Riverine Flood Risk Assessment Report

For the Communities of:

Camden-on-Gauley
Clendenin
Marlinton
Rainelle
Richwood
White Sulphur Springs

WV GIS Technical Center
West Virginia University

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OVERVIEW

The comprehensive risk assessment data supports detailed, site-specific analysis at the building or feature level (stream, buyout parcel, roads/railroads, National Register Areas, etc.). It also allows analysis at the community level (unincorporated areas/incorporated places) as well as the county scale to identify which jurisdictions are at more risk than others. All the community-, and building-level risk assessment data in this report should assist stakeholders in evaluating specific risk factors and correlating these risks to potential mitigation measures.

An Index Guide provides *access* to the various risk assessment products that include GIS files, risk assessment tables at the building and community level scales, static and online maps, subject reports, and 3D flood visualizations. Most of the risk assessment data can be viewed on the interactive WV Flood Tool (https://www.mapwv.gov/flood).

The WV Building-Level Risk Assessment (BLRA) Cycle and Methodology provides procedural information about how the flood risk assessment data and flood models are generated and validated through engagement with the communities. The statewide building risk assessment database is updated annually with new building characteristics from the statewide tax assessment database. It can be updated with user-defined values, corrections, or updates from stakeholders, especially in validating properties that have been mitigated.

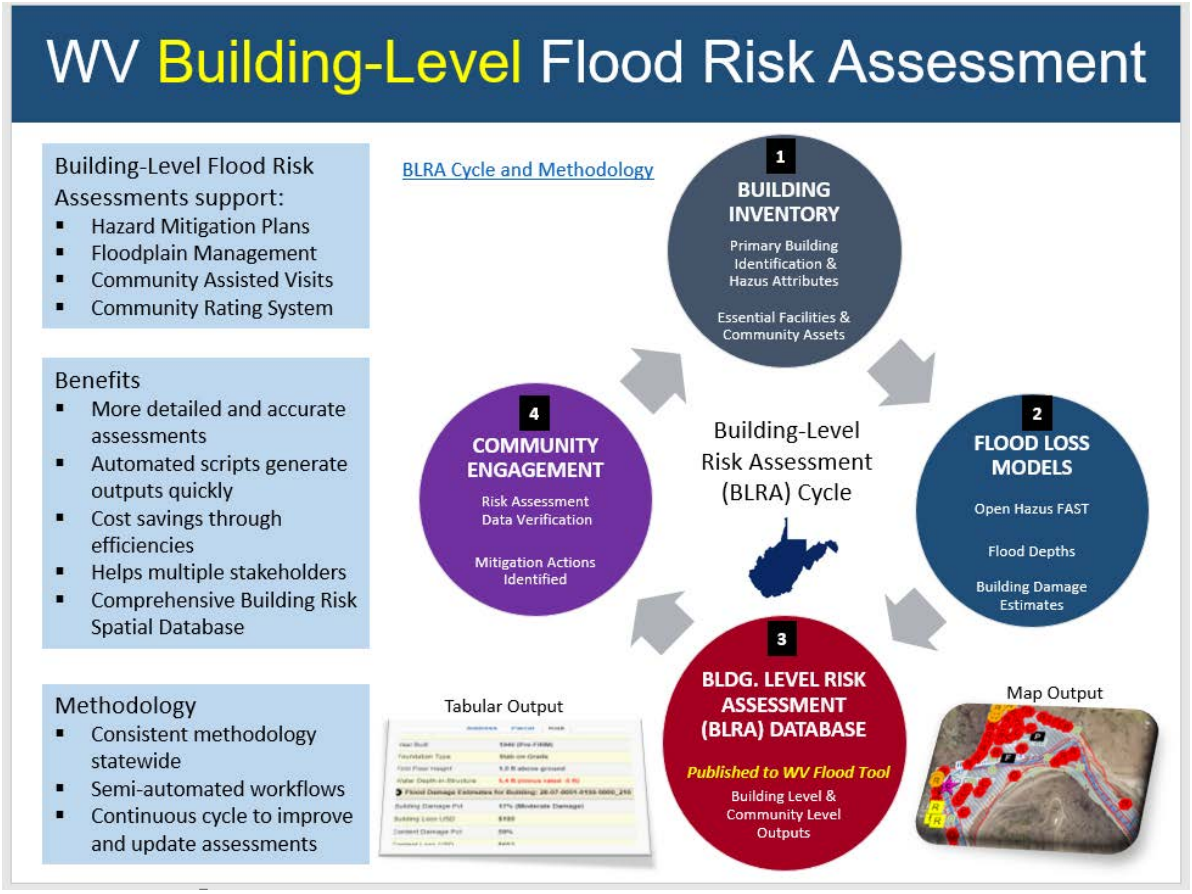


Figure 1. WV Building-Level Flood Risk Assessment (BLRA)

As a primary task of a project funded by the National Science Foundation (NSF), the WV GIS Technical Center (WVGISTC) developed a statewide flood risk index. The WV Flood Risk Index combines several risk indicators at multiple scales, covering all 11 Planning and Development Council (PDC) regions, 55 counties, 229 incorporated places, 55 unincorporated areas, 156 major streams, and 33 watersheds in West Virginia. This index was constructed based on several flood risk indicators grouped in seven major categories of Floodplain Characteristics, Building Exposure, Building Characteristics, Critical Infrastructure, Community Assets, Building Damage Loss, and People/Social Vulnerabilities. The needed data were collected from the BLRA (of Apr. 2024) as well as other sources such as the Federal Emergency Management Agency (FEMA) (of May 2024) and Census Bureau (of 2021), then processed and aggregated as the risk indicators and total risk index at the above scales. For each indicator, geographic units of the same scale were ranked, and percentile scores were calculated. These scores were then combined using an additive approach to develop category index scores and total flood risk index scores. Based on these risk scores, geographic units were classified from very high risk (top 20%) to very low risk (bottom 20%) for each indicator, risk category, and the cumulative risk index. The results are publicly accessible through the West Virginia Risk Explorer (WVRE), which features online tools such as the Risk Maps and Risk Reports.

Compared to other disaster risk indices, such as FEMA's National Risk Index (NRI), the WV Flood Risk Index stands out in several key aspects. One of its unique features is its ability to assess flood risk across multiple scales, from the state level down to the incorporated places. Most existing indices typically focus on just one or two scales. Additionally, the WV Flood Risk Index includes unincorporated areas as a separate level of analysis. Given West Virginia's rural character, unincorporated areas are crucial for understanding flood risk. The WV Flood Risk Index also takes a comprehensive approach to flood risk, combining various factors such as hazard characteristics, physical and human exposure, vulnerability, and loss impacts. A distinct feature of the index is that data for most of the indicators are created at the building level first and then aggregated at larger scales, providing a higher level of detail and accuracy. In contrast, other indices often rely on data at the census tract or block levels, whereas the WV Flood Risk Index offers greater granularity and precision by using building-level data.

This report summarizes the risk assessment analyses conducted for six communities of **Camden-on-Gauley** in Webster County, **Clendenin** in Kanawha County, **Marlinton** in Pocahontas County, **Rainelle** and **White Sulphur Springs** in Greenbrier County, and **Richwood** in Nicholas County. These communities were selected for detailed study because most were significantly impacted by the 2016 flood disaster in West Virginia, with Marlinton having been severely affected by the 1985 flood. Additionally, the analyzed indicators in the risk index highlight the high levels of flood risk associated with these communities. The chapters of this report are organized according to the aforementioned risk categories used for the flood risk index.

GENERAL INFORMATION

Among the studied communities, **Marlinton** has the largest area, covering 1,566 acres, followed by **White Sulphur Springs** with 1,214 acres, and **Richwood** with 1,068 acres. The municipality of **Clendenin** spans 974 acres, while **Rainelle** covers 714 acres and **Camden-on-Gauley** encompasses 214 acres.

According to the Census Bureau's 2021 American Community Survey (ACS) 5-year estimates, **White Sulphur Springs** has a total population of 2,659, while **Richwood** has 2,604 residents and **Marlinton** has 1,329. **Clendenin**'s population is 1,297, **Rainelle** has 1,236 residents, and **Camden-on-Gauley** has 176. The number of households is 1,177 in **White Sulphur Springs**, 964 in **Richwood**, 585 in **Rainelle**, 370 in **Clendenin**, 354 in **Marlinton**, and 56 in **Camden-on-Gauley**. The average household size is calculated after excluding individuals living in group quarters such as college residence halls, residential treatment centers, skilled nursing facilities, group homes, military barracks, correctional facilities, and workers' dormitories. The average household size is 3.6 in **Marlinton**, 3.5 in **Clendenin**, 3.1 in **Camden-on-Gauley**, 2.6 in **Richwood**, 2.2 in **White Sulphur Springs**, and 2.0 in **Rainelle**.

Based on E-911 address counts in the communities, **White Sulphur Springs** has a total of 1,657 structures, while **Richwood** has 1,341. **Rainelle** has 996 buildings in its community area, and **Marlinton** has 673 structures. The above number is 575 in **Clendenin** while it is 107 in **Camden-on-Gauley**.

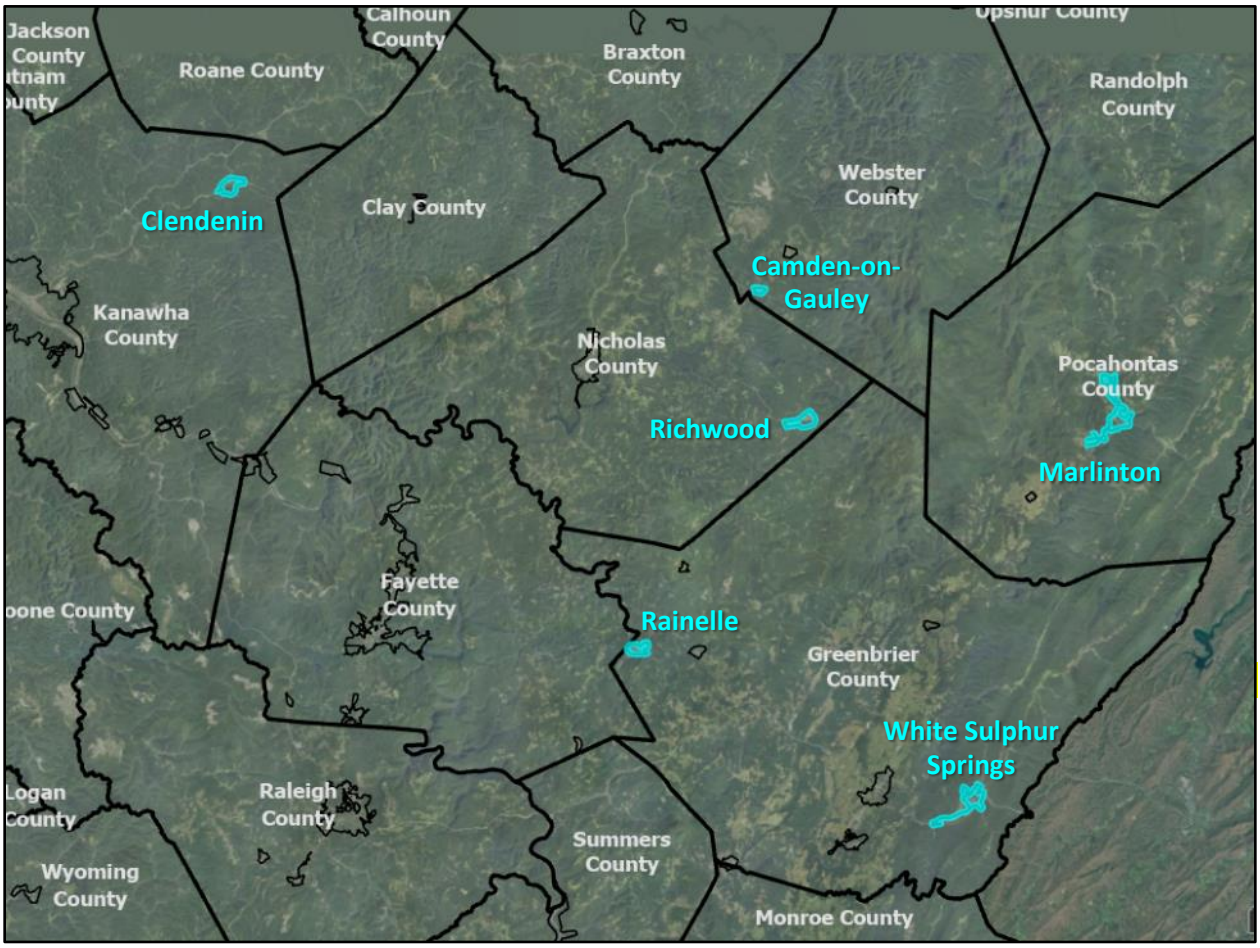


Figure 2. Selected communities for the detailed study

CUMULATIVE RISK INDEX

The results of the Cumulative Risk Index, developed combining 25 flood risk indicators across seven major categories, show that four of the studied communities are among the ***top 10%*** of incorporated places in the state, classified in the "VERY HIGH" risk group.

- **Clendenin** ranks ***1st*** in the ***top 10%*** of all 229 incorporated places with the highest risk index score of 100%. This community is in the top 10% for nine risk indicators and in the top 20% for 15 of them.
- **Marlinton** ranks ***4th*** in the ***top 10%*** of all incorporated places with a risk index score of 98.6%. It is among the top 10% for nine risk indicators and the top 20% for 14.
- **Richwood**, ranked ***18th***, is among the ***top 10%*** of incorporated places with a cumulative risk index score of 92.5%. This community is in the top 10% for five risk indicators and the top 20% for nine.
- **Rainelle**, ranked ***19th***, remains in the ***top 10%*** of incorporated places with a risk index score of 92.1%. It ranks in the top 10% for seven risk indicators and in the top 20% for 13.

Additionally, two other communities fall into the "Relatively High" risk category:

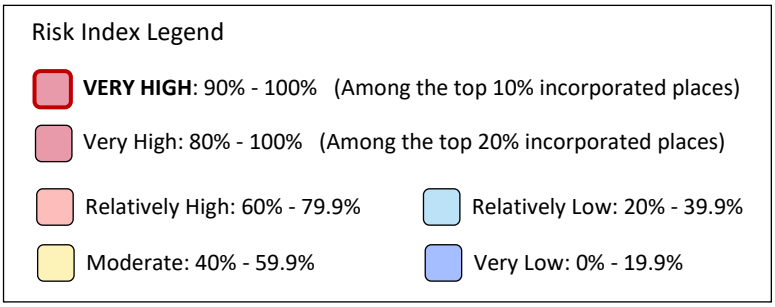
- **White Sulphur Springs**, ranked 82nd, has a cumulative risk index score of 64.4%, placing it in the top 10% for two risk indicators and the top 20% for four.
- **Camden-On-Gauley**, ranked 85th, has a risk index score of 63.1%, placing it in the top 10% for two indicators and the top 20% for five.

These results, which highlight the severity of flood risk in the mentioned communities, can be used by floodplain managers, planners, emergency managers, and other decision-makers, as well as for the general public, for purposes of planning, risk communication, and mitigation efforts. *Communities with higher risk index scores should be prioritized when allocating resources and developing plans. It is crucial to enhance resilience and hazard mitigation plans for these areas and ensure their emergency operation plans are regularly updated. Additionally, fostering community-level risk communication and engagement is essential. Informing the insurance and mortgage industries about the heightened risk levels, as well as educating new homeowners and renters, is strongly recommended. Moreover, identifying areas of mitigation interest within these communities should be a priority. Consideration should be given to creating or enhancing development codes and standards, alongside long-term community recovery policies.*

Table 1 summarizes the Cumulative Risk Index for the selected communities. The colors in the table represent the degree of risk in the communities, ranging from "VERY HIGH" to "Relatively High", as indicated in the legend. *Figure 3* shows the six selected communities on the cumulative risk index map.

Table 1. Cumulative Risk Index summary for the selected communities

Incorporated Place	CUMULATIVE RISK INDEX				
	Cumulative Index Score (0 to 100%)	Index Rating	Rank in Incorporated Places	Cumulative Top 10% Rank Flags	Cumulative Top 20% Rank Flags
Clendenin	**100%**	**VERY HIGH**	1	9	15
Marlinton	**98.6%**	**VERY HIGH**	4	9	14
Richwood	**92.5%**	**VERY HIGH**	18	5	9
Rainelle	**92.1%**	**VERY HIGH**	19	7	13
White Sulphur Springs	64.4%	Relatively High	82	2	4
Camden-On-Gauley	63.1%	Relatively High	85	2	5



Below is the link to the online risk report for the selected communities, available through the West Virginia Risk Explorer (WVRE):
https://wvfrf.org/wvre/report/?scaleid=5&entityid=159,173,243,293,298,346&type=comparison

Additionally, the online interactive risk maps for the selected communities can be accessed via the following links:

Clendenin: https://wvfrf.org/wvre/map/?scaleid=5&gslid=540075&index=CUM_INDEX&type=pct
Marlinton: https://wvfrf.org/wvre/map/?scaleid=5&gslid=540159&index=CUM_INDEX&type=pct
Richwood: https://wvfrf.org/wvre/map/?scaleid=5&gslid=540147&index=CUM_INDEX&type=pct
Rainelle: https://wvfrf.org/wvre/map/?scaleid=5&gslid=540228&index=CUM_INDEX&type=pct
White Sulphur Springs:
https://wvfrf.org/wvre/map/?scaleid=5&gslid=540045&index=CUM_INDEX&type=pct
Camden-On-Gauley:
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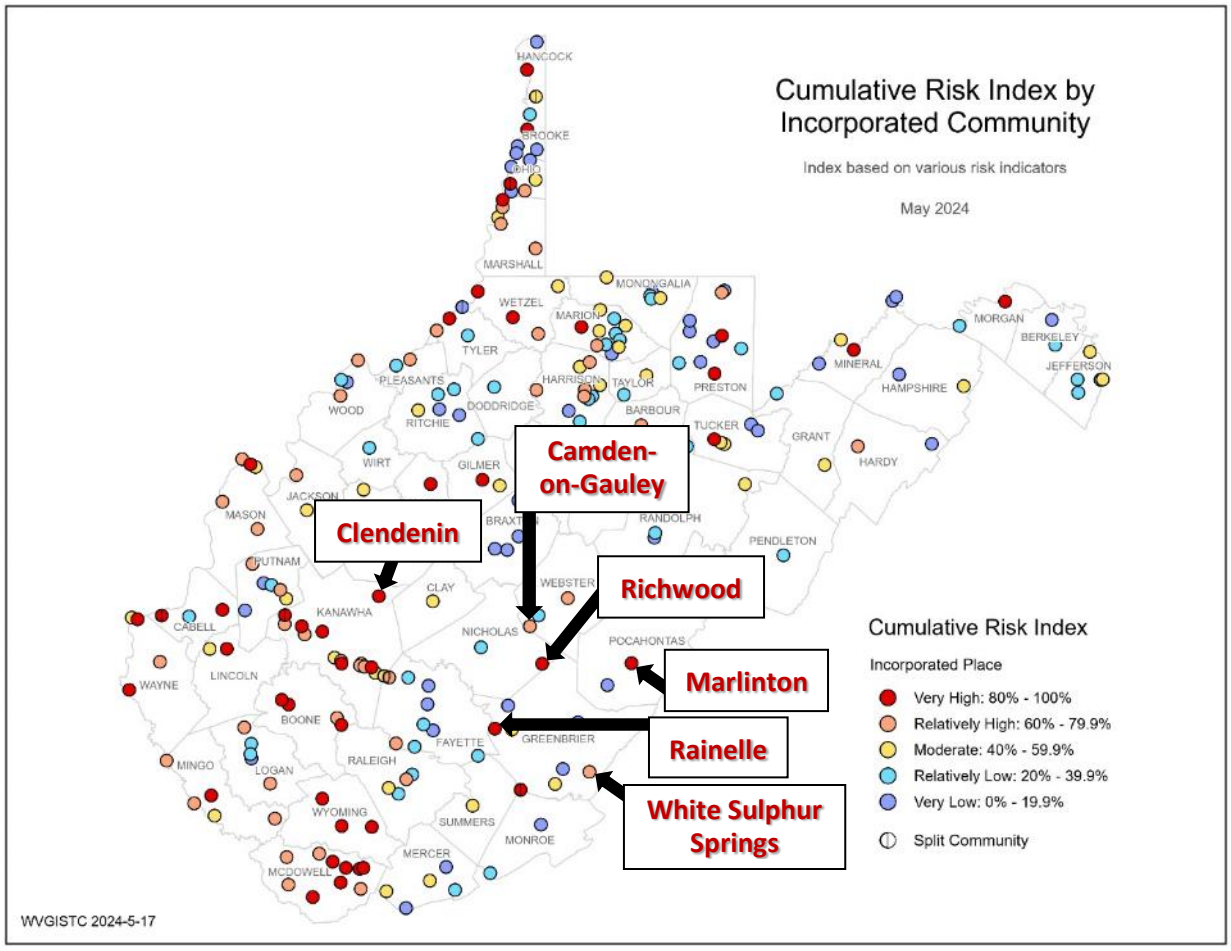


Figure 3. The selected communities on the cumulative risk index map of incorporated places

FLOODPLAIN CHARACTERISTICS

FEMA's effective and advisory flood zone maps for riverine flooding are utilized for the inventory of all primary structures in the high-risk 1%-annual-chance floodplain. Certain regions of the State have advisory floodplains which in the future most likely will become effective upon the completion of restudies. The flood zone maps are continuously being restudied and changing based on historical flood and updated stream flow information.

Active Flood Studies and Mapping

FEMA is creating new flood maps for the state which will alter the floodplain boundaries and base flood elevations. The active flood studies will significantly affect the floodplain boundary and base flood elevations of certain communities, which in turn will affect the building-level inventory and risk assessments as well. For example, the town of **Rainelle** in Greenbrier County experienced a notable expansion in its floodplain area. This can primarily be attributed to the utilization of inaccurate effective floodplain maps that had been in use since 2012. On the 2022 flood map of Rainelle, the total acreage of high-risk flood zones increased significantly by 143 acres. The previous incomplete mapping led to residents being underinsured for major floods in 2016.

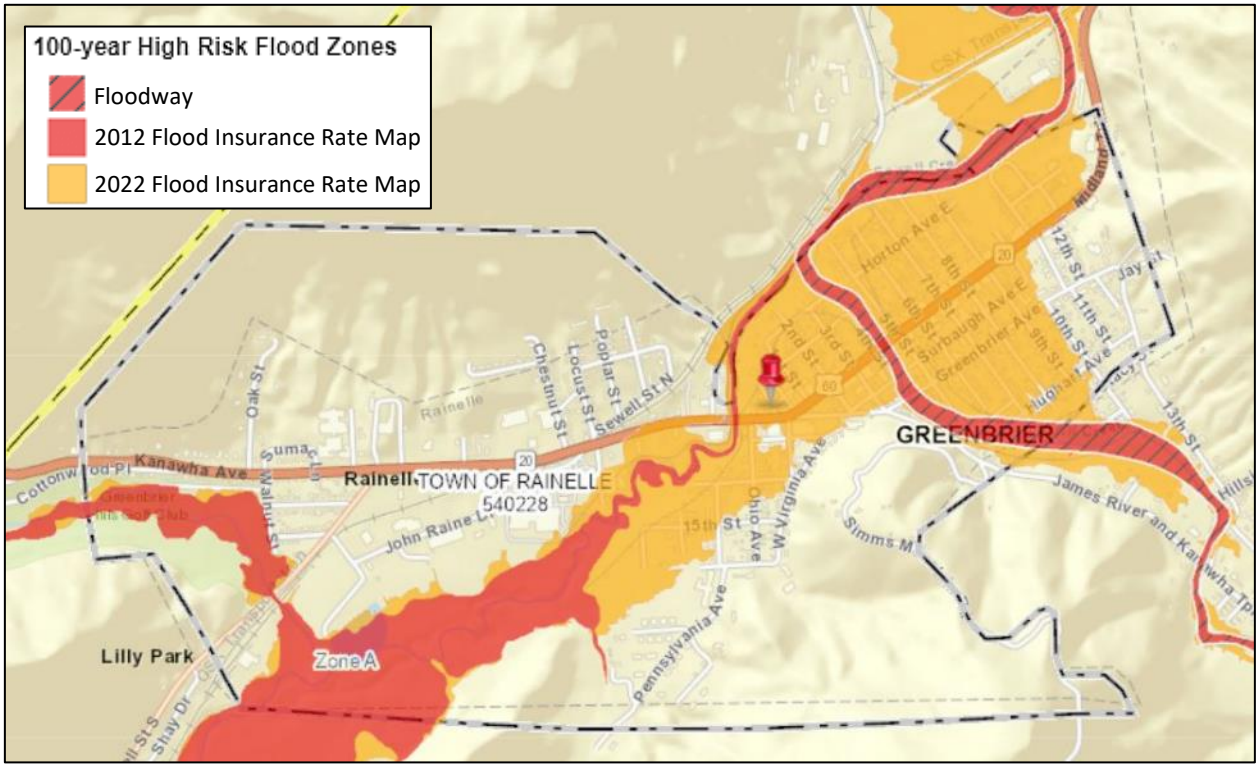


Figure 4. Mapped SFHA area increase in Rainelle, 2012 and 2022

For **Marlinton**, the preliminary floodplain map shows significant expansion of the floodway up to 300 yards (900 feet). According to the cross-sections on this map, the Base Flood Elevation (BFE) of a 1%-annual-chance flood increases by up to about two feet.

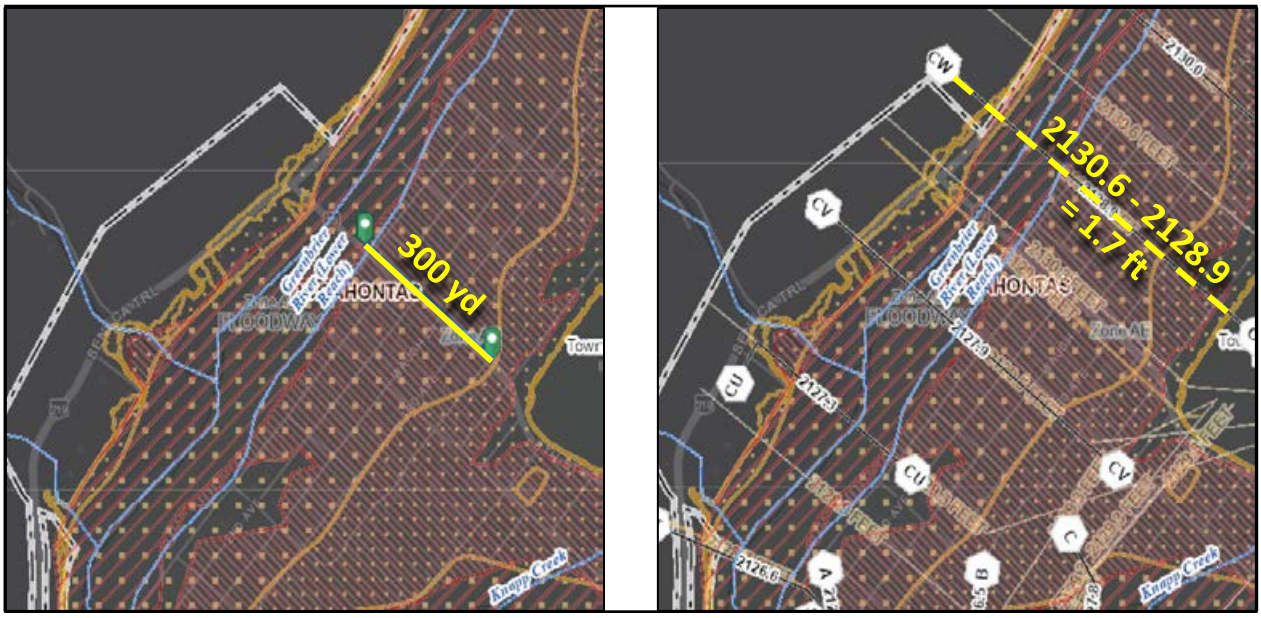


Figure 5. Example of floodway expansion and base flood depth increase in Marlinton viewable on the Risk MAP View of WV Flood Tool

As another instance, the base flood elevation is increasing six feet along the Gauley River for the community of **Camden-on-Gauley** in Webster County. During the restudies new high-water marks, stream flow data, and topography are incorporated into the new flood map studies to determine the base flood elevations.

Figure 6. Gauley River floodplain in Camden-on-Gauley

Floodplain Area / Ratio

The first measurement of the flood zones is the acreage of the Special Flood Hazard Area (SFHA), the 1%-annual-chance (100-year) flood zone. At the community level, incorporated places with a higher ratio of floodplain area to community area face more significant challenges for development. Small towns in which a high percentage of their total incorporated land is in the Special Flood Hazard Area (SFHA) often have a higher flood exposure than other communities.

For the selected communities, the high-risk floodplain or SFHA areas are as follows: 494 acres in **Marlinton**, 267 acres in **White Sulphur Springs**, 247 acres in **Richwood**, 235 acres in **Clendenin**, 223 acres in **Rainelle**, and 35 acres in **Camden-on-Gauley**. The floodplain area ratio represents the proportion of the Special Flood Hazard Area (SFHA) acreage to the total community area. Regarding this ratio, 31.5% of **Marlinton** (ranked ***25th***) and 31.2% of **Rainelle** (ranked ***28th***) are covered by high-risk floodplains, placing these communities among the ***top 20%*** incorporated places for this risk indicator. High-risk floodplains cover 24.1% of **Clendenin**, 23.1% of **Richwood**, and 22.0% of **White Sulphur Springs**. In **Camden-on-Gauley**, this ratio is 16.4%. *Figure 9* displays the ranking of incorporated communities for floodplain area ratio, categorized into five groups ranging from very high (top 20%) to very low (bottom 20%). As seen on the map, **Marlinton** and **Rainelle** are classified in the "Very High" group for the floodplain area ratio. Except for Camden-on-Gauley, all these communities have floodplain ratios higher than the statewide average ratio of 18.3% for all incorporated places.

A high floodplain ratio indicates less available land for development outside the floodplain. Communities such as Marlinton and Rainelle facing this situation should adopt higher standards for development within the floodplain. Additionally, they should consider implementing green infrastructure solutions, such as wetlands and permeable surfaces in vicinity of their communities, to manage flood risks effectively. Smaller jurisdictions must be vigilant in relocating critical facilities away from the floodplain along with enforcing its floodplain management ordinance for any development. Although expensive to build and maintain, engineering flood mitigation structures like levees, floodwalls, and dams can protect vulnerable flood-prone communities.

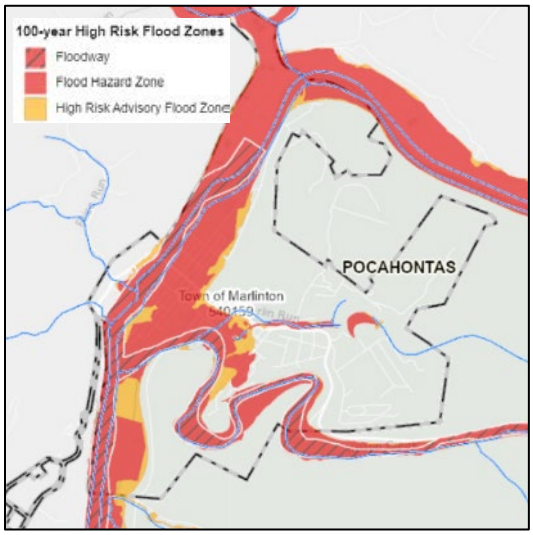


Figure 7. High-Risk Flood Zones, 31.5% of Marlinton's area

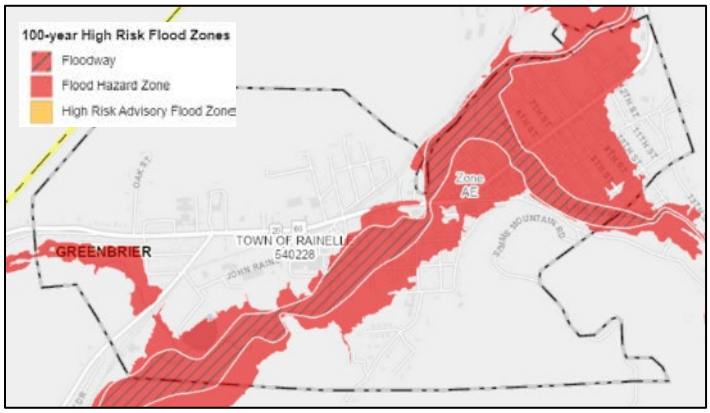


Figure 8. High-Risk Flood Zones, 31.2% of Rainelle's area

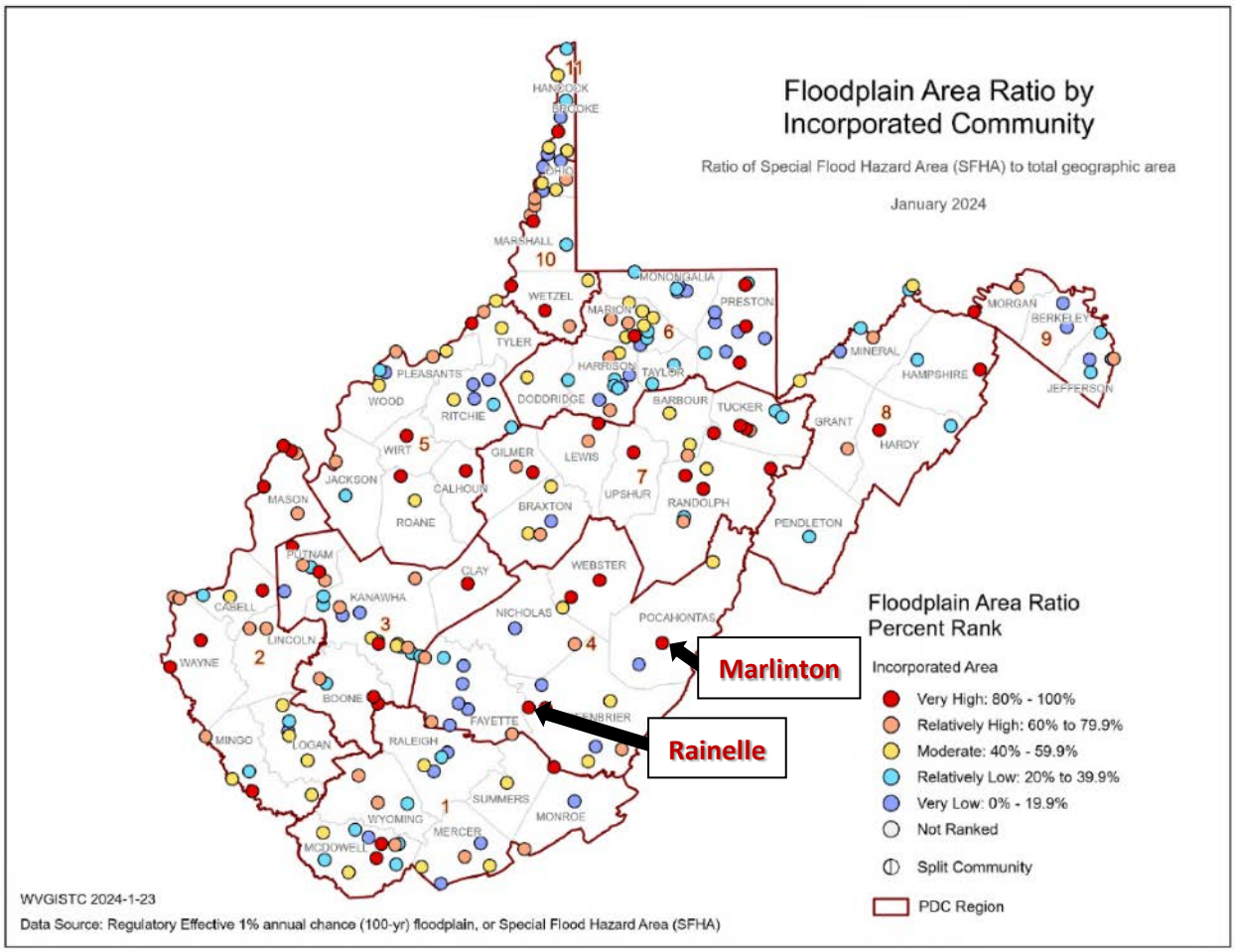


Figure 9. Marlinton and Rainelle on the map of floodplain area ratio ranks for incorporated places

Floodplain Length / Ratio

A second estimate for flood characteristics is the mileage of the high-risk 1%-annual chance floodplain. Larger jurisdictions typically have more miles of floodplain extent compared to smaller communities. In smaller communities, the floodplain area is more compact, making it easier to monitor new development within the floodplain compared to larger communities. For incorporated places, the floodplain length ratio, which is the length of the Special Flood Hazard Area (in miles) to the total community area (in acres), was calculated and used as a risk indicator to rank the communities.

In **Marlinton**, there are 9.9 miles of high-risk floodplain, while **White Sulphur Springs** has 5.9 miles, **Richwood** has 4.9 miles, **Clendenin** has 3.8 miles, **Rainelle** has 3.7 miles, and **Camden-on-Gauley** has 1.5 miles. The floodplain length ratio is 0.0069 miles/acre for **Camden-on-Gauley**, 0.0063 miles/acre for **Marlinton**, 0.0052 miles/acre for **Rainelle**, 0.0049 miles/acre for **White Sulphur Springs**, 0.0046 miles/acre for **Richwood**, and 0.0039 miles/acre for **Clendenin**. These communities are not among the top 20% incorporated places for this risk indicator; however, **Camden-on-Gauley** and **Marlinton** have floodplain length ratios above the average ratio of 0.0059 miles/acre for all incorporated places.

Flood Disaster Frequency

Flood Declared Disasters

Previous disasters and their frequency indicate potential future risks. Additionally, the recentness of flood disasters has been shown to increase communities' willingness to seek mitigation activities. In West Virginia, many flood control structures (e.g., dams, levees, flood walls) built in the 20th century have decreased the number of major flood disasters.

According to FEMA's online database of Disaster Declarations for States and Counties (including incident subcategories of "flood," "severe storms," or "hurricanes"), there have been 24 federally-declared flood disasters in Kanawha County, where **Clendenin** is located, since 1953. This places Clendenin among the ***top 20%*** incorporated communities for this risk indicator. During the same period, 18 declared disasters were recorded for Greenbrier County, where **Rainelle** and **White Sulphur Springs** are located, and Nicholas County, where **Richwood** is. Webster County, where **Camden-on-Gauley** is located, has recorded 17 disasters, while Pocahontas County, where **Marlinton** is located, has recorded 15.

Figure 10 shows the ranking of counties for federally-declared flood disasters, classified into five groups from very high (top 20%) to very low (bottom 20%).

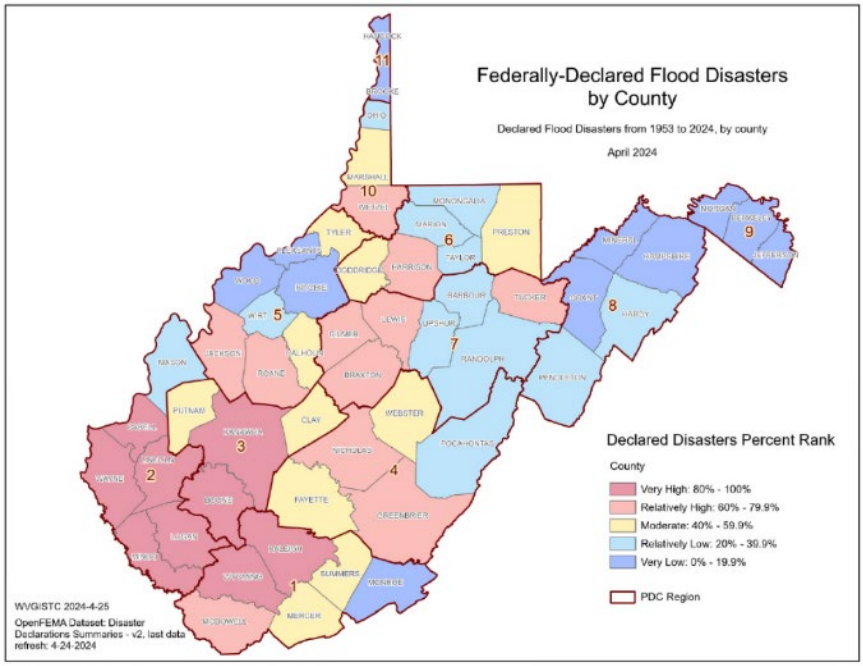


Figure 10. Map of federally-declared flood disasters ranks for counties

In June 2016, Central West Virginia including Rainelle, White Sulphur Springs, Richwood, Clendenin, and Camden-on-Gauley experienced a catastrophic flood. The impact of the 2016 flood was severe resulting in the destruction or damage of numerous buildings, the loss of at least 23 lives, and widespread flooding across various communities in West Virginia. A State of Emergency was declared in 44 of West Virginia's 55 counties, and 12 of these counties received a Presidential Disaster Declaration. The National Oceanic and Atmospheric Administration (NOAA) estimated that overall damages from the storm system amounted to over $1 billion.

USGS high-water marks (n=421) collected from the June 2016 flood event and other historical flood information should be evaluated as a risk factor. West Virginia High-Water Marks are viewable on the WV Flood Tool. *For new development, the design flood elevation should be above the recorded high-water marks.*

An excellent resource for risk assessment and planning is the FEMA Region III published report named the "Understanding Flood Dangers in Central West Virginia: Lessons Learned from the June 2016 Flood." Story Maps created as supplemental to this report about the devastating June 2016 flood:

- Flood Risk in West Virginia: What We Learned from the June 2016 Flood
- WV Flooded Towns, June 2016: The Historic Flooding of Southern West Virginia on June 23, 2016

The 2016 flood elevation high-water marks in **Rainelle** show a maximum flood depth or water surface elevation of about 8.5 feet above the ground while the high-water marks in **White Sulphur Springs** show up to six feet above the ground. It is important to keep in mind that the 2016 flood in Rainelle surpassed the severity of a 100-year (1%-annual-chance) event but fell short of the magnitude associated with a 500-year (0.2%-annual-chance) flood and was not a 1000-year (0.1%-annual-chance) flood as erroneously publicized in the news media. In White Sulphur Springs, the new FEMA flood study reveals that the major 2016 flood exhibited similarities to a 500-year event. Similarly, both **Clendenin** and **Richwood** experienced floodwaters reaching an elevation of approximately six feet above ground level, as indicated by their highest water marks. In **Camden-on-Gauley**, a high-water mark of the 2016 flood shows an inundation depth exceeding seven feet caused by that event. In **Marlinton**, a high-water mark from the 1985 flood indicates a flood depth of 7.5 feet.

Figure 11. 1985 high-water mark at Marlinton Methodist Church (7.5 ft)
(Building ID: 38-08-0005-0032-0000_806)

Figure 12. 2016 high-water mark in Camden-on-Gauley (9.1 ft)
(Building ID: 51-04-0003-0006-0000_81)

A major disaster declaration provides a wide range of federal assistance programs for individuals and public infrastructure, including funds for both emergency and permanent work. Historical flooding data, including high water marks, should be incorporated into communities' flood reduction efforts to identify areas of mitigation interest. Additionally, researching flood fatality locations and risk behaviors during past major floods is crucial.

Scenarios of Flood Frequencies

Different flood frequencies were mapped and analyzed for the communities under study. Initially, FEMA's model was utilized to identify areas susceptible to specific annual chance floods, including the 10%-annual-chance (10-year), 4%-annual-chance (25-year), 2%-annual-chance (50-year), 1%-annual-chance (100-year), and 0.2%-annual-chance (500-year) riverine floods. In addition, to incorporate the future climate change effect, a new inundation grid (100-year+) was computed adding three feet to the Base Flood Elevation (BFE) by re-delineating the cross-sections.

For each scenario, the floodplain area ratio or the percentage of community area that could be flooded was calculated to provide a better understanding of the inundation extent. *Table 2* shows the percentage of community area in each studied incorporated place that could be inundated based on the above scenarios.

Table 2. Floodplain area ratios in the studied communities for different scenarios based on FEMA

Incorporated Place	Floodplain Area Ratio (Percentage of Inundated Area) in Community					
	10%-annual-chance (10-year) Flood	4%-annual-chance (25-year) Flood	2%-annual-chance (50-year) Flood	1%-annual-chance (100-year) Flood	100-year+ (Climate Change) Scenario	0.2%-annual-chance (500-year) Flood
Camden-on-Gauley	10%	12%	12%	16%	13%	15%
Clendenin	13%	19%	23%	24%	24%	25%
Marlinton	22%	29%	32%	32%	35%	35%
Rainelle	13%	20%	26%	31%	31%	37%
Richwood	7%	11%	16%	23%	22%	22%
White Sulphur Springs	13%	17%	20%	22%	25%	27%

In addition, *Figure 13* compares the floodplain area ratios, or the percentages of inundated areas, based on the above scenarios in the communities.

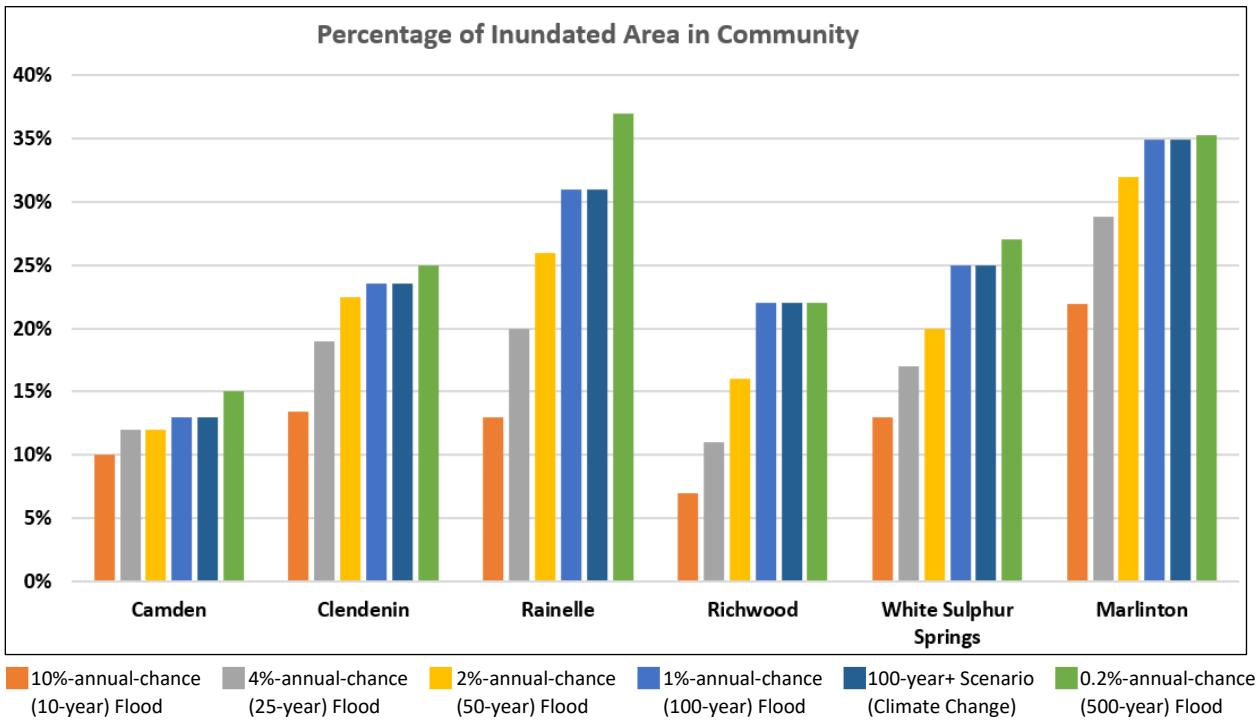


Figure 13. Bar chart of floodplain area ratio in the studied communities for different scenarios based on FEMA

As can be seen in the chart, the percentage of the community area in **Marlinton** and **Rainelle** inundated by severe flood events (50-year or larger) is higher compared to the other studied communities. Additionally, for **Rainelle**, the area inundated by a 0.2%-annual-chance (500-year) flood, which has the highest severity and lowest probability, is significantly different from the inundation areas of other scenarios such as the 1%-annual-chance flood and the more frequent and less severe 10-year, 25-year, and 50-year floods (see *Figure 20*). Camden-on-Gauley has the lowest floodplain area ratio for the severe flood events, with more similarities among the inundation areas of different scenarios.

Moreover, using data from the First Street Foundation (FSF) obtained in 2022, areas susceptible to various flood frequencies, specifically the 20%-, 5%-, 1%-, and 0.2%-annual-chance (or respectively, 5-year, 20-year, 100-year, and 500-year) events, were mapped. It is worth noting that the FSF's dataset encompasses both riverine (fluvial) and overland (pluvial) flood probabilities based on hydrodynamic modeling and historical analyses, offering a more detailed and comprehensive analysis.

The resulting maps illustrating these flood risk areas based on both FEMA and FSF models for **Camden-on-Gauley**, **Clendenin**, **Marlinton**, **Rainelle**, **Richwood**, and **White Sulphur Springs** are provided on the following pages.

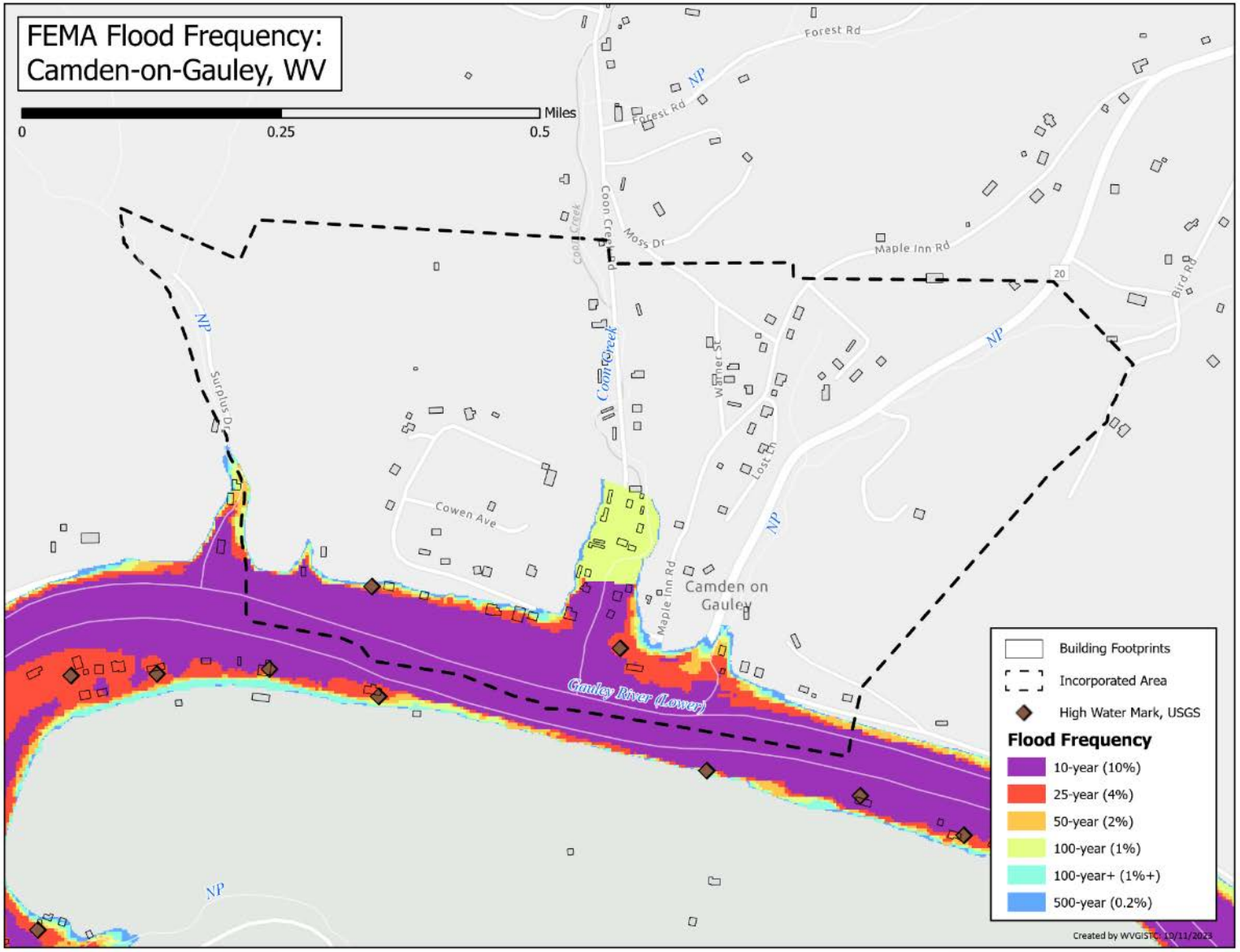


Figure 14. FEMA flood frequency map for Camden-on-Gauley

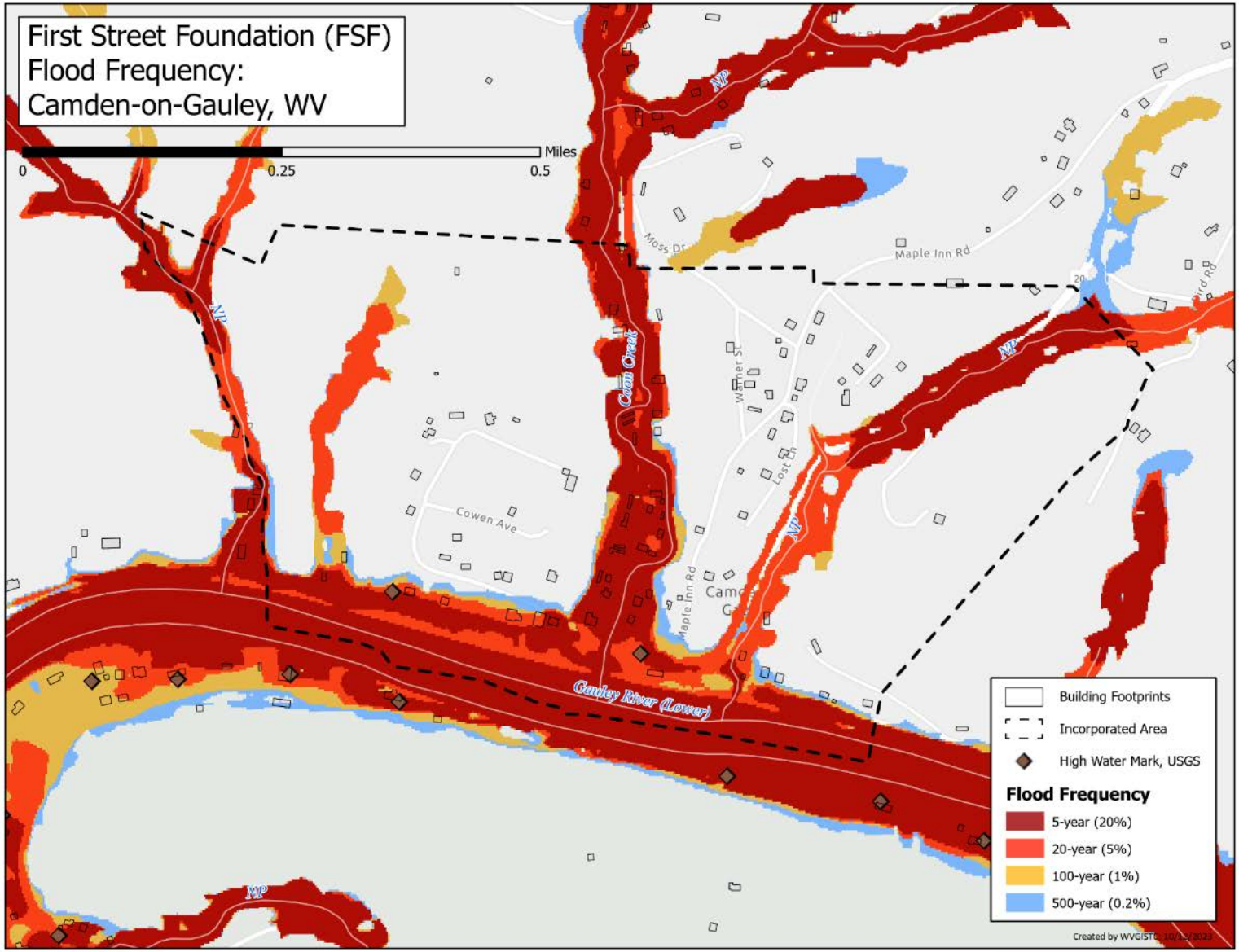


Figure 15. First Street Foundation (FSF) flood frequency map for Camden-on-Gauley

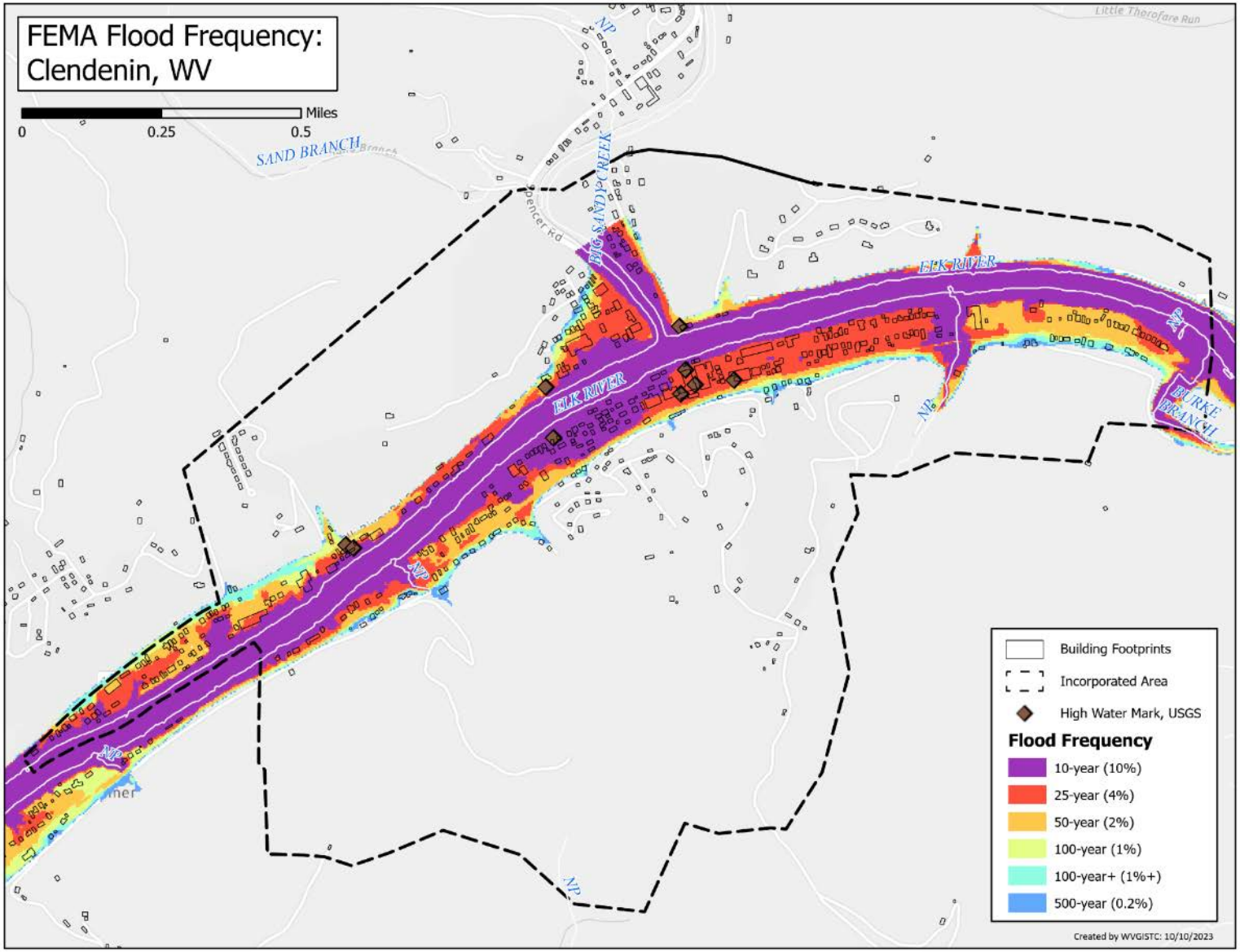


Figure 16. FEMA flood frequency map for Clendenin

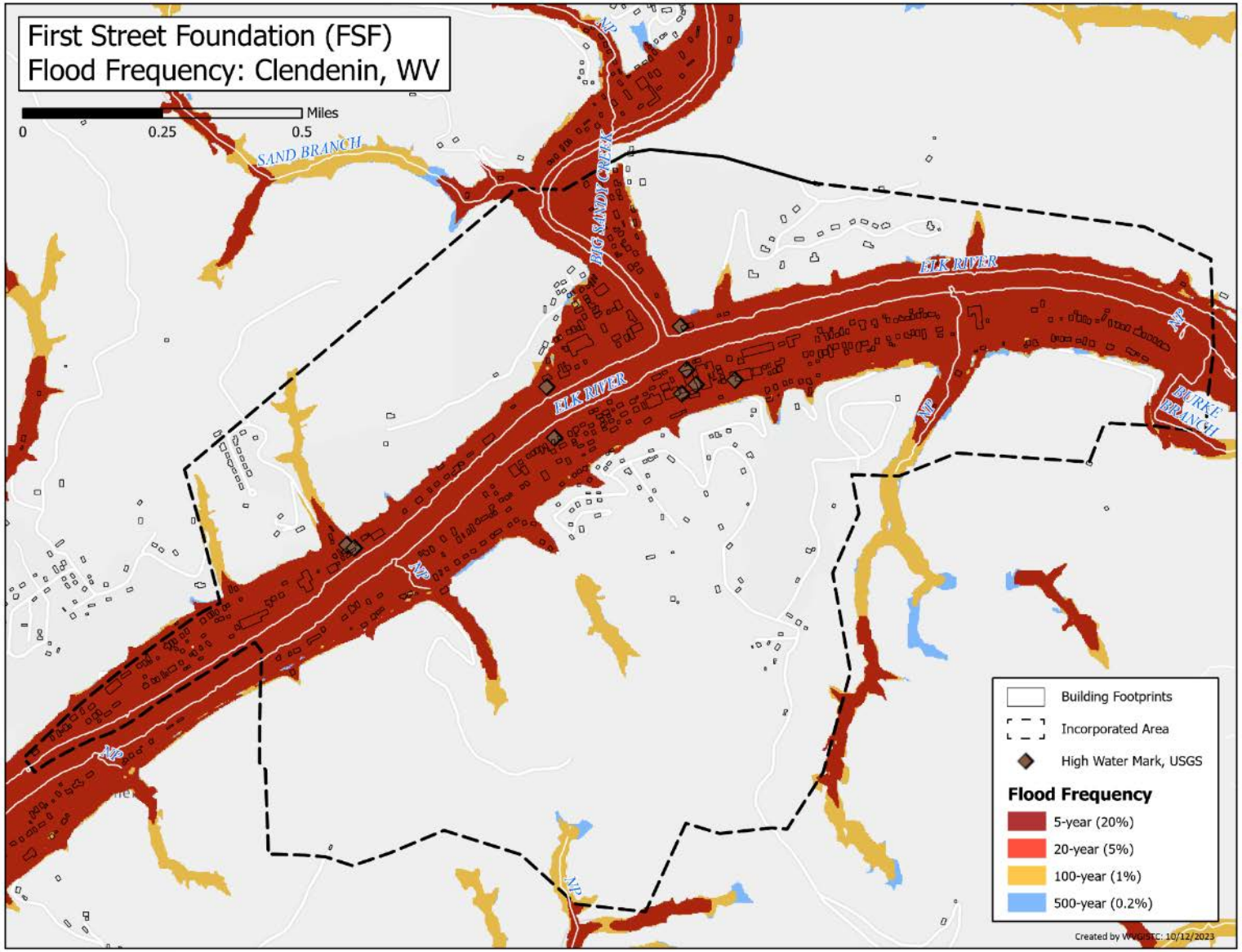


Figure 17. First Street Foundation (FSF) flood frequency map for Clendenin

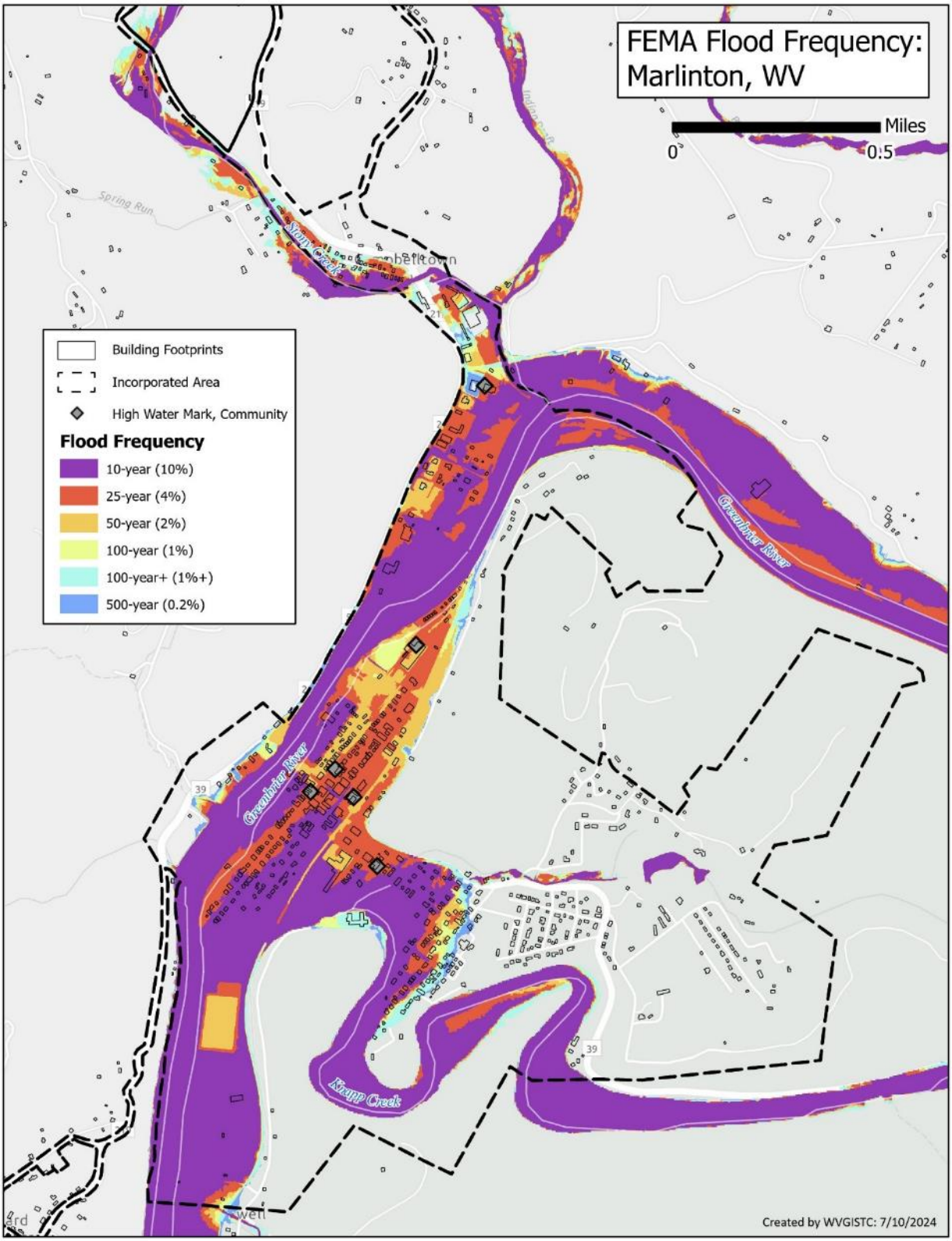


Figure 18. FEMA flood frequency map for Marlinton

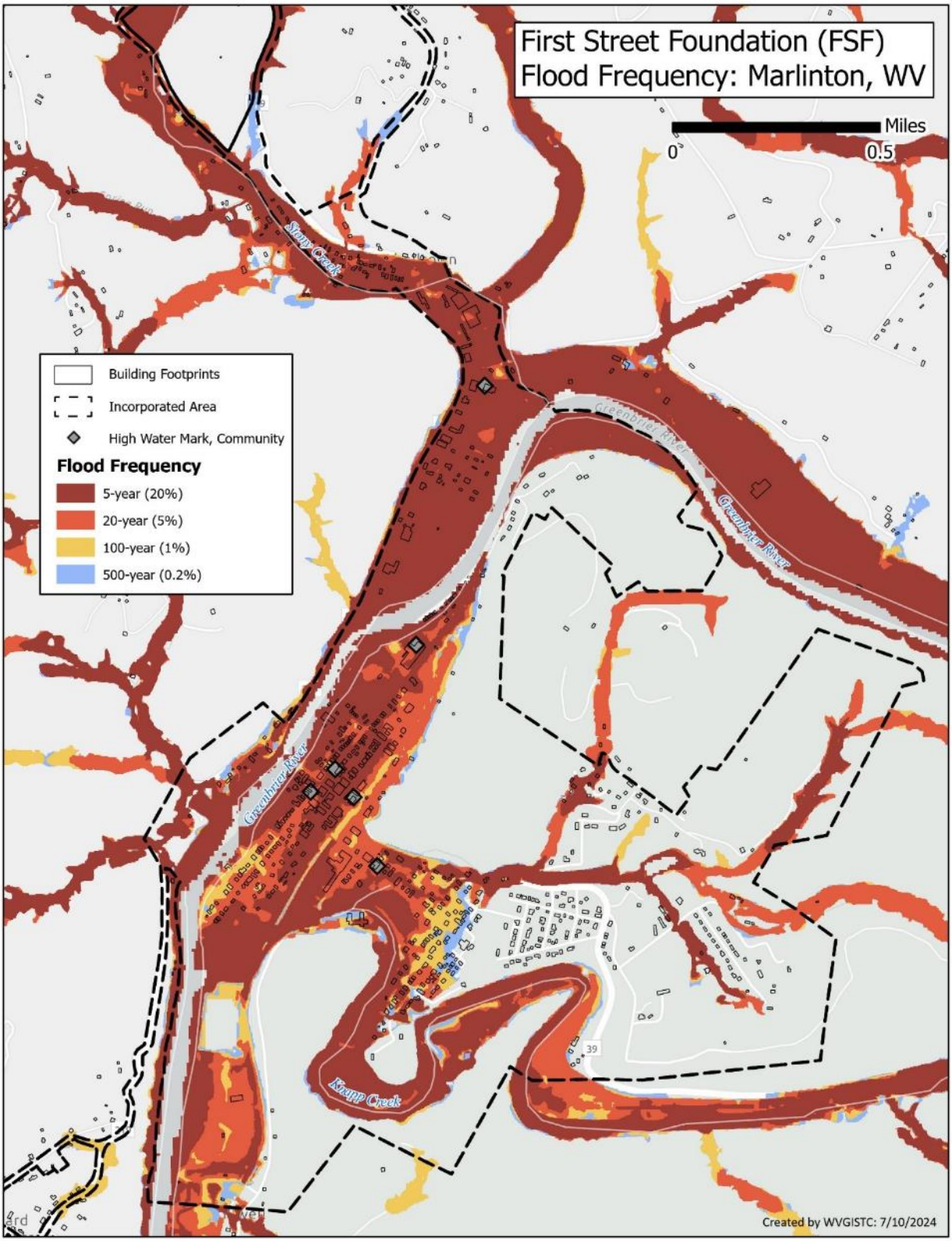


Figure 19. First Street Foundation (FSF) flood frequency map for Marlinton

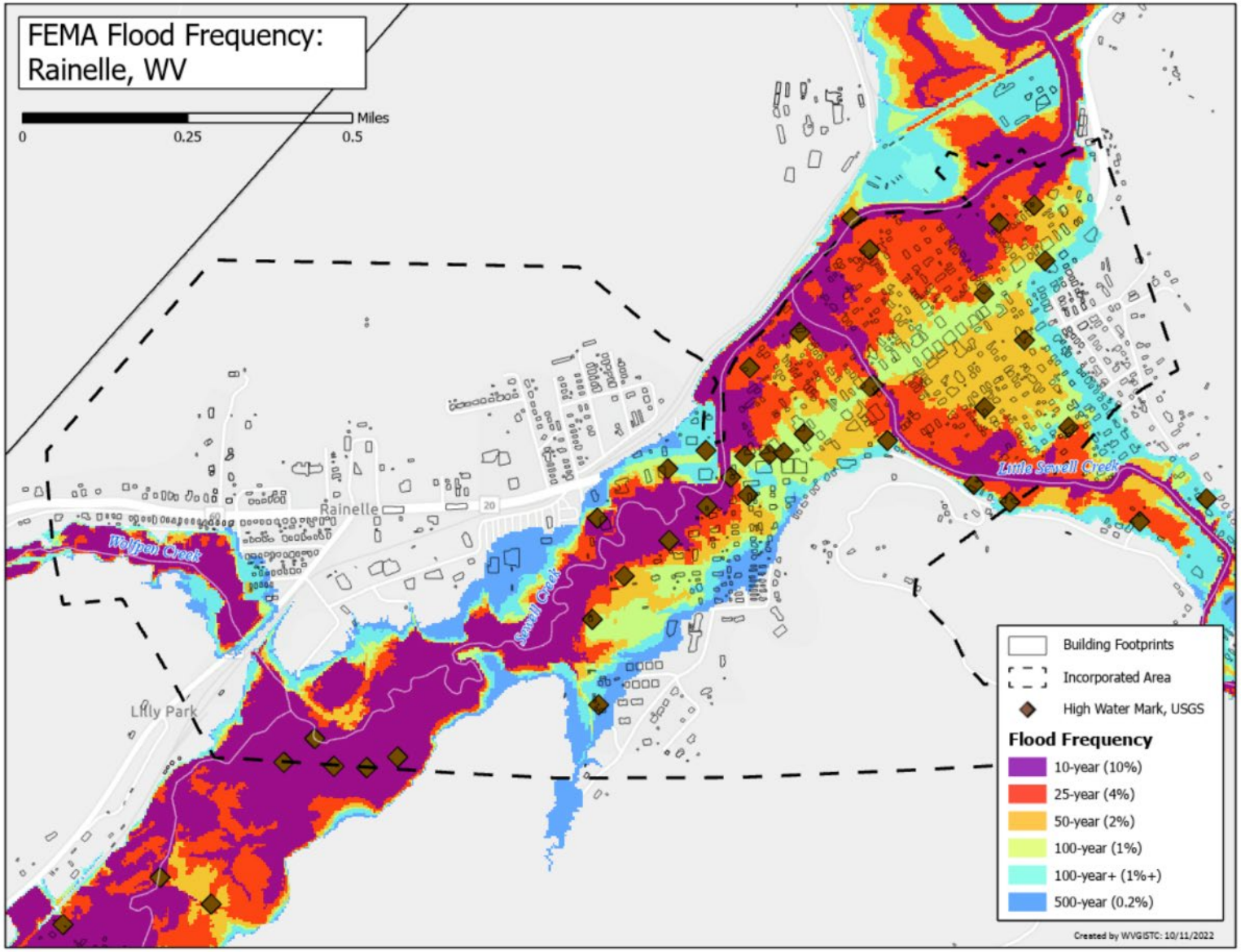


Figure 20. FEMA flood frequency map for Rainelle

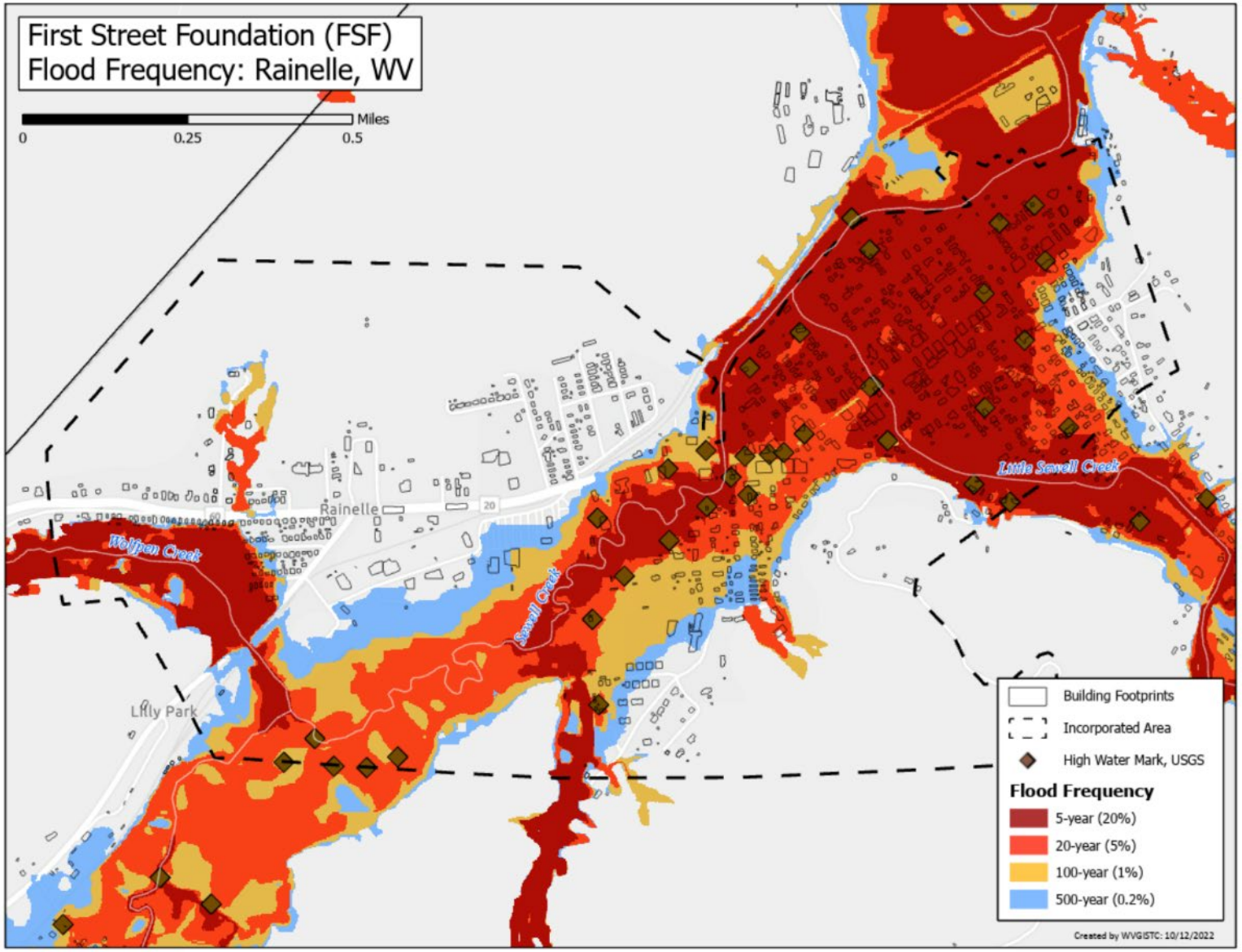


Figure 21. First Street Foundation (FSF) flood frequency map for Rainelle

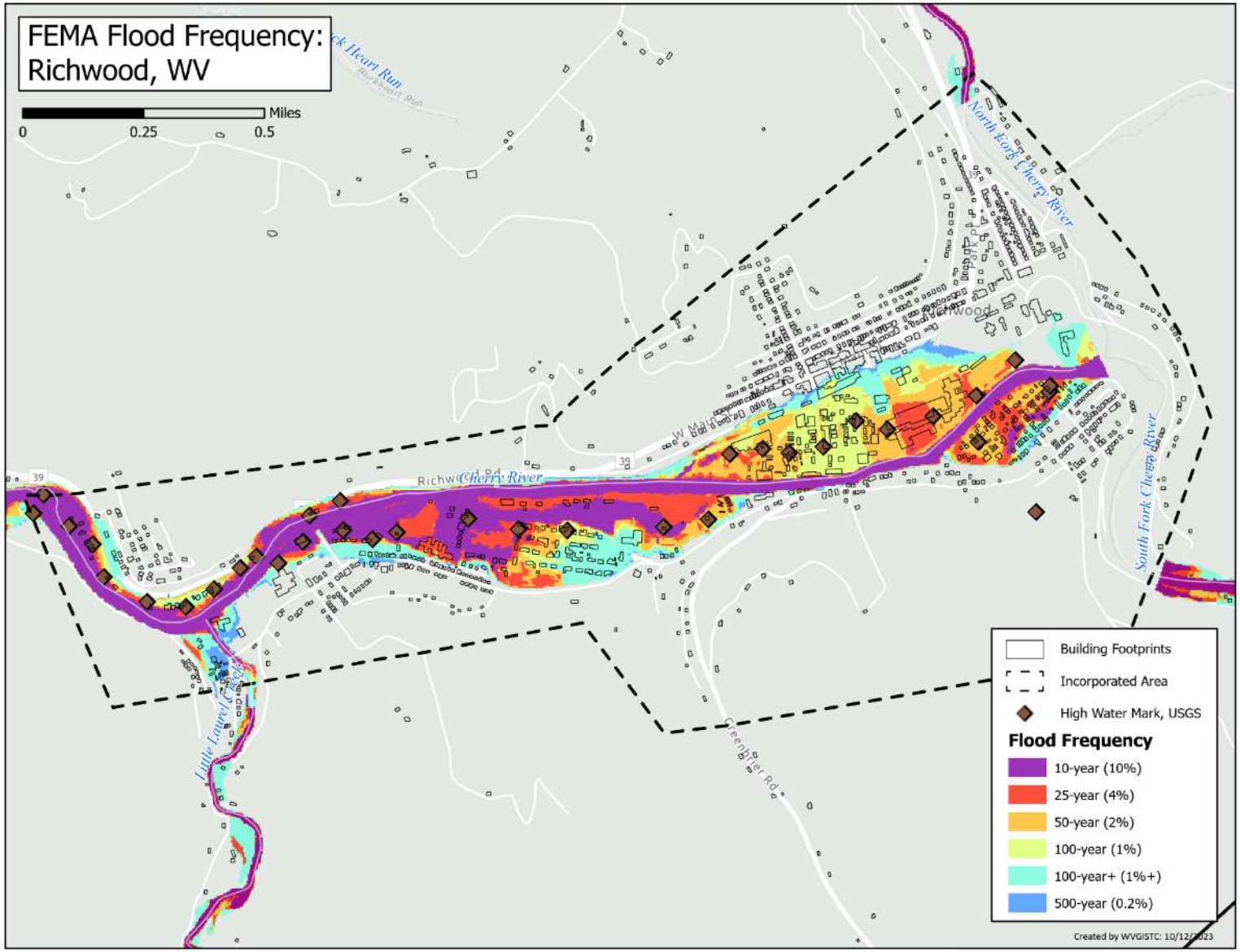


Figure 22. FEMA flood frequency map for Richwood

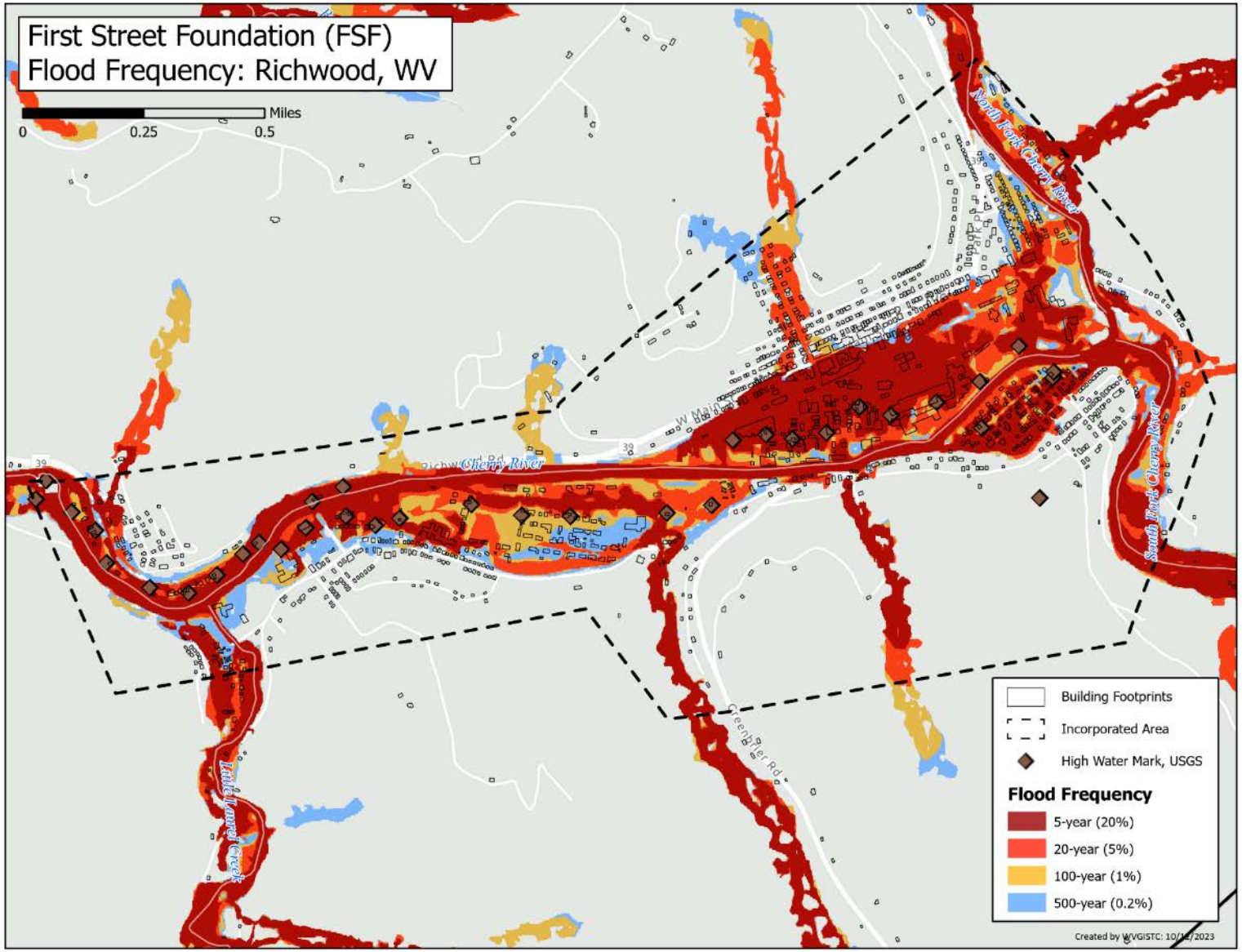


Figure 23. First Street Foundation (FSF) flood frequency map for Richwood

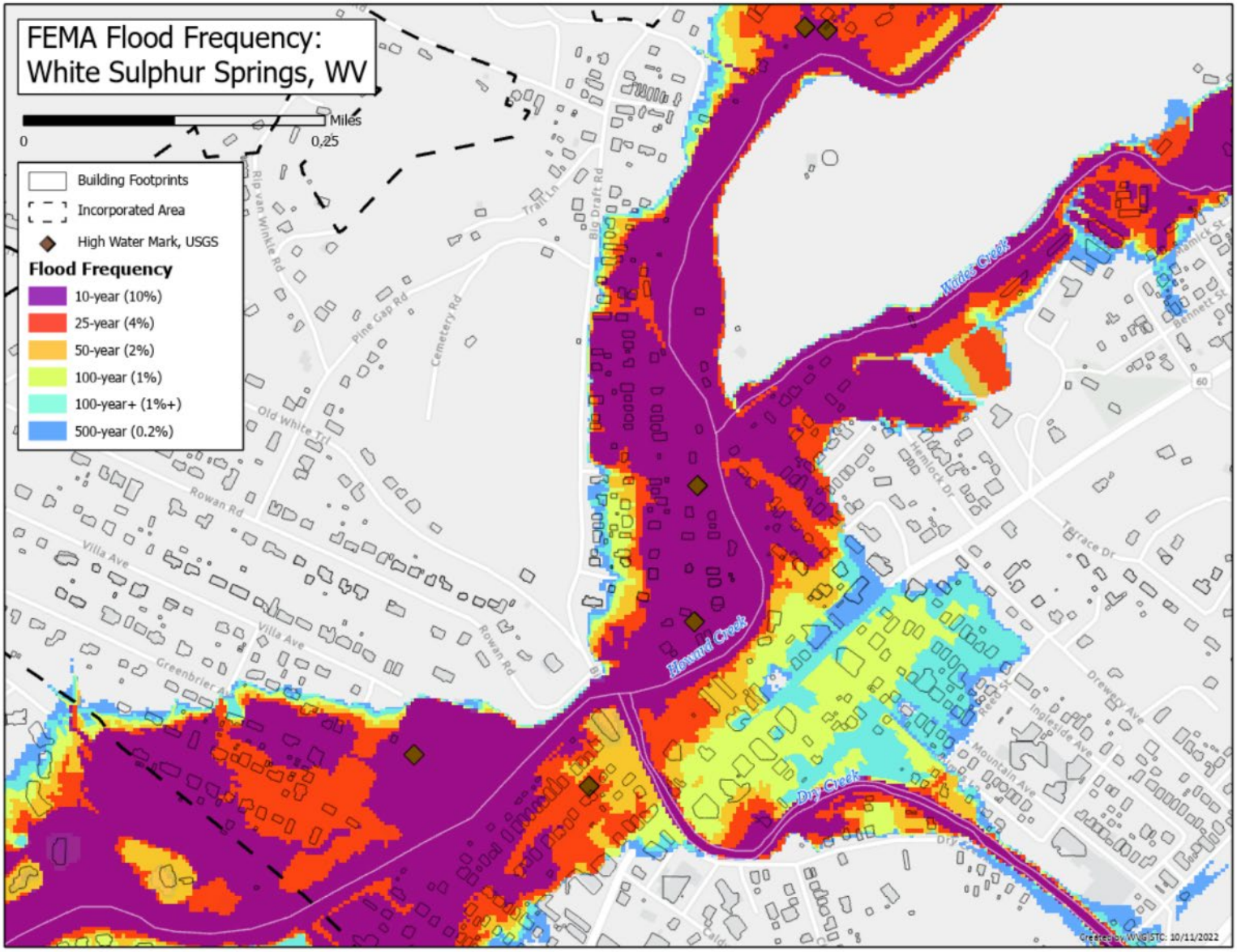


Figure 24. FEMA flood frequency map for White Sulphur Springs

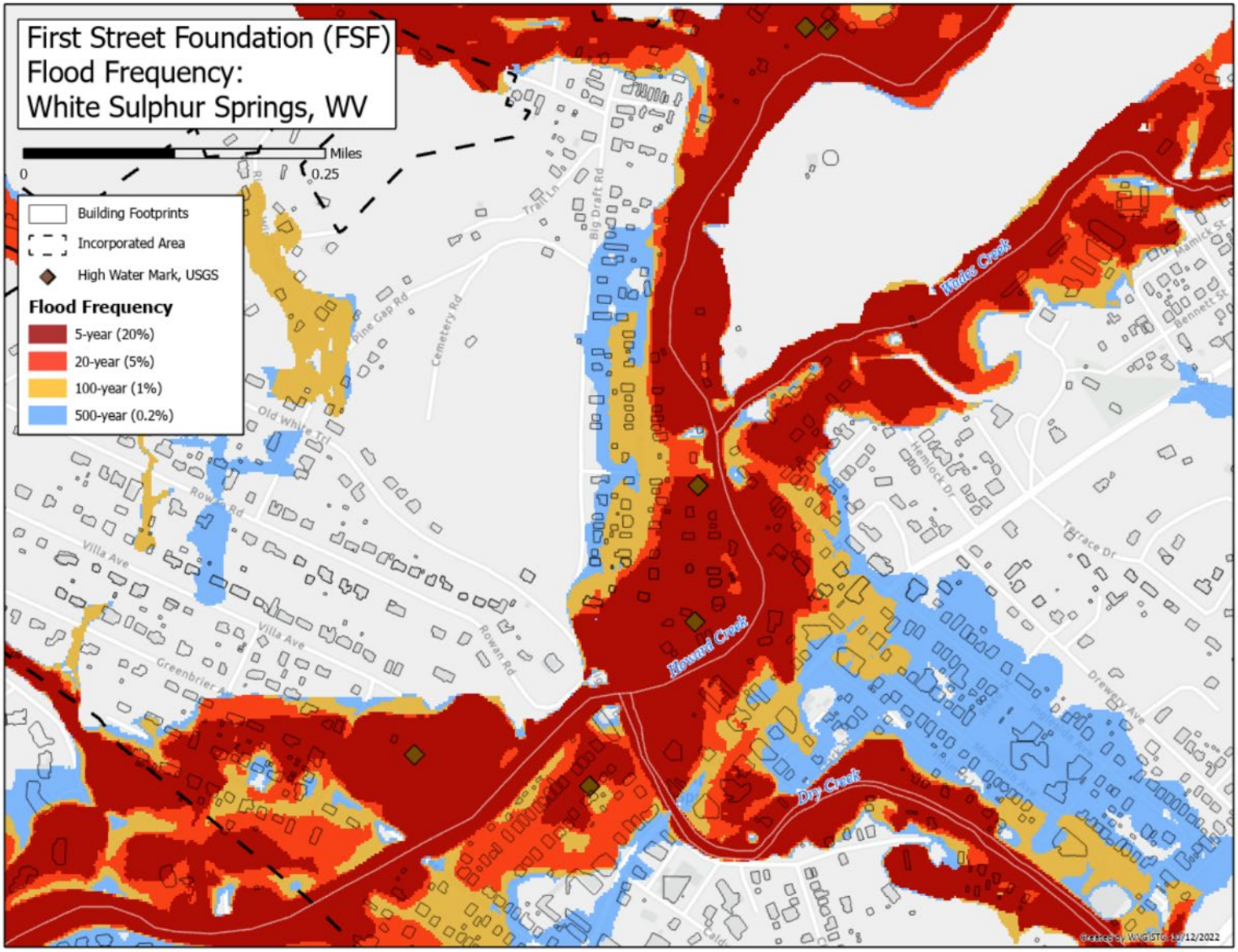


Figure 25. First Street Foundation (FSF) flood frequency map for White Sulphur Springs

3D Viewsheds of Flood Inundation Scenarios

To better communicate the results and improve the comprehensibility of the data, appropriate techniques were used to create 3-dimensional viewsheds. These viewsheds illustrate various inundation scenarios in each of the studied communities, offering a clearer visualization of the flood risk. Similar to the 2D maps, these viewsheds model the 10-year, 25-year, 50-year, 100-year, 500-year, and 100-year+ (climate change projection) inundation scenarios based on FEMA's data as well as the 5-year, 20-year, 100-year, and 500-year scenarios using the First Street Foundation (FSF) data.

The produced viewsheds for these communities are provided on the following pages. These viewsheds can also be downloaded via these links:

Camden-on-Gauley: https://data.wvgis.wvu.edu/pub/RA/HL/RA-L/VIEWSHED/Camden-on-Gauley/Viewshed_Camden-on-Gauley_2024.pdf

Clendenin: https://data.wvgis.wvu.edu/pub/RA/HL/RA-L/VIEWSHED/Clendenin/Viewshed_Clendenin_2024.pdf

Marlinton: https://data.wvgis.wvu.edu/pub/RA/HL/RA-L/VIEWSHED/Marlinton/VIEWSHED_Marlinton_2024.pdf

Rainelle: https://data.wvgis.wvu.edu/pub/RA/HL/RA-L/VIEWSHED/Rainelle/VIEWSHED_Rainelle_2024.pdf

Richwood: https://data.wvgis.wvu.edu/pub/RA/HL/RA-L/VIEWSHED/Richwood/VIEWSHED_Richwood_2024.pdf

White Sulphur Springs: https://data.wvgis.wvu.edu/pub/RA/HL/RA-L/VIEWSHED/WhiteSulphurSprings/VIEWSHED_WhiteSulphurSprings_2024.pdf

3D Flood Risk Visualization Movies (Animations)

Moreover, flood risk visualization animations were created to aid the targeted communities in gaining a more comprehensive understanding of the potential extent and impacts of flood events across various scenarios. These animations depict simulated flood inundations affecting exposed buildings, with a particular focus on the structures that have been mitigated against flood risk. Additionally, the movies highlight significant structures located within the inundated areas, providing a more detailed perspective on flood impacts in the communities.

The following links can be used to access these visualization movies produced for these communities:

Clendenin: https://data.wvgis.wvu.edu/pub/RA/HL/RA-L/MOVIE/3Dmovie_Clendenin_2024.mp4

Marlinton:

Rainelle: https://data.wvgis.wvu.edu/pub/RA/HL/RA-L/MOVIE/3Dmovie_Rainelle_2024.mp4

White Sulphur Springs: https://data.wvgis.wvu.edu/pub/RA/HL/RA-L/MOVIE/3Dmovie_WhiteSulphurSprings_2024.mp4

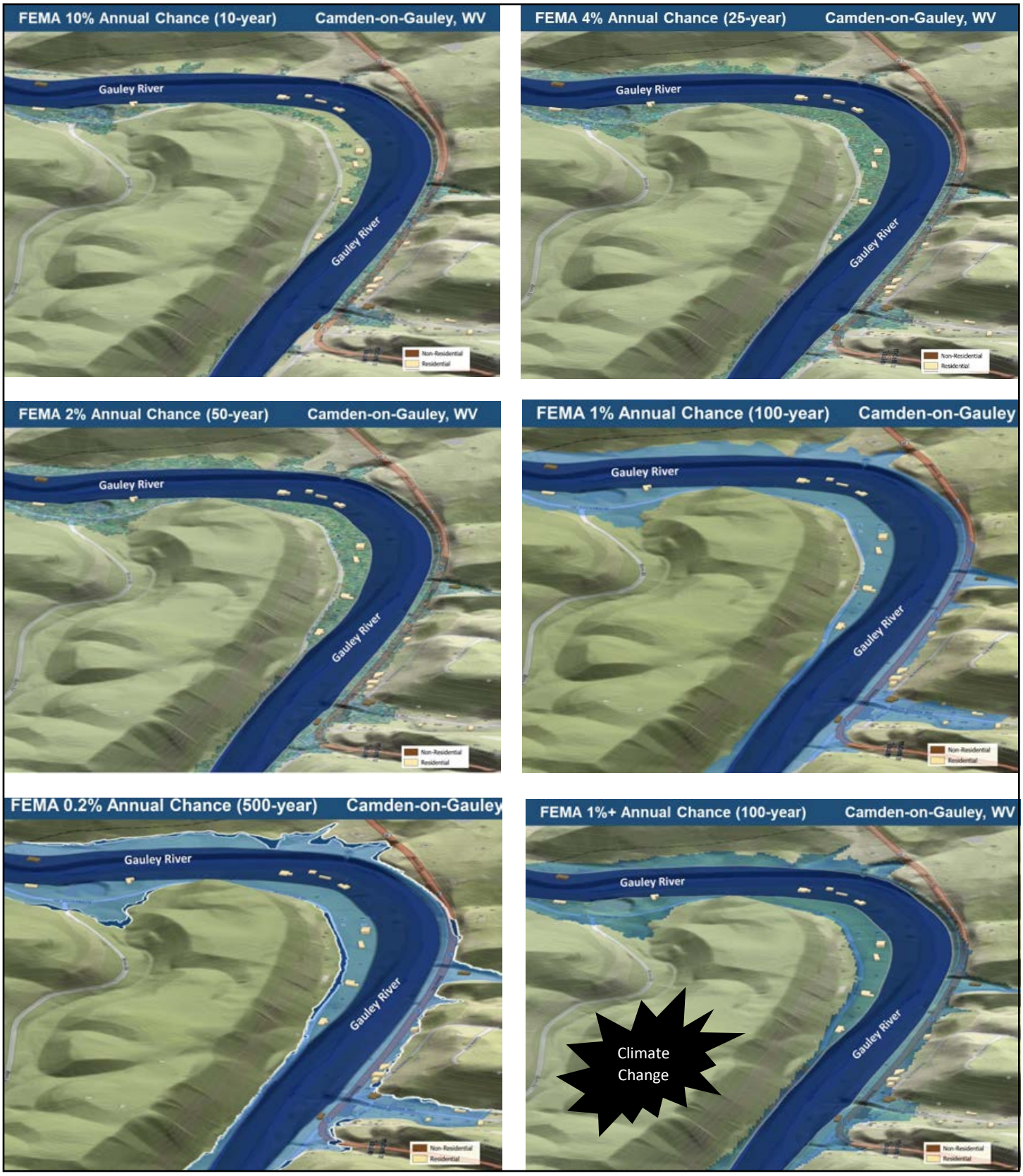


Figure 26. 3D viewsheds of flood inundation scenarios based on FEMA frequencies for Camden-on-Gauley

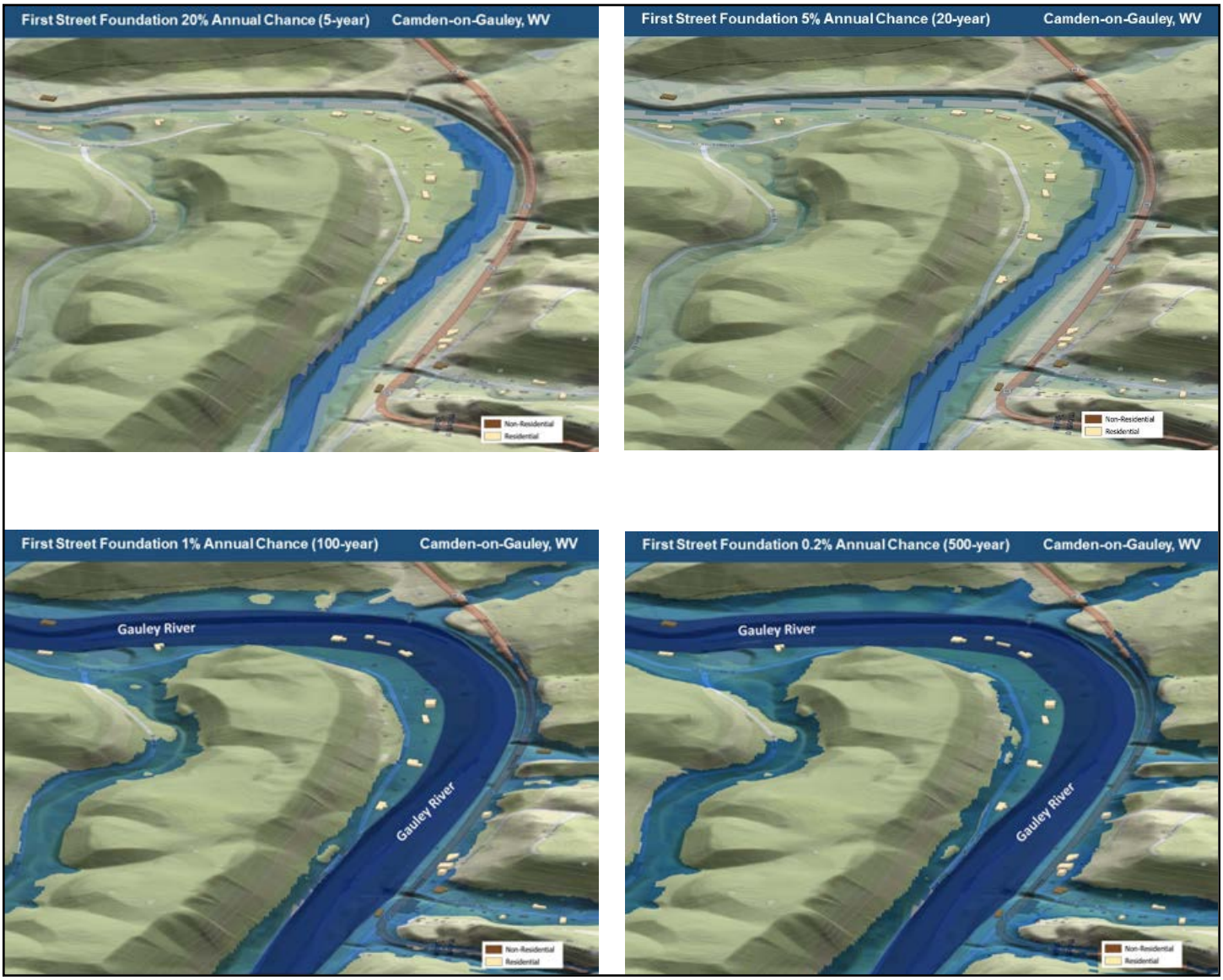


Figure 27. 3D viewsheds of flood inundation scenarios based on FSF frequencies for Camden-on-Gauley

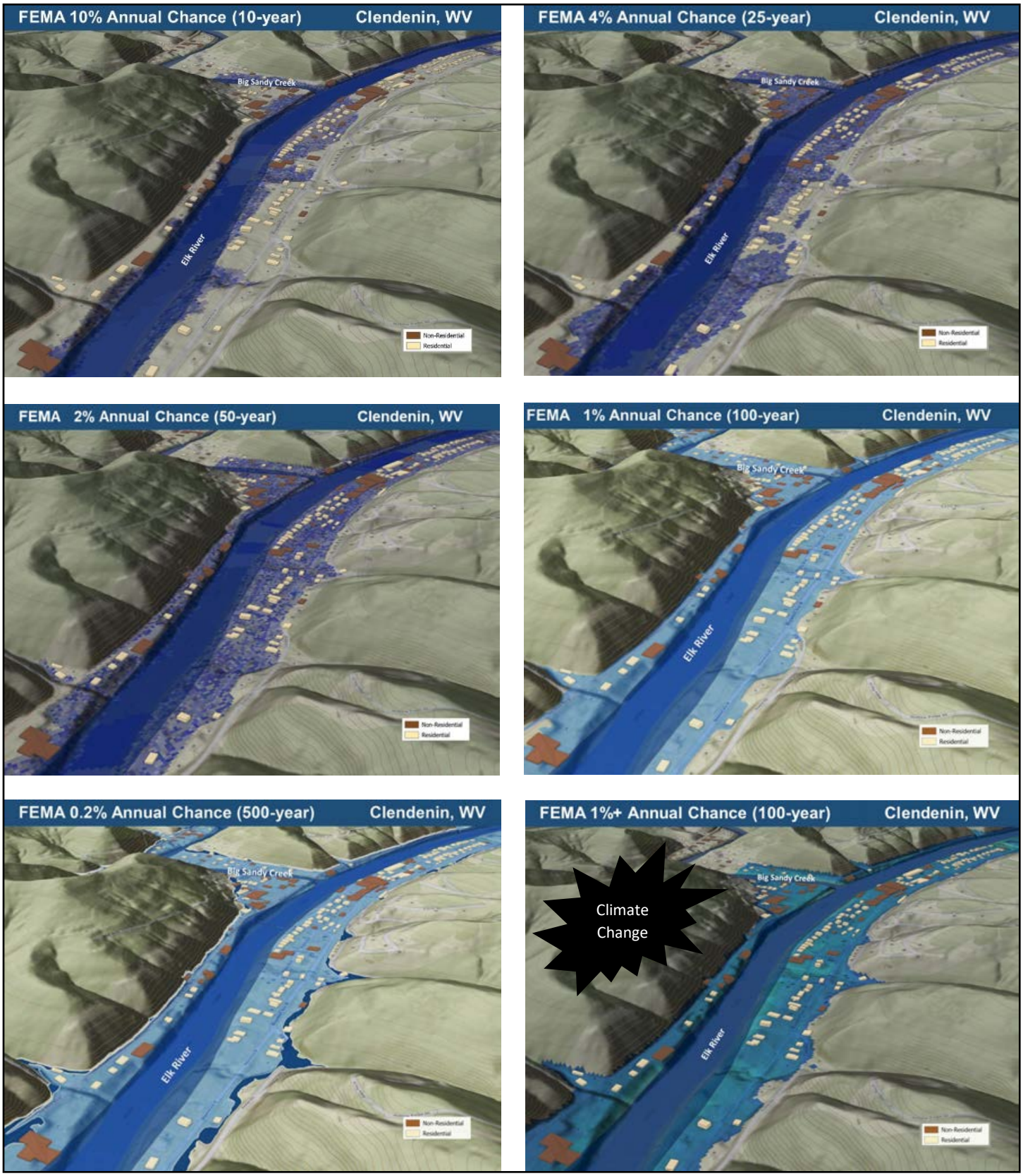


Figure 28. 3D viewsheds of flood inundation scenarios based on FEMA frequencies for Clendenin

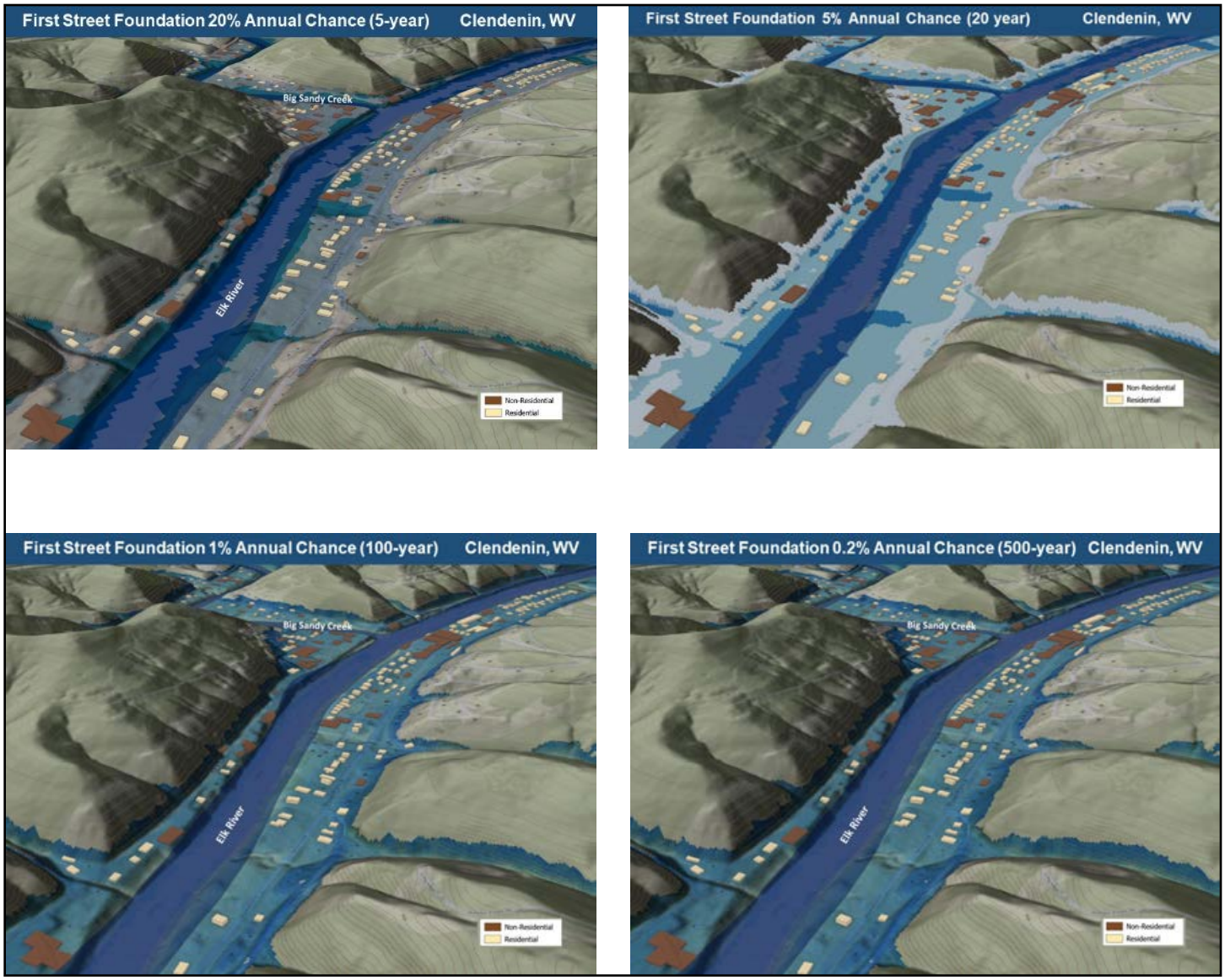


Figure 29. 3D viewsheds of flood inundation scenarios based on FSF frequencies for Clendenin

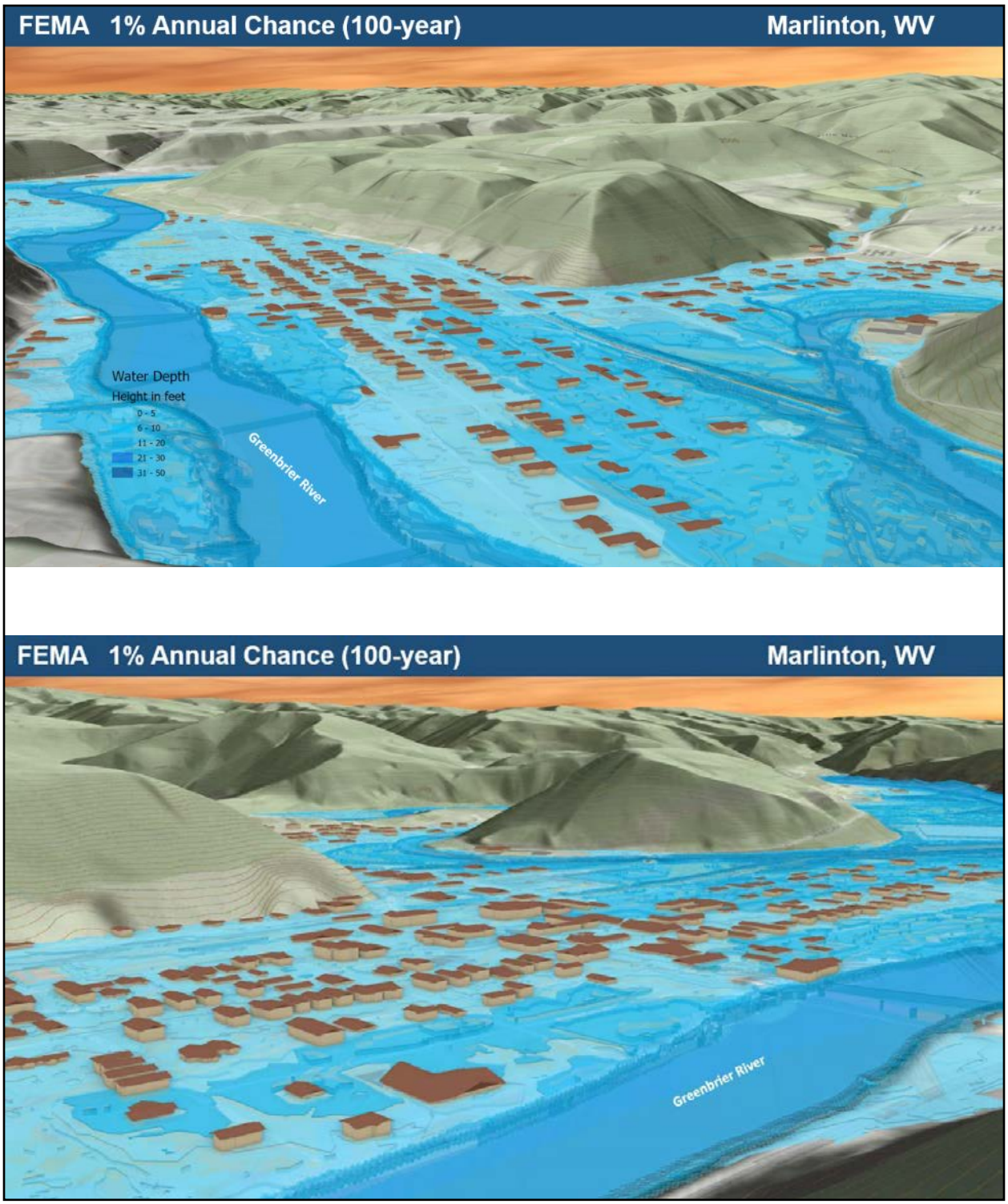


Figure 30. 3D viewsheds of 1%-annual-chance inundation scenario based on FEMA frequencies for Marlinton

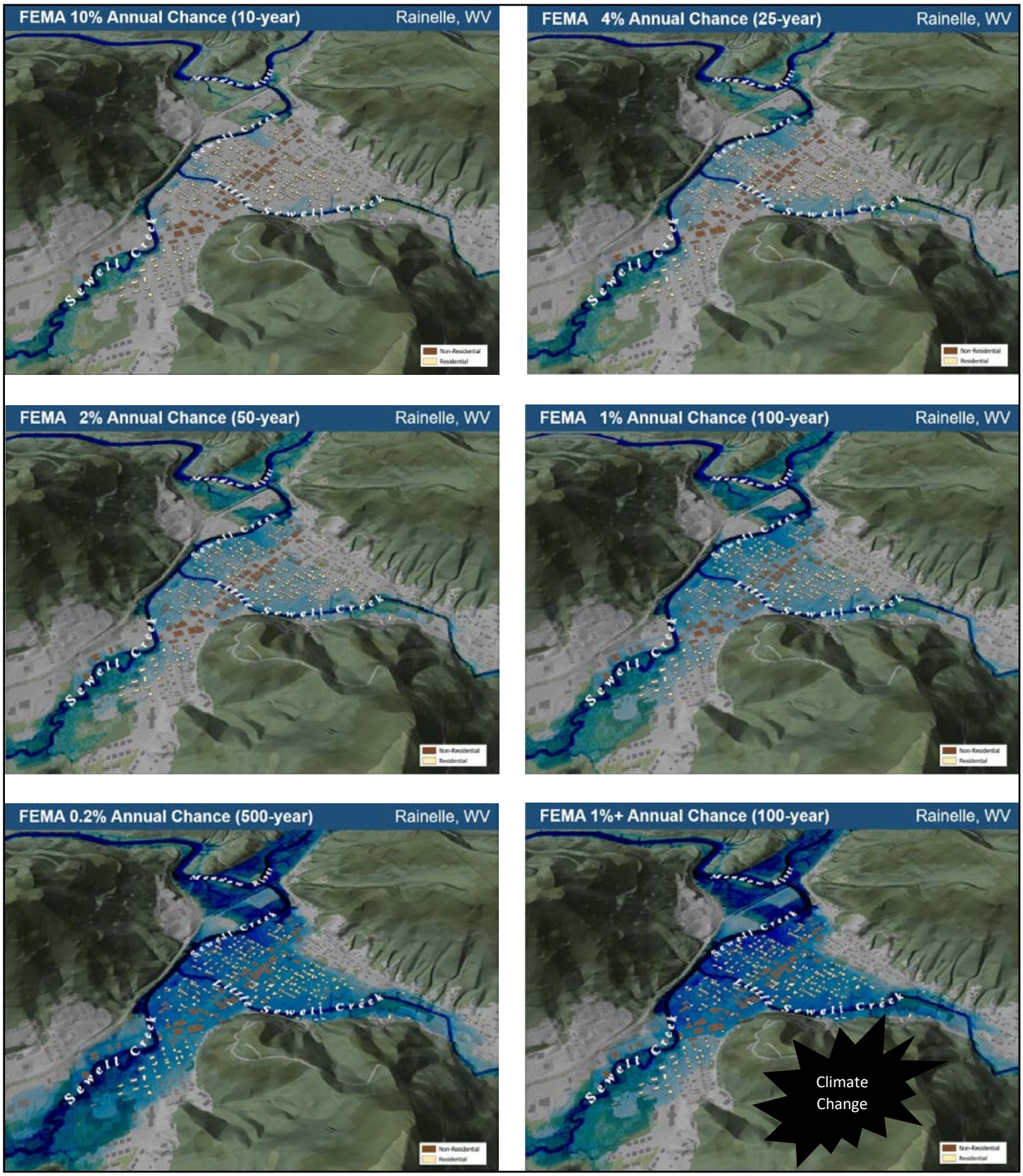


Figure 31. 3D viewsheds of flood inundation scenarios based on FEMA frequencies for Rainelle

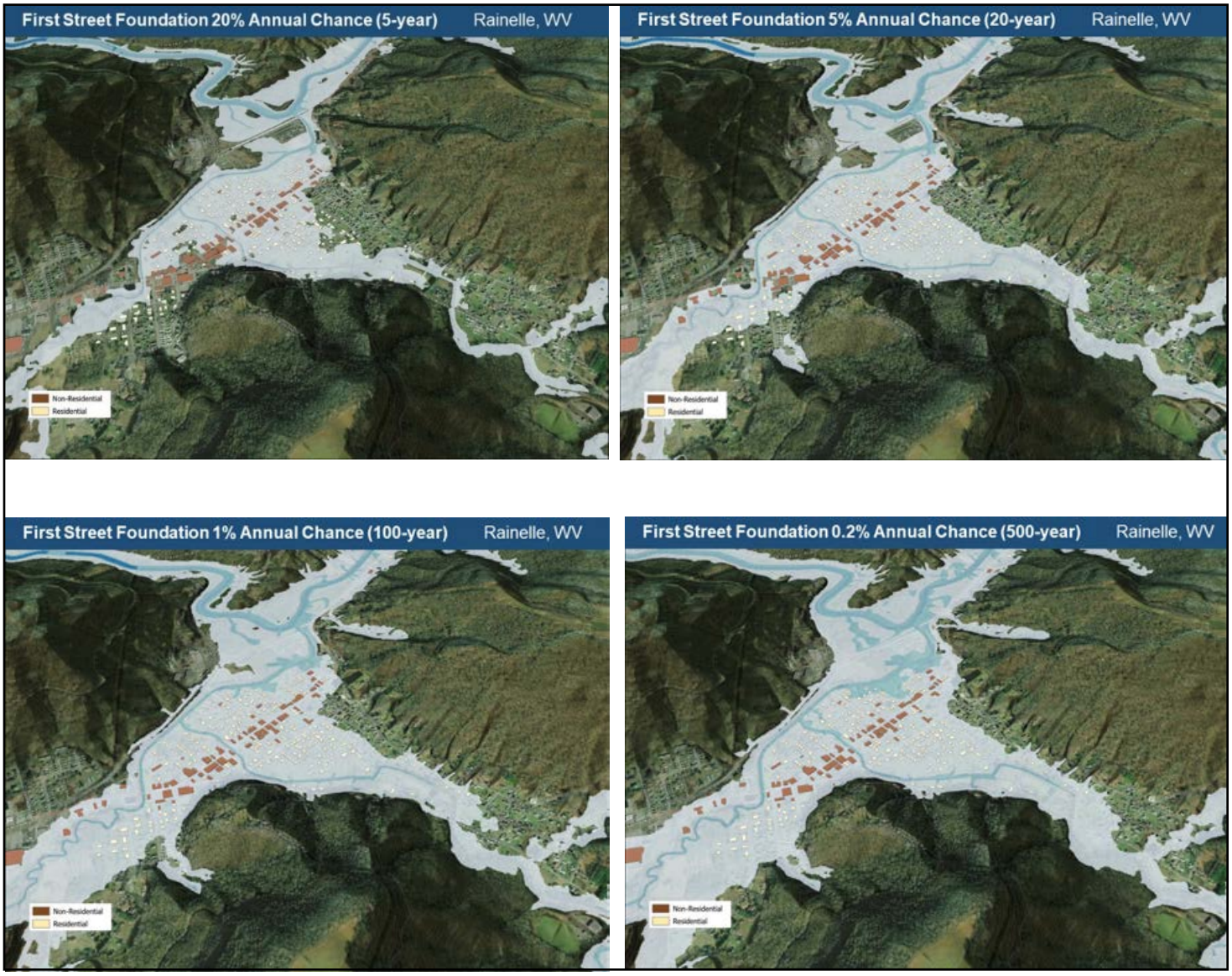


Figure 32. 3D viewsheds of flood inundation scenarios based on FSF frequencies for Rainelle

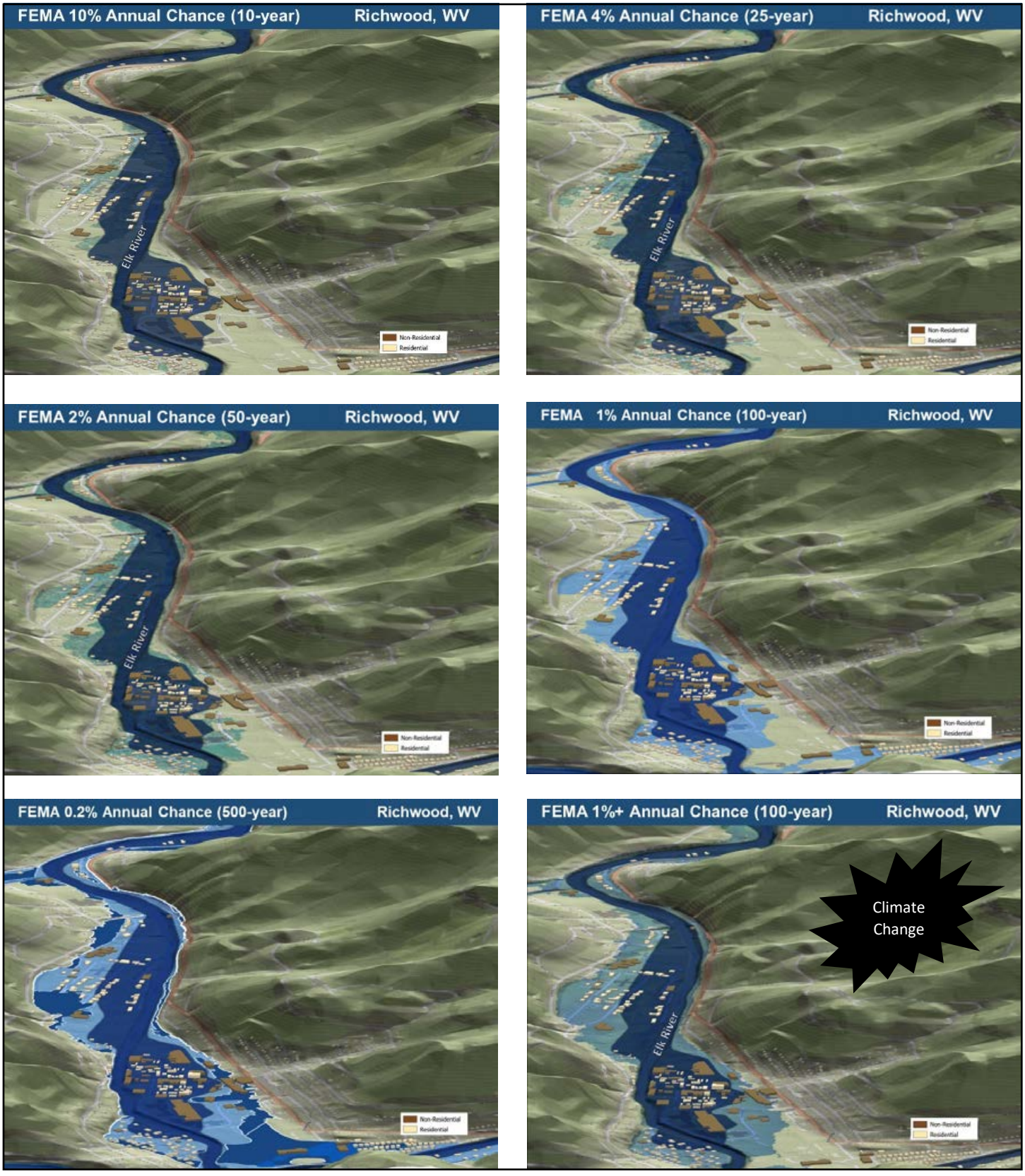


Figure 33. 3D viewsheds of flood inundation scenarios based on FEMA frequencies for Richwood

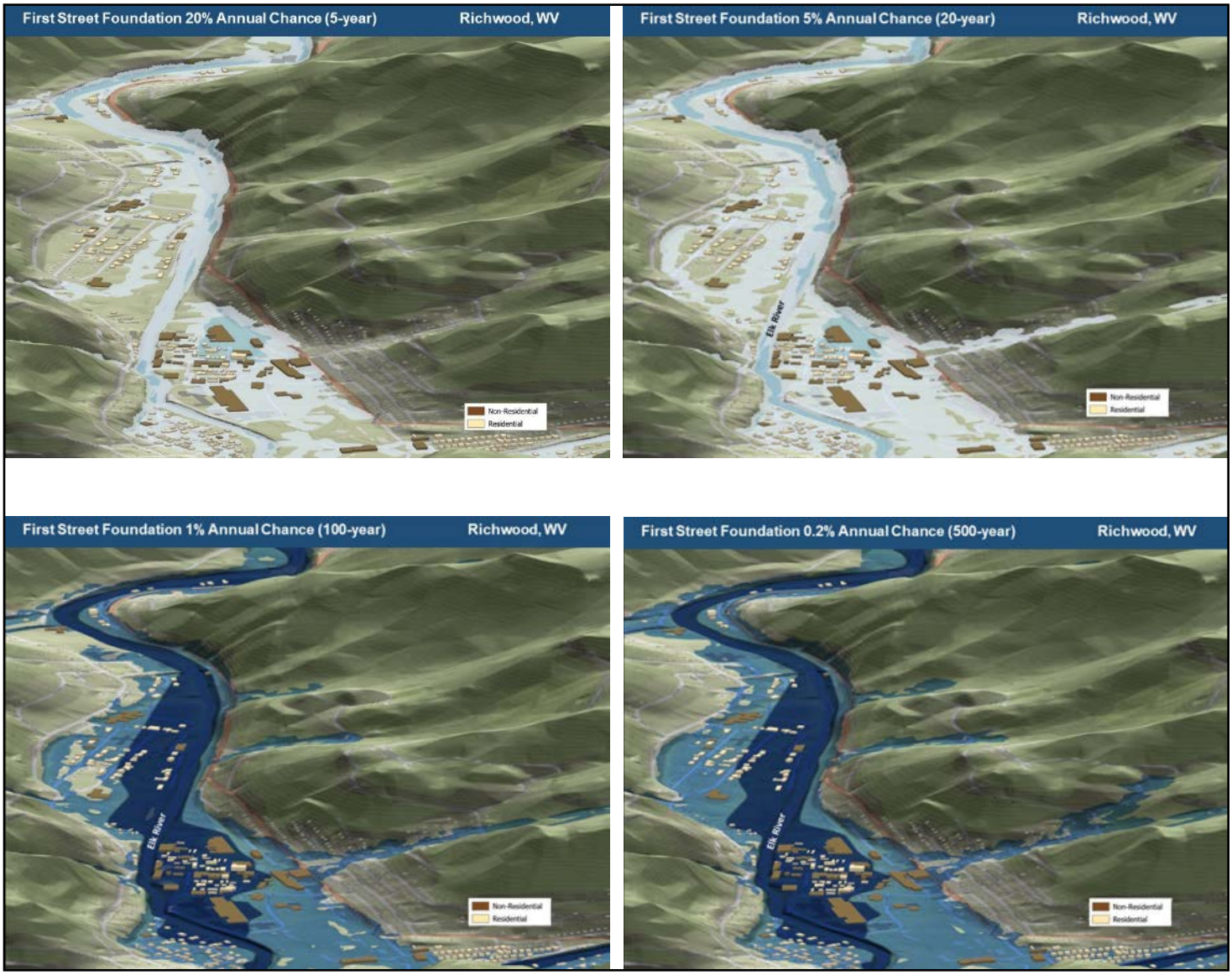


Figure 34. 3D viewsheds of flood inundation scenarios based on FSF frequencies for Richwood

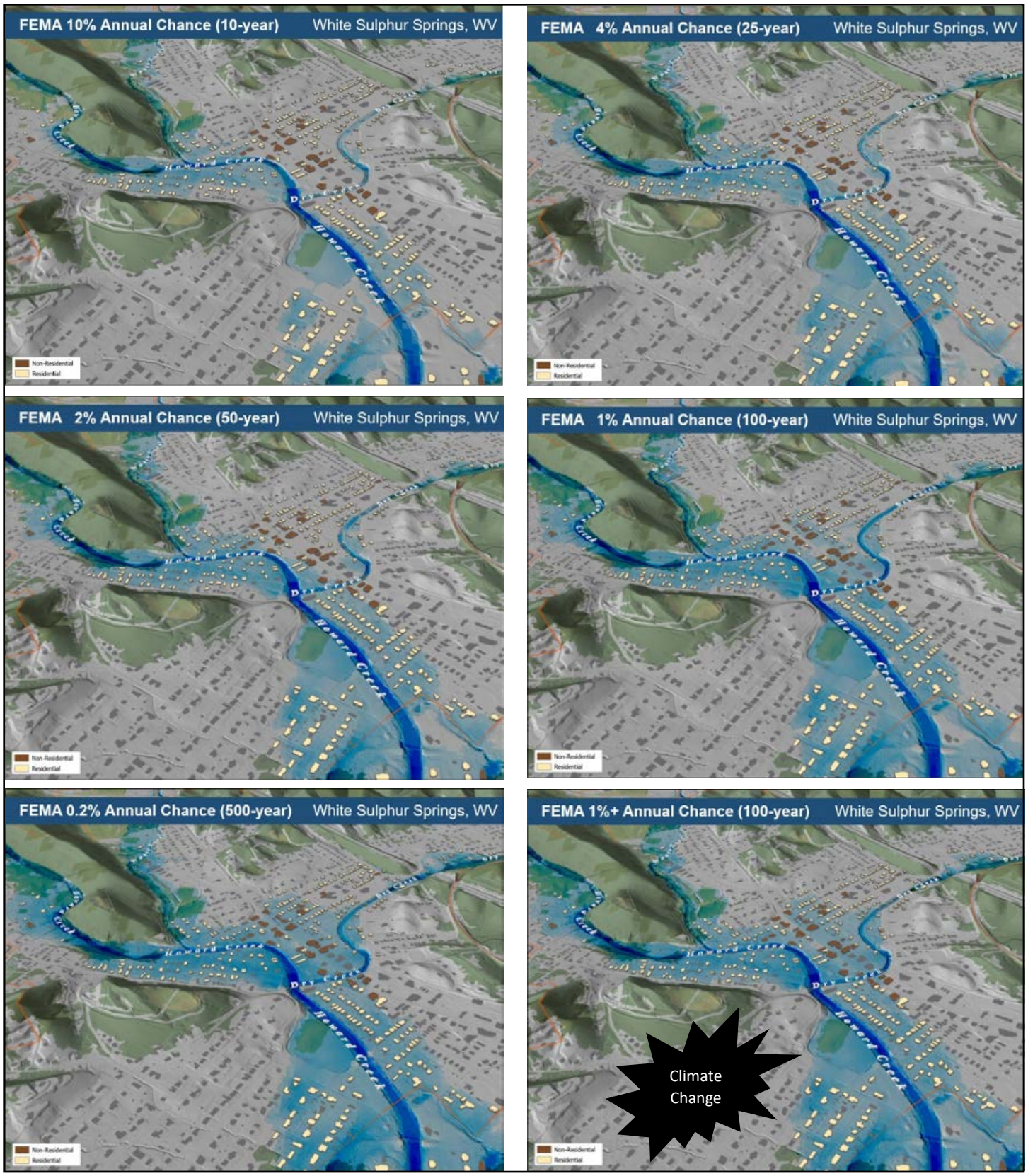


Figure 35. 3D viewsheds of flood inundation scenarios based on FEMA frequencies for White Sulphur Springs

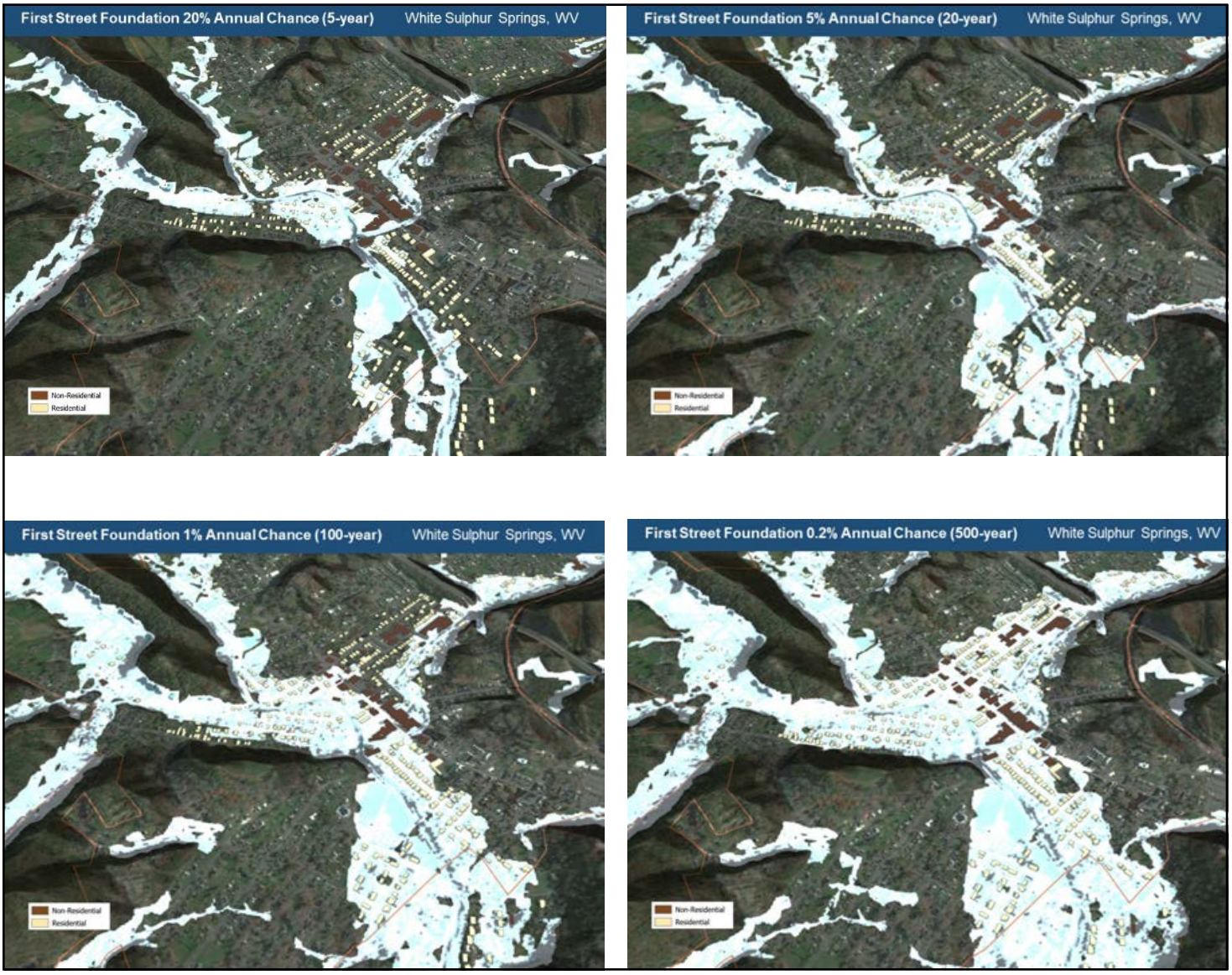


Figure 36. 3D viewsheds of flood inundation scenarios based on FSF frequencies for White Sulphur Springs

Flood Depth

Flood Depth Median

Flood depth is the primary factor that has the greatest impact on the extent of both physical and human losses. The depth of floodwater around a structure is the most critical element to consider when planning and designing flood-proofing measures. It largely determines the strength and stability requirements for the entire structure and for individual structural elements prone to inundation.

For a 1%-annual-chance (100-year) flood based on FEMA's model, the median value of flood depths of all inventoried primary structures for **Clendenin** (ranked ***10th*** in all incorporated places) is 6.4 feet while it is 6.1 feet for **Camden-on-Gauley** (ranked ***11th***). These two communities are among the ***top 10%*** incorporated places for this risk indicators. The median depth is 4.0 feet for **Marlinton** (ranked ***35th***) placing this community among the ***top 20%*** incorporated places for this factor. For **Rainelle**, the median flood depth is 2.1 feet, for **Richwood** it is 1.8 feet, and for **White Sulphur Springs** it is 1.5 feet. Except for White Sulphur Springs, all these communities have median flood depths reaching or exceeding the statewide median for all incorporated places, which is 1.8 feet.

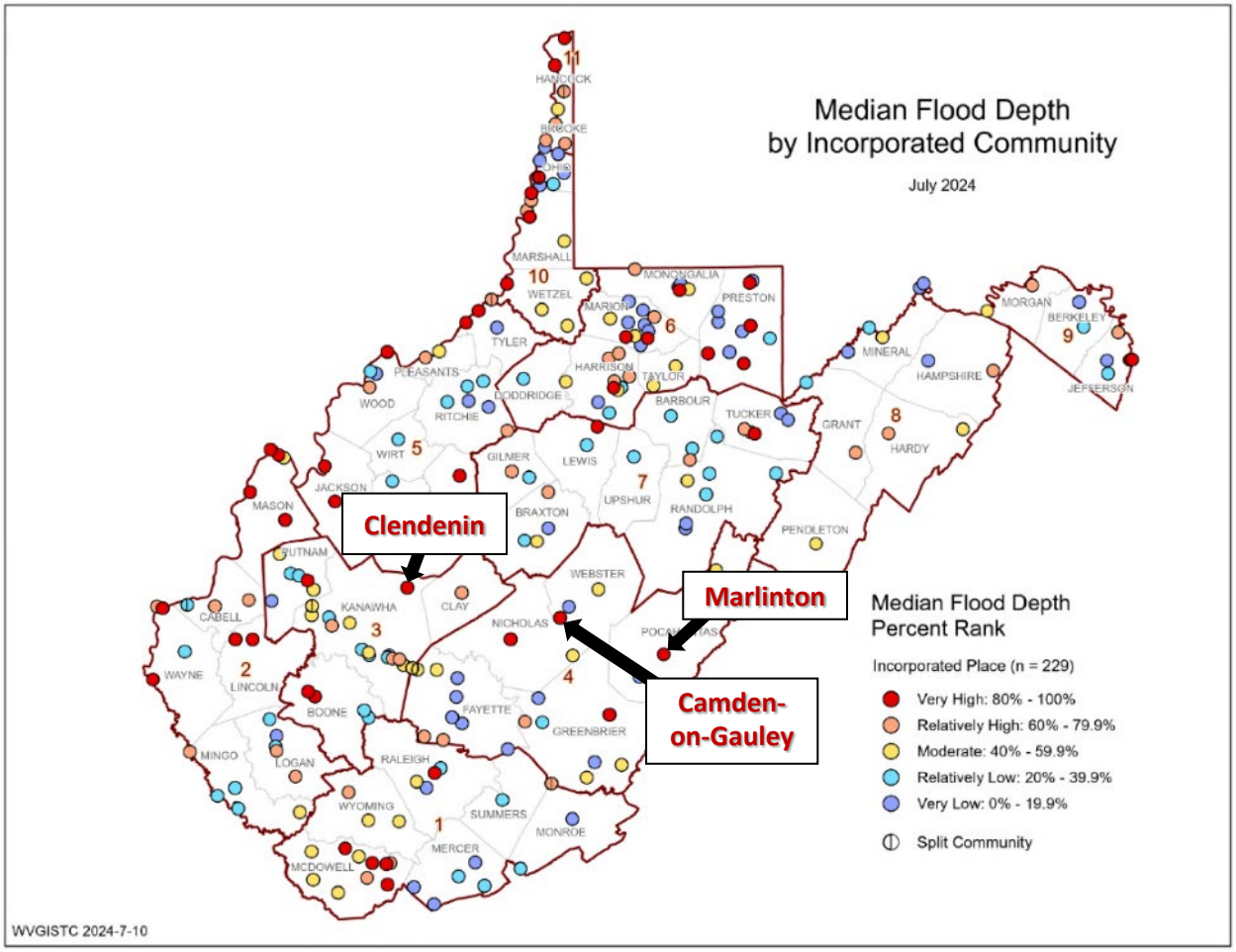


Figure 37. Clendenin, Camden-on-Gauley, and Marlinton on the map of median flood depth ranks for incorporated places

Paying attention to estimated flood depths is crucial for effective mitigation efforts. Mitigation measures like elevation and wet floodproofing are not economically viable for flood depths greater than 12 feet (source: USACE). Additionally, dry floodproofing is not recommended when water depths exceed 3 feet under base flood conditions and base flood velocities surpass 5 feet per second (source: FEMA).

Flood Depth Analysis of Inundation Scenarios

Estimated flood depths associated with various inundation scenarios were analyzed and compared for each studied community. For a 1%-annual-chance (100-year) flood based on FEMA's model for the primary structures, the maximum inundation depth in **Clendenin** is 26.6 feet while it is 12.6 feet in **Camden-on-Gauley**. In **Marlinton**, the maximum flood depth is 9.2 feet whereas it is 7.8 feet in **Richwood**, 6.2 feet in **Rainelle**, and 5.4 feet in **White Sulphur Springs**. *Table 3* summarizes the base flood depth values of a 1%-annual-chance (100-year) event based on FEMA's model.

Table 3. Base (1%-annual-chance or 100-year) flood depth for the studied communities

Incorporated Place	1%-annual-chance (100-year) Base Flood Depth (FEMA)	
	Depth Median (feet)	Maximum Depth (feet)
Camden-on-Gauley	6.1	12.6
Clendenin	6.4	26.6
Marlinton	4.0	9.2
Rainelle	2.1	6.2
Richwood	1.8	7.8
White Sulphur Springs	1.5	5.4

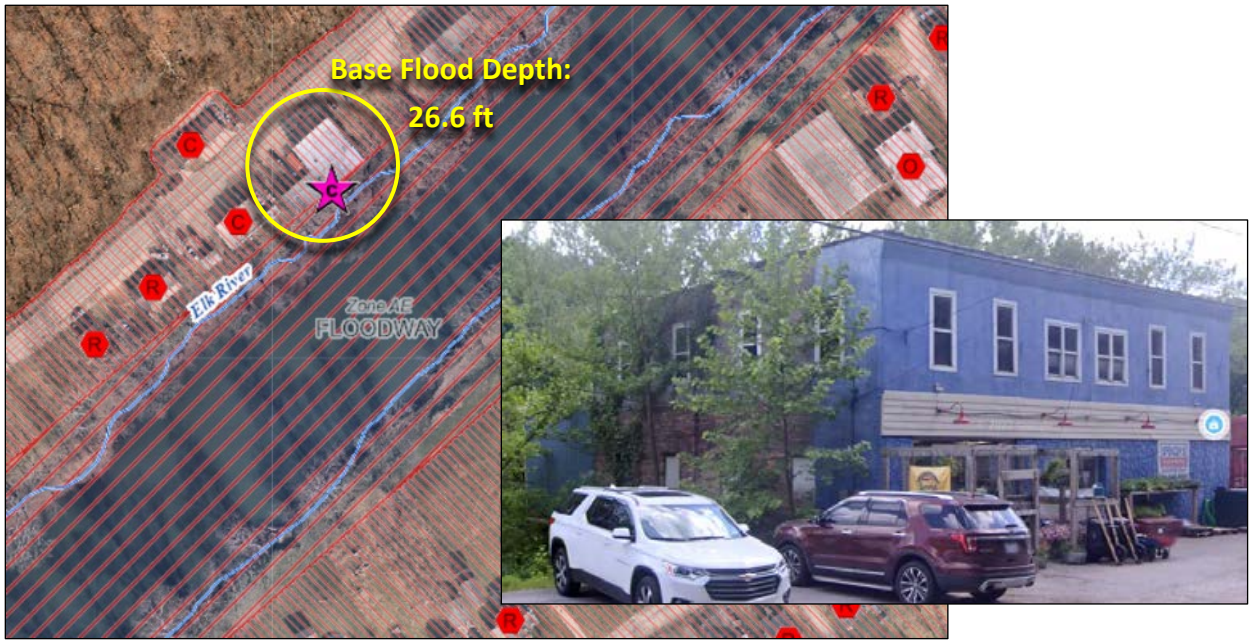


Figure 38. Structure with the maximum flood depth in Clendenin (Building ID: 20-02-0001-0025-0000_8290)

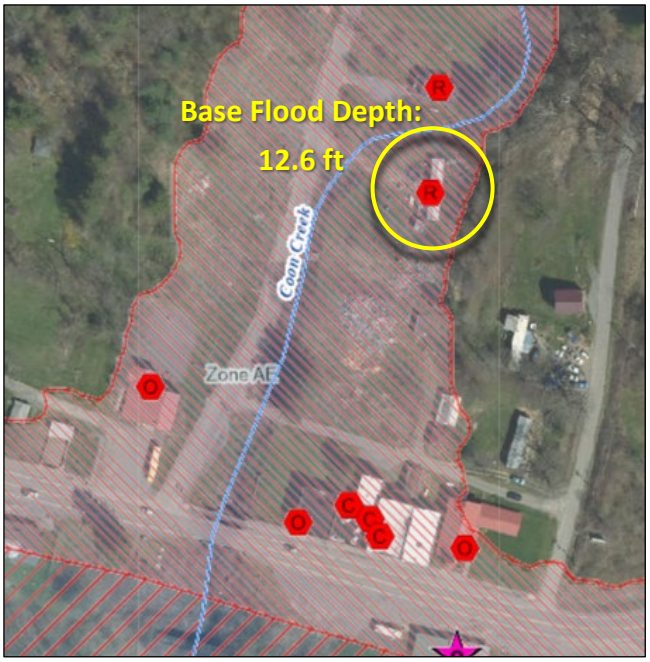


Figure 39. Structure with the maximum flood depth in Camden-on-Gauley
(Building ID: 51-01-0003-0121-0000_42)

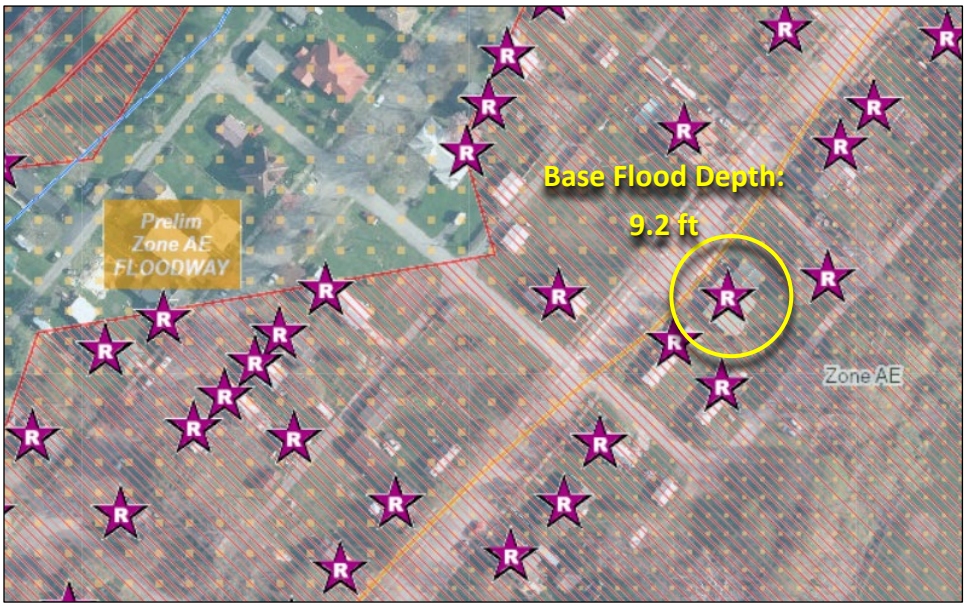


Figure 40. Structure with the maximum flood depth in Marlinton
(Building ID: 38-08-0002-0183-0000_1025)

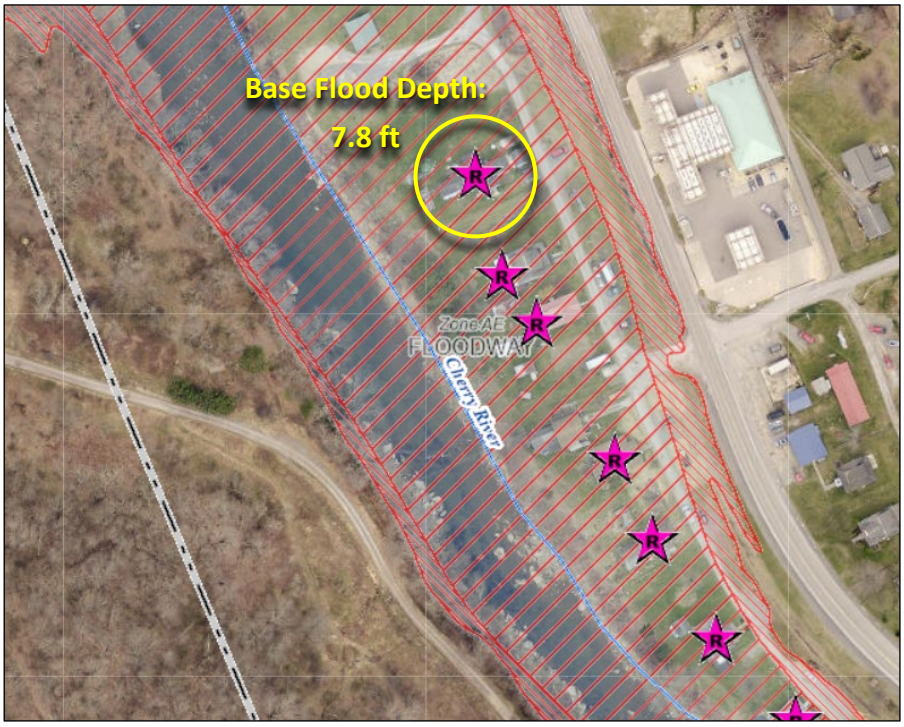


Figure 41. Structure with the maximum flood depth in Richwood
(Building ID: 34-06-0009-0011-0001_81)

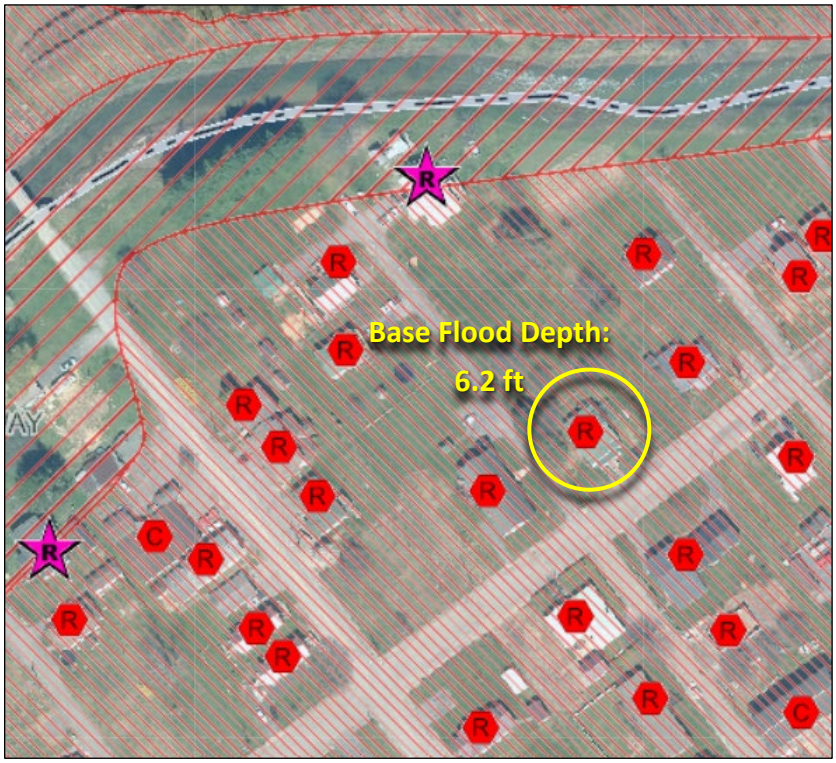


Figure 42. Structure with the maximum flood depth in Rainelle
(Building ID: 13-13-0001-0085-0000_417)

Figure 43. Structure with the maximum flood depth in White Sulphur Springs (Building ID: 13-17-0009-0009-0000_148)

For a 1%-annual-chance (100-year) flood, the First Street Foundation (FSF) model indicates that flood depths in **Clendenin** range between 8.0 and 33.8 feet. Based on this model, the estimated flood depth in **Marlinton** ranges between 0.2 and 16.3 feet, while it varies from 0.2 to 13.8 feet in **Richwood**. The FSF estimates depths between 1.5 and 12.8 feet for **Rainelle**, 1.9 and 12.0 feet in **Camden-on-Gauley**, and 0.2 and 12 feet in **White Sulphur Springs**.

The maps on the following pages summarize the flood depth analyses visually, in addition to depth estimations for a 0.2%-annual-chance (500-year) flood, offering a comprehensive view of the varying flood depths experienced in each community under different flood scenarios.

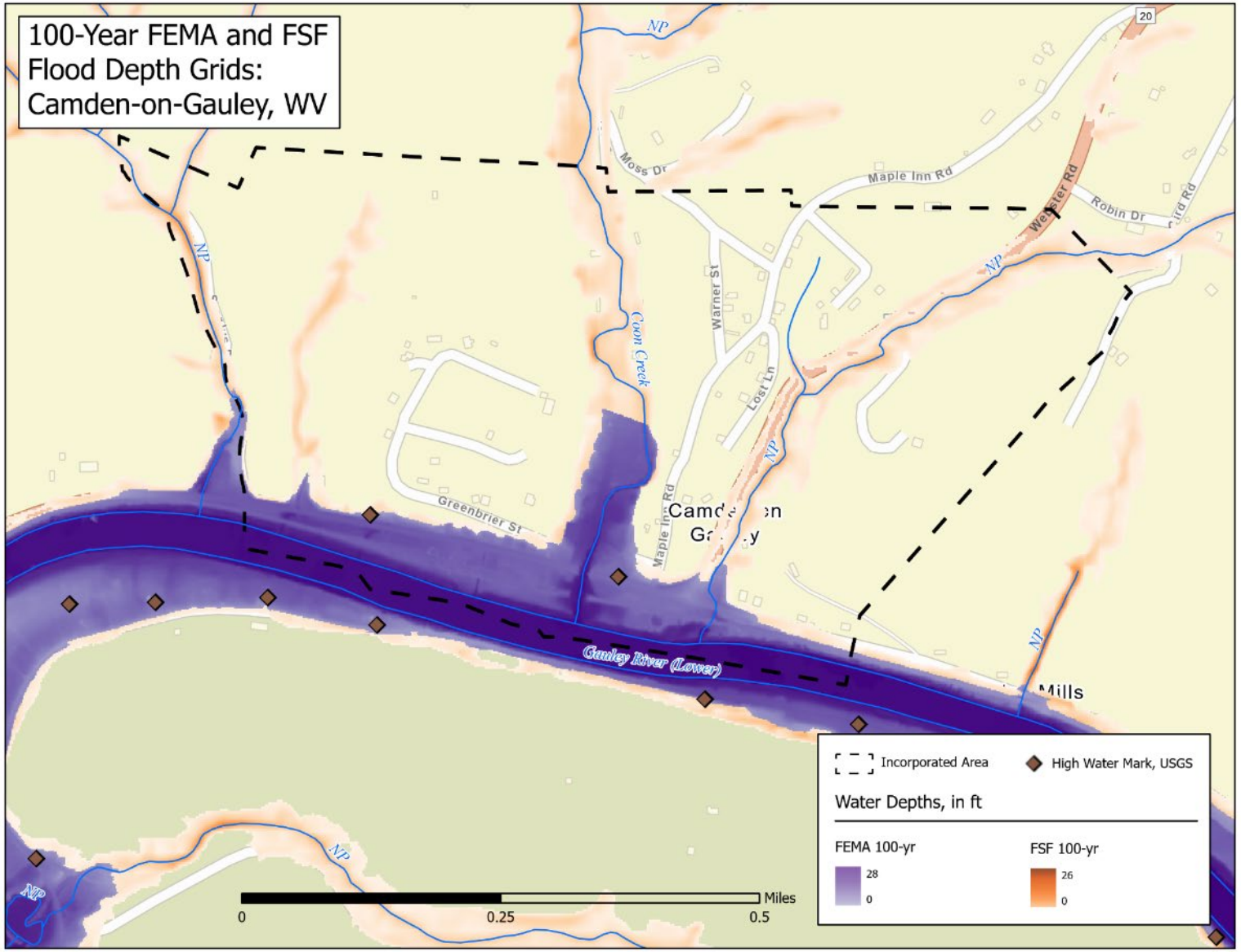


Figure 44. FEMA and FSF depth grids for 1%-annual-chance (100-year) flood in Camden-on-Gauley

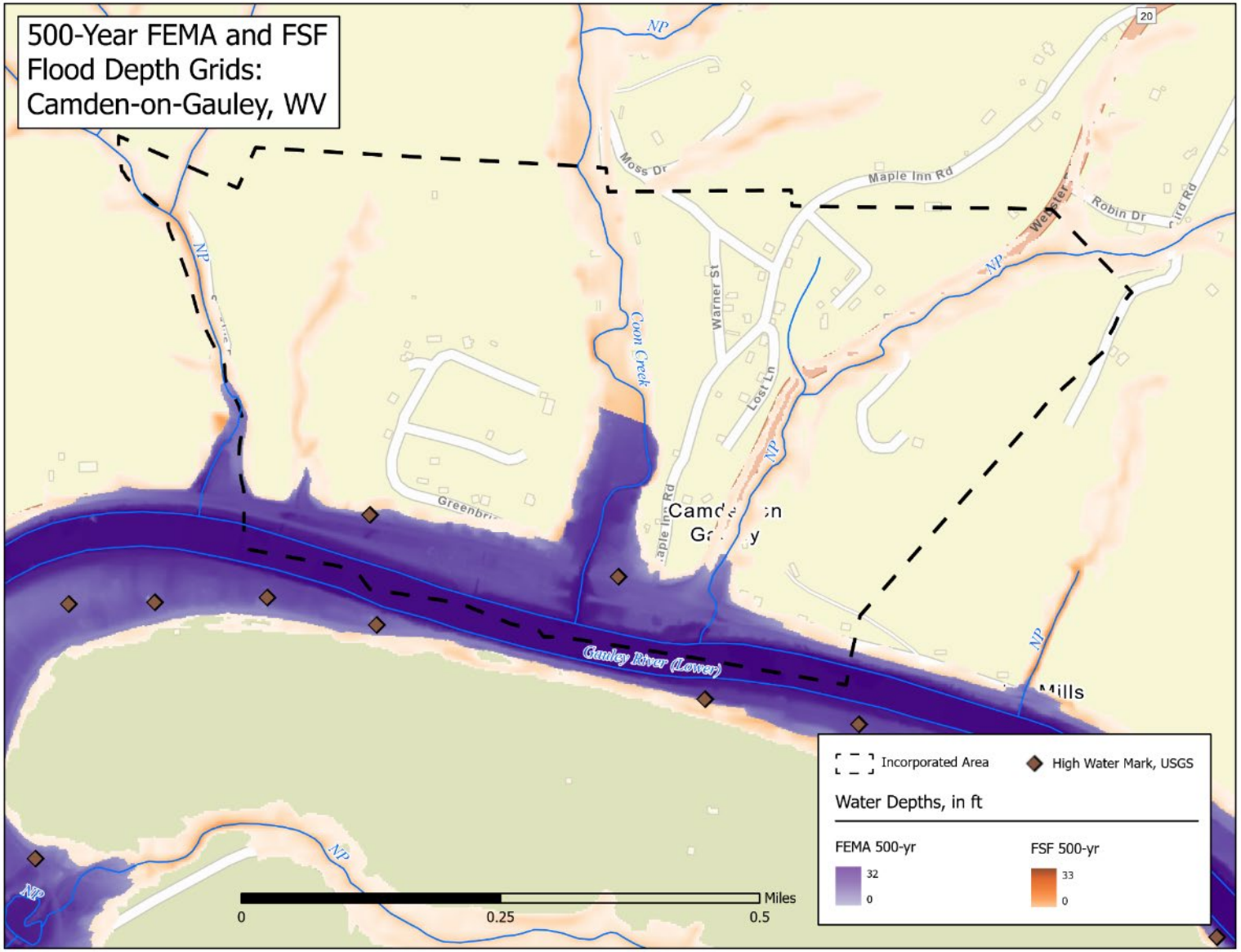


Figure 45. FEMA and FSF depth grids for 0.2%-annual-chance (500-year) flood in Camden-on-Gauley

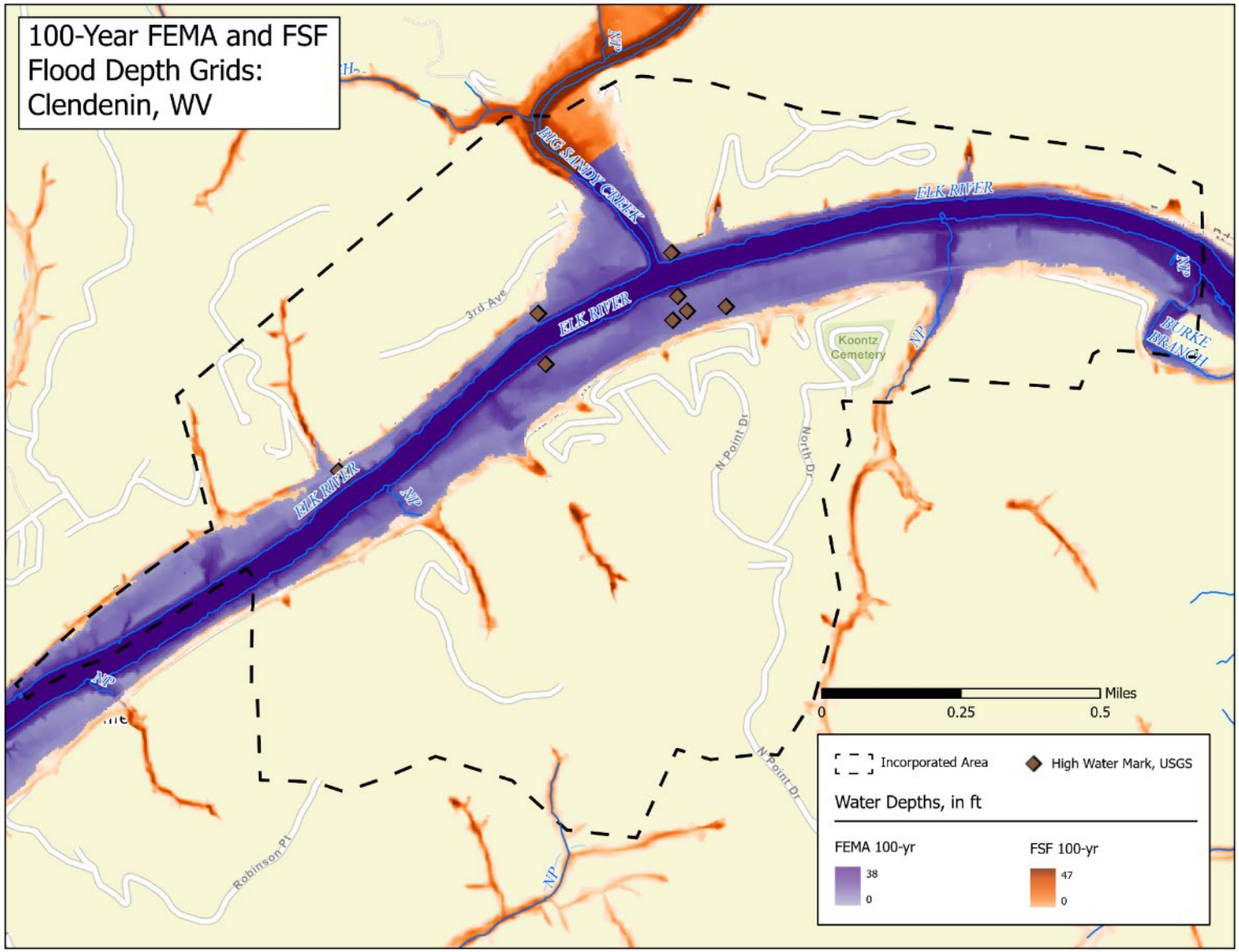


Figure 46. FEMA and FSF depth grids for 1%-annual-chance (100-year) flood in Clendenin

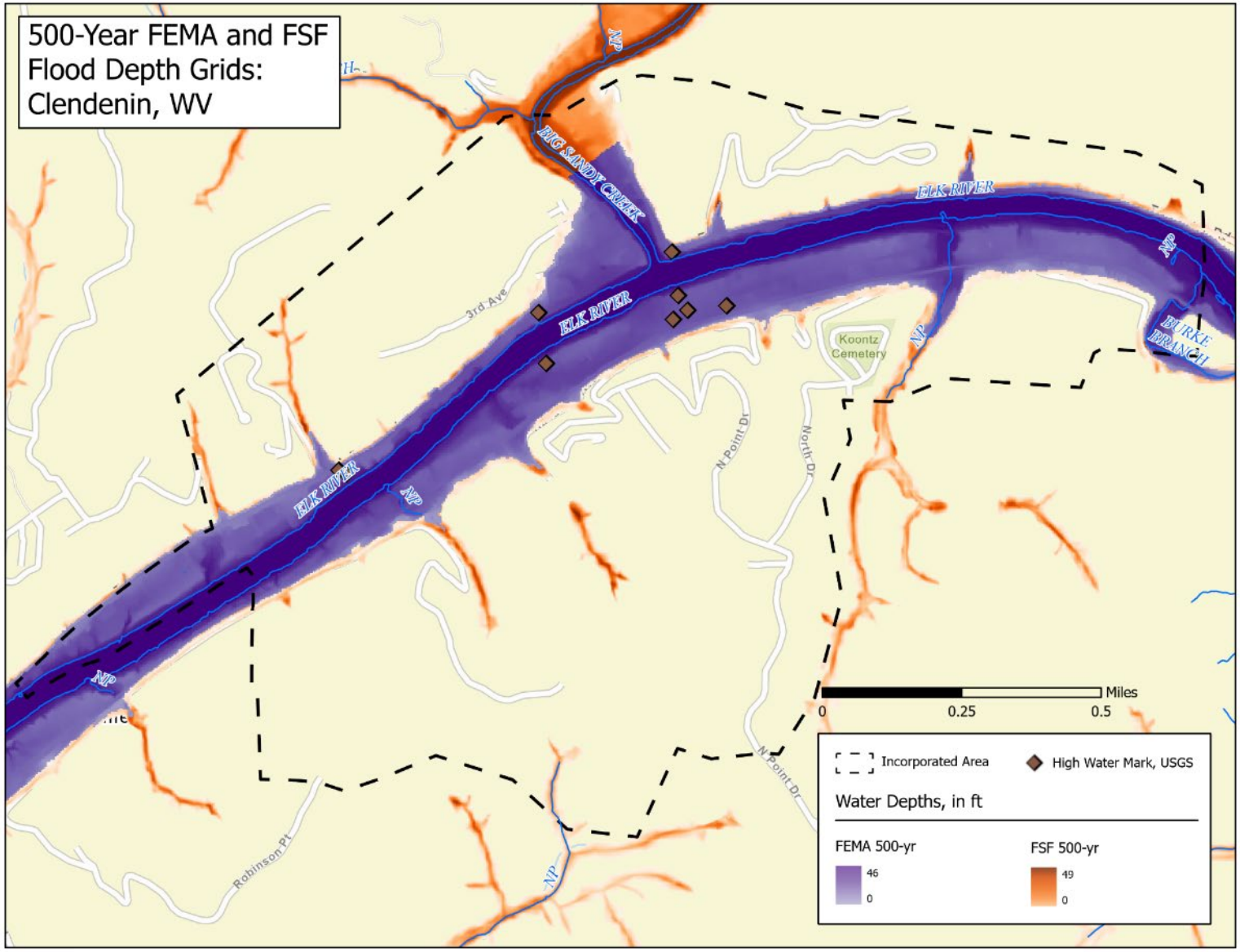


Figure 47. FEMA and FSF depth grids for 0.2%-annual-chance (500-year) flood in Clendenin

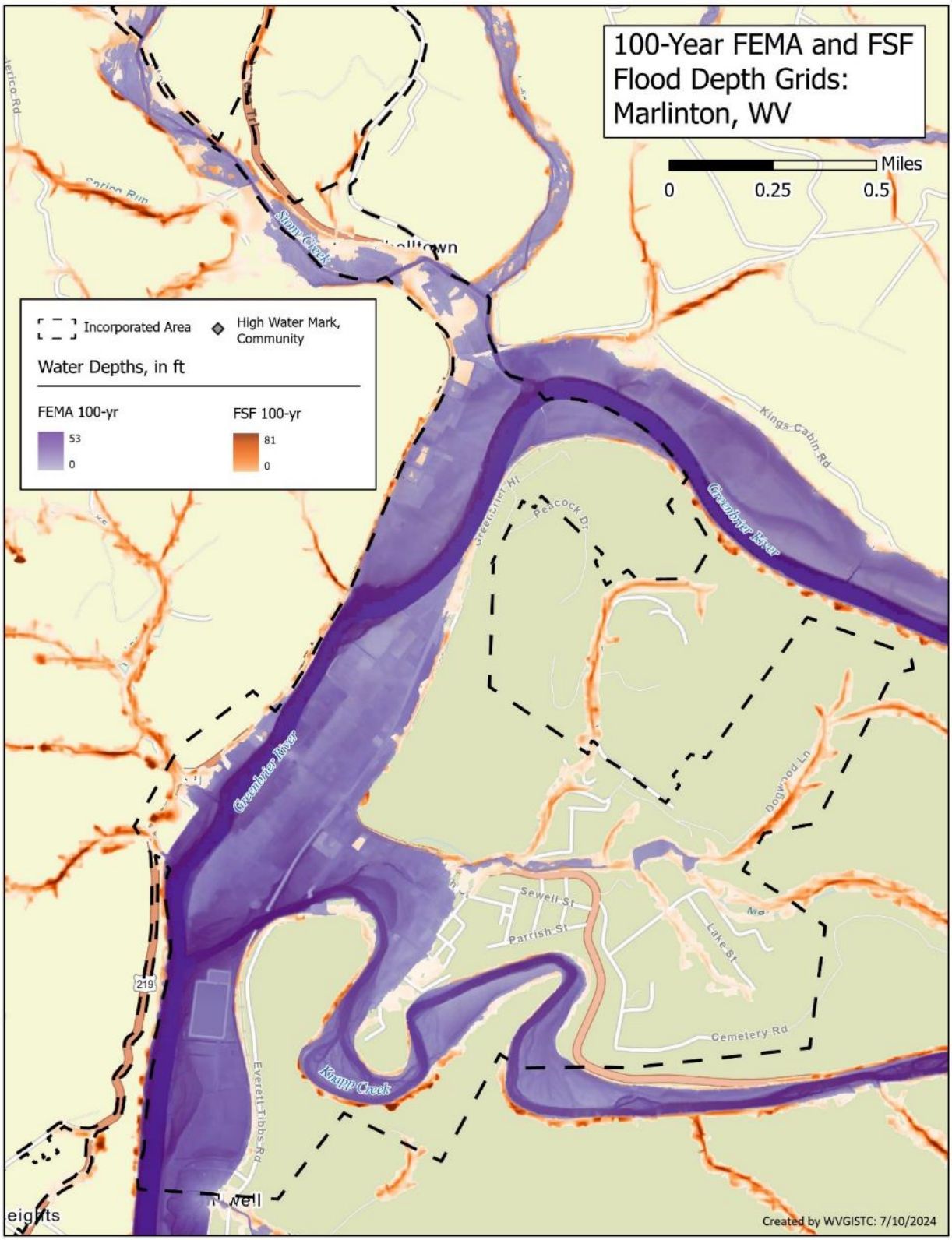


Figure 48. FEMA and FSF depth grids for 1%-annual-chance (100-year) flood in Marlinton

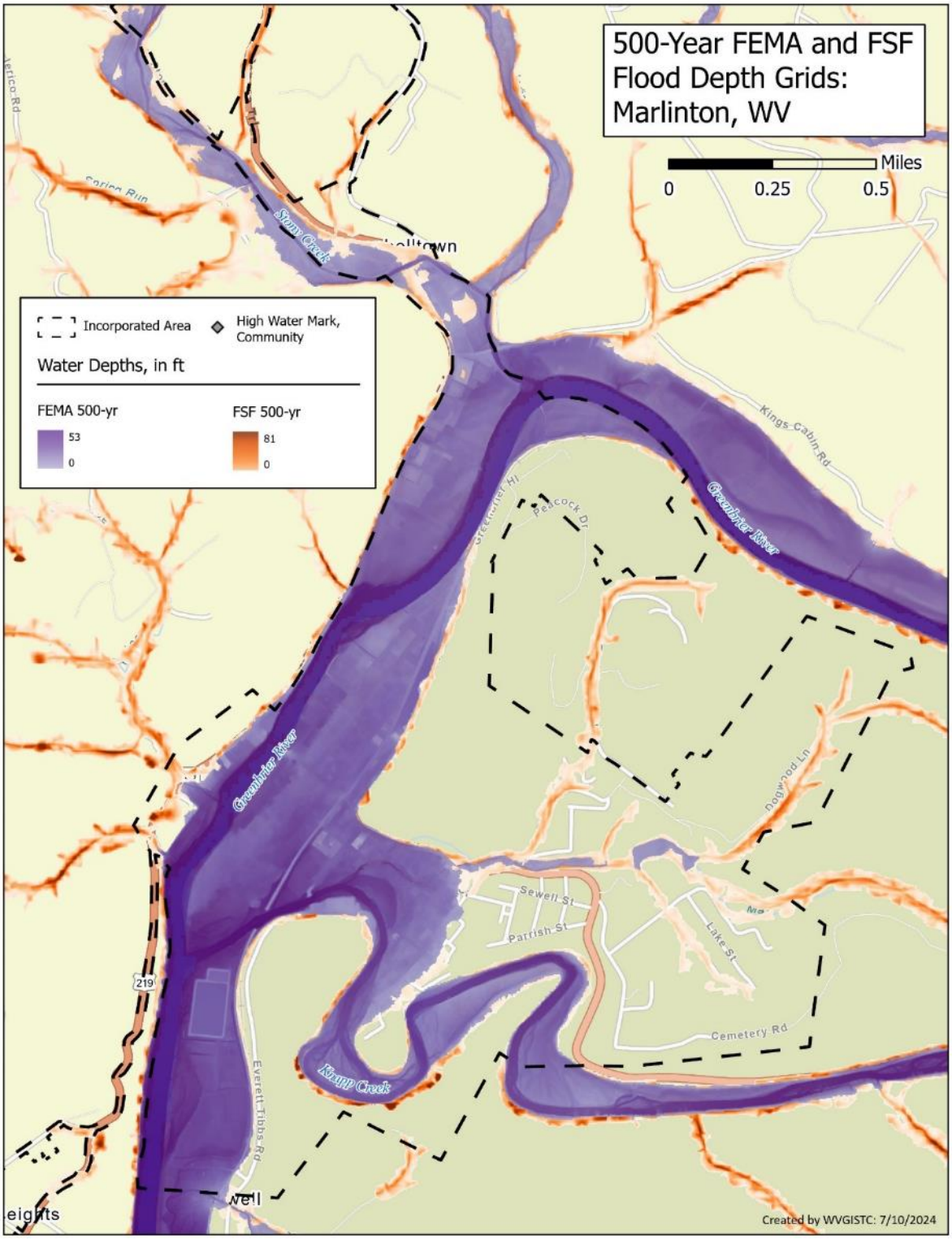


Figure 49. FEMA and FSF depth grids for 0.2%-annual-chance (500-year) flood in Marlinton

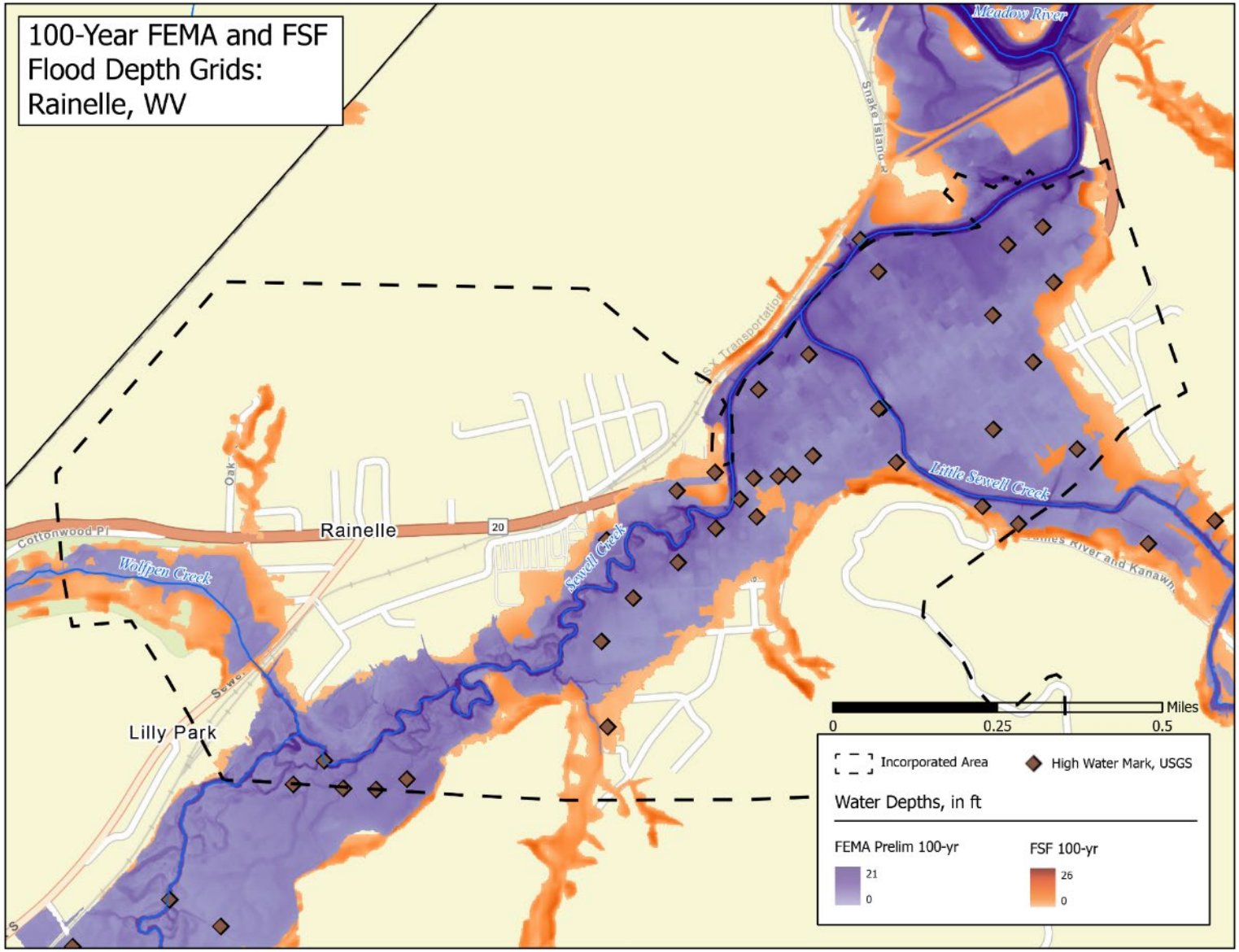


Figure 50. FEMA and FSF depth grids for 1%-annual-chance (100-year) flood in Rainelle

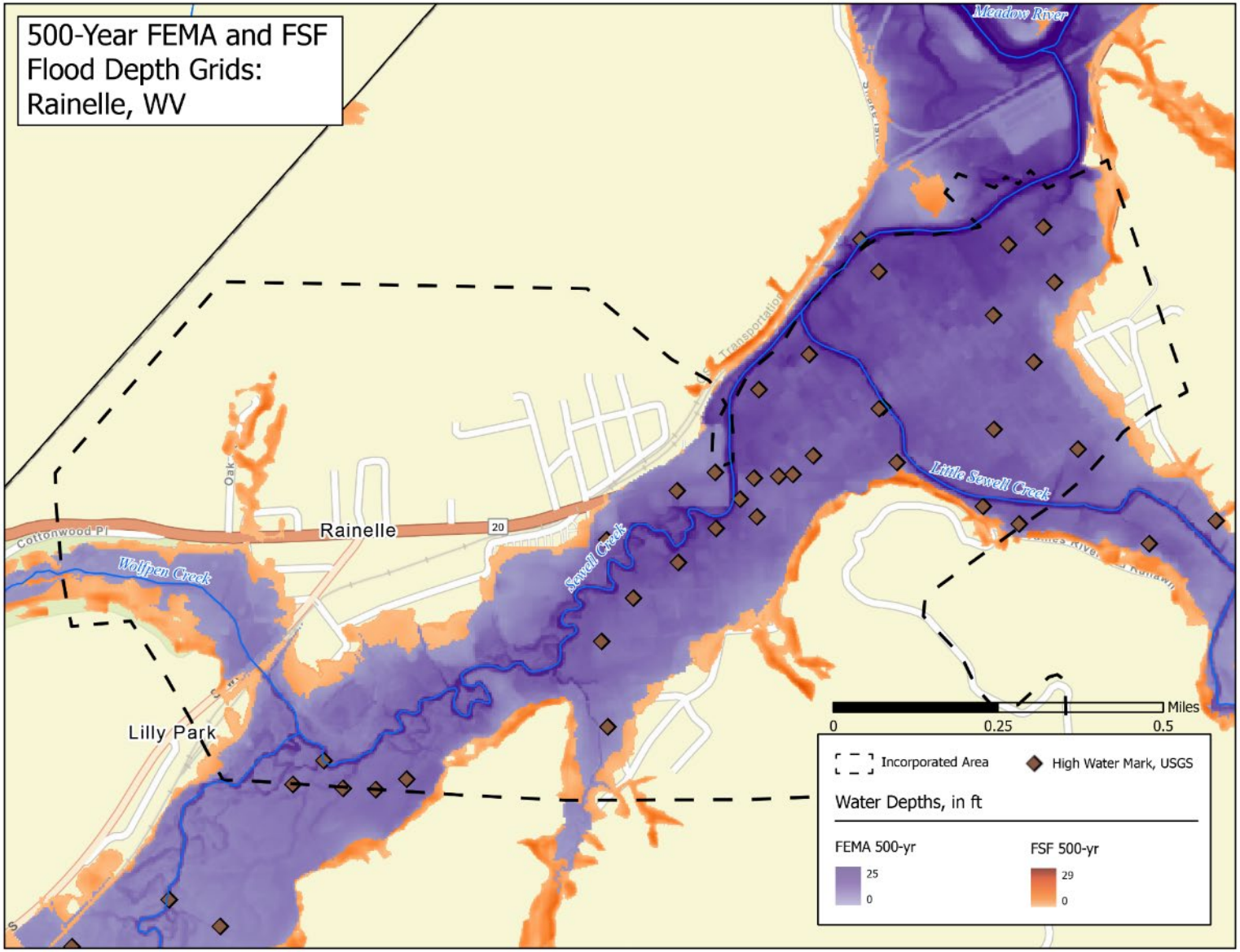


Figure 51. FEMA and FSF depth grids for 0.2%-annual-chance (500-year) flood in Rainelle

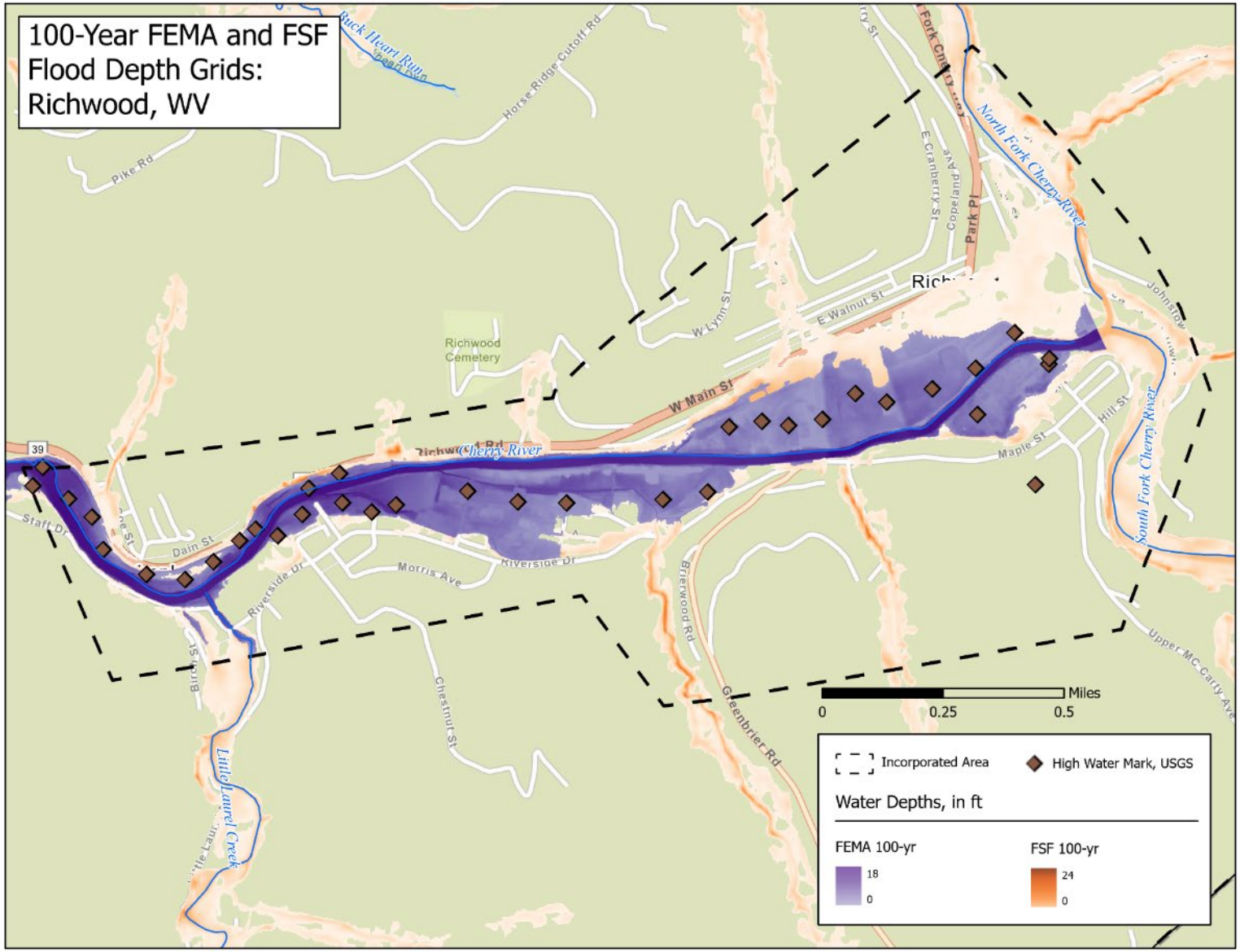


Figure 52. FEMA and FSF depth grids for 1%-annual-chance (100-year) flood in Richwood

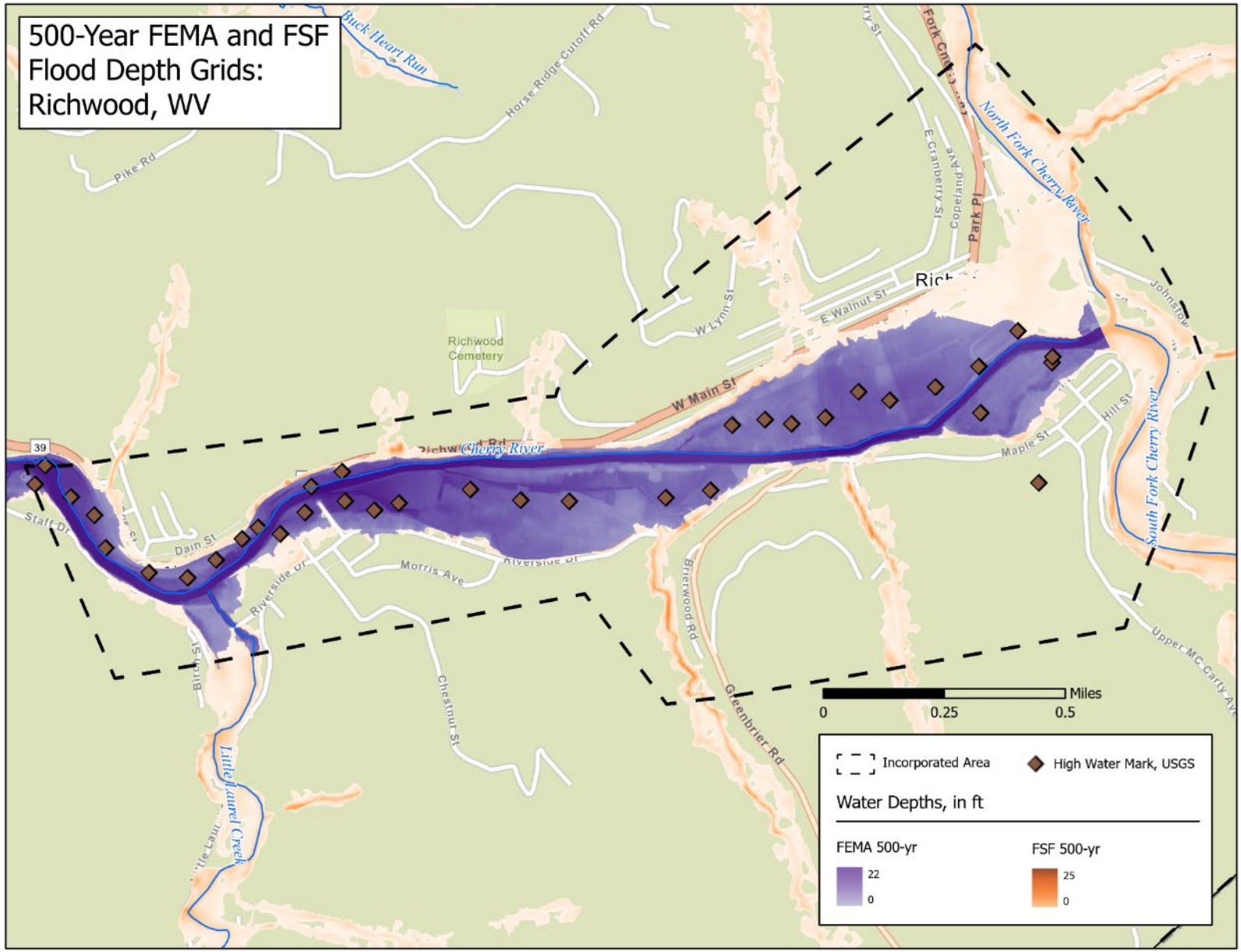


Figure 53. FEMA and FSF depth grids for 0.2%-annual-chance (500-year) flood in Richwood

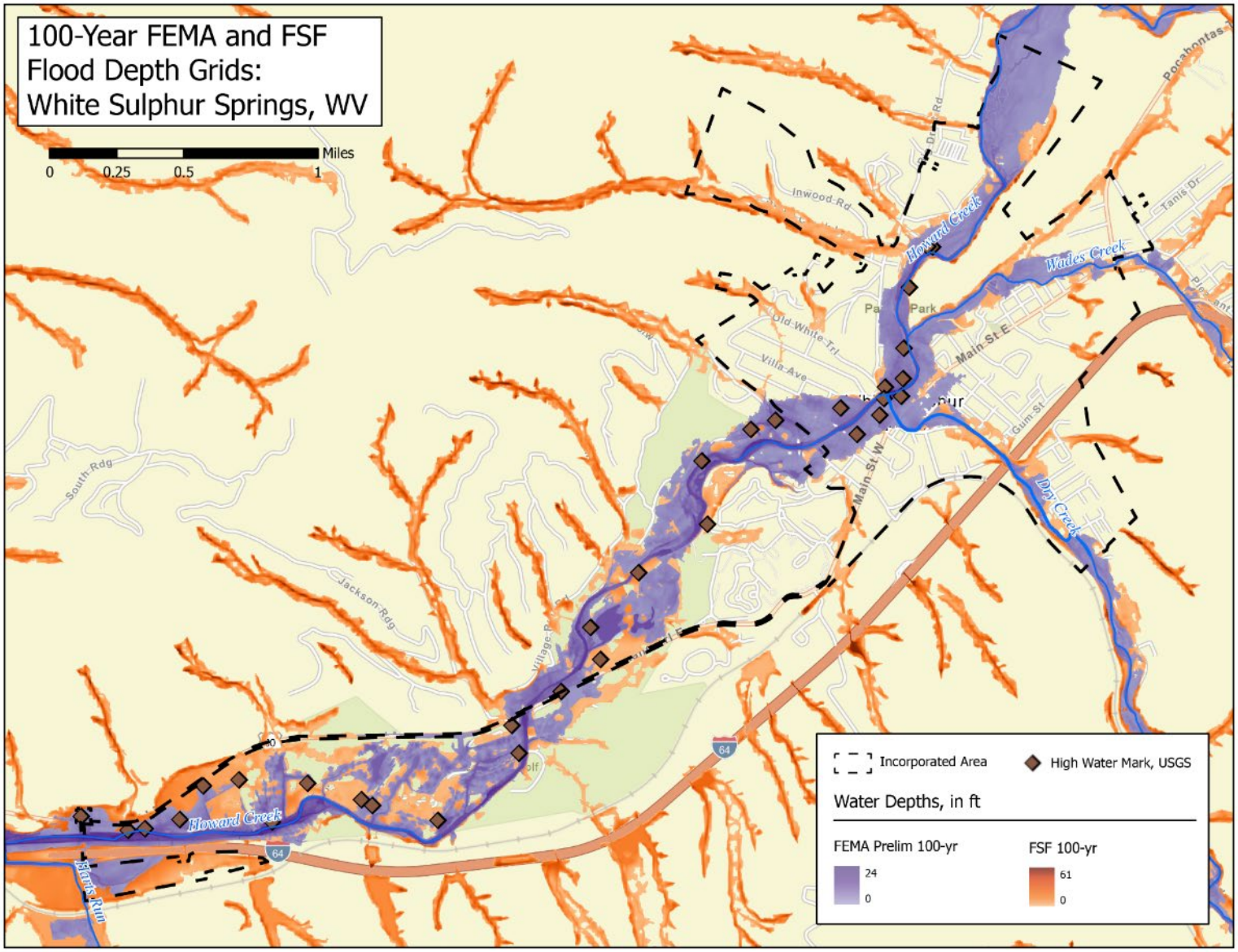


Figure 54. FEMA and FSF depth grids for 1%-annual-chance (100-year) flood in White Sulphur Springs

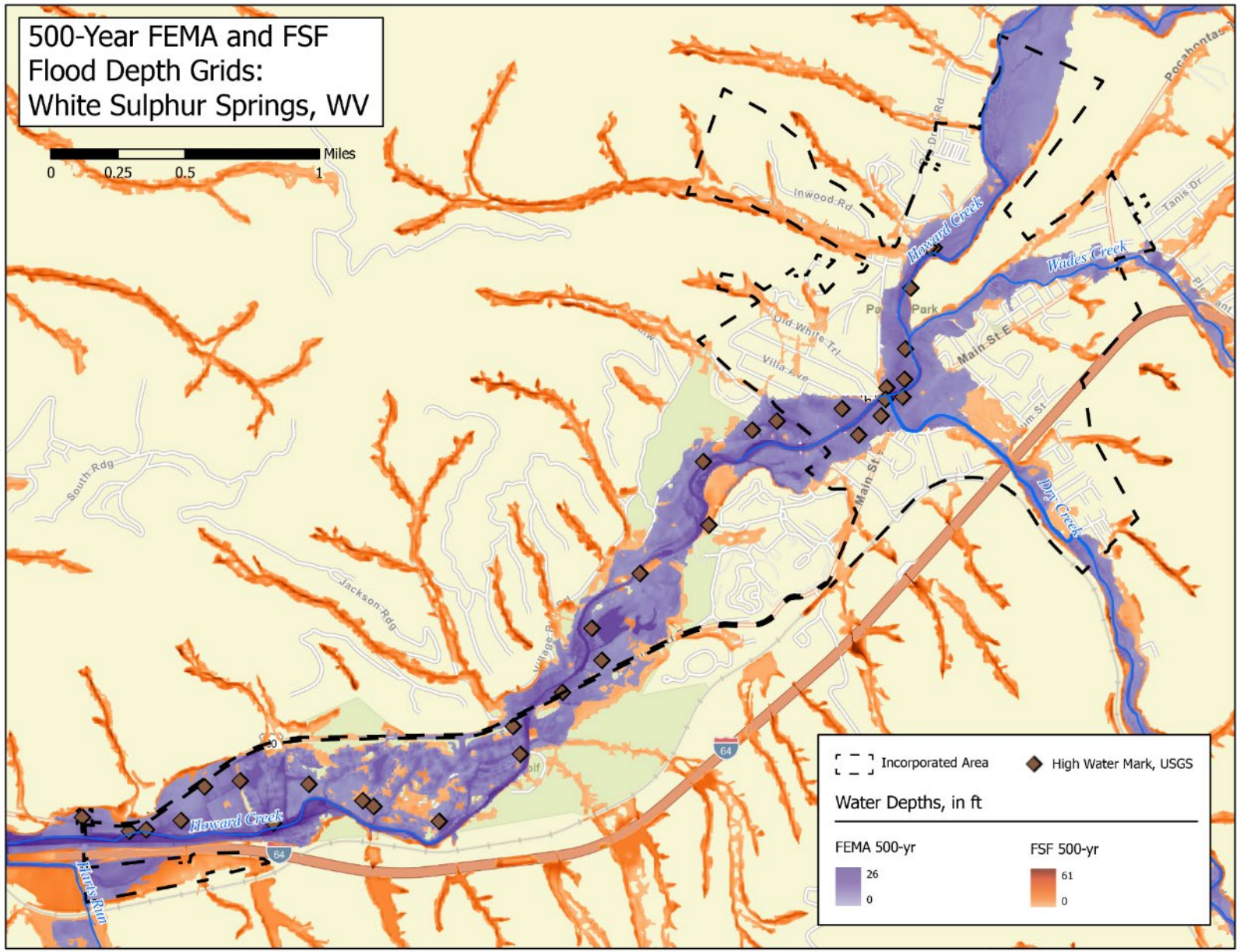


Figure 55. FEMA and FSF depth grids for 0.2%-annual-chance (500-year) flood in White Sulphur Springs

Building Flood Profiles

To analyze the inundation scenarios at a detailed scale, flood profiles were developed for selected individual buildings. A building flood profile is a graphical representation that illustrates the relationship between a building's elevation and flood depth. It typically displays critical data points, including the building's height, Base Flood Elevation (BFE), flood depth from different return periods (e.g., 10-year, 50-year, 100-year, 500-year floods), and historical high-water marks from past flood events. Even elevated structures may be vulnerable to major flood events, therefore at-risk residents should be ready to evacuate early. These profiles help assess the buildings' vulnerability to flooding by comparing their elevations to established flood risk levels, indicating whether the structures meet regulatory requirements and standards for flood resilience. They provides essential information for decision-making regarding flood mitigation measures, insurance needs, and overall safety during flood events. The inclusion of specific flood depth measurements, such as those from FEMA guidelines, allows stakeholders to understand better the risks posed by potential flooding in the area.

Figure 56. Example of building flood profiles in Clendenin

The following links can be used to access the building flood profiles produced for these communities:

Camden-on-Gauley: https://data.wvgis.wvu.edu/pub/RA/HL/RA-L/BLDG-PROFILE/BLDG-PROFILE_Camden-on-Gauley_2024.pdf

Clendenin: https://data.wvgis.wvu.edu/pub/RA/HL/RA-L/BLDG-PROFILE/BLDG-PROFILE_Clendenin_2024.pdf

Marlinton: https://data.wvgis.wvu.edu/pub/RA/HL/RA-L/BLDG-PROFILE/BLDG-PROFILE_Marlinton_2024.pdf

Rainelle: https://data.wvgis.wvu.edu/pub/RA/HL/RA-L/BLDG-PROFILE/BLDG-PROFILE_Rainelle_2024.pdf

Richwood: https://data.wvgis.wvu.edu/pub/RA/HL/RA-L/BLDG-PROFILE/BLDG-PROFILE_Richwood_2024.pdf

White Sulphur Springs: https://data.wvgis.wvu.edu/pub/RA/HL/RA-L/BLDG-PROFILE/BLDG-PROFILE_WhiteSulphurSprings_2024.pdf

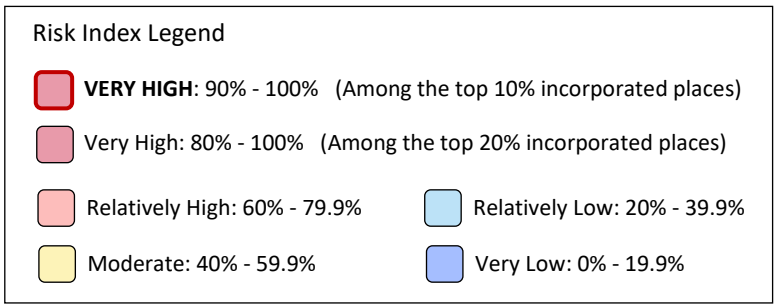
Category Index Scores and Summary for Floodplain Characteristics

From the floodplain characteristics, four indicators of Floodplain Area Ratio, Floodplain Length Ratio, Flood Declared Disasters, and Flood Depth Median were considered for the development of the WV flood risk index at the scale of incorporated places. These indicators provide a comprehensive understanding of the flood risk each community faces. The combined scores for these risk indicators place **Clendenin** (ranked ***22nd***) among the ***top 10%*** incorporated places for floodplain characteristics. **Camden-On-Gauley** (ranked ***37th***), **Marlinton** (ranked ***40th***), and **Rainelle** (ranked ***43rd***) are among the ***top 20%*** incorporated places in this category (*Table 4*). Consequently, these communities are identified as being at "Very High" risk due to floodplain characteristics. This information is critical for prioritizing flood hazard mitigation efforts and allocating resources effectively to reduce flood risk and enhance community resilience. **Richwood** (ranked 70th) and **White Sulphur Springs** (ranked 87th) are classified in the "Relatively High" group for the floodplain characteristics.

Table 4 summarizes the indicators used to measure floodplain characteristics for the selected communities, as discussed in the chapter. The colors in the table represent the degree of risk for each indicator and the category index in the communities, ranging from "VERY HIGH" to "Very Low", as indicated in the legend. As shown in the table, **Clendenin** and **Camden-on-Gauley** are among the ***top 10%*** incorporated places for median flood depth, while **Marlinton** ranks in the ***top 20%*** for this indicator. Additionally, **Clendenin** is in the ***top 20%*** for the number of federally-declared flood disasters. **Marlinton** and **Rainelle** are in the ***top 20%*** incorporated places for the ratio of floodplain area within these communities.

Table 4. Category summary of floodplain characteristics for the selected communities

Incorporated Place	FLOODPLAIN CHARACTERISTICS					
	Floodplain Area Ratio	Floodplain Length Ratio	Flood Declared Disasters	Flood Depth Median	Category Score (0 to 100%)	Category Rank in Incorporated Places
Clendenin	24.1%	0.0039	24	**6.4**	**90.7%**	22
Camden-on-Gauley	16.4%	0.0069	17	**6.1**	84.2%	37
Marlinton	31.5%	0.0063	15	4.0	82.8%	40
Rainelle	31.2%	0.0052	18	2.1	81.5%	43
Richwood	23.1%	0.0046	18	1.8	69.7%	70
White Sulphur Springs	22.0%	0.0049	18	1.5	62.2%	87



BUILDING EXPOSURE

The building exposure category counts primary structures located in the high-risk Special Flood Hazard Area and Regulatory Floodway. It also measures building density by calculating the ratio of structures in high-risk flood zones to the total number of buildings or specific geographic areas. All buildings inventoried in these high-risk flood zones, or the 1% annual chance (100-year) floodplain, are verified as primary structures using various reference data sets, including tax parcel assessments, E-911 addresses, aerial imagery, building photos, and elevation certificates.

Building Floodplain Count / Ratio

A higher number of buildings in the floodplain indicates greater physical and human exposure to riverine flooding. More structures also correlate with higher debris totals and more displaced people during a major storm. If a building owner has a mortgage from a federally regulated lender and the property is in the Special Flood Hazard Area (SFHA), federal law requires the owner to carry flood insurance. The building count in the SFHA is a crucial variable for communities participating in FEMA's Community Rating System (CRS) program.

Primary insurable buildings have been inventoried for both the effective and advisory high-risk 1%-annual-chance (100-year) floodplains. To use as a flood risk indicator, structures that are no longer located within the high-risk flood zone of the advisory flood maps, known as mapped-out buildings, were excluded from the total floodplain counts.

Marlinton, ranked ***12th*** among all incorporated places, has a total building count of 371 in the effective and preliminary Special Flood Hazard Area (SFHA), followed by **Rainelle** (ranked ***14th***) with 336 floodplain buildings. **Clendenin** and **White Sulphur Springs** (ranked ***20th*** each have 302 primary structures in the high-risk floodplains, while **Richwood** (ranked ***22nd***) has 286. These five communities are among the ***top 10%*** incorporated places for this risk indicator. **Camden-on-Gauley** has only 21 buildings in the high-risk floodplain. Except for Camden-on-Gauley, all of these communities have building counts in the floodplain higher than the statewide average of 140 for all incorporated places. *Figure 56* displays the ranking of the five mentioned communities, classified as "Very High", among all incorporated places in the state.

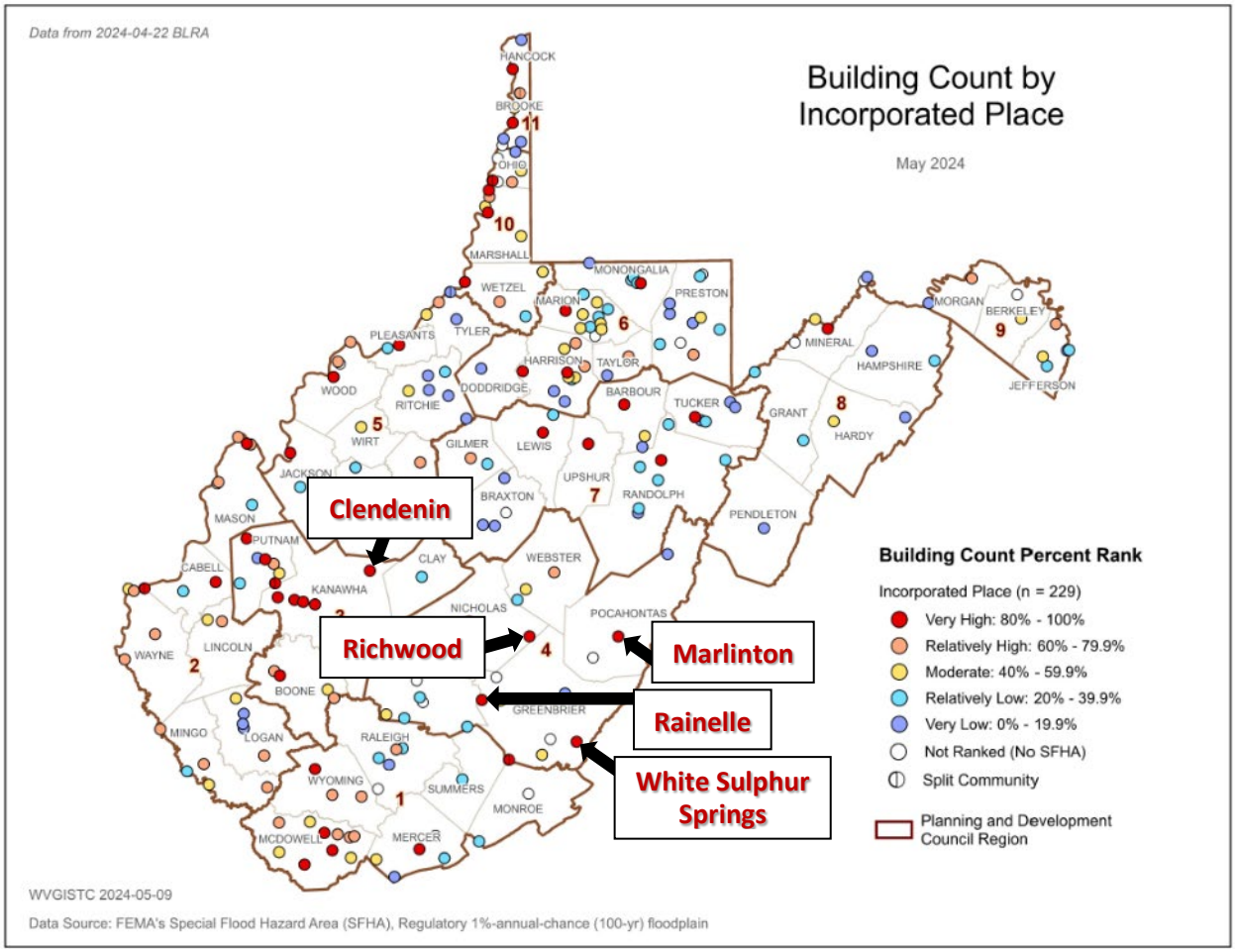


Figure 57. Marlinton, Rainelle, Clendenin, White Sulphur Springs, and Richwood on the map of building floodplain count ranks for incorporated places

Based on the count of buildings in the 1%-annual-chance (100-year) floodplains relative to the total number of structures in the communities, the percentage of flood-prone structures was calculated as the building floodplain ratio. The results show that 55.1% of all buildings in **Marlinton** are located in the high-risk floodplain, which gives this community the ***3rd*** rank among all incorporated places. This ratio is 52.5% for **Clendenin** (ranked ***6th***) and 33.7% for **Rainelle** (ranked ***19th***). These high ratios place these three communities among the ***top 10%*** of incorporated places for this risk indicator. In **Richwood**, 21.3% of the structures are in the high-risk floodplain, while this ratio is 19.6% for **Camden-on-Gauley** and 18.2% for **White Sulphur Springs**. All of these communities have floodplain building ratios higher than the statewide average of 15.5% for all incorporated places. *Figure 57* shows the ranking of all incorporated places in the state for building floodplain ratio. As seen on the map, Marlinton, Clendenin, and Rainelle are classified in the "Very High" group for this risk indicator.

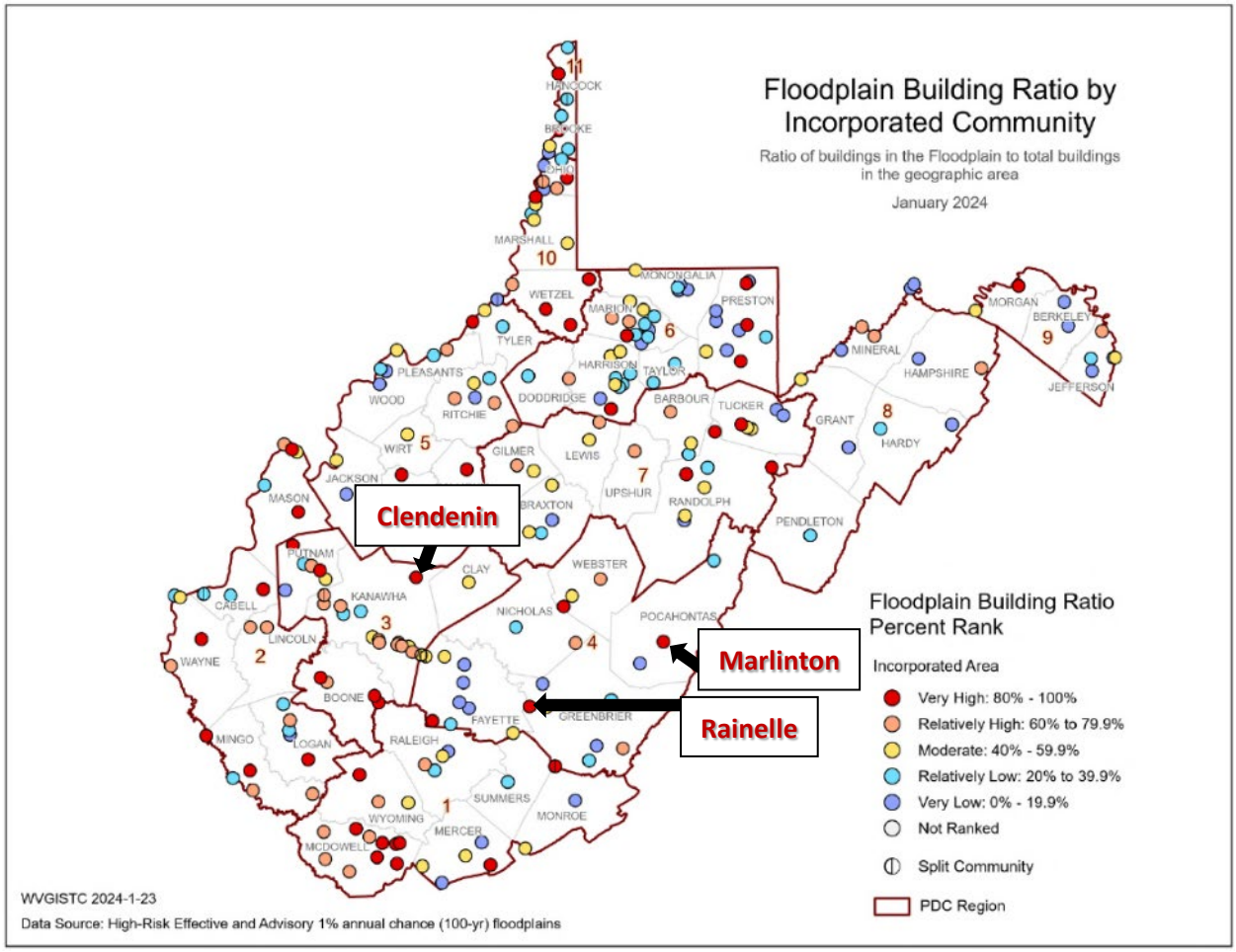


Figure 58. Marlinton, Clendenin, and Rainelle on the map of building floodplain ratio ranks for incorporated places

Communities with a high floodplain building count, such as Marlinton, Rainelle, Clendenin, White Sulphur Springs, and Richwood, should actively engage property owners about flood insurance and ways to minimize flood losses. For more information, see Floodsmart.gov. Additionally, these communities can enhance their flood resilience by exceeding the minimum National Flood Insurance Program (NFIP) requirements. Local communities can adopt higher building standards, such as increasing the freeboard of the base flood elevation or encouraging property owners to build to the higher 500-year flood elevation or historical high-water mark.

Floodplain managers and emergency planners should pre-load at-risk structures into substantial damage estimator software. Local officials should review early warning systems and identify short-term shelters located outside the floodplain and away from inundated roads. State and county leaders should prioritize pre-disaster planning for communities with numerous flood-prone buildings. It is worth noting that, according to an analysis by the National Institute of Building Sciences, natural hazard mitigation saves an average of $6 for every $1 spent on federal mitigation grants.

Building Floodway Count

High flood velocities and flood depths increase the risk of physical damage and loss of life. Buildings located in the main floodway channel of a river or stream, or close to the flood source, are exposed to the greatest flood depths, highest velocities, and most significant debris potential. Owners of structures in the floodway are required to purchase mandatory flood insurance for federally-backed loans. Additionally, development in floodways is restricted. Before a local permit can be issued for proposed development in the floodway, a 'No-Rise/No Impact' certification must be submitted by a professional engineer licensed in West Virginia to ensure that the proposed project will not increase flood levels.

Marlinton has 189 primary structures in the floodway, which is the highest number among all incorporated places statewide (***1st*** rank). **Richwood**, ranked ***3rd***, has 136 primary buildings in the floodway, while **White Sulphur Springs** (ranked ***7th***) has 105, and **Rainelle** (ranked ***18th***) has 47. These communities rank among the ***top 10%*** of incorporated places for this risk indicator. **Clendenin** has only four structures in the floodway, and **Camden-on-Gauley** has just two. **Marlinton**, **Richwood**, **White Sulphur Springs**, and **Rainelle** have building in floodway counts higher than the statewide average for all incorporated areas, which is 14. *Figure 58* displays the ranking of all incorporated places in the state for building count in floodway.

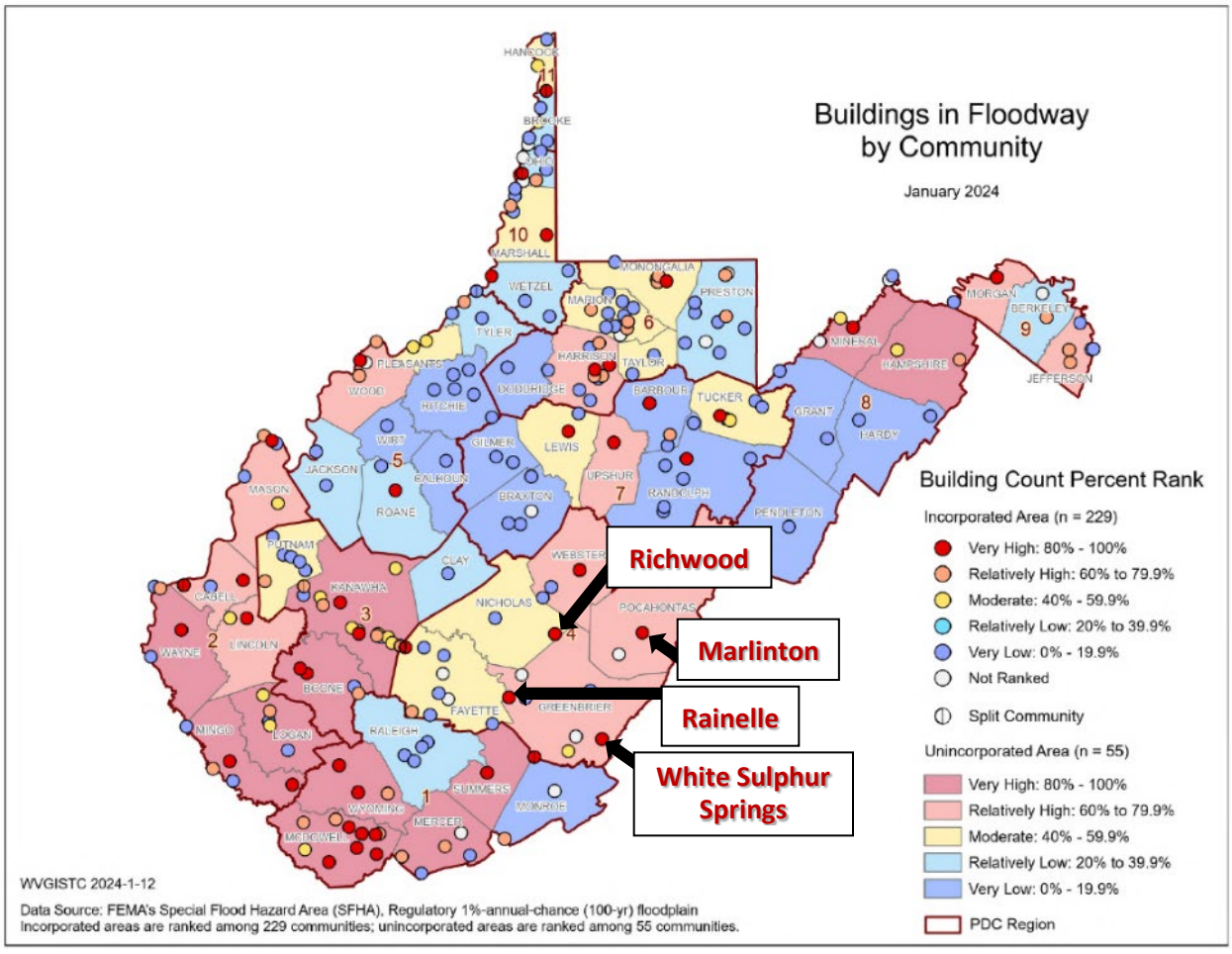


Figure 59. Marlinton, Richwood, White Sulphur Springs, and Rainelle on the map of building floodway count ranks for communities

Community floodplain management ordinances often recommend against constructing closed foundations or solid perimeter walls where flood velocities exceed 5 feet per second (source: Kershaw County, SC). Nonstructural mitigation measures are also not recommended where flood velocities exceed 6 feet per second or where debris impacts may occur (source: USACE). FEMA recommends open foundations (e.g., piers, posts, columns, pilings) for riverine Special Flood Hazard Areas (SFHAs) where flow velocities are expected to exceed 10 feet per second (source: FEMA). These recommendations apply to floodways, where flood depths, velocities, and debris potential are maximized

Table 5 represents the building count breakdown in the high-risk 1%-annual-chance (100-year) flood zones or SFHA of the studied communities. As seen in the table, the majority of the flood-prone structures in the studied communities are located in the effective detailed AE Zone and floodway.

Table 5. Building count breakdown in floodplains of the studies communities

Incorporated Place	Effective SFHA				Advisory SFHA	SFHA Total	Community Buildings Total	Building Floodplain Ratio
	Approximate A Zone	AE Zone	AE Floodway	Effective SFHA Total				
Camden-on-Gauley	4	15	2	21	0	21	107	19.6%
Clendenin	0	298	4	302	0	302	575	52.5%
Marlinton	68	71	189	328	43	371	673	55.1%
Rainelle	0	289	47	336	0	336	996	33.7%
Richwood	0	123	136	259	27	286	1,341	21.3%
White Sulphur Springs	0	197	105	302	0	302	1,657	18.2%

New / Future Map Conditions

Where advisory floodplains exist, the "mapped-in" structures (orange color primary structures on WV Flood Tool) represent buildings that most likely will be included in the SFHA when future FEMA Restudies are done and new FIRMs become effective. Non-regulatory advisory floodplains are generated from Preliminary/Draft Risk MAP studies or Advisory Flood Height studies. *Communities should review all "mapped-in" structures. Homeowners are at higher risk to flooding and should be contacted about Flood Insurance Preferred Risk Policies and other potential mitigation measures.* "Mapped-out" structures are primary buildings no longer located within the high-risk advisory flood zones. *Although the purchase of flood insurance is not required for such structures it is recommended that the owners maintain flood insurance coverage, since the risk of flooding has not been removed. If owners of the mapped-out structures do currently have flood insurance, they should not cancel their flood insurance before the new flood maps are officially adopted by the community. Moreover, if they have a federally-backed mortgage, they should never cancel their flood insurance before consulting the mortgage lender.*

The new FEMA maps became effective in Greenbrier County on July 5, 2023 and revealed that the towns of **Rainelle** and **White Sulphur Springs** had many structures mapped in the SFHA with the counts of 325 and 76, respectively. In Rainelle, 38 of these buildings were mapped into the new regulatory floodway. In White Sulphur Springs the number of buildings newly mapped in the floodway was 14; however, 40 other buildings which were previously located in the SFHA, but not in its floodway, were identified

within the floodway, according to the new maps (flood fringe to floodway). On the other hand, only one structure was mapped out in Rainelle while the number of mapped-out buildings in White Sulphur Springs was 118. Based on the revised maps of Kanawha County enforced on August 1, 2023, in **Clendenin**, 28 structures were mapped in the SFHA while three others were mapped out. Two structures in Clendenin were mapped from the SFHA to the regulatory floodway, according to these maps. In **Camden-on-Gauley**, two buildings previously located in the SFHA were mapped into the new regulatory floodway. Based on the advisory maps to be effective in the future, the number of mapped-in buildings in **Richwood** is 27 while this community has two structures to be mapped out. In **Marlinton**, 43 structures are mapped in the floodplain, while 29 other buildings are mapped out. Due to the expansion of the floodway in this community, 176 buildings currently within the Special Flood Hazard Area (SFHA) are mapped into the floodway.

Table 6. Summary of the new and future map conditions for the studied communities since 2023

Incorporated Place	Mapped-in			SFHA to New Floodway	Mapped-out	No Change SFHA	Final SFHA Count
	Mapped-in SFHA	Mapped-in Floodway	Mapped-in Total				
Camden-on-Gauley	0	0	0	2	0	19	21
Clendenin	28	0	28	2	3	272	302
Marlinton	43	0	43	176	29	152	371
Rainelle	287	38	325	0	1	11	336
Richwood	27	0	27	0	2	259	286
White Sulphur Springs	62	14	76	40	118	186	302

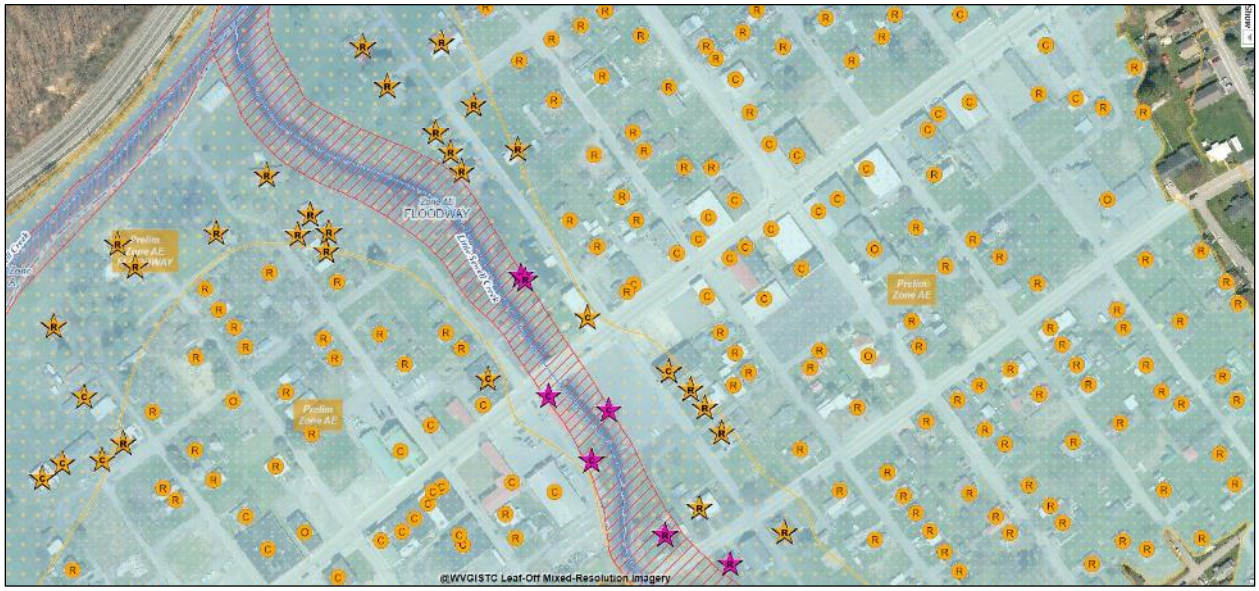


Figure 60. Mapped-in SFHA and mapped-in floodway structures in Rainelle (by the map of July 5, 2023)

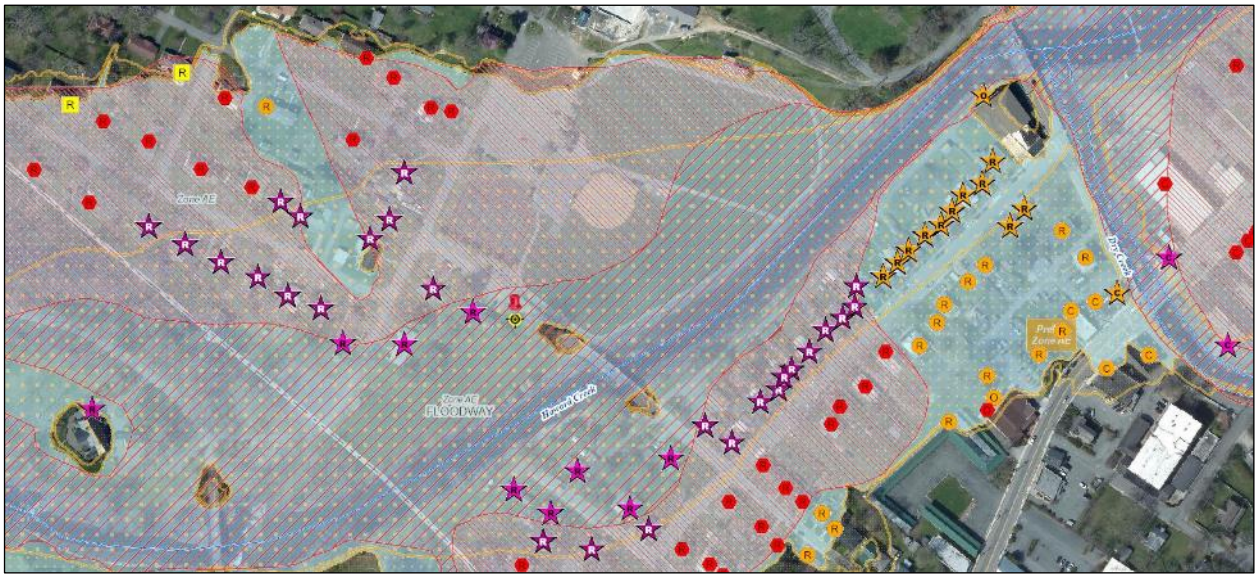


Figure 61. Mapped-in SFHA, mapped-in floodway, and flood fringe to floodway structures in White Sulphur Springs (by the map of July 5, 2023)

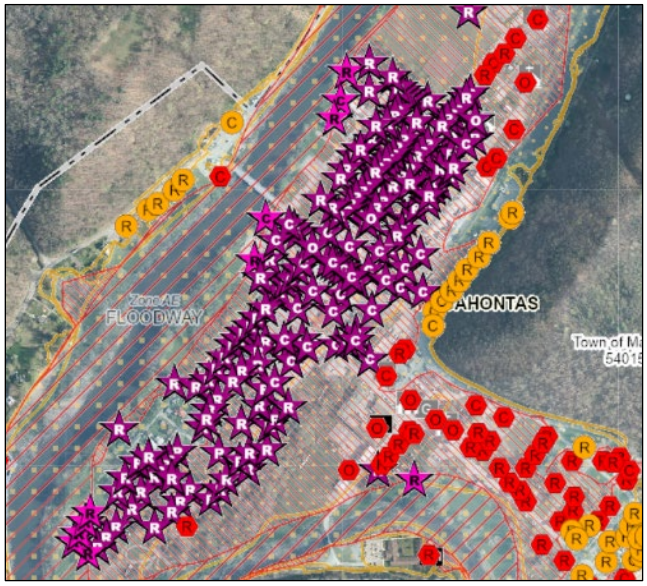


Figure 62. Mapped-in SFHA and flood fringe to floodway structures in Marlinton (Preliminary maps)

Legend:

- MAPPED OUT-Residential
- MAPPED OUT-COMMERCIAL
- MAPPED OUT-Other
- MAPPED IN-Residential
- MAPPED IN-Commercial
- MAPPED IN-Other
- MAPPED IN FLOODWAY-Residential
- MAPPED IN FLOODWAY-Commercial
- MAPPED IN FLOODWAY-Other
- FLOOD FRINGE TO FLOODWAY-Res.
- FLOOD FRINGE TO FLOODWAY-Com.
- FLOOD FRINGE TO FLOODWAY-Other
- FLOODWAY NO CHANGE-Residential
- FLOODWAY NO CHANGE-Commercial
- FLOODWAY NO CHANGE-Other
- NO CHANGE-Residential
- NO CHANGE-Commercial
- NO CHANGE-Other

Building Density

The floodplain building density was considered as another risk indicator. It refers to the number of buildings per acre of the high-risk 1%-annual-chance (100-year) floodplain area. Higher building densities indicate more intensive development within the floodplain, resulting in greater physical and human exposure to flooding, thereby increasing the risk.

The building density in the high-risk floodplain of **Rainelle** (ranked ***32nd***) is 1.5 buildings per acre, while it is 1.3 for **Clendenin** (ranked ***46th***). These two communities are among the ***top 20%*** of incorporated places for this risk indicator. The building density in the high-risk floodplain of **Richwood** is 1.2 buildings per acre, 1.1 in **White Sulphur Springs**, 0.8 in **Marlinton**, and 0.6 in **Camden-on-Gauley**. Except for Marlinton and Camden-on-Gauley, all the other communities have floodplain building densities higher than the statewide average of 0.9 per acre for all incorporated places.

Figure 62 displays the ranking of incorporated places based on floodplain building density, classified into five groups. As shown on the map, **Rainelle** and **Clendenin** are in the "Very High" group for this indicator. A reason for this can be that steep slopes, as shown in *Figure 63* and *Figure 64,* restrict development in these communities to the floodplain.

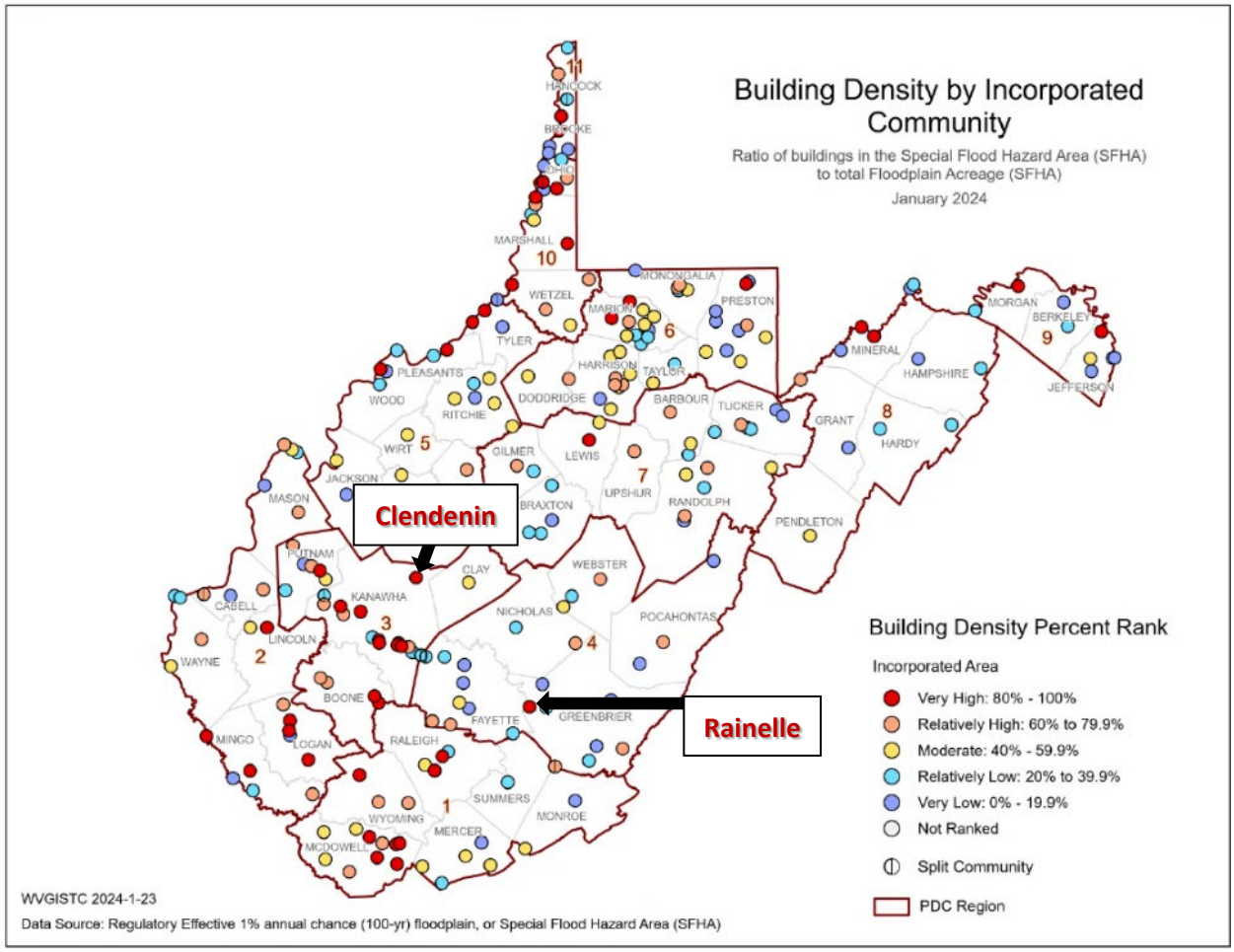


Figure 63. Rainelle and Clendenin on the map of building density ranks for incorporated places

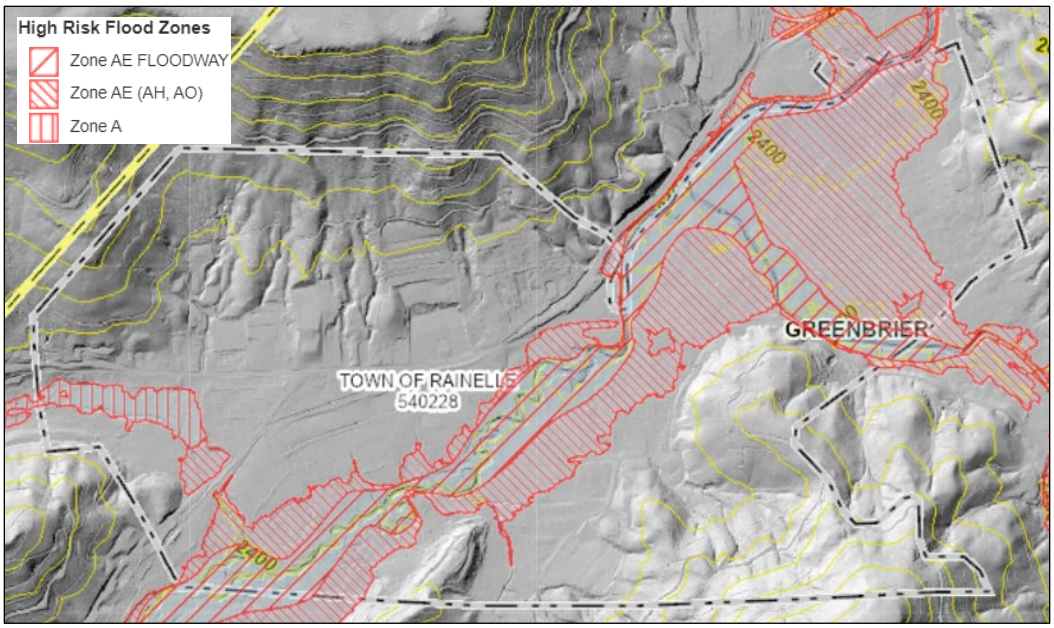


Figure 64. Steep slopes restricting development to the floodplain in Rainelle

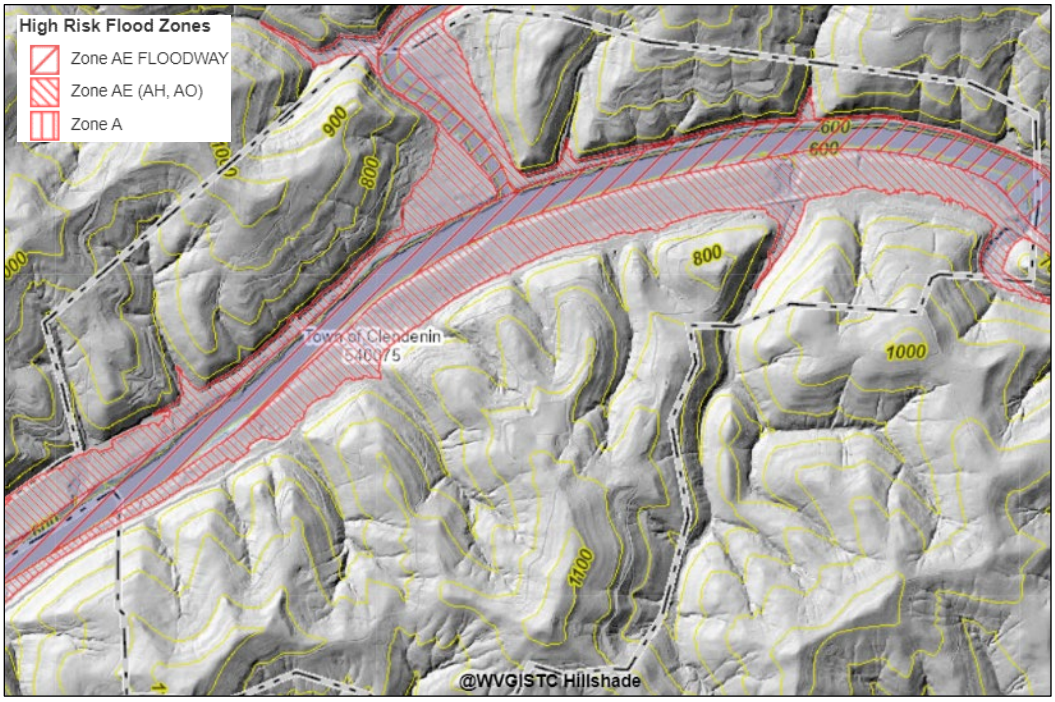


Figure 65. Steep slopes restricting development to the floodplain in Clendenin

Regulations to minimize development in the floodplain would be the ideal solution for high floodplain building density. In cases like Rainelle and Clendenin, where suitable land for development is limited, local officials should consider encouraging property owners to elevate primary structures and purchase flood insurance, exceeding the minimum National Flood Insurance Program (NFIP) community-level requirements, adopting higher building standards such as increasing the freeboard, and implementing early warning systems. Additionally, these communities should be prioritized in pre-disaster planning by state and county officials.

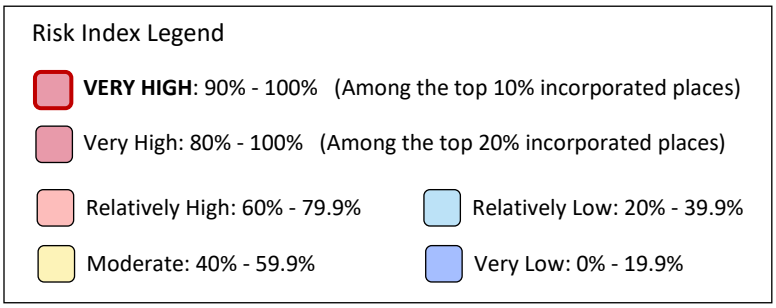
Category Index Scores and Summary for Building Exposure

Four indicators of Building Floodplain Count, Building Floodway Count, Building Floodplain Ratio, and Building Density, from the building exposure category, were considered for the development of the WV flood risk index. The combined scores for these risk indicators place **Rainelle** (ranked ***3rd***), **Marlinton** (ranked ***7th***), **Richwood** (ranked ***15th***), **Clendenin** (ranked ***18th***), and **White Sulphur Springs** (ranked ***21st***) among the ***top 10%*** incorporated places for building exposure. Consequently, these communities are identified as being at "VERY HIGH" risk due to building exposure. **Camden-On-Gauley** (ranked 94th) is classified under the "Moderate" group for this category. This information is critical for having a better understanding of the physical exposure in the high-risk floodplains to apply mitigation efforts more efficiently.

Table 7 summarizes the indicators used to measure building exposure for the selected communities, as discussed in the chapter. The colors in the table represent the degree of risk for each indicator and the category index in the communities, ranging from "VERY HIGH" to "Very Low", as indicated in the legend. As shown in the table, **Marlinton**, **Rainelle**, **Clendenin**, **White Sulphur Springs**, and **Richwood** are among the ***top 10%*** incorporated places for building count in the high-risk floodplain. **Marlinton**, **Richwood**, **White Sulphur Springs**, and **Rainelle** are in the ***top 10%*** for building count in floodway. **Marlinton** ranks 1st among all incorporated places statewide for the floodway count. In addition, **Marlinton**, **Clendenin**, and **Rainelle** are in the ***top 10%*** for the building floodplain ratio. For the building density in floodplain, **Rainelle** and **Clendenin** are among the ***top 20%*** incorporated places.

Table 7. Category summary of building exposure for the selected communities

Incorporated Place	BUILDING EXPOSURE					
	Building Floodplain Count	Building Floodway Count	Building Floodplain Ratio	Building Density	Category Score (0 to 100%)	Category Rank in Incorporated Places
Rainelle	**336**	**47**	**33.7%**	1.5	**99.1%**	3
Marlinton	**371**	**189 (1st Rank)**	**55.1%**	0.8	**97.3%**	7
Richwood	**286**	**136**	21.3%	1.2	**93.8%**	15
Clendenin	**302**	4	**52.5%**	1.3	**92.1%**	18
White Sulphur Springs	**302**	**105**	18.2%	1.1	**91.2%**	21
Camden-On-Gauley	21	2	19.6%	0.6	59.2%	94



BUILDING CHARACTERISTICS

This group of risk indicators relates to building characteristics, such as the median appraised value of all primary structures located in high-risk floodplains. It also includes building property factors that are more vulnerable to flood risk, such as the percentage of floodplain buildings that are manufactured homes, one-story structures, Pre-FIRM structures, or have subgrade basements. While building type and value are primarily determined using tax assessment data (including building value, occupancy class, foundation type, number of stories, construction year, and area), the Building-Level Risk Assessment (BLRA) database allows default tax assessment values to be replaced with more accurate, user-defined data from other sources. The building year, along with the date of the initial Flood Insurance Rate Map (FIRM), determines whether a structure is classified as Pre- or Post-FIRM. Another risk factor in this category is the percentage of minus-rated Post-FIRM structures, which may not have been properly mitigated in line with local floodplain management ordinances. It is important to note that all detailed building attributes in this category are collected for all primary structures within the Special Flood Hazard Area, or 1% annual chance (100-year) floodplain.

Building Median Value

The median building value quantifies the financial risk of potential flood damage to residential and commercial properties. Higher building values in floodplains can lead to increased insurance costs, which may motivate property owners to take proactive measures to protect their investments and reduce vulnerability. Buildings that are more expensive to repair typically result in greater losses and higher insurance premiums. Additionally, higher building values raise the substantial damage thresholds and increase the costs of mitigation and reconstruction.

As an indicator of the WV Flood Risk Index, the median appraised values of flood-prone structures from the most recent tax assessment data, or other data sources for tax-exempt structures, were calculated across various scales of analysis including the incorporated places. The median value of structures in floodplain is $53,950 in **White Sulphur Springs**, $49,000 in **Clendenin**, $38,500 in **Rainelle**, and $32,300 in **Marlinton**. In **Richwood**, the median value is $19,100, while in **Camden-On-Gauley**, it is $16,700. None of these communities are among the top 20% incorporated areas for this indicator. The following maps and images illustrate the distribution of building values and highlight the structures with the highest values located in the floodplains of these communities. **White Sulphur Springs** and **Clendenin** have median building values in the floodplain that are higher than the statewide median value of $41,500 for all incorporated places.

Communities should plan to keep new development outside high-risk floodplains. Implementing stricter zoning laws and land-use regulations can help prevent future construction in flood-prone areas, reducing flood risk. Additionally, they should consider acquisition and relocation projects, such as property buyouts, to lower building values in floodplains and decrease insurance and recovery costs. Purchasing flood insurance is essential to protect against damage and ensure a faster recovery. Below are some useful links about flood insurance:

- National Flood Insurance Program Risk Rating 2.0, Congressional Research Service, 2024
- Rate Explanation Guide FEMA, 2022
- Discount Explanation Guide, FEMA, 2022
- Flood Insurance Mitigation Discount Tool, FEMA, 2024

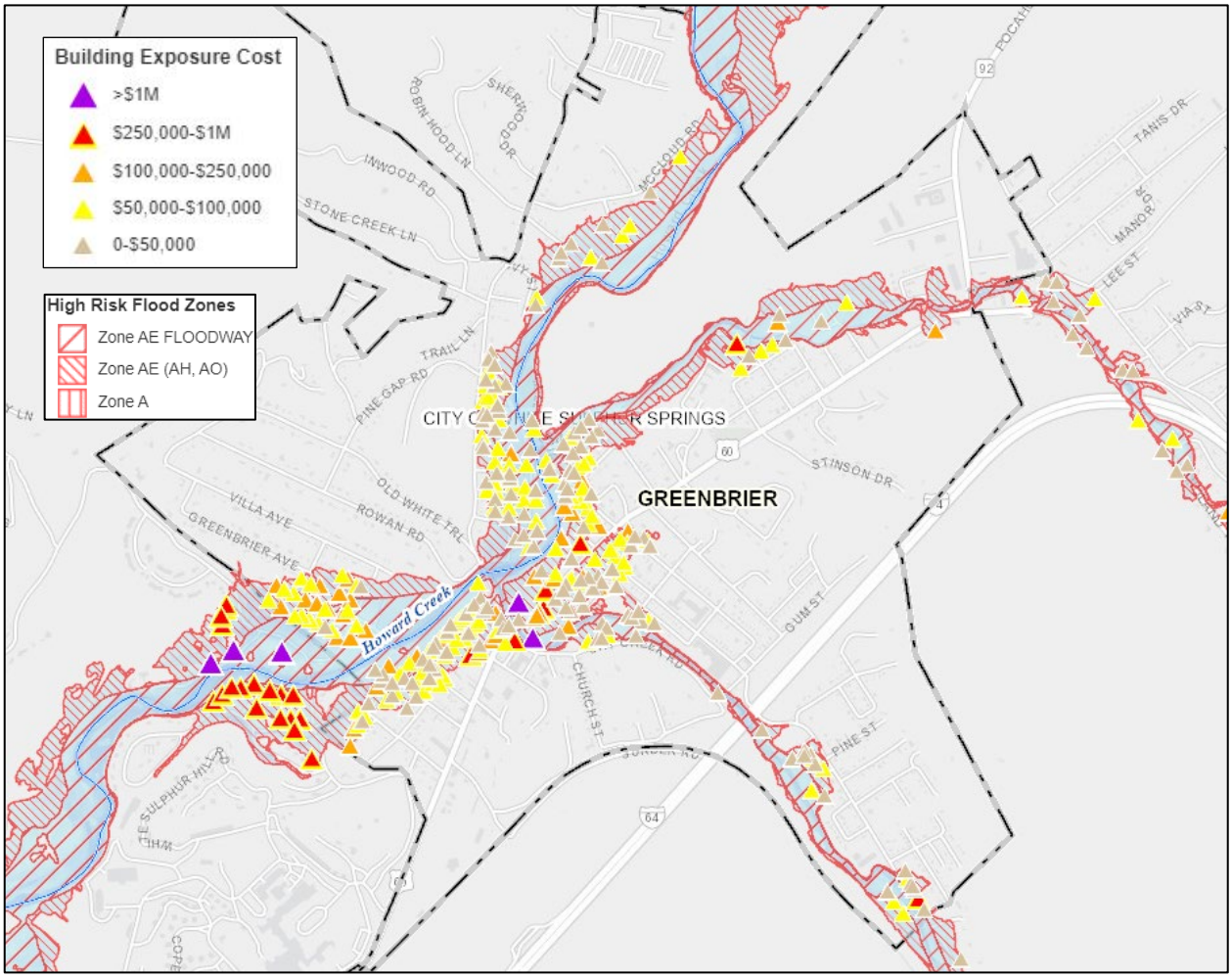


Figure 66. White Sulphur Springs' building dollar exposure viewable on the Risk MAP View of WV Flood Tool

Figure 67. Structure with the maximum value ($1.68M) in floodplain of White Sulphur Springs (Building ID: 13-17-0008-0186-0000_703)

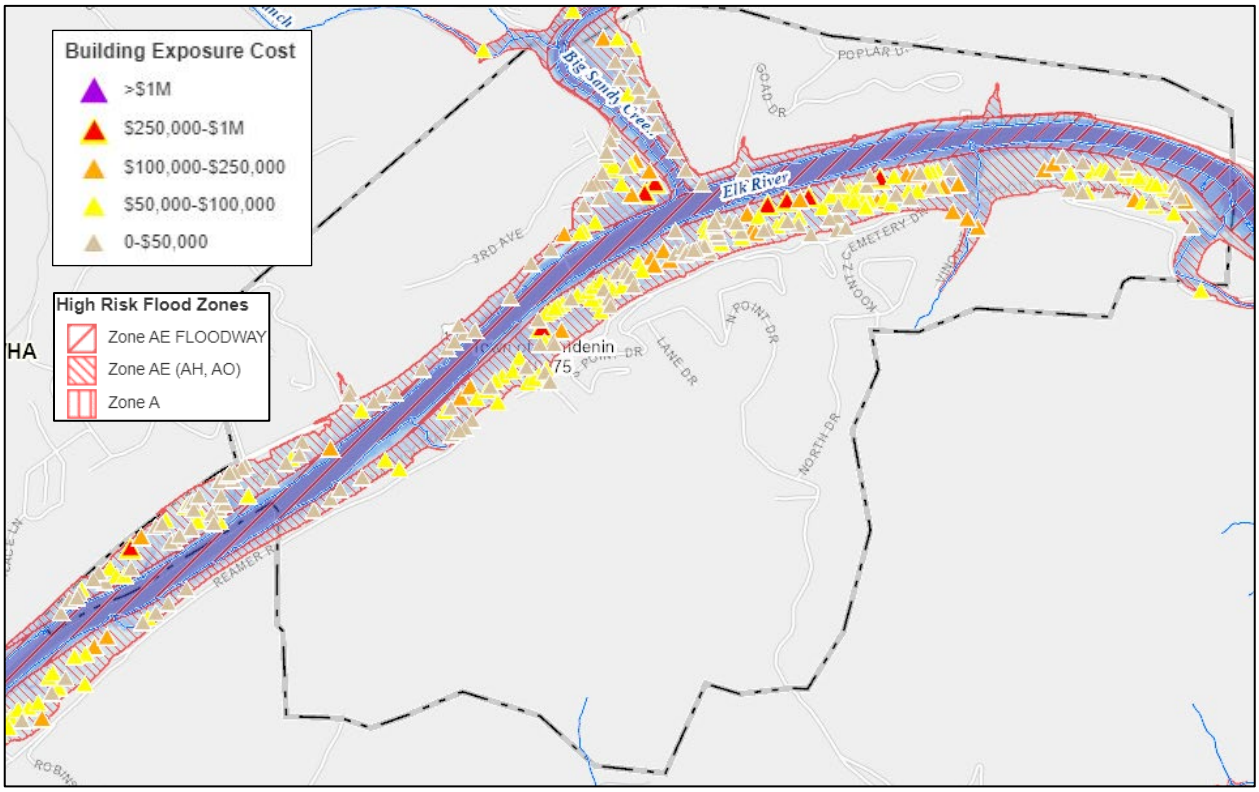


Figure 68. Clendenin's building dollar exposure viewable on the Risk MAP View of WV Flood Tool

Figure 69. Structure with the maximum value ($511K) in floodplain of Clendenin (Kanawha County Public Library, Clendenin Branch, Building ID: 20-02-0007-0004-0000_9999)

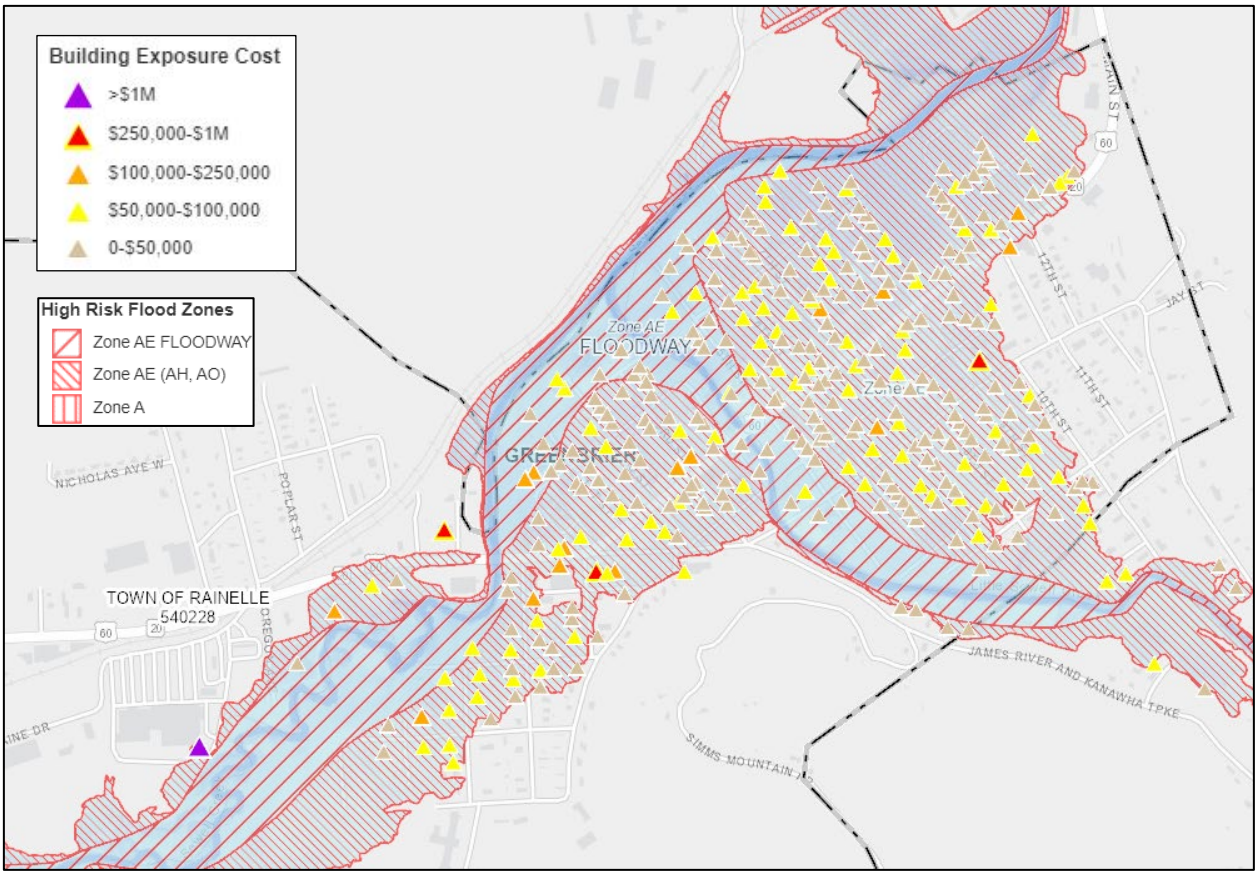


Figure 70. Rainelle's building dollar exposure viewable on the Risk MAP View of WV Flood Tool

Figure 71. Structure with the maximum value ($1.49M) in floodplain of Rainelle
(Building ID: 13-13-0004-0194-0000_506)

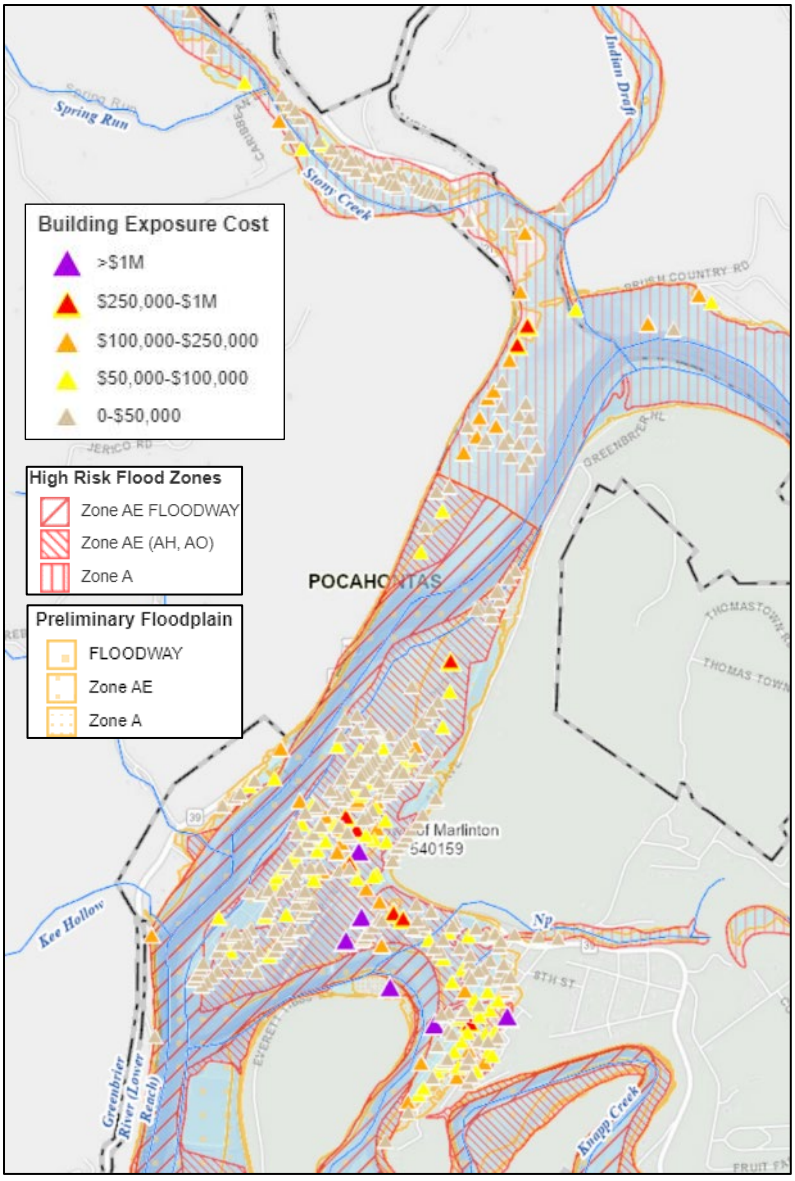


Figure 72. Marlinton's building dollar exposure viewable on the Risk MAP View of WV Flood Tool

Figure 73. Structure with the maximum value ($8.9M) in floodplain of Marlinton (Marlinton Water Plant, Building ID: 38-08-0005-0088-0000_1002)

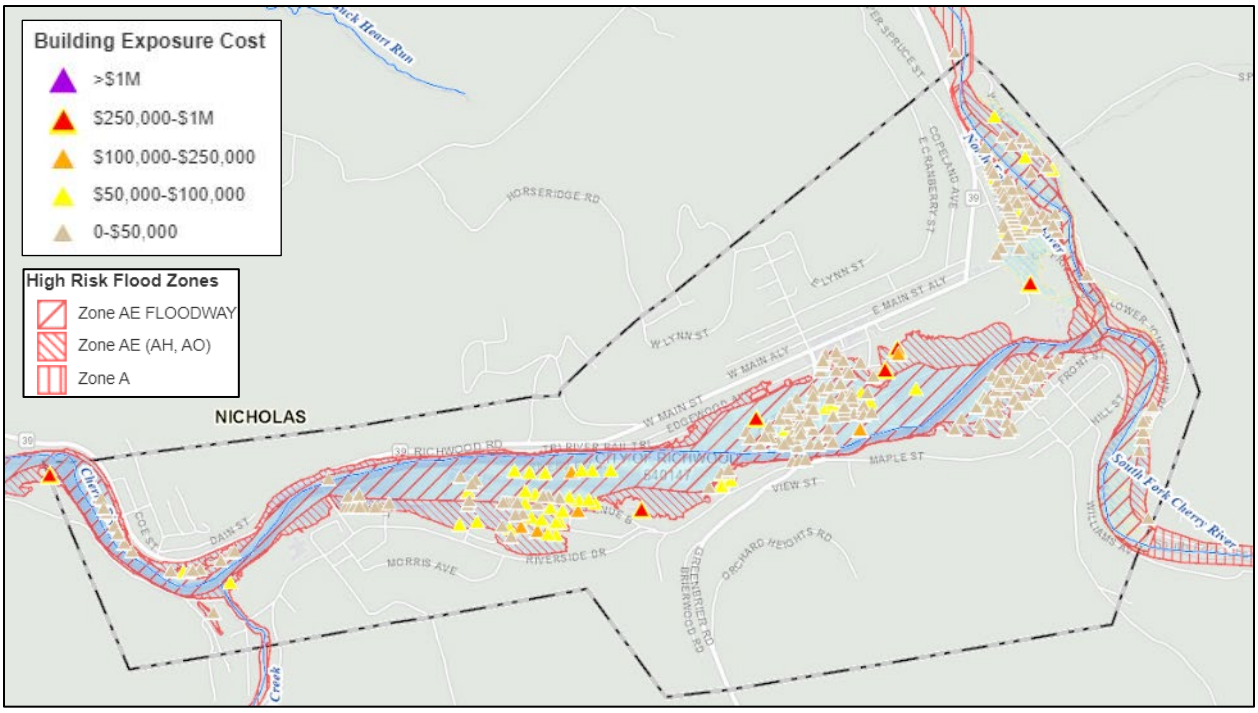


Figure 74. Richwood's building dollar exposure viewable on the Risk MAP View of WV Flood Tool

Figure 75. Structure with the maximum value ($880K) in floodplain of Richwood
(City of Richwood Wastewater Treatment Plant, Building ID: 34-05-0030-0014-0000_408)

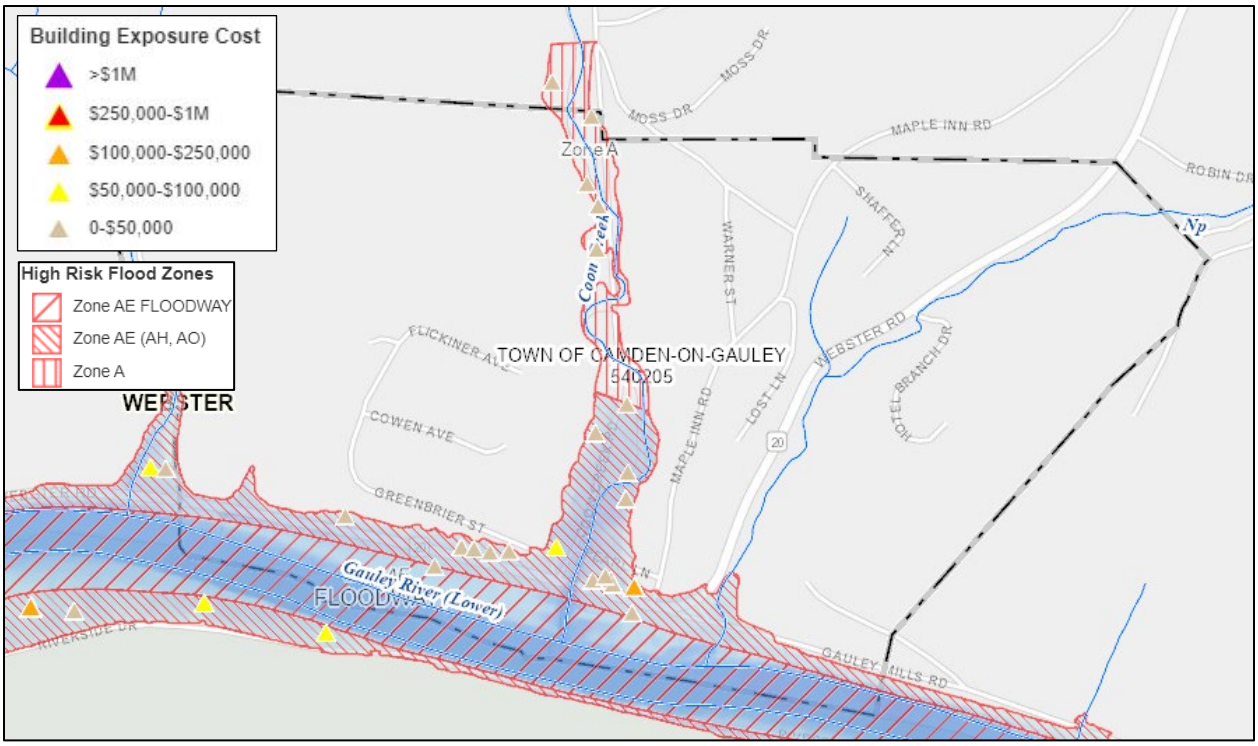


Figure 76. Camden-on-Gauley's building dollar exposure viewable on the Risk MAP View of WV Flood Tool

Figure 77. Structure with the maximum value ($145K) in floodplain of Camden-on-Gauley (Bethel Methodist Church, Building ID: 51-01-0003-0144-0000_9999)

Mobile Homes Ratio

Lightweight manufactured homes are particularly more susceptible to flooding compared to conventional dwellings. These structures are not designed to withstand extreme weather conditions or flooding. Mobile homes are commonly located in rural areas or less desirable urban districts and are more affordable for low-income families. Moreover, these homes are often situated in regions beyond the urban core, where access to major roadways and public transit systems may be limited. As a result, the concentration of such housing units can exacerbate both physical and social vulnerabilities. Mobile homes located in a floodway or the main channel of a stream, where flood velocity and depth are higher, are even more vulnerable. Communities with a higher prevalence of manufactured homes often encounter more obstacles in achieving resilience, as these structures typically do not offer the same level of security as traditionally constructed homes. Disaster recovery initiatives often fail to consider the distinct social and regulatory challenges confronting individuals residing in mobile homes. Following a flood, these residents often encounter difficulties when it comes to accessing federal and state aid, are at a higher risk of enduring prolonged recovery setbacks, and face a greater likelihood of enduring permanent displacement.

As an indicator for the WV Flood Risk Index, the percentage of manufactured buildings (occupancy code RES2) among all single-family residential structures (RES1 and RES2) in high-risk floodplains was analyzed. In **Camden-on-Gauley**, ranked ***39th***, with four mobile homes in the floodplain, this ratio is 30.8%, placing the community in the ***top 20%*** incorporated places for this indicator. **Richwood** has 39 at-risk manufactured homes, resulting in a ratio of 17.2%. **Marlinton**, with 23 flood-prone mobile homes, has a ratio of 8.1%, while **Clendenin**'s ratio is 6.4%, with 14 mobile homes. **Rainelle** also has 14 manufactured homes, representing 5.9% of its residential buildings in the floodplain. **White Sulphur Springs** has just two manufactured homes exposed to a 1%-annual-chance flood, making up 0.8% of its residential structures in the floodplain. The average statewide ratio of mobile homes for all incorporated places is 18.1%.

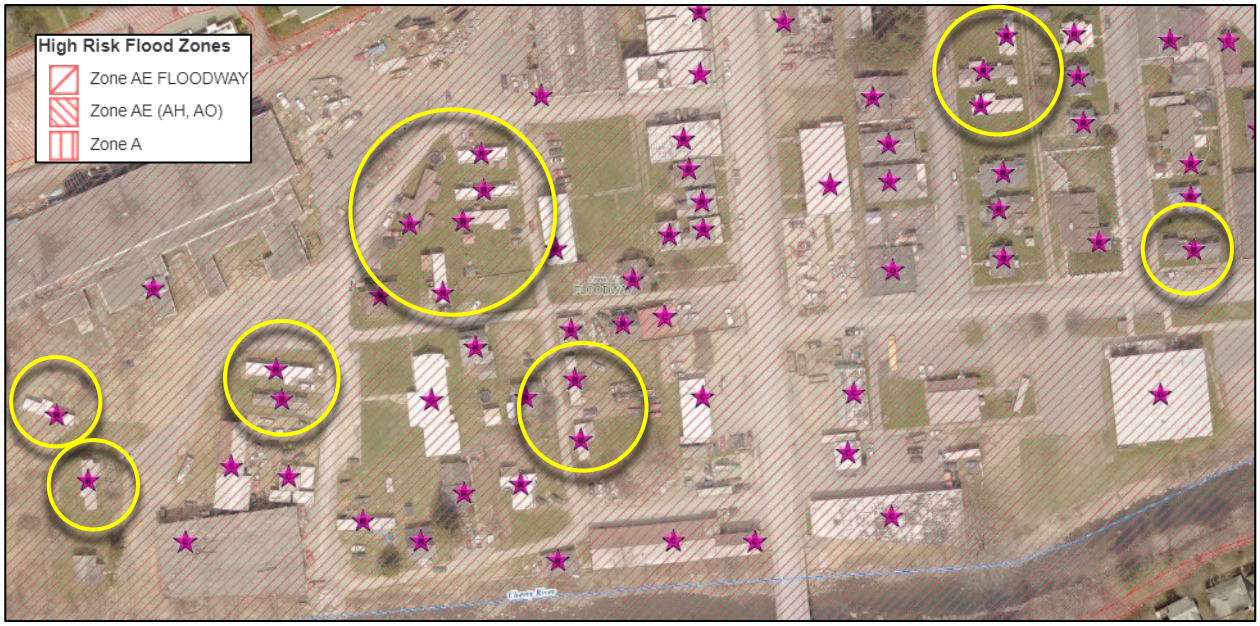


Figure 78. Mobile homes in floodway of the Cherry River in Richwood viewable on the Risk MAP View of WV Flood Tool

To mitigate risk, manufactured (mobile) homes should be prioritized for evacuation during floods. These structures must be elevated so that the lowest floor is above the Base Flood Elevation (BFE) for a 1% annual-chance event and anchored to a permanent foundation to resist flotation, collapse, or lateral movement. When elevating a manufactured home, it is crucial that all parts exposed to floodwaters are made of flood-resistant materials. Additionally, utility systems and mechanical equipment must be elevated to or above the BFE. Proper flood vents should also be installed to protect any enclosed areas below the lowest floor (Sources: FEMA and WV Emergency Management Division).

Subgrade Basements Ratio

Subgrade basements are particularly vulnerable to flooding, especially during flash floods, which can lead to structural damage, property loss, and increased recovery costs. Due to their below-ground location, basements face a heightened risk of flooding during heavy rainfall or rising water levels, particularly in areas with poor drainage or high water tables. Additionally, electrical equipment in basements can increase the risk of electrocution during flooding. The foundation type provides key insights into where flood risk is likely to start. For example, risk varies depending on whether a building's foundation is underground, at ground level, or elevated. As a result, foundation type is an important factor in determining a building's unique flood risk and corresponding insurance premiums.

Another risk indicator calculated is the percentage of primary structures with subgrade basements located in high-risk floodplains. A basement is defined as any part of a structure with a subgrade floor (below ground level) on all sides. The BLRA used in this study relies on tax assessment data, which does not distinguish between subgrade basements and walkout basement enclosures. To ensure accurate identification of foundation types and prevent overestimating flood vulnerability and potential damage, elevation certificates and building photos should be used for verification.

In **Clendenin**, 105 at-risk primary buildings have basements, accounting for 34.8% of the exposed structures. **Marlinton** has 93 primary structures with subgrade basements in the floodplain, representing 23.3% of the flood exposure. In **White Sulphur Springs**, 56 structures with basements are located in the 1%-annual-chance floodplain, making up 18.5% of the exposed buildings. **Richwood** has 33 structures with basements in high-risk flood zones (11.5%), while **Rainelle** has 23 (6.8%), and **Camden-on-Gauley** has 3 (14.3%). None of these communities are among the top 20% of incorporated places for this indicator. However, **Clendenin** and **Marlinton** have subgrade basement ratios higher than the statewide average for all incorporated places, which is 23.0%.

Basements below the Base Flood Elevation (BFE) are not permitted in new developments, and flood insurance coverage for existing basements is very limited, for good reason. Just an inch of water over the sill can cause the entire basement to flood. Excavating a basement into fill does not always ensure safety, as saturated groundwater can still damage the walls (Source: WV Emergency Management Division). For existing basements, filling them in, if feasible, can be an effective mitigation effort. Constructing berms and barriers, only with required permits, can help water slope away from basements. Electrical components, mechanicals, and appliances in floodplain basements should be elevate to at least one foot above the base flood elevation. When elevating is not an option, barrier walls and waterproofing can be considered to protect such equipment from serious damage. Installing sump pumps and backflow valves can help mitigate basement flooding with a relatively lower cost. Overhead sewer systems can be used to prevent sewer backup while flooding in basements (Source: FEMA). Residents or first respondents should never enter a flooded basement unless they are certain the power

has been turned off, as the water level may be above electrical outlets or there could be submerged electrical cords. They must also be alert for gas leaks and use a flashlight to inspect for damage. Smoking, using candles, lanterns, or open flames should be avoided unless they are sure the gas has been turned off and the area is properly ventilated (Source: City of Ann Arbor, Flood Safety).

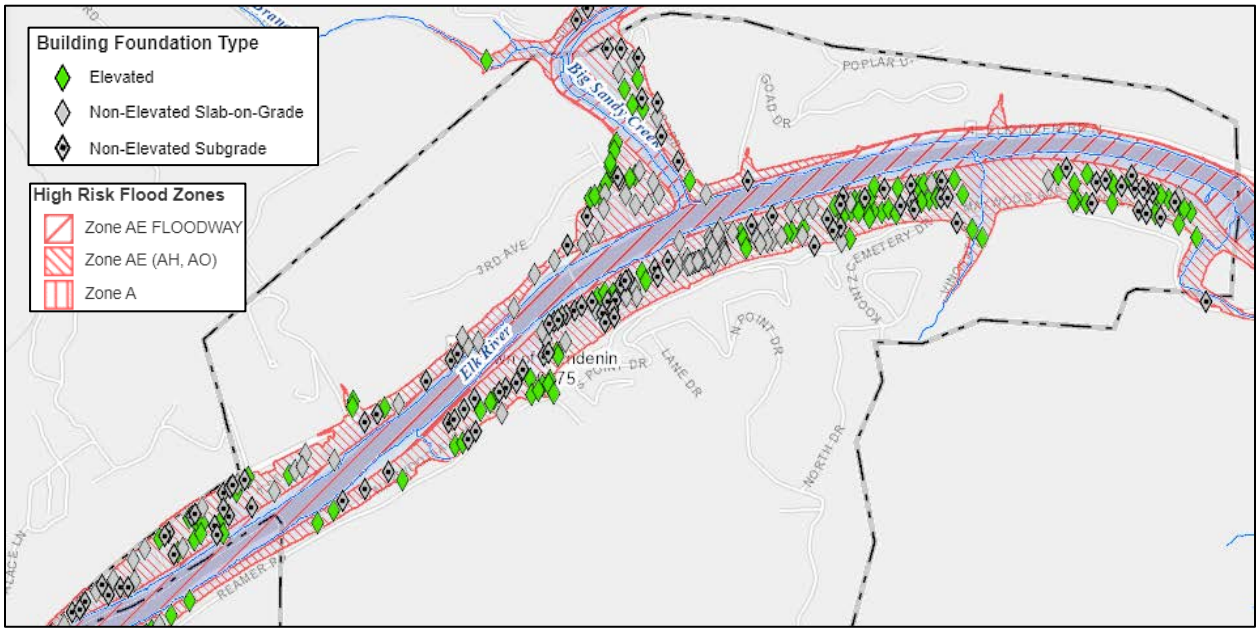


Figure 79. Building foundation types in floodplain of Clendenin viewable on the Risk MAP View of WV Flood Tool

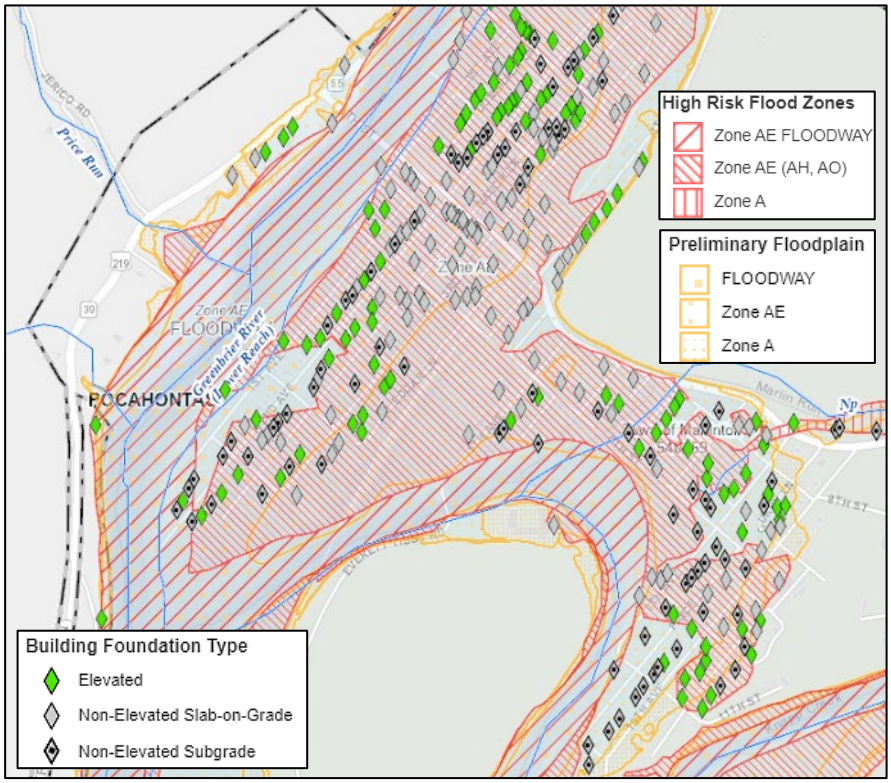


Figure 80. Building foundation types in floodplain of Marlinton viewable on the Risk MAP View of WV Flood Tool

One-Story Buildings Ratio

One-story buildings are more vulnerable to flooding compared to multi-story structures. During a flood event, occupants of one-story buildings have limited options for seeking higher elevations within their places. Also, they may face challenges during flood evacuation and emergency sheltering, especially for flash floods. Therefore, such structures may potentially cause higher human loss. Additionally, because the entirety of a one-story building is typically exposed to floodwaters, the ratio of flood damage to replacement cost is often higher for such structures. Buildings with more floors spread their risk over a higher area. Consequently, the number of stories is a factor in determining a building's unique flood risk and associated premium.

As a risk indicator of building characteristics, the percentage of one-story structures among all primary buildings in the high-risk floodplain was considered. The findings show that 291 one-story buildings exist in the high-risk floodplain of **Rainelle** which accounts for 86.6% of the building exposure. In **White Sulphur Springs**, there are 237 single-story structures in the floodplain representing 78.5% of the total at-risk buildings in the city. In **Clendenin**, 75.5% of the buildings within the 1%-annual-chance floodplain, totaling 228 structures, are one-story. In **Richwood**, 74.0% of the buildings within the floodplain, represented by a count of 213, are one-story. In **Camden-on-Gauley**, the percentage of single-story buildings within the floodplain is 66.7% with a total count of 14 such structures while the ratio in **Marlinton** is 55.0% with 220 one-story buildings in floodplain. The average statewide ratio of one-story buildings among all buildings located in the high-risk floodplains of the incorporated places is 75.3%. Although none of the above communities are among the top 20% incorporated places for this indicator, **Rainelle**, **White Sulphur Springs**, and **Clendenin** have the percentages exceeding the statewide ratio.

Occupants of one-story buildings should be informed about the increased flood risk associated with their structures to be more vigilant. These buildings should be prioritized in evacuation action plans, with occupants evacuated before inundation begins at their structures and access roads to their places. Providing early warning systems and clear evacuation routes can help ensure the safety of these residents.

Building Year, Pre-FIRM Ratio

Building year can show if a structure was constructed prior to or after the Flood Insurance Rate Map (FIRM) date when the initial flood maps became effective and floodplain development standards were adopted by the community. Pre-FIRM structures are more vulnerable to flooding because they were built before the initial FIRM date and thus were not constructed according to the regulations and building codes for floodplain development. Additionally, many Pre-FIRM buildings are unwisely located, repeatedly flooded, and account for a significant portion of flood insurance claims (Source: WV Conservation Agency).

As an indicator for the WV Flood Risk Index, the percentage of Pre-FIRM buildings in the high-risk floodplain was calculated. A Pre-FIRM building, for floodplain management purposes, is defined as: (1) a building constructed before December 31, 1974; (2) a building constructed before the effective date of the initial Flood Insurance Rate Map (FIRM); or (3) a newly mapped Post-FIRM structure included in an expanded Special Flood Hazard Area due to a restudy (Post-FIRM regulated to Pre-FIRM). In addition, structures with unknown building year and FIRM status were also included in this category.

According to the results, **Rainelle** has 332 flood-prone structures classified as Pre-FIRM, accounting for 98.8% of the community's building exposure. This ratio ranks Rainelle ***6th*** among the ***top 10%*** of incorporated places. **Camden-on-Gauley** (ranked ***25th***) is also in the ***top 20%*** for Pre-FIRM ratios, with 20 (95.3%) structures in the high-risk floodplain identified as Pre-FIRM. **Richwood** has 266 Pre-FIRM buildings, representing 92.3% of its floodplain structures. In **White Sulphur Springs**, 274 Pre-FIRM structures account for 90.7% of buildings in the high-risk floodplain. **Marlinton** has 357 Pre-FIRM buildings, making up 89.4% of its 1%-annual-chance floodplain, while **Clendenin** has 255 Pre-FIRM structures, comprising 84.5% of its floodplain buildings. All of these communities have Pre-FIRM ratios higher than the statewide average of 82.1% for all incorporated places.

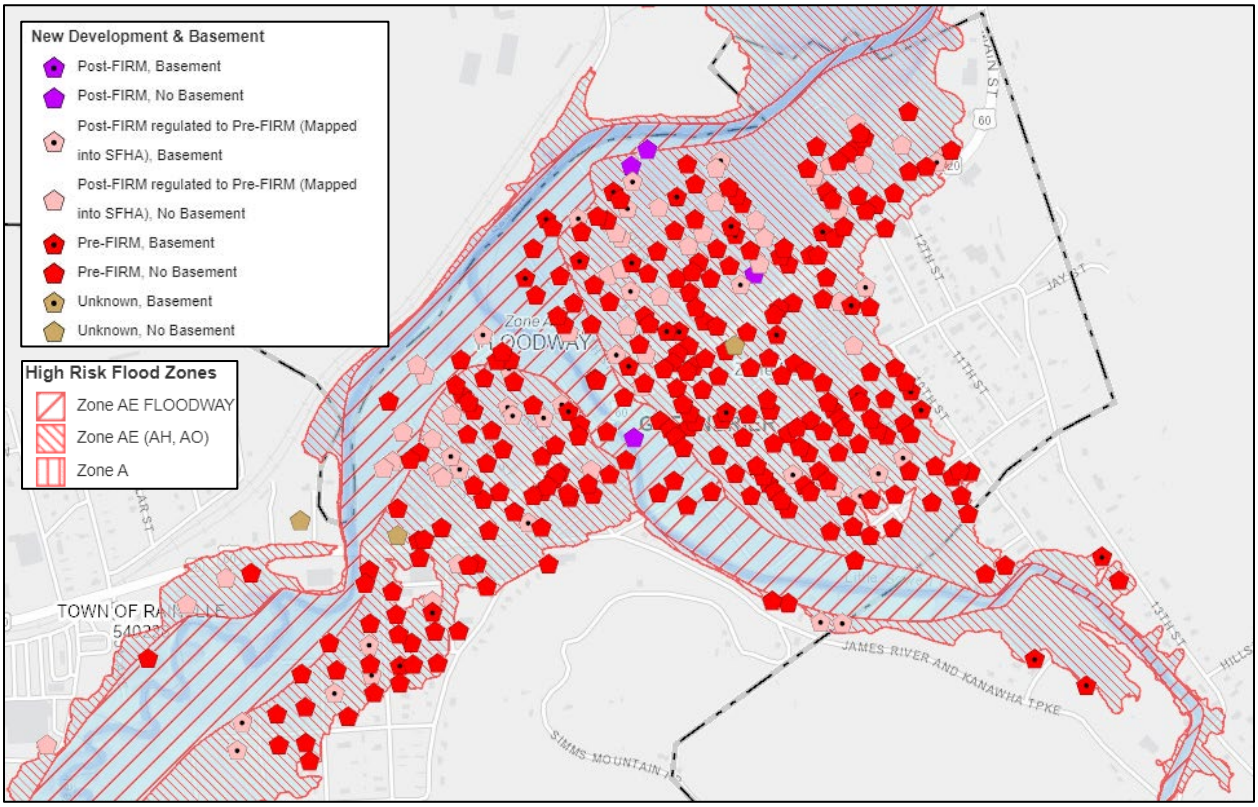


Figure 81. FIRM status and basements in floodplain of Rainelle viewable on the Risk MAP View of WV Flood Tool

The inventory of pre-FIRM floodplain structures will continue to be at risk of flooding unless deliberate actions are taken to reduce their losses (Source: WV Conservation Agency). Flood insurance can serve as a mitigation effort for pre-FIRM structures. Such buildings can be insured using "subsidized" rates. These rates are designed to help people afford flood insurance even though their buildings were not built with flood protection in mind (Source: FEMA).

Building Year, Minus Rated Post-FIRM Ratio

For insurance rating purposes, a Post-FIRM building is one that was constructed or substantially improved after December 31, 1974, or after the effective date of the initial Flood Insurance Rate Map (FIRM) of a community, whichever is later. A Post-FIRM building is required to meet the National Flood Insurance Program's minimum Regular Program flood protection standards and is expected to be constructed in accordance with regulations and building codes for floodplain development. For building

level risk assessments, the Post-FIRM building identified from the Building Year of the assessment records. The Pre-FIRM or Post-FIRM category is displayed in the Flood Risk Assessment Tab of the WV Flood Tool. Buildings rated as more than one foot below the Base Flood Elevation (BFE), known as Minus Rated, are at a higher risk for flooding. Some Minus Rated policies may not be eligible for CRS premium discounts. Knowing the ratio of Minus Rated Post-FIRM buildings can inform risk assessments and emergency planning about the unexpected higher risk at such Post-FIRM structures.

Based on the rationale above, the ratio of Minus Rated Post-FIRM structures among primary buildings in the high-risk floodplain was calculated and used as a risk indicator. The results show that **Clendenin** has 33 Minus Rated Post-FIRM structures in the high-risk floodplain, accounting for 10.9% of its building exposure. This ranks Clendenin ***27th***, placing it in the ***top 20%*** of incorporated places statewide. **Marlinton** has 23 such structures, representing 6.2% of its floodplain buildings, while **White Sulphur Springs** has three (1.0%), **Richwood** has two (0.7%), and **Rainelle** has one (0.3%). **Camden-On-Gauley** has no Minus Rated Post-FIRM structures (0.0%). **Clendenin** and **Marlinton** have Minus Rated Post-FIRM ratios that exceed the statewide average of 4.8% for all incorporated areas.

Figure 81 shows **Clendenin** ranked in the "Very High" group of incorporated places based on the Minus Rated Post-FIRM ratio. *Figure 82* illustrates the distribution of Minus Rated structures within this community.

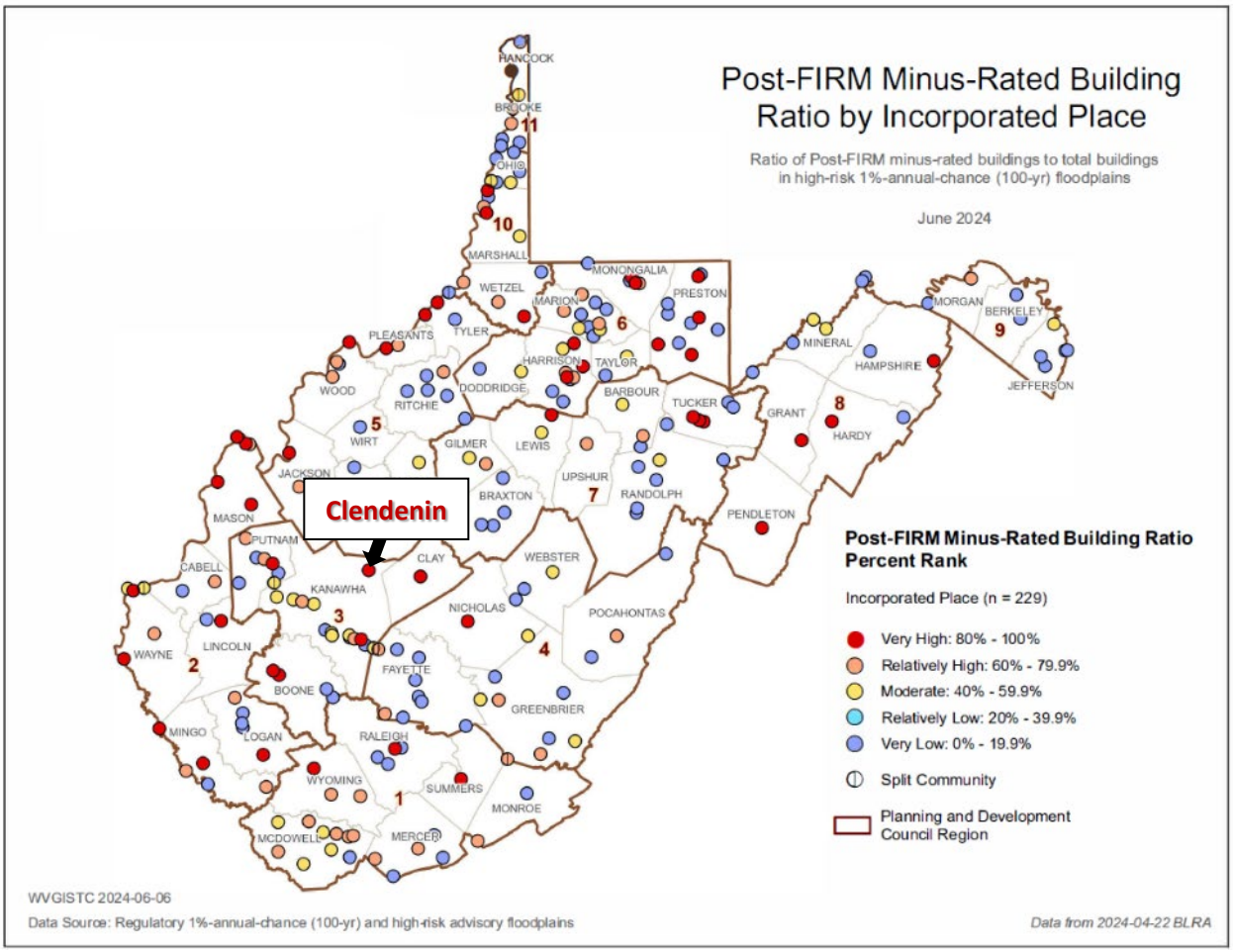


Figure 82. Clendenin on the map of Minus Rated Post-FIRM ratio ranks for incorporated places

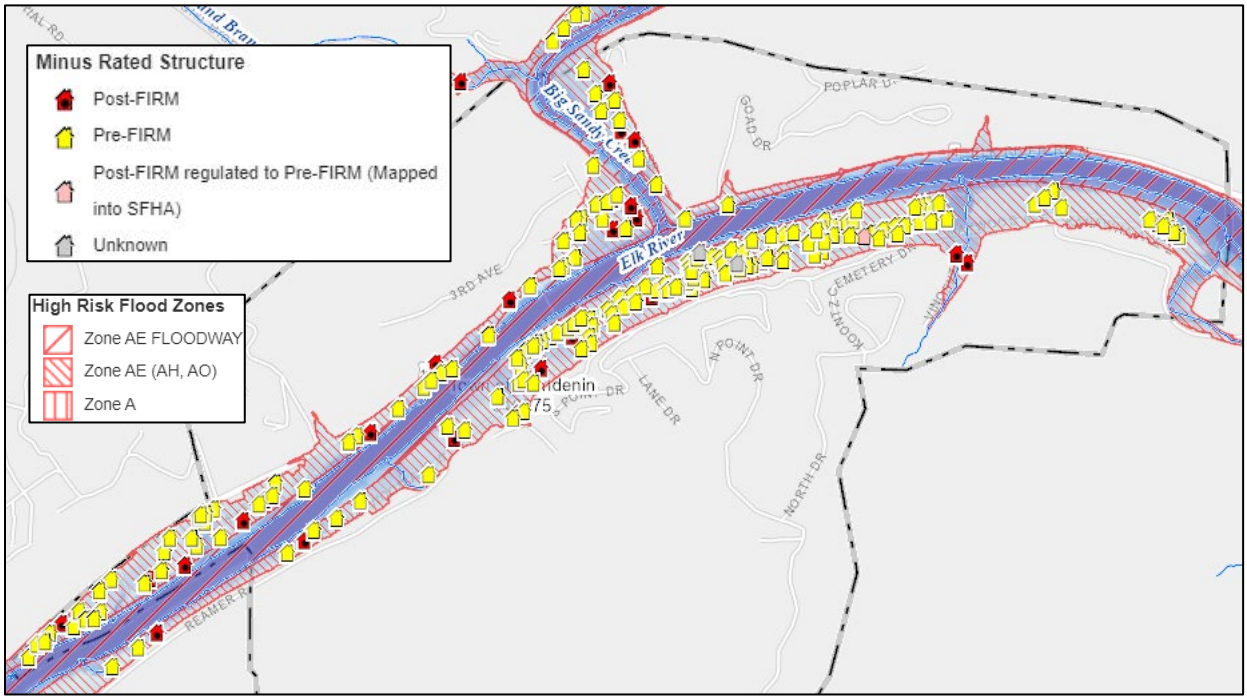


Figure 83. Post-FIRM and Pre-FIRM Minus Rated structures in Clendenin viewable on the Risk MAP View of WV Flood Tool

Figure 84. Post-FIRM building (1984) with the highest depth in structure (8.6 ft) in Clendenin,
(Building ID: 20-02-0002-0085-0000_8657)

Floodplain management is a community-based effort to prevent or reduce the risk of flooding, resulting in a more resilient community. According to FEMA, structures built to meet or exceed NFIP minimum floodplain management standards incur a minimum 65% less flood damage on average. Through the local adoption and enforcement of the NFIP's minimum land use and development standards, NFIP Compliance saves individuals, their homes, and livelihoods; and saves communities, their tax base, local economy, and livability. While investigating Minus Rated Post-FIRM structures, historical FIRM maps should be considered to check if these structures were in the Special Flood Hazard Area (SFHA) when they were constructed. Mitigating the risk at minus-rated structures will save money from floodplain management. Owners of such buildings should be educated about the risks and encourage participation in flood insurance programs and mitigation initiatives. Grants or low-interest loans should be offered to owners of such Post-FIRM structures for retrofitting their buildings with flood mitigation measures. Mitigation actions for minus rated structures also include retrofitting with proper flood openings, eliminating below-grade crawl spaces, elevating HVAC systems, and other measures.

Category Index Scores and Summary for Building Characteristics

As discussed in the chapter, six indicators were considered in the building characteristics category for the development of the WV Flood Risk Index: Building Median Value, Mobile Homes Ratio, Subgrade Basements Ratio, One-Story Buildings Ratio, Pre-FIRM Ratio, and Minus Rated Post-FIRM Ratio. None of the studied communities for this report ranked within the top 20% for the combined scores of these risk indicators. **Clendenin** (ranked 50th) falls into the "Relatively High" risk group for this category, while **Rainelle** (ranked 123rd), **White Sulphur Springs** (ranked 127th), and **Marlinton** (ranked 132nd) are classified as "Moderate" risk. **Richwood** (ranked 148th) and **Camden-On-Gauley** (ranked 165th) are in the "Relatively Low" risk group for building characteristics.

Table 8 summarizes the indicators used to assess building characteristics for the selected communities. The table's colors indicate the degree of risk for each indicator and the overall category index in the communities, with a range from "VERY HIGH" to "Very Low," as explained in the legend. As highlighted in the table, **Rainelle** ranks among the ***top 10%*** of incorporated places for the Pre-FIRM ratio, while **Clendenin** is within the ***top 20%*** for the Minus Rated Post-FIRM ratio, and **Camden-On-Gauley** is in the ***top 20%*** for the mobile homes and Pre-FIRM ratios.

Table 8. Category summary of building characteristics for the selected communities

Incorporated Place	BUILDING CHARACTERISTICS							
	Building Median Value	Bldg. Mobile Homes Ratio	Bldg. Subgrade Basements Ratio	Building 1-Story Ratio	Bldg. Year Pre-FIRM Ratio	Bldg. Year Minus Rated Post-FIRM Ratio	Category Score (0 to 100%)	Category Rank in Incorporated Places
Clendenin	$49,000	6.4%	34.8%	75.5%	84.5%	10.9%	78.5%	50
Rainelle	$38,500	5.9%	6.8%	86.6%	**98.8%**	0.3%	46.0%	123
White Sulphur Springs	$53,950	0.8%	18.5%	78.5%	90.7%	1.0%	44.2%	127
Marlinton	$32,300	8.1%	23.3%	55.0%	89.4%	6.2%	42.5%	132
Richwood	$19,100	17.2%	11.5%	74.0%	92.3%	0.7%	35.5%	148
Camden-On-Gauley	$16,700	30.8%	14.3%	66.7%	95.3%	0.0%	28.0%	165

Risk Index Legend

VERY HIGH: 90% - 100% (Among the top 10% incorporated places)

Very High: 80% - 100% (Among the top 20% incorporated places)

Relatively High: 60% - 79.9%

Relatively Low: 20% - 39.9%

Moderate: 40% - 59.9%

Very Low: 0% - 19.9%

CRITICAL INFRASTRUCTURE

This category includes risk indicators for essential facilities and roadways, both of which are community lifelines that support the ongoing operations of critical businesses and government functions during and after a disaster.

Essential Facilities

Essential facilities provide critical services to the community and include police and fire stations, E-911 emergency operations centers, schools, hospitals, and nursing homes. FEMA identifies these critical facilities as essential in its Hazus-MH risk assessment tool. Fire and police departments, along with E-911 centers, must remain operational during natural disasters. Hospitals and nursing homes are particularly vulnerable due to immobile patients, and schools, often serving as refuges during floods, *also require special attention due to the heightened vulnerability of children during such events.*

Communities need to establish emergency protocols to maintain critical services during a flood, prioritizing the protection and operational continuity of essential facilities located in floodplains. These facilities must be safeguarded with enhanced flood protection measures to ensure they remain functional during and following a flood. In the long term, communities should plan for the relocation of these critical facilities out of flood-prone areas. According to Executive Order 11988 on Floodplain Management, federal agencies that fund or permit critical facilities are required to avoid the 0.2%-annual-chance (500-year) floodplain. If relocation is not possible, these facilities should be protected to the 500-year flood level to ensure they continue providing services after a flood event. Essential facilities mapped to higher flood depths will most likely be subject to greater flood damage. Communities should identify socio-economic effects if these facilities are not restored to original function within days after flood event.

As another risk indicator for the WV Flood Risk Index, the number of essential facilities located within high, moderate, or reduced-risk flood zones was analyzed. In addition to the Building-Level Risk Assessment (BLRA), data form other sources such as Emergency Management Division, Department of Education, USA Reference, and Department of Transportation were considered.

Marlinton has six essential facilities in floodplains, ranking it ***6th*** among the ***top 10%*** of incorporated places statewide. These facilities include the **Marlinton Volunteer Fire Department** (flood depth: 3.8 ft) and **Marlinton Police Department** (flood depth: 3.7 ft) which are currently in the floodplain according to the effective maps, but will be located in the floodway based on the preliminary maps. The other essential facilities in the floodplain are **Marlinton Elementary School** (flood depth: 2.0 ft) and the **Pocahontas Center (Nursing Home)** which will be mapped out of the high-risk floodplain but will still remain in the moderate-risk 500-year floodplain with an approximate flood depth of 1.0 ft. Similarly, the **Pocahontas County 911 Center** will be mapped out of the high-risk floodplain but will stay in the 500-year floodplain with a flood depth of approximately 4.0 ft. Additionally, the **Pocahontas County Sheriff's Office**, currently in the 100-year floodplain, will be mapped out according to the preliminary maps. However, according to the preliminary maps, this essential facility may still be at risk due to the 1%-annual-chance backwater effect where Knapp Creek meets the larger Greenbrier River.

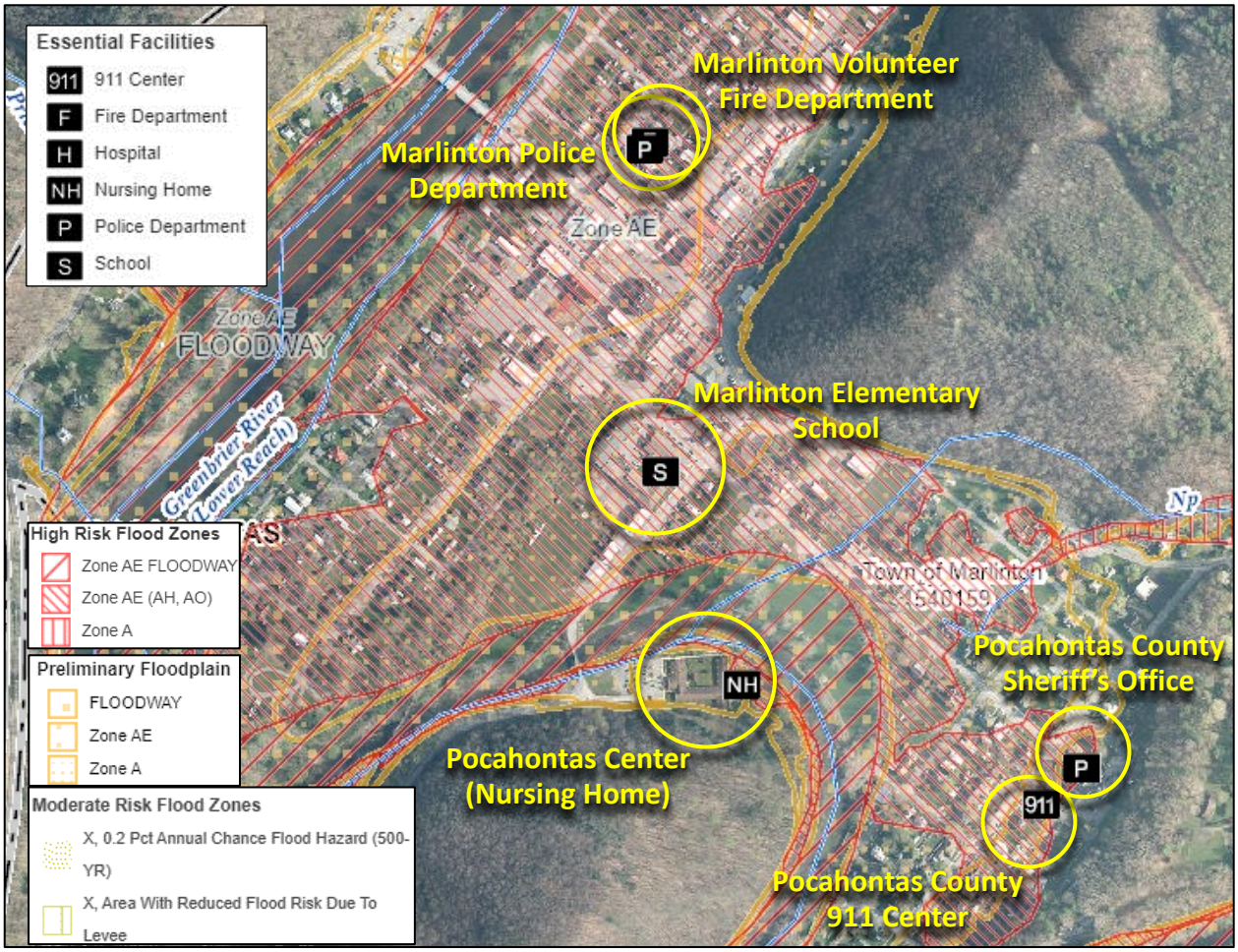


Figure 85. Essential Facilities in Marlinton viewable on the Risk MAP View of WV Flood Tool

Figure 86. Marlinton Police Department (Building ID: 38-08-0001-0096-0000_709A)

Figure 87. Fire department in Marlinton flooded in November 1985

Figure 88. Marlinton Volunteer Fire Department
(Building ID: 38-08-0001-0095-0000_709B)

Figure 89. Marlinton Elementary School
(Building ID: 38-08-0005-0009-0000_926)

Figure 90. Pocahontas Center (Nursing Home)
(Building ID: 38-08-0005-0065-0002_5)

In **Richwood**, three essential facilities are exposed to flood risk: The **Richwood Volunteer Fire Department** (flood depth: 0.5 ft) and the **Richwood Police Department** (flood depth: 0.1 ft) both intersecting the high-risk 1%-annual-change (100-year) floodplain in addition to the **WV State Police Troop 6 - Richwood Detachment** in the moderate risk 0.2%-annual-change (500-year) floodplain with an approximate flood depth of 2.0 ft. Richwood, ranked ***43rd***, is among the ***top 20%*** incorporated places statewide for the number of essential facilities in floodplains.

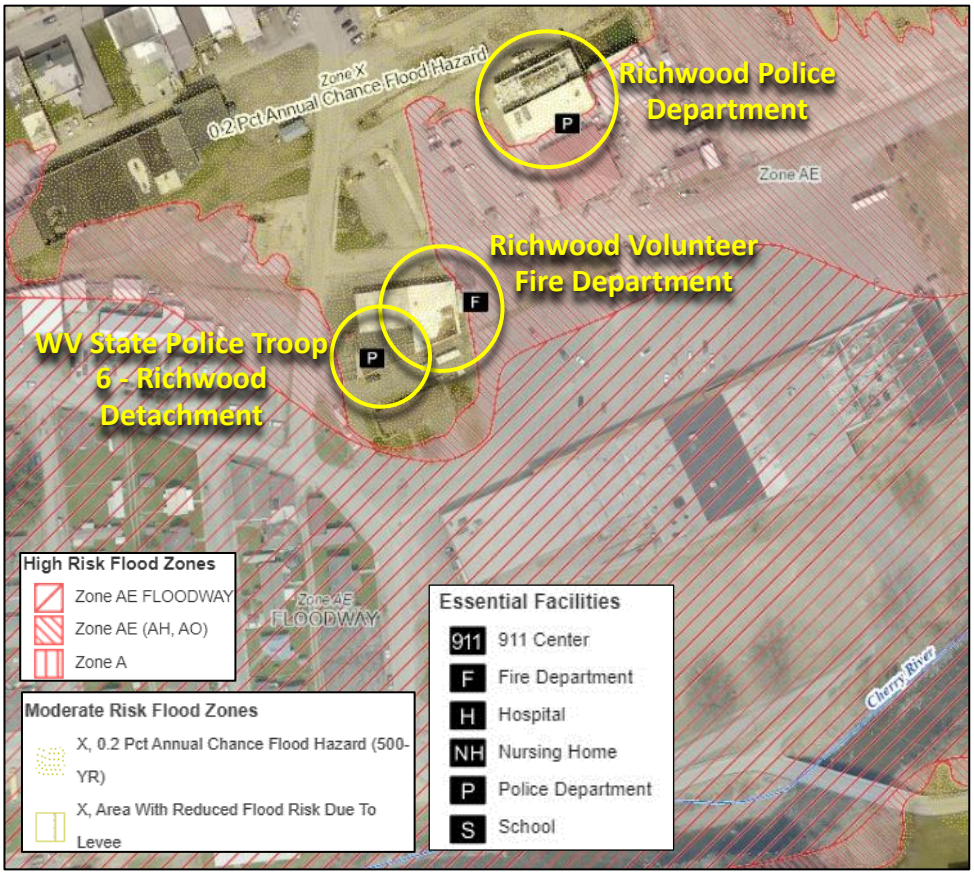


Figure 91. Essential Facilities in Richwood viewable on the Risk MAP View of WV Flood Tool

Figure 92. Richwood Volunteer Fire Department
(Building ID: 34-06-0005-0407-0005_10)

In **Clendenin**, two essential facilities are at the risk: The **Clendenin Volunteer Fire Department** (flood depth: 6.5 ft) and **Clendenin Police Department** (flood depth: 6.2 ft) both in the 1%-annual-change floodplain.

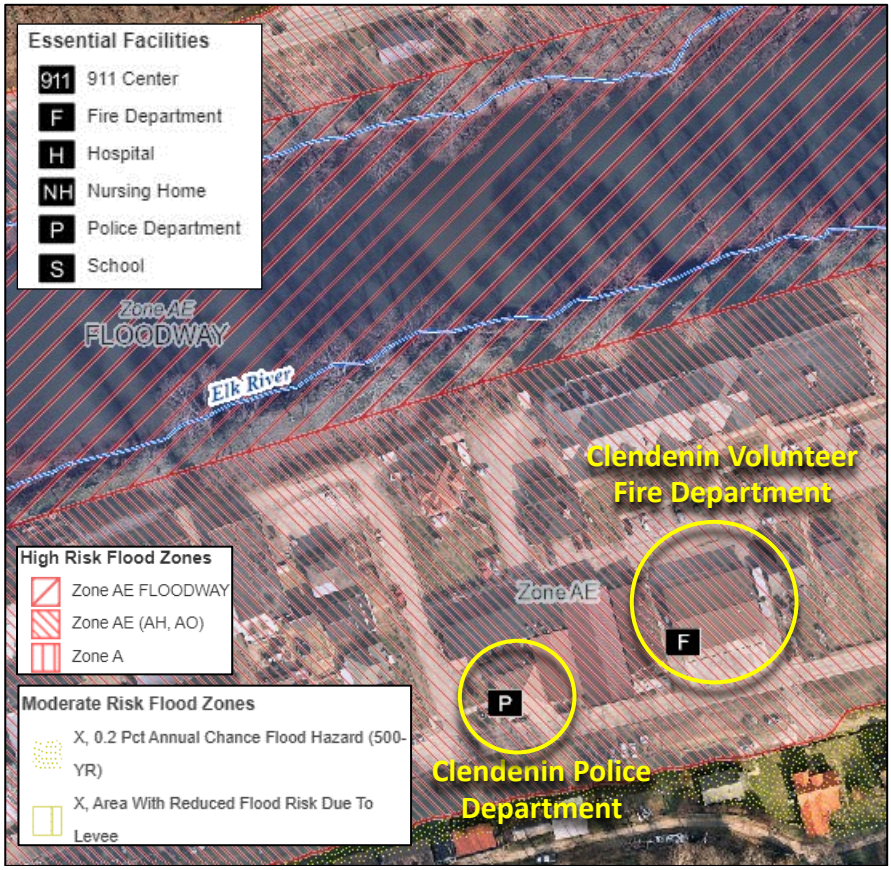


Figure 93. Essential Facilities in Clendenin viewable on the Risk MAP View of WV Flood Tool

Figure 94. Clendenin Volunteer Fire Department (Building ID: 20-02-0007-0040-0000_109)

Figure 95. Clendenin Police Department (Building ID: 20-02-0007-0034-0000_103)

In **Rainelle**, there are two essential facilities located in the flood zones: The **Rainelle Volunteer Fire Department** (flood depth: 0.5 ft) in the 100-year floodplain and the **Rainelle Police Department** in the 500-year zone with an approximate flood depth of 3 ft.

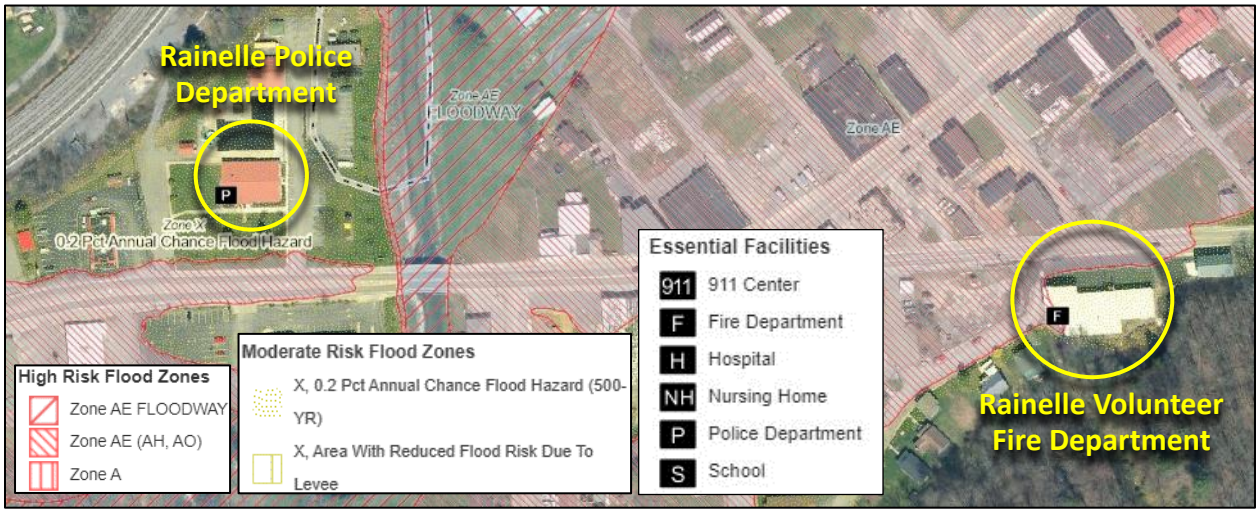


Figure 96. Essential Facilities in Rainelle viewable on the Risk MAP View of WV Flood Tool

Figure 97. Rainelle Volunteer Fire Department
(Building ID: 13-13-0005-0424-0000_212)

Figure 98. Rainelle Police Department
(Building ID: 13-13-0004-0147-0000_1233)

In **White Sulphur Springs**, one essential facility which is the **White Sulphur Springs Police Department** (flood depth: 0.5 ft) is located in the high-risk floodplain. Before the new maps became effective, the White Sulphur Elementary School was in the floodplain too; however, it was mapped out according to the restudies.

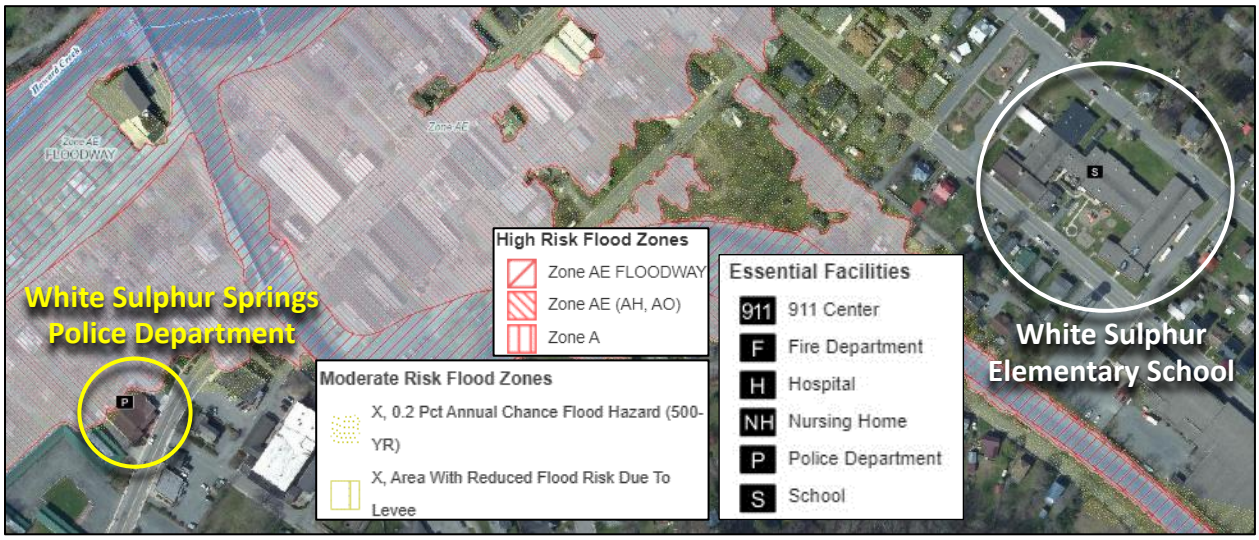


Figure 99. Essential Facilities in White Sulphur Springs viewable on the Risk MAP View of WV Flood Tool

Figure 100. White Sulphur Springs Police Department
(Building ID: 13-17-0011-0249-0000_585)

In **Camden-on-Gauley**, the storage facility of **Camden-on-Gauley Police Department** (flood depth: 10.2 ft) on Webster Road is the only essential facility in the floodplain.

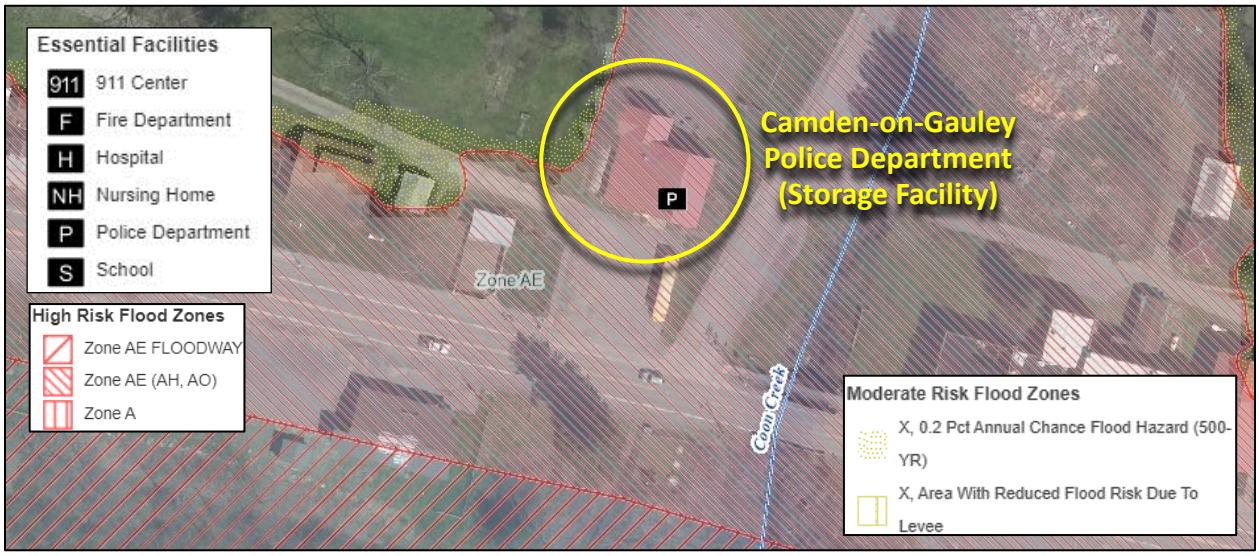


Figure 101. Essential Facility in Camden-on-Gauley viewable on the Risk MAP View of WV Flood Tool

Figure 102. Camden-on-Gauley Police Department, Storage Facility
(Building ID: 51-01-0003-0094-0000_9676)

Table 9 presents a summary of the essential facility count, categorized by facility type and flood zone, for the studied communities.

Table 9. Essential facility breakdown by type and flood zone in the studies communities

Incorporated Place	Facility Type					Flood Zone			Total Essential Facilities
	Police Station	Fire Station	911 Center	School	Nursing Home	Floodway	100-Yr Floodplain	500-Yr Floodplain	
Marlinton	2	1	1	1	1	2	1	3	6
Richwood	2	1	0	0	0	0	2	1	3
Clendenin	1	1	0	0	0	0	2	0	2
Rainelle	1	1	0	0	0	0	1	1	2
White Sulphur Springs	1	0	0	0	0	0	1	0	1
Camden-on-Gauley	1	0	0	0	0	0	1	0	1

Roads Inundated Ratio

A foot of water can float many vehicles making roads impassable and disrupting access to essential services and properties. Analyzing inundation at this level is essential for flood risk planning, as it can block regular access to properties and services. Around three feet of flood depth is the practical limit for deploying high-profile vehicles in rescues. When water depths reach approximately six feet or higher, rescues typically require the use of boats and helicopters, underscoring the need for clear evacuation routes and emergency protocols in flood-prone areas.

To consider as an indicator for the WV Flood Risk Index, the percentage of roads inundated by flood waters of 1 foot or more by a major 1%-annual-chance (100-year) flood event was calculated based on the 2023 roads dataset of Topologically Integrated Geographic Encoding and Referencing (TIGER) developed by the U.S. Census Bureau. Based on the results, 15.5 miles of roads in Clendenin can be inundated with the depth of at least one foot by a 100-year flood. This equals to 51.8% of the total roads in this community placing it in the 4th rank among the top 10% incorporated places statewide. In Rainelle, 8.8 miles or 39.1% of the total road length is exposed to such an inundation ranking this community 16th in the top 10% incorporated places. Camden-on-Gauley (ranked 27th) is among the top 20% for this risk indicator with 1.9 miles which equals to 55.2% of the total road milage. In Marlinton (ranked 38th), this ratio is 22.8% related to 14.5 miles of inundated roads placing it among the top 20% incorporated places statewide. Richwood (ranked 42nd) is also among the top 20% incorporated places with 9.3 miles or 21.5% of roads inundated. In White Sulphur Springs, the road inundation ratio is 16.4% related to 6.3 miles.

To incorporate road inundation as an indicator for the WV Flood Risk Index, the percentage of roads inundated by at least one foot of water during a 1%-annual-chance (100-year) flood event was calculated using the 2023 Topologically Integrated Geographic Encoding and Referencing (TIGER) roads dataset of the U.S. Census Bureau. The results show significant road vulnerability across the selected communities. In **Clendenin**, 15.5 miles of roads, or 51.8% of the total road network, are susceptible to such inundation, placing the community in the ***4th*** rank statewide and among the ***top 10%*** of incorporated places. **Rainelle** faces a similar issue, with 8.8 miles, or 39.1% of its roads, exposed to floodwaters, ranking it ***16th*** among the ***top 10%***. In addition, two bridges in Rainelle are susceptible to inundation. **Camden-on-Gauley**, with 1.9 miles of inundated roads accounting for 29.2% of the community's road network, ranks ***27th*** and is within the ***top 20%*** of incorporated places for this risk indicator. **Marlinton** has 14.5 miles of roads, or 22.8%, exposed to potential floodwaters, placing it in the ***38th*** rank and among the ***top 20%*** of incorporated places statewide. In **Richwood**, ranked ***42nd***, 9.3 miles of roads or 21.5% of the total road length are at risk, placing it similarly in the ***top 20%***. In **White Sulphur Springs**, 6.3 miles of inundated roads represents 16.4% of the total road network. All of these communities have the road inundation ratios higher that the statewide average for the incorporated places, which is 15.8%.

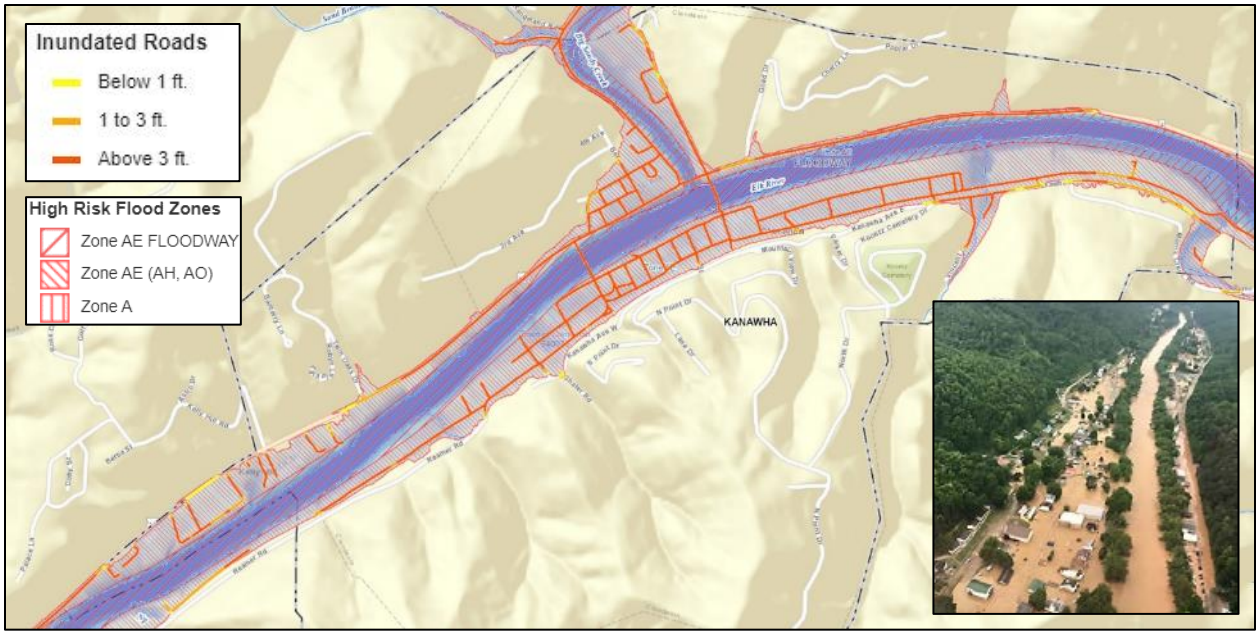


Figure 103. Road inundation map of Clendenin viewable on the Risk MAP View of WV Flood Tool and inundation in 2016

The map shows that two bridges in **Rainelle** are susceptible to inundation during a 1%-annual-chance flood. These bridges can obstruct water flow, elevating flood risk by creating backwater flooding. Additionally, an engineering flood study for Rainelle indicates that during large floods, the town's built environment can experience backwater flooding where Sewell Creek meets the larger Meadow River, potentially raising the flood water surface elevation by up to six feet upstream of their confluence.

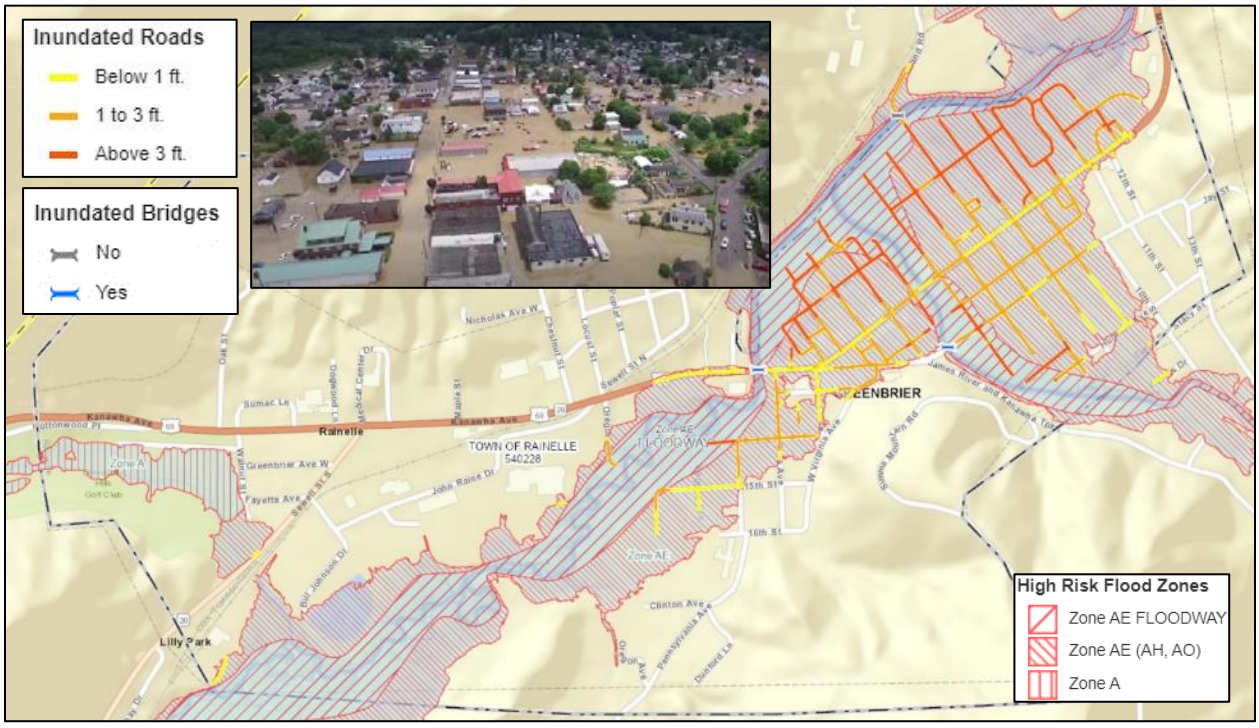


Figure 104. Road inundation map of Rainelle viewable on the Risk MAP View of WV Flood Tool and inundation in 2016

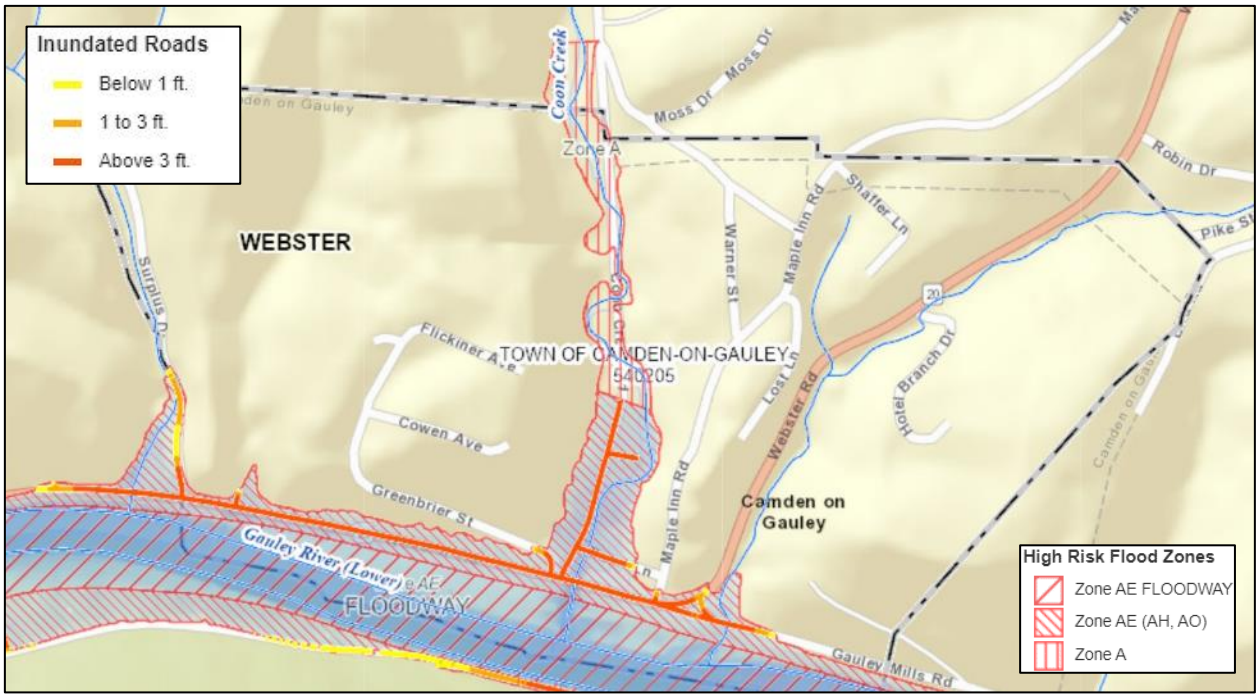


Figure 105. Road inundation map of Camden-on-Gauley viewable on the Risk MAP View of WV Flood Tool

Figure 106. Road inundation map of Richwood viewable on the Risk MAP View of WV Flood Tool and inundation in 2016

In **Marlinton**, none of the bridges appear to be inundated according to the effective maps. However, the preliminary maps indicate that the bridge on 5th Avenue over Knapp Creek, which connects the Pocahontas Center nursing home to main roads, could be inundated due to the 1%-annual-chance backwater effects from the Greenbrier River. This same risk also applies to the bridge on the Greenbrier River Trail.

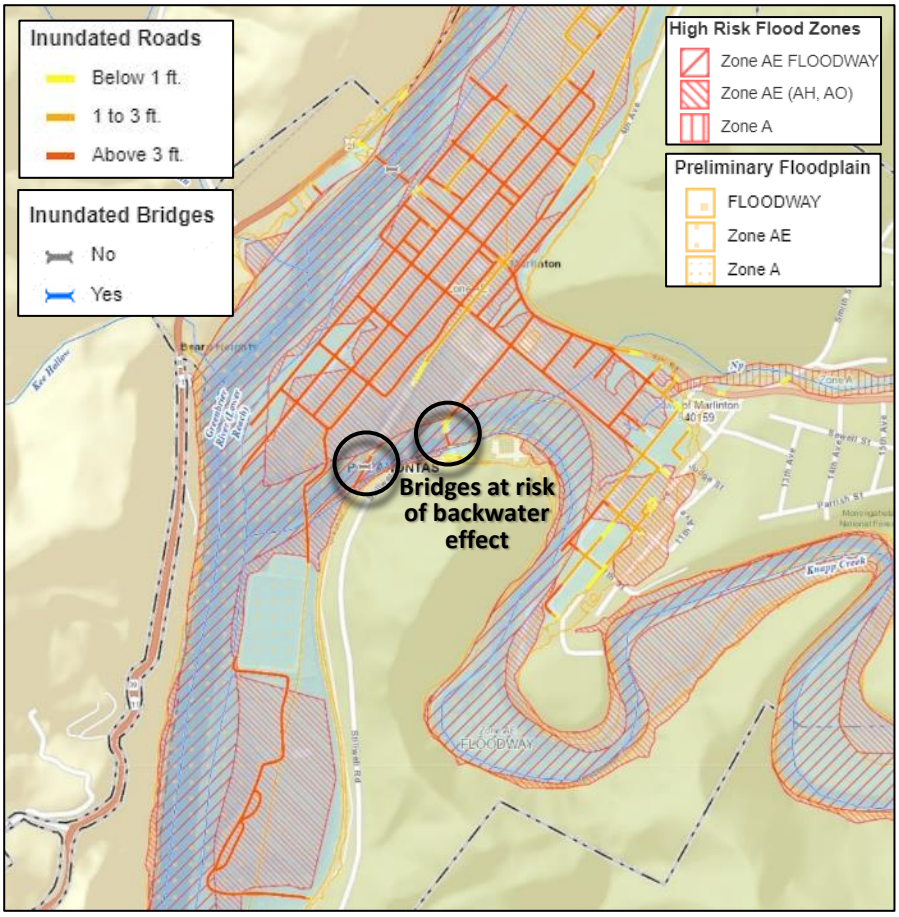


Figure 107. Road inundation map of Marlinton viewable on the Risk MAP View of WV Flood Tool

To mitigate the risk of road inundation during flooding, communities should first analyze historical flooding events alongside flood estimation models to assess the vulnerability of active major roads. By identifying which roadways are most susceptible to flooding, they can plan for alternative evacuation and rescue routes that remain accessible during emergencies. In the long term, these communities should consider elevating critical roadways to reduce the likelihood of inundation. This would enhance transportation resilience and ensure safer access for residents and emergency services during future flood events.

Category Index Scores and Summary for Critical Infrastructure

As discussed in the chapter, two indicators of Essential Facilities and Roads Inundated Ratio were considered in the critical infrastructure category for the development of the WV Flood Risk Index. The combined scores for these risk indicators place **Marlinton** (ranked ***5th***), **Clendenin** (ranked ***13th***), **Richwood** (ranked ***17th***), and **Rainelle** (ranked ***21st***) among the ***top 10%*** incorporated places for critical infrastructure at risk of flooding. Consequently, these communities are identified as being at "VERY HIGH" risk for this category. **Camden-On-Gauley** (ranked 64th) and **White Sulphur Springs** (ranked 84th) are classified under the "Relatively High" group for this category.

Table 10 provides a summary of the indicators used to assess at-risk critical infrastructure in the selected communities. The table's color scheme highlights the degree of risk, with categories ranging from "VERY HIGH" to "Vey Low" based on the legend. According to the table, **Marlinton** ranks within the ***top 10%*** of incorporated places for the number of essential facilities located in floodplains, while **Richwood** is in the ***top 20%*** for this indicator. Both **Clendenin** and **Rainelle** are among the ***top 10%*** of incorporated places for the roads inundation ratio, demonstrating significant vulnerability in terms of road access during floods. Additionally, **Camden-On-Gauley**, **Marlinton**, and **Richwood** rank among the ***top 20%*** for this risk factor, showing a notable risk to roadways in these communities.

Table 10. Category summary of critical infrastructure for the selected communities

Incorporated Place	CRITICAL INFRASTRUCTURE			
	Essential Facilities	Roads Inundated Ratio	Category Score (0 to 100%)	Category Rank in Incorporated Places
Marlinton	**6**	22.8%	**98.2%**	5
Clendenin	2	**51.8%**	**94.7%**	13
Richwood	3	21.5%	**92.9%**	17
Rainelle	2	**39.1%**	**91.2%**	21
Camden-On-Gauley	1	29.2%	72.3%	64
White Sulphur Springs	1	16.4%	63.1%	84

Risk Index Legend

VERY HIGH: 90% - 100% (Among the top 10% incorporated places)

Very High: 80% - 100% (Among the top 20% incorporated places)

Relatively High: 60% - 79.9%

Relatively Low: 20% - 39.9%

Moderate: 40% - 59.9%

Very Low: 0% - 19.9%

COMMUNITY ASSETS

This category is comprised of historical and non-historical community assets in the Special Flood Hazard Area, or 100-year floodplain.

Historical Community Assets

Historical assets hold considerable cultural and historical significance, making it essential to identify how many of these are located in flood-prone areas. Understanding the number and distribution of historical assets at risk helps in prioritizing resource allocation for flood resilience measures and emergency preparedness. Additionally, the presence of historical assets in floodplains may influence insurance premiums for property owners and can also affect their eligibility for government grants or funding dedicated to flood mitigation and restoration efforts. Protecting these irreplaceable landmarks ensures the preservation of cultural heritage while reducing potential financial losses during flood events.

As a risk indicator for the WV Flood Risk Index, the number of historical community assets located within the 1%-annual-chance (100-year) floodplain was assessed. This includes structures officially listed on the National Register of Historic Places, a federal designation for buildings, sites, and districts considered worthy of preservation for their historical significance. Additionally, it encompasses buildings within National Register Areas that were constructed before 1930. In **Clendenin**, 54 historical community assets were identified in the floodplain, ranking it ***5th*** among the ***top 10%*** of incorporated places statewide. These structures were constructed before 1930 within the **Clendenin Historic District**.

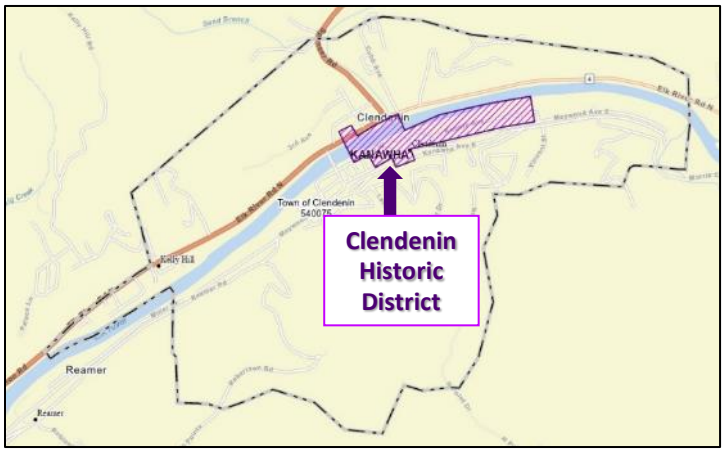


Figure 108. Clendenin Historic District viewable on the Interactive Map of WV State Historic Preservation Office (SHPO)

Figure 109. Historical community assets in Clendenin Historic District viewable on the Risk MAP View of WV Flood Tool

Richwood, ranked ***23rd***, falls within the ***top 20%*** incorporated places with nine historical assets. These are the buildings constructed before 1930 in the **Downtown Richwood Historic District**. Four of these structures are in the regulatory floodway.

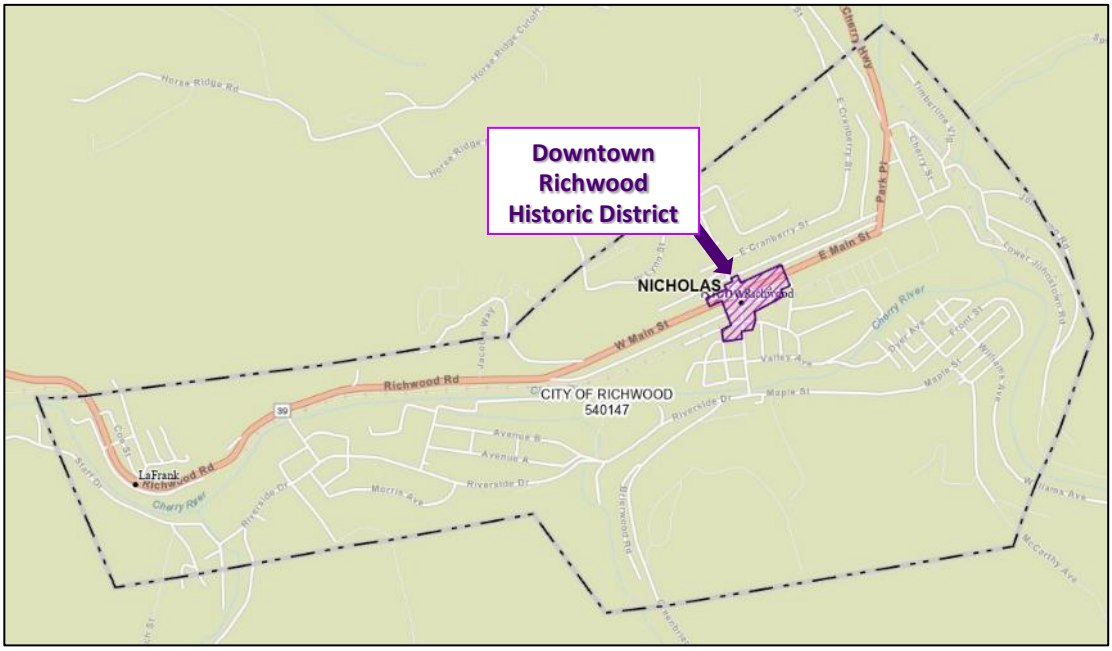


Figure 110. Downtown Richwood Historic District viewable on the Interactive Map of WV State Historic Preservation Office (SHPO)

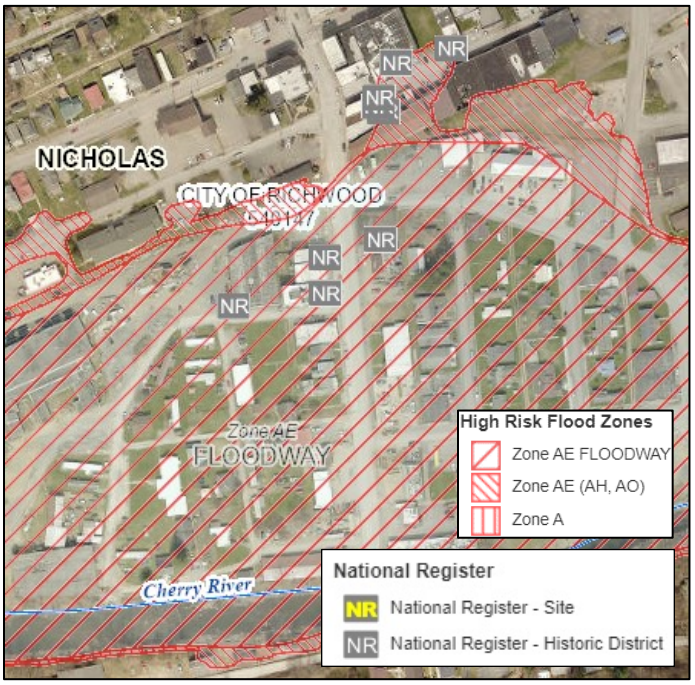


Figure 111. Historical community assets in Downtown Richwood Historic District viewable on the Risk MAP View of WV Flood Tool

Marlinton, ranked ***29th***, is also within the ***top 20%*** with five historical structures listed in the National Register located in floodplain. These structures include the **IOOF Lodge Building** (flood depth: 3.6 ft), **Pocahontas Times Print Shop** (flood depth: 3.3 ft), **Marlinton Chesapeake and Ohio Railroad Station** (flood depth: 3.1 ft) , **Marlinton Opera House** (flood depth: 4.8 ft), and **Pocahontas County Courthouse and Jail**. Except for the courthouse, the other four assets will be in the floodway according to the preliminary maps.

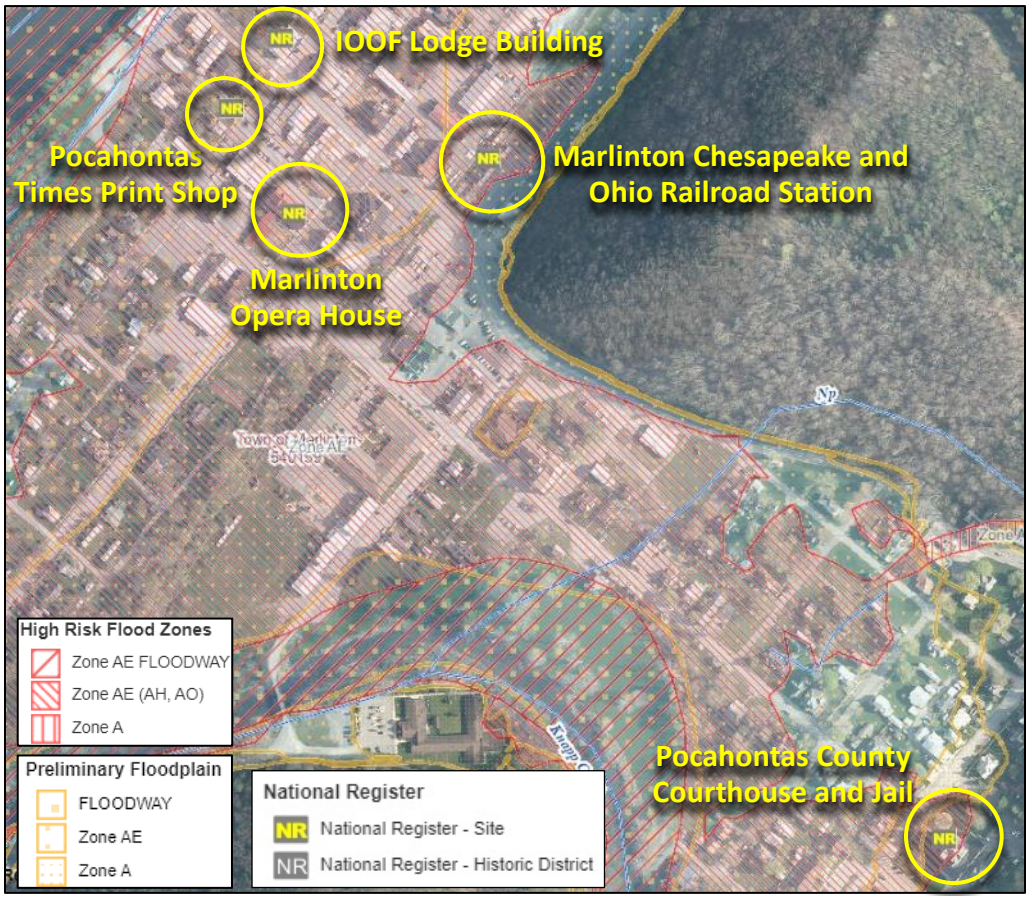


Figure 112. Historical community assets in Marlinton viewable on the Risk MAP View of WV Flood Tool

Figure 113. IOOF Lodge Building in Marlinton
(Building ID: 38-08-0001-0021-0000_109)

Figure 114. Marlinton Opera House
(Building ID: 38-08-0002-0159-0000_818)

Figure 115. Marlinton Chesapeake & Ohio Railroad Station
(Building ID: 38-08-0003-0041-0000_315)

No historical assets were identified in the floodplains of **Rainelle**, **White Sulphur Springs**, or **Camden-On-Gauley**.

Table 11 provides a summary of the historical community assets, categorized by type and flood zone, for the studied communities. Among these communities, **Clendenin** has a higher number of historical community assets located in floodplain compared to the statewide average of 14 or all incorporated places.

Table 11. Historical community asset breakdown by type and flood zone in the studies communities

Incorporated Place	Historical Community Asset Type		Flood Zone		Total Historical Assets
	National Register Bldg. Sites	Buildings in Historic District (older than 1930)	Floodway	100-Yr Floodplain	
Clendenin	0	54	0	54	54
Richwood	0	9	4	5	9
Marlinton	5	0	4	1	5
Camden-on-Gauley	0	0	0	0	0
Rainelle	0	0	0	0	0
White Sulphur Springs	0	0	0	0	0

Communities need to identify the flood risk, vulnerabilities, and existing capacity for resilience of historical properties in floodplain. For historical community assets, it is crucial to document the property and its character-defining features as a record and guide for future repair work. This documentation should be stored in a safe location, with at least one duplicate kept at a secure site. The building, its site, and setting should be maintained in good repair, and character-defining features should be monitored regularly. Adaptive flood mitigation options should always be selected to minimize impacts on the historical character and appearance of a historical building or district. These options can range from temporary protective measures, such as temporary barriers, systems, or equipment, to structural and landscape adaptations. Examples include constructing berms or levees, elevating roads, sidewalks, and infrastructure along with buildings, all while maintaining the historical spatial relationships and settings.

Historical assets should be protected by proper drainage to avoid erosion of foundation walls by floods, water draining toward the building, or landscape damage. Additionally, improving or restoring on-site or adjacent natural systems, such as wetlands and green spaces, can be very helpful in mitigating flood risk. Since historical community assets often have basements, similar recommendations for protecting basements from floods should be applied. These include elevating electrical components, mechanicals, and appliances or protecting them with barrier walls and waterproofing and installing sump pumps along with backflow valves (Source: National Park Service).

Non-Historical Community Assets

Non-historical community assets include utilities (water, sewage, gas, electric, or phone), post-secondary educational facilities, emergency medical services (EMS), government buildings at national, state, or local levels providing public services, facilities hosting religious services, and other buildings of significance that contribute to the built environment of community. These assets are vital to a community's functioning and resilience making them highly significant for flood management. Churches, for instance, often serve as emergency shelters during floods. Flooding can severely disrupt essential community lifelines such as safety, water, shelter, health, and energy. In addition, the inundation of government buildings can lead to service interruptions and cause the loss of important documents and records, further complicating recovery efforts.

The number of non-historical community assets located in the high-risk 1%-annual-chance floodplain was considered as another risk indicator. To identify these assets, a variety of data sources were utilized including the Building-Level Risk Assessment (BLRA), Reference USA, Homeland Infrastructure Foundation-Level Data, WV Water Development Authority, WV Infrastructure Jobs Development Council, and WV Division of Natural Resources. Additionally, input from community feedback was incorporated to ensure comprehensive identification of non-historical assets.

In **Clendenin**, a total of 15 non-historical community assets were identified in the floodplain, ranking the community ***5th*** among the ***top 10%*** of incorporated places statewide. These assets include 10 religious buildings (flood depths: 0.5 to 13.4 ft), four government buildings (flood depths: 6.2 to 9.5 ft), and the EMS facility of the Kanawha County Emergency Ambulance Authority (flood depth: 7.5 ft). Among these structures, the **Kanawha County Public Library (Clendenin Branch)** holds the highest appraised value at $511K. Additionally, the religious building of **Praying Pelican Missions** is located in the highest estimated flood depth of 13.4 feet.

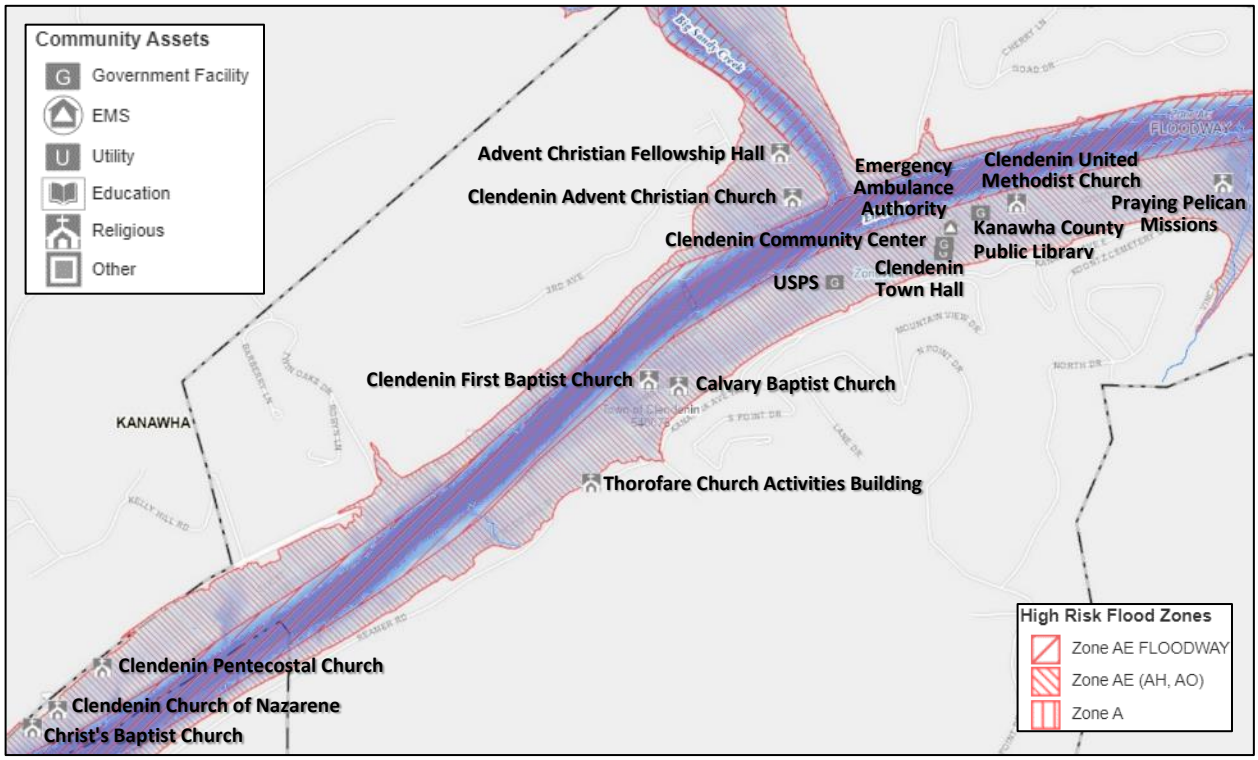


Figure 116. Non-historical community assets in Clendenin viewable on the Risk MAP View of WV Flood Tool

Figure 117. Kanawha County Public Library, Clendenin Branch,
Highest community asset value ($511K) in floodplain
(Building ID: 20-02-0007-0004-0000_9999)

Figure 118. Praying Pelican Missions,
Highest non-historical community asset flood depth (13.4 ft) in Clendenin
(Building ID: 20-02-0007-0030-0000_103)

Figure 119. Kanawha County Emergency Ambulance Authority in Clendenin's floodplain
(Building ID: 20-02-0007-0004-0002_105)

There are 13 non-historical community assets in the high-risk floodplain of **Marlinton** placing this community at the ***8th*** rank among the ***top 10%*** of incorporated places statewide. These structures include six religious institutions (flood depths: 2.6 to 4.4 ft), five government buildings (flood depths: 0.9 to 4.8 ft), and two utility structures of Marlinton Water Plant (flood depth: 3.0 ft) and the Monongahela Power Company (flood depth: 2.3 ft). Notably, the **Marlinton Water Plant** is in the regulatory floodway and will remain in this zone according to the preliminary maps. The **Marlinton Presbyterian Church**, **Grace Baptist Church**, and the **Marlinton Municipal Building** will also be mapped into the floodway due to its expansion on future maps. Among Marlinton's non-historical community assets, the **Marlinton Water Plant** has the highest appraised value at $8.9M, while the **United States Postal Service (USPS)** office, located in the floodplain, faces the highest flood depth of 4.8 feet.

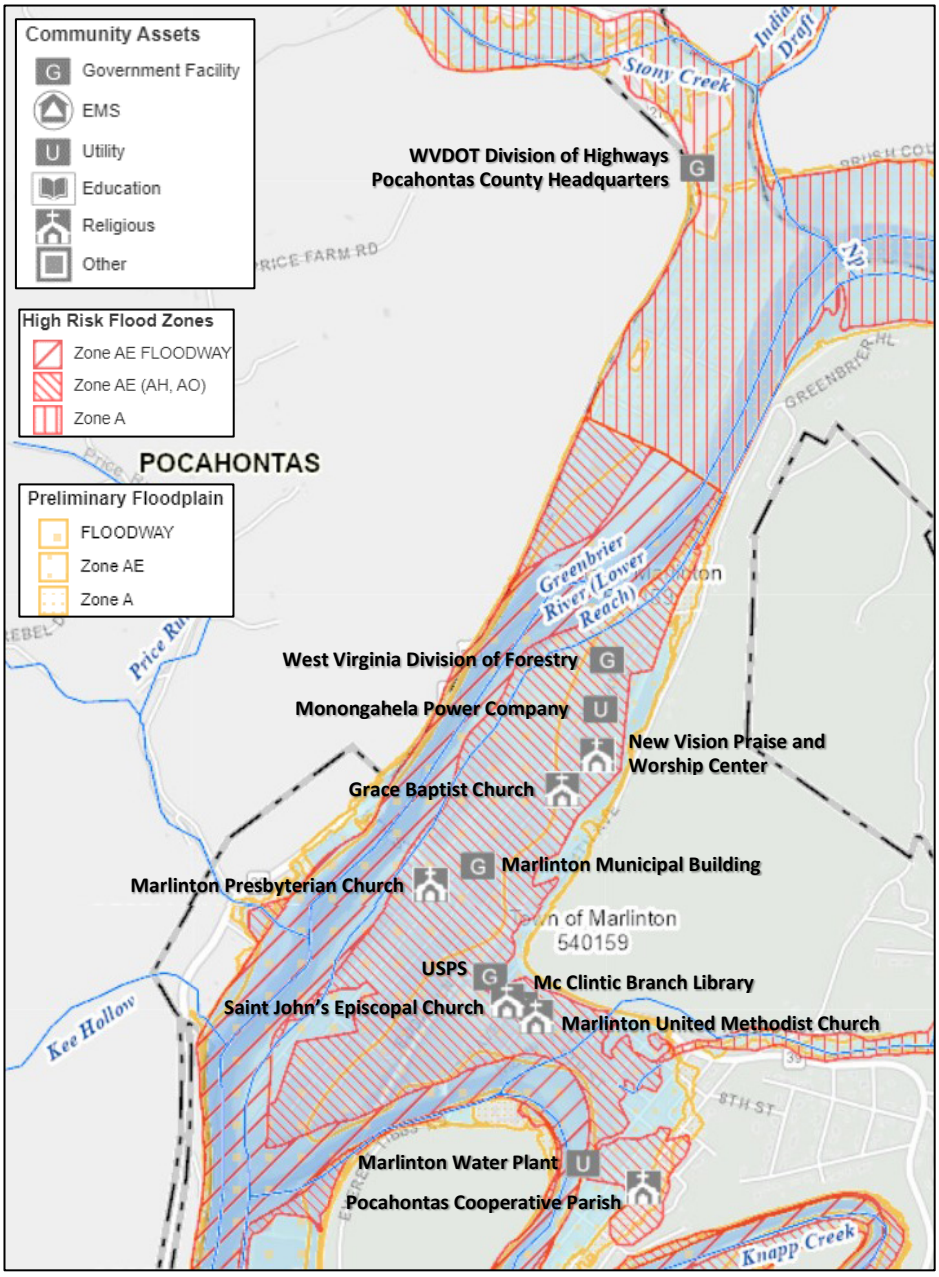


Figure 120. Non-historical community assets in Marlinton viewable on the Risk MAP View of WV Flood Tool

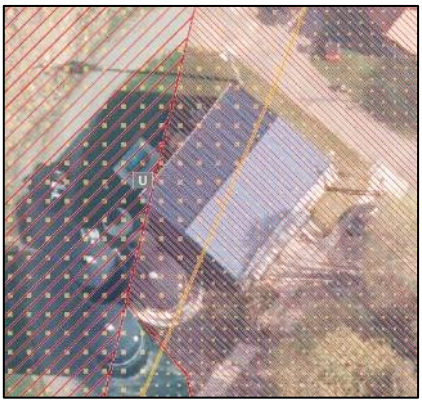


Figure 121. Marlinton Water Plant in floodway,
Highest community asset value ($8.9M) in floodplain
(Building ID: 38-08-0005-0088-0000_1002)

Figure 122. United States Postal Service (USPS) office,
Highest non-historical community asset flood depth (4.8 ft) in Marlinton
(Building ID: 38-08-0005-0006-0000_819)

Figure 123. Marlinton Presbyterian Church in floodway
(Building ID: 38-08-0002-0104-0000_815)

In **Richwood**, eight non-historical community assets are located within the high-risk floodplain placing it ***19th*** among the ***top 10%*** of incorporated places statewide. These assets include five religious institutions (flood depths: 1.4 ft to 3.4 ft), two government buildings: West Virginia Economic Development Authority (flood depth: 1.3 ft) and Richwood Public Library (flood depth: 0.2 ft), and the utility structure of the City of Richwood Wastewater Treatment Plant (flood depth: 0.4 ft). Among these, the **Richwood Christian Church**, the **Family Center of Richwood**, and **West Virginia Ministries of the Church of God** are located in the regulatory floodway. The **Richwood Wastewater Treatment Plant** has the highest appraised value at $880K while the **Family Center** is exposed to the highest flood depth of 3.4 feet.

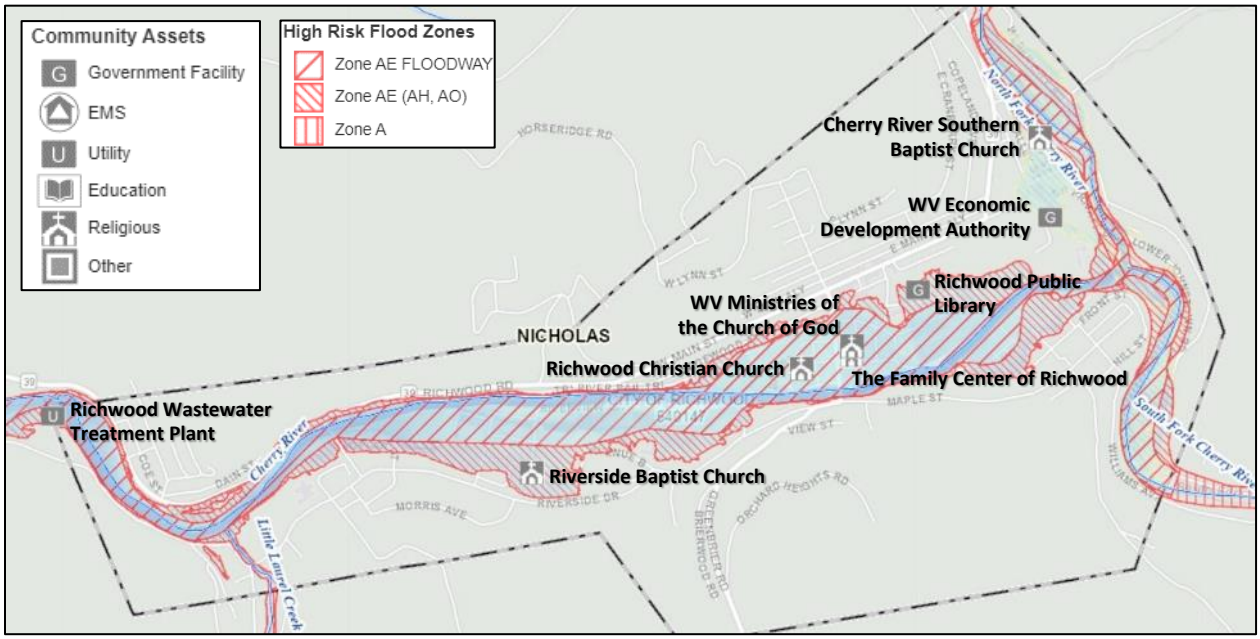


Figure 124. Non-historical community assets in Richwood viewable on the Risk MAP View of WV Flood Tool

Figure 125. Richwood Wastewater Treatment Plant, Highest community asset value ($880K) in floodplain (Building ID: 34-05-0030-0014-0000_408)

Figure 126. Family Center of Richwood, Highest non-historical community asset flood depth (3.4 ft) (Building ID: 34-06-0011-0077-0000_3)

In **White Sulphur Springs**, seven non-historical community assets were identified within the high-risk floodplain ranking this community ***22nd*** and placing it among the ***top 20%*** incorporated places for this risk indicator. These structures include three churches (flood depths: 0.1 to 1.9 ft) and four government buildings of the White Sulphur Springs National Fish Hatchery (flood depth: 2.4 ft), the Municipal Court (flood depth: 0.3 ft), the White Sulphur Springs City Hall (flood depth: 0.1 ft), and a USPS office (flood depth: 0.4 ft). Among these community assets, the **National Fish Hatchery**, the **First Church of God**, and the **White Sulphur Springs Baptist Church** are located in the regulatory floodway. The **National Fish Hatchery** has the highest appraised value of $425K and the highest flood depth (2.4 ft).

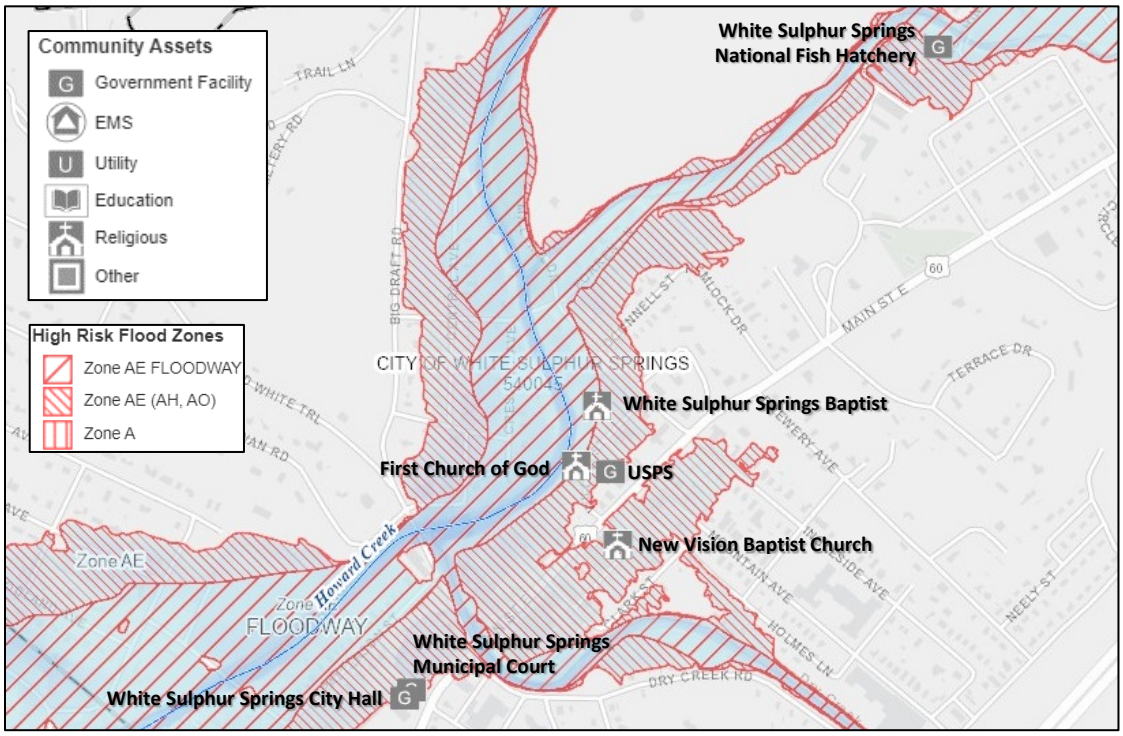


Figure 127. Non-historical community assets in White Sulphur Springs viewable on the Risk MAP View of WV Flood Tool

Figure 128. White Sulphur Springs National Fish Hatchery, Highest non-historical community asset value ($425K) and flood depth (2.4 ft) (Building ID: 13-17-0009-0206-0000_1087)

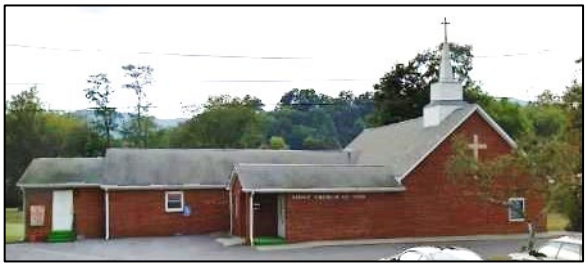


Figure 129. First Church of God in White Sulphur Springs' Floodway (Building ID: 13-17-0009-0066-0000_155)

Figure 130. WSS Baptist Church in Floodway (Building ID: 13-17-0009-0073-0000_201)

In **Rainelle**, there are six non-historical community assets in the high-risk flood zone placing it ***35th*** among the ***top 20%*** incorporated places. These assets include four churches (flood depths: 1.6 to 3.3 ft) and two government buildings of the Rainelle Public Library (flood depth: 1.8 ft) and the Municipal Water Department (flood depth: 0.5 ft). Among these, the **Greenbrier Ave Church of God** has the highest dollar value of $435K while the **Rainelle Seventh-Day Adventist Church** has the highest estimated flood depth (3.3 ft).

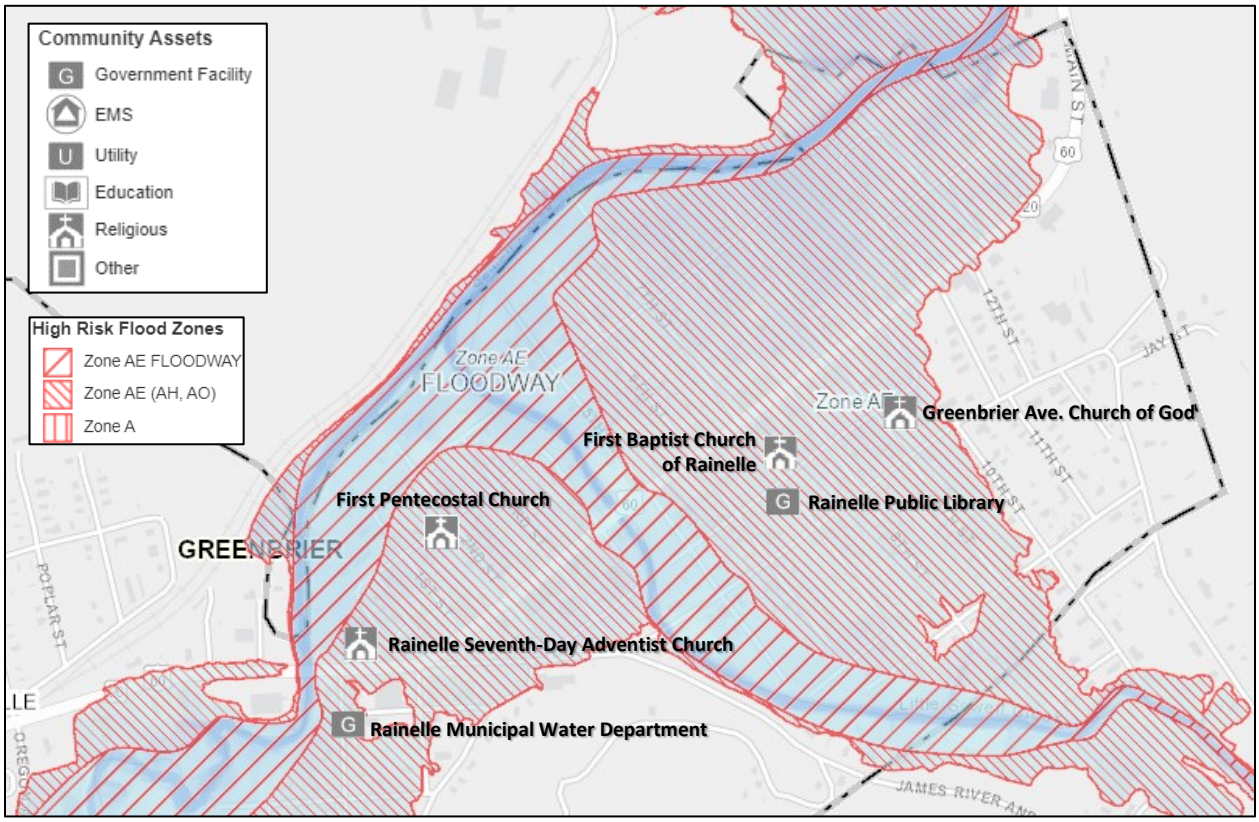


Figure 131. Non-historical community assets in Rainelle viewable on the Risk MAP View of WV Flood Tool

Figure 132. Greenbrier Ave. Church of God, Highest community asset value ($435K) in Rainelle's floodplain (Building ID: 13-13-0005-0366-0000_373)

Figure 133. First Pentecostal Church, Highest non-historical community asset flood depth (3.3 ft) in Rainelle (Building ID: 13-13-0005-0081-0000_176)

In **Camden-on-Gauley**, the **Bethel Methodist Church** (flood depth: 2.1 ft) is the only community asset in the high-risk floodplain. The appraised value of this structure is $145K.

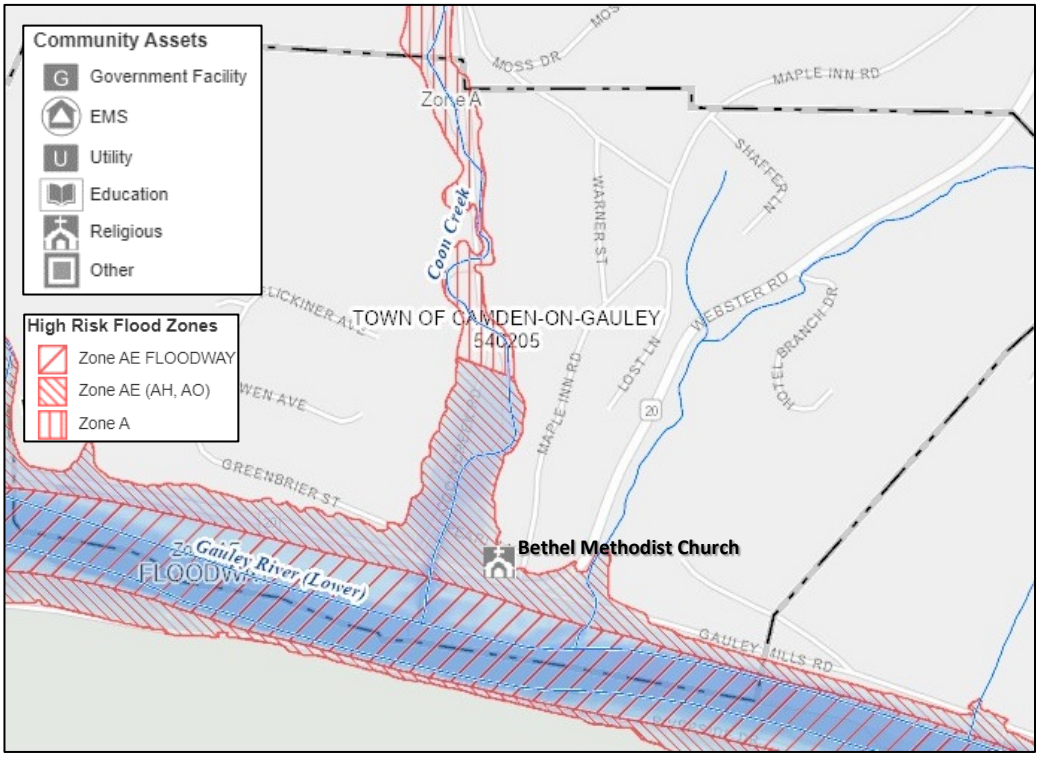


Figure 134. Non-historical community assets in Camden-on-Gauley viewable on the Risk MAP View of WV Flood Tool

Figure 135. Bethel Methodist Church,
in Camden-on-Gauley's floodplain
(Building ID: 51-01-0003-0144-0000_9999)

Table 12 displays a summary of the non-historical community assets, categorized by type and flood zone, for the studied communities. With the exception of Camden-on-Gauley, all these communities have more non-historical community assets in floodplains than the statewide average of four for incorporated places.

Table 12. Non-historical community asset breakdown by type and flood zone in the studies communities

Incorporated Place	Non-Historical Community Asset Type				Flood Zone		Total Non-Historical Assets
	Religious	Government	Utility	EMS	Floodway	100-Yr Floodplain	
Clendenin	10	4	0	1	0	15	15
Marlinton	6	5	2	0	4	9	13
Richwood	5	2	1	0	3	5	8
White Sulphur Springs	3	4	0	0	3	4	7
Rainelle	4	2	0	0	0	6	6
Camden-on-Gauley	1	0	0	0	0	1	1

It is crucial for floodplain managers and risk planners to perform hazard vulnerability analyses of community assets to devise appropriate mitigation strategies. They should also create plans for the long-term relocation of key community assets (e.g., utilities, town halls, churches, etc.) out of the floodplain. Examples of mitigation measures for utilities are emergency response plans, barriers around key assets, elevated electrical equipment, emergency generators, and bolted down chemical tanks (Source: EPA).

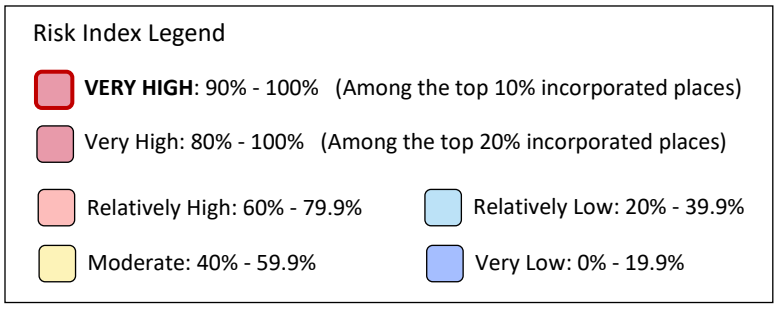
Category Index Scores and Summary for Community Assets

As discussed in the chapter, the number of historical and non-historical community assets located in the 1%-annual-chance (100-year) floodplain were used as two indicators for the WV Flood Risk Index. The combined scores for these indicators rank **Clendenin** (***4th***), **Marlinton** (***12th***), and **Richwood** (***13th***) within the ***top 10%*** of incorporated places with the highest number of community assets at risk of flooding. These communities are classified as being at "VERY HIGH" risk for this category. **White Sulphur Springs** (ranked 57th) and **Rainelle** (ranked 64th) fall into the "Relatively High" risk group, while **Camden-On-Gauley** (ranked 120th) is identified as having a "Relatively Low" risk for this category.

Table 13 summarizes the indicators used to assess at-risk community assets in the selected communities. The table uses a color scheme to highlight the degree of risk, ranging from "VERY HIGH" to "Very Low," as defined in the legend. According to the table, **Clendenin** ranks within the ***top 10%*** of incorporated places for historical community assets located in the floodplain, while **Marlinton** and **Richwood** fall within the ***top 20%*** for this indicator. For non-historical community assets in the floodplain, **Clendenin**, **Marlinton**, and **Richwood** rank in the ***top 10%***, with **White Sulphur Springs** and **Rainelle** ranking in the ***top 20%***.

Table 13. Category summary of community assets for the selected communities

Incorporated Place	COMMUNITY ASSETS			
	Community Assets Historical	Community Assets Non-Historical	Category Score (0 to 100%)	Category Rank in Incorporated Places
Clendenin	**54**	**15**	**98.6%**	4
Marlinton	5	**13**	**95.1%**	12
Richwood	9	**8**	**94.7%**	13
White Sulphur Springs	0	7	72.8%	57
Rainelle	0	6	68.8%	64
Camden-On-Gauley	0	1	25.8%	120



BUILDING DAMAGE LOSS

This category of risk indicators measures building damage by estimation models and recorded flood insurance claims. It includes the counts of substantially damaged structures and their ratios within floodplain buildings, as explained later. Additionally, the number of previous damage claims and repetitive losses were considered as part of this risk category.

Substantial Damage Count / Ratio

Damage of any origin sustained by a structure whereby the cost of restoring the structure to its before damaged condition would equal or exceed 50 percent of the market value of the structure before the damage occurred is referred to as substantial. Flood loss models, generated using FEMA's flood loss methodology, quantify the degree of flood risk, including estimates of substantially damaged structures. Accurately measuring flood risk is essential for effective risk communication and flood mitigation efforts. The estimate of substantial damage is a key indicator of the severity and impact of flood events, helping to efficiently allocate resources for recovery and reconstruction, adjust insurance premiums, and better understand risk exposure. For many communities with pre-FIRM structures, determining substantial damage is one of the most effective tools to ensure owners comply with the NFIP's minimum requirements and any higher standards set by the community (Source: FEMA Region 3).

Flood loss models quantify the degree of flood risk, including estimates of substantially damaged structures. Quantifying the degree of flood risk is important for risk communications and flood reduction efforts. Hazus flood loss models and the best-available depth grids quantify the degree of flood risk of each structure or feature. FEMA's open-source Hazus utility, Flood Assessment Structure Tool (FAST), provides a standardized methodology for estimating potential building losses for a 1%-annual-chance flood event.

The estimated number of primary structures substantially damaged in a 1% annual chance (100-year) flood, calculated based on the Hazus model, was used as a risk indicator in the development of the WV Flood Risk Index. **Clendenin**, with 46 substantially damaged structures, ranks ***5th*** among the ***top 10%*** of incorporated places, while **Marlinton** (ranked ***27th***) is in the ***top 20%***, with 16 structures estimated to be at least 50% damaged. Both communities are classified as "Very High" risk for this indicator. **Camden-On-Gauley**, with four primary structures estimated to be substantially damaged, falls into the "Relatively High" risk group. **Richwood** and **Rainelle**, each with only one substantially damaged structure, are classified as "Moderate" risk. **White Sulphur Springs** has no buildings estimated to be substantially damaged. **Clendenin** and **Marlinton** have higher substantial damage counts than the statewide average of seven for all incorporated places.

As another risk indicator, the percentage of substantially damaged structures (damaged equal to or greater than 50% of the building value) relative to total structures located in the 1%-annual-chance (100-year) floodplain was calculated. Based on the results, **Camden-On-Gauley** has a substantial damage ratio of 19.0%, ranking ***18th*** among the ***top 10%*** of incorporated places. In **Clendenin**, 15.2% of primary buildings in the high-risk floodplain are estimated to be substantially damaged, placing the community ***27th*** and within the ***top 20%***. Both communities fall into the "Very High" risk class for this indicator. **Marlinton**, with a ratio of 4.3%, is classified in the "Relatively High" risk group. In **Richwood** and **Rainelle**, the ratio is 0.3%, placing them in the "Moderate" risk class, while **White Sulphur Springs**

has a ratio of zero. The ratio in **Camden-On-Gauley** and **Clendenin** is higher than the statewide average of 5.9% for all incorporated places.

Substantially damaged buildings may qualify for Increased Cost of Compliance (ICC) assistance under the National Flood Insurance Program (NFIP). This assistance can help cover the costs of meeting mitigation requirements, such as elevation, relocation, demolition, or floodproofing for nonresidential structures, or a combination of these measures. Policyholders with flood insurance in high-risk areas (Special Flood Hazard Areas) can receive up to $30,000 to bring their home or business into compliance with local floodplain management regulations (Source: FEMA). Communities with a high number of substantially damaged buildings should consider leveraging such assistance programs to mitigate future flood risk.

It is important to note that certain limitations may exist with the flood loss model used, which can be summarized as follows.

Undervalued Building Appraisals: The building damage loss estimates will be lower if the market value of the building stock is undervalued. The tax assessment database is the replacement value for most of the building level risk assessments. Other building value sources are used for tax exempt structures or mobile homes assessed as personal property.

Flood Damage Overestimates: To avoid flood damage overestimates, communities should verify that the designated Foundation and First Floor Heights of highly damaged building estimates are correct. The basement information from the tax assessment database does not distinguish between a subgrade basement or a walkout basement enclosure, for example. Elevation certificates and buildings pictures are useful in determine the correct foundation type and first-floor height for structures, resulting in more accurate depth-damage building loss estimates.

Flood Damage Outside SFHA: The flood loss models also do not calculate damage estimates for buildings outside the effective or advisory 1%-annual-chance floodplains. FEMA's publication "Understanding Flood Dangers in Central West Virginia: Lessons Learned from the June 2016 Flood" reported that extensive property damage occurred outside the Special Flood Hazard Areas. Besides overbank flooding on major rivers and streams, flash flooding on small streams, runoff rushing down mountainsides, and urban overflow flooding can all contribute to significant damage outside designated Special Flood Hazard Areas. The report concluded of the nearly 1,000 flood insurance claims in the declared counties, 77% were in the 1% annual-chance floodplain and approximately 23% of the insurance claims were outside. On average, in floods across the country, about 25% of claims are outside the Special Flood Hazard Area, so this is consistent with the national trend.

Model-Backed Flood Depths: The best-available HEC-RAS model-backed depth grids at a preferred grid resolution of 1-meter cell are employed for the building-level risk assessments. Unfortunately, model-backed depth grids do not exist for Approximate A Zones for 18 counties in West Virginia and are missing for smaller tributary streams in other counties. Where no model backed depth grids exist, a Hazus depth grid is substituted if depth values are available for that stream location.

- No Model-Backed Base Flood *Depth Grids* or Advisory Flood Heights exist for Approximate A Zones for Nicholas, Pocahontas, and Webster counties. See status graphic.
- A less accurate *Hazus* depth grid is utilized for Building Damage Loss Estimates until model-backed depth grids for Approximate A Zones become available.

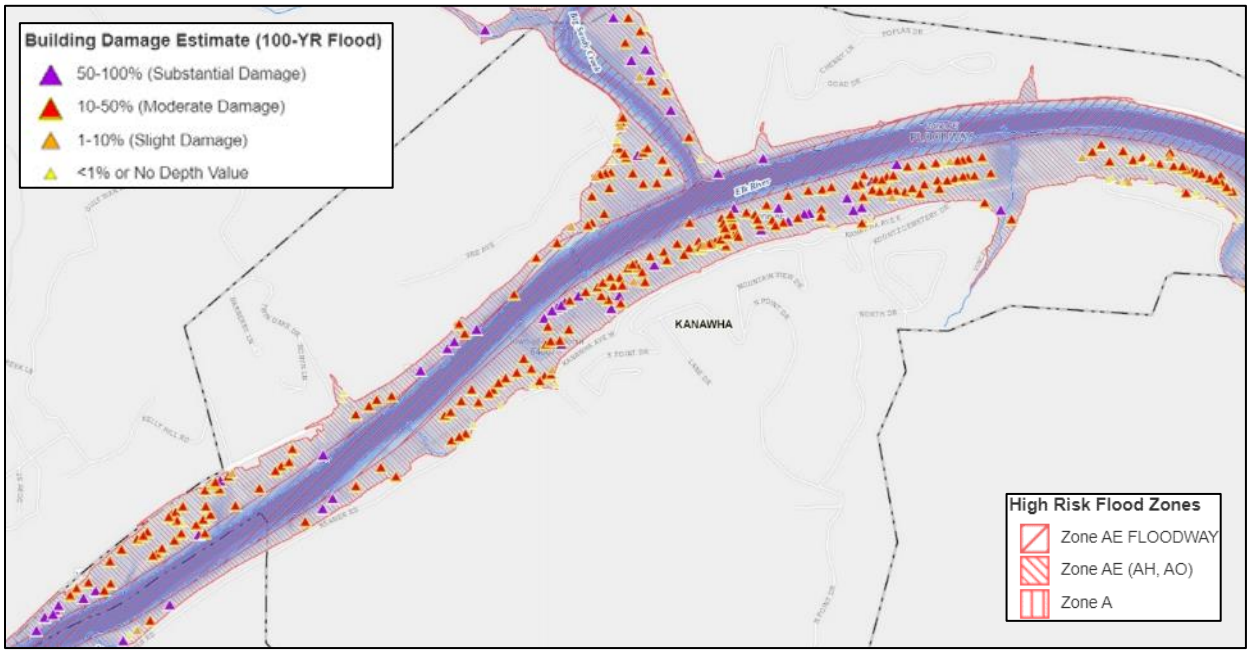


Figure 136. Building damage estimates (percent of appraised value) in Clendenin viewable on the Risk MAP View of WV Flood Tool

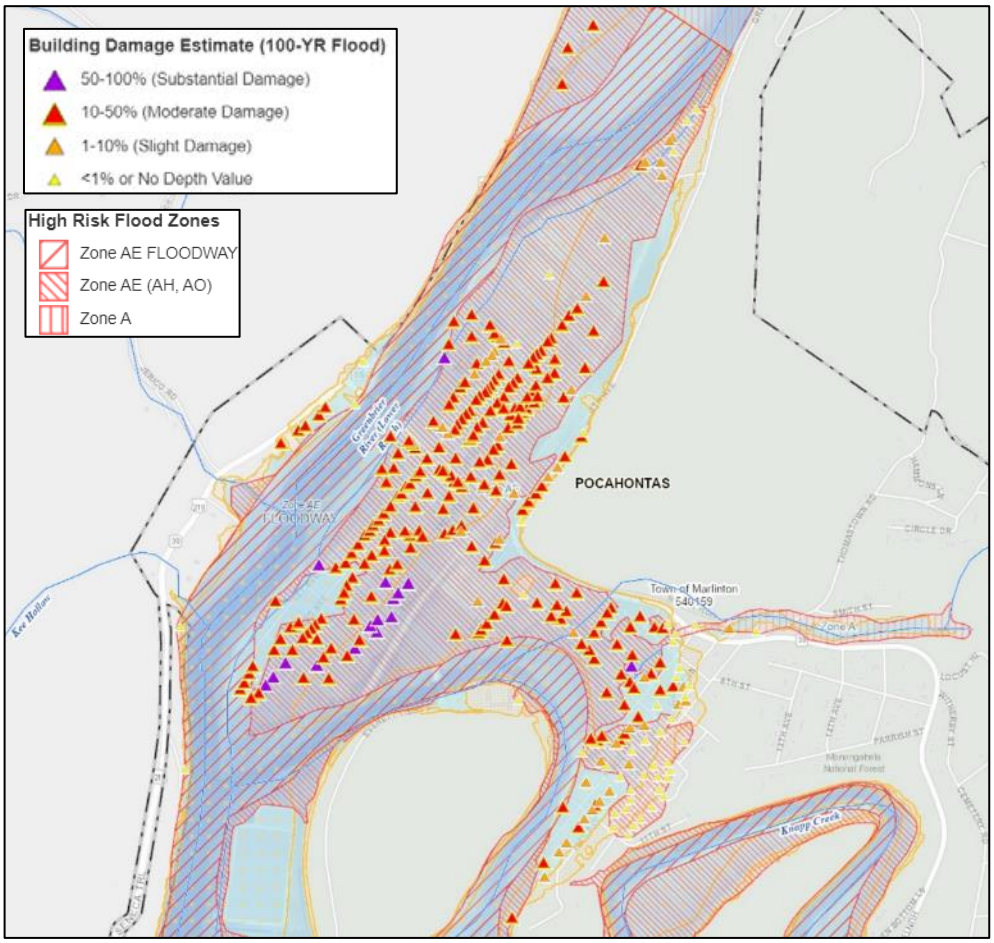


Figure 137. Building damage estimates (percent of appraised value) in Marlinton viewable on the Risk MAP View of WV Flood Tool

Figure 138. Highest estimated building loss in Clendenin ($84K),
Clendenin Health Center (Building ID: 20-02-0007-0004-0003_107)

Figure 139. Highest estimated building loss in Marlinton ($248K),
Marlinton Elementary School (Building ID: 38-08-0005-0009-0000_926)

Figure 140. Highest estimated building loss in Camden-on-Gauley ($25K),
Police Department, Storage Facility (Building ID: 51-01-0003-0094-0000_9676)

Previous Damage Claims

A high number of flood insurance claims in a community indicates that flooding is occurring, and community members are making claims against their policies. The frequency of flooding and the community's claim history are key factors in determining a building's individual flood risk and the associated insurance premium.

The number of previous flood-related insurance claims since 1978 was another indicator used in developing the WV Flood Risk Index. The data came from the National Flood Insurance Program (NFIP) records for West Virginia, provided by FEMA in 2024. **Marlinton**, with 585 claims, ranks ***2nd*** among incorporated places, while **Rainelle** ranks ***21st*** with 154 claims. These figures place both communities in the ***top 10%*** of incorporated places, earning them a "VERY HIGH" risk classification for this indicator. **Richwood** (ranked 23rd) with 144 claims, **Clendenin** (ranked 28th) with 122 claims, and **White Sulphur Springs** (ranked 32nd) with 89 claims fall within the ***top 20%*** incorporated places, classifying them as "Very High" risk. **Camden-on-Gauley** has 21 previous claims. All of these communities, except for Camden-on-Gauley, exceed the statewide average of 71 claims for incorporated places.

Communities with a high number of previous flood claims should be prioritized for mitigation planning and funding. Strengthening or establishing floodplain management policies, such as stricter building codes and land use regulations, can help reduce future flood damage and lower the number of claims.

Repetitive Loss Structures

Buildings insured under the National Flood Insurance Program (NFIP) that have had at least two paid flood losses of more than $1,000 each in any 10-year period since 1978 are classified as repetitive loss structures. A preponderance of repetitive loss structures indicates that the community is at a higher risk for future losses. Repetitive loss structures can cause direct cost of the continued need for emergency services as well as the indirect cost related to lost economic activity and sales tax revenue from businesses that are offline during recovery efforts in addition to lost property taxes for abandoned properties (Source: FEMA Region 3).

The number of repetitive loss structures was considered as another risk indicator in the WV Flood Risk Index. The needed data were obtained from the NFIP Policy and Claims Report for West Virginia, provided by FEMA in 2024, along with geocoded points for repetitive loss structures from 2020 in the state. In **Marlinton**, 252 repetitive loss structures were identified, placing the community ***2nd*** statewide and in the ***top 10%*** of all incorporated places. **Richwood**, ranked ***19th*** with 66 repetitive loss structures, also falls within the ***top 10%***. **Rainelle**, ranked ***29th***, has 35 repetitive loss structures, while **Clendenin**, ranked ***39th***, has 24. Both of these communities are among the ***top 20%*** of incorporated places for this risk indicator. **Camden-on-Gauley** has 11 repetitive loss structures, and **White Sulphur Springs** has only two. The repetitive loss count in **Marlinton** and **Richwood** is higher than the statewide average of 27 for all incorporated places.

Repetitive loss structures may be eligible for the Flood Mitigation Assistance (FMA) grant program by FEMA up to a 90% cost share for mitigation efforts such as property acquisition, structure demolition or relocation, building elevation, and dry flood proofing of non-residential structures (Source: FEMA). Communities with high numbers of repetitive loss structures should consider such grants to mitigate the risk. They should also consider comprehensive plans and economic development plans to identify sites for relocation from flood-prone areas in order to avoid future risk (Source: FEMA Region 3).

Category Index Scores and Summary for Building Damage Loss

As explained in the chapter, four indicators of Substantial Damage Count, Substantial Damage Ratio, Previous Damage Claims, and Repetitive Loss Structures were considered for this category. The combined scores for these indicators place **Marlinton** in the ***8th*** place and **Clendenin** in the ***9th***, both ranking within the ***top 10%*** of incorporated places for the building damage loss category. **Camden-On-Gauley** (ranked ***40th***) falls within the ***top 20%***. These three communities are classified in the "Very High" risk class for building damage. **Richwood** (ranked 50th) and **Rainelle** (ranked 51st) are classified in the "Relatively High" risk class, while **White Sulphur Springs** (ranked 127th) is in the "Moderate" risk group.

Table 14 summarizes the indicators used to measure building loss in the selected communities. The table employs a color scheme to highlight the degree of risk, ranging from "VERY HIGH" to "Very Low," as explained in the legend. According to the table, **Clendenin** ranks within the ***top 10%*** of incorporated places for substantial damage count, while **Marlinton** falls within the ***top 20%*** for this indicator. For the substantial damage ratio, **Camden-On-Gauley** ranks in the ***top 10%***, with **Clendenin** in the ***top 20%***. In terms of previous damage claims, **Marlinton** and **Rainelle** are in the ***top 10%***, while **Clendenin**, **Richwood**, and **White Sulphur Springs** rank in the ***top 20%***. **Marlinton** and **Richwood** are in the ***top 10%*** of incorporated places for repetitive loss structures, with **Clendenin** and **Rainelle** ranking in the ***top 20%*** for this indicator.

Table 14. Category summary of building damage loss for the selected communities

Incorporated Place	BUILDING DAMAGE LOSS					
	Substantial Damage Count	Substantial Damage Ratio	Previous Damage Claims	Repetitive Loss Structures	Category Score (0 to 100%)	Category Rank in Incorporated Places
Marlinton	16	4.3%	**585**	**252**	**96.9%**	8
Clendenin	**46**	15.2%	122	24	**96.4%**	9
Camden-On-Gauley	4	**19.0%**	21	11	82.8%	40
Richwood	1	0.3%	144	**66**	78.5%	50
Rainelle	1	0.3%	**154**	35	78.0%	51
White Sulphur Springs	0	0.0%	89	2	44.7%	127

Risk Index Legend

VERY HIGH: 90% - 100% (Among the top 10% incorporated places)

Very High: 80% - 100% (Among the top 20% incorporated places)

Relatively High: 60% - 79.9%

Relatively Low: 20% - 39.9%

Moderate: 40% - 59.9%

Very Low: 0% - 19.9%

PEOPLE / SOCIAL VULNERABILITIES

This risk group measures population exposure to flood, evacuation needs, and social vulnerabilities. Specifically, this category includes Population in Floodplain Ratio, Population Displaced Ratio, and WV Social Vulnerability Index.

Population in Floodplain Ratio

Floods pose a significant threat to human life and health, making people the most important and valuable elements to protect during a flood. The direct impacts can include drowning, physical trauma, electrocution, and heart attacks, while the indirect consequences may involve mental trauma and economic challenges. Most flood-related fatalities result from flash floods caused by extreme precipitation events. Additionally, fatalities often occur due to risky behaviors, such as underestimating the danger and failing to evacuate to higher ground in a timely manner, entering floodwaters on foot or in vehicles, or attempting to rescue others, pets, or personal belongings.

A larger population residing in floodplains increases human exposure to floods, which can result in greater human losses. As an indicator in the WV Flood Risk Index, the percentage of the population residing in high-risk Special Flood Hazard Areas (100-year floodplain) relative to the total population of 2021 was calculated. The population in the floodplain was estimated at the building level by identifying the type of residential buildings (single-family homes, apartments, etc.) and the corresponding number of units using data from the WV BLRA. This number was then multiplied by the average household size from community-level data in the Census Bureau's 2021 American Community Survey (ACS) 5-year estimates.

According to the results, 84.6% of population in **Marlinton**, ranked ***8th*** in incorporated places, reside in the effective or advisory 1%-annual-chance floodplains (1,124 of 1,329 people). In **Clendenin**, ranked ***13th***, the population in floodplain ratio is 66.8% (866 of 1,297 people). Both communities fall within the ***top 10%*** of incorporated places and are classified in the "VERY HIGH" risk group for this indicator. In **Rainelle**, 45.6% of the population (564 out of 1,236 people) live in high-risk floodplains, placing it ***31st*** and among the ***top 20%*** of incorporated places. This community is also classified in the "Very High" risk category. In **White Sulphur Springs**, 25.8% of the population are in the high-risk floodplains (685 of 2,659 people), while this percentage is 23.8% in **Richwood** (621 of 2,604 people), and 23.3% in **Camden-on-Gauley** (41 of 176 people). These three incorporated places are classified in the "Relatively High" group for this indicator. All of these communities reach or exceed the statewide average ratio of 23.3% for all incorporated places.

Regarding previous disasters, of the 23 total deaths resulting from the 2016 flood in West Virginia, five occurred in **White Sulphur Springs**, four in **Rainelle**, and one in **Clendenin**. In the 1985 flood, which claimed 49 lives across the state, two of the victims were residing in **Marlinton**.

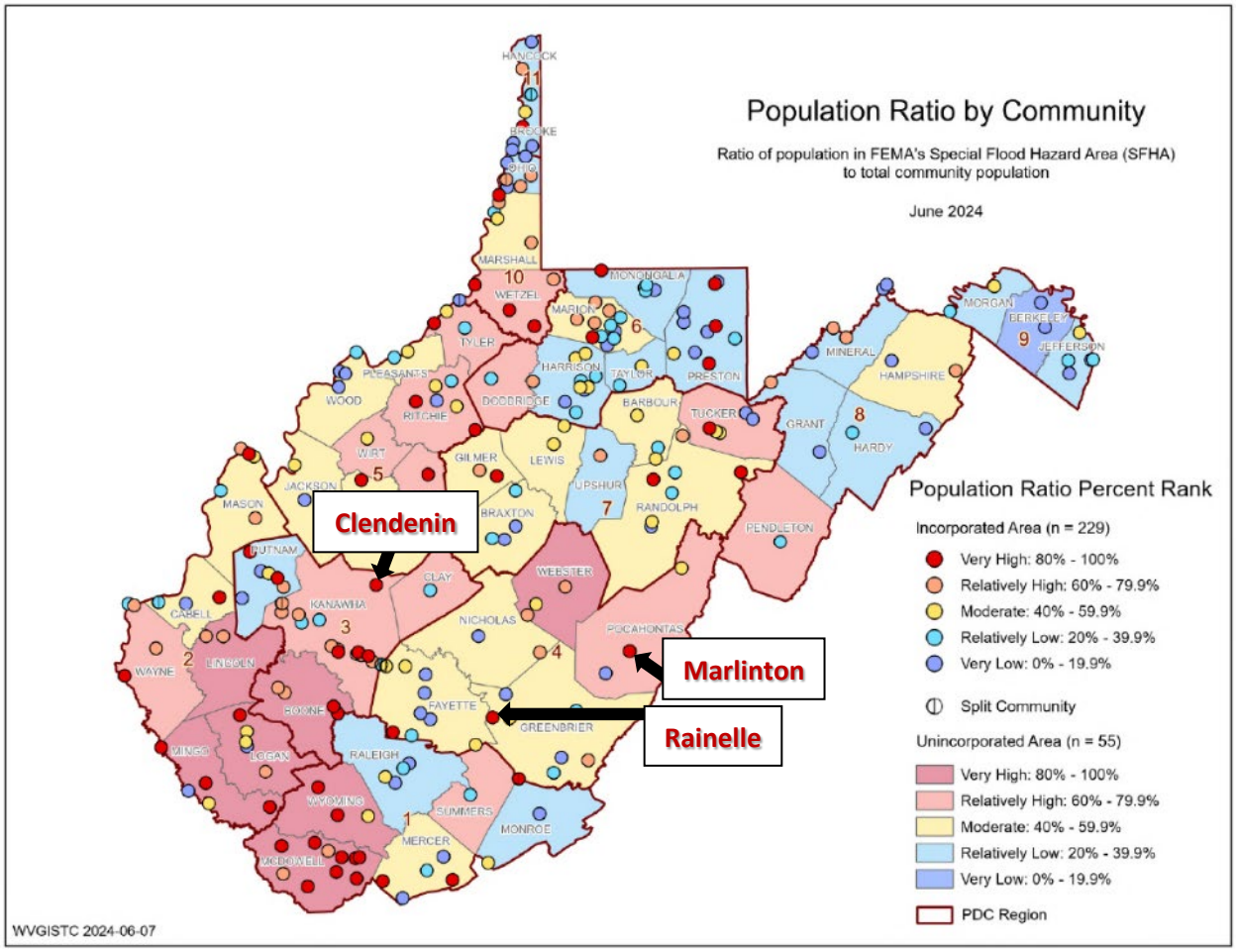


Figure 141. Marlinton, Clendenin, and Rainelle on the map of population in floodplain ratio ranks for communities

Community officials should consider land use planning and zoning strategies to prevent residential development in floodplains. It is essential to communicate flood risks to residents living in these areas, educating them about the hazards and available mitigation measures, such as purchasing flood insurance, elevating structures, and using wet floodproofing techniques. Emergency evacuation plans for flood disasters should include flood warning systems and evacuation protocols tied to specific flood stages to ensure the safe evacuation of people and pets. For further guidance, officials and residents can consult resources such as Ready.gov, which offers recommendations on disaster planning for flooding and other emergencies, including considerations for people with disabilities, older adults, and pets. Additionally, reviewing the National Safety Council and the National Weather Service's Flood Safety Tips and Resources can be useful for further safety measures.

Population Displaced Ratio

Exposure to floods can result in population displacement or relocation, which may be either temporary (short-term) or permanent (long-term). Permanent relocation can occur when residential buildings are substantially damaged and uninhabitable, or when the area is at high risk of repeated flooding. Short-term displacement often happens when homes are damaged or when inundation blocks access to residential buildings. In such cases, evacuees plan to return to their communities once the floodwaters recede and the damaged residential units are restored. During displacement, people may stay with relatives or friends, find accommodation in hotels, or use short-term shelters in safer areas. Typically, the flood depth for evacuation ranges from six inches, which is the typical height of a street curb, to one foot, which is the inundation depth at which vehicles start to float. Population displacement estimates can aid in pre-disaster emergency management and evacuation planning.

The ratio of population displaced on a short-term basis was considered as an indicator in the WV Flood Risk Index. This ratio represents the estimated percentage of the total population that would be displaced by a major flood with a 1%-annual-chance (100-year) probability, resulting in inundation of one foot or more. To calculate population displacement, the number of residential units located in areas with flood depths of one foot or higher was multiplied by the average household size, based on data from the Census Bureau's 2021 American Community Survey (ACS) 5-year estimates. These building-level estimates were then aggregated across multiple scales, including incorporated places, and the percentages of displaced population were calculated in relation to the total population, also derived from the 2021 ACS 5-year estimates.

The results show that 76.0% of **Marlinton**'s total population (1,010 out of 1,329 people) could be displaced by a high-risk flood event, ranking the community ***5th*** among incorporated places statewide. In **Clendenin**, the displacement ratio is 63.0% (817 out of 1,297 people), placing it ***8th***, while **Rainelle** has a displacement ratio of 38.3% (473 out of 1,236 people), ranked ***22nd***. These three communities are in the ***top 10%*** of incorporated places and are classified in the "VERY HIGH" risk group for this indicator. **White Sulphur Springs** has a population displacement ratio of 17.5% (466 out of 2,659 people), **Richwood**'s ratio is 16.9% (440 out of 2,604 people), and **Camden-on-Gauley**'s is 15.9% (28 out of 176 people). These communities are classified in the "Relatively High" risk group for this indicator. All of these communities, except for Camden-on-Gauley have the population displaced ratios higher than the statewide average ratio of 16.1% for incorporated places.

Communities should use population displacement estimates to enhance their emergency response, particularly for evacuation during high-risk floods. They should use these estimates to identify evacuation routes and improve planning for transportation, shelters, and supplies. Additionally, many households have companion pets, such as dogs and cats. According to the 2023 U.S. Pet Ownership Statistics, 45% of households own dogs and 26% own cats. Emergency plans should account for mobile pet shelter resources, such as trailers, plastic crates, and pens, to accommodate companion animals and other pets.

Figure 142. Evacuation of the 2016 flood in Rainelle

WV Social Vulnerability Index

Natural hazards, such as floods, can impact individuals and communities differently, depending on their social and demographic characteristics. Social vulnerability is a situation where certain demographic and socioeconomic characteristics make some groups of people more susceptible to hazards, affecting their ability to anticipate, respond to, and recover from them. Communities with higher social vulnerability are less likely to recover quickly or fully from a flood disaster.

For West Virginia, a local approach identified eight vulnerability factors relevant to the state's social context to create the WV Social Vulnerability Index (WVSVI). These factors include economic indicators (Poverty Rate and Unemployment Rate), population characteristics (Vulnerable Ages Ratio, Disability Ratio, Population without a High School Education Ratio, and Population Change Ratio), and housing indicators (Median Housing Unit Value and Mobile Homes as a Percentage of Housing). The 2021 American Community Survey (ACS) 5-year estimates published by the Census Bureau was used for most factors, except for population change which was based on the Decennial Census (DEC) data from 2010 and 2020. The vulnerability scores range from 100%, representing the most vulnerable entities, to zero, indicating the least vulnerable spatial units. The WVSVI was then used as an indicator in the development of the WV Flood Risk Index.

Based on the results, **Richwood** (ranked ***18th*** among incorporated places statewide) has a social vulnerability score of 92.5%, placing it in the ***top 10%*** of incorporated places and in the "VERY HIGH" risk class. **Rainelle** (ranked ***36th***) is among the ***top 20%*** of incorporated places with a vulnerability score of 84.6%, placing it in the "Very High" risk group. **Marlinton**, with a score of 60.4%, falls into the "Relatively High" risk class. Meanwhile, the score is 36.6% in **Clendenin**, 27.3% in **Camden-on-Gauley**, and 21.1% in **White Sulphur Springs** classifying them in the "Relatively Low" risk group for social vulnerability.

Decision makers should pay attention to the social vulnerability index to identify the most vulnerable communities. By using available grants more efficiently, they can better serve vulnerable populations before, during, and after a flood event. This proactive approach ensures resources are allocated where they are needed most, enhancing overall community resilience and recovery efforts. Additionally, investing in outreach and education programs is vital to help vulnerable populations understand their flood risks and prepare effectively. This can further enhance resilience, fostering better preparedness and quicker recovery in the face of flood hazards.

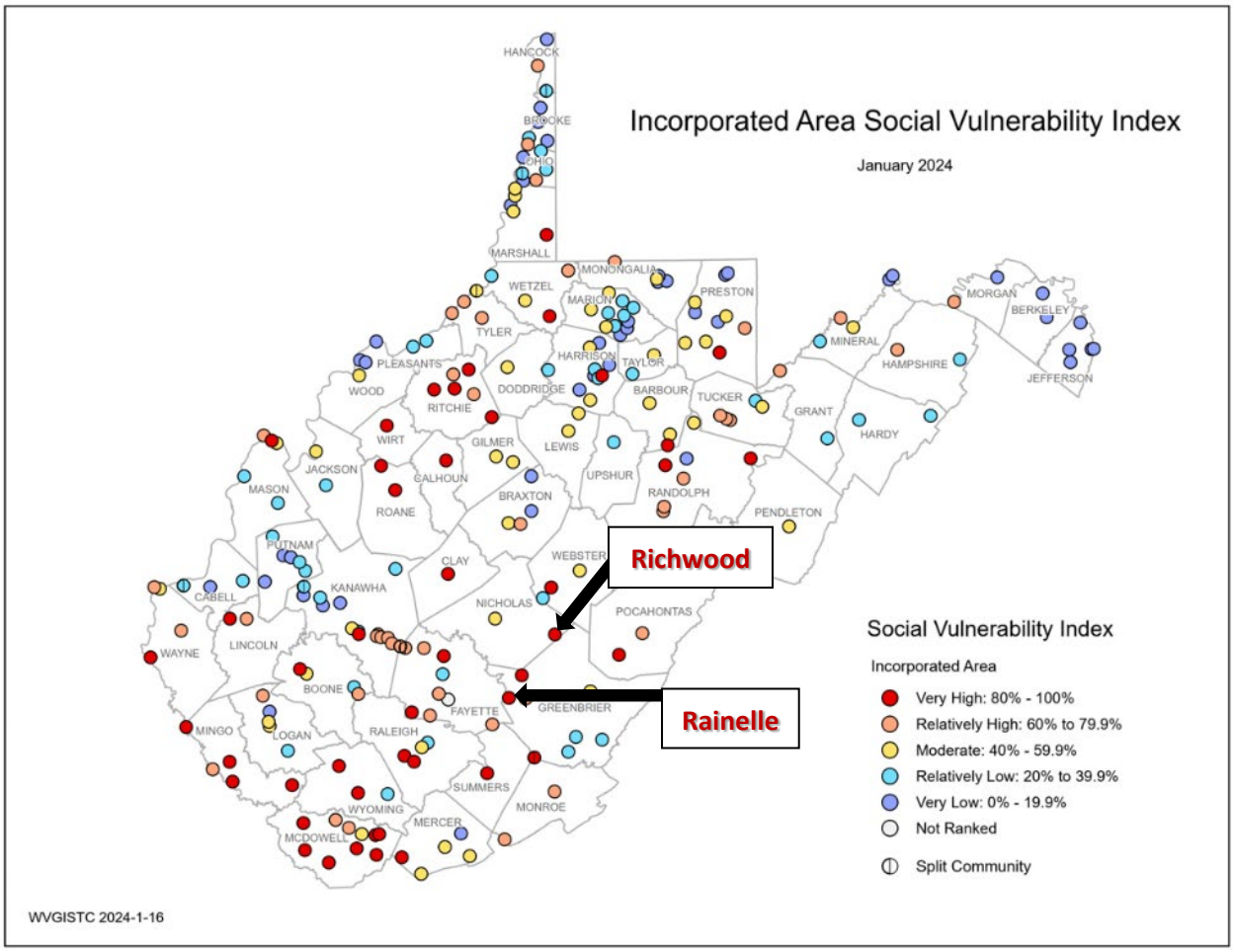


Figure 143. Richwood and Rainelle on the map of WV Social Vulnerability Index for incorporated places

Table 15 summarizes the eight key factors used to create the WV Social Vulnerability Index (WVSVI), which include indicators from economic, population, and housing characteristics. To provide a broader context for the index, the values are also computed at the state and national levels. The comparison can help in better understanding the magnitude of vulnerability in the study areas. Additionally, Table 16 provides detailed descriptions and the rationale behind selecting these indicators.

Table 15. Summary of WV Social Vulnerability Index factors

Vulnerability Factor	Richwood	Rainelle	Marlinton	Clendenin	Camden-on-Gauley	White Sulphur Springs	State Ratio or value	National Ratio or Value
Poverty Rate	26.1%	27.7%	25.7%	9.2%	14.3%	21.9%	17.0%	12.4%
Unemployment Rate	39.8%	22.1%	16.3%	7.3%	8.3%	13.0%	23.7%	14.6%
Vulnerable Ages Ratio	43.1%	36.0%	37.6%	45.4%	33.0%	37.5%	36.7%	34.6%
Disability Ratio	29.9%	31.9%	27.6%	11.2%	9.7%	20.5%	19.3%	12.6%
No High School Diploma Ratio	13.2%	15.4%	16.1%	10.1%	4.8%	8.3%	11.9%	11.1%
Population Change Ratio	-19.1%	-20.9%	-5.3%	-30.4%	-25.4%	-9.1%	-3.2%	7.4%
Median Housing Value	$68.3K	$59.1K	$79.7K	$70.3K	$73.8K	$121.0K	$128.8K	$244.9K
Mobile Homes Ratio	7.5%	9.3%	4.9%	3.9%	11.1%	0.0%	14.0%	5.9%
WV Social Vulnerability Index Score	92.5%	84.6%	60.4%	36.6%	27.3%	21.1%	-	-

Table 16. Descriptions and rationale of WV Social Vulnerability factors

Vulnerability Factor	Description	Rationale
Poverty Rate	Percentage of households with incomes below poverty level	The poor often lack the financial means to prepare for potential disasters and may be less able to recover from the effects.
Unemployment Rate	Percentage of families (two or more people residing together and related by birth, marriage, or adoption) with no workers in the past 12 months (from 2021)	The unemployed may not have any financial assets or health benefits to recover from disasters.
Vulnerable Ages Ratio	Percentage of population in two groups of "younger than 15" or "65 and older"	Children and the elderly are generally more vulnerable to disasters such as flooding due to the lack of experience or physical and cognitive limitations to protect themselves.
Disability Ratio	Percentage of civilian noninstitutionalized population with disabilities of independent living, self-care, ambulatory, cognitive, vision, or hearing difficulties	Disabled people are more vulnerable to natural hazards such as flooding and may require special assistance to evacuate.
No High School Diploma Ratio	Percentage of population 25 years and older with no high school diploma	Highly educated individuals and societies are reported to have better preparedness and response to disasters, suffered lower negative impacts, and can recover faster.
Population Change Ratio	Percentage of population change from 2010 to 2020	A community with a negative population growth rate in the SFHA area will likely have less resources to recover from a major flood disaster than an area undergoing economic growth.
Median Housing Value	Median dollar values of owner-occupied residential units	Residents in communities with higher median housing values may be more likely to carry flood insurance policies, as their properties represent substantial investments. This can enhance financial preparedness and resilience.
Mobile Homes Ratio	Percentage of manufactured homes in the residential buildings within the whole community	Light-weight manufactured homes are not designed for withstanding floods making them more susceptible to flood damage. Communities with many manufactured homes face greater challenges in resilience, as these structures provide less security than traditional homes. Additionally, mobile homes are often located outside urban cores, which limits access to major roadways and public transit systems.

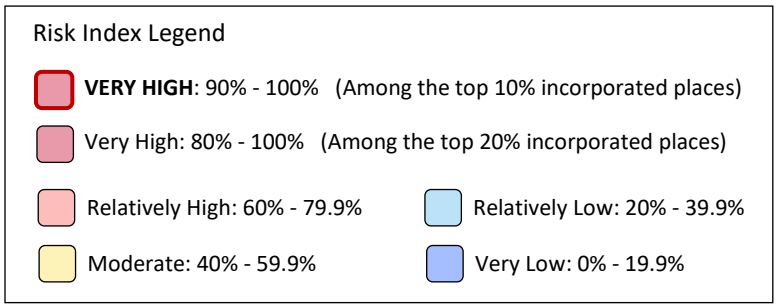
Category Index Scores and Summary for People / Social Vulnerabilities

As described in the chapter, three indicators were used in this category for the development of the WV Flood Risk Index: Population in Floodplain Ratio, Population Displaced Ratio, and WV Social Vulnerability Index. Based on combined scores for these indicators, **Rainelle** ranks ***17th*** and **Marlinton** ***23rd***, placing them among the ***top 10%*** of incorporated places statewide in the "VERY HIGH" risk class for the People/Social Vulnerabilities category. **Richwood** (ranked ***33rd***) and **Clendenin** (ranked ***45th***) are within the ***top 20%*** and also fall in the "Very High" risk class for this category. Meanwhile, **Camden-On-Gauley** (ranked 91st) is in the "Relatively High" risk class, and **White Sulphur Springs** (ranked 93rd) is in the "Moderate" risk group.

Table 17 summarizes the indicators used to assess population exposure and social vulnerability across the selected communities. A color scheme is applied to indicate the degree of risk, from "VERY HIGH" to "Very Low," as outlined in the legend. As shown, **Marlinton** and **Clendenin** rank among the ***top 10%*** of incorporated places for the ratio of population residing in floodplains, while **Rainelle** is within the ***top 20%*** for this indicator. For the population displacement ratio, **Marlinton**, **Clendenin**, and **Rainelle** fall in the ***top 10%*** of incorporated places. Regarding social vulnerability, **Richwood** ranks in the ***top 10%***, with **Rainelle** in the ***top 20%***.

Table 17. Category summary of people / social vulnerabilities for the selected communities

Incorporated Place	PEOPLE / SOCIAL VULNERABILITIES				
	Population in Floodplain Ratio	Population Displaced Ratio	WV Social Vulnerability Index	Category Score (0 to 100%)	Category Rank in Incorporated Places
Rainelle	45.6%	**38.3%**	84.6%	**92.9%**	17
Marlinton	**84.6%**	**76.0%**	60.4%	**90.3%**	23
Richwood	23.8%	16.9%	**92.5%**	85.9%	33
Clendenin	**66.8%**	**63.0%**	36.6%	80.7%	45
Camden-On-Gauley	23.3%	15.9%	27.3%	60.5%	91
White Sulphur Springs	25.8%	17.5%	21.1%	59.6%	93



REFERENCES

American Veterinary Medical Association (AVMA). (2023). *U.S. pet ownership statistics.* https://www.avma.org/resources-tools/reports-statistics/us-pet-ownership-statistics

City of Ann Arbor, Michigan. (2024). *Flood safety.* https://www.a2gov.org/departments/systems-planning/water-resources/floodplains/Pages/Flood-Safety.aspx

Congressional Research Service. (2024). *National Flood Insurance Program Risk Rating 2.0: Frequently asked questions.* https://crsreports.congress.gov/product/pdf/IN/IN11777

Federal Emergency Management Agency (FEMA), Region 3. (2021). *Reducing risk in the floodplain: Connecting the dots between community floodplain management, hazard mitigation planning, emergency management, land use, and water resource management; Take immediate action.* https://www.fema.gov/sites/default/files/documents/fema_r3_reducing-risk-in-floodplain-guide.pdf#page=30

Federal Emergency Management Agency (FEMA), Region 3. (2021). *Reducing risk in the floodplain: Connecting the dots between community floodplain management, hazard mitigation planning, emergency management, land use, and water resource management; Mitigating repetitive flood losses.* https://www.fema.gov/sites/default/files/documents/fema_r3_reducing-risk-in-floodplain-guide.pdf#page=23

Federal Emergency Management Agency (FEMA). (2009). *Protecting manufactured homes from floods and other hazards: A multi-hazard foundation and installation guide.* https://www.fema.gov/sites/default/files/2020-08/fema_p85.pdf

Federal Emergency Management Agency (FEMA). (2010). *Mitigation and basement flooding.* https://www.fema.gov/pdf/hazard/flood/2010/1935/Basement_Flood_Mitigation.pdf

Federal Emergency Management Agency (FEMA). (2018). *Natural hazard mitigation saves interim report.* https://www.fema.gov/sites/default/files/2020-07/fema_mitsaves-factsheet_2018.pdf

Federal Emergency Management Agency (FEMA). (2020). *Glossary: Pre-FIRM building.* https://www.fema.gov/about/glossary/pre-firm-building

Federal Emergency Management Agency (FEMA). (2020). *Requirements for flood openings in foundation walls and walls of enclosures: Below elevated buildings in Special Flood Hazard Areas in accordance with the National Flood Insurance Program; Enclosed areas under buildings elevated on open foundations.* https://www.fema.gov/sites/default/files/2020-07/fema_tb1_openings_foundation_walls_walls_of_enclosures_031320.pdf#page=21

Federal Emergency Management Agency (FEMA). (2021). *Requirements for the design and certification of dry floodproofed non-residential and mixed-use buildings located in Special Flood Hazard Areas in accordance with the National Flood Insurance Program: Limitations on the use of dry floodproofing.* https://www.fema.gov/sites/default/files/documents/fema_technical-bulletin-3_1-2021.pdf#page=8

Federal Emergency Management Agency (FEMA). (2022). *Discount explanation guide.* https://www.fema.gov/sites/default/files/documents/fema_discount-Explanation-Guide.pdf

Federal Emergency Management Agency (FEMA). (2022). *Rate explanation guide.* https://www.fema.gov/sites/default/files/documents/fema_rate-explanation-guide.pdf

Federal Emergency Management Agency (FEMA). (2023). *Floodplain management: Increased cost of compliance coverage.* https://www.fema.gov/floodplain-management/financial-help/increased-cost-compliance

Federal Emergency Management Agency (FEMA). (2023). *Hazard Mitigation Assistance Program and policy guide; program-specific guidance: D.1. FMA: Eligibility.* https://www.fema.gov/grants/mitigation/guide/part-10/d/1

Federal Emergency Management Agency (FEMA). (2024). *Flood Insurance Mitigation Discount Tool.* https://www.floodsmart.gov/flood-insurance-mitigation-discount-tool

Federal Emergency Management Agency (FEMA). (2024). *What to do before a flood.* https://www.floodsmart.gov/first-prepare-flooding

Federal Emergency Management Agency (FEMA). *Understanding flood dangers in Central West Virginia: Lessons learned from the June 2016 flood.* https://www.fema.gov/sites/default/files/documents/Region_III_WV_FloodReport.pdf

Kershaw County, South Carolina. (2024). *Code of ordinances; Chapter 16: Flood damage prevention.* https://library.municode.com/sc/kershaw_county/codes/code_of_ordinances?nodeId=COOR_CH16FLDAPR_ARTVLESTPR_S16-136EFUPOUBUPE

National Safety Council. (2024). *When the waters rise, will you know what to do?* https://www.nsc.org/community-safety/safety-topics/emergency-preparedness/flood-preparedness?utm_source=google_search&utm_medium=cpc&utm_campaign=home_safety_emergency_preparedness_gps&utm_content=nsc&gad_source=1&gclid=Cj0KCQjwzby1BhCQARIsAJ_0t5M2DZSMaqQVIvldqZ3FygQcGEi9XctG65vTS8W3CaxRIYVR3aNBpEYaAkcMEALw_wcB

National Weather Service. (2024). *Flood Safety Tips and Resources.* https://www.weather.gov/safety/flood

U.S. Department of Homeland Security. (2024). *Ready: Floods.* https://www.ready.gov/floods

U.S. Department of the Interior, National Park Service. (2019). *The Secretary of the Interior's standards for rehabilitation & guidelines on flood adaptation for rehabilitating historic buildings.* https://www.nps.gov/orgs/1739/upload/flood-adaptation-guidelines-2021.pdf

United States Environmental Protection Agency (EPA). (2014). *Flood resilience: A basic guide for water and wastewater utilities.* https://www.epa.gov/sites/default/files/2015-08/documents/flood_resilience_guide.pdf

US Army Corps of Engineers (USACE), National Nonstructural Committee. (2019). *Nonstructural flood risk management.* https://usace.contentdm.oclc.org/utils/getfile/collection/p16021coll11/id/3974

West Virginia Conservation Agency. (2010). *West Virginia statewide flood protection plan.* https://www.wvca.us/flood/pdf/wv_statewide_plan.pdf

West Virginia Division of Homeland Security and Emergency Management. (2017). *Floodplain management in West Virginia: Quick guide; Manufactured homes deserve special attention.* https://data.wvgis.wvu.edu/pub/RA/_resources/FPM/WV_Quick_Guide_FPM_Version_2017.pdf#page=59

West Virginia Division of Homeland Security and Emergency Management. (2017). *Floodplain management in West Virginia: Quick guide; Basements are unsafe in Special Flood Hazard Areas.* https://data.wvgis.wvu.edu/pub/RA/_resources/FPM/WV_Quick_Guide_FPM_Version_2017.pdf#page=36

West Virginia GIS Technical Center (WVGISTC). (2019). *WV flooded towns, June 2016: The historic flooding of Southern West Virginia on June 23, 2016.* https://wvu.maps.arcgis.com/apps/Cascade/index.html?appid=7b98379452094cd6827dc8f09c8293bd

West Virginia GIS Technical Center (WVGISTC). (2022). *Flood risk in West Virginia: What we learned from the June 2016 flood.* https://wvu.maps.arcgis.com/apps/Cascade/index.html?appid=32292859b21b44e99c0be706f6da8aa3

West Virginia GIS Technical Center (WVGISTC). (2022). *West Virginia Flood Tool advisory flood height (AFH) data.* https://www.mapwv.gov/flood/content/documents/AFHhandout.pdf

West Virginia GIS Technical Center (WVGISTC). (2024). *West Virginia Risk Explorer (WVRE).* https://wvfrf.org/wvre/

West Virginia GIS Technical Center (WVGISTC). (2024). *WV advisory flood heights (A zones): State-sponsored advisory BFE mapping.* https://data.wvgis.wvu.edu/pub/RA/_resources/status/Advisoy_A_and_AFH_Status.pdf

West Virginia GIS Technical Center (WVGISTC). (2024). *WV Flood Tool.* https://www.mapwv.gov/flood

West Virginia State Historic Preservation Office (SHPO). (2024). *Interactive Map.* https://mapwv.gov/shpo/viewer/index.html