Hazard Identification and Risk Assessment (HIRA)

Summary of Changes:

The following changes were made to the HIRA in the Hazard Mitigation Plan Update Process. The planning management team met on September 15th, 2011 and arrived at a ranking system for hazards in Region 2000 through a survey. The ranking system and survey results are located in the planning process sections and the Appendix. Winter storms, flood, drought, wind, wildfire, landslide and land subsistence and terrorism received the same rankings as in the original Hazard Mitigation Plan so they will be examined in much the same way.

Updated information from the 2010 Census was used *when available* in this update. The population data in Table 5.1 was updated using 2010 census data. The median value of housing units was recorded from the American Community Survey's 3 year estimates from 2007-2009.

The critical facilities layer was updated to reflect current conditions. The updated list includes airports, police stations, hospitals, fire stations, dams, schools, churches, select industrial sites, select industrial and manufacturing buildings, and large shopping centers. The updated list in its entirety can be found in the appendix. Local officials had an opportunity to comment on what critical facilities to include in the plan during the 9/15/11 project management team meeting.

The loss estimates from the original Hazard Mitigation Plan were produced through HAZUS analysis which used 2000 Census data for its calculations. The newest version of HAZUS is also running on 2000 Census Data so the numbers in the HAZUS section are consistent from the original plan to the 2011 update. FEMA stresses the use of best available data for the plan and the tables will be updated in subsequent updates as new data becomes available.

The federal emergency declarations table (Table 5.3) was updated with information from the FEMA website. There have been two additional federal emergency declarations for the area in Region 2000 since the original hazard mitigation plan was created in 2006. Both declarations were in response to the severe winter weather the Region felt in January and February of 2010.

The severe repetitive loss properties were updated with information from the Department of Conservation and Recreation.

FEMA State and Local Mitigation Planning how-to guides defines the risk assessment as "the process of measuring the potential loss of life, personal injury, economic injury, and property damage resulting from natural hazards by assessing the vulnerability of people, buildings, and infrastructure to natural hazards."

Purpose of HIRA

1. Identify the hazards that could affect the jurisdictions in Region 2000.

2. Profile hazard events and determine what areas and community assets are the most vulnerable to damage from these hazards

3. Estimate losses and prioritize the potential risks to the community

The first step—identifying hazards—will determine all the natural hazards that might affect the area. The hazards will be ranked to determine what hazards are most likely to impact the communities of Region 2000. Hazards that are determined to have significant impact (a ranking of 4 or 5 according to the survey completed by Region 2000 jurisdictions for the 2013 update) will be analyzed in the greatest detail to determine the magnitude of future events and the vulnerability for the community and the critical facilities. Hazards that receive a moderate impact ranking (a ranking of 3 according to the survey completed by Region 2000 jurisdictions for the 2013 update) will be analyzed with available data to determine the risk and vulnerability to the specified hazard. The limited impact hazards (those hazards with a ranking of 1 according to the survey completed by Region 2000 jurisdictions for the 2011 update) will be briefly outlined in the HIRA.

Regional Information

Table 5-1 and Figure 5-1 illustrate the land area of each of the communities in Region 2000, as well as the population in the communities and number of households. This information will prove to be a key component in determining the risk to communities from natural hazards.

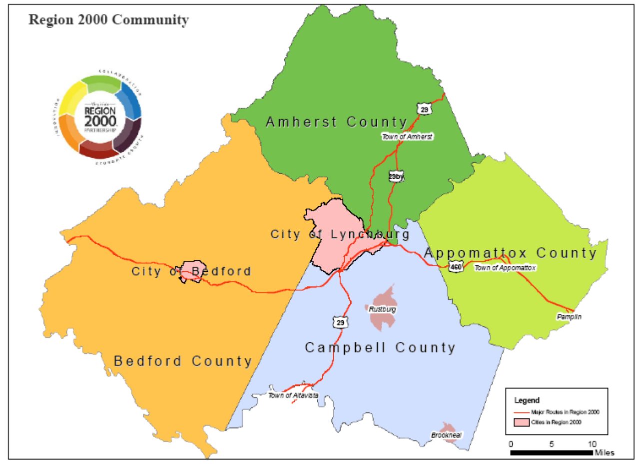


Figure 5.1 Region 2000 Partnership Jurisdictions, Source: Region 2000

Table 5.1 Breakdown of Region 2000 Jurisdictions, Source 2010 US Census, ACS 2007-2009

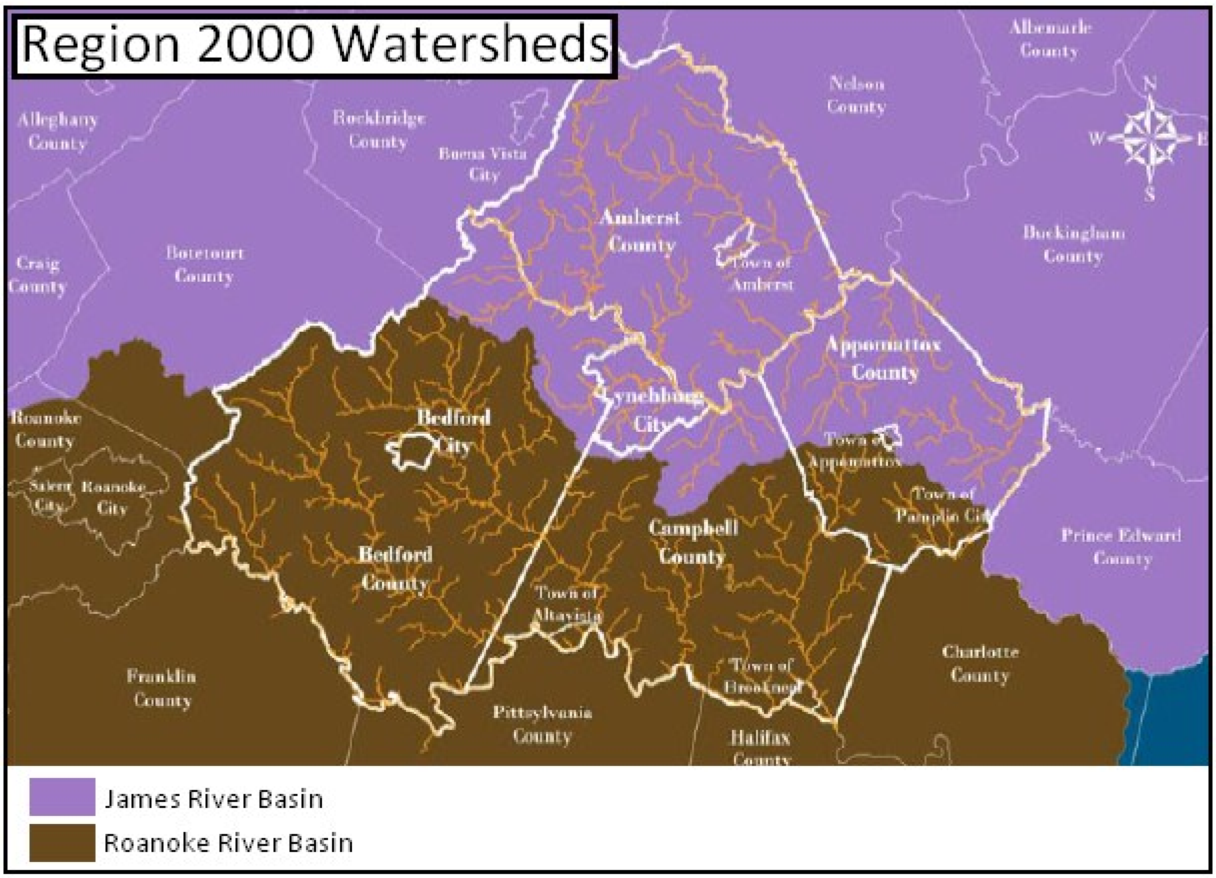
NAME	Area (Sq Mile)	2010 Pop	2010 Pop per Sq Mile	Median Home Value**	Total Housing Units
Amherst County	471.17	32,353	68.7	$149,700	13,976
Amherst, Town of	4.9	2,231	455.3	DATA N/A	1,032
Appomattox County	329.41	14,973	45.5	DATA N/A	6,921
Appomattox, Town of	2.1	1,733	825.2	DATA N/A	849
Pamplin City, Town of	0.25	219	876.0	DATA N/A	104
Bedford City	6.79	6,222	916.3	DATA N/A	2,920
Bedford County	757.02	68,676	90.7	$188,300	31,937
Campbell County	499.2	54,842	109.9	$138,400	24,769
Altavista, Town of	4.8	3,450	718.8	DATA N/A	1,669
Brookneal, Town of	3.6	1,112	308.9	DATA N/A	567
Lynchburg City	48.97	75,568	1543.1	$134,900	31,992

All data taken from the 2010 US Census except for **Median Home Value—taken from ACS2007-2009

Watersheds

The major watersheds for Region 2000 jurisdictions include the James River Basin and the Roanoke River Basin. The following Figure 5-2 illustrates the location of the major watershed boundaries for the jurisdictions in Region 2000. The region is separated by two major watersheds, the James River Basin to the north and the Roanoke River Basin to the south.

Figure 5-2. Region 2000 Watersheds, Source: VA-DCR



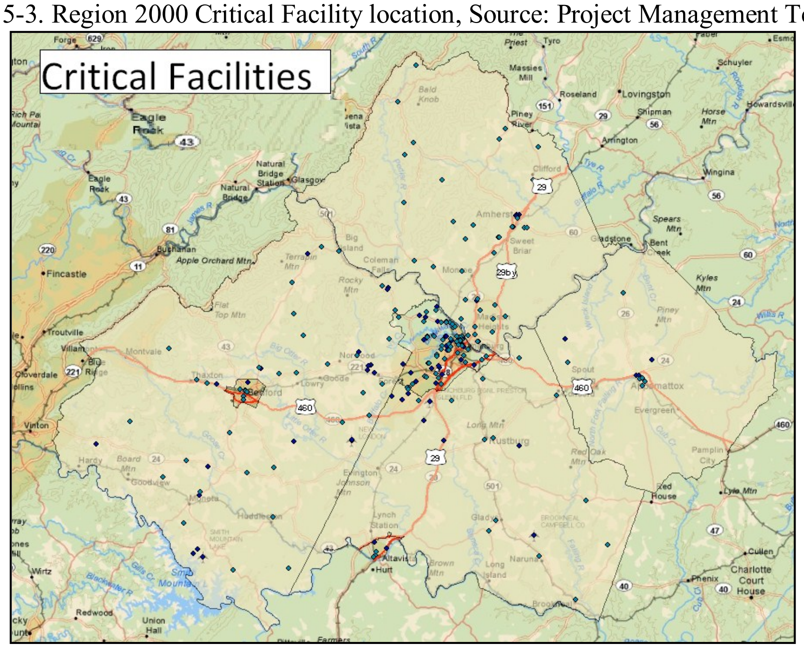
Critical Facilities

According to the FEMA State and Local Plan Interim Criteria, a critical facility is defined as a facility in either the public or private sector that provides essential products and services to the general public, is otherwise necessary to preserve the welfare and quality of life in the County, or fulfills important public safety, emergency response, and/or disaster recovery functions.

Critical facilities for Region 2000 were derived from a variety of sources. Information provided by the communities for the original Hazard Mitigation Plan was supplemented with ESRI data, FEMA HAZUS-MH location data. In this update, a list of critical facilities was given to each project management team member for review. Many of the critical facilities from the original plan are included in the update. Critical facilities in this plan update include all airports, police stations, hospitals, fire stations, dams, schools, churches, select industrial sites, select industrial and manufacturing buildings, and large shopping centers. This list was supported at the September 15th, 2011 meeting of the project management team. Please see the appendix for a full list of critical facilities and their locations.

Critical facilities, residential and industrial buildings within the 100 year floodplain were identified for flood analysis and wildfire analysis. The HAZUS-MH model was used to estimate damage from hurricanes in the region and is detailed in the hurricane section. Terrorism was addressed through consulting community Emergency Operations Plans, if available, for more detailed information.

Figure 5-3. Region 2000 Critical Facility location, Source: Project Management Team



Data Limitations

Inadequate information posed a problem for developing loss estimates for most of the identified hazards. The limiting factor for the data was that the hazard mapping precision is only at the county or jurisdiction level. Many of the hazards do not have defined damage estimate criteria.

Analysis for the region was completed using the best available data. The detail level of the data received from the communities drove the specifics of the vulnerability analysis. When detailed building footprint data was available, it was used to assess the vulnerability at a building specific level. When building specific data was not available, census blocks were used to assess the areas vulnerability to specific hazards. Flooding analysis was conducted using two main methods.

When communities provided real estate property values and building footprints, a detailed analysis was completed to determine the percent of property at risk. When real estate values were not readily available, 2000 Census data for average structure value per block was used as a replacement cost in the event of a disaster. In the case of the update, census data from 2000 will still be used since values from the 2010 Census have not been included in the HAZUS-MH datasets yet. This value can serve as a guide in assessing the impacts of various hazards. Dams or hazmat locations, when available, were included in with critical facilities and analysis preformed.

The FEMA guidelines emphasize using “best available” data for this plan. The impact of these data limitations will be shown through the different vulnerability assessments and loss estimation methods used for hazards. ***In the HIRA sections on each hazard, more detail will be provided on the data and analysis limitations.***

Region 2000 staff, as well as staff in the localities, provided available base map data and building information for the analysis. All other data was derived from existing sources or created by Region 2000 staff.

The FEMA guidelines emphasize using “best available” data for this plan. In the loss estimates section of the HIRA, the “best available” data was from 2000 Census data because the newest version of HAZUS software didn’t include 2010 data yet. Therefore, many of the loss estimates from the original Hazard Mitigation Plan remain in the updated plan.

Hazard Identification

Types of Hazards

While nearly all disasters are possible for any given area in the United States, the most likely hazards to potentially affect the communities in Region 2000 generally include:

- Droughts
- Earthquakes
- Flooding (Hurricanes)
- Hurricanes
- Landslides and Land Subsidence
- Terrorism
- Wildfires
- Wind (Hurricane/Tornado)
- Winter Storms (Ice/Snow)

Probability of Hazards

Hazards were ranked by the project management team to determine what hazards they judged to have the largest impact on their communities. The results are summarized in Table 5-2. The addition of a "Low" ranking by the project management team caused the earthquake hazard to be analyzed a bit further in this update. The earthquake hazard was originally ranked has having no impact on the area, but a recent earthquake in Virginia reminded the project management team that it is a possible threat. The type of analysis that was completed was determined by the type of data available and the scale of data available for the analysis. The project management team also decided that ranking the Region as a whole represented each jurisdiction's vulnerability. Therefore, the rankings in the table below stand true for all jurisdictions in Region 2000.

Table 5.2 Hazard Identification Results, Source: Project Management Team

Hazard Identification Results	
Hazard Type	**Rank**
Winter Storms (Ice/Snow)	High
Flood (Hurricane)	High
Drought	High
Wind (Hurricane/Tornado)	Medium
Wildfire	Medium
Landslide and Land Subsidence	Low
Terrorism	Low
Earthquake	Low

Rankings derived from the September 15th, 2011 meeting. Surveys attached in appendix.

Major Disasters

Table 5-3 lists the major disasters that have occurred in Region 2000 Jurisdictions including Presidential declared disasters. The table shows which hazards impacted each of the communities in Region 2000, as well as the designated federal disaster number. The region has had 9 declared disasters since 1969, with a majority of the disasters being split between flooding and with winter weather. Nine declared disasters have been noted for the time period prior to 1969, when FEMA began to denote disasters with declaration numbers. For a detailed description of the disaster for the region, consult the *Hazard History Tables* located in the appendix. The updated table includes two additional disasters that occurred since the original hazard mitigation plan was written. They both encompass the heavy snowfall that occurred at the beginning of 2010.

Table 5- 3. Region 2000 Federal Disasters, Source: FEMA

Communities Impacted	Date of Declaration	Federal Declaration #	Federal Description
Amherst, Appomattox, Lynchburg	1771	N/A	Severe Storms & Flooding
Amherst, Appomattox, Lynchburg	1870	N/A	Severe Storms & Flooding
Amherst, Appomattox	1877	N/A	Severe Storms & Flooding
Appomattox	1877	N/A	Severe Storms & Flooding
Amherst, Appomattox	1913	N/A	Severe Storms & Flooding
Amherst, Appomattox	1935	N/A	Severe Storms & Flooding
Amherst, Appomattox, Bedford City, Bedford	1936	N/A	Severe Storms & Flooding
Campbell	1937	N/A	Severe Storms & Flooding
Amherst, Appomattox, Bedford City, Campbell, Bedford	1940	N/A	Severe Storms & Flooding
Amherst, Bedford, Bedford City, Campbell, Lynchburg City	8/23/1969	274	Severe Storms & Flooding (Hurricane Camille): This major storm made landfall out of the gulf as a category 5 and weakened to a tropical depression before reaching the state. Precipitation trained over regions many hours, dropping more than 27 inches of rain in Nelson County and over ten inches in the area from Lynchburg to Charlottesville. Flooding and landslides, triggered by saturated soils, resulted in catastrophic damage. More than 150 people died and another 100 were injured. At the time, damage was estimated at more than $113 million.

Amherst, Appomattox, Bedford, Bedford City, Campbell, Lynchburg	6/23/1972	339	Tropical Storm Agnes: This event produced devastating flooding throughout the Mid-Atlantic States. Some areas of eastern Virginia received over 15 inches of rainfall as the storm moved through. The Potomac and James Rivers experienced major flooding, which created 5 to 8 feet flood waters in many locations along the rivers. Richmond was impacted the most by these high water levels. Water supply and sewage treatment plants were inundated, as were electric and gas plants. Only one of the five bridges across the James River was open, while the Downtown area was closed for several days and businesses and industries in the area suffered immense damage. Sixteen people lost their lives in the state and damage was estimated at $222 million. These startling numbers resulted in 63 counties and 23 cities qualifying for disaster relief.
Amherst, Appomattox, Bedford, Campbell	4/11/1994	1021	Severe Winter Ice Storm: This winter storm coated portions of Virginia with 1 to 3 inches of ice from freezing rain and sleet. This led to the loss of approximately 10 to 20 percent trees in some counties, which blocked roads and caused many people to be without power for a week. There were numerous automobile accidents and injuries from people falling on ice. Damages were estimates at $61 million.
Amherst, Bedford, Bedford City, Campbell, Lynchburg City	7/1/1995	1059	Severe Storms & Flooding
Amherst, Appomattox, Bedford, Campbell, Lynchburg City	1/13/1996	1086	Blizzard of 1996 (severe storm): Also known as the “Great Furlough Storm” due to Congressional impasse over the federal budget, the blizzard paralyzed the Interstate 95 corridor, and reached westward into the Appalachians where snow depths of over 48 inches were recorded. Several local governments and schools were closed for more than a week. The blizzard was followed with another storm, which blanketed the entire state with at least one foot of snow. To compound things, heavy snowfall piled on top of this storm’s accumulations in the next week, which kept snow pack on the ground for an extended period of time. This snow was eventually thawed by higher temperatures and heavy rain that fell after this thaw resulted in severe flooding. Total damage between the blizzard and subsequent flooding was over $30 million.
Amherst, Appomattox, Bedford, Bedford City, Campbell, Lynchburg	9/6/1996	1135	Hurricane Fran: This hurricane is notable not only for the $350 million in damages, but because of its widespread effects, including a record number of people without power and the closure of 78 primary and 853 secondary roads. Rainfall amounts between 8 and 20 inches fell over the mountains and Shenandoah Valley, leading to record-level flooding in many locations within this region. 100 people had to be rescued from the flood waters and hundreds of homes and buildings were damaged by the flood waters and high winds.
Amherst, Appomattox, Bedford, Campbell, Lynchburg City	2/28/2000	1318	2000 Winter Storms

Bedford, Bedford City, Lynchburg City	5/5/2002	1411	2002 Floods/Tornadoes
Amherst, Appomattox, Bedford, Bedford City, Campbell, Lynchburg	9/18/2003	1491	Hurricane Isabel was the costliest and deadliest hurricane in the 2003 Atlantic hurricane season. Wind and flood damage were reported in Region 2000 jurisdictions.
Amherst, Bedford	2/16/2010	1874	High amounts of snowfall throughout the state of Virginia cause the president to declare a major disaster for the entire state. Eligible local governments received federal funding on a cost sharing basis for emergency work and the repair or replacement of facilities damaged by the severe winter storm.
Amherst, Bedford	4/27/2010	1905	A second presidential disaster declaration was signed in response to the high amounts of snowfall that crippled parts of Virginia in February of 2010.

Mapping Considerations

Level of Hazard Mapping

Table 5-4 provides a breakdown of the natural hazards addressed in this plan. The level of planning consideration given to each hazard was determined by the committee members. Based on the input of committee members, the hazards were broken into three distinct categories which represent the level of consideration they will receive throughout the planning process.

In order to focus on the most critical hazards that may affect Region 2000 communities, the hazards assigned by a level of *High* or *Medium* will receive the most extensive attention in the remainder of the planning analysis, while those with a *Low* planning consideration level will be assessed in more general terms. Those hazards with a planning level of *None* will not be addressed in this plan. The level of *None* should be interpreted as not being critical enough to warrant further evaluation; however, these hazards should not be interpreted as having zero probability of impact.

In the original plan, earthquakes were designated with a hazard level of *None*, and were therefore not included in the analysis. The project management team for the 2011 update deemed earthquakes a viable threat to the region so a *Low* ranking was assigned. An earthquake is the shaking of the ground’s surface caused by movements of the plates beneath it. According to the HAZUS analysis, earthquakes generate about $669,000 in annualized losses to the region.

Problem Spot Mapping

Additional areas of impact were noted by the committee members through a problem spot worksheet, as well as indicating what areas were of concern on paper maps for the region which is included in the appendix.

Each locality provided input, to the best of their ability, in determining what areas were concerns or "problems" in their communities. Multiple forums were used to develop a complete list of problem spot areas, including taking comments at two project management team meetings. The areas that the committee members and public indicated were taken into consideration during the analysis phase. The individual community problem spot maps

(Appendix) that were developed, based on community and public input, are:

Flooding
Amherst County
Bedford County
Campbell County
Altavista, Town of
Lynchburg City

Winter Storm
Amherst County
Bedford City
Lynchburg City

Wind
Lynchburg City

Thunderstorms
Bedford County

Landslide
Amherst County
Bedford Country

Hazard	Type	Detail Level	Analysis Level	Data Reference
Blizzards/ Winter Storms	Including winter storms, ice storms, and excessive cold	High	Covered by HIRA blizzards/winter storm analysis	NOAA National Weather Service Records, VirginiaView PRISM, Climate Source
Flooding	Riverine	High	Covered by HIRA flood analysis	FEMA DFIRM, Q3, and FIRM Mapping
Drought	Including excessive heat	High	Covered by HIRA drought analysis	Drought Monitor Task Force, Water Systems
Wind	Hurricane	Medium	Covered by HIRA hurricane analysis	FEMA DFIRM, Q3, and FIRM Mapping and ASCE Design Wind Speed Maps, FEMA HAZUS-MH model
	Tornado	Medium	Description and Regional Maps	NOAA National Weather Service Records
Wildfire	Wildfire	Medium	Covered by HIRA wildfire analysis	Virginia Department of Forestry
Landslide/Land Subsidence	Landslide/Land Subsidence	Low	Description and Regional Maps	USGS
Terrorism	Terrorism	Low	Description	Addressed in community Emergency Operation Plans (EOP)
Earthquake	Earthquake	Low	Description	FEMA HAZUS-MH

Severe Winter Storm (High Ranking)

Hazard History

The appendix includes descriptions of major winter storm events that have occurred in Region 2000. Events have been broken down by the date of occurrence and when available, by individual community descriptions. As Table 5-3 illustrates, a large percentage of the region's federal declared disasters were due to severe winter weather. When no community specific description is available, the general description should be used as representing the entire planning area. A complete winter storm hazard history is included in the appendix.

Hazard Profile

The impacts of winter storms are minimal in terms of property damage and long-term effects. The most notable impact from winter storms is the damage to power distribution networks and utilities. Severe winter storms have the potential to inhibit normal functions of the community. Governmental costs for this type of event are a result of the needed personnel and equipment for clearing streets. Private sector losses are attributed to lost work when employees are unable to travel. Homes and businesses suffer damage when electric service is interrupted for long periods of time. Health threats can become severe when frozen precipitation makes roadways and walkways very slippery, due to prolonged power outages, and if fuel supplies are jeopardized. Occasionally, buildings may be damaged when snow loads exceed the design capacity of their roofs or when trees fall due to excessive ice accumulation on branches. The primary impact of excessive cold is increased potential for frostbite, and potentially death as a result of over-exposure to extreme cold.

Some of the secondary effects presented by extreme/excessive cold are a danger to livestock and pets, and frozen water pipes in homes and businesses.

The maps for the ice and snowfall risks from the original Hazard Mitigation Plan are still viable. There has been no increasing or decreasing trend in snowfall amounts since the original plan was passed.

Predictability and Frequency

Winter storms can be a combination of heavy snowfall, high winds, ice and extreme cold. These are classified as extra-tropical cyclones that originate as mid-latitude depressions. Winter weather impacts the state of Virginia between the months of November and April, with varied intensities from east to west. In order to create a statewide winter weather hazard potential map that captures this variability, gridded climate data was obtained from the Climate Source and through the VirginiaView program. This data was developed by the Oregon State University Spatial Climate Analysis Service (SCAS) using **PRISM** (**P**arameter-elevation **R**egressions on **I**ndependent **S**lopes **M**odel). This climate mapping system is an analytical tool that uses point weather station observation data, a digital elevation model, and other spatial data sets to generate gridded estimates of monthly, yearly, and event-based climatic parameters. The project management team for the 2013 plan update agreed that this analysis would suffice for the update.

PRISM data was selected for this analysis because it is an interpolation system that incorporates elevation fluctuation into the regression equations that are used to predict the gridded variation of each climate parameter. This winter weather risk assessment uses monthly normal precipitation, mean annual days with snowfall greater than 1 inch, and mean monthly snowfall PRISM data to develop snow and ice potential maps for the state.

These datasets have been generated to incorporate topographic effects on precipitation, capture orographic rain shadows, and include coastal and lake effect influences on precipitation and snowfall. The monthly precipitation grid provides a 30-year climatological average of total precipitation in inches. The mean monthly snowfall grid provides a 30-year climatological average depth of freshly fallen snow in inches. The mean annual days map reveals the 30-year average of the number of days that a location will receive greater than 1 inch of snowfall in a 24 hour period in a given year.

A criterion of “greater than 1 inch” was selected for winter snowfall severity assessment because this depth will result in complete road coverage that can create extremely dangerous driving conditions that will require removal by the local community. This amount of snowfall in a 24 hour period can also lead to business closure and school delays or cancellation. Figure 5-4 shows the average number of days with snowfall greater than one inch for the state and Figure 5-5 shows the average number of days with snowfall greater than one inch for Region 2000. These assessments can act as indicators of the likelihood of future occurrences. Average number of days with snowfall greater than one inch increases dramatically near the mountain ranges. In Region 2000 the Blue Ridge Mountains in the northern portions of Amherst and Bedford counties receive the greatest amount of snowfall.

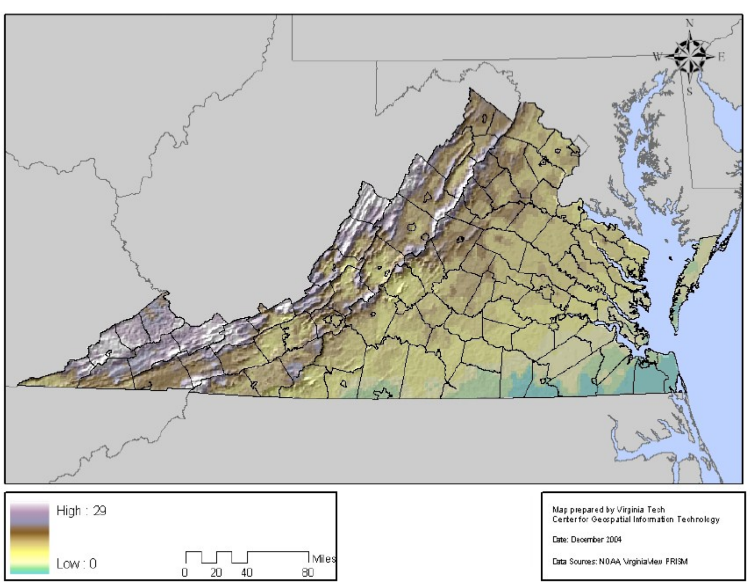
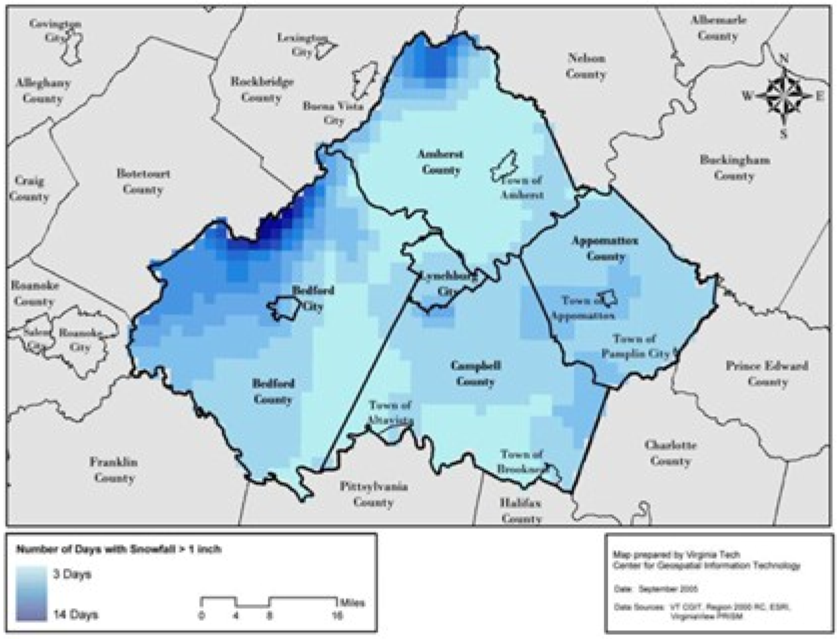


Figure 5.4 Virginia Average Number of Days with Snowfall > 1 inch.

Figure 5.5 Region 2000 Average Number of Days with Snowfall > 1 inch, Source: Virginia Tech CGIT



North Eastern Snowfall Impact Scale (NESIS)

The Northeast Snowfall Impact Scale (NESIS) was developed by members of the National Weather Service in 2004. The scale ranks high-impact snowstorms that impact the northeast corridor. The scale was developed because of the impact Northeast snowstorms can have on the rest of the country. The storms have large areas of 10 inch snowfall accumulations and the scale has five categories: Extreme, Crippling, Major, Significant, and Notable. The index is unique in that it uses population information as well as meteorological measurements. Because of this additional information, the NESIS scale gives an indication of a storm's societal impacts.

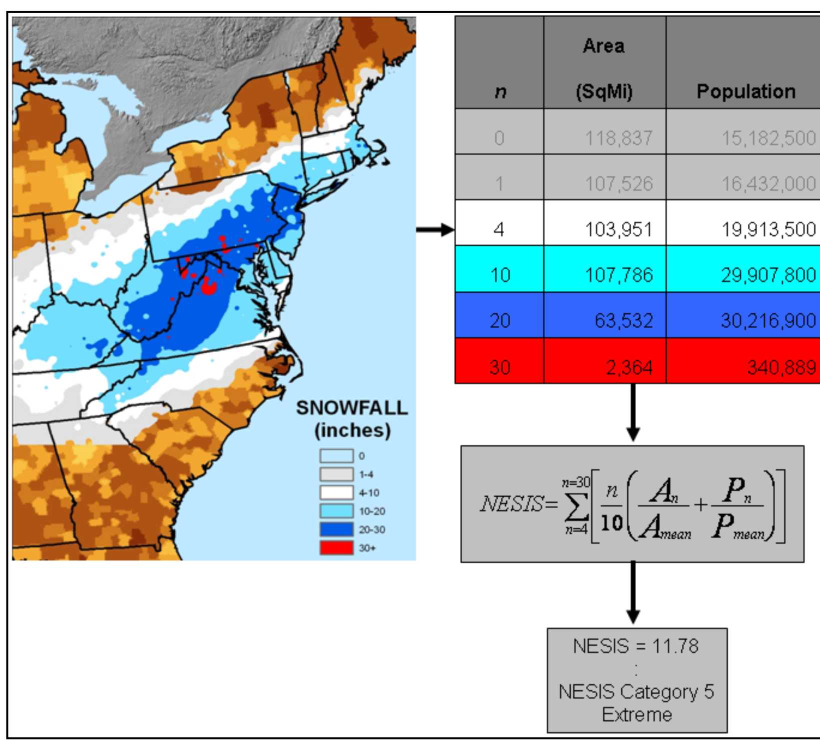


Figure 5.5a North Eastern Snowfall Impact Scale (NESIS)

Region 2000 is part of the Northeast urban corridor and is therefore included in the NESIS ranking system. Please see Squires and Lawrimore (2006) for more information.

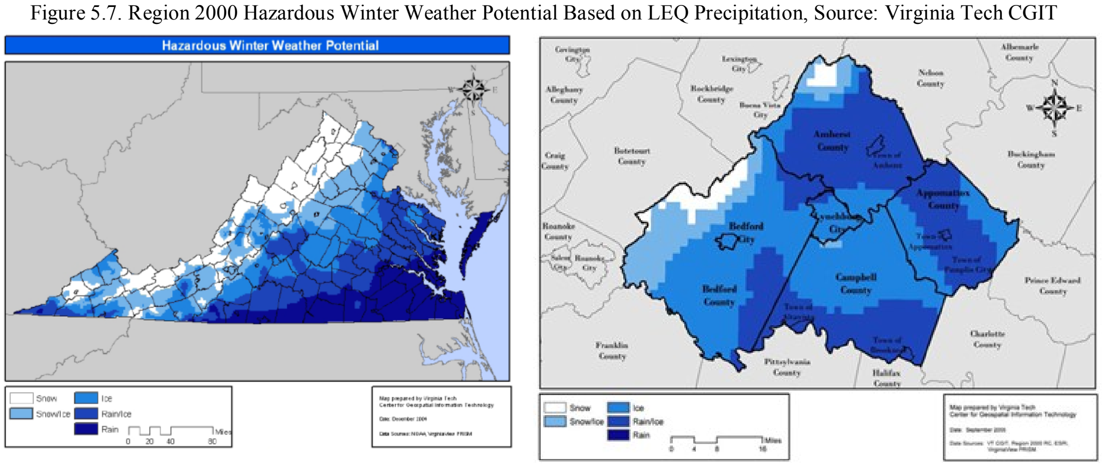
Ice Potential

Another challenge with winter weather in Virginia and in the region is the amount of ice that often comes as part of winter weather. Snowfall and ice potential are generated based on the percentage difference between the total precipitation from November to April and the corresponding liquid equivalent snowfall depth. Since snow falls in a frozen state, it does not accumulate on the surface the same way as rainfall would. In order to account for this difference, there are characteristic snow/rain relationships that have been created.

For example a value of 1 would mean that all of the precipitation at the location falls as liquid rainfall, and a value of 0.5 would mean that half of the precipitation falls as liquid rainfall and half falls as frozen precipitation. It is assumed that the lower the percentage the greater potential that precipitation within these months is falling as snow. The values in the middle of the two extremes would represent regions that favor ice conditions over rain and snow. A five quintile distribution was applied to the output statewide grid to split the percentages into five characteristic climatological winter weather categories (snow, snow/ice, ice, rain/ice, and rain). Figure 5.6 shows the statewide map and Figure 5.7 shows the Region 2000 map; for likelihood of future occurrences. The project management team agreed that these maps accurately depicted the level of risk of future events for their respective localities. The trend of ice potential in Virginia is highest in the area between the eastern edge of the Blue Ridge Mountains and the piedmont plateau since it usually snows in the mountains and rains on the coast.

Region 2000 receives a winter mix of snow, ice and rain/ice. As Figure 5.5 illustrates, the mountains in Amherst and Bedford Counties get a majority of the snow, while the southeast portion of the region receives a winter sleet mix.

Figure 5.7. Region 2000 Hazardous Winter Weather Potential Based on LEQ Precipitation, Source: Virginia Tech CGIT



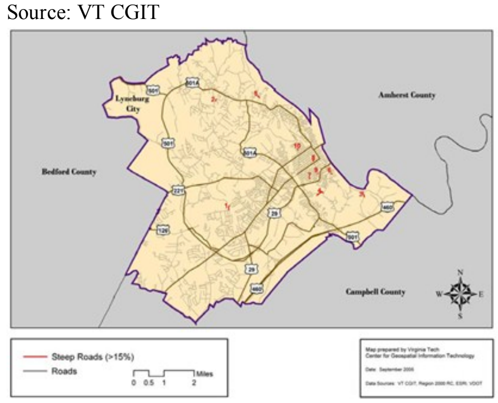
Steep Slopes

Lack of extensive GIS data throughout the region limited any other additional winter storm vulnerability assessment except in Lynchburg. The Lynchburg City GIS department was able to provide detailed streets and terrain data that could be used to identify streets that would be of a higher risk during ice storm events. A GIS analysis was performed to identify streets throughout with slopes greater than 15%, which would have vehicle traction issues during ice storms. Table 5.6 and Figure 5.8 illustrate selected roadways in the City of Lynchburg that have a slope greater than a 15%. These areas should be focused on as having a higher potential for accidents. The eastern portion of the city has a large amount of roads with greater than 15% slope.

Table 5.6 Lynchburg City Steep Slope Locations **(>15%), Source: VT CGIT**

1	500 Sandusky Dr. 15%
2	1700 Clayton Ave. 15%
3	130 Rockwell Rd. 15.3%
4	1400 Augusta St. 15.8%
5	N/A Paxton Ave. 16.8%
6	2000 Rose St. 17.3%
7	1220 17th St. 18.3%
8	600 11th St. 18.5%
9	1700 Locust St. 18.6%
10	200 Polk St. 19.2%

Figure 5.8 Lynchburg City Steep Slope Locations (>15%), Source: VT CGIT



Vulnerability Analysis

Figures 5.6 and 5.7 illustrate the overall winter weather and ice potential for the region. Figures 5.9 and 5.10 show the relative risk or vulnerability based on these previous maps. These were developed by assigning a high risk to those census blocks within the regions with the greatest potential for snowy days (> 1 in of snow) or ice. Division into high, medium and low were based on the levels predicted from potential maps. Tables 5.7 and 5.8 show the population in each locality impacted by the overall snowfall and ice risks.

Note Tables 5.7 and 5.8 indicate the town populations impacted; the county totals include the populations of the towns. Future revision of this plan will need to develop a method to calculate the potential loss from these winter storms. Areas of high susceptibility for snowfall (Figure 5.9) are centralized around the foothills of the Blue Ridge Mountains, with the highest snowfall risk around the Peaks of Otter in Bedford County. Relative ice potential (Figure 5.10) for the region has a slightly different trend of potential risk. The northern portion of Amherst County follows a similar pattern as the snowfall risk. There is a band of high ice potential starting in Lynchburg City south into the majority of Campbell County and a southwest band of ice risk in Bedford County and City.

The winter weather mapping resolution does not support town based analysis, since most towns in Region 2000 would be represented by one or two pixels at this resolution. *As weather data has better spatial resolution in the future, the ability to create practical town based analysis will be improved.* While Tables 5.7 and 5.8 show town based vulnerability, the analysis method was designed to derive broad regional vulnerability comparisons, not pinpoint location comparisons. Also, the nature of winter storm preparedness and impact cannot be represented with snow or ice potential maps. Even though Bedford County may receive more snow than other localities, they may have more VDOT and power companies resources prepared to address winter weather than other communities.

The appendix contains the zoom-in maps for relative snowfall potential and relative ice potential for each of the localities in the region. The appendix contains a full size map for the region, followed by the subsequent locality maps. The northern portion of Bedford County has the highest relative snowfall risk for the region. Relative ice risk for the region is scattered in each of the localities, with high potential being in the northern portion of Amherst County, Lynchburg City, northern Campbell County, southeast Bedford County and Bedford City. These maps were consulted during the mitigation action development for potential sites of future actions

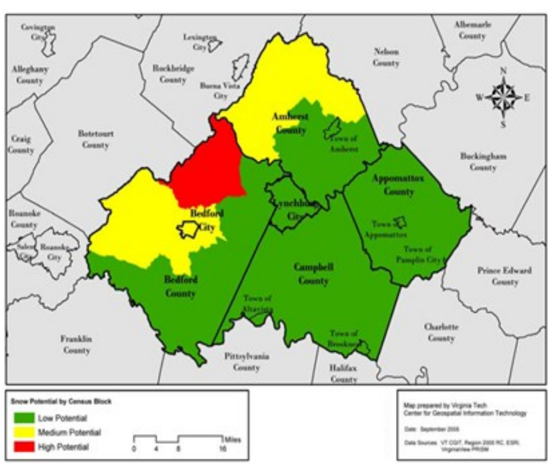


Figure 5.9. Region 2000 Snowfall Relative Risk, Source: VT CGIT

Table 5.7. Region 2000 Population Snowfall Relative Risk (from 2000 Census). *denotes town values that are also included in totals for the perspective County. 2000 Census information is the "best available" dataset for this section because the 2010 data isn't included in HAZUS software yet.

Community	Low	Medium	High	Total
Amherst	27,741	5,061	0	**32,802**
**Amherst, Town of*	*2,251*	*0*	*0*	***2,251***
Appomattox	14,068	0	0	**14,068**
**Appomattox, Town of*	*1,761*	*0*	*0*	***1,761***
**Pamplin City, Town of*	*199*	*0*	*0*	***199***
Bedford City	0	6,386	0	**6,386**
Bedford County	41,612	18,356	3,756	**63,724**
Campbell	51,078	0	0	**51,078**
**Altavista, Town of*	*3,425*	*0*	*0*	***3,425***
**Brookneal, Town of*	*1,259*	*0*	*0*	***1,259***
Lynchburg City	65,013	0	0	**65,013**
Total	**200,382**	**29,803**	**3,756**	**233,941**

Figure 5.10. Region 2000 Ice Relative Risk, Source: VT CGIT

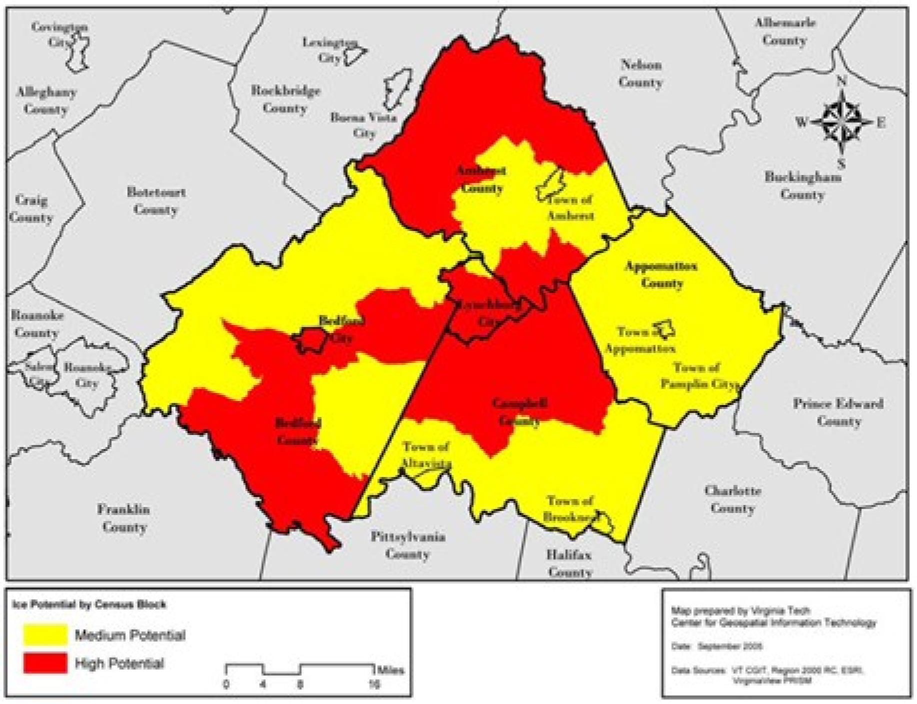


Table 5.8. Region 2000 Population Ice Relative Risk (from 2000 Census). *denotes town values that are also included in totals for the perspective County. 2000 Census information is the "best available" dataset for this section because the 2010 data isn't included in HAZUS software yet.

Community	Low	Medium	High	Total
Amherst County	0	14,257	18,545	**32,802**
**Amherst, Town of*	*0*	*2,251*	*0*	***2,251***
Appomattox County	0	14,068	0	**14,068**
**Appomattox, Town of*	*0*	*1,761*	*0*	***1,761***
**Pamplin City, Town of*	*0*	*199*	*0*	***199***
Bedford City	0	0	6,386	**6,386**
Bedford County	0	30,110	33,614	**63,724**
Campbell County	0	14,773	36,305	**51,078**
**Altavista, Town of*	*0*	*3,425*	*0*	***3,425***
**Brookneal, Town of*	*0*	*1,259*	*0*	***1,259***
Lynchburg City	0	4,774	60,239	**65,013**
Total	**0**	**77,982**	**155,959**	**233,941**

Flooding (High Ranking)

Hazard History

A table of all the major flood events that have occurred in Region 2000 is included in the appendix. Events have been broken down by the date of occurrence and when available, by individual community descriptions. When no community specific description is available, the general description should be used as representing the entire planning area. As Table 5.3 demonstrates, a large percentage of the region's declared disasters were due to flooding.

Hazard Profile

A flood occurs when an area that is normally dry becomes inundated with water. Floods may result from the overflow of surface waters, overflow of inland and tidal waters, dam breaks or mudflows. Flooding can occur at any time of the year, with peak hazards in the late winter and early spring. Snowmelt and ice jam breakaway contribute to winter flooding; seasonal rain patterns and torrential rains from hurricanes and tropical systems contribute to flooding. Development of flood-prone areas tends to increase the frequency and degree of flooding.

Floods are typically characterized by frequency. For example, the "1%-annual chance flood" is commonly referred to as the "100-year" flood. The 1%-percent annual chance flood is used for most regulatory and hazard identification purposes. While more frequent floods do occur, as well as larger events that has lower probabilities of occurrence.

Floods pick up chemicals, sewage, and toxins from roads, factories and farms. Therefore any property affected by the flood may be contaminated with hazardous materials. Debris from vegetation and man-made structures may also be hazardous following the occurrence of a flood. In addition, floods may threaten water supplies and water quality, as well as initiate power outages.

Flooding can pose some significant secondary impacts to the area where the event has taken place. Some of the impacts to consider include infrastructure and utility failure, impacts to roadways, water service and wastewater treatment. These impacts can affect the entire planning district, making the area vulnerable to limited emergency services.

Flood Maps

More detailed data was available as "Q3 flood maps" for a majority of the counties in the region. The Q3 flood maps are digital versions of the FEMA paper FIRMs that have been georectified and digitized. When a digital version of the floodplains was not available, digital paper copies of the FEMA Flood Insurance Rate Maps (FIRMs) were utilized. To be able to conduct analysis, the digital paper FIRMs were georectified and digitized. Bedford City was able to provide detailed data for Big Otter and Ivy Creek reaches.

These maps were used to determine the risk and vulnerability of flooding to the planning district. Figure 5.11 shows the extent of the FEMA mapped floodplain in the region.

Digital Q3 FEMA FIRMS maps were available for the following counties and are included in the appendix:

- Amherst County
- Appomattox County
- Bedford County
- Campbell County
- City of Lynchburg
- City of Bedford

Vulnerability Analysis

The project management team and data focus groups helped to document specific areas that are susceptible to flooding based on their local knowledge. These areas were taken into account when completing the hazard identification and risk assessment. Flooding problem spot maps and tables can be found in the appendix for section 5.

Many factors contribute to the relative vulnerabilities of areas within the floodplain. Some of these factors include development or the presence of people and property in the floodplain, flood depth, velocity, elevation, construction type, and flood duration.

Table 5.9 Total Value in Losses Paid by NFIP, Source: VDEM, DCR

	Entry in NFIP	FIRM Current Effective Date	Flood Insurance Policies	Insured Value	Claims	Total Value in Losses Paid
Cities:						
Lynchburg	9/1/1978	6/6/2010	96	$29,150,600.00	80	$3,247,935.56
Bedford	6/1/1978	9/29/2010	2	$78,000.00	0	$0.00
Counties:						
Amherst	7/17/1978	9/19/2007	46	$9,848,800.00	38	$9,848,800.00
Campbell	10/17/1978	8/28/2008	28	$7,078,900.00	12	$7,078,900.00
Bedford	9/29/1978	9/29/2010	145	$36,887,300.00	20	$206,583.05
Appomattox	7/17/1978	1/2/2008	10	$1,839,200.00	8	$253,216.06
Towns:						
Amherst	11/2/1977	9/19/2007	2	$450,800.00	29	$128,029.19
Pamplin	2/12/1976	2/12/1976	0	$0.00	0	$0.00
Appomattox	5/25/1984	5/25/1984	0	$0.00	0	$0.00
Brookneal	3/1/1978	8/28/2008	3	$589,400.00	0	$0.00
Altavista	8/1/1978	8/28/2008	12	$2,688,800.00	5	$79,561.38

FEMA-Designated Repetitive Loss Properties

Within a 10 year timeframe dating back to 1978, FEMA has provided a Repetitive Loss List of the properties in communities that have received two or more flood insurance claims greater than $1,000, from the National Flood Insurance Program (NFIP) within a 10 year timeframe. The Repetitive Loss list includes pertinent information regarding the property address, dates of claims, amounts received and owner information. Some of this information has been withheld from Table 5.10; see your local NFIP coordinator for specific information.

There are 25 repetitive loss properties in Region 2000, with an average payment of $32,461 per structure (Table 5.10). A majority of the repetitive loss structures for the region are non-residential properties. Note that FEMA designates counties, cities and towns separately in the table. This table provides a listing of the houses that have repetitive loss; this list does not include all of the houses that have had damage due to flooding.

Table 5.10a Region 2000 Severe Repetitive Loss Structures, Source: FEMA

Locality	As of date	Mitigation Efforts and by what means?
LYNCHBURG	2/28/2011	Berm built by owners without FEMA/State funds.

Table 5.10b Region 2000 Repetitive Loss Structures, Source: FEMA

Locaility	Residential	Non-Residential	# of Claims	Total Losses
Amherst County	1	0	3	$74,723.03
Amherst, Town of	0	1	22	$122,011.86
Appomattox County	2	0	7	$246,937.00
Bedford County	2	1	20	$291,620.00
Lynchburg, City of	7	11	50	$1,978,130.00

Structures at Risk-Vulnerability

In general, when tax parcel level information on property value existed, then they were used in the flood loss analysis. When they were not available, average structural value per census block from HAZUS-MH was used (Table 5.11). Information from table 5.11 has not changed since the original plan. The "best available data" is represented in the table.

Table 5.11 Structural and Property Data Availability in Region 2000 Jurisdictions

Community	Structural and Property Data
Amherst County	GIS tax parcels without values; Average building value per census block from HAZUS-MH.
Amherst, Town of	GIS tax parcels without values; Average building value per census block from HAZUS-MH.
Appomattox County	Average building value per census block from FEMA HAZUS-MH
Appomattox, Town of	GIS tax parcels without values; Average building value per census block from HAZUS-MH.
Pamplin City, Town of	GIS tax parcels without values; Average building value per census block from HAZUS-MH.
Bedford City	GIS building footprints without values; Average building value derived from HAZUS-MH census blocks
Bedford County	GIS tax parcels with values
Campbell County	GIS tax parcels with values and building footprints
Altavista, Town of	GIS tax parcels with values and building footprints
Brookneal, Town of	GIS tax parcels with values and building footprints
Lynchburg City	GIS building footprints without values; Average building value derived from HAZUS-MH census block

The flood vulnerability was determined for each locality based on the intersection of floodplain mapping and structure value mapping. This varied by community based on the data availability. In communities like Bedford City, Campbell County and Lynchburg City where building footprints for structures were known, the intersection analysis showed which structures were entirely or partially within the floodplain. If a community only had parcel mapping, the mapping intersection determined which parcels were partially or entirely in the floodplain. When only census block mapping was available, the mapping intersection showed which census blocks where partially or entirely within the floodplain. Based on the mapping intersection and the number of households and housing units in the census block, an estimate was determined of the total structures flooded in each the census block.

Table 5.12 lists the total replacement value of structures vulnerable to flooding (both partially and entirely within the floodplain) in each community. These replacement values for structures were calculated as 10% greater than the assessed improvement values from community parcel data or from the HAZUS-MH census block average values. For communities without parcel level property values, these values are underestimates, especially for any non-residential structures in the floodplain.

Table 5.12 Structure Value Vulnerability, Source: HAZUS, US Census 2000

Community	Total Structure Value Vulnerability
Amherst County	$37,592,830
** Amherst, Town of*	*$2,788,170*
Appomattox County	$14,547,720
** Appomattox, Town of*	*$745,800*
**Pamplin City, Town of*	*$0*
Bedford City	$3,551,350
Bedford County	$206,103,700
Campbell County	$57,723,356
**Altavista, Town of*	*$2,384,820*
**Brookneal, Town of*	*$241,340*
Lynchburg City	$20,764,480
Total	**$346,443,566**

*denotes town values that are also included in totals for the perspective County.

Estimating Losses

Using the property values from Table 5.1 and 5.2, an estimate of the potential flood loss for each community was developed. Losses included structure and contents damage using a method based on FEMA Benefit Cost Analysis. Contents values were estimated as 30% of the structural replacement value. Structural damage percentages were based on the portion of the footprint, parcel, or census block that was in the floodplain. Table 5.13 shows the basis for these damage percentages and how they were assigned depending on the mapping detail. Contents damages were estimated as 50% greater than the structural damage percentage. These values were used to predict the damage from a 100-yr flood event for the structure.

To calculate an annualized flood damage estimate, it was assumed for each structure damages began with a 25-yr event. A percentage of the 100-yr flood damage value was used for events less frequent than the 100-yr event. For example, a parcel with 45% in the floodplain is estimated to have a structure worth

$100,000 based on the community parcel database. The replacement value of the structure would be $110,000 and the contents value $33,000. Based on 45% of the parcel in the floodplain, the structure would be in flood damage class 2, with 20% 100-yr structure damage and the 30% contents damage. The final 100-yr flood damage equals $22,000 structural plus $9,900 contents or $31,900 from a 100-yr flood event. Figure 5.12 shows the probability assumptions are used to estimate the annualized loss at $797.50.

Table 5.13. Flood Damage Classes, Source: HAZUS

Flood Damage Class	100-yr % Structural Damage	Representative Flood Depth Range	Mapped Footprints in Floodplain	Mapped Parcels in Floodplain	Mapped Census Blocks in Floodplain
1	11%	0 to +1 ft		< 33%	< 33%
2	20%	+1 to + 3 ft	Partial	33% - 66%	33% - 66%
3	28%	> 3 ft	Entire	> 66 %	> 66 %

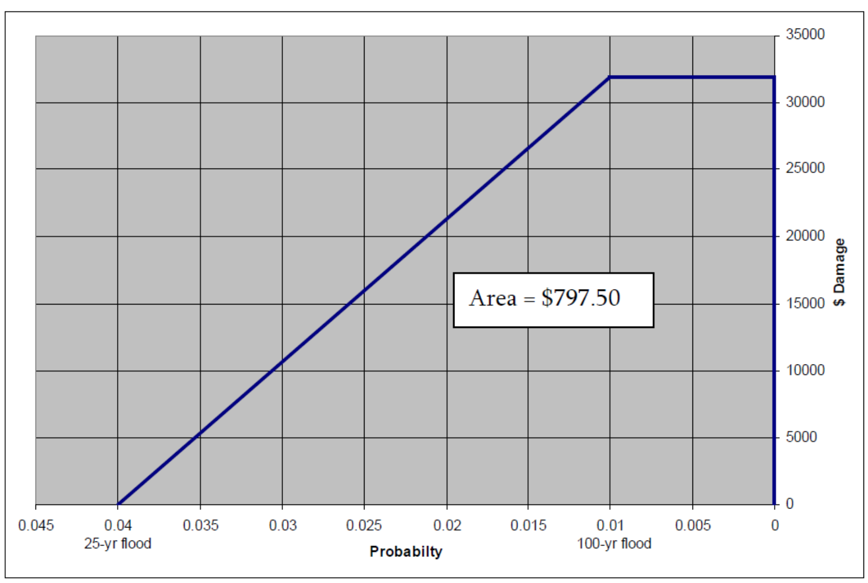


Figure 5.12. Example of Flood Loss Estimate Technique, Source: HAZUS

Table 5.14 provides the total flood loss estimates for each flood class and county. Figure 5.13 shows the census blocks where these losses occur. While most of the flood prone census blocks have less than $20,000 annual flood losses, there are a select number of locations in Bedford County with over $40,000 in one census block. Table 5.14 shows the annualized loss estimate for damage to structures and contents, broken down by community. From the table, Bedford County makes up 63% of the total estimated damage amounts followed by Amherst County with 15% of the total estimated damage amount. Figure 5.13 illustrates the distribution of annualized flood damage for Region 2000. A large majority of the flood damage is within the "less than $20,000 annually" category, categorized by census blocks.

Table 5.14. Annualized Structure and Contents Loss Estimates, Source: HAZUS

Community	Total Loss Estimate
Amherst County	$133,471
* *Amherst, Town of*	$10,477
Appomattox County	$51,340
* *Appomattox, Town of*	$2,389
**Pamplin City, Town of*	$0
Bedford City	$31,410
Bedford County	$1,557,077
Campbell County	$162,655
**Altavista, Town of*	$85,893
**Brookneal, Town of*	$773
Lynchburg City	$159,046
Total	**$2,194,531**

*denotes town values that are also included in totals for the perspective County.

The appendix for this section contains the zoom-in maps for the annualized flood damages for each of the localities in the region. The Appendix contains a full size map for the region, followed by the subsequent locality maps. These maps were consulted during the mitigation action development for potential sites of future actions.

Jurisdictional specific annualized flood damage maps have been created for the region in the Appendix. It should be noted that no FEMA floodplain maps exist for the towns of Pamplin City. Each region is unique in their exposure to flooding. The following is a summation of the major trends illustrated on the jurisdictional specific maps:

- Amherst County receives most of its annualized flood damage in the southeastern portion of the county along the James River. The flood damages in the county, by Census block are less than $20,000 annually.
- The Buffalo River, Rutledge Creek, Williams Creek and Higginbotham Creek account for the annual flood damages in the Town of Amherst.
- Appomattox County has a sprinkling of annual flood damages throughout the county. The James River borders the northwest of the county, and Cedar Creek boarders the southeastern portion of the county.
- The Town of Appomattox has very limited annual flood damages. Purdums Branch and the South Fork of the Appomattox River run through the southern tip of the town.

- No FEMA flood plain maps exist of the Town of Pamplin City.
- Bedford County receives a high amount of flood damages as a result of Smith Mountain Lake in the southern tip of the County. Annual damage estimates range from $20,000 to $40,000 per Census block.
- Bedford City receives most of its flood damages from an unnamed tributary to Little Otter River. A majority of flood damages occurs outside of the city limits.
- Campbell County, like Appomattox County, has very limited annualized flood damages. A majority of the present damage occurs along the Roanoke River to the south and along Beaver Creek to the north.
- The majority of the Town of Altavista is within a flood damage area. The Roanoke River to the south accounts for high damages to Census block, with greater than $20,000 annual damage.
- The northern portion of the Town of Brookneal receives all of the annualized flood damages for the town. Falling River and the Brookneal Reservoir account for this damage.
- The City of Lynchburg receives most of its' flood damage from main stream branches. These bodies of water being the James River, Blackwater Creek and Ivy Creek.

Problem Spot Mapping

See the appendix for Figures and Tables summarizing the problem spot locations that were denoted by the project management team during the Sept 15th, 2011 meeting. These are areas of concern that were designated by the project management team and the public. When specific town information was provided it was included on the problem spot maps. If no information was provided by the localities, or they acknowledged there was no need for a specific map, the map was omitted from the Appendix.

Critical Facilities

The impacts of flooding on critical facilities can significantly increase the overall effect of a flood event on a community. It should be noted that these facilities have been determined to be in the floodplain using Geographic Information Systems (GIS) and should be used only as a planning tool. In order to accurately determine if a structure is actually in the floodplain, site-specific information must be available. Twenty critical facilities were denoted as being located within the FEMA designated floodplain (Table 5.15). Mitigation actions address these concerns for critical facilities.

Table 5.15. Critical Facilities in the Floodplain, Source: Project Management Team

Amherst County	Dodd’s Store
Amherst County	Early Dam
Amherst County	Elon Water Works Dam
Amherst County	Graham Creek Res. Dam #1
Amherst County	Kick's Store
Amherst County	Holcomb Rock Dam
Amherst County	Midway Church
Amherst County	Pedlar Fire and Rescue
Amherst County	St. Paul's Mission School
Amherst County	St. Paul's Episcopal Mission
Appomattox County	East Fork Falling River #15 Dam
Appomattox County	East Fork Falling River #21 Dam
Bedford County	Bore Auger Church
Bedford County	Coleman's Fall Dam
Bedford County	Pent Holiness Church
Bedford County	Sharon Church
Bedford County	Sharon School (historical)
Bedford County	Steven's Chapel
Campbell County	Hazmat location
Campbell County	Altavista Area YMCA Discovery Place

Dams

Dam failure poses minimal risk as a hazard, but is a large potential threat to areas with large populations surrounding dams. One of the major events in Region 2000 took place on June 22 and 23, 1995 when the Timberlake dam failed. See the Appendix for a more detailed summary of this failure.

Many different scenarios can result in dam failure. Overtopping is one of the most common causes of dam failure, and it occurs when the dam’s spillway is inadequate for dealing with excess water. During flood events, too much water to be properly handled by the spillway may rush to the dam site, and flow over the top of the dam. Improper building construction, including using easily eroded construction materials, also frequently leads to the slow structural failure of dams. This failure can be compounded by underlying geological factors such as porous bedrock that loses structural integrity when saturated. Landslides pose two threats to dams, both upstream from the dam and at the dam site itself. At the dam site, a landslide could completely wipe out the dam from its foundation. A landslide upstream has the potential to send a wave of water surging towards the dam, quite possibly causing an overtopping event. Earthquakes are also a major threat to dams, though it is very rare that a dam will be completely destroyed by an earthquake. In the event of total failure, the most common cause is the liquefaction of fill along the dam wall. Terrorist attacks are also another concern for dam safety.

No matter what the cause of dam failure, the aftermath of such an event can range from moderate to severe. It is likely that the failure of major dams will cause widespread loss of life downstream to humans and animals, as well as extreme environmental stress along the flood path. Water supplies upstream could be left completely dry, while water supplies downstream are overrun or contaminated with debris from the ensuing flood.

The National Inventory of Dams provides information about individual dams. Figure 5.14 illustrates the locations and hazard potential of dams in the region. A large percentage of the dams in Region 2000 have been rated as low or significant potential for failure. The dam inventory also provides information on the downstream hazard potential of a dam failure.

The dam inventory divides the hazard potential into three categories: low, high and significant. The classification is based on two main criteria 1) Loss of human life and 2) Economic, environmental, and lifeline losses. Dams that were assigned a low potential indicate that there is a low potential for failure or miss-operation resulting in no probable human loss or economic and environmental losses. Significant potential for dam failure is often in predominantly rural or agricultural areas but could affect areas with populations and infrastructure. High potential areas are categorized by dam failure that would probably result in the loss of human life. It is important to note that the areas potentially affected if these dams were to fail are not restricted to these counties.

Figure 5.14. Region 2000 Dam Locations and Failure Potential, Source: NID

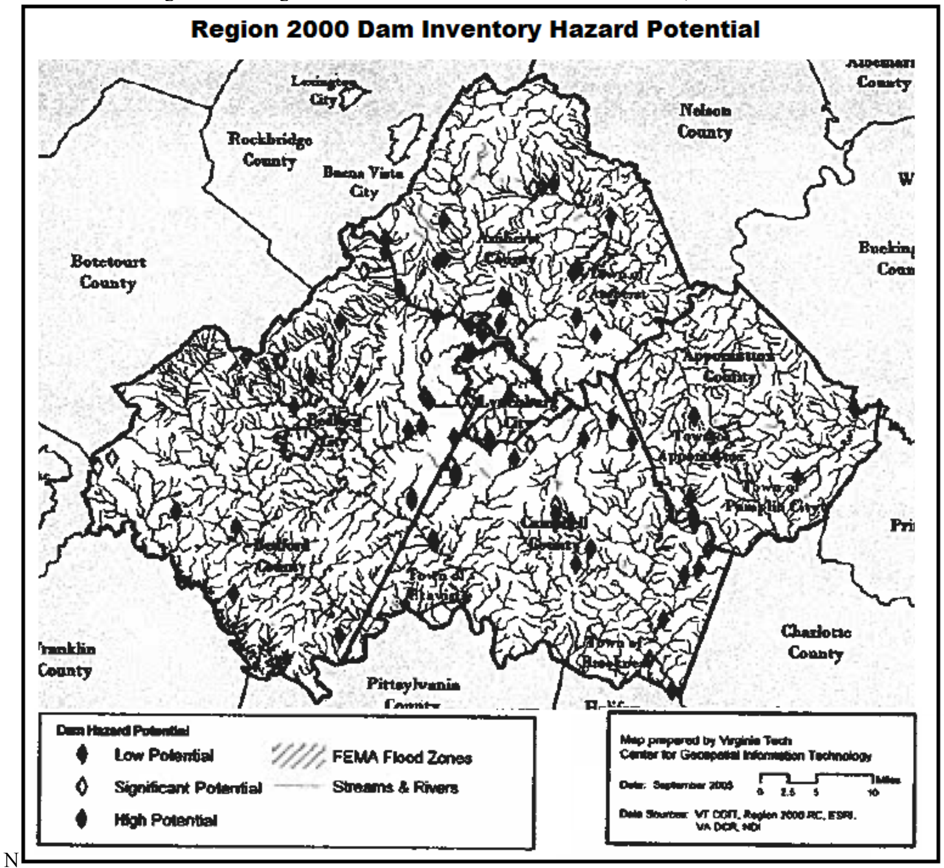


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Table 5.16 denotes the classification that VA DCR uses to regulate dams in the Commonwealth. On-going dam inspections and Virginia's participation in the National Dam Safety Program maintained by FEMA and the U.S. Army Corps of Engineers serve as preventative measures against dam failures.

Virginia impounding structure regulations specify that each dam be classified based on potential loss of human life or property damage if it were to fail. Classification is based on a determination of the effects that a dam failure would likely have on people and property in the downstream inundation zone. *Hazard potential classifications* descend in order from *high* to *low*, *high* having the greatest potential for adverse downstream impacts in event of failure. This classification is unrelated to the physical condition of the dam or the probability of its failure. The hazard potential classifications are:

Table 5.16 Dam Classifications, Source: DCR

High	Dams that upon failure would cause probable 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 damge only to property of the dam owner.

Safety standards become increasingly more stringent as the potential for adverse impact increases. For example, a *high hazard* dam -- that is, one whose failure would cause probable loss of human life -- is required to meet higher standards than a dam whose failure would not be as likely to result in such severe adverse consequences. Classification, however, is not static. Downstream conditions, including land use, can and often do change. Although a dam itself may remain relatively stable, it is subject to reclassification if a change occurs in the *downstream* inundation zone. For example, if new homes are built in the downstream inundation zone of a Class II, III or IV dam, the dam could be reclassified to Class I.

A change in hazard classification can create a dilemma because if a dam is reclassified, it usually does not meet the higher standards of the new hazard classification. To meet the required higher standards, the owner of the dam is often required to make expensive modifications. Any dam that does not meet the most extreme standards of a *high hazard* dam could become deficient in the future if land use in the downstream inundation zone changes.

To avoid the need for some of these expensive modifications, all affected parties -- dam owner, engineer, downstream land owners, and local governments -- need to work together. People should be aware of the impacts development downstream can have on the required standards of a dam. It is better and cheaper to address this potential problem beforehand rather than wait and deal with modifications later.

Drought (High Ranking)

Hazard History

Table 5.17 includes descriptions of major droughts that have occurred in Region 2000 jurisdictions. Events have been broken down by the date of occurrence and when available, by individual community descriptions. When no community specific description is available, the general description should be used as representing the entire planning area.

Table 5.17. Drought Hazard History, Source: FEMA

Date	Damages
1976-1977	Ten months of below average precipitation. The drought began in November of 1976 when rainfall totaled to only 50% to 75% of normal.
1985-1986	Very little rainfall began in December and the trend continued throughout the summer. Total precipitation January and February was 2 inches.
2001-2002	Stream levels were below normal with record lows observed at gages for the York, James, and Roanoke River Basins. By November of 2002 the US Secretary of Agriculture had approved 45 counties for primary disaster designation, while 36 requests remained pending.
2007-2008	Drought conditions were observed by the NOAA drought monitor throughout the commonwealth and remained stable in 2007. Drought conditions showed minor improvement in March of 2008 but statewide precipitation was below normal for the 2 year span (81% of normal).

Hazard Profile

A drought can be characterized in several different ways depending on the impact. The most common form of drought is agricultural. Agricultural droughts are characterized by unusually dry conditions during the growing season. Meteorological drought is an extended period of time (6 or more months) with precipitation less than 75 percent of the normal precipitation. Severity of droughts often depends on the community reliance on a specific water source. Many problems can arise at the onset of a drought, some of which include diminished water supplies and quality, livestock and wildlife becoming undernourished, crop damage, and possible wildfires. Secondary impacts from droughts pose problems to farmers with reductions in income, while food prices and lumber prices could drastically increase.

The impact of excessive heat is most prevalent in urban areas, where urban heat island effects prevent inner-city building from releasing heat built up during the daylight hours.

Secondary impacts of excessive heat are severe strain on the electrical power system and potential brownouts or blackouts.

Table 5.18 provides a summary of drought categories and impacts. Notice that water restrictions start off as voluntary and then become required. For excessive heat, the National Weather Service utilizes heat index thresholds as criteria for the issuance of heat advisories and excessive heat warnings.

Table 5.18 Drought Severity Classification

Drought Severity		
Category	**Description**	**Possible Impacts**
D0	Abnormally Dry	Going into drought: short-term dryness slowing planting, growth of crops or pastures; fire risk above average. Coming out of drought: some lingering water deficits; pastures or crops not fully recovered.
D1	Moderate Drought	Some damage to crops, pastures; fire risk high; streams, reservoirs, or wells low, some water shortages developing or imminent, voluntary water use restrictions requested
D2	Severe Drought	Crop or pasture losses likely; fire risk very high; water shortages common; water restrictions imposed
D3	Extreme Drought	Major crop/pasture losses; extreme fire danger; widespread water shortages or restrictions

Drought response plans have been prepared for the region, which contain pertinent information on how the region responds on the eve and during drought conditions.

During long periods of drought, each locality imposes restrictions on water use. Some mitigation actions detail voluntary restrictions, community education, and developing and maintaining secondary water supplies on a regional basis.

Vulnerability Analysis

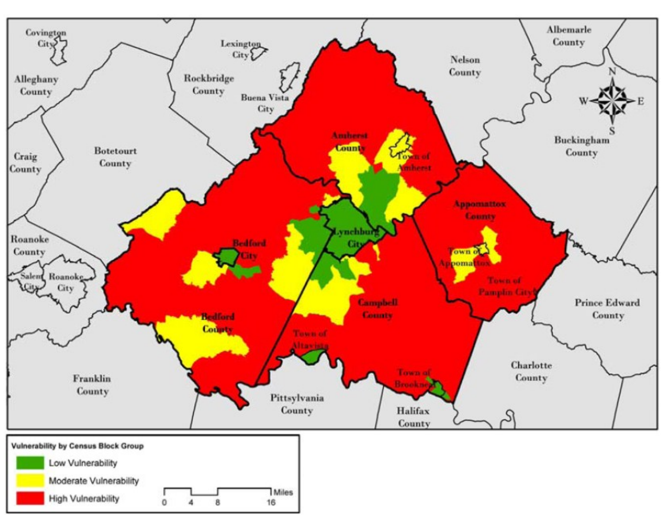
The 1990 U.S. Census data contained detailed information about source of water per census block group. For purposes of this analysis, it was assumed that areas with populations having less than 25% of public/private water systems had a high vulnerability ranking. When a drought occurs, these areas would likely have a larger impact since most homes receive their water from wells, which may dry up during a drought. Low vulnerability was assigned to regions with more than 50% of their population drawing from public or private water systems. Table 5.19 provides a summary of the 1990 population in three categories of drought vulnerability. Note that the table contains information specific to the towns; this information has also been included with the county totals. As a result of using 1990 U.S. Census data, at the tract level, there are some discrepancies with the town boundaries. Boundary adjustments into “high vulnerability” areas are a result of the older census data, which is a data limitation issue and remains an issue in the

2013 plan update. Future updates of this plan will use, if available, the most current census data for water systems. Figure 5.15 shows each of the designated categories for each of the jurisdictions. Most cities and towns are supplied by a public or private water system. Mitigation actions for the region reflect the regions concern for drought and water supply. Although there are areas in Region 2000 that have a "low" drought vulnerability distinction, the entire planning region is susceptible to future drought conditions.

Table 5.19. Region 2000 Population Drought Risk, Source: US Census 1990 *denotes town values that are also included in totals for the perspective County.

Percent Population with Public or Private Water Systems				
Community	**HIGH (< 25%)**	**MEDIUM (25% - 50%)**	**LOW (> 50 %)**	**TOTAL**
Amherst County	6,146	4,259	18,173	**28,578**
**Amherst, Town of*	*0*	*1,060*	*0*	*1,060*
Appomattox County	9,334	2,024	940	**12,298**
**Appomattox, Town of*	**0*	*1,707*	*0*	*1,707*
**Pamplin City, Town of*	*208*	*0*	*0*	*208*
Bedford City	0	0	6,073	**6,073**
Bedford County	27,365	10,116	8,175	**45,656**
Campbell County	21,819	6,337	19,416	**47,572**
**Altavista, Town of*	*0*	*0*	*3,686*	*3,686*
**Brookneal, Town of*	**0*	*0*	*1,344*	*1,344*
Lynchburg City	0	0	66,049	**66,049**
Total	**64,664**	**22,736**	**118,826**	**206,226**

Figure 5. 15. Region 2000 Drought Vulnerability, Source: VDEM



According to the project management team, drought remains of high concern. The data in this section also suggests a high degree of probability for future drought events in Region 2000 jurisdictions.

5.15 b. Drought Monitor for Virginia, Source: NOAA/NESDIS/NCDC

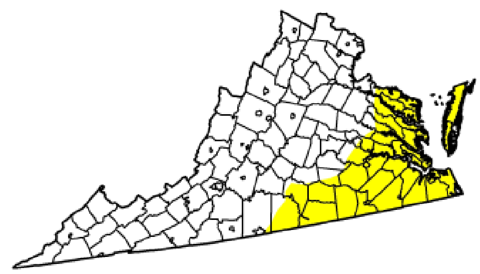
U.S. Drought Monitor

Virginia

February 21, 2012
Valid 7 a.m. EST

Drought Conditions (Percent Area)

	None	D0-D4	D1-D4	D2-D4	D3-D4	D4
Current	73.77	26.23	0.00	0.00	0.00	0.00
Last Week (02/14/2012 map)	73.77	26.23	0.00	0.00	0.00	0.00
3 Months Ago (11/22/2011 map)	100.00	0.00	0.00	0.00	0.00	0.00
Start of Calendar Year (12/27/2011 map)	98.44	1.56	0.00	0.00	0.00	0.00
Start of Water Year (09/27/2011 map)	95.83	4.17	0.00	0.00	0.00	0.00
One Year Ago (02/15/2011 map)	1.78	98.22	65.28	0.00	0.00	0.00



Intensity:

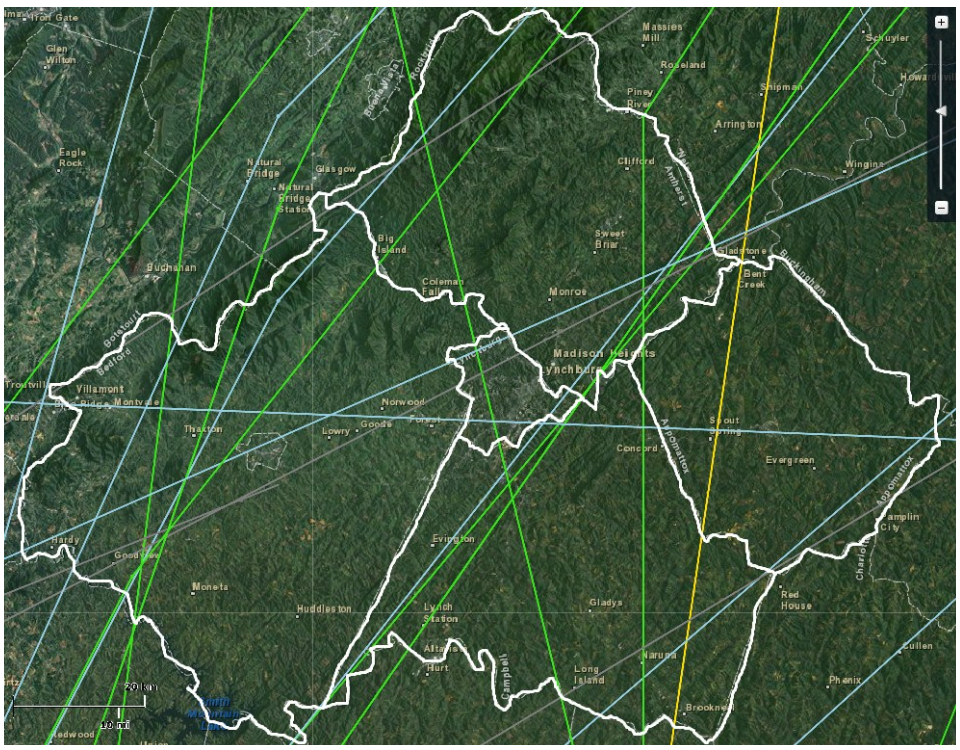
- D0 Abnormally Dry
- D1 Drought - Moderate
- D2 Drought - Severe
- D3 Drought - Extreme
- D4 Drought - Exceptional

Hurricane Wind (Medium Ranking)

Hazard History

Events have been broken down by the date of occurrence and when available, by individual community descriptions. When no community specific description is available, the general description should be used as representing the entire planning area.

Figure 5.16 Region 2000 Hurricane Tracks from 1851-2010 Source: National Oceanic and Atmospheric Administration



The National Oceanic and Atmospheric Administration shows historical hurricane tracks from 1851 to 2010 (Figure 5.16). The hurricane track map gives an idea of the historical occurrences in Region 2000. A majority of the hurricanes that have tracked through the region were Category 1(not named in 1893, 1896, and 1893) with Tropical Depression Fran (1996) and Tropical Storm Camille (1969). It should be noted that Figure 5.16 indicates the location of the center of the hurricane. Impacts from hurricanes could span many miles in all directions of the designated track.

Hazard Profile

A tropical cyclone is the generic term for a non-frontal synoptic scale low-pressure system that originates over tropical or sub-tropical waters with organized convection and definite cyclonic surface wind circulation. Depending on strength, they are classified as hurricanes or tropical storms. Tropical cyclones involve both atmospheric and hydrologic characteristics, such as severe winds, storm, surge flooding, high waves, coastal erosion, extreme rainfall, thunderstorms, lightning, and, in some cases, tornadoes. Storm surge flooding can push inland,

and riverine flooding associated with heavy inland rains can be extensive. High winds are associated with hurricanes, with two significant effects: widespread debris due to damaged and downed trees and damaged buildings; and power outages.

Secondary hazards from a hurricane event could include high winds, flooding, heavy waves, and tornadoes. Once inland, the hurricane's band of thunderstorms produces torrential rains and sometimes tornadoes. A foot or more of rain may fall in less than a day causing flash floods and mudslides. The rain eventually drains into the large rivers, which may still be flooding for days after the storm has passed. The storm's driving winds can topple trees and utility poles, and damage buildings. Communication and electricity is lost for days and roads are impassable due to fallen trees and debris.

Hurricane Damage Scale

Hurricanes are categorized by the Safer-Simpson Hurricane Damage Scale listed below (Table 5.21). Following the table are detailed descriptions of each category and the potential damage caused by each. The Safer-Simpson Hurricane Damage Scale has changed since the original plan and are noted in Table 5.21.

Table 5.21 Safer-Simpson Hurricane Damage Scale, Source: National Weather Service

Hurricane Category	Sustained Winds (mph)	Summary	Description
1	74-95	Very dangerous winds will produce some damage	People, livestock, and pets struck by flying or falling debris could be injured or killed. Older (mainly pre-1994 construction) mobile homes could be destroyed, especially if they are not anchored properly as they tend to shift or roll off their foundations. Newer mobile homes that are anchored properly can sustain damage involving the removal of shingle or metal roof coverings, and loss of vinyl siding, as well as damage to carports, sunrooms, or lanais. Some poorly constructed frame homes can experience major damage, involving loss of the roof covering and damage to gable ends as well as the removal of porch coverings and awnings. Unprotected windows may break if struck by flying debris. Masonry chimneys can be toppled. Well- constructed frame homes could have damage to roof shingles, vinyl siding, soffit panels, and gutters. Failure of aluminum, screened-in, swimming pool enclosures can occur. Some apartment building and shopping center roof coverings could be partially removed. Industrial buildings can lose roofing and siding especially from windward corners, rakes, and eaves. Failures to overhead doors and unprotected windows will be common. Windows in high- rise buildings can be broken by flying debris. Falling and broken glass will pose a significant danger even after the storm. There will be occasional damage to commercial signage, fences, and canopies. Large branches of trees will snap and shallow rooted trees can be toppled. Extensive damage to power lines and poles will likely result in power outages that could last a few to several days.
2	96-110	Extremely dangerous winds will cause extensive damage	There is a substantial risk of injury or death to people, livestock, and pets due to flying and falling debris. Older (mainly pre-1994 construction) mobile homes have a very high chance of being destroyed and the flying debris generated can shred nearby mobile homes. Newer mobile homes can also be destroyed. Poorly constructed frame homes have a high chance of having their roof structures removed especially if they are not anchored properly. Unprotected windows will have a high probability of being broken by flying debris. Well-constructed frame homes could sustain major roof and siding damage. Failure of aluminum, screened-in, swimming pool enclosures will be common. There will be a substantial percentage of roof and siding damage to apartment buildings and industrial buildings. Unreinforced masonry walls can collapse. Windows in high-rise buildings can be broken by flying debris. Falling and broken glass will pose a significant danger even after the storm. Commercial signage, fences, and canopies will be damaged and often destroyed. Many shallowly rooted trees will be snapped or uprooted and block numerous roads. Near-total power loss is expected with outages that could last from several days to weeks. Potable water could become scarce as filtration systems begin to fail.
3	111-130	Devastating damage will occur	There is a high risk of injury or death to people, livestock, and pets due to flying and falling debris. Nearly all older (pre-1994) mobile homes will be destroyed. Most newer mobile homes will sustain severe damage with potential for complete roof failure and wall collapse. Poorly constructed frame homes can be destroyed by the removal of the roof and exterior walls. Unprotected windows will be broken by flying debris. Well-built frame homes can experience major damage involving the removal of roof decking and gable ends. There will be a high percentage of roof covering and siding damage to apartment buildings and industrial buildings. Isolated structural damage to wood or steel framing can occur. Complete failure of older metal buildings is possible, and older unreinforced masonry buildings can collapse. Numerous windows will be blown out of high-rise buildings resulting in falling glass, which will pose a threat for days to weeks after the storm. Most commercial signage, fences, and canopies will be destroyed. Many trees will be snapped or uprooted, blocking numerous roads. Electricity and water will be unavailable for several days to a few weeks after the storm passes.
4	131-155	Catastrophic damage will occur	There is a very high risk of injury or death to people, livestock, and pets due to flying and falling debris. Nearly all older (pre-1994) mobile homes will be destroyed. A high percentage of newer mobile homes also will be destroyed. Poorly constructed homes can sustain complete collapse of all walls as well as the loss of the roof structure. Well-built homes also can sustain severe damage with loss of most of the roof structure and/or some exterior walls. Extensive damage to roof coverings, windows, and doors will occur. Large amounts of windborne debris will be lofted into the air. Windborne debris damage will break most unprotected windows and penetrate some protected windows. There will be a high percentage of structural damage to the top floors of apartment buildings. Steel frames in older industrial buildings can collapse. There will be a high percentage of collapse to older unreinforced masonry buildings. Most windows will be blown out of high-rise buildings resulting in falling glass, which will pose a threat for days to weeks after the storm. Nearly all commercial signage, fences, and canopies will be destroyed. Most trees will be snapped or uprooted and power poles downed. Fallen trees and power poles will isolate residential areas. Power outages will last for weeks to possibly months. Long-term water shortages will increase human suffering. Most of the area will be uninhabitable for weeks or months.
5	>155	Catastrophic damage will occur	People, livestock, and pets are at very high risk of injury or death from flying or falling debris, even if indoors in mobile homes or framed homes. Almost complete destruction of all mobile homes will occur, regardless of age or construction. A high percentage of frame homes will be destroyed, with total roof failure and wall collapse. Extensive damage to roof covers, windows, and doors will occur. Large amounts of windborne debris will be lofted into the air. Windborne debris damage will occur to nearly all unprotected windows and many protected windows. Significant damage to wood roof commercial buildings will occur due to loss of roof sheathing. Complete collapse of many older metal buildings can occur. Most unreinforced masonry walls will fail which can lead to the collapse of the buildings. A high percentage of industrial buildings and low-rise apartment buildings will be destroyed. Nearly all windows will be blown out of high-rise buildings resulting in falling glass, which will pose a threat for days to weeks after the storm. Nearly all commercial signage, fences, and canopies will be destroyed. Nearly all trees will be snapped or uprooted and power poles downed. Fallen trees and power poles will isolate residential areas. Power outages will last for weeks to possibly months. Long-term water shortages will increase human suffering. Most of the area will be uninhabitable for weeks or months.

Vulnerability Analysis

HAZUS-MH was used to complete the wind analysis for vulnerability and loss estimates. The HAZUS software has been developed by FEMA and the National Institute of Building Sciences. Level 1, with default parameters, was used for the analysis done in this plan. For analysis purposes, the U.S. Census tracks are the smallest extent in which the model runs. The results of this analysis are captured in the vulnerability analysis and loss estimation.

HAZUS-MH uses historical hurricane tracks and computer modeling to identify the probabilistic tracks of a range of hurricane events. The appendix contains the individual wind speed maps (50-yr, 100-yr, and 1,000-yr events) for the jurisdictions in the region.

When a hurricane impacts these areas, these maps can be used to determine what areas will be more impacted than others (at the U.S. Census Track level). Results from the model were used to develop the annualized damages. The impacts of these various events are combined to create a total annualized loss or the expected value of loss in any given year. Figure 5.14 illustrates the annualized damages from hurricane winds. It should be noted that these are climatologically trend tracks, and therefore the specified track, realistically, can vary significantly from what is shown.

Building Types

Table 5.22 illustrates the probabilistic building stock exposure by building type to hurricanes. In Region 2000, wood-frame buildings account for a large percentage of the building stock. Table 5.23 illustrates the building stock exposure broken down by the type of occupancy. From the table, 83% of the building stock for Region 2000 is considered residential, with approximately 14% of the building stock coming from commercial and industrial.

HAZUS-MH hurricane model only conducts analysis at the U.S. Census track level; which is larger than all of the towns in Region 2000. Town exposure has been estimated based on the percentage of the housing units in the County.

Building Stock Exposure by Building Type						
Community	**Wood**	**Masonry**	**Concrete**	**Steel**	**MH**	**TOTAL**
Amherst County	$1,088,291	$466,536	$78,671	$135,504	$55,740	**$1,824,742**
**Amherst, Town of*	*$83,986*	*$36,004*	*$6,071*	*$10,457*	*$4,302*	*$140,820*
Appomattox County	$446,231	$173,247	$12,362	$43,398	$43,019	**$718,257**
**Appomattox, Town of*	*$58,727*	*$22,800*	*$1,627*	*$5,711*	*$5,662*	*$94,527*
**Pamplin City, Town of*	*$6,814*	*$2,646*	*$189*	*$663*	*$657*	*$10,969*
Bedford City	$238,566	$124,589	$27,091	$58,111	$1,090	**$449,447**
Bedford County	$2,513,542	$976,105	$70,447	$206,432	$166,762	**$3,933,288**
Campbell County	$1,649,161	$676,211	$59,213	$233,111	$161,113	**$2,778,809**
**Altavista, Town of*	*$123,194*	*$50,514*	*$4,423*	*$17,414*	*$12,035*	*$207,580*
**Brookneal, Town of*	*$43,305*	*$17,756*	*$1,555*	*$6,121*	*$4,231*	*$72,968*
Lynchburg City	$2,448,010	$1,235,429	$278,580	$565,286	$19,468	**$4,546,773**
Total	**$8,383,801**	**$3,652,117**	**$526,364**	**$1,241,842**	**$447,192**	**$14,251,316**
						All values are in thousands of dollars

Table 5.22. Building Stock Exposure by Building Type (from HAZUS-MH).

*denotes town values that are also included in totals for the perspective County.

Table 5.23. Building Stock Exposure by General Occupancy, Source: HAZUS

Building Stock Exposure By General Occupancy								
Community	**Residential**	**Commercial**	**Industrial**	**Agri.**	**Religion**	**Gov't**	**Ed.**	**Total**
Amherst County	$1,584,986	$142,958	$50,622	$3,360	$28,601	$939	$13,277	**$1,824,743**
**Amherst, Town of*	*$122,317*	*$11,032*	*$3,907*	*$259*	*$2,207*	*$72*	*$1,025*	*$140,820*
Appomattox County	$628,950	$64,068	$10,528	$2,496	$6,902	$2,234	$3,080	**$718,258**
**Appomattox, Town of*	*$82,774*	*$8,432*	*$1,386*	*$328*	*$908*	*$294*	*$405*	*$94,527*
**Pamplin City, Town of*	*$9,605*	*$978*	*$161*	*$38*	*$105*	*$34*	*$47*	*$10,969*
Bedford City	337543	$71,152	$22,262	$1,109	$13,507	$1,471	$2,403	**$449,447**
Bedford County	$3,486,963	$273,431	$88,455	$9,372	$59,213	$2,525	$13,335	**$3,933,294**
Campbell County	$2,306,096	$264,942	$122,837	$8,381	$45,326	$18,791	$12,447	**$2,778,820**
**Altavista, Town of*	*$172,268*	*$19,791*	*$9,176*	*$626*	*$3,386*	*$1,404*	*$930*	*$207,581*
**Brookneal, Town of*	*$60,555*	*$6,957*	*$3,226*	*$220*	*$1,190*	*$493*	*$327*	*$72,968*
Lynchburg City	$3,502,793	$694,372	$196,531	$3,514	$95,804	$5,863	$47,899	**$4,546,776**
Total	**$11,847,331**	**$1,510,923**	**$491,235**	**$28,232**	**$249,353**	**$31,823**	**$92,441**	**$14,251,338**
								All values are in thousands of dollars

*denotes town values that are also included in totals for the perspective County.

Critical Facilities

Vulnerability to critical facilities from hurricane winds is fairly uniform throughout the region. As Figure 5.17 shows, there is only slight variation in the region, with a few "hot spots". Bedford County, Bedford City, Lynchburg City and Campbell County have a slightly larger annualized hurricane loss when compared to Amherst and Appomattox Counties. Table 5.26 illustrates the percentage of critical facilities in the different annualized loss categories. Critical facilities that are located within towns have been included in the county totals. Future updates of this plan will hopefully include a region wide comprehensive database for critical facilities.

Loss Estimation

Table 5.24 provides the loss estimations from HAZUS-MH by building type. As noted earlier, wood structures compose the majority of the structures, and also account for the majority of the losses. Table 5.25 shows the loss by occupancy type. Note the differences between the totals in the tables are due to rounding in the calculations in HAZUS-MH.

HAZUS-MH hurricane model only conducts analysis at the U.S. Census track level; which is larger than all of the towns in Region 2000. Town building stock loss has been estimated based on the percentage of the housing units in the County.

Table 5.24. Building Stock Loss by Building Type, Source: HAZUS

Building Stock Loss by Building Type						
Community	**Wood**	**Masonry**	**Concrete**	**Steel**	**MH**	**TOTAL**
Amherst County	$106.52	$39.52	$2.11	$5.86	$5.86	**$159.87**
**Amherst, Town of*	*$8.22*	*$3.05*	*$0.16*	*$0.45*	*$0.45*	*$12.34*
Appomattox County	$55.77	$17.73	$0.40	$1.87	$5.39	**$81.16**
**Appomattox, Town of*	*$7.34*	*$2.33*	*$0.05*	*$0.25*	*$0.71*	*$10.68*
**Pamplin City, Town of*	*$0.85*	*$0.27*	*$0.01*	*$0.03*	*$0.08*	*$1.24*
Bedford County	$243.01	$81.25	$1.72	$7.68	$19.61	**$353.27**
Bedford City	$29.34	$12.80	$1.01	$3.66	$0.14	**$46.96**
Campbell County	$190.29	$69.36	$2.24	$11.24	$19.18	**$292.32**
**Altavista, Town of*	*$14.21*	*$5.18*	*$0.17*	*$0.84*	*$1.43*	*$21.84*
**Brookneal, Town of*	*$5.00*	*$1.82*	*$0.06*	*$0.30*	*$0.50*	*$7.68*
Lynchburg City	$299.48	$138.05	$10.80	$35.27	$2.55	**$486.15**
Total	**$924.41**	**$358.72**	**$18.28**	**$65.59**	**$52.73**	**$1,419.73**
						**All values are in thousands of dollars*

*denotes town values that are also included in totals for the perspective County

Table 5.25. Building Stock Loss by General Occupancy, Source: HAZUS

Building Stock Loss By General Occupancy								
Community	**Residential**	**Commercial**	**Industrial**	**Agri.**	**Religion**	**Gov't**	**Ed.**	**Total**
Amherst County	**$148.75**	**$6.12**	**$3.03**	**$0.18**	**$1.03**	**$0.04**	**$0.55**	**$159.70**
**Amherst, Town of*	*$11.48*	*$0.47*	*$0.23*	*$0.01*	*$0.08*	*$0.00*	*$0.04*	*$12.32*
Appomattox County	**$77.27**	**$2.71**	**$0.56**	**$0.16**	**$0.26**	**$0.18**	**$0.13**	**$81.27**
**Appomattox, Town of*	*$10.17*	*$0.36*	*$0.07*	*$0.02*	*$0.03*	*$0.02*	*$0.02*	*$10.70*
**Pamplin City, Town of*	*$1.18*	*$0.04*	*$0.01*	*$0.00*	*$0.00*	*$0.00*	*$0.00*	*$1.24*
Bedford County	**$335.38**	**$10.96**	**$4.20**	**$0.57**	**$1.99**	**$0.06**	**$0.50**	**$353.66**
Bedford City	**$40.02**	**$4.40**	**$1.52**	**$0.09**	**$0.68**	**$0.13**	**$0.13**	**$46.97**
Campbell County	**$268.54**	**$12.74**	**$8.04**	**$0.52**	**$1.81**	**$0.88**	**$0.53**	**$293.06**
**Altavista, Town of*	*$20.06*	*$0.95*	*$0.60*	*$0.04*	*$0.14*	*$0.07*	*$0.04*	*$21.89*
**Brookneal, Town of*	*$7.05*	*$0.33*	*$0.21*	*$0.01*	*$0.05*	*$0.02*	*$0.01*	*$7.70*
Lynchburg City	**$418.23**	**$45.11**	**$15.25**	**$0.30**	**$4.72**	**$0.48**	**$2.75**	**$486.84**
Total	**$1,288.19**	**$82.03**	**$32.60**	**$1.82**	**$10.49**	**$1.77**	**$4.60**	**$1,421.50**
								** All values are in thousands of dollars*

*denotes town values that are also included in totals for the perspective County.

Figure 5.17. Region 2000 Annualized Total Hurricane Loss Estimate, Source: VDEM

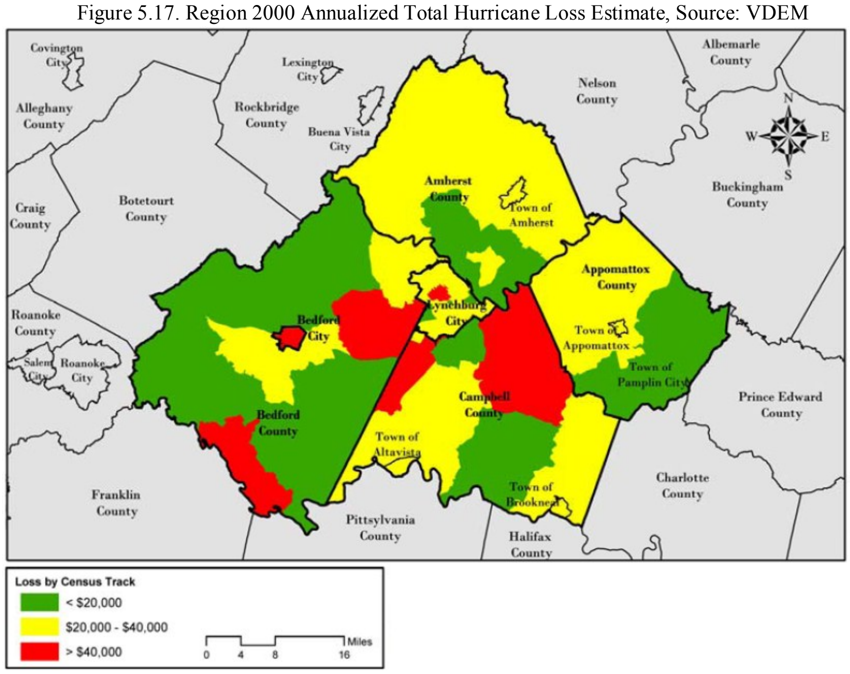


Table 5.26. Region 2000 Percentage of Annual Hurricane Loss by Critical Facility, Source: HAZUS

Community	<$20,000	$20,000 -$40,000	>$40,000
Amherst County	21%	79%	0%
Appomattox County	22%	78%	0%
Bedford County	62%	12%	26%
Bedford City	0%	0%	100%
Campbell County	15%	51%	34%
Lynchburg City	14%	81%	4%

Problem Spot Mapping

The project management team didn’t pinpoint any specific areas in Region 2000 that were more susceptible to hurricane damage. This region wide approach mirrored the discussion that the project management team had that the entire region shared the same probability of a future hurricane event. Figure 5.19 shows that hurricane paths over the last 50 years are randomly distributed throughout the region. The region usually gets receives substantial hurricane damage once every 10-15 years.

Tornado Wind (Medium Ranking)

Hazard History

Table 5.27 includes descriptions of major tornado events that have touched down in Region 2000. Events have been broken down by the date of occurrence and when available, by individual community descriptions. When no community specific description is available, the general description should be used as representing the entire planning area.

Hazard Profile

Damaging winds typically are associated with tornadoes or land falling hurricanes. Isolated "downburst" or "straight-line" winds associated with any common thunderstorm can also cause extensive property damage. Tornadoes are classified as a rotating column of wind that extends between a thunderstorm cloud and the earth's surface. Winds are typically less than 100 mph, with severe tornado wind speeds exceeding 250 mph. The rotating column of air often resembles a funnel-shaped cloud. The widths of tornadoes are usually several yards across, with infrequent events being over a mile wide. Tornadoes and their resultant damage can be classified into six categories using the Fujita Scale (see Table 5.28). This scale assigns numerical values for wind speeds inside the tornado according to the type of damage and degree of the tornado. Most tornadoes are F0 and F1, resulting in little widespread damage. Tornado activity normally spans from April through July but tornadoes can occur at any time throughout the year. In Virginia, peak tornado activity is in July. Hot, humid conditions stimulate the tornadoes growth.

Strong tornadoes may be produced by thunderstorms and often are associated with the passage of hurricanes. On average, about seven tornadoes are reported in Virginia each year. The total number may be higher as incidents may occur over areas with sparse populations, or may not cause any property damage.

Tornadic thunderstorms also produce hail. Hailstorms are also outgrowths of severe thunderstorms. During summer months, when the difference between ground and upper level temperatures is significant, hail may develop. The size of the hailstones is directly related to the severity and size of the storm. Hail is described as chunks of ice, often in a spherical or oblong shape, that are produced by thunderstorms. The size of the hail greatly affects the magnitude or severity of damage. Storms can produce hail from as small as ¼ inch in diameter to up to 4 ½ inches. Depending on the size of hail determines the potential damage.

Table 5.28. Enhanced Fujita Tornado Intensity Scale, Source: National Weather Service

FUJITA SCALE			DERIVED EF SCALE		OPERATIONAL EF SCALE	
F Number	Fastest 1/4-mile (mph)	3 Second Gust (mph)	EF Number	3 Second Gust (mph)	EF Number	3 Second Gust (mph)
0	40-72	45-78	0	65-85	0	65-85
1	73-112	79-117	1	86-109	1	86-110
2	113-157	118-161	2	110-137	2	111-135
3	158-207	162-209	3	138-167	3	136-165
4	208-260	210-261	4	168-199	4	166-200
5	261-318	262-317	5	200-234	5	Over 200

The classification of the tornado gives an approximate depiction of what the corresponding damage of the tornado will be. A majority of Virginia's tornadoes are F0 and F1 on the Fujita Scale, shown in Table 5.29. These result in minimal extensive damage. Damage that is likely to occur would be damage to trees, shrubbery, signs, antennas, with some damage to roofs and unanchored trailers.

Table 5.29. Virginia Tornado Statistics 1950-2007, Source: VDEM

	Number	% of all Tornadoes	Deaths	Injuries	Property Damages
F/EF0	194	34%	0	2	$5,838,000
F/EF1	242	42%	1	88	$514,508,000
F/EF2	84	14%	3	94	$171,843,000
F/EF3	30	5%	19	104	71,728,000
F/EF4	2	0.03%	4	248	$52,000,000
Unspecified	26	4%	0	3	$899,000
TOTAL	578		27	539	$814,169,000

Vulnerability Analysis

Tornadoes are high-impact, low-probability hazards. There have only been two documented tornado touchdowns in Region 2000 since 2006—one E0 near Brookneal and one E1 near Hixburg. The net impact of a tornado depends on the storm intensity and the vulnerability of development in its path. Many variables would need to be considered in order to establish an intensity-damage relationship.

Table 5.30 and Figure 5.18 show tornado occurrences in the region. Some areas in the region appear to be slightly more prone to tornadoes than others, especially in central Bedford County and Bedford City. It is thought that this is caused by topographical influences on thunderstorms such as the change in low-level wind flow and humidity caused by the orientation of the mountains. The probability of future occurrences of tornados is definite; predicting the potential locations for such events is inappropriate.

Since tornadoes are so infrequent and sporadic for the region, the Hurricane Wind analysis covers more probable high wind occurrences.

Table 5.30a. Region 2000 Tornado Touchdowns (1950-2007)

Tornadoes by Jurisdiction, 1950-2007	
Amherst County	2
Appomattox County	1
Bedford County	3
Bedford City	3
Campbell County	6
Lynchburg City	3

Table 5.30b. Virginia Tornadoes by Calendar Month (1950-2007)

Virginia Tornadoes by Calendar Month												
Category	Jan	Feb	Mar	Apr	May	Jun	Jul	Aug	Sep	Oct	Nov	Dec
F/EF0-F/EF1	13	13	14	36	60	44	72	64	81	21	11	1
F/EF2-F/EF4	4	0	3	16	14	12	9	14	26	12	6	0
Unspec.	0	1	2	2	4	2	9	3	0	2	0	1
TOTAL	17	14	19	54	78	58	90	81	107	35	17	2

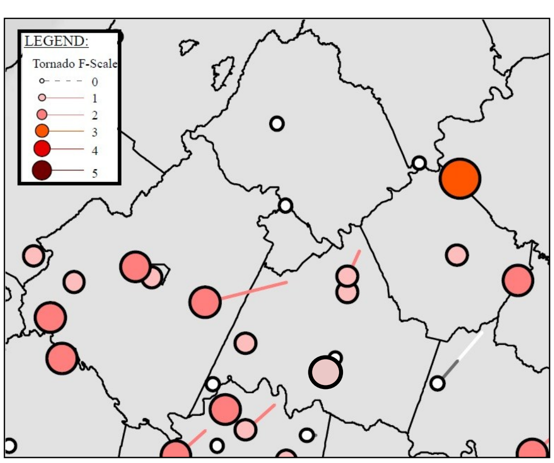


Figure 5.18. Historic Tornado Touchdowns and Tracks: 1950-2010. Sources: (VDEM, NOAA SVRGIS, VGIN, ESRI)

Wildfire (Medium Ranking)

Hazard History

The Virginia Department of Forestry website provided fire incidence data for fire years 1995-2001. The data provided by VDOF was summarized into the following tables.

Note that the tables do not include data for towns or cities; this data was not available through VDOF. Table 5.31 provides information on the breakdown of number of acres burned and the total amount of damage per county. Table 5.32 illustrates the cause of fire broken down by county. It is noted that the largest percentages of wildfires were caused by debris (44%), followed by 22% from miscellaneous causes.

Table 5.31. Wildfire Summary 1995-2001, Source: VDOF

Fire Year	2002		2003		2004		2005		2006	
County	Total Acres	Total Damage	Total Acres	Total Damage	Total Acres	Total Damage	Total Acres	Total Damage	Total Acres	Total Damage
Amherst	447.6	$1,010	25.8	$101,400	36.2	$113,750	18.1	$186,520	34.2	$197,670
Appomatox	55.1	$700	20.2	$0	2.5	$350	12.6	$2,000	88.4	$10,800
Bedford	107.3	$23,040	11	$1,100	47.1	$3,650	41.3	$11,900	219.9	$153,960
Campbell	97.6	$5,200	20.8	$15,750	44.7	$12,650	56.7	$28,350	62.5	$23,735
Total	707.6	$29,950	77.8	$118,250	130.5	$130,400	128.7	$228,770	405	$386,165

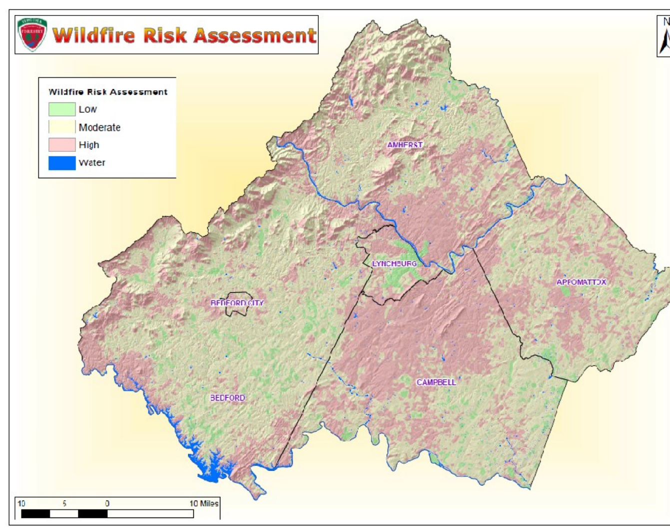
Fire Year	2007		2008		2009		2010		2011			
County	Total Acres	Total Damage	Total Acres	Total Damage	Total Acres	Total Damage	Total Acres	Total Damage	Total Acres	Total Damage	Acres Total	Damages Total
Amherst	1444	$92,525	147.8	$7,300	383.3	$422,200	34.7	$31,300	205.2	$100,300	2776.9	$1,253,975
Appomatox	11.6	$102,200	234.8	$279,025	19.5	$150,300	30.2	$101,370	25.7	$40,000	501	$686,745
Bedford	73.5	$183,650	1139.2	$13,500	36.9	$0	1007.7	$300,500	425.3	$0	3,109	$691,300
Campbell	176.4	$203,800	257	$806,200	63.1	$5,700	28.6	$10,306	187.8	$80,360	995	$1,192,051
Total	1705.5	$582,175	1778.8	$1,106,025	502.8	$578,200	1101.2	$443,476	844	$220,660	7381.9	$3,824,071

Table 5.32. Wildfire Causes 2001-2011, Source: VDOF

County	Lightening	Camp Fire	Smoking	Debris	Incendiary	Equip. Use	R&R	Children	Misc.	Total
Amherst	23	1	4	48	9	6	5	5	44	145
Appomattox	15	5	4	52	11	16	5	6	25	139
Bedford	11	2	3	56	8	32	10	5	29	156
Campbell	8	0	3	92	60	27	13	7	87	297

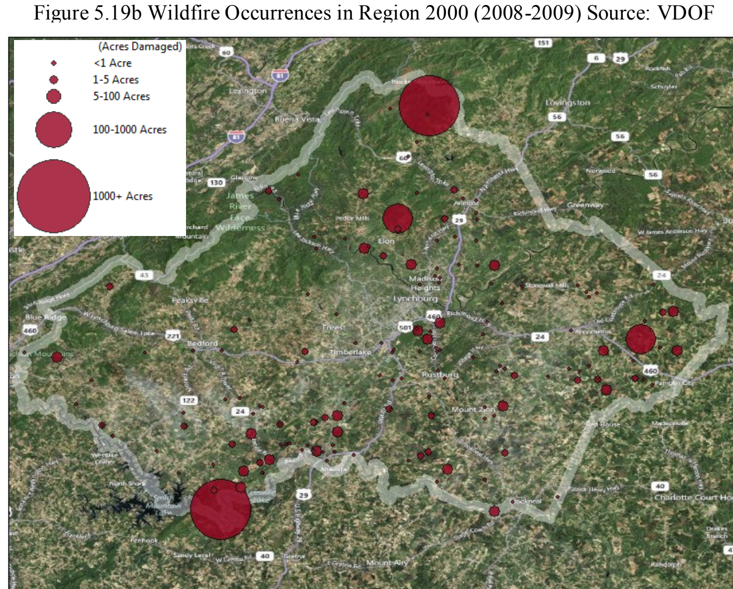
Hazard Profile

Figure 5.19a Wildfire Risk Assessment, Source: VDOF



Wildfire is a unique hazard in that it can be significantly altered based on efforts to control its course during the event. The Virginia Department of Forestry (VDOF) indicates that there are three principle factors that can lead to the formation of wildfire hazards: topography, fuel, and weather. The environmental conditions that exist during these seasons exacerbate the hazard. When relative humidity is low and high winds are coupled with a dry forest floor (brush, grasses, leaf litter), wildfires may easily ignite.

Figure 5.19b Wildfire Occurrences in Region 2000 (2008-2009) Source: VDOF



Years of drought can lead to environmental conditions that promote wildfires. Accidental or intentional setting of fires by humans is the largest contributor to wildfires. Residential areas or "woodland communities" that expand into wild land areas also increase the risk of wildfire threats. Spring (March and April) and fall (October and November) are the two seasons for wildfires.

Secondary effects from wildfires can pose a significant threat to the communities surrounding the hazard. During a wildfire, the removal of groundcover that serves to stabilize soil can potentially lead to hazards such as landslides, mudslides, and flooding. In addition, the leftover scorched and barren land may take years to recover and the resulting erosion can be problematic.

Vulnerability Analysis

Figure 5.19a shows the wildfire hazard map developed by VDOF. In 2010 and 2011, VDOF examined which factors influence the occurrence and advancement of wildfires and how these factors could be represented in a GIS model. VDOF determined that historical fire incidents, land cover (fuels surrogate), topographic characteristics, population density, and distance to roads were critical variables in a wildfire risk analysis. The resulting high, medium, and low risk category reflect the results of this analysis. Campbell County has a large portion in the high potential category for wildfire risk, followed by Amherst County, Town of Amherst, Bedford County and Appomattox County. The bands of high potential could be a result of the state and national forests and parks located throughout the region. Figure 5.19b shows wildfire occurrences that were reported to the Virginia Department of Forestry in 2008 and 2009. In this two year study span, there were only four fires reported that damaged more than 100 acres of land. Figure 5.19b along with table 5.32 (causes of fire) show that there is no concentrated area of wild fire occurrences and that the risk of a damaging wildfire is equal throughout the wooded areas of Region 2000.

Department of Forestry

Table 33 illustrates the number of homes within woodland communities, as designated by Virginia Department of Forestry, in Region 2000. For Region 2000, 33% of the woodland homes fall into the high potential for a wildfire. Amherst County has the highest relative percentage of homes in areas of high wildfire potential at 63% of homes in the highest risk category. Bedford County has the second highest relative risk for wildfire with 32% of woodland homes at risk. Table 5.34 provides a breakdown of the number of critical facilities in wildfire prone areas. Campbell and Amherst Counties have a relatively high percentage of critical facilities at risk (49%, 44 %) followed by Bedford County (32%). Overall, Region 2000 has a relatively low number of critical facilities at risk to wildfire (37%) events. Figures and tables in Appendix 5.1 summarize the problem spot locations that were denoted by committee members.

Table 5.33. Woodland Homes Wildfire Risk, Source: HAZUS

Number of Woodland Homes by Fire Rank				
County	Medium Potential	High Potential	Grand Total	% High Risk
Amherst County	20	12	**32**	**63%**
Appomattox County	0	2	**2**	**0%**
Bedford County	18	38	**56**	**32%**
Campbell County	1	29	**30**	**3%**
Total	**39**	**81**	**120**	**33%**

Table 5.34. Region 2000 Critical Facilities Wildfire Vulnerability, Source: HAZUS

Number of Critical Facilities by Fire Risk					
Community	Low Potential	Medium Potential	High Potential	Total	% in High Risk
Amherst County	18	182	154	**354**	**44%**
Appomattox County	28	56	27	**111**	**24%**
Bedford County	21	258	130	**409**	**32%**
Bedford City	0	36	11	**47**	**23%**
Campbell County	56	124	173	**353**	**49%**
Lynchburg City	61	14	15	**90**	**17%**
Total	**184**	**670**	**510**	**1364**	**37%**

Landslide and Land Subsidence (Low Ranking)

Hazard History

No detailed hazard history was available for Region 2000. Figures 5.20 and 5.21 illustrate potential risk areas for the Commonwealth of Virginia.

Figure 5.20. Landslide Hazards for Virginia, Source: VDEM

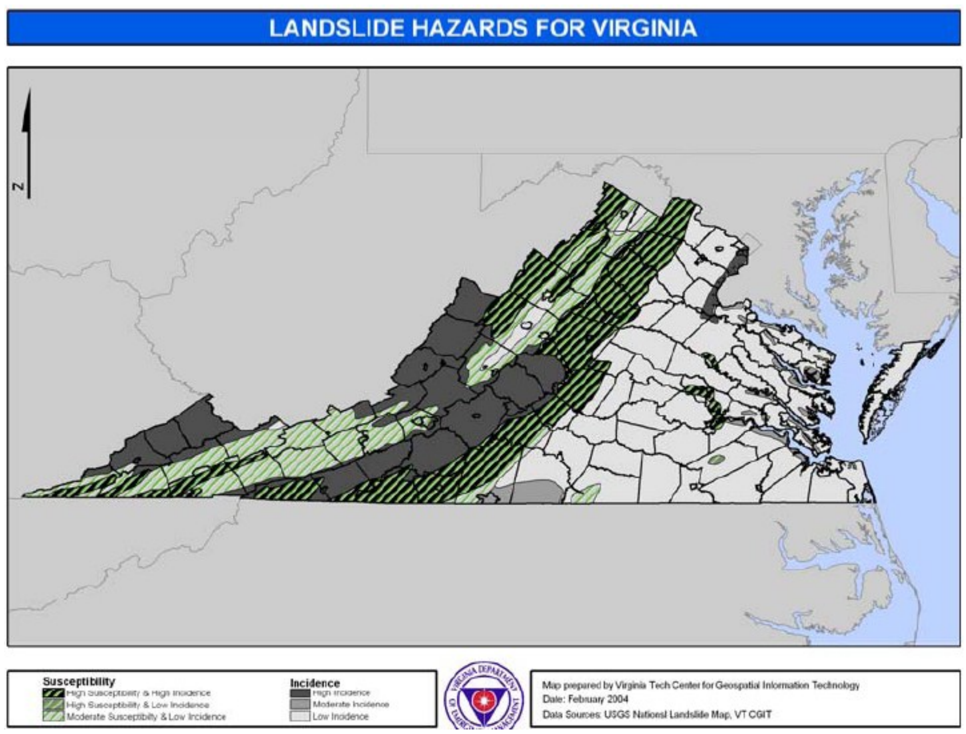


Figure 5.21a. Karst Regions and Historical Subsidence in Virginia, Source: VDEM

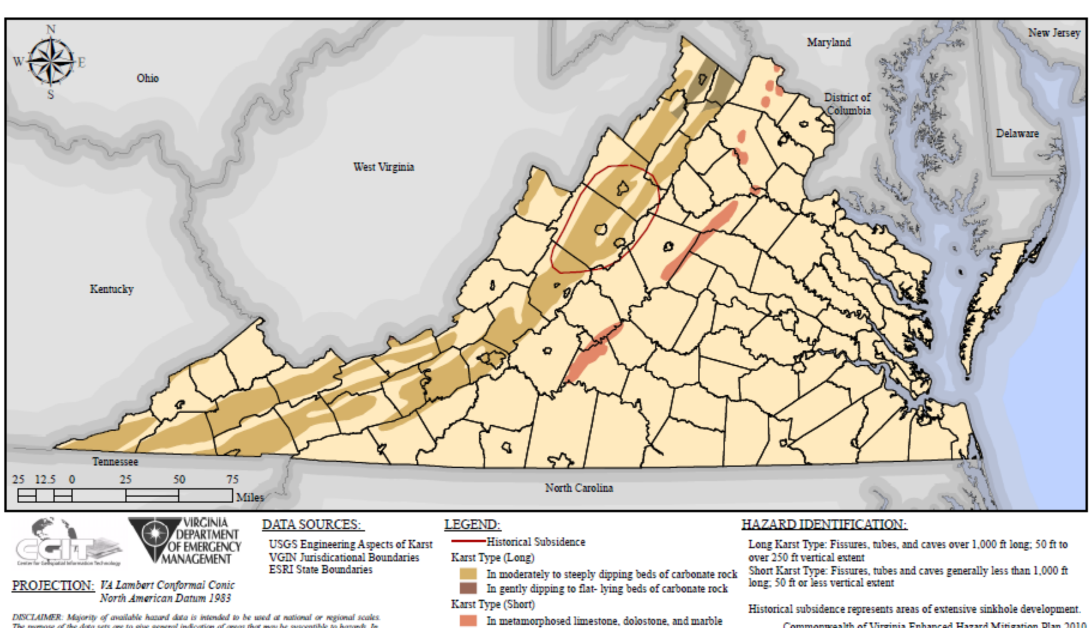
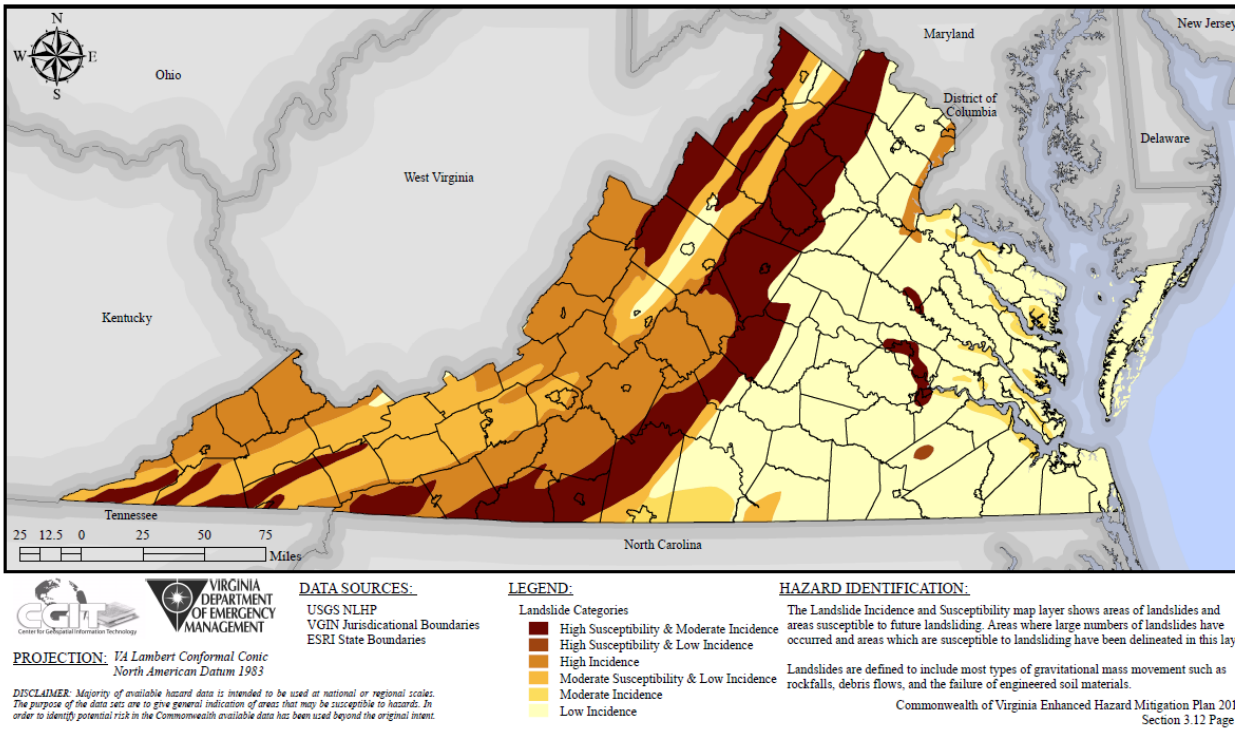


Figure 5.21b. Landslide Incidence and Susceptibility, Source: VDEM



Hazard Profile

Land subsidence is the lowering of surface elevations due to changes made underground. The USGS notes that land subsidence is usually caused by human activity such as pumping of water, oil, or gas from underground reservoirs. Land subsidence often occurs in regions with mildly acidic groundwater and the geology is dominated by limestone, dolostone, marble or gypsum. Karst is the term used to refer to geology dominated by limestone and similar soluble rocks. The acidic groundwater dissolves the surrounding geology creating sinkholes. Sinkholes are classified as natural depressions of the land surface. Areas with large amounts of karst are characterized by the presence of sinkholes, sinking streams, springs, caves and solution valleys.

The term "landslide" is used to describe the downward and outward movement of slope forming materials reacting under the force of gravity. Figure 5.21b gives an indication that the eastern portion of Region 2000 is the most susceptible to future landslide incidents. The term covers a broad category of events, including mudflows, mudslides, debris flows, rock falls, rock slides, debris avalanches, debris slides, and earth flows. These terms vary by the amount of water in the materials that are moving.

The USGS divides landslide risk into six categories. These six categories were grouped into three, broader categories to be used for the risk analysis and ranking; geographic extent is based off of these groupings. These categories include:

High Risk

1. High susceptibility to land sliding and moderate incidence.
2. High susceptibility to land sliding and low incidence.
3. High landslide incidence (more than 15% of the area is involved in land sliding).

Moderate Risk

4. Moderate susceptibility to land sliding and low incidence.
5. Moderate landslide incidence (1.5 – 15% of the area is involved in land sliding).

Low Risk

6. Low landslide incidence (less than 1.5% of the area is involved in land sliding).

The six categories were grouped into High (categories 1-3), Medium (categories 4-5), and Low (category 6) to assess the risk to state faculties, critical facilities and jurisdictions.

Several natural and human factors may contribute to or influence landslides. How these factors interrelate is important in understanding the hazard. The three principal natural factors are topography, geology, and precipitation. The principle human activities are cut-and-fill construction for highways, construction of buildings and railroads, and mining operations.

The USGS recognizes four major impacts caused by land subsidence:

- Changes in elevation and slope of streams, canals, and drains
- Damage to bridges, roads, railroads, storm drains, sanitary sewers, canals, and levees
- Damage to private and public buildings
- Failure of well casings from forces generated by compaction of fine-grained materials in aquifer systems

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.

Hazard Areas

Region 2000 is located adjacent to the edge of the karst regions in Virginia (Figure 5.21). Campbell and Appomattox Counties have a higher relative susceptibility to landslides comparative to the rest of the region.

Vulnerability Analysis

There is no scientific information that would suggest the probability of a landslide event. The impact and extent of the damage will greatly hinge on where the landslide occurs. The largest danger from landslides and debris flows occurs in area of high relief or abrupt changes in topography, especially areas susceptible to slope failure initiated by sustained and/or heavy rain events.

Problem Spot Mapping

See Appendix 5.1 for Figures and Tables summarizing the problem spot locations that were present in the original Hazard Mitigation Plan and confirmed by the project management team. No new problem areas were noted in the plan update. When specific town information was provided it was included on the problem spot maps. If no information was provided by the localities, or they acknowledged there was no need for a specific map, the map was omitted from the Appendix.

Terrorism (Low Ranking)

Hazard History

No terrorism history was available for Region 2000 at the time of the update. Several of the communities in the region provided information about their Emergency Operation Plans (EOP). These plans are beginning to address terrorism as a concern in operation. Please consult local EOPs for further guidance.

The FEMA risk management series on mitigating potential terrorist attacks against buildings provides information on developing a realistic prioritization of human-caused hazards. The mitigation strategies section on this report should provide projects to address human caused hazard vulnerability. Future concepts to consider include:

I. Communities determine the relative importance of various critical and non-critical facilities and the asset of these systems

II. Determine the vulnerability to the specified hazard

III. Determine what threats are known to exist in the communities

Hazard Profile

Currently there is no universal definition for terrorism. Terror can be exhibited through many different forms. The code of Federal Regulations defines terrorism as “the unlawful use of force and violence against persons or property to intimidate or coerce a government, civilian population, or any segment thereof, in furtherance of political or social objectives.”

Hazard Areas

Local Emergency Operation Plans are beginning to address annexations and terrorism areas of concern. Consult these plans for further information.

Vulnerability Analysis

Vulnerability analysis, when available, has been conducted by the different localities. This information has been addressed in local Emergency Operation Plans.

Earthquakes

Hazard Profile

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. The damage from earthquakes can span hundreds of thousands of square miles; cause extensive damage into the billions of dollars; and result in tremendous amounts of injuries and death because of their sudden and unpredictable nature. Earthquakes also have extensive ripple effects on the economic and social functioning of the affected area as well.

Hazard History

Though very rare, earthquakes have the potential to affect Region 2000. The table below shows all earthquakes that have been recorded by the USGS in Virginia.

Locality	Date	Magnitude
Giles County, VA	5/31/1897	5.9
Virginia	5/5/2003	3.9
Virginia	12/9/2003	4.5
Louisa County, VA	8/23/2011	5.8

Vulnerability Analysis

The majority of property damage and earthquake related deaths result from 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 a number of factors: amplitude, duration of the shaking, distance from the fault, and regional geology. Earthquakes can also cause landslides (the down-slope movement of soil and rock) and liquefaction (in which ground soil loses the ability to resist shear and acts much like quick sand).

The majority of earthquakes are caused by the release of stresses accumulated along fault planes along the Earth's outer crust. None of the major fault lines are located in or near Region 2000. The North American plate follows the continental border with the Pacific Ocean in the west, but follows the mid-Atlantic trench in the east. Earthquakes occurring along the mid-Atlantic trench usually pose little risk to humans. The greatest risk for earthquakes in the United States is along the Pacific Coast.

Earthquakes are measured in terms of their magnitude and intensity. Magnitude is measured using the Richter Scale—described in Table 5.35. The scale is based on an open-ended logarithmic scale that describes the energy release of an earthquake through a measure of shock wave amplitude. Each unit increase in magnitude on the Richter Scale corresponds to a tenfold increase in wave amplitude, or a 32-fold increase in energy. Intensity is most commonly measured using the Modified Mercalli Intensity (MMI) Scale—described in Table 5.36) 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).

Table 5.35 Description of Richter Scale, Source: North Carolina Division of Emergency Management

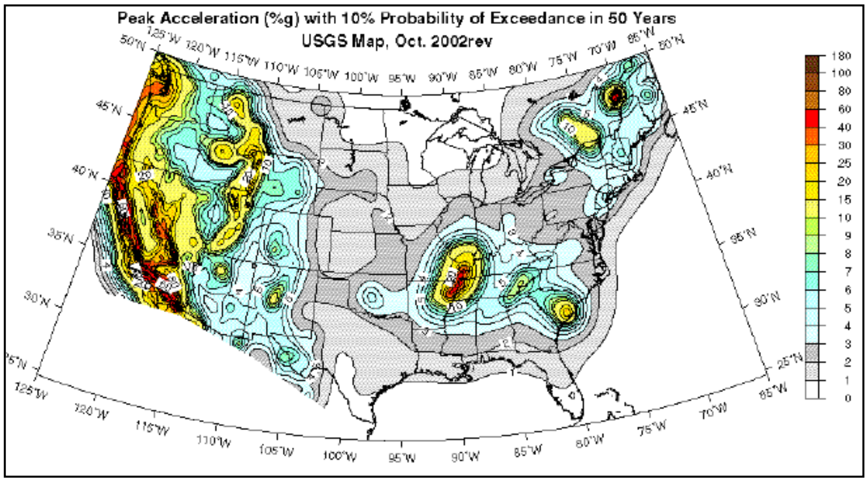
Richter Magnitudes	Earthquake Effects
<3.5	Generally not felt, but recorded.
3.5-5.4	Often felt, but rarely causes damage.
Under 6.0	At most slight damage to well-designed buildings. Can cause major damage to poorly constructed buildings over small regions.
6.1-6.9	Can be destructive in areas up to about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

Table 5.36 Description of Mercalli Intensity Scale, Source: Michigan Tech

Scale	Intensity	Description of Effects	Corresponding Richter Scale Magnitude
I	Instrumental	Detected mainly on seismographs, felt by very few people	1.0 – 2.0
II	Feeble	Some people feel it, especially on upper floors	2.0 – 3.0
III	Slight	Felt by people resting, especially on upper floors; May not be recognized as an earthquake	3.0 – 4.0
IV	Moderate	Felt by many people indoors, a few outdoors; may feel like a large truck rumbling by	4.0
V	Slightly Strong	Felt by almost everyone, some people awakened; small objects moved, trees and poles may shake.	4.0 – 5.0
VI	Strong	Felt by everyone; difficult to stand, some heavy furniture moved, some plaster falls; chimneys may be slightly damaged.	5.0 – 6.0
VII	Very Strong	Slight to moderate damage in well built, ordinary structures, considerable damage to poorly built structures; some walls may fall.	6.0
VIII	Destructive	Little damage in specially built structures, considerable damage to ordinary buildings, severe damage to poorly built structures; some walls collapse.	6.0 – 7.0
IX	Ruinous	Considerable damage to specially built structures, buildings shifted off foundations; ground cracked noticeably; wholesale destruction, landslides.	7.0
X	Disastrous	Most masonry and frame structures and their foundations destroyed; ground badly cracked; landslides, wholesale destruction.	7.0 – 8.0
XI	Very Disastrous	Total damage; few, if any, structures standing; bridges destroyed, wide cracks in ground, waves seen on ground.	8.0
XII	Catastrophic	Total damage; waves seen on ground; objects thrown up into air.	8.0 or greater

Figure 5.22 shows the probability that ground motion will reach a certain level during an earthquake. The data shows the "peak horizontal ground acceleration" which translates to the fastest measured change in speed for a particle at ground level that is moving horizontally due to an earthquake. The map shows that all of the jurisdictions in Region 2000 are located low probability area therefore remains a low future threat.

Figure 5.22 Peak acceleration with 10 percent probability of exceedance in 50 years, Source: USGS



Plan Linkage

The *Hazard Identification and Risk Assessment (HIRA)* takes a hazard specific approach in determining the regions concerns and vulnerabilities are. The information provided should be used as one of its planning tools in mitigating hazards. At this point in time data limitations provide a stumbling block in determining pinpoint locations of hazards.

This HIRA provides broad regional information that the communities should use in developing their mitigation actions.

Section VI on *Mitigation Actions* uses the HIRA findings and applies it to current and potential mitigation actions that will lessen the impacts from the hazards of concern. The Mitigation section bridges the gap of where the "problem spots" are and how they can mitigate them so they become less of a problem