2.0 RISK ASSESSMENT

§201.6(c)(2)(i)	[The risk assessment shall include a] description of the…location and extent of all natural hazards that can affect the jurisdiction. The plan shall include information on previous occurrences of hazard events and on the probability of future hazard events.

2018 UPDATE

Risk calculations have been moved to their own section here, formatted, updated, and expanded upon since the last plan update. Analysis of impacts and vulnerability for each hazard is new to this plan. All tables, maps, and charts have been updated to reflect the most up-to-date data available from a variety of sources.

OVERVIEW

A risk assessment analyzes “the potential for damage, loss, or other impacts created by the interaction of hazards with community assets” (FEMA, 2013). The risk assessment section contains information on:

- identified hazards that threaten the region in profiles,
- the vulnerability of the area as it relates to its assets,
- a list of community assets for Region 8, and
- an analysis of planned development and development challenges.

2.1 RISK & VULNERABILITY

§201.6(c)(2)(i)	[The risk assessment shall include a] description of the type…of all natural hazards that can affect the jurisdiction.

§201.6(c)(2)(i)	[The risk assessment shall include a] description of the…location and extent of all natural hazards that can affect the jurisdiction. The plan shall include information on previous occurrences of hazard events and on the probability of future hazard events.

2.1.1 Risk

One of the components of the risk assessment is determining both the probability of a hazard occurring and the potential severity of that hazard event. This process helps identify which hazards pose the most significant risk to Region 8 counties and municipalities. The probability and severity of an event are largely based on historical research. The probability of an event happening is determined based on the number of events that have occurred within a certain timeframe. The timeframe is based on information available from different resources and varies depending on the data. Different sources provide data on the number of events throughout a period of years. This data is used to calculate probability.

The probability of occurrence is broken down into five categories as seen in the table to the right. The chance of occurrence of a hazard within the next year can be quantified based on historical data. This can be expressed in a numerical measure or as a percentage of 0-100 percent. It is calculated by adding the total occurrences of a specific hazard and dividing it by the years of available data.

TABLE 2.2.1.A. PROBABILITY		
Value	*Description*	*Definition*
1.1+ (101%)	Frequent	Will occur several times during a year
.76 – 1.0 (76 – 100%)	Probable	Likely to occur a few times in a year
.51 - .75 (51 – 75%)	Occasional	Likely to occur sometime during a year
.26 - .50 (26 – 50%)	Remote	Unlikely to occur in a year
0 - .25 (0 – 25%)	Improbable	So unlikely that it can be assumed it will not occur in a year

Although some hazards have no recorded occurrences, the risk may still exist. Since non-natural hazards generally do not depend on weather patterns to occur, they are not informed by this type of historical data. Non-natural and technological hazards are nearly impossible to assign a measurement of probability.

The severity of an event is based on three main factors: 1) the historical deaths, injuries, and property/crop damage; 2) the extent of potential secondary and/or cascading impacts of the hazard and; 3) the potentially impacted geographic area as determined through risk mapping. Generally, the severity estimations will be less exact than probability estimations. The four classifications of severity are shown on the right.

TABLE 2.2.1.B. SEVERITY	
Description	*Definition*
Catastrophic	Death or major structural loss
Critical	Severe injury, severe illness, or marginal structural damage
Marginal	Minor injury, minor illness, or structural damage
Negligible	Less than minor injury, illness or structural damage

The combination of hazard probability and hazard severity results are shown in a table known as the Risk Assessment Matrix. There are many definitions for the level of risk (i.e. low or very low, high or very high); for the purposes of this plan, the determinations are made to follow the *2013 West Virginia Statewide Hazard Mitigation Plan Update* document so as to align this regional plan with the state's plan. The matrix is designed to show the hazards that are of most concern to Region 8. Each profile details the level of severity and probability, therefore generating the level of risk.

TABLE 2.2.1.C. RISK ASSESSMENT MATRIX						
		PROBABILITY				
		Frequent	*Probable*	*Occasional*	*Remote*	*Improbable*
SEVERITY	*Catastrophic*	High	High	Medium High	Medium	Medium Low
	Critical	Medium High	Medium High	Medium	Medium Low	Low
	Marginal	Medium High	Medium	Medium Low	Low	Low
	Negligible	Medium	Medium Low	Medium Low	Low	Low

2.1.2 Vulnerability

Vulnerability is a "measure of propensity of an object, area, individual, group, community, country, or other entity to incur the consequences of a hazard" (Coppola, 2015, p. 33). There are many aspects that contribute to the vulnerability of a people; these can include income disparity, class, race or ethnicity, gender, age, disability, health, and literacy (Thomas & Phillips, 2013, p. 2, 3). The following is a brief description of how each of the aspects can contribute to vulnerability to disasters.

- **Income Disparity**: Income disparities produce different outcomes from disasters that can cause more human suffering, and requiring more external support.
- **Class**: Lower-income families tend to live in housing that suffers disproportionately during disasters.
- **Race or Ethnicity**: Warning messages tend to be issued in the dominant language with an expectation that people will take the recommended action immediately.

- **Gender**: Domestic and stranger violence increases after a disaster. Although women tend to be the ones most likely to secure relief aid for the family, they are underrepresented and underused in recovery efforts.
- **Age**: Elderly populations are frequently reluctant to seek assistance before and secure aid after a disaster out of concern that they may lose their independence.
- **Disability**: People with disabilities experience challenges in acquiring transportation to evacuate areas as well as to access appropriate shelters and post-disaster housing.
- **Health**: Disasters can disrupt access to care. Individuals on health services are faced with life threatening circumstances if these services cannot be accessed. Disasters tend to exasperate chronic and mental health conditions.
- **Literacy**: Many emergency preparedness materials are available in written form. Few options exist for people with low reading levels, other languages, or cognitive abilities.

2.1.3 Perceptions

During the first steering committee meeting, members had a chance to rank each hazard identified herein according to their perception of its probability and severity. Members filled out risk assessment matrices and then they were averaged out. The table on the right denotes the perspective of hazards that the committee members have as a whole. The steering committee feels that the hazard of highest risk in the region is flooding, while land subsidence is a low risk to the area.

TABLE 2.1.3.A COMMITTEE RISK PERSPECTIVE

Hazard	*Committee Probability Perspective*	*Committee Severity Perspective*	*Committee Risk Assessment*
Dam Failure	Remote	Critical	Medium Low
Drought	Occasional	Marginal	Medium Low
Earthquake	Remote	Critical	Medium Low
Epidemic	Remote	Critical	Medium Low
Flood	Probable	Catastrophic	High
Hazmat	Remote	Critical	Medium Low
Land Subsidence	Remote	Marginal	Low
Severe Summer Weather	Probable	Marginal	Medium
Severe Winter Weather	Probable	Marginal	Medium
Terrorism	Remote	Critical	Medium Low
Wildfire	Occasional	Marginal	Medium Low

Members of the public (through the online survey) and the steering committee were both asked about their level of concern for each hazard. The following table shows the committee's and the public's responses side by side to compare. In most cases the public and the committee are equally concerned with the hazards. However, in some instances, there are differences. For example, the committee members are more concerned with flooding than the general public; this may be due to the deeper knowledge committee members have about occurrences in their areas. In contrast, the public is more concerned about severe summer weather and wildfires than the committee.

TABLE 2.1.3.B HAZARD LEVEL OF CONCERN

Hazard	*Committee*	*Public*
Dam Failure	Somewhat Concerned	Somewhat Concerned
Drought	Somewhat Concerned	Somewhat Concerned
Earthquake	Somewhat Concerned	Somewhat Concerned
Epidemic	Somewhat Concerned	Somewhat Concerned
Flooding	Very Concerned	Concerned
Hazmat	Concerned	Concerned
Land Subsidence	Somewhat Concerned	Somewhat Concerned
Severe Summer Weather	Somewhat Concerned	Concerned
Severe Winter Weather	Concerned	Concerned
Terrorism	Somewhat Concerned	Somewhat Concerned
Wildfire	Somewhat Concerned	Concerned

2.2 HAZARDS OVERVIEW

§201.6(c)(2)(i)	[The risk assessment shall include a] description of the…location and extent of all natural hazards that can affect the jurisdiction. The plan shall include information on previous occurrences of hazard events and on the probability of future hazard events.

2.2.1 Hazard Identification

A variety of natural and human-caused profiles were analyzed for inclusion in this plan. The following is a list of the hazards that were analyzed and how they are included or why they are excluded from this plan. Those included are described in the profiles in the following sections.

TABLE 2.2.1.A HAZARD IDENTIFICATION

Hazard	*Status*	*Description*	*Research Sources*
Avalanche	Not Included	Avalanches happen mainly in the western United States and Canada.	• Keller, Devecchio, 2015 p. 229
Coastal Erosion	Not Included	The Atlantic East Coast, where coastal erosion is nearest, is approximately 350 miles away and the Pacific West Coast is approximately 2,200 miles away.	• Google Earth
Dam Failure	Included	See Section 2.3.1 Dam Failure. Included due to the presence of dams in the region.	• Association of State Dam Safety Officials • National Performance of Dams Program • National Inventory of Dams
Drought	Included	See Section 2.3.2 Drought. Included because the area has experienced droughts in the past.	• USDA Census of Agriculture • National Integrated Drought Information System • National Centers for Environmental Information (NOAA) • Spatial Hazard Events and Losses Database (SHELDUS)
Earthquake	Included	See Section 2.3.3 Earthquake. Included because there are occurrences of earthquakes in the past.	• Association of American State Geologists • United States Geological Service
Epidemic	Included	See Section 2.3.4 Epidemic. Included because the potential for epidemics is always present.	• Centers for Disease Control and Prevention • Local Health Departments • WV Department of Health and Human Resources
Extreme Temperatures	Included	See Section 2.3.8 Severe Summer Weather. Included because the area experiences many occurrences of severe summer weather including extreme heat.	• National Centers for Environmental Information (NOAA) • Northeast Regional Climate Center • Spatial Hazard Events and Losses Database (SHELDUS)
Flood	Included	See Section 2.3.5 Flood. Included because the region has experienced many floods.	• Federal Emergency Management Agency Flood Rate Map • National Centers for Environmental Information (NOAA)

TABLE 2.2.1.A HAZARD IDENTIFICATION			
Hazard	*Status*	*Description*	*Research Sources*
			• U.S. Environmental Protection Agency • Spatial Hazard Events and Losses Database (SHELDUS)
Hail	Included	See Section 2.3.8 Severe Summer Weather. Included because the area experiences many occurrences of severe summer weather including hail.	• National Centers for Environmental Information (NOAA) • Northeast Regional Climate Center • Spatial Hazard Events and Losses Database (SHELDUS)
Hazardous Materials Incident	Included	See Section 2.3.6. Hazardous Materials Incident. Included because the roads and facilities are susceptible to hazardous materials incidents at any time.	• Federal Railroad Administration • Pipeline and Hazardous Materials Safety Administration • National Transportation Safety Board • National Pipeline Mapping System • USCG National Response Center
Hurricanes	Not Included	The Atlantic East Coast, where hurricane paths are nearest, is approximately 350 miles away and the Pacific West Coast is approximately 2,200 miles away.	• Google Earth
Landslide	Included	See Section 2.3.7 Land Subsidence. Included because there have been instances of land and rock slides in the area.	• United States Geological Service • West Virginia Division of Highways • Spatial Hazard Events and Losses Database (SHELDUS)
Lightning	Included	See Section 2.3.8 Severe Summer Weather. Included because the area experiences many occurrences of severe summer weather including lightning	• National Centers for Environmental Information (NOAA) • Northeast Regional Climate Center • Spatial Hazard Events and Losses Database (SHELDUS)
Sea Level Rise	Not Included	Sea level rise occurs in the ocean; the Atlantic East Coast is approximately 350 miles away and the Pacific West Coast is approximately 2,200 miles away.	• Google Earth
Storm Surge	Not Included	Storm surges occur in the ocean; the Atlantic East Coast is approximately 350 miles away and the Pacific West Coast is approximately 2,200 miles away.	• Google Earth
Terrorism	Included	See Section 2.3.10 Terrorism. Included because the potential for terrorist activities in the region is present.	• Study of Terrorism and Responses to Terrorism (START) • West Virginia Department of Military Affairs and Public Safety (DMAPS)
Tornado	Included	See Section 2.3.8 Severe Summer Weather. Included because the area experiences many occurrences of severe summer weather including tornadoes.	• National Centers for Environmental Information (NOAA) • The Tornado Project • Spatial Hazard Events and Losses Database (SHELDUS)
Tsunamis	Not Included	The Atlantic East Coast, where tsunamis would be closest, is approximately 350 miles away and the Pacific West Coast is approximately 2,200 miles away.	• Google earth
Wind	Included	See Section 2.3.8 Severe Summer Weather. Included because the area experiences many occurrences of severe summer weather including wind events.	• National Centers for Environmental Information (NOAA) • Northeast Regional Climate Center

TABLE 2.2.1.A HAZARD IDENTIFICATION			
Hazard	*Status*	*Description*	*Research Sources*
			• Spatial Hazard Events and Losses Database (SHELDUS)
Winter Weather	Included	See Section 2.3.9 Severe Winter Weather. Included because the area experiences many occurrences of severe winter weather.	• National Centers for Environmental Information (NOAA) • Northeast Regional Climate Center • Spatial Hazard Events and Losses Database (SHELDUS)
Wildfire	Included	See Section 2.3.11 Wildfire. Included because there have been occurrences of wildfires in the area.	• National Centers for Environmental Information (NOAA) • West Virginia Division of Forestry • Spatial Hazard Events and Losses Database (SHELDUS)
Volcanoes	Not Included	The closest monitored volcano is in Yellowstone National Park in Wyoming and is approximately 1,550 miles away.	• Google Earth • United States Geological Survey

The steering committee settled on a list of 11 hazards. In order to maintain a manageable list, the committee grouped certain hazards under one profile heading; for example, hail, lightning, tornadoes, and wind were grouped under severe summer weather.

- Dam Failure
- Drought
- Earthquake
- Epidemic
- Flood
- Hazardous Materials Incident
- Land Subsidence
- Severe Summer Weather
    - Hail
    - Lightning
    - Tornado
    - Wind
- Severe Winter Weather
    - Blizzard
    - Ice Storm
    - Winter Storm
    - Winter Weather
- Terrorism
- Wildfire

2.2.2 Complicating Variables

Direct consequences of disasters can include fatalities, injuries, and damages to humans, animals or property. However, disasters do not end there; there are a number of indirect effects, both tangible and intangible associated with disasters even before a disaster strikes. Some examples of these include loss of livelihood and income, loss of community and population, mental and psychosocial impacts, costs of rebuilding, repair or replacement, loss of inventory, wages and tax revenue, etc. (Coppola, 2015). All of these also have a cost associated with them but it is much more difficult to assign a specific dollar value and quantify accurately.

A variety of situations could occur that would result in a disruption to a number of critical systems throughout Region 8 counties. Some hazards are complicated by a series of loosely-related variables; these are often considered *cascading hazards*. For example, high winds may cause sporadic damage throughout the county, but often do not become a significant countywide concern until a large number of residents are without power.

A single event may not always reach all impacts described herein. However, it is important to understand that the impacts of hazards go beyond what is seen immediately before or after the event or incident. The effects of one event can be years or months in the making and last months or even years, especially where public health, social, economic, environmental and infrastructure impacts are concerned.

2.2.3 Hazards and Climate Change

Many natural hazards are related to climate such as droughts, severe weather, floods and wildfires. There is an important distinction between weather and climate. Weather refers to the atmospheric conditions of a geographical region over a short period of time, such as days or weeks. Climate, in contrast, refers to the atmospheric conditions of a geographical area over long periods of time, such as years, or even decades (Keller, Devecchio, 2015, pp. 406-407).

According to the U.S. Global Change Research Program (2016), there are several weather and climate changes that have already been observed in the United States.

- Since recordkeeping began in 1895, the average U.S. temperature has increased by 1.3°F to 1.9°F with most of the increase happening since 1970. In addition, the first decade of the 2000s has been the warmest on record.

- The average precipitation across the U.S. has increased since 1900 with some areas experiencing higher than the national average and some lower. Heavy downpours are increasing, especially over the last 30-50 years.
- Drought events have increased in the west. Changes in precipitation and runoff, combined with changes in consumption and withdrawal, have reduced surface and groundwater supplies in many areas.
- Some types of severe weather events have experienced changes; heat waves are more frequent and intense, and cold waves have become less frequent and intense overall.
- The intensity, frequency, and duration of North Atlantic hurricanes have increased since the early 1980s.

Climate change can have a significant impact on human health and the environment. The changes mentioned above can affect the environment by leading to changes in land-use, ecosystems, infrastructure conditions, geography and agricultural production. Extreme heat, poor air quality, reduced food and water supply and quality, changes in infectious agents and population displacement can lead to public health concerns such as heat-related illnesses, cardiopulmonary illnesses, food, water and vector-borne diseases and have consequences on mental health and stress (USGCRP, 2016).

The National Climate Assessment (NCA) defined climate trends for national U.S. regions in 2014. The major trends are seen to be

- wildfires and heat waves on the west coast,
- rising temperatures and increased severity and frequency of winter storms in the middle of the country,
- more rain and flooding in the Midwest and northeastern parts of the country, and
- an increase in sea levels in the mid-Atlantic with an increase of hurricane activity in the southeastern states.

In West Virginia, the trend will be an increase in extreme precipitation which will lead to more events of hazards such as flooding, and possible dam failures or reportable disease epidemics.

2.3 HAZARD PROFILES

§201.6(c)(2)(i)	[The risk assessment shall include a] description of the…location and extent of all natural hazards that can affect the jurisdiction. The plan shall include information on previous occurrences of hazard events and on the probability of future hazard events.

The following table contains a summary of all the hazards analyzed, presented in alphabetical order. For a detailed description of the hazards and methodology for the information presented in the table, refer to each separate profile.

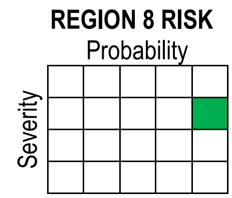
TABLE 2.3.A. HAZARD SNAPSHOTS

Hazard	*Period of Occurrence*	*Warning Time*	*Potential Impacts*	*Probability*	*Severity*	*Risk*	*Loss/Damage Estimate*
Dam Failure	At any time	Minimal – depends on frequency of inspection and maintenance practices.	Potential loss of human life, economic loss, environmental damage, disruption of lifeline facilities.	Improbable	Critical	Low	Cost of maintenance or repair depends on each dam.
Drought	Summer months or extended periods with no precipitation	Weeks	Activities that rely heavily on high water usage may be impacted significantly, including agriculture, tourism, wildlife protection, municipal water usage, commerce, recreation, electric power generation, and water quality deterioration. Droughts can lead to economic losses such as unemployment, decreased land values, and agribusiness losses. Minimal risk of damage or cracking to structural foundations, due to soils.	Remote	Negligible	Low	Agricultural losses over a period of several years have not occurred due to drought conditions.
Earthquake	At any time	None	According to FEMA, areas with a PGA of 2 to 4 (0.02 to 0.04) will incur little to no damage with no function loss.	Improbable	Marginal	Low	Over $443 billion in a worst case scenario.
Epidemic	At any time	Months to weeks	Potential loss of human life, economic loss, disruption of lifeline facilities	Occasional	Critical	Medium	Ob average, about $488 per person per year.
Flood	Potomac River – Primarily January through May (history shows incidents occurring year-round) Flash Flood – At any time depending on recent weather conditions Result of Dam Failure – At any time	River Flood – 3 to 5 days Flash Flood – Minutes to hours	Impacts to human life, health, and public safety. Utility damage and outages, infrastructure damage (transportation and communication systems), structural damage, fire, damaged or destroyed critical facilities, and hazardous material releases. Can lead to economic losses such as unemployment, decreased land values and agrobusiness losses. Floodwaters are a public safety issue due to contaminants and pollutants.	Frequent	Critical	Medium High	NCEI and SHELDUS estimates over $186 million for damages
Hazardous Materials	At any time	None	Potential loss of human life, economic loss, environmental damage	Frequent	Negligible	Medium	PHMSA data indicates that each incident could cost, on average $28,500.
Land	At any time – Chance	Weeks to months – Some	Economic losses such as decreased land	Occasional	Negligible	Medium	DOH cost to repair

TABLE 2.3.A. HAZARD SNAPSHOTS

Hazard	*Period of Occurrence*	*Warning Time*	*Potential Impacts*	*Probability*	*Severity*	*Risk*	*Loss/Damage Estimate*
Subsidence	of occurrence increases following long periods of heavy rain, snowmelt, or near construction activity.	instances of land subsidence can occur quickly without warning, but often in the context of other storm events.	values, agrobusiness losses, disruption of utility and transportation systems, and costs for any litigation. May cause geological movement, causing infrastructure damages ranging from minimal to severe.			Low	road slips averages between $25K and $50K.
Severe Summer Weather	Hail – at any time, during thunderstorms. Thunderstorm – spring, summer, and fall months. Wind and tornado – at any time, primarily between months of March and August.	Hail – minutes to hours Thunderstorm – minutes to hours Wind and tornado – minutes to hours.	Hail - Large hail can minimally damage property (facilities) as well as crops Thunderstorm: Utility damage and outages, infrastructure damage (transportation and communication systems). Impacts human life, health, and public safety. Wind and tornado - Utility damage and outages, infrastructure damage (transportation and communication systems), structural damage, and damaged or destroyed critical facilities. Impacts human life, health, and public safety	Frequent	Critical	Medium High	Average cost per event is over $5K.
Severe Winter Weather	During winter months	Snow – Days Ice – Minutes to hours	Utility damage and outages, infrastructure damage (transportation and communication systems), structural damage, damaged critical facilities. Can cause severe transportation problems and make travel extremely dangerous. Power outages, which result in loss of electrical power and potentially loss of heat. Extreme cold temperatures may lead to frozen water mains and pipes, damaged car engines, and prolonged exposure to cold resulting in frostbite	Frequent	Marginal	Medium High	Average cost per event is over $2K
Terrorism	At any time	Minimal – Depends on the presence of a threat	Potential loss of human life, economic loss, environmental damage, disruption of lifeline facilities.	Improbable	Critical	Low	N/A
Wildfire	At any time – primarily during summer months	Minimal	Impacts human life, health, and public safety. Loss of wildlife habitat, increased soil erosion, and degraded water quality. Utility damage and outages, infrastructure damage (transportation and communication systems), and damaged or destroyed critical facilities.	Frequent	Negligible	Medium	Federal cost of firefighting averages around $285 per acre.

2.3.1 Dam Failure



A dam is a barrier, generally made of earth, concrete, or rock fill, that impounds water.

HAZARD OVERVIEW

The West Virginia Department of Environmental Protection (WVDEP) defines dams as man-made barriers or obstructions that impounds water and must be at least 25 feet or more in height and impound 15 or more acre-feet of water volume (WVDEP, 2009). The WVDEP is responsible for inspecting existing dams and those under construction, reviewing design plans, and reporting emergencies (WVDEP. 2016). There are four categories of dams; the Mine Safety and Health Administration defines them as follows.

- **Class 1 or High Hazard**: failure would probably cause loss of human life.
- **Class 2 or Significant Hazard**: failure would likely not result in loss of human life, but can cause economic loss, environmental damage, or disruption of lifeline facilities.
- **Class 3 or Low Hazard**: failure would result in no probable loss of human life and low economic and/or environmental loss.
- **Class 4 or Negligible Hazard**: losses would mainly be restricted to the dam.

Dams are used for a variety of purposes. In Region 8, the majority of the dams are used for flood control, water supply or recreation. The following describes these types of dams.

- **Flood Control:** Prevents loss of life and property caused by flooding. They impound floodwaters and either release them under control to the river below or store or divert the water for other uses.
- **Recreation**: These are designed for boating, skiing, camping, picnic areas, and boat launches and can all be supported by these dams.
- **Water Supply**: This type of type of dam is used to gather and supply water from rivers to urban areas.

POSSIBLE CAUSES

Dam failure is often the result of prolonged rainfall or flooding or, during prolonged dry periods, erosion. The primary hazard surrounding dam failure is the swift, unpredictable flooding of those areas immediately downstream. While general inundation areas can be determined, it is often impossible to know exactly how and where water held back by a dam will flow during a rapid failure of the dam.

Generally, there are three types of dam failures: hydraulic, seepage, and structural.

- **Hydraulic Failure (Overtopping)***:* Hydraulic failures result from the uncontrolled flow of water over the dam, around and adjacent to the dam, and the erosive action of water on the dam and its foundation. Earthen dams are particularly vulnerable to hydraulic failure since earth erodes at relatively small velocities.
- **Seepage Failure (Piping)**: All dams exhibit some seepage that must be controlled in velocity and amount. Seepage occurs both through the dam and the foundation. If uncontrolled, seepage can erode material from the foundation of an earthen dam to form a conduit through which water can pass. This passing of water often leads to a complete failure of the structure, known as piping.
- **Structural Failure**: Structural failures involve the rupture of the dam and/or its foundation. This is particularly a hazard for large dams and for dams built of low strength materials such as silts, slag, fly ash, etc. "When trees and woody plants are allowed to grow on earthen dams, they can hinder safety inspections, can interfere with safe operation, or can even cause dam failure" (USDHS, 2005).

Dam failures generally result from a complex interrelationship of several failure modes. Uncontrolled seepage may weaken the soils and lead to a structural failure. Structural failure may shorten the seepage path and lead to a piping failure. Surface erosion may lead to structural or piping failures.

LOCATION AND EXTENT

There are 88 dams reported in the National Inventory of Dams for the counties of Region 8; 23 in Grant County, 4 in Hampshire County, 10 in Hardy County, 32 in Mineral County, and 19 in Pendleton County. Of the total dams, 58 are classified as high hazard dams, 24 are significant hazard, 3 are low hazard, and 3 are unknown.

TABLE 2.3.1.A DAMS IN REGION 8

Dam Name	*Owner Type*	*Height (ft.)*	*Hazard Class*	*Primary Purpose*	*Dam Type*	*River*	*County*
Elk Run WS Reservoir	Private	25	Unknown	Water supply	Other	-	Grant
Lunice Creek No. 09	Local government	87	High	Flood control	Earth	North Fork	Grant

TABLE 2.3.1.A DAMS IN REGION 8							
Dam Name	*Owner Type*	*Height (ft.)*	*Hazard Class*	*Primary Purpose*	*Dam Type*	*River*	*County*
Lunice Creek No. 10	Local government	87	High	Flood control	Earth	Saltblock Run	Grant
Lunice Creek No. 11	Local government	83.4	High	Flood control	Earth	Lunice Creek	Grant
Mill Run WS Dam	Private	17	High	Water supply	Other	Mill Run	Grant
Mt. Storm Lake Dam	Public utility	153	High	Other	Rock fill, earth	Stony River	Grant
N&S Mill Creek No. 03	Local government	89	Significant	Flood control	Earth	Rough Run	Grant
N&S Mill Creek No. 04	Local government	68	Significant	Flood control	Earth	South Mill Creek	Grant
N&S Mill Creek No. 16	Local government	67	High	Flood control	Earth	Gum hollow	Grant
N&S Mill Creek site No. 07	Local government	75.2	High	Flood control	Rock fill, earth	South Mill Creek	Grant
New Creek No. 12 Dam	Local government	77	High	Flood control	Earth	U.T. Of New Creek	Grant
New Creek No. 14 Dam	Local government	110	High	Flood control	Earth	Linton Creek	Grant
Patterson Creek No. 01 Dam	Local government	52	High	Flood control	Earth	Patterson Creek	Grant
Patterson Creek No. 02 Dam	Local government	57.5	High	Flood control	Earth	Tr-Patterson Creek	Grant
Patterson Creek No. 03 Dam	Local government	55.5	High	Flood control	Earth	Thorn Run	Grant
Patterson Creek No. 04 Dam	Local government	69	Significant	Flood control	Earth	Middle Fork	Grant
Patterson Creek No. 06 Dam	Local government	82	High	Flood control	Earth	Elklick Run	Grant
Patterson Creek No. 12 Dam	Local government	75	Significant	Flood control	Earth	Thorn Run	Grant
Patterson Creek No. 13 Dam	Local government	86	Significant	Flood control	Earth	Rossen Run	Grant
Patterson Creek No. 41 Dam	Local government	88	High	Flood control	Earth	North Fork	Grant
Patterson Creek No. 49 Dam	Local government	48	High	Flood control	Earth	Patterson Creek	Grant
Pond No. 01 Dam	Public utility	0	Unknown	Water supply	Earth	Buffalo Creek	Grant
Stony River Dam	Private	48.5	Significant	Flood control	Gravity	Stony Rv of Potomac Rv	Grant
Boone farms Lake Dam	Private	31	Significant	Recreation	Earth	Little Cacapon	Hampshire
Crooked Run Lake Dam	Private	26	Significant	Recreation	Earth	Tr. Of Cacapon	Hampshire
Ferndale Farms Recreation Lake	Private	23	Significant	Recreation	Earth	U.T. South Branch	Hampshire
Wilson Big Hollow Dam	Private	32	Significant	Recreation	Other	-	Hampshire
Lost River No. 04 Dam	Local government	90.9	High	Flood control	Earth	Kimsey Run	Hardy
Lost River No. 10 Dam	Local government	0	Unknown	Flood control	Earth	Camp Branch	Hardy
Lost River No. 27 Dam	Local government	0	High	Flood control	Earth	Upper cove Run	Hardy
Norman Wratchford Lake	Unknown	Unknown	Unknown	Unknown	Unknown	South Fork South Branch Potomac	Hardy
Rock Cliff Dam	Federal	66	Low	Flood control	Earth	Trout Run	Hardy
South Fork No. 01 Dam	Local government	122	Significant	Flood control	Earth	Shook's Run	Hardy
South Fork No. 02 Dam	Local government	123.1	Significant	Flood control	Earth	Stump Run	Hardy
South Fork No. 04 Dam	Local government	116.7	High	Flood control	Earth	Rodabaugh Run	Hardy
South Fork No. 05 Dam	Local government	107	High	Flood control	Earth	Radabaugh	Hardy

TABLE 2.3.1.A DAMS IN REGION 8

Dam Name	*Owner Type*	*Height (ft.)*	*Hazard Class*	*Primary Purpose*	*Dam Type*	*River*	*County*
Thorn Bottom Farm Lake	Private	37	Low	Fire protection, stock, or small fish pond	Earth	Trout Run	Hardy
Warden Lake	State	30	High	Recreation	Rock fill, earth	Moore's Run	Hardy
Lakewood Dam	Private	74	High	Recreation	Rock fill, earth	Death Valley	Mineral
Markwood cedar Lake Dam	Private	0	Low	-	Earth	Patterson Creek trib	Mineral
New Creek Dam No. 01	Local government	42	High	Flood control	Earth	New Creek	Mineral
New Creek Dam No. 05	Local government	35	High	Flood control	Earth	New Creek	Mineral
New Creek Dam No. 07	Local government	51	High	Flood control	Earth	New Creek	Mineral
New Creek Dam No. 09	Local government	58	High	Flood control	Earth	New Creek	Mineral
New Creek Dam No. 10	Local government	63	High	Flood control	Earth	New Creek	Mineral
New Creek Dam No. 16	Local government	101	High	Flood control	Earth	Thunderhill Run	Mineral
New Creek Dam No. 17	Local government	68.3	High	Flood control	Earth	Ash Spring Run	Mineral
Old Keyser Reservoir	Local government	25	High	Other	Concrete, earth	Limestone Run	Mineral
Patterson Creek No. 50	Local government	73	High	Flood control	Earth	Patterson Creek	Mineral
Patterson Creek No.14	Local government	63	High	Flood control	Earth	Harness Run	Mineral
Patterson Creek No.15	Local government	85	High	Flood control	Earth	Mike's Run	Mineral
Patterson Creek No.20	Local government	61	High	Flood control	Earth	Liller Run	Mineral
Patterson Creek No.21	Local government	74	High	Flood control	Earth	Mill Creek	Mineral
Patterson Creek No.22	Local government	54	Significant	Flood control	Earth	Wild meadow Run	Mineral
Patterson Creek No.24	Local government	36	Significant	Flood control	Earth	Patterson Creek	Mineral
Patterson Creek No.25	Local government	59	High	Flood control	Earth	Johnson Run	Mineral
Patterson Creek No.26	Local government	49	High	Flood control	Earth	Patterson Creek	Mineral
Patterson Creek No.27	Local government	39	High	Flood control	Earth	Patterson Creek	Mineral
Patterson Creek No.28	Local government	50	High	Flood control	Earth	Cabin Run	Mineral
Patterson Creek No.30	Local government	64	High	Flood control	Earth	O'Neil's Run	Mineral
Patterson Creek No.32	Local government	65	High	Flood control	Earth	Patterson Creek	Mineral
Patterson Creek No.36	Local government	38	High	Flood control	Earth	Patterson Creek	Mineral
Patterson Creek No.37	Local government	47	High	Flood control	Earth	Patterson Creek	Mineral
Patterson Creek No.38	Local government	51	Significant	Flood control	Earth	Hollenbeck Run	Mineral
Patterson Creek No.44	Local government	34	High	Flood control	Earth	Long pasture	Mineral
Patterson Creek No.45	Local government	42	High	Flood control	Earth	Grave yard Run	Mineral
Patterson Creek No.46	Local government	67	High	Flood control	Earth	Painter Run	Mineral
Patterson Creek No.47	Local government	31	Significant	Flood control	Earth	Patterson Creek	Mineral
Patterson Creek No.48	Local government	71	High	Flood control	Earth	Pursley Run	Mineral
Patterson Creek No.52	Local government	36	Significant	Flood control	Earth	Mud Run	Mineral
South Fork No. 06	Local government	105.5	Significant	Flood control	Earth	South Fork	Pendleton
South Fork No. 09	Local government	99.2	Significant	Flood control	Earth	Dice Run	Pendleton
South Fork No. 17	Local government	111.5	High	Flood control	Earth	Little Fork	Pendleton
South Fork No. 19	Local government	81	High	Flood control	Earth	South Fork	Pendleton
South Fork No. 21	Local government	94.8	High	Flood control	Earth	Little Rough M	Pendleton

TABLE 2.3.1.A DAMS IN REGION 8							
Dam Name	*Owner Type*	*Height (ft.)*	*Hazard Class*	*Primary Purpose*	*Dam Type*	*River*	*County*
South Fork No. 27	Local government	71.2	High	Flood control	Earth	South Fork	Pendleton
South Fork No. 32	Local government	59.5	High	Flood control	Earth	South Fork	Pendleton
South Fork No. 33	Local government	59.9	High	Flood control	Earth	Fisher Run	Pendleton
South Fork No. 35	Local government	65.3	Significant	Flood control	Earth	South Fork	Pendleton
South Fork No. 36	Local government	53.9	High	Flood control	Earth	Little stony Run	Pendleton
South Fork No. 37	Local government	97.7	High	Flood control	Earth	Camp Run	Pendleton
South Fork No.10	Local government	75.6	Significant	Flood control	Earth	Stony Run	Pendleton
South Fork No.11	Local government	89.1	Significant	Flood control	Earth	Road Run	Pendleton
South Fork No.12	Local government	64	Significant	Flood control	Earth	Detimer Run	Pendleton
South Fork No.13	Local government	80.1	High	Flood control	Earth	Hawes Run	Pendleton
South Fork No.14	Local government	72.5	High	Flood control	Earth	Broad Run	Pendleton
South Fork No.15	Local government	88.4	High	Flood control	Earth	Mitter Run	Pendleton
South Fork No.16	Local government	73.6	Significant	Flood control	Earth	George Run	Pendleton
South Fork No.18	Local government	76	High	Flood control	Earth	Stony Run	Pendleton

Source: National Inventory of Dams and National Performance of Dams Program

Even though a region is defined geographically, it doesn't mean that it is self-containing; hazards originate in other areas outside the borders of Region 8 can still have an effect on the counties in Region 8. One example of this are the dams that are located in Maryland that, where they to fail, could impact counties in region 8. These dams include the following:

- Jennings Randolph Dam on the North Branch of the Potomac River
- Savage River Dam on the Savage River
- Industrial Dam on the North Branch of the Potomac River

HISTORICAL OCCURRENCES

There have been only two incidents in all the counties of Region 8 that have been reported. The first was at Stony River Dam in Grant County; it experienced an inflow flood from a hydrologic event in 1914 (NPDP, n.d.).

According to NCEI, on July 29, 2017 in Bayard (Grant County) a strong upper level low interacted with a frontal boundary near the Mid-Atlantic region and low pressure formed along the boundary. High moisture content and thunderstorms led to widespread flooding across the Mid-Atlantic region. Due to this activity, a levee breached on Buffalo Creek pushing it out of its banks flooding nearby areas.

IMPACTS AND VULNERABILITY

Dam failures themselves do not pose a threat to public health; the cascading effects that occur after a failure are more concerning. When a dam fails it causes flooding downstream that can cause death, injury, and illnesses relating to water-borne diseases and standing water. The consequences of flooding from a dam can cause damage to buildings and transportation infrastructure and power outages. As a result of flooding, people might have to evacuate and be displaced from their homes. In a large enough event, this can translate into economic loss for the area due to businesses closing and loss of workforce including the cost of clean-up activities after the event.

LOSS AND DAMAGES

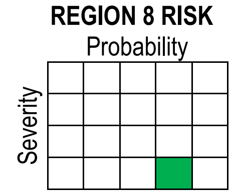
There have been no losses of life or property in any Region 8 counties due to a dam failure. However, this does not mean that there will never be any losses due to this type of event.

"Dam safety risk assessment is like a stool that stands on three legs. These legs quantify the likelihood that various initiating events (hydrologic, seismic, structural/internal, mechanical, or human error) will occur; the likelihood that the dam would fail given these initiating events; and the likelihood that, given a failure, the resulting flood wave would result in various levels of damage. The meaningful quantification of risk depends on credible estimates of the damages that would result from each significant failure scenario. Loss of human life is generally accepted as the most important consequence so it often dominates dam-safety decisions. Unfortunately, the confidence with which life loss can currently be estimated is low. This high level of uncertainty applies to both statistical confidence limits and to expert opinion. As such, this single limitation is a critical hindrance to the credibility and value of dam-safety risk assessment results. Indeed, some would like to push the stool over on its weak leg and abandon probabilistic risk assessment altogether" (USACE, 2002).

RISK ASSESSMENT

TABLE 2.3.1.B DAM FAILURE RISK CALCULATION				
Probability		*Severity*		*Risk*
IMPROBABLE		CRITICAL		LOW
Since 1914 there have been no dam failure events or incidents in the area. Because of the lack of historical occurrences and the programs that are in place to ensure proper maintenance of dams, this hazard has a low probability of occurrence to the area.	+	Many of the dams in the region are categorized as a high or significant hazard class meaning that there could potentially be loss of human life and damage to the environment and critical infrastructure.	=	According to the risk assessment matrix, a probability of 'improbable' and a severity of 'critical' puts dam failure risk at low.

2.3.2 Drought



A drought is a natural phenomenon that occurs when an area or region does not receive the normal amount of precipitation and persists for several weeks or months.

HAZARD OVERVIEW

A drought is a "prolonged dry period in natural climate cycle. It is a slow-onset phenomenon caused by rainfall deficit combined with other predisposing factors. They are often predictable" (WHO).

The most prevalent method of measuring drought severity in the United States is the Palmer Drought Severity Index (PDSI) developed in 1965. The index takes a number of factors into account to assign a score between -4 (extremely dry) and +4 (extremely wet), with 0 being the "normal" value (Palmer, 1965). Palmer drought values typically reflect long term drought, but can be calculated both monthly and weekly. The PDSI is shown graphically to the right.

TABLE 2.3.2.A PALMER DROUGHT SEVERITY INDEX

< -4.0	Extreme drought
-3.99 to -3.0	Severe drought
-2.99 to -2.0	Moderate drought
-1.99 to -1.0	Mild drought
-0.99 to -0.5	Incipient drought
-0.49 to 0.49	Near normal
0.50 to 0.99	Incipient moist spell
1.0 to 1.99	Moist spell
2.0 to 2.99	Unusual moist spell
3.0 to 3.99	Very moist spell
> 4.0	Extreme moist spell

There are four types of droughts, increasing in severity level: meteorological drought, hydrological drought, agricultural drought, and socioeconomic drought.

- **Meteorological Drought**: Dry weather patterns dominating an area.
- **Hydrological Drought**: Usually after several months of meteorological drought, when low water supplies become noticeable (i.e. low water levels in streams and reservoirs).
- **Agricultural Drought**: When crops become affected by the drought conditions.
- **Socioeconomic Drought**: Relates the supply and demand of various commodities to drought.

Drought conditions are not the same everywhere. To know what drought conditions for the area are, it is necessary to know the normal precipitation amount and average climate of the region. The NCEI provides average "normal" of precipitation and temperatures; data was collected from weather stations located in the county seats for each county. The precipitation for the whole year in the entire region averages 3.04 inches per month, or 36.5 inches a year.

TABLE 2.3.2.B CLIMATE NORMALS IN REGION 8												
	Precipitation (Inches)						*Average Temperature (°F)*					
Month	*Petersburg*	*Romney*	*Moorefield*	*Keyser*	*Franklin*	*Average Precipitation Region 8 (Inches)*	*Petersburg*	*Romney*	*Moorefield*	*Keyser*	*Franklin*	*Average Temperature Region 8 (°F)*
January	2.35	2.25	1.82	2.92	2.16	**2.3**	32.5	30.2	30.7	29.9	31.8	**31.02**
February	2.56	2.24	1.85	2.65	1.98	**2.3**	35.1	33.2	33.6	33	34.6	**33.9**
March	3.5	3.23	2.76	3.63	3.1	**3.2**	42.6	41.3	41.7	41.2	42.3	**41.82**
April	3.33	3.14	2.63	3.65	2.96	**3.1**	52.4	52.1	51.9	52	51.7	**52.02**
May	4.14	3.94	3.73	4.1	4.08	**4.0**	61.2	61.3	61.4	61.4	60.3	**61.12**
June	3.54	2.94	3.39	3.36	3.13	**3.3**	69.7	70.1	70.2	70.1	68.2	**69.66**
July	4.37	3.95	4.01	3.99	4.23	**4.1**	73.7	74.1	73.7	74.2	71.5	**73.44**
August	3.13	3.16	3.03	3.36	3.41	**3.2**	72.3	72.6	72.6	72.5	70.5	**72.1**
September	3.04	3.44	3.09	3.52	3.41	**3.3**	65.6	65.2	65.3	65.3	63.7	**65.02**
October	2.51	2.52	2.39	2.71	2.3	**2.5**	54.2	53.6	54.3	53.2	53.8	**53.82**
November	2.84	2.69	2.34	3.11	2.87	**2.8**	44.7	43.5	43.7	43.1	44.3	**43.86**
December	2.43	2.42	1.98	2.87	2.4	**2.4**	35.2	33.7	34	33.1	35	**34.2**
Totals	**37.74**	**35.92**	**33.02**	**39.87**	**36.03**	**36.5**	N/A	N/A	N/A	N/A	N/A	N/A

POSSIBLE CAUSES

Precipitation falls in uneven patterns across the country; the amount of precipitation at a particular location varies from year to year, but over a period of years, the average amount is fairly constant. The amount of rain and snow also varies with the seasons. Even if the total amount of rainfall for a year is about average, rainfall shortages can occur during a period when moisture is critically needed for plant growth, such as in the early summer. When little or no rain falls, soils can dry out and plants can die. When rainfall is less than normal for several weeks, months, or years, the flow of streams and rivers declines, water levels in lakes and reservoirs fall, and the depth to water in wells increases. If dry weather persists and water-supply problems develop, the dry period can become a drought (USGS, 2016).

LOCATION AND EXTENT

All Region 8 PDC counties have experienced droughts that affected the entire region in the past. This hazard is a region-wide hazard that can affect all areas and jurisdictions within the region. Droughts are widespread events that may extend to several states in varying degrees of severity. In Region 8 counties, the extent of a drought would be equal given the region's geography and environmental qualities.

A drought can vary in severity throughout the year; what starts out as a mild drought can reach severe or extreme drought status and then return to a mild drought. This process could take weeks or even months and the effects could be felt even months after the drought conditions are over.

HISTORICAL OCCURRENCES

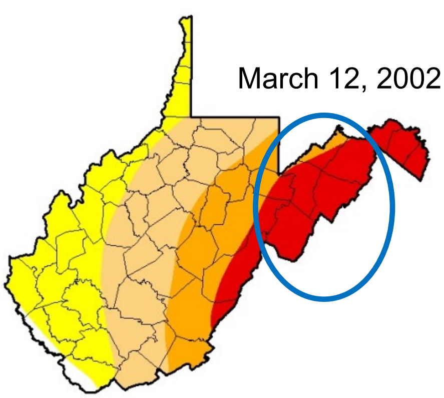
The table below represents the amount of weeks each county in Region 8 has spent under drought conditions since 2000. D-0 (Abnormally Dry) weeks are the total number of weeks there have been droughts in the counties; subsequent categories' weeks in drought conditions are not in addition to the previous drought severity weeks, but a part of them. For example, Grant County has spent 324 weeks in D-0 conditions, of which 78 were a moderate drought (D-1), of which 10 weeks were a severe drought (D-2), of which 9 were extreme drought (D-3) conditions. No counties have experienced exceptional droughts (D-4) since 2000.

TABLE 2.3.2.C WEEKS IN DROUGHT CONDITIONS SINCE 2000

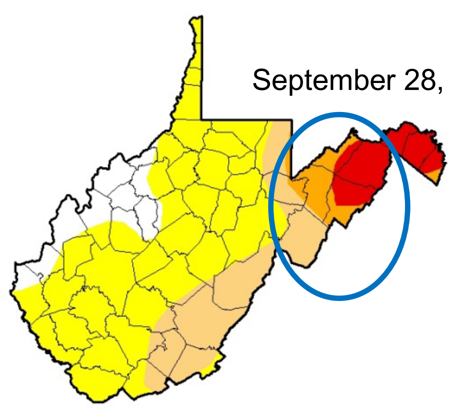
County	D-0 Weeks	D-1 Weeks	D-2 Weeks	D-3 Weeks	D-4 Weeks
Grant	324	78	10	9	0
Hampshire	280	82	24	11	0
Hardy	293	88	28	12	0
Mineral	300	62	20	7	0
Pendleton	346	84	15	5	0

There have been two instances when there has been a severe drought in the counties of Region 8; the first instance was at the end of February through the middle of April of 2002, and the second was during September of 2010. The maps below illustrate the drought conditions in the state and in Region 8 on a select week of these extreme droughts.

March 12, 2002



September 28, 2010



IMPACTS AND VULNERABILITY

Some of the impacts of each type of drought include the following.

D0	Abnormally Dry	Going into drought: • short-term dryness slowing planting, growth of crops or pastures Coming out of drought: • some lingering water deficits • pastures or crops not fully recovered
D1	Moderate Drought	• Some damage to crops, pastures streams, reservoirs, or wells low, some water shortages developing or imminent • Voluntary water-use restrictions requested
D2	Severe Drought	• Crop or pasture losses likely • Water shortages common • Water restrictions imposed
D3	Extreme Drought	• Major crop/pasture losses Widespread water shortages or restrictions
D4	Exceptional Drought	• Exceptional and widespread crop/pasture losses • Shortages of water in reservoirs, streams, and wells creating water emergencies

LOSS AND DAMAGES

SHELDUS provides drought data from 1977 to 1999. In it, the total amount of crop damages amounted to over $12 million. The NCEI does not report any drought data from 2000 through the present but has data for droughts in 1997, 1998, and 1999 with damage totaling over $3 million.

Droughts mostly affect crops; one way of determining if there has been any crop damage in the last years is by consulting the USDA NASS census of agriculture data for 1997, 2002, 2007, and 2012 to spot trends in loss or gain of crops over the years when comparing it to the drought years that are presented previously, 2002 and 2010.

Between the census years of 1997 and 2002, all counties increased their farms except Pendleton which lost six. However, the harvested acres of cropland and total sales increased in every county despite losses in previous census years.

TABLE 2.3.2.D USDA CENSUS DATA 1997-2002					
Farms (units)					
County	*1997*	*2002*	*2007*	*2012*	*Δ (%) 1997-2002*
Grant	375	357	471	486	30
Hampshire	547	635	677	798	46
Hardy	467	468	514	494	6
Mineral	343	465	493	429	25
Pendleton	590	546	600	556	-6
Totals	**2,322**	**2,471**	**2,755**	**2,763**	**19**
Harvested Cropland (Acres)					
County	*1997*	*2002*	*2007*	*2012*	*Δ (%) 1997-2002*
Grant	14,730	14,758	15,922	18,519	26
Hampshire	25,121	27,851	25,993	30,623	22
Hardy	20,889	21,684	22,891	27,240	30
Mineral	13,934	15,012	14,708	13,946	0
Pendleton	18,237	19,804	17,158	21,692	19
Totals	**92,911**	**99,109**	**96,672**	**112,020**	**21**
Total Sales (Dollars)					
County	*1997*	*2002*	*2007*	*2012*	*Δ (%) 1997-2002*
Grant	$35,651,000	$39,251,000	$42,123,000	$51,272,000	30.6
Hampshire	$15,945,000	$19,642,000	$32,549,000	$39,183,000	99.5
Hardy	$111,541,000	$123,627,000	$148,029,000	$188,970,000	52.9
Mineral	$8,537,000	$14,195,000	$15,470,000	$22,243,000	56.7
Pendleton	$68,297,000	$74,012,000	$91,788,000	$118,766,000	60.5
Totals	**$239,971,000**	**$270,727,000**	**$329,959,000**	**$420,434,000**	**55.3**

Baseline information
Gain or no change from previous year
Loss from previous year

Even though the farms or harvested acres may have dropped from one census year to the next, the total sales in dollars have always increased. Therefore, overall, there have been zero economic losses from one year to the next.

RISK ASSESSMENT

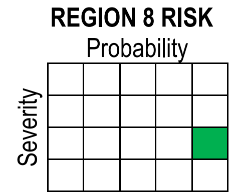
To calculate probability, data was analyzed by drought type, using the county with the most consecutive weeks under those conditions as a representative of the region. The number of events is taken from data in the US Drought Monitor. The following table illustrates the calculations.

TABLE 2.3.2.E PROBABILITY OF DROUGHT				
Drought Type	*Representative County (Consecutive Weeks)*	*Number of Events since 2000*	*Average Number of Events per Year*	*Overall Probability of Drought*
D-0	Pendleton (346)	27	1.5	Frequent
D-1	Hardy (88)	7	0.41	Remote
D-2	Hardy (28)	3	0.17	Improbable
D-3	Hardy (12)	2	0.11	Improbable
D-4	N/A (0)	0	0	Improbable

To obtain an average probability, the number of events were added together and divided by five (for each type of drought event). The average probability of drought events in the region is equal to 0.43 events per year making drought a remote event overall.

TABLE 2.3.2.F DROUGHT RISK CALCULATION						
Probability				*Severity*		*Risk*
REMOTE				NEGLIGIBLE		LOW
Events	39	= 0.43	+	All data indicates that there has been minimal loss from drought conditions throughout the years in Region 8	=	The risk assessment matrix calculates this type of hazard to be of a low risk to the area.
Years	17					
There is a remote probability that a drought event will occur during a given year.						

2.3.3 Earthquake



The moving or shifting of the Earth's tectonic plates due to built-up pressure is known as an earthquake.

HAZARD OVERVIEW

The Earth's sudden release of stored energy may manifest itself by the shaking or displacement of the ground, known as an earthquake. According to the U.S. Geological Society, based on historical trends, the frequency of an earthquake occurrence inversely relates to its magnitude. There are an estimated 1.3 million earthquakes every year with a magnitude between 2.0 and 2.9 while there is, on average, one magnitude 8.0 or higher earthquake annually.

Earthquakes move or shake the earth in three different directions depending on the plate movements: convergent, divergent, and transform generating primary and secondary waves. There are three common ways to measure an earthquake:

- **Richter Scale**: Developed in 1935, the Richter scale measures the scale and severity of an earthquake, The magnitude of an earthquake can range between 0 and 10. The effects of an earthquake can extend far beyond the site of its occurrence.
- **Modified Mercalli Scale**: The modified Mercalli scale measures earthquakes based on their intensity on the surface. This scale uses roman numerals I through XII to denote detection and damage levels associated with an earthquake.
- **Peak Ground Acceleration (PGA):** PGA is "the maximum ground acceleration that occurred during earthquake shaking at a location. PGA is equal to the amplitude of the largest absolute acceleration recorded on an accelerogram at a site during a particular earthquake" (Douglas, 2003).

POSSIBLE CAUSES

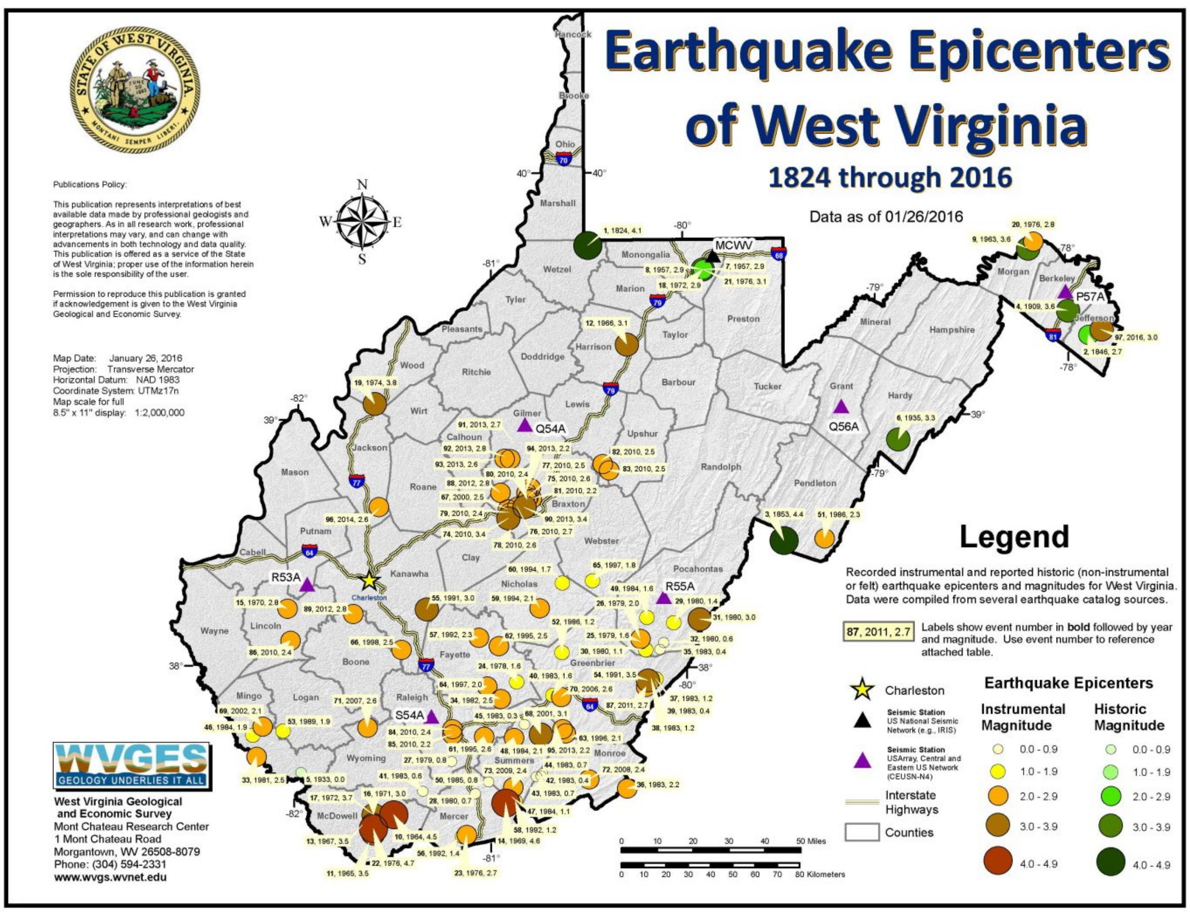
The Earth is made up of tectonic plates; the boundary lines where these tectonic plates meet are called faults. Friction along the boundaries or faults causes the rocks to stress and strain. "When the stress of the rocks exceed their strength, that is, their ability to withstand the force, the rock rupture and are permanently displaced along the fault plane" (Keller & Devecchio, 2015) causing earthquakes that reach and affect the infrastructure on the surface.

A common misconception is that hydraulic fracturing, or “fracking” is causing all of the induced earthquakes. In reality, fracking “is directly causing a small percentage of the felt-induced earthquakes observed in the United States…Most induced earthquakes in the United States are a result of the deep disposal of fluids (waste water) related to oil and gas production” (Rubinstein and Mahani, 2015).

LOCATION AND EXTENT

The United States has areas that are prone to earthquakes. The coasts of California, Oregon and Washington are more vulnerable to seismic activity due to the presence of the Ballenas, Brothers, and the San Andreas Faults on the west coast. Also of note is the New Madrid Seismic Zone located in Arkansas, Missouri, and Tennessee. On the east coast, there is the Eastern Tennessee Seismic Zone that stretches from Alabama to Virginia.

As seen in the map below, there have been very few instances of earthquake epicenters in Region 8. The majority of earthquakes felt in the region would likely originate outside the Region 8 counties.



HISTORICAL OCCURRENCES

Between the years of 1824 and 2016 there have been three epicenters of earthquakes in the Region 8 Counties; one in Hardy County in 1935 on November 1 with a magnitude of 3.3, and two in Pendleton County in 1853 on March 2 with a magnitude of 4.4, and 1986 on February 26 with a magnitude of 2.3, all along the Virginia border. Surrounding counties such as Morgan Berkeley, Jefferson and Pocahontas have also experienced earthquake epicenters. Grant, Mineral, and Hampshire Counties have not experienced epicenters.

IMPACTS AND VULNERABILITY

Earthquakes can affect people and structures alike, although older structures may be more susceptible to cracks and damage. "With most earthquakes, trauma caused by the collapse of buildings is the cause of most deaths and injuries. However, a surprisingly large number of patients require acute care for non-surgical problems such as acute myocardial infraction, exacerbation of chronic diseases such as diabetes or hypertension, anxiety and other mental health problems, respiratory disease from exposure to dust and asbestos fibers from rubble, and near-drowning because of flooding from broken dams. An earthquake may precipitate a major technologic disaster by damaging or destroying nuclear power stations, hospitals with dangerous biologic products, hydrocarbon storage areas, and hazardous chemical plants. As with most natural disasters, the risk of secondary epidemics is minimal, and only mas vaccination campaigns based on results of epidemiological surveillance are appropriate following earthquakes" (Noji, 1999).

LOSS & DAMAGES

The effects of a potential earthquake striking each county in Region 8 were analyzed using the HAZUS-MH program from the Federal Emergency Management Agency. The scenario depicts a 5.0 earthquake (the lowest possible magnitude to use in the program) located at the county seat of each county. The following tables describe the expected building damages by occupancy type and the building-related economic loss estimates.

TABLE 2.3.3.A GRANT COUNTY EXPECTED BUILDING DAMAGE BY OCCUPANCY (HAZUS)										
	None		*Slight*		*Moderate*		*Extensive*		*Complete*	
	Count	*%*	*Count*	*%*	*Count*	*%*	*Count*	*%*	*Count*	*%*
Agriculture	6	0.17	4	0.25	4	0.36	2	0.40	0	0.46
Commercial	60	1.69	35	2.39	45	4.10	22	5.21	6	6.05
Education	5	0.14	2	0.12	2	0.18	1	0.22	0	0.24
Government	4	0.12	2	0.11	2	0.19	1	0.24	0	0.28
Industrial	26	0.73	14	0.95	21	1.87	10	2.51	3	2.94
Other Residential	903	25.38	393	27.23	445	40.31	218	52.30	50	47.32
Religion	10	0.28	5	0.37	5	0.46	2	0.52	1	0.55
Single Family	2,545	71.49	990	68.57	580	52.53	161	38.60	44	42.16
TOTAL	**3,559**		**1,444**		**1,104**		**417**		**105**	

TABLE 2.3.3.B GRANT COUNTY HAZUS BUILDING-RELATED ECONOMIC LOSS ESTIMATES (MILLIONS OF DOLLARS)							
Category	*Area*	*Single Family*	*Other Residential*	*Commercial*	*Industrial*	*Others*	*Total*
Income Losses	Wage	0.00	0.62	3.06	0.51	0.22	**4.40**
	Capital Related	0.00	0.26	2.19	0.31	0.06	**2.83**
	Rental	1.32	0.77	1.16	0.30	0.12	**3.67**
	Relocation	4.87	1.43	2.15	1.49	0.94	**10.88**
	Subtotal	6.19	3.08	8.56	2.61	1.33	**21.78**
Capital Stock Losses	Structural	6.96	2.05	2.39	4.57	0.99	**19.69**
	Non Structural	23.35	6.61	6.67	14.68	2.59	**53.91**
	Content	8.46	1.47	3.65	10.81	1.42	**25.81**
	Inventory	0.00	0.00	0.10	2.30	0.03	**2.43**
	Subtotal	38.77	10.13	12.81	32.36	5.03	**99.10**
TOTAL		**44.96**	**13.22**	**21.37**	**34.97**	**6.37**	**120.88**

TABLE 2.3.3.C HAMPSHIRE COUNTY EXPECTED BUILDING DAMAGE BY OCCUPANCY (HAZUS)										
	None		*Slight*		*Moderate*		*Extensive*		*Complete*	
	Count	*%*	*Count*	*%*	*Count*	*%*	*Count*	*%*	*Count*	*%*
Agriculture	13	0.17	4	0.17	3	0.21	1	0.23	0	0.27
Commercial	80	1.06	34	1.45	41	2.51	19	3.49	6	4.49
Education	4	0.05	1	0.06	2	0.11	1	0.15	0	0.18
Government	12	0.16	4	0.15	4	0.26	2	0.35	1	0.43
Industrial	23	0.31	8	0.32	10	0.58	5	0.83	1	1.04
Other Residential	1,959	25.97	746	31.76	767	76.76	315	57.27	64	51.58
Religion	17	0.23	6	0.27	5	0.33	2	0.42	1	0.50
Single Family	5,435	72.06	1,545	65.82	807	49.24	205	37.27	52	41.51
TOTAL	**7,543**		**2,348**		**1,640**		**550**		**125**	

TABLE 2.3.3.D HAMPSHIRE COUNTY HAZUS BUILDING-RELATED ECONOMIC LOSS ESTIMATES (MILLIONS OF DOLLARS)							
Category	*Area*	*Single Family*	*Other Residential*	*Commercial*	*Industrial*	*Others*	*Total*
Income Losses	Wage	0.00	0.72	2.33	0.08	0.34	**3.47**
	Capital Related	0.00	0.30	1.53	0.05	0.05	**1.93**
	Rental	1.73	0.94	1.12	0.02	0.10	**3.92**
	Relocation	6.41	2.05	1.98	0.15	0.83	**11.41**
	Subtotal	8.14	4.00	6.97	0.31	1.32	**20.73**
Capital Stock Losses	Structural	8.62	2.91	1.19	0.41	0.90	**15.03**
	Non Structural	28.43	8.97	5.86	1.35	2.26	**46.86**
	Content	10.26	1.97	3.22	0.88	1.31	**17.64**
	Inventory	0.00	0.00	0.11	0.20	0.04	**0.35**
	Subtotal	47.30	13.85	11.39	2.84	4.51	**79.88**
TOTAL		**55.44**	**17.85**	**18.36**	**3.14**	**5.83**	**100.62**

TABLE 2.3.3.E HARDY COUNTY EXPECTED BUILDING DAMAGE BY OCCUPANCY (HAZUS)										
	None		*Slight*		*Moderate*		*Extensive*		*Complete*	
	Count	*%*	*Count*	*%*	*Count*	*%*	*Count*	*%*	*Count*	*%*
Agriculture	25	0.51	7	0.46	4	0.44	1	0.47	0	0.37
Commercial	125	2.51	38	2.45	29	3.13	8	3.76	1	3.79
Education	7	0.14	2	0.13	2	0.17	0	0.19	0	0.21
Government	12	0.25	4	0.23	3	0.33	1	0.37	0	0.38
Industrial	56	1.12	15	0.96	12	1.27	3	1.32	0	1.25
Other Residential	1,104	22.20	444	28.30	418	44.45	99	46.82	11	35.54
Religion	13	0.26	4	0.24	2	0.26	1	0.30	0	0.32
Single Family	3,631	73.00	1,054	67.23	470	49.96	99	46.77	19	58.13
TOTAL	**4,973**		**1,568**		**940**		**211**		**32**	

TABLE 2.3.3.F HARDY COUNTY HAZUS BUILDING-RELATED ECONOMIC LOSS ESTIMATES (MILLIONS OF DOLLARS)							
Category	*Area*	*Single Family*	*Other Residential*	*Commercial*	*Industrial*	*Others*	*Total*
Income Losses	Wage	0.00	0.14	0.87	0.20	0.25	**1.46**
	Capital Related	0.00	0.06	0.61	0.12	0.02	**0.81**
	Rental	0.92	0.29	0.45	0.07	0.05	**1.78**
	Relocation	3.42	0.84	0.76	0.24	0.38	**5.63**
	Subtotal	4.33	1.32	2.68	0.63	0.70	**9.67**
Capital Stock Losses	Structural	4.43	0.86	0.75	0.60	0.38	**7.03**
	Non Structural	14.54	2.45	2.06	2.29	1.01	**22.35**
	Content	5.33	0.50	1.22	1.81	0.65	**9.43**
	Inventory	0.00	0.00	0.05	0.56	0.02	**0.63**
	Subtotal	24.30	3.81	4.09	5.18	2.07	**39.45**
TOTAL		**28.64**	**5.14**	**6.77**	**5.81**	**2.77**	**14.12**

TABLE 2.3.3.G MINERAL COUNTY EXPECTED BUILDING DAMAGE BY OCCUPANCY (HAZUS)										
	None		*Slight*		*Moderate*		*Extensive*		*Complete*	
	Count	*%*	*Count*	*%*	*Count*	*%*	*Count*	*%*	*Count*	*%*
Agriculture	8	0.10	3	0.11	3	0.15	1	0.17	0	0.19
Commercial	124	1.62	58	1.93	70	3.35	32	4.58	9	5.38
Education	10	0.13	4	0.13	5	0.22	2	0.28	1	0.32
Government	13	0.17	5	0.16	6	0.29	3	0.37	1	0.41
Industrial	36	0.47	13	0.44	17	0.82	8	1.17	2	1.37
Other Residential	2,060	26.94	909	30.03	850	40.51	351	49.66	79	45.07
Religion	23	0.30	9	0.29	8	0.36	3	0.43	1	0.45
Single Family	5,374	70.28	2,024	66.91	1,140	54.30	306	43.3	82	46.80
TOTAL	**7,647**		**3,025**		**2,099**		**707**		**175**	

TABLE 2.3.3.H MINERAL COUNTY HAZUS BUILDING-RELATED ECONOMIC LOSS ESTIMATES (MILLIONS OF DOLLARS)							
Category	*Area*	*Single Family*	*Other Residential*	*Commercial*	*Industrial*	*Others*	*Total*
18.01	Wage	0.00	0.57	5.31	0.20	0.74	**6.81**
	Capital Related	0.00	0.23	3.93	0.12	0.10	**4.39**
	Rental	2.61	1.74	2.21	0.06	0.18	**6.80**
	Relocation	9.66	2.37	4.08	0.27	1.62	**18.01**
	Subtotal	12.28	4.91	15.53	0.65	2.65	**36.01**
Capital Stock Losses	Structural	13.84	3.63	4.61	0.81	1.37	**24.26**
	Non Structural	46.53	13.46	12.51	2.69	4.24	**79.42**
	Content	16.97	3.39	6.94	1.78	2.49	**31.57**
	Inventory	0.00	0.00	0.24	0.48	0.03	**0.75**
	Subtotal	77.33	20.47	24.60	5.76	8.13	**135.99**
TOTAL		**89.61**	**25.38**	**39.82**	**6.41**	**10.77**	**127.00**

TABLE 2.3.3.I PENDLETON COUNTY EXPECTED BUILDING DAMAGE BY OCCUPANCY (HAZUS)										
	None		*Slight*		*Moderate*		*Extensive*		*Complete*	
	Count	*%*	*Count*	*%*	*Count*	*%*	*Count*	*%*	*Count*	*%*
Agriculture	5	0.18	3	0.21	3	0.29	1	0.31	0	0.36
Commercial	31	1.22	19	1.36	24	2.28	12	2.98	4	3.52
Education	2	0.07	1	0.07	1	0.13	1	0.16	0	0.18
Government	4	0.16	2	0.15	3	0.28	1	0.37	0	0.43
Industrial	14	0.55	8	0.61	13	1.19	7	1.76	2	2.08
Other Residential	527	20.95	341	27.72	410	38.48	198	50.50	45	45.00
Religion	3	0.12	2	0.14	2	0.18	1	0.23	0	0.25
Single Family	1,932	76.75	1,005	72.73	609	57.17	172	43.70	48	48.18
TOTAL	**2,517**		**1,381**		**1,065**		**393**		**100**	

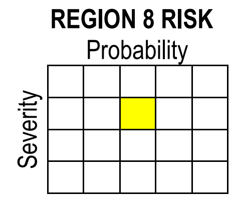
TABLE 2.3.3.J PENDLETON COUNTY HAZUS BUILDING-RELATED ECONOMIC LOSS ESTIMATES (MILLIONS OF DOLLARS)							
Category	*Area*	*Single Family*	*Other Residential*	*Commercial*	*Industrial*	*Others*	*Total*
Income Losses	Wage	0.00	1.01	1.20	0.20	0.35	**2.75**
	Capital Related	0.00	0.41	1.04	0.15	0.04	**1.62**
	Rental	1.39	0.67	0.63	0.15	0.08	**2.91**
	Relocation	5.14	1.21	0.96	0.73	0.65	**8.67**
	Subtotal	6.53	3.30	3.82	1.20	1.11	**15.95**
Capital Stock Losses	Structural	6.75	1.79	1.11	1.28	0.80	**11.73**
	Non Structural	23.03	5.32	2.97	4.17	1.80	**37.29**
	Content	8.45	1.14	1.56	3.08	1.07	**15.30**
	Inventory	0.00	0.00	0.06	0.47	0.04	**0.58**
	Subtotal	38.23	8.25	5.70	9.00	3.71	**64.90**
TOTAL		**44.76**	**11.55**	**9.53**	**10.20**	**4.82**	**80.85**

Total potential losses for a worst case scenario event in all counties in Region 8 could amount to over $443,470,000,000.

RISK ASSESSMENT

TABLE 2.3.3.K EARTHQUAKE RISK CALCULATION				
Probability		*Severity*		*Risk*
IMPROBABLE		MARGINAL		LOW
Based on past occurrences of earthquakes in the area, the probability of an epicenter occurring in one of the Region 8 counties is improbable.	+	The most likely damages to occur from an earthquake are minor structural losses.	=	The risk assessment matrix calculates the risk of earthquakes to the area to be low.

2.3.4 Epidemic



An epidemic is a sudden increase in the number of cases of an infectious disease above what is normally expected.

HAZARD OVERVIEW

According to the Centers for Disease Control and Prevention (CDC), there are various levels that refer to the amount or extent of a disease occurrence (CDC, 2012).

- **Endemic** refers to the constant presence and/or usual prevalence of a disease or infectious agent in a population within a geographic area; it is the amount of a particular disease that is usually present in a community or baseline.
- **Sporadic** refers to a disease that occurs infrequently and irregularly.
- **Hyper endemic** refers to persistent, high levels of disease occurrence.
- **Cluster** refers to an aggregation of cases grouped in place and time that are suspected to be greater than the number expected, even though the expected number may not be known.
- **Epidemic** refers to an increase, often sudden, in the number of cases of a disease above what is normally expected in that population in that area. Epidemics occur when an agent and susceptible hosts are present in adequate numbers, and the agent can be effectively conveyed from a source to the susceptible hosts. More specifically, an epidemic may result from:
    - a recent increase in amount or virulence of the agent,
    - the recent introduction of the agent into a setting where it has not been before,
    - an enhanced mode of transmission so that more susceptible persons are exposed,
    - a change in the susceptibility of the host response to the agent, and/or
    - factors that increase host exposure or involve introduction through new portals of entry.
- **Outbreak** carries the same definition of epidemic, but is often used for a more limited geographic area.
- **Pandemic** refers to an epidemic that has spread over several countries or continents, usually affecting a large number of people.

Some diseases are so rare in a given population that a single case warrants an epidemiologic investigation (e.g., rabies, plague, polio), other diseases occur more commonly so that only deviations from the norm warrant investigation.

POSSIBLE CAUSES

Epidemics can develop with little or no warning and quickly erode the capacity of local medical care providers. A fast developing epidemic can last several days and extend into several weeks. In some extreme cases, they can last for several months. An epidemic can occur at any time of the year, but the warm summer months, when bacteria and microorganism growth are at their highest, present the greatest risk.

The overall health of the population can be a factor in assessing the risk to the population. In general, the healthier the population is the less inclined they are to become ill.

LOCATION & EXTENT

According to the regional Epidemiologist, there are numerous outbreaks every year but cannot identify them by name or county because of confidentiality concerns. However, grouped together, since 2013, Region 8 counties have had numerous outbreaks of influenza and gastroenteritis (usually norovirus) in long-term care facilities, pertussis associated with schools and daycares, influenza at schools and the regional jail, campylobacter in constructions workers doing contract work at a local plant, a foodborne outbreak involving a food service establishment, hand, foot, and mouth disease in schools, scabies in schools and long-term care facilities, and a case of acute flaccid myelitis in a child (which is considered an outbreak, because it is a rare disease for the region, possibly one or two cases statewide annually.

HISTORICAL OCCURRENCES

According to the regional Epidemiologist, the types of illness or disease health departments in Region 8 are most concerned about are Influenza, rabies, tuberculosis, sexually-transmitted diseases, opioid epidemic and increasing numbers of Hepatitis B and Hepatitis C.

Data for the following table was provided by the Regional Epidemiologist for the Public Health District 3.

- The health departments have records that go back to 2012 and 2017 data was not yet available.

- The animal exposure data also only includes those exposures involving humans. Any exposures that only involve animals, i.e. dog attacked by skunk, etc., are investigated by the health department, but are not in the electronic system.
- The numbers provided are from confirmed and probable cases, because that is what is reported to CDC. Suspect cases and those deemed to not be cases are not reported, and were pulled out from the data set.
- There are more reportable diseases than there are listed on the table; this is because the disease has been removed from the list if there have been no instances of occurrence in the last five years. Examples include Anthrax, Influenza-related death or people under age 18, Plague, etc.
- Influenza has not been tracked until 2017 and therefore is not on the list or reportable diseases.

TABLE 2.3.4.A HEALTH DEPARTMENT REPORTED DISEASES PER COUNTY

Disease	*2012*					*2013*					*2014*					*2015*					*2016*				
	Grant	*Hampshire*	*Hardy*	*Mineral*	*Pendleton*	*Grant*	*Hampshire*	*Hardy*	*Mineral*	*Pendleton*	*Grant*	*Hampshire*	*Hardy*	*Mineral*	*Pendleton*	*Grant*	*Hampshire*	*Hardy*	*Mineral*	*Pendleton*	*Grant*	*Hampshire*	*Hardy*	*Mineral*	*Pendleton*
Animal Bites/Exposures	24	47	3	10	31	19	48	1	10	25	22	37	0	0	27	24	29	0	43	28	30	51	0	66	26
Campylobacteriosis	2	2	6	0	1	1	5	3	0	0	3	5	9	3	1	4	6	9	9	4	3	8	7	9	5
Carbepenem-resistant Enterobacteriaceae	0	0	0	0	0	0	0	0	0	0	0	0	0	0	1	0	0	1	1	0	3	0	1	2	1
Cryptosporidiosis	0	0	0	1	0	0	0	0	2	0	0	0	1	0	0	0	0	0	3	0	0	0	0	2	0
E. coli shiga-toxin producing (STEC)	0	0	0	0	0	0	0	0	0	0	2	0	0	1	0	0	0	0	0	0	0	0	1	0	0
Ehrlichiosis/Anaplasmosis	0	0	0	0	0	0	0	1	1	0	0	0	0	0	0	0	1	0	0	0	0	0	0	0	0
Giardiasis	0	0	2	0	1	1	0	0	0	1	0	2	1	3	1	0	0	0	1	0	0	0	2	1	0
Haemophilus influenzae, invasive	0	0	0	0	2	1	0	0	1	0	0	0	0	0	0	0	0	0	0	1	0	2	2	0	0
Hepatitis A, Acute	1	0	0	0	0	0	0	0	0	0	0	0	0	0	0	0	1	0	0	0	0	1	0	0	0
Hepatitis B, Acute	0	0	0	1	0	1	0	0	0	0	0	0	0	0	0	0	0	0	1	0	0	0	0	0	0
Hepatitis B, Chronic	0	2	1	3	0	0	0	0	2	0	2	0	3	0	1	0	2	0	1	0	0	0	2	1	1
Hepatitis C, Acute	0	0	0	0	0	1	0	0	0	0	0	1	0	0	0	0	1	0	1	0	0	0	2	0	0
Hepatitis C, Chronic	19	21	15	29	6	13	18	11	12	14	23	49	30	31	5	10	41	21	38	6	17	57	38	27	13
Legionellosis	0	0	0	1	1	0	1	0	1	0	0	1	0	0	0	0	0	0	3	0	0	0	0	0	0
Listeriosis	0	0	0	1	0	0	0	0	0	1	0	0	0	0	0	0	0	0	0	0	0	0	0	0	0
Lyme Disease	0	6	1	1	0	0	11	1	2	0	0	26	1	6	1	1	24	2	14	1	2	36	4	22	3
Malaria	0	0	1	0	0	0	0	0	0	0	0	0	0	1	0	0	0	0	1	0	0	0	0	0	0
Neisseria meningitidis, invasive	1	0	0	0	1	0	0	0	0	0	0	0	0	0	0	0	0	0	0	0	0	0	0	0	0
Novel Influenza A infection	0	0	0	1	0	0	0	0	0	0	0	0	0	0	0	0	0	0	0	0	0	0	0	0	0
Pertussis	0	0	0	1	0	0	0	0	0	0	0	1	3	0	0	1	6	0	0	0	0	0	0	0	0
Q Fever	0	0	0	0	0	0	0	0	0	0	0	1	0	0	1	0	1	0	0	0	0	0	0	0	0
Rabies, animal	5	2	7	4	12	5	2	4	3	12	6	0	2	3	6	7	0	1	10	3	5	5	1	3	0
Rocky Mt. Spotted Fever	0	0	1	0	0	0	1	0	0	0	1	0	0	1	0	0	0	0	0	0	0	2	0	0	0

TABLE 2.3.4.A HEALTH DEPARTMENT REPORTED DISEASES PER COUNTY																									
	2012					*2013*					*2014*					*2015*					*2016*				
Disease	*Grant*	*Hampshire*	*Hardy*	*Mineral*	*Pendleton*	*Grant*	*Hampshire*	*Hardy*	*Mineral*	*Pendleton*	*Grant*	*Hampshire*	*Hardy*	*Mineral*	*Pendleton*	*Grant*	*Hampshire*	*Hardy*	*Mineral*	*Pendleton*	*Grant*	*Hampshire*	*Hardy*	*Mineral*	*Pendleton*
Salmonella	3	2	1	1	0	1	0	3	3	0	0	2	2	1	1	0	2	3	3	0	1	0	1	1	0
Streptotoccal Toxic Shock Syndrome	0	0	0	0	1	0	0	0	0	0	0	0	0	0	0	0	0	0	0	0	0	0	0	0	0
Streptococcus, Group A invasive	1	0	0	0	1	1	0	0	1	0	0	0	0	0	0	0	0	0	1	0	0	0	0	0	0
Streptococcus, Group B invasive	0	2	0	3	0	3	0	1	1	0	1	2	0	2	1	1	1	0	1	1	0	3	1	3	0
Streptococcus pneumoniae, invasive	1	0	0	3	2	8	0	1	3	1	1	5	2	5	1	1	2	1	4	0	2	2	0	5	0
Yersiniosis	0	0	0	0	1	0	0	0	0	0	0	0	0	0	0	0	0	0	0	0	0	0	0	0	0
Zika Virus Disease	0	0	0	0	0	0	0	0	0	0	0	0	0	0	0	0	0	0	0	0	1	0	0	0	0
TOTAL	**57**	**84**	**38**	**60**	**60**	**55**	**86**	**26**	**42**	**54**	**61**	**132**	**54**	**57**	**47**	**49**	**117**	**38**	**135**	**44**	**64**	**167**	**62**	**142**	**49**

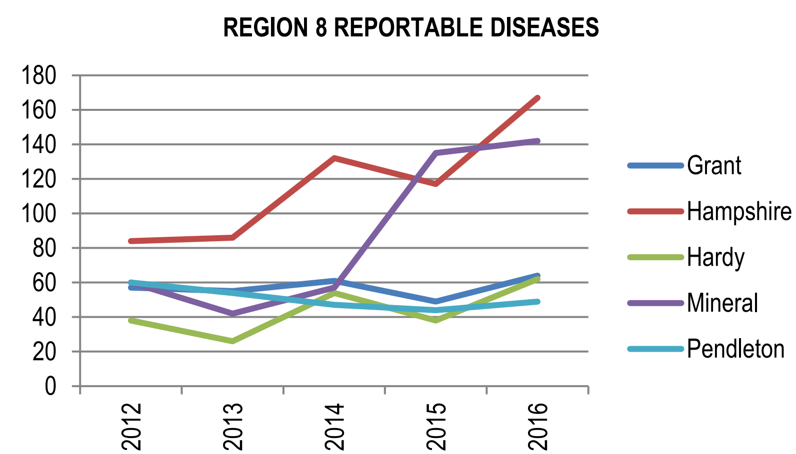


TABLE 2.3.4.B REPORTABLE DISEASE SUMMARY							
County	*2012*	*2013*	*2014*	*2015*	*2016*	*Total (County)*	*Average Per Year (County)*
Grant	57	55	61	49	64	286	**57.2**
Hampshire	84	86	132	117	167	586	**117.2**
Hardy	38	26	54	38	62	218	**43.6**
Mineral	60	42	57	135	142	436	**87.2**
Pendleton	60	54	47	44	49	254	**50.8**
Total (Region 8)	299	263	351	383	484	1780	**356**
Average Per Year (Region 8)	**59.8**	**52.6**	**70.2**	**76.6**	**96.8**	**356**	**71.2**

IMPACT AND VULNERABILITY

Indirectly, the continual reduction in funding for public health at the state and local level is affecting our ability to perform public health services in a timely manner, primarily because of lack of staff, but also because of inability to purchase resources needed to provide those services that are mandated by law. The expiration of the funding for the federal Children's Health Insurance Program (CHIP) is of concern to public health. One of the avenues Congress is looking at to fund CHIP is by cutting the funding in the Prevention and Public Health Fund (PPHF), which provides nearly $2.2 million to WV annually. The proposed cut is 75% of this money over 10 years. This money funds the Epidemiology and Laboratory Capacity Grant (provides 3 regional epidemiologists and partial funding for several state epidemiologists, along with the influenza testing capacity and other laboratory resources at the state Office of Laboratory Services), as well as the Immunization and Vaccines for Children Program. Cuts to this funding would eliminate the regional epidemiologist position, as well as funds for the state to purchase vaccines for the immunization program. Not being able to provide necessary, and required, public health services, should be considered a hazard to the health of the citizens in the area.

LOSS & DAMAGES

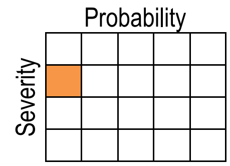
Losses based on historical epidemic occurrences are difficult to estimate. According to a study by Molinari (2007), seasonal influenza results in a substantial economic impact, estimated, in part, at $16.3 billion in lost earnings. By population, Region 8 represents 0.25% of the United States. Since seasonal influenza primarily impacts the human population, using Region 8's composition of the U.S. as a multiplier (i.e., 0.0025) and applying it to the potential economic impact, lost earnings in Region 8 counties could reach a staggering $40,750,000 each year. Though that number appears high, it equates to approximately $488 per year for each person in the county. Epidemics rarely affect structures. Epidemics may affect people and, at times, the operations of critical facilities, businesses, and other community assets.

RISK ASSESSMENT

TABLE 2.3.4.C EPIDEMIC RISK CALCULATION				
Probability		*Severity*		*Risk*
OCCASIONAL		CRITICAL		MEDIUM
Although there are on average 71 cases of reportable diseases in Region 8 annually, this does not indicate the presence of an epidemic. However, due to the prevalence of Influenza (although not reported) in the area, the probability is set at occasional.	+	Historically in the area, there has been a low impact from epidemics. Even calculating economic implications, the loss is less than $500 per person per year. There is no damage to structures from epidemics, but due to the potential illness and loss of life, the severity is critical.	=	The risk assessment matrix estimates that the risk of an epidemic to Region 8, based on probability and severity, is medium.

2.3.5 Flood

REGION 8 RISK



A flood is an overflow of water that submerges land that is typically dry.

HAZARD OVERVIEW

Flooding is arguably the highest priority hazard in all five counties throughout the region (as is the case in most of West Virginia). The counties are susceptible to flooding largely due to physical geography, which includes several rivers and creeks as well as varied topography. The worst floods usually occur when a river overflows its banks. Periodic floods occur naturally on most rivers, forming an area known as a "floodplain". With enough rainfall, the rivers and creeks will rise up to and over the floodplain, thus causing a flood.

Flash flooding is also a common concern throughout the region. Historical occurrences can indicate where flash flooding will strike, but it is somewhat more unpredictable than riverine flooding. Flash flooding can be a result of an overloaded storm water management system, a washed out creek bed, water rushing off of a hill or mountain, etc. In some cases, flash floods result in great damage because areas that are not in identified floodplains (and are thus not prepared for potential flooding) are affected.

NATIONAL FLOOD INSURANCE PROGRAM

Each jurisdiction has designated an "NFIP Coordinator", sometimes referred to as the "Floodplain Manager". This individual maintains the jurisdiction's floodplain ordinance and ensures that development is compliant with that ordinance (and, consequently, the NFIP). The operations of the floodplain offices in Region 8 are similar from jurisdiction to jurisdiction. Generally, floodplain managers provide three basic services: floodplain identification, floodplain management, and outreach.

The following local governments in Region 8 are participants in the National Flood Insurance Program (NFIP).

TABLE 2.3.5.A REGION 8 COMMUNITIES PARTICIPATING IN THE NFIP

Community Name	*County*	*Initial FHBM Identified*	*Initial FIRM Identified*	*Current Effective Map Date*	*Reg-Emer Date*
Bayard, Town of	Grant County	11/22/1974	08/10/79	09/02/09(M)	08/10/79
Capon Bridge Town	Hampshire County	08/16/74	04/01/88	11/7/2002	04/01/88
Franklin, Town of	Pendleton County	05/31/74	09/01/87	03/02/10	09/01/87
Grant County*	Grant County	01/10/75	08/01/87	09/02/09	08/01/87

TABLE 2.3.5.A REGION 8 COMMUNITIES PARTICIPATING IN THE NFIP					
Community Name	*County*	*Initial FHBM Identified*	*Initial FIRM Identified*	*Current Effective Map Date*	*Reg-Emer Date*
Hampshire County*	Hampshire County	01/31/75	08/01/87	11/7/2002	08/01/87
Hardy County *	Hardy County	04/25/75	06/19/85	09/02/09	06/19/85
Keyser, City of	Mineral County	06/28/74	09/27/91	03/19/13	09/27/91
Mineral County *	Mineral County	01/31/75	09/27/91	03/19/13	09/27/91
Moorefield, Town of	Hardy County	05/31/74	12/15/1990	09/02/09	07/01/87
Pendleton County*	Pendleton County	04/25/75	07/01/87	03/02/10	07/01/87
Petersburg, Town of	Grant County	05/07/74	05/03/90	09/02/09	06/18/87
Piedmont, City of	Mineral County	08/23/74	09/27/91	03/19/13	09/27/91
Ridgeley, Town of	Mineral County	01/31/75	09/27/91	03/19/13	04/03/13
Romney, Town of	Hampshire County	05/06/77	06/15/88	11/7/2002	06/15/88
Wardensville, Town of	Hardy County	11/15/1974	08/01/87	09/02/09(M)	08/01/87

* Includes unincorporated communities
(M) No elevation determined – all zone A, C, and X

Throughout the region, the floodplain managers are the primary local contact for floodplain mapping. In many cases, they are responsible for using these maps to determine whether structures or proposed structures/developments are either in or out of the floodplain. Floodplain managers can provide information as to the "zone" (e.g., A, AE, etc.) a proposed development is located. Zone designations can affect insurance policies and rates.

Floodplain managers work with surveyors and engineers to assist the public with elevation certificates. This assistance includes putting those in need in contact with appropriate surveyors, providing access to certain forms (e.g., letter of map amendment, etc.), etc. Floodplain managers may also serve as a liaison with the Federal Emergency Management Agency (FEMA) by collecting and submitting completed certificates.

The coordinators for the five counties in the region also often provide support to municipal floodplain coordinators. County and other municipal floodplain coordinators often support these municipalities with advice, technical assistance, quality control (i.e., a "second opinion"), etc. Further, many of the municipal jurisdictions throughout the region are small with part-time or volunteer government staff. County coordinators can support these efforts as well. Municipalities themselves, though, are responsible for providing the "ultimate say" for cases within their jurisdiction.

Floodplain managers are responsible for enforcing the floodplain ordinance (usually through the floodplain identification tasks discussed above). Floodplain managers also keep records of all maps and certificates for their jurisdictions. Floodplain identification and management also include integration with other planning efforts such as comprehensive plans and hazard mitigation plans.

Floodplain coordinators serve as the Points of Contact (POCs) for their jurisdiction's residents regarding floodplain regulations. All coordinators indicated that they maintain the appropriate forms, contact lists for local surveyors and engineers, the most recent version of FIRM or D-FIRM information, etc. Educating the community about the value of flood insurance also falls under this category. As an example in Hardy County, many citizens, when informed by the County that their parcel of land is located in the 1% floodplain, consistently reply, unless affected by the 1985 and 1996 floods, that there was never any flood on their land, "as long as they could remember". Despite this, the Hardy County Planning Office has all of the up-to-date FEMA flood literature to educate the public.

Finally, on an as-needed basis, floodplain managers review updates to the flood maps themselves. This type of service is done to varying degrees throughout the region. As a follow up to map review, floodplain managers work with their governing body to update the floodplain ordinance appropriately. In some jurisdictions, such maintenance is a joint approach

It is significant to note that all counties in Region 8 have adopted the most recent versions of the Flood Insurance Rate Map (FIRM) mapping for their jurisdictions. In August of 2008, Hardy County adopted a more stringent floodplain ordinance. In addition, the towns of Moorefield and Wardensville have updated their floodplain ordinances.

Hampshire County has recently updated the floodplain management plan pursuant to participating in the Community Rating System (CRS). A copy of this plan is included in Appendix 4: Hampshire County Floodplain Management Plan.

POSSIBLE CAUSES

According to NOAA, some of the possible causes for flooding include the following.

- **Excessive Rainfall:** This is the most common cause of flooding. Water accumulates quicker than the soil can absorb resulting in flooding.
- **Snowmelt**: It occurs when the major source of water involved is caused by melting snow. Unlike rainfall that can reach the soil almost immediately, the snowpack can store the water for an extended amount of time until temperatures rise above freezing and the snow melts.
- **Ice or Debris Jams**: Common during the winter and spring along rivers, streams and creeks. As ice or debris moves downstream, it may get caught on any sort of

obstruction to the water flow. When this occurs, water can be held back, causing upstream flooding. When the jam finally breaks, flash flooding can occur downstream.

- **Dam Breaks or Levee Failure**: Dams can overtop, have excessive seepage or have structural failure. For more information on this topic see Section 2.3.1 Dam Failure.

HISTORICAL OCCURRENCES

All of the Region 8 counties have an extensive history of flooding. Historic floods include:

- **Grant County:** The county experienced flooding events in both January and September of 1996. The areas that felt the most effects were Cabins and the Town of Bayard. Grant County, like many other areas in West Virginia, sufferance the most devastating flood of the past 40 years in 1985. Petersburg was significantly affected in 1985. A number of the deaths reported as a result of the 85 Flood occurred in Grant County.
- **Hampshire County:** In November, 1985, small stream and river flooding in the Potomac River basin affected Hampshire County.
- **Hampshire County**: In 1996, five homes were destroyed and 15 were damaged as a result of snow melt and heavy rains. Numerous roads and one bridge sustained damages. The Springfield area was without water for several days until the National Guard provided a 3,500 gallon water tanker for the residents. Also, in September 1996 Hurricane Fran dropped 4 to 6 inches of rain across the already saturated Potomac Highlands. In Hampshire County, 240 homes were damaged, 13 single-family homes and 108 mobile homes were destroyed and 40 single-family homes received major damage

Flooding events since the last plan update include the following, according to data from NCEI.

- **Kessel, Hardy County – 07/20/2012**: A slow-moving cold front produced showers and thunderstorms in a highly moist atmosphere. High rainfall rates over already-saturated grounds produced isolated flash flooding in Hardy County. Flash Flooding on Kessel Road.
- **Headsville, Mineral County – 10/29/2012**: Hurricane Sandy moved up the Atlantic coast and then turned Northwest and made landfall northeast of MD. Heavy rain and

high winds over spread coastal regions and most of Maryland, eastern panhandle of West Virginia and Northern Virginia. Heavy rain caused flooding and river flooding. There was water running over Headsville Road at Patterson Creek.

- **Franklin, Pendleton County – 07/19/2013**: High pressure was off the South Carolina coast. Warm and humid conditions existed across the Mid-Atlantic and isolated thunderstorms formed over the higher terrain. There were several streets flooded in Franklin WV.
- **Wardensville, Hardy County – 07/22/2013**: A surface trough was over the area while an upper level disturbance moved overhead. Showers and thunderstorms produced heavy rainfall as they moved over the mountains. There were three roads closed by water over the road.
- **Romney, Hampshire County – 06/03/2016**: A cold front approached the region while Tropical Storm Bonnie was off the Outer Banks of North Carolina. Full sunshine and easterly flow across the area led to instability and showers and thunderstorms produced heavy rainfall that led to flooding across Central Virginia and the Potomac Highlands. Sand Hill Road was closed due to flooding.

The following table lists the flooding events in Region 8 by county and includes the SHELDUS (for events from 1967 through 1995) and NCEI (for events from 1996 to 2017) data available. According to the data, Hampshire County has experienced the most flooding events, but Hardy and Pendleton Counties have experienced the most flash flood events.

TABLE 2.3.5.B FLOOD EVENTS 1967-2017

County	Events (SHELDUS 1967-1995)	Events (NCEI 1996-2017)		Total Events (1967-2017)
		Floods	Flash Floods	
Grant	13	13	24	50
Hampshire	14	22	24	60
Hardy	15	11	27	53
Mineral	16	8	24	48
Pendleton	14	1	28	43
Totals	**72**	**55**	**127**	**254**

LOCATION AND EXTENT

All five counties have experienced flooding in the past and will continue to do so. However, there are locations within the counties that may be more susceptible to flooding due to geography.

- **Grant County:** Areas surrounding downtown Petersburg, including the Grant County Airport, are located in the floodplain. Parts of Lunice Creek Highway, North Fork Highway (WV 55), and Patterson Creek Road could potentially be cut off.
- **Hampshire County**: A number of roadways commonly flood in Hampshire County. These include the following.
    - Silas Milleson Road 28/5
    - Cliffside Road 28/5
    - Herriott Road 28/5
    - Buffalo Hollow Road 28/1
    - Taylor Road 3/7
    - Maple Landing on Rt. 3
    - Toll Bridge on Rt. 1
    - Arnold Stickley Road North 1/1
    - Foxes Hollow Road 50/4
    - Mack Road 7/5
    - River Road (Capon Bridge) Rt. 15
    - Branch to Kump Road 23/9
    - Gaston Road 45/7
    - Little Cacapon Road South Rt. 12
    - Christian Church Road. Rt. 13
    - Dillons Run Road 50/25

- **Hardy County:** Like the other areas in the region, Hardy County experienced significant flooding in 1985 and 1996. Moorefield as well as the communities of Fisher and Lost River have frequently experienced flooding.
- **Mineral County:** The county was also noted as being heavily affected by events in 1985 and 1996. Isolated floods have affected the area in 2009, 2010, and 2011.
- **Pendleton County:** Pendleton County was another area that experienced a number of deaths as a result of the 1985 flood. Pendleton County was identified as one of the most devastated counties in the state. Fifty-eight single-family homes and 130 mobile homes were totally destroyed. Eighty-six single-family homes and 59 mobile homes received major damage and 214 single-family homes and 3 mobile homes received minor damages. Thirty-nine businesses were destroyed or damaged. Eighteen public buildings, 60 private bridges, 206 outbuildings, 51 barns, and 204

recreational vehicles received damage or were destroyed. Farmland damage was estimated at $175 million. In January, 1996, heavy rain and melting snow caused small stream and river flooding across the region. Major problems for Pendleton County included water supply and the need for hay to feed cattle. However, in September, 1996, the county received a greater amount of damage thanks to the remnants of Hurricane Fran dropping between five and six inches of rain onto the already saturated Potomac Highlands. One hundred total homes were damaged, with one single family home and 32 mobile homes being totally destroyed. Ten West Virginia Counties, including the five counties of the Potomac Highlands, were declared federal disaster areas by President Clinton. Additionally, during 2003, there were three isolated floods in the county.

IMPACT AND VULNERABILITY

One of the main concerns with health and floods is that many times floods can cause power outages that affect people who are dependent on power to run life-sustaining equipment. During a flood, people and first responders run the risk of sustaining injuries related to saving people and property as well as the possibility of drowning. In rare circumstances, floodwater can carry bacteria that can be harmful.

Floods often disrupt many services including power, sewer, water, communications, and road access. Lacking these, it is difficult to continue critical services to the community. Damage to property, facilities, and infrastructure can range from minimal to total loss. The cost of recovery from floods can vary for everyone. Homeowners and businesses can claim insurance benefits if they have them, but may not be able to continue working due to devastation of the community or of their own property.

LOSS AND DAMAGES

HAZUS reports from 2010 were compiled for the 100-year flood event, which is a flood event with a 1% chance of being equaled or exceeded in any single year. If an event, though, were to be classified as a 100-year flood in any county, it is likely that the event itself would be regional and affect, at least minimally, other nearby counties. The following structure loss estimates apply to a 100-year flood.

TABLE 2.3.5.C VULNERABLE STRUCTURES AND LOSSES (HAZUS 2010)										
County	Residential	Commercial	Industrial	Agricultural	Religious	Government	Education	Utilities	Total	Losses
Grant	318	5	0	33	0	0	0	3	359	$36,166,031
Hampshire	2500	50	1	400	15	2	2	10	2,980	$281,600,644
Hardy	646	13	0	51	1	0	0	6	717	$93,666,558
Mineral	652	9	0	25	1	0	0	12	699	$84,223,615
Pendleton	411	6	0	120	4	0	0	4	545	$54,977,892
TOTALS	**4527**	**83**	**1**	**629**	**21**	**2**	**2**	**35**	**5,300**	**$550,634,740**

Several communities experience repeated flooding problems. Some even contain a number of properties that have been flooded and repaired multiple times. These properties are referred to as "Repetitive Loss" (RL) properties. Actual RL listings are protected by privacy laws because of the presence of names, addresses, losses, etc. These properties, though, can be depicted by occupancy type.

TABLE 2.3.5.D REPETITIVE LOSS PROPERTIES IN REGION 8								
Community	RL Properties	Total Losses	← Occupancy Type →	2-4 Family	Condo	Non Residential	Other	Single Family
Grant County	6	13		0	0	3	0	3
Petersburg	10	20		0	1	3	1	5
Hampshire County	33	70		0	0	0	1	32
Capon Bridge	4	10		0	0	0	0	4
Hardy County	2	4		0	0	1	0	1
Moorefield	2	4		0	0	1	0	1
Mineral County	7	11		0	0	1	0	6
Keyser	15	44		2	1	0	1	11
Pendleton County	6	15		0	0	1	0	5
Totals	**85**	**196**		**2**	**2**	**10**	**3**	**68**

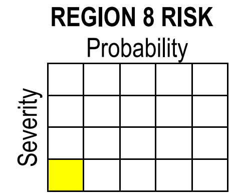
The following table outlines the damages incurred from flood events in Region 8 based on data available from SHELDUS and NCEI.

TABLE 2.3.5.E DAMAGES FOR FLOOD EVENTS 1967-2017				
County	Total Events (1967-2017)	Damages (SHELDUS)	Damages (NCEI)	Total Damage
Grant	50	$36,940,097	$325,000	$37,265,097
Hampshire	60	$36,843,658	$301,000	$37,144,658
Hardy	53	$36,853,528	$12,000	$36,865,528
Mineral	48	$38,668,163	$22,000	$38,690,163
Pendleton	43	$36,911,045	$34,000	$36,945,045
Totals	**254**	**$186,216,491**	**$694,000**	**$186,910,491**

RISK ASSESSMENT

<table>
<tr><th colspan="7">TABLE 2.3.5.F FLOOD RISK CALCULATION</th></tr>
<tr><th colspan="3">Probability</th><td rowspan="5">+</td><th>Severity</th><td rowspan="5">=</td><th>Risk</th></tr>
<tr><td colspan="3">FREQUENT</td><td>CRITICAL</td><td>MEDIUM HIGH</td></tr>
<tr><td>Events</td><td>254</td><td rowspan="2">= 5.08</td><td rowspan="3">With mainly structural damage, the severity of this hazard is critical due to the cascading effects that floods cause.</td><td rowspan="3">The risk assessment matrix categorizes the risk for flood based on its probability and severity as medium high.</td></tr>
<tr><td>Years</td><td>50</td></tr>
<tr><td colspan="3">There are roughly five flooding events in the Region 8 counties every year making this hazard a frequent one.</td></tr>
</table>

2.3.6 Hazardous Materials Incident



Hazardous materials are any items or agents that have the potential to cause harm to humans, animals, or the environment.

HAZARD OVERVIEW

A hazardous material may be defined as a substance or material, which, because of its chemical, physical or biological nature, poses a threat to life, health, or property if released from a confined setting. A release may occur by spilling, leaking, emitting toxic vapors, or any other process that enables the material to escape its container, enter the environment, and create a potential hazard. Several common hazardous materials include those that are explosive, flammable or combustible, poisonous or radioactive. Related combustible hazardous materials include oxidizers and reactive materials, while toxins produced by etiological (biological) agents are types of poison that can cause disease.

A hazmat release while in transit is of great concern to the U. S. Department of Transportation. While most hazardous materials are stored and used at fixed sites, these materials are usually produced elsewhere and shipped to the fixed facility by rail car, truck, or onboard ships or barges. Signs identify these vehicles or placards denoting the hazard, however, the possibility of release is present at any time. Hazardous materials are constantly being moved in West Virginia on interstate highways, the rail system and on shipping lanes on various rivers. Region 8 counties do not have any river ports.

There are two major agencies that collect data as they relate to hazardous materials incidents the Pipeline and Hazardous Materials Safety Administration (PHMSA) governed by the U.S. Department of Transportation (DOT), and the National Response Center (NRC), governed by the U.S. Coast Guard (USCG).

TABLE 2.3.6.A NRC HAZMAT INCIDENT CAUSES

Cause for Failure	*Incidents*
Derailment	3
Dumping	5
Equipment Failure	9
Explosion	1
Natural Phenomenon	2
Operator Error	9
Other	8
Transportation Accident	2
Trespasser	1
Unknown	22
Total	**62**

POSSIBLE CAUSES

There are a variety of reasons why a hazardous materials incident could occur. In data maintained by the NRC, the major reason for an incident is unknown, meaning that the cause of the incident was not reported. However, the two main reasons that are known for failures are due to equipment failure and operator error. A breakout of the causes reported can be seen in Table 2.3.6.A.

LOCATION & EXTENT

Hazardous materials spills, leaks, or accidents can occur at any location in all counties of Region 8. More specifically, they are more likely to happen on transportation pathways such as roads and railways, and at facilities that routinely handle hazardous materials such as gas stations, chemical companies, and other Tier II reporting facilities.

TABLE 2.3.6.B NRC INCIDENT LOCATIONS	
Location of Incidents	*Incidents*
Fixed Facility	36
Mobile	4
Pipeline	2
Railroad	13
Storage Tank	5
Unknown Sheen	2
Total	**62**

The extent of the damage from hazmat can be localized to just a cleanup on the road, or widespread, to include hazardous materials reaching source water via storm drains, and the river. According to data from the NRC, there are several locations where hazmat incidents can occur.

All counties in Region 8 contain "fixed facilities", also known as Tier II facilities, which report the use and/or storage of hazardous materials to the appropriate county Local Emergency Planning Committee (LEPC). The following are approximate facility counts for each county (*Source: Local LEPCs*):

- **Grant:** 15*
- **Hampshire:** 19
- **Hardy:** 15*
- **Mineral:** 27
- **Pendleton:** 19*

**NOTE: "Star" denotes estimated numbers.*

HISTORICAL OCCURRENCES

Between 2010 and 2017, the majority of reported hazmat incidents occurred in Mineral County, followed by Grant, Hampshire, Hardy, and Pendleton Counties. Both databases utilized indicate that there have been a total

TABLE 2.3.6.C HAZMAT INCIDENTS			
County	*Incidents (NRC) 2010-2017*	*Incidents (PHMSA) 1990-2011*	*Total Incidents 1990-2017*
Grant	17	2	19
Hampshire	14	2	16
Hardy	6	4	10
Mineral	22	7	29
Pendleton	3	2	5
Total	**62**	**17**	**79**

of 79 incidents. It is likely that there have been many more incidents that have not been reported to either agency.

IMPACTS AND VULNERABILITY

Due to the wide variety of substances that are used, transported and stored in the area, it is difficult to assign an overall impact of these substances to public health, the environment, the economy and the infrastructure. There are some spills that cause minor if any damage to the area. For example, spilling a few gallons of gasoline on concrete during transfer causes minimal economic impact; rarely does the spilled substance cause any environmental impacts. This is not to say that all spills are minor, some can be very harmful to human health and the environment and costs thousands, if not millions of dollars to clean up.

LOSS AND DAMAGES

The NRC reports not contain loss information data. PHMSA reported 17 hazmat incidents between 1990 and 2011 to which damages amounted to around $485,484. This is on average around $28,500 per incident. If this same amount is applied to all data, including the 62 additional incidents reported by the NRC between 2010 and 2017, then the estimated damages would amount to roughly $814,501,500.

RISK ASSESSMENT

<table>
<tr><th colspan="7">TABLE 2.3.6.D HAZMAT RISK CALCULATION</th></tr>
<tr><th colspan="3">Probability</th><td rowspan="5">+</td><th>Severity</th><td rowspan="5">=</td><th>Risk</th></tr>
<tr><td colspan="3">FREQUENT</td><td>NEGLIGIBLE</td><td>MEDIUM</td></tr>
<tr><td>Events</td><td>79</td><td rowspan="2">= 2.9</td><td rowspan="3">There have been few, if any injuries associated with the reported incidents. Mainly the damages are caused to the environment.</td><td rowspan="3">The risk assessment matrix categorizes this hazard as a medium risk to the area.</td></tr>
<tr><td>Years</td><td>27</td></tr>
<tr><td colspan="3">On average, according to data available, there are about three reported incidents in the region every year.</td></tr>
</table>