6.– Risk Assessment

Introduction

A comprehensive understanding of flood risk throughout the county is the foundation for sound decision-making in the context of flood risk reduction. Assessing risk and vulnerability is essential for identifying and prioritizing locations and projects for flood risk reduction. A risk assessment uses available data, both spatial and non-spatial, to analyze the risk posed to a community, including the people and assets within.

This section provides an assessment of flood-related hazards within Buchanan County, to include:

- A description of potential flood hazards, including natural and man-made contributors to current and future flood risk;
- A summary of previous flood occurrences and associated impacts;
- A qualitative assessment of potential flood impacts, including impacts to buildings and infrastructure, public health, life safety, and the economy;
- A quantitative analysis of structures considered at-risk to flood; and,
- Areas prioritized for risk reduction, based on the results of the assessment.

Description of Flood Hazards

Flooding is a frequent, dangerous, and costly hazard. In the US, flooding results in an average of 120 deaths and $5 billion in damages annually.[1] Nearly 90% of all presidential disaster declarations result from natural events where flooding was a major component. Floods cause infrastructure damage (e.g., transportation, communication, water, and power systems), service outages, structural damage to buildings, crop loss, decreased land values, and impeded travel.

Flooding is the most common environmental hazard, due to the widespread geographical distribution of valleys and coastal areas, and the population density in these areas. The severity of a flooding event is typically determined by a combination of several major factors including stream and river basin topography and physiography; precipitation and weather patterns; recent soil moisture conditions; and the degree of vegetative clearing and impervious cover. Flooding may occur when rainfall cannot drain or be absorbed fast enough (known as pluvial, or urban, flooding) or when rivers and streams exceed the capacity of their channels and water rises out of riverbanks onto surrounding lands. These types of flooding are described in depth below.

Rainfall-induced (Pluvial) Flooding and Extreme Precipitation

Rainfall-induced flooding, also called pluvial flooding, is usually caused by heavy rain over a short period of time. As land is converted from fields or woodlands to roads and parking lots, it loses its ability to absorb rainfall. Since sidewalks and roads are non-absorbent, rivers of water flow down streets and into sewers. Roads and buildings generate more runoff than forestland. Fixed drainage channels in developed areas may be unable to contain the runoff that is generated by relatively small, but intense, rainfall events. Development (or urbanization) increases runoff two to six times over what would occur on natural terrain. This high volume of water can turn parking lots into lakes, flood basements and businesses, and cause lakes to form in roads where drainage is poor or overwhelmed.

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[1] Flood Impact (n.d.). FEMA Preparedness Community. Retrieved from Flood | Impact (fema.gov).

Rainfall-induced flooding can also occur where there has been development within stream floodplains. Development intensifies the magnitude and frequency of floods by increasing impermeable surfaces, amplifying the speed of drainage collection, reducing the carrying capacity of the land and, occasionally, overwhelming sewer systems. A diagram depicting types of rainfall-induced flooding is presented in Figure 6-1.

In addition to development, flooding caused by extreme precipitation events is occurring more frequently and becoming more intense in some locations due to shifts in the global climate, including Buchanan County. Extreme precipitation events may overwhelm existing drainage systems and result in rainfall-induced flooding or flash flooding. Flash floods occur within a few minutes or hours of heavy amounts of rainfall and can destroy buildings, uproot trees, and scour out new drainage channels. Most flash flooding is caused by slow-moving thunderstorms or repeated thunderstorms in a local area, or by heavy rains from hurricanes and tropical storm or their remnants. Flash flooding often occurs in mountainous areas and is also common in urban areas where much of the ground is covered by impervious surfaces. In addition to flash flooding, steep slopes that are oversaturated during extreme rainfall events may prompt slope failure, resulting in landslides, mud- and debris-flows.

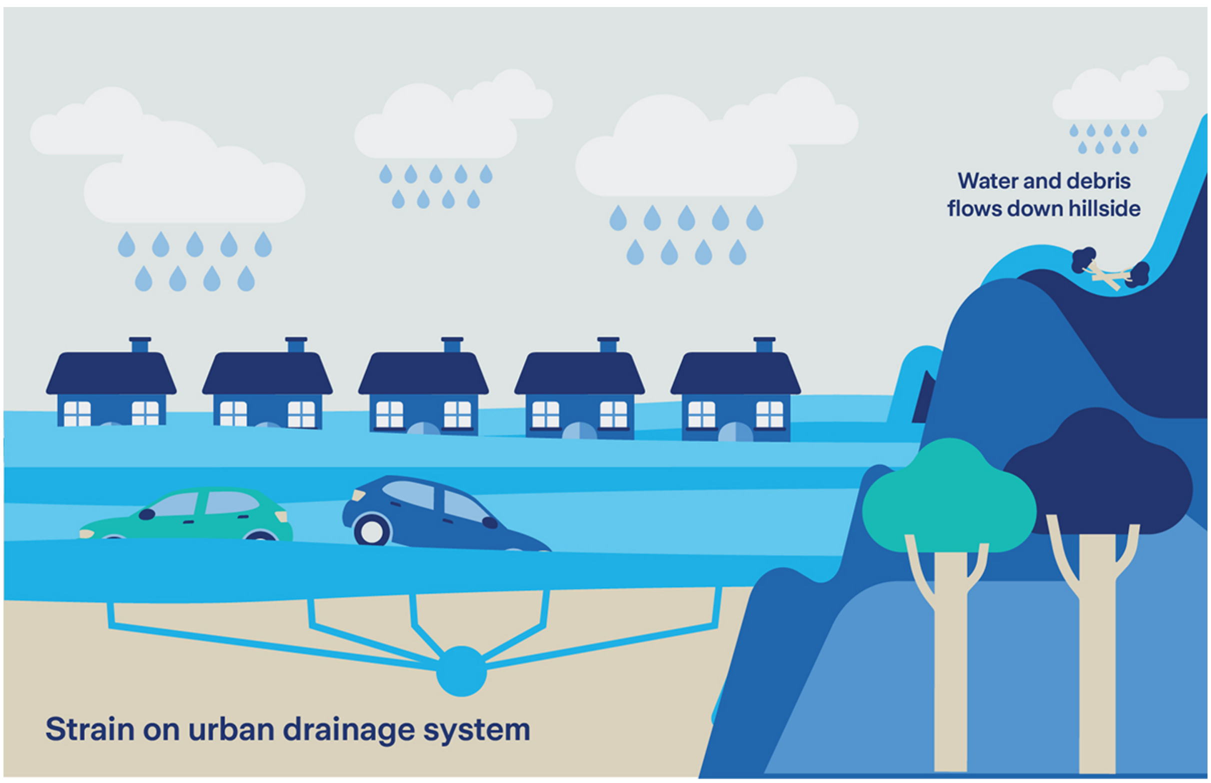

Figure 6-1: Rainfall-induced (Pluvial) Flooding[2]

Riverine Flooding

Periodic flooding of lands adjacent to non-tidal rivers and streams (known as the floodplain) is a natural and inevitable occurrence. When stream flow exceeds the capacity of the normal waterway, some of the above-normal stream flows onto adjacent lands within the floodplain. Riverine flooding is a function of

[2] Zurich (2022). Three common types of flooding explained. Retrieved from [Three common types of flood explained | Zurich Insurance](#).

precipitation levels and water runoff volumes within the watershed of a stream or river, as shown in Figure 6-2. According to USGS, the recurrence interval of a flood is defined as probability of an event in any given year (e.g., 1% annual chance or 100-year floodplain). Flood magnitude increases with increasing recurrence interval.

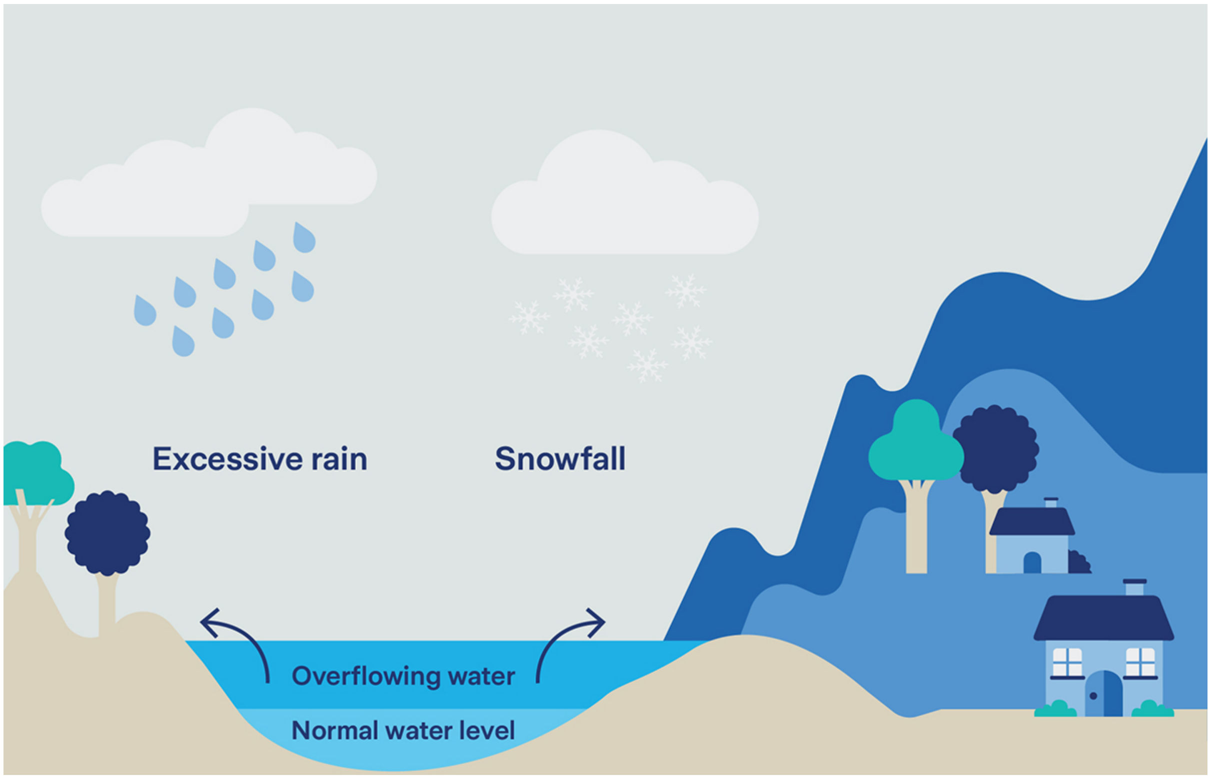

Figure 6-2: Riverine Flooding[3]

Flooding is also governed by the size and the nature of the stream's watershed. A watershed is the geographic area of land where all runoff drains to a common point. Buchanan County is located entirely within the Big Sandy River Basin, and is comprised of two watersheds, the Upper Levisa and the Tug. The tributaries flowing into these watersheds include Knox Creek which flows into Tug Fork, Dismal Creek and Fishtrap Lake tributaries flow into Levisa Fork, and Lick Creek, which flows into Russell Fork and eventually into Levisa Fork.

Floodplain Mapping

A floodplain is the land area susceptible to being inundated or flooded by water from any waterway (i.e., river, stream, lake, estuary). Floodplains are natural features of any river or stream. In many areas, FEMA has mapped floodplains for streams that drain more than one square mile. The mapped floodplain areas are called the regulatory floodplain. The regulatory floodplain mapping is a result of the hydrologic (rainfall) and hydraulic (runoff) analysis of the watershed and stream.

The regulatory floodplain is also known as the 100-year floodplain, base flood elevation, 1.0% annual chance floodplain or the Special Flood Hazard Area. The 100-year floodplain is the land area that is

[3] Zurich (2022). Three common types of flooding explained. Retrieved from [Three common types of flood explained | Zurich Insurance](#).

subject to a 1.0% or greater chance of flooding in any given year. The term “100-year flood” is often misinterpreted. The 100-year flood does not mean that it will occur once every 100 years. A 100-year flood has a 1/100 (1.0%) chance of occurring in any given year. A 100-year flood could occur two times in the same year or two years in a row. It is also possible not to have a 100-year flood event over the course of 100 years or more.

The floodway is portion of the floodplain required to convey the flood event. The flood fringe provides flood water storage. The floodway is the high velocity area and structures or obstructions in the floodway can increase flood heights. The floodway is regulated by the Virginia Department of Conservation and Recreation (DCR) and the county’s Flood Damage Prevention Ordinance.

While the 100-year (or base flood) is the standard most commonly used for floodplain management and regulatory purposes in the United States, the 500-year flood, also known as the 0.2% annual chance flood area, is the national standard for protecting critical facilities, such as hospitals and power plants. A 500-year flood has a 1/500 (0.2%) chance of occurring in any given year. It is generally deeper than a 100-year flood and covers a greater amount of area; however, it is statistically less likely to occur.

FEMA offers flood insurance through the National Flood Insurance Program (NFIP). A Special Flood Hazard Area (SFHA) shown on a Flood Insurance Rate Map (FIRM) is the regulatory floodplain. FIRMs are produced by FEMA. SFHAs are delineated on the FIRMs and may be designated as Zones A, AE, AO, AH, AR V, VE, A-99. Structures located in the SFHA are highly susceptible to flooding. Structures located in the SFHA A-Zones are required by lenders to purchase flood insurance. Anyone in a community that participates in the NFIP, as Buchanan County does, may voluntarily purchase flood insurance. The following SFHA zones are present within Buchanan County:

- Zone A: Zone A is the flood insurance rate zone that corresponds to the 1.0% annual chance floodplains determined in the Flood Insurance Study by approximate methods. Because detailed hydraulic analyses are not performed for such areas, no Base Flood Elevations (BFEs) or depths are shown within this zone. Mandatory flood insurance purchase requirements apply.
- Zone AE: Zone AE is the flood insurance rate zone that corresponds to the 1.0% annual chance floodplains determined in the Flood Insurance Study by detailed methods. In most instances, BFEs derived from the detailed hydraulic analyses are shown at selected intervals within this zone. Mandatory flood insurance purchase requirements apply.

In addition to SFHA zones, Zone X is also present in Buchanan County. Zone X corresponds to areas outside of the 1.0% annual chance flood area, and it includes areas in the 0.2% annual chance flood boundary (500-year floodplain) and areas of minimal flood hazard.

Contributors to Flooding

Flooding can occur any time of year. The severity of flooding is determined by a combination of precipitation and weather patterns, topography and physiography, ground cover, and recent soil moisture conditions. Man-made structures and practices, such as flood control structures (i.e., dams and levees), development patterns, and mining practices may also contribute to flooding. These natural and non-natural contributors to flooding are described throughout this section, within the context of Buchanan County.

Weather and Climate

Regional Weather Patterns

The amount of precipitation, and the frequency it occurs, in a particular location is a large determinant in whether an area will experience flooding throughout the year. Precipitation quantity and frequency are governed by the weather (short-term conditions) and the climate (long-term weather trends) of that location. National and regional weather patterns are driven by large-scale forces. These include air masses, pressure systems, wind patterns, and ocean surface currents.[4] As illustrated in Figure 6-3, Virginia is located in an area that is greatly influenced by interactions between dry, cool air from the north with moist, warm air from the south. This area of interaction, called the polar front, produces frontal systems that are most active in Virginia from the late fall through the middle of spring. Storms resulting from these interactions are typically slow-moving and produce moderate amounts of precipitation. This can result in flooding as rain continues over the same region for an extended period.

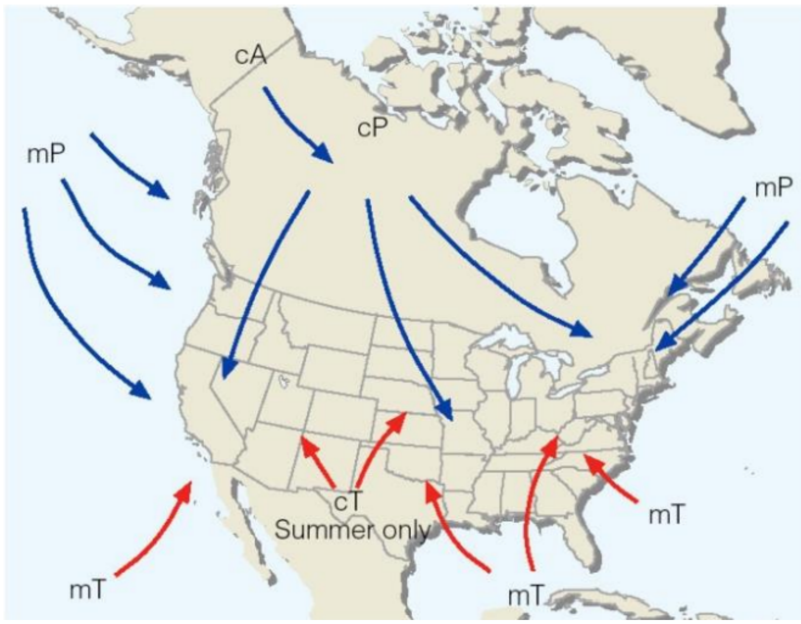

Figure 6-3: Air mass source regions affecting Virginia.[5]

Smaller, localized storms capable of producing more precipitation in a shorter amount of time influence the region from mid-spring through early fall but can occur at any time of the year. These storms often start as morning thunderstorms over the middle of the country and travel eastward, reaching southwest Virginia by late afternoon or evening. En route to the area, moisture is added to the storms from air flowing from the Gulf of Mexico. These storms often produce heavy rain, damaging winds, and hail.

Buchanan County is far enough inland that it is not impacted directly by hurricanes and tropical storms. However, remnants of tropical systems often pass through the area and have produced catastrophic

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[4] Science Education Resource Center. (2022). Climatology Basics. Carleton College. Retrieved November 14, 2022 from https://serc.carleton.edu/eslabs/weather/3b.html

[5] Virginia Department of Conservation and Recreation. (2015). Probable Maximum Precipitation Study for Virginia. Retrieved November 8, 2022 from https://www.dcr.virginia.gov/dam-safety-and-floodplains/document/pmp-final-report.pdf

flooding in the past, such as the flooding caused in 2021 by the remnants of Hurricane Ida. These storms occur from June through November, with August through October being the most active timeframe.

Storm systems may not always act independently of each other. Frontal storms are commonly influenced by a tropical system. This commonly occurs when a frontal system, moving east into the area, is stalled by a tropical system moving north or northwest from the Gulf of Mexico or the Atlantic Ocean.[6] This can produce an effect called training thunderstorms, where precipitation continues to form over the same area in a relatively short period of time, producing flash floods.[7]

Future Conditions

Although a location's climate is based on decades, or even centuries, of weather and atmospheric trends, it is not static. As a result of both natural and human-induced changes, the earth's climate is always evolving. Globally, increasing average annual temperatures have increased evaporation and led to higher amounts of water vapor in the air. This has led to increased precipitation in certain areas, including Virginia. Average annual precipitation in Virginia has increased at a rate of approximately 0.33 inches per decade over the last 120 years, as shown in Figure 6-4.[8]

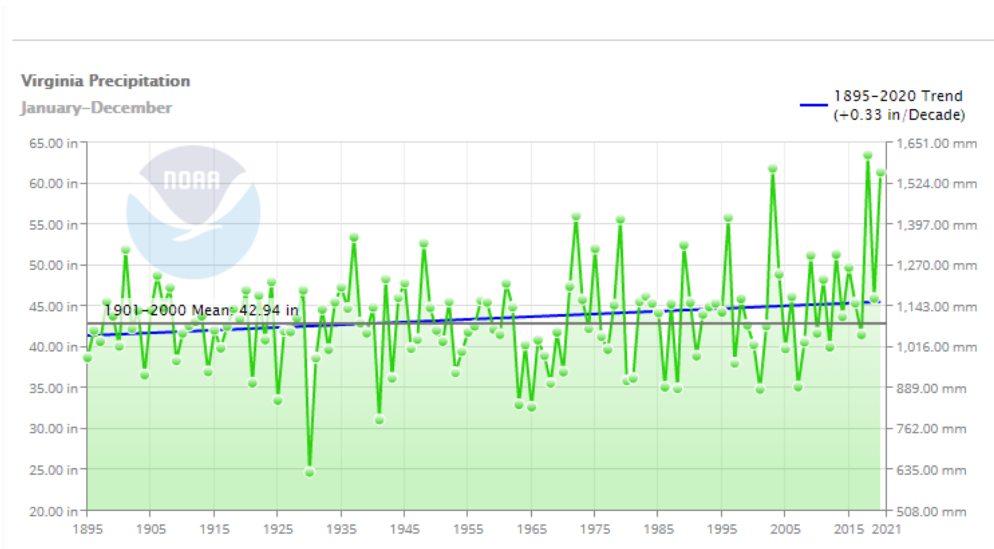


Figure 6-4: Virginia precipitation trend, 1895-2020.[9]

[6] Virginia Department of Conservation and Recreation. (2015). Probable Maximum Precipitation Study for Virginia. Retrieved November 8, 2022 from https://www.dcr.virginia.gov/dam-safety-and-floodplains/document/pmp-final-report.pdf

[7] National Weather Service. (2009). Glossary. Retrieved November 11, 2022 from https://w1.weather.gov/glossary/index.php?letter=t

[8] Voelsong, Sarah. (2021). Yes, Virginia, we are seeing more – and more intense – rainfall. Virginia Mercury. Retrieved October 21, 2022 from https://www.virginiamercury.com/2021/08/20/yes-virginia-we-are-seeing-more-and-more-intense-rainfall/

[9] Voelsong, Sarah. (2021). Yes, Virginia, we are seeing more – and more intense – rainfall. Virginia Mercury. Retrieved October 21, 2022 from https://www.virginiamercury.com/2021/08/20/yes-virginia-we-are-seeing-more-and-more-intense-rainfall/

In addition to average annual rainfall, extreme precipitation events have become more frequent during the 21st century. Figure 6-5 illustrates observed changes in precipitation experienced over both long-term and short-term timeframes. The southeast has experienced an 18% increase in extreme precipitation events since 1901 and a 27% increase in events since 1958.[10]

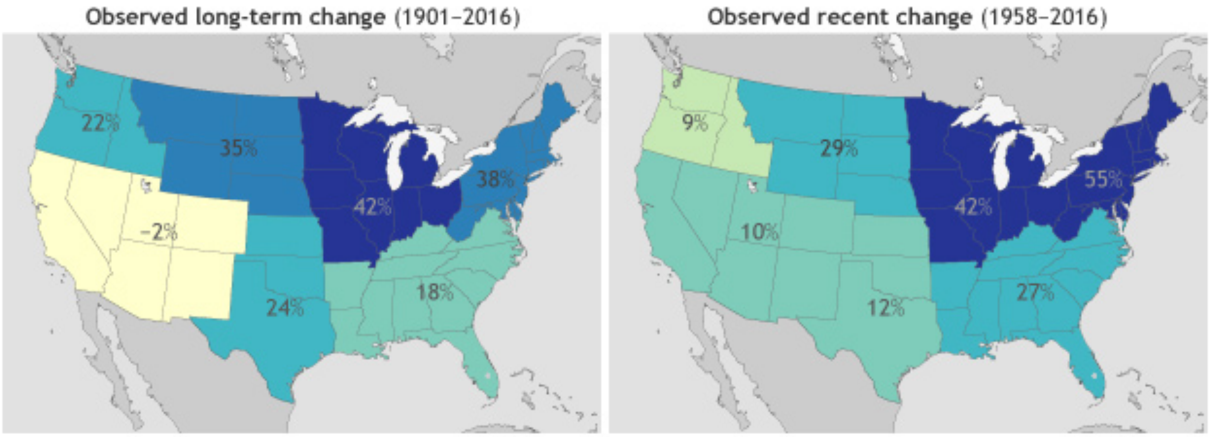
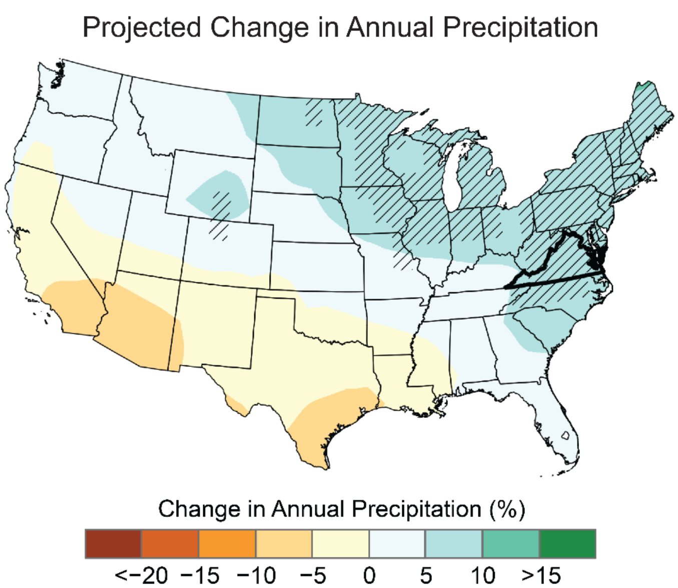


Figure 6-5: Change in extreme precipitation across the U.S.[11]

Observed increases in precipitation are expected to continue through the 21st century. Figure 6-6 shows projected changes in annual precipitation across the U.S. Virginia, assuming business-as-usual greenhouse gas emissions, is expected to see a 5% to 10% increase in precipitation by mid-century (2050) compared to the late 20th century.



[10] Scott, Michon. (2019). Prepare for more downpours: Heavy rain has increased across most of the United States, and is likely to increase further. NOAA Climate.gov. Retrieved November 11, 2022 from https://www.climate.gov/news-features/featured-images/prepare-more-downpours-heavy-rain-has-increased-across-most-united-0

[11] Easterling, D. R., Kunkel, K. E., & Arnold, J. R. (2017). Precipitation change in the United States. Retrieved November 11, 2022 from https://doi.org/10.7930/J0H993CC.

Figure 6-6: Projected changes in precipitation (%) for mid-century compared to the late 20th century (RCP8.5).[12,13]

Precipitation projections, assuming business-as-usual greenhouse gas emissions, indicate that Buchanan County will receive an average of 48.2 inches of precipitation annually in the late 21st century. This is 3.4 more inches than the 1990 average. Further, Buchanan County is projected to experience 5 days per year with greater than 1 inch of precipitation by the late 21st century, which is an increase of 1.9 days from 1990.[14] This is paired with a projected decrease in the overall annual number of days with measurable precipitation, indicating that Buchanan County may experience increased flooding as a result of increased heavy rainfall events.

Projections for increased precipitation and heavier rainfall events align with results of joint research conducted by USACE and the Ohio River Basin Alliance. This study saw the development of localized climate models used to predict mean annual streamflow for the Ohio River Basin in the early, mid-, and late 21st century. The Big Sandy River Basin, which contains Buchanan County, is located within the Ohio River Basin. The study found that the Tug and the Levisa Forks are expected to experience some of the highest streamflow increases within the entire Ohio River Basin, with annual mean streamflow increasing by 15-25% during the early and mid-21st century timeframes. By the late 21st century, the research indicates the annual mean streamflow will increase by 25-35%, shown in Figure 6-7.

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12 Projected changes are based on "business-as-usual" (RCP8.5) greenhouse gas emissions. Hatching represents areas where the majority of climate models indicate a statistically significant change.

13 Runkle, J. et al. (n.d.). State Climate Summaries 2022 - Virginia. NOAA Technical Report NESDIS 150-VA. NOAA/NESDIS. Retrieved November 15, 2022, from https://statesummaries.ncics.org/chapter/va/

14 U.S. Global Change Research Program. (2022). Climate Mapping for Resilience and Adaptation Assessment Tool. Retrieved November 15, 2022 from https://livingatlas.arcgis.com/assessment-tool/home.

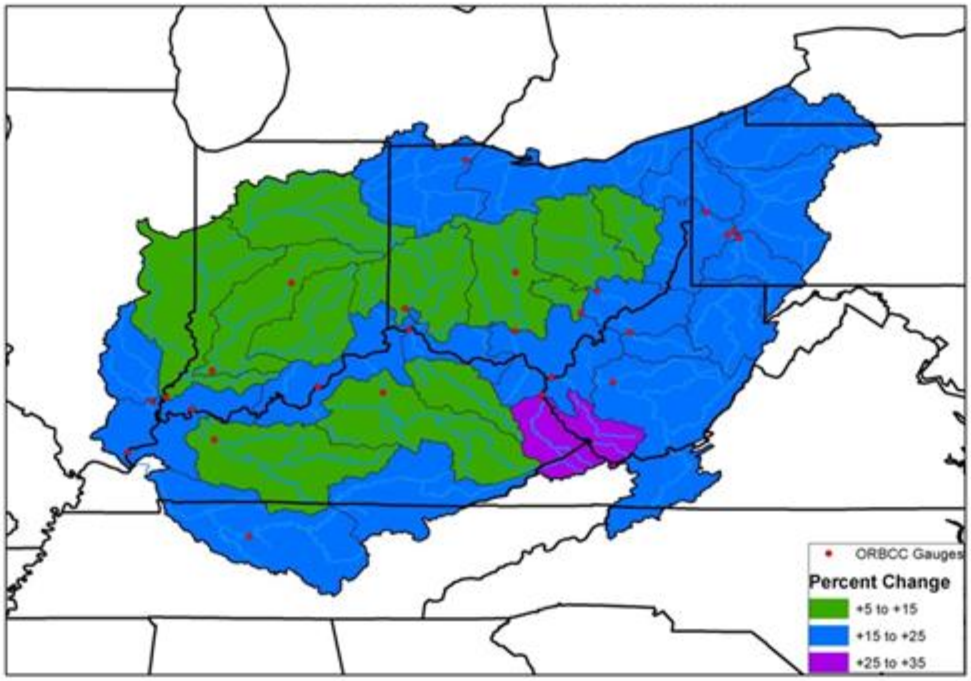

Figure 6-7: Forecasted annual mean percent change in streamflow (2071-2099)[15]

Topography

Weather systems are influenced, to a varying degree, by the terrain of the earth. Terrain at a higher elevation, like Buchanan County, has more influence on weather systems. Additionally, an area's terrain, or topography, influences the direction and speed of rainfall runoff as it travels over land and through stream channels. Orographic precipitation, shown below in Figure 6-8, is a phenomenon where warm, moisture filled air is forced upwards by physical terrain features such as hills or mountains. As a result, the moist air cools rapidly and water vapor condenses and forms precipitation, which is released on the windward side of the mountain. This creates a scenario where the leeward side of the mountain is in a rain shadow region and receives significantly less precipitation than the windward side.

[15] Drum, R., Noel, J., Kovatch, J., Yeghiazarian, L., Stone, H., Stark, J., & Raff, D. (2017). Ohio River Basin–Formulating Climate Change Mitigation/Adaptation Strategies through Regional Collaboration with the ORB Alliance. Retrieved November 10, 2022 from Ohio River Basin - Formulating Climate Change Mitigation/Adaption Strategies (army.mil).

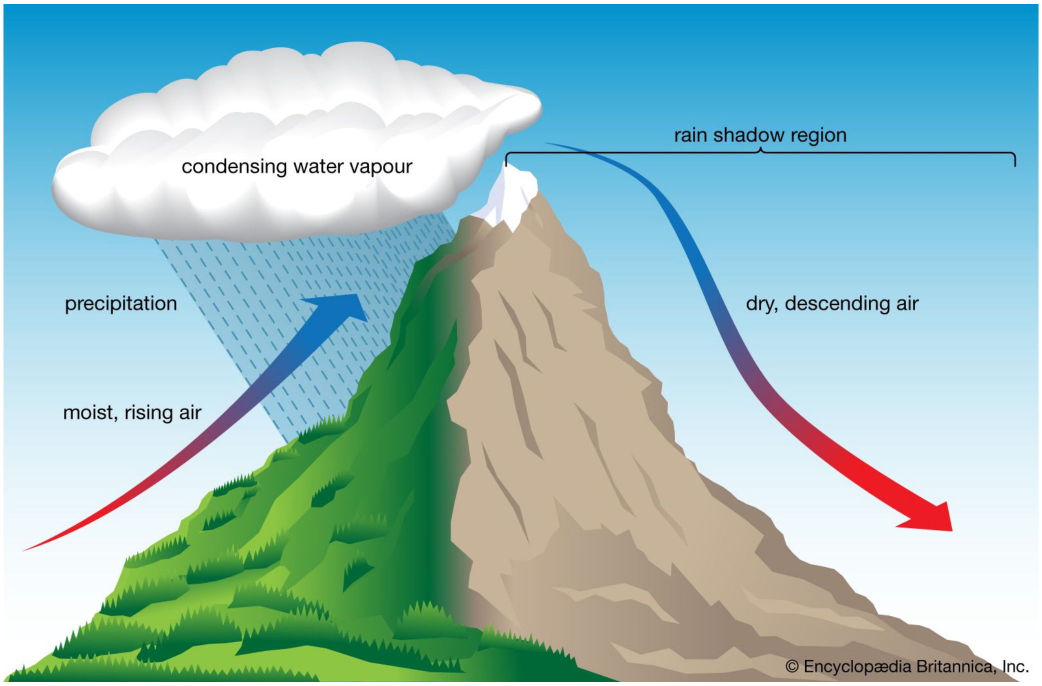

Figure 6-8: Orographic precipitation[16]

Regionally, rain shadows are evident east and northeast of Buchanan County, in the New River Valley and the Shenandoah Valley, shown as the lighter green areas in Figure 6-9. These areas receive some of the lowest amounts of precipitation throughout the state. Within Buchanan County, the high ridges along the southeastern border of the county may cause large amounts of precipitation to be rapidly released over the southeastern portion of Buchanan County. This area is notably higher than the rest of the county and precipitation in this area is drained in a northwest direction, which could result in flooding throughout the county.

[16] Encyclopedia Britannica. (n.d.) Orographic Lift. Retrieved November 15, 2022 from https://www.britannica.com/science/orographic-precipitation#/media/1/433062/140263

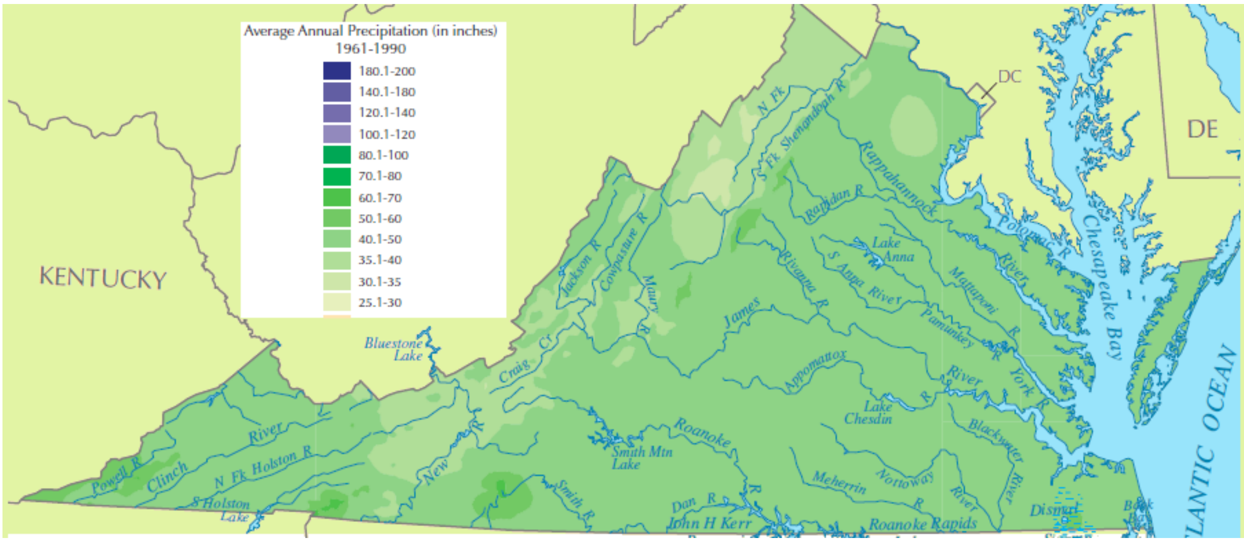

Figure 6-9: Average Annual Precipitation 1961-1990.[17]

Aside from producing orographic precipitation, the high mountain ridges throughout the county influence how weather systems travel through the area on a local scale. The ridges may restrict and slow air currents as they travel across the county.[18] This may produce localized heavy rainfall events as a result of a stalled storm or front.

As mentioned above, the terrain of Buchanan County also influences the direction and speed of precipitation runoff. The steep mountains and deep valleys allow runoff to travel rapidly from high ridges to the low-lying streams and rivers. Furthermore, the steep terrain results in water moving at high velocity through tributaries. The combination of high speed and large volumes of water can result in destructive flooding along almost any of the county's waterways during a heavy rainfall event.

Man-made Influences

In addition to the natural influences described above, man-made structures and practices have the potential to increase the likelihood and/or severity of flood events. Development, which increases the amount of impervious cover, such as roads and buildings, within a watershed, can exacerbate rain-fall-induced flooding. Additionally, man-made structures within waterways, such as bridges, may restrict flows. Similarly, stored property within the floodplain, and especially the floodway, such as cars, trailers, equipment, and outbuildings, may also restrict flows when they are carried into the stream during flood events. Further, in Buchanan County, flood control structures such as dams and levees may impact flooding, and decades of mining across the county have contributed to flood risk. These influences are described further below.

Dams and Dam Failure

A dam is an artificial barrier constructed across a stream channel or a man-made basin for the purpose of storing, controlling or diverting water. Dams typically are constructed of earth, rock, concrete or mine

[17] Virginiaplaces.org. (n.d.) Rain Shadows – The Orographic Effect. Retrieved November 11, 2022 from http://www.virginiaplaces.org/geology/rainshadow.html

[18] Carpenter, Michael. (2018). How Do Mountains Affect Precipitation? Sciencing by Leaf Group Ltd. Retrieved November 11, 2022 from https://sciencing.com/do-mountains-affect-precipitation-8691099.html

tailings. The area directly behind the dam where water is impounded or stored is referred to as a reservoir. Dams provide a number of vital functions to nearby communities. Often, they are a source of hydroelectric power, drinking water, and/or provide a recreational area to residents.

A dam failure is the partial or total collapse, breach or other failure of a dam that causes flooding downstream. Dam failures can result from natural events such as floods, earthquakes or landslides, human-induced events such as improper maintenance, or a combination of both. In the event of a dam failure, the people, property, and infrastructure downstream could be subject to devastating damage.

Dam failures can result from one or more of the following:

- Prolonged periods of rainfall and flooding (the cause of most failures);
- Inadequate spillway capacity resulting in excess flow overtopping the dam;
- Internal erosion caused by embankment or foundation leakage;
- Improper maintenance (including failure to remove trees, repair internal seepage problems, maintain gates, valves, and other operational components, etc.);
- Improper design (including use of improper construction materials and practices);
- Negligent operation (including failure to remove or open gates or valves during high flow periods);
- Failure of an upstream dam on the same waterway;
- Landslides into reservoirs which cause surges that result in overtopping of the dam;
- High winds which can cause significant wave action and result in substantial erosion; and
- Earthquakes which can cause longitudinal cracks at the tops of embankments that can weaken entire structures.

The U.S. Army Corps of Engineers (USACE) National Inventory of Dams (NID) lists six dams within Buchanan County, and one dam (Laurel Lake Dam) in neighboring Dickenson County. These dams are listed in Table 6-1 and Figure 6-10 provides a map of their locations. Inundation areas were not available for these dams.

Table 6-1 and Figure 6-9 both include the hazard potential and the condition assessment for these seven dams. These are two rating systems tracked in the NID. USACE classifies a dam's hazard potential based on the potential of a dam to affect the safety and health of citizens and property, should the dam fail. This is separate from the condition of the dam, and only assesses the potential consequences of a dam failure. The three hazard potential ratings are:

- High-hazard potential – failure will probably cause loss of human life;
- Significant-hazard potential – failure will result in no probable loss of human life but can cause economic loss, environmental damage, disruption of lifeline facilities, or can affect other concerns;
- Low-hazard potential – failure will result in no probable loss of human life and low economic and/or environmental losses.

Beginning 2009, USACE also began providing a condition assessment of high-hazard potential dams. This rating is used to provide a rating of the steel and concrete components of a dam. The five condition ratings are satisfactory, fair, poor, unsatisfactory, and not rated.

The hazard potential for all the dams in and adjacent to Buchanan County is listed as undetermined, meaning their hazard potential has not been evaluated. All the dams in Buchanan County received a condition assessment of not rated, meaning the dam has not been inspected, is not under state jurisdiction, or has been inspected but has not been rated. Laurel Lake Dam received a satisfactory condition assessment, the highest rating available. Of the seven dams discussed, only the Laurel Lake Dam (Dickenson County) and Buchanan Dam #2 are listed as state regulated dams.

It should be noted that projected increases in future flows of the Big Sandy River Basin could produce more strain on dams in the area, increasing the likelihood of dam failure in the future.

Table 6-1: Dams in and adjacent to Buchanan County.[19]

Name	River	Hazard Potential	Condition Assessment
Buchanan Dam #2	Not provided	Undetermined	Not Rated
Virginia Energy Dam	Middle Elk Creek	Undetermined	Not Rated
West Fork Slurry Impoundment Dam	Not provided	Undetermined	Not Rated
Long Bottom Branch Dam	Long Bottom Branch	Undetermined	Not Rated
Star Branch Dam #1	Star Branch (off stream)	Undetermined	Not Rated
Harman Mining Corp Dam	Starr Branch	Undetermined	Not Rated
Laurel Lake Dam (Dickenson County, VA)	Laurel Branch	Undetermined	Satisfactory

[19] U.S. Army Corps of Engineers. (2020). National Inventory of Dams. Retrieved October 27, 2022 from https://nid.usace.army.mil/#/

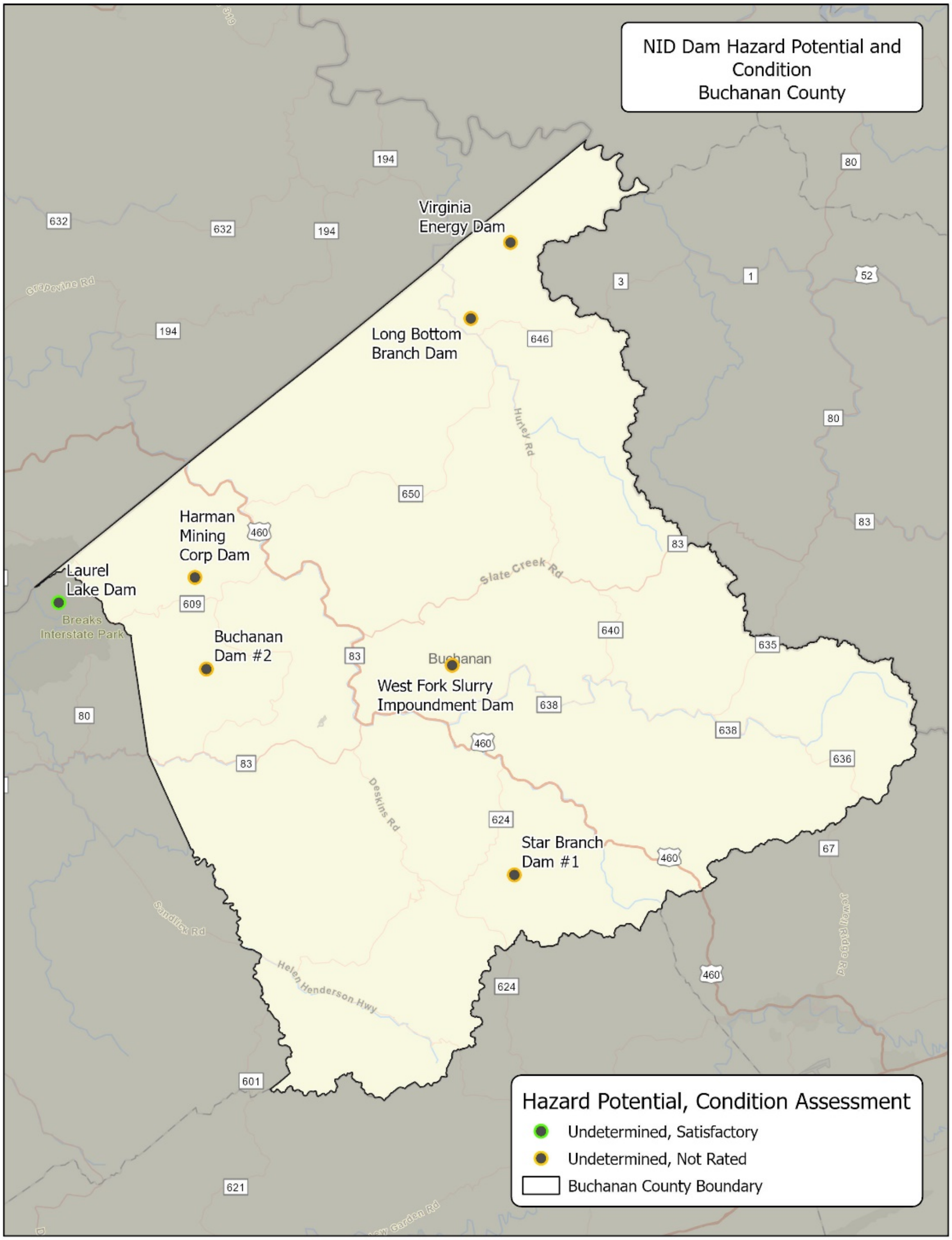
NID Dam Hazard Potential and Condition
Buchanan County
Virginia Energy Dam
Long Bottom Branch Dam
Harman Mining Corp Dam
Laurel Lake Dam
Buchanan Dam #2
West Fork Slurry Impoundment Dam
Star Branch Dam #1
Buchanan
Breaks Interstate Park
Hazard Potential, Condition Assessment
Undetermined, Satisfactory
Undetermined, Not Rated
Buchanan County Boundary

Figure 6-10: NID dams in and around Buchanan County.[20]

[20] U.S. Army Corps of Engineers. (2020). National Inventory of Dams. Retrieved October 27, 2022 from https://nid.usace.army.mil/#/

Dam watersheds are generated for most dams in Virginia by the Virginia Department of Conservation and Recreation's (DCR) Dam Safety program. These watersheds are shown below in Figure 6-11. Watersheds are not the same as inundation areas; the watersheds show the area that drains into each respective dam's reservoir. A heavy rain event in these areas would add increased strain on the associated dam.

Figure 6-11: Dam Watersheds in Buchanan County

Levees and Levee Failure

A levee is a man-made structure used to contain, control, or diver the reduce flood risk. Although levees are designed to reduce flood risk, they do not eliminate the risk entirely. Levees may be overtopped or fail if a flood event exceeds the severity of its design standard (the amount of water the levee is designed to hold).

Based on information available through the National Levee Database (NLD), there is one levee present in Buchanan County, located in the Town of Grundy. The Grundy levee system is located on the right descending bank of the Levisa Fork of the Big Sandy River and reduces flood risk within Grundy. The project was completed in 2008 by the federal government in response to the devastating flood of April 1977. The levee is owned, operated and maintained by the Town of Grundy. The system consists of 787 feet of concrete floodwall and 607 feet of levee/highway. It has one pumping station and two traffic openings that must be closed quickly during a flood event.

The US Army Corps of Engineers (USACE) has assessed this levee system to be low risk. It is 15 years old and has not yet been tested during a major flood. Flash flooding on the Levisa Fork can cause flood waters to rise very rapidly to unpredictable heights. The NLD summary estimates the population behind the levee (within the shaded area shown in Figure 6-12 below) to be 20, with seven buildings and property values at approximately \$4.7 million.[21] In addition to data available from the NLD, FEMA maps areas of reduced risk due to levees on FIRMs. This area is assessed in the *Flood Hazard Analysis* section.

Figure 6-12: System and Area Protected by Grundy Levee System

Debris and Waterway Blockages

Often during a flooding event, debris being carried by floodwaters can become stuck at a chokepoint in a waterway. Personal property located or stored within the floodplain, and especially within the floodway can contribute to this problem. Cars, tractors, outbuildings (such as sheds) and other items stored in

[21] USACE (2019). National Levee Database. Retrieved from National Levee Database (army.mil).

flood hazard areas can be picked up during floods and jam up waterways, especially at bridges and narrow areas, to exacerbate flooding. Natural debris, such as woody debris from trees and sediment from erosion and logging, can also restrict the natural capacity of the stream (e.g., sediment building up on the streambed) and contribute to flooding.

When not cleared, especially after a flood event where areas pile up with debris, a hazard is created as the stream is essentially dammed and increases the likelihood that a rainfall event will become a major flood event.

Mining Impacts and Clogged Streams

The mining industry was unregulated at the federal level until 1977 and largely unregulated at a state level until 1968. Some methods and practices used in the mining industry previously have resulted in unforeseen impacts on the environment and public health and safety. Some of the potential environmental impacts (which may also affect residents) from mining include stream sedimentation from loose soils, acid draining tailings and waste piles, groundwater degradation, trash dumps, and landslides. Some of the potential public health and safety impacts from mining include fall hazards from highwalls, shafts and other mine openings, the unauthorized and unsupervised use of mine sites as recreational areas, and loss or degradation of drinking water. [22]

Reclamation laws enacted by the Virginia General Assembly in the 1960's and 1970's were put in place to minimize the impacts of past mining practices on the environment and public health and safety. In the 1970's, the Abandoned Mine Land (AML) Program was established to reclaim sites that were mined prior to December 15, 1981.[23] Virginia's Department of Energy also has the Mined Land Repurposing program which applies annually for federal money to reclaim high priority AML sites. The federal program is the Abandoned Mine Land Economic Revitalization Program and has provided Virginia $10 million every year since 2017 to develop and repurpose AML.

The federal government has also recently approved further legislation to help fund AML revitalization projects. The Infrastructure Investment and Jobs Act, passed in 202, appropriated $11.293 billion for deposit into the Abandoned Mine Reclamation Fund and included provisions to extend the AML fee collections and mandatory AML Grant distributions.[24]

In addition to the environmental and public health and safety impacts mentioned above, the mining process produces waste material, or gob, as the coal is separated from the rest of the soil. In the past, and possibly continuing until recently, gob piles have been dumped in the valleys, or hollows, throughout the county. These piles can create an impediment for runoff in the valleys and often leads to clogged streams. Data available from the Virginia Department of Mines, Minerals and Energy (DMME) shows where confirmed gob piles and clogged streams are located, however it's likely there are more gob piles

[22] Virginia Department of Energy. (2021). Abandoned Mineral Mined Lands. Retrieved November 14, 2022 from https://energy.virginia.gov/mineral-mining/AMML.shtml.

[23] Virginia Department of Energy. (2021). Abandoned Mine Land. Retrieved November 14, 2022 from https://energy.virginia.gov/coal/mined-land-repurposing/abandoned-mine-land.shtml.

[24] Office of Surface Mining Reclamation and Enforcement. (2022). Guidance on the Bipartisan Infrastructure Law Abandoned Mine Land Grant Implementation. Retrieved November 15, 2022 from https://www.osmre.gov/sites/default/files/inline-files/BIL_AML_Guidance_7-19-22.pdf

and clogged streams throughout the county that have not been mapped. Figure 6-13 shows these locations.

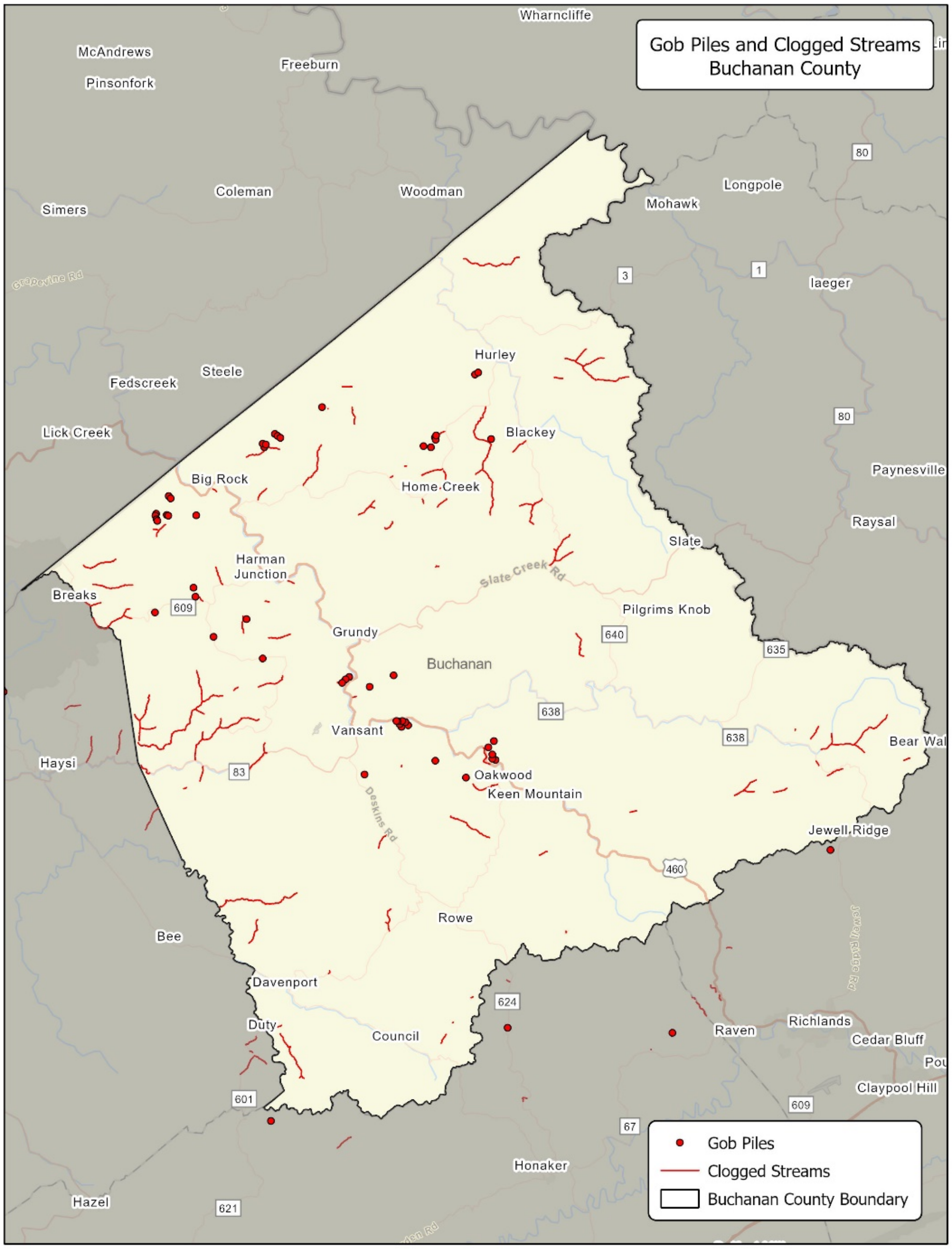

Figure 6-13: Buchanan County gob piles and clogged streams[25]

Abandoned mines also create a flooding hazard after they fill with water. Conversations with community leaders indicate that there are countless abandoned mines throughout the county that periodically fill with water or have standing water. The pressure produced by this water can cause a mine blowout,

[25] VA DMME

sending water rushing out of the underground cavern and down the mountain. Many abandoned mines, especially those that have been mapped, have mechanisms in place to allow water to drain as the mine fills with water; however, these mechanisms may become clogged with sediment and debris when not maintained properly, contributing to the likelihood of a blowout.

Local news covered one of these incidents as recently as 2019, which resulted in four feet of water rushing down a neighborhood road. A Buchanan County Board of Supervisors member pointed out that at least three major floods in recent years were caused by mine blowouts or mining pond failures. Figure 6-14 illustrates some of the damage caused by the 2019 blowout. Although not pictured, the incident damaged some homes, stranded one resident due to their driveway being washed out, and one elderly woman was forced to evacuated.[26] Figure 6-15 provides a map of various mine openings (any opening or entrance from the surface into an active, or abandoned, underground mine) identified by the DMME. These openings allow precipitation and runoff to enter underground mines, potentially leading to a mine blowout. It is likely that there are more mine openings and portals throughout the county.

Figure 6-14: 2019 mine blowout damage near Hurley, VA

Mine blowouts, in addition to the damage caused by the force and volume of flood waters, produce mudslides which leave large amounts of sediment on roads, private or public property, and can block normal streamflow.

[26] WYMT. (2019). Official: Some homes damaged by mine blowout in Buchanan County. Gray Television, Inc. Retrieved November 1, 2022 from https://www.wymt.com/content/news/Official-Some-homes-damaged-by-mine-blowout-in-Buchanan-County-505132431.html

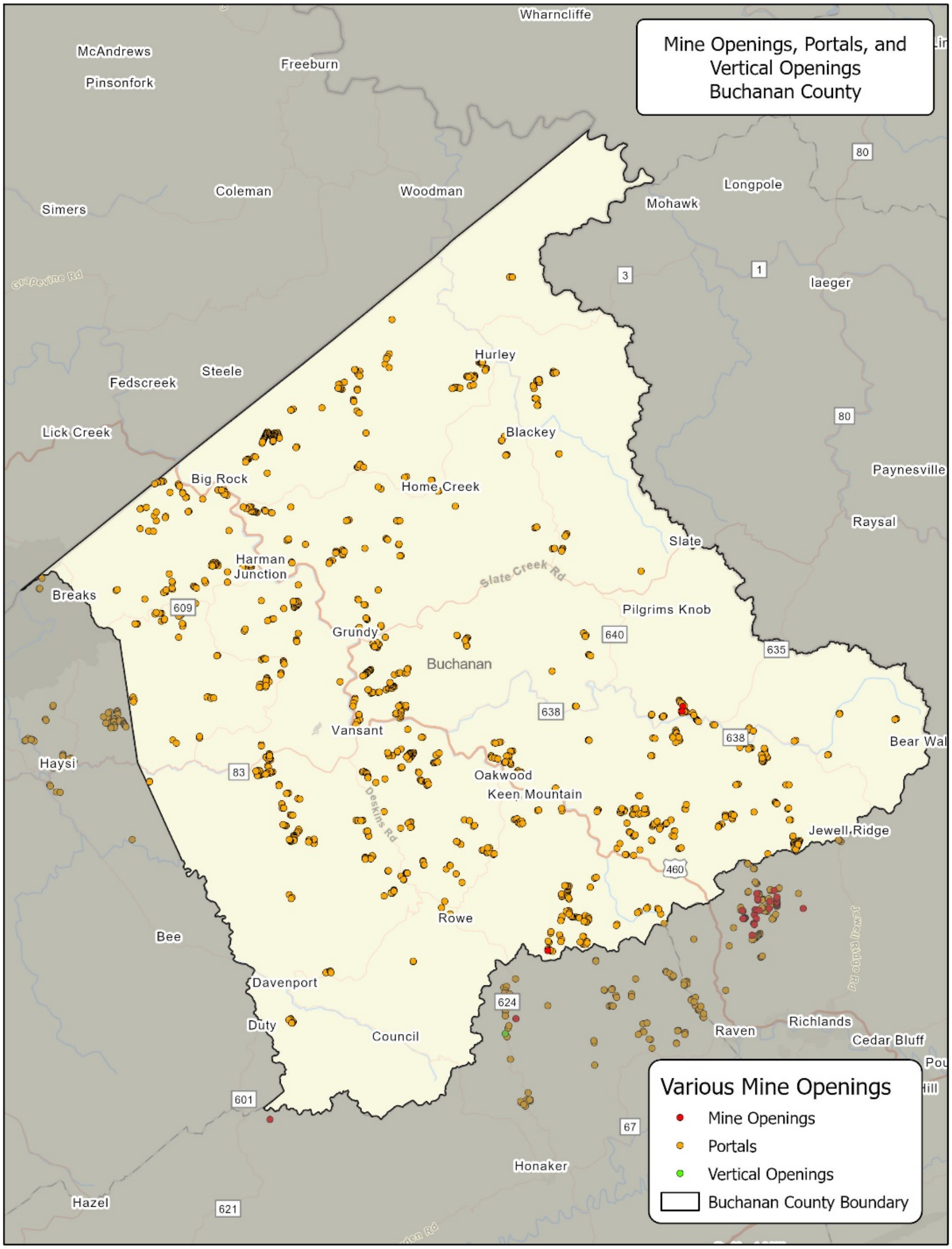

Figure 6-15: Mine openings in and around Buchanan County[27]

[27] VA DMME

Previous Flood Occurrences

Buchanan County has experienced damaging floods in the past. Several data sources were used to assess past flood events in the county, such as the CPPDC Hazard Mitigation Plan, NCEI, and Disaster Declarations. Based on these sources, 33 damaging flood events were reported in Buchanan County in the last 80 years. These events are presented in Table 4-3 within the *Existing Conditions* section of this plan. Descriptions of the most severe flood events to impact the county are provided below.

July 2022 Whitewood Flood

Severe flash flooding impacted the Whitewood, Pilgrim's Knob, and Jewell Valley areas of Buchanan County in after several days of heavy rainfall, resulting in significant damage. According to local news reports, the area received up to six inches of rainfall within just a few hours. Between 100 and 125 structures incurred structural damage, one person was injured, and over 2,000 power outages were reported within the affected communities. For 24 hours after the event, 40 stranded residents were unaccounted for due to loss of cell service and roadways that were impassable due to high water. This event was declared a state emergency as well as a federal disaster. FEMA individual assistance was estimated at $1.96 million and public assistance, primarily due to road and bridge damages, was estimated at $14 million.[28] It should be noted that many of the areas impacted by this flood event were outside of FEMA mapped flood hazard areas. The events during and the aftermath following this storm were discussed in the public meeting. The area, with some of the comments from residents, are shown below in Figure 6-16.

Figure 6-16: Public meeting comments regarding July 2022 flood event

August 2021 Hurley / Guesses Fork Flood

[28] FEMA-4674-DR Preliminary Damage Assessment Report. Retrieved from FEMA-4674-DR-VA.

Slow-moving storms and remnants of Hurricane Ida brought heavy rainfall to the Hurley, Guesses Fork, and Kelsa areas of Buchanan County, resulting in flooding, landslides, and mudflows. Guesses Creek rose of out its banks, flooding nearby roadways and houses. One elderly woman died within her flooded home. Thirty-one homes were destroyed, 27 sustained major damage, and eight sustained minor damages. This event was declared a federal disaster, with just under $1.9 million provided in public assistance. Individual assistance was not provided as part of the disaster declaration.

February 2003 Countywide Flood

Two days of heavy rain fell from February 14-16, 2003. Streams and creeks across the county flooded and washed-out roads. Hurley recorded 3.7 inches of rain, while Grundy recorded 4.3 inches. The Virginia Department of Emergency Management reported 35 homes and 20 businesses had major damage throughout Buchanan County. Some of the more prominent locations that recorded damage during the event included the Grundy Police Department, Grundy Town Hall, and Hurley High School. In total approximately $850,000 in damages was caused by the storm and a federal disaster was declared as a result.

May 2002 Hurley Flood

Repeated heavy rainfall over the course of several weeks was capped off by a major flooding event on May 2, 2002. The ground was already saturated with water when storms dumped up to four inches of rain within six hours on the area. Along with the rain, the storms brought strong winds and large hail. Knox Creek overtopped its banks and caused significant damage in Hurley.[29] The flooding caused an estimated $2.5 million in damages, including destroying the Hurley Post Office, most of the businesses in Hurley, and completely destroying or severely damaging at least 347 homes in the county. Additionally, over 100 private bridges were washed out, countless vehicles were destroyed, and power and phone service was knocked out. Unfortunately, there were two fatalities within Buchanan County. This flooding event was declared a federal disaster and the National Guard was activated in both West Virginia and Virginia.

April 1977 Grundy Flood

In early April of 1977, heavy rainfall across the region resulted in one of the worst flooding events ever recorded in Buchanan County. Rainfall amounts up to 15.5 inches over a 30-hour period were observed in the area. The gaging station along the Levisa Fork near Grundy crested at over 27 feet, which was 11 feet higher than the previously recorded peak.[30] The flooding exceeded levels associated with a 100-year flood event and caused major damage, washing away several homes and businesses. There were three fatalities and $15 million worth of damage caused by the flood event.[31] A number of property owners required FEMA loans to pay for repairs and several properties were left vacant in the downtown area and never restored. The flood significantly altered the lives of residents and would eventually lead to a number of redevelopment projects in Grundy, including several properties participating in a federal

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[29] Stephanie Simon. (2002). Appalachia Digs Out After Flash Floods. Los Angeles Times. Retrieved November 10, 2022 from [Appalachia Digs Out After Flash Floods - Los Angeles Times (latimes.com)]

[30] Runner, G. S., & Chin, E. H. (1980). Flood of April 1977 in the Appalachian Region of Kentucky, Tennessee, Virginia, and West Virginia (No. 1098). US Govt. Print. Off. Retrieved from https://www.weather.gov/media/rlx/April1977FloodsinAppalachianRegion.pdf.

[31] Moxley, Tonia. (2002). Grundy, Va. Picks Up and Moves to Higher Ground. The Appalachian VOICE. Retrieved November 10, 2022 from https://appvoices.org/2002/06/01/2911/.

buyback process and a massive undertaking by VDOT and USACE to widen U.S. 460 and develop a 13-acre site across the Levisa Fork from the original downtown business district.

Flood Hazard Analysis

Location

Buchanan County is characterized by mountains with steep valley slopes and deep streambeds. Throughout much of the county, the only flat land is found along streams on narrow valley floors. Due to the topography of the county, development typically follows streams.

FEMA produces maps of special flood hazard areas based on riverine flooding. These include the areas with a 1.0% and 0.2% annual chance of flooding (the 100-year flood and 500-year flood zones, respectively). Given the county's development patterns, most development falls within one of these zones. Figure 6-17 shows the 100-year and 500-year flood zones located throughout the county.

In addition to flooding that occurs in the mapped special flood hazard areas, county officials have noted that flooding is possible within all low-lying areas of the county, depending on where rainfall occurs. This is also evident from recent flooding events, as well as conversations held during meetings with residents and county officials. The Pilgrim's Knob, Elk Creek, and Jewell Valley communities were all highlighted as areas where flooding has occurred outside of the special flood hazard areas. Other communities throughout the county are likely vulnerable to similar flooding incidents, where localized heavy precipitation, clogged streams, or mine blowouts may produce flooding outside of expected areas.

Figure 6-17: Buchanan County FEMA flood hazard areas

Building Data

Building footprints data was developed as part of the flood hazard analysis. The buildings dataset was formed using open-source building footprint spatial data, address point data with land use received from Buchanan County, and Buchanan County's parcel data, which included tax-assessed value of improvements (i.e., structures). A full description of the process used to develop this dataset is provided in **Appendix XX**.

In total, there are an estimated 18,396 buildings in Buchanan County. A breakdown of their estimated land use and value is provided in Table 6-2.

Table 6-2: Estimated Building Footprints

Buchanan County Building Summary

Land use	Number of Structures	Estimated Value*
Commercial	727	$ 63,829,630
Communication	2	$ 9,717
Industrial	16	$ 18,411,767
Institutional	267	$ 127,020,392
Other	120	$ 5,452,204
Residential	8,797	$ 299,660,763
Residential - Manufactured	3,075	$ 39,543,038
Uncategorized	5,249	$ 225,478,608
Utilities	143	$ 13,588,461
Total	**18,396**	**$ 792,994,579**

**Value may exclude tax-exempt improvements.*

Critical Facilities

Critical facilities are structures or systems that provide essential services and functions for a community. These facilities are vital to continued operations and recovery following a natural disaster or public health crisis. Facilities were selected with consideration to FEMA's community lifelines. Table 6-3 provides a full list of Buchanan County's critical facilities, presented by community lifeline.[32] These facilities were identified by reviewing the CPPDC's Hazard Mitigation Plan, Buchanan County's Comprehensive Plan, and input from the Planning Team comprised of county officials.

[32] FEMA Community Lifelines. Retrieved from Community Lifelines | FEMA.gov.

Table 6-3: Buchanan County Critical Facilities

Buchanan County Critical Facilities

Energy
AEP Electric Utility Substations (15)
Food, Water, Shelter
Council Elementary/Middle School
Council High School
Grundy High School
Hurley Elementary/Middle School
Hurley High School
Riverview Elementary/Middle School
Twin Valley Elementary/Middle School
Twin Valley High School
Buchanan County Public Service Authority
Buchanan County Social Services
Buchanan Information Park / School District
Feeding My Sheep, Inc.
YMCA - Grundy
Heritage Hall XIV Nursing Home (Grundy)
John Flannagan Water Authority
Sewer Pump Station*
Pump Station 1*
Pump Station 2*
Pump Station at Hospital / YMCA*
Dismal Pump Station*
Patterson Pump Station*
Rockhouse Pump Station*
Oakwood Pump Station*
Lancaster Pump Station*
Building housing water utility SCADA system*
Hazardous Materials
Buchanan County Waste Transfer Station
Conaway Wastewater Treatment
SunCoke Plant
Health and Medical

Buchanan County Critical Facilities
Appalachian College of Pharmacy
Buchanan General Hospital
Buchanan County Health Department
Safety and Security
911 Dispatch Center & Sheriff's Office
Town of Grundy Police Department
Buchanan County Courthouse
Council Volunteer Fire Department
Dismal River Volunteer Rescue
Grundy Volunteer Fire Department
Whitewood Volunteer Fire Department
Big Rock Volunteer Fire Department
Harmon Volunteer Fire Department
Keen Mountain Correctional Center
Knox Creek Volunteer Fire Department
Oakwood Volunteer Fire Department
Russel Prater Volunteer Fire Department
Slate Creek Volunteer Fire Department
Virginia State Police Area 29
Transportation
US Highway 460*
State Route 80*
State Route 83*
State Route 638*

**Not included in flood risk exposure analysis.*

Riverine Flood Analysis

Riverine flooding presents a risk to buildings and infrastructure (including critical facilities) as well as populations, especially when development has occurred on land within the floodplain. In Buchanan County, the steep relief of the mountainous terrain has led to most development occurring in valleys, often within the floodplain. Using FEMA special flood hazard area GIS data and GIS data for the county's structures, critical facilities, and socially vulnerable populations, a spatial analysis was conducted to inform potential flood risk.

Buildings

A structure's flood risk is associated with several factors, such as its location within flood hazard areas, and any mitigation that has been implemented, such as first floor elevation, dry floodproofing, or presence of flood control structures. For example, buildings constructed to modern building codes, after the adoption of the county's Flood Damage Prevention Ordinance, may carry less risk than older structures due to how they were constructed.

A spatial analysis of buildings within FEMA mapped flood hazard areas was conducted; the results of the analysis are presented below in Table 6-4. This analysis does not account for building elevations. It should also be noted that flooding occurs outside of mapped floodplains.

Table 6-4: Structure Flood Risk Analysis Results for Buchanan County

Buildings in Floodway*

Land Use	Number of Structures	Estimated Value**
Commercial	112	$ 4,561,930
Communication	1	$ 9,717
Industrial	7	$ 5,977,867
Institutional	33	$ 22,629,213
Other	4	$ 38,541
Residential	330	$ 12,470,879
Residential - Manufactured	120	$ 980,158
Uncategorized	163	$ 4,232,102
Utilities	5	$ 1,367
Total	**775**	**$ 50,901,773**

Buildings in 100-Year Flood Zone*

Land Use	Number of Structures	Estimated Value**
Commercial	174	$ 11,792,460
Industrial	2	$ 10,278,700
Institutional	58	$ 16,292,413
Other	17	$ 167,733
Residential	1,105	$ 52,746,195
Residential - Manufactured	485	$ 5,182,368
Uncategorized	486	$ 15,890,012
Utilities	16	$ 3,695,430

Total	**2,343**	**$**	**116,045,312**

Buildings in 500-Year Flood Zone*

Land Use	Number of Structures	Estimated Value**	
Commercial	68	$	8,832,378
Industrial	1	$	1,077,600
Institutional	22	$	4,077,281
Other	5	$	224,883
Residential	300	$	13,945,785
Residential - Manufactured	97	$	1,670,510
Uncategorized	127	$	14,264,292
Total	**620**	**$**	**44,092,729**

** Buildings included in each flood zone were exclusive to each grouping (i.e., the Floodway were not also included in the 100-year flood zone or 500-year flood zone, and building counts in the 500-year flood zone (non-regulatory) do not include buildings accounted for in FEMA 100-year flood zones.*

***Value of "At-Risk Improvements" may exclude the value of tax-exempt improvements.*

Many of the county's critical facilities fall in special flood hazard areas or have been impacted by past flooding events. Flooding in 1977 inundated Hurley High School and the Buchanan County Career and Technical Center. More recently, flooding in 2021 disrupted a major water line and caused service outages.

Critical Facilities

GIS analysis was used to determine the number of critical facilities within flood hazard areas. In all, there are 22 out of 65 identified critical facilities located in FEMA flood hazard areas: 10 critical facilities in the FEMA regulated floodway, 8 critical facilities in the FEMA 1.0% annual chance (100-year) floodplain, 3 critical facilities within the FEMA 0.2% annual chance (500-year) floodplain, and 1 within the FEMA Area with Reduced Risk due to Levee flood zone. The SunCoke Plant facility was only counted as falling within the FEMA floodway, but it also has 2 buildings within the FEMA 1.0% annual chance floodplain. Table 6-5 lists critical facilities within or partially within flood hazard areas.

Table 6-5: Critical Facilities Flood Risk Analysis

Critical Facility (by Community Lifeline)	Flood Hazard Area	Planning Team Comments
Energy		
AEP Electric Utility Substations (15 total)	Floodway - 3; 1.0% Annual Chance -1	-
Food, Water, Shelter		
Council Elementary/Middle School	1.0% Annual Chance	-
Council High School	1.0% Annual Chance	-
Grundy High School	-	-
Hurley Elementary/Middle School	-	-
Hurley High School	1.0% Annual Chance	Flooded in 2021; to be consolidated
Riverview Elementary/Middle School	-	-
Twin Valley Elementary/Middle School	Floodway	-
Twin Valley High School	-	-
Buchanan County Public Service Authority	-	-
Buchanan County Social Services	0.2% Annual Chance	Flood prone, being assessed under USACE program
Buchanan Information Park / School District	-	-
Feeding My Sheep, Inc.	Floodway	-
YMCA – Grundy	Floodway	Impacted by previous floods
Heritage Hall XIV Nursing Home (Grundy)	-	Flood prone
John Flannagan Water Authority	-	-
Sewer Pump Station*	-	-
Pump Station 1*	-	-
Pump Station 2*	-	-
Pump Station at Hospital / YMCA*	-	-
Dismal Pump Station*	-	-
Patterson Pump Station*	-	-
Rockhouse Pump Station*	-	-
Oakwood Pump Station*	-	-
Lancaster Pump Station*	-	-
Building housing water utility SCADA system*	-	Flooded during 2022 Whitewood flood; no back-up; would like to relocate

Hazardous Materials		
Buchanan County Waste Transfer Station	-	Not considered vulnerable
Conaway Wastewater Treatment	-	Will be replaced under Capital Improvement Plan
SunCoke Plant	Floodway (7 buildings); 1.0% Annual Chance (2 buildings)	Flood prone; potential for flood-caused hazardous materials release
Health and Medical		
Appalachian College of Pharmacy	Floodway	-
Buchanan General Hospital	Floodway	Flood prone
Buchanan County Health Department	-	Not considered vulnerable
Safety and Security		
911 Dispatch Center & Sheriff's Office	1.0% Annual Chance	Not impacted by previous floods, but adjacent to creek
Town of Grundy Police Department	0.2% Annual Chance	-
Buchanan County Courthouse	Area with Reduced Risk due to Levee	Mitigated by flood ring wall
Council Volunteer Fire Department	1.0% Annual Chance	Flood prone
Dismal River Volunteer Rescue	1.0% Annual Chance	-
Grundy Volunteer Fire Department	0.2% Annual Chance	-
Whitewood Volunteer Fire Department	-	Flooded in 2021
Big Rock Volunteer Fire Department	-	-
Harmon Volunteer Fire Department	-	Flood prone
Keen Mountain Correctional Center	-	Not considered vulnerable
Knox Creek Volunteer Fire Department	-	-
Oakwood Volunteer Fire Department	Floodway	Floodprone
Russel Prater Volunteer Fire Department	-	-
Slate Creek Volunteer Fire Department	-	Flood prone
Virginia State Police Area 29	1.0% Annual Chance	-
Transportation		
US Highway 460*	-	-
State Route 80*	-	Flood prone – pinch point at Russell Fork
State Route 83*	-	Flood prone – pinch point at nursing home at intersection with Lick Creek

State Route 638*	-	Flood prone – pinch points at Whitewood and Hurley

**Not included in flood risk exposure analysis.*

Areas of Reduced Risk Due to Levee

The failure of a levee can be attributed to the loss of structural integrity of a wall, dike, berm, or elevated soil by erosion, piping, saturation, or under seepage. Levee failures cause water to inundate an area normally protected by the levee. The overtopping of a levee may occur when flood levels raise over the top of the levee, causing water to fill the protected area. This would cause the levee to experience additional stress and may lead to failure of the structure Although most levee systems are maintained and closely monitored during potential events such as excessive rainfall that could result in breaches, levees sometimes fail for different reasons. Occasionally, levee systems are compromised due to record inflows of water that surpass their designed protection levels.

Within Buchanan County, a levee has been built by in Grundy to protect a number of buildings in the downtown area where Slate Creek flows into the Levisa Fork. Table 6-6 shows the buildings identified, their use, and the estimated improvement value. Figure 6-18 shows the location of these buildings. Among the buildings being protected by this levee are the Buchanan County Courthouse and the Grundy Post Office, both very important facilities. The estimated improvement value of all the structures protected by the levee is $4,042,300, with the courthouse accounting for $3,610,400 of this value.

Table 6-6: Buildings identified in the FEMA area with reduced risk due to levee.

Buildings in Area with Reduced Risk due to Levee

	Number of Structures	Estimated Value*
Commercial	1	$ 32,500
Institutional	3	$ 4,009,800
Total	**4**	**$ 4,042,300**

**Value of "At-Risk Improvements" may exclude the value of tax-exempt improvements.*

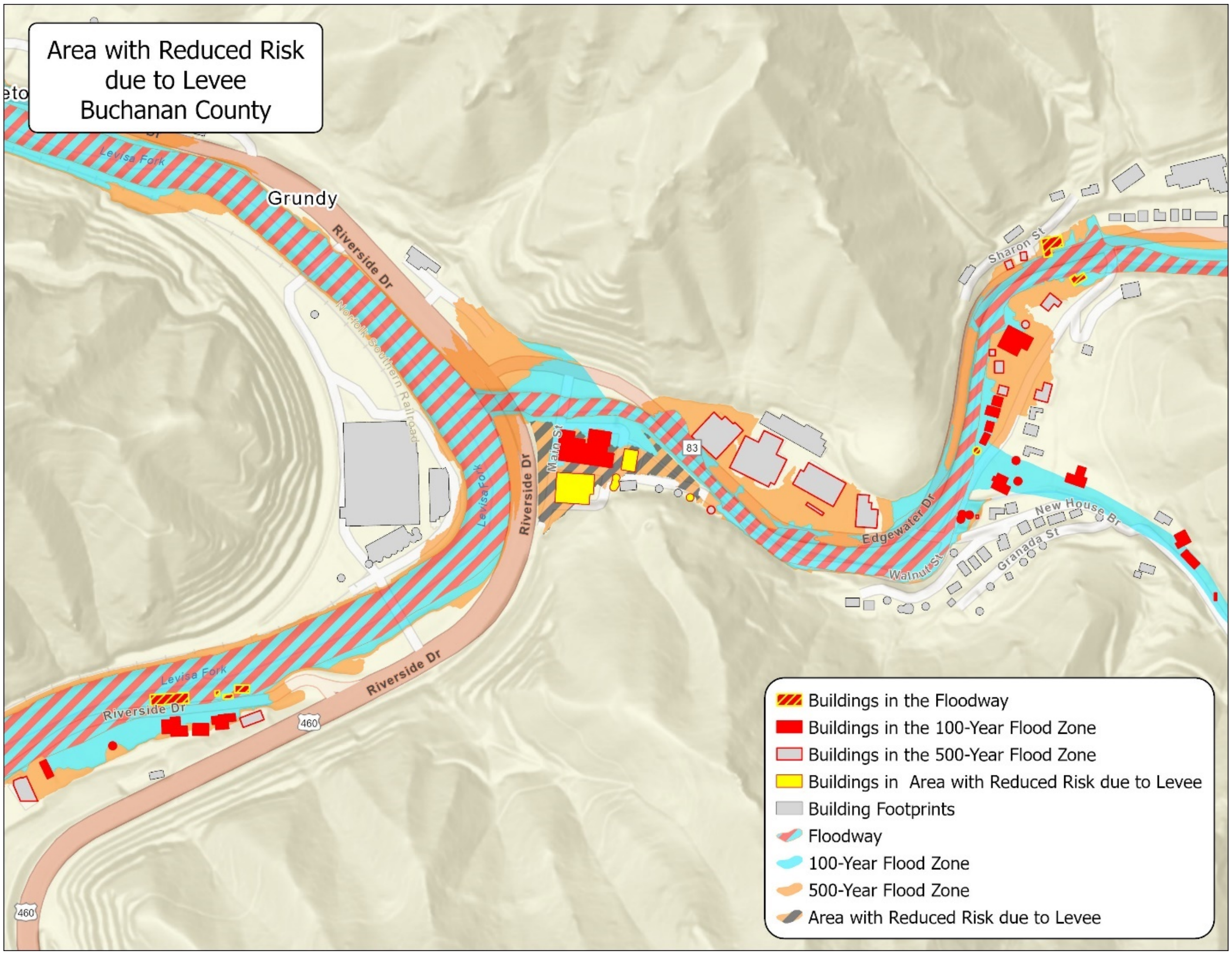

Figure 6-18: Buildings protected by levee in downtown Grundy

Socially Vulnerable Populations

In the US in general, low-income and minority populations are more likely to live in high-risk flood zones. One way to consider exposure of socially vulnerable populations to flood risk in Buchanan County is by assessing the number of buildings at-risk to flood within census tracts with high social vulnerability. The U.S. Agency for Toxic Substances and Disease Registry (ATSDR), in conjunction with the Centers for Disease Control and Prevention (CDC), the publish a social vulnerability index (SVI). The SVI uses 16 US Census statistics to map socially vulnerable populations. The intent of the program is to plan support for communities that will most likely need support before, during, and after a public health emergency or a natural disaster. The statistics used include poverty, lack of vehicle access, and housing conditions, among others, which are collected at a census tract level and grouped into four themes. Each tract receives a separate ranking for each of the themes, as well as an overall ranking.[33] Figure 6-19 shows the overall ranking for Buchanan County's seven census tracts.

[33] Agency for Toxic Substance and Disease Registry. (2022). At A Glance: CDC/ATSDR Social Vulnerability Index. Retrieved November 12, 2022 from https://www.atsdr.cdc.gov/placeandhealth/svi/at-a-glance_svi.html.

A GIS intersect analysis was performed using buildings within flood risk areas (FEMA 1.0% and FEMA 0.2% annual chance) and social vulnerability census tract ratings from the NRI. Results show that the majority of buildings in Buchanan County within flood hazard areas are not located in census tracts defined as having the highest social vulnerability. Of the XX buildings at risk from flood, XX (XX%) are located within tracts with “relatively high” social vulnerability and XX (XX%) are located within tracts with "relatively moderate" social vulnerability. Figure 6-XX shows buildings within flood hazard hazards alongside NRI social vulnerability ratings by census tract.

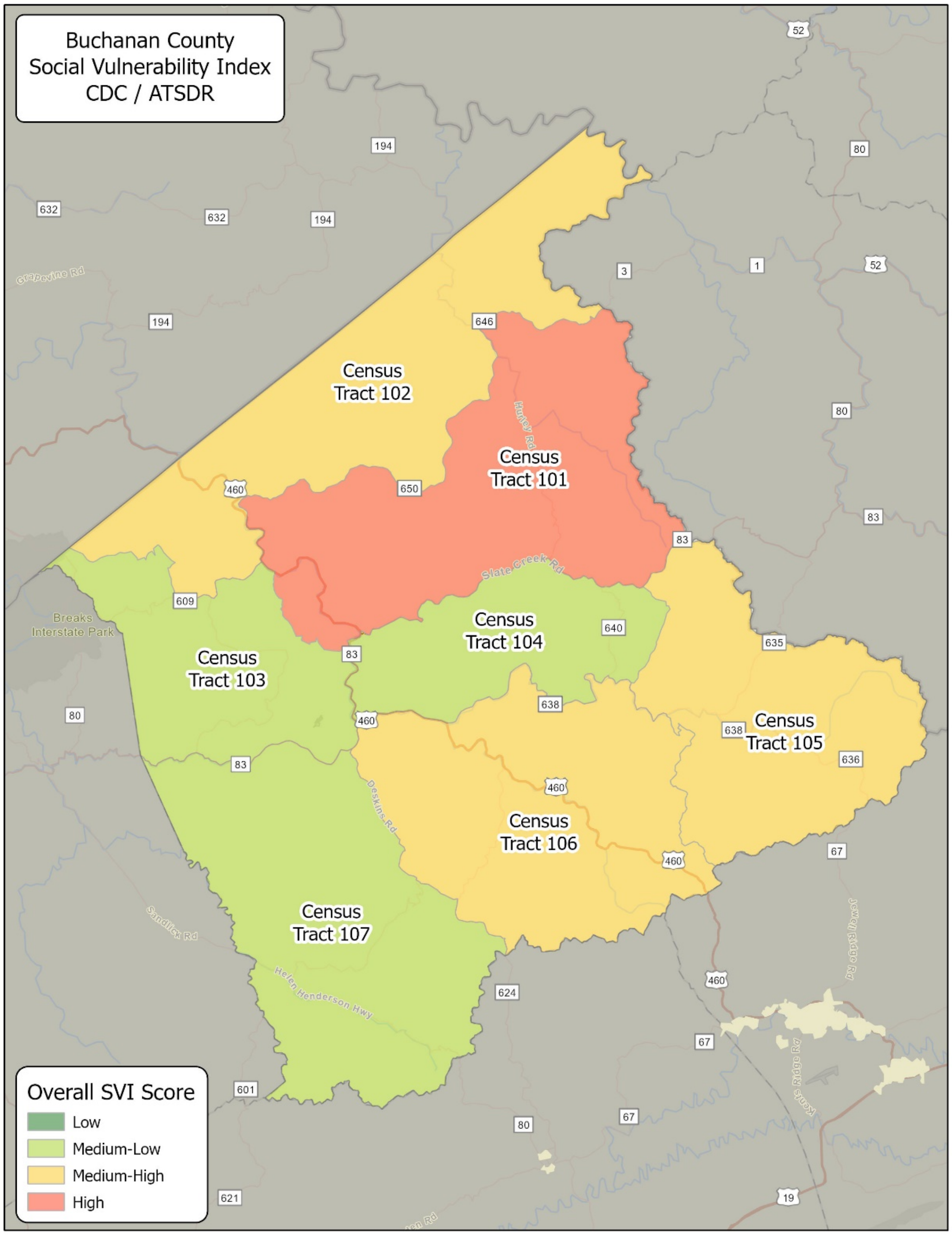

Figure 6-19: Buchanan County SVI Source: CDC/ATSDR

Flooding Impacts

Given its history of severe flood events and projected future conditions, Buchanan County is susceptible to flooding. Aware of the risk, Buchanan County has adopted a Flood Damage Prevention Ordinance, and if participating in several programs aimed at reducing flood risk. These efforts are detailed in *Section 5: Capability and Capacity Assessment*. Despite these steps, Buchanan County remains vulnerable to flooding, as demonstrated through recent events and through results of the GIS analysis. Flooding concerns within the county's watersheds are increasing as the climate changes, as detailed in the *Weather and Climate* subsection.

Floods have a variety of impacts and effect people, structures, and infrastructure in different ways, with both immediate and long-term impacts. Flood impacts to buildings, infrastructure, the economy, public health, and life safety, including impacts on socially vulnerable populations, are described below. Cascading hazard impacts, such as flooding-induced mudflows, are also described.

Buildings

Structures exposed to flooding, including critical facilities, can be severely damaged by floodwaters. Building contents can be lost, damaged, or destroyed, and structures themselves can be compromised by floodwaters. After a flood, wooden structures may rot.

Pressure from floodwater, especially as seepage through soil, can damage building foundations. Furthermore, as illustrated in Figure 6-20 and Figure 6-21, the force of rushing floodwaters can push whole structures off their foundations. Mobile homes and manufactured homes that are not elevated or properly anchored to a permanent foundation are more susceptible to being lifted up and carried hundreds of feet during a flood event. When this occurs, not only is the structure itself damaged or destroyed, but the structure then becomes a threat to other structures, property, and residents as travels downstream.

Figure 6-20: Buchanan County home that was pushed off its foundation during July 2022 flooding[34]

[34] Bill Bowling via WSET News Lynchburg, VA.

Figure 6-21: Flood damage resulting from July 2022 flooding in Pilgrims Knob area of Buchanan County[35]

Infrastructure

Infrastructure throughout the county has the potential to be impacted by flooding, including roads, railroads, bridges, dams, electrical systems, and water / wastewater systems. Potential infrastructure impacts are detailed in Table 6-7 below.

[35] Buchanan County Emergency Management.

Table 6-7: Infrastructure Flood Impacts

Infrastructure Type	Vulnerability to Flooding
Railroads	Flooding can result in the need to divert trains due to high waters, or even result in train derailments from washed-out tracks. In Buchanan County, railroads often hug streambanks within narrow valleys. No damage to railroads within the county were noted by officials from previous events.
Highways	Floods can wash out roads, causing long-lasting access issues. High, quick-moving floodwaters on highways can sweep up vehicles and pedestrians. Flooding on major roads can interfere with evacuations. Flooding-induced landslides and mud/debris flows can block and damage roads. County officials noted several areas within the county where roadways routinely flood, including Lester's Fork Road, State Road 643, Slate Creek Road, and Spruce Pine Road.
Bridges	Bridges can become washed out or inundated during flood events. In Buchanan County, bridge washouts (both personal bridges and state or local bridges) are common during flood events, when quick-moving water rushes through narrow channels. Washed-out bridges can be carried downstream and contribute to debris that blocks channels. Further, bridges that do not fail may be exposed to scouring and become unsafe for future use. Bridges also act as chokepoints during flood events, at which debris carried in floodwaters collects at the bridge and has a damming effect, as shown in Figure 6-22. Buchanan County has a high number of bridges that are constructed by private property owners; these bridges are less likely to go through the permitting process.
Dams	Dams are vulnerable to failure during flood events. Failed dams can result in damage to the dam itself, as well as increased flooding downstream. Further, failure at dams that impound hazardous materials, such as slurry or coal ash, may have severe environmental and public health impacts. Buchanan County has several dams associated with mining.
Electric	Electric systems can be damaged during flood events, causing costly repairs and prolonged service outages. Floodwaters may damage substations and utility poles. In Buchanan County, precipitation-induced landslides, mudflows, and debris carried down steep slopes by runoff can cause damage, as shown in Figure 6-23.
Water / Wastewater	Water and wastewater systems and facilities have the potential to be impacted by flooding, resulting in costly damages and prolonged service outages. Treatment facilities may become inundated or inaccessible due to floodwaters. Pump stations may become damaged. When roads are washed out, or during landslides, underground watermains and sewage conveyance systems may break. During main breaks, bacteria may be introduced to drinking water systems or low pressure may cause service disruptions. Further, Buchanan County's water and wastewater systems require electricity to treat and pump water; when electricity is out, water service outages may occur if backup power is insufficient.

Figure 6-22: Debris collected at a bridge in Hurley, 2021[36]

[36] WHSV (2021). Major flooding and mudslides in Hurley, VA. Retrieved from [Major flooding and mudslides in Hurley, VA (whsv.com)](whsv.com).

Figure 6-23: Flood damage at Appalachian Power's Dismal River Substation, 2022[37]

Economy

Businesses disrupted by floods often have to close. They lose their inventories, customers cannot reach them, and employees are often busy protecting or cleaning up their flooded homes. Business can be disrupted regardless of the business being located in the floodplain when customers and clients cannot reach their location, such as when roads are flooded. This is especially true in mountainous areas such as Buchanan County. Like the buildings and homes throughout the county, the county's road network is generally confined to the narrow valley floors along streambanks. Paired with a lack of alternative routes, a flooding event will isolate individuals, neighborhoods, or entire communities in the county.

Business interruption means forgone sales tax revenue for the county. As with flooded roads, public expenditures on flood preparation, response, and recovery, including sandbags, public works, emergency calls, debris clean-up, and repairs to damaged public property affect all residents of the county, not just those in the floodplain. Further, some residents may choose to leave the county after their homes have been flooded; it was noted as both public meetings that residents who relocated after being impacted by floods did not move back. Emigration of residents can impact property values, businesses, and tax revenues for the county.

Public Health Impacts

Floodwaters often contain contaminants such as bacteria and chemicals. Flooding may cause combined sewer overflows, resulting in sewage in floodwaters. Individuals traversing floodwaters or children playing in floodwaters could contract diseases, injuries, and infections.

6.[37] WDBJ7 (2022). Some still unaccounted for after Buchanan County flooding; swiftwater teams respond. Retrieved from Some still unaccounted for after Buchanan County flooding; swiftwater teams respond (nbc12.com).

Structures exposed to floodwaters can also present public health hazards. Damaged electrical systems and natural gas tanks present risk of fire and explosions. Structures exposed to flooding may develop mold or wood rot. People with asthma, allergies, or breathing conditions may be at a higher risk to mold.[38]

Trains or trucks carrying hazardous materials during flood events have the potential spill or release hazardous materials due to crashes or derailments, which could negatively impact public health. Fixed sites, such as factories or industrial facilities, can also release hazardous materials when their facilities flood.

Life Safety

The public often underestimates the dangers presented by floodwaters. Flooding is often localized to certain parts of a community (e.g., certain roads, intersections, or neighborhoods), and floodwaters can prevent normal access to buildings and facilities. This presents a danger when motorists and pedestrians attempt to traverse floodwaters. Motor vehicles and pedestrians can get swept up in flood currents, increasing the risk for drowning. Even in shallow waters, fast-moving currents can carry individuals or vehicles into deeper waters, where pressure from flowing water can prevent drivers from escaping submerged vehicles. As little as six inches of floodwater can move a vehicle, and as little as two inches can move a person. In addition, floodwaters often conceal conditions that are a danger to those on foot, including electrical wires, debris, nails, and open manholes hidden beneath the surface. In addition, roads and bridges can be weakened by flood impacts, making them unsafe for travel. Flood conditions necessitate warnings, such as flash flood warnings, road closure warnings, and flood advisories. Evacuations may be necessary, as was the case in both the 2021 and 2022 events in the county. The lack of public education regarding evacuation routes and procedures within the county was noted by residents during public meetings and by the Planning Team.

Socially Vulnerable Populations

Floods have the potential to disproportionately impact socially vulnerable populations. Economically constrained households (homeowners and renters) may have trouble affording flood insurance premiums. In the event of a flood, these households have a diminished capacity to repair homes, remediate mold, and replace destroyed belongings. Further, economically constrained households may not be able to afford preventative measures, such as backwater check valves or sump pumps. Individuals that do not have paid time off or are unable to work remotely (such as those in food service and hospitality) may attempt to traverse floodwaters to commute or may lose income in the event they cannot report to work due to a flood.

Certain populations may face difficulty evacuating during an extreme flood event, such as the elderly, disabled, or those who are otherwise mobility challenged. During public meetings, it was noted that several elderly individuals within Buchanan County required assistance from neighbors or family to safety evacuate. This may be particularly relevant to Buchanan County due to an aging population; approximately 24% of the county's population is 65 years or older, compared to 16% for the state of Virginia. Non-English speakers may also have difficulty heading flood warnings and evacuation notices.

[38] The Centers for Disease Control and Prevention. (2020). Mold after a disaster. Retrieved November 11, 2022 from https://www.cdc.gov/disasters/mold/.

Cascading Hazards

Flood events may lead to cascading hazards, or events where a primary hazard, such as extreme precipitation or flooding, results in subsequent hazard events. Extreme precipitation and flooding are known to trigger landslides, mudslides, and debris flows in Buchanan County. During a rainfall event, water fills the small pockets of air that naturally occur within soil, increasing the potential for a landslide. During a flooding event, flood waters can erode and, eventually, can undercut the base of the slope, carrying away a section of earth. With a portion of the slope base removed, the strength of the entire slope is now compromised, leaving it far more susceptible to a landslide. Furthermore, slopes with little or no vegetation as a result of mining operations, development, or a previous wildfire have elevated risk of landslides or mudslides.[39] Lands impacted by abandoned mines may also be more prone to slides. For example, in February 2020 DMME responded to a landslide in Lower Mill Branch that was caused by past mining and heavy precipitation. The landslide partially moved a home off its foundation before residents were evacuated and crews were able to stabilize the slope.[40]

Flood events may also lead to hazardous materials releases, when facilities containing hazardous materials, such as water/wastewater treatment facilities or industrial facilities, flood. This can have environmental and public health emergencies, necessitating response, clean up, and/or evacuation measures.

Areas Prioritized for Risk Reduction

It is acknowledged that all areas of Buchanan County, especially low-lying areas adjacent to stream channels, are at risk to flooding. Areas that have not previously been impacted by a major event may be impacted in the future. However, certain areas, eight in total, were identified to be prioritized for risk reduction actions. These areas are shown in Figure 6-24, with Figure 6-25 to Figure 6-32 showing these areas in more detail. Areas prioritized for risk reduction were identified based on previous flood events, results from the flood hazard analysis, and input from the Planning Team and the public.

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[39] Cumberland Plateau Planning District Commission. (2018). Hazard Mitigation Plan Update. Retrieved October 10, 2022 from http://cppdc.org/Reports/Mitigation%20Plan%20Edit.pdf.

[40] WCYS (2020). Officials: Buchanan County landslide declared an abandoned mine emergency. Retrieved from Officials: Buchanan County landslide declared an abandoned mine emergency | WCYB.

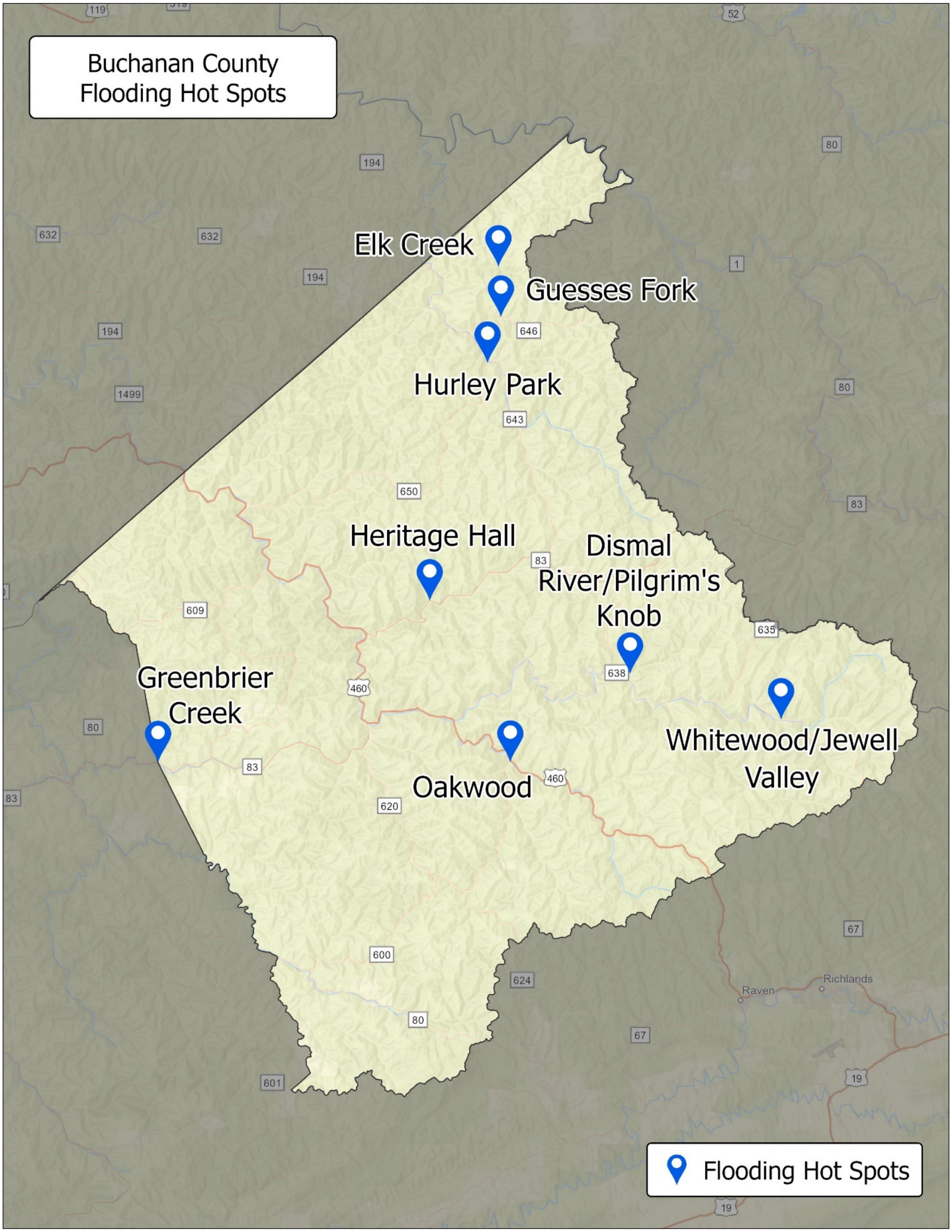

Figure 6-24: Buchanan County flooding hotspots

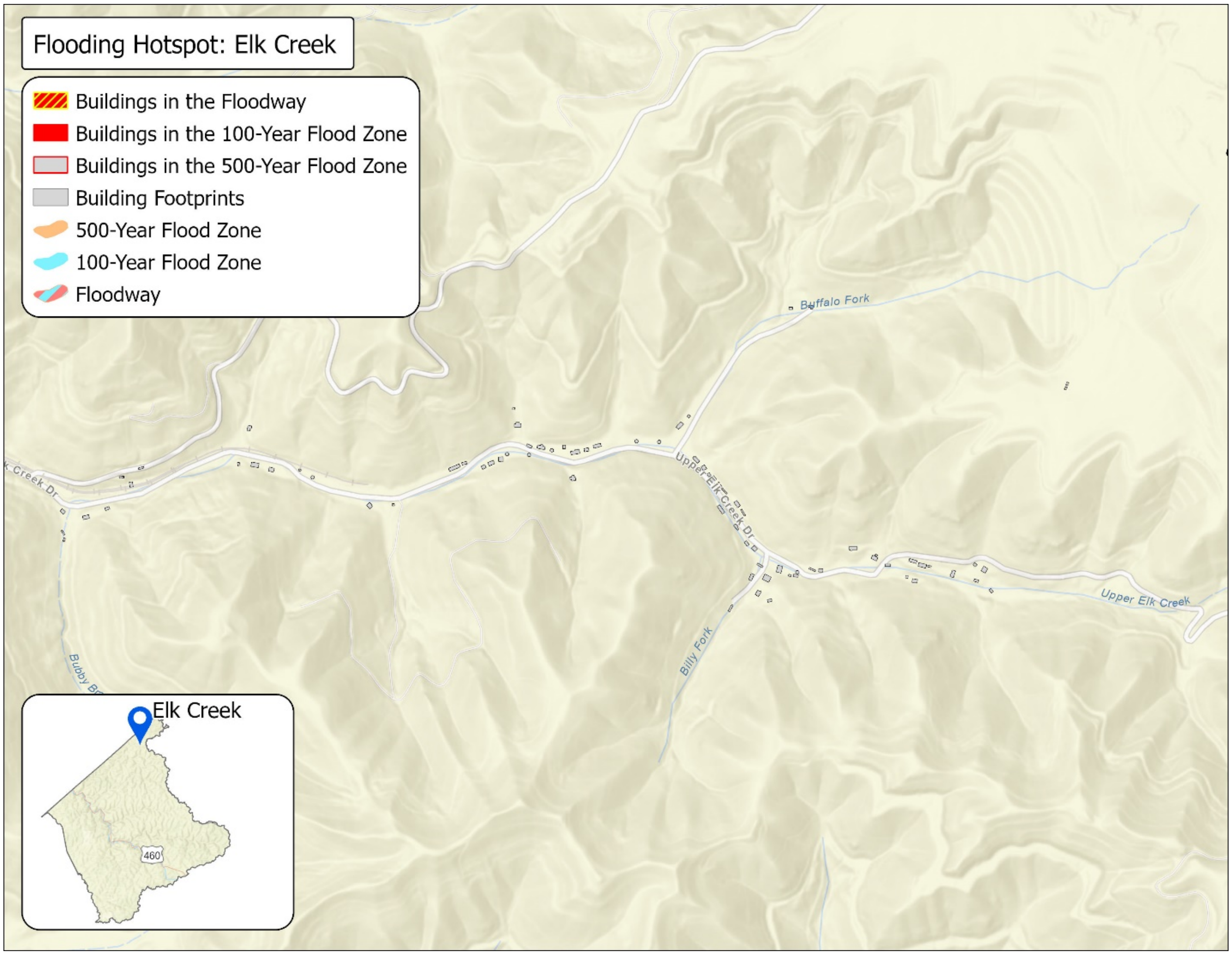

Figure 6-25: Elk Creek Priority Area

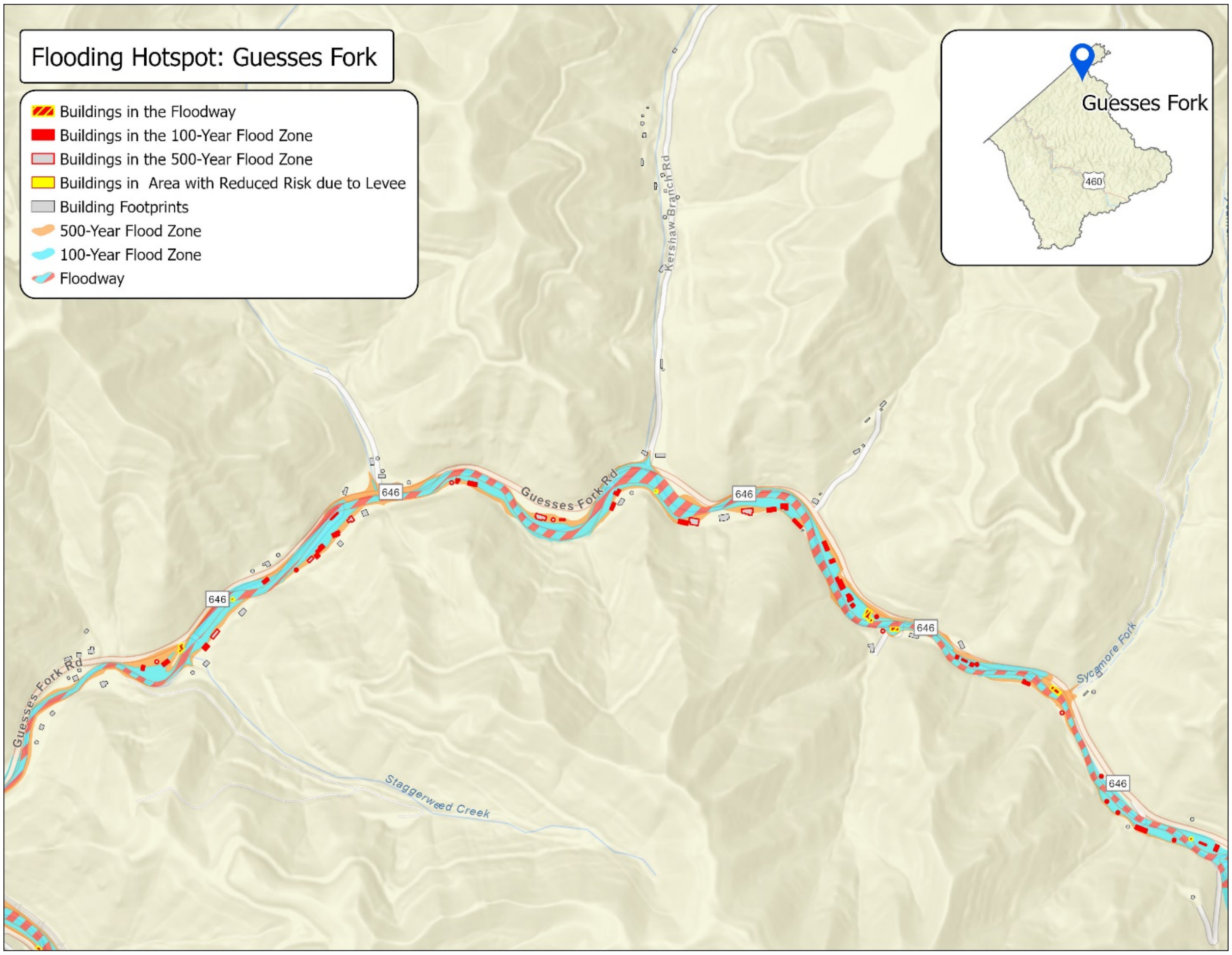

Figure 6-26: Guesses Fork Priority Area

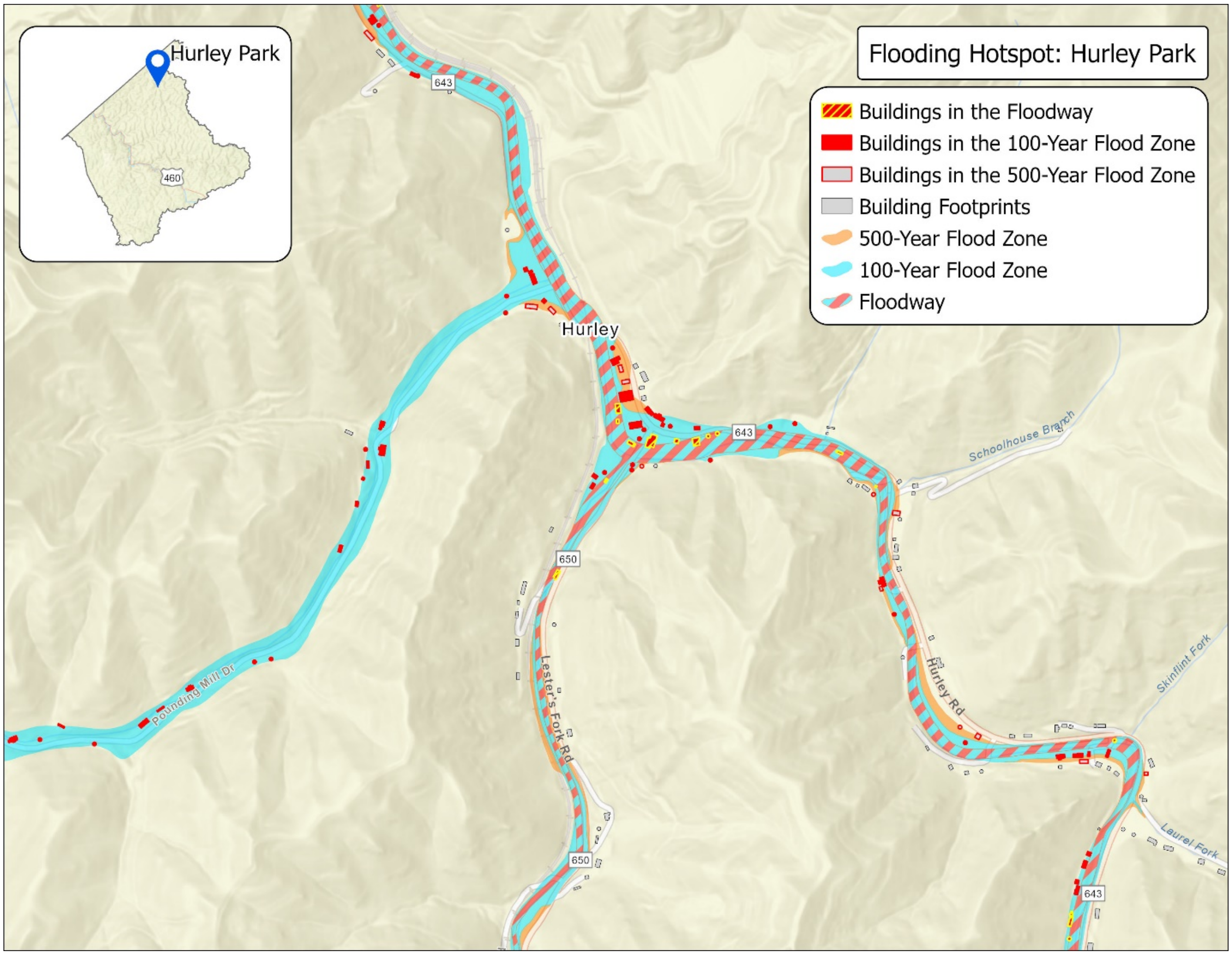

Figure 6-27: Hurley Park Priority Area

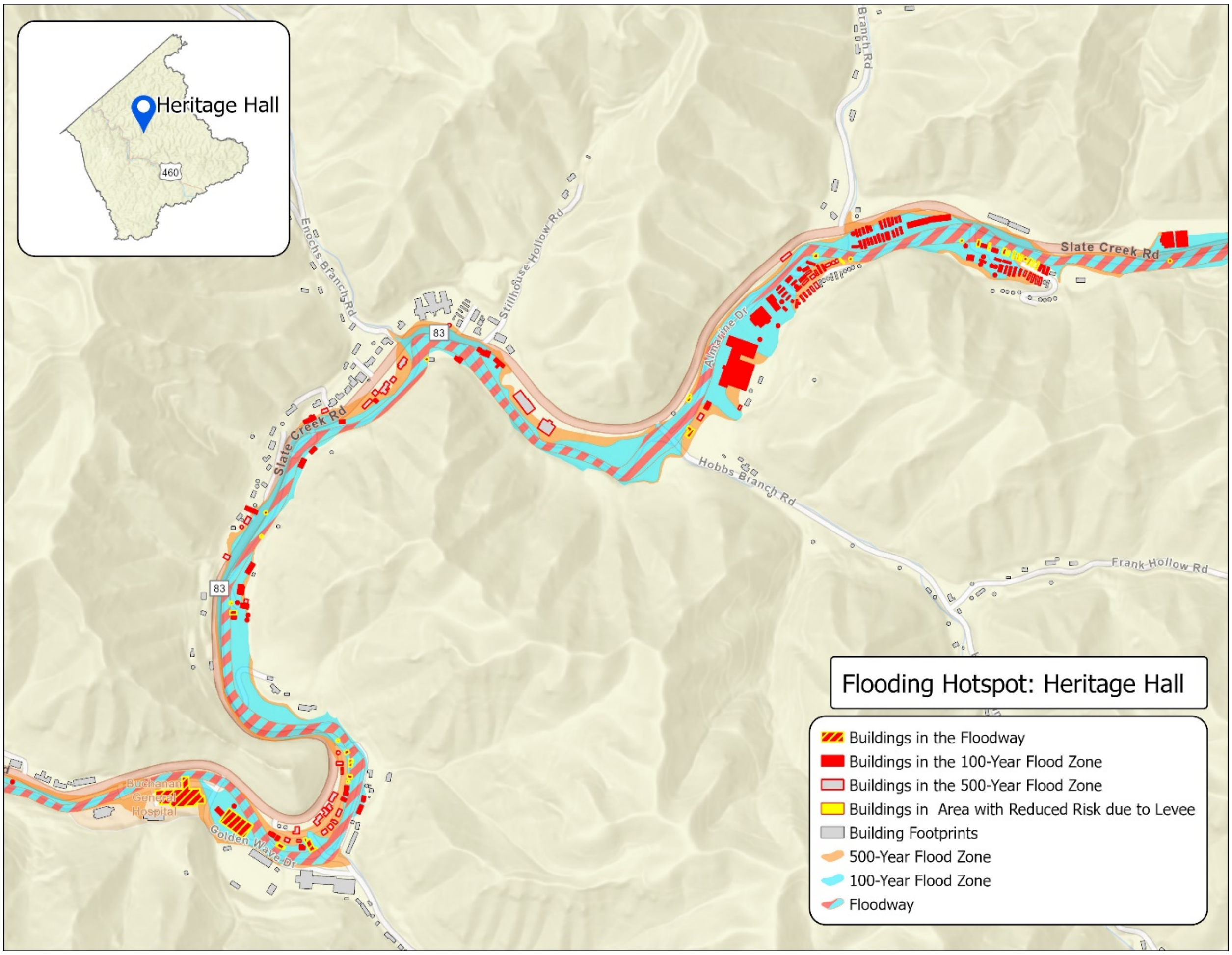

Figure 6-28: Heritage Hall Priority Area

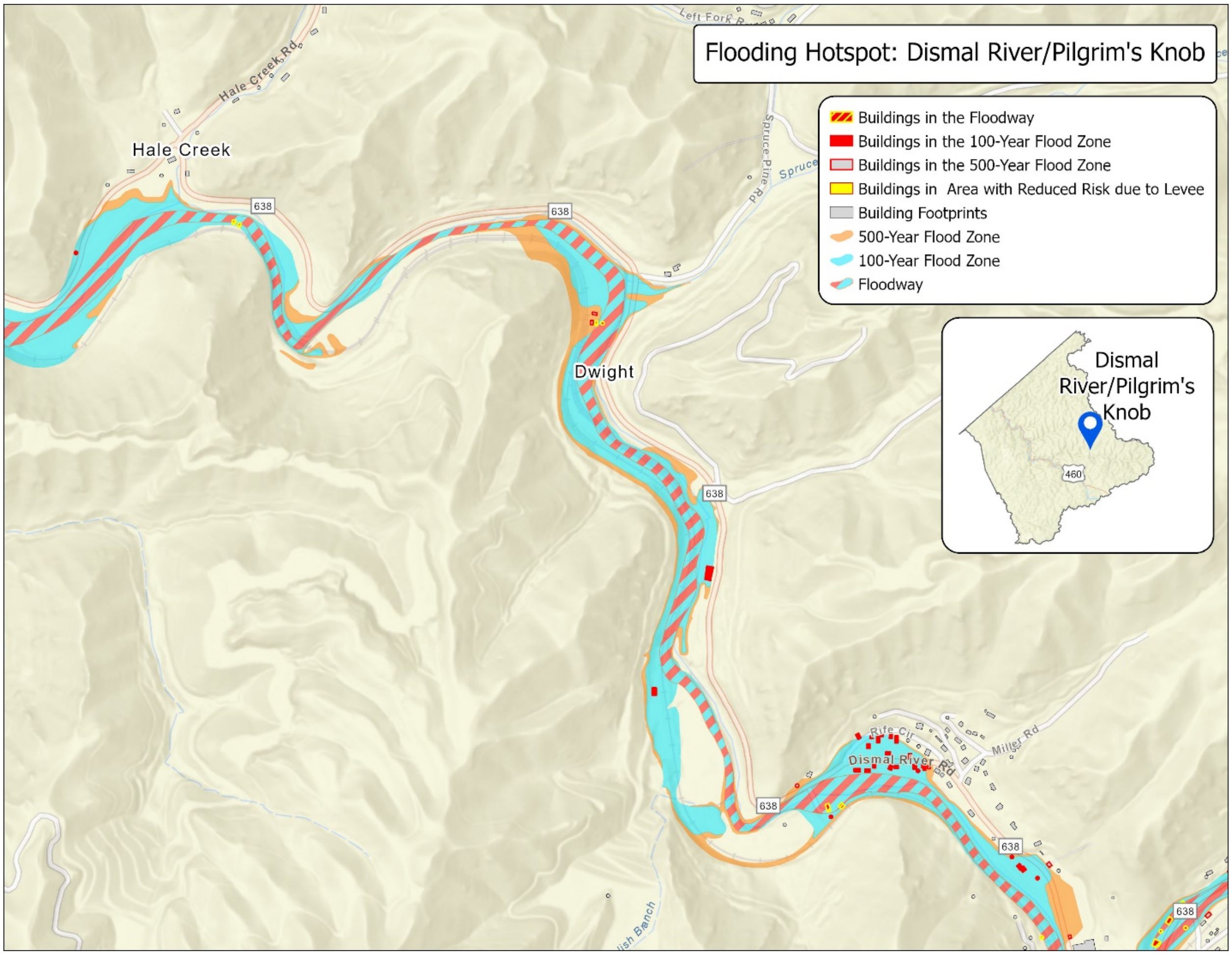

Figure 6-29: Dismal River/Pilgrim's Knob Priority Area

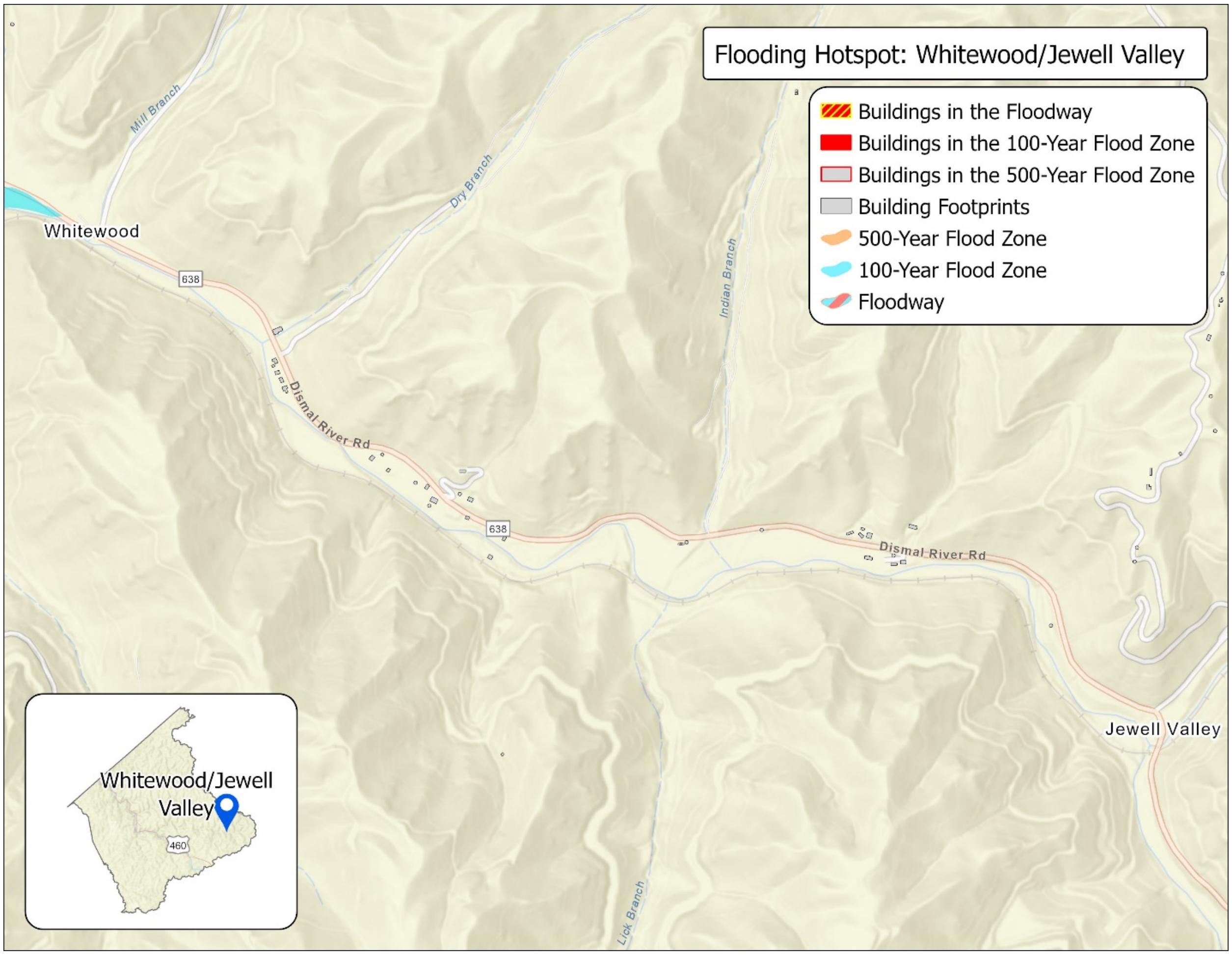

Figure 6-30: Whitewood/Jewell Valley Priority Area

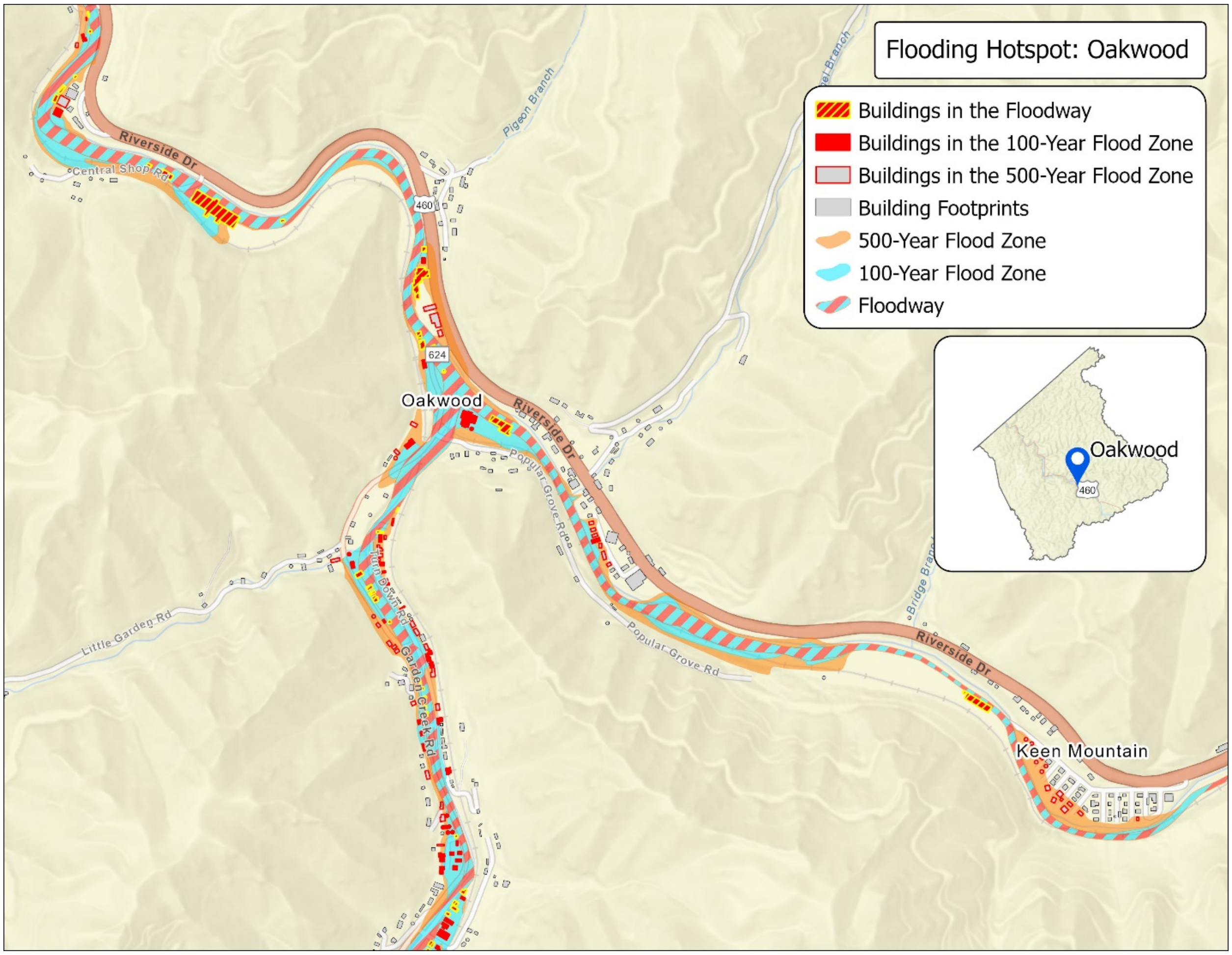

Figure 6-31: Oakwood Priority Area

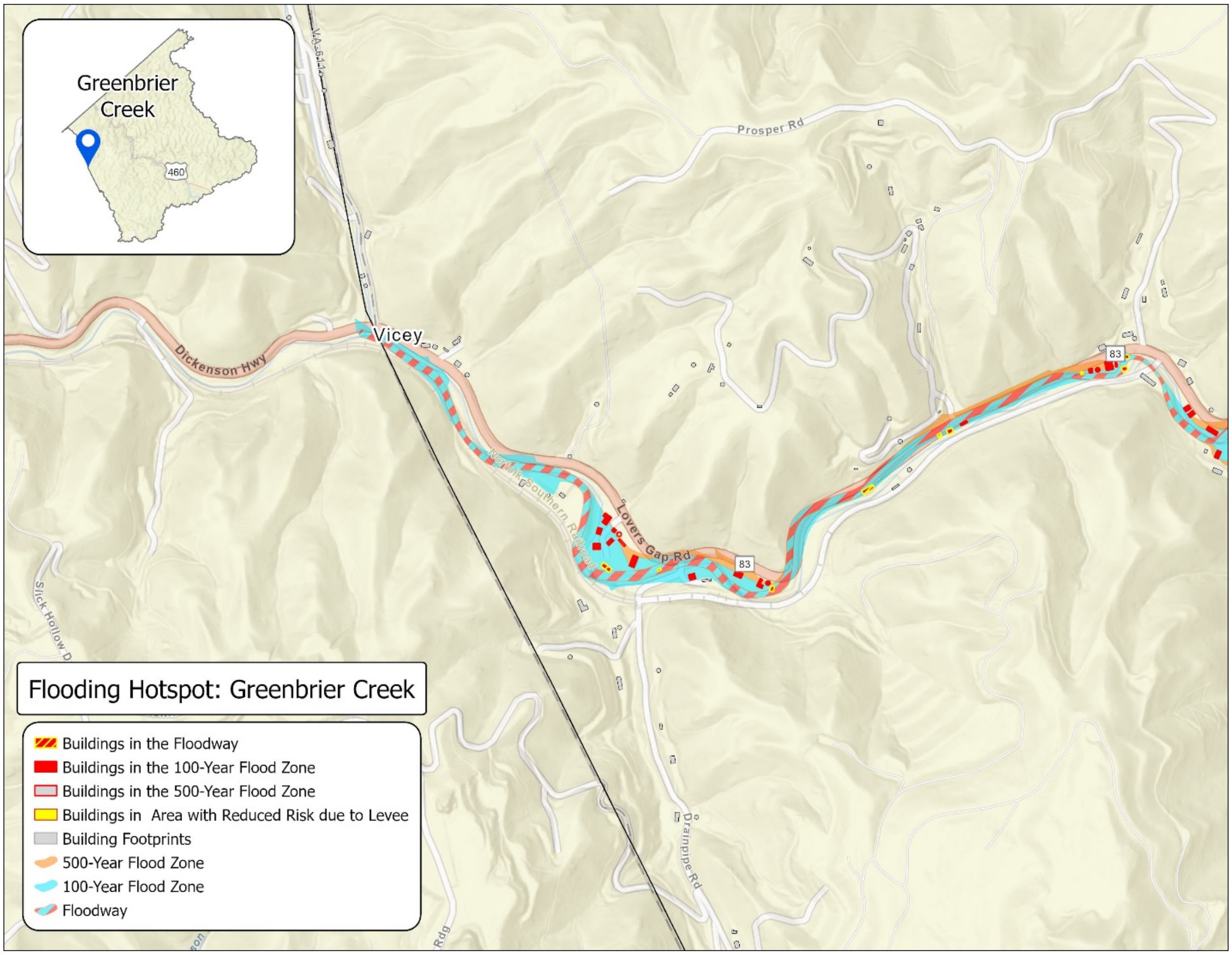

Figure 6-32: Greenbrier Creek Priority Area

Another area prioritized for risk reduction is Census Tract 103, located in the western corner of the county, shown in Figure 6-33. This area is a Low-Income Community Opportunity Zone, which means it qualifies for an incentivized capital investment program. The benefits include deferred capital gains tax, a reduction in capital gains tax due, or the elimination of tax due on capital gains within the opportunity zone.[41] The Investing in Opportunity Act, passed in 2017, created a program in which the IRS provides tax incentives for investments in identified zones. Each state's governor may submit nominations for the program, which are certified by the U.S. Department of the Treasury.[42] In addition to being an Opportunity Zone, Census Tract 103 also contains one of the identified flooding hotspots, Greenbrier Creek, shown in Figure 6-*32*.

Within Census Tract 103, structures along Greenbrier/Little Greenbrier Creek (southeastern portion of the tract), Levisa Fork (eastern boundary), Little Prater Creek, Bull Creek (northern boundary), and Deel Fork (northern boundary), are within flood hazard areas. There are a total of 2,582 estimated building

[41] OpportunityDb. (2020). What are Opportunity Zones? Retrieved November 10, 2022 from https://opportunitydb.com/guide/opportunity-zones/

[42] Congress.gov. (2017). S.293 – Investing in Opportunity Act. Retrieved November 10, 2022 from https://www.congress.gov/bill/115th-congress/senate-bill/293

structures in Census Tract 103. Of those, 386 buildings are within a FEMA flood hazard area, including 101 of these are within the floodway, 215 within the 1.0% annual chance flood zone, and 70 within the 0.2% annual chance flood zone. There are four critical facilities located in the census tract: two AEP substations, the Buchanan Information Park, and the Russel Prater Volunteer Fire Department. None of these critical facilities are located within a FEMA flood hazard area.

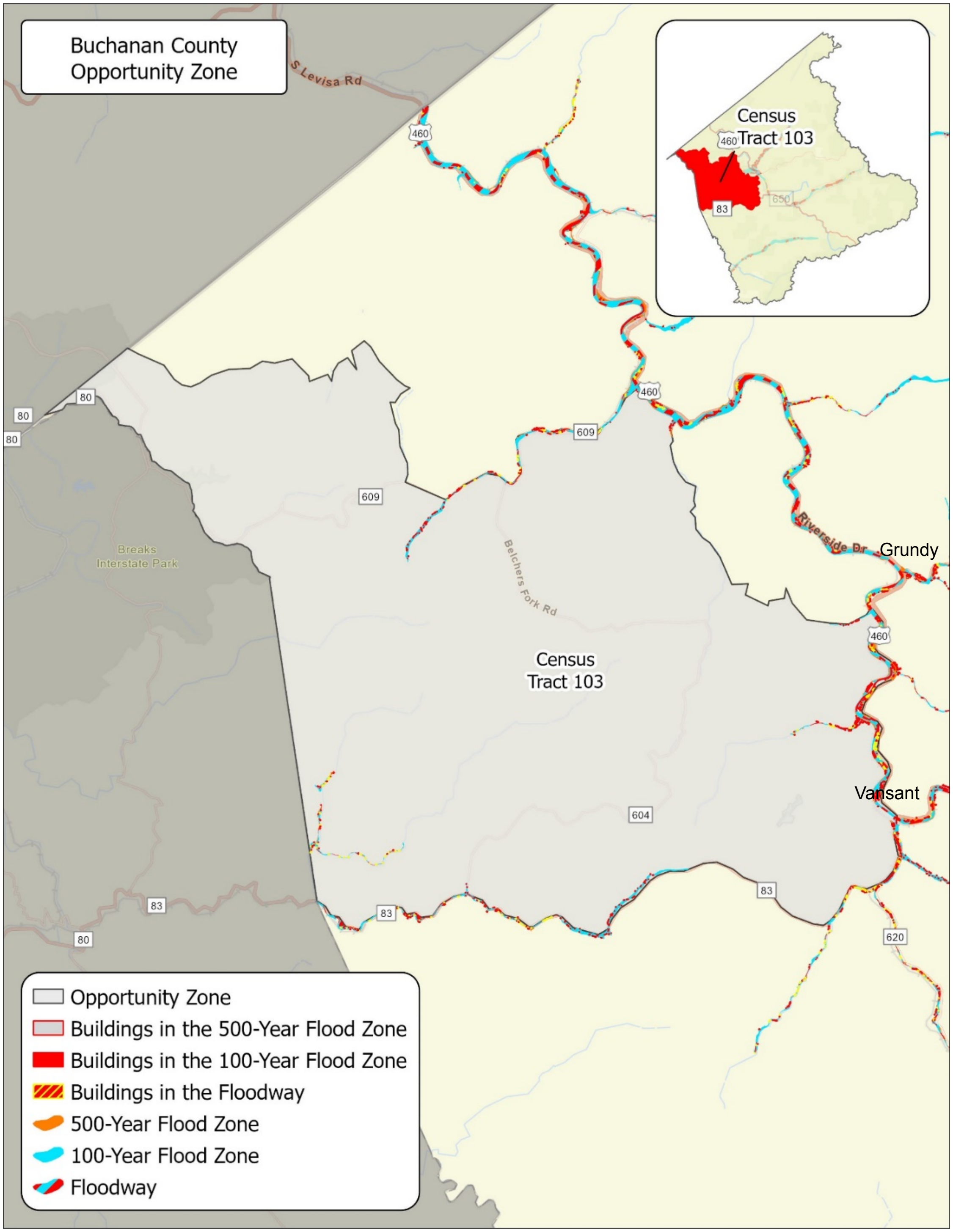

Figure 6-33: Buchanan County Opportunity Zone