Virginia. Felt reports were primarily received from people in Fairfax County, the District of Columbia, and Montgomery County, Maryland.

On December 9, 2003, an earthquake was widely felt in the Washington-Baltimore area and occurred west of Richmond, Virginia, in the Central Virginia Seismic Zone. It had a magnitude of 4.3[19].

On April 9, 1918, the Shenandoah Valley region was strongly shaken by an earthquake. It was called the "most severe earthquake ever experienced" at Luray. Although little damage resulted, people in many places over the northern valley region were greatly alarmed and rushed from their houses. Broken windows were reported in Washington, DC. The tremor was noticed by President Wilson and his family at the White House; the President's secretary called a newspaper office to learn the cause of the terrifying noise. The felt area extended over 155,000 square kilometers, including parts of Maryland, Pennsylvania, and West Virginia.

On May 3, 1897, the largest historical earthquake to originate in Virginia occurred. The epicenter was in Giles County, where on May 3rd, an earlier tremor at Pulaski, Radford, and Roanoke had caused damage. Loud rumblings were heard in the epicentral region at various times between May 3rd and 31st. The shock on the latter date was felt from Georgia to Pennsylvania and from the Atlantic Coast westward to Indiana and Kentucky, an area covering about 725,000 square kilometers. It was especially strong at Pearisburg, where the walls of old brick houses were cracked and bricks were thrown from chimney tops. Springs were muddied and a few earth fissures appeared. Chimneys were shaken down in Bedford City, Houston, Pulaski, Radford, and Roanoke. Chimneys were also broken at Raleigh, North Carolina; Bristol and Knoxville, Tennessee; and Bluefield, West Virginia. Minor tremors continued in the epicentral region from time to time until June 6; other disturbances felt on June 28, September 3, and October 21 were probably aftershocks.

On August 31, 1861, the earthquake epicenter was probably in extreme southwestern Virginia or western North Carolina. At Wilkesboro, North Carolina, bricks were shaken from chimneys. The lack of Virginia reports may perhaps be ascribed to the fact that the Civil War was under way and there was rather heavy fighting in Virginia at the time. This shock affected about 775,000 square kilometers and was felt along the Atlantic coast from Washington, DC, to Charleston, South Carolina, and westward to Cincinnati, Louisville, and Gallatin, Tennessee, and southwestward to Columbus, Georgia.

On April 29, 1852, another moderately strong, widely felt shock occurred. At Buckingham and Wytheville, chimneys were damaged. The felt area extended to Washington, DC, Baltimore, and Philadelphia, and also included many points in North Carolina - approximately 420,000 square kilometers.

On August 27, 1833, the earthquake covered a broad felt area from Norfolk to Lexington and from Baltimore, Maryland, to Raleigh, North Carolina - about 135,000 square kilometers. Two miners were killed in the panic the shock caused at Brown's Coal Pits, near Dover Mills, about 30 kilometers from Richmond. At Charlottesville, Fredericksburg, Lynchburg, and Norfolk, windows rattled violently, loose objects shook, and walls of buildings were visibly agitated.

On March 9, 1828, an earthquake, apparently centered in southwestern Virginia, was reported felt over an area of about 565,000 square kilometers, from Pennsylvania to South Carolina and the Atlantic Coastal Plain to Ohio. Very few accounts of the shock were available from places in Virginia; it was reported that doors and windows rattled. President John Quincy Adams felt this tremor in Washington, DC, and provided a graphic account in his diary. He compared the sensation to the heaving of a ship at sea.

On February 21, 1774, a strong earthquake was felt over much of Virginia and southward into North Carolina. Many houses were moved considerably off their foundations at Petersburg and Blandford. The shock was described as "severe" at Richmond and "small" at Fredericksburg. However, it "terrified the inhabitants greatly." The total felt area covered about 150,000 square kilometers.

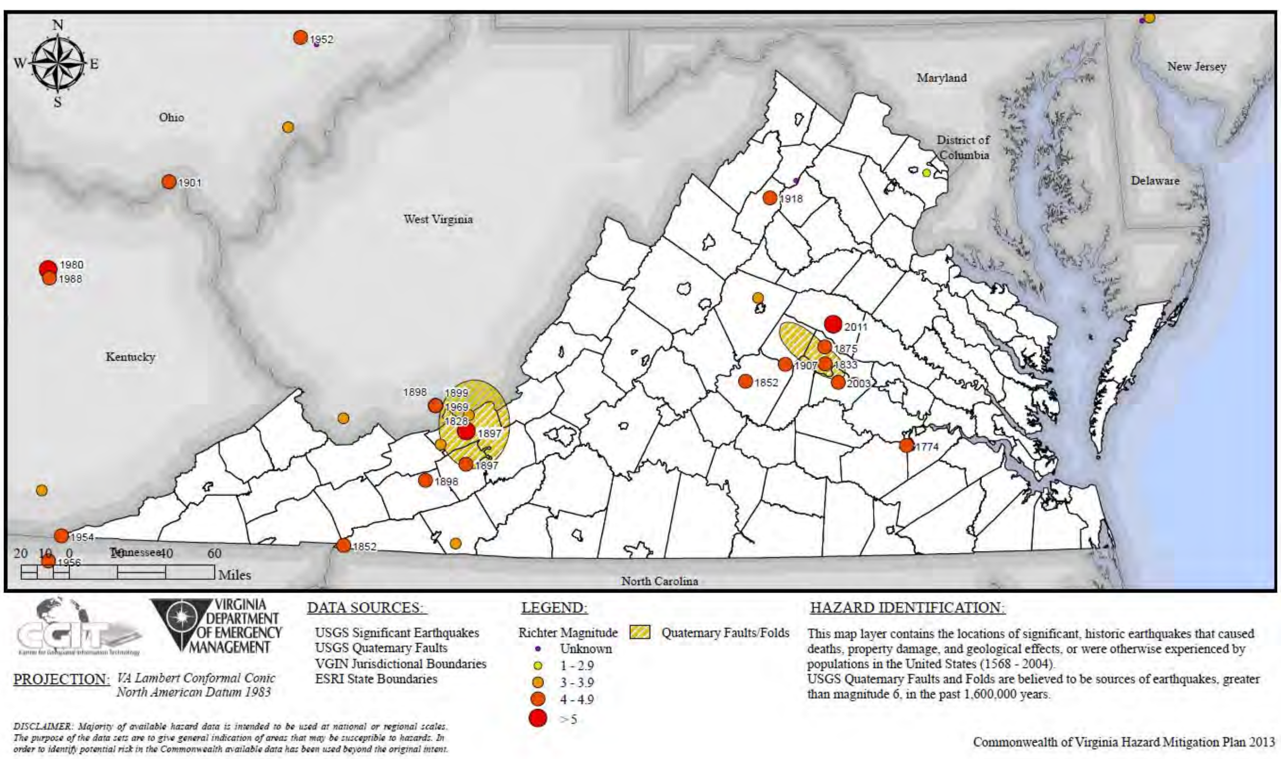


Figure 4.38. Significant Earthquakes 1568 – 2011.

B. Risk Assessment

Similar to other states on the eastern seaboard, the State of Virginia is designated as a moderate risk state for earthquake occurrence by the USGS. Earthquake events can and occasionally do occur in the State, though of much less intensity than those that occur along the west coast. The greatest seismic risk in Virginia is in the Eastern Tennessee Seismic Zone, located in the southwestern portions of the State and far from the Northern Virginia region.

1. Probability of Future Events (Chance of Occurrence)

Earthquakes are low probability, high-consequence events. Although earthquakes may occur only once in the lifetime of an asset, they can have devastating impacts. A moderate earthquake can cause serious damage to unreinforced buildings, building contents, and non-structural systems, and can cause serious disruption in building operations. Moderate and even very large earthquakes are inevitable, although very infrequent, in areas of normally low seismic activity. Consequently, in these regions buildings are seldom designed to deal with an earthquake threat; therefore, they are extremely vulnerable.

Probabilistic ground motion maps are typically used to assess the magnitude and frequency of seismic events. These maps measure the probability of exceeding a certain ground motion, expressed as percent peak ground acceleration (%PGA), over a specified period of years. The severity of earthquakes is site specific, and is influenced by proximity to the earthquake epicenter and soil type, among other factors. Figure 4.39[20] shows the PGA zones for the 2500-year Return Period derived from HAZUS^{MH} data developed by VDEM for the Commonwealth Hazard Mitigation Plan. The 2500-year Return period, or 0.04%-annual-chance of occurrence, is much more varied than the 100-year Return period and similar to the two USGS earthquake zones discussed in the earthquake Previous Occurrence section. Southwest and Central Virginia have an increased likelihood of experiencing a significant earthquake. The PGA zones for the 2500-year Return Period were used as the geographic extent parameter for ranking earthquakes. See the Risk Assessment and Methodology and Risk section for more details.

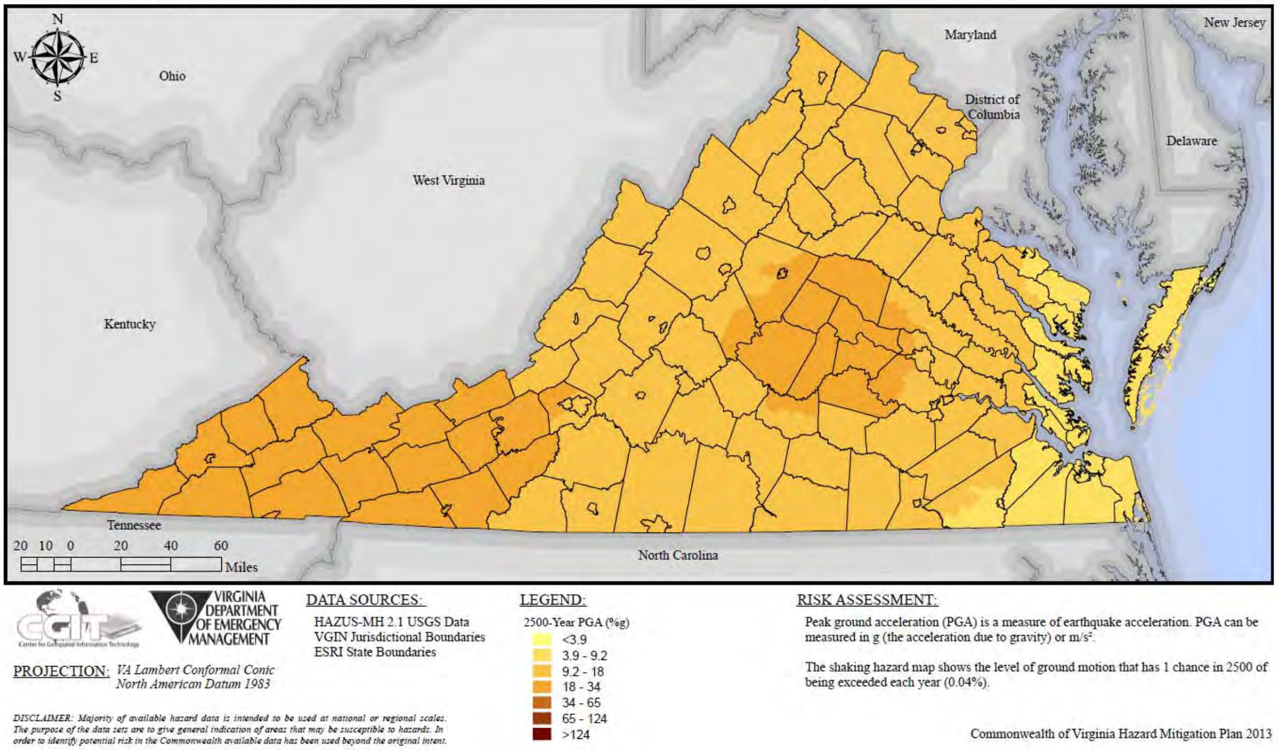


Figure 4.39. 2500-year Return Period Peak Ground Acceleration.

The recurrence interval for significant earthquake events in the Northern Virginia region is very low; however, the potential impact of a major seismic event along the Eastern Tennessee or Central Virginia seismic zone could be moderately destructive. Based on correspondence with Dr. Martin Chapman[21], director of the Virginia Tech Seismological Observatory, the majority of continued earthquake activity takes place in Goochland County, Virginia, and therefore would be a reasonable earthquake scenario for Northern Virginia. This scenario has been modeled using HAZUS^{MH}; results are summarized below in the Risk section.

2. Impact & Vulnerability

Impacts from earthquakes can be severe and cause significant damage. Table 4.97 provides the corresponding intensity equivalents in terms of MMI, as well as perceived shaking and potential damage expected for given values. These values were used as thresholds to group State and critical facilities into different vulnerability/risk zones based on potential damage.

Table 4.97. Modified Mercalli Intensity (MMI) and PGA.

MMI	PGA (%g)	Perceived Shaking	Potential Damage
I	<0.17	Not Felt	None
II	0.17 - 1.4	Weak	None
III	0.17 - 1.4	Weak	None
IV	1.4 -3.9	Light	None
V	3.9 -9.2	Moderate	Very Light
VI	9.2 -18	Strong	Light
VII	18 -34	Very Strong	Moderate

Table 4.97. Modified Mercalli Intensity (MMI) and PGA.			
MMI	**PGA (%g)**	**Perceived Shaking**	**Potential Damage**
VIII	34 - 65	Severe	Moderate to Heavy
IX	65 - 124	Violent	Heavy
X	> 124	Extreme	Very Heavy
XI	> 124	Extreme	Very Heavy
XII	> 124	Extreme	Very Heavy

The Northern Virginia planning region vulnerability and impact has been calculated in terms of total direct economic loss, as defined by HAZUS^{MH}. This includes damage to structural, non-structural, building, contents, inventory loss, relocation, income loss, rental loss, and wage loss. Additional information can be found in the Jurisdiction Risk portion of this section.

3. Risk

Moderate and even very large earthquakes are inevitable, although very infrequent, in areas of normally low seismic activity. Earthquake HAZUS^{MH} analysis was completed for the 2016 plan update, to continue the methodology used in previous plans. Below are highlights of the results.

HAZUS-MH Analysis

Due to the region's relatively low seismic risk, buildings and infrastructure throughout the region are not designed to withstand major ground shaking events. This means that if such events do occur, while unlikely, the losses would likely be substantial. HAZUS^{MH} was used to update damage and loss estimates for the probabilistic ground motions associated with each of eight return periods (100, 250, 750, 1000, 2000, and 2500 years). The building damage estimates were then used as the basis for computing direct economic losses. These include building repair costs, contents and business inventory losses, costs of relocation, capital-related, wage, and rental losses. Annualized loss was computed, in HAZUS^{MH}, by multiplying losses from the eight potential ground motions by the respective annual frequencies of occurrence, and summing the values.

Specific result reports and GIS-generated by HAZUS can be found in Appendix D.

HAZUS^{MH} can be used to evaluate a variety of hazards and associated risk to support hazard mitigation. This revision utilized a Level 1 analysis for the earthquake module. Level 1 analysis involves using the provided hazard and inventory data with no additional local data collection. This is an acceptable level of information for mitigation planning; a future version of this plan could be enhanced with Level 2 or 3 analyses. The estimates of social and economic impacts contained in this report were produced using HAZUS^{MH} loss estimation methodology software, which is based on current scientific and engineering knowledge. There are uncertainties inherent in any loss estimation technique. Therefore, there may be significant differences between the modeled results contained in this report and the actual social and economic losses following a specific earthquake. These results can be improved by using enhanced inventory, geotechnical, and observed ground motion data.

For this plan update, the probabilistic scenario in HAZUS^{MH} was run on a region-wide basis, with the assessment focusing on the 2500-year return event. Based on this analysis, the Northern

Virginia region can expect over $1.49 million in annualized damages to transportation, utility, and building stock throughout the region. The scenario modeled a 6.5 magnitude earthquake, centered near the same location as the actual 2011 Louisa County earthquake, with a depth of 10 meters, which was the same scenario used in the 2010 update. This scenario was maintained for continuity of the assessment. As discussed above, this would be a reasonable and likely scenario for the region. The results of this magnitude earthquake would result in over $3.74 billion dollars in damages to building stock, utility infrastructure, and transportation infrastructure. Table 4.98 summarizes the results of the region-wide analysis for the probabilistic scenario. (*Note: Town information is included the county totals.*) Building stock data includes damages to buildings, contents, inventory, and business interruption costs. Utility infrastructure includes damages to facilities and pipelines. Transportation infrastructure accounts for segments, bridges, tunnels, and facilities.

Table 4.98. HAZUS^{MH} Estimate: Damages from probabilistic scenario 2500-year return interval.

Jurisdiction	Building Stock	Transportation Infrastructure	Utility Infrastructure	Total
Arlington County	$343,903,000	$4,726,000	$3,172,000	$347,551,000
Fairfax County	$1,794,989,000	$12,702,000	$20,528,000	$1,828,219,000
Loudoun County	$430,261,000	$1,985,000	$8,280,000	$440,526,000
Prince William County	$679,957,000	$4,027,000	$15,648,000	$699,632,000
City of Alexandria	$274,089,000	$3,011,000	$4,038,000	$281,238,000
City of Fairfax	$63,431,000	$28,000	$286,000	$63,745,000
City of Falls Church	$274,089,000	$0	$154,000	$274,243,000
City of Manassas	$74,521,000	$854,000	$5,412,000	$80,787,000
City of Manassas Park	$20,296,000	$131,000	$165,000	$20,592,000
Total	$3,708,422,000	$27,464,000	$57,684,000	$3,793,570,000

Critical Facility Risk

HAZUS^{MH} estimates the region has 2,857 hospital beds available for use. Based on the scenario, on the day of the earthquake the region would have 71% of hospital beds available (functionality) for use by patients already in the hospital and those injured by the earthquake. All essential facilities would have functionality of greater than 50% on the day of the earthquake. After one week, 87% of the beds would be back in service; by 30 days after the event, 97% would be back in service.

Sheltering Needs

The model estimates 2,437 households to be displaced from the scenario. Of these, 1,283 people (out of a total population of 2,230,623) will seek temporary shelter.

Debris Generation
HAZUS^{MH} estimates the region would have to deal with a total of 1.21 million tons of debris from the scenario event. Of that amount, 69% would be made up of brick and wood debris, with the remainder being reinforced concrete and steel. If this amount of debris is converted to an estimated number of truckloads (assuming 25 tons per truckload), the scenario requires 48,520 truckloads to remove the debris generated by this scenario earthquake.

Existing Buildings and Infrastructure Risk
As discussed in the community profiles previously, there is an estimated 663,000 buildings in the region with an aggregate total building replacement value (excluding contents) of $320,418 million dollars. The majority of the buildings in the region are associated with residential housing. Wood frame construction makes up 73.6% of the building inventory.

Based on the HAZUS^{MH} scenario, there would be about 22,807 buildings with at least moderate damage. Approximately 554 buildings would be damaged beyond repair. Table 4.99 summarizes the expected damage and number of buildings damaged, by occupancy.

Table 4.99. HAZUS^{MH} Estimate: Expected Building Damage by Occupancy.

Occupancy Type	None		Slight		Moderate	
	Count	%	Count	%	Count	%
Agriculture	1,311	0.20	219	0.34	99	0.44
Commercial	26,688	4.67	4,502	6.97	2,524	11.06
Education	1,458	0.26	237	0.37	134	0.59
Government	918	0.16	154	0.24	93	0.41
Industrial	6,281	1.10	1,072	1.66	663	2.91
Other Residential	21,475	3.76	2,924	4.53	1,482	6.50
Religious	2,920	0.51	395	0.61	203	0.89
Single Family	510,548	89.32	55,062	85.28	17,609	77.21
Sub-totals:	**571,600**	--	**64,566**	--	**22,807**	--
	Extensive		**Complete**		**Totals**	
	Count	**%**	**Count**	**%**	**Count**	**--**
Agriculture	19	0.45	2	0.29	1,650	--
Commercial	464	11.16	51	9.19	34,229	--
Education	22	0.52	3	0.53	1,854	--
Government	15	0.36	2	0.33	1,182	--
Industrial	116	2.80	12	2.25	8,144	--
Other Residential	201	4.82	18	3.29	26,100	--
Religious	41	0.99	5	0.93	3,564	--
Single Family	3,281	78.90	461	83.20	586,961	--
Sub-totals:	**4,158**	--	**554**	--	--	--

Overall Loss Estimates and Ranking

No earthquake events were recorded in the NCDC database for the Northern Virginia region; as a result, no NCDC annualized loss estimates were calculated.

The hazard ranking for earthquake is based on events reported in the NCDC Storm Events database and a generalized geographic extent. The geographic extent ranking category used the PGA values for the 2500 Return Period. This return period represents a 0.04%-annual-chance of occurrence in any given year. The Northern Virginia planning region was ranked as 'Moderate' for earthquakes. Figure 4.39 shows the seven parameters that were used to derive the overall risk ranking. As discussed in the risk assessment methodology section, parameters that did not have recorded events in the NCDC database were given the lowest default score (1).

For the 2016 plan update the qualitative assessment was performed by jurisdiction. Given the widespread nature of the hazard, however, all counties, cities, and towns were determined to have the same qualitative risk to the hazard. Therefore, to avoid repetition, Table 4.100 provides the results of the qualitative assessment for all participating jurisdictions, as all jurisdictions were found to have the same results.

Table 4.100. 2016 Qualitative Assessment for Earthquakes.

	Probability	Impact	Spatial Extent	Warning Time	Duration
Risk Level	Possible	Critical	Moderate	Less than 6 hours	Less than one week

XII. Landslides

NOTE: As part of the 2016 plan update, the Landslides hazard was reexamined and a new analysis performed. This new analysis included, but was not limited to: 1) refreshing the hazard profile; 2) updating the previous occurrences; 3) determining number of hazard events and losses by jurisdiction using NCDC and other data sources where available; 4) updating the assessment of risk by jurisdiction based on new data; and 5) ranking of the hazard by jurisdiction using the methodology described in detail in Chapter 4, Section IV Ranking and Analysis Methodologies. Each section of the plan was also reformatted for improved clarity, and new maps and imagery, when available and appropriate, were inserted.

A. Hazard Profile

1. Description

Landslides are the downward movement of large volumes of surface materials under gravitational influences.[22] Types of movement include: rotational, translational, block, falls, topples, avalanche, earth flow, creep, and lateral spreading.[23] Landslide materials in motion generally consist of fractured or weathered rock, loose or unconsolidated soils, and vegetative debris Landslides may be triggered by both natural and human-caused changes in the environment, including heavy rain, rapid snow melt, steepening of slopes due to construction or erosion, earthquakes, volcanic eruptions, and changes in groundwater levels.

There are several types of landslides: rock falls, rock topple, slides, and flows. Rock falls are rapid movements of bedrock, which result in bouncing or rolling. A topple is a section or block of rock that rotates or tilts before falling to the slope below. Slides are movements of soil or rock along a distinct failure surface. Mudflows, sometimes referred to as mudslides, lahars, or debris avalanches, are fast-moving rivers of rock, earth, and other debris saturated with water. They develop when water rapidly accumulates in the ground, such as heavy rainfall or rapid snowmelt, changing the soil into a flowing river of mud or 'slurry.' Slurry can flow rapidly down slopes or through channels, and can strike with little or no warning at avalanche speeds. Slurry can travel several miles from its source, growing in size as it picks up trees, cars, and other materials along the way. As the flows reach flatter ground, the mudflow spreads over a broad area where it can accumulate in thick deposits.

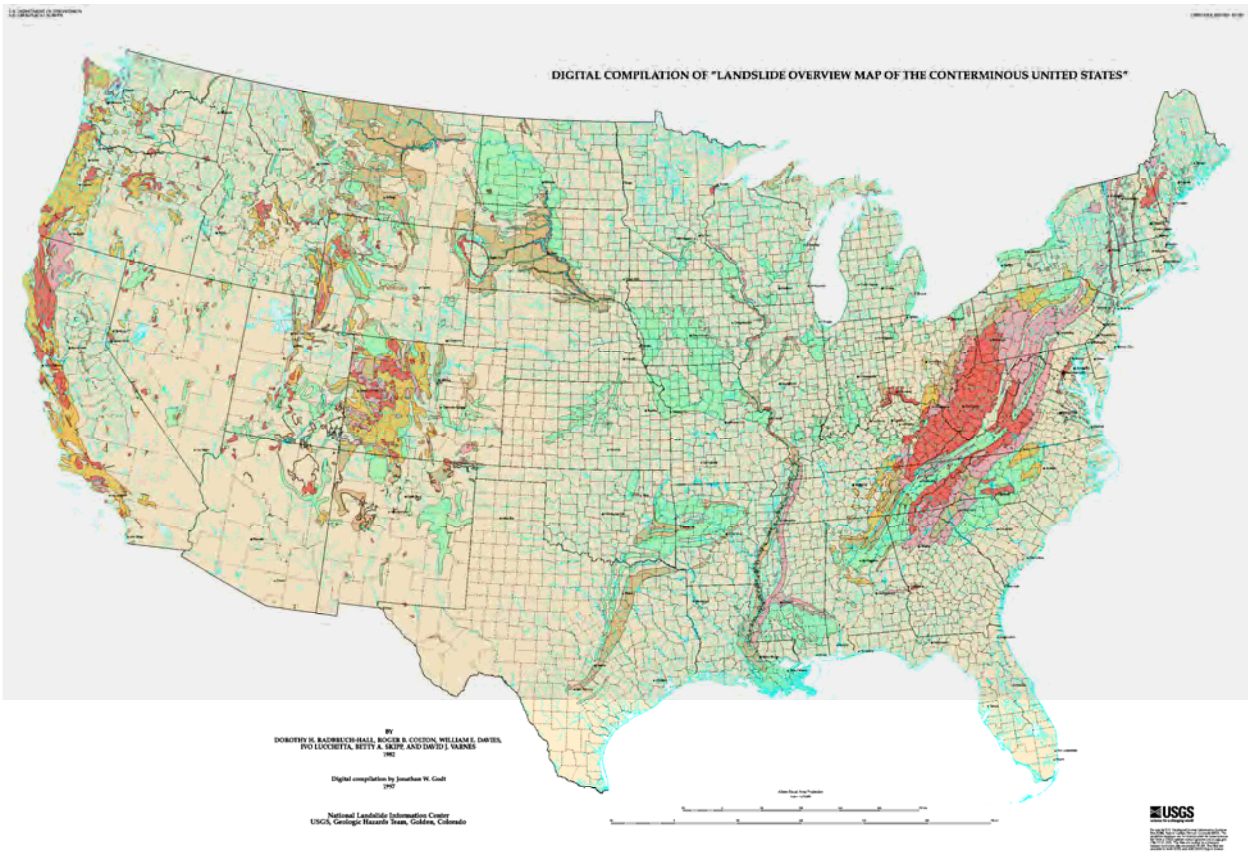
Among the most destructive types of debris flows are those that accompany volcanic eruptions. A spectacular example in the United States was a massive debris flow resulting from the 1980 eruptions of Mount St. Helens, in the State of Washington. Areas near the bases of many volcanoes in the Cascade Mountain Range of California, Oregon, and Washington are at risk from the same types of flows during future volcanic eruptions.

2. Geographic Location / Extent

In the United States, it is estimated that landslides cause up to $2 billion in damages and from 25 to 50 deaths annually. Globally, landslides cause billions of dollars in damage and thousands of deaths and injuries each year. Figure 4.40 delineates areas where large numbers of landslides have occurred and areas that are susceptible to landslides in the conterminous United States. This map layer is provided in the USGS Professional Paper 1183, "Landslide Overview Map of the Conterminous United States."

While mountainous areas in Virginia are the most susceptible to landslide events, landslide and subsidence hazards do exist elsewhere in the State, including the Northern Virginia region – though these events are quite rare and limited in terms of their impact on people and property. Minor landslide events are possible in localized, steep-sloped areas of the Northern Virginia region during extremely wet conditions. These areas are primarily located in western Loudoun County, as well as some areas of moderate risk in extreme eastern areas of Fairfax and Prince William counties. Figure 4.41 provides a general indication of where landslide events are most likely to occur in Virginia based on landslide incidence and susceptibility data provided by the USGS and mapped by VDEM.

Areas that are generally prone to landslide hazards include: previous landslide areas; the bases of steep slopes; the bases of drainage channels; and developed hillsides where leach-field septic systems are used. Areas that are typically considered safe from landslides include: areas that have not moved in the past; relatively flat-lying areas away from sudden changes in slope; and areas at the top or along ridges, set back from the tops of slopes.



EXPLANATION

LANDSLIDE INCIDENCE

- Low (less than 1.5% of area involved)
- Moderate (1.5%-15% of area involved)
- High (greater than 15% of area involved)

LANDSLIDE SUSCEPTIBILITY/INCIDENCE

- Moderate susceptibility/low incidence
- High susceptibility/low incidence
- High susceptibility/moderate incidence

Susceptibility not indicated where same or lower than incidence. Susceptibility to landsliding was defined as the probable degree of response of [the areal] rocks and soils to natural or artificial cutting or loading of slopes, or to anomalously high precipitation. High, moderate, and low susceptibility are delimited by the same percentages used in classifying the incidence of landsliding. Some generalization was necessary at this scale, and several small areas of high incidence and susceptibility were slightly exaggerated.

Figure 4.40. Landslide Overview Map of the Conterminous United States.

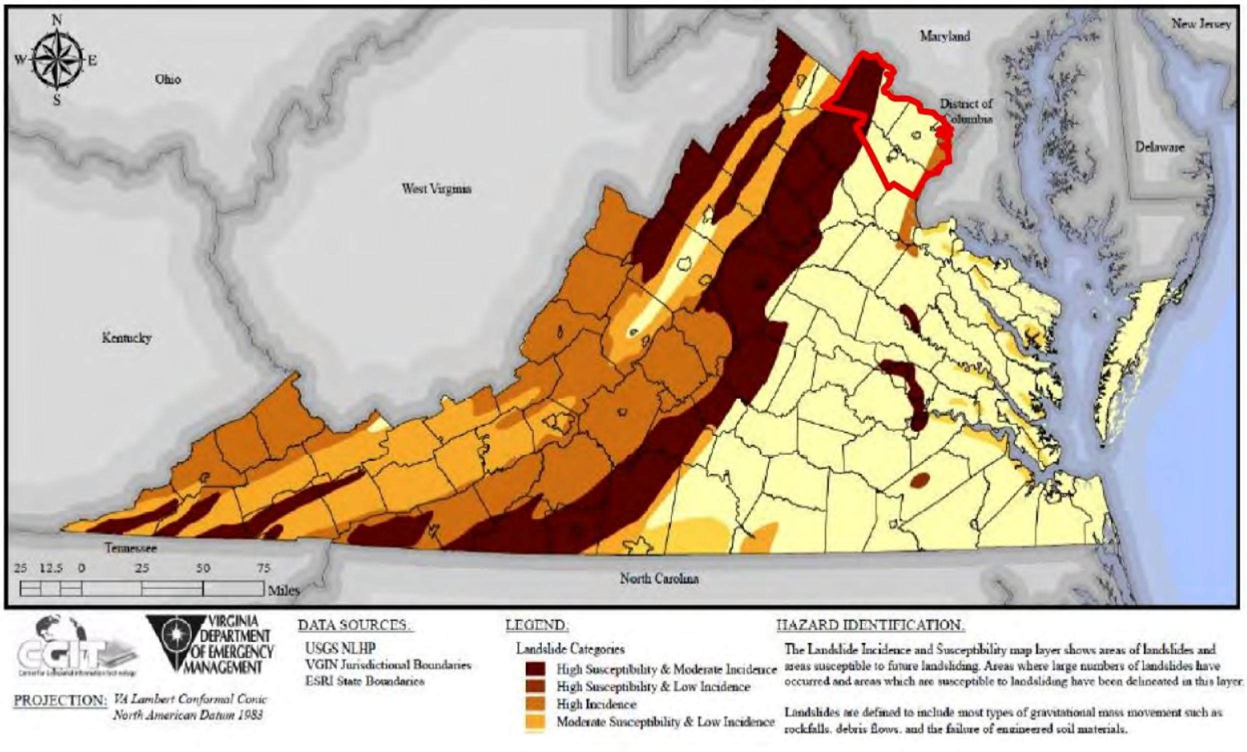


Figure 4.41. Landslide Incidence and Susceptibility.

3. Magnitude or Severity

Landslides are frequently associated with periods of heavy rainfall or rapid snow melt. Such landslides tend to worsen the effects of flooding that often accompanies these weather events. In areas burned by forest and brush fires, a lower threshold of precipitation may initiate landslides. Some landslides move slowly and cause damage gradually, whereas others move so rapidly that they can destroy property and take lives suddenly and unexpectedly.

4. Previous Occurrences

There are no historical records of major landslide events in the Northern Virginia region, as they are relatively uncommon events. No recent incidents were reported for the 2016 update to this plan. Minor landslide events are possible and have been known to occur in localized, steep-sloped areas of the region during extremely wet conditions. Though there are no documented occurrences, landslides are more likely to occur in western portions of Loudoun County than other areas of the region. Small landslides and minor subsidence issues are possible in eastern areas of Fairfax County, possibly due to the presence of marine clay, though no major damages have ever been recorded.

In June 2003, a minor landslide occurred in the Lansdowne area of Loudoun County, breaching a retaining wall, disrupting underground utility lines, and threatening 10 homes. According to local officials this was a very isolated incident brought on by heavy spring rains and should not indicate that the area is prone to recurring landslides.

B. Risk Assessment

The landslide data set shows areas in the United States where large numbers of landslides have occurred and areas that are susceptible to landslides. This data set is a digital representation of USGS Open-File Report 97-289, which is a PDF version of the 1997 USGS Digital representation of Landslide Overview Map (scale 1: 4,000,000). The report classifies the major physical subdivision of the United States and assesses the vulnerability based on subdivision characteristics. Figure 4.42 highlights the areas of increased incidence and susceptibility. The purpose of this dataset is to provide a general indication of areas that may be susceptible to sliding. It is not suitable for site selection or local planning initiatives.

As is evident from the following figure, the majority of the planning area falls within a low risk of incidence area, with small portions falling within a high risk of incidence area and the remainder within an area defined as high susceptibility/moderate incidence.

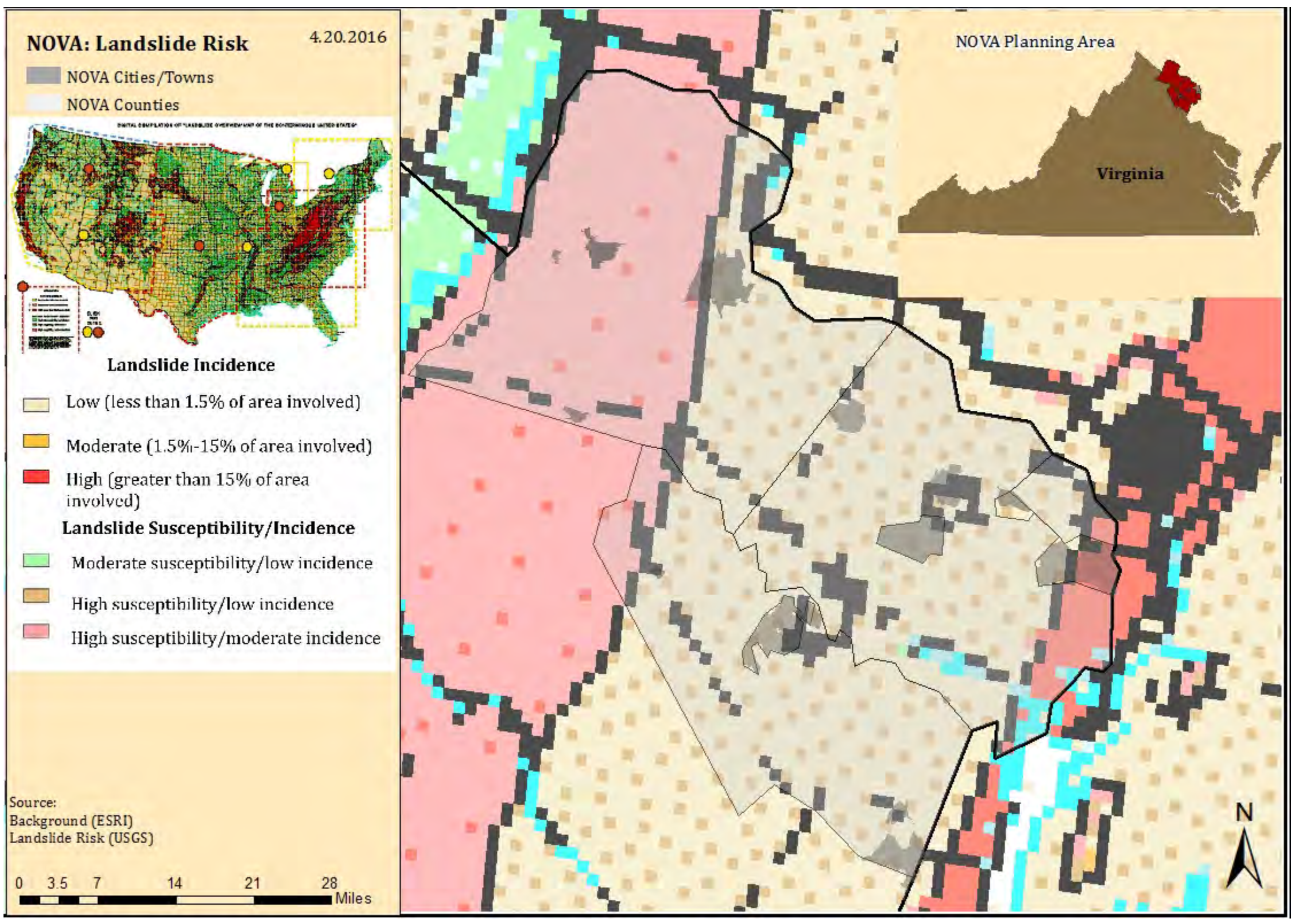


Figure 4.42. Planning Area Landslide Risk.

1. Probability of Future Occurrences

Landslide probability is highly site-specific, and cannot be accurately characterized on a statewide basis, except in the most general sense. Relative risk ranking is intended only for general comparison to the other hazards that impact the region. The magnitude of landslides is dependent on the amount of liquid and landmass in motion and the amount of development in the area. Often a landslide will be more severe in areas with higher slopes and poorly drained soils. Some areas that are generally prone to landslides include old landslide sites, the base of slopes, the base of minor drainage hollows, the base or top of old fill slope, the base or top of a steep cut slope, and developed hillsides where leach field septic systems are used.

2. Impact & Vulnerability

Landslides can cause serious damage to highways, buildings, homes, and other structures that support a wide range of economies and activities. Landslides commonly coincide with other natural disasters. Expansion of urban development contributes to greater risk of damage by landslides.

3. Risk

While some slope stability problems have been associated with marine clay in Fairfax County (marine clay becomes loose as moisture content increases, and is subject to slope creep if the natural slope is steepened during site development) the county has identified areas of marine clay and has established regulations requiring special engineering investigations and design procedures in the areas.

With future growth, various non-structural methods, such as zoning and grading ordinances, as well as structural methods, should be analyzed in terms of cost-effective alternatives. Zoning and grading ordinances to avoid building in areas of potential hazard or to regulate construction to minimize the potential for landslides is one non-structural method to reduce the likely consequences of debris flows. Loudoun County has adopted zoning ordinances preventing the development of building sites with steep slopes along the Blue Ridge (defined in the ordinance as exceeding a 15% grade, equivalent to an eight-degree slope), which substantially reduces the hazards of landslides and debris flows within that area.

Critical Facility Risk

Due to the lack of specific data regarding landslides and specific building information in the planning area, the potential risk to critical facilities and existing buildings and infrastructure was not estimated for this plan update.

Existing Buildings and Infrastructure Risk

For the purposes of this risk assessment, potentially at-risk buildings for landslides were not considered due to the fact that the landslide incidence data is highly generalized, owing to the small scale and the scarcity of precise landslide information for much of the country, and is unsuitable for local planning or actual site selection. This precaution should be noted and is applicable to the analysis completed for critical facilities in the landslide zones.

Overall Loss Estimates and Ranking

Due to the lack of any historical landslide damage data and well established occurrence probabilities, damages caused by landslides and associated dollar losses could not be estimated for the 2016 update or any previous version of this plan.

The Commonwealth of Virginia's 2013 Hazard Mitigation Plan ranking was based on the NCDC database. The update to the Northern Virginia plan used this same framework to establish a common system for evaluating and ranking hazards. While this ranking methodology makes sense for the majority of the hazards in this plan, the data is limited/non-existent for landslides.

Inputs for landslide were very limited as a result of having no landslide events available in the NCDC database. To be able to include landslide in the ranking, some general assumptions were made; geographic extent was the primary basis for establishing risk and was calculated as what percent of the jurisdiction is in the high risk zone, as defined by USGS. In lieu of probability for future occurrence, areas with high landslide risk were assumed to be at greater risk. Since there are no recorded landslide events, the lowest ranking score (1) was assigned to the jurisdictions for events, damages, deaths, and injuries to be able to compare landslide to the other hazards.

For the 2016 plan update the qualitative assessment was performed by jurisdiction. Given the widespread nature of the hazard, however, all counties, cities, and towns were determined to have the same qualitative risk to the hazard. It is possible that Loudoun County may have a slightly higher level of risk to the hazard, but this cannot be determined from the available data and a single occurrence. For practical and planning purposes, the region is assumed to have a uniform qualitative risk of 'Low'. Therefore, to avoid repetition, Table 4.101 below provides the results of the qualitative assessment for all participating jurisdictions, as all jurisdictions were found to have the same results

Table 4.101. 2016 Qualitative Assessment for Landslide.

	Probability	Impact	Spatial Extent	Warning Time	Duration
Risk Level	Unlikely	Critical	Moderate	Less than 6 hours	Less than one week

XIII. Wildfire

NOTE: As part of the 2016 plan update, the Wildfire hazard was reexamined and a new analysis performed. This new analysis included, but was not limited to: 1) refreshing the hazard profile; 2) updating the previous occurrences; 3) determining number of hazard events and losses by jurisdiction using NCDC and other data sources where available; 4) updating the assessment of risk by jurisdiction based on new data; and 5) ranking of the hazard by jurisdiction using the methodology described in detail in Chapter 4, Section IV Ranking and Analysis Methodologies. Each section of the plan was also reformatted for improved clarity and new maps and imagery, when available and appropriate, were inserted.

A. Hazard Profile

1. Description

A wildfire is any fire occurring in a wildland area (i.e., grassland, forest, brush land) except for fire under prescription. Prescription burning, or 'controlled burn,' undertaken by land management agencies is the process of igniting fires under selected conditions, in accordance with strict parameters. Wildfires are part of the natural management of the Earth's ecosystems, but may also be caused by natural or human factors. More than 80% of forest fires are started by negligent human behavior such as smoking in wooded areas or improperly extinguishing campfires. The second most common cause for wildfire is lightning.

There are three classes of wildland fires: surface fire, ground fire, and crown fire. A surface fire is the most common of these three classes and burns along the floor of a forest, moving slowly and killing or damaging trees. A ground fire (muck fire) is usually started by lightning or human carelessness and burns on or below the forest floor. Crown fires spread rapidly by wind and move quickly by jumping along the tops of trees. Wildland fires are usually signaled by dense smoke that fills the area for miles around.

State and local governments can impose fire safety regulations on home sites and developments to help curb wildfire. Land treatment measures such as fire access roads, water storage, helipads, safety zones, buffers, firebreaks, fuel breaks, and fuel management can be designed as part of an overall fire defense system to aid in fire control. Fuel management, prescribed burning, and cooperative land management planning can also be encouraged to reduce fire hazards.

Fire probability depends on local weather conditions; outdoor activities such as camping, debris burning, and construction; and the degree of public cooperation with fire prevention measures. Drought conditions and other natural disasters (tornadoes, hurricanes, etc.) may increase the probability of wildfires by producing fuel in both urban and rural settings. Forest damage from hurricanes and tornadoes may block interior access roads and fire breaks, pull down overhead power lines, or damage pavement and underground utilities.

Many individual homes and cabins, subdivisions, resorts, recreational areas, organizational camps, businesses, and industries are located within high fire hazard areas. The increasing demand for outdoor recreation places more people in wildlands during holidays, weekends, and vacation periods. Unfortunately, wildland residents and visitors are rarely educated or prepared for the inferno that can sweep through brush and timber and destroy property in minutes.

2. Geographic Location/Extent

Wildfires commonly begin unnoticed and spread quickly through vegetative fuels. As discussed in the ranking methodology section, the VDOF risk assessment represents the geographic extent or locations throughout the Commonwealth that have a higher risk for wildfire. The geographic extent score for a given jurisdiction is based on the percent of the jurisdiction that falls within the "high" risk area as defined by VDOF. Fairfax and Prince William Counties have the highest percent of their land area within the high risk classifications as compared to the other jurisdictions in the planning region. Figure 4.43 reflects the VDOF risk assessment and includes the geographic extent parameter used in the hazard ranking. Several areas in Northern Virginia are conducive to wildfires: the Conway-Robinson State Forest and Prince William Forests Park in Prince William County among them.

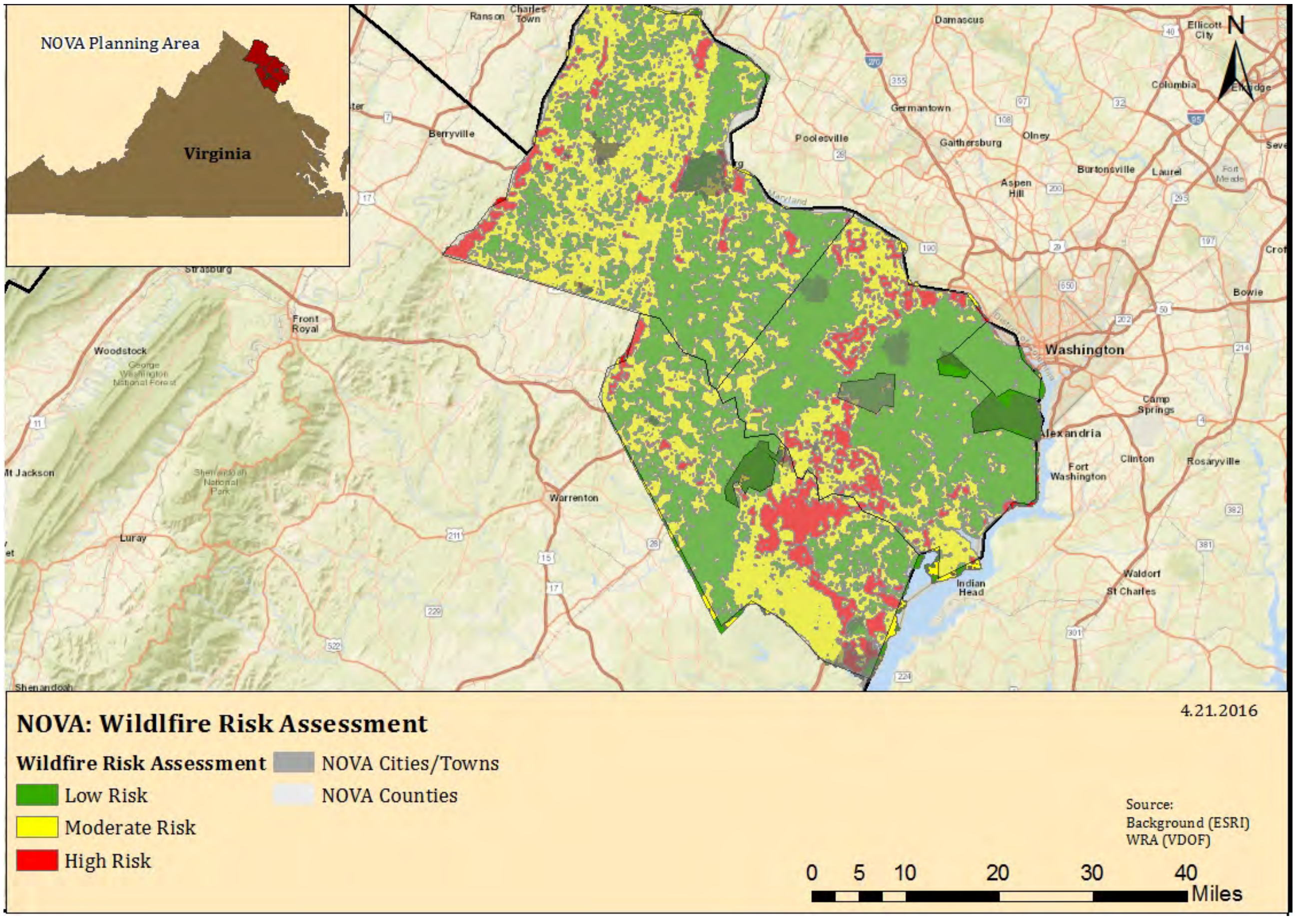


Figure 4.43. VDOF Wildfire Risk Assessment of Northern Virginia.

3. Magnitude or Severity

The Northern Virginia region is not considered as at-risk to wildfire as other areas of the State, but wildfire occurrence is certainly a hazard that does occur. According to VDOF records, there were 141 wildfire events in the Northern Virginia region between 1995 and 2013 (the latest year for which data was available). These fires burned a total of 966 acres, but fortunately caused no deaths or injuries. These fires were typically small in size, burning an average of approximately 16 acres before being suppressed. Of the 141 recorded historical incidents during this period, six fires burned an area greater than 10 acres (all in Loudoun or Prince William County). This is a significant increase in the last few years, as ten of these fires occurred between 2009 and 2013. Table 4.102 lists the number of these fire events, acres burned, and estimated damages by jurisdiction for the Northern Virginia region (where available).

4. Previous Occurrences

While the Commonwealth of Virginia rarely experiences the large, extensive wildfires typically seen in the western regions of the United States, wildfire risk remains a genuine concern. According to the VDOF, as of 2011 (the most recent year for which acreage calculations were available), about 1,411 wildfires consume an average of 10,181 acres in the State each year. During 2011, Virginia lost more than 22,000 acres to wildfires.

Local records of wildfire occurrences do exist, though the detail recorded in them varies significantly from jurisdiction to jurisdiction. This makes determining if an incident was, in fact, a wildfire and the consequences of that incident difficult to do for comparison purposes. The majority of wildfires that do occur are contained before they grow large, and are handled by local fire resources, which means that the majority of data regarding previous occurrences is stored, in some form, at the local level.

Given the amount of wildland/urban interface acreage within the planning area, it is unsurprising that there are numerous instances where local responders are called upon to deal with wildfires – sometimes multiple times in a single day. For example, on February 19, 2011, Fairfax County responded to a 20-acre wildfire, a 2-acre wildfire, a 5-acre wildfire, and numerous other incidents – all on the same day.

Virginia's wildfire season normally occurs in the spring (March and April) and then again in the fall (October and November). During these times, the relative humidity is usually lower, winds tend to be higher, and the fuels are cured to the point where they readily ignite. Also during these times hardwood leaves are on the ground providing more fuel and allowing sunlight to directly reach the forest floor, warming and drying the surface fuels.

Fire activity fluctuates during each month and also varies from year to year based on precipitation amounts. During years of adequate rain and snow, wildfire occurrence is typically low. Lack of moisture during other years means extended periods of warm, dry, windy days and therefore increased fire activity. The damage caused by Hurricane Isabel in 2003 increased the threat of wildfires in Virginia, and creating a major threat to lives and homes in the eastern half of Virginia for several years to come. The dead and downed timber caused by the storm has had time to cure and could produce wildfires that will be larger and much harder and dangerous to suppress.

Records indicate that most of Virginia's wildfires are caused by people. According to VDOF, the majority of wildfire incidents in the State from 1995 to 2011 (the most recent year for which data was available) occurred because of debris burning – a human-caused activity. Virginia is growing more rapidly than many other States, and its population has more than doubled in the last 50 years. Further, people are moving into residential developments located within forested areas, and there is an increased use of the forests for recreational uses. All of these trends increase the risk of wildfires and require continued fire prevention and protection activities.

There have been 141 wildfire burning 966 acres during 1995 through 2013 (the most recent year for which data was available) totaling at least $180,895 in damages. Table 4.102 shows the total number of fires, acres burned, jurisdictions that had recorded wildfire events by VDOF. Loudoun and Prince William County wildfires make up the majority of damages in Northern Virginia during the period of record (1995-2013).

Table 4.102. Wildfire events in the Northern Virginia Region, 1995-2013, based on VDOF Data.		
Jurisdiction	**Number of Fires**	**Total Acres**
Fairfax County	2	3
Loudoun County	100	379
Town of Leesburg	2	2
Prince William County	36	615
Town of Dumfries	1	6
Total	**120**	**368**

The available data illustrates that majority of the wildfire occurrences in the Northern Virginia region were caused by debris burning and other human activities. Table 4.103 shows the leading causes of wildfires in the region based on VDOF records for the 141 historical wildfires occurring between 1995 and 2013 (the most recent year for which data was available).

Table 4.103. Leading Causes of Wildfires in the Northern Virginia Region, 1995-2013		
Cause	**# of Fires**	**% of Wildfires**
Debris Burning	42	30%
Children	24	17%
Miscellaneous	31	22%
Incendiary	15	10%
Smoking	12	8%
Equipment Use	9	6%
Campfire	2	1%
Lightning	1	1%
Railroad	1	1%
Power Lines	2	1%
Prescribed Burn	1	1%
Firearms/Ammunition	1	1%

Source: VDOF

Based on the number of historical occurrences, wildfires are fairly prevalent events in the Northern Virginia region. These events, however, are usually contained to very small areas and have caused minimal damages to property due to strong fire response and suppression capabilities.

B. Risk Assessment

1. Probability of Future Events

Future wildfire incidents are difficult to predict, as the factors influencing wildfire generation vary greatly with changing weather conditions and human activities. There is currently no quantitative estimate of future wildfire probability for specific regions of the State.

While the VDOF Wildfire Risk Assessment does indicate the relative propensity for wildfires across the State, this assessment does not assign probabilities of occurrence or return intervals as is common with some of the other hazards. Based on available data from VDOF, during the years 1995 – 2011 (the most recent year for which data was available), Virginia experiences an average of 1,141 wildfires per year, affecting an average of 10,181 acres annually.

2. Impact & Vulnerability

Vulnerability to wildfire is influenced by a variety of factors, such as land cover, weather, and the effectiveness of land management techniques. Highly urbanized areas may be less vulnerable to wildfire, but suburban neighborhoods located at the urban/wildland interface are vulnerable to wildfire. The primary impacts of most wildfires are timber loss and environmental damage, although the threat to nearby buildings is always present. Secondary impacts may also include landslides and mudslides caused by the loss of groundcover which stabilizes the soil.

3. Risk

In 2002 and 2003, VDOF used GIS to develop a statewide spatial *Wildfire Risk Assessment* model that aims to: (1) identify areas where conditions are more conducive and favorable to wildfire occurrence and wildfire advancement; (2) identify areas that require closer scrutiny at larger scales; and (3) examine the spatial relationships between areas of relatively high risk and other geographic features of concern, such as woodland home communities, fire stations, and fire hydrants. This model incorporates data from several other State and Federal agencies including land cover, demographics, transportation corridors, and topography to illustrate the level of wildfire risk for all areas across the State of Virginia. The results of this model were merged and the wildfire risks were classified and scored as: 1 (low), 2 (moderate), and 3 (high). This data is presented in Table 4.104.

Prince William County has over 15% of its acreage in the high risk category, with the Town of Round Hill having almost one-third of its acreage at high risk. Fairfax County has approximately 12% of its acreage in the high risk category, with over 16% of the Town of Clifton's area in high risk. The Northern Virginia region is mostly low (48.97%) and medium (41%) risk, with a tenth of the region in the high risk category.

Table 4.104. Wildfire Risk by Jurisdiction

Jurisdiction	Low (acres)	Low % Area	Medium (acres)	Medium % Area	High (acres)	High % Area	Total Acres
Arlington County	16,064	**96.30%**	435	**2.61%**	183	**1.10%**	**16,682**
Fairfax County	143,682	**57.22%**	77,244	**30.76%**	30,174	**12.02%**	**251,100**
Town of Herndon	2,734	***99.93%***	1	***0.04%***	0	***0.00%***	**2,736**
Town of Vienna	2,795	***99.25%***	21	***0.75%***	0	***0.00%***	**2,816**
Town of Clifton	43	***26.06%***	95	***57.58%***	27	***16.36%***	**165**
Loudoun County	136,046	**42.16%**	166,511	**51.60%**	20,114	**6.23%**	**322,672**
Town of Leesburg	4,670	***58.46%***	2,635	***32.98%***	684	***8.56%***	**7,989**

Table 4.104. Wildfire Risk by Jurisdiction

Jurisdiction	Low (acres)	Low % Area	Medium (acres)	Medium % Area	High (acres)	High % Area	Total Acres
Town of Purcellville	278	***13.69%***	1,738	***85.62%***	14	***0.69%***	**2,030**
Town of Middleburg	219	***33.08%***	389	***58.76%***	55	***8.31%***	**662**
Town of Round Hill	0	***0.00%***	165	***69.62%***	71	***29.96%***	**237**
Prince William County	87,118	**39.77%**	98,129	**44.79%**	33,828	**15.44%**	**219,076**
Town of Dumfries	745	***73.40%***	255	***25.12%***	14	***1.38%***	**1,015**
Town of Haymarket	240	***78.43%***	66	***21.57%***	0	***0.00%***	**306**
Town of Occoquan	83	***74.77%***	27	***24.32%***	0	***0.00%***	**111**
Town of Quantico	44	***93.62%***	3	***6.38%***	0	***0.00%***	**47**
City of Alexandria	9,644	**98.83%**	114	**1.17%**	0	**0.00%**	**9,758**
City of Fairfax	3,801	**94.65%**	215	**5.35%**	0	**0.00%**	**4,016**
City of Falls Church	1,275	**100.00%**	0	**0.00%**	0	**0.00%**	**1,275**
City of Manassas	6,130	**95.50%**	287	**4.47%**	2	**0.03%**	**6,419**
City of Manassas Park	741	**65.29%**	265	**23.35%**	129	**11.37%**	**1,135**
TOTAL	**416,352**	**48.97%**	**348,595**	**41.00%**	**85,295**	**10.03%**	**850,247**

Critical Facility Risk

The US Forest Service offers a product called the Wildfire Hazard Potential (WHP) map. This product is a raster geospatial product that can help to inform evaluations of wildfire risk across large landscapes. On its own, the WHP is not an explicit map of wildfire threat or risk, but when paired with data depicting highly valued local resources and assets – such as critical facilities – it can provide approximate relative wildfire risk to those resources and assets.

The locally-provided critical and historical facilities data was intersected with the US Forest Service's wildfire hazard potential to determine which facilities were at an increased risk for wildfire, or being in the urban/wildland interface. Figure 4.44 illustrates the current estimates for wildland fire potential throughout the Northern Virginia region. Figure 4.45 illustrates the location of locally-identified critical facilities within the fire potential estimates. As can be seen in these images, the majority of the region falls within areas currently classified as having very low or low potential for wildfire, with other significant amounts of areas classified as non-burnable.

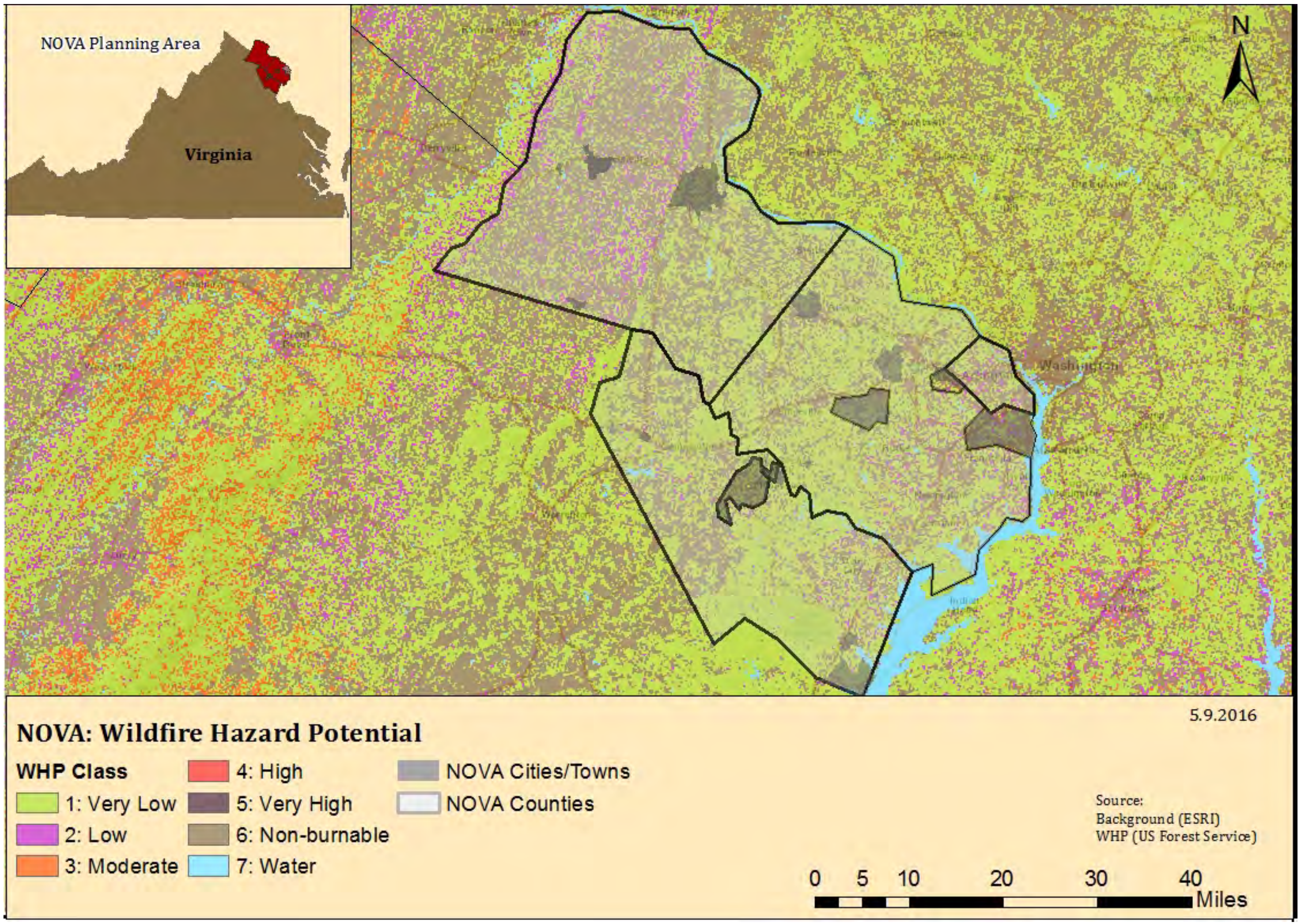


Figure 4.44. Wildfire Hazard Potential for Northern Virginia, based on USFS data.

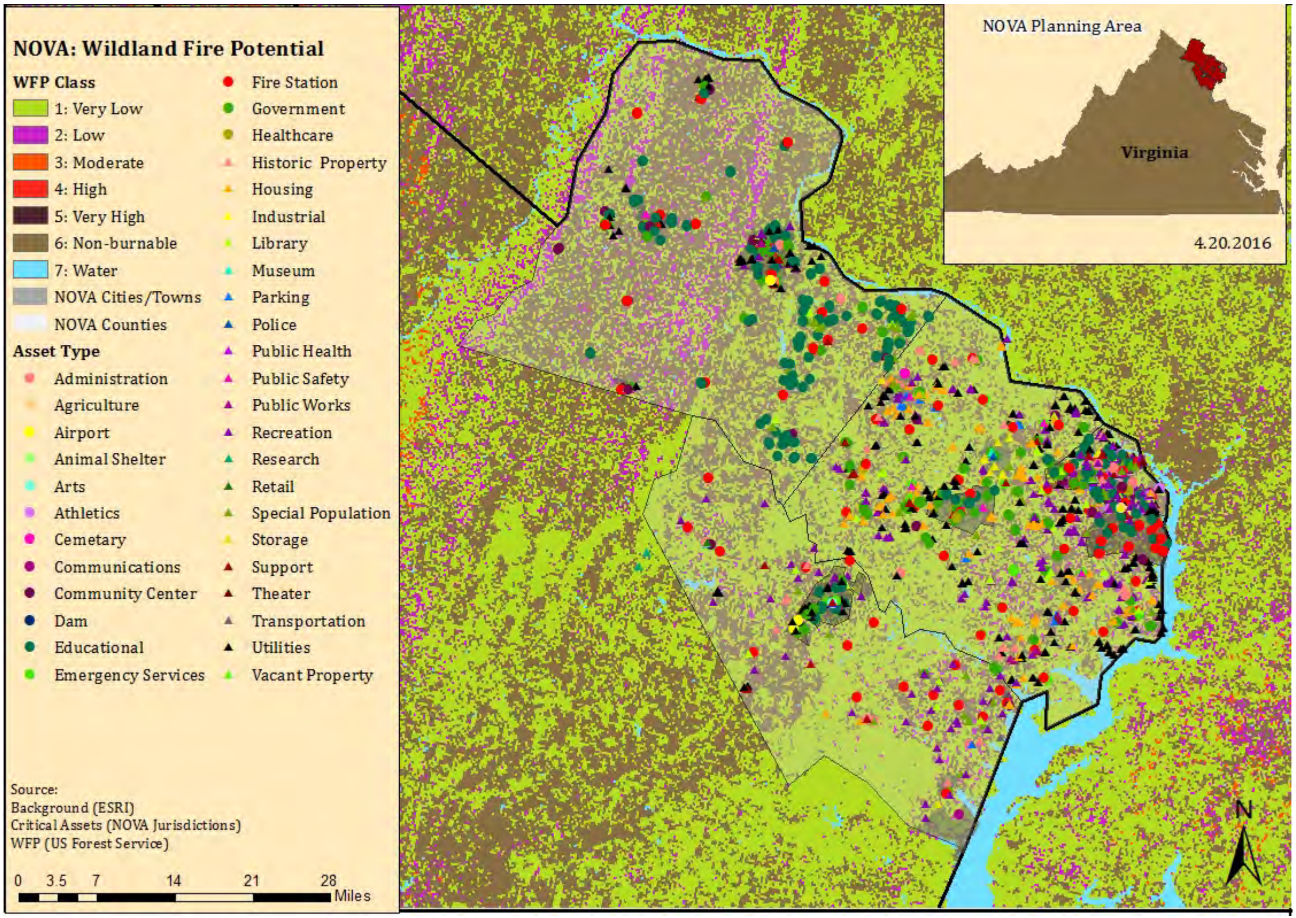


Figure 4.45. Wildfire Hazard Potential for Northern Virginia – With Critical Facilities.

Table 4.105 shows the number of critical facilities, by locality, and the corresponding wildfire potential for their location. The names and information for the local critical facilities in the wildfire risk zones are available in the Critical Facility-Risk Appendix D. Figures for each participating jurisdiction can also be found in Appendix D. The lack of wildfire probabilities and detailed infrastructure data led to the inability to calculate potential losses due to wildfire.

Table 4.105. Wildfire Hazard Class Exposure for Locally-Provided Critical and Historic Assets

Jurisdiction	WHP Class	Asset Value	Contents Value	Total Value of Exposure
Arlington County	Non-burnable or Water	$976,001,803	$96,448,098	$1,072,449,901
	Very Low	$600,313,587	$107,401,659	$707,715,246
	Low	$47,190,500	$3,209,400	$50,399,900
	Undefined	$81,600	$2,000	$83,600
	Subtotal	*$1,623,587,490*	*$207,061,157*	*$1,830,648,647*
Fairfax County	Non-burnable or Water	$1,281,440,265	$157,830,545	$1,439,270,810
	Very Low	$583,864,501	$53,541,788	$637,406,289
	Low	$32,697,355	$4,364,984	$37,062,339
	Undefined	$161,505,240	$15,975,815	$177,481,055

Table 4.105. Wildfire Hazard Class Exposure for Locally-Provided Critical and Historic Assets				
Jurisdiction	**WHP Class**	**Asset Value**	**Contents Value**	**Total Value of Exposure**
	Subtotal	*$2,059,507,361*	*$231,713,132*	*$2,291,220,493*
Loudoun County	Non-burnable or Water	$1,087,409,540	$1,087,409,540	$2,174,819,080
	Very Low	$1,093,424,340	$1,093,424,340	$2,186,848,680
	Low	$1,141,390	$1,141,390	$2,282,780
	Subtotal	*$2,181,975,270*	*$2,181,975,270*	*$4,363,950,540*
Prince William County	Non-burnable or Water	$463,216,250	$78,327,055	$541,543,305
	Very Low	$107,653,000	$6,417,385	$114,070,385
	Subtotal	*$570,869,250*	*$84,744,440*	*$655,613,690*
City of Alexandria	Non-burnable or Water	$13,455,000	$5,000,000	$18,455,000
	Very Low	$257,461,735	$59,000,000	$316,461,723
	Low	$25,434,825	$0	$25,434,825
	Subtotal	*$296,351,560*	*$64,000,000*	*$360,351,560*
City of Fairfax	Non-burnable or Water	$194,474,176	$0	$194,474,176
	Subtotal	*$194,474,176*	*$0*	*$194,474,176*
City of Falls Church	Non-burnable or Water	$71,530,100	$0	$71,530,100
	Very Low	$1,860,200	$0	$1,860,200
	Subtotal	*$73,390,300*	*$0*	*$73,390,300*
City of Manassas	Non-burnable or Water	$181,079,188	$49,562,538	$230,641,726
	Very Low	$175,569,875	$24,132,350	$199,702,225
	Subtotal	*$356,649,063*	*$73,694,888*	*$430,343,951*
City of Manassas Park	Non-burnable or Water	*$38,897,500*	*$0*	*$38,897,500*
	Very Low	*$61,770,900*	*$0*	*$61,770,900*
	Subtotal	*$100,668,400*	*$0*	*$100,668,400*
Town of Clifton	Non-burnable or Water	$0	$0	$0
	Very Low	$0	$0	$0
	Subtotal	*$0*	*$0*	*$0*
Town of Haymarket	Non-burnable or Water	$3,671,280	$203,863	$3,875,143
	Very Low	$324,353	$2,014	$326,367
	Subtotal	*$3,995,633*	*$205,877*	*$4,201,510*
Town of Herndon	Non-burnable or Water	$30,010,198	$2,780,084	$32,790,282
	Very Low	$17,103,282	$2,459,867	$19,563,149
	Subtotal	*$47,113,480*	*$5,239,951*	*$52,353,431*
Town of Leesburg	Non-burnable or Water	$91,153,261	$28,138,520	$119,291,781
	Very Low	$53,707,958	$17,131,332	$70,839,290
	Low	$1,783,300	$1,997,900	$3,781,200

Table 4.105. Wildfire Hazard Class Exposure for Locally-Provided Critical and Historic Assets				
Jurisdiction	**WHP Class**	**Asset Value**	**Contents Value**	**Total Value of Exposure**
	Subtotal	*$146,644,519*	*$47,267,752*	*$193,912,271*
Town of Lovettsville	Very Low	$164,950	$164,950	329,900
	Subtotal	*$164,950*	*$164,950*	*329,900*
Town of Middleburg	Non-burnable or Water	$675,400	$675,400	$1,350,800
	Very Low	$191,700	$191,700	$383,400
	Low	$6,220	$6,220	$12,440
	Subtotal	*$873m320*	*$873,320*	*$1,746,646*
Town of Occoquan	Non-burnable or Water	$1,645,900	$0	$1,645,900
	Very Low	$320,300	$30,000	$350,300
	Subtotal	*$1,966,200*	*$30,000*	*$1,006,200*
Town of Purcellville	Non-burnable or Water	$2,015,900	$2,015,900	$4,031,800
	Very Low	$3,246,770	$3,246,770	$6,493,540
	Subtotal	*$5,262,670*	*$5,262,670*	*$10,525,340*
Town of Round Hill	Non-burnable or Water	$386,370	$386,370	$772,740
	Subtotal	*$386,370*	*$386,370*	*$772,740*
Town of Vienna	Non-burnable or Water	$25,875,000	$1,945,000	$27,820,000
	Very Low	$6,925,000	$750,000	$7,675,000
	Subtotal	*$32,800,000*	*$2,695,000*	*$34,495,000*
Total Exposure	**Non-burnable or Water**	**$4,280,937,131**	**$1,510,722,913**	**$5,973,660,044**
	Very Low	**$2,963,902,451**	**$1,368,280,525**	**$4,332,182,006**
	Low	**$108,253,590**	**$184,537,720**	**$1,480,253,006**
	Undefined	**$161,586,840**	**$2,398,931,432**	**$5,516,919,344**

Existing Buildings and Infrastructure Risk

As demonstrated above and in the critical facility analysis, most of the wildfire risk in the Northern Virginia region is located in areas of Loudoun and Prince William counties. Historically, wildfires have been larger and caused more damages in these counties mainly due to not only increased vegetative fuel loads, but also because the areas are sparsely settled and have less rapid fire response capabilities. The most at-risk properties within these areas are considered to be those structures located along the wildland-urban interface, defined by the National Wildfire Coordinating Group[24] as “the line, area or zone where structures and other human development meet or intermingle with undeveloped wildland or vegetative fuels.” Structures with combustible roofs and less than 30 feet of cleared defensible space are particularly at risk.

Overall Loss Estimates and Ranking

Between 1995 and 2013 (the most recent year for which data was available), the VDOF recorded 141 wildfire events in the Northern Virginia. Table 4.106 shows the specific annualized number of fires by jurisdiction. This is based on the total VDOF reported damages divided by the number of years of record.

Table 4.106. Annual Number of Wildfires Annualized, based on VDOF data, 1993 – 2013.

Jurisdiction	Annualized Number of Fires
Fairfax County	0.11
Loudoun County	5.55
Town of Leesburg	0.11
Prince William County	2.0
Town of Dumfries	0.05

No wildfire events were recorded in the NCDC database for the Northern Virginia region; as a result, no NCDC annualized loss estimate was calculated**.** The Commonwealth of Virginia's 2013 Hazard Mitigation Plan ranking was based on the VDOF data. The update to the Northern Virginia plan used this same framework to establish a common system for evaluating and ranking hazards.

For the 2016 plan update the qualitative assessment was organized by jurisdiction. Based on the data available, Prince William and Loudoun Counties and their associated participating towns were determined to have different risks than all other participating jurisdictions, that of 'Moderate', while all other participating jurisdictions were determined to be 'Low'. To avoid repetition, all other participating jurisdictions are represented below in a single table, and Loudoun and Prince William Counties (and their associated participating towns) are represented in standalone tables.

Loudoun County and the Town of Leesburg, the Town of Lovettsville, the Town of Purcellville, the Town of Middleburg, and the Town of Round Hill; Prince William County and the Town of Dumfries, the Town of Haymarket, the Town of Occoquan, and the Town of Quantico

Table 4.107. 2016 Qualitative Assessment for Wildfire

	Probability	Impact	Spatial Extent	Warning Time	Duration
Risk Level	Likely	Critical	Moderate	Less than 6 hours	Less than one week

Arlington County and the Town of Clifton, the Town of Herndon, and the Town of Vienna; Fairfax County, the City of Alexandria; the City of Fairfax; the City of Falls Church; the City of Manassas; and the City of Manassas Park.

Table 4.108. 2016 Qualitative Assessment for Wildfire

	Probability	Impact	Spatial Extent	Warning Time	Duration
Risk Level	Unlikely	Critical	Small	Less than 6 hours	Less than one week

XIV. Sinkholes / Karst / Land Subsidence

NOTE: As part of the 2016 plan update, the Sinkholes/Karst/Land Subsidence hazards were reexamined and a new analysis performed. This new analysis included, but was not limited to: 1) refreshing the hazard profile; 2) updating the previous occurrences; 3) determining number of hazard events and losses by jurisdiction using NCDC and other data sources where available; 4) updating the assessment of risk by jurisdiction based on new data; and 5) ranking of the hazard by jurisdiction using the methodology described in detail in Chapter 4, Section IV Ranking and Analysis Methodologies. Each section of the plan was also reformatted for improved clarity, and new maps and imagery, when available and appropriate, were inserted.

A. Hazard Profile

1. Description

Sinkholes are a frequent occurrence in areas underlain by calcareous carbonate formations, especially limestone and dolomite. Groundwater flow through cracks, fissures, joints, and other discontinuities in the rock mass dissolves the carbonate minerals creating small voids. Over time continued water seepage and dissolution of minerals enlarges the void to form caves and caverns in the rock. As the void increases in size, so does the load supported by the void roof. If the strength of the roof layer becomes less than the weight of the material above it, the roof fails and the overburden materials collapse into the void. If the collapse manifests itself at the surface, the resulting depression is referred to as a sinkhole. Other calcareous carbonate materials include partially-cemented to well-cemented shell formations found in coastal areas of the southeastern United States.

The process of sinkhole formation depends on a complex set of variables including geologic structure, geochemistry, hydrologic conditions, and development activity. If the roof above the void is sound rock and the water level falls below the roof level, future growth of the void may not reduce the roof thickness and collapse may not occur. However, if the roof rock is fractured or otherwise cracked, shallow groundwater from above can flow into the void bringing with it eroded overburden soil. The erosion of overburdened soil into the rock void creates a similar soil void that can migrate to the surface, resulting in a collapse of the soil roof even though the underlying rock has not collapsed.

Changes in hydrologic conditions, natural or man-made, can increase the occurrence of sinkholes. An increase in the volume and/or velocity of flow through the rock provides more fresh water to dissolve soluble minerals and more energy to erode solid particles, increasing existing voids or creating new ones. Water supply and open pit mining are common reasons for pumping large volumes of water through soluble calcareous formations.

Sink holes vary in size, ranging from a few feet to a mile or more in diameter. Sink holes can reach several hundred feet below the surface. Areas of abundant sinkholes are referred to as karst topography. Karst areas have few surface streams as drainage is primarily through underground solution channels.

Sinkholes can also occur due to the impacts of constructed facilities in most geologic environments, including those not underlain by calcareous carbonate rocks. Undetected leaks in underground utility lines can result in subsurface erosion of soil from around the pipe. Left undetected, the erosion creates a void that expands upward until the soil roof cannot support the overburden load and the roof collapses.

2. Geographic Location / Extent

Sinkholes are prevalent in the Great Valley region of central Virginia, including karst terrains in the Shenandoah Valley where voids are formed by the natural dissolution of soluble rock such as limestone and dolomite.

According to the Virginia Department of Mines, Minerals and Energy, sinkholes are very rare in the Northern Virginia region and do not pose a significant risk. However, a band of metamorphosed limestone, dolostone, and marble located in eastern Loudoun County and the Town of Leesburg has a history of sinkhole activity. Figure 4.46 shows the karst regions and areas of historical subsidence in the Commonwealth, based on the USGS Engineering Aspects of Karst. The karst regions in Northern Virginia are considered short karst type, which include fissured, tube, and caves generally less than 1,000 feet long; and 50 feet or less in vertical extent.

Loudoun County has a region of karst geology located in an area roughly one mile on either side of State Route 15 from just south of Leesburg, north to the Potomac River Bridge. The region is bounded sharply to the west by the Bull Run Fault, which runs at the base of Catoctin Mountain through Loudoun County. Figure 4.47 shows the limestone district for Loudoun County. The Limestone Overlay District (LOD) is primarily comprised of the following geologic formations:

- Cf-Frederick Limestone;
- Ct-Tomstown Dolomite;
- JTRc-Catharpin Creek Formation;
- JTRcg-Catharpin Creek Formation Goose Creek Member;
- TRbl-Balls Bluff Siltstone Leesburg Member; and
- TRbs-Balls Bluff Siltsone Fluvial and Deltaic Sandstone Member.

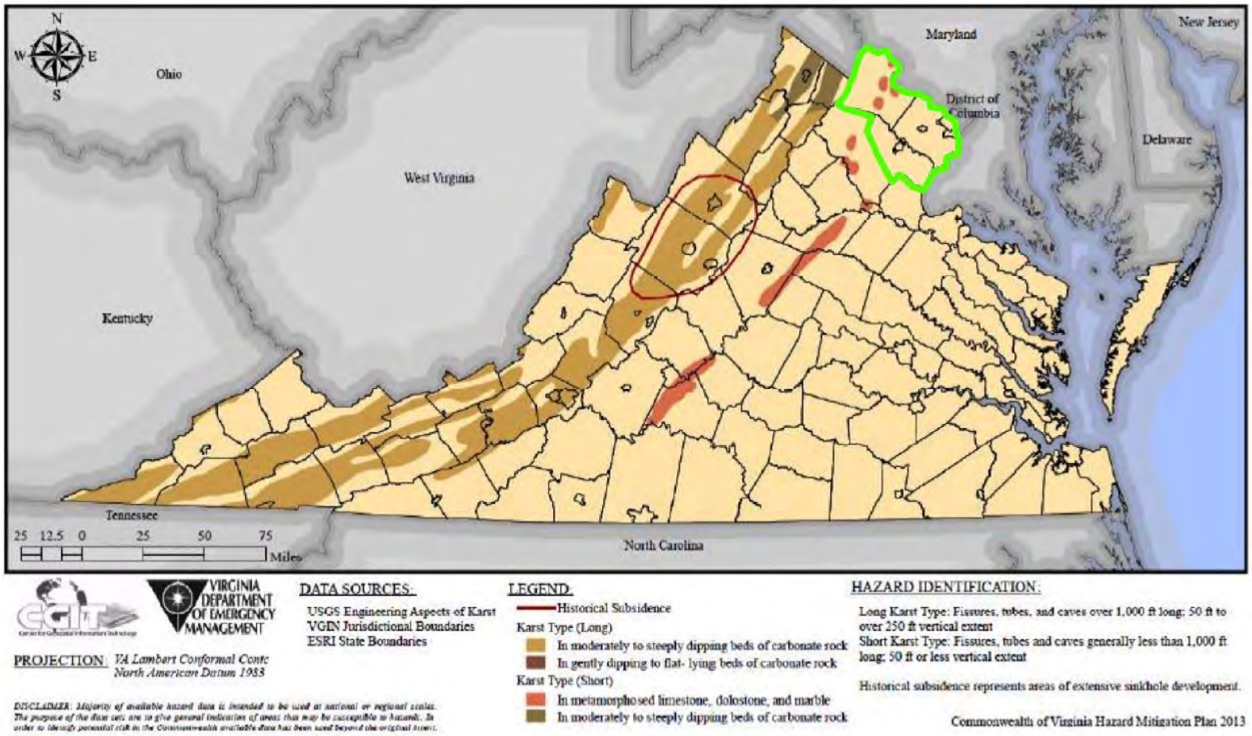


Figure 4.46. Karst Regions and Historical Subsidence in Virginia.

Source: Commonwealth of Virginia Hazard Mitigation Plan

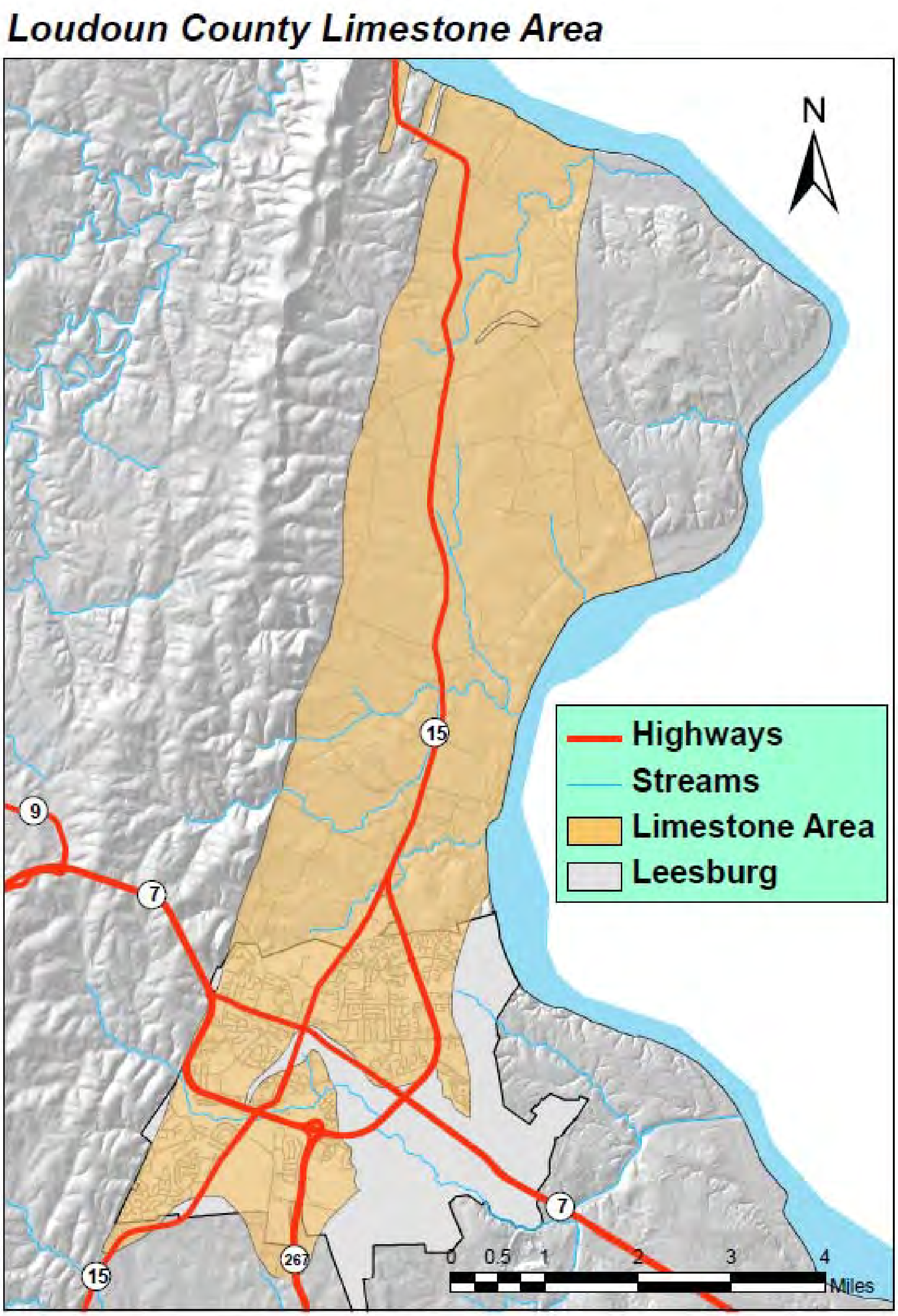


Figure 4.47. Loudoun County limestone district.
Source: Loudoun County

3. Magnitude or Severity

Although sinkholes frequently occur without notice, there are warnings of potential sinkhole development including:

- Slumping or leaning fence posts, utility poles, trees, etc.;
- Discolored vegetation;
- Tension crack visible in the ground surface;
- Discolored well water;
- New cracks in building walls and/or; and
- Newly sagging floors or pavements.

Sinkhole formation is aggravated and accelerated by urbanization. Development increases water usage, alters drainage pathways, overloads the ground surface, and redistributes soil. According to FEMA, the number of human-induced sinkholes has doubled since 1930, costing nearly $100 million. The increasing frequency of sinkholes could be affected by reporting biases. A paper published by the USGS, Tampa, Florida shows a significant increase in sinkhole development that corresponds to a period of drought. Changes in ground water levels increase the overburden stress on the void roof increasing the potential for roof collapse. Thus using that period as indicating a larger trend may not be appropriate, especially given the context of the initial data. Additionally, Florida data suggests that the jump in sinkhole development in the 1987 to 1991 period was caused, at least in part, by natural events. Further, the reason for the jump in insurance payouts is likely the result of naturally caused sinkholes occurring under more expensively developed real estate[25].

4. Previous Occurrences

Water leaking from culverts or other drainage structures can create a void beneath the drainage structure by compaction or internal scour of the soil. This reduction in support can result in displacement of the leaking structure and an increase in leakage or breakage. The void may increase in size to the extent that the soil has insufficient strength to support itself with subsequent failure, leading to the formation of a steep sided, collapsed sinkhole.

Sinkholes remain a possible occurrence in localized areas of the Northern Virginia region. To date, there have been no Federal Declared Disasters or NCDC recorded events for karst related events.

In April 2015, a sinkhole opened in the Exeter Community of Loudoun County. The hole, which measured approximately 30 by 40 feet, formed in the parking lot of a townhouse community, and caused some damages, including the sinking of the roadway and disruption of water service to approximately 65 structures in the area. Reports indicate this was the second sinkhole in this same area in the previous two decades.

Other known events, although not comprehensive, include:

- Heavy rain caused the collapse of a major thoroughfare in Loudoun County in June 2014. The collapse occurred on Dry Mill Road and exposed a 48-inch water main, and resulted in a five-mile detour for motorists.
- A sinkhole 20 feet deep and 25 feet wide closed down Dale Boulevard west of Mapledale Avenue, about four miles from Interstate 95 in Prince William County (2008).
- August 11, 2001, heavy rainfall washed out a culvert and created a sinkhole in Arlington County, though no damages were reported.

B. Risk Assessment

The Engineering Aspects of Karst data set shows areas of karst in the United States. This data set is a digital representation of USGS Open-File Report 2004-1352, which is a PDF version of the 1984 USGS Engineering Aspects of Karst map (scale 1: 7,500,000). These maps depict areas containing distinctive surficial and subterranean features, developed by solution of carbonate and other rocks and characterized by closed depressions, sinking streams, and cavern openings. Loudoun County and the Town of Leesburg are the only areas in the planning region that have been included in the USGS Engineering Aspects of Karst.

David Hubbard, geologist with the Virginia Department of Mines, Minerals, and Energy developed 1: 24,000 scale sinkhole boundary maps during 1980 and 1988 for the State. Sinkhole distribution is shown in three main regions along the Valley and Ridge province. A total of 48,807 sinkholes have been mapped over 254 standard (7.5 minute) topographic maps for an average of 192.1 sinkholes per map. The southern third of the project area represented more than half of the mapped location. There appears to be an increase in the relative degree of karstification from north to south across the State of Virginia[26]. These maps are not currently available in digital format. Additional analysis may be able to be completed in future versions of this plan as digital data becomes available.

In May 2010, Loudoun County re-adopted and re-enacted the LOD. In February 2010 the Board of Supervisors adopted amendments to the Zoning Ordinance Zoning Map, Facilities and Standards Manual, the land Subdivision & Development Ordinance, and other county ordinances to create the LOD. The amendments will implement the County’s adopted Comprehensive Plan provisions concerning limestone areas by creating and mapping a new LOD and amending Section 6-407(A) of the Zoning Ordinance to add a LOD to the list of environmental overlay districts for which the Zoning Administrator is authorized to make cartographic interpretations, and amending Article 8, Definitions, of the Zoning Ordinance to add and/or revise definitions for uses and terminology used in the proposed amendments.

1. Probability of Future Occurrences

The exact time that land subsidence will occur cannot be predicted; it can occur suddenly without warning or over an extended period of several years. However, some factors that can cause a decrease in strength are wet conditions, vibrations, and increased surface loading. Land subsidence that occurs as a result of a drawdown of the groundwater table is likely to take place over a number of years. Procedures for predicting the occurrence of land subsidence have not yet been developed.

To be able to include karst in the risk assessment some general assumptions were made. Geographical Extent, using USGS Karst Topography maps, was the primary basis for establishing risk and was calculated as a percent of the jurisdictional area. In lieu of probability of future occurrence, areas with more karst were assumed to be at greater risk.

2. Impact & Vulnerability

The potential impacts of land subsidence depend on the type of subsidence that occurs (regional or localized, gradual or sudden) and the location that the subsidence occurs. The impacts of subsidence occurring in nonurban areas are likely to be less damaging than subsidence that occurs in heavily populated locations. The amount of structural damage depends on the type of construction, the structure location and orientation with respect to the subsidence location, and the characteristics of the subsidence event (sag or pit).

Potential impacts from land subsidence could include damage to residential, commercial, and industrial structures; damage to underground and above-ground utilities; damage to transportation infrastructure, including roads, bridges, and railroad tracks; as well as damage or loss of crops. The extent and value of the potential damage cannot be assessed because the nature of the damage is site- and event-specific.

3. Risk

As discussed previously, sinkholes are relatively uncommon events in the Northern Virginia region. The existing soil types are not conducive to creating natural sinkholes, and those that do occur are related to soil piping or the dissolution of sparse carbonate rock and typically cause very little damage. There are no known sources of sinkhole probability data for the region and no record of historical incidences causing property damages.

As previously mentioned, Loudoun County has adopted a LOD in their zoning ordinance that seeks to preserve and protect the unique geologic characteristics and the quality of the groundwater in its limestone area. The ordinance is intended to regulate land use and development in areas underlain by limestone and in areas with Karst features and Karst terrain in such a manner as to[27]:

- Protect the health, safety and welfare of the public;
- Protect groundwater and surface water resources from contamination; and
- Reduce potential for property damage resulting from subsidence or other earth movement.

Critical Facility Risk

The vulnerability of each identified critical facility was assessed using GIS analysis by comparing their physical location with the extent of known hazard areas that can be spatially defined through GIS technology. Of those critical facilities identified in the region, some were indeed determined to be in known hazard areas upon further GIS analysis and thereby determined to be ‘potentially at-risk.’

Loudoun County maintains a karst feature database (the mapped karst features in the County are the developer’s responsibility to provide necessary information to determine if all the requirements or ordinances and provisions have been met). For applications within the LOD, all documentation and studies are outlined in Section 4-1900 of the zoning ordinance. This organization allows Loudoun County to significantly reduce risk of sinkhole development to facilities, property, and people.

Using the Limestone Layer available through Loudoun County's website, mapped critical assets in Loudoun County were viewed via the County's GIS portal. Of the mapped critical assets, which include schools, fire stations, police stations, other public safety assets, and emergency medical assets, at least one fire station was found to be located within the known limestone area of Loudoun County. Figure 4.48 provides this graphic; the area identified as limestone is indicated in pink on the image.

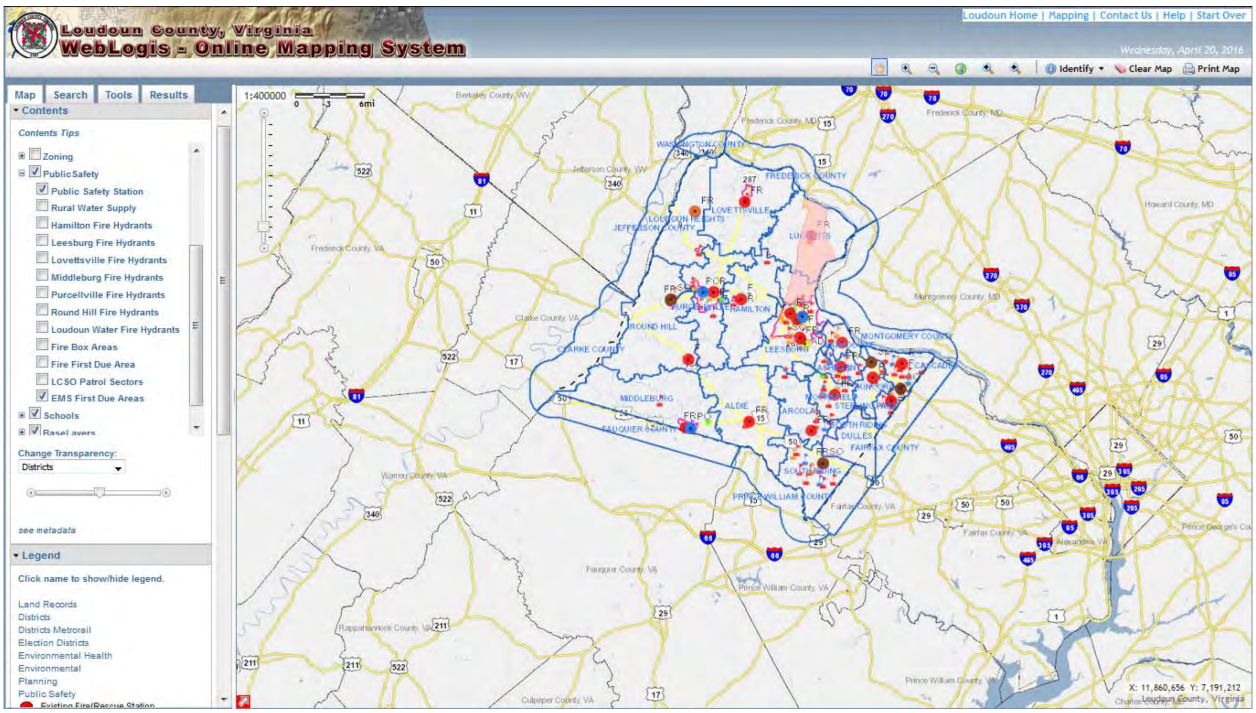


Figure 4.48. Loudoun County Limestone and Critical Assets Map.

Existing Buildings and Infrastructure Risk

Loss estimates could not be calculated for land subsidence events due to a lack of detailed and accurate information regarding structures and assets located in the previously determined hazard areas. In addition, due to the extremely localized and site specific nature of typical subsidence events, any inventory of potential at risk structures may grossly over-estimate potential losses.

Overall Loss Estimates and Ranking

As stated above, loss estimates could not be calculated for land subsidence events due to a lack of historical data causing property damages and probability of future occurrences.

There are currently no karst related records in NCDC; as a result, the lowest ranking score (1) was assigned to the annualized data for events, damages, and deaths and injuries to be able to compare karst to the other hazards, as described in Risk Assessment Methodology section. Refer to the Risk Assessment Methodology section of the HIRA for a full description of the methodology and the limitations of the data used for ranking the hazards.

For the 2016 plan update the qualitative assessment was organized by jurisdiction. The hazard ranking for land subsidence is based on events reported and a generalized geographic extent. As previously discussed, Loudoun County and the Town of Leesburg has a slightly elevated risk due to the short karst features in the region, resulting in a vulnerability ranking of ‘Moderate’, compared to ‘Low’ for all other participating jurisdictions in the planning area. Loudoun County has ordinances in place to help mitigate their risk to this hazard.

Loudoun County and the Town of Leesburg

Table 4.109. 2016 Qualitative Assessment for Sinkholes

	Probability	Impact	Spatial Extent	Warning Time	Duration
Risk Level	Moderate	Moderate	Low	6 to 12 hours	Less than one week

All Other Jurisdictions

Table 4.110. 2016 Qualitative Assessment for Sinkholes

	Probability	Impact	Spatial Extent	Warning Time	Duration
Risk Level	Low	Moderate	Low	6 to 12 hours	Less than one week

XV. Dam Failure

NOTE: As part of the 2016 plan update, the Dam Failure hazard was reexamined and a new analysis performed. This new analysis included, but was not limited to: 1) refreshing the hazard profile; 2) updating the previous occurrences; 3) determining the number of hazard events and losses by jurisdiction using NCDC and other data sources where available; 4) updating the assessment of risk by jurisdiction based on new data; and 5) ranking of the hazard by jurisdiction using the methodology described in detail in Chapter 4, Section IV Ranking and Analysis Methodologies. Each section of the plan was also reformatted for improved clarity, and new maps and imagery, when available and appropriate, were inserted.

A. Hazard Profile

1. Description

Worldwide interest in dam and levee safety has risen significantly in recent years. Aging infrastructure, new hydrologic information, and population growth in floodplain areas downstream from dams and near levees have resulted in an increased emphasis on safety, operation, and maintenance. The distinction between dams and levees is their purpose: dams are constructed to impound water behind them and levees are constructed to keep water out of the land behind them.

There are about 87,000 dams in the United States today, the majority of which are privately owned. Public owners include State and local authorities, and Federal agencies. The benefits of dams are numerous: they provide water for drinking, improved waterway navigation, hydroelectric power, flood control, and agricultural irrigation. Dams also provide enhanced recreation opportunities.

2. Geographic Location / Extent

The National Inventory of Dams (NID) was developed by the U.S. Army Corps of Engineers (USACE) in cooperation with FEMA's National Dam Safety Program. The full inventory contains over 87,000 dams, and is used to track information on the country's water control infrastructure.

According to the NID, there are 11 major dams located in the Northern Virginia region and 133 non-major dams. Major dams are defined as dams being 50 feet or more in height, or with a normal storage capacity of 5,000 acre-feet or more, or with a maximum storage capacity of 25,000 acre-feet or more. The state regulatory agency for dams is the Virginia Department of Conservation and Recreation (DCR) through the Dam Safety and Floodplain Management Program. In addition to the 11 major dams discussed here, the DCR tracks and regulates a number of other smaller dams (e.g., farm pond impoundments, etc.) that present less severe hazard threats. The DCR maintains additional data on State-regulated dams in the Northern Virginia region, as well as information on the potential impact of failure. There are no major levees located in the Northern Virginia region.

Both the NID and the DCR use the same classification terminology to categorize the hazard potential of dams – high, significant, or low. This classification can change over time, as it is tied to how the failure of the dam may lead to loss of life and property downstream in the event of failure. Hazard potential is unrelated to the structural integrity of the dam; rather, it is directly related to the potential adverse downstream impacts should the dam fail. The classifications are described by the DCR as follows:

High – Dams that upon failure would cause probably loss of life or serious economic damage.
Significant – Dams that upon failure might cause loss of life or appreciable economic damage.
Low – Dams that upon failure would lead to no expected loss of life or significant economic damage. Special criteria: This classification includes dams that upon failure would cause damage only to the property of the dam owner.

Of the 11 major dams located in the region, six are classified as high hazards where failure of the dam may cause loss of human life. Another four major dams are classified as significant hazards, where failure or mis-operation results in no probable loss of human life, but can cause economic loss, environmental damage, disruption of lifeline facilities, or impact other concerns. Only one of the 11 major dams is classified as a low hazard. It is important to remember that these hazard classifications are not related to the physical condition or structural integrity of the dam (nor the probability of its failure), but strictly to the potential for adverse downstream effects if the dam were to fail.

Table 4.111 lists some of the descriptive information made available for each of the 11 major dams in the Northern Virginia region.

Table 4.111. Major Dams in the Northern Virginia Region, Based on the National Inventory of Dams.

Dam Name	Hazard Class	Drainage Area (Sq. Mi.)	Primary Purpose	Owner
Upper Occoquan Dam	High	595	Water Supply	Fairfax County Water Authority
T. Nelson Elliott Dam	High	60	Water Supply	City of Manassas
Barcroft Dam	High	14.5	Recreation	Lake Barcroft Watershed Improvement District
Lake Montclair Dam	High	11.3	Recreation	Montclair Property Owners Association
Pohick Creek Dam #1	High	6.2	Flood Control	Fairfax County Board of Supervisors
Lake Thoreau Dam	High	<1	Flood Control	Reston Association
Sleeter Lake Dam	Significant	10	Irrigation	Round Hill Investors, LLC
Beaverdam Creek Dam*	Significant	5.5	Water Supply	City of Fairfax
Kingstowne Lake Dam	Significant	<1	Recreation	Kingstowne Community Association
Possum Point Ash Dam #D	Significant	< 1	Debris Control	Dominion
Horsepen Dam	Low	22.8	Water Supply	Metro-Washington Airport Authority

** This dam is now owned by Loudoun County, rather than the City of Fairfax, as reported in the NID.*

3. Magnitude or Severity

Though dams have many benefits, they also can pose a risk to communities if not designed, operated, and maintained properly. In the event of a dam failure, the energy of the water stored behind even a small dam is capable of causing loss of life and great property damage if development exists downstream of the dam. Downstream properties may be quickly submerged in floodwaters and residents may become trapped by this rapidly rising water. The failure of dams has the potential to place large numbers of people and great amounts of property in harm's way.

4. Previous Occurrences

While dam failures are not common occurrences, there have been some notable recent events throughout Virginia. Most failures occur due to lack of maintenance of the dam in combination with major rainfall, such as hurricanes and thunderstorms. In 1995, torrential rains burst the

Timberlake Dam in Campbell County, killing two people downstream in the flooding. Following Hurricane Floyd in 1999, 13 dam failures were reported across the eastern portion of the State causing significant damages.

The Barcroft dam in Fairfax County failed during heavy rains associated with Hurricane Agnes (June 1972). Although it caused no loss of life, the dam failure resulted in damage to the Holmes Run area, most notably the destruction of an overpass at Van Dorn Street and Holmes Run ($300,000 plus an additional $200,000 to clear away 29 acres of trees and debris from the stream). The dam, which had originally been built in 1913, also suffered major damage and had to be rebuilt in order to restore Lake Barcroft, a recreational area for community residents.

No additional occurrences were reported for the 2016 plan update.

B. Risk Assessment

1. Probability of Future Occurrences

Predicting the probability of flooding due to dam failure requires a detailed, site-specific engineering analysis for each dam in question. Failure may result from hydrologic and hydraulic design limitations, or from geotechnical or operational factors.

Dam failure remains an unlikely occurrence for all major and non-regulated dams in the Northern Virginia region. The DCR is tasked with monitoring the routine inspection and maintenance of those dams that present the greatest risk or are in need of structural repair.

2. Impact & Vulnerability

Failure of dams may result in catastrophic localized damages. Vulnerability to dam failure is dependent on dam operations planning and the nature of downstream development. Depending on the elevation and storage volume of the impoundment, the impact of flooding due to dam failure may include loss of human life, economic losses such as property damage and infrastructure disruption, and environmental impacts such as destruction of habitat. Evaluation of vulnerability and impact is highly dependent on site-specific conditions.

3. Risk

Dam failure is considered unlikely in the Northern Virginia region due to existing safety measures and rigorous inspection reporting programs. The DCR requires specific operation and maintenance procedures, as well as routine inspections and regularly updated emergency action plans for each of the major and State-regulated dams in the Northern Virginia region. Therefore, future damages caused by dam failure and associated dollar losses are expected to be negligible – though the danger remains real and will continue to receive critical attention through the DCR's Dam Safety and Floodplain Management Program.

Due to the lack of specific data on dam failure probability or inundation zones, the potential risk to critical facilities and existing buildings and infrastructure was not estimated for this revision of the Plan. Virginia's new Impounding Structure Regulations require dam break inundation zone mapping and additional information is available from the DCR Dam Safety Program.

There are 11 dams in the region classified as major. Ten of those are classified as significant or high hazard class. Four are located in Fairfax County, three are located in Loudoun County, three are located in Prince William County, and the remaining one is located in both Prince William and Fairfax Counties. Again, these hazard classifications are not related to the physical condition or structural integrity of the dam (nor the probability of its failure), but strictly to the potential for adverse downstream effects from failure or mis-operation of the dam or facilities. There are no dam failure inundation maps available for the Northern Virginia region that can be included in this plan.

Only three of the major dams classified as high hazard have a drainage area of more than 20 square miles (the Upper Occoquan dam in Fairfax County, the T. Nelson Elliot dam in Prince William County, and the Horsepen Dam in Loudoun County), making the possibility of a catastrophic dam failure event elsewhere highly unlikely in the region. The Northern Virginia region is likely more prone to intentional water releases by dam operators immediately prior to or during major rainfall events, though in such cases the releases are coordinated with local emergency management officials to minimize potential risks to people and property.

Overall Loss Estimates and Ranking

Dam failure was not ranked with the hazards as a result of limited data available for analysis. As discussed regarding critical facilities, loss estimates were not developed due to the lack of specific data on dam failure probability or inundation zones. Fairfax County has the highest percentage of dams in the high and significant downstream hazard potentials in relation to the rest of the planning region.

For the 2016 plan update the qualitative assessment was organized by jurisdiction.

Fairfax County, Loudoun County, Prince William County, Town of Purcellville, and Town of Round Hill

Table 4.113. 2016 Qualitative Assessment for Dam Failure.

	Probability	Impact	Spatial Extent	Warning Time	Duration
Risk Level	Possible	Critical	Moderate	Less than 6 hours	Less than one week

All Other Jurisdictions

Table 4.112. 2016 Qualitative Assessment for Dam Failure.

	Probability	Impact	Spatial Extent	Warning Time	Duration
Risk Level	Unlikely	Critical	Moderate	Less than 6 hours	Less than one week

XVI. Extreme Temperatures

NOTE: As part of the 2016 plan update, the extreme temperatures hazard was examined and analyzed separately. This new analysis included, but was not limited to: 1) creating the hazard profile; 2) consolidating the previous occurrences; 3) determining the number of hazard events and losses by jurisdiction using NCDC and other data sources where available; 4) completing the assessment of risk by jurisdiction based on new data; and 5) ranking of the hazard by jurisdiction using the methodology described in detail in Chapter 4 Section IV Ranking and Analysis Methodologies. Each section of the plan was also reformatted for improved clarity, and new maps and imagery, when available and appropriate, were inserted.

A. Hazard Profile

1. Description

Extreme heat is defined as summertime weather that is substantially hotter and/or more humid than average for a location at that time of year. Extreme heat conditions can increase the incidence of mortality and morbidity in affected populations. People can suffer heat-related illnesses when the body is unable to compensate for the extreme heat and properly cool itself. Very high body temperatures can cause damage to the brain and other vital organs.

What is considered an excessively cold temperature varies according to the normal climate for that region. Whenever temperatures drop decidedly below normal and wind speed increases, heat leaves the human body more rapidly, increasing the possibility of negative effects of these extreme temperatures.

The greatest danger from extreme cold is to people, as prolonged exposure can cause frostbite or hypothermia, and can become life threatening. Body temperatures that are too low affect the brain, making it difficult for the victim to think clearly or move well. This makes hypothermia particularly dangerous for those suffering from it, as they may not understand what is happening to them or what to do about it.

2. Geographic Location / Extent

Extreme temperature is not a hazard with a defined geographic boundary. All areas of the Northern Virginia area are subject to experience the hazard.

The National Weather Service (NWS) issues a range of watches and warnings associated with extreme heat, as illustrated below:

- Excessive Heat Outlook: when the potential exists for an excessive heat event in the next 3 to 7 days. An outlook is used to indicate that a heat event may develop. It is intended to provide information to those who need considerable lead time to prepare for the event, such as public utilities, emergency management and public health officials.
- Excessive Heat Watch: when conditions are favorable for an excessive heat event in the next 12 to 48 hours. A watch is used when the risk of a heat wave has increased, but its occurrence and timing is still uncertain. It is intended to provide enough lead time so

those who need to set their plans in motion can do so, such as established individual city excessive heat event mitigation plans.

- Excessive Heat Warning/Advisory: when an excessive heat event is expected in the next 36 hours. These products are issued when an excessive heat event is occurring, is imminent, or has a very high probability of occurrence. The warning is used for conditions posing a threat to life or property. An advisory is for less serious conditions that cause significant discomfort or inconvenience and, if caution is not taken, could lead to a threat to life and/or property.

The NWS also developed the Heat Index (HI). The HI is sometimes referred to as the "apparent temperature". The HI, given in degrees F, is a measure of how hot it really feels when relative humidity (RH) is added to the actual air temperature. To find the HI, NWS uses the Heat Index Chart, found following in Figure 4.49. As an example, if the air temperature is 96 degrees Fahrenheit (found on the top of the table) and the RH is 65% (found on the left of the table), the HI - or how hot it really feels - is 121 degrees Fahrenheit. This is at the intersection of the 96-degree column and the 65% row.

Since HI values were devised for shady, light wind conditions, exposure to full sunshine can increase HI values by up to 15 degrees Fahrenheit. Also, strong winds, particularly with very hot, dry air, can be extremely hazardous. Note the shaded zone above 105 degrees Fahrenheit on the Heat Index Chart. This corresponds to a level of HI that may cause increasingly severe heat disorders with continued exposure and/or physical activity.

NOAA's National Weather Service

Heat Index

Temperature (ºF)

Relative Humidity (%)	80	82	84	86	88	90	92	94	96	98	100	102	104	106	118	110
40	80	81	83	85	88	91	94	97	101	105	109	114	119	124	130	136
45	80	82	84	87	89	93	96	100	104	109	114	119	124	130	137	
50	81	83	85	88	91	95	99	103	108	113	118	124	131	137		
55	81	84	86	89	93	97	101	106	112	117	124	130	137			
60	82	84	88	91	95	100	105	110	116	123	129	137				
65	82	85	89	93	98	103	108	114	121	126	130					
70	83	86	90	95	100	105	112	119	126	134						
75	84	88	92	97	103	109	116	124	132							
80	84	89	94	100	106	113	121	129								
85	85	90	96	102	110	117	126	135								
90	86	91	98	105	113	122	131									
95	86	93	100	108	117	127										
100	87	95	103	112	121	132										

Likelihood of Heat Disorders with Prolonged Exposure or Streuous Activity

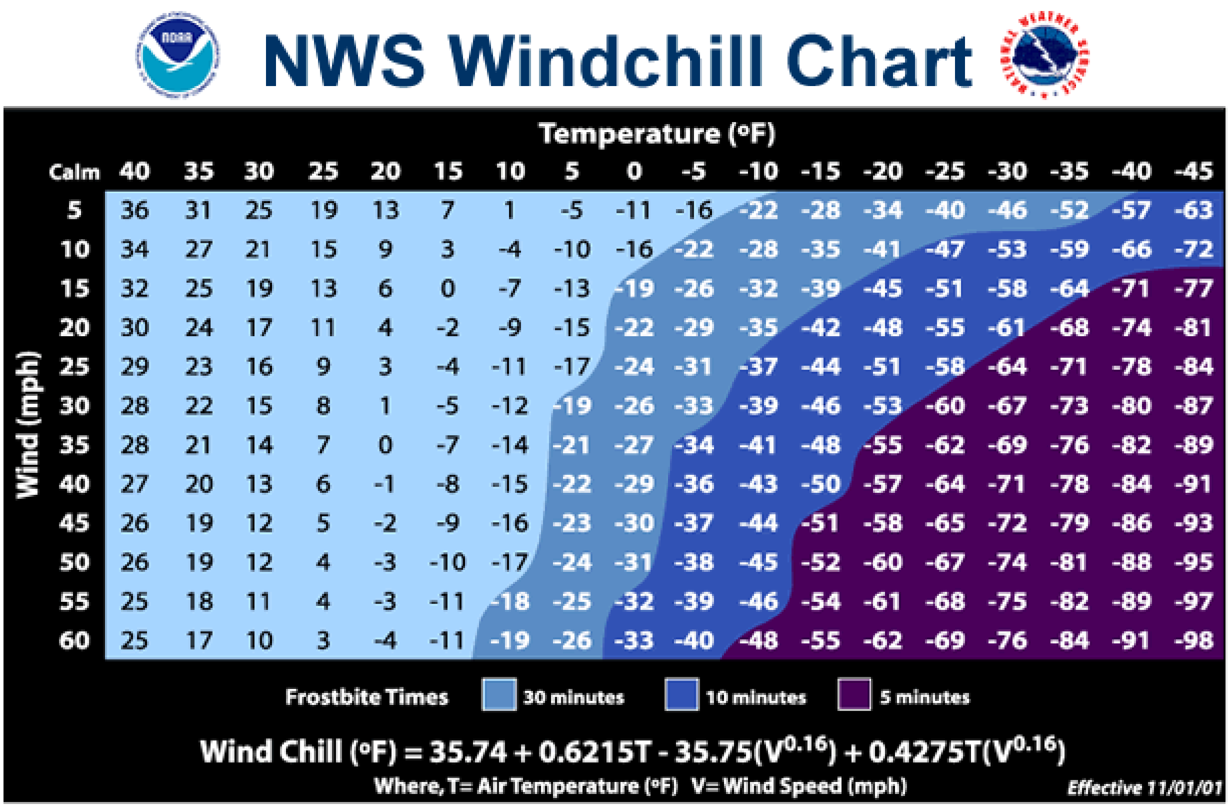
Caution   Extreme Caution   Danger   Extreme Danger

Figure 4.49. NOAA's National Weather Service Heat Index.

When extreme heat occurs or is forecast to occur, the NWS issues heat advisories based on heat indices; these advisories are issued through the media and the Emergency Alert System. The NWS provides assistance to state and local health officials in preparing civil emergency messages for severe heat waves, in addition to preparing special weather statements that define who is most at risk, safety rules, and the expected severity of the situation. The NWS also aids state and local authorities with issuing warnings and survival tips.

Extreme cold has a wide range of extent and severity markers and characteristics. The National Weather Service issues Extreme Cold Warnings when the temperature feels like it is -30 degrees Fahrenheit or colder across a wide area for a period of at least several hours. When possible, these advisories are issued a day or two in advance of the onset of the conditions.

Perhaps the most common extent/severity marker for extreme cold is the Wind Chill scale. Figure 4.50 depicts the National Weather Service's methodology for determining wind chill, using wind speed and actual temperature. While wind chill is not necessarily related to extreme cold as a single cause, the advisory system that the NWS currently uses relies on wind chill to relay warning and advisory information to the public. Extreme cold severity is a function of wind chill and other factors, such as precipitation amount (rain, sleet, ice, and/or snow).


NWS Windchill Chart

Temperature (°F)

Wind (mph) / Calm	40	35	30	25	20	15	10	5	0	-5	-10	-15	-20	-25	-30	-35	-40	-45
5	36	31	25	19	13	7	1	-5	-11	-16	-22	-28	-34	-40	-46	-52	-57	-63
10	34	27	21	15	9	3	-4	-10	-16	-22	-28	-35	-41	-47	-53	-59	-66	-72
15	32	25	19	13	6	0	-7	-13	-19	-26	-32	-39	-45	-51	-58	-64	-71	-77
20	30	24	17	11	4	-2	-9	-15	-22	-29	-35	-42	-48	-55	-61	-68	-74	-81
25	29	23	16	9	3	-4	-11	-17	-24	-31	-37	-44	-51	-58	-64	-71	-78	-84
30	28	22	15	8	1	-5	-12	-19	-26	-33	-39	-46	-53	-60	-67	-73	-80	-87
35	28	21	14	7	0	-7	-14	-21	-27	-34	-41	-48	-55	-62	-69	-76	-82	-89
40	27	20	13	6	-1	-8	-15	-22	-29	-36	-43	-50	-57	-64	-71	-78	-84	-91
45	26	19	12	5	-2	-9	-16	-23	-30	-37	-44	-51	-58	-65	-72	-79	-86	-93
50	26	19	12	4	-3	-10	-17	-24	-31	-38	-45	-52	-60	-67	-74	-81	-88	-95
55	25	18	11	4	-3	-11	-18	-25	-32	-39	-46	-54	-61	-68	-75	-82	-89	-97
60	25	17	10	3	-4	-11	-19	-26	-33	-40	-48	-55	-62	-69	-76	-84	-91	-98

Frostbite Times: 30 minutes, 10 minutes, 5 minutes

$$\text{Wind Chill (°F)} = 35.74 + 0.6215T - 35.75(V^{0.16}) + 0.4275T(V^{0.16})$$

Where, T = Air Temperature (°F) V = Wind Speed (mph) *Effective 11/01/01*

Figure 4.50 NWS Windchill Chart.

3. Magnitude or Severity

Health risks from extreme heat include sunburn, dehydration, heat cramps, heat exhaustion, and heat stroke. Heat disorders generally result from a reduction or collapse of the body's ability to cool itself by circulatory changes and sweating, or a chemical (salt) imbalance caused by too much sweating. When the body cannot cool itself, or when it cannot compensate for fluids and salt lost through perspiration, the temperature of the body's inner core begins to rise, and heat-related illness may develop. All other factors being equal, the severity of heat disorders tends to increase with age. Heat cramps in a 17-year-old may be heat exhaustion in someone who is 40, and heat stroke in a person over 60. Table 4.133 provides the potential health hazards associated with heat, by category.

Table 4.133. Health Hazards Associated with Heat.

Category	Heat Index	Health Hazards
Extreme Danger	130 degrees Fahrenheit and Higher	Heat stroke/ sunstroke is likely with continued exposure.
Danger	105 degrees Fahrenheit to 129 degrees Fahrenheit	Sunstroke, muscle cramps, and/or heat exhaustion with prolonged exposure and/or physical activity.
Extreme Caution	90 degrees Fahrenheit to 105 degrees Fahrenheit	Sunstroke, muscle cramps, and/or heat exhaustion with prolonged exposure and/or physical activity.
Caution	80 degrees Fahrenheit to 90 degrees Fahrenheit	Fatigue possible with prolonged exposure and/or physical activity.

In addition to the effects that extreme heat can have on people, there are also potential effects to assets from extreme heat. Northern Virginia is home to a significant human population. Increases in the exterior temperature mean that the utilities and processes by which interior spaces are controlled and conditioned must work harder to regulate those interior temperatures. This places an additional strain on existing utility systems, which can fail under the increased workload. Failure of cooling mechanisms places research, patients, and people at risk from prolonged exposure to extreme heat.

Extreme cold can also have significant impacts on people. Hypothermia is most likely at very cold temperatures, but can occur at higher temperatures (above 40 degrees Fahrenheit) if the person exposed is also wet from rain, sweat, or submersion. Warning signs of hypothermia include shivering, exhaustion, confusion, fumbling hands, memory loss, slurred speech, or drowsiness. In infants, symptoms include bright red and cold skin and very low energy. A person with hypothermia should receive medical attention as soon as possible, as delays in medical treatment may result in death.

In addition to the threat posed to humans, extreme cold weather poses a significant threat to utility production, which in turn threatens facilities and operations that rely on utilities, specifically climate stabilization. As temperatures drop and stay low, increased demand for heating places a strain on the electrical grid, which can lead to temporary outages. These outages can impact operations throughout the campus, which can result in interruptions and delays in services. Broken pipes may cause flooding in buildings, causing property damage and loss of utility service.

4. Previous Occurrences

In 1996, the NCDC began keeping records of occurrences of extreme temperatures. Because of the widespread spatial nature of the hazard, the most reliable records are found at the county-level. The independent cities of Northern Virginia have their own reports, of course, but they are largely identical to those provided for the geographically adjacent counties, with the exception of the City of Falls Church. The towns in Northern Virginia are included in the reports for the counties. To account for this method of reporting, and to limit overestimation of occurrences and damages where possible, the records for the four counties and for the City of Falls Church are included in this assessment. All other records are excluded as duplications.

From 1996 to 2015, there have been at least 275 extreme temperature event reports recorded by the NCDC for the Northern Virginia region. Approximately $75,000 in crop damages in Prince William County were recorded for these events, though other damages have undoubtedly occurred as an indirect result of the hazard. In addition, there were three fatalities and 102 injuries recorded.

The following occurrences, taken from NCDC records, impacted large portions of the planning area:

July 18, 2013 (Extreme Heat)
High pressure was located over much of the eastern United States and light southerly flow persisted all week. This led to above normal temperatures throughout the region and dew points in the mid-70s. Heat indices were approximately 105 to 107 degrees Fahrenheit at Quantico, 105 degrees Fahrenheit at Dulles International Airport, and 105 to 107 degrees Fahrenheit at Reagan National Airport.

July 21-22, 2011 (Extreme Heat)
Upper level high pressure caused excessive heat conditions throughout the planning area. Surface pressure over the Atlantic caused moist air to move into the region from the south. The combination of heat and humidity caused heat indices in excess of 100 degrees Fahrenheit in some locations, and up to 110-112 degrees Fahrenheit in other parts of the region. Heat indices of up to 116 degrees Fahrenheit at Dulles International Airport and 118 degrees Fahrenheit at Quantico were recorded during this period.

June 8, 2008 (Extreme Heat)
A strong ridge of high pressure over the eastern United States set the stage for a period of hot weather and high humidity in Northern Virginia. One person died due to heat-related complications in Alexandria as temperatures on this day reached into the mid to upper 90s combining with dew points in the lower 70s to produce heat indices that approached 105 degrees Fahrenheit.

December 7, 2002 (Extreme Cold)
Record-breaking cold settled into northern Virginia on this day as low temperatures reached 1 degree above zero at Dulles International Airport. Temperatures fell to -1 degrees Fahrenheit in Lincoln in Loudoun County and -4 degrees Fahrenheit at the NWS Forecast Office in Sterling.

January 27, 2000 (Extreme Cold)
High pressure was located directly over the Mid-Atlantic region between the 27th and 29th. The combination of clear skies, calm winds, and a snowpack led to extremely cold temperatures that fell to below zero degrees Fahrenheit. On the 27th, a 59-year-old woman was found dead in the parking lot of a shopping center in Fairfax, an apparent victim of hypothermia.

July 4–7, 1999 (Extreme Heat)
High pressure sat off the Mid-Atlantic coast, drawing extremely warm and humid air into Northern Virginia. Temperatures on the 4th through the 7th were oppressively hot, and extremely humid conditions added to the misery. Temperatures soared into the upper 90s to lower 100s during the period, and dew points were in the lower to middle 70s, creating heat indices between 100 and 115 degrees Fahrenheit. Overnight lows only dipped into the 70s and heat index values ranged from the upper 70s to upper 80s. The heat index only dropped to 90 degrees Fahrenheit at National Airport in the Washington, DC, suburbs on the morning of the 6th. Record highs were broken at Washington National Airport on the 5th and 6th. The record high at Dulles International Airport was broken on the 4th and tied on the 5th.

August 16–17, 1997 (Extreme Heat)
West winds circulating around a "Bermuda High" pressure system allowed temperatures to soar over the weekend of the 16th and 17th. Maximum temperatures surpassed the century mark across most of Northern Virginia (except in the higher elevations) both days. Heat index values ranged from 105 to 110 degrees Fahrenheit each day, but aside from a few heat exhaustion cases, it appeared that at-risk residents remained in air conditioned locations. No heat-related deaths were reported by Virginia medical authorities. A record high was achieved at Dulles International Airport on the 16th with a new maximum of 100 degrees Fahrenheit. That temperature was matched on the 17th, before strong to severe thunderstorms moved through.

April 10, 1997 (Extreme Cold)
A record cold arctic air mass overspread the Northern Virginia piedmont and the Shenandoah Valley overnight on the 9th and 10th, dropping temperatures into the upper teens to lower 20s across the entire area. These temperatures arrived on the heels of an above normal winter season, especially pronounced in late March, when peach and apple blossoms reached critical bloom stage up to 2 weeks ahead of schedule. This accelerated growth led to high kill percentages across the region, with estimates showing at least a 70 to 90 percent kill of the peach crop, and similar kills among the Red Delicious apple crop.

July 1995 (Extreme Heat)
A 38-hour period of extremely hot and humid weather in mid-July took its toll on humans and animals. The heat was caused by strengthening of a Bermuda High, extending from the surface to the upper levels of the atmosphere. The most life-threatening period of the heat wave occurred during the afternoon of the 15th, when temperatures ranged from 98 to 103 degrees Fahrenheit, with heat indices between 115 and 129 degrees Fahrenheit. On this day, an all-time record for power usage was established in Northern Virginia, with 13,512 megawatts recorded (mostly from air conditioning usage). Five thousand customers were without power in the same general area. In Alexandria, a National Park Service bicycle patrol ranger collapsed near Daingerfield Island, then later died from complications resulting from hyperthermia.

There were several additional instances of heat exhaustion during the remainder of the month, concentrated during the middle two weeks. Alexandria hospitals reported about 80 persons requiring treatment between the 14th and 23rd. The heat wave returned twice in late July, from the 21st through the 25th and again from the 29th through the 31st. However, temperatures were not as oppressive, ranging from 90 to 97 degrees Fahrenheit. Daytime heat indices ranged from 105 to 115 degrees Fahrenheit, but fell below 90 each night. No deaths or injuries were directly attributed to either episode.

B. Risk Assessment

1. Probability of Future Occurrences

The future incidence of extreme temperatures is highly unpredictable and may be localized, which makes it difficult to assess the probability of a future occurrence. Some form of extreme temperature typically impacts the Northern Virginia region annually. As a result, while the future probability of some type of extreme temperature may be estimated as High, the exact severity or manifestation of the hazard cannot be quantified at this time.

2. Impact & Vulnerability

While this hazard occurs with some regularity, it is not one with a significant history of causing damages or losses to property in the Northern Virginia region. The risk of exposure and negative health impacts to people, animal, and agriculture are the greatest risk, with the risk to the loss of utility service (particularly electrical) also a consideration. Humans and animals can be injured or die from exposure to both extreme cold and extreme heat; agriculture can be damaged or destroyed by extremes in temperature, rending crops unusable. Utility systems may fail under strains of demand, resulting in increases in exposure of humans and animals to extreme temperatures, as facilities cannot provide regulated temperatures and climate.

3. Risk

Estimates of the financial impacts or losses from extreme temperatures can be developed based on NCDC data that runs from January 1996 to December 2015. Examination of NCDC data shows that there were approximately 275 extreme temperature events in the database.

Risk to People

NCDC reports describe three fatalities and 102 injuries for the 19-year period of record. This equates to annualized rates of .15 fatalities per year and 5.3 injuries per year for the period of record. It is people that are at the greatest risk from extreme temperatures, and people that must be protected from this hazard.

Critical Facility and Infrastructure Risk

Quantitative assessment of critical facilities for the extreme temperature risk was not feasible for this update. Even so, it is apparent that the infrastructure that supports critical facilities are at risk from extreme temperatures, as demands on generation and distribution networks may overtax the system and result in failure. Finally, not all critical facilities have redundant power sources and may not even be wired to accept a generator for auxiliary heat or cooling. Future plan updates should consider including a more comprehensive examination of critical facility vulnerability to extreme temperatures, including those that have emergency heating or cooling equipment and those that may be wired to receive portable equipment.

Overall Loss Estimates and Ranking

In keeping with other assessments updated or validated for this plan, the assessment for extreme temperatures is based on NCDC data.

For the 2016 plan update the qualitative assessment was performed by jurisdiction. Given the widespread nature of the hazard, however, all counties, cities, and towns were determined to have the same qualitative risk to the hazard, that of 'High'. Therefore, to avoid repetition, Table 4.134 below provides the results of the qualitative assessment for all participating jurisdictions, as all jurisdictions were found to have the same results.

Table 4.134. 2016 Qualitative Assessment for Extreme Temperatures.

	Probability	Impact	Spatial Extent	Warning Time	Duration
Risk Level	Highly Likely	Minor	Large	More than 24 hours	Less than one week

Endnotes

[1] NCDC's Storm Event database is available at http://www4.ncdc.noaa.gov/cgi-win/wwcgi.dll?wwEvent~Storms.
[2] National Water Service Instruction 10-1605. Operations and Services Performance: Storm Data Preparation Guide. August 17, 2007. Available at: http://www.nws.noaa.gov/directives/sym/pd01016005curr.pdf
[3] Commonwealth of Virginia Emergency Operations Plan Annex 3 (Volume II)
[4] IPCC. (2007). Climate Change 2007: The Physical Science Basis. Intergovernmental Panel on Climate Change.

[5] Pfeffer, W., Harper, J., & O'Neil, S. (2008). Kinematic Constraints on Glacier Contributions to 21st-Century Sea-Level Rise. *Science , 321*, 1340-1343.
[6] NFIP repetitive loss data is protected under the federal Privacy Act of 1974 (5 U.S.C. 552a) which prohibits personal identifiers (i.e., owner names, addresses, etc.) from being published in local mitigation plans.
[7] National Flood Insurance Program
[8] HAZUS-MH Flood User Manual
[9] Global Climate Change Impacts in the United States, Thomas R. Karl, Jerry M. Melillo, and Thomas C. Peterson, (eds.). Cambridge University Press, 2009.
[10] Changes in severe thunderstorm environment frequency during the 21st century caused by anthropogenically enhanced global radiative forcing; Robert J. Trapp*†, Noah S. Diffenbaugh*, Harold E. Brooks‡, Michael E. Baldwin*, Eric D. Robinson*, and Jeremy S. Pal; PNAS December 11, 2007, vol. 104, no. 50.
[11] IPCC Special Report on Emissions Scenarios, 2000
[12] Modeled Impact of Anthropogenic Warming on the Frequency of intense Atlantic Hurricanes, Morris A. Bender, Thomas R. Knutson, Robert E. Tuleya, Joseph J. Sirutis, Gabriel A. Vecchi, Stephen T. Garner, Isaac M. Held
[13] HAZUS Hurricane Manual
[14] Whole Building Design Guide (WBDG) Wind Safety of the Building Envelop by Tom Smith 5/26/2008
[15] Gutowski, W.J., G.C. Hegerl, G.J. Holland, T.R. Knutson, L.O. Mearns, R.J. Stouffer, P.J. Webster, M.F. Wehner, and F.W. Zwiers, 2008: Causes of observed changes in extremes and projections of future changes. In: *Weather and Climate Extremes in a Changing Climate: Regions of Focus: North America, Hawaii, Caribbean, and U.S. Pacific Islands* [Karl, T.R., G.A. Meehl, C.D. Miller, S.J. Hassol, A.M. Waple, and W.L. Murray (eds.)]. Synthesis and Assessment Product 3.3. U.S. Climate Change Science Program, Washington, DC, pp. 81-116.
[16] Significant Earthquakes figure is from the 2013 Commonwealth of Virginia's Hazard Mitigation Plan. Earthquake Section 3.13, Figure 3.13-1.
[17] The Daily News Spot July 16, 2010 interview with Amy Vaughan, geophysicist USGS National Earthquake Information Center.

[18]Recent Earthquakes from NEIC Earthquake Bulletin: Magnitude 3.4-Potomac-Shenandoan Region. USGS July 16, 2010. http://earthquake.usgs.gov/earthquakes/recenteqsww/Quakes/us2010yua6.php
[19]Recent Earthquakes from NEIC Earthquake Bulletin: Magnitude 3.4-Potomac-Shenandoan Region. USGS July 16, 2010. http://earthquake.usgs.gov/earthquakes/recenteqsww/Quakes/us2010yua6.php
[20] 2500-year Return Period Peak Ground Acceleration (PGA) figure is from the 2013 Commonwealth of Virginia's Hazard Mitigation Plan. Earthquake Section 3.13, Figure 3.13-3.
[21] Telephone and Email correspondence with Dr. Martin Chapman. June 3, 2010.
[22] Smith, K., *Environmental Hazards, Assessing Risk and Reducing Disaster*, Third Edition, Rutledge Press, New York 1991
[23] USGS Fact Sheet 2004-3072
[24] The National Wildfire Coordinating Group (NWCG) is made up of the USDA Forest Service; four Department of the Interior agencies: Bureau of Land Management (BLM), National Park Service (NPS), Bureau of Indian Affairs (BIA), and the Fish and Wildlife Service (FWS); and State forestry agencies through the National Association of State Foresters. The purpose of NWCG is to coordinate programs of the participating wildfire management agencies so as to avoid wasteful duplication and to provide a means of constructively working together.
[25] Tihansky, B, Ann. U.S Geological Survey, Tampa, Florida. Sinkholes, West-Central Florida: A link between surface water and ground water.
[26] Hubbard, D. A. "Sinkhole Distribution of the Valley and Ridge Province, Virginia." Geotechnical and Environmental Applications of Karst Geology and Hydrology, (April 2001): 33–36.
[27] Loudoun County Zoning Ordinance Section 4-1900 Limestone Overlay District. May 6, 2010.

Chapter 5: Capability Assessment

I. Introduction

This portion of the plan assesses the current capacity of the communities of Northern Virginia to mitigate the effects of the natural hazards identified in Chapter 4 of the plan.

The purpose of conducting a capability assessment is to determine the ability of a local jurisdiction to implement a comprehensive mitigation strategy, and to identify potential opportunities for establishing or enhancing specific mitigation policies, programs or projects.[1] As in any planning process, it is important to try to establish which goals, objectives, and/or actions are feasible, based on an understanding of the organizational capacity of those agencies or departments tasked with their implementation. A capability assessment helps to determine which mitigation actions are practical and likely to be implemented over time given a local government's planning and regulatory framework, level of administrative and technical support, amount of fiscal resources, and current political climate.

A capability assessment has two primary components: an inventory of a local jurisdiction's relevant plans, ordinances, or programs already in place; and an analysis of its capacity to carry them out. Careful examination of local capabilities will detect any existing gaps, shortfalls, or weaknesses with ongoing government activities that could hinder proposed mitigation activities and possibly exacerbate community hazard vulnerability. A capability assessment also highlights the positive mitigation measures already in place or being implemented at the local government level, which should continue to be supported and enhanced through future mitigation efforts.

For the 2016 update, each participating jurisdiction was given an opportunity to update their capability assessment information presented in the 2010 plan. This effort included updating a Plans, Ordinances, and Programs table, Relevant Fiscal Resources table, and Relevant Staff and Personnel Resources table. Additionally, updates to the information presented below were conducted to better reflect the capabilities within the region as of 2016.

II. Conducting the Capability Assessment

In order to facilitate an update of the 2010 inventory and analysis of local government capabilities throughout the Northern Virginia region, specific tables and components of the previous plan were distributed to the communities. These tables, which were completed by appropriate local government officials, requested information on a variety of "capability indicators" such as existing local plans, policies, programs, or ordinances that contribute to or

[1] While the Interim Final Rule for implementing the Disaster Mitigation Act of 2000 does not require a local capability assessment to be completed for local hazard mitigation plans, it is a critical step in developing a mitigation strategy that meets the needs of each jurisdiction while taking into account their own unique abilities. The Rule does state that a community's mitigation strategy should be "based on existing authorities, policies, programs and resources, and its ability to expand on and improve these existing tools" (44 CFR, Part 201.6(c)(3)).

hinder the community's ability to implement hazard mitigation actions. Other indicators included information related to each jurisdiction's fiscal, administrative, and technical capabilities, such as access to local budgetary and personnel resources for mitigation purposes.

At a minimum, the updates to the 2010 information provided an extensive inventory of existing local plans, ordinances, programs, and resources in place or under development, in addition to their overall effect on hazard loss reduction. The update thereby not only helps to accurately assess each jurisdiction's degree of local capability, but also serves as a good source of introspection for those jurisdictions that want to improve their capabilities as identified gaps, weaknesses, or conflicts can be recast as opportunities for specific actions to be proposed as part of the community's mitigation strategy.

III. Capability Assessment Findings

The findings of the capability assessment are summarized in this Plan to provide insight into the relevant capacity of participating jurisdictions to implement hazard mitigation activities. All information is based upon the input provided by local government officials through the Mitigation Advisory Committee.

A. Administrative and Technical Capability

1. Administrative

The ability of a local government to develop and implement mitigation projects, policies, and programs is directly tied to its ability to direct staff time and resources for that purpose. Administrative capability can be evaluated by determining how mitigation-related activities are assigned to local departments and if there are adequate personnel resources to complete these activities. The degree of intergovernmental coordination among departments will also affect administrative capability for the implementation and success of proposed mitigation activities.

The following table, originally developed under the 2006 Northern Virginia Hazard Mitigation plan, was updated as part of the 2016 planning process. A (Y) indicates that the given local staff member(s) is maintained through each particular jurisdiction's local government resources. A (Y*) indicates that this capability is new as of the 2016 update.

Table 5.1. Administrative and Technical Capabilities										
Jurisdiction	Planners with knowledge of land development and land management practices	Engineers or professionals trained in construction practices related to buildings and/or infrastructure	Planners or engineers with an understanding of natural and/or human-caused hazards	Emergency manager	Floodplain manager	Land surveyors	Scientist familiar with the hazards of the community	Staff with education or expertise to assess the community's vulnerability to hazards	Personnel skilled in Geographic Information Systems (GIS) and/or HAZUS[MH]	Resource development staff or grant writers
Alexandria, City of	Y	Y	Y	Y	Y	Y		Y	Y	Y
Arlington County	Y	Y	Y	Y	Y	Y	Y	Y	Y	Y
Dumfries, Town of	Y	Y	Y	Y						Y
Fairfax County	Y	Y	Y	Y	Y	Y	Y	Y	Y	Y
Fairfax, City of	Y	Y	Y	Y	Y	Y		Y	Y	Y*
Falls Church, City of	Y	Y	Y	Y	Y	N	N	Y	Y	Y
Haymarket, Town of	Y*	Y*	Y	Y	Y	N	N	Y	N	Y
Herndon, Town of	Y	Y	Y	Y	Y	Y	N	Y	Y	Y
Leesburg, Town of	Y	Y	Y*	Y*	Y*	Y*		Y*	Y*	Y*
Loudoun County	Y	Y	Y	Y	Y	Y	Y	Y	Y	Y
Lovettsville, Town of	Y	Y	Y	Y	N	N	N	Y	Y	N
Manassas Park, City of	Y	Y	Y	Y	Y	Y	N*	Y	N*	Y
Manassas, City of	Y	Y	Y	Y*	Y	Y		Y	Y	
Middleburg, Town of	Y	Y	Y		Y				Y	
Occoquan, Town of										
Prince William County	Y	Y	Y	Y	Y	Y		Y	Y	Y
Purcellville, Town of	Y	Y	Y	Y	Y	Y		Y	Y	Y
Round Hill, Town of	Y	Y	Y	N	Y	Y	N	N	Y	Y
Vienna, Town of	Y		Y	Y	Y	Y*		Y*	Y	Y*

As described previously, the planning area is comprised of four counties, five cities, and 12 towns. All of the counties in the planning area, Arlington County, Fairfax County, Loudoun County, and Prince William County, operate under a Board of Supervisors - County Administrator/Executive system. In this form of government, the elected board of supervisors appoints a county administrator who oversees daily operations of the county.

The Cities of Alexandria, Falls Church, Fairfax, Manassas, and Manassas Park operate under the City Council – City Manager system. The City Council is elected and it, in turn, appoints a City Manager who acts as the chief administrative officer and oversees daily business operations of the City.

The Towns of Clifton, Dumfries, Occoquan, and Round Hill operate under the Town Council – Mayor system; and the Towns of Haymarket, Herndon, Leesburg, Lovettsville, Middleburg, Purcellville, and Vienna operate under a Town Council – Town Manager system, where the council appoints the Town Manager to act as the administrative officer.

Under the County Administrator, City, and Town Manager systems, each jurisdiction (with the exception of the Town of Quantico) has departments, councils, and boards that are responsible for the various functions of local government. The following table highlights the departments in each jurisdiction that could facilitate the implementation of this hazard mitigation plan.

Table 5.2. Departments that could facilitate mitigation action implementation

Jurisdiction	Departments
Alexandria, City of	Office of Code Administration Fire Department Fire Planning and Zoning Transportation and Environmental Services
Arlington County	Community Planning, Housing and Development Fire Department Environmental Services Office of Emergency Management
Clifton, Town of	Planning Commission
Dumfries, Town of	Department of Public Works Community Development Department Police Department
Fairfax County	Office of Emergency Management Fire and Rescue Planning and Zoning Public Works and Environmental Services Water Authority
Fairfax, City of	Community Development and Planning Fire Department Public Works Police Department

Table 5.2. Departments that could facilitate mitigation action implementation	
Jurisdiction	**Departments**
Falls Church, City of	Development Services, Public Works, Emergency Management, Police
Haymarket, Town of	Planning Commission Police Department Engineer
Herndon, Town of	Community Development Police Department Department of Public Works
Leesburg, Town of	Planning and Zoning Police Department
Loudoun County	Emergency Management Fire and Rescue Public Works Sheriff's Office Building and Development Planning & Zoning
Manassas Park, City of	Fire and Rescue Department of Community Development Police Public Works
Manassas, City of	Emergency Preparedness Fire and Rescue Police Department Public Works Community Development Utilities and Engineering
Middleburg, Town of	Zoning and Planning Police Department Utilities Department Engineering
Occoquan, Town of	Town Council
Prince William County	Department of Fire and Rescue Planning Office Police Department Department of Public Works Department of Development Services
Purcellville, Town of	Town Manager Planning Department Police Department Public Works
Quantico, Town of	None
Round Hill, Town of	Planning Department
Vienna, Town of	Planning and Zoning

Table 5.2. Departments that could facilitate mitigation action implementation	
Jurisdiction	**Departments**
	Public Works Police

While exact responsibilities differ from jurisdiction to jurisdiction, the general duties of the departments highlighted in the table are described below.

The emergency management offices are responsible for the mitigation, preparedness, response, and recovery operations that deal with both natural and man-made disaster events. Fire/EMS departments provide medical aid and fire suppression at the scene of accidents and emergencies. These departments are often responsible for responding to hazardous materials incidents.

The planning agency addresses land use planning. This department, depending on the jurisdiction, may enforce the NFIP requirements and other applicable local codes. Zoning also may be managed by the planning agency or it may be a separate office.

In some jurisdictions, the utilities department oversees community water facilities or natural gas provisions. In others, the Public Works Department oversees the maintenance of infrastructure including roadways, sewer and stormwater facilities and the community's water treatment facilities. This department also may review new development plans, ensure compliance with environmental regulations, and work with the Virginia Department of Transportation on road issues. Depending on the jurisdiction, the public works agency may enforce the NFIP requirements.

2. Technical Capability

Mitigation cuts across many disciplines. For a successful mitigation program, it is necessary to have a broad range of people involved with diverse backgrounds. These people include planners, engineers, building inspectors, emergency managers, floodplain managers, people familiar with GIS, and grant writers. Technical capability can generally be evaluated by assessing the level of knowledge and technical expertise of local government employees, such as personnel skilled in using GIS to analyze and assess community hazard vulnerability.

GIS systems can best be described as a set of tools (hardware, software, and people) used to collect, manage, analyze, and display spatially-referenced data. Many local governments are now incorporating GIS systems into their existing planning and management operations. GIS is invaluable in identifying areas vulnerable to hazards. Access to the Internet can facilitate plan development, public outreach, and project implementation.

The table below summarizes the technical capabilities of the jurisdictions. When provided, the specific department that has the technical capability is identified.

5.3. Technical Capabilities of each Jurisdiction								
Jurisdiction	**Land Use Planners**	**Civil or Building Engineers**	**Emergency manager**	**Floodplain manager**	**Staff familiar with hazards**	**GIS staff**	**Grant writers**	**Internet access?**
Alexandria, City of	Planning & Zoning	Transportation & Environmental Services	Fire Department – Office of Emergency Management	Transportation & Environmental Services	Fire Department – Office of Emergency Management	Planning & Zoning	Planning & Zoning, City Administration	**Yes**
Arlington County	Community Planning	Environmental Services	Office of Emergency Management	Community Planning	Office of Emergency Management	Environmental Services	Office of Emergency Management, Police Department, Fire Department	**Yes**
Dumfries, Town of	Community Development	Public Works	Town Manager	Town Council	Police Department		Community Services	**Yes**
Fairfax County	Planning & Zoning	Public Works	Emergency Management	Planning and Zoning	Emergency Management	Information Technology	County Administration	**Yes**
Fairfax, City of	Community Development & Planning	Public Works	Office of Emergency Management	Community Development & Planning	Community Development & Planning, Office of Public Safety	Information Technology	City Administration	**Yes**
Falls Church, City of	Development Services	Public Works	OEM – Fire Marshal	Public Works	Police, Public Works	Public Works	Public Works	**Yes**
Haymarket, Town of	Planning Commission	Town Engineer	Police Department	Town Engineer	Town Engineer, Police Department	Contracted as needed	Town Clerk, Town Engineer	**Yes**
Herndon, Town of	Community Development	Public Works	Police Department	Public Works	Public Works, Police Department	Information Technology	Community Development, Public Works, Police	**Yes**

5.3. Technical Capabilities of each Jurisdiction								
Jurisdiction	**Land Use Planners**	**Civil or Building Engineers**	**Emergency manager**	**Floodplain manager**	**Staff familiar with hazards**	**GIS staff**	**Grant writers**	**Internet access?**
Leesburg, Town of	Planning & Zoning	Planning & Zoning	Police Department	Planning & Zoning	Police Department	Police Department	Town Council	**Yes**
Loudoun County	Planning Department Zoning Building & Development	Building & Development Public Works	Emergency Management	Building & Development	Emergency Management Building & Development Fire and Rescue Sheriff's Office	Department of GIS, Fire and Rescue, Emergency Management	All departments	**Yes**
Manassas Park, City of	Community Development	Public Works	Fire and Rescue	Community Development	Police, Fire & Rescue		Fire and Rescue, City Administration	**Yes**
Manassas, City of	Community Development	Public Works	Fire and Rescue, Prevention and Preparedness Division	Engineering Department	Public Safety	Information Technology	Community Development	**Yes**
Lovettsville, Town of	Zoning & Planning	Engineering	Police Department	Zoning & Planning	Public Safety	Information Technology	Zoning & Planning	**Yes**
Middleburg, Town of	Zoning & Planning	Engineering	Police Department	Zoning & Planning	Police Department	Police Department	Zoning & Planning	**Yes**
Occoquan, Town of	Town Council	Town Council	Town Council	Town Council	Town Council	Town Council	Town Council	**Yes**
Prince William County	Planning Office	Department of Public Works	Department of Fire & Rescue, Police Department	Planning Office	Department of Fire & Rescue, Police Department	Department of Fire & Rescue, Police Department	Planning Office	**Yes**
Purcellville, Town of	Planning Office	Public Works	Town Manager, Police Department	Planning Office	Police Department	Police Department	Town Manager, Planning Office	**Yes**

5.3. Technical Capabilities of each Jurisdiction								
Jurisdiction	**Land Use Planners**	**Civil or Building Engineers**	**Emergency manager**	**Floodplain manager**	**Staff familiar with hazards**	**GIS staff**	**Grant writers**	**Internet access?**
Round Hill, Town of	Planning and Zoning	Utility Department	Community Policing	Planning and Zoning	Town Council	Planning and Zoning	Planning and Zoning	**Yes**
Vienna, Town of	Planning & Zoning	Public Works	Police	Planning & Zoning	Police	Police	Planning & Zoning	**Yes**

B. Planning and Regulatory Capability

Planning and regulatory capability is based on the implementation of plans, ordinances, and programs that demonstrate a jurisdiction's commitment to guiding and managing growth, development, and redevelopment in a responsible manner, while maintaining the general welfare of the community. It includes emergency operations and mitigation planning, comprehensive land use planning, and transportation planning, in addition to the enforcement of zoning or subdivision ordinances and building codes that regulate how land is developed and structures are built, as well as protecting environmental, historic, and cultural resources in the community. Although some conflicts can arise, these planning initiatives generally present significant opportunities to integrate hazard mitigation principles and practices into the local decision making process.

The Planning and Regulatory capability assessment is designed to provide a general overview of the key planning and regulatory tools or programs in place or under development, along with their potential effect on loss reduction. This information helps identify opportunities to address existing planning and programmatic gaps, weaknesses, or conflicts with other initiatives, in addition to integrating the implementation of this plan with existing planning mechanisms where appropriate.

The table below provides an update to the 2010 Northern Virginia Hazard Mitigation Plan. It summarizes relevant local plans, ordinances, and programs already in place or under development for participating jurisdictions. A (Y) indicates that the given item is currently in place and being implemented by the local jurisdiction (or in some cases by the County on behalf of that jurisdiction), or that it is currently being developed for future implementation. A (Y*) indicates that capability is new as of the 2016 update.

Table 5.4. Local plans, ordinances and programs												
Jurisdiction	Hazard Mitigation Plan	Comprehensive Land Use Plan	Floodplain Management Plan**	Open Space Management Plan	Stormwater Management Plan	Flood Response Plan	Emergency Operations Plan	SARA Title III Plan	Radiological Emergency Plan	Continuity of Operations Plan	Evac Plan	Disaster Recovery Plan
Alexandria, City of	Y	Y	Y	Y	Y	Y	Y	Y	Y	Y	Y	
Arlington County	Y	Y	Y	Y	Y	Y	Y	Y	Y	Y	Y	Y
Dumfries, Town of	Y	Y	Y		Y		Y					
Fairfax County	Y	Y	Y	Y	Y	Y	Y	Y	Y	Y	Y	Y
Fairfax, City of	Y	Y	Y	Y	Y	Y	Y	Y	Y	Y	Y	Y
Falls Church, City of	Y	Y	Y	Y	Y	Y	Y	See Arlington	See Arlington	Y	Y	N
Haymarket, Town of	Y	Y	N	N	N	N	Y	Y	N*	N*	N*	N*
Herndon, Town of	Y	Y	Y	Y	Y	Y	Y	N	Y	Y	Y	Y
Leesburg, Town of	Y	Y	Y	Y	Y	Y	Y	Y	Y	Y	Y	Y
Loudoun County	Y	Y	Y	Y	Y	Y	Y	Y	Y	Y	Y	Y
Manassas Park, City of	Y	Y	N*	Y	Y	N*	Y	Y	N*	Y	N*	N*
Manassas, City of	Y	Y	Y	Y	Y	Y	Y	Y	Y	Y	Y	Y
Lovettsville, Town of	Y	Y	N	Y	N	N	Y	N	N	N	N	N
Middleburg, Town of	Y	Y	Y	Y	Y	Y		Y	Y	Y		Y
Occoquan, Town of	Y											
Prince William County	Y	Y	Y				Y	Y	Y	Y	Y	Y*
Purcellville, Town of	Y	Y	Y	Y	Y	Y	Y	Y	Y*	Y*	Y	Y
Round Hill, Town of	Y	Y	N	N	N	N	Y	N	N	N	N	N
Vienna, Town of	Y	Y	Y*	Y	Y	Y*	Y	Y	Y	Y	Y	Y*

** To view how each jurisdiction manages their day to day floodplain management see APPENDIX G

Table 5.4. Local plans, ordinances and programs

Jurisdiction	Capital Improvements Plan	Economic Development Plan	Historic Preservation Plan	Flood Damage Prevention Ordinance	Zoning Ordinance	Subdivision Ordinance	Post-disaster Red/Rec. Ordinance	Building Code	Fire Code	National Flood Insurance Program	NFIP Community Rating System
Alexandria, City of	Y			Y	Y	Y		Y	Y	Y	Y
Arlington County	Y	Y	Y	Y	Y	Y	Y	Y	Y	Y	Y
Dumfries, Town of	Y	Y		Y	Y	Y		Y	Y	Y	
Fairfax County	Y	Y	Y	Y	Y	Y	Y	Y	Y	Y	Y
Fairfax, City of	Y	Y	Y	Y	Y	Y	Y	Y	Y	Y	Y
Falls Church, City of	Y	Y	Y	Y	Y	Y	N	Y	Y	Y	Y
Haymarket, Town of	Y*				Y*	Y*				Y*	
Herndon, Town of	Y	Y	Y	Y	Y	Y	Y	Y	Y	Y	Y
Leesburg, Town of	Y	Y	Y	Y	Y	Y		Y	Y	Y	
Loudoun County	Y	Y	Y	Y	Y	Y		Y	Y	Y	Y
Lovettsville, Town of	Y	Y	Y		Y	Y		Y	Y	Y	
Manassas Park, City of	Y	Y	Y	Y	Y	Y	Y	Y	Y	Y	
Manassas, City of	Y	Y	Y	Y	Y	Y		Y	Y	Y	
Middleburg, Town of										Y	
Occoquan, Town of										Y	
Prince William County	Y	Y	Y	Y	Y	Y		Y	Y	Y	Y
Purcellville, Town of	Y	Y	Y	Y	Y	Y		Y	Y	Y	
Round Hill, Town of	Y*				Y*	Y*			Y*	Y*	
Vienna, Town of	Y	Y*	Y*	Y	Y	Y	Y*	Y	Y	Y	Y

A more detailed discussion on each jurisdiction's planning and regulatory capability follows.

Emergency Management

Hazard mitigation is widely recognized as one of the five primary phases of emergency management. The three other phases include preparedness, response, and recovery. In reality each phase is interconnected with hazard mitigation as Figure 5.1 suggests. Opportunities to reduce potential losses through mitigation practices are most often implemented before disaster strikes, such as elevation of flood prone structures or through the continuous enforcement of policies that prevent and regulate development that is vulnerable to hazards because of its location, design, or other characteristics. Mitigation opportunities will also be presented during immediate preparedness or response activities (such as installing storm shutters in advance of a hurricane), and certainly during the long-term recovery and redevelopment process following a hazard event.

Figure 5.1
The Four Phases of Emergency Management

Planning for each phase is a critical part of a comprehensive emergency management program and a key to the successful implementation of hazard mitigation actions.

Hazard Mitigation Plan: A hazard mitigation plan represents a community's blueprint for how it intends to reduce the impact of natural and human-caused hazards on people and the built environment. The essential elements of a hazard mitigation plan include a risk assessment, capability assessment, and mitigation strategy.

Disaster Recovery Plan: A disaster recovery plan serves to guide the physical, social, environmental, and economic recovery and reconstruction process following a disaster. In many instances, hazard mitigation principles and practices are incorporated into local disaster recovery plans with the intent of capitalizing on opportunities to break the cycle of repetitive disaster losses. Disaster recovery plans can also lead to the preparation of disaster redevelopment policies and ordinances to be enacted following a hazard event.

- Twelve out of 19 jurisdictions have or are developing Disaster Recovery Plans, although some jurisdictions indicate that other plans include this topic, e.g., an emergency operations plan, and there is no separate disaster recovery plan that addresses long-term recovery issues.

Emergency Operations Plan: All of the Cities and Counties in Virginia are required to have an Emergency Operations Plan which also applies to the towns within their boundaries. Several of the Towns have also written Emergency Operations Plans to guide their emergency response activities.

Continuity of Operation Plan: A continuity of operations plan establishes a chain of command, line of succession, and plans for backup or alternate emergency facilities in case of an extreme emergency or disaster event.

- Survey results indicate that five jurisdictions do not have continuity of operations plans in place.

Radiological Emergency Plan: A radiological emergency plan delineates roles and responsibilities for assigned personnel and the means to deploy resources in the event of a radiological accident.

- Thirteen jurisdictions have a plan to address radiological emergencies.

SARA Title III Emergency Response Plan: A Superfund Amendments and Re-authorization Act (SARA) Title III Emergency Response Plan outlines the procedures to be followed in the event of a chemical emergency such as the accidental release of toxic substances. These plans are required by federal law under Title III of the SARA, also known as the Emergency Planning and Community Right-to-Know Act.

- Fifteen jurisdictions have an Emergency Response Plan for chemical emergencies.

General Planning

The implementation of hazard mitigation activities often involves agencies and individuals beyond the emergency management profession. Stakeholders may include local planners, public works officials, economic development specialists, and others. In many instances, concurrent local planning efforts will help to achieve or complement hazard mitigation goals even though they are not designed as such. Therefore, the *Capability Assessment Survey* also asked questions regarding each jurisdiction's general planning capabilities and the degree to which hazard mitigation is integrated into other on-going planning efforts.

Comprehensive Land Use Plan: A comprehensive land use plan establishes the overall vision for what a community wants to be and serves as a guide to future governmental decision making. Typically a comprehensive plan contains sections on demographic conditions, land use, transportation elements, and community facilities. Given the broad nature of the plan and its regulatory standing in many communities, the integration of hazard mitigation measures into the comprehensive plan can enhance the likelihood of achieving risk reduction goals, objectives, and actions.

- Survey results indicate that 19 jurisdictions have a comprehensive land use plan. All the jurisdictions indicated that their land use plans either strongly support or help facilitate hazard loss reduction. Some jurisdictions indicated that although hazard mitigation is not specifically addressed in the plan, some elements of the plan might be relevant to hazard mitigation (e.g., environmental protection).

Capital Improvements Plan: A capital improvement plan guides the scheduling of spending on public improvements. A capital improvements plan can serve as an important mechanism for guiding future development away from identified hazard areas. Limiting public spending in hazardous areas is one of the most effective long-term mitigation actions available to local governments.

- Survey results indicate that all jurisdictions have a capital improvements plan in place or under development. Most of these are five-year plans that are updated annually, and all survey respondents indicated they either support or facilitate loss reduction efforts in their community.

Historic Preservation Plan: A historic preservation plan is intended to preserve historic structures or districts within a community. An often overlooked aspect of the historic preservation plan is the assessment of buildings and sites located in areas subject to natural hazards, and the identification of ways to reduce future damages.[1] This may involve retrofitting or relocation techniques that account for the need to protect buildings that do not meet current building standards, or are within a historic district that cannot easily be relocated out of harm's way.

- In 2010, survey results indicate that 13 out of 19 jurisdictions have a historic preservation plan for their communities. The Town of Dumfries, and the Town of Vienna indicated that they do not have any plans that address historic preservation. In 2016, this information was not changed.

Zoning Ordinances: Zoning represents the primary means by which land use is controlled by local governments. As part of a community's police power, zoning is used to protect the health, safety, and welfare of those in a given jurisdiction that maintains zoning authority. A zoning ordinance is the mechanism through which zoning is typically implemented. Since zoning regulations enable municipal governments to limit the type and density of development, it can serve as a powerful tool when applied in identified hazard areas.

- Survey results indicate that all jurisdictions in the Northern Virginia region have adopted and enforce a zoning ordinance. All jurisdictions indicated that their zoning ordinance either strongly supports or helps facilitate hazard loss reduction.

Subdivision Ordinances: A subdivision ordinance is intended to regulate the development of housing, commercial, industrial, or other uses, including associated public infrastructure, as land is subdivided into buildable lots for sale or future development. Subdivision design that accounts for natural hazards can dramatically reduce the exposure of future development.[2]

- As of the 2010 survey results indicate that all jurisdictions in the Northern Virginia region, except Arlington County, have adopted and enforce a subdivision ordinance. By the 2016 survey Arlington County, has adopted and enforces a subdivision ordinance.

[2] For additional information regarding the use of subdivision regulations in reducing flood hazard risk, see Subdivision Design in Flood Hazard Areas. 1997. Morris, Marya. Planning Advisory Service Report Number 473. American Planning Association: Washington, D.C.

The jurisdictions indicated that their ordinance either strongly supports or helps facilitate hazard loss reduction.

Building Codes, Permitting and Inspections: Building Codes regulate construction standards. In many communities permits are issued for, and inspections of work take place on, new construction. Decisions regarding the adoption of building codes (that account for hazard risk), the type of permitting process required both before and after a disaster, and the enforcement of inspection protocols all affect the level of hazard risk faced by a community.

- The Virginia Uniform Statewide Building Code (USBC) is a State regulation promulgated by the Virginia Board of Housing and Community Development for the purpose of establishing minimum regulations to govern the construction and maintenance of buildings and structures. As of October 1, 2003, the 2000 version of the International Building Code and International Fire Code were adopted by the Commonwealth of Virginia.
- As provided in the USBC Law, the USBC supersedes the building codes and regulations of the counties, municipalities, and other political subdivisions and state agencies.

The adoption and enforcement of building codes by local jurisdictions is routinely assessed through the Building Code Effectiveness Grading Schedule (BCEGS) program developed by the Insurance Services Office, Inc. (ISO).[3] Under the BCEGS program, ISO assesses the building codes in effect in a particular community and how the community enforces its building codes, *with special emphasis on mitigation of losses from natural hazards*. The results of BCEGS assessments are routinely provided to ISO's member private insurance companies, which in turn may offer ratings credits for new buildings constructed in communities with strong BCEGS classifications. The concept is that communities with well-enforced, up-to-date codes should experience fewer disaster-related losses, and as a result should have lower insurance rates.

In conducting the assessment, ISO collects information related to personnel qualification and continuing education, as well as number of inspections performed per day. This type of information combined with local building codes is used to determine a grade for that jurisdiction. Table 5.5 shows the BCEGS rating for the jurisdictions in the Northern Virginia region. The grades range from 1 to 10, with the lower grade being better. A BCEGS grade of 1 represents exemplary commitment to building code enforcement, and a grade of 10 indicates less than minimum recognized protection.

[3] Participation in BCEGS is voluntary and may be declined by local governments if they do not wish to have their local building codes evaluated.

Table 5.5. BCEGS Rating for the Northern Virginia Region		
Jurisdiction	**Year of Evaluation**	**BCEGS Rating**
Arlington County	2000	3
Fairfax County	2015	3-Residential, 2- Commercial
Loudoun County	1997	3
Prince William County	1997	4
Alexandria, City of	1998	3
Fairfax, City of	2016	3
Falls Church, City of	2014	3-Residential, 2-Commercial
Manassas, City of	1997	4
Manassas Park, City of	2000	3
Dumfries, Town of	1997	5
Herndon, Town of	2014	3 for 1&2 Family Residential
Leesburg, Town of	1997	3
Purcellville, Town of	1997	3
Vienna, Town of	N/A	N/A

Source: Insurance Services Office, Inc. (ISO)

1. NFIP participation

Communities that regulate development in floodplains are able to participate in the NFIP. In return, the NFIP makes federally-backed flood insurance policies available for eligible properties in the community. All of the participating jurisdictions included in this planning initiative participate in the NFIP. The table below shows when each of the jurisdictions began participating in the NFIP. The table also provides the date of the FIRM in effect in each community. These maps were developed by FEMA or its predecessor and show the boundaries of the 100-year and 500-year floods. As the table shows, 13 of the maps are over 15 years old. Parts of the planning area have experienced dramatic growth over the past decade that is not reflected in the FIRM. This difference may mean that the actual floodplain varies from that depicted on the map.

Table 5.6. Communities participating in the NFIP.					
Community Name	**Init FHBM Identified**	**Init FIRM Identified**	**Current Effective Map Date**	**Reg-Emer Date**	**DFIRM/Q3**
Arlington County	Not Listed	10/1/1969	8/9/2013	12/31/1976	DFIRM
Fairfax County	5/5/1970	3/5/1990	9/17/2010	1/7/1972	DFIRM
Town of Herndon	6/14/1974	8/1/1979	9/17/2010	8/1/1979	
Town of Vienna	8/2/1974	2/3/1982	9/17/2010	2/3/1982	
Town of Clifton	3/28/1975	5/2/1977	9/17/2010	5/2/1977	

Table 5.6. Communities participating in the NFIP.					
Community Name	**Init FHBM Identified**	**Init FIRM Identified**	**Current Effective Map Date**	**Reg-Emer Date**	**DFIRM/Q3**
Loudoun County	4/25/1975	1/5/1978	7/5/2001	1/5/1978	DFIRM
Town of Leesburg	8/3/1974	9/30/1982	7/5/2001	9/30/1982	
Town of Purcellville	7/11/1975	11/15/1989	7/5/2001	11/15/1989	
Town of Middleburg		7/5/2001	7/5/2001	7/31/2001	
Town of Round Hill	5/13/1977	7/5/2001	7/5/2001	1/10/2006	
Prince William County	1/10/1976	12/1/1981	8/3/2015	12/1/1981	DFIRM
Town of Haymarket	8/9/1974	1/17/1990	1/5/1995	1/31/1990	
Town of Occoquan	7/19/1974	9/1/1978	1/5/1995	9/1/1978	
City of Alexandria	8/22/1969	8/22/1969	6/16/2011	5/8/1970	DFIRM
City of Fairfax	5/5/1970	12/23/1971	6/2/2006	12/17/1971	DFIRM
City of Falls Church	9/6/1974	2/3/1982	7/16/2004	2/3/1982	DFIRM
City of Manassas	5/31/1974	1/3/1979	1/5/1995	1/3/1979	DFIRM
City of Manassas Park	3/11/1977	9/29/1978	1/5/1995	9/29/1978	DFIRM

as of 1/30/2017 *http://www.fema.gov/cis/VA.html*

C. Fiscal Capability

For Fiscal Year 2016, the budgets of the participating jurisdictions range from $4.9 Million (Town of Middleburg) to $3.8 Billion (Fairfax County). The table below shows the total budget amounts for each jurisdiction in addition to the amount budgeted for public safety, public works and their respective planning and zoning departments. The counties, cities, and towns receive most of their revenue through real estate taxes, State and local sales tax, local services, and through restricted intergovernmental contributions (Federal and State pass through dollars).

Table 5.7. 2016 budgets by jurisdiction				
Jurisdiction	**FY 2016 Budget ($)**	**Public Works Budget ($)**	**Public Safety Budget ($)**	**Planning Budget ($)**
Alexandria, City of	649.2M	51.7M	146.6M	6.1M
Arlington County	943M	85M	180M	11.9M
Clifton, Town of	*Not Available for Review*	*Not Available for Review*	*Not Available for Review*	*Not Available for Review*
Dumfries, Town of	5M	1.3M	1.3M	0.25M
Fairfax County	3.8B	72.6M	453.3M	10.7M
Fairfax, City of	130M	11.4M	25.2M	2.3M
Falls Church, City of	83M	5.8M	9.9M	2M
Haymarket, Town of	2.3M	0.2M	0.8M	.06M
Herndon, Town of	55.5M	10.5M	9.7M	1.9M
Leesburg, Town of	45.1M	10.9M	10.9M	1.58M
Loudoun County	2.2B	*3.1M*	155M	6.5M
Lovettsville, Town of	3M	*.3M*	.017M	.13M
Manassas Park, City of	*39M*	*1.8M*	*6.6M*	*650K*
Manassas, City of	370.7M	8.7M	29.9M	388K
Middleburg, Town of	4.9M	*.99M*	0.72M	0.23M
Occoquan, Town of	*Not Available for Review*	*Not Available for Review*	*Not Available for Review*	*Not Available for Review*
Prince William County	2.7B	74.6M	289.7M	5.2M
Purcellville, Town of	17.4M	3.4M	2.1M	0.458M
Quantico, Town of	*Not Available for Review*	*Not Available for Review*	*Not Available for Review*	*Not Available for Review*
Round Hill, Town of	2.7 M	1.4 M	*Not Available for Review*	*Not Available for Review*
Vienna, Town of	20.8M	6.7M	5.6M	.746M

The following table is an update to the 2010 Northern Virginia Hazard Mitigation Plan. The table highlights each jurisdiction's fiscal capability through the identification of locally available financial resources. A (Y) indicates that the given fiscal resource is locally available for hazard mitigation purposes (including match funds for State and Federal mitigation grant funds). A (Y*) indicates that capability is new as of the 2016 update.

5.8. Fiscal capabilities by jurisdiction									
Jurisdiction	**Capital Improvement Programming**	**Community Development Block Grants**	**Special Purpose Taxes**	**Gas / Electric Utility Fees**	**Water / Sewer Fees**	**Stormwater Utility Fees**	**Development Impact Fees**	**General Obligation Bonds / Revenue Bonds / Special Tax Bonds**	**Partnering Arrangements or Intergovernmental Agreements**
Alexandria, City of	Y	Y	Y	N	Y	N	Y	Y	Y
Arlington County	Y	Y	Y*	Y	Y	Y	Y*	Y	Y
Dumfries, Town of	Y	Y	Y	Y	Y	Y	Y	Y	Y
Fairfax County	Y	Y	Y	Y	Y	Y	Y	Y	Y
Fairfax, City of	Y		Y		N*				
Falls Church, City of	Y	Y	Y	Y(Gas)	Y (sewer)	Y	Y	Y	Y
Haymarket, Town of	Y*	N	N	N	N	N	Y	N	N
Herndon, Town of	Y	N	Y	Y	Y	Y	Y	Y	Y
Leesburg, Town of	Y		Y*	Y	Y			Y	Y
Loudoun County	Y	Y	Y	N	N	N		Y	Y
Lovettsville, Town of	Y	Y	N	N	Y	N	N	Y	Y
Manassas Park, City of	Y	N*	N*	N*	Y	Y	Y*	Y	Y
Manassas, City of	Y	Y	Y	Y	Y	Y		Y	Y
Middleburg, Town of	Y*	Y*			Y*			Y*	Y*
Occoquan, Town of									
Prince William County	Y	Y	Y		Y	Y	Y	Y	Y
Purcellville, Town of	Y	Y	Y		Y			Y	Y
Round Hill, Town of	Y	N	N	N	Y	N	N	Y	Y
Vienna, Town of	Y	Y*	Y*	Y*	Y*	Y*	Y*	Y*	Y*

[1] See Protecting the Past from Natural Disasters. 1989. Nelson, Carl. National Trust for Historic Preservation: Washington, D.C.

Chapter 6: Mitigation Strategies

This section of the Plan describes the most challenging part of any such planning effort – the development of a Mitigation Strategy. It is a process of:

1. Setting mitigation goals;
2. Considering mitigation alternatives;
3. Identifying objectives and strategies; and
4. Developing a mitigation action plan.

In being comprehensive, the development of the strategy included a thorough review of all natural hazards and identified far-reaching policies and projects intended to not only reduce the future impacts of hazards, but also to assist counties and municipalities to achieve compatible economic, environmental, and social goals. In being strategic, the development of the strategy ensures that all policies and projects are linked to established priorities and assigned to specific departments or individuals responsible for their implementation with target completion deadlines. When necessary, funding sources are identified that can be used to assist in project implementation.

For the 2016 update, the regional goals, objectives, and strategies were re-examined by the committee and jurisdictions and new goals and strategies were included in this section of the plan update. Local jurisdiction strategies are included in Chapter 7.

I. Planning Process for Setting Mitigation Goals

The hazard mitigation planning process conducted by the MAC is a typical problem-solving methodology:

- Describe the problem (Hazard Identification);
- Estimate the impacts the problem could cause (Vulnerability Assessment);
- Assess what safeguards exist that might already or could potentially lessen those impacts (Capability Assessment); and
- Using this information, determine what, if anything, can be done, and select those actions that are appropriate for the community in question (Develop an Action Plan).

When a community decides that certain risks are unacceptable and that certain mitigation actions may be achievable, the development of *goals* and *objectives* takes place. Goals and objectives help to describe what actions should occur, using increasingly narrow descriptors. Initially, long-term and general statements known as broad-based goals are developed. Goals then are accomplished by meeting objectives, which are specific and achievable in a finite time period. In most cases there is a third level, called *strategies*, which are detailed and specific methods to meet the objectives.

The MAC discussed regional goals and objectives for this plan at the May 10, 2016 committee meeting. The committee discussed the results of the HIRAs and reaffirmed the regional mitigation strategy. This strategy was broad and applicable to the region and the committee felt that in general, it is still applicable to the 2016 plan update. During this same meeting, the committee made the decision to remove the regional mitigation actions. Each individual jurisdiction will incorporate these actions in their jurisdictional section of the plan as appropriate.

Following the development of the regional strategy, jurisdictional meetings were conducted during the months of May, June and July 2016. During these separate jurisdictional meetings, the HIRA was presented to the attendees, and then strategies, or actions, were developed specific to each jurisdiction.

Data collection supports the goals and recommended actions in two ways. First, the HIRA data identifies areas exposed to hazards, at-risk critical facilities, and future development at risk. Second, the Capability Assessment data identifies areas for integration of hazard mitigation into existing policies and plans.

The MAC members used the results of the data collection efforts to develop goals and prioritize actions for their jurisdiction. The priorities differ somewhat from jurisdiction to jurisdiction. Each jurisdiction's priorities were developed using a ranking of the STAPLE/E criteria.

II. Considering Mitigation Alternatives

Each jurisdiction was responsible for the development of their own mitigation actions. In general, they held separate jurisdictional meetings that occurred between May and July 2016. Members of each jurisdiction were presented with the HIRA findings. Discussions held during the meeting resulted in the generation of a range of potential mitigation goals and actions to address the hazards. A range of alternatives were then identified and prioritized by each jurisdiction. These alternatives are presented in Chapter 7.

A. Identification and Analysis of Mitigation Techniques

In formulating Northern Virginia's mitigation strategy, a wide range of activities were considered in order to help achieve the general regional goals in addition to the specific hazard concerns of each participating jurisdiction. This includes the following activities as recommended by the Emergency Management Accreditation Program[1] (EMAP):

1) The use of applicable building construction standards;
2) Hazard avoidance through appropriate land-use practices;
3) Relocation, retrofitting, or removal of structures at risk;
4) Removal or elimination of the hazard;
5) Reduction or limitation of the amount or size of the hazard;
6) Segregation of the hazard from that which is to be protected;
7) Modification of the basic characteristics of the hazard;
8) Control of the rate of release of the hazard;
9) Provision of protective systems or equipment for both cyber or physical risks;
10) Establishment of hazard warning and communication procedures; and
11) Redundancy or duplication of essential personnel, critical systems, equipment, and information materials.

All activities considered by the MAC can be classified under one of the following six (6) broad categories of mitigation techniques:

Prevention

Preventative activities are intended to keep hazard problems from getting worse, and are typically administered through government programs or regulatory actions that influence the way land is developed and buildings are built. They are particularly effective in reducing a community's future vulnerability, especially in areas where development has not occurred or capital improvements have not been substantial. Examples of preventative activities include:

- Planning and zoning;
- Building codes;
- Open space preservation;
- Floodplain regulations;
- Stormwater management regulations;
- Drainage system maintenance;
- Capital improvements programming; and
- Shoreline / riverine / fault zone setbacks.

Property Protection

Property protection measures involve the modification of existing buildings and structures to help them better withstand the forces of a hazard, or removal of the structures from hazardous locations. Examples include:

- Acquisition;
- Relocation;
- Building elevation;
- Safe rooms;
- Critical facilities protection;
- Retrofitting (e.g., windproofing, floodproofing, seismic design techniques, etc.);
- Safe rooms, shutters, shatter-resistant glass; and
- Insurance.

Natural Resource Protection

Natural resource protection activities reduce the impact of natural hazards by preserving or restoring natural areas and their protective functions. Such areas include floodplains, wetlands, steep slopes, and sand dunes. Parks, recreation, or conservation agencies and organizations often implement these protective measures. Examples include:

- Floodplain protection;
- Watershed management;
- Beach and dune preservation;
- Riparian buffers;
- Forest/vegetation management (e.g., fire resistant landscaping, fuel breaks, etc.);
- Erosion and sediment control;
- Wetland preservation and restoration;
- Habitat preservation; and
- Slope stabilization,

Structural Projects

Structural mitigation projects are intended to lessen the impact of a hazard by modifying the environmental natural progression of the hazard event through construction. They are usually designed by engineers and managed or maintained by public works staff. Examples include:

- Reservoirs;
- Dams / levees / dikes / floodwalls / seawalls;
- Diversions / detention / retention;
- Channel modification;
- Beach nourishment; and
- Storm sewers.

Emergency Services

Although not typically considered a "mitigation" technique, emergency service measures do minimize the impact of a hazard event on people and property. These commonly are actions taken immediately prior to, during, or in response to a hazard event. Examples include:

- Warning systems;
- Evacuation planning and management;
- Emergency response training and exercises;
- Sandbagging for flood protection; and

Public Education and Awareness

Public education and awareness activities are used to advise residents, elected officials, business owners, potential property buyers, and visitors about hazards, hazardous areas, and mitigation techniques they can use to protect themselves and their property. Examples of measures to educate and inform the public include:

- Outreach projects;
- Speaker series / demonstration events;
- Hazard map information;
- Real estate disclosure;
- Library materials;
- School children educational programs; and
- Hazard expositions.

B. Prioritizing Alternatives

Through discussion and self-analysis, each jurisdiction used the STAPLE/E (Social, Technical, Administrative, Political, Legal, Economic, and Environmental) Criteria when considering and prioritizing the most appropriate mitigation actions. This methodology requires that social, technical, administrative, political, legal, economic, and environmental considerations be taken into account when reviewing potential actions for the area's jurisdictions to undertake. This process was used to help ensure that the most equitable and feasible actions would be undertaken based on a jurisdiction's capabilities.

Table 6.1, below, provides information regarding the review and selection criteria for alternatives.

Table 6.1. STAPLE/E Review and Selection Criteria for Alternatives
Social
▪ Is the proposed action socially acceptable to the community(s)? ▪ Are there equity issues involved that would mean that one segment of a community is treated unfairly? ▪ Will the action cause social disruption?
Technical
▪ Will the proposed action work? ▪ Will it create more problems than it solves? ▪ Does it solve a problem or only a symptom? ▪ Is it the most useful action in light of other community(s) goals?
Administrative
▪ Can the community(s) implement the action? ▪ Is there someone to coordinate and lead the effort? ▪ Is there sufficient funding, staff, and technical support available? ▪ Are there ongoing administrative requirements that need to be met?
Political
▪ Is the action politically acceptable? ▪ Is there public support both to implement and to maintain the project?
Legal
▪ Is the community(s) authorized to implement the proposed action? Is there a clear legal basis or precedent for this activity? ▪ Are there legal side effects? Could the activity be construed as a taking? ▪ Is the proposed action allowed by a comprehensive plan, or must a comprehensive plan be amended to allow the proposed action? ▪ Will the community(s) be liable for action or lack of action? ▪ Will the activity be challenged?
Economic
▪ What are the costs and benefits of this action? ▪ Do the benefits exceed the costs? ▪ Are initial, maintenance, and administrative costs taken into account? ▪ Has funding been secured for the proposed action? If not, what are the potential funding sources (public, non-profit, and private)? ▪ How will this action affect the fiscal capability of the community(s)? ▪ What burden will this action place on the tax base or local economy? ▪ What are the budget and revenue effects of this activity? ▪ Does the action contribute to other community goals, such as capital improvements or economic development? ▪ What benefits will the action provide?
Environmental
▪ How will the action affect the environment? • Will the action need environmental regulatory approvals? • Will it meet local and state regulatory requirements?

Table 6.1. STAPLE/E Review and Selection Criteria for Alternatives
• Are endangered or threatened species likely to be affected?

Ranking was completed in order of relative priority based on the STAPLE/E criteria, as well as the strategy's potential to reduce vulnerability to natural hazards.

III. Identifying Objectives and Strategies

A. Goals and Strategies

Through a series of jurisdictional meetings, the following goals and strategies for the region were accepted by the MAC. The goals and strategies form the basis for the development of a Mitigation Action Plan and specific mitigation projects to be considered for the Region. The process consisted of 1) setting goals, 2) considering mitigation alternatives, 3) identifying strategies, and 4) developing an action plan resulting in a mitigation strategy.

Community officials should consider the goals that follow before making community policies, public investment programs, economic development programs, or community development decisions for their communities. In addition, Regional strategies have been developed for each goal. These strategies state a more specific outcome that the jurisdictions of the Northern Virginia region expect to accomplish over the next five years. The strategies will outline the specific steps necessary to achieve that end.

Regional Goals and Strategies

- Goal 1: Improve the quality and utilization of best available data for conducting detailed hazard risk assessments and preparing meaningful mitigation action plans.
- Goal 2: Increase the capability of the Northern Virginia jurisdictions to successfully mitigate hazards to include participation in grant programs, revision of codes, and expansion of programs such as the Community Rating System, and continuation or expansion of outreach programs.
- Goal 3: Develop and maintain specific plans to minimize the effects of known hazards in the region.
- Goal 4: Improve existing local policies, codes, and regulations to reduce or eliminate the impacts of known hazards. This includes maintaining continued compliance with the NFIP for all participating jurisdictions.
- Goal 5: Investigate and implement a range of structural and non-structural projects that will reduce the effects of hazards on public and private property throughout the region.
- Goal 6: Increase the public's awareness of hazard risks in the Northern Virginia region, while also educating residents and businesses on the mitigation measures available to minimize those risks.

The previous regional strategy from the 2010 plan has been removed and mitigation actions found within it have been incorporated into local action plans found in Chapter 7 where appropriate.

Local Mitigation Strategies

In formulating a mitigation strategy, a wide range of activities were considered in order to help achieve the goals and to lessen the vulnerability of the Northern Virginia jurisdictions to the effects of the natural hazards identified in this plan. Through a series of jurisdictional meetings, conference calls, and e-mail exchanges, all of the jurisdictions (county, cities, and towns) participated in the development and review of the local mitigation strategy.

Strategies were ranked by each community. Ranking was completed in order of relative priority based on the STAPLE/E criteria, as well as the strategy's potential to reduce vulnerability to natural hazards. Actions were given a ranking of high, medium, or low, with the following meanings:

- High (H) – actions should be implemented in the short-term
- Medium (M) – actions should be implemented in the long-term
- Low (L) – actions should be implemented only as funding becomes available

When deciding on which strategies should receive priority in implementation, the communities considered:

- Time – Can the strategy be implemented quickly?
- Ease to implement – How easy is the strategy to implement? Will it require many financial or staff resources?
- Effectiveness – Will the strategy be highly effective in reducing risk?
- Lifespan – How long will the effects of the strategy be in place?
- Hazards – Does the strategy address a high priority hazard or does it address multiple hazards?
- Post-disaster implementation – Is this strategy easier to implement in a post-disaster environment?

In addition, the anticipated level of cost effectiveness of each measure was a primary consideration when developing mitigation actions. Because mitigation is an investment to reduce future damages, it is important to select measures for which the reduced damages over the life of the measure are likely to be greater than the project cost. For structural measures, the level of cost effectiveness is primarily based on the likelihood of damages occurring in the future, the severity of the damages when they occur, and the level of effectiveness of the selected measure. Although detailed analysis was not conducted during the mitigation action development process, these factors were of primary concern when selecting measures. For those measures that do not result in a quantifiable reduction of damages, such as public education and outreach, the relationship of the probable future benefits and the cost of each measure was considered when developing the mitigation actions. Each jurisdiction's mitigation strategy can be found in Chapter 7 and the status of 2010 mitigation strategies can be found in Appendix E. Where a strategy's status is blank, updates were unable to be retrieved from the jurisdiction's representative.

Each of the strategies are numbered in the action plans and listed in order of their prioritization (High, Medium, or Low). The strategies that were brought forward from the 2010 plan are listed first in the table under their original strategy number, combined with the year that they were developed. The new strategies for this new planning cycle start at 1 again. The year column found in the 2010 plan has been removed and the year a strategy was developed was incorporated into the action number.

[1] The EMAP Standard is based on the NFPA 1600 Standard on Disaster/Emergency Management and Business Continuity Programs, 2004 Edition.

Chapter 7: Jurisdiction Executive Summaries

I. Alexandria

What is now the City of Alexandria was first settled as part of the British Colony of Virginia in the late 1690s. In 1791, George Washington included portions of the City of Alexandria in what was to become the District of Columbia. That portion was given back to Virginia in 1846 and the City of Alexandria was re-chartered in 1852. In 1870, the City of Alexandria became independent of Alexandria County, with the remainder of the county changing its name to Arlington County in 1920. The population of the city was 128,283 as of the 2000 Census and was estimated to be 139,966 in 20109.

Alexandria has a moderate climate. The average annual temperature is approximately 58 degrees. Temperatures generally range from January lows in the mid-20s to July highs in the upper-80s and lower-90s. Annual precipitation averages above 40 inches and approximately 14 - 16 inches of snow falls in any given year. Recent history proves that weather events well outside of these averages can and do occur. Climate change is expected to continue the trend of the past 40 to 50 years of an increased frequency of extreme weather events.

Alexandria's high population density and its location along the banks of the Potomac River increase the city's vulnerability to a variety of hazards, most notably flooding. In addition to snow melt and rain-related river flooding episodes, Alexandria is also subjected to tidal and storm surge flooding. As sea levels rise, permanent inundation of low lying areas along and near the river shoreline is also a concern. Winter weather and high wind events also pose a significant threat to the city as the 2009 – 2010 winter and summer seasons have proven.

To a large extent, historical records are used to identify the level of risk within the Northern Virginia region, including Alexandria, with the assumption that the data sources cited are reliable and accurate. Unless otherwise cited, data on historical weather-related events is based on information made available through the Storm Event Database by NOAA's NCDC[1]. Hazards were ranked using a semi-quantitative scoring system that involved grouping the data values (normalized to account for inflation) based on statistical methods. This method prioritizes hazard risk based on a blend of quantitative factors extracted from NCDC and other available data sources. The parameters considered include:

- Historical occurrence;
- Vulnerability of population in the hazard area; and
- Historical impact, in terms of human lives and property and crop damage.

The hazard scores were assigned a category of 'Low'; 'Medium-Low'; 'Medium'; 'Medium-High'; or 'High'. Based on this methodology, Flood, Wind, Tornado, Winter Weather, and

Landslide hazards were ranked as 'High' for Alexandria. See Table 7.1 for a summary of hazard rankings.

Table 7.1: Hazard Ranking for Alexandria									
Hazard	Flood	Wind	Tornado	Winter Weather	Drought	Earthquake	Landslide	Wildfire	Karst
Ranking	High	High	High	High	Med-High	Med	Low	Med-Low	Med-Low

A. Alexandria Mitigation Actions and Action Plan

#	Agency/Department: Mitigation Action	Lead Agency Department Organization	Flood	Winter Storm	Wind\ Severe Storm	Tornado	Drought	Wildfire	Earthquake	Extreme Temps	Dam Failure	Landslides	Karst \ Sinkholes	Funding Source	Target Completion Date	Interim Measure of Success	Priority	Comments
2006-6	Support mitigation of priority flood-prone structures through promotion of acquisition/ demolition, elevation, flood proofing, minor localized flood control projects, mitigation reconstruction and where feasible using FEMA HMA programs where appropriate.	Transportation and Environmental Services	X		X									FEMA Unified Hazard Mitigation Assistance funding,	Ongoing	Identify all priority flood-prone structures by December 2011.	Medium	Promotion of mitigation is included as part of the City's annual outreach program associated with FEMA's Community Rating System (CRS) annual recertification.
2010-3	Conduct annual outreach to each FEMA-listed repetitive loss and severe repetitive loss property owner, providing information on mitigation programs (grant assistance, mitigation measures, flood insurance information) that can assist them in reducing their flood risk.	Transportation and Environmental Services	X		X									Internal funding	Ongoing	Develop outreach materials, or identify appropriate outreach materials for dissemination by June 2011.	Medium	Included as part of the City's annual outreach program associated with FEMA's Community Rating System (CRS) annual recertification.
2010-4	Promote structural mitigation to assure redundancy of critical facilities, to include but not limited to roof structure improvement, to meet or exceed building code standards, upgrade of electrical panels to accept generators, etc.	Emergency Management	X		X									FEMA Unified Hazard Mitigation Assistance funding,	Ongoing	Query local government building services staffs as to effectiveness of provided information regarding the	Medium	Submitted HMPG for generators

#	Agency/Department: Mitigation Action	Lead Agency Department Organization	Flood	Winter Storm	Wind\ Severe Storm	Tornado	Drought	Wildfire	Earthquake	Extreme Temps	Dam Failure	Landslides	Karst \ Sinkholes	Funding Source	Target Completion Date	Interim Measure of Success	Priority	Comments
																structural review.		
2010-5	Review locality's compliance with the National Flood Insurance Program with an annual review of the Floodplain Ordinances and any newly permitted activities in the 100-year floodplain. Additionally, Conduct annual review of repetitive loss and severe repetitive loss property list requested of VDEM to ensure accuracy. Review will include verification of the geographic location of each repetitive loss property and determination if that property has been mitigated and by what means. Provide corrections if needed by filing form FEMA AW-501.	Transportation and Environmental Services	X		X									Local program	Ongoing	Establish a schedule of review and review committee (if necessary) by June 2011.	Medium	The City's floodplain ordinance was revised in April 2011 to comply with NFIP minimum standards. The City conducted a Repetative Loss Area Analysis in 2012. Annual report updates are published as part of the annual CRS recertification.
2010-7	Re-grade section of lower King Street, Union Street and The Strand to improve drainage and minimize flooding.	Transportation and Environmental Services	X		X									Alexandria Capital Improvement Project funding	2015	Integrate into capital improvement budgets; complete design and permitting.	Low	Engineering Feasibility Study completed in 2013. Project now part of the Water Front Plan Implementation.

#	Agency/Department: Mitigation Action	Lead Agency Department Organization	Flood	Winter Storm	Wind\ Severe Storm	Tornado	Drought	Wildfire	Earthquake	Extreme Temps	Dam Failure	Landslides	Karst \ Sinkholes	Funding Source	Target Completion Date	Interim Measure of Success	Priority	Comments
2010-8	Construct an elevated walkway along Potomac riverfront to elevation 6.0 feet (NAVD88) to mitigate flooding.	Transportation and Environmental Services	X		X									Alexandria Capital Improvement Project funding and developer contributions	2020	Integrate into capital improvement budgets; complete design and permitting.	Low	Part of the Waterfront Plan Implementation. Design contract in place February 2016.
2017-1	Build permanent standalone EOC	Emergency Management	X	X	X	X	X	X	X	X	X	X	X	CIP	December 2018	Entering Phase 2 of construction process	High	No
2017-2	Identify and exploit the most effective tools for communications with the public during emergencies, including leveraging emerging technologies.	Emergency Management	X	X	X	X	X	X	X	X	X	X	X	Internal funding	Ongoing	3,000 new subscribers to e-News for receipt of emergency alerts by end of 2018.	High	No
2017-3	Four Mile Run Stream Restoration	Transportation and Environmental Services	X			X								Internal funding	November 2018	Complete final adoption public review as prescribed by NFIP.	High	No
2017-4	Litter control infrastructure, to provide a capture area for debris before it flows into the Potomac River.	Transportation and Environmental Services	X											Alexandria Capital Improvement Project funding with matching funds from	November 2018		Medium	Approved FY 2017 - FY 2026 CIP. Page 126

#	Agency/Department: Mitigation Action	Lead Agency Department Organization	Flood	Winter Storm	Wind\ Severe Storm	Tornado	Drought	Wildfire	Earthquake	Extreme Temps	Dam Failure	Landslides	Karst \ Sinkholes	Funding Source	Target Completion Date	Interim Measure of Success	Priority	Comments
														Arlington County				
2017-5	Excavate sediment from channel bed of Cameron Run - I495 bridge to upstream, as needed.	Transportation and Environmental Services	X											City of Alexandria CIP	Ongoing	Secure funding for project by March 2011	High	The City does excavate sediment from Cameron Run starting at the I495 bridge to upstream as needed.

[1] NCDC's Storm Event database is available at http://www4.ncdc.noaa.gov/cgi-win/wwcgi.dll?wwEvent~Storms.

II. Arlington County

The area that today encompasses Arlington County was first settled as part of the British Colony of Virginia in the late 1690s. In 1791, George Washington surveyed the area in what was to become the District of Columbia. Congress returned the area to the Commonwealth of Virginia in 1842 as the County of Alexandria. In 1870, the City of Alexandria became independent of Alexandria County. The county portion was officially renamed Arlington County in 1920. The 2009 census estimate for the county is 212,038, an approximately 12% increase during the past decade. Based on the 2005-2009 American Community Survey, the county population was comprised of 71.3% white, 8.1% black or African American, 0.3% Native American, 0.1% Pacific Islander, 8.4% Asian, 8.5% from other races, and 3.3% bi-racial. Hispanic or Latino of any race were 16.7% of the total population. Arlington's schools are incredibly diverse with students from 124 nations fluent in 93 languages.

Arlington has a moderate climate. The average annual temperature is approximately 58 degrees. Temperatures generally range from lows in the mid-20s in January to highs in the upper-80s and lower-90s during the month of July. Annual precipitation averages are approximately 40 inches of rain and 15 inches of snowfall in any given year. Recent history proves that weather events well outside of these averages can and do occur. Climate change is expected to continue the trend of the past 40 to 50 years of an increased frequency of extreme weather events.

Arlington is an urban county of about 26 square miles located directly across the Potomac River from Washington DC. Arlington's central location in the Washington DC metropolitan area, its ease of access by car and public transportation, and its highly skilled labor force have attracted an increasingly varied residential and commercial mix. Arlington is one of the most densely populated communities in the nation with more than 7,315 persons per square mile.

Arlington's high population density and its location along the banks of the Potomac River, increase the county's vulnerability to a variety of hazards, most notably flooding. In addition to snow melt and rain-related river flooding episodes, Arlington is also subjected to tidal and storm surge flooding. As sea levels rise, permanent inundation of low lying areas along and near the river shoreline is also a threat. Additionally, winter storms pose significant threats, as evidenced during the 2009 – 2010 winter season.

To a large extent, historical records are used to identify the level of risk within the Northern Virginia region, including Arlington, with the assumption that the data sources cited are reliable and accurate. Unless otherwise cited, data on historical weather-related events is based on information made available through the Storm Event Database by NOAA's NCDC[1]. Hazards were ranked using a semi-quantitative scoring system that involved grouping the data values (normalized to account for inflation) based on statistical methods. This method prioritizes hazard risk based on a blend of quantitative factors extracted from NCDC and other available data sources. The parameters considered include:

- Historical occurrence
- Vulnerability of population in the hazard area
- Historical impact, in terms of human lives and property and crop damage

The hazard scores were assigned a category of 'Low'; 'Medium-Low'; 'Medium'; 'Medium-High'; or 'High'. Based on this methodology, Flood, Wind, Tornado, and Winter Weather hazards were ranked as 'High' for Arlington. See Table 7.6 for a summary of hazard rankings.

Table 7.2: Hazard Ranking for Arlington

Hazard	Flood	Wind	Tornado	Winter Weather	Drought	Earthquake	Landslide	Wildfire	Karst
Ranking	High	High	High	High	Med-High	Med	Med	Med-Low	Med-Low

A. Arlington Mitigation Actions and Action Plan

#	Agency/Department: Mitigation Action	Lead Agency Department Organization	Flood	Winter Storm	Wind \ Severe Storm	Tornado	Drought	Wildfire	Earthquake	Extreme Temps	Dam Failure	Landslides	Karst\ Sinkholes	Funding Source	Target Compl etion Date	Interim Measure of Success	Priority (Critical , High, Medium , Low)	Comments
2006-1	Upgrade county EOC to modern standards.	Office of Emergency Management	X	X	X	X	X	X	X	X	X	X	X	Not Determ-ined	Dec. 2018	Funding sources identified/secured by June 2016. EOC upgrade plan completed	High	Currently seeking leased space. Funding stream remains unclear after project was removed from County CIP
2006-7	Continue training for employees and partners on the Incident Command System.	Office of Emergency Management	X	X	X	X	X	X	X	X	X	X	X	DHS and Authority	Contin ual	Continue periodic training and exercise activities internally and with Arlington County.	Medium	Ongoing program
2010-1	Enhance the ability of patrol officers, through increased training and additional equipment, to respond to active shooter and/or terrorist attacks	Police Department												Bureau of Justice Administ ration DHS funding	Contin ual	Funding Secured Training in progress Equipment upgrades ongoing	Critical	Completed 2012 and ongoing
2010-6	Secure additional special needs supplies to support the special needs population.	Arlington Red Cross	X	X	X	X		X	X	X	X	X	X	UASI	Contin ual	Secure funding and storage and order supplies by January 2011.	High	Completed regionally in 2016

#	Agency/Department: Mitigation Action	Lead Agency Department Organization	Flood	Winter Storm	Wind \ Severe Storm	Tornado	Drought	Wildfire	Earthquake	Extreme Temps	Dam Failure	Landslides	Karst\ Sinkholes	Funding Source	Target Completion Date	Interim Measure of Success	Priority (Critical, High, Medium, Low)	Comments
2010-10	Coordinate regionally to integrate multiple evacuation plans.	VDEM/Arlington County Office of Emergency Management	X	X	X	X		X	X		X	X	X	State and Federal funding sources	Continual	Regional evacuation plan developed by August 2011.	High	Complete
2010-11	Secure prisoner transportation resources in the event of a jail evacuation.	Sheriff's Office	X	X	X	X		X	X		X	X	X	County Funding	Sept. 2011	Determine number and type of assets required by March 2011.	High	Yes
2010-12	Identify building(s) to house the Courts, if the Courthouse is compromised.	Sheriff's Office/ Department of Environmental Services	X	X	X	X			X			X	X	County Funding	June 2011	Determine capacity and resource requirements to house the Courts by February 2011.	High	Yes
2010-15	Conduct annual outreach to each FEMA-listed repetitive loss and severe repetitive loss property owner, providing information on mitigation programs (grant assistance, mitigation measures, (flood insurance information) that can assist them in reducing their flood risk.	Office of Emergency Management	X		X									FEMA Unified Hazard Mitigation Assistance funding,	Ongoing	Develop outreach materials, or identify appropriate outreach materials for dissemination by June 2011.	Medium	Complete

#	Agency/Department: Mitigation Action	Lead Agency Department Organization	Flood	Winter Storm	Wind \ Severe Storm	Tornado	Drought	Wildfire	Earthquake	Extreme Temps	Dam Failure	Landslides	Karst\ Sinkholes	Funding Source	Target Completion Date	Interim Measure of Success	Priority (Critical, High, Medium, Low)	Comments
2010-16	Support mitigation of priority flood-prone structures through promotion of acquisition/ demolition, elevation, flood proofing, minor localized flood control projects, mitigation reconstruction and where feasible using FEMA HMA programs where appropriate.	Office of Emergency Management	X		X									FEMA Unified Hazard Mitigation Assistance funding	Ongoing	Identify all priority flood-prone structures by December 2011.	Medium	Ongoing– not more than 2-3 such structures exist.
2010-17	Promote structural mitigation to assure redundancy of critical facilities, to include but not limited to roof structure improvement, to meet or exceed building code standards, upgrade of electrical panels to accept generators, etc.	Office of Emergency Management	X		X									FEMA Unified Hazard Mitigation Assistance funding	Ongoing	Query local government building services staffs as to effectiveness of provided information regarding the structural review.	Medium	Ongoing
2010-18	Review locality's compliance with the National Flood Insurance Program with an annual review of the Floodplain Ordinances and any newly permitted activities in the 100-year floodplain. Additionally, Conduct annual review of repetitive loss and severe repetitive loss property list requested of VDEM to ensure accuracy. Review will include verification of the geographic location of each repetitive loss property and determination if that property has been mitigated and by what means. Provide corrections if needed by filing form FEMA AW-501.	Office of Emergency Management	X		X									County funding.	Ongoing	Establish a schedule of review and review committee (if necessary) by June 2011.	Medium	Ongoing
2010-19	Develop a Communications Plan with the private industry within Arlington County for emergency management (preparedness and response) purposes.	Office of Communications	X	X	X	X	X	X	X	X	X	X	X	County funding	Continual	Create a partnering committee with at least 5 members of the	Medium	Complete – Significant retirement will require training.

#	Agency/Department: Mitigation Action	Lead Agency Department Organization	Flood	Winter Storm	Wind \ Severe Storm	Tornado	Drought	Wildfire	Earthquake	Extreme Temps	Dam Failure	Landslides	Karst\ Sinkholes	Funding Source	Target Completion Date	Interim Measure of Success	Priority (Critical, High, Medium, Low)	Comments
																private industry to assist in developing the plan by January 2012.		
2010-20	Conduct a gap analysis of workforce safety within the County.	Department of Human Resources	X	X	X	X	X	X	X	X	X	X	X	County funding	Continual	Establish parameters of analysis (i.e. determine what areas need to be analyzed specifically) by April 2011.	Medium	Completed- Departmental Safety Officer Staffing increased significantly in 2010
2010-21	Establish a partnership with members of the academic community. Look at specific opportunities to partner with Virginia Tech.	Office of Emergency Management	X	X	X	X	X	X	X	X	X	X	X	County funding	Continual	Schedule a meeting between County and academic partners to discuss opportunities by January 2011.	Medium	Ongoing – Currently have two OEM staff working on a weekly basis.
2010-22	Conduct preparedness presentations in the community to ensure public awareness of steps the public can take to care for themselves during an emergency.	Arlington Red Cross	X	X	X	X	X	X	X	X	X	X	X	Arlington Red Cross	Continual	Schedule the first presentation by April 2011.	Medium	Ongoing
2010-26	Acquire the ability to have remote access to medical records.	Sheriff's Office	X	X	X	X	X	X	X	X	X	X	X	County Funding	January 2018	Secure funding by January	Medium	In Progress

#	Agency/Department: Mitigation Action	Lead Agency Department Organization	Flood	Winter Storm	Wind \ Severe Storm	Tornado	Drought	Wildfire	Earthquake	Extreme Temps	Dam Failure	Landslides	Karst\ Sinkholes	Funding Source	Target Completion Date	Interim Measure of Success	Priority (Critical, High, Medium, Low)	Comments
																2012		
2010-27	Identify the most effective tools for communications with the public during emergencies, including leveraging emerging technologies, e.g., social media.	Office of Communications	X	X	X	X	X	X	X	X	X	X	X	FEMA Unified Hazard Mitigation Assistance Grants	Continual	Improve situational awareness to enhance public outreach and notification by April 2011.	Medium	Ongoing
2010-28	Identify effective means of communicating with special populations, e.g., - Non-English speakers - Special needs - Tourists Non-digital	Office of Communications	X	X	X	X	X	X	X	X	X	X	X	FEMA Unified Hazard Mitigation Assistance Grants	Continual	Planning underway	Medium	Ongoing
2010-29	Ensure delivery of critical emergency text messages (Arlington Alert) to Arlington Public Schools' School Talk alert system.	Office of Communications	X	X	X	X	X	X	X	X	X	X	X	FEMA Unified Hazard Mitigation Assistance Grants	Continual	Hold discussions with Arlington Public Schools and set-up process	Medium	Ongoing
2017-01	Acquire additional Snow Melting equipment	Department of Environmental Service (ESF3)		X										County Operational Funds	Dec 2017	Identify the right type of equipment.	Low	
2017-02	Develop and adopt Threat & Hazard Identification and Assessment Plan for County	Office of Emergency Management	X	X	X	X	X	X	X	X	X	X	X	County Funding	December 2017	Draft ready by June 2017	High	

[1] NCDC's Storm Event database is available at http://www4.ncdc.noaa.gov/cgi-win/wwcgi.dll?wwEvent~Storms.

III. Fairfax County

The land that is now Fairfax County was part of the Northern Neck Proprietary granted by King Charles II in 1660 and inherited by Thomas Fairfax, Sixth Lord Fairfax of Cameron, in 1719. The county itself was formed in 1742 from Prince William County. The 2010 census population estimate for the county is 1,081,685 an approximately 5.6% increase during the past decade. Based on the 2005-2009 American Community Survey, the county population was comprised of 62.7% white, 9.2% black or African American, 0.6% Native American, 0.1% Pacific Islander, 17.5% Asian, 4.8% from other races, and 4.1% bi-racial. Hispanic or Latino of any race were 15.6% of the total population.

Fairfax County has a moderate climate. Due to its situation on both the Virginia piedmont and the Atlantic coastal plain, the county experiences a variety of weather. The average annual temperature is approximately 58 degrees. Temperatures generally range from lows in the mid-20s in January to highs in the upper-80s and lower-90s during the month of July. Annual precipitation averages are approximately 40 inches of rain and 15 or more inches of snow fall in any given year. Recent history proves that weather events well outside of these averages can and do occur. Climate change is expected to continue the trend of the past 40 to 50 years of an increased frequency of extreme weather events.

Fairfax County comprises about 407 square miles located directly across the Potomac River from Washington, DC. The county's location in the Washington metropolitan area, its ease of access by car and public transportation, and its highly skilled labor force have attracted an increasingly varied residential and commercial mix. Most commercial development is centered in Tysons Corner, which is the 12th largest central business district in the Nation.

The diversity of Fairfax County's landscape increases the county's vulnerability to a variety of hazards, most notably flooding and severe storms. In addition to snow melt and rain-related river flooding episodes, low-lying areas of Fairfax County along the Potomac River are also subject to tidal and storm surge flooding. As sea levels rise, permanent inundation of low lying areas along and near the river shoreline is also a threat. Additionally, winter storms pose significant threats, as evidenced during the 2015 – 2016 winter season.

To a large extent, historical records are used to identify the level of risk within the Northern Virginia region, including Fairfax County, with the assumption that the data sources cited are reliable and accurate. Unless otherwise cited, data on historical weather-related events is based on information made available through the Storm Event Database by NOAA's NCDC[1]. Hazards were ranked using a semi-quantitative scoring system that involved grouping the data values (normalized to account for inflation) based on statistical methods. This method prioritizes hazard risk based on a blend of quantitative factors extracted from NCDC and other available data sources. The parameters considered include:

- Historical occurrence;
- Vulnerability of population in the hazard area; and
- Historical impact, in terms of human lives and property and crop damage.

The hazard scores were assigned a category of 'Low'; 'Medium-Low'; 'Medium'; 'Medium-High'; or 'High'. Based on this methodology, Flood, Wind, Tornado, and Winter Weather hazards were ranked as 'High' for Fairfax County. See Table 7.11 for a summary of hazard rankings.

Table 7.3: Hazard Ranking for Fairfax County

Hazard	Flood	Wind	Tornado	Winter Weather	Drought	Earthquake	Landslide	Wildfire	Karst	Extreme Temp.	Dam Failure
Ranking	High	High	High	High	Med-High	Med	Med-Low	Med	Med-Low	Med-Low	Med-Low

A. Fairfax County Mitigation Actions and Action Plan

#	Agency/Department: Mitigation Action	Lead Agency Department Organization	Flood	Winter Storm	Wind \ Severe Storm	Tornado	Drought	Wildfire	Earthquake	Extreme Temps	Dam Failure	Landslides	Karst \ Sinkholes	Funding Source	Target Completion Date	Interim Measure of Success	Priority	Comments
2006-2	Continue to develop and implement flood proofing solutions for structures analyzing flood causes and responsibilities.	DPWES - Stormwater	X	X	X						X			County Funding	Ongoing	Initiate service request within 48 hours of receiving the request	High	These projects are completed when the county attorney we are responsible, and the efforts are ongoing. The language for this action has been modified slightly for the 2017 plan but the intent remains unchanged.
2006-5	Continue to install remote lake level sensors, data collectors/alarms, stream flow gauges, tide gauges and rain gauges at critical locations throughout the county to allow for earlier warning of potential flooding.	DPWES - Stormwater	X		X						X			Hazard Mitigation Assistance grant funding, US Army Corp of Engineers, County Funding	Ongoing	Prioritize installation of gauges within one year of substantial completion and as resources allow	High	These projects are ongoing and competed as funding becomes available.
2006-13	Identify need for backup generators, communications, and/or vehicles at critical public facilities. Develop means to address shortfall identified.	Park Authority	X	X	X	X	X	X	X	X	X	X	X	UASI funding, county funding	July 2014	Conduct generator survey to identify which facilities require a backup generator by January 2012.	Medium	This program will be completed when funding becomes available.
2006-28	Continue to implement building and development standards as required under the National Flood Insurance Program.	Land Development Services	X	X	X	X	X	X	X	X	X	X	X	Hazard Mitigation Assistance grant funding, US Army Corp of Engineers, County Funding	Ongoing	Implement one new standard (at least at County facilities) every year.	Medium	This task is ongoing as updates are made to building and development standards, they are reviewed and incorporated as appropriate. All new policies and procedures are in accordance with the National Flood Insurance Program (NFIP).

#	Agency/Department: Mitigation Action	Lead Agency Department Organization	Flood	Winter Storm	Wind \ Severe Storm	Tornado	Drought	Wildfire	Earthquake	Extreme Temps	Dam Failure	Landslides	Karst \ Sinkholes	Funding Source	Target Completion Date	Interim Measure of Success	Priority	Comments
2010-6	Continue to employ a broad range of warning systems throughout the county.	Office of Emergency Management	X	X	X	X	X	X	X	X	X	X	X	UASI funding, DHS grants, county funding	Ongoing		High	OEM launched the new Fairfax Alerts system in the summer of 2014, and continues to look for new ways to alert residents including social media and WEA.
2010-12	Identify funding opportunities to replace vulnerable or undersized culvert stream crossings with bridges or larger culverts to reduce flood hazards.	Park Authority	X		X						X			FEMA Unified Hazard Mitigation Assistance Grants	Ongoing	Develop list of vulnerable or undersized culverts by January 2012.	High	PA has trail development strategy plan that addresses this concern.
2010-16	Upgrade the New Alexandria/Belle View pump station fuel oil storage tanks from underground to above-ground storage.	DPWES - Wastewater	X		X									County Funding	June 2018	Complete Design by June 2017	High	This project is planned to be completed. The language was changed slightly from the text in the 2010 plan, but the intent is the same.
2010-17	Continue to seek voluntary buy-outs of FEMAs repetitive loss properties within the floodplain.	DPWES - Stormwater	X	X	X	X	X	X	X	X	X	X	X	Hazard Mitigation Assistance grant funding, County Funding	Ongoing	Complete one buy-out per year.	High	These projects are completed as funding is available.
2010-20	Collaborate with FEMA to develop risk maps for the Cameron Run Watershed and the Belle View communities.	DPWES - Stormwater	X	X	X	X	X	X	X	X	X	X	X	Hazard Mitigation Assistance grant funding,	Ongoing		High	Progress is controlled by FEMA's schedule.

#	Agency/Department: Mitigation Action	Lead Agency Department Organization	Flood	Winter Storm	Wind \ Severe Storm	Tornado	Drought	Wildfire	Earthquake	Extreme Temps	Dam Failure	Landslides	Karst \ Sinkholes	Funding Source	Target Completion Date	Interim Measure of Success	Priority	Comments
														County Funding				
2010-21	Develop an outreach program aimed at assisting private dam owners with proper operation and maintenance.	DPWES - Stormwater	X		X						X			Hazard Mitigation Grant Program – 5% initiative funds FEMA has a national dam safety program: unsure if funding is available. Virginia Floodplain Management Fund (administered by DCR Division of Dam Safety and Floodplain Management)	July 2017	Identify specific outreach techniques for this audience by January 2017.	High	This program will be completed when funding becomes available.
2010-23	Identify gaps in current Recovery Planning efforts within the county.	Office of Emergency Management	X	X	X	X	X	X	X	X	X	X	X	County funding	July 2011	Establish metrics for review of plan by February 2011.	Medium	In 2012 Fairfax County published the Pre-Disaster Recovery Plan. The plan is scheduled to be revised in 2017. During that process gaps will be identified and addressed again.

#	Agency/Department: Mitigation Action	Lead Agency Department Organization	Flood	Winter Storm	Wind \ Severe Storm	Tornado	Drought	Wildfire	Earthquake	Extreme Temps	Dam Failure	Landslides	Karst \ Sinkholes	Funding Source	Target Completion Date	Interim Measure of Success	Priority	Comments
2010-26	Use fee simple and/or permanent easement to prevent development in the highest priority undeveloped floodplain (and/or wetlands) areas. Work with land trusts to purchase the land or conservation easements. Use these areas as public open space for passive recreational uses.	Park Authority	X											FEMA Unified Hazard Mitigation Assistance Grants, county funding	December 2013	Ongoing	Medium	Yes
2010-27	Continue development of a comprehensive River Flood Response System for New Alexandria/Belle View and Huntington in partnership with the National Weather Service and the U.S. Army Corps of Engineers.	DPWES - Stormwater	X		X									Hazard Mitigation Assistance grant funding, US Army Corp of Engineers, County Funding	Ongoing		Medium	These Projects are completed as funding becomes available.
2010-29	Conduct annual outreach to each FEMA-listed repetitive loss and severe repetitive loss property owner, providing information on mitigation programs (grant assistance, mitigation measures, flood insurance information) that can assist them in reducing their flood risk.	DPWES – Stormwater	X		X									County Funding	Ongoing		Medium	This action was reassigned to DPWES-Stormwater. It is performed annually as part of the CRS Program.

#	Agency/Department: Mitigation Action	Lead Agency Department Organization	Flood	Winter Storm	Wind \ Severe Storm	Tornado	Drought	Wildfire	Earthquake	Extreme Temps	Dam Failure	Landslides	Karst \ Sinkholes	Funding Source	Target Completion Date	Interim Measure of Success	Priority	Comments
2010-30	Promote structural mitigation to assure redundancy of critical facilities, to include but not limited to roof structure improvement, to meet or exceed building code standards, upgrade of electrical panels to accept generators, etc.	Office of Emergency Management	X		X									FEMA Unified Hazard Mitigation Assistance funding,	Ongoing		Medium	This is completed as funding is available.
2010-32	Encourage public and private water conservation plans, including consideration of rainwater catchment system.	Park Authority					X							County funding	Ongoing	Engage in public outreach regarding water conservation by January 2012.	Low	This is completed as funding is available.
2010-33	Work with the Virginia Department of Forestry to review local zoning and subdivision ordinances to identify areas to include wildfire mitigation principles.	Park Authority						X						Hazard Mitigation Assistance grant funding	Ongoing	Establish working group by December 2011.	Low	
2017-1	Develop an Emergency Action Plan for the Huntington Levee project.	DPWES – Stormwater	X								X			Hazard Mitigation Assistance Grant	December 2018		High	
2017-2	Collaborate with other departments of Fairfax County to identify satellite locations throughout Fairfax County to build	DPWES - Stormwater		X										County Funding	June 2018	Identify and build at least two sites by November 2017	High	

#	Agency/Department: Mitigation Action	Lead Agency Department Organization	Flood	Winter Storm	Wind \ Severe Storm	Tornado	Drought	Wildfire	Earthquake	Extreme Temps	Dam Failure	Landslides	Karst \ Sinkholes	Funding Source	Target Completion Date	Interim Measure of Success	Priority	Comments
	additional salt storage facilities to reduce the travel time and distance during snow/ice events.																	
2017-3	Secure funding to purchase additional equipment/trucks to enhance our current level of service to be able to dedicate one piece of equipment/truck to each police station within Fairfax County or identify other resources to accomplish this need.	DPWES – Stormwater		X										County Funding	June 2020	Secure funding to purchase at least 2 additional trucks/pieces of equipment each year for the next four years or establish a contract that would dedicate resources to each County police station by November 2017	High	
2017-4	Coordinate and support the Virginia Department of Transportation in the identification and resolution of road flooding and drainage issues related to VDOT roadways.	DPWES – Stormwater	X		X						X			VDOT Maintenance Funding	Ongoing	Prioritization and implementation of higher priorities.	High	
2017-5	Armor stream bank and construct a flood wall to prevent stream bank erosion and flooding at the Noman M. Cole, Jr. Pollution Control Plant	DPWES – Wastewater	X		X									County Funding	February 2018	Construction project management review and inspections	High	

#	Agency/Department: Mitigation Action	Lead Agency Department Organization	Flood	Winter Storm	Wind \ Severe Storm	Tornado	Drought	Wildfire	Earthquake	Extreme Temps	Dam Failure	Landslides	Karst \ Sinkholes	Funding Source	Target Completion Date	Interim Measure of Success	Priority	Comments
2017-6	Design and construct safe rooms at critical facilities to house personnel and community members during high wind events.	Office of Emergency Management		X	X	X			X					Hazard Mitigation Grant Funds, County Funding	Ongoing		High	This action replaces 2010-11, and provides for storm proofing any critical facilities, not just shelter.
2017-7	Provide emergency utility capabilities for critical facilities. This includes, but is not limited to providing generator and emergency water hookups.	Office of Emergency Management	X	X	X	X			X	X	X	X	X	Hazard Mitigation Grant Funds, County Funding	Ongoing		High	This action replaces 2010-1
2017-8	Improve the County's Community Rating System (CRS) classification from Class 6 to Class 5 by documenting services that are currently being provided.	DPWES – Stormwater	X								X			County Funding	Ongoing		Medium	
2017-9	Provide routine inspections and maintenance of dams to ensure they are functional.	DPWES – Stormwater	X		X						X			County Funding	Ongoing	Routine Maintenance	Medium	
2017-10	Continue to implement flood mitigation projects for communities in Fairfax County that are exposed to severe flooding risk.	DPWES – Stormwater	X		X						X			Hazard Mitigation Grant Funds, County Funding	Ongoing		Medium	
2017-11	Update flood information website to include a link to the Office of	DPWES – Stormwater	X								X			County Funding	Check links at least once every year.		Low	

#	Agency/Department: Mitigation Action	Lead Agency Department Organization	Flood	Winter Storm	Wind \ Severe Storm	Tornado	Drought	Wildfire	Earthquake	Extreme Temps	Dam Failure	Landslides	Karst \ Sinkholes	Funding Source	Target Completion Date	Interim Measure of Success	Priority	Comments
	Emergency Management website and the private dam owners outreach materials.																	
2017-12	Support mitigation of priority flood-prone structures through promotion of acquisition/ demolition, elevation, flood proofing, minor localized flood control projects, mitigation reconstruction and where feasible using FEMA HMA programs where appropriate.	DPWES – Stormwater	X		X									FEMA Unified Hazard Mitigation Assistance funding,	Ongoing	Identify all priority flood-prone structures by December 2019	Medium	Action carried over from previous plan; still relevant and necessary

[1] NCDC's Storm Event database is available at http://www4.ncdc.noaa.gov/cgi-win/wwcgi.dll?wwEvent~Storms.

IV. Loudoun County

Loudoun County was established in 1757 and was formerly part of Fairfax County. It was named after John Campbell, Forth Earl of Loudoun and past Governor of the Commonwealth of Virginia. It was the most populous county in Virginia during the time of the American Revolution. Since 1757, the county seat has always been Leesburg. In 2010, Loudoun County was ranked by Forbes as America's wealthiest county. The County has a total area of 521 square miles, of which one square mile is water. As of the 2000 Census, it has a population density of 272 persons per square mile. The population was estimated to be approximately 349,679 in 2013 by the U.S. Census Bureau. Based on the 2005-2009 American Community Survey, the county population was comprised of 73.2% white, 7.8% black or African American, 0.1% Native American, 0.1% Pacific Islander, 12.2% Asian, 3.9% from other races, and 2.7% bi-racial. Hispanics or Latinos of any race were 10.1% of the total population.

Geographically, Loudoun County is bounded to the North by the Potomac River; to the south by Prince William and Fauquier counties; and on the west by the watershed of the Blue Ridge Mountains. The Bull Run Mountains and Catoctin Mountain run through the County. There are seven incorporated and 60 unincorporated towns within the County.

Loudoun County has a moderate climate. The average annual temperature is approximately 58 degrees. Temperatures generally range from lows in the mid-20s in January to highs in the upper-80s and lower-90s during the month of July. Annual precipitation averages are approximately 38 inches of rain and 20 inches or so of snow fall in any given year. The wettest month on average is May. Recent history proves that weather events well outside of these averages can and do occur. Climate change is expected to continue the trend of the past 40 to 50 years of an increased frequency of extreme weather events.

Risk factors for the county are in part due to its proximity to the Nation's capital and its growth rate. The county has a risk of flooding due to low lying areas surrounding the Potomac River and other natural hazards and risks, such as storm damage and winter weather. Winter storms pose significant threats, as evidenced during the 2009 – 2010 winter season.

To a large extent, historical records are used to identify the level of risk within the Northern Virginia region, including Loudoun County, with the assumption that the data sources cited are reliable and accurate. Unless otherwise cited, data on historical weather-related events is based on information made available through the Storm Event Database by NOAA's NCDC[1]. Hazards were ranked using a semi-quantitative scoring system that involved grouping the data values (normalized to account for inflation) based on statistical methods. This method prioritizes hazard risk based on a blend of quantitative factors extracted from NCDC and other available data sources. The parameters considered include:

- Historical occurrence;

- Vulnerability of population in the hazard area; and
- Historical impact, in terms of human lives and property and crop damage.

The hazard scores were assigned a category of ‘Low’; ‘Medium-Low’; ‘Medium’; ‘Medium-High’; or ‘High’. Based on this methodology, Flood, Wind, Tornado, Winter Weather and Drought hazards were ranked as ‘High’ for Loudoun County. See Table 7.17 for a summary of hazard rankings.

Table 7.4: Hazard Ranking for Loudoun County

Hazard	Flood	Wind	Tornado	Winter Weather	Drought	Earthquake	Landslide	Wildfire	Karst
Ranking	High	High	High	High	High	Med	Med-High	Med-Low	Med-Low

A. Loudoun County Mitigation Actions and Action Plan

#	Agency/Department: Mitigation Action	Lead Agency Department Organization	Flood	Winter Storm	Wind \ Severe Storm	Tornado	Drought	Wildfire	Earthquake	Extreme Temps	Dam Failure	Landslides	Karst \ Sinkholes	Funding Source	Target Completion Date	Interim Measure of Success	Priority	Comments
2006-8	Maintain high quality aerial photography of the County.	Office of Mapping/Office of Emergency Management	X	X	X	X	X	X	X	X	X	X	X	Department of Homeland Security grants, UASI funding, county funding	Ongoing	Continue to work with our local officials in stressing the importance of this initiative and identify funding to maintain the current capabilities.	Low (Currently being done, but need to ensure it continues to be funded).	
2010-1	Meet with VDOT and develop a plan for adding flooding signage and gates for known trouble spots	Office of Emergency Management/Loudoun County Sheriff's Office	X		X									Internal county funding, Federal Highway Administration grants Tiger Grants	Ongoing	Within ninety days of endorsement of the plan have our kick-off meeting – within six months of our kick-off meeting have identified and vetted locations for action. Remaining period of time to identify funding sources and complete installation.	High	Since 2010, we have met with VDOT and increased signage capability available for deployment notifying the public of road closed due to "high water". We have initiated conversation with VDOT regarding the installation of gates, but those conversations are in the infancy stage.
2010-2	Evaluate Repetitive Loss and Severe Repetitive Loss properties within the County. Support	Office of Emergency Management	X		X									FEMA Unified Hazard Mitigation Assistance Grants	Ongoing	Property owner interest and application to participate in	High	Since 2010 Loudoun County has participated in the Risk Map program and have

#	Agency/Department: Mitigation Action	Lead Agency Department Organization	Flood	Winter Storm	Wind \ Severe Storm	Tornado	Drought	Wildfire	Earthquake	Extreme Temps	Dam Failure	Landslides	Karst \ Sinkholes	Funding Source	Target Completion Date	Interim Measure of Success	Priority	Comments
	mitigation of priority flood-prone structures through promotion of acquisition/ demolition, elevation, flood proofing, minor localized flood control projects, mitigation reconstruction and where feasible using FEMA HMA programs where appropriate.													Hazard Mitigation Grant Program Repetitive Flood Claims Severe Repetitive Loss		FEMA grant program		preliminary discussed these options in a variety of settings. Given the results of the Risk Map project, we will need to develop and implement strategies that continue the discussions and look at ways to minimize risk.
2010-3	Review locality's compliance with the National Flood Insurance Program with an annual review of the Floodplain Ordinances and any newly permitted activities in the 100-year floodplain. Additionally, Conduct annual review of repetitive loss and severe repetitive loss property list requested of VDEM to ensure accuracy. Review will include verification of the geographic location of each repetitive loss property and determination if that	Office of Emergency Management	X		X									FEMA Unified Hazard Mitigation Assistance Grants Hazard Mitigation Grant Program Repetitive Flood Claims Severe Repetitive Loss	Ongoing	Property owner interest and application to participate in FEMA grant program	High	This is part of the Risk Map project, which will yield additional requirements associated with this mitigation action.

#	Agency/Department: Mitigation Action	Lead Agency Department Organization	Flood	Winter Storm	Wind \ Severe Storm	Tornado	Drought	Wildfire	Earthquake	Extreme Temps	Dam Failure	Landslides	Karst \ Sinkholes	Funding Source	Target Completion Date	Interim Measure of Success	Priority	Comments
	property has been mitigated and by what means. Provide corrections if needed by filing form FEMA AW-501.																	
2010-4	Collaboration with VDOT, transportation officials and law enforcement to develop a strategy for installation of permanent variable message boards for public messaging and traffic cameras for maintaining situational awareness.	Office of Emergency Management/Loudoun County Sheriff's Office	X	X	X	X								Internal county funding, Federal Highway Administration grants Tiger Grants	Ongoing	Within ninety days of endorsement of the plan have our kick-off meeting – within six months of our kick-off meeting have identified and vetted locations for action. Remaining period of time to identify funding sources and complete installation.	Medium	Through a partnership with VDOT, we have deployed mobile variable message boards to several strategic locations to enhance the ability of public messaging. VDOT has increased the number of traffic cameras throughout the eastern portion of the County, which allows for collecting situational awareness. We are presently working through the County Attorney's Office regarding an agreement with VDOT through

#	Agency/Department: Mitigation Action	Lead Agency Department Organization	Flood	Winter Storm	Wind \ Severe Storm	Tornado	Drought	Wildfire	Earthquake	Extreme Temps	Dam Failure	Landslides	Karst \ Sinkholes	Funding Source	Target Completion Date	Interim Measure of Success	Priority	Comments
																		the Secure Partner's initiative.
2010-5	Research possible vulnerable population registration systems to better identify and serve at risk citizens	Office of Emergency Management	X	X	X	X	X	X	X	X	X	X	X	Department of Homeland Security grants, UASI funding, county funding	Ongoing	Continue ongoing work in this area. Within one year of endorsement of the plan be able to identify possible solutions and spend the remaining period of time working to identify funding sources to complete the project.	Medium	Loudoun County implemented the County of Loudoun Evacuation Assistance Registry, which allows for the identification of those individuals at risk and needing assistance during an evacuation.

#	Agency/Department: Mitigation Action	Lead Agency Department Organization	Flood	Winter Storm	Wind \ Severe Storm	Tornado	Drought	Wildfire	Earthquake	Extreme Temps	Dam Failure	Landslides	Karst \ Sinkholes	Funding Source	Target Completion Date	Interim Measure of Success	Priority	Comments
2010-6	Determine feasibility of developing a drought preparedness and response plan	Office of Emergency Management					X							Department of Homeland Security grants, UASI funding, Internal county funding	December 2018	Research and identify applicable funding mechanisms to develop the plan.	Medium	This initiative has not commenced as of yet and will be continued in the next planning cycle.
2017-1	Continue working with VDOT regarding the development and implementation of gates to prevent drivers from crossing known flood prone roadways.	Office of Emergency Management	X		X									Department of Homeland Security grants, TIGER grants, Transportation Grants, Commonwealth of Virginia	2018	Upon approval of the plan we will convene representatives to discuss current progress and to further develop the project concept.	High	
2017-2	Evaluate Repetitive Loss and Severe Repetitive Loss properties within the County. Support mitigation of priority flood-prone structures through promotion of acquisition/ demolition, elevation, flood proofing, minor localized flood control projects, mitigation reconstruction and	Office of Emergency Management	X		X									FEMA Unified Hazard Mitigation Assistance Grants Hazard Mitigation Grant Program Repetitive Flood Claims Severe Repetitive Loss	Ongoing	Further timeframe will be identified as Loudoun County continues our participation in the Risk Map process.	High	

#	Agency/Department: Mitigation Action	Lead Agency Department Organization	Flood	Winter Storm	Wind \ Severe Storm	Tornado	Drought	Wildfire	Earthquake	Extreme Temps	Dam Failure	Landslides	Karst \ Sinkholes	Funding Source	Target Completion Date	Interim Measure of Success	Priority	Comments
	where feasible using FEMA HMA programs where appropriate.																	
2017-3	Review locality's compliance with the National Flood Insurance Program with an annual review of the Floodplain Ordinances and any newly permitted activities in the 100-year floodplain. Additionally, Conduct annual review of repetitive loss and severe repetitive loss property list requested of VDEM to ensure accuracy. Review will include verification of the geographic location of each repetitive loss property and determination if that property has been mitigated and by what means. Provide	Office of Emergency Management	X		X									FEMA Unified Hazard Mitigation Assistance Grants Hazard Mitigation Grant Program Repetitive Flood Claims Severe Repetitive Loss	Ongoing	Further timeframe will be identified as Loudoun County continues our participation in the Risk Map process.	High	

#	Agency/Department: Mitigation Action	Lead Agency Department Organization	Flood	Winter Storm	Wind \ Severe Storm	Tornado	Drought	Wildfire	Earthquake	Extreme Temps	Dam Failure	Landslides	Karst \ Sinkholes	Funding Source	Target Completion Date	Interim Measure of Success	Priority	Comments
	corrections if needed by filing form FEMA AW-501.																	
2017-4	Collaboration with VDOT and transportation officials to continue expanding the traffic cameras to maintain the ability for situational awareness.	Office of Emergency Management	X	X	X	X								Internal county funding, Federal Highway Administration grants Tiger Grants	2020	Upon approval of the plan convene a meeting of stakeholders to determine current status and to develop the project scope.	Medium	
2017-5	Determine feasibility of developing a drought preparedness and response plan	Office of Emergency Management					X							Department of Homeland Security grants, UASI funding, Internal county funding	2020	Research and identify applicable funding mechanisms to develop the plan.	Medium	

[1] NCDC's Storm Event database is available at http://www4.ncdc.noaa.gov/cgi-win/wwcgi.dll?wwEvent~Storms.

V. Prince William County

Prince William County was formed in 1730, and was named by the Virginia General Assembly to honor the son of King George II. The county seat is the City of Manassas. Prince William County has a total area of 338 square miles, of which 11 square miles are water. It has a population density of 819 persons per square mile. In 2009, the population was estimated at 386,934, approximately a 38% increase over the 2000 census. It was the fourth fastest growing county in the United States during that period. Based on the 2005-2009 American Community Survey, the county population was comprised of 60.9% white, 19.4% black or African American, 0.5% Native American, 0.1% Pacific Islander, 6.9% Asian, 9.2% from other races, and 3.1% bi-racial. Hispanics or Latinos of any race were 18.5% of the total population.

Prince William County has a moderate climate. The average annual temperature is approximately 58 degrees. Temperatures generally range from lows in the mid-20s in January to highs in the upper-80s and lower-90s during the month of July. Annual precipitation averages are approximately 38 inches of rain and 16 inches of snow fall in any given year. The wettest month on average is May. Recent history proves that weather events well outside of these averages can and do occur. Climate change is expected to continue the trend of the past 40 to 50 years of an increased frequency of extreme weather events.

Prince William County has grown more than 200% over a 20-year period. This is because of its central location to the Washington, DC, metropolitan area. Population growth rate poses another risk; as open land is developed flood management must be addressed with the increasing amounts of impervious surfaces. Flood risk is also due to low lying areas surrounding the Potomac River. Other natural hazards and risks are storm damage and winter weather. Winter storms pose significant threats, as evidenced during the 2009 – 2010 winter season.

To a large extent, historical records are used to identify the level of risk within the Northern Virginia region, including Prince William County, with the assumption that the data sources cited are reliable and accurate. Unless otherwise cited, data on historical weather-related events is based on information made available through the Storm Event Database by NOAA's NCDC[1]. Hazards were ranked using a semi-quantitative scoring system that involved grouping the data values (normalized to account for inflation) based on statistical methods. This method prioritizes hazard risk based on a blend of quantitative factors extracted from NCDC and other available data sources. The parameters considered include:

- Historical occurrence;
- Vulnerability of population in the hazard area; and
- Historical impact, in terms of human lives and property and crop damage.

The hazard scores were assigned a category of 'Low'; 'Medium-Low'; 'Medium'; 'Medium-High'; or 'High'. Based on this methodology, Flood, Wind, Tornado, and Winter Weather hazards were ranked as 'High' for Prince William County. See Table 7.22 for a summary of hazard rankings.

Table 7.5: Hazard Ranking for Prince William County								
Flood	**Wind**	**Tornado**	**Winter Weather**	**Drought**	**Earthquake**	**Landslide**	**Wildfire**	**Karst**
High	High	High	High	High	Med	Med-Low	Med	Med-Low

A. Prince William County Mitigation Actions and Action Plan

#	Agency/Department: Mitigation Action	Lead Agency Dept. Organization	Flood	Winter Storm	Wind \ Severe Storm	Tornado	Drought	Wildfire	Earthquake	Extreme Temps	Dam Failure	Landslides	**Karst \ Sinkholes**	Funding Source	Target Completion Date	Interim Measure of Success	Priority	Comments
2006-07	Promote structural mitigation to assure redundancy of critical facilities, to include but not limited to roof structure improvement, to meet or exceed building code standards, upgrade of electrical panels to accept generators, etc.	Department of Development Services, Department of Fire and Rescue, Department of Public Works	X	X	X	X			X					FEMA Unified Hazard Mitigation Assistance funding	Ongoing	Continue adhere to building code and flood plain ordinance.	Medium	No
2010-03	Provide outreach and educate to those citizens who are at risk of flooding.	Office Emergency Management, Department of Public Works and or Virginia Cooperative Extension	X		X									FEMA Unified Hazard Mitigation Assistance Grants Hazard Mitigation Grant Program – 5% initiative funds	Ongoing	NA	High	No
2010-05	Review and update Emergency Action Plans (EAP) for Dams owned by the County and work with private dam owners on inspections, maps, and updates.	Department of Public Works, Office of Emergency Management	X		X						X			Hazard Mitigation Grant Program – 5% initiative funds Virginia Floodplain Management Fund (administered by DCR Division of Dam Safety and Floodplain Management), County Funding	Ongoing	Continue to evaluate as required.	High	Lake Jackson and Silver Lake Dams have been rehabilitated and meet all currents standards. Non-County owned dam EAP are reviewed when received from the dam owner and recommendations are made to the owner of the dam.
2010-07	Evaluate parent notification processes at schools to include	Prince William County	X	X	X	X	X	X	X	X	X	X	X	No cost – internal County School staff	Ongoing	Continue to increase language	Medium	Numerous methods of commutations with parents and guardians.

#	Agency/Department: Mitigation Action	Lead Agency Dept. Organization	Flood	Winter Storm	Wind \ Severe Storm	Tornado	Drought	Wildfire	Earthquake	Extreme Temps	Dam Failure	Landslides	**Karst \ Sinkholes**	Funding Source	Target Completion Date	Interim Measure of Success	Priority	Comments
	language evaluation.	Schools												support		evaluation capability		Will continue to evaluate and address language evaluation.
2010-09	Development of a storm water inventory framework/monitoring system.	Department of Public Works	X		X						X			PWC storm water management fee funds this ongoing initiative.	Ongoing	Update and maintain inventory database.	Medium	Utilize current manual system to provide flood checks before major storm events as well as annual inspection of County maintained facilities.
2010-13	Review locality’s compliance with the National Flood Insurance Program to include, an annual review of the Floodplain Ordinances and any newly permitted activities in the 100-year floodplain. Additionally, conduct annual review of repetitive loss and severe repetitive loss property list requested from VDEM to ensure accuracy and conduct outreach as appropriate. Review will include verification of the geographic location of each repetitive loss property and determination if that property has been mitigated and by what means. Provide corrections if needed by	Department of Public Works, Office of Emergency Management	X		X									Hazard Mitigation Grant Program, County floodplain management program,	Ongoing	Annual review	Medium	No

#	Agency/Department: Mitigation Action	Lead Agency Dept. Organization	Flood	Winter Storm	Wind \ Severe Storm	Tornado	Drought	Wildfire	Earthquake	Extreme Temps	Dam Failure	Landslides	**Karst \ Sinkholes**	Funding Source	Target Completion Date	Interim Measure of Success	Priority	Comments
	filing form FEMA AW-501.																	
2010-14	Review and update County Debris Management Plan as required.	Department of Public Works	X	X	X	X					X			Internal staff; PWC Contracted services	Ongoing	Annual training and exercise on debris Management Plan	Low	Update sent to FEMA for formal review and approval by December 2016.
2017-01	Develop, test and exercise County Continuity of Operations Plan and Agency Continuity of Operations (COOP) Plans	Office of Emergency Management	X	X	X	X	X	X	X	X	X	X	X	PWC funding	Ongoing	Annual review of County and agency COOP Plans, and completion of annual Training and Exercise Matrix	High	N/A
2017-02	Create a Disaster Recovery program for information technology systems.	Department of Information Technology	X	X	X	X	X	X	X	X	X	X	X	County funding	Ongoing	Conduct annual contingency test on mission critical systems.	Medium	N/A
2017-03	Prince William County Flood Mitigation Assistance Pilot Grant Program to acquire Severe Repetitive Loss properties and create green space	Office of Emergency Management	X											Flood Mitigation Assistance (FMA) Grant	Grant Period of Performance ends October 2018	FEMA Grant awarded May 26, 2016	Medium	Pending evaluation of pilot program and homeowner participation.

#	Agency/Department: Mitigation Action	Lead Agency Dept. Organization	Flood	Winter Storm	Wind \ Severe Storm	Tornado	Drought	Wildfire	Earthquake	Extreme Temps	Dam Failure	Landslides	**Karst \ Sinkholes**	Funding Source	Target Completion Date	Interim Measure of Success	Priority	Comments
2017-04	Support mitigation of priority flood-prone structures through promotion of acquisition/ demolition, elevation, flood proofing, minor localized flood control projects, mitigation reconstruction and where feasible using FEMA HMA programs where appropriate.	Department of Public Works	X		X									FEMA Unified Hazard Mitigation Assistance funding,	Ongoing	Identify all priority flood-prone structures by December 2019	Medium	Action carried over from previous plan; still relevant and necessary

[1] NCDC's Storm Event database is available at http://www4.ncdc.noaa.gov/cgi-win/wwcgi.dll?wwEvent~Storms.

VI. City of Fairfax

The area encompassing the City of Fairfax was originally settled in the early 18th century by farmers originating from the Virginia Tidewater area. Fairfax was incorporated as a town in 1805 and as an independent city in 1961. The city is home to George Mason University. Its population was 22,542 as estimated by the Census Bureau in 2010 and 24,013 of 2015. Based on the 2010-2014 American Community Survey, the city population was comprised of 73.1% white, 5.4% black or African American, 0.7% Native American, 0.1% Pacific Islander, 17.2% Asian, 4.3% from other races. Hispanics or Latinos of any race were 16.8% of the total population.

The City of Fairfax has a moderate climate. Temperatures generally range from lows in the mid-20s in January to highs in the upper-80s and lower-90s during the month of July. Annual precipitation averages are approximately 40 inches of rain and 15 or more inches of snow fall in any given year. Recent history proves that weather events well outside of these averages can and do occur. Climate change is expected to continue the trend of the past 40 to 50 years of an increased frequency of extreme weather events.

The city's location on the eastern edge of the Virginia piedmont make it susceptible to other natural hazards and risks, such as storm damage and winter weather, as evidenced during the recent winter season.

To a large extent, historical records are used to identify the level of risk within the Northern Virginia region, including the City of Fairfax, with the assumption that the data sources cited are reliable and accurate. Unless otherwise cited, data on historical weather-related events is based on information made available through the Storm Event Database by NOAA's NCDC[1]. Hazards were ranked using a semi-quantitative scoring system that involved grouping the data values (normalized to account for inflation) based on statistical methods. This method prioritizes hazard risk based on a blend of quantitative factors extracted from NCDC and other available data sources. The parameters considered include:

- Historical occurrence;
- Vulnerability of population in the hazard area; and
- Historical impact, in terms of human lives and property and crop damage.

The hazard scores were assigned a category of 'Low'; 'Medium-Low'; 'Medium'; 'Medium-High'; or 'High'. Based on this methodology, Wind, Tornado, and Winter Weather hazards were ranked as 'High' for Fairfax. See Table 7.29 for a summary of hazard rankings.

Table 7.6: Hazard Ranking for City of Fairfax

Hazard	Flood	Wind	Tornado	Winter Weather	Drought	Earthquake	Landslide	Wildfire	Karst
Ranking	High	High	High	High	Med-High	Med	Med-Low	Med	Med-Low

A. City of Fairfax Mitigation Actions and Action Plan

#	Agency/Department: Mitigation Action	Lead Agency Department Organization	Flood	Winter Storm	Wind \ Severe Storm	Tornado	Drought	Wildfire	Earthquake	Extreme Temps	Dam Failure	Landslides	Karst\ Sinkholes	Funding Source	Target Completion Date	Interim Measure of Success	Priority	Comments
2006-7	Consider becoming members of the Community Rating System.	Public Works	X		X									FEMA Unified Hazard Mitigation Assistance Grants	2019	Secure funding by January 2018.	High	Action carried over from previous plan; still relevant and necessary
2010-1	Secure funding and conduct a safety analysis of the tank farm within the City. Consider hardening the facility.	Fire Department												UASI funding, FEMA Unified Hazard Mitigation Assistance Grants Hazard Mitigation Grant Program	January 2019	Secure funding by July 2018.	High	Action carried over from previous plan; still relevant and necessary
2010-5	Identify and secure funding to conduct a generator cost estimate for city shelters.	Office of Emergency Management	X	X	X	X	X	X	X	X	X	X	X	FEMA Unified Hazard Mitigation Assistance Grants	December 2018	Secure funding as available by HMPG.	Medium	Action carried over from previous plan; still relevant and necessary; some progress has been accomplished since previous, but work remains to be done.
2010-6	Consider posting permanent evacuation signs on City-operated evacuation routes.	Office of Emergency Management	X	X	X	X		X	X		X			FEMA Unified Hazard Mitigation Assistance Grants	June 2018	Identify where, and how many, signs will be needed by January 2018.	Medium	Action carried over from previous plan; still relevant and necessary
2010-10	Conduct annual outreach to each FEMA-listed repetitive loss and severe repetitive loss property	Office of Emergency Management	X		X									FEMA Unified Hazard Mitigation Assistance	Ongoing	Develop outreach materials, or identify appropriate	Medium	Action carried over from previous plan; still relevant and necessary

#	Agency/Department: Mitigation Action	Lead Agency Department Organization	Flood	Winter Storm	Wind \ Severe Storm	Tornado	Drought	Wildfire	Earthquake	Extreme Temps	Dam Failure	Landslides	Karst\ Sinkholes	Funding Source	Target Completion Date	Interim Measure of Success	Priority	Comments
	owner, providing information on mitigation programs (grant assistance, mitigation measures, flood insurance information) that can assist them in reducing their flood risk.													funding,		outreach materials for dissemination by June 2018		
2010-11	Support mitigation of priority flood-prone structures through promotion of acquisition/ demolition, elevation, flood proofing, minor localized flood control projects, mitigation reconstruction and where feasible using FEMA HMA programs where appropriate.	Public Works	X		X									FEMA Unified Hazard Mitigation Assistance funding,	Ongoing	Identify all priority flood-prone structures by December 2019	Medium	Action carried over from previous plan; still relevant and necessary
2010-12	Promote structural mitigation to assure redundancy of critical facilities, to include but not limited to roof structure improvement, to meet or exceed building code standards, upgrade of electrical panels to accept generators, etc.	Office of Emergency Management	X		X									FEMA Unified Hazard Mitigation Assistance funding,	Ongoing	Query local government building services staffs as to effectiveness of provided information regarding the structural review.	Medium	Action carried over from previous plan; still relevant and necessary

#	Agency/Department: Mitigation Action	Lead Agency Department Organization	Flood	Winter Storm	Wind \ Severe Storm	Tornado	Drought	Wildfire	Earthquake	Extreme Temps	Dam Failure	Landslides	Karst\ Sinkholes	Funding Source	Target Completion Date	Interim Measure of Success	Priority	Comments
2010-13	Review locality's compliance with the National Flood Insurance Program with an annual review of the Floodplain Ordinances and any newly permitted activities in the 100-year floodplain. Additionally, Conduct annual review of repetitive loss and severe repetitive loss property list requested of VDEM to ensure accuracy. Review will include verification of the geographic location of each repetitive loss property and determination if that property has been mitigated and by what means. Provide corrections if needed by filing form FEMA AW-501.	Public Works	X		X									City funding.	Ongoing	Establish a schedule of review and review committee (if necessary) by June 2019	Medium	Action carried over from previous plan; still relevant and necessary
2017-1	Increase departmental awareness regarding funding opportunities for mitigation.	Office of Emergency Management	X	X	X	X	X	X	X	X	X	X	X	City Funding	Ongoing	Conduct yearly outreach to interested parties related to FEMA hazard mitigation grant programs.	Low	

#	Agency/Department: Mitigation Action	Lead Agency Department Organization	Flood	Winter Storm	Wind \ Severe Storm	Tornado	Drought	Wildfire	Earthquake	Extreme Temps	Dam Failure	Landslides	Karst\ Sinkholes	Funding Source	Target Completion Date	Interim Measure of Success	Priority	Comments
2017-2	Conduct a building assessment and analysis to identify vulnerability to extreme heat.	Public Works								X				City Funding	September 2019	Prioritize City building for assessment completing one every 3 month	Low	
2017-3	Develop repository for storage and access of hazard, risk and vulnerability data for all City assets.	Office of Emergency Management/ Information Technology	X	X	X	X	X	X	X	X	X	X	X	City Funding	2018	Implement a repository for needed access by City employees	Low	
2017-4	Prioritize critical facilities and complete site surveys to identify vulnerabilities.	Office of Emergency Management / Public Works	X	X	X	X	X	X	X	X	X	X	X	City Funding	Ongoing	Implement a strategy to help identify critical facilities	Medium	
2017-5	Provide grants information, planning tools, training and technical assistance to increase the number of hazard mitigation projects.	Office of Emergency Management	X	X	X	X	X	X	X	X	X	X	X	City Funding	Ongoing	Continue support of hazard mitigation planning, project identification and implementation	Medium	
2017-6	Provide for user-friendly hazard-data accessibility for mitigation and other planning efforts and for private citizens	Information Technology	X	X	X	X	X	X	X	X	X	X	X	City Funding	September 2019	Develop a simple GIS platform, or build upon an existing platform, to maintain and analyze critical facilities inventories and information about hazards.	Low	

#	Agency/Department: Mitigation Action	Lead Agency Department Organization	Flood	Winter Storm	Wind \ Severe Storm	Tornado	Drought	Wildfire	Earthquake	Extreme Temps	Dam Failure	Landslides	Karst\ Sinkholes	Funding Source	Target Completion Date	Interim Measure of Success	Priority	Comments
2017-7	Implement mitigation projects and programs intended to reduce risk to critical facilities and critical infrastructure	Public Works	X	X	X	X	X	X	X	X	X	X	X	Hazard Mitigation Grants	Ongoing	Monitor the need for mitigation projects	High	
2017-8	Integrate hazard mitigation and notification system training into existing employee training.	Personnel / Information Technology	X	X	X	X	X	X	X	X	X	X	X	City Funding	Ongoing	Add program to new employee orientation	Medium	
2017-9	Prioritize servers to ensure that critical data remains available during and after hazard events	Information Technology	X	X	X	X	X	X	X	X	X	X	X	City Funding	October 2017	.Identify all City owned servers by 2017	Medium	
2017-10	Determine necessary equipment / hardening to maintain administrative services during and after a hazard event.	Information Technology	X	X	X	X	X	X	X	X	X	X	X	City Funding/ HMGP	January 2018	Develop a list of services needed to be maintained	Medium	
2017-11	Ensure that all critical facilities have generators and fuel storage location, or quick connects for temporary generator use.	Public Works	X	X	X	X	X	X	X	X	X	X	X	City Funding / HMGP	2019	Identify all City owned facilities with and without generators	High	

[1] NCDC's Storm Event database is available at http://www4.ncdc.noaa.gov/cgi-win/wwcgi.dll?wwEvent~Storms.

VII. City of Falls Church

The area now known as Falls Church was originally settled in the late 17th century by European colonists who shared the site with the local Native American population. The settlement was centered on the Anglican Falls Church, which was completed in 1734. In 1948, the township broke ties with Fairfax County to become an independent city. The population of the city was 12,332 as of the 2010 Census and was estimated by the Census Bureau to be 13,892 in 2015. Based on the 2010 Census survey, the city population was comprised of 79.9% white, 4.3% black or African American, 0.3% Native American, 9.4% Asian, 2.1% from other races, and 4% bi-racial. Hispanics or Latinos of any race was 9% of the total population. Falls Church has a significant Vietnamese-American commercial population.

Falls Church has a moderate climate. The average annual temperature is approximately 54 degrees. Temperatures generally range from lows in the mid-20s in January to highs in the upper-80s and lower-90s during the month of July. Annual precipitation averages are approximately 42 inches of rain and 19 inches of snow fall in any given year. Recent history proves that weather events well outside of these averages can and do occur. Climate change is expected to continue the trend of the past 40 to 50 years of an increased frequency of extreme weather events.

The City of Falls Church comprises about 2.2 square miles located approximately 10 miles west of Washington, DC. Falls Church's location in the Washington metropolitan area and its ease of access by car and public transportation have allowed increasingly-varied residential and commercial development. Falls Church is densely populated with more than 6,314 persons per square mile.

Falls Church experiences significant flood threats due to the presence of Four Mile Run and Tripps Run. The City's location on the eastern edge of the Virginia Piedmont make it susceptible to other natural hazards and risks, such as damage from severe storms and winter weather, as evidenced during the 2009 – 2010 winter and summer seasons. Falls Church has been declared a Federal disaster area six times since 1965 for hurricane, severe storm, and winter weather events.

To a large extent, historical records are used to identify the level of risk within the Northern Virginia region, including Falls Church, with the assumption that the data sources cited are reliable and accurate. Unless otherwise cited, data on historical weather-related events is based on information made available through the Storm Event Database by NOAA's NCDC[1]. Hazards were ranked using a semi-quantitative scoring system that involved grouping the data values (normalized to account for inflation) based on statistical methods. This method prioritizes hazard risk based on a blend of quantitative factors extracted from NCDC and other available data sources. The parameters considered include:

- Historical occurrence;
- Vulnerability of population in the hazard area; and
- Historical impact, in terms of human lives and property and crop damage.

The hazard scores were assigned a category of ‘Low’; ‘Medium-Low’; ‘Medium’; ‘Medium-High’; or ‘High’. Based on this methodology, Flood, Wind, and Winter Weather hazards were ranked as ‘High’ for City of Falls Church. See Table 7.33 for a summary of hazard rankings.

Table 7.7: Hazard Ranking for Falls Church

Hazard	Flood	Wind	Tornado	Winter Weather	Drought	Earthquake	Landslide	Wildfire	Karst
Ranking	High	High	High	High	Med-High	Med	Med-Low	Med-Low	Med-Low

A. City of Falls Church Mitigation Actions and Action Plan

#	Agency/Department: Mitigation Action	Lead Agency Department Organization	Flood	Winter Storm	Wind \ Severe Storm	Tornado	Hurricane	Drought	Wildfire	Earthquake	Extreme Temps	Dam Failure	Landslides	Karst\ Sinkholes	Funding Source	Target Complet-ion Date	Interim Measure of Success	Priority	Comments
2010-5	Conduct annual outreach to each FEMA-listed repetitive loss and severe repetitive loss property owner, providing information on mitigation programs (grant assistance, mitigation measures, and flood insurance information) that can assist them in reducing their flood risk.	Department of Public Works	X		X		X								FEMA Unified Hazard Mitigation Assistance funding for qualified structures.	Ongoing	Continue outreach program with educational materials.	Medium	The City has monitored the NFIP claims list and there are no repetitive loss properties in the City. We will continue to monitor for repetitive loss properties and conduct outreach if any become listed.
2010-6	Support mitigation of priority flood-prone structures through promotion of acquisition/ demolition, elevation, flood proofing, minor localized flood control projects, mitigation reconstruction and where feasible using FEMA HMA programs where appropriate.	Department of Public Works	X		X		X								FEMA Unified Hazard Mitigation Assistance funding for qualified structures.	Ongoing	Ongoing identification process.	Medium	The City has identified all flood prone structures and conduct annual outreach about flood safety to those properties. We have and continue to pursue local flood control projects
2010-7	Promote structural mitigation to assure redundancy of critical facilities, to include but not limited to roof structure	Development Services	X	X	X	X	X			X					FEMA Unified Hazard Mitigation Assistance funding for qualified	Modified	Query local government building services staffs as to effectiveness	Medium	Directed to the City Building Official.

#	Agency/Department: Mitigation Action	Lead Agency Department Organization	Flood	Winter Storm	Wind \ Severe Storm	Tornado	Hurricane	Drought	Wildfire	Earthquake	Extreme Temps	Dam Failure	Landslides	Karst\ Sinkholes	Funding Source	Target Complet-ion Date	Interim Measure of Success	Priority	Comments
	improvement, to meet or exceed building code standards, upgrade of electrical panels to accept generators, etc.														structures.		of provided information regarding the structural review.		
2010-8	Review locality's compliance with the National Flood Insurance Program with an annual review of the Floodplain Ordinances and any newly permitted activities in the 100-year floodplain. Additionally, Conduct annual review of repetitive loss and severe repetitive loss property list requested of VDEM to ensure accuracy. Review will include verification of the geographic location of each repetitive loss property and determination if that property has been mitigated and by what means. Provide corrections if needed by filing form FEMA AW-501.	Department of Public Works	X	X	X		X								Falls Church general funds	Ongoing	Establish a schedule of review and review committee (if necessary) by June 2011.	Medium	The City may rewrite the floodplain ordinance in the next 5-year term of the HMP to make it more clear. Review all floodplain development annually as part of our participation if FEMA's Community Rating System.

#	Agency/Department: Mitigation Action	Lead Agency Department Organization	Flood	Winter Storm	Wind \ Severe Storm	Tornado	Hurricane	Drought	Wildfire	Earthquake	Extreme Temps	Dam Failure	Landslides	Karst\ Sinkholes	Funding Source	Target Complet-ion Date	Interim Measure of Success	Priority	Comments
2017-1	All City Departments are responsible to ensure mitigation plans; policies and procedures are developed and executed to ensure continuity of operations by their respective Department.	Falls Church Office of Emergency Management	X	X	X	X	X			X					Falls Church General Funds	2017/2018	Drafting of Departmental COOP Plans.	Medium	New Beginning 2016

[1] NCDC's Storm Event database is available at http://www4.ncdc.noaa.gov/cgi-win/wwcgi.dll?wwEvent~Storms.

VIII. City of Manassas

The City of Manassas is an independent city in the Commonwealth of Virginia and covers an area 10 square miles. The jurisdiction grew from a crossroads after the Civil War, and was incorporated in 1873. The city was the staging ground for the First Battle of Manassas in 1861, also known as First Battle of Bull Run. Originally it was called Manassas Junction for its strategic railroad location leading to Richmond, Washington, DC, and the Shenandoah Valley. Modern history has seen increased development due to its proximity to Washington, DC. The population of the city was estimated by the Census Bureau to be 41,764 in 2015. Based on the 2010-2014 American Community Survey, the city population was comprised of 46.1% white, Hispanics or Latinos, of any race, represent 31.9%, 13.5% black or African American, 0.2% Native American, 5.3% Asian, 0.2% from other races, and 3.8% bi-racial.

Manassas has a moderate climate. Temperatures generally range from lows in the mid-20s in January to highs in the upper-80s and lower-90s during the month of July. Annual precipitation averages are approximately 38 inches of rain and 16 inches of snow fall in any given year. The wettest month on average is May. Recent history proves that weather events well outside of these averages can and do occur. Climate change is expected to continue the trend of the past 40 to 50 years of an increased frequency of extreme weather events.

Manassas is subject to high wind events, winter weather, and flooding. Winter storms pose significant threats, as evidenced during the 2015-2016 winter season. The city has instituted a winter weather preparation program.

To a large extent, historical records are used to identify the level of risk within the Northern Virginia region, including Manassas, with the assumption that the data sources cited are reliable and accurate. Unless otherwise cited, data on historical weather-related events is based on information made available through the Storm Event Database by NOAA's NCDC[1]. Hazards were ranked using a semi-quantitative scoring system that involved grouping the data values (normalized to account for inflation) based on statistical methods. This method prioritizes hazard risk based on a blend of quantitative factors extracted from NCDC and other available data sources. The parameters considered include:

- Historical occurrence;
- Vulnerability of population in the hazard area; and
- Historical impact, in terms of human lives and property and crop damage.

The hazard scores were assigned a category of 'Low'; 'Medium-Low'; 'Medium'; 'Medium-High'; or 'High'. Based on this methodology, Flood, Wind, Tornado, and Winter Weather hazards were ranked as 'High' for Manassas. See Table 7.37 for a summary of hazard rankings.

Table 7.8 Hazard Ranking for City of Manassas

Flood	Wind	Tornado	Winter Weather	Drought	Earthquake	Landslide	Wildfire	Karst
High	High	High	High	Med-High	Med	Med-Low	Med-Low	Med-Low

A. City of Manassas Mitigation Actions and Action Plan

#	Agency/Department: Mitigation Action	Lead Agency Department Organization	Flood	Winter Storm	Wind \ Severe Storm	Tornado	Drought	Wildfire	Earthquake	Extreme Temps	Dam Failure	Landslides	Karst \ Sinkholes	Funding Source	Target Compl-etion Date	Interim Measure of Success	Priority	Comments
2017-1	Evaluate Repetitive Loss and Severe Repetitive Loss properties within the City. Support mitigation of priority flood-prone structures through promotion of acquisition/ demolition, elevation, flood proofing, minor localized flood control projects, mitigation reconstruction and where feasible using FEMA HMA programs where appropriate.	Public Works Emergency Management	X	X	X						X			FEMA Unified Hazard Mitigation Assistance	Ongoing	Obtain funding	High	Ongoing.
2017-2	Train required City staff on NIMS/ICS	All agencies												EMPG	1/1/2020	Annual staff certifications	Low	This is being completed as new staff are hired.
2017-3	Expand communications and notification participation through public outreach	Emergency Management; CERT volunteers; Fire and Rescue Department – Safe Around Manassas Program (SAM)	X	X	X	X	X	X	X	X	X	X	X	Staff and volunteer resources; UASI grants; and private donations	1/1/2020	Complete outreach plan Prioritize outreach efforts Implement outreach to priority stakeholder/citizen groups Development of marketing materials	Medium	SAM Program is in process with limited resources.

#	Agency/Department: Mitigation Action	Lead Agency Department Organization	Flood	Winter Storm	Wind \ Severe Storm	Tornado	Drought	Wildfire	Earthquake	Extreme Temps	Dam Failure	Landslides	Karst \ Sinkholes	Funding Source	Target Compl-etion Date	Interim Measure of Success	Priority	Comments
2017-4	Educate citizens on use of Manassas Alert	Emergency Management; Citizen Corps or CERT volunteers	X	X	X	X	X	X	X	X	X	X	X	Staff and volunteer resources	1/1/2020	Prioritize stakeholder groups for Manassas Alert outreach effort	Medium	Ongoing
2017-5	Cross train staff across departments to support critical functions	Office of Emergency Management	X	X	X	X	X	X	X	X	X	X	X	City staff resources	Ongoing	Develop a plan for cross training staff	Medium	Ongoing as new staff are hired.
2017-6	Update flood inundation maps	Department of Public Works	X								X			FEMA Risk MAP City funds	1/1/2020	Develop a plan (including schedule) for updating maps	Low	In progress.
2017-7	Conduct annual outreach to each FEMA-listed repetitive loss and severe repetitive loss property owner, providing information on mitigation programs (grant assistance, mitigation measures, and flood insurance information) that can assist them in reducing their flood risk.	Department of Public Works	X		X									FEMA Unified Hazard Mitigation Assistance funding for qualified structures.	Ongoing	Develop outreach materials, or identify appropriate outreach materials for dissemination.	Medium	Ongoing
2017-8	Support mitigation of priority flood-prone structures through promotion of acquisition/ demolition, elevation, flood proofing, minor	Department of Public Works	X		X									FEMA Unified Hazard Mitigation Assistance funding for qualified	Ongoing	Identify all priority flood-prone structures.	Medium	Ongoing

#	Agency/Department: Mitigation Action	Lead Agency Department Organization	Flood	Winter Storm	Wind \ Severe Storm	Tornado	Drought	Wildfire	Earthquake	Extreme Temps	Dam Failure	Landslides	Karst \ Sinkholes	Funding Source	Target Compl-etion Date	Interim Measure of Success	Priority	Comments
	localized flood control projects, mitigation reconstruction and where feasible using FEMA HMA programs where appropriate.													structures.				
2017-9	Promote structural mitigation to assure redundancy of critical facilities, to include but not limited to roof structure improvement, to meet or exceed building code standards, upgrade of electrical panels to accept generators, etc.	Office of Emergency Management; Community Development Department	X		X									FEMA Unified Hazard Mitigation Assistance funding for qualified structures.	Ongoing	Query local government building services staffs as to effectiveness of provided information regarding the structural review.	Medium	Ongoing
2017-10	Review locality's compliance with the National Flood Insurance Program with an annual review of the Floodplain Ordinances and any newly permitted activities in the 100-year floodplain. Additionally, Conduct annual review of repetitive loss and severe repetitive loss property list requested of VDEM to ensure accuracy. Review will	Department of Public Works	X		X									City funds	Ongoing	Establish a schedule of review and review committee (if necessary).	Medium	Ongoing

#	Agency/Department: Mitigation Action	Lead Agency Department Organization	Flood	Winter Storm	Wind \ Severe Storm	Tornado	Drought	Wildfire	Earthquake	Extreme Temps	Dam Failure	Landslides	Karst \ Sinkholes	Funding Source	Target Compl-etion Date	Interim Measure of Success	Priority	Comments
	include verification of the geographic location of each repetitive loss property and determination if that property has been mitigated and by what means. Provide corrections if needed by filing form FEMA AW-501.																	
2017-11	Conduct preparedness presentations in the community to ensure public awareness of steps the public can take to care for themselves during an emergency.	Emergency Management; CERT; Fire and Rescue Department	x	x	x	x	x	x	x	x	x	x	x	LEMPG and UASI Citizen Corps (CERT) Grant	Ongoing	Complete outreach plan. Development of outreach materials.	Low	
2017-12	Increase generator capacity at schools that function as shelters.	Manassas City Public Schools	x	x	x	x			x					Unknown	2021	Identify funding source.	Medium	
2017-13	Increase snow removal capacity at shelter sites.	Manassas City Public Schools		x										City funds	2018	Identify tools and process to increase capacity.	Low	
2017-14	Maintain GIS planimetric data.	IT; GIS	x	x	x	x						x	x	City funds	2019	Create update schedule.	Low	

[1] NCDC's Storm Event database is available at http://www4.ncdc.noaa.gov/cgi-win/wwcgi.dll?wwEvent~Storms.

IX. City of Manassas Park

The City of Manassas Park was incorporated in 1957 and became an independent city in 1975. It was the last town in Virginia to become a city before a moratorium was placed on other towns achieving similar status. The population of the city was 15,726 as of the 2015 Census and was estimated by the Census Bureau to be 14,026 in 2009. Based on the 2015 United States Census Bureau information, the city population was comprised of 67.9% white, 13.0% black or African American, 0.3% Native American, 7.9% Asian, 10.5% from other races, and 7.9% bi-racial. Hispanics or Latinos, of any race, represents 34.0% of the total population.

The City of Manassas Park is seeing population growth with new residents focusing on the city center in new densely configured housing units. While traditional residents live in less dense areas in older dwellings.

The City of Manassas Park has a moderate climate. Temperatures generally range from lows in the mid-20s in January to highs in the upper-80s and lower-90s during the month of July. Annual precipitation averages are approximately 38 inches of rain and 16 inches of snow fall in any given year. The wettest month on average is May. Recent history proves that weather events well outside of these averages can and do occur. Climate change is expected to continue the trend of the past 40 to 50 years of an increased frequency of extreme weather events.

The City of Manassas Park is subject to high wind events and extreme winter weather. Winter storms pose significant threats, as evidenced during the 2009 – 2010 winter season.

To a large extent, historical records are used to identify the level of risk within the Northern Virginia region, including Manassas Park, with the assumption that the data sources cited are reliable and accurate. Unless otherwise cited, data on historical weather-related events is based on information made available through the Storm Event Database by NOAA's NCDC[1]. Hazards were ranked using a semi-quantitative scoring system that involved grouping the data values (normalized to account for inflation) based on statistical methods. This method prioritizes hazard risk based on a blend of quantitative factors extracted from NCDC and other available data sources. The parameters considered include:

- Historical occurrence;
- Vulnerability of population in the hazard area; and
- Historical impact, in terms of human lives and property and crop damage.

The hazard scores were assigned a category of 'Low'; 'Medium-Low'; 'Medium'; 'Medium-High'; or 'High'. Based on this methodology, Flood, Wind, and Winter Weather hazards were ranked as 'High' for Manassas Park. See Table 7.41 for a summary of hazard rankings.

Table 7.9: Hazard Ranking for Manassas Park									
Hazard	**Flood**	**Wind**	**Tornado**	**Winter Weather**	**Drought**	**Earthquake**	**Landslide**	**Wildfire**	**Karst**
Ranking	High	Med-High	Med-High	High	Low	Med-Low	Low	Med-Low	Low

A. City of Manassas Park Mitigation Actions and Action Plan

#	Agency/Department: Mitigation Action	Lead Agency Department Organization	Flood	Winter Storm	Wind \ Severe Storm	Tornado	Drought	Wildfire	Earthquake	Extreme Temps	Dam Failure	Landslides	Karst \ Sinkholes	Funding Source	Target Completion Date	Interim Measure of Success	Priority	Comments
2017-1	Distribute hazard education information using different media's to include social media and webpages.	Office of Emergency Management	X	X	X	X	X	X	X	X	X	X	X	Internal funding	June 2018	Develop distribution schedule and identify which utility mailing to include the fliers in by May 2011.	Medium	No
2017-2	Consider executing a public outreach campaign in the City's schools to educate staff about all hazards.	Office of Emergency Management	X	X	X	X	X	X	X	X	X	X	X	No cost – internal staff support	January 2018	Develop agreement with Manassas Park Public Schools to distribute educational fliers by January 2012.	High	No
2017-3	Display and distribute educational hazard and emergency brochures at local events where information displays exist (i.e. National Night Out, Fire Prevention week and Preparedness Month).	Office of Emergency Management, Law Enforcement	X	X	X	X	X	X	X	X	X	X	X	Internal funding	June 2018	Ensure sufficient quantity of brochures for dissemination.	Medium	No
2017-4	Continue to update the City's stormwater management plan.	Department of Public Works	X	X	X									Internal funding, Possible Water Quality Improvement Act funds, revolving loan funds,	Ongoing	Review by July 2018.	High	No

#	Agency/Department: Mitigation Action	Lead Agency Department Organization	Flood	Winter Storm	Wind \ Severe Storm	Tornado	Drought	Wildfire	Earthquake	Extreme Temps	Dam Failure	Landslides	Karst \ Sinkholes	Funding Source	Target Completion Date	Interim Measure of Success	Priority	Comments
														Section 319 NPS grants from DCR.				
2010-5	Exercise the Everbridge and next Gen 911 systems City-wide.	Office of Emergency Management	X	X	X	X	X	X	X	X	X	X	X	UASI funding	Ongoing	Secure funding by grant funds annually.	Medium	No
2010-6	Conduct annual outreach to each FEMA-listed repetitive loss and severe repetitive loss property owner, providing information on mitigation programs (grant assistance, mitigation measures, and flood insurance information) that can assist them in reducing their flood risk.	Office of Emergency Management	X		X									FEMA Unified Hazard Mitigation Assistance funding,	Ongoing	Develop outreach materials, or identify appropriate outreach materials for dissemination ongoing.	Medium	No
2010-7	Support mitigation of priority flood-prone structures through promotion of acquisition/ demolition, elevation, flood proofing, minor localized flood control projects, mitigation reconstruction and where feasible using FEMA HMA	Office of Emergency Management	X		X									FEMA Unified Hazard Mitigation Assistance funding,	Ongoing	Identify all priority flood-prone structures.	Medium	No

#	Agency/Department: Mitigation Action	Lead Agency Department Organization	Flood	Winter Storm	Wind \ Severe Storm	Tornado	Drought	Wildfire	Earthquake	Extreme Temps	Dam Failure	Landslides	Karst \ Sinkholes	Funding Source	Target Completion Date	Interim Measure of Success	Priority	Comments
	programs where appropriate.																	
2010-7	Promote structural mitigation to assure redundancy of critical facilities, to include but not limited to roof structure improvement, to meet or exceed building code standards, upgrade of electrical panels to accept generators, etc.	Office of Emergency Management	X		X									FEMA Unified Hazard Mitigation Assistance funding,	Ongoing	Query local government building services staffs as to effectiveness of provided information regarding the structural review.	Medium	No
2010-8	Review locality’s compliance with the National Flood Insurance Program with an annual review of the Floodplain Ordinances and any newly permitted activities in the 100-year floodplain. Additionally, Conduct annual review of repetitive loss and severe repetitive loss property list requested of VDEM to ensure accuracy. Review will include verification of the geographic location of each repetitive loss property and determination if that	Office of Emergency Management	7		X									Internal program support.	Ongoing	Establish a schedule of review and review committee.	Medium	No

#	Agency/Department: Mitigation Action	Lead Agency Department Organization	Flood	Winter Storm	Wind \ Severe Storm	Tornado	Drought	Wildfire	Earthquake	Extreme Temps	Dam Failure	Landslides	Karst \ Sinkholes	Funding Source	Target Completion Date	Interim Measure of Success	Priority	Comments
	property has been mitigated and by what means. Provide corrections if needed by filing form FEMA AW-501.																	

[1] NCDC's Storm Event database is available at http://www4.ncdc.noaa.gov/cgi-win/wwcgi.dll?wwEvent~Storms.

X. Town of Dumfries

Located in Prince William County, Dumfries was chartered on May 11, 1749, and is Virginia's oldest continuously chartered town. John Graham gave the land on which the town was founded and it is named after his birthplace, Dumfrieshire, Scotland. The population of the town was 4,937 as of the 2000 Census and was estimated by the Census Bureau to be 4,954 in 2009. Based on the 2005-2009 American Community Survey, the town population was comprised of 47.6% white, 31.4% black or African American, 0.7% Native American, 2.8% Asian, 12.9% from other races, and 4.6% bi-racial. Hispanics or Latinos, of any race, represent 27.4% of the total population.

Dumfries has a moderate climate. Temperatures generally range from lows in the mid-20s in January to highs in the upper-80s and lower-90s during the month of July. Annual precipitation averages are approximately 39 inches of rain and 16 or more inches of snow fall in any given year. Recent history proves that weather events well outside of these averages can and do occur. Climate change is expected to continue the trend of the past 40 to 50 years of an increased frequency of extreme weather events.

Dumfries is also subjected to tidal and storm surge flooding, due to the town's location below the Fall Line on Quantico Creek. As sea levels rise, permanent inundation of low lying areas along and near the river shoreline is also a concern. Dumfries is also susceptible to other natural hazards and risks, such as storm damage and winter weather, as evidenced during the 2009 – 2010 winter and summer seasons.

To a large extent, historical records are used to identify the level of risk within the Northern Virginia region, including Dumfries, with the assumption that the data sources cited are reliable and accurate. Unless otherwise cited, data on historical weather-related events is based on information made available through the Storm Event Database by NOAA's NCDC[1]. Hazards were ranked using a semi-quantitative scoring system that involved grouping the data values (normalized to account for inflation) based on statistical methods. This method prioritizes hazard risk based on a blend of quantitative factors extracted from NCDC and other available data sources. The parameters considered include:

- Historical occurrence;
- Vulnerability of population in the hazard area; and
- Historical impact, in terms of human lives and property and crop damage.

The hazard scores were assigned a category of 'Low'; 'Medium-Low'; 'Medium'; 'Medium-High'; or 'High'. Based on this methodology, Flood, Wind, Tornado, Winter Weather, and Drought hazards were ranked as 'High' for Dumfries. See Table 7.51 for a summary of hazard rankings.

Table 7.10: Hazard Ranking for Town of Dumfries									
Hazard	**Flood**	**Wind**	**Tornado**	**Winter Weather**	**Drought**	**Earthquake**	**Landslide**	**Wildfire**	**Karst**
Ranking	**High**	**High**	**High**	**High**	**High**	**Med**	**Med-Low**	**Med**	**Med-Low**

A. Town of Dumfries Mitigation Actions and Action Plan

#	Agency/Department: Mitigation Action	Lead Agency Department Organization	Flood	Winter Storm	Wind \ Severe Storm	Tornado	Drought	Wildfire	Earthquake	Extreme Temps	Dam Failure	Landslides	Karst\ Sinkholes	Funding Source	Target Comple-tion Date	Interim Measure of Success	Priority	Comments
2017-1	Police Radios	Police Department	X	X	X	X	X		X	X				General Fund	2019		Low	Improve communication with surrounding departments
2017-2	Public Safety Vehicle Replacement	Police Department	X	X	X	X	X		X	X				General Fund	2021	Purchase 1 vehicle in 2018	Low	Provide reliable transportation for police department
2017-3	Possum Point Drainage Improvement	Public Works	X											General Fund State/Federal Grants	2018	Initiate design 2016	Medium	In progress
2017-4	Dewey's Creek Stream Restoration	Public Works/Prince William County	X											US Fish and Wildlife Service Grant	2017	Design and permits are in place	Medium	
2017-5	Prince William Estates Drainage	Public Works	X											Stormwater Management Fees	2017		Medium	
2017-6	Orange Street Drainage	Public Works	X											VDOT Urban Maintenance/Stormwater Management Fees	2017	Design started	Medium	
2017-7	Quantico Creek Stream Restoration	Public Works	X											Stormwater Management Fees/Grants	2021		High	
2017-8	Tripoli Boulevard Stormwater Management	Public Works	X											General Fund	2019		Medium	

[1] NCDC's Storm Event database is available at http://www4.ncdc.noaa.gov/cgi-win/wwcgi.dll?wwEvent~Storms.

XI. Town of Haymarket

Located near Civil War Battlefields and on the "Journey Through Hallowed Ground," the Town of Haymarket is an important historical site as well as a growing destination for shoppers and history buffs. Chartered in 1799 by the Virginia General Assembly, the Town of Haymarket was incorporated in 1882. The population of the town was 1,782 as of the 2010 Census and was estimated by the Census Bureau to be 1,980 in 2015.

Since the 1900s it has been popular for fox hunting and steeple chasing and is also known for its wineries. The town covers 0.5 square miles of land and is located in Prince William County. Based on the 2010-2014 American Community Survey, the town population was comprised of 66.9% white, 8.5% Hispanics or Latinos of any race, 7.4% black or African American, 0.0% American Indian or Pacific Islander, 10.6% Asian, 0.1% from other races, and 6.5% bi-racial.

Haymarket has a moderate climate. Temperatures generally range from lows in the mid-20s in January to highs in the upper-80s and lower-90s during the month of July. Annual precipitation averages are approximately 38 inches of rain and 16 inches of snow fall in any given year. The wettest month on average is May. Recent history proves that weather events well outside of these averages can and do occur. Climate change is expected to continue the trend of the past 40 to 50 years of an increased frequency of extreme weather events.

Haymarket is subject to high wind events and extreme winter weather. Winter storms pose significant threats, as evidenced during the 2011-2015 winter seasons.

To a large extent, historical records are used to identify the level of risk within the Northern Virginia region, including Haymarket, with the assumption that the data sources cited are reliable and accurate. Unless otherwise cited, data on historical weather-related events is based on information made available through the Storm Event Database by NOAA's NCDC[1]. Hazards were ranked using a semi-quantitative scoring system that involved grouping the data values (normalized to account for inflation) based on statistical methods. This method prioritizes hazard risk based on a blend of quantitative factors extracted from NCDC and other available data sources. The parameters considered include:

- Historical occurrence;
- Vulnerability of population in the hazard area; and
- Historical impact, in terms of human lives and property and crop damage.

The hazard scores were assigned a category of 'Low'; 'Medium-Low'; 'Medium'; 'Medium-High'; or 'High'. Based on this methodology, Flood, Wind, Tornado, Winter Weather and Drought hazards were ranked as 'High' for the Town of Haymarket. See Table 7.56 for a summary of hazard rankings.

Table 7.11: Hazard Ranking for Town of Haymarket										
Hazard	Flood	Wind	Tornado	Winter Weather	Drought	Earthquake	Landslide	Wildfire	Karst	Extreme Temp
Ranking	Med	High	High	High	High	Med	Low	Med	Low	High

A. Town of Haymarket Mitigation Actions and Action Plan

#	Agency/Department: Mitigation Action	Lead Agency Department Organization	Flood	Winter Storm	Wind \ Severe Storm	Tornado	Drought	Wildfire	Earthquake	Extreme Temps	Dam Failure	Landslides	Karst \ Sinkholes	Funding Source	Target Compl-etion Date	Interim Measure of Success	Priority	Comments
2017-1	Assess the roadway structure at various intersections throughout the Town of Haymarket to avoid repeated flooding.	Town of Haymarket Police Department	X		X									Hazard Mitigation Assistance grant funding, County funding	December 2020	Identify funding sources by January 2017	High	No
2017-2	Continue to identify and employ a broad range of warning systems throughout the Town of Haymarket.	Town of Haymarket Police Department	X	X	X	X	X	X	X	X	X	X	X	UASI funding, DHS grants, town/county funding	December 2020	Identify one new warning system to utilize by December 2017.	High	No
2017-3	Conduct annual outreach to each FEMA-listed repetitive loss and severe repetitive loss property owner, providing information on mitigation programs (grant assistance, mitigation measures, and flood insurance information) that can assist them in reducing their flood risk.	Town of Haymarket Town Manager	X		X									FEMA Unified Hazard Mitigation Assistance funding for qualified structures.	Ongoing	Develop outreach materials, or identify appropriate outreach materials for dissemination by June 2018.	Medium	No
2017-4	Support mitigation of priority flood-prone structures through promotion of acquisition/ demolition, elevation, flood proofing, minor localized flood control projects, mitigation reconstruction and	Town of Haymarket Town Manager and Building Official	X		X									FEMA Unified Hazard Mitigation Assistance funding for qualified structures.	Ongoing	Identify all priority flood-prone structures by December 2016.	Medium	No

#	Agency/Department: Mitigation Action	Lead Agency Department Organization	Flood	Winter Storm	Wind \ Severe Storm	Tornado	Drought	Wildfire	Earthquake	Extreme Temps	Dam Failure	Landslides	Karst \ Sinkholes	Funding Source	Target Compl-etion Date	Interim Measure of Success	Priority	Comments
	where feasible using FEMA HMA programs where appropriate.																	
2017-5	Promote structural mitigation to assure redundancy of critical facilities, to include but not limited to roof structure improvement, to meet or exceed building code standards, upgrade of electrical panels to accept generators, etc.	Town of Haymarket Town Manager and Police Department	X		X									FEMA Unified Hazard Mitigation Assistance funding for qualified structures.	Ongoing	Query local government building services staffs as to effectiveness of provided information regarding the structural review.	Medium	No
2017-6	Review locality's compliance with the National Flood Insurance Program with an annual review of the Floodplain Ordinances and any newly permitted activities in the 100-year floodplain. Additionally, Conduct annual review of repetitive loss and severe repetitive loss property list requested of VDEM to ensure accuracy. Review will include verification of the geographic location of each repetitive loss property	Town of Haymarket Town Manager	X		X									General funds	Ongoing	Establish a schedule of review and review committee (if necessary) by June 2017.	Medium	No

#	Agency/Department: Mitigation Action	Lead Agency Department Organization	Flood	Winter Storm	Wind \ Severe Storm	Tornado	Drought	Wildfire	Earthquake	Extreme Temps	Dam Failure	Landslides	Karst \ Sinkholes	Funding Source	Target Compl-etion Date	Interim Measure of Success	Priority	Comments
	and determination if that property has been mitigated and by what means. Provide corrections if needed by filing form FEMA AW-501.																	
2017-7	Assess vacant buildings, determine historical significance, and develop a plan for restoring or demolishing the buildings vulnerable to hazards.	Town of Haymarket Town Manager and Building Official	X	X	X	X	X	X	X	X	X	X	X	FEMA Unified Hazard Mitigation Assistance funding for qualified structures.	Ongoing	Assess at least one vacant lot per year	Low	No
2017-8	Participate in the region-wide Commodity Flow Survey, particularly as it relates to hazardous material transportation on railways. Develop signage to warn motorists and pedestrians at railway crossings.	Town of Haymarket Police Department												UASI Funding	December 2020	Identify Funding by December 2017	Low	No
2017-9	Determine feasibility of developing a drought preparedness and response plan	Town of Haymarket Town Manager					X							UASI funding, DHS grants, town/county funding	December 2018	Research and identify applicable funding mechanisms to develop the plan.	Low	No

[1] NCDC's Storm Event database is available at http://www4.ncdc.noaa.gov/cgi-win/wwcgi.dll?wwEvent~Storms.

XII. Town of Herndon

The Town of Herndon was originally established as a railroad depot in the late 1850s and was officially incorporated as a town in 1879. The town's population is 24,554, based on 2014 U.S. Census estimates. In 2010, also based on U.S. Census data, the town's population was comprised of 36.2% white, 33.6% Hispanic, and 17.9% Asian and 9.2% black or African American. Herndon has a well-educated population, with 45.4 percent of residents 25 and older holding bachelor's degrees or higher.

The Town of Herndon has a moderate climate due to its location on the eastern edge of the Virginia piedmont. Temperatures generally range from lows in the mid-20s in January to highs in the upper-80s and lower-90s during the month of July. Annual precipitation averages are approximately 40 inches of rain and 15 or more inches of snow fall in any given year. Recent history proves that weather events well outside of these averages can and do occur, as evidenced during the 2012 Derecho event and Winter Storm Jonas in 2016. Climate change is expected to continue the trend of the past 40 to 50 years of an increased frequency of extreme weather events.

To a large extent, historical records are used to identify the level of risk within the Northern Virginia region, including Herndon, with the assumption that the data sources cited are reliable and accurate. Unless otherwise cited, data on historical weather-related events is based on information made available through the Storm Event Database by NOAA's NCDC[1]. Hazards were ranked using a semi-quantitative scoring system that involved grouping the data values (normalized to account for inflation) based on statistical methods. This method prioritizes hazard risk based on a blend of quantitative factors extracted from NCDC and other available data sources. The parameters considered include:

- Historical occurrence;
- Vulnerability of population in the hazard area; and
- Historical impact, in terms of human lives and property and crop damage.

The hazard scores were assigned a category of 'Low'; 'Medium-Low'; 'Medium'; 'Medium-High'; or 'High'. Based on this methodology, Flood, Wind, Tornado, and Winter Weather hazards were ranked as 'High' for Herndon. See Table 7.60 for a summary of hazard rankings.

Table 7.12: Hazard Ranking for the Town of Herndon									
Hazard	**Flood**	**Wind**	**Tornado**	**Winter Weather**	**Drought**	**Earthquake**	**Landslide**	**Wildfire**	**Karst**
Ranking	**High**	**High**	**High**	**High**	**Med-High**	**Med**	**Med-Low**	**Med**	**Med-Low**

A. Town of Herndon Mitigation Actions and Action Plan

#	Agency/Department: Mitigation Action	Lead Agency Department Organization	Flood	Winter Storm	Wind \ Severe Storm	Tornado	Drought	Wildfire	Earthquake	Extreme Temps	Dam Failure	Landslides	Karst \ Sinkholes	Funding Source	Target Compl-etion Date	Interim Measure of Success	Priority	Comments
2017-1	Purchase and plan for deployment of industrial grade water pumps to mitigate flood waters in known flood prone locations to include roadways.	Public Works	X	X										FEMA Unified Hazard Mitigation Assistance Funding	Ongoing	Identify and prioritize locations for placement of pumps, identify funding	Medium	None
2017-2	Improve flood prone intersections by adding new drainage structures and systems. Two known intersections: 1)Herndon Pkwy and Van Buren Street 2)Monroe Street and Worldgate Drive	Public Works	X	X										Currently included in Town CIP budget	Ongoing	Identify construction start dates.	Medium	None
2017-3	Evaluate and assess older storm water systems in the Town to include 5 year CCTV inspections and trenchless repair methods.	Public Works	X	X										FEMA Unified Hazard Mitigation Assistance Funding	Ongoing	Create and initiate a plan and schedule for evaluation and assessment	Medium	None
2017-4	Support mitigation of priority flood-prone structures through promotion of acquisition/ demolition, elevation, flood proofing, minor localized flood control projects, mitigation reconstruction and where feasible using	Public Works	X	X	X									FEMA Unified Hazard Mitigation Assistance Funding		Identify properties	Medium	

#	Agency/Department: Mitigation Action	Lead Agency Department Organization	Flood	Winter Storm	Wind \ Severe Storm	Tornado	Drought	Wildfire	Earthquake	Extreme Temps	Dam Failure	Landslides	Karst \ Sinkholes	Funding Source	Target Compl-etion Date	Interim Measure of Success	Priority	Comments
	FEMA HMA programs where appropriate.																	
2017-5	Review locality's compliance with the National Flood Insurance Program with an annual review of the Floodplain Ordinances and any newly permitted activities in the 100-year floodplain. Additionally, Conduct annual review of repetitive loss and severe repetitive loss property list requested of VDEM to ensure accuracy. Review will include verification of the geographic location of each repetitive loss property and determination if that property has been mitigated and by what means. Provide corrections if needed by filing form FEMA AW-501.	Community Development/Public Works	X	X	X									General Funds	Ongoing	Establish a schedule of review	Medium	No

[1] NCDC's Storm Event database is available at http://www4.ncdc.noaa.gov/cgi-win/wwcgi.dll?wwEvent~Storms.

XIII. Town of Leesburg

Steeped in history, Leesburg is the county seat of Loudoun County. Leesburg was established in 1758, and formally became a town by signed act of the Virginia General Assembly on February 18, 1813. It is located just over 30 miles west-northwest of Washington, DC, at the base of Catoctin Mountain and adjacent to the Potomac River. The principal drainage for the town is Tuscarora Creek and its northern "Town Branch," which empties into Goose Creek located to the east of town.

European settlement began in the late 1730s. After founding, it was the location of the post office and regional courthouse. The town was originally established on 60 acres of land.

The population of the town was 28,311 as of the 2000 Census and was estimated by the Census Bureau to be 40,927 in 2009. As of the 2000 census there were 10,325 households. The population density in 2000 was 2,440 people per square mile. Based on the 2005-2009 American Community Survey, the town population was comprised of 72.8% white, 12% black or African American, 6.7% Asian, 5.2% from other races, and 3.3% bi-racial. Hispanics or Latinos of any race were 12% of the total population.

Leesburg has a moderate climate. The average annual temperature is approximately 58 degrees. Temperatures generally range from lows in the mid-20s in January to highs in the upper-80s and lower-90s during the month of July. Annual precipitation averages are approximately 43 inches in any given year, with approximately 20 inches of snowfall annually. Recent history proves that weather events well outside of these averages can and do occur. Climate change is expected to continue the trend of the past 40 to 50 years of an increased frequency of extreme weather events.

Leesburg has a rapidly growing population and is less than an hour's car ride to Washington, DC. Risks for the town include its proximity to the Nation's capital, its growth rate, flooding of low lying areas surrounding the Potomac River, and other natural hazards such as storm damage and winter weather. Winter storms pose significant threats, as evidenced during the 2009 – 2010 winter season.

To a large extent, historical records are used to identify the level of risk within the Northern Virginia region, including Leesburg, with the assumption that the data sources cited are reliable and accurate. Unless otherwise cited, data on historical weather-related events is based on information made available through the Storm Event Database by NOAA's NCDC[1]. Hazards were ranked using a semi-quantitative scoring system that involved grouping the data values (normalized to account for inflation) based on statistical methods. This method prioritizes hazard risk based on a blend of quantitative factors extracted from NCDC and other available data sources. The parameters considered include:

- Historical occurrence;

- Vulnerability of population in the hazard area; and
- Historical impact, in terms of human lives and property and crop damage.

The hazard scores were assigned a category of 'Low'; 'Medium-Low'; 'Medium'; 'Medium-High'; or 'High'. Based on this methodology, Flood, Wind, Tornado, Winter Weather and Drought hazards were ranked as 'High' for Leesburg. See Table 7.65 for a summary of hazard rankings.

Table 7.13: Hazard Ranking for Leesburg

	Flood	Wind	Tornado	Winter Weather	Drought	Earthquake	Landslide	Wildfire	Karst
Ranking	High	High	High	High	High	Med	Med-High	Med-Low	Med-Low

A. Town of Leesburg Mitigation Actions and Action Plan

#	Agency/Department: Mitigation Action	Lead Agency Department Organization	Flood	Winter Storm	Wind \ Severe Storm	Tornado	Drought	Wildfire	Earthquake	Extreme Temps	Dam Failure	Landslides	Karst \ Sinkholes	Funding Source	Target Completion Date	Interim Measure of Success	Priority	Comments
2006-1	Improve drainage in low-lying or poor drainage areas along primary and secondary roads where needed town wide. During heavy rain events, several area roadways become inundated with water runoff. Priority Projects: 1. Tuscarora Creek Improvements 2. Town Branch Improvements—King Street 3. Turner-Hardwood Drainage	Public Works, Office of Capital Projects, Planning,	X	X	X	X	X	X	X	X	X	X	X	Coordinate with Virginia Department of Transportation (VDOT)	Undetermined at this point—based on funding availability	Identify funding	High	No
2006-2	Improve security measures as needed around critical facilities	Executive Office	X	X	X	X	X	X	X	X	X	X	X	U.S. Department of Homeland Security, Office of Domestic Preparedness: Homeland Security Grant Program (HSGP); Buffer Zone Protection Program (BZPP)	Undetermined at this time—dependent on funding source and availability	Develop security enhancement plan	Moderate	No
2006-3	Provide back-up power (generators, where needed) for	Executive Office/ all depts.	X	X	X	X	X	X	X	X	X	X	X	U.S. Department of Homeland	Time schedule is dependent on	Identify funding	Moderate	No

#	Agency/Department: Mitigation Action	Lead Agency Department Organization	Flood	Winter Storm	Wind \ Severe Storm	Tornado	Drought	Wildfire	Earthquake	Extreme Temps	Dam Failure	Landslides	Karst \ Sinkholes	Funding Source	Target Completion Date	Interim Measure of Success	Priority	Comments
	critical facilities (i.e., fire stations, police stations, water facilities, etc.).													Security, Office of Domestic Preparedness: Homeland Security Grant Program (HSGP); Buffer Zone Protection Program (BZPP)	funding source and availability			
2010-1	Develop and test government Continuity of Operations (Coop) plans.	Town Manager / dept directors	X	X	X	X	X	X	X	X	X	X	X	Internal Town of Leesburg	Ongoing	Develop plan / train staff	High	Department Managers are reviewing respective components of the COOP.
2010-2	Develop and test model evacuation and shelter-in-place plans for government facilities to include identifying and stocking shelter areas, testing notification systems	All Departments	X	X	X	X	X	X	X	X	X	X	X	Internal town funding, U.S. Department of Homeland Security, Office of Domestic Preparedness: Homeland Security Grant Program (HSGP)	Ongoing	Develop evac and shelter in place plan for town facilities	Moderate	No

#	Agency/Department: Mitigation Action	Lead Agency Department Organization	Flood	Winter Storm	Wind \ Severe Storm	Tornado	Drought	Wildfire	Earthquake	Extreme Temps	Dam Failure	Landslides	Karst \ Sinkholes	Funding Source	Target Completion Date	Interim Measure of Success	Priority	Comments
2010-3	Provide additional automation and display equipment for Emergency Operations Center (EOC). Develop means for inclusion of GIS capability to track storm-related events including road closures, traffic signal status, power outages and building damage due to storm events. Identify and train staff required to operate EOC	Police, Public Works and IT Department	X	X	X	X	X	X	X	X	X	X	X	Internal town funding, Federal Highway Administration grants Tiger Grants, Department of Homeland Security grants, county funding	Ongoing	Identifying and purchasing needed equipment	Moderate	Display equipment upgraded in the TOL EOC with similar upgrades in other meeting areas for redundancy. Dedicated GIS computer has been added to the EOC and migration of data to a GIS server is in progress.
2010-4	Variable Traffic Message Signs: This project will add several traffic message boards to the town's inventory. These boards are effective in the dissemination of information in the event of an emergency. They can be programmed with various messages including general traffic rerouting information, and other emergency messages. Additionally locations	Public Works – Street Department /Police dept	X	X	X	X	X	X	X	X	X	X	X	Internal town funding, Federal Highway Administration grants Tiger Grants, Department of Homeland Security grants, county funding	Ongoing	Identify locations	Moderate	Variable Message Boards have been purchased. Work continues on pad and dedicated power locations for expanded deployment.

#	Agency/Department: Mitigation Action	Lead Agency Department Organization	Flood	Winter Storm	Wind \ Severe Storm	Tornado	Drought	Wildfire	Earthquake	Extreme Temps	Dam Failure	Landslides	Karst \ Sinkholes	Funding Source	Target Completion Date	Interim Measure of Success	Priority	Comments
	will be identified and pads prepared with power for deployment																	
2010-5	Practical Emergency Operations Training Exercise on a town wide basis for a natural disaster.	Town Manager / Police (All Agencies)	X	X	X	X	X	X	X	X	X	X	X	Internal town funding Department of Homeland Security grants, UASI funding, county funding	Ongoing	Develop exercise	High	Practical exercises have been completed for some departments as well as for the Department Directors. Continuing work on town wide training exercise.
2010-6	Update Town of Leesburg citizen guide to emergency Preparedness. Mail to residents and post on web	Police/ Executive/IT	X	X	X	X	X	X	X	X	X	X	X	U.S. Department of Homeland Security, Office of Domestic Preparedness: Homeland Security Grant Program (HSGP)	Ongoing	Identify funding	Moderate	No

#	Agency/Department: Mitigation Action	Lead Agency Department Organization	Flood	Winter Storm	Wind \ Severe Storm	Tornado	Drought	Wildfire	Earthquake	Extreme Temps	Dam Failure	Landslides	Karst \ Sinkholes	Funding Source	Target Completion Date	Interim Measure of Success	Priority	Comments
2010-7	Establish and full test emergency notification procedures and protocols for key government personnel to include; emergency email groups, text based alerts, pager based alerts, etc as well as establishment of Emergency call trees	Executive /All Depts	X	X	X	X	X	X	X	X	X	X	X	Internal town funding Department of Homeland Security grants, UASI funding, county funding	Ongoing	Develop protocols	High	Enhancements of upgraded Everbridge system have been incorporated into routine, incident, and emergency exercise alerts. Continuing work on the establishment of phone trees and review of the Town' Crisis Communication Plan.
2010-8	Conduct annual outreach to each FEMA-listed repetitive loss and severe repetitive loss property owner, providing information on mitigation programs (grant assistance, mitigation measures, flood insurance information) that can assist them in reducing their flood risk.	Public Works	X		X									FEMA Unified Hazard Mitigation Assistance funding for qualified structures.	Ongoing	Develop outreach materials, or identify appropriate outreach materials for dissemination by June 2011.	Medium	No
2010-9	Support mitigation of priority flood-prone structures through promotion of acquisition/ demolition, elevation, flood proofing, minor	Public Works	X		X									FEMA Unified Hazard Mitigation Assistance funding for qualified	Ongoing	Identify all priority flood-prone structures by December 2011.	Medium	No

#	Agency/Department: Mitigation Action	Lead Agency Department Organization	Flood	Winter Storm	Wind \ Severe Storm	Tornado	Drought	Wildfire	Earthquake	Extreme Temps	Dam Failure	Landslides	Karst \ Sinkholes	Funding Source	Target Completion Date	Interim Measure of Success	Priority	Comments
	localized flood control projects, mitigation reconstruction and where feasible using FEMA HMA programs where appropriate.													structures.				
2010-10	Promote structural mitigation to assure redundancy of critical facilities, to include but not limited to roof structure improvement, to meet or exceed building code standards, upgrade of electrical panels to accept generators, etc.	Public Works	X		X									FEMA Unified Hazard Mitigation Assistance funding for qualified structures.	Ongoing	Query local government building services staffs as to effectiveness of provided information regarding the structural review.	Medium	No
2010-11	Review locality's compliance with the National Flood Insurance Program with an annual review of the Floodplain Ordinances and any newly permitted activities in the 100-year floodplain. Additionally, Conduct annual review of repetitive loss and severe repetitive loss property list requested of VDEM to ensure accuracy. Review will	Public Works	X		X									General funds	Ongoing	Establish a schedule of review and review committee (if necessary) by June 2011.	Medium	No

#	Agency/Department: Mitigation Action	Lead Agency Department Organization	Flood	Winter Storm	Wind \ Severe Storm	Tornado	Drought	Wildfire	Earthquake	Extreme Temps	Dam Failure	Landslides	Karst \ Sinkholes	Funding Source	Target Completion Date	Interim Measure of Success	Priority	Comments
	include verification of the geographic location of each repetitive loss property and determination if that property has been mitigated and by what means. Provide corrections if needed by filing form FEMA AW-501.																	
2010-12	Determine feasibility of developing a drought preparedness and response plan	Public Works					X							Internal town funding Department of Homeland Security grants, UASI funding, county funding	Ongoing	Research and identify applicable funding mechanisms to develop the plan.	Medium	No

[1] NCDC's Storm Event database is available at http://www4.ncdc.noaa.gov/cgi-win/wwcgi.dll?wwEvent~Storms.

XIV. Town of Lovettsville

Lovettsville, originally known as The German Settlement, is a small town with historical roots that go back to 1732. The Town was laid out in 1820 by David Lovett and served as a thriving commercial center for the surrounding farming areas for over one-hundred years. This function was eventually eclipsed during the post-World War II period by other, larger communities in Loudoun County, Northern Virginia, and nearby Maryland, which is about three miles from the Town.

Since 2005, Lovettsville has experienced a rapid increase in population and housing associated with growth of single-family detached residences. The population influx consists of people who are attracted to the traditional main street character of Lovettsville set in the larger context of the (mostly) rural northern Loudoun Valley. This beautiful setting, in which the Short Hill Mountains can be viewed from most locations in and around the Town, makes Lovettsville an attractive community to existing and would-be residents.

The Town is served by a number of public services (e.g. water, sewer, and solid waste collection) and facilities (e.g. a community center, library, and elementary school) as well as by private businesses including a convenience store, bank, dine-in restaurants, professional medical offices, and other small business establishments. The Lovettsville Elementary School, the Lovettsville Library, the Lovettsville Museum, and the Lovettsville Community Center are all located in Lovettsville. Upon completion, the Lovettsville Community Park will be a large, County-owned recreational facility partially located in Town that is master planned for a variety of active and passive recreational uses. Residents have access to places of worship both inside and outside the Town. The Town's home-based businesses, sidewalks, quiet country lanes, and overall setting create a rural feel that helps keep Lovettsville's pace of life slower and less congested than found in the more densely populated areas in the region. The Town is served by the Lovettsville Volunteer Fire and Rescue, Company 12, and a modern federal post office located on North Church Street. The Town's small brick government building, located at 6 East Pennsylvania Avenue in Lovettsville, was constructed in 1975 and has served as the office of the Town government since that time.

Lovettsville is close enough to larger urban centers and towns (Leesburg and Purcellville, Virginia; Brunswick and Frederick, Maryland; and Charles Town, West Virginia), so that residents have access to more expansive retail, cultural, and employment opportunities. The MARC train station in Brunswick, Maryland, located about three miles from Lovettsville on the Brunswick Line, provides commuter rail transportation to Montgomery County and Washington, DC for residents of the Lovettsville area.

Medical services are provided to Town residents by Loudoun Healthcare, a division of INOVA Health System and the Loudoun County Health Department. Loudoun Healthcare's INOVA Loudoun Hospital is located in Lansdowne, approximately 20 miles southeast of Lovettsville.

Loudoun Healthcare's Mobile Medical Van serves Lovettsville occasionally, providing wellness-oriented walk-in services. Loudoun Healthcare operates an Emergency Department at its Cornwall Street campus in Leesburg, approximately 15 miles southeast of Lovettsville, along with a free clinic. The Loudoun County Health Department is located in Leesburg. There are two dentists' offices and a doctor's office in Lovettsville.

Climate and Topography

The climate of Lovettsville is classified as "modified continental" by the National Weather Service and is characterized by mild winters and warm, humid summers. The average mean annual temperature is 51 degrees. Precipitation is well distributed throughout the year with the maximum occurring in June and the minimum in February. The average annual precipitation is 40 inches. The prevailing wind is from a south-to-southwest direction, with secondary winds from the north. The topography of Lovettsville is generally uniform without much slope characteristic. The Short Hill Mountains are only a few miles to the west of Lovettsville and help make the Town's setting attractive and refreshing.

Geology and Soils

The Town is underlain by saprolitic soils, typically extending to a depth of 60 feet or more and overlying metamorphic bedrock (metagranites and gneiss). The bedrock is relatively impermeable except where weathered and fractured areas occur. Groundwater occurs mainly in the weathered upper-most bedrock/soil-rock interface and in fractures in the upper 250 feet of bedrock. Well yields are generally low but can be substantially enhanced where fracturing is more prevalent. The most common soil associations in the Lovettsville area are: Swampoodle-Lovettsville Complex (approximately 22 percent), consists of deep and very deep, well-drained clayey soils with seasonal water tables on nearly level summits. It is characterized by low strength and high frost heave potential and has a poor potential for development on central water and sewer. Adequate engineering solutions can usually offset this drawback. Philomont-Purcellville-Swampoodle Complex (approximately 15 percent), consists of very deep, well drained loam and silt, as well as a well-drained clayey soil, which is good for development on central water and sewer and for conventional septic systems. Morrisonville-Philomont Complex (approximately 15 percent) is characterized by very deep, well-drained red silty, clayey, and brown loamy soils on undulating and rolling landscapes. It has good potential for development of central water and sewer and for conventional septic tank systems. Approximately fifty percent of the soils underlying Lovettsville are contained within three soil type classifications, according to the detailed soils maps of Loudoun County. In general, the soils are considered fair to good for development on central water and sewer systems and on conventional septic systems.

Floodplain

Three major watersheds drain Lovettsville: Dutchman Creek, Quarter Branch, and tributaries to Catoctin Creek. The western part of Town, which constitutes the largest of the three drainage areas, flows north and west towards Dutchman Creek. The eastern portion of the Town drains south and east towards Catoctin Creek. The northern section of Town, north of Route 855 drains north towards Quarter Branch Creek. The water from these three streams eventually flows north to the Potomac River.

The Federal Emergency Management Agency (FEMA) completed an updated County floodplain map, July 5, 2001, which identifies a 100-year flood plain along Dutchman Creek within the Town limits, along the western corporate limits. This area, which encompasses approximately 16 acres within the Town, drains approximately 600 acres as the watercourse exits the Town limits to the north. This floodplain is categorized as a Special Flood Hazard Area, which can be expected to be inundated by the 100-year flood. A smaller flood hazard area is also identified within the Town limits on a tributary to Dutchman Creek running along West Broadway. Much of the floodplain in this area has been modified by engineering required for the development of the Town Center project.

Wetlands have been identified along Dutchman Creek tributaries on a portion of the Town Center project. The project has treated these areas according to the requirements of the US Army Corps of Engineers, which is the agency responsible for protecting wetlands throughout the country.

Natural Vegetation

Natural trees, shrubs, and ground cover are considered a significant environmental feature as they serve a variety of ecological functions including retaining rainwater, controlling erosion, cleansing the air of pollutants, offering visual relief from development, and providing wildlife habitat.

There is scattered tree cover throughout the Town. There is significant tree cover in and near the stream valley along the southwest boundary of the Town north of Heritage Highlands, the retirement community. There is substantial tree cover along streets and scattered on various properties in the old part of Town. Newer subdivisions have a limited amount of tree cover but much of the most recent residential development has trees that were planted as part of the development. The Town Center project has little tree save area but trees have and will be planted along all the streets.

Water Supply Protection

In an effort to further protect the Town's ground water supply, Lovettsville completed a wellhead protection plan in 2005. This plan identified the Town's geographical features and public water production resources in an effort to determine potential threats to the public water supply. This plan provided a recommended list of actions to protect the Town's source water. In 2007 and 2008 the Town received grant funding provided by the Virginia Department of Environmental Quality to identify and abandon existing non-active wells that could pose a threat to the Town's water supply. Thirteen wells were professionally sealed during this process. In 2009 the Town was awarded additional grant funds to develop zoning and subdivision regulations that would protect wells in the Town.

Table 7.14: Hazard Ranking for Leesburg									
	Flood	Wind	Tornado	Winter Weather	Drought	Earthquake	Landslide	Wildfire	Karst
Ranking	High	High	High	High	High	Med	Med-High	Med-Low	Med-Low

A. Town of Lovettsville Mitigation Actions and Action Plan

#	Agency/Department: Mitigation Action	Lead Agency Department Organization	Flood	Winter Storm	Wind \ Severe Storm	Tornado	Drought	Wildfire	Earthquake	Extreme Temps	Dam Failure	Landslides	Karst \ Sinkholes	Funding Source	Target Completion Date	Interim Measure of Success	Priority	Comments
2017-1	Maintain high quality aerial photography of the Town.	Planning Department	X	X	X	X	X	X	X	X			X	Internal but will target Department of Homeland Security grants, UASI funding, county funding	On-going	Continue to work with our local officials in stressing the importance of this initiative and identify funding to maintain the current capabilities.	Medium	
2017-2	Build redundancy in our Water Infrastructure by adding planned 2nd Water Tower	Administration, Engineering, and Utility Department			X	X			X					Internal funding, but will target external Grants	2030	In Town CIP with Availability Fee Structure in place to help fund.	High	
2017-3	Provision of Information to flood plain areas about having adequate insurance and safety measures.	Administration	X		X									Internal funding, but will target external Grants	Ongoing	Begin Work	Medium	

#	Agency/Department: Mitigation Action	Lead Agency Department Organization	Flood	Winter Storm	Wind \ Severe Storm	Tornado	Drought	Wildfire	Earthquake	Extreme Temps	Dam Failure	Landslides	Karst \ Sinkholes	Funding Source	Target Completion Date	Interim Measure of Success	Priority	Comments
2017-4	Research possible vulnerable population registration systems to better identify and serve at risk citizens	Office of Emergency Management	X	X	X	X	X	X	X	X			X	Targeting outside funding from Department of Homeland Security grants, UASI funding, county funding	2022	Begin Work	Medium	
2017-5	Build redundancy in our Sewer Infrastructure by adding Equalization Basin.	Administration, Engineering, and Utility Department			X	X			X					Internal funding, but will target external Grants	2021	In Town CIP with Availability Fee Structure in place to help fund.	High	

XV. Town of Middleburg

The Town of Middleburg was established in 1787. The population of the town was 632 as of the 2000 Census and was estimated by the Census Bureau to be 976 in 2009. Middleburg is located in Loudoun County and covers approximately 0.6 square miles of land. The population density of the town is 1,083 people per square mile. Based on the 2005-2009 American Community Survey, the town population was comprised of 73.8% white and 26.2% black or African American. Hispanics or Latinos of any race were 0.8% of the total population.

Middleburg has a moderate climate. Temperatures generally range from lows in the mid-20s in January to highs in the upper-80s and lower-90s during the month of July. Annual precipitation averages are approximately 38 inches of rain and approximately 20 inches of snow fall in any given year. The wettest month on average is May. Recent history proves that weather events well outside of these averages can and do occur. Climate change is expected to continue the trend of the past 40 to 50 years of an increased frequency of extreme weather events.

Middleburg is subject to high wind events and extreme winter weather. Winter storms pose significant threats, as evidenced during the 2009 – 2010 winter season.

To a large extent, historical records are used to identify the level of risk within the Northern Virginia region, including Middleburg, with the assumption that the data sources cited are reliable and accurate. Unless otherwise cited, data on historical weather-related events is based on information made available through the Storm Event Database by NOAA's NCDC[1]. Hazards were ranked using a semi-quantitative scoring system that involved grouping the data values (normalized to account for inflation) based on statistical methods. This method prioritizes hazard risk based on a blend of quantitative factors extracted from NCDC and other available data sources. The parameters considered include:

- Historical occurrence;
- Vulnerability of population in the hazard area; and
- Historical impact, in terms of human lives and property and crop damage.

The hazard scores were assigned a category of 'Low'; 'Medium-Low'; 'Medium'; 'Medium-High'; or 'High'. Based on this methodology, Flood, Wind, Tornado, Winter Weather and Drought hazards were ranked as 'High' for Middleburg. See Table 7.70 for a summary of hazard rankings.

Table 7.15: Hazard Ranking for Middleburg

Hazard	Flood	Wind	Tornado	Winter Weather	Drought	Earthquake	Landslide	Wildfire	Karst
Ranking	High	High	High	High	High	Med	Med-High	Med-Low	Med-Low

A. Town of Middleburg Mitigation Actions and Action Plan

#	Agency/Department: Mitigation Action	Lead Agency Department Organization	Flood	Winter Storm	Wind \ Severe Storm	Tornado	Drought	Wildfire	Earthquake	Extreme Temps	Dam Failure	Landslides	Karst \ Sinkholes	Funding Source	Target Completion Date	Interim Measure of Success	Priority	Comments
2010-1	Develop and test government Continuity of Operations Plan (COOP).	Town Administration	X	X	X	X	X	X	X	X	X	X	X	Internal to general fund	Ongoing	Develop the COOP and train staff.	High	In 2016 the police department updated MOU's within the Northern Virginia response area. Our dispatch center is and remains Loudoun County which has multiple back up plans. There is a standing partnership between the Police Department and the Loudoun County Sheriff for multi-agency response to critical incidents. Recently in cooperation with the Virginia State Police we have been working on predetermined assignments for evacuation and or the need to shutdown major roadways within the region. We are in the process of providing generator power to two Town facilities without a generator.
2010-2	Develop Geographical Information System with critical layers between the town and the county.	Planning	X	X	X	X	X	X	X	X	X	X	X	Internal to general fund, DHS Grant Funding, Hazard Mitigation	Ongoing	Development of GIS system and associated data for hazard mitigation.	High	The Town in cooperation with Loudoun County Mapping has geo-located all fire hydrants. The Town is also in the process of doing an inventory of and geo-locating all water

#	Agency/Department: Mitigation Action	Lead Agency Department Organization	Flood	Winter Storm	Wind \ Severe Storm	Tornado	Drought	Wildfire	Earthquake	Extreme Temps	Dam Failure	Landslides	Karst \ Sinkholes	Funding Source	Target Completion Date	Interim Measure of Success	Priority	Comments
														Grant Funds				infrastructure. Sewer infrastructure will be included in future years.
2010-3	Conduct annual outreach to each FEMA-listed repetitive loss and severe repetitive loss property owner, providing information on mitigation programs (grant assistance, mitigation measures, flood insurance information) that can assist them in reducing their flood risk.	Planning and Zoning	X		X									FEMA Unified Hazard Mitigation Assistance funding for qualified structures.	Ongoing	Develop outreach materials, or identify appropriate outreach materials for dissemination by June 2011.	Medium	There are no FEMA-listed repetitive loss or severe repetitive loss properties within the Town limits. The Town will continue to monitor and update floodplain limits in coordination with FEMA and the County.
2010-4	Support mitigation of priority flood-prone structures through promotion of acquisition/ demolition, elevation, flood proofing, minor localized flood control projects, mitigation reconstruction and where feasible using FEMA HMA programs where appropriate.	Planning and Zoning	X		X									FEMA Unified Hazard Mitigation Assistance funding for qualified structures.	Ongoing	Identify all priority flood-prone structures by December 2011.	Medium	There are no priority flood-prone structures in the Town limits at this time, but the Town will continue monitoring the new floodplain limits and support mitigation should structures fall into flood-prone areas.
2010-5	Promote structural mitigation to assure redundancy of critical	Planning and Zoning	X		X									FEMA Unified Hazard	Ongoing	Query local government building	Medium	The Town has a new wastewater treatment facility as of October

#	Agency/Department: Mitigation Action	Lead Agency Department Organization	Flood	Winter Storm	Wind \ Severe Storm	Tornado	Drought	Wildfire	Earthquake	Extreme Temps	Dam Failure	Landslides	Karst \ Sinkholes	Funding Source	Target Completion Date	Interim Measure of Success	Priority	Comments
	facilities, to include but not limited to roof structure improvement, to meet or exceed building code standards, upgrade of electrical panels to accept generators, etc.													Mitigation Assistance funding for qualified structures.		services staffs as to effectiveness of provided information regarding the structural review.		2010 that meets all building code standards and includes a generator. All Town utility facilities include generators and, where metal roofed, include snow catchers. The Town is in the process of installing generators for the Town Office and Police Department, including upgrades to electrical panels where required.
2010-6	Review locality's compliance with the National Flood Insurance Program with an annual review of the Floodplain Ordinances and any newly permitted activities in the 100-year floodplain. Additionally, Conduct annual review of repetitive loss and severe repetitive loss property list requested of VDEM to ensure accuracy. Review will include verification of the geographic location of each repetitive loss property and determination if that	Planning and Zoning	X		X									General funds	Completed ordinance update; In Progress on annual reviews of properties	Establish a schedule of review and review committee (if necessary) by June 2011.	Medium	Town adopted a new floodplain ordinance on 2/10/15 to comply with updated FEMA requirements. Revised FEMA floodplain maps have also been completed for the Town. There are currently no repetitive loss or severe repetitive loss properties within the Town limits, but this situation will be monitored annually.

#	Agency/Department: Mitigation Action	Lead Agency Department Organization	Flood	Winter Storm	Wind \ Severe Storm	Tornado	Drought	Wildfire	Earthquake	Extreme Temps	Dam Failure	Landslides	Karst \ Sinkholes	Funding Source	Target Completion Date	Interim Measure of Success	Priority	Comments
	property has been mitigated and by what means. Provide corrections if needed by filing form FEMA AW-501.																	
2010-7	Determine feasibility of developing a drought preparedness and response plan	Planning and Zoning					X							General funds	Ongoing	Research and identify applicable funding mechanisms to develop the plan.	Medium	No

[1] NCDC's Storm Event database is available at http://www4.ncdc.noaa.gov/cgi-win/wwcgi.dll?wwEvent~Storms.

XVI. Town of Occoquan

Derived from a Dogue Indian word meaning 'at the end of the water,' Occoquan was divided into lots and streets and laid out in 1804 by Nathaniel Ellicott, James Campbell and Luke Wheeler. The town is located in northeastern Prince William County along the Occoquan River bordering Fairfax County. The population of the town was 934 as of the 2010 Census and was estimated by the Census Bureau to be 1,025 in 2015. Based on the 2010-2014 American Community Survey, the town population was comprised of 80.3% white, 11.0% black or African American, 3.4% Asian, 1.4% Native Hawaiian and other Pacific Islander, 3.6% identifying two or more races, and Hispanic or Latino, of any race, represents 4.2% of the total population.

Occoquan has a moderate climate. Temperatures generally range from lows in the mid-20s in January to highs in the upper-80s and lower-90s during the month of July. Annual precipitation averages are approximately 39 inches of rain and 16 or more inches of snow fall in any given year. Recent history proves that weather events well outside of these averages can and do occur. Climate change is expected to continue the trend of the past 40 to 50 years of an increased frequency of extreme weather events.

Due to Occoquan's location at the Fall Line on the Occoquan River, a tributary to the Potomac River, the town is also subjected to tidal and storm surge flooding. As sea levels rise, permanent inundation of low lying areas along and near the river shoreline is of concern. Occoquan is also susceptible to other natural hazards and risks, such as storm damage and winter weather, as evidenced during the 2015 - 2016 winter and summer seasons.

To a large extent, historical records are used to identify the level of risk within the Northern Virginia region, including Occoquan, with the assumption that the data sources cited are reliable and accurate. Unless otherwise cited, data on historical weather-related events is based on information made available through the Storm Event Database by NOAA's NCDC[1]. Hazards were ranked using a semi-quantitative scoring system that involved grouping the data values (normalized to account for inflation) based on statistical methods. This method prioritizes hazard risk based on a blend of quantitative factors extracted from NCDC and other available data sources. The parameters considered include:

- Historical occurrence
- Vulnerability of population in the hazard area
- Historical impact, in terms of human lives and property and crop damage

The hazard scores were assigned a category of 'Low'; 'Medium-Low'; 'Medium'; 'Medium-High'; or 'High'. Based on this methodology, Flood, Wind, Tornado, Winter Weather, and Drought hazards were ranked as 'High' for Occoquan. See Table 7.74 for a summary of hazard rankings.

Table 7.17: Hazard Ranking for Town of Occoquan									
Hazard	**Flood**	**Wind**	**Tornado**	**Winter Weather**	**Drought**	**Earthquake**	**Landslide**	**Wildfire**	**Karst**
Ranking	**High**	**High**	**High**	**High**	**High**	**Med**	**Med-Low**	**Med**	**Med-Low**

A. Town of Occoquan Mitigation Actions and Action Plan

#	Agency/Department: Mitigation Action	Lead Agency Department Organization	Flood	Winter Storm	Wind \ Severe Storm	Tornado	Drought	Wildfire	Earthquake	Extreme Temps	Dam Failure	Landslides	Karst \ Sinkholes	Funding Source	Target Completion Date	Interim Measure of Success	Priority	Comments
2010-2	Initiate a public outreach campaign to inform residents of local hazards, to include dam failure and the new dam failure sirens.	Town Manager	X	X	X	X	X	X	X	X	X	X	X	FEMA Unified Hazard Mitigation Assistance funding, US Army Corp of Engineers funding	Ongoing	Develop outreach plan and identify dissemination methods by July 2012.	Low	Completed initial public outreach campaign. Continue coordination with Fairfax Water as funding becomes available.
2010-3	Support mitigation of priority flood-prone structures through promotion of acquisition/ demolition, elevation, flood proofing, minor localized flood control projects, mitigation reconstruction and where feasible using FEMA HMA programs where appropriate.	Town Manager	X		X						X			FEMA Unified Hazard Mitigation Assistance funding	Ongoing	Identify all priority flood-prone structures by December 2011.	Medium	These projects are ongoing and completed as funding becomes available.
2010-5	Promote structural mitigation to assure redundancy of critical facilities, to include but not limited to roof structure improvement, to meet or exceed building code standards, upgrade of electrical panels to accept generators, etc.	Town Manager	X		X						X			FEMA Unified Hazard Mitigation Assistance funding,	Ongoing	Identify all priority flood-prone structures by December 2011.	High	These projects are ongoing and completed as funding becomes available.

2010-6	Determine feasibility of developing a drought preparedness and response plan.	Town Manager					X							FEMA Unified Hazard Mitigation Assistance funding	July 2018	Research and identify applicable funding mechanisms to develop the plan.	Low	This project will be completed as funding becomes available.

[1] NCDC's Storm Event database is available at http://www4.ncdc.noaa.gov/cgi-win/wwcgi.dll?wwEvent~Storms.

XVII. Town of Purcellville

First settled in 1764, the village became known as Purcellville on July 9, 1852, and was incorporated in 1908. Many present structures in the town reflect the Victorian architecture of the turn of the century. Located in the western portion of Loudoun County, the town has a total area of 3.5 square miles. Craft beverages is a thriving industry in this area, with 4 breweries and 1 distillery in the Town and approximately 40 wineries in the region. The Blue Ridge Mountains are just to the west and in good weather are usually visible from town. Recreation includes the WO&D bike trail, the western portion of which ends here.

The population of the town was 7,727 as of the 2000 Census and was estimated by the Census Bureau to be over 9,000 in 2016. The population density in 2016 was estimated at 2,600 persons per square mile. There were an estimated 2,400 housing units at an average density of 686 per square mile. Based on the 2010 Census, the town population was comprised of 86% white, 5.2% black or African American, 3.2% Asian, 2.2% from other races, and 3.3% bi-racial. Hispanics or Latinos of any race were 6.6% of the total population.

Purcellville has a moderate climate. The average annual temperature is approximately 58 degrees. Temperatures generally range from lows in the mid-20s in January to highs in the upper-80s and lower-90s during the month of July. Annual precipitation averages are approximately 43 inches with over 20 inches of snow falling in any given year. Recent history proves that weather events well outside of these averages can and do occur. Climate change is expected to continue the trend of the past 40 to 50 years of an increased frequency of extreme weather events.

To a large extent, historical records are used to identify the level of risk within the Northern Virginia region, including Purcellville, with the assumption that the data sources cited are reliable and accurate. Unless otherwise cited, data on historical weather-related events is based on information made available through the Storm Event Database by NOAA's NCDC[1]. Hazards were ranked using a semi-quantitative scoring system that involved grouping the data values (normalized to account for inflation) based on statistical methods. This method prioritizes hazard risk based on a blend of quantitative factors extracted from NCDC and other available data sources. The parameters considered include:

- Historical occurrence;
- Vulnerability of population in the hazard area; and
- Historical impact, in terms of human lives and property and crop damage.

The hazard scores were assigned a category of 'Low'; 'Medium-Low'; 'Medium'; 'Medium-High'; or 'High'. Based on this methodology, Flood, Wind, Tornado, Winter Weather, and Drought hazards were ranked as 'High' for Purcellville. See Table 7.79 for a summary of hazard rankings.

Table 7.17: Hazard Ranking for Purcellville

Flood	Wind	Tornado	Winter Weather	Drought	Earthquake	Landslide	Wildfire	Karst
High	High	High	High	High	Med	Med-High	Med-Low	Med-Low

A. Town of Purcellville Mitigation Actions and Action Plan

#	Agency/Department: Mitigation Action	Lead Agency Department Organization	Flood	Winter Storm	Wind \ Severe Storm	Tornado	Drought	Wildfire	Earthquake	Extreme Temps	Dam Failure	Landslides	Karst \ Sinkholes	Funding Source	Target Completion Date	Interim Measure of Success	Priority	Comments
2006-4	Assess the roadway structure at various intersections throughout the Town of Purcellville to avoid repeated flooding.	Public Works	X		X									Hazard Mitigation Assistance grant funding, County funding	Ongoing	Identify funding sources by January 2012	High	No
2010-2	Conduct annual outreach to each FEMA-listed repetitive loss and severe repetitive loss property owner, providing information on mitigation programs (grant assistance, mitigation measures, flood insurance information) that can assist them in reducing their flood risk.	Planning and Zoning	X		X									FEMA Unified Hazard Mitigation Assistance funding for qualified structures.	Ongoing	Develop outreach materials, or identify appropriate outreach materials for dissemination by June 2011.	Medium	No
2010-3	Support mitigation of priority flood-prone structures through promotion of acquisition/ demolition, elevation, flood proofing, minor localized flood control projects, mitigation reconstruction and where feasible using FEMA HMA programs where	Planning and Zoning	X		X									FEMA Unified Hazard Mitigation Assistance funding for qualified structures.	Ongoing	Identify all priority flood-prone structures by December 2011.	Medium	No

#	Agency/Department: Mitigation Action	Lead Agency Department Organization	Flood	Winter Storm	Wind \ Severe Storm	Tornado	Drought	Wildfire	Earthquake	Extreme Temps	Dam Failure	Landslides	Karst \ Sinkholes	Funding Source	Target Completion Date	Interim Measure of Success	Priority	Comments
	appropriate.																	
2010-4	Promote structural mitigation to assure redundancy of critical facilities, to include but not limited to roof structure improvement, to meet or exceed building code standards, upgrade of electrical panels to accept generators, etc.	Planning and Zoning	X		X									FEMA Unified Hazard Mitigation Assistance funding for qualified structures.	Ongoing	Query local government building services staffs as to effectiveness of provided information regarding the structural review.	Medium	No
2010-5	Review locality's compliance with the National Flood Insurance Program with an annual review of the Floodplain Ordinances and any newly permitted activities in the 100-year floodplain. Additionally, Conduct annual review of repetitive loss and severe repetitive loss property list requested of VDEM to ensure accuracy. Review will include verification of the geographic location of each repetitive loss property and determination if that property has been	Planning and Zoning	X		X									General funds	Ongoing	Establish a schedule of review and review committee (if necessary) by June 2011.	Medium	No

#	Agency/Department: Mitigation Action	Lead Agency Department Organization	Flood	Winter Storm	Wind \ Severe Storm	Tornado	Drought	Wildfire	Earthquake	Extreme Temps	Dam Failure	Landslides	Karst \ Sinkholes	Funding Source	Target Completion Date	Interim Measure of Success	Priority	Comments
	mitigated and by what means. Provide corrections if needed by filing form FEMA AW-501.																	
2010-6	Determine feasibility of developing a drought preparedness and response plan	Town Manager					X							General Funds, FEMA Unified Hazard Mitigation Assistance funding,	Ongoing	Research and identify applicable funding mechanisms to develop the plan.	Medium	Mitigation strategies include mandatory water restrictions, enhanced use of alternate water sources, and continued development of water redundancy. Long-term capital improvement projects identified to support these activities.
2017-01	Update and Refine Continuity of Operations Plan for Government Operations	Town Manager	X	X	X	X			X					General Funds, FEMA Unified Hazard Mitigation Assistance funding,	July 2017	Identify key resources, most critical operations to assist in preparing the Plan.	High	No
2017-02	Determine feasibility of redundancy of internet services and direct TLS between facilities	Information Technology	X	X	X	X			X					General Funds, Rural Broadband Grants, FCC Opportunities	July 2017	Identify opportunities to gain wireless spectrum and connection to County facilities	High	No

[1] NCDC's Storm Event database is available at http://www4.ncdc.noaa.gov/cgi-win/wwcgi.dll?wwEvent~Storms.

XVIII. Town of Round Hill

Named after the 910 foot hill located just southwest of the town center, and part of the foothills of the Blue Ridge Mountains, Round Hill was incorporated in 1900. Round Hill was used during the American Civil War as a signals post by both the Confederate and Union troops.

The Town is located at the crossroads of Virginia routes 7 and 719, approximately 45 miles northwest of Washington, DC. The town was the terminus of the Washington and Old Dominion Railroad, formerly the Washington and Ohio line. It is located 7 miles from the Shenandoah River, 15 miles from Harpers Ferry and four miles from the Appalachian Trail.

The population of the Round Hill was 500 as of the 2000 Census and was 539 in 2010. It is part of Loudoun County. Round Hill covers 0.2 square miles of land. The town population was comprised of 93% white, 2.8% Black or African American, 1.1% Asian, and 0.9% bi-racial.

Round Hill has a moderate climate. Temperatures generally range from lows in the mid-20s in January to highs in the upper-80s and lower-90s during the month of July. Annual precipitation averages are approximately 38 inches of rain and 20 inches of snow fall in any given year, with May being the wettest month on average. Recent history proves that weather events well outside of these averages can and do occur. Climate change is expected to continue the trend of the past 40 to 50 years of an increased frequency of extreme weather events.

Round Hill is subject to high wind events and extreme winter weather. Winter storms pose significant threats, as evidenced during the 2009 – 2010 winter season.

To a large extent, historical records are used to identify the level of risk within the Northern Virginia region, including Round Hill, with the assumption that the data sources cited are reliable and accurate. Unless otherwise cited, data on historical weather-related events is based on information made available through the Storm Event Database by NOAA's NCDC[1]. Hazards were ranked using a semi-quantitative scoring system that involved grouping the data values (normalized to account for inflation) based on statistical methods. This method prioritizes hazard risk based on a blend of quantitative factors extracted from NCDC and other available data sources. The parameters considered include:

- Historical occurrence;
- Vulnerability of population in the hazard area; and
- Historical impact, in terms of human lives and property and crop damage.

The hazard scores were assigned a category of 'Low'; 'Medium-Low'; 'Medium'; 'Medium-High'; or 'High'. Based on this methodology, Flood, Wind, Tornado, Winter Weather, and Drought hazards were ranked as 'High' for Round Hill. See Table 7.88 for a summary of hazard rankings.

Table 7.18: Hazard Ranking for Round Hill									
Hazard	Flood	Wind	Tornado	Winter Weather	Drought	Earthquake	Landslide	Wildfire	Karst
Ranking	High	High	High	High	High	Med	Med-High	Med-Low	Med-Low

A. Town of Round Hill Mitigation Actions and Action Plan

#	Agency/Department: Mitigation Action	Lead Agency Department Organization	Flood	Winter Storm	Wind \ Severe Storm	Tornado	Drought	Wildfire	Earthquake	Extreme Temps	Dam Failure	Landslides	Karst \ Sinkholes	Funding Source	Target Completion Date	Interim Measure of Success	Priority	Comments
2010-1	Identify the Town's Critical Infrastructure and develop a GIS layer	Loudoun County Office of Emergency Management/Town of Round Hill Planning	X	X	X	X	X	X	X	X	X	X	X	Local funding, DHS funding, Hazard Mitigation Grant Programs	In Progress	Secure funding	Critical	Hired an Intern to manage project in partnership with the County
2010-2	Implement drainage improvements in low-lying roadways.	Virginia Department of Transportation	X	X	X	X	X	X	X	X	X	X	X	DHS funding, Hazard Mitigation Grant Programs	In Progress	Secure funding	Critical	No
2010-4	Establish and test emergency notification procedures and protocols for Town personnel.	Town of Round Hill	X	X	X	X	X	X	X	X	X	X	X	Local funding	In Progress	Allocate funding	Critical	No
2010-5	Develop and test a Continuity of Operations Plan (COOP).	Town of Round Hill / Loudoun County Office of Emergency Management	X	X	X	X	X	X	X	X	X	X	X	Local funding, DHS funding, Hazard Mitigation Grant Programs	December 2018	Secure funding	Critical	This is planned for the FY2018 Budget
2010-6	Conduct annual outreach to each FEMA-listed repetitive loss and severe repetitive loss property owner, providing information on mitigation programs (grant assistance, mitigation measures, flood insurance information) that can assist them in reducing their flood risk.	Planning Commission	X		X									FEMA Unified Hazard Mitigation Assistance funding for qualified structures.	Ongoing	Develop outreach materials, or identify appropriate outreach materials for dissemination by June 2011.	Medium	No

#	Agency/Department: Mitigation Action	Lead Agency Department Organization	Flood	Winter Storm	Wind \ Severe Storm	Tornado	Drought	Wildfire	Earthquake	Extreme Temps	Dam Failure	Landslides	Karst \ Sinkholes	Funding Source	Target Completion Date	Interim Measure of Success	Priority	Comments
2010-7	Support mitigation of priority flood-prone structures through promotion of acquisition/ demolition, elevation, flood proofing, minor localized flood control projects, mitigation reconstruction and where feasible using FEMA HMA programs where appropriate.	Planning Commission	X		X									FEMA Unified Hazard Mitigation Assistance funding for qualified structures.	Ongoing	Identify all priority flood-prone structures by December 2011.	Medium	No
2010-8	Promote structural mitigation to assure redundancy of critical facilities, to include but not limited to roof structure improvement, to meet or exceed building code standards, upgrade of electrical panels to accept generators, etc.	Planning Commission	X		X									FEMA Unified Hazard Mitigation Assistance funding for qualified structures.	Ongoing	Query local government building services staffs as to effectiveness of provided information regarding the structural review.	Medium	No
2010-9	Review locality's compliance with the National Flood Insurance Program with an annual review of the Floodplain Ordinances and any newly permitted activities in the 100-year floodplain. Additionally, Conduct	Planning Commission	X		X									General funds	Ongoing	Establish a schedule of review and review committee (if necessary) by June 2011.	Medium	No

#	Agency/Department: Mitigation Action	Lead Agency Department Organization	Flood	Winter Storm	Wind \ Severe Storm	Tornado	Drought	Wildfire	Earthquake	Extreme Temps	Dam Failure	Landslides	Karst \ Sinkholes	Funding Source	Target Completion Date	Interim Measure of Success	Priority	Comments
	annual review of repetitive loss and severe repetitive loss property list requested of VDEM to ensure accuracy. Review will include verification of the geographic location of each repetitive loss property and determination if that property has been mitigated and by what means. Provide corrections if needed by filing form FEMA AW-501.																	
2010-9	Determine feasibility of developing a drought preparedness and response plan	Town of Round Hill / Loudoun County Office of Emergency Management					X							General Funds, FEMA Unified Hazard Mitigation Assistance funding,	Ongoing	Research and identify applicable funding mechanisms to develop the plan.	Medium	No

7-125

[1] NCDC's Storm Event database is available at http://www4.ncdc.noaa.gov/cgi-win/wwcgi.dll?wwEvent~Storms.

XIX. Town of Vienna

Originally called Ayr Hill, the Fairfax County village agreed in the 1850s to change its name to Vienna at the request of William Hendrick, a medical doctor who grew up in Vienna, New York. Vienna was incorporated into a town in 1890. The population of the town was estimated by the Census Bureau to be 15,687 in 2010. Based on the 2010 Census Bureau, the town population was comprised of 75.5% white, 3.2% black or African American, 0.3% Native American, 12.1% Asian, 5.3% from other races, and 3.6% bi-racial. Hispanics or Latinos, of any race, represent 12.0% of the total population.

The Town of Vienna has a moderate climate. Temperatures generally range from lows in the mid-20s in January to highs in the upper-80s and lower-90s during the month of July. Annual precipitation averages are approximately 45 inches of rain and 15 or more inches of snow fall in any given year. Recent history proves that weather events well outside of these averages can and do occur. Climate change is expected to continue the trend of the past 40 to 50 years of an increased frequency of extreme weather events.

The town's location on the eastern edge of the Virginia piedmont make it susceptible to other natural hazards and risks, such as storm damage and winter weather, as evidenced during the 2009 – 2010 winter season.

The Town of Vienna's situation in the Washington metropolitan area and its ease of access by car and public transportation have attracted an increasingly-varied residential and commercial development. Fairfax County's central business district, Tyson's Corner, is just outside of the town's corporate limits. It is the 12th largest central business district in the United States.

To a large extent, historical records are used to identify the level of risk within the Northern Virginia region, including the Town of Vienna, with the assumption that the data sources cited are reliable and accurate. Unless otherwise cited, data on historical weather-related events is based on information made available through the Storm Event Database by NOAA's NCDC[1]. Hazards were ranked using a semi-quantitative scoring system that involved grouping the data values (normalized to account for inflation) based on statistical methods. This method prioritizes hazard risk based on a blend of quantitative factors extracted from NCDC and other available data sources. The parameters considered include:

- Historical occurrence;
- Vulnerability of population in the hazard area; and
- Historical impact, in terms of human lives and property and crop damage.

The hazard scores were assigned a category of 'Low'; 'Medium-Low'; 'Medium'; 'Medium-High'; or 'High'. Based on this methodology, Flood, Wind, Tornado, and Winter Weather hazards were ranked as 'High' for the Town of Vienna. See Table 7.92 for a summary of hazard rankings.

Table 7.19: Hazard Ranking for the Town of Vienna									
Hazard	Flood	Wind	Tornado	Winter Weather	Drought	Earthquake	Landslide	Wildfire	Karst
Ranking	High	High	High	High	Med-High	Med	Med-Low	Med	Med-Low

A. Town of Vienna Mitigation Actions and Action Plan

#	Agency/Department: Mitigation Action	Lead Agency Department Organization	Flood	Winter Storm	Wind \ Severe Storm	Tornado	Drought	Wildfire	Earthquake	Extreme Temps	Dam Failure	Landslides	Karst \ Sinkholes	Funding Source	Target Completion Date	Interim Measure of Success	Priority	Comments
2010-1	Assess the roadway structure at various intersections throughout the Town of Vienna to avoid repeated flooding.	Town of Vienna Public Works	X		X									Hazard Mitigation Assistance grant funding, County funding	December 2015	Identify funding sources by January 2012	High	No
2010-2	Continue to identify and employ a broad range of warning systems throughout the Town of Vienna.	Town of Vienna Police Department	X	X	X	X	X	X	X	X	X	X	X	UASI funding, DHS grants, town/county funding	December 2015	Identify one new warning system to utilize by December 2012.	High	No
2010-3	Conduct annual outreach to each FEMA-listed repetitive loss and severe repetitive loss property owner, providing information on mitigation programs (grant assistance, mitigation measures, flood insurance information) that can assist them in reducing their flood risk.	Town of Vienna Police Department	X		X									FEMA Unified Hazard Mitigation Assistance funding for qualified structures.	Ongoing	Develop outreach materials, or identify appropriate outreach materials for dissemination by June 2011.	Medium	No
2010-4	Support mitigation of priority flood-prone structures through promotion of acquisition/ demolition, elevation, flood proofing, minor localized flood	Town of Vienna Police Department	X		X									FEMA Unified Hazard Mitigation Assistance funding for qualified structures.	Ongoing	Identify all priority flood-prone structures by December 2011.	Medium	No

#	Agency/Department: Mitigation Action	Lead Agency Department Organization	Flood	Winter Storm	Wind \ Severe Storm	Tornado	Drought	Wildfire	Earthquake	Extreme Temps	Dam Failure	Landslides	Karst \ Sinkholes	Funding Source	Target Completion Date	Interim Measure of Success	Priority	Comments
	control projects, mitigation reconstruction and where feasible using FEMA HMA programs where appropriate.																	
2010-5	Promote structural mitigation to assure redundancy of critical facilities, to include but not limited to roof structure improvement, to meet or exceed building code standards, upgrade of electrical panels to accept generators, etc.	Town of Vienna Police Department	X		X									FEMA Unified Hazard Mitigation Assistance funding for qualified structures.	Ongoing	Query local government building services staffs as to effectiveness of provided information regarding the structural review.	Medium	No
2010-6	Review locality's compliance with the National Flood Insurance Program with an annual review of the Floodplain Ordinances and any newly permitted activities in the 100-year floodplain. Additionally, Conduct annual review of repetitive loss and severe repetitive loss property list requested of VDEM to ensure accuracy. Review will include verification of	Town of Vienna Police Department	X		X									General funds	Ongoing	Establish a schedule of review and review committee (if necessary) by June 2011.	Medium	No

#	Agency/Department: Mitigation Action	Lead Agency Department Organization	Flood	Winter Storm	Wind \ Severe Storm	Tornado	Drought	Wildfire	Earthquake	Extreme Temps	Dam Failure	Landslides	Karst \ Sinkholes	Funding Source	Target Completion Date	Interim Measure of Success	Priority	Comments
	the geographic location of each repetitive loss property and determination if that property has been mitigated and by what means. Provide corrections if needed by filing form FEMA AW-501.																	
2017-1	Assess the roadway structure at various intersections throughout the Town of Vienna to avoid repeated flooding.	Town of Vienna Public Works	X		X									Hazard Mitigation Assistance grant funding, County funding	Ongoing	Identify funding sources by January 2018	High	No
2017-2	Continue to identify and employ a broad range of warning systems throughout the Town of Vienna.	Town of Vienna Police Department	X	X	X	X	X	X	X	X	X	X	X	UASI funding, DHS grants, town/county funding	Ongoing	Identify one new warning system to utilize by December 2017.	High	No
2017-3	Conduct annual outreach to each FEMA-listed repetitive loss and severe repetitive loss property owner, providing information on mitigation programs (grant assistance, mitigation measures, flood insurance information) that can	Town of Vienna Police Department	X		X									FEMA Unified Hazard Mitigation Assistance funding for qualified structures.	Ongoing	In partnership with Fairfax County, seek to develop outreach materials, or identify appropriate outreach materials for dissemination by June	Medium	No

#	Agency/Department: Mitigation Action	Lead Agency Department Organization	Flood	Winter Storm	Wind \ Severe Storm	Tornado	Drought	Wildfire	Earthquake	Extreme Temps	Dam Failure	Landslides	Karst \ Sinkholes	Funding Source	Target Completion Date	Interim Measure of Success	Priority	Comments
	assist them in reducing their flood risk.															2017.		
2017-4	Support mitigation of priority flood-prone structures through promotion of acquisition/ demolition, elevation, flood proofing, minor localized flood control projects, mitigation reconstruction and where feasible using FEMA HMA programs where appropriate.	Town of Vienna Police Department	X		X									FEMA Unified Hazard Mitigation Assistance funding for qualified structures.	Ongoing	Identify all priority flood-prone structures by December 2017.	Medium	No
2017-5	Promote structural mitigation to assure redundancy of critical facilities, to include but not limited to roof structure improvement, to meet or exceed building code standards, upgrade of electrical panels to accept generators, etc.	Town of Vienna Public Works Department	X		X									FEMA Unified Hazard Mitigation Assistance funding for qualified structures.	Ongoing	Query local government building services staffs as to effectiveness of provided information regarding the structural review.	Medium	No
2017-6	Review locality's compliance with the National Flood Insurance Program with an annual review of the Floodplain Ordinances and any	Town of Vienna Police Department	X		X									General funds	Ongoing	In partnership with Fairfax County, establish a schedule of review and	Medium	No

#	Agency/Department: Mitigation Action	Lead Agency Department Organization	Flood	Winter Storm	Wind \ Severe Storm	Tornado	Drought	Wildfire	Earthquake	Extreme Temps	Dam Failure	Landslides	Karst \ Sinkholes	Funding Source	Target Completion Date	Interim Measure of Success	Priority	Comments
	newly permitted activities in the 100-year floodplain. Additionally, Conduct annual review of repetitive loss and severe repetitive loss property list requested of VDEM to ensure accuracy. Review will include verification of the geographic location of each repetitive loss property and determination if that property has been mitigated and by what means. Provide corrections if needed by filing form FEMA AW-501.															review committee (if necessary) by June 2017.		

[1] NCDC's Storm Event database is available at http://www4.ncdc.noaa.gov/cgi-win/wwcgi.dll?wwEvent~Storms.

Chapter 8: Plan Maintenance

This section discusses how the mitigation strategies will be implemented by the Northern Virginia jurisdictions and how the overall Plan will be evaluated and enhanced over time. These aspects were reviewed and updated by the MAC for the 2016 update. This section also discusses how the public will continue to be involved in the hazard mitigation planning process. It consists of the following three subsections:

- Implementation;
- Monitoring, Evaluation and Enhancement; and
- Continued Public Involvement.

I. Implementation

Each jurisdiction participating in the Northern Virginia Hazard Mitigation Plan is responsible for implementing specific mitigation actions as prescribed in their locally adopted Mitigation Action Plan. In each Mitigation Action Plan, every proposed action is assigned to a specific local department or agency in order to assign responsibility and accountability and increase the likelihood of subsequent implementation. This approach enables individual jurisdictions to update their unique Mitigation Action Plan as needed without altering the broader focus of the Regional Plan. The separate adoption of locally-specific actions also ensures that each jurisdiction is not held responsible for monitoring and implementing the actions of other jurisdictions involved in the planning process.

In addition to the assignment of a local lead department or agency, the completion date and interim measure of success date have been assigned in order to assess whether actions are being implemented in a timely fashion. The Northern Virginia jurisdictions will seek outside funding sources to implement mitigation projects in both the pre-disaster and post-disaster environments. When applicable, potential funding sources have been identified and targeted for the proposed actions listed in the Mitigation Action Plans.

It will be the responsibility of each participating jurisdiction to determine additional implementation procedures beyond those listed within their Mitigation Action Plan. This includes integrating the requirements of the Northern Virginia Hazard Mitigation Plan into other local planning documents, processes, or mechanisms, such as comprehensive or capital improvement plans, when appropriate[1]. The members of the Northern Virginia MAC will remain charged with ensuring that the goals and strategies of new and updated local planning documents for their jurisdictions or agencies are consistent with the goals and actions of the Hazard Mitigation Plan, and will not contribute to increased hazard vulnerability in their jurisdictions or the region as a whole.

Opportunities to integrate the requirements of this Plan into other local planning mechanisms shall continue to be identified through future meetings of the Northern Virginia MAC and through the five-year review process described herein. Although it is recognized that there are many possible benefits to integrating components of this Plan into other local planning mechanisms, the development and maintenance of this stand-alone Hazard Mitigation Plan is deemed by the Northern Virginia MAC to be the most effective and appropriate method to implement local hazard mitigation actions at this time. As such, the primary means for integrating mitigation strategies into other local planning mechanisms will be through the revision, update, and implementation of each jurisdiction's individual Mitigation Action Plan specific planning and administrative tasks (e.g., plan amendments, ordinance revisions, capital improvement projects, etc.).

The MAC will continue to coordinate with local jurisdictions in creating processes by which the requirements of this Plan will be incorporated into other local plans. During the planning process for new and updated local planning documents, such as a comprehensive plan, capital improvements plan, or emergency management plan, the MAC will provide a copy of the Plan to the appropriate parties. The MAC will continue to recommend that all goals and strategies of new and updated local planning documents be consistent with the Regional Plan and will not contribute to increased hazards in the affected jurisdiction(s).

II. Monitoring, Evaluation, and Enhancement

Periodic revisions and updates of the Northern Virginia Hazard Mitigation Plan are required to ensure that the goals of the plan are kept current, taking into account potential changes in hazard vulnerability and mitigation priorities. In addition, revisions may be necessary to ensure that the Plan is in full compliance with applicable Federal and State regulations. Periodic evaluation of the Plan will also ensure that specific mitigation actions are being reviewed and carried out according to each participating jurisdiction's individual Mitigation Action Plan.

The Northern Virginia MAC will continue to meet annually and following any disaster events warranting a reexamination of the mitigation actions being implemented or proposed by the participating jurisdictions. This will ensure that the Plan is continuously updated to reflect changing conditions and needs within the region. Additionally, they will reexamine the need to incorporate specific strategies into other planning initiatives as necessary. Each participating jurisdiction will be encouraged by the MAC to complete yearly reviews on the progress of their respective Mitigation Action Plan, and incorporate their strategies into local planning initiatives as appropriate. If determined appropriate or as requested, an annual report on the Plan will be developed by the MAC and submitted to the local governing bodies of participating jurisdictions in order to report progress on the actions identified in the Plan and to provide information on the latest legislative requirements and/or changes to those requirements.

If any participating jurisdiction no longer wishes to actively participate in the development and maintenance of the plan, they must notify the MAC in writing.

A. Five-Year Plan Review

The plan will be reviewed by the MAC every five years to determine whether there have been any significant changes in the region that may, in turn, necessitate changes in the types of mitigation actions proposed. New development in identified hazard areas, an increased exposure to hazards, the increase or decrease in capability to address hazards, and changes to Federal or State legislation are examples of factors that may affect the necessary content of the Plan.

The plan review process provides regional and community officials with an opportunity to evaluate those actions that have been successful and to explore the possibility of documenting potential losses avoided due to the implementation of specific mitigation measures. The plan review also provides the opportunity to address mitigation actions that may not have been successfully implemented as assigned. The Northern Virginia Emergency Managers will be responsible for reconvening the MAC and conducting the five-year review in coordination with the VDEM.

During the five-year plan review process, the following questions will be considered as criteria for assessing the effectiveness and appropriateness of the Plan:

- Do the regional goals address current and expected conditions?
- Has the nature or magnitude of risks changed?
- Are the current resources appropriate for implementing the Plan?
- Are there local implementation problems, such as technical, political, legal, or coordination issues with other agencies?
- Have the outcomes occurred as expected?
- Did the jurisdictions, agencies, and other partners participate in the plan implementation process as proposed?

Following the five-year review, any necessary revisions will be implemented according to the reporting procedures and plan amendment process outlined herein. Upon completion of the review and update/amendment process, the Northern Virginia Hazard Mitigation Plan will be submitted to the State Hazard Mitigation Officer for final review and approval in coordination with FEMA.

B. Disaster Declaration

Following a disaster declaration, the Northern Virginia MAC will reconvene and the Plan will be revised as necessary to reflect lessons learned, or to address specific circumstances arising from the event. It will be the responsibility of the Northern Virginia Emergency Managers to reconvene the MAC and to ensure the appropriate stakeholders are invited to participate in the plan revision and update process following declared disaster events.

C. Reporting Procedures

The results of the five-year review will be summarized by the MAC in a report that will include an evaluation of the effectiveness of the Plan and any required or recommended changes or amendments. The report will also include an evaluation of implementation progress for each of the proposed mitigation actions, identifying reasons for delays or obstacles to their completion along with recommended strategies to overcome them.

Any necessary revisions to the Regional Plan elements shall follow the plan amendment process outlined herein. For changes and updates to the individual Mitigation Action Plans, appropriate local designees will assign responsibility for completion of the task.

D. Plan Amendment Process

Local participating jurisdictions have the authority to approve/adopt changes to their own Mitigation Action Plans without approval from the MAC; however, the MAC should be advised of all changes as a courtesy and for consideration for changes or modifications to the regional Plan. The MAC will be responsible for verifying that the proposed change will not affect the jurisdiction's compliance with current State and Federal mitigation planning requirements. Changes to either the Regional Plan or local Mitigation Action Plans will necessitate the adoption of these changes by the appropriate governing body, and ultimately or upon request the updated Plan or plan component(s) will be submitted to VDEM.

The MAC and its participating jurisdictions will forward information on any proposed change(s) to all interested parties including, but not limited to, all affected county and municipal departments, residents and businesses. When a proposed amendment may directly affect particular private individuals or properties, each jurisdiction will follow existing local, State or Federal notification requirements which may include published public notices as well as direct mailings. Information on any proposed plan amendments will also be forwarded to VDEM. This information will be disseminated in order to seek input on the proposed amendment(s) for not less than a 45-day review and comment period.

At the end of the 45-day review and comment period, the proposed amendment(s) and all comments will be forwarded to the MAC for final consideration. The committee will review the proposed amendment along with the comments received from other parties, and if acceptable, the committee will submit a recommendation for the approval and adoption of changes to the Plan to each appropriate governing body within 60 days.

In determining whether to recommend approval or denial of a plan amendment request, the following factors will be considered by the MAC:

- There are errors, inaccuracies, or omissions made in the identification of issues or needs in the Plan;
- New issues or needs have been identified which are not adequately addressed in the Plan;
- There has been a change in information, data, or assumptions from those on which the Plan is based; and
- There has been a change in local capabilities to implement proposed hazard mitigation activities.

Upon receiving the recommendation from the Northern Virginia MAC and prior to adoption of the Plan, each local governing body will hold a public hearing. The governing body will review the recommendation from the committee (including the factors listed above) and any oral or written comments received at the public hearing. Following that review, the governing body will take one of the following actions:

- Adopt the proposed amendments as presented;
- Adopt the proposed amendments with modifications;
- Refer the amendments request back to the MAC for further revision; or
- Defer the amendment request back to the MAC for further consideration and/or additional hearings.

III. Continued Public Involvement

Public participation is an integral component of the mitigation planning process and will continue to be essential as this Plan evolves over time. As described above, significant changes or amendments to the Plan may require a public hearing prior to any adoption procedures.

Additional efforts to involve the public in the maintenance, evaluation, and revision process will be made as necessary. These efforts may include:

- Advertising proposed changes to the Plan to the public;
- Utilizing the MAC and municipal or county websites to advertise any maintenance and/or periodic review activities taking place; and
- Keeping copies accessible via public Websites.

---

[1] A listing of each jurisdiction's local planning documents (or those under development) is provided in Section 7: Capability Assessment.

APPENDIX A

PLAN CROSSWALK

Note, to be completed following conditional approval.

LOCAL MITIGATION PLAN REVIEW TOOL

The *Local Mitigation Plan Review Tool* demonstrates how the Local Mitigation Plan meets the regulation in 44 CFR §201.6 and offers States and FEMA Mitigation Planners an opportunity to provide feedback to the community.

- The Regulation Checklist provides a summary of FEMA's evaluation of whether the Plan has addressed all requirements.
- The Plan Assessment identifies the plan's strengths as well as documents areas for future improvement.
- The Multi-jurisdiction Summary Sheet is an optional worksheet that can be used to document how each jurisdiction met the requirements of the each Element of the Plan (Planning Process; Hazard Identification and Risk Assessment; Mitigation Strategy; Plan Review, Evaluation, and Implementation; and Plan Adoption).

The FEMA Mitigation Planner must reference this *Local Mitigation Plan Review Guide* when completing the *Local Mitigation Plan Review Tool*.

Jurisdiction: Northern Virginia Region	**Title of Plan: Northern Virginia Hazard Mitigation Plan Update**	**Date of Plan: February 2017**

Local Point of Contact: Greg Zebrowski	**Address:** **4890 Alliance Drive** **Suite 2200** **Fairfax, VA 22030**
Title: Lead Planner	
Agency: Fairfax County Office of Emergency Management	
Phone Number: 571-350-1297	**E-Mail:Gregory.zebrowski@fairfaxcounty.gov**

State Reviewer:	**Title:**	**Date:**

FEMA Reviewer:	**Title:**	**Date:**
Date Received in FEMA Region ***(insert #)***		
Plan Not Approved		
Plan Approvable Pending Adoption		
Plan Approved		

SECTION 1:
REGULATION CHECKLIST

INSTRUCTIONS: The Regulation Checklist must be completed by FEMA. The purpose of the Checklist is to identify the location of relevant or applicable content in the Plan by Element/sub-element and to determine if each requirement has been 'Met' or 'Not Met.' The 'Required Revisions' summary at the bottom of each Element must be completed by FEMA to provide a clear explanation of the revisions that are required for plan approval. Required revisions must be explained for each plan sub-element that is 'Not Met.' Sub-elements should be referenced in each summary by using the appropriate numbers (A1, B3, etc.), where applicable. Requirements for each Element and sub-element are described in detail in this *Plan Review Guide* in Section 4, Regulation Checklist.

1. REGULATION CHECKLIST **Regulation** (44 CFR 201.6 Local Mitigation Plans)	**Location in Plan** (section and/or page number)	**Met**	**Not Met**
ELEMENT A. PLANNING PROCESS			
A1. Does the Plan document the planning process, including how it was prepared and who was involved in the process for each jurisdiction? (Requirement §201.6(c)(1))	Introduction p.1.1 Chapter 2 p.2-1 thru 2-6		
A2. Does the Plan document an opportunity for neighboring communities, local and regional agencies involved in hazard mitigation activities, agencies that have the authority to regulate development as well as other interests to be involved in the planning process? (Requirement §201.6(b)(2))	Chapter 2, Section 2 p.2-4-2 thru 2-6		
A3. Does the Plan document how the public was involved in the planning process during the drafting stage? (Requirement §201.6(b)(1))	Chapter 2, Section 2 p.2-4-2 thru 2.6		
A4. Does the Plan describe the review and incorporation of existing plans, studies, reports, and technical information? (Requirement §201.6(b)(3))	Chapter 2, Section 2 p.2-6		
A5. Is there discussion of how the community(ies) will continue public participation in the plan maintenance process? (Requirement §201.6(c)(4)(iii))	Chapter 8 p. 8-5		
A6. Is there a description of the method and schedule for keeping the plan current (monitoring, evaluating and updating the mitigation plan within a 5-year cycle)? (Requirement §201.6(c)(4)(i))	Chapter 8 p. 8-1 thru 8-5		
<u>**ELEMENT A: REQUIRED REVISIONS**</u>			
ELEMENT B. HAZARD IDENTIFICATION AND RISK ASSESSMENT			

1. REGULATION CHECKLIST **Regulation** (44 CFR 201.6 Local Mitigation Plans)	**Location in Plan** (section and/or page number)	**Met**	**Not Met**
B1. Does the Plan include a description of the type, location, and extent of all natural hazards that can affect each jurisdiction(s)? (Requirement §201.6(c)(2)(i))	Chapter 1 : Section I Background p. 1-1 Chapter 4: Section III Hazard Identification: P. 4-27 thru 4-35		
B2. Does the Plan include information on previous occurrences of hazard events and on the probability of future hazard events for each jurisdiction? (Requirement §201.6(c)(2)(i))	Chapter 4 p.4-1 thru 4-191		
B3. Is there a description of each identified hazard's impact on the community as well as an overall summary of the community's vulnerability for each jurisdiction? (Requirement §201.6(c)(2)(ii))	Chapter 4: Regional HIRA p. 4-38, Chapter 3: Regional Information p. 3-1-3-28 Chapter 7: Jurisdiction Executive Summaries p.7-1 thru p. 7-117		
B4. Does the Plan address NFIP insured structures within the jurisdiction that have been repetitively damaged by floods? (Requirement §201.6(c)(2)(ii))	Chapter 4: Regional Hazard Identification and Risk Assessment p. 4-67 thru p.4-68 including Table 4.24		
ELEMENT B: REQUIRED REVISIONS •			
ELEMENT C. MITIGATION STRATEGY			
C1. Does the plan document each jurisdiction's existing authorities, policies, programs and resources and its ability to expand on and improve these existing policies and programs? (Requirement §201.6(c)(3))	Chapter 6: p. 6-1 thru 6-6 Chapter 7: Jurisdiction Executive Summaries p.7-1 thru p. 7-117		
C2. Does the Plan address each jurisdiction's participation in the NFIP and continued compliance with NFIP requirements, as appropriate? (Requirement §201.6(c)(3)(ii))	Chapter 6: pg. 6-1 thru 6-6 Chapter 7: Jurisdiction Executive Summaries p.7-1 thru p.7-117		
C3. Does the Plan include goals to reduce/avoid long-term vulnerabilities to the identified hazards? (Requirement §201.6(c)(3)(i))	Chapter 6: p. 6-1 thru p.6-6 Chapter 7: Jurisdiction Executive Summaries p.7-1 thru p.7-117		
C4. Does the Plan identify and analyze a comprehensive range of specific mitigation actions and projects for each jurisdiction being considered to reduce the effects of hazards, with emphasis on new and existing buildings and infrastructure? (Requirement §201.6(c)(3)(ii))	Chapter 6: p. 6-1 thru 6-6 Chapter 7: Jurisdiction Executive Summaries p.7-1 thru p.7-117		

1. REGULATION CHECKLIST **Regulation** (44 CFR 201.6 Local Mitigation Plans)	**Location in Plan** (section and/or page number)	**Met**	**Not Met**
C5. Does the Plan contain an action plan that describes how the actions identified will be prioritized (including cost benefit review), implemented, and administered by each jurisdiction? (Requirement §201.6(c)(3)(iv)); (Requirement §201.6(c)(3)(iii))	Chapter 6: p. 6-1 thru 6-6 Chapter 7: Jurisdiction Executive Summaries p.7-1 thru p.7-117		
C6. Does the Plan describe a process by which local governments will integrate the requirements of the mitigation plan into other planning mechanisms, such as comprehensive or capital improvement plans, when appropriate? (Requirement §201.6(c)(4)(ii))	Chapter 6: pg. 6-1 thru 6-6 Chapter 7: Jurisdiction Executive Summaries p.7-1 thru p.7-117		
ELEMENT C: REQUIRED REVISIONS			
ELEMENT D. PLAN REVIEW, EVALUATION, AND IMPLEMENTATION (applicable to plan updates only)			
D1. Was the plan revised to reflect changes in development? (Requirement §201.6(d)(3))	Chapter 3, p. 3-23		
D2. Was the plan revised to reflect progress in local mitigation efforts? (Requirement §201.6(d)(3))	Chapter 7: Jurisdiction Executive Summaries p.7-1 thru p.7-117		
D3. Was the plan revised to reflect changes in priorities? (Requirement §201.6(d)(3))	Chapter 6: Section II: Considering Mitigation Alternatives p. 6-1		
ELEMENT D: REQUIRED REVISIONS			
ELEMENT E. PLAN ADOPTION			
E1. Does the Plan include documentation that the plan has been formally adopted by the governing body of the jurisdiction requesting approval? (Requirement §201.6(c)(5))	This will be covered in the Final version in Appendix B-Adoption Resolution		
E2. For multi-jurisdictional plans, has each jurisdiction requesting approval of the plan documented formal plan adoption? (Requirement §201.6(c)(5))	This will be covered in the Final version in Appendix B-Adoption Resolution		
ELEMENT E: REQUIRED REVISIONS			
ELEMENT F. ADDITIONAL STATE REQUIREMENTS (OPTIONAL FOR STATE REVIEWERS ONLY; NOT TO BE COMPLETED BY FEMA)			
F1. Does the plan include a Capabilities Assessment for each participating jurisdiction?	Chapter 5 p.5-1thru p.5-17		

1. REGULATION CHECKLIST **Regulation** (44 CFR 201.6 Local Mitigation Plans)	**Location in Plan** (section and/or page number)	**Met**	**Not Met**
F2. Are flood maps included for each participating jurisdiction?	Included in Appendix D-HIRA Documentation		
F3. Have other high hazard risk maps been included for each participating jurisdiction?	Included in Appendix D-HIRA Documentation		
F4. Does the plan include a repetitive loss strategy to verify the geographic location of each repetitive loss property and determine if that property has been mitigated and by what means?	Chapter 4 p. 4-67 thru p.4-68		
ELEMENT F: REQUIRED REVISIONS			

SECTION 2:
PLAN ASSESSMENT

INSTRUCTIONS: The purpose of the Plan Assessment is to offer the local community more comprehensive feedback to the community on the quality and utility of the plan in a narrative format. The audience for the Plan Assessment is not only the plan developer/local community planner, but also elected officials, local departments and agencies, and others involved in implementing the Local Mitigation Plan. The Plan Assessment must be completed by FEMA. The Assessment is an opportunity for FEMA to provide feedback and information to the community on: 1) suggested improvements to the Plan; 2) specific sections in the Plan where the community has gone above and beyond minimum requirements; 3) recommendations for plan implementation; and 4) ongoing partnership(s) and information on other FEMA programs, specifically RiskMAP and Hazard Mitigation Assistance programs. The Plan Assessment is divided into two sections:

1. Plan Strengths and Opportunities for Improvement
2. Resources for Implementing Your Approved Plan

Plan Strengths and Opportunities for Improvement is organized according to the plan Elements listed in the Regulation Checklist. Each Element includes a series of italicized bulleted items that are suggested topics for consideration while evaluating plans, but it is not intended to be a comprehensive list. FEMA Mitigation Planners are not required to answer each bullet item, and should use them as a guide to paraphrase their own written assessment (2-3 sentences) of each Element.

The Plan Assessment must not reiterate the required revisions from the Regulation Checklist or be regulatory in nature, and should be open-ended and to provide the community with suggestions for improvements or recommended revisions. The recommended revisions are suggestions for improvement and are not required to be made for the Plan to meet Federal regulatory requirements. The italicized text should be deleted once FEMA has added comments regarding strengths of the plan and potential improvements for future plan revisions. It is recommended that the Plan Assessment be a short synopsis of the overall strengths and weaknesses of the Plan (no longer than two pages), rather than a complete recap section by section.

Resources for Implementing Your Approved Plan provides a place for FEMA to offer information, data sources and general suggestions on the overall plan implementation and maintenance process. Information on other possible sources of assistance including, but not limited to, existing publications, grant funding or training opportunities, can be provided. States may add state and local resources, if available.

A. Plan Strengths and Opportunities for Improvement

This section provides a discussion of the strengths of the plan document and identifies areas where these could be improved beyond minimum requirements.

Element A: Planning Process

How does the Plan go above and beyond minimum requirements to document the planning process with respect to: • *Involvement of stakeholders (elected officials/decision makers, plan implementers, business owners, academic institutions, utility companies, water/sanitation districts, etc.);* • *Involvement of Planning, Emergency Management, Public Works Departments or other planning agencies (i.e., regional planning councils);* • *Diverse methods of participation (meetings, surveys, online, etc.); and* • *Reflective of an open and inclusive public involvement process.*

Element B: Hazard Identification and Risk Assessment

In addition to the requirements listed in the Regulation Checklist, 44 CFR 201.6 Local Mitigation Plans identifies additional elements that should be included as part of a plan's risk assessment. The plan should describe vulnerability in terms of: *1) A general description of land uses and future development trends within the community so that mitigation options can be considered in future land use decisions;* *2) The types and numbers of existing and future buildings, infrastructure, and critical facilities located in the identified hazard areas; and* *3) A description of potential dollar losses to vulnerable structures, and a description of the methodology used to prepare the estimate.* *How does the Plan go above and beyond minimum requirements to document the Hazard Identification and Risk Assessment with respect to:* • *Use of best available data (flood maps, HAZUS, flood studies) to describe significant hazards;* • *Communication of risk on people, property, and infrastructure to the public (through tables, charts, maps, photos, etc.);* • *Incorporation of techniques and methodologies to estimate dollar losses to vulnerable structures;* • *Incorporation of Risk MAP products (i.e., depth grids, Flood Risk Report, Changes Since Last FIRM, Areas of Mitigation Interest, etc.); and* • *Identification of any data gaps that can be filled as new data became available.*

Element C: Mitigation Strategy

How does the Plan go above and beyond minimum requirements to document the Mitigation Strategy with respect to:

- *Key problems identified in, and linkages to, the vulnerability assessment;*
- *Serving as a blueprint for reducing potential losses identified in the Hazard Identification and Risk Assessment;*
- *Plan content flow from the risk assessment (problem identification) to goal setting to mitigation action development;*
- *An understanding of mitigation principles (diversity of actions that include structural projects, preventative measures, outreach activities, property protection measures, post-disaster actions, etc);*
- *Specific mitigation actions for each participating jurisdictions that reflects their unique risks and capabilities;*
- *Integration of mitigation actions with existing local authorities, policies, programs, and resources; and*
- *Discussion of existing programs (including the NFIP), plans, and policies that could be used to implement mitigation, as well as document past projects.*

Element D: Plan Update, Evaluation, and Implementation (*Plan Updates Only*)

How does the Plan go above and beyond minimum requirements to document the 5-year Evaluation and Implementation measures with respect to:

- *Status of previously recommended mitigation actions;*
- *Identification of barriers or obstacles to successful implementation or completion of mitigation actions, along with possible solutions for overcoming risk;*
- *Documentation of annual reviews and committee involvement;*
- *Identification of a lead person to take ownership of, and champion the Plan;*
- *Reducing risks from natural hazards and serving as a guide for decisions makers as they commit resources to reducing the effects of natural hazards;*
- *An approach to evaluating future conditions (i.e. socio-economic, environmental, demographic, change in built environment etc.);*
- *Discussion of how changing conditions and opportunities could impact community resilience in the long term; and*
- *Discussion of how the mitigation goals and actions support the long-term community vision for increased resilience.*

B. Resources for Implementing Your Approved Plan

Ideas may be offered on moving the mitigation plan forward and continuing the relationship with key mitigation stakeholders such as the following:

- *What FEMA assistance (funding) programs are available (for example, Hazard Mitigation Assistance (HMA)) to the jurisdiction(s) to assist with implementing the mitigation actions?*
- *What other Federal programs (National Flood Insurance Program (NFIP), Community Rating System (CRS), Risk MAP, etc.) may provide assistance for mitigation activities?*
- *What publications, technical guidance or other resources are available to the jurisdiction(s) relevant to the identified mitigation actions?*
- *Are there upcoming trainings/workshops (Benefit-Cost Analysis (BCA), HMA, etc.) to assist the jurisdictions(s)?*
- *What mitigation actions can be funded by other Federal agencies (for example, U.S. Forest Service, National Oceanic and Atmospheric Administration (NOAA), Environmental Protection Agency (EPA) Smart Growth, Housing and Urban Development (HUD) Sustainable Communities, etc.) and/or state and local agencies?*

SECTION 3:
MULTI-JURISDICTION SUMMARY SHEET (OPTIONAL)

INSTRUCTIONS: For multi-jurisdictional plans, a Multi-jurisdiction Summary Spreadsheet may be completed by listing each participating jurisdiction, which required Elements for each jurisdiction were 'Met' or 'Not Met,' and when the adoption resolutions were received. This Summary Sheet does not imply that a mini-plan be developed for each jurisdiction; it should be used as an optional worksheet to ensure that each jurisdiction participating in the Plan has been documented and has met the requirements for those Elements (A through E).

MULTI-JURISDICTION SUMMARY SHEET												
#	Jurisdiction Name	Plan POC	Mailing Address	Email	Phone	Requirements Met (Y/N)					
						A. Planning Process	B. Hazard Identification & Risk Assessment	C. Mitigation Strategy	D. Plan Review, Evaluation & Implementation	E. Plan Adoption	F. State Require-ments
1	Alexandria	Corey A. Smedley		Corey.smedley@alexandriava.gov	703.746.5256						
2	Arlington County	David R. Morrison		Dmorrison@arlingtonva.us	703.228.3256						
3	Fairfax County	Gregory Zebrowski	4890 Alliance Drive, Suite 2200 Fairfax, VA 22030	Gregory.zebrowski@fairfaxcounty.gov	571-350-1297						
4	Loudoun County	Kevin Johnson	801 Sycolin Road SE #100 PO Box 7100 Leesburg, VA 20177-7100	Kevin.Johnson@loudoun.gov	703-737-8831						
5	Prince William County	Alexa (Hussar) Lenhart		AHussar@pwcgov.org	703-792-5254						

MULTI-JURISDICTION SUMMARY SHEET											
#	Jurisdiction Name	Plan POC	Mailing Address	Email	Phone	Requirements Met (Y/N)					
						A. Planning Process	B. Hazard Identification & Risk Assessment	C. Mitigation Strategy	D. Plan Review, Evaluation & Implementation	E. Plan Adoption	F. State Require-ments
6	City of Fairfax	Walter English,III	City of Fairfax Office of Emergency Management 10455 Armstrong Street Fairfax, VA 22030	walter.english@fairfaxva.gov	703-273-6269						
7	City of Falls Church	Tom Polera	300 Park Ave, G2 East Falls Chuch, VA 22046	TPolera@fallschurchva.gov	703-248-5058						
8	City of Manassas	Amelia Gagnon	9324 West Street - Suite 103 Manassas, Virginia 20110	agagnon@ci.manassas.va.us	703-257-8062						
9	City of Manassas Park	Robert Hoffower	4975 Alliance Drive, 4th Floor, Suite 4E-200 Fairfax, VA 22033	robert.hoffower@vdem.virginia.gov	804-205-6911						
10	Town of Dumfries	Richard Paul West	17755 Main Street Dumfries, VA 22026	rwest@dumfriesva.gov	703-221-3400 ext: 119						
11	Town of Haymarket	Holly Montague	15000 Washington Street #100 Haymarket, Virginia 20169	hmontague@townofhaymarket.org	703-753-2600						
12	Town of Herndon	Lt. Stephen Thompson	397 Herndon Parkway Herndon, VA 20170	stephen.thompson@herndon-va.gov	(703) 436-6881 x2332						

MULTI-JURISDICTION SUMMARY SHEET											
#	Jurisdiction Name	Plan POC	Mailing Address	Email	Phone	Requirements Met (Y/N)					
						A. Planning Process	B. Hazard Identification & Risk Assessment	C. Mitigation Strategy	D. Plan Review, Evaluation & Implementation	E. Plan Adoption	F. State Require-ments
13	Town of Leesburg	Kevin Johnson	801 Sycolin Road SE #100 PO Box 7100 Leesburg, VA 20177-7100	Kevin.Johnson@loudoun.gov	703-737-8831						
14	Town of Middleburg	Kevin Johnson	801 Sycolin Road SE #100 PO Box 7100 Leesburg, VA 20177-7100	Kevin.Johnson@loudoun.gov	703-737-8831						
15	Town of Occoquan	Kirstyn B. Jovanovich	314 Mill Street PO Box 195 Occoquan, VA 22125	kjovanovich@occoquanva.gov	703-491-1918 Ext. 2						
16	Town of Purcellville	Kevin Johnson	801 Sycolin Road SE #100 PO Box 7100 Leesburg, VA 20177-7100	Kevin.Johnson@loudoun.gov	703-737-8831						
17	Town of Round Hill	Kevin Johnson	801 Sycolin Road SE #100 PO Box 7100 Leesburg, VA 20177-7100	Kevin.Johnson@loudoun.gov	703-737-8831						
18	Town of Vienna	Daniel Janickey,		dan.janickey@viennava.gov	703-255-6397						

LOCAL MITIGATION PLAN REVIEW TOOL

The *Local Mitigation Plan Review Tool* demonstrates how the Local Mitigation Plan meets the regulation in 44 CFR §201.6 and offers States and FEMA Mitigation Planners an opportunity to provide feedback to the community.

- The Regulation Checklist provides a summary of FEMA's evaluation of whether the Plan has addressed all requirements.
- The Plan Assessment identifies the plan's strengths as well as documents areas for future improvement.
- The Multi-jurisdiction Summary Sheet is an optional worksheet that can be used to document how each jurisdiction met the requirements of the each Element of the Plan (Planning Process; Hazard Identification and Risk Assessment; Mitigation Strategy; Plan Review, Evaluation, and Implementation; and Plan Adoption).

The FEMA Mitigation Planner must reference this *Local Mitigation Plan Review Guide* when completing the *Local Mitigation Plan Review Tool*.

Jurisdiction: **Northern Virginia**	**Title of Plan:** **Northern Virginia PDC HMP**	**Date of Plan:**

Local Point of Contact:	**Address:**
Title:	
Agency:	
Phone Number:	**E-Mail:**

State Reviewer: **Debbie Messmer**	**Title:**	**Date:**

FEMA Reviewer: **Matt McCullough**	**Title:** Community Planner	**Date:** 01/06/17
Date Received in FEMA Region ***(insert #)***		
Plan Not Approved		
Plan Approvable Pending Adoption		
Plan Approved		

SECTION 1:
REGULATION CHECKLIST

INSTRUCTIONS: The Regulation Checklist must be completed by FEMA. The purpose of the Checklist is to identify the location of relevant or applicable content in the Plan by Element/sub-element and to determine if each requirement has been 'Met' or 'Not Met.' The 'Required Revisions' summary at the bottom of each Element must be completed by FEMA to provide a clear explanation of the revisions that are required for plan approval. Required revisions must be explained for each plan sub-element that is 'Not Met.' Sub-elements should be referenced in each summary by using the appropriate numbers (A1, B3, etc.), where applicable. Requirements for each Element and sub-element are described in detail in this *Plan Review Guide* in Section 4, Regulation Checklist.

1. REGULATION CHECKLIST **Regulation** (44 CFR 201.6 Local Mitigation Plans)	**Location in Plan** (section and/or page number)	**Met**	**Not Met**
ELEMENT A. PLANNING PROCESS			
A1. Does the Plan document the planning process, including how it was prepared and who was involved in the process for each jurisdiction? (Requirement §201.6(c)(1))	Pg. 2-1 – 2-6 Table 2.2 Appx C	X	
A2. Does the Plan document an opportunity for neighboring communities, local and regional agencies involved in hazard mitigation activities, agencies that have the authority to regulate development as well as other interests to be involved in the planning process? (Requirement §201.6(b)(2))	Pg. 2-1 – 2-6	X	
A3. Does the Plan document how the public was involved in the planning process during the drafting stage? (Requirement §201.6(b)(1))	Pg. 2-4 – 2-6	X	
A4. Does the Plan describe the review and incorporation of existing plans, studies, reports, and technical information? (Requirement §201.6(b)(3))	P. 2-6		**X**
A5. Is there discussion of how the community(ies) will continue public participation in the plan maintenance process? (Requirement §201.6(c)(4)(iii))	Pg. 8-5	X	
A6. Is there a description of the method and schedule for keeping the plan current (monitoring, evaluating and updating the mitigation plan within a 5-year cycle)? (Requirement §201.6(c)(4)(i))	Pg. 8-1 – 8-4	X	

1. REGULATION CHECKLIST **Regulation** (44 CFR 201.6 Local Mitigation Plans)	**Location in Plan** (section and/or page number)	**Met**	**Not Met**
ELEMENT A: REQUIRED REVISIONS **Note:** Pg. 2-4: Are there specific public outreach meetings types following the conditional approval of the plan? Pg. 2-5: References Appendix H. The CD only lists Appendices up to F. Pg. 2-5: Fairfax County Outreach- was there any feedback documented for the newsletters sent to the Council of Governments or Businesses? **A2.) Recommended Revision:** Pg. 2-4 & 2-5: In the next plan update please include a description as to how neighboring jurisdictions were invited to participate. **A4.) Required Revision:** - Please include a brief narrative as to how the documents listed on pg. 2-6 were incorporated into the plan. - Please cite the additional sources of data and information that was used. Example-NCDC site **A5.) Note:** Utilizing the idea of after-conditional meetings noted on Pg. 2-4; communities could create a bi-annual or annual opportunity for continued public involvement. **Kudos:** Excellent documentation			
ELEMENT B. HAZARD IDENTIFICATION AND RISK ASSESSMENT			
B1. Does the Plan include a description of the type, location, and extent of all natural hazards that can affect each jurisdiction(s)? (Requirement §201.6(c)(2)(i))	Pg. 4-50 – 4-193	X	
B2. Does the Plan include information on previous occurrences of hazard events and on the probability of future hazard events for each jurisdiction? (Requirement §201.6(c)(2)(i))	Pg. 4-30 – 4-193	X	
B3. Is there a description of each identified hazard's impact on the community as well as an overall summary of the community's vulnerability for each jurisdiction? (Requirement §201.6(c)(2)(ii))	Pg. 4-50 – 4-193	X	
B4. Does the Plan address NFIP insured structures within the jurisdiction that have been repetitively damaged by floods? (Requirement §201.6(c)(2)(ii))	Pg. 4-67 – 4-68	X	

1. REGULATION CHECKLIST **Regulation** (44 CFR 201.6 Local Mitigation Plans)	**Location in Plan** (section and/or page number)	**Met**	**Not Met**
ELEMENT B: REQUIRED REVISIONS **B1.) Required Revision:** Pg. 4-90 & 4-91: Please better identify the planning area for Figures 4.24 & 4.25. Highlighting the borders of the PDC will be sufficient. Pg. 4-97 -4-100: Please better identify the planning area for Figures 4.26 -4.29. Circling the general Northern Virginia area will suffice. Pg. 4-132: Figure 4.34, 4.35, 4.37, 4.41,-Ditto- Circle or Highlight Pg 4-173: Figure 4.46 Please remove circled portion and circle or highlight the NoVA PDC **Discussion:** Pg. 4-35 – 4-42: Are the rankings on Table 4.10 – 4.15 being attributed to individual jurisdictions? Pg. 4-44 and 4-46 are no present. Is there additional information on those pages? (Unique and varied risk) **Note:** Pg. 4-110: Was there a disaster declaration for Virginia for Hurricane Sandy? **Kudos:** Great mapping! Yes, I made it all the way to page 1092 in Appendix D			
ELEMENT C. MITIGATION STRATEGY			
C1. Does the plan document each jurisdiction's existing authorities, policies, programs and resources and its ability to expand on and improve these existing policies and programs? (Requirement §201.6(c)(3))	Chapter 5	X	
C2. Does the Plan address each jurisdiction's participation in the NFIP and continued compliance with NFIP requirements, as appropriate? (Requirement §201.6(c)(3)(ii))	Pg. 5-17 & 5-18		X
C3. Does the Plan include goals to reduce/avoid long-term vulnerabilities to the identified hazards? (Requirement §201.6(c)(3)(i))	Pg. 6-3 – 6-4	X	
C4. Does the Plan identify and analyze a comprehensive range of specific mitigation actions and projects for each jurisdiction being considered to reduce the effects of hazards, with emphasis on new and existing buildings and infrastructure? (Requirement §201.6(c)(3)(ii))	Pg. 7-1 – 7-132	X	
C5. Does the Plan contain an action plan that describes how the actions identified will be prioritized (including cost benefit review), implemented, and administered by each jurisdiction? (Requirement §201.6(c)(3)(iv)); (Requirement §201.6(c)(3)(iii))	Pg. 6-3 Table 6.1	X	
C6. Does the Plan describe a process by which local governments will integrate the requirements of the mitigation plan into other planning mechanisms, such as comprehensive or capital improvement plans, when appropriate? (Requirement §201.6(c)(4)(ii))	Pg. 5-13 – 5-16	X	

1. REGULATION CHECKLIST **Regulation** (44 CFR 201.6 Local Mitigation Plans)	Location in Plan (section and/or page number)	Met	Not Met
ELEMENT C: REQUIRED REVISIONS **C2.) Required Revision:** Pg. 5-17: Please include information for each jurisdiction as to their day-to-day management of the floodplain. This would include mapping, enforcement and insurance. Please see the attached Strategy Guide and Matrix for reference. **Discussion:** Pg. 7-9- Action 2010-16: Fairfax County has only listed Buy-Out as a strategy. Pg. 7-39: Prince William County does not have a strategy noted for Acquisition, Elevation, Relocation, etc.. Pg. 7-73: Town of Dumfries does not have a strategy noted for Acquisition, Elevation, Relocation, etc.. Pg. 7-98: Town of Lovettsvile does not have a strategy noted for Acquisition, Elevation, Relocation, etc.. **Note:** Pg. 7-48: City of Fairfax strategy 2017-6. The development of this platform could be extremely useful in the plan integration realm. **Recommended Revision:** More accurately align the strategy to the hazard it is supposed to be addressing. Example: Pg. 7-121; Strategy 2010-3 **C6.) Kudos:** Excellent write-up on potential plan integration opportunities. Please see the attached copy of “Plan Integration: Linking Local Planning Efforts”. This tool can be used to further identify specific points of risk reduction integration, into other planning mechanisms.			
ELEMENT D. PLAN REVIEW, EVALUATION, AND IMPLEMENTATION (applicable to plan updates only)			
D1. Was the plan revised to reflect changes in development? (Requirement §201.6(d)(3))	Pg. 3-21 – 3-29	X	
D2. Was the plan revised to reflect progress in local mitigation efforts? (Requirement §201.6(d)(3))	Chapter 7	X	
D3. Was the plan revised to reflect changes in priorities? (Requirement §201.6(d)(3))	Pg. 6-1	X	
ELEMENT D: REQUIRED REVISIONS **D.1) Kudos:** Very in-depth discussion on land use, population and potential change. **Note:** Pg. 7-48: City of Fairfax strategy 2017-6. The development of this platform could be extremely useful in the plan integration realm. **D.2) Recommendation:** Enhance the Executive Summary space to include a narrative on mitigation practices and principles that are being engaged in for that given jurisdiction.			
ELEMENT E. PLAN ADOPTION			

1. REGULATION CHECKLIST **Regulation** (44 CFR 201.6 Local Mitigation Plans)	**Location in Plan** (section and/or page number)	**Met**	**Not Met**
E1. Does the Plan include documentation that the plan has been formally adopted by the governing body of the jurisdiction requesting approval? (Requirement §201.6(c)(5))			
E2. For multi-jurisdictional plans, has each jurisdiction requesting approval of the plan documented formal plan adoption? (Requirement §201.6(c)(5))			
ELEMENT E: REQUIRED REVISIONS			
ELEMENT F. ADDITIONAL STATE REQUIREMENTS (OPTIONAL FOR STATE REVIEWERS ONLY; NOT TO BE COMPLETED BY FEMA)			
F1.			
F2.			
ELEMENT F: REQUIRED REVISIONS			

SECTION 2:
PLAN ASSESSMENT

INSTRUCTIONS: The purpose of the Plan Assessment is to offer the local community more comprehensive feedback to the community on the quality and utility of the plan in a narrative format. The audience for the Plan Assessment is not only the plan developer/local community planner, but also elected officials, local departments and agencies, and others involved in implementing the Local Mitigation Plan. The Plan Assessment must be completed by FEMA. The Assessment is an opportunity for FEMA to provide feedback and information to the community on: 1) suggested improvements to the Plan; 2) specific sections in the Plan where the community has gone above and beyond minimum requirements; 3) recommendations for plan implementation; and 4) ongoing partnership(s) and information on other FEMA programs, specifically RiskMAP and Hazard Mitigation Assistance programs. The Plan Assessment is divided into two sections:

1. Plan Strengths and Opportunities for Improvement
2. Resources for Implementing Your Approved Plan

Plan Strengths and Opportunities for Improvement is organized according to the plan Elements listed in the Regulation Checklist. Each Element includes a series of italicized bulleted items that are suggested topics for consideration while evaluating plans, but it is not intended to be a comprehensive list. FEMA Mitigation Planners are not required to answer each bullet item, and should use them as a guide to paraphrase their own written assessment (2-3 sentences) of each Element.

The Plan Assessment must not reiterate the required revisions from the Regulation Checklist or be regulatory in nature, and should be open-ended and to provide the community with suggestions for improvements or recommended revisions. The recommended revisions are suggestions for improvement and are not required to be made for the Plan to meet Federal regulatory requirements. The italicized text should be deleted once FEMA has added comments regarding strengths of the plan and potential improvements for future plan revisions. It is recommended that the Plan Assessment be a short synopsis of the overall strengths and weaknesses of the Plan (no longer than two pages), rather than a complete recap section by section.

Resources for Implementing Your Approved Plan provides a place for FEMA to offer information, data sources and general suggestions on the overall plan implementation and maintenance process. Information on other possible sources of assistance including, but not limited to, existing publications, grant funding or training opportunities, can be provided. States may add state and local resources, if available.

A. Plan Strengths and Opportunities for Improvement

This section provides a discussion of the strengths of the plan document and identifies areas where these could be improved beyond minimum requirements.

Element A: Planning Process

How does the Plan go above and beyond minimum requirements to document the planning process with respect to:

- *Involvement of stakeholders (elected officials/decision makers, plan implementers, business owners, academic institutions, utility companies, water/sanitation districts, etc.);*
- *Involvement of Planning, Emergency Management, Public Works Departments or other planning agencies (i.e., regional planning councils);*
- *Diverse methods of participation (meetings, surveys, online, etc.); and*
- *Reflective of an open and inclusive public involvement process.*

Element B: Hazard Identification and Risk Assessment

In addition to the requirements listed in the Regulation Checklist, 44 CFR 201.6 Local Mitigation Plans identifies additional elements that should be included as part of a plan's risk assessment. The plan should describe vulnerability in terms of:

1) *A general description of land uses and future development trends within the community so that mitigation options can be considered in future land use decisions;*
2) *The types and numbers of existing and future buildings, infrastructure, and critical facilities located in the identified hazard areas; and*
3) *A description of potential dollar losses to vulnerable structures, and a description of the methodology used to prepare the estimate.*

How does the Plan go above and beyond minimum requirements to document the Hazard Identification and Risk Assessment with respect to:

- *Use of best available data (flood maps, HAZUS, flood studies) to describe significant hazards;*
- *Communication of risk on people, property, and infrastructure to the public (through tables, charts, maps, photos, etc.);*
- *Incorporation of techniques and methodologies to estimate dollar losses to vulnerable structures;*
- *Incorporation of Risk MAP products (i.e., depth grids, Flood Risk Report, Changes Since Last FIRM, Areas of Mitigation Interest, etc.); and*
- *Identification of any data gaps that can be filled as new data became available.*

Element C: Mitigation Strategy

How does the Plan go above and beyond minimum requirements to document the Mitigation Strategy with respect to: • *Key problems identified in, and linkages to, the vulnerability assessment;* • *Serving as a blueprint for reducing potential losses identified in the Hazard Identification and Risk Assessment;* • *Plan content flow from the risk assessment (problem identification) to goal setting to mitigation action development;* • *An understanding of mitigation principles (diversity of actions that include structural projects, preventative measures, outreach activities, property protection measures, post-disaster actions, etc);* • *Specific mitigation actions for each participating jurisdictions that reflects their unique risks and capabilities;* • *Integration of mitigation actions with existing local authorities, policies, programs, and resources; and* • *Discussion of existing programs (including the NFIP), plans, and policies that could be used to implement mitigation, as well as document past projects.*

Element D: Plan Update, Evaluation, and Implementation (*Plan Updates Only*)

How does the Plan go above and beyond minimum requirements to document the 5-year Evaluation and Implementation measures with respect to: • *Status of previously recommended mitigation actions;* • *Identification of barriers or obstacles to successful implementation or completion of mitigation actions, along with possible solutions for overcoming risk;* • *Documentation of annual reviews and committee involvement;* • *Identification of a lead person to take ownership of, and champion the Plan;* • *Reducing risks from natural hazards and serving as a guide for decisions makers as they commit resources to reducing the effects of natural hazards;* • *An approach to evaluating future conditions (i.e. socio-economic, environmental, demographic, change in built environment etc.);* • *Discussion of how changing conditions and opportunities could impact community resilience in the long term; and* • *Discussion of how the mitigation goals and actions support the long-term community vision for increased resilience.*

B. Resources for Implementing Your Approved Plan

Ideas may be offered on moving the mitigation plan forward and continuing the relationship with key mitigation stakeholders such as the following: • *What FEMA assistance (funding) programs are available (for example, Hazard Mitigation Assistance (HMA)) to the jurisdiction(s) to assist with implementing the mitigation actions?* • *What other Federal programs (National Flood Insurance Program (NFIP), Community Rating System (CRS), Risk MAP, etc.) may provide assistance for mitigation activities?* • *What publications, technical guidance or other resources are available to the jurisdiction(s) relevant to the identified mitigation actions?* • *Are there upcoming trainings/workshops (Benefit-Cost Analysis (BCA), HMA, etc.) to assist the jurisdictions(s)?* • *What mitigation actions can be funded by other Federal agencies (for example, U.S. Forest Service, National Oceanic and Atmospheric Administration (NOAA), Environmental Protection Agency (EPA) Smart Growth, Housing and Urban Development (HUD) Sustainable Communities, etc.) and/or state and local agencies?*

INSTRUCTIONS: For multi-jurisdictional plans, a Multi-jurisdiction Summary Spreadsheet may be completed by listing each participating jurisdiction, which required Elements for each jurisdiction were 'Met' or 'Not Met,' and when the adoption resolutions were received. This Summary Sheet does not imply that a mini-plan be developed for each jurisdiction; it should be used as an optional worksheet to ensure that each jurisdiction participating in the Plan has been documented and has met the requirements for those Elements (A through E).

MULTI-JURISDICTION SUMMARY SHEET													
#	Jurisdiction Name	Jurisdiction Type (city/borough/ township/ village, etc.)	Plan POC	Mailing Address	Email	Phone	Requirements Met (Y/N)						
							A. Planning Process	B. Hazard Identification & Risk Assessment	C. Mitigation Strategy	D. Plan Review, Evaluation & Implementation	E. Plan Adoption	F. State Require-ments
1												
2												
3												
4												
5												
6												
7												
8												
9												

MULTI-JURISDICTION SUMMARY SHEET													
#	Jurisdiction Name	Jurisdiction Type (city/borough/ township/ village, etc.)	Plan POC	Mailing Address	Email	Phone	Requirements Met (Y/N)					
							A. Planning Process	B. Hazard Identification & Risk Assessment	C. Mitigation Strategy	D. Plan Review, Evaluation & Implementation	E. Plan Adoption	F. State Require-ments
10												
11												
12												
13												
14												
15												
16												
17												
18												
19												
20												

LOCAL MITIGATION PLAN REVIEW TOOL

The *Local Mitigation Plan Review Tool* demonstrates how the Local Mitigation Plan meets the regulation in 44 CFR §201.6 and offers States and FEMA Mitigation Planners an opportunity to provide feedback to the community.

- The Regulation Checklist provides a summary of FEMA's evaluation of whether the Plan has addressed all requirements.
- The Plan Assessment identifies the plan's strengths as well as documents areas for future improvement.
- The Multi-jurisdiction Summary Sheet is an optional worksheet that can be used to document how each jurisdiction met the requirements of the each Element of the Plan (Planning Process; Hazard Identification and Risk Assessment; Mitigation Strategy; Plan Review, Evaluation, and Implementation; and Plan Adoption).

The FEMA Mitigation Planner must reference this *Local Mitigation Plan Review Guide* when completing the *Local Mitigation Plan Review Tool*.

Jurisdiction: **Northern Virginia**	**Title of Plan:** **Northern Virginia PDC HMP**	**Date of Plan:**

Local Point of Contact:	**Address:**
Title:	
Agency:	
Phone Number:	**E-Mail:**

State Reviewer: **Debbie Messmer**	**Title:**	**Date:**

FEMA Reviewer: **Matt McCullough**	**Title:** Community Planner	**Date:** 01/06/17
Date Received in FEMA Region ***(insert #)***		
Plan Not Approved		
Plan Approvable Pending Adoption		
Plan Approved		

SECTION 1:
REGULATION CHECKLIST

INSTRUCTIONS: The Regulation Checklist must be completed by FEMA. The purpose of the Checklist is to identify the location of relevant or applicable content in the Plan by Element/sub-element and to determine if each requirement has been 'Met' or 'Not Met.' The 'Required Revisions' summary at the bottom of each Element must be completed by FEMA to provide a clear explanation of the revisions that are required for plan approval. Required revisions must be explained for each plan sub-element that is 'Not Met.' Sub-elements should be referenced in each summary by using the appropriate numbers (A1, B3, etc.), where applicable. Requirements for each Element and sub-element are described in detail in this *Plan Review Guide* in Section 4, Regulation Checklist.

1. REGULATION CHECKLIST **Regulation** (44 CFR 201.6 Local Mitigation Plans)	**Location in Plan** (section and/or page number)	**Met**	**Not Met**
ELEMENT A. PLANNING PROCESS			
A1. Does the Plan document the planning process, including how it was prepared and who was involved in the process for each jurisdiction? (Requirement §201.6(c)(1))	Pg. 2-1 – 2-6 Table 2.2 Appx C	X	
A2. Does the Plan document an opportunity for neighboring communities, local and regional agencies involved in hazard mitigation activities, agencies that have the authority to regulate development as well as other interests to be involved in the planning process? (Requirement §201.6(b)(2))	Pg. 2-1 – 2-6	X	
A3. Does the Plan document how the public was involved in the planning process during the drafting stage? (Requirement §201.6(b)(1))	Pg. 2-4 – 2-6	X	
A4. Does the Plan describe the review and incorporation of existing plans, studies, reports, and technical information? (Requirement §201.6(b)(3))	P. 2-6		**X**
A5. Is there discussion of how the community(ies) will continue public participation in the plan maintenance process? (Requirement §201.6(c)(4)(iii))	Pg. 8-5	X	
A6. Is there a description of the method and schedule for keeping the plan current (monitoring, evaluating and updating the mitigation plan within a 5-year cycle)? (Requirement §201.6(c)(4)(i))	Pg. 8-1 – 8-4	X	

1. REGULATION CHECKLIST **Regulation** (44 CFR 201.6 Local Mitigation Plans)	Location in Plan (section and/or page number)	Met	Not Met
ELEMENT A: REQUIRED REVISIONS **Note:** Pg. 2-4: Are there specific public outreach meetings types following the conditional approval of the plan? Pg. 2-5: References Appendix H. The CD only lists Appendices up to F. Pg. 2-5: Fairfax County Outreach- was there any feedback documented for the newsletters sent to the Council of Governments or Businesses? **A2.) Recommended Revision:** Pg. 2-4 & 2-5: In the next plan update please include a description as to how neighboring jurisdictions were invited to participate. **A4.) Required Revision:** - Please include a brief narrative as to how the documents listed on pg. 2-6 were incorporated into the plan. - Please cite the additional sources of data and information that was used. Example-NCDC site Language was updated to include other jurisdictions and partners draft was sent to. Language was added to describe what other documents were used and how they were utilized. **A5.) Note:** Utilizing the idea of after-conditional meetings noted on Pg. 2-4; communities could create a bi-annual or annual opportunity for continued public involvement. **Kudos:** Excellent documentation			
ELEMENT B. HAZARD IDENTIFICATION AND RISK ASSESSMENT			
B1. Does the Plan include a description of the type, location, and extent of all natural hazards that can affect each jurisdiction(s)? (Requirement §201.6(c)(2)(i))	Pg. 4-50 – 4-193	X	
B2. Does the Plan include information on previous occurrences of hazard events and on the probability of future hazard events for each jurisdiction? (Requirement §201.6(c)(2)(i))	Pg. 4-30 – 4-193	X	
B3. Is there a description of each identified hazard's impact on the community as well as an overall summary of the community's vulnerability for each jurisdiction? (Requirement §201.6(c)(2)(ii))	Pg. 4-50 – 4-193	X	
B4. Does the Plan address NFIP insured structures within the jurisdiction that have been repetitively damaged by floods? (Requirement §201.6(c)(2)(ii))	Pg. 4-67 – 4-68	X	

1. REGULATION CHECKLIST **Regulation** (44 CFR 201.6 Local Mitigation Plans)	Location in Plan (section and/or page number)	Met	Not Met
ELEMENT B: REQUIRED REVISIONS **B1.) Required Revision:** Pg. 4-90 & 4-91: Please better identify the planning area for Figures 4.24 & 4.25. Highlighting the borders of the PDC will be sufficient. Pg. 4-97 -4-100: Please better identify the planning area for Figures 4.26 -4.29. Circling the general Northern Virginia area will suffice. Pg. 4-132: Figure 4.34, 4.35, 4.37, 4.41,-Ditto- Circle or Highlight Pg 4-173: Figure 4.46 Please remove circled portion and circle or highlight the NoVA PDC Map revisions were completed. However, for Figure 4.46 the circled portion was not changed as it is part of the file image and represents a historical subsidence area noted in the map's key. **Discussion:** Pg. 4-35 – 4-42: Are the rankings on Table 4.10 – 4.15 being attributed to individual jurisdictions? Pg. 4-44 and 4-46 are no present. Is there additional information on those pages? (Unique and varied risk) Tables 4.10-4.15- the scores are summed at a jurisdictional level for each hazard separately, permitting comparison between jurisdictions for each hazard type. Additional language has been added for clarification. See page 4-38 for additional clarification. Page 4-44 now appears in the draft. Page 4-46 remains missing. It's a formatting error in the original draft that cannot be corrected without recreating the entire document. There is no data on page 4-46; it's an issue of sections/footers/pagination. **Note:** Pg. 4-110: Was there a disaster declaration for Virginia for Hurricane Sandy? Information for Sandy has been added, though the declaration did not include the NoVA area. **Kudos:** Great mapping! Yes, I made it all the way to page 1092 in Appendix D			
ELEMENT C. MITIGATION STRATEGY			
C1. Does the plan document each jurisdiction's existing authorities, policies, programs and resources and its ability to expand on and improve these existing policies and programs? (Requirement §201.6(c)(3))	Chapter 5	X	
C2. Does the Plan address each jurisdiction's participation in the NFIP and continued compliance with NFIP requirements, as appropriate? (Requirement §201.6(c)(3)(ii))	Pg. 5-17 & 5-18		X
C3. Does the Plan include goals to reduce/avoid long-term vulnerabilities to the identified hazards? (Requirement §201.6(c)(3)(i))	Pg. 6-3 – 6-4	X	
C4. Does the Plan identify and analyze a comprehensive range of specific mitigation actions and projects for each jurisdiction being considered to reduce the effects of hazards, with emphasis on new and existing buildings and infrastructure? (Requirement §201.6(c)(3)(ii))	Pg. 7-1 – 7-132	X	

1. REGULATION CHECKLIST **Regulation** (44 CFR 201.6 Local Mitigation Plans)	**Location in Plan** (section and/or page number)	**Met**	**Not Met**
C5. Does the Plan contain an action plan that describes how the actions identified will be prioritized (including cost benefit review), implemented, and administered by each jurisdiction? (Requirement §201.6(c)(3)(iv)); (Requirement §201.6(c)(3)(iii))	Pg. 6-3 Table 6.1	X	
C6. Does the Plan describe a process by which local governments will integrate the requirements of the mitigation plan into other planning mechanisms, such as comprehensive or capital improvement plans, when appropriate? (Requirement §201.6(c)(4)(ii))	Pg. 5-13 – 5-16	X	

ELEMENT C: REQUIRED REVISIONS

C2.) Required Revision:
Pg. 5-17: Please include information for each jurisdiction as to their day-to-day management of the floodplain. This would include mapping, enforcement and insurance. Please see the attached Strategy Guide and Matrix for reference.

Plan was updated to include Appendix G – Appendix is the NFIP survey completed by all participating jurisdictions.

Discussion:
Pg. 7-9- Action 2010-16: Fairfax County has only listed Buy-Out as a strategy.
Pg. 7-39: Prince William County does not have a strategy noted for Acquisition, Elevation, Relocation, etc..
Pg. 7-73: Town of Dumfries does not have a strategy noted for Acquisition, Elevation, Relocation, etc..
Pg. 7-98: Town of Lovettsvile does not have a strategy noted for Acquisition, Elevation, Relocation, etc..

Fairfax County and Prince William updated language in Mitigation actions included in Chapter 7 – Fairfax and Prince William sections attached for review

Note:
Pg. 7-48: City of Fairfax strategy 2017-6. The development of this platform could be extremely useful in the plan integration realm.

Recommended Revision:
More accurately align the strategy to the hazard it is supposed to be addressing. Example: Pg. 7-121; Strategy 2010-3

C6.) Kudos:
Excellent write-up on potential plan integration opportunities. Please see the attached copy of "Plan Integration: Linking Local Planning Efforts". This tool can be used to further identify specific points of risk reduction integration, into other planning mechanisms.

ELEMENT D. PLAN REVIEW, EVALUATION, AND IMPLEMENTATION (applicable to plan updates only)			
D1. Was the plan revised to reflect changes in development? (Requirement §201.6(d)(3))	Pg. 3-21 – 3-29	X	
D2. Was the plan revised to reflect progress in local mitigation efforts? (Requirement §201.6(d)(3))	Chapter 7	X	
D3. Was the plan revised to reflect changes in priorities? (Requirement §201.6(d)(3))	Pg. 6-1	X	

1. REGULATION CHECKLIST **Regulation** (44 CFR 201.6 Local Mitigation Plans)	**Location in Plan** (section and/or page number)	**Met**	**Not Met**
ELEMENT D: REQUIRED REVISIONS **D.1) Kudos:** Very in-depth discussion on land use, population and potential change. **Note:** Pg. 7-48: City of Fairfax strategy 2017-6. The development of this platform could be extremely useful in the plan integration realm. **D.2) Recommendation:** Enhance the Executive Summary space to include a narrative on mitigation practices and principles that are being engaged in for that given jurisdiction.			
ELEMENT E. PLAN ADOPTION			
E1. Does the Plan include documentation that the plan has been formally adopted by the governing body of the jurisdiction requesting approval? (Requirement §201.6(c)(5))			
E2. For multi-jurisdictional plans, has each jurisdiction requesting approval of the plan documented formal plan adoption? (Requirement §201.6(c)(5))			
ELEMENT E: REQUIRED REVISIONS			
ELEMENT F. ADDITIONAL STATE REQUIREMENTS (OPTIONAL FOR STATE REVIEWERS ONLY; NOT TO BE COMPLETED BY FEMA)			
F1.			
F2.			
ELEMENT F: REQUIRED REVISIONS			

SECTION 2:
PLAN ASSESSMENT

INSTRUCTIONS: The purpose of the Plan Assessment is to offer the local community more comprehensive feedback to the community on the quality and utility of the plan in a narrative format. The audience for the Plan Assessment is not only the plan developer/local community planner, but also elected officials, local departments and agencies, and others involved in implementing the Local Mitigation Plan. The Plan Assessment must be completed by FEMA. The Assessment is an opportunity for FEMA to provide feedback and information to the community on: 1) suggested improvements to the Plan; 2) specific sections in the Plan where the community has gone above and beyond minimum requirements; 3) recommendations for plan implementation; and 4) ongoing partnership(s) and information on other FEMA programs, specifically RiskMAP and Hazard Mitigation Assistance programs. The Plan Assessment is divided into two sections:

1. Plan Strengths and Opportunities for Improvement
2. Resources for Implementing Your Approved Plan

Plan Strengths and Opportunities for Improvement is organized according to the plan Elements listed in the Regulation Checklist. Each Element includes a series of italicized bulleted items that are suggested topics for consideration while evaluating plans, but it is not intended to be a comprehensive list. FEMA Mitigation Planners are not required to answer each bullet item, and should use them as a guide to paraphrase their own written assessment (2-3 sentences) of each Element.

The Plan Assessment must not reiterate the required revisions from the Regulation Checklist or be regulatory in nature, and should be open-ended and to provide the community with suggestions for improvements or recommended revisions. The recommended revisions are suggestions for improvement and are not required to be made for the Plan to meet Federal regulatory requirements. The italicized text should be deleted once FEMA has added comments regarding strengths of the plan and potential improvements for future plan revisions. It is recommended that the Plan Assessment be a short synopsis of the overall strengths and weaknesses of the Plan (no longer than two pages), rather than a complete recap section by section.

Resources for Implementing Your Approved Plan provides a place for FEMA to offer information, data sources and general suggestions on the overall plan implementation and maintenance process. Information on other possible sources of assistance including, but not limited to, existing publications, grant funding or training opportunities, can be provided. States may add state and local resources, if available.

A. Plan Strengths and Opportunities for Improvement

This section provides a discussion of the strengths of the plan document and identifies areas where these could be improved beyond minimum requirements.

Element A: Planning Process

How does the Plan go above and beyond minimum requirements to document the planning process with respect to: • *Involvement of stakeholders (elected officials/decision makers, plan implementers, business owners, academic institutions, utility companies, water/sanitation districts, etc.);* • *Involvement of Planning, Emergency Management, Public Works Departments or other planning agencies (i.e., regional planning councils);* • *Diverse methods of participation (meetings, surveys, online, etc.); and* • *Reflective of an open and inclusive public involvement process.*

Element B: Hazard Identification and Risk Assessment

In addition to the requirements listed in the Regulation Checklist, 44 CFR 201.6 Local Mitigation Plans identifies additional elements that should be included as part of a plan's risk assessment. The plan should describe vulnerability in terms of: *1) A general description of land uses and future development trends within the community so that mitigation options can be considered in future land use decisions;* *2) The types and numbers of existing and future buildings, infrastructure, and critical facilities located in the identified hazard areas; and* *3) A description of potential dollar losses to vulnerable structures, and a description of the methodology used to prepare the estimate.* *How does the Plan go above and beyond minimum requirements to document the Hazard Identification and Risk Assessment with respect to:* • *Use of best available data (flood maps, HAZUS, flood studies) to describe significant hazards;* • *Communication of risk on people, property, and infrastructure to the public (through tables, charts, maps, photos, etc.);* • *Incorporation of techniques and methodologies to estimate dollar losses to vulnerable structures;* • *Incorporation of Risk MAP products (i.e., depth grids, Flood Risk Report, Changes Since Last FIRM, Areas of Mitigation Interest, etc.); and* • *Identification of any data gaps that can be filled as new data became available.*

Element C: Mitigation Strategy

How does the Plan go above and beyond minimum requirements to document the Mitigation Strategy with respect to: • *Key problems identified in, and linkages to, the vulnerability assessment;* • *Serving as a blueprint for reducing potential losses identified in the Hazard Identification and Risk Assessment;* • *Plan content flow from the risk assessment (problem identification) to goal setting to mitigation action development;* • *An understanding of mitigation principles (diversity of actions that include structural projects, preventative measures, outreach activities, property protection measures, post-disaster actions, etc);* • *Specific mitigation actions for each participating jurisdictions that reflects their unique risks and capabilities;* • *Integration of mitigation actions with existing local authorities, policies, programs, and resources; and* • *Discussion of existing programs (including the NFIP), plans, and policies that could be used to implement mitigation, as well as document past projects.*

Element D: Plan Update, Evaluation, and Implementation (*Plan Updates Only*)

How does the Plan go above and beyond minimum requirements to document the 5-year Evaluation and Implementation measures with respect to: • *Status of previously recommended mitigation actions;* • *Identification of barriers or obstacles to successful implementation or completion of mitigation actions, along with possible solutions for overcoming risk;* • *Documentation of annual reviews and committee involvement;* • *Identification of a lead person to take ownership of, and champion the Plan;* • *Reducing risks from natural hazards and serving as a guide for decisions makers as they commit resources to reducing the effects of natural hazards;* • *An approach to evaluating future conditions (i.e. socio-economic, environmental, demographic, change in built environment etc.);* • *Discussion of how changing conditions and opportunities could impact community resilience in the long term; and* • *Discussion of how the mitigation goals and actions support the long-term community vision for increased resilience.*

B. Resources for Implementing Your Approved Plan

Ideas may be offered on moving the mitigation plan forward and continuing the relationship with key mitigation stakeholders such as the following:

- *What FEMA assistance (funding) programs are available (for example, Hazard Mitigation Assistance (HMA)) to the jurisdiction(s) to assist with implementing the mitigation actions?*
- *What other Federal programs (National Flood Insurance Program (NFIP), Community Rating System (CRS), Risk MAP, etc.) may provide assistance for mitigation activities?*
- *What publications, technical guidance or other resources are available to the jurisdiction(s) relevant to the identified mitigation actions?*
- *Are there upcoming trainings/workshops (Benefit-Cost Analysis (BCA), HMA, etc.) to assist the jurisdictions(s)?*
- *What mitigation actions can be funded by other Federal agencies (for example, U.S. Forest Service, National Oceanic and Atmospheric Administration (NOAA), Environmental Protection Agency (EPA) Smart Growth, Housing and Urban Development (HUD) Sustainable Communities, etc.) and/or state and local agencies?*

SECTION 3:
MULTI-JURISDICTION SUMMARY SHEET (OPTIONAL)

INSTRUCTIONS: For multi-jurisdictional plans, a Multi-jurisdiction Summary Spreadsheet may be completed by listing each participating jurisdiction, which required Elements for each jurisdiction were 'Met' or 'Not Met,' and when the adoption resolutions were received. This Summary Sheet does not imply that a mini-plan be developed for each jurisdiction; it should be used as an optional worksheet to ensure that each jurisdiction participating in the Plan has been documented and has met the requirements for those Elements (A through E).

MULTI-JURISDICTION SUMMARY SHEET													
#	Jurisdiction Name	Jurisdiction Type (city/borough/ township/ village, etc.)	Plan POC	Mailing Address	Email	Phone	Requirements Met (Y/N)						
							A. Planning Process	B. Hazard Identification & Risk Assessment	C. Mitigation Strategy	D. Plan Review, Evaluation & Implementation	E. Plan Adoption	F. State Require-ments
1												
2												
3												
4												
5												
6												
7												
8												
9												

MULTI-JURISDICTION SUMMARY SHEET													
#	Jurisdiction Name	Jurisdiction Type (city/borough/ township/ village, etc.)	Plan POC	Mailing Address	Email	Phone	Requirements Met (Y/N)					
							A. Planning Process	B. Hazard Identification & Risk Assessment	C. Mitigation Strategy	D. Plan Review, Evaluation & Implementation	E. Plan Adoption	F. State Require-ments
10												
11												
12												
13												
14												
15												
16												
17												
18												
19												
20												

APPENDIX B

PLAN ADOPTION

Note, to be completed following conditional approval.

Appendix B – Sample Plan Adoption Resolution

Adoption of the Multi-Jurisdictional Hazard Mitigation Plan Update for the Northern Virginia Region

(Name of Jurisdiction) ______________________________

(Governing Body) ______________________________

(Address) ______________________________

WHEREAS, the Disaster Mitigation Act of 2000, as amended, requires that local governments, develop, adopt and update natural hazard mitigation plans in order to receive certain federal assistance; and,

WHEREAS, the Northern Virginia Regional Hazard Mitigation Plan has been prepared in accordance with FEMA requirements at 44C.F.R. 201.6; and,

WHEREAS, a Mitigation Advisory Committee (*MAC), comprised of representatives from the Counties of Arlington, Fairfax, Loudon, and Prince William; the Cities of Alexandria, Fairfax, Falls Church, Manassas, and Manassas Park; and Towns of Clifton, Dumfries, Haymarket, Herndon, Leesburg, Middleburg, Purcellville, Occoquan, Quantico, Round Hill, and Vienna, was convened in order to assess the risks of hazards facing the Northern Virginia region, and to make recommendations on actions to be taken to mitigate these hazards; and,

WHEREAS, a request for proposals was issued to hire an experienced consulting firm to work with the MAC to update a comprehensive hazard mitigation plan for the Northern Virginia region; and,

WHEREAS, the plan incorporates the comments, ideas and concerns of the community and of the public in general, which this plan is designed to protect, ascertained through a series of public meetings, publication of the draft plan, press releases, and other outreach activities; and

RESOLVED – the jurisdiction of (governing body name) recognizes that recent events of the Virginia Earthquake, Hurricane Irene, and Tropical Storm Lee are not captured in the current FEMA approved pending adoption update of the local Hazard Mitigation Plan. Being committed to mitigation planning and activities, the jurisdiction of (governing body name), as part of the next update, will fully endeavor to identify, evaluate, and include these event and their impacts as part of the next update cycle.

NOW THEREFORE, BE IT RESOLVED by the (governing body name) that the Northern Virginia Hazard Mitigation Plan Update dated (mm/dd/yyyy) is hereby approved and adopted by the (governing body name), and resolves to execute the actions in the plan. A copy of the plan is attached to this resolution.

ADOPTED by the on this _____ day of ___________ , 2012.

APPROVED

____

(Head of jurisdiction's governing body)

ATTEST

____

(Jurisdiction representative)

APPENDIX C

Meeting Documentation

Northern Virginia Hazard Mitigation Plan Status Update Meeting Agenda

October 8, 2015
2:00 PM

1. Opening Remarks
    a. On behalf of Dave and Roy, Thank you all for coming to the meeting. The goal of today's meeting is to relay to you all the status of the Hazard Mitigation Plan, and the actions that have been taken to date so that you can take them back to your jurisdiction to further discuss.
2. Roll Call - Since there are folks on the phone, let's do a quick roll call.
3. Overview of plan status and actions taken to date
    a. As I am sure you all know by now, at a recent NVERS meeting there was discussion of the Hazard Mitigation Plan, and that it was due for update. Dave volunteered Fairfax to take the lead on that and the group supported it.
    b. Plan is due February 2017 and the 2012 plan update took 2 years to complete and cost approximately 200,000
    c. We applied for a hazard mitigation grant. The application was submitted to the state and subsequently FEMA in August.
    d. We applied for 150,000 and there is a requirement for 25% match. We plan to do in kind match, and match cannot be grant funded.
    e. Grant funds would be awarded sometime in the summer of 2016.
    f. We put together a scope of work that we sent to Witt, as we have had good luck with them in the past.
    g. Their quote came back at 194,000, which is in line with the last update.
    h. Funding:
        i. Obviously there is the grant we applied for next summer
        ii. NVERS has all but promised me 50,000. Their surveys were to be reviewed today, so we should know very soon. Money must be spent by May 2016.
        iii. NVERS was also talking to the state to try to get another 50,000 for this project.
    i. Here is a draft schedule, which is definitely subject to change and refinement.
4. Discussion of next steps
    a. Group recommendations for how to proceed
        i. There seem to be two broad choices for how to proceed
            1. Continue pursuing grant funds to cover the whole project
            2. Write the plan internally. If we do this, we can use the funds to hire a consultant for project management etc.
        ii. What else should we do? Another quote? From who?

   b. October 26 NVERS Meeting – Dave plans to put this on the agenda for the October NVERS meeting so the local EMs can make the final decision on how to proceed.
5. Validate group membership – I just want to check and confirm that I have the right people in the room from each jurisdiction. Check in. Only inviting cities and counties. Rely on counties to involve the towns?
6. Adjournment

Hazard Mitigation Plan Update Briefing
10/8/2015

Name	Agency	Initials
Adetula, Akins	Fairfax County	[illegible]
English, Walter	City of Fairfax	[illegible]
Gagnon, Amelia	City of Manassas	[illegible]
Gonzalez, Carrie	VDEM	on phn
Guditus, Michael	Fairfax County	[illegible]
Hoffower, Robert	VDEM	[illegible]
Hope, Aaron	Alexandria County	on phn
Johnson, Kevin	Loudoun County	[illegible]
Kelly, Adam	Fairfax County	ACK
Lenhart, Alexa	Prince William County	
Morrison, David	Arlington County	[illegible]
Polera, Tom	City of Falls Church	on phn
Teevan, Francis	City of Manassas	

Northern Virginia Hazard Mitigation Plan Status Update Meeting Notes

December 1, 2015
1:00 PM

Meeting Attendance:

Amelia Gagnon
Carrie Gonzalez
Mike Guditus
Robb Hoffower
Kevin Johnson
Jake Kazele
Adam Kelly
Alexa Lenhart
David Morrison
Tom Polera
Greg Zebrowski

Notes:

1. Project Update
    a. NVERS is working to secure the $50,000 in grand funds for the HIRA. They expect to have the money officially allocated, and the contract with WITT setup within the week. They are currently working on the PMP for the project.
2. Timeline and Responsibilities
    a. See attached. Please note with the schedule, the dates are when things happen, preparations for events such as public outreach will need to start sooner. The group did not have any substantive comments on the schedule and agreed with it.
3. Establish a Meeting Schedule
    a. I will setup monthly meetings on Tuesdays at 1:30 PM. The meeting invite will go out shortly. If the meetings are not necessary, we will cancel. There will always be a call in number available.
4. Data Requirements for HIRA
    a. See attached. Witt will have more information on this when they have had a chance to review the data from the last plan update.
    b. Please review the attachment and provide necessary information by January 1.
    c. Review the list of hazards in the 2012 plan. Let me know by January 1 if you feel the list of hazards need to change.
        i. The thought yesterday was that the list of hazards is probably okay, but that descriptions of events that have happened since 2011 need to be included.

5. Inclusion of Towns
    a. Provide me with the contact information for the Towns within your jurisdiction (should just apply to Fairfax, Loudoun, and Prince William). I will include them on my emails, but I will not reach directly to the Towns until the corresponding County has briefed them and told me it is okay.

Action Items:

1. Provide Data by January 1. - All
2. Provide list of hazards by January 1. - All
3. Determine the best source for the NFIP data to ensure properties attributed to the Towns are within the corporate limit, and not just the zip code.

Hazard Mitigation Plan December Meeting
12/1/2015

Name	Agency	Initials
Adetula, Akins	Fairfax County	
English, Walter	City of Fairfax	
Gagnon, Amelia	City of Manassas	phone
Gonzalez, Carrie	VDEM	~~ph~~ phone.
Guditus, Michael	Fairfax County	MG
Hoffower, Robert	VDEM	phone
Hope, Aaron	City of Alexandria	
Johnson, Kevin	Loudoun County	phone
Kazele, Jake	VDEM	phone
Kelly, Adam	Fairfax County	AK
Lenhart, Alexa	Prince William County	phone
Morrison, David	Arlington County	DM
Polera, Tom	City of Falls Church	phone
Teevan, Francis	City of Manassas	
Zebrowski, Greg	Fairfax County	GZ

Northern Virginia Hazard Mitigation Plan Status Update
Meeting Notes

January 12, 2016
1:30 PM

Meeting Attendance:
Hal Cohen
Amelia Gagnon
Kelly George
Mike Guditus
Brian Henshaw
Robb Hoffower
Dan Janickey
Kevin Johnson
Kirstyn Jovanovich
Jake Kazele
Adam Kelly
Alexa Lenhart
David Morrison
Blake Stave
Sandra Sca
Steve Thompson
Greg Zebrowski

Notes:

1. Project Update
    a. Due to timing constraints we have chosen to update the vast majority of this plan ourselves as directed by the NOVA Emergency Managers group. We are no longer pursuing the State Hazard Mitigation Grant because the timing would not allow us to complete the plan by the 2017 deadline.
    b. We have secured $50,000 in funding from NVERS to have Witt perform the HIRA portion of our plan. These funds do not have any local match requirement. The only stipulation is that the funds need to be spent by May 2016.
    c. The current project timeline is attached.
2. HIRA
    a. Please see the attached presentation from Kelly George with Witt. The one major change to the attached spreadsheet is that data is now due to Witt on February 15, not January 31.

b. There was discussion of how the HIRA associated with this plan interacts with the NCR THIRA. The group agreed that this HIRA would likely drive what is in the THIRA. Witt will review the THIRA and HIRA to make sure there are no conflicts.
c. There was discussion of the methodology used in the HIRA. As outlined in the power point, Witt has proposed and the group has approved using the same methodology as the previous plan. This will allow for comparison to the previous. The methodology is complex, but produces good results. The group approved the usage of the 2012 HIRA methodology.
d. There was discussion of what data sets should be used in this plan update. The committee voiced concern with the 2012 plan update because there were several events that happened while the plan was in draft status and were not included when the plan was finalized. The recommendation of Witt was that every plan needs to have a defined time period that it examines. The Committee will discuss strategies for presenting this to our elected officials at a later Committee meeting.
e. The group approved the usage of 2010 census data for the plan.
f. In 2012 FEMA changed their interpretation of the hazard mitigation regulations, and now requires each jurisdiction to be fully participating in the plan update. The towns will need to be split into their own section and not lumped in with the Counties.
g. Witt clarified that there will be a regional summary to the HIRA, but there will not be regional analysis. The analysis will be done at the local level.
h. The time period that will be examined in this HIRA is January 1, 2011 – December 31, 2015.
i. When collecting historic site data. If there is a historic district designation there is no need to list all historic sites within that. For instance, the Town of Haymarket is considered a historic district so they do not need to provide any data on specific historic sites.
j. Witt proposed adding the category of Extreme Temperatures to the HIRA list of hazards, and removing those from Winter Storm and Drought because it's possible to have extreme temperatures without drought or a winter storm. The committee approved this.
k. Witt discussed that the requirements have changed significantly since 2012 for what data needs to be used in the HIRA. In our 2012 plan, most of the asset data was open source.
l. When referring to assets in the data requirements this generally refers to facilities owned by the jurisdiction that have some sort of infrastructure, but does not include equipment (trucks etc). It should be all facilities owned by the jurisdiction. Generally, leased facilities are not required to be reported. When listing the use of the facility, include all uses (for instance, police station fire station and public office).

Action Items:

1. **Provide requested data by February 15** – All Jurisdiction to include Counties, Cities, and Towns.

Hazard Mitigation Plan December Meeting
1/12/2016

Name	Agency	Initials
Cohen, Hal	Witt O'Briens	
English, Walter	City of Fairfax	
Gagnon, Amelia	City of Manassas	AG
George, Kelly	Witt O'Briens	[illegible]
Gonzalez, Carrie	VDEM	
Guditus, Michael	Fairfax County	MG
Henshaw, Brian	Town of Haymarket	BPH
Hoffower, Robert	VDEM	Phone
Hope, Aaron	City of Alexandria	[illegible]
Janickey, Dan	Town of Vienna	DJ
Johnson, Kevin	Loudoun County	[illegible]
Jovanovich, Kirstyn	Town of Occoquan	[illegible]
Kazele, Jake	VDEM	Phone
Kelly, Adam	Fairfax County	[illegible]
Lenhart, Alexa	Prince William County	AL
Morrison, David	Arlington County	DM
Polera, Tom	City of Falls Church	
Sca, Sandra	Town of Clifton	
Stave, Blake	City of Alexandria	BS
Teevan, Francis	City of Manassas	
Thompson, Stephen	Town of Herndon	[illegible]
Zebrowski, Greg	Fairfax County	[illegible]

Northern Virginia Hazard Mitigation Plan Update

HAZARD IDENTIFICATION & RISK ASSESSMENT

JANUARY 12, 2016

WITT | O'BRIEN'S

CONTROL THE OUTCOME®

HIRA Update
Meeting Agenda

- What is a HIRA?
- Regulatory requirements of a HIRA
- Review/validation of hazards to be included
- Risk assessment update and methodology
- Documents and data needed
- HIRA update schedule
- Contact information

What is a HIRA?

WITT | O'BRIEN'S

What is a hazard identification & risk assessment (HIRA)?

- FEMA's *Local Mitigation Planning Handbook* (March 2013) breaks this section of the plan into four steps:
  1. Describe hazards
  2. Identify community assets
  3. Analyze risks
  4. Summarize vulnerability

1. Describe hazards

- Each hazard must be described in terms of:
  - Definition: what the hazard is (or is not)
  - Location: the geographic area that is affected (or likely to be affected) by the hazard
  - Extent: the strength or magnitude of the hazard (e.g., scale values, depth, speed of onset, or duration)
  - Previous occurrences
  - Probability of future events

2. Identify community assets

- Assets include things like:
  - People
  - Economy
  - Built environment:
    - Critical facilities
    - Other facilities
    - Housing stock
    - Infrastructure
    - Transportation routes
  - Natural environment
- Note: as a general rule, assets should be owned/operated/serviced by the jurisdiction if included in this listing.

WITT | O'BRIEN'S

3. Analyze risk

- Involves evaluating vulnerable assets, describing potential impacts, and estimating losses for each hazard.
- Methods include:
  - Exposure analysis (quantifies the number, type, and value of assets in the hazard areas)
  - Historical analysis (uses information on impacts and losses from previous events to predicts potential impacts and losses from a similar future event)
  - Scenario analysis (predicts the impacts of a particular event)
- Note: Updated HIRAs must address changes in development since the previous plan was approved.

WITT | O'BRIEN'S

4. Summarize vulnerability

- The hazard and risk information must be summarized so that the average person can understand the most significant risks and vulnerabilities of their community.
- The plan must provide an overall summary of each jurisdiction's vulnerability to the identified hazards.

Legislative & Regulatory Requirements

WITT | O'BRIEN'S

Legislative and regulatory requirements

- Local mitigation plans became a requirement to receive federal mitigation grant funding with the passage of the Disaster Mitigation Act of 2000 (DMA2K); this legislation went into effect for disasters declared after November 1, 2004.
- The legislation was codified into rules in 44 CFR §201.6
- FEMA has issue several versions of guidance documents related to mitigation planning and the contents of HIRAs

44 CFR §201.6(c) Plan Content

- (c) *Plan Content.* The Plan shall include the following:
  - (1) Documentation of the *planning process* used to develop the plan, including how it was prepared, who was involved in the process, and how the public was involved.
  - (2) A *risk assessment* that provides the factual basis for activities proposed in the strategy to reduce losses from the identified hazards. Local risk assessments must provide sufficient information to enable the jurisdiction to identify and prioritize appropriate mitigation actions to reduce losses from identified hazards. The risk assessment shall include:

44 CFR §201.6(c) Plan Content (continued)

- … (c)(2)
  - (i) a description of the type, location, and extent of all natural hazards that can affect the jurisdiction. The plan shall includes information on previous occurrences of hazard events and on the probability of future hazard events.
  - (ii) a description of the jurisdiction’s vulnerability to the hazards described in paragraph (c)(2)(i)(A) of this section. This description shall include an overall summary of each hazard and its impact on the community. All plans approved after October 1, 2008 must also address NFIP insured structures that have been repetitively damaged by floods. The plan should describe vulnerability in terms of:

44 CFR, §201.6(c) Plan Content (continued)

- … (c)(2)(ii)
  - (A) The types and numbers of existing and future buildings, infrastructure, and critical facilities located in the identified hazard areas;
  - (B) An estimate of the potential dollar losses to vulnerable structures identified in paragraph (c)(2)(i)(A) of this section and a description of the methodology used to prepared the estimate;
  - (C) Providing a general description of land uses and development trends within the community so that mitigation options can be considered in future land use decisions.
  - (iii) For multi-jurisdictional plans, the risk assessment section must assess each jurisdiction's risks where they vary from the risks facing the entire planning area.

Review/validation of the hazards to be included

Hazards in the current plan

- Flood:
  - Flash flooding
  - Sea level rise
  - Flood-related erosion
- Winter storm (includes extreme cold):
  - Snow
  - Sleet
  - Freezing rain
  - Freezing temperatures
- High wind/Severe storms (includes thunderstorms and hurricanes):
  - Severe thunderstorms
  - Hailstorms
- Tornadoes
- Drought (and extreme heat)
- Earthquake
- Landslides
- Wildfire
- Sinkholes/Karst/Land subsidence
- Dam failure

WITT | O'BRIEN'S

Recommendation

- We recommend:
  - Separating extreme cold from winter storm
  - Separating extreme heat from drought
  - Including Extreme temperatures (both cold and heat) as an independent hazard
  - Rationales:
    - It's possible to have occurrences of extreme temperatures in the absence of other hazard events
    - Extreme cold is not necessarily a component of winter storms
    - Extreme heat is not necessarily a component of a drought
- Recommendation accepted? Yes

Risk Assessment

WITT | O'BRIEN'S

WITT | O'BRIEN'S

Risk assessment update

- No requirements exist as to the methodology used for risk assessments, so long as the criteria in 44 CFR §201.6 are met
- We will use the same methodologies to update the risk assessment as are used in the current plan:
  - Exposure analysis
  - Historical analysis
  - Scenario analysis
- The updated HIRA will contain GIS products to ensure both continuity and familiarity for ease of understanding for users and readers

Risk assessment methodology

- The risk assessment methodology used in the 2010 update is the same as the methodology used in the 2010 *Commonwealth of Virginia Hazard Mitigation Plan.*
- This methodology was originally developed for VDEM by the Center for Geospatial Information Technology (CGIT) at Virginia Tech.
- This methodology is based on the use of NCDC data, with other data input as necessary to fill gaps

Risk assessment methodology description

"CGIT and VDEM developed a standardized methodology to compare different hazards' risk on a jurisdictional basis. As some of the hazards assess in this plan did not have a precisely quantifiable probability or impact data, a semi-quantitative scoring system was used to compare all of the hazards. This method prioritized hazard risk based on a blend of quantitative factors from the available data. A number of parameters have been considered in this methodology, all of which could be derived from the NCDC dataset:

- History occurrence
- Vulnerability of people in the hazard area;
- Probably geographic extent of the hazard area; and
- Historical impact, in terms of human lives and property." (NOVA HMP, p. 82)

Risk assessment methodology description

“The ranking methodology tries to balance these factors, whose reliability varies from hazard to hazard due to the nature of the underlying data. Each parameter was rated on a scale of one through four….. These scores are summed at the jurisdictional level for each hazard separately, permitting comparison between jurisdictions for each hazard type. A summation of all the scores from all hazards in each jurisdiction provides an overall all-hazards risk prioritization.” (NOVA HMP, pp. 82-3)

Risk assessment methodology parameters

- Population vulnerability and density

Table 4.14: Population Vulnerability as the percentage of people that will be affected by the occurrence of the hazard.	
Population Vulnerability	
Rank	***Definition***
1	<= 0.229 % of the total population of the State
2	0.230% - 0.749% of the total population of the State
3	0.750% - 2.099% of the total population of the State
4	> = 2.100% of the total population of the State

Table 4.15: Population Density as the number of people per square mile that will be affected by the occurrence of the hazard.	
Population Density	
Rank	***Definition***
1	<= 60.92 people/sq mi
2	60.93 – 339.10 people/sq mi
3	339.11 - 1,743.35 people/sq mi
4	>= 1,743.36 people/sq mi

WITT | O'BRIEN'S

Risk assessment methodology parameters

- Geographic extent

Table 4.16: Geographic Extent as the percentage of a jurisdiction impacted by the hazard.			
Geographic Extent			
Hazard	***Description***	***Category Breaks***	
		Rank	*Definition*
Flood	Percent of a jurisdiction that falls within FEMA Special Flood Hazard Area (SFHA).	*1*	*<=2.99%*
		2	*3.00-4.99%*
		3	*5.00 -9.99%*
	Data: FEMA Floodplains (DFIRMs)	*4*	*>=10.00%*
High Wind	Average maximum wind speed throughout the entire jurisdiction.	*1*	*<= 59.9*
		2	*60.0 - 73.9*
	Data: HAZUS-MH 3-second Peak Gust Wind Speeds	*3*	*74.0 - 94.9*
		4	*>= 95.0*
Wildfire	Percent of jurisdiction that falls within a "high" risk.	*1*	*<= 9.9%*
		2	*10.0% - 19.9%*
		3	*20.0% - 49.9%*
	Data: VDOF Wildfire Risk Assessment	*4*	*>= 50.0%*
Karst	Percent of jurisdiction where the risk is "high" for karst related events.	*1*	*<= 24.9%*
		2	*25.0% - 49.9%*
		3	*50.0% - 74.9%*
	Data: USGS Engineering Aspects of Karst	*4*	*>= 75.0%*

WITT | O'BRIEN'S

Risk assessment methodology parameters

➢ Geographic extent (continued)

Table 4.16: Geographic Extent as the percentage of a jurisdiction impacted by the hazard.			
Geographic Extent			
Hazard	***Description***	***Category Breaks***	
		Rank	*Definition*
Landslide	Percent of jurisdiction where a high landslide risk exists. Data: USGS Landslide Incidence & Susceptibility	*1*	*<= 24.9%*
		2	*25.0% - 49.9%*
		3	*50.0% - 74.9%*
		4	*>= 75.0%*
Earthquake	Average 2,500-year return period max percent of gravitational acceleration (PGA).	*1*	*<= 0.069*
		2	*0.070 - 0.159*
		3	*0.160 - 0.299*
	Data: HAZUS^{MH} 2,500-year PGA	*4*	*>= 0.300*
Winter Storm	Average annual number of days receiving at least 3 inches of snow, calculated as an area-weighted average for each jurisdiction. Data: NWS snowfall statistics	*1*	*<= 1.49*
		2	*1.50 - 1.99*
		3	*2.00 - 2.99*
		4	*>= 3.0*
Tornado	Annual tornado hazard frequency (times 1 million), calculated as an area-weighted average for each jurisdiction. Data: NCDC tornado frequency statistics	*1*	*<= 1.24*
		2	*1.25 - 9.99*
		3	*10.00 - 99.9*
		4	*>= 100.00*

Risk assessment methodology parameters

- Annualizing the data for analysis
  - Data from the NCDC database was annualized in order to compare the results on a common system. In general, this was completed by taking the parameter of interest and dividing by the length of record for each hazard. The annualized value should only be utilized as an estimate of what can be extended in a given year.
  - Deaths/injuries, property and crop damage, and events were all annualized in this fashion.

WITT | O'BRIEN'S

Risk assessment methodology parameters

- Annualized deaths and injuries

Table 4.17: Annualized Deaths and Injuries as the number of deaths or injuries that a hazard event would likely cause in a given year.	
Annualized Deaths and Injuries	
Rank	*Definition*
1	<= 1.019 deaths and/or injuries per year
2	1.020 – 6.279 deaths and/or injuries per year
3	6.280 – 13.199 deaths and/or injuries per year
4	>= 13.200 deaths and/or injuries per year

WITT | O'BRIEN'S

Risk assessment methodology parameters

- Annualized crop and property damage

Table 4.18: Annualized Crop and Property Damage as the estimated damages that a hazard event will likely cause in a given year.	
Annualized Crop and Property Damage	
Rank	*Definition: Crop Damage*
1	*<= $25,711 per year*
2	*$25,712 – $100,270 per year*
3	*$100,271 - $291,384 per year*
4	*>= $291,385 per year*

WITT | O'BRIEN'S

Risk assessment methodology parameters

- Annualized events

Table 4.19: Annualized Events as the number of times that a hazard event would likely happen in a given year.	
Annualized Events	
Rank	***Definition***
1	<= 0.09 events per year
2	0.10 – 0.99 events per year
3	1.00 – 4.99 events per year
4	>= 5.00 events per year

WITT | O'BRIEN'S

Risk assessment methodology parameters

- Overall hazard ranking
  - The scores from these categories were added together for each hazard to estimate the total jurisdictional risk due to that hazard.
  - The total scores were broken into five categories to better illustrate the distribution of risk scores.
    - <8.50 = low risk
    - 8.50 to 9.99 = medium-low risk
    - 10.0 to 11.49 = medium risk
    - 11.50 to 12.99 = medium-high risk
    - >13.00 = high risk

Risk assessment methodology parameters

- **Overall hazard ranking (continued)**
  - In order to asses the total risk of a jurisdiction across all hazard categories, each of the previous categories were summed across the different hazard types:
    - <86.00 = low risk
    - 86.01 to 93.50 = medium-low risk
    - 95.51 to 100.00 = medium risk
    - 100.01 to 108.00 = medium-high risk
    - >108.01 = high risk

WITT | O'BRIEN'S

Risk assessment methodology recommendation

- As this is an update to an existing plan, we recommend continuing with this established methodology, with the following exceptions:
  - Towns will be added to the HIRA as independent jurisdictions
  - The HIRA will be reformatted to be organized by jurisdiction, rather than by hazard
- Recommendation accepted? Yes

Documents and data needed

WITT | O'BRIEN'S

Documents and data previously requested

- Listing of assets owned by each participating jurisdiction, including:
  - Street address
  - Lat/long coordinates
  - Footprint (sf)
  - Type of construction
  - Type of roof
  - Number of stories
  - Typical use of asset
  - Current value of the asset
  - Current value of the contents of the asset
- Same details for any historic structures in each participating jurisdiction, including registry status

Documents and data previously requested (cont.)

- Detailed descriptions of hazard occurrences since 2011 in each participating jurisdiction, including:
  - Type of incident
  - Narrative description of what occurred
  - Any damages associated with the incident, including increased operating or manpower costs
  - Any cleanup costs associated with the incident

WITT | O'BRIEN'S

Documents and data previously requested (cont.)

- Current NFIP data for each participating jurisdiction, including:
  - Listing of policies in effect
  - Claims from those policies
  - Listing of structures designed as Repetitive Loss (RL) by the NFIP
  - Listing of structures designated as Severe Repetitive Loss (SRL) by the NFIP
- All of this data has been received – thanks!

WITT | O'BRIEN'S

Documents and data previously requested (cont.)

- To meet the timeline for this project, we must have all of this data in hand no later than ~~January 31~~ February 15.
- What questions can I answer about this data request?

HIRA update schedule

WITT | O'BRIEN'S

Estimated schedule for HIRA update completion

- January 2016:
  - Kickoff meeting with Committee
  - Data/documentation collection
  - ~~All data/documentation received by Jan. 31~~
- February 2016:
  - All data/documentation received by February 15
  - HAZUS runs for HIRA update
  - GIS development
  - Reformatting of HIRA
- March 2016:
  - HAZUS runs for HIRA update
  - GIS development
  - Drafting of HIRA update
  - QA/QC of HIRA update
- ~~April 1, 2016~~ April 15, 2016: Updated HIRA delivered to Committee for review/comment

Contact information

WITT | O'BRIEN'S

WITT | O'BRIEN'S

Consultant contact information

- Kelly George, CFM – Project Manager/Senior Mitigation Planner:
  - kgeorge@wittobriens.com
- Hal Cohen – Subject Matter Expert
  - hcohen@wittobriens.com
- Erin Buchanan, CFM – Mitigation Planner/Data Management Specialist:
  - ebuchanan@wittobriens.com
- Jake Halley – GIS Specialist:
  - jhalley@wittobriens.com

Northern Virginia Hazard Mitigation Plan Status Update Meeting Notes

February 9, 2016
1:30 PM

Meeting Attendance:
Walter English
Amelia Gagnon
Carrie Gonzalez
Brian Henshaw
Dan Janickey
Adam Kelly
Alexa Lenhart
David Morrison
Blake Stave

Notes:

1. Project Update – Attached is the updated schedule to reflect the slightly later completion of the HIRA, all other dates remain the same. HIRA delivery is expected to be April 15. Tentatively, Kelly George plans to attend our May meeting to present the HIRA and answer any questions we may have after we have had an opportunity to review it.
2. Data Collection
    a. NFIP and Hospital Data has been collected by Adam Kelly for all jurisdictions and has been provided to Witt. NFIP data was provided by the state, and NVHA provided the hospital data.
    b. Arlington County: Working on data, and should have no problem meeting the Tuesday deadline. They have having the hardest time finding roof data for their facilities.
    c. Alexandria: Data will be delivered on Friday.
    d. Falls Church: Working on data collection and plan to have it in by the deadline.
    e. Fairfax City: In the process of compiling data and hope to have it done by the deadline.
    f. Fairfax County: All data has been compiled for Fairfax County and will be submitted to Witt this week.
        i. Clifton: Only owns 1 facility, will provide data.
        ii. Herndon: Data has been submitted to Fairfax.
        iii. Vienna: working on compiling data, plan to have it complete by Friday.
    g. Manassas: They are good on compiling the asset data, but finding some holes in data on past hazard occurrences. Working to complete the data collection.

h. Manassas Park: On schedule with data collection, will deliver by Tuesday.
i. Loudoun County: (not on call, update submitted via email) e data collection continues for Loudoun County and incorporated towns. As a result of the blizzard, I was unable to meet with the Towns of Middleburg and Round Hill. I have spoken with the Town contact's and we are working to identify a date/time convenient to meet with them. I'm hopeful that we will be able to accomplish this sometime soon. In the meantime both jurisdictions have limited owned, leased, operated facilities, so I should be able to collect the information by the requested deadline for those two jurisdictions. I have received preliminary information from the Town of Leesburg and am working to incorporate their data into our spreadsheet. I don't believe there will be any issue with delivery by Monday, February 15, 2016.
j. Prince William County: Awaiting data from the service authority and plan to have it done by the end of the week. Hazard information has been submitted. Working to contact Dumfries and Quantico.
    i. Haymarket: Asset data has been submitted.
    ii. Occoquan: Asset data has been submitted, and they are working to compile hazard data.

3. Next Meeting: The first round of public outreach is planned to happen in the April/May timeframe where we will provide the public an opportunity to weigh in on the HIRA. Please come to next month's meeting prepared to discuss ideas for this.

Action Items:

1. **<u>Provide requested data by February 15</u>** – All Jurisdiction to include Counties, Cities, and Towns.
2. **<u>Brainstorm Outreach Methods by March 8</u>** – Come to the March Meeting prepared to discuss possible outreach strategies.

Hazard Mitigation Plan December Meeting
2/9/2016

Name	Agency	Initials
Cohen, Hal	Witt O'Briens	—
English, Walter	City of Fairfax	✓
Gagnon, Amelia	City of Manassas	✓
George, Kelly	Witt O'Briens	—
Gonzalez, Carrie	VDEM	✓
Guditus, Michael	Fairfax County	
Henshaw, Brian	Town of Haymarket	
Hoffower, Robert	VDEM	✓
Hope, Aaron	City of Alexandria	—
Janickey, Dan	Town of Vienna	✓
Johnson, Kevin	Loudoun County	—
Jovanovich, Kirstyn	Town of Occoquan	—
Kazele, Jake	VDEM	—
Kelly, Adam	Fairfax County	Ack
Lenhart, Alexa	Prince William County	✓
Morrison, David	Arlington County	✓
Polera, Tom	City of Falls Church	
Sca, Sandra	Town of Clifton	
Stave, Blake	City of Alexandria	✓
Teevan, Francis	City of Manassas	
Thompson, Stephen	Town of Herndon	—
Zebrowski, Greg	Fairfax County	—

Northern Virginia Hazard Mitigation Plan Status Update
Meeting Notes

March 8, 2016
1:30 PM

Meeting Attendance:
Walter English
Amelia Gagnon
Carrie Gonzalez
Brian Henshaw
Robert Hoffower
Kevin Johnson
Adam Kelly
David Morrison
Blake Stave
Stephen Thompson
Greg Zebrowski

1. HIRA Update
   a. Witt is in the process of entering all data so they can begin the HIRA, they have asked some follow ups, but no major issues. Once all the locations are entered into HAZUS there may be some additional follow ups, but they do not expect any major issues.
   b. Witt is scheduled to deliver the HIRA to us on April 15. Comments are due May 6, and Witt will be here on May 10 to attend our meeting and address any remaining issues.
2. Review of the Outreach Plan and Schedule
   a. The original plan was to post the HIRA for public review. The regulations state "An opportunity for the public to comment on the plan during the drafting stage and prior to plan approval." Per Witt, their interpretation of this is that the "during drafting stage" review needs to be giving the public an opportunity to review the full draft plan. I will confirm this with VDEM and Witt and get back to you all. Kelly George with Witt is out of the office for a few days so this will not happen until next week. Getting public input is as simple as posting the plan on our websites, so it's not a huge rush to make this decision.
   b. Whatever our outreach strategy is for the plan, every jurisdiction will need to advertise and request feedback on the plan. We can post it on one website and direct everyone to that if we want, but every jurisdiction will have to notify the public of the opportunity to review.
3. Initial Review of Mitigation Actions (found in the Jurisdiction Executive Summaries)
   a. It was presented to the Committee, and approved that each jurisdiction will perform an initial review of the mitigation actions found in the Hazard Mitigation Plan. While the

HIRA must be complete to fully review and determine mitigation actions, this will be a good opportunity to start the review process and clear out any obvious changes that need to be made.

   b. Deadline is May 2.

4. Update of the Capability Assessment
   a. It was presented to the Committee, and approved that each jurisdiction will review the capability assessment chapter (chapter 5) and validate the information. For all jurisdictions who participated in the 2012 plan, please review chapter 5 and confirm that all information is still valid for your jurisdiction. For the couple new jurisdictions in Loudoun provide the information needed that has been provided for all other jurisdictions.
   b. Deadline is May 2.
5. Project Update
   a. I will be out of the office for 2 weeks in late March/Early April. My wife and I are expecting a baby March 28. During my absence, Greg Zebrowski will be the point of contact. He can be reached at Gregory.zebrowski@fairfaxcounty.gov or 571-350-1297.
   b. The April 12 meeting will be cancelled.

Action Items

1. **Confirm requirements for public input in the plan (Adam, due April 1)**
2. **Perform initial review of your jurisdiction's mitigation actions (Everyone, May 2)**
3. **Review and validate the information in the capability assessment (Everyone, May 2)**
4. **Review and provide comment to me and Witt on the HIRA (Everyone, due May 6)**

Hazard Mitigation Plan December Meeting
3/8/2016

Name	Agency	Initials
Cohen, Hal	Witt O'Briens	
English, Walter	City of Fairfax	Phone
Gagnon, Amelia	City of Manassas	Phone
George, Kelly	Witt O'Briens	
Gonzalez, Carrie	VDEM	Phone
Guditus, Michael	Fairfax County	
Henshaw, Brian	Town of Haymarket	Phone
Hoffower, Robert	VDEM	Phone
Hope, Aaron	City of Alexandria	
Janickey, Dan	Town of Vienna	
Johnson, Kevin	Loudoun County	phone
Jovanovich, Kirstyn	Town of Occoquan	
Kazele, Jake	VDEM	
Kelly, Adam	Fairfax County	AK
Lenhart, Alexa	Prince William County	
Morrison, David	Arlington County	Phone
Polera, Tom	City of Falls Church	
Sca, Sandra	Town of Clifton	
Stave, Blake	City of Alexandria	BS
Teevan, Francis	City of Manassas	
Thompson, Stephen	Town of Herndon	[illegible]
Zebrowski, Greg	Fairfax County	[illegible]

Northern Virginia Hazard Mitigation Plan Status Update Meeting Agenda

May 10, 2016
1:30 PM

Attendance:

Walter English
Amelia Gagnon
Kelly George
Carrie Gonzalez
Mike Guditus
Brian Henshaw
Robert Hoffower
Dan Janickey
Kevin Johnson
Kirstyn Jovanovich
Adam Kelly
Alexa Lenhart
David Morrison
Tom Polera
Blake Stave
Steve Thompson
Greg Zebrowski

1. **HIRA Overview and Discussion** – See attached presentation
    a. HIRA Comments are due to Kelly George at Witt by May 13, her email is in the previously distributed spreadsheet.
    b. The group asked that the HIRA be reviewed for consistency and consolidation where appropriate. There are inconsistencies with how hazards are addressed and how the document is formatted.
    c. Witt will perform a methodology consistency check and technical edit before the final delivery.
    d. The group asked Witt to remove references to the previous plans as much as possible.
    e. The state Dam data has over 200 dams, the ones listed in the plan are the high and significant hazard dams. Witt will add reference to the fact that all 200 were used in the analysis. Methodology and assumptions used for this analysis will be added to the plan.
    f. Witt will compile everyone's comments with notes for how they were adjudicated and share that with the Steering Committee.
2. **Regional Mitigation Strategy and Goals (Chapter 6)**

a. In the meeting we discussed and reaffirmed our regional mitigation strategy and goals. Below is a summary of specific changes and decisions by the Steering Committee.
b. It was proposed that we remove the reference to EMAP on page 297. The group chose to leave the reference in the document.
c. The group reaffirmed the guidance for activities considered when coming up with mitigations actions on pages 298-299.
d. The group reaffirmed the use of STAPLE\E as our criteria for assigning priority to jurisdictional mitigation activities.
   i. A spreadsheet will be provided to aid each jurisdiction in using this criteria. Each mitigation action will be scored using the criteria in STAPLE\E. For each of the 7 criteria in STAPLE\E, a low, medium or high (1 for low, 2 for medium, 3 for high) ranking will be assigned, then averaged to determine the overall ranking for that action.
e. The current plan does not elaborate on why some mitigation actions are listed as critical. The Steering Committee agreed to remove Critical and prioritize each mitigation action as Low, Medium or High based on the STAPLE\E criteria
   i. Text will be added to chapter 6 to justify this.
f. The group chose to remove the table of regional mitigation actions on page 303. Each jurisdiction should include these actions as appropriate. Text will be added to the chapter 6 to explain this.
g. The 6 regional mitigations goals were reaffirmed with the following changes
   i. Remove references to human caused hazards.
   ii. Add "and nonstructural" to goal 5 as a way to capture mitigation actions that do not fall easily into another category.

3. Mitigation Recommendations from Witt

a. Based on our HIRA, Kelly discussed the fact that wind (from all sources – hurricane, tornado and severe storms) is our biggest threat.
b. It was recommended that we each examine a range of mitigation activities to address high winds. Some of these include:
   i. Building 361 compliant safe rooms. https://www.fema.gov/media-library/assets/documents/3140
   ii. Tie downs and other building improvements.
c. Include emergency utilities in the mitigation activities, not just generators.
d. After the meeting Kelly committed to providing examples of other plans she has worked on to give us suggestions for mitigation activities that we could include. These will be distributed as soon as received.
e. Kelly recommended breaking the next update of the Mitigation Plan up. It is becoming too large to manage the process and the document itself. She suggested that if we did individual plans, but still went through the process at the same time and in coordination we could still have the economy of scale by all utilizing the same consultant.

4. Jurisdictional Mitigation Strategy Assignment

a. Each jurisdiction is responsible for updating their section of Chapter 7 of the plan and developing their own mitigation strategy/actions.
b. This must be complete and all documents delivered to me by July 15. Each jurisdiction must update chapter 7 and complete the spreadsheet that describes any mitigation actions that were in the 2012 plan that were removed from this one, and the STAPLE\E spreadsheet.
c. I will provide Microsoft Word versions of these sections as well as a table to detail any mitigation actions that appeared in the 2012 plan that are removed from this plan and a spreadsheet to facilitate the STAPLE\E ranking.

5. **Public Input Process**
   a. As part of our planning process we are required to provide two opportunities for public input on our plan. The regulations state (http://www.ecfr.gov/cgi-bin/text-idx?rgn=div5&node=44:1.0.1.4.53#se44.1.201_16):

      (b) Planning process. An open public involvement process is essential to the development of an effective plan. In order to develop a more comprehensive approach to reducing the effects of natural disasters, the planning process shall include:
      (1) An opportunity for the public to comment on the plan during the drafting stage and prior to plan approval;
      (2) An opportunity for neighboring communities, local and regional agencies involved in hazard mitigation activities, and agencies that have the authority to regulate development, as well as businesses, academia and other private and non-profit interests to be involved in the planning process; and
      (3) Review and incorporation, if appropriate, of existing plans, studies, reports, and technical information

   b. As shown above, the regulations are relatively vague for how to receive public input. Per Witt, the general guidance from FEMA is that you advertise the document as you would other public documents in your jurisdiction. Each jurisdiction must check their regulations and report back by May 20.
      i. It was proposed that we will advertise the plan from June 13-24. This was tabled until jurisdictions have an opportunity to review their own requirements.
      ii. I will confirm with VDEM, but it is acceptable to post the plan on our websites and direct the public to review it.
   c. Each jurisdiction must request public input on the plan and will be responsible for providing documentation to me after the input process.
      i. I contacted Debbie Messmer at VDEM as requested and she did say FEMA likes to see the plan advertised two different ways. She said that posting it on the website and advertising it via social media/blogs etc was acceptable. Forums like public meetings and posting in the library are also acceptable.
   d. Comments will be given to Witt for incorporation into the HIRA.
   e. We also need to provide an opportunity for stakeholders to review. This includes surrounding jurisdictions (D.C., Montgomery, Clarke, Fauquier, Stafford), VOAD,

educational facilities (schools, universities, and community colleges), and business partners.

i. Provide list of who you would like me to email by May 20, I will send it to all of these stakeholders so it is easier to document who we sent it to.

Action Items:

Adam:

1. **Provide editable versions of the following documents to each jurisdiction by May 27:**
   a. **Chapter 7**
   b. **STAPLE\E ranking spreadsheet**
   c. **Table to document actions removed from this version of the plan**

Group:

1. **Provide comments on the HIRA to Kelly by May 13.**
2. **Provide information to me on how long/how your jurisdiction will advertise the plan for public comment by May 20.**
3. **Provide contacts to review the HIRA, and completed Plan (late summer/early fall) to Adam by May 20 (reference Section 5e above).**
4. **Provide Completed Chapter 7, STAPLE\E and appendix table to Adam by July 15.**

Hazard Mitigation Plan December Meeting
5/10/2016

Name	Agency	Initials
Christman, Amanda	Town of Clifton	
English, Walter	City of Fairfax	[illegible]
Gagnon, Amelia	City of Manassas	on phone
George, Kelly	Witt O'Briens	present
Gonzalez, Carrie	VDEM	[illegible]
Guditus, Michael	Fairfax County	
Henshaw, Brian	Town of Haymarket	on phone
Hoffower, Robert	VDEM	on phone
Hope, Aaron	City of Alexandria	
Janickey, Dan	Town of Vienna	DJ
Johnson, Kevin	Loudoun County	[illegible]
Jovanovich, Kirstyn	Town of Occoquan	[illegible]
Kazele, Jake	VDEM	
Kelly, Adam	Fairfax County	[illegible]
Lenhart, Alexa	Prince William County	[illegible]
Morrison, David	Arlington County	[illegible]
Polera, Tom	City of Falls Church	[illegible]
Stave, Blake	City of Alexandria	[illegible]
Teevan, Francis	City of Manassas	
Thompson, Stephen	Town of Herndon	
Zebrowski, Greg	Fairfax County	

Northern Virginia Hazard Mitigation Plan Update

HAZARD IDENTIFICATION & RISK ASSESSMENT

REVIEW MEETING

MAY 10, 2016

WITT | O'BRIEN'S

CONTROL THE OUTCOME®

Hazard Identification &Risk Assessment Update

WITT | O'BRIEN'S

What is a hazard identification & risk assessment (HIRA)?

- FEMA's *Local Mitigation Planning Handbook* (March 2013) breaks this section of the plan into four steps:
  1. Describe hazards
  2. Identify community assets
  3. Analyze risks
  4. Summarize vulnerability

Risk assessment update

- No requirements exist as to the methodology used for risk assessments, so long as the criteria in 44 CFR §201.6 are met
- We used the same methodologies to update the risk assessment as are used in the 2010 plan:
  - Exposure analysis
  - Historical analysis
  - Scenario analysis
- The updated HIRA used both GIS and HAZUS-MH 3.1, where appropriate

Risk assessment methodology

- The risk assessment methodology used in the 2016 update is the same or very similar as the methodology used in the 2010 update
- This methodology is primarily based on the use of NCDC data (where applicable and appropriate), with other data input as necessary to fill gaps
- Where applicable and appropriate, GIS and HAZUS-MH (version 3.1) were also used, just as in the 2010 update

Risk assessment methodology description

"CGIT and VDEM developed a standardized methodology to compare different hazards' risk on a jurisdictional basis. As some of the hazards assess in this plan did not have a precisely quantifiable probability or impact data, a semi-quantitative scoring system was used to compare all of the hazards. This method prioritized hazard risk based on a blend of quantitative factors from the available data. A number of parameters have been considered in this methodology, all of which could be derived from the NCDC dataset:

- History occurrence
- Vulnerability of people in the hazard area;
- Probably geographic extent of the hazard area; and
- Historical impact, in terms of human lives and property." (2010 NOVA HMP, p. 82)

Risk assessment methodology description

"The ranking methodology tries to balance these factors, whose reliability varies from hazard to hazard due to the nature of the underlying data. Each parameter was rated on a scale of one through four….. These scores are summed at the jurisdictional level for each hazard separately, permitting comparison between jurisdictions for each hazard type. A summation of all the scores from all hazards in each jurisdiction provides an overall all-hazards risk prioritization." (2010 NOVA HMP, pp. 82-3)

Process for HIRA Update

- Starting point: data, sources, and calculations in the 2010 update
- Added data from October 2009-December 2015 to HIRA:
  - Occurrences
  - Impacts
  - Vulnerabilities
- Data obtained from:
  - Federal: NCDC, FEMA, USACE (National Inventory of Dams), Forest Service
  - State: forestry
  - Local: user reports
  - Other: media accounts

Process for HIRA Update (continued)

- Recreated/created GIS products with updated data
  - Locally-provided assets were included
  - Where appropriate, GIS products were created for each hazard and each jurisdiction
  - The individual jurisdiction maps are in the appendix, as there are approximately 200 of them
- Recreated HAZUS-MH models with updated runs (HAZUS-MH v.3.1 and ArcGIS 10.2)
  - Three models: flood, hurricane wind, & earthquake
  - Default assets were included (due to time constraints caused by release date)
  - Variances in model output from last run, which was completed using HAZUS-MH 2.1 and ArcGIS 10
  - The individual reports and maps are in the appendix, as there are more than 100 of them

Process for HIRA Update (continued)

- Removed the majority of references to 2006 plan
  - Information was dated and no longer applicable
  - Methodology no longer applied
- Removed repetitive narrative
  - Largely methodology descriptions
- Reformatted to specifically include all participating jurisdictions
  - Though many sub-sections were consolidated where appropriate, noting jurisdictions included in narrative, to avoid extraneous text

HIRA Update: Remaining Tasks & Schedule

WITT | O'BRIEN'S

Remaining Tasks for HIRA Update

WITT | O'BRIEN'S

- Receipt and compilation of Committee comments
- Revisions to HIRA based on comments
  - Re-inserting Lewisburg data (Sorry, Lewisburg!)
- QA/QC of data and calculations
- Creation of HIRA summary tables
- Consolidation of HIRA files into single section (Chapter 4)
- QA/QC of document (i.e., tense, numbering, typos, formatting, etc.)
- Finalization of appendices for HIRA
- Delivery of HIRA and appendices to Adam

WITT | O'BRIEN'S

Estimated schedule for HIRA update completion

- April 22, 2016: Review Draft of Updated HIRA delivered to Committee for review/comment
- May 10, 2016: Presentation to Committee
- May 13, 2016: All Committee Review comments due to consultants
- June 03, 2016: Final Draft of Updated HIRA (and appendices) delivered
- June 2016-September 2017: Technical assistance/revisions (from public, VDEM, and FEMA reviews) as required

Contact information

WITT | O'BRIEN'S

WITT | O'BRIEN'S

Consultant contact information

- Kelly George, CFM – Project Manager/Senior Mitigation Planner:
  - kgeorge@wittobriens.com
- Hal Cohen – Subject Matter Expert
  - hcohen@wittobriens.com
- Erin Buchanan, CFM – Mitigation Planner/Data Management Specialist:
  - ebuchanan@wittobriens.com
- Jake Halley – GIS Specialist:
  - jhalley@wittobriens.com

Fairfax County Mitigation Strategy Session
5/26/2016

Name	Agency	Initials
Alvarez, Carmita	DAHS	
Baldwin, Sara K.	FCPA	
Barbiere, Marc	FCHD	[illegible]
Batts, Dennis E.	DPWES	DB
Bilowus, Jonathan	HCD	
Bird Shrout, Cynthia	DPSC	
Black, Beverly	NCS	BAB
Braff, Evan L.	NCS	
Bui, Joseph L	DPWES	
Coyle, Regina	DPZ	
Dove, James	FMD	[illegible]
Easley, Robert C.	HCD	
Erhard, Carol	HCD	
Flynn, Teri	RMD	
Green, Lynn S.	DPWES	[illegible]
Gregoire, Ian P.	Fire	[illegible]
Guditus, Michael	OEM	
Habourn, Jesse	HCHD	JH
Hatfield, Doug	FMD	
Henry, Elizabeth	DFS	
Innocenti, Patricia	DPSM	
Johnson, Todd	FCPA	TJ
Kelly, Adam C.	OEM	
Lane, G. Michael	CSB	
Lay, Dean	FCPD	
Leduc, Leonise D.	HCD	
Liberman, Michael S.	DCCS	
Matos Candelario, Jansel	FMD	

Fairfax County Mitigation Strategy Session
5/26/2016

Name	Agency	Initials
Messier, Michael W	Sheriff	
Miracle, Kris	HCD	
Moffatt, Mark	DVS	
Paris, Jennifer	DPWES	JP
Person, Jim	OPA	
Quetsch, Carolyn	DTA	
Richardson, Rhonda	DPWES	
Seidler, Laura B.	FMD	
Shultzaberger, Laurel A.	DPWES	LS
Speight, James	HCD	
Springsteen, Howard J.	DVS	
Stratoudakis, James P. Dr.	CSB	
Teitelman, Eric M.	FCDOT	[illegible]
~~Turner, John W~~ Lori Harcy	HCD	LH
Williams, William	CSB	
Zebrowski, Gregory	OEM	

Hazard Mitigation Strategy

May 26, 2016

Mitigation Plan Overview

- Purpose
  - Requirement to apply for mitigation funds
  - Utilized in the Community Rating System which, in part determines our residents flood insurance rates.
- Overview
  - Public document
  - Local plan done regionally
  - 21 participating jurisdictions
  - 5 year cycle, last approved spring 2012 (but generally referred to as the 2010 plan)
- Project Timeline / Status
  - We plan to submit it to VDEM/FEMA in October at the latest
  - 2 rounds of public input, one in June, one early fall before submission

Significant changes in the 2017 plan

- The Northern Virginia Emergency Managers gave the planning team the committee the direction to remove the human caused hazards section of the plan.
- Regional Mitigation Actions are being removed and incorporated locally, if applicable.

Plan Components

1. Introduction
2. Planning Process
3. Regional Information (geography, climate, population, economy, land use and development etc…)
4. Hazard Identification and Risk Assessment (HIRA)
5. Capability Assessment
6. Regional Mitigation Strategy
7. **Executive Summaries (local mitigation activities)**
8. Plan Maintenance

HIRA Overview

- FEMA's *Local Mitigation Planning Handbook* (March 2013) breaks this section of the plan into four steps:
  1. Describe hazards
  2. Identify community assets
  3. Analyze risks
  4. Summarize vulnerability

- Listing of Hazards

Flood	Winter Storm	High Wind/Severe Storm	Tornado
Drought	Earthquake	Landslide	Wildfire
Geologic	Dam Failure	Extreme Temps	

Hazards Changes from 2010

- Extreme cold was removed from winter storm
- Extreme heat was removed from drought
- Extreme temperatures was added as a hazard (heat and cold)
- Rationales:
  - It’s possible to have occurrences of extreme temperatures in the absence of other hazard events
  - Extreme cold is not necessarily a component of winter storm
  - Extreme heat is not necessarily a component of a drought

Hazard	Probability	Impact	Spatial Extent	Warning Time	Duration
Flood	Highly Likely	Critical	Moderate	6-12 hours	Less than one week
Winter Storm	Highly Likely	Critical	Moderate	6-12 hours	Less than one week
High Wind / Severe Storms	Highly Likely	Critical	Moderate	12-24 hours	Less than one week
Tornado	Highly Likely	Critical	Moderate	0-12 hours	Less than one week
Drought	Likely	Moderate	Moderate	3-6 months	More than one month
Earthquake	Possible	Critical	Moderate	Less than 6 hours	Less than one week

Hazard	Probability	Impact	Spatial Extent	Warning Time	Duration
Landslide	Unlikely	Critical	Moderate	Less than 6 hours	Less than one week
Wildfire	Unlikely	Critical	Small	Less than 6 hours	Less than one week
Geologic (sinkholes / karst / land subsidence)	Very Low	Moderate	Low	6-12 hours	Less than one week
Dam Failure	Possible	Critical	Moderate	Less than 6 hours	Less than one week
Extreme Temps	Likely	Minor	Large	More than 24 hours	Less than one week

Mitigation Actions

- Mitigation activities should fit in the following categories.
  - Prevention
  - Property Protection
  - Natural Resource Protection
  - Structural Projects
  - Emergency Services
  - Public Education and Awareness

  - **See Chapter 6 of the existing plan for more details**

Countywide Mitigation Recommendations

- **Outreach / Public Messaging**
- **Emergency Utilities / Generators**
- **Community Safe Rooms**

Hazard Mitigation Assistance

- Hazard Mitigation Grant Program – Assists in implementing long-term hazard mitigation measures following a Presidential major disaster declaration. Generally 15% of total Federal assistance provided to a state following a major disaster declaration
- Predisaster Mitigation Grant – Provides funds for hazard mitigation planning and projects on an annual basis
- Flood Mitigation Assistance Grant – Provides funds for projects to reduce or eliminate risk of flood damage to buildings that are insured under NFIP
- http://www.fema.gov/hazard-mitigation-assistance

Next Steps – What do I need to do?

- **Agencies need to provide an update for all actions in the 2010 plan**
  - Status – in progress, complete, no longer valid etc.
  - Brief comment/update on the action.
- **Develop new mitigation actions**
  - Provide me any new mitigation actions your agency thinks are appropriate. Include all of the information found in the 2010 mitigation actions handout.
  - I will distribute several other mitigation plans that may give you ideas.

  - Provide all updates to me by June 24.

Current Plan

- The current plan can be found here:

http://www.fairfaxcounty.gov/oem/northern-virginia-hazard-mitigation-plan-2012final.pdf

Northern Virginia Hazard Mitigation Plan Status Update
Meeting Notes

June 14, 2016
1:30 PM

Meeting Attendance:
Amelia Gagnon
Carrie Gonzalez
Robert Hoffower
Jake Kazele
Adam Kelly
Alexa Lenhart
David Morrison
Tom Polera
Stephen Thompson

1. **Project Update**
    a. HIRA Update – The draft HIRA has been delivered and all comments should be in by July 1 to pass along to Witt.
    b. Status of the rest of the plan – Drafts of the rest of the chapters of the plan are complete and Greg Zebrowski will be sending those out in the next week. You will have 3 weeks to review the documents and provide comments to Greg. For the most part, the documents were just updated to reflect current statistics etc, but the Plan Maintenance chapter is undergoing a significant update.
    c. Outreach – We are all responsible for advertising the plan to the public. Please provide all comments to Greg and me so we can pass them along to Witt. Please provide screen shots or other documentation of your outreach efforts. Remember to advertise the document in two ways, most jurisdictions are doing social media and a web site posting.
    d. Capability Assessment – If you have not completed this, please do it ASAP and provide it to Greg. Also attached to this email is a summary of who has completed it and other aspects of the plan.
    e. Jurisdictional Mitigation Action Plans – These are due July 15 to Greg. Please let Greg or me know ASAP if you have any questions. There were no questions on this process during the meeting. At the meeting we discussed deleting the annualized loss data from the jurisdictional executive summaries. There were no objections, I have attached the Fairfax County Executive Summary as an example. We will all be deleting the text in red (starting directly below the Hazard Ranking Table) and running down to the Action Plan. This information is in the HIRA and is repetitive. The information you need to update

the Hazard Ranking table is found on page 4-45 of the updated HIRA. http://www.fairfaxcounty.gov/oem/mitigation/nova_hira_-_chapter_4_-_final_draft_-_06.09.16.pdf

2. **Project Management Update** – I will be out of the office for 10 weeks this summer beginning Saturday, July 2 and running through early September. I will send you another note about this as the time gets a little closer. If you need anything related to hazard mitigation during my absence please contact Greg Zebrowski, 571-350-1297, or Gregory.zebrowski@fairfaxcounty.gov. You will start seeing him reaching out to you for things in the coming days (such as providing drafts of the other plan chapters).

Hazard Mitigation Plan Meeting
6/14/2016

Name	Agency	Initials
Tiwana, Barnes	Town of Dumfries	
Christman, Amanda	Town of Clifton	
English, Walter	City of Fairfax	
Frazier, Rita	Town of Quantico	
Gagnon, Amelia	City of Manassas	phone
George, Kelly	Witt O'Briens	
Gonzalez, Carrie	VDEM	phone
Guditus, Michael	Fairfax County	
Henshaw, Brian	Town of Haymarket	
Hoffower, Robert	VDEM	phone
Hope, Aaron	City of Alexandria	
Janickey, Dan	Town of Vienna	
Johnson, Kevin	Loudoun County	
Jovanovich, Kirstyn	Town of Occoquan	
Kazele, Jake	VDEM	phone
Kelly, Adam	Fairfax County	ACK
Lenhart, Alexa	Prince William County	phone
Morrison, David	Arlington County	phone
Polera, Tom	City of Falls Church	[illegible]
Teevan, Francis	City of Manassas	
Thompson, Stephen	Town of Herndon	[illegible]
Zebrowski, Greg	Fairfax County	

Northern Virginia Hazard Mitigation Plan Status Update Meeting Notes

July 12, 2016
1:30 PM

Meeting Attendance:

Walter English
Amelia Gagnon
Carrie Gonzalez
Mike Guditus
Robb Hoffower
Aaron Hope
Dan Janickey
Jake Kazele
Alexa Lenhart
Holly Montague
David Morrison
Tom Polera
Steve Thompson
Greg Zebrowski

Notes:

1. Roll Call

2. Project Update
    a. HIRA update: The draft HIRA has been delivered to Witt. They are updating the draft HIRA and expect to have the finalized draft returned by the first week of September.

    b. Status of the plan: Jurisdictions are still providing required data and updates for the plan and the Draft 2017 Hazard Mitigation plan is being compiled.

    c. Outreach: We are all responsible for advertising the plan to the public. Remember to advertise the document in two ways, most jurisdictions are doing social media and a web site posting.

    d. Capability Assessment: These are past due. If you have not submitted please submit to Greg as soon as possible. July 15. There were no questions on this process during the meeting.

e. Jurisdictional Mitigation action plans: These are due July 15 to Greg. Please let Greg or me know ASAP if you have any questions. There were no questions on this process during the meeting.

3. Project Management Update: Greg Zebrowski, is now the project team lead for the Hazard Mitigation Plan project. . If you need anything related to hazard mitigation please contact Greg Zebrowski, 571-350-1297, or Gregory.zebrowski@fairfaxcounty.gov. You will start seeing him reaching out to you for things in the coming days (such as providing drafts of the other plan chapters).

4. Adjournment

Action Items:

1. Executive summary/ Action plan is due by July 15

Hazard Mitigation Plan Meeting
7/12/2016

Name	Agency	Initials
Christman, Amanda	Town of Clifton	Withdrew
English, Walter	City of Fairfax	On Phone
Gagnon, Amelia	City of Manassas	On Phone
George, Kelly	Witt O'Briens	
Gonzalez, Carrie	VDEM	On Phone
Guditus, Michael	Fairfax County	
Montague Holly ~~Henshaw, Brian~~	Town of Haymarket	On Phone
Hoffower, Robert	VDEM	On Phone
Hope, Aaron	City of Alexandria	[illegible]
Janickey, Dan	Town of Vienna	On Phone
Johnson, Kevin	Loudoun County	
Jovanovich, Kirstyn	Town of Occoquan	
Kazele, Jake	VDEM	
Kelly, Adam	Fairfax County	
Lenhart, Alexa	Prince William County	AL
Morrison, David	Arlington County	On Phone
Polera, Tom	City of Falls Church	On Phone
Aaron Hope ~~Stave, Blake~~	~~City of Alexandria~~	
Teevan, Francis	City of Manassas	
Thompson, Stephen	Town of Herndon	On Phone
Zebrowski, Greg	Fairfax County	GZ

Northern Virginia Hazard Mitigation Plan Status Update Meeting Notes

August 9, 2016
1:30 PM

Meeting Attendance:

Walter English
Amelia Gagnon
Carrie Gonzalez
Robb Hoffower
Aaron Hope
Dan Janickey
Kevin Johnson
Holly Montague
David Morrison
Tom Polera
Steve Thompson
Richard West
Greg Zebrowski

Notes:

1. Roll Call

2. Project Update
    a. Overdue jurisdiction status: At this time 2 jurisdictions are overdue in submitting their data to Greg Zebrowski. They are aware they are overdue and Greg Zebrowski will be working with them to get things submitted as soon as possible.

    b. Status of the plan: The draft HIRA has been delivered to Witt. They are updating the draft HIRA and expect to have the finalized draft returned by the first week of September. Jurisdictions are still providing required data and updates for the plan and the Draft 2017 Hazard Mitigation plan is being compiled.

    c. Outreach: The group was reminded they are all responsible for advertising the plan to the public. Remember to advertise the document in two ways, most jurisdictions are doing social media and a web site posting.

3. Project Management Update: Greg Zebrowski, is now the project team lead for the Hazard Mitigation Plan project. . If you need anything related to hazard mitigation please contact Greg Zebrowski, 571-350-1297, or Gregory.zebrowski@fairfaxcounty.gov.

4. Questions and comments: There were no questions or comments from the group.

5. Adjournment

Action Items:

1. Work with overdue jurisdictions to complete required work

Hazard Mitigation Plan Meeting
8/9/2016

Name	Agency	Initials
Christman, Amanda	Town of Clifton	
English, Walter	City of Fairfax Ken Rudnicki	[illegible]
Gagnon, Amelia	City of Manassas	
George, Kelly	Witt O'Briens	
Gonzalez, Carrie	VDEM	
Guditus, Michael	Fairfax County	
Hoffower, Robert	VDEM	
Hope, Aaron	City of Alexandria	
Janickey, Dan	Town of Vienna	
Johnson, Kevin	Loudoun County	
Jovanovich, Kirstyn	Town of Occoquan	
Kazele, Jake	VDEM	
Lenhart, Alexa	Prince William County	
Montague, Holly	Town of Haymarket	
Morrison, David	Arlington County	
Polera, Tom	City of Falls Church	
Teevan, Francis	City of Manassas	
Thompson, Stephen	Town of Herndon	
West, Richard	Town of Dumfries	
Zebrowski, Greg	Fairfax County	

Northern Virginia Hazard Mitigation Plan Status Update
Meeting Notes

September 13, 2016
1:30 PM

Meeting Attendance:

Walter English
Amelia Gagnon
Carrie Gonzalez
Mike Guditus
Robb Hoffower
Dan Janickey
Kirstyn Jovanovich
Alexa Lenhart
Holly Montague
David Morrison
Ray Whatley
Greg Zebrowski

Notes:

1. Roll Call

2. Project Update
    a. Jurisdiction status: Question was asked if the jurisdictions are still looking to have the plan finalized to present to their political body by February. All jurisdictions agreed February is the required timeframe.

    b. Status of the plan: The draft HIRA has been delivered from Witt and is being incorporated into the plan. Jurisdictions are still providing required data and updates for the plan and the Draft 2017 Hazard Mitigation plan is being compiled. The draft plan will be compiled and delivered to the jurisdictions to outreach on September 16.

    c. Outreach: The group was reminded they are all responsible for advertising the plan to the public. Remember to advertise the document in two ways, most jurisdictions are doing social media and a web site posting.

3. Project Management Update: Greg Zebrowski, is now the project team lead for the Hazard Mitigation Plan project. . If you need anything related to hazard mitigation please contact Greg Zebrowski, 571-350-1297, or Gregory.zebrowski@fairfaxcounty.gov.

4. Questions and comments: There were no questions or comments from the group.

5. Adjournment

Action Items:

1. Work with overdue jurisdictions to complete required work
2. Deliver the draft plan to jurisdictions by September 16
3. Jurisdiction need to send screenshots of the draft plan outreach efforts. This is a required element for the final plan.

Hazard Mitigation Plan Meeting
9/13/2016

Name	Agency	Initials
~~Christman, Amanda~~	~~Town of Clifton~~	withdrew
English, Walter	City of Fairfax	On Phone
Gagnon, Amelia	City of Manassas	on phone
George, Kelly	Witt O'Briens	N/A
Gonzalez, Carrie	VDEM	On phone
Guditus, Michael	Fairfax County	MG
Hoffower, Robert	VDEM	On Phone
~~Hope, Aaron~~	~~City of Alexandria~~	
Janickey, Dan	Town of Vienna	on Phone
Johnson, Kevin	Loudoun County	X
Jovanovich, Kirstyn	Town of Occoquan	On Phone
Kazele, Jake	VDEM	X
Lenhart, Alexa	Prince William County	on Phone
Montague, Holly	Town of Haymarket	on Phone
Morrison, David	Arlington County	On Phone
Polera, Tom	City of Falls Church	excused
Smedley, Corey	City of Alexandria	X
Retired Teevan, Francis	City of Manassas	X
Thompson, Stephen	Town of Herndon	excused
West, Richard	Town of Dumfries	excused
Whatley, Ray	City of Alexandria	on Phone
Zebrowski, Greg	Fairfax County	GZ

Northern Virginia Hazard Mitigation Plan Status Update
Meeting Notes

December 13, 2016
1:30 PM

Meeting Attendance:

Walter English
Robb Hoffower
Dan Janickey
Holly Montague
David Morrison
Tom Polera
Stephen Thompson
Greg Zebrowski

Notes:

1. Roll Call

2. Project Update

    a. Status of the plan: The Hazard Mitigation Plan has been submitted to the state in November for the State and Region review. The state completed their review and the draft plan was submitted to FEMA Region III for review and approval.

    b. Jurisdiction status: Question was asked if the jurisdictions are still looking to have the plan finalized to present to their political body by February. All jurisdictions agreed February is the required timeframe. Jurisdictions also asked for standardized talking points.

3. Questions and comments: There were no questions or comments from the group.

4. Adjournment

Action Items:

1. Work with overdue jurisdictions to complete required work
2. Develop standardized talking points

Hazard Mitigation Plan Meeting
12/13/2016

Name	Agency	Initials
Christman, Amanda	Town of Clifton	
English, Walter	City of Fairfax	on phone
Gagnon, Amelia	City of Manassas	
George, Kelly	Witt O'Briens	
Gonzalez, Carrie	VDEM	
Guditus, Michael	Fairfax County	
Hoffower, Robert	VDEM	on phone
Hope, Aaron	City of Alexandria	
Janickey, Dan	Town of Vienna	on phone
Johnson, Kevin	Loudoun County	
Jovanovich, Kirstyn	Town of Occoquan	
Kazele, Jake	VDEM	
Lenhart, Alexa	Prince William County	
Montague, Holly	Town of Haymarket	on phone
Morrison, David	Arlington County	on phone
Polera, Tom	City of Falls Church	on phone
Smedley, Corey	City of Alexandria	
Teevan, Francis	City of Manassas	
Thompson, Stephen	Town of Herndon	on phone
West, Richard	Town of Dumfries	
Whatley, Ray	City of Alexandria	
Zebrowski, Greg	Fairfax County	on phone host

Northern Virginia Hazard Mitigation Plan Status Update
Meeting Notes

January 10, 2017
1:30 PM

Meeting Attendance:

Walter English
Amelia Gagnon
Dan Janickey
Kevin Johnson
Kirstyn Jovanovich
Holly Montague
Tom Polera
Katie Smith
Stephen Thompson
Ray Whatley
Greg Zebrowski

Notes:

1. Roll Call

2. Project Update
    a. State review was completed: VDEM completed their review of the draft plan on November 14, 2016 with no comment and submitted the plan to FEMA Region III on the same date.

    b. FEMA Region III review was completed: The draft HazMit was delivered from VDEM to FEMA on November 14, 2016. The Draft 2017 Hazard Mitigation plan review was completed and FEMA returned the Northern Virginia PDC Plan Review Tool. The review was sent to the committee for their review.

3. The Northern Virginia PDC Plan Review Tool demonstrates how the Local Mitigation Plan meets the regulation in 44 CFR §201.6 and offers States and FEMA Mitigation Planners an opportunity to provide feedback to the community.

4. Work Assignments: The committee was assigned the task of completing the NFIP survey as a required element of the 2017 Hazard Mitigation Plan.

5. Questions and comments: There were no questions or comments from the group.

6. Adjournment

Action Items:

1. Work with overdue jurisdictions to complete required work
2. Jurisdictions must complete the NFIP survey
3. Complete development of the standardized talking points

Hazard Mitigation Plan Meeting
1/10/2017

Name	Agency	Initials
Christman, Amanda	Town of Clifton	withdrew
English, Walter	City of Fairfax	
Gagnon, Amelia	City of Manassas	on phon
George, Kelly	Witt O'Briens	
Gonzalez, Carrie	VDEM	excused
Guditus, Michael	Fairfax County	
Hoffower, Robert	VDEM	excused
~~Hope, Aaron~~	City of Alexandria	
Janickey, Dan	Town of Vienna	on phone
Johnson, Kevin	Loudoun County	on phone
Jovanovich, Kirstyn	Town of Occoquan	on phon
Kazele, Jake	VDEM	excused
~~Lenhart, Alexa~~	~~Prince William County~~	
Montague, Holly	Town of Haymarket	On phone
Morrison, David	Arlington County	
Polera, Tom	City of Falls Church	excused/Joined on phon
Smedley, Corey	City of Alexandria	
Teevan, Francis	City of Manassas	
Thompson, Stephen	Town of Herndon	On phone
West, Richard	Town of Dumfries	
Whatley, Ray	City of Alexandria	On Phone
Zebrowski, Greg	Fairfax County	gf
Katie Smith	Prince William	on phone

Northern Virginia Hazard Mitigation Plan Status Update
Meeting Notes

February 14, 2017
1:30 PM

Meeting Attendance:

Walter English
Amelia Gagnon
Dan Janickey
Kevin Johnson
Kirstyn Jovanovich
Holly Montague
David Morrison
Tom Polera
Katie Smith
Stephen Thompson
Ray Whatley
Greg Zebrowski

Notes:

1. Roll Call

2. Project Update

    a. FEMA Region III review was completed: The draft HazMit was delivered from VDEM to FEMA on November 14, 2016. The Draft 2017 Hazard Mitigation plan review was completed and FEMA returned the Northern Virginia PDC Plan Review Tool. The review was sent to the committee for their review.

3. Work Assignments: The committee was assigned the task of completing the NFIP survey as a required element of the 2017 Hazard Mitigation Plan. Most Jurisdictions have completed the survey but a few still need to submit.

4. Presentation for your Jurisdictional leadership: Fairfax County is putting together a PowerPoint presentation to share with the other Committee members. This presentation will be sent out as soon as it is approved by Senior Leadership.

5. Questions and comments: There were no questions or comments from the group.

6. Adjournment

Action Items:

1. Work with overdue jurisdictions to complete required work
2. Send Presentation and Adoption Agreement to Jurisdictions
3. Complete development of the standardized talking points

Hazard Mitigation Plan Meeting
2/14/2017

Name	Agency	Initials
~~Christman, Amanda~~	~~Town of Clifton~~	
English, Walter	City of Fairfax	On phone
Gagnon, Amelia	City of Manassas	On phone
George, Kelly	Witt O'Briens	N/A
Gonzalez, Carrie	VDEM	Excused
Guditus, Michael	Fairfax County	Excused
Hoffower, Robert	VDEM	Excused
~~Hope, Aaron~~	~~City of Alexandria~~	
Janickey, Dan	Town of Vienna	Excuse
Johnson, Kevin	Loudoun County	on phon
Jovanovich, Kirstyn	Town of Occoquan	On phon
Kazele, Jake	VDEM	excused
~~Lenhart, Alexa~~	~~Prince William County~~	
Montague, Holly	Town of Haymarket	On phone
Morrison, David	Arlington County	DM
Polera, Tom	City of Falls Church	on phon
Smedley, Corey	City of Alexandria	Excused
Teevan, Francis	City of Manassas	Excused
Thompson, Stephen	Town of Herndon	Excused
West, Richard	Town of Dumfries	
Whatley, Ray	City of Alexandria	On Phone
Zebrowski, Greg	Fairfax County	
Smith, Katie	Prince William County	KS

APPENDIX D

HAZARD IDENTIFICATION AND RISK ASSESSMENT INFORMATION

APPENDIX D

Critical Assets – All Jurisdictions

Arlington County Critical Assets

Critical Asset	Jurisdiction	Tornado Scenario .25 Mile Buffer	SFHA 100 Year	SFHA 500 Year	WFP Class	Asset Values	Content Values
ΓÇ£Super StopΓÇ¥	Arlington County	No	No	No	Non-burnable	$250,000	$0
Activated Sludge Effluent Pump Station 1 - ASE1	Arlington County	Yes	No	Yes	Water	$4,276,200	$0
Advance Backwash Building - ABWB	Arlington County	Yes	No	No	Non-burnable	$4,603,600	$0
Alcove Heights - Restrooms	Arlington County	No	No	No	Very Low	$109,000	$0
Alcove Heights Park	Arlington County	No	No	No	Very Low	$124,800	$0
Animal Welfare League	Arlington County	No	No	Yes	Very Low	$0	$0
ANSER	Arlington County	No	No	No	Non-burnable	$0	$2,575,000
Argus House	Arlington County	No	No	No	Non-burnable	$990,500	$135,000
Arlington Arts Center	Arlington County	No	No	No	Non-burnable	$1,906,400	$45,000
Arlington Children's Center	Arlington County	No	No	No	Non-burnable	$548,800	$0
Arlington Hall West Park	Arlington County	No	No	No	Non-burnable	$0	$0
Arlington Heights Park	Arlington County	No	No	No	Very Low	$0	$5,000
Arlington Mill Community Center	Arlington County	No	No	No	Very Low	$22,000,000	$2,000,000
Arlington Transit Bur	Arlington County	Yes	No	No	Non-burnable	$0	$10,000
Art Bus Office	Arlington County	Yes	No	No	Non-burnable	$46,233	$0
Art Bus Shed	Arlington County	Yes	No	No	Non-burnable	$13,700	$0
ARTISPHERE	Arlington County	No	No	No	Very Low	$0	$5,586,713
Aurora Hills Library / Aurora Hills Community Center & Senior Center	Arlington County	Yes	No	No	Very Low	$3,636,200	$2,535,000
Bailey's Branch Park	Arlington County	No	No	No	Non-burnable	$0	$0
Ballston Garage	Arlington County	No	No	No	Non-burnable	$58,384,500	$0
Ballston Plaza lll	Arlington County	Yes	No	No	Non-burnable	$0	$2,575,000
Ballston Plaza Place	Arlington County	No	No	No	Non-burnable	$0	$2,935,500
Barcroft Park	Arlington County	No	No	Yes	Non-burnable	$1,000,000	$0
Barcroft Park - Bike Shop	Arlington County	No	No	Yes	Non-burnable	$52,000	$25,750
Barcroft Park - Concessions	Arlington County	No	No	Yes	Non-burnable	$169,400	$5,000
Barcroft Park - Greenhouse	Arlington County	No	No	Yes	Non-burnable	$78,000	$5,150
Barcroft Park - Metal Storage Building	Arlington County	No	No	Yes	Non-burnable	$5,200	$2,060
Barcroft Park - Nursery Shop	Arlington County	No	No	Yes	Non-burnable	$52,000	$20,600
Barcroft Park - Parking Deck	Arlington County	No	No	Yes	Non-burnable	$4,946,500	$5,000

Arlington County Critical Assets

Barcroft Park - Picnic Shelter #1	Arlington County	No	No	Yes	Non-burnable	$75,000	$0
Barcroft Park - Restrooms	Arlington County	No	No	Yes	Non-burnable	$213,900	$0
Barcroft Park - Synthetic field	Arlington County	No	No	Yes	Non-burnable	$0	$0
Barcroft Sports & Fitness Ctr.	Arlington County	No	No	No	Non-burnable	$4,379,200	$415,000
BB&T	Arlington County	No	No	No	Non-burnable	$0	$2,575,000
Benjamin Banneker Park	Arlington County	No	Yes	No	Non-burnable	$0	$0
Big Walnut Park	Arlington County	No	No	No	Very Low	$0	$0
Biological Sludge Processing Building - BIO / Household Hazardous Waste Disposal Point - HHW	Arlington County	Yes	No	No	Very Low	$15,454,976	$206,000
Bluemont Junction Park - Caboose	Arlington County	Yes	No	No		$81,600	$2,000
Bluemont Park	Arlington County	No	No	No	Very Low	$0	$0
Bluemont Park - Picnic shelter	Arlington County	No	Yes	No	Very Low	$260,700	$2,575,000
Bluemont Park - Reeves Property	Arlington County	No	No	No	Very Low	$282,400	$25,000
Bluemont Park - Restrooms	Arlington County	No	Yes	No	Very Low	$52,000	$0
Bluemont Park - Shelter	Arlington County	No	No	No	Very Low	$217,500	$0
Bon Air Park	Arlington County	No	No	No	Very Low	$0	$0
Bon Air Park - Pesticide Storage Building	Arlington County	No	No	No	Very Low	$26,000	$5,150
Bon Air Park - Picnic Shelter	Arlington County	No	No	No	Very Low	$90,000	$0
Bon Air Park - Restrooms	Arlington County	No	No	No	Very Low	$31,200	$0
Bus shelters (98)	Arlington County	No	No	No	Non-burnable	$153,184	$0
Butler Holmes Park	Arlington County	No	No	No	Non-burnable	$0	$0
Cable TV Equip	Arlington County	No	No	No	Non-burnable	$0	$927,000
Capital Hospice / Hospice of Northern Virginia	Arlington County	No	No	No	Non-burnable	$0	$0
Carlin Hall Community Center	Arlington County	No	No	No	Non-burnable	$387,100	$45,000
Carver Community Center	Arlington County	No	No	No	Very Low	$0	$50,000
Carver Park	Arlington County	No	No	No	Very Low	$0	$0
Central Library	Arlington County	No	No	No	Very Low	$12,055,600	$11,600,000
Charles E. Stewart Park	Arlington County	No	No	No	Very Low	$0	$0
Cherrydale Branch Library	Arlington County	No	No	No	Very Low	$990,400	$1,200,000
Cherryvale Park	Arlington County	No	No	No	Non-burnable	$0	$0

Chestnut Hills Park	Arlington County	No	No	No	Very Low	$0	$0
Clarendon Central Park	Arlington County	No	No	No	Very Low	$0	$0
Clarendon House	Arlington County	No	No	No	Very Low	$457,300	$75,000
Clarenford Station Park	Arlington County	Yes	No	No	Low	$0	$0
Clarmount Mini Park	Arlington County	No	No	No	Non-burnable	$0	$0
Columbia Pike Branch Library	Arlington County	No	No	No	Non-burnable	$0	$1,815,281
Community Residence	Arlington County	No	No	No	Non-burnable	$389,900	$25,500
Computer Software	Arlington County	No	No	No	Non-burnable	$0	$9,391,200
Computers	Arlington County	No	No	No	Non-burnable	$0	$0
Court Square West	Arlington County	No	No	No	Non-burnable	$10,770,300	$1,700,000
Court Square West - Back-up 911 Center	Arlington County	No	No	No	Non-burnable	$0	$6,386,000
Courthouse and Police Building	Arlington County	No	No	No	Non-burnable	$91,642,100	$10,300,000
Courthouse and Police Building -911 Center	Arlington County	No	No	No	Very Low	$0	$7,807,400
Courthouse Plaza	Arlington County	No	No	No	Very Low	$0	$11,985,270
Courthouse Plaza	Arlington County	No	No	No	Very Low	$0	$2,575,000
Culpepper Garden Senior Center	Arlington County	No	No	No	Very Low	$0	$25,853
Nastos	Arlington County	No	No	No	Non-burnable	$597,800	$25,000
DES Traffic Engineering / Solid Waste Bureau	Arlington County	No	No	No	Non-burnable	$1,954,300	$275,000
Detention Facility	Arlington County	No	No	No	Very Low	$103,217,800	$8,300,000
Dewatering Building - DWB	Arlington County	Yes	No	No	Non-burnable	$41,152,600	$47,100
DHS Headquarters	Arlington County	No	No	No	Very Low	$0	$4,236,000
Dissolved Air Floatation Building - DAFT	Arlington County	Yes	No	No	Very Low	$8,440,000	$155,000
Distribution Center No. 5 -DSB-5	Arlington County	Yes	No	No	Non-burnable	$824,230	$0
Doctor's Run Park	Arlington County	No	No	No	Very Low	$0	$0
Donaldson Run Pump Station - DON	Arlington County	Yes	No	No	Very Low	$389,400	$1,171,200
Douglas Park	Arlington County	No	No	No	Very Low	$0	$0
Dover Run Pump Station - DOV	Arlington County	No	No	No	Very Low	$132,800	$669,900
Drew Community Center	Arlington County	No	No	No	Non-burnable	$0	$47,174
Drew Park	Arlington County	No	No	No	Non-burnable	$0	$0
Drewry Center	Arlington County	No	No	No	Very Low	$5,070,500	$350,000
Eads Park	Arlington County	Yes	No	No	Non-burnable	$0	$0

East Falls Church Park	Arlington County	No	No	No	Very Low	$0	$0
East Mixed Liquor Flow Distribution Structure - Building #33- EMLFDS	Arlington County	Yes	No	Yes	Non-burnable	$5,250,000	$0
East Tunnel Access Building - ETAB	Arlington County	Yes	No	No	Very Low	$0	$0
Edison Park	Arlington County	Yes	No	No		$0	$0
Electrical Distribution Center #1 (DC#1)	Arlington County	Yes	No	No	Very Low	$900,000	$0
Ethan Allen Pump Station	Arlington County	No	No	No	Non-burnable	$1,407,500	$0
Fairlington Community Center	Arlington County	No	No	No	Non-burnable	$5,024,900	$185,000
Fences & Lights	Arlington County	No	No	No	Non-burnable	$0	$0
Fenwick Center	Arlington County	No	No	No	Non-burnable	$3,221,900	$100,000
Fillmore Park	Arlington County	No	No	No	Non-burnable	$0	$0
Filtration and Disinfection Facility / Sodium Hypochlorite Facility	Arlington County	Yes	No	No	Non-burnable	$49,676,600	$0
Fire Academy	Arlington County	No	No	No	Non-burnable	$1,705,200	$85,200
Fire Academy Fire Tower	Arlington County	No	No	No	Non-burnable		$50,000
Fire Academy Three Bay Tent	Arlington County	No	No	No	Non-burnable	$170,000	$40,000
Fire Academy Two Bay Tent	Arlington County	No	No	No	Non-burnable	$60,000	$20,000
Fire Station 1	Arlington County	No	No	No	Low	$2,396,900	$125,000
Fire Station 10	Arlington County	No	No	No	Non-burnable	$1,902,600	$95,000
Fire Station 2	Arlington County	Yes	No	No	Non-burnable	$1,999,200	$115,000
Fire Station 3	Arlington County	No	No	No	Non-burnable	$3,000,000	$175,000
Fire Station 4	Arlington County	No	No	No	Low	$4,401,100	$145,000
Fire Station 5	Arlington County	Yes	No	No	Very Low	$5,209,500	$210,000
Fire Station 6	Arlington County	No	No	No	Very Low	$0	$0
Fire Station 7	Arlington County	No	No	No	Low	$463,100	$25,000
Fire Station 8	Arlington County	No	No	No	Very Low	$1,345,400	$75,000
Fire Station 9	Arlington County	No	No	No	Very Low	$2,423,400	$123,500
Flow Equalization Tanks 1, 2, and 3	Arlington County	Yes	No	No	Non-burnable	$23,616,600	$0
FMR meter vault	Arlington County	Yes	No	Yes	Non-burnable	$49,920	$1,833,456
Foam Collection Pumping Station Building - FCPS #33	Arlington County	Yes	No	Yes	Non-burnable	$7,052,100	$0
Former Thrifty Car Rental Site	Arlington County	Yes	No	No	Non-burnable	$208,900	$0
Fort Bernard Park	Arlington County	No	No	No	Non-burnable	$0	$0

Fort Bernard Park - Shelter	Arlington County	No	No	No	Non-burnable	$20,000	$0
Fort Bernard Pump Station	Arlington County	No	No	No	Very Low	$1,290,700	$0
Fort Bernard Pumping Station - Reservoir	Arlington County	No	No	No	Very Low	$0	$0
Fort CF Smith - Caretaker Cottage	Arlington County	No	No	No	Non-burnable	$108,400	$25,000
Fort CF Smith - Main House	Arlington County	No	No	No	Non-burnable	$634,000	$55,000
Fort CF Smith - Tractor Shed and Cottage	Arlington County	No	No	No	Non-burnable	$74,000	$12,000
Fort Ethan Allen Park	Arlington County	No	No	No	Non-burnable	$3,120	$0
Fort Myer Heights Park	Arlington County	No	No	No	Non-burnable	$0	$0
Fort Scott Park	Arlington County	Yes	No	No	Very Low	$0	$0
Fort Scott Park - Restrooms	Arlington County	Yes	No	No	Very Low	$0	$0
Fort Scott Park - Shelter	Arlington County	Yes	No	No	Very Low	$43,000	$0
Four Mile Run Pumping Station - FMRL	Arlington County	Yes	No	No	Very Low	$8,226,900	$75,000
Foxcroft Heights Park	Arlington County	No	No	No	Very Low	$0	$0
Fraser Park	Arlington County	No	No	No	Non-burnable	$0	$0
Fueling Station	Arlington County	No	No	No	Very Low	$994,500	$0
Gallery at the Ellipse	Arlington County	Yes	No	No	Very Low	$0	$46,350
Gateway Park	Arlington County	No	No	No	Non-burnable	$0	$0
George Mason Center	Arlington County	No	No	No	Non-burnable	$3,585,800	$100,000
Glebe Road Park	Arlington County	No	No	No	Non-burnable	$0	$0
Glen Carlyn Branch Library	Arlington County	No	No	No	Non-burnable	$659,200	$1,125,000
Glen Carlyn Park	Arlington County	Yes	Yes	No	Non-burnable	$0	$0
Glen Carlyn Park - Restrooms	Arlington County	Yes	Yes	No	Non-burnable	$93,000	$0
Glen Carlyn Park - Shelter 1	Arlington County	Yes	Yes	No	Non-burnable	$72,800	$0
Glen Carlyn Park - Shelter 2	Arlington County	Yes	Yes	No	Non-burnable	$72,800	$0
Greenbrier - Bleachers	Arlington County	No	No	No	Non-burnable	$0	$0
Greenbrier - Synthetic field	Arlington County	No	No	No	Non-burnable	$0	$0
Greenbrier Park	Arlington County	No	No	No	Non-burnable	$0	$0
Greenbrier Park - Baseball Concessions	Arlington County	No	No	No	Non-burnable	$63,232	$0
Greenbrier Park - Press box / Softball Concessions	Arlington County	No	No	No	Non-burnable	$30,784	$0
Greenbrier Park - Pressbox	Arlington County	No	No	No	Very Low	$70,400	$15,000
Greenbrier Park - Restrooms	Arlington County	No	No	No	Very Low	$298,200	$0
Greenbrier Park - Stadium Concessions	Arlington County	No	No	No	Non-burnable	$110,900	$15,000

Greenbrier Park - Ticket booth	Arlington County	No	No	No	Non-burnable	$51,584	$0
Guard House Booth - Salt	Arlington County	No	No	No	Non-burnable	$7,800	$0
Gulf Branch County Park	Arlington County	No	No	No	Very Low	$0	$0
Gulf Branch Nature Center - Blacksmith	Arlington County	No	No	No	Very Low	$15,600	$3,090
Gulf Branch Nature Center - Log Cabin	Arlington County	No	No	No	Very Low	$52,000	$22,660
Gulf Branch Nature Center Main - Building	Arlington County	No	No	No	Very Low	$582,300	$25,000
Gulf Run Pump Station - GRPS	Arlington County	No	No	No	Very Low	$316,700	$1,389,100
Gunston Bubble	Arlington County	No	No	No	Non-burnable	$310,700	$45,000
Gunston Community Center and Theater Props	Arlington County	No	No	No	Very Low	$0	$200,000
Gunston Park	Arlington County	No	No	No	Non-burnable	$0	$0
Gunston Park - Synthetic field	Arlington County	No	No	No	Non-burnable	$0	$0
Haley Park	Arlington County	No	No	No	Very Low	$0	$0
Hayes Park	Arlington County	No	No	No	Non-burnable	$0	$0
Hayes Park - Shelter	Arlington County	No	No	No	Non-burnable	$169,000	$0
Henry Clay Park	Arlington County	No	No	No	Non-burnable	$0	$0
High View Park	Arlington County	No	No	No	Non-burnable	$0	$0
Highview Park - Restrooms	Arlington County	No	No	No	Non-burnable	$5,200	$0
Hillside Park	Arlington County	No	No	No	Non-burnable	$0	$0
Homeless Shelter and Offices	Arlington County	No	No	No	Non-burnable	$1,445,800	$75,000
Human Services Facility	Arlington County	No	No	No	Non-burnable	$2,258,200	$0
Human Services Facility	Arlington County	No	No	No	Non-burnable	$1,479,800	$105,000
Human Services Facility - Lab	Arlington County	No	No	No	Non-burnable	$349,900	$0
I-66 Parking Garage	Arlington County	No	No	No	Non-burnable	$5,000,000	$0
Independence House	Arlington County	No	No	No	Non-burnable	$702,000	$35,000
Jennie Dean Park	Arlington County	No	No	Yes	Non-burnable	$0	$0
Jennie Dean Park - Shelter and Restrooms	Arlington County	No	No	Yes	Non-burnable	$159,800	$0
Kirby Lithographic Building	Arlington County	Yes	No	No	Non-burnable	$3,436,000	$100,000
Kirkwood Run Pump Station - KWPS	Arlington County	No	No	No	Non-burnable	$823,400	$0
Lacey Woods - Shelter	Arlington County	No	No	No	Non-burnable	$83,800	$2,000
Lacey Woods - Shelter and Restrooms	Arlington County	No	No	No	Non-burnable	$150,900	$0

Lacey Woods Park	Arlington County	No	No	No	Non-burnable	$0	$0
Langston Brown Rec. Ctr.	Arlington County	No	No	No	Non-burnable	$0	$130,810
Lee Community Center	Arlington County	No	No	No	Non-burnable	$1,543,000	$110,000
Lee Pumping Station	Arlington County	No	No	No	Very Low	$1,681,300	$0
Lee Pumping Station #1	Arlington County	No	No	No	Very Low	$0	$0
Lee Pumping Station - Building under elevated tank	Arlington County	No	No	No	Very Low	$20,800	$0
Lee Pumping Station - Com. Building	Arlington County	No	No	No	Very Low	$0	$2,575,000
Lee Pumping Station - Elevated tank / 500,000 gallon	Arlington County	No	No	No	Very Low	$0	$0
Lee Pumping Station # 2	Arlington County	No	No	No	Very Low	$0	$0
Little Falls Booster Station	Arlington County	No	Yes	No	Non-burnable	$1,641,400	$0
Long Branch Nature Center	Arlington County	Yes	No	No	Non-burnable	$473,300	$35,500
Long Bridge Park	Arlington County	No	No	No	Non-burnable	$0	$0
Long Bridge Park - Maintenance	Arlington County	No	No	No	Non-burnable	$357,068	$5,000
Long Bridge Park - North Restrooms	Arlington County	No	No	No	Non-burnable	$357,859	$0
Long Bridge Park - South Restrooms	Arlington County	No	No	No	Non-burnable	$357,859	$0
Long Bridge Park - Synthetic fields	Arlington County	No	No	No	Non-burnable	$0	$0
Low Level Pump Station	Arlington County	Yes	No	Yes	Non-burnable	$508,700	$0
Lubber Run Park	Arlington County	Yes	No	No	Very Low	$0	$0
Lubber Run Park - Amphitheatre	Arlington County	Yes	No	No	Non-burnable	$31,200	$5,000
Lubber Run Park - Pavilion	Arlington County	Yes	No	No	Very Low	$50,000	$0
Lubber Run Park - Restrooms	Arlington County	Yes	No	No	Very Low	$20,000	$0
Lubber Run Recreation Center	Arlington County	Yes	No	No	Very Low	$2,332,000	$105,000
Lucky Run Meter Station - LRMS	Arlington County	No	No	Yes	Non-burnable	$35,360	$170,156
Lyon Village Park	Arlington County	No	No	No	Non-burnable	$0	$0
Lyon Village Park - Shelter	Arlington County	No	No	No	Non-burnable	$41,600	$0
Madison Community Center	Arlington County	No	No	No	Non-burnable	$4,328,500	$55,000
Madison Manor	Arlington County	No	No	No	Non-burnable	$0	$0
Madison Manor - Restrooms	Arlington County	No	No	No	Non-burnable	$41,600	$0
Madison Manor - Shelter	Arlington County	No	No	No	Non-burnable	$31,200	$0

Arlington County Critical Assets

Marcey Creek Pump Station - MCPS	Arlington County	No	No	No	Non-burnable	$5,491	$226,453
Marcey Park	Arlington County	No	No	No	Non-burnable	$0	$0
Maury Park	Arlington County	No	No	No	Non-burnable	$0	$0
Maywood Park	Arlington County	No	No	No	Non-burnable	$0	$0
Meter Repair	Arlington County	No	No	No	Non-burnable	$0	$0
Methanol Feed Facility	Arlington County	Yes	No	No	Non-burnable	$3,086,500	$0
Metro Tunnel	Arlington County	No	No	No	Non-burnable	$8,131,900	$0
Minor Hill Pump Station	Arlington County	No	No	No	Non-burnable	$1,420,500	$0
Minor Hill Pump Station - Reservoirs	Arlington County	No	No	No	Non-burnable	$0	$0
Monroe Park	Arlington County	No	No	No	Very Low	$0	$0
Motorola Building	Arlington County	No	No	Yes	Non-burnable	$717,700	$25,000
NAC ll	Arlington County	No	No	No	Non-burnable	$4,000,000	$1,500,000
National Center Ejector Station - NCES	Arlington County	Yes	No	No	Non-burnable	$805,400	$0
Nauck Park	Arlington County	No	No	No	Very Low	$24,000	$0
Nelly Custis Park	Arlington County	Yes	No	No	Non-burnable	$0	$0
New Maintenance Building - NMB	Arlington County	Yes	No	No	Very Low	$9,567,234	$500,000
North Ferric Facility (NFF)	Arlington County	Yes	No	Yes	Non-burnable	$6,793,800	$0
North Side Salt Storage Tank	Arlington County	No	No	No	Very Low	$301,400	$0
Nottingham Park	Arlington County	No	No	No	Very Low	$0	$0
Oak Grove Park	Arlington County	No	No	No	Very Low	$0	$0
Oakland Mini Park	Arlington County	No	No	No	Very Low	$0	$0
Old Scale House	Arlington County	No	No	No	Very Low	$10,000	$0
Old Signature Theater	Arlington County	No	No	Yes	Very Low	$1,649,700	$0
Old Vehicle Repair Building (Storage)	Arlington County	No	No	No	Very Low	$1,025,200	$300,000
Operations Control Building - OCB	Arlington County	Yes	No	Yes	Non-burnable	$15,997,700	$56,100
Paint and Sandblast Building - PB	Arlington County	Yes	No	No	Very Low	$82,400	$10,000
Palisades Pump Station - PAL	Arlington County	No	No	No	Non-burnable	$5,491	$1,724,844
Parkhurst Park	Arlington County	No	No	No	Very Low	$0	$0
Parks & Recreation Cultural Resource Center	Arlington County	No	No	Yes	Very Low	$8,529,400	$3,300,000
Penrose Park	Arlington County	No	No	No	Non-burnable	$0	$0
Police Impoundment Building	Arlington County	No	No	No	Non-burnable	$325,300	$65,000

Arlington County Critical Assets

Post Aeration Facility (Chlorine Contact Tanks)	Arlington County	Yes	No	No	Non-burnable	$5,540,600	$0
Potomac Intercept and Meter Vault	Arlington County	Yes	No	Yes	Non-burnable	$950,200	$0
Potomac Yards Pump Station - PYPS	Arlington County	Yes	No	No	Non-burnable	$964,000	$0
Powhattan Spring Park	Arlington County	No	No	No	Very Low	$0	$0
Powhattan Spring Park - Restrooms	Arlington County	No	No	No	Very Low	$136,800	$0
Powhattan Spring Park - Shelter	Arlington County	No	No	No	Very Low	$75,000	$0
Powhattan Spring Park - Office	Arlington County	No	No	No	Very Low	$113,600	$7,000
Preliminary Treatment Building - PTB	Arlington County	Yes	No	No	Very Low	$12,347,400	$0
Primary Clarifiers - PCL	Arlington County	Yes	No	Yes	Non-burnable	$12,712,000	$0
Primary Effluent Flume	Arlington County	Yes	No	Yes	Non-burnable	$6,600,000	$0
Primary Effluent Pumping Station - PEPS	Arlington County	Yes	No	Yes	Non-burnable	$290,035	$3,955,181
Primary Gravity Thickener Building and Tanks - PGTB	Arlington County	Yes	No	No	Very Low	$6,026,800	$0
Quincy Park	Arlington County	No	No	No	Non-burnable	$20,800	$0
Radios in police/fire & others	Arlington County	No	No	No	Non-burnable	$0	$0
Recycle Intercept Pump Station - RIPS Building #36	Arlington County	Yes	No	No	Very Low	$70,000	$0
Reeves Property - Garage	Arlington County	No	No	No	Very Low	$20,800	$0
Repair Garage	Arlington County	No	No	Yes	Non-burnable	$439,900	$0
Residential Program Center	Arlington County	No	No	No	Very Low	$3,340,200	$225,000
River Estates Ejector Station - REES	Arlington County	Yes	No	No	Very Low	$32,448	$196,868
Rivercrest Pump Station	Arlington County	Yes	No	No	Very Low	$35,360	$115,385
Riverwood Ejector Station - RWES	Arlington County	No	No	No	Very Low	$59,904	$67,973
Roaches Run Pump Station - RRPS	Arlington County	No	No	No	Very Low	$677,200	$837,000
Rocky Run Park	Arlington County	No	No	No	Very Low	$0	$0
Rosslyn Highlands Park	Arlington County	No	No	No	Very Low	$0	$0
Rosslyn Spectrum Theater	Arlington County	No	No	No	Very Low	$0	$195,700

Satellite Warehouse (DWB area)	Arlington County	Yes	No	No	Non-burnable	$59,280	$0
Scales	Arlington County	No	No	No	Very Low	$146,000	$0
Secondary Aeration Tanks - SAT	Arlington County	Yes	No	No	Non-burnable	$62,700,000	$0
Secondary Aeration Tanks Pipe Gallery	Arlington County	Yes	No	No	Non-burnable	$0	$0
Secondary Blower Building - SBB	Arlington County	Yes	No	Yes	Non-burnable	$14,627,600	$22,100
Secondary Clarifiers 1- to 6	Arlington County	Yes	Yes	No	Non-burnable	$0	$0
Secondary Clarifiers 7, 8. 9	Arlington County	Yes	No	No	Non-burnable	$40,300,000	$0
Secondary Services Pumping Station - SPR	Arlington County	Yes	Yes	No	Non-burnable	$9,204,600	$0
Shirlington Bus Station	Arlington County	No	No	No	Low	$429,200	$10,000
Unknown *	Arlington County	No	No	No	Non-burnable	$17,840,300	$4,605,800
Single Family Detached	Arlington County	No	No	No	Non-burnable	$233,500	$0
Skater Park	Arlington County	No	No	No	Non-burnable	$0	$0
Sludge Storage Tanks (SST1, SST2)	Arlington County	Yes	No	No	Non-burnable	$3,830,500	$0
Smartcape House	Arlington County	No	No	No	Non-burnable	$271,100	$45,000
South Ferric Facility (SFF)	Arlington County	Yes	Yes	No	Non-burnable	$4,371,600	$0
South Side Salt Storage Facility	Arlington County	No	No	No	Non-burnable	$389,300	$0
South Tunnel Access Building - STAB	Arlington County	Yes	No	Yes	Non-burnable	$0	$0
Standby Generator Facility	Arlington County	Yes	No	Yes	Non-burnable	$5,350,781	$8,671,083
Storage for Signs, Signals, Meters	Arlington County	No	No	No	Non-burnable	$220,600	$85,000
Sullivan House	Arlington County	No	No	No	Low	$1,415,500	$25,000
Surface Waste Pump Station - SWPS	Arlington County	Yes	No	Yes	Non-burnable	$2,367,900	$0
The Ritz Carlton Hotel	Arlington County	No	No	No	Non-burnable	$0	$2,575,000
Third Street Group	Arlington County	Yes	No	No	Non-burnable	$150,000	$10,000
Thomas Building	Arlington County	No	No	No	Non-burnable	$10,181,730	$140,000
Thomas Jefferson - Synthetic fields	Arlington County	No	No	No	Non-burnable	$0	$0
Thomas Jefferson Community Center	Arlington County	No	No	No	Non-burnable	$0	$300,000
Tower Park	Arlington County	No	No	No	Non-burnable	$75,000	$0
Trade Center Truck Wash	Arlington County	No	No	No	Non-burnable	$250,400	$1,500
Trades Center Parking Deck	Arlington County	No	No	No	Non-burnable	$6,598,800	$0

Arlington County Critical Assets

Traffic Warehouse Expansion	Arlington County	No	No	No	Non-burnable	$523,000	$65,000
Troy Park	Arlington County	No	Yes	No	Non-burnable	$0	$0
Tuckahoe Park	Arlington County	No	No	No	Very Low	$0	$0
Tyrol Hill Park	Arlington County	Yes	No	No	Very Low	$5,000	$0
Upper Pimmit Meter Station - UPMS	Arlington County	No	No	Yes	Very Low	$11,970	$225,034
Vacant Property	Arlington County	No	No	No	Very Low	$0	$0
Vacant Property	Arlington County	No	No	No	Very Low	$70,000	$0
Vehicle Repair Facility	Arlington County	No	No	No	Non-burnable	$4,734,400	$550,000
Virginia Highland - Comfort Station	Arlington County	No	No	No	Non-burnable	$116,100	$0
Virginia Highland Park	Arlington County	No	No	No	Non-burnable	$11,440	$0
Virginia Highland Park - Synthetic field	Arlington County	No	No	No	Non-burnable	$0	$0
Walnut Park	Arlington County	No	No	No	Non-burnable	$0	$0
Walter Reed Community Center	Arlington County	No	No	No	Non-burnable	$4,048,800	$250,000
Water / Sewer / Streets Bureau Building	Arlington County	No	No	No	Non-burnable	$2,680,100	$215,000
Water / Sewer / Streets Bureau Warehouse	Arlington County	No	No	No	Non-burnable	$1,603,400	$950,000
West Mixed Liquor Flow Distribution Structures-WMLFDS	Arlington County	Yes	No	Yes	Non-burnable	$5,250,000	$0
West Secondary Pump Services Building - WSPSB	Arlington County	Yes	No	No	Non-burnable	$9,400,454	$0
Westover Branch Library	Arlington County	No	No	No	Non-burnable	$0	$1,985,200
Westover Park	Arlington County	No	No	No	Low	$0	$0
Westover Park - Restrooms	Arlington County	No	No	No	Low	$118,900	$0
Westover Park - Shelter	Arlington County	No	No	No	Low	$19,100	$0
Wet Weather Filtration Facility	Arlington County	Yes	No	No	Non-burnable	$16,192,436	$0
WETA Cultural Affairs and Recreation	Arlington County	No	No	No	Non-burnable	$3,977,800	$310,000
Windy Run Pump Station - WIN	Arlington County	No	No	Yes	Non-burnable	$633,200	$1,058,800
Woodlawn Park	Arlington County	Yes	No	Yes	Non-burnable	$0	$0
Woodmont School - Records and Handicap Center	Arlington County	No	No	No	Non-burnable	$4,222,300	$110,000
Woodstock Park	Arlington County	Yes	No	No	Low	$0	$0

Arlington County Critical Assets

Fenwick Center	Arlington County	No	No	No	Non-burnable	$3,221,900	$0
Abingdon Elementary School	Arlington County	No	No	No	Non-burnable	$12,330,600	$1,173,400
Arlington Science Focus	Arlington County	No	No	No	Very Low	$9,726,000	$1,221,900
Arlington Traditional	Arlington County	Yes	No	No	Very Low	$11,022,000	$1,142,000
Ashlawn Elementary School	Arlington County	No	No	No	Very Low	$11,109,370	$1,097,977
Barcroft Elementary School	Arlington County	No	No	No	Very Low	$9,533,700	$965,500
Barrett Elementary School	Arlington County	No	No	No	Very Low	$11,032,500	$1,048,400
Campbell Elementary School	Arlington County	No	No	No	Low	$9,713,000	$991,400
Career Center	Arlington County	No	No	No	Non-burnable	$28,905,000	$2,425,000
Carlin Springs Elementary	Arlington County	No	No	No	Non-burnable	$12,578,900	$1,216,800
Claremont Elementary School	Arlington County	No	No	No	Non-burnable	$10,909,400	$1,038,600
Cottage at the Outdoor Lab	Arlington County	No	No	No	Non-burnable	$253,500	$75,000
Drew Elementary School	Arlington County	No	No	No	Non-burnable	$14,367,400	$1,397,300
Education Center	Arlington County	No	No	No	Non-burnable	$8,759,900	$225,000
Facilities and Operations	Arlington County	No	No	No	Non-burnable	$8,619,800	$1,285,000
Glebe Elementary School	Arlington County	No	No	No	Very Low	$12,528,100	$1,132,500
Gunston Middle School	Arlington County	No	No	No	Very Low	$28,307,600	$2,830,700
HB Woodlawn Secondary Program	Arlington County	Yes	No	No	Very Low	$22,406,000	$2,024,700
Henry Elementary School	Arlington County	No	No	No	Very Low	$8,305,500	$835,000
Hoffman-Boston Elementary	Arlington County	No	No	No	Very Low	$15,893,400	$1,464,600
Hoffman-Boston Elementary Annex	Arlington County	No	No	No	Very Low	$308,100	$300,000
Jamestown Elementary School	Arlington County	No	No	No	Very Low	$10,777,000	$1,250,300
Jefferson Middle School	Arlington County	No	No	No	Very Low	$28,955,400	$2,953,500
Kenmore Middle School	Arlington County	No	No	No	Low	$28,233,700	$1,888,000
Key Elementary School	Arlington County	No	No	No	Non-burnable	$12,245,600	$1,261,400
Langston HS Continuation Program	Arlington County	No	No	No	Non-burnable	$5,240,032	$183,600
Long Branch Elementary School	Arlington County	No	No	No	Non-burnable	$10,493,400	$965,600
Marshall Center	Arlington County	No	No	No	Non-burnable	$1,466,100	$150,000
McKinley Elementary School	Arlington County	No	No	No	Very Low	$7,459,800	$783,200
Nottingham Elementary School	Arlington County	No	No	No	Very Low	$9,782,900	$976,900
Oakridge Elementary School	Arlington County	No	No	No	Non-burnable	$10,891,700	$1,078,300
Outdoor Lab	Arlington County	No	No	No	Non-burnable	$427,600	$217,000
Planetarium	Arlington County	No	No	No	Non-burnable	$329,600	$50,000

Randolph Elementary School	Arlington County	No	No	No	Very Low	$9,668,700	$967,200
Reed Facility	Arlington County	No	No	No	Very Low	$15,475,500	$971,700
Sequoia	Arlington County	No	No	No	Very Low	$0	$1,500,000
Swanson Middle School	Arlington County	No	No	No	Very Low	$18,115,500	$1,816,700
Taylor Elementary School	Arlington County	Yes	No	No	Very Low	$10,873,900	$1,070,700
Tuckahoe Elementary School	Arlington County	No	No	No	Very Low	$9,610,200	$961,500
Wakefield High School	Arlington County	No	No	No	Non-burnable	$86,645,000	$3,490,300
Wakefield High School	Arlington County	No	No	No	Non-burnable	$0	$0
Wakefield High School - Football, Softball and Baseball Stadium - Bleachers, New Concession Stands and Press Boxs	Arlington County	No	No	No	Non-burnable	$0	$0
Wakefield - Synthetic field	Arlington County	No	No	No	Non-burnable	$0	$0
Wakefield High School - Stadium -Football Concessions	Arlington County	No	No	No	Non-burnable	$7,000	$3,000
Washington-Lee High School	Arlington County	No	No	No	Non-burnable	$81,147,000	$3,490,300
Washington-Lee High School Stadium -Bleachers and Press box	Arlington County	No	No	No	Non-burnable	$0	$0
Washington-Lee High School - Stadium Concessions	Arlington County	No	No	No	Non-burnable	$20,000	$3,000
Washington-Lee - Synthetic Field	Arlington County	No	No	No	Non-burnable	$0	$0
Washington-Lee High School Pedestrian Bridge to I-66 parking deck	Arlington County	No	No	No	Non-burnable	$0	$0
Williamsburg Middle School	Arlington County	No	No	No	Very Low	$22,595,500	$2,359,500
Wilson School	Arlington County	No	No	No	Very Low	$2,578,800	$682,696
Yorktown High School	Arlington County	No	No	No	Very Low	$70,979,025	$3,061,340
166 School buses (see Schedule under Vehicle coverage)	Arlington County	No	No	No	Non-burnable	$0	$0
Boat Fleet-not for rent	Arlington County	No	No	No	Non-burnable	$0	$0
EDP/Data/AV Equipment	Arlington County	No	No	No	Non-burnable	$0	$0
Telephone Systems	Arlington County	No	No	No	Non-burnable	$0	$0
Fences & Lights	Arlington County	No	No	No	Non-burnable	$0	$0

Arlington County Critical Assets

Leased and Owned Relocatables see attached schedule	Arlington County	No	No	No	Non-burnable	$0	$0
						$1,623,587,490	$207,061,157

City of Alexandria Critical Assets

Critical Asset	Jurisdiction	Tornado .25 Mile Buffer	SFHA 100 Year	SFHA 500 Year	WFP Class	Asset Values	Content Values
Alexandria Police Department	City of Alexandria	No	No	No	Non-burnable	$0.00	$0.00
Samuel W. Tucker Elementary School	City of Alexandria	Yes	No	Yes	Very Low	$15,635,100	$45,000,000.00
T.C. Williams High Schools	City of Alexandria	No	No	No	Very Low	$91,553,900	$5,000,000.00
James K Polk Elementary School	City of Alexandria	No	No	No	Very Low	$14,871,170	$4,000,000.00
Francis C. Hammond Middle School	City of Alexandria	No	No	No	Very Low	$46,044,375	$0.00
George Washington Middle School	City of Alexandria	No	No	No	Very Low	$46,279,740	$0.00
T.C. Williams High School Minnie Howard Campus	City of Alexandria	No	No	No	Low	$25,434,825	$0.00
Dee Campbell Rowing Center	City of Alexandria	No	Yes	No	Very Low	$4,056,000	$1,000,000.00
John Adams Elementary School	City of Alexandria	Yes	No	No	Very Low	$26,783,250	$0.00
Charles Barrett Elementary School	City of Alexandria	No	No	No	Very Low	$12,238,200	$4,000,000.00
Cora Kelly School of Math, Science and Technology	City of Alexandria	Yes	No	Yes	Non-burnable	$13,455,000	$5,000,000.00
Fire Station 201	City of Alexandria	No	No	No	Non-burnable	$0.00	$0.00
Fire Station 202	City of Alexandria	Yes	No	No	Non-burnable	$0.00	$0.00
Fire Station 203	City of Alexandria	No	No	No	Non-burnable	$0.00	$0.00
Fire Station 204	City of Alexandria	No	No	No	Non-burnable	$0.00	$0.00
Fire Station 205	City of Alexandria	No	No	No	Non-burnable	$0.00	$0.00
Fire Station 206	City of Alexandria	No	No	No	Non-burnable	$0.00	$0.00
Fire Station 207	City of Alexandria	No	No	No	Non-burnable	$0.00	$0.00
Fire Station 208	City of Alexandria	Yes	No	No	Non-burnable	$0.00	$0.00
Fire Station 209	City of Alexandria	No	No	No	Very Low	$0.00	$0.00
Fire Station 210	City of Alexandria	Yes	No	No	Non-burnable	$0.00	$0.00
						$296,351,560.00	$64,000,000.00

City of Fairfax Critical Assets

Critical Asset	Jurisdiction	Tornado .25 Mile Buffer	SFHA 100 Year	SFHA 500 Year	WFP Class	Asset Values	Content Values
Fairfax High School	City of Fairfax	No	No	No	Non-burnable	$60,537,800	$0
Lanier Middle School	City of Fairfax	No	No	No	Non-burnable	$25,714,000	$0
Daniels Run Elematary	City of Fairfax	No	Yes	No	Non-burnable	$17,240,300	$0
Providence Elematary School	City of Fairfax	No	No	No	Non-burnable	$19,736,400	$0
City Of Fairfax Police Station	City of Fairfax	No	No	No	Non-burnable	$11,060,200	$0
City of Fairfax Fire Station 3	City of Fairfax	No	No	No	Non-burnable	$5,124,600	$0
City of Fairfax Fire Station 33	City of Fairfax	No	No	No	Non-burnable	$3,587,000	$0
City of Fairfax Public Safety Training Center	City of Fairfax	No	No	No	Non-burnable	$1,810,976	$0
City of Fairfax City Hall	City of Fairfax	No	No	No	Non-burnable	$22,568,100	$0
City of Fairfax Property Yard	City of Fairfax	No	Yes	No	Non-burnable	$13,547,400	$0
Cue Bus	City of Fairfax	No	Yes	No	Non-burnable	$13,547,400	$0
INOVA EMERGENCY CARE CENTER - FAIRFAX CITY	City of Fairfax	No	No	No	Non-burnable	$0.00	$0
Petroleum Tank Farm	City of Fairfax	No	No	No	Non-burnable	$0.00	$0
PAUL VI CATHOLIC HIGH SCHOOL	City of Fairfax	No	No	No	Non-burnable	$0.00	$0
ST LEO THE GREAT SCHOOL	City of Fairfax	No	No	No	Non-burnable	$0.00	$0
THE BOYD SCHOOL	City of Fairfax	No	No	No	Non-burnable	$0.00	$0
						$194,474,176.00	$0

City of Falls Church Critical Assets

Critical Asset	Jurisdiction	Tornado .25 Mile Buffer	SFHA 100 Year	SFHA 500 Year	WFP Class	Asset Values	Content Values
CITY OF FALLS CHURCH CITY HALL	City of Falls Church	Yes	No	No	Non-burnable	$13,508,200	$0
CITY OF FALLS CHURCH COMMUNTIY CENTER	City of Falls Church	No	No	No	Non-burnable	$6,178,000	$0
Mary Riley Styles Public Library	City of Falls Church	Yes	No	No	Non-burnable	$3,294,300	$0
THOMAS JEFFERSON ELEM.	City of Falls Church	No	No	No	Non-burnable	$3,769,400	$0
MARY ELLEN HENDERSON MIDDLE	City of Falls Church	No	No	No	Non-burnable	$0.00	$0
GEORGE MASON HIGH SCHOOL	City of Falls Church	No	No	No	Non-burnable	$43,467,000	$0
City of Falls Church Property Yard Building	City of Falls Church	No	No	No	Non-burnable	$484,600	$0
City of Falls Church Fire Station	City of Falls Church	No	No	No	Non-burnable	$828,600	$0
Aurora House	City of Falls Church	Yes	No	Yes	Very Low	$1,860,200	$0
						$73,390,300.00	$0

City of Manassas Park Critical Assets

Critical Asset	Jurisdiction	Tornado .25 Mile Buffer	SFHA 100 Year	SFHA 500 Year	WFP Class	Asset Value	Content Value
City Hall	Manassas Park	Yes	No	No	Non Burnable	$2,658,000	$0.00
Community Center	Manassas Park	No	No	No	Very Low	$23,914,500	$0.00
Police Department	Manassas Park	No	No	No	Non Burnable	$5,435,300	$0.00
Fire Department	Manassas Park	Yes	No	No	Very Low	$4,868,500	$0.00
Public Works and Garage	Manassas Park	No	No	No	Non Burnable	$0.00	$0.00
Mathis Tank	Manassas Park	No	No	No	Non Burnable	$162,300	$0.00
Matthew Dr Sewer Pump Station	Manassas Park	No	No	No	Very Low	$0.00	$0.00
Cynthia Dr Sewer Pump Station	Manassas Park	No	No	No	Very Low	$0.00	$0.00
Joshua Ct Water Pump Station and Tower	Manassas Park	No	No	No	Very Low	$106,300	$0.00
Blooms Quarry Water Pump Station and Tower	Manassas Park	Yes	No	No	Very Low	$0.00	$0.00
Signal Hill Park	Manassas Park	Yes	No	No	Non Burnable	$0.00	$0.00
Generals Ridge Golf Course	Manassas Park	No	No	No	Non Burnable	$0.00	$0.00
Conner House	Manassas Park	No	No	No	Very Low	$0.00	$0.00
Stone House	Manassas Park	No	No	No	Very Low	$0.00	$0.00
MP Pre_K	Manassas Park	No	No	No	Non Burnable	$0.00	$0.00
Cougar Elementary School	Manassas Park	No	No	No	Non Burnable	$30,641,900	$0.00
MP Elementary School	Manassas Park	No	No	No	Very Low	$0.00	$0.00
MP Middle School	Manassas Park	Yes	No	No	Very Low	$0.00	$0.00
MP High School	Manassas Park	Yes	No	No	Very Low	$32,881,600	$0.00
						$100,668,400.00	$0.00

City of Manassas Critical Assets

Critical Asset	Jurisdiction	Tornado .25 Mile Buffer	SFHA 100 Year	SFHA 500 Year	WFP Class	Asset Values	Content Values
Old Town Hall	City of Manassas	No	No	No	Very Low	$736,848	$180,386
New City Hall	City of Manassas	No	No	No	Very Low	$7,192,122	$947,683
Museum	City of Manassas	No	No	No	Very Low	$1,506,030	$193,390
Liberia House	City of Manassas	No	No	No	Very Low	$816,306	$0
Stonewall Recreation Center	City of Manassas	No	No	No	Very Low	$346,432	$3,470
Stonewall Recreation Center Swimming Pool	City of Manassas	No	No	No	Very Low	$819,876	$287,850
Stonewall Recreation Center Pavillion	City of Manassas	No	No	No	Very Low	$48,996	$0
Byrd Park Restrooms	City of Manassas	No	No	No	Very Low	$42,142	$0
Police Station	City of Manassas	No	No	No	Non-burnable	$4,574,088	$827,190
Old Electric Complex Shop	City of Manassas	No	No	No	Non-burnable	$216,360	$43,977
Old Electric Complex Warehouse	City of Manassas	No	No	No	Non-burnable	$185,407	$43,592
Old Electric Complex Generator Facility	City of Manassas	No	No	No	Non-burnable	$313,242	$4,277,350
Old Electric Complex Pole Barn	City of Manassas	No	No	No	Non-burnable	$126,031	$0
Public Works - Office Bldg	City of Manassas	No	No	No	Non-burnable	$2,072,130	$533,785
Public Works - Warehouse Bldg	City of Manassas	No	No	No	Non-burnable	$1,727,166	$1,956,697
Public Works - Maintenance Shop	City of Manassas	No	No	No	Non-burnable	$1,415,964	$476,872
Public Works - Generator Bldg	City of Manassas	No	No	No	Non-burnable	$506,328	$0
Public Works - Parking Garage	City of Manassas	No	No	No	Non-burnable	$1,091,808	$296,940
Public Works - Salt Storage	City of Manassas	No	No	No	Non-burnable	$448,225	$0
Airport Sewer Pump Station	City of Manassas	Yes	Yes	No	Non-burnable	$15,000	$0
Fairview Sewer Pump Station	City of Manassas	No	No	No	Non-burnable	$15,000	$0
Church Sewer Pump Station	City of Manassas	No	No	No	Non-burnable	$15,000	$0
Redoubt Sewer Pump Station	City of Manassas	Yes	No	No	Non-burnable	$50,000	$0
WTP Meter Vault	City of Manassas	No	No	No	Non-burnable	$50,000	$0
Dean Tank 2.5M	City of Manassas	No	No	No	Non-burnable	$5,000,000	$200,000
Dean Water Pump Station	City of Manassas	No	No	No	Non-burnable	$250,000	$0
Quarry Tower 1M	City of Manassas	No	No	No	Non-burnable	$3,000,000	$8,000
Prince William Tower 300k	City of Manassas	No	No	No	Non-burnable	$1,500,000	$2,500

City of Manassas Critical Assets

Water Treatment Plant - Diversion Structure	City of Manassas	No	No	No	Non-burnable	$44,064	$9,595
Water Treatment Plant - Control Bldg	City of Manassas	No	No	No	Non-burnable	$5,147,124	$2,186,650
Water Treatment Plant Floculation Basin #1	City of Manassas	No	No	No	Non-burnable	$2,182,596	$653,268
Water Treatment Plant Floculation Basin #2	City of Manassas	No	No	No	Non-burnable	$2,005,116	$591,759
Water Treatment Plant Generator Bldg	City of Manassas	No	No	No	Non-burnable	$984,300	$0
Water Treatment Plant Filter Bldg	City of Manassas	No	No	No	Very Low	$1,297,848	$531,058
Water Treatment Plant Pump Bldg	City of Manassas	No	No	No	Very Low	$400,758	$655,288
Water Treatment Plant Chemical Bldg	City of Manassas	No	No	No	Non-burnable	$520,608	$196,748
Water Treatment Plant Clarifier	City of Manassas	No	Yes	No	Non-burnable	$1,011,024	$290,880
Water Treatment Plant Surge Basin	City of Manassas	No	Yes	No	Non-burnable	$905,148	$65,246
Water Treatment Plant Ground Water Tank 1.25 M Gallons	City of Manassas	No	No	No	Very Low	$1,150,560	$0
Water Treatment Plant Decant Pump Station	City of Manassas	No	No	No	Very Low	$66,810	$25,048
Water Treatment Plant Caustic Soda Bldg	City of Manassas	No	No	No	Very Low	$84,252	$48,884
Water Treatment Plant Rapid Mix Tank	City of Manassas	No	No	No	Very Low	$84,048	$28,482
Dam Complex Plant	City of Manassas	No	Yes	No	Very Low	$815,881	$2,538,455
Dam with Rubber Skirt	City of Manassas	No	Yes	No	Very Low	$7,497,714	$227,250
Dam Complex Compressor Building	City of Manassas	No	No	No	Non-burnable	$101,796	$38,986
Generator Facility Building	City of Manassas	No	No	No	Non-burnable	$1,671,678	$14,791,450
Airport Complex Dulles Hanger	City of Manassas	Yes	No	Yes	Non-burnable	$1,723,800	$0
Airport Complex Maintenance Bldg	City of Manassas	No	No	No	Non-burnable	$929,757	$0
Airport Complex Electrical Vault Bldg	City of Manassas	No	No	No	Non-burnable	$89,550	$198,282

City of Manassas Critical Assets

Airport Complex Control Tower and base building	City of Manassas	Yes	No	No	Non-burnable	$3,054,594	$0
Airport Complex Aurora East	City of Manassas	Yes	No	No	Non-burnable	$2,100,384	$0
Airport Complex Generator Bldg	City of Manassas	No	No	No	Non-burnable	$137,190	$1,762,450
Airport complex Terminal	City of Manassas	No	No	No	Non-burnable	$6,963,132	$297,950
Railroad Depot	City of Manassas	No	No	No	Non-burnable	$722,592	$0
Diesel Peaking Bldg	City of Manassas	No	No	No	Non-burnable	$263,874	$4,735,486
Dominion Peaking Bldg	City of Manassas	No	No	No	Very Low	$670,140	$5,984,856
Hopkins Candy Factory	City of Manassas	No	No	No	Very Low	$3,593,562	$0
City Square Pavilion Ancillary Bldg	City of Manassas	No	No	No	Very Low	$204,124	$160,456
City Square Pavilion Pavilion	City of Manassas	No	No	No	Very Low	$616,746	$171,918
Animal Shelter	City of Manassas	No	No	No	Very Low	$2,543,472	$349,056
Speiden Carper Historic House	City of Manassas	No	No	No	Very Low	$489,008	$63,024
Prince William Street Parking Garage	City of Manassas	No	No	No	Very Low	$12,960,222	$0
Storage Bldg	City of Manassas	No	No	No	Very Low	$511,632	$651,450
DMV Building	City of Manassas	No	No	No	Very Low	$2,270,736	$0
Prince William Substation	City of Manassas	No	No	No	Very Low	$1,375,000	$500,000
Point of Woods Substation	City of Manassas	Yes	No	No	Very Low	$1,175,000	$500,000
Airport Substation	City of Manassas	No	No	No	Very Low	$1,475,000	$150,000
Battery Heights Substation	City of Manassas	No	No	No	Very Low	$1,295,000	$150,000
Micron Substation	City of Manassas	No	No	No	Very Low	$2,125,000	$250,000
Micron Substation	City of Manassas	No	No	No	Very Low	$2,125,000	$150,000
LOMAR Substation	City of Manassas	No	No	No	Non-burnable	$2,095,000	$150,000
Communications Server Building	City of Manassas	No	Yes	No	Non-burnable	$65,000	$1,500,000
Baldwin Elementary School	City of Manassas	No	No	No	Non-burnable	$13,820,010	$1,862,875
Jennie Dean Elementary School	City of Manassas	No	No	No	Non-burnable	$22,329,250	$1,848,530
Haydon Elementary School	City of Manassas	No	No	No	Non-burnable	$15,167,580	$1,197,620
Round Elementary School	City of Manassas	No	No	No	Non-burnable	$17,608,110	$1,750,000
Weems Elementary School	City of Manassas	No	No	No	Non-burnable	$15,291,780	$1,156,810
Mayfield Intermediate School	City of Manassas	No	No	No	Non-burnable	$34,500,000	$2,565,000
Metz Middle School	City of Manassas	No	No	No	Very Low	$48,098,520	$3,576,020
Osbourn High School	City of Manassas	No	No	No	Very Low	$71,135,090	$5,808,326
Manassas Volunteer Fire Company (owned by the volunteers)	City of Manassas	No	No	No	Non-burnable	$3,000,000	$2,750,000

City of Manassas Critical Assets

Manassas Rescue Station	City of Manassas	Yes	No	No	Non-burnable	$2,072,382	$296,050
Central Fuel Farm	City of Manassas	No	No	No	Non-burnable	$2,000,000	$0
Airport East T-Hangars	City of Manassas	No	No	No	Non-burnable	$0.00	$0
Airport West T-Hangars	City of Manassas	No	No	No	Non-burnable	$0.00	$0
						###########	$73,694,888

Fairfax County Critical Assets

Critical Asset	Jurisdiction	Tornado .25 Mile Buffer	SFHA 100 Year	SFHA 500 Year	WFP Class	Asset Values	Content Values
Pohick Regional library	Fairfax County	No	No	No	Non-burnable	$3,571,541	$1,404,152
Cornerstones - Attached to A New Beginning Property 264 Occupancy listed there	Fairfax County	No	No	No	Non-burnable	$1,163,341	$104,835
Patrick Henry Library	Fairfax County	Yes	No	No	Non-burnable	$1,685,961	$575,564
Richard Byrd Library	Fairfax County	Yes	No	No	Non-burnable	$3,810,536	$222,768
Sherwood Regional Library	Fairfax County	No	No	No	Low	$3,719,594	$1,369,562
John Marshall Library	Fairfax County	No	No	No	Non-burnable	$1,897,699	$568,782
Kings Park Library	Fairfax County	No	No	No	Non-burnable	$2,432,144	$327,457
West Ford III - 59 units for Housing Authority located at: 3000-3043 Fordson Ct and 3001-3031 Westford View Ct	Fairfax County	No	No	No	Non-burnable	$6,358,746	$163,049
Four Townhouses at 6037 and 6043 Masondale Road, 5956 and 5953 Manorview Way. 6037 value $132,580 at 1080 SqFt, 6043 valued $133,830 at 1096 SqFt, 5956 valued $130,960 at 1166 SqFt and 5953 valued $132,190 at 1166 SqFt.	Fairfax County	No	No	No	Non-burnable	$612,701	$0
Thomas Jefferson Library	Fairfax County		No	No	Non-burnable	$2,222,055	$211,099
Martha Washington Library	Fairfax County	Yes	No	No	Non-burnable	$2,138,949	$462,894
George Mason Regional Library	Fairfax County	Yes	No	No	Non-burnable	$3,825,215	$1,205,176
Lincolnia Senior Center	Fairfax County	No	No	No	Non-burnable	$8,847,985	$652,630
Dolley Madison Library	Fairfax County	No	No	No	Very Low	$1,385,900	$444,030
Tysons-Pimmit Library	Fairfax County	No	No	No	Very Low	$3,183,986	$1,334,368
Springfield Green Apartments Housing Authority 19 Units 7087 - 7095 Springfield Garden Drive	Fairfax County	Yes	No	No	Very Low	$4,055,899	$70,000

Fairfax County Critical Assets

Woodrow Wilson Library	Fairfax County	No	No	No		$1,646,546	$508,759
Centreville Regional Library	Fairfax County	No	No	No	Non-burnable	$3,762,935	$1,277,111
Line Maint/ Robert P. Mcmath Facility	Fairfax County	Yes	No	No	Non-burnable	$3,499,036	$709,572
Line Maint Division Upper Cub Run Facility - No visible structure	Fairfax County	No	No	No	Non-burnable	$255,079	$0
Line Maint - Jones Pt. Pumping Station	Fairfax County	Yes	No	No	Non-burnable	$574,625	$0
West Glade Apartments Housing Authority 50 Units (HALP) 2100 through 2136 West Glade Drive (even #'s) - The Green LP	Fairfax County	No	No	No	Non-burnable	$6,510,946	$136,092
Line Maintenance - 50-66 Main Pump Stat	Fairfax County	No	Yes	No	Non-burnable	$395,705	$245,265
Line Maintenance Division - Accotink Pump Station	Fairfax County	No	Yes	No	Very Low	$1,995,860	$1,669,702
Line Maintenance - Arcturus Pump Station - 14 x 7 Brick structure	Fairfax County	No	No	No	Low	$136,148	$0
Line Maintenance - Barcroft #1 Pump Station	Fairfax County	No	No	No	Non-burnable	$163,183	$0
Line Mait Division- Barcroft #2 Pump Station	Fairfax County	No	No	No	Non-burnable	$162,073	$0
Line Maint Division- Belle Haven County Club pump/grinder station - no above ground structure. Only electircal box.	Fairfax County	Yes	No	No	Non-burnable	$3,275	$0
Line Maintenance Mt. Vernon Terrace Pump Station	Fairfax County	No	Yes	No	Very Low	$574,625	$0
Line Mait Division - CIA Pump Station	Fairfax County	No	No	No	Very Low	$547,011	$0

Fairfax County Critical Assets

Line Maint Division- Carters Pump Station - No above ground structure. Electrical box only	Fairfax County	No	Yes	No	Very Low	$7,500	$0
Line Maint Division - Columbia Oaks #1 Pump Station	Fairfax County	Yes	No	No	Low	$18,118	$0
Line Maint Division - Columbia Oaks #2 Pump Station	Fairfax County	Yes	No	No	Low	$18,118	$0
Line Maint Dead Run Pump Station	Fairfax County	No	Yes	No	Very Low	$1,294,923	$0
Line Maint Difficult Run Pump Station	Fairfax County	No	No	No	Very Low	$2,448,628	$1,784,273
Line Maint Freund House (previously called Dogue Creek) Pump Station	Fairfax County	No	No	Yes	Very Low	$4,638,000	$1,669,702
Line Maint Downcrest Pumping Station	Fairfax County	No	No	No	Very Low	$66,286	$0
Line Mait F Street Pump Station	Fairfax County	No	Yes	No	Very Low	$732,368	$0
Line Mait George Mason Univ Pump Station	Fairfax County	No	No	No	Non-burnable	$855,039	$0
Line Maint Georgetown Pike 1 Grinder--Underground Does not require inspection	Fairfax County	No	No	No	Non-burnable	$18,006	$0
Line Maint Georgetown Pike 2 Grinder Pump Station--underground does not require inspection	Fairfax County	No	No	No	Non-burnable	$18,006	$0
Line Mait Highridge Office Park Pump Station	Fairfax County	No	No	No	Non-burnable	$168,809	$0
Line Maitenance Holmes Run Pump Station	Fairfax County	No	No	Yes	Non-burnable	$845,021	$0
Line Maint Jefferson Ave Pump Station	Fairfax County	Yes	Yes	No	Non-burnable	$19,973	$0
Line Mait Keene Mill Rd Pump Station	Fairfax County	No	Yes	No	Non-burnable	$616,944	$0

Line Mait Division Lakevale Estates Pump Station	Fairfax County	No	No	No	Very Low	$211,901	$0
Line Mait Langley Oaks Pump Station	Fairfax County	No	No	No	Very Low	$162,621	$0
Line Mait Division Langley School Pump Station	Fairfax County	No	No	No	Very Low	$195,375	$0
Line Mait Various Locations Grinder Pump @245 Homes---these do not require inspections	Fairfax County	No	No	No	Very Low	$2,250,803	$0
Line Maint Div Little Hunting Creek Pump Station	Fairfax County	No	No	No	Very Low	$1,377,289	$1,157,306
Line Maint Long Branch Pump Station	Fairfax County	No	Yes	No	Very Low	$841,070	$426,950
Line Mait Merrywood Pump Station	Fairfax County	No	No	No	Very Low	$555,000	$0
Stonegate Apartments Housing Authority 240 Units - HCDC I LP (HALP) 2200 - 2265 Stone Wheel Drive & 2200 - 2225 Mill Race Lane	Fairfax County	No	No	No	Non-burnable	$17,579,177	$27,516
Line Maint Oak Marr Pump Station	Fairfax County	No	No	No	Non-burnable	$135,611	$0
Line Maint Oxford Pump Station - 6 x 4 wooden shed	Fairfax County	No	No	No	Very Low	$51,768	$0
Line Mait Pender Pump Station	Fairfax County	Yes	No	No		$937,474	$0
Line Mait Penderbrook Pump Station	Fairfax County	No	No	No	Very Low	$337,620	$0
Line Maint Pike Branch Pump Station - No above ground structure. Electrical box only. Inspection not required	Fairfax County	No	No	No	Very Low	$7,500	$0
Line Maint Ravenwood Pump Station--Not inspected	Fairfax County	No	Yes	No	Non-burnable	$31,511	$0

Line Mait River Towers Pump Station	Fairfax County	No	No	No	Non-burnable	$525,490	$0
Line Maint Riverwood Pump Station - 14 x 7 Brick structure	Fairfax County	No	No	No	Very Low	$81,950	$0
Line Maint Shirley Gate Grinder Pump Station - no above ground structure. Electrical box only. Does not Require Inspection	Fairfax County	No	No	No	Non-burnable	$7,500	$0
Line Mait Springfield Estates Pump Station - Behind wooden gate and inaccessible. Appears to be a 6 x 8 wooden shed.	Fairfax County	No	No	No	Non-burnable	$155,305	$0
Line Maint Springfield Forest Pump Station - Could not locate anything at the site. No above ground structure.	Fairfax County	No	No	No	Non-burnable	$7,500	$0
Line Maint Telgraph Rd Grinder Pump Station - no above ground structure. Only an electrical box	Fairfax County	No	No	No	Very Low	$7,500	$0
Line Maint Tysons Corner Pump Station	Fairfax County	No	No	No		$283,048	$0
Line Mait Washington Woods Pump Station - 14 x 7 Cement slab structure	Fairfax County	No	No	No	Very Low	$137,298	$0
Line Mait Waynewood #1 Pump Station -14 x 7 Brick	Fairfax County	No	No	No	Very Low	$155,350	$0
Line Mait Waynewood #2 Pump Station - 14 x 7 brick structure	Fairfax County	No	No	No	Very Low	$165,151	$0
Line Mait Weid Pump Station	Fairfax County	No	No	No		$439,404	$0
Line Mait Wellington #1 Pump Station	Fairfax County	No	Yes	No	Very Low	$284,682	$0

Line Mait Wellington #2 Pump Station - GIS shows no indication of any above ground structure. Private property not accessible	Fairfax County	No	No	No	Very Low	$184,085	$0
Line Mait Wesley House Pump Station	Fairfax County	No	No	No	Very Low	$189,067	$0
Line Mait Yacht Haven Pump Station	Fairfax County	No	Yes	No	Very Low	$991,526	$0
Line Maitenance Belleview Pump Station	Fairfax County	No	Yes	No	Very Low	$413,652	$222,793
Line Mait Braddock Rd Pump Station	Fairfax County	No	Yes	No	Non-burnable	$541,944	$281,817
Line Maint Clifton Pump And Haul Station	Fairfax County	Yes	No	No	Non-burnable	$13,504	$0
Stormwater Dam Site #4 - No above ground structure. Earthen dam Does not require LP Audit	Fairfax County	No	No	No	Non-burnable	$11,253	$0
Line Mait The Fairfax Pump Station	Fairfax County	No	No	No	Very Low	$365,755	$0
Line Mait Giles Run Pump Station	Fairfax County	No	No	No	Very Low	$390,513	$0
The Park Apartments Housing Authority 24 Units 6440 - 6471 Burwell St(shows as 6319 Georgia St in tax system)	Fairfax County	No	No	No	Non-burnable	$2,680,434	$58,902
Line Mait Llv Odor Control Pump Station	Fairfax County	Yes	No	No	Non-burnable	$382,931	$0
Maintenance And Stormwater New Alex Storm Pump Station--maintained by Wastewater Collection.	Fairfax County	No	Yes	No	Non-burnable	$545,782	$382,047
Line Mait Piney Branch Pump Station	Fairfax County	No	No	No	Very Low	$438,906	$0

Fairfax County Critical Assets

Line Maintenance Edgewater Pump Station	Fairfax County	No	No	No	Low	$675,241	$0
Station 1 - Mclean Fire Station	Fairfax County	No	No	No	Very Low	$2,899,072	$577,333
Fire And Rescue Academy	Fairfax County	Yes	No	No	Very Low	$12,309,547	$1,591,226
Station 9 - Mount Vernon Fire Station	Fairfax County	No	No	No	Very Low	$1,403,264	$375,279
Station 10 - Bailey's Crossrds Fire Station	Fairfax County	No	No	No	Very Low	$2,397,615	$500,000
Station 11 - Penn Daw Fire Station	Fairfax County	No	No	No	Low	$2,007,662	$454,463
Station 12 - Great Falls Volunteer Fire Station	Fairfax County	No	No	No	Non-burnable	$1,240,576	$676,373
Station 38 - West Centreville	Fairfax County	No	No	No	Non-burnable	$1,629,051	$350,884
Station 18 Jefferson fire station	Fairfax County	No	No	No	Non-burnable	$1,866,206	$400,067
Station 19 - Lorton Fire Station	Fairfax County	No	No	No	Non-burnable	$1,399,483	$272,891
Station 20 - Gunston Fire Station	Fairfax County	No	No	No	Non-burnable	$1,081,786	$224,392
Station 24 - Woodlawn Fire Station	Fairfax County	No	No	No	Non-burnable	$840,278	$412,313
Station 34- Oakton Fire Station	Fairfax County	Yes	No	No	Non-burnable	$1,418,461	$265,031
Station 32 - Fairview Fire Station	Fairfax County	No	No	No	Non-burnable	$1,254,763	$228,158
Station 31 - Fox Mill Fire Station	Fairfax County	No	No	No	Non-burnable	$1,255,849	$262,135
Station 29- Tysons Corner Fire Station	Fairfax County	No	No	No	Non-burnable	$1,504,759	$272,127
Station 28 - Seven Corners Fire Station	Fairfax County	No	No	No	Non-burnable	$1,272,862	$244,176
Station 26 - Edsall Rd Fire Station	Fairfax County	No	No	No	Non-burnable	$1,289,651	$258,890
Station 25 - Reston Fire Station	Fairfax County	No	No	No	Very Low	$1,274,556	$267,261

FairCrest North - 6 townhouses located at 5313, 5323, 5333 Rosemallow Circle, 5207 Prairie Willow Lane and 13522, 13507 Prairie Mallow Lane. Each unit is valued at $130,774.	Fairfax County	No	No	No	Non-burnable	$1,092,532	$0
Station 15 - Chantilly Fire Station	Fairfax County	No	No	No	Non-burnable	$1,439,373	$305,466
Station 36 - Frying Pan Fire Station	Fairfax County	No	No	No	Non-burnable	$1,371,237	$289,535
Station 30 - Merrifield Stat And Providence Dist Bus Office	Fairfax County	No	No	No	Non-burnable	$1,609,180	$327,943
Station 21 - Fair Oaks, & Police Department	Fairfax County	No	No	No	Non-burnable	$7,701,719	$510,530
Station 37 - Kingstowne Fire Station	Fairfax County	No	No	No	Non-burnable	$2,083,387	$435,097
Line Maintenance Ordway Road Pumping Station	Fairfax County	No	No	No	Non-burnable	$574,625	$0
Line Maintenance LLV Odor Control Site	Fairfax County	Yes	No	No	Very Low	$574,625	$0
Line Maintenance Lorton Road Pumping Station	Fairfax County	No	No	No	Low	$574,625	$0
Line Maintenance Langley Court Pumping Station	Fairfax County	No	No	No	Non-burnable	$574,625	$0
Arrowhead Park - Two 8X6 irrigation buildings. As of 10-27-2015, includes two synthetic turf fields and new fencing.	Fairfax County	No	No	No	Non-burnable	$27,347	$0
Line Maintenance Jermantown Road Pumping Station	Fairfax County	No	No	No	Non-burnable	$574,625	$0
Line Maintenance Gunston Pump and Haul	Fairfax County	No	No	No	Very Low	$574,625	$0
Noman C. Cole Pollution Control Plan	Fairfax County	No	No	No		$151,602,820	$15,047,198

Line Maintenance Wiley Pump and Haul	Fairfax County	No	No	No	Very Low	$574,625	$0
Line Maintenance New Alexandria Tide Gate	Fairfax County	No	Yes	No	Non-burnable	$574,625	$0
Line Maintenance Hunter Estates Pumping Station	Fairfax County	No	No	No	Non-burnable	$574,625	$0
Line Maintenance Gunston Commerce Center Pumping Station	Fairfax County	No	No	No	Non-burnable	$574,625	$0
Line Maintenance Ordway Road Pumping Station (Also 7203, 7300, 7301 Ordway Road) No visible structure	Fairfax County	No	No	No	Non-burnable	$574,625	$0
McConnell Public Safety and Transportation Operations Center and Forensics Facility.	Fairfax County	Yes	No	No	Non-burnable	$18,381,000	$41,000,000
Burke Centre Library	Fairfax County	Yes	No	No	Non-burnable	$2,338,369	$500,000
Baron Cameron Park Irrigation Building	Fairfax County	No	No	No	Non-burnable	$21,054	$0
Dulles Corner park - Irrigation Building	Fairfax County	No	No	No	Non-burnable	$25,025	$0
8X6 irrigation building	Fairfax County	No	No	No	Non-burnable	$20,052	$0
Arrowbrook Park - Utilition Building, Pavillion and Rest Rooms	Fairfax County	No	No	No	Non-burnable	$95,988	$0
Mclean Community Center	Fairfax County	No	No	No	Non-burnable	$7,434,531	$616,127
Shelter House- Consisting Apartments For Families; Each Valued At $50,000 Per Unit	Fairfax County	No	No	No	Non-burnable	$584,358	$37,128
Housing Authority property	Fairfax County	No	No	No	Non-burnable	$296,085	$100,000
Reston Regional Library	Fairfax County	No	No	No	Non-burnable	$3,781,217	$1,253,161

Little River Glen Apartments Housing Authority 120 Units 4003, 4005, 4007, 4009 Barker Court	Fairfax County	Yes	No	No	Non-burnable	$9,473,043	$282,990
Spring Hill Recreation Ctr	Fairfax County	No	No	No	Very Low	$15,787,035	$482,609
Oak Marr Recreation Center, Golf Course and Maintenance Shop	Fairfax County	No	No	No	Non-burnable	$10,826,290	$574,127
Hollin Hall Senior Center	Fairfax County	No	No	No	Non-burnable	$6,566,387	$367,758
Baileys Community Center, Sr. Center and Higher Horizon Head start	Fairfax County	No	No	No	Non-burnable	$2,003,597	$52,479
Gum Springs Community Center	Fairfax County	No	No	No	Low	$9,178,604	$570,771
James Lee Community Center	Fairfax County	Yes	No	No	Non-burnable	$4,918,597	$262,395
Huntington Community Center	Fairfax County	No	Yes	No	Non-burnable	$340,642	$104,958
Mott Community Center	Fairfax County	No	No	No	Non-burnable	$1,660,034	$0
Lorton Prison Max Security Facility. Inclused all buildings at site, including Laurel Hill House, Education Services, Lipscomb House & Garage, Barrett House, Stempson House & Garage and Drug Testing facility. None are in current use.	Fairfax County	No	No	No	Very Low	$53,592,000	$0
Donated by Olander Banks, Jr who retains a life estate and lives on property.	Fairfax County	No	No	No	Non-burnable	$464,341	$400,000
Burgundy Recreation Ctr - Frame building with plastic siding.	Fairfax County	No	No	No	Non-burnable	$233,163	$20,992
I-66 Transfer Station	Fairfax County	Yes	No	No	Non-burnable	$14,075,266	$1,530,436
I-95 Landfill-Refuse Disp	Fairfax County	No	No	No	Non-burnable	$973,983	$81,164
Alban Maintenance Garage	Fairfax County	No	No	No	Non-burnable	$2,928,353	$2,800,000