4.5 Flooding: Riverine, Flash Flooding and Dam Inundation

Flooding is perhaps the most common and widespread hazard within the New River Valley, as it is across the nation. DFIRMs from the NFIP are available for all counties and the city in the NRV. These are digitized versions of the paper maps created in the 1970s at the origination of the NFIP. The DFIRMs locate the 100-year floodplain, meaning the area that has a 1% chance of flooding in any given year. Property owners living within a community that participates in the NFIP can purchase flood insurance through the federal program, regardless of their location in or outside of the floodplain. Insurance rates do increase as the predicted risk of flooding increases, as based off the DFIRMs.

Figure 4-16 below shows a generalized depiction of a 100-year floodplain. The base flood is also called the 100-year flood which has a 1% probability of being equaled or exceeded in any given year. The floodplain is defined as any land area susceptible to partial or complete inundation by water from any source. The floodway is the central channel and that portion of the adjacent floodplain which must remain open to permit passage of the base flood. The greatest intensity floodwaters are generally in the floodway, and anything in this area is at greatest risk during a flood. The remainder of the 100-year floodplain is called the "fringe" where water may be shallower and slower. The depth and intensity of the water flow here is determined by existence of obstructions.

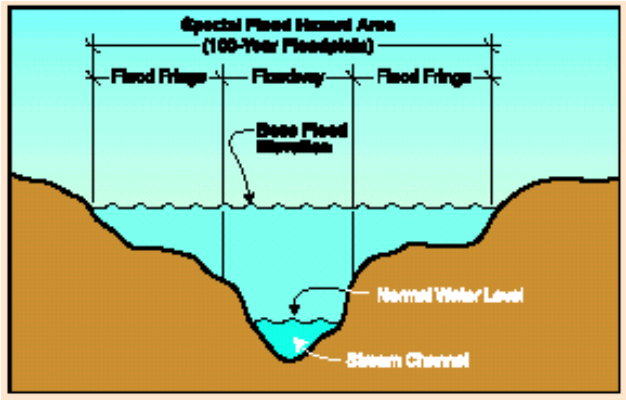

Figure 4-16. Generalized 100-Floodplain

It is important to note that on the FIRMs and in the supporting Flood Insurance Studies "the hydraulic analysis…is based on the effects of unobstructed flow. The flood elevations as shown are considered valid only if the hydraulic structures in general remain unobstructed and do not fail." When flow is obstructed, as often happens with debris, the impacted area is wider and/or the depths of the water are greater.

Table 4-8 below describes the flood hazard areas as depicted by the DFIRMs and their associated probabilities.

Table 4-8. FEMA Special Flood Hazard Area designations and probabilities

Probability	Zone	Description
Annual probability of Flooding of 1% or	A	Subject to 100-year flood. Base flood elevation undetermined.

Probability	Zone	Description
Greater	AE or A1-A30	Both AE and A1-A30 represent areas subject to 100-year flood with base flood determined.
	AH	Subject to 100-year shallow flooding (usually areas of poundings) with average depth of 1-3 feet. Base flood elevation determined.
	AO	Subject to 100-year shallow flooding (usually sheet flow on sloping terrain) with average depth of 1-3 feet. Base flood elevation undetermined.
	V	Subject to 100-year flood and additional velocity hazard (wave action). Base flood elevation undetermined.
	VE or V1-V30	Both VE and V1-V30 represent areas subject to 100-year flood and additional velocity hazard (wave action). Base flood elevation determined.
Annual Probability of Flooding of 0.2% to 1%	B or X500	Both B and X500 represent areas between the limits of the 100-year and 500-year flood; or certain areas subject to 100-year flood with average depths less than 1 foot or where the contributing drainage area is less than 1 square mile; or areas protected by levees from the 100-year flood.
Annual Probability of Flooding of Less than 0.2%	C or X	Both C and X represent areas outside the 500-year flood plain with less than 0.2% annual probability of flooding.
Annual Probability of Flooding of Less than 1%	No SFHA	Areas outside a “Special Flood Hazard Area” (or 100-year flood plain). Can include areas inundated by 0.2% annual chance flooding; areas inundated by 1% annual chance flooding with average depths of less than 1 foot or with drainage areas less than 1 square mile; areas protected by levees from 1% annual chance flooding; or areas outside the 1% and 0.2% annual chance floodplains.

In the NRV there are multiple properties that are defined as either Repetitive Loss or Severe Repetitive Loss by the NFIP. Table 4-9 summarizes these properties.

Table 4-9. Repetitive and Severe Repetitive Loss Properties by Locality

Locality	Repetitive Loss Properties	Severe Repetitive Loss Properties	Type of Properties
Floyd County	1	1	All residential
Giles County	5	1	All residential
Montgomery County	15	1	1 commercial, 14 residential
Pulaski County	5	0	All residential
Town of Pulaski	2	0	All residential

The Town of Pulaski acquired two repetitive loss properties in 2002 and have successfully utilized five structural acquisitions for community greenspace.

4.5.1 History

The New River Valley is prone to riverine and flash flooding. The history of each is delineated next.

4.5.1.1 Riverine

Riverine flooding is the more gradual flooding that occurs on major waterways such as the New River following many days of rain. There is typically advance notice for this type of flooding. Riverine flooding occurred along the New River in 1878, 1916 and 1940. All three events were deemed "100-year event. Notably, all of these events occurred prior to the completion of the power-generating dam on the New River, though it was not built for flood control purposes. Riverine flooding not only affects the development on the river, including that in Radford, Pearisburg and Narrows, but it also causes backwater effects into the downstream portions of tributaries like Little Stony and Doe Creeks.

In addition to these notable flood events, seven flood events have been recorded in the National Climatic Data Center (NCDC) database from 1996 to 2006. These recorded events have cost just over $5 million in damages and resulted in two deaths and one injury. Unfortunately these records do not indicate the magnitude of the flooding, so it is impossible to tell if these were 100-year floods, or more common flooding that occurs regularly in some portions of the region.

4.5.1.2 Flash Flooding

The more frequent and damaging type of flooding in the NRV is flash flooding. The mountains of western Virginia are among the most dangerous flash flood-prone areas in the U.S., due to the strong storms created by the collision of warm, moist Gulf air and cold fronts from the North (Water News, Virginia Tech, 1987). Often this flooding occurs from localized thunderstorms or tropical storm-related events. For example, in June, 1972, Tropical Storm Agnes wreaked havoc on western Virginia.

Since 1995, approximately 120 flash floods have been reported throughout the NRV in the NCDC database. Even though these events were reported much more frequently than riverine flooding, the damages reported were just over $4 million, with no deaths or injuries reported.

4.5.1.3 Dam Inundation

Various types of dams exist to serve a multitude of functions within the NRVPDC area. These include farm use, recreation, hydroelectric power generation, flood and storm-water control, water supply and fish or wildlife ponds. In some cases, a single dam structure serves multiple functions, such as generating hydroelectric power and providing recreational opportunities to boaters and fishermen.

State and federal governments regulate dam construction, maintenance and repair. On the state level, the Virginia Dam Safety Act of 1982 (and as amended effective December 22, 2010) serves as the guiding legislation. Within the NRV there are 15 dams that are of a class that is regulated. Table 4-10 below describes these dams.

Table 4-10. Regulated Dams in the NRV

Dam Name	County	River/Stream	City	Owner
Hogan's Dam	Pulaski	Hogan Branch	Pulaski	Town of Pulaski
Gatewood Dam	Pulaski	Peak Creek	Pulaski	Town of Pulaski
Radford (Little River Hydro)	Montgomery	Little River	Radford	City of Radford
Claytor	Pulaski	New River	Radford	Appalachian Power Co, American Electric Power
Little River Dam	Montgomery	Little River	Radford	City of Radford
Scott Dam	Floyd			Frank A. Scott
Mabry Mill Pond Dam	Floyd	Mabry Mill Pond		
Park Ridge Dam	Floyd			Park Ridge Property Owner
Rakes Mill Dam	Floyd	Dodd Creek		
Bennetts Dam	Montgomery	Smith Creek		William F. Bennett
Lake Powhatan Dam	Pulaski	Big Macks Creek		B.S.A., Blue Ridge Mountain
Ottari Scout Camp #2 Dam	Pulaski	Little Laurel Creek		B.S.A., Blue Ridge Mountain
Thornhill Dam	Pulaski	BOT		Bernard Simmons
Glen Lyn Bottom Ash Dikes Dam	Giles	New River		AEP Service Corp.
Glen Lyn Flyash Dam	Giles	East River		AEP Service Corp.

The federal government maintains an inventory of dams through the National Dam Inspection Act of 1972 and, more recently, the Water Resources Development Act of 1996. Maintained by the U.S. Army Corps of Engineers, the National Inventory of Dams has been available on-line since January 1999 (https://nid.usace.army.mil).

State and federal regulations differ slightly from each other in methods of classifying dam hazard potential. For the federal national inventory, dams are grouped into one of three categories, based on two criteria: the potential for loss of human life and the potential to cause economic, environmental and lifeline losses, in the event of a dam failure. Dams classified as a high hazard indicate that loss of one human life is likely if the dam fails, while dams classified as significant hazards indicate that possible loss of human life and likely significant property or environmental destruction should the dam fail. It is interesting to note that of the dams above, only 4 are shown in the national database that includes a hazard rating. These four are listed in Table 4-11 below.

Table 4-11. Hazard Rating of Dams in NRV

Dam Name	River/Stream	Year Built	Hazard Rating
Hogan's Dam	Hogan Branch	1900	High
Gatewood Dam	Peak Creek	1958	High
Claytor	New River	1939	High

Dam Name	River/Stream	Year Built	Hazard Rating
Little River Dam	Little River	1934	Significant

4.5.2 Risk Assessment and Vulnerability of Flooding[1]

FEMA's HAZUS-MH MR3[2] was used to assess the flood vulnerability for New River Valley PDC. The potential for loss, or the degree of vulnerability, was measured using three different factors:

1. Amount of county land area susceptible to a 100-year flood.
2. Amount of potential damage by square footage of buildings (by construction type and by occupancy).
3. Amount of direct economic losses related to buildings.

The three measures of loss give a general picture of the very complex issue of vulnerability to floods.

4.5.2.1 Location and Aerial Extent

HAZUS-MH MR3 was used to generate the flood depth grid for 100-year and 500-year return periods (Map 13) calculated for one square mile drainage areas. The riverine model was determined from a user provided US Geological Survey (USGS) 10 meter digital elevation model (DEM) and peak discharge values obtained for reaches so generated.

The majority of flooding in the New River Valley is along the New River itself. Other feeder streams were also modeled but their contribution and impact is minimal. Complete vulnerability scenario modeling for every county (and Radford City) yielded a picture of varying degrees of vulnerability to flooding (Table 4-12). Pulaski County has the largest flood zone (24.9 square miles) while Floyd County has the smallest flood zone (9.37 sq miles). Floyd County, far removed from the main course of the New River, has the lowest percentage of its land in floodplains. In contrast, Radford City, which is the smallest in area, lies directly along the New River and as such it has the highest percentage (12%) of land area within the floodplain. Overall, 69.75 square miles of the planning district's 1,470.84 square miles fall within the 100-year floodplain. In other words, 4.74% of the land area of the planning district is vulnerable to a 100-year flood event.

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[1] *Disclaimer*:
The estimates of social and economic impacts contained in this report were produced using HAZUS MH MR3 loss estimation methodology software which is based on current scientific and engineering knowledge. There are uncertainties inherent in any loss estimation technique. Therefore, there may be significant differences between the modeled results contained in this report and the actual social and economic losses following a specific flood. These results can be improved by using enhanced inventory data and flood hazard information.

[2] Released July 2007.

Map 13. NRV Floodplains

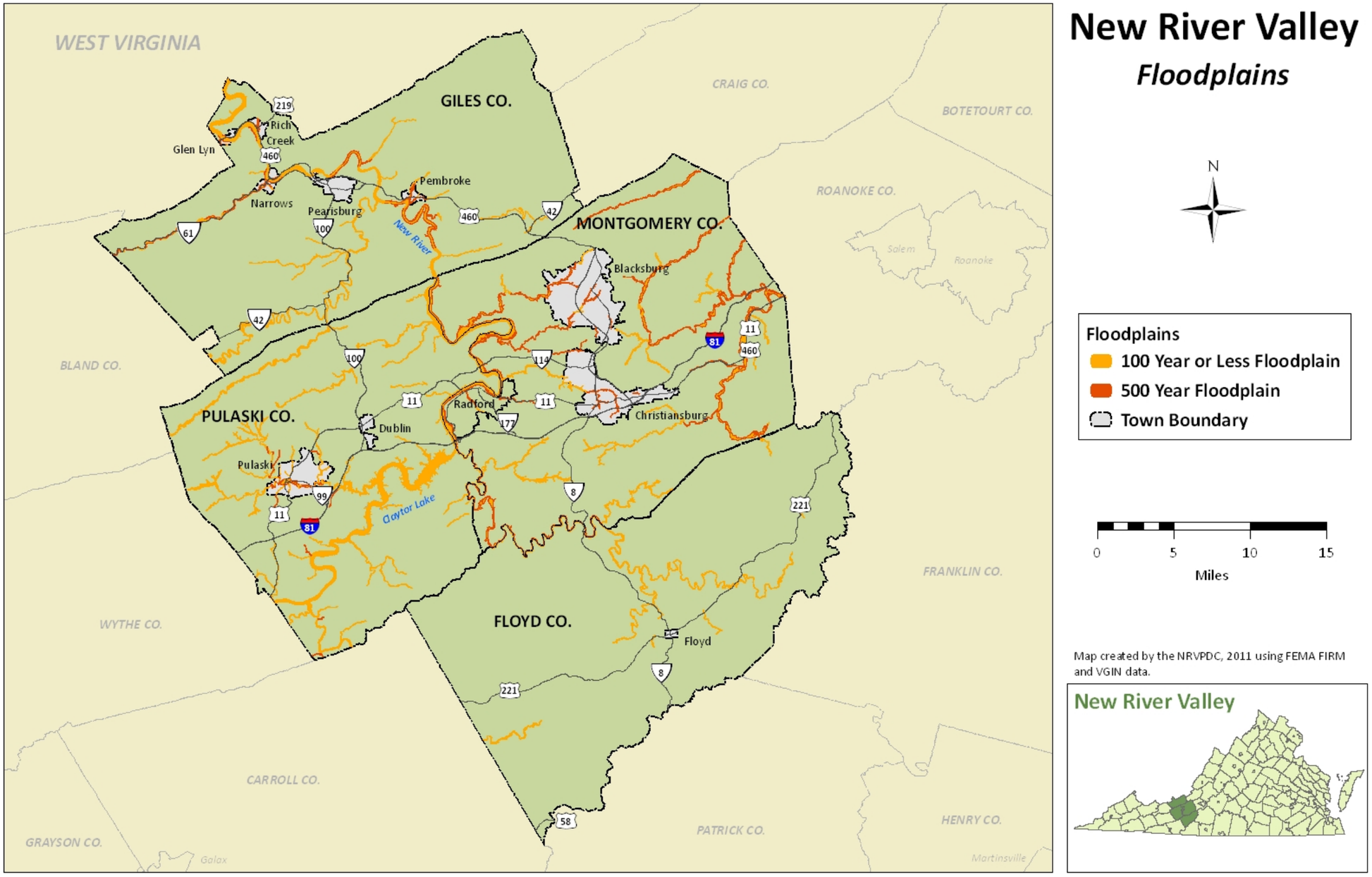


Table 4-12. 100-year Flood Zone Area

Locality	Flood zone Area (sq. mi)	Total Area (sq. mi)	% of Total
Floyd	9.37	381.46	2.46
Giles	18.02	360.32	5.00
Montgomery	16.22	389.47	4.16
Pulaski	24.9	329.49	7.56
Radford	1.24	10.10	12.28
NVRPDC Total	**69.75**	**1470.84**	**4.74**

The size of the flood zone is a convenient and more general measure of flood vulnerability. A more accurate method for expressing the level of vulnerability is loss estimation based on potential damage from a 100-year flood event. HAZUS-MH processing capability accounts for five flood events (10, 20, 50, 100, and 500 years) per return period. The following estimations are based on a 100-year flood event.

4.5.2.2 Loss Estimation Analysis

The HAZUS-MH loss estimation results (average expected value per year) can be obtained for deterministic and probabilistic scenarios. The flood risk assessment presented herein was based on probabilistic analysis since no specific flood event was modeled. Deterministic analyses are based on the laws of physics and correlations among experience or tests to predict a particular outcome. One or more worst credible possible scenarios can be developed, but the frequency of events must be evaluated.

Probabilistic analyses are used to develop loss estimations and annualized losses due to potential damage. HAZUS standardized hazard outputs can be in the form of direct economic losses, induced, social and business interruptions. The analyses consider the likelihood of occurrence of a specific event, its resulting losses and consequences. The likelihood estimates are based on both statistics and historical information.

4.5.2.3 Building Damage and Stock Exposure by Building Type

One common measure in loss estimation is the amount of square feet of damage to buildings by construction type and/or by occupancy in the event of a flood. A simplified statistic can be derived by setting a threshold on a specified level of damage. One such a statistic is substantial damage.

Substantial damage is defined as any damage that is over 50% of the available square footage by the type of building construction. For instance it can be observed from Table 4-13 that in Floyd County the overall amount of building damage by construction type is 37.2%. This means that a 100-year flood event will most likely cause damage in excess of 50% in 37.2% of the buildings. The table also provide specific breakdown by construction type. For Floyd County the total square footage of wood buildings is 34,000 square feet, and of these, 14,000 square feet will most likely experience damage in excess of 50%.

Given that Floyd County averages significant damage in 37.4% of its structures, it is clear therefore that wood structures will have proportionately greater damage than any other type. It is also apparent that based on this statistic, Radford City structures along the 100-year floodplain

are more vulnerable with 58% receiving substantial damage. Pulaski County is the least vulnerable with only 20% of structures likely to experience damage in excess of 50%. The average for the planning district is 28% receiving substantial damage, which is just over ¼ of the total square footage.

Overall, Floyd County has the least amount of square footage receiving substantial damage in almost all categories. In part this is due to the limited amount of area subject to flooding. For instance, the County has no concrete or manufactured housing in the floodplains.

Manufactured housing tends to be extremely vulnerable particularly in Montgomery (124/139), Giles (33/36) and Pulaski counties (45/46). In the event of a 100-year flood, substantial damage to the buildings in these counties will be 89%, 92%, and 98%, respectively.

Although construction types are spatially much more widespread than occupancy categories, damage to manufactured housing (91.40%) dominates wood (24.85%), concrete (24.83%), masonry (22.95%) and steel (22.19%) structures. In general, these patterns show overall distribution of vulnerability averaging across categories at 28.4%.

Table 4-13. Building Damage by Building Type

		Locality					
Building Type		**Floyd**	**Giles**	**Montgomery**	**Pulaski**	**Radford**	**NVRPDC**
Concrete	Total	0	14	27	68	36	145
	Substantial	0	2	1	10	23	36
	Percentage	0.00%	14.29%	3.70%	14.71%	63.89%	24.83%
Manuf. Housing	Total	0	36	139	46	0	221
	Substantial	0	33	124	45	0	202
	Percentage	0.00%	91.67%	89.21%	97.83%	0.00%	91.40%
Masonry	Total	3	132	126	271	91	623
	Substantial	1	41	9	40	52	143
	Percentage	33.33%	31.06%	7.14%	14.76%	57.14%	22.95%
Steel	Total	6	113	92	317	103	631
	Substantial	1	26	7	44	62	140
	Percentage	16.67%	23.01%	7.61%	13.88%	60.19%	22.19%
Wood	Total	34	344	316	530	128	1352
	Substantial	14	103	29	119	71	336
	Percentage	41.18%	29.94%	9.18%	22.45%	55.47%	24.85%
% Substantial of Net Total		**37.2**	**32.1**	**24.3**	**20.9**	**58.1**	**28.4**

In thousands of square feet
Substantial damage >50% damage

4.5.2.4 Building Damage and Stock Exposure by Occupancy

A breakdown of the total square feet of potential building damage by county into different categories of occupancy, provide a different perspective of flood vulnerability (Table 4-14). As in the case of damage by building type, damage by occupancy was also analyzed at ≥50% as substantial damage.

The occupancy categories tracked by HAZUS-MH are agricultural, commercial, educational, governmental, industrial, religious/non-profit and residential. The overall substantial damage for the NRV is between 20% and 40% of structures. However, it is noteworthy that the majority of the potential damage to buildings in the NRV is to residential buildings. In both absolute (907.5 square feet) and percentage (34.28%) terms, residential buildings are more vulnerable than any other category. The category with least impact across the counties is government. In fact in Radford City there are no government buildings at substantial risk in the event of a 100-year flood. The figure for Floyd County seems high but it is also important to examine the raw square footage; it is very small meaning a few government building(s) may account for this lopsided statistic. Similar to government buildings, education facilities (mainly schools) are not found within the floodplain for the most part. Therefore, substantial damage to education buildings is generally very low in the NRV; it is only in Pulaski County that 14.5% of educational facilities stand a chance for substantial damage from a 100-year flood event. This trend demonstrates the importance of the public service sector in the NRV.

The distribution of agricultural damage shows Giles County with the highest vulnerability with approximately 47% receiving substantial damage. The rest of the counties' agriculture is much less vulnerable. Radford City stands out as the one with the highest commercial (56.61%) and industrial (59.99%) flood vulnerability.

Table 4-14. Building Damage by General Occupancy

		Locality					
Occupancy Type		**Floyd**	**Giles**	**Montgomery**	**Pulaski**	**Radford**	**NVRPDC**
Residential	Total	133.66	653.64	770.04	911.72	178.48	2647.54
	Substantial	54.07	242.89	234.58	273.08	102.89	907.51
	Percentage	40.45%	37.16%	30.46%	29.95%	57.65%	34.28%
Commercial	Total	15.11	170.84	56.45	219.4	136.79	598.59
	Substantial	4.29	67.96	12.78	7.28	77.43	169.74
	Percentage	28.39%	39.78%	22.64%	3.32%	56.61%	28.36%
Industrial	Total	10.6	84.75	127.86	361.32	49.94	634.47
	Substantial	1.18	8.47	10.49	75.22	29.96	125.32
	Percentage	11.13%	9.99%	8.20%	20.82%	59.99%	19.75%
Agriculture	Total	2.57	5.39	12.91	7.19	0.32	28.38
	Substantial	0.62	2.53	2.82	2.38	0.13	8.48
	Percentage	24.12%	46.94%	21.84%	33.10%	40.63%	29.88%
Religion	Total	1.3	22.59	15.19	32.59	5.86	77.53
	Substantial	0.27	5.72	0.46	1.55	2.81	10.81
	Percentage	20.77%	25.32%	3.03%	4.76%	47.95%	13.94%
Government	Total	0.64	9.24	1.28	36.74	0	47.9
	Substantial	0.42	1.35	0.07	0.57	0	2.41
	Percentage	65.63%	14.61%	5.47%	1.55%	0.00%	5.03%
Education	Total	0.1	8.85	11.09	4.64	0.21	24.89
	Substantial	0.01	0.59	0.17	0.67	0	1.44
	Percentage	10.00%	6.67%	1.53%	14.44%	0.00%	5.79%

	Locality					
Occupancy Type	**Floyd**	**Giles**	**Montgomery**	**Pulaski**	**Radford**	**NVRPDC**
% Substantial of Net Total	37.1%	34.5%	26.3%	22.9%	57.4%	30.2%

In thousands of square feet
Substantial damage >50% damage

4.5.2.5 Dollar Exposure

Unless floodwaters flow at a high velocity and the structure and the foundation become separated or the structure is impacted by flood-borne debris, it is unlikely that a building will suffer structural failure in a flood (HAZUS-MH MR4 Technical Manual, 2010). Therefore, the way HAZUS-MH works is that building type, design level and quality of construction do not play a major role in damage resistance to flooding. In general, it is expected that the major structural components of a building will survive a flood, but that the structural finishes and contents/inventory may be severely damaged due to inundation.

HAZUS-MH models general building stock dollar exposure which can be viewed by general occupancy, general building type or specific building type. This option provides estimates of direct physical damages to buildings and contents, the exposure of essential facilities to flooding, the consequential direct economic losses and the number of people displaced by evacuation and inundation. The latter is not examined in this report.

Table 4-15 and Table 4-16 provide summary statistics for building stock exposure by type and occupancy for the NRV.

Table 4-15. Building Stock Exposure by Building Type

Building Type	Locality					NVRPDC
	Floyd	**Giles**	**Montgomery**	**Pulaski**	**Radford**	
Concrete	59,329	98,857	610,883	273,406	125,741	1,168,216
Manuf. Housing	52,115	46,867	162,613	75,355	6,431	343,381
Masonry	149,262	217,139	1,148,394	488,926	238,054	2,241,775
Steel	15,649	28,456	332,338	86,315	85,578	548,336
Wood	355,950	485,412	1,986,348	1,023,597	387,218	4,238,525
Total	**632,305**	**876,731**	**4,240,576**	**1,947,599**	**843,022**	**8,540,233**

All values in thousands of dollars

Table 4-16. Building Stock Exposure by Occupancy

Occupancy Type	Locality					NVRPDC
	Floyd	**Giles**	**Montgomery**	**Pulaski**	**Radford**	
Residential	501,948	664,208	3,041,634	1,402,236	630,010	6,240,036
Commercial	66,969	128,799	758,327	224,807	137,775	1,316,677
Industrial	31,853	42,881	134,789	232,722	42,414	484,659
Agriculture	7,137	4,374	18,368	7,523	835	38,237
Religion	11,785	24,008	105,638	42,903	19,099	203,433
Government	5,236	5,231	28,960	17,909	4,704	62,040

Occupancy Type	Locality					NVRPDC
	Floyd	Giles	Montgomery	Pulaski	Radford	
Education	7,327	7,259	152,853	19,467	8,165	195,071
Total	**632,255**	**876,760**	**4,240,569**	**1,947,567**	**843,002**	**8,540,153**

All values in thousands of dollars

Table 4-15 shows the dollar exposure by building construction type. The overall picture presents a typical expected outcome based on the quality and durability of the construction. Within the NRV the most likely damage in order of magnitude range from manufactured housing ($343,381,000) to steel ($548,336,000) to concrete ($1,168,216,000) to masonry ($2,241,775,000) to wood ($4,238,525,000) for an estimated total of $8,540,233,000. Notice that that wood damage is the highest in part because it is common, but also because it is more vulnerable. Steel has one of the lowest damage values because it is rare and also less vulnerable. Manufactured housing which dominates the percentage of square footage receiving substantial damage (see Table 4-13) has a low dollar exposure mainly because of their value and cheaper construction.

As can be seen in Table 4-16, the agriculture category has the least exposure in terms of dollar value. This is expected since land designated as agriculture has the least number of standing buildings. The major damage is in residential and commercial buildings. Government buildings also have a low exposure risk for the simple reason that public facilities are seldom in flood-prone areas.

The key difference in the dollar exposure values provided is the issue of spatial location. Consistently Radford City tends to show high risks primarily due to its proximity to the New River. The same can be said about Giles County. At the same time, Montgomery and Pulaski are both large counties but ones with few buildings within the floodplains.

One key parameter not considered in this estimation of expected flood damage is building age. Age is an issue because building codes (and expected building performance) change over time, and because development regulations change when a community enters the NFIP. In cases where the building floor data was developed prior to entrance in the NFIP, it can be assumed that this portion of data in the exposure analysis will be more susceptible to damage resulting from a 100-year flood event. In the final analysis, the interpretation of the statistics generated depends not only on the type and occupancy of the buildings but also the age of the buildings in question.

4.5.2.6 Transportation System Dollar Exposure

The broad transportation systems included in HAZUS-MH program are highways, railways, light rail, bus, ports, ferries and airports.

The following are the characteristics of the categories under consideration in this analysis:

- Highways - consists of roadways, bridges and tunnels. HAZUS-MH MR3 as is does not include assessment of losses to street segments and other highway components.
- Railways - consists of tracks, bridges, tunnels, stations, fuel, dispatch and maintenance facilities. The HAZUS-MH MR3 flood model does not account for flood-borne debris impact or the loads resulting from flood-borne debris trapped against transportation

features such as bridges. Also the model does not assess losses to railway segments and other railway components, but will produce an estimate of the percent damage to a bridge and the probability of the bridge being functional, depending on the estimated damage.

- Bus - bus transportation system consists of urban stations fuel facilities, dispatch and maintenance facilities. In the NRV there are two functional bus systems: *Blacksburg Transit* (BT) that operates fixed-routes mainly in the Towns of Blacksburg and Christiansburg and *Pulaski Area Transit* which operates primarily in the Town of Pulaski. Both transit services also provide an on-demand service for qualifying disabled residents. There is also a local bus system in the City of Radford, *The Tartan*, operated by Radford University. The BT system was included in the present modeling, but the other two were not.

- Airport - an airport transportation system consists of control towers, runways, terminal buildings, parking structures, fuel facilities and maintenance and hangar facilities. There are two facilities within the NRV namely the New River Valley Airport (NRV Airpark) in Dublin (Pulaski County) and the Virginia Tech Montgomery Executive Airport in Blacksburg (Montgomery County).

Overall the most impact in the event of a 100-year flood, highways will experience the largest loss followed by railways and airports. Montgomery County will bear most of the brunt and in all categories (Table 4-17).

Note that light rail, ports and ferry categories are not included in the analysis because they do not exist in the NRV.

Table 4-17. Transportation System Dollar Exposure

	Locality					
Transportation	**Floyd**	**Giles**	**Montgomery**	**Pulaski**	**Radford**	**NVRPDC**
Highway	325,836.08	508,996.01	624,394.27	397,872.44	67,188.53	1,924,287.33
Railway	0	62,752.33	78,330.38	38,847.70	11,784.57	191,714.98
Bus Facility	0	0	2,027.40	0	0	2,027.40
Airport	0	0	67,945.80	33,972.90	0	101,918.70
Total	**325,836.08**	**571,748.34**	**772,697.85**	**470,693.04**	**78,973.10**	**2,219,948.41**

All values in thousands of dollars

4.5.2.7 Utility Dollar Exposure

The inventory classification scheme for lifeline systems separates components that make up the system into a set of pre-defined classes. The classification system includes potable water, wastewater, oil, natural gas, electric power and communication systems. Oil systems and natural gas are not included in the report because they do not exist in the form described within the NRV. The following is a brief description of the utility systems:

- Potable water – this system consists of pipelines, water treatment plants, control vaults and control stations, wells, storage tanks and pumping stations. The model estimates damage, losses and functionality for select vulnerable components of the potable water

system. These include treatment plants, control vaults and control stations and pumping stations.

- Wastewater – wastewater system consists of pipelines, wastewater treatment plants, control vaults and control stations and lift stations. The model will estimate damage, losses, and functionality for select vulnerable components within the wastewater system including treatment plants, control vaults and control stations and lift stations.
- Electric power – electric power system consists of generating plants, substations, distribution circuits and transmission towers. The flood model as is only performs a limited analysis on select vulnerable electric power system components vis-à-vis generating plants and substations.
- Communication – a communication system consists of communications facilities, communications lines, control vaults, switching stations, radio/TV station, weather station or other facilities. At this time HAZUS-MH MR3 flood model has deferred estimating damage and losses for communications facilities.

The inventory data used to estimate utility dollar exposure in each case includes the geographical location and classification of system components, replacement cost for facilities and the repair costs for the system components.

At the moment wastewater systems are more vulnerable than any of the other categories in part because collecting points for wastewater is always located downhill, coinciding with river flood zones. Potable water systems are significantly at risk at a distant second to wastewater in all localities except Floyd County (Table 4-18).

At this time, the flood model does not account for flood borne debris impact, or water borne debris loads which can cause significant clean-up efforts for utility systems (HAZUS-MH MR3 Technical Manual, 2007). The Flood Model analyzes those system components that are more vulnerable or costly to clean-up, repair or replace since they are likely to control the overall recovery costs and time.

Table 4-18. Utility System Dollar Exposure

	Locality					
Utility	**Floyd**	**Giles**	**Montgomery**	**Pulaski**	**Radford**	**NVRPDC**
Potable Water	0	30,969.00	30,969.00	61,938.00	30,969.00	**154,845**
Waste Water	61,938.00	309,690.00	309,690.00	123,876.00	0	**805,194**
Electric Power	0	102,300.00	0	0	0	**102,300**
Communication	93	186	651	744	93	**1,767**
Total	**62,031.00**	**443,238.00**	**341,310.00**	**186,558.00**	**31,062.00**	**1,064,199**

All values in thousands of dollars

4.5.2.8 Vehicle Dollar Exposure

Vehicle dollar exposure is the estimated value of the vehicles[3] by location, based on home address (by census block). The flood model looks at passenger cars, light trucks (including SUVs) and heavy trucks (commercial/industrial vehicles including 18-wheelers). The HAZUS estimation procedure for flood damage of motor vehicles (vehicle dollar exposure) is based on vehicle inventory within a study area, allocation of vehicles by time of day to different locations, estimated value of vehicles and the percent loss damage function according to the flood depth.

Generally, vehicle dollar exposure is higher for night – when registered vehicles are assumed to be at the registered residence – than day. If the day dollar exposure is high then the model assumes that the locality records more day into-locality traffic (commuters) than out-of-locality traffic. Giles County has such traffic flow, recording more vehicles during the day than at night.

Table 4-19. Vehicle Dollar Exposure – Day

	Floyd	Giles	Montgomery	Pulaski	Radford	NVRPDC
Cars	7,744,005	60,876,281	61,448,130	26,630,381	11,304,286	168,003,083
Light Trucks	3,256,585	25,600,293	25,840,773	11,198,870	4,753,790	70,650,311
Heavy Trucks	6,028,317	47,389,109	47,834,265	20,730,406	8,799,816	130,781,913
Total	**17,028,907**	**133,865,683**	**135,123,168**	**58,559,657**	**24,857,892**	**369,435,307**

All values in thousands of dollars

Table 4-20. Vehicle Dollar Exposure – Night

	Floyd	Giles	Montgomery	Pulaski	Radford	NVRPDC
Cars	15,252,605	33,462,314	115,663,533	42,549,215	22,816,621	229,744,288
Light Trucks	6,414,176	14,071,902	48,639,967	17,893,215	9,595,070	96,614,330
Heavy Trucks	11,873,382	26,048,721	90,038,216	33,122,414	17,761,587	178,844,320
Total	**33,540,163**	**73,582,937**	**254,341,717**	**93,564,843**	**50,173,277**	**505,202,937**

All values in thousands of dollars

4.5.2.9 Direct Economic Annualized Losses for Buildings

Annualized loss provided an estimate of the maximum potential annual loss. Annualized losses are essentially the summation of losses over all return periods multiplied by the probability of those floods occurring. In mathematical terms, the analysis essentially looks like this:

Annual Loss = Sum of (Probability of Occurrence) * ($ loss)

These loss estimates document the magnitude of the natural hazards problems, as well as provide a benchmark against which progress toward reducing losses due to natural hazards through public policy can be assessed. Annualized Direct Economic Losses estimates are only available

[3] The vehicle valuation is based on the distribution of new and used vehicles provided by each state's Department of Motor Vehicles (DMV) and the average sale prices of these vehicles.

for buildings because HAZUS-MH focuses on building assets using a more complete inventory and analysis.

Table 4-21. Direct Economic Annualized Losses for Buildings in the NRV

	Capital Stock Losses				Income Losses				
Locality	**Cost Building Damage**	**Cost Content Damage**	**Inventory Loss**	**Building Loss Ratio**	**Relocation Loss**	**Capital Related Loss**	**Wages Loss**	**Rental Income Loss**	**Total Loss**
Floyd	3,918	3,365	225	2.0	2	1	9	1	**7,549**
Giles	26,048	32,385	2,124	4.9	53	88	426	18	**61,597**
Montgomery	20,843	21,509	980	3.3	41	67	195	20	**44,048**
Pulaski	32,570	48,700	4,769	3.2	71	104	763	25	**87,635**
Radford	17,804	28,539	1,091	10.0	54	66	164	18	**48,054**
NVRPDC Total	**101,183**	**134,498**	**9,189**	**23.4**	**221**	**326**	**1557**	**82**	**248,883**

All values in thousands of dollars

Although only about 5% of the New River Valley is predicted to be vulnerable to flooding impacts, it is evident that estimated losses can easily run into several million dollars.

The following sections contain locality specific information and mapping for flooding. Original information was compiled from FEMA reports, National Flood Insurance Studies, Army Corps of Engineer studies, Natural Resources Conservation Service reports, newspaper accounts and local records.

4.5.2.10 Floyd County

Floyd County is situated atop a high plateau of the Blue Ridge Mountains that divides eastward flowing waters from westward flowing waters. Essentially no water flows into Floyd County; all flowing water begins in the county and drains to other areas. A number of important streams originate in Floyd County, including Big Reed Island Creek and Little River (tributaries of the New) and headwater streams of the Dan, Smith, Pigg, Backwater and Roanoke Rivers. The following were studied in detail by the Flood Insurance Study performed by FEMA to identify and prioritize flood hazards (1989):

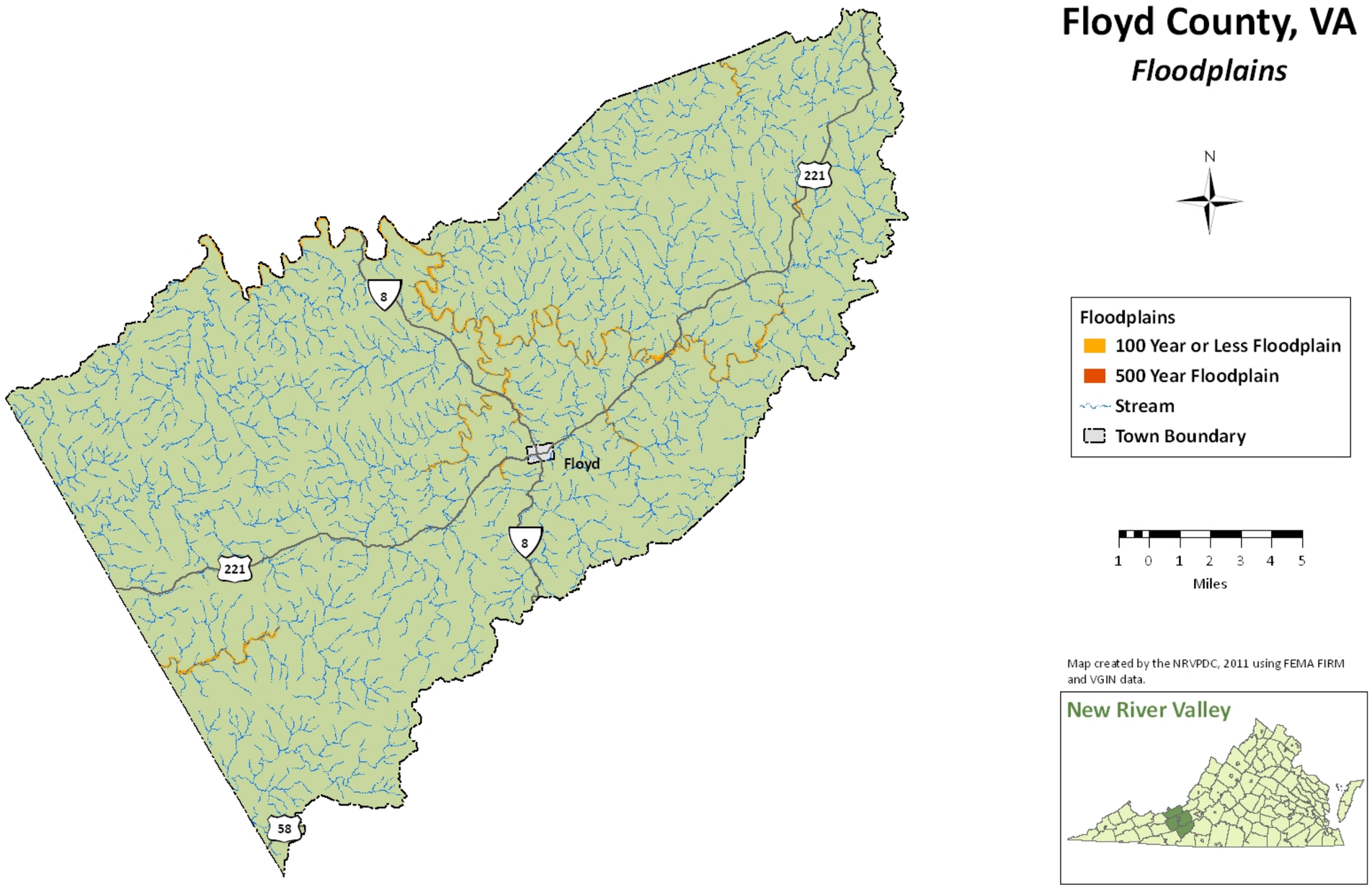
- Little River
- Dodd Creek
- West Fork of Little River
- Pine Creek
- Meadow Run

Flooding has been recorded in these areas of the county in 1940, 1959, 1972, 1985, and 2003. The floods are primarily due to heavy rains from localized storms and tropical storms in this area and cause significant economic damage to private, commercial, and public property, especially roads and bridges. The largest flood occurred on June 21, 1972 when Little River's discharge at

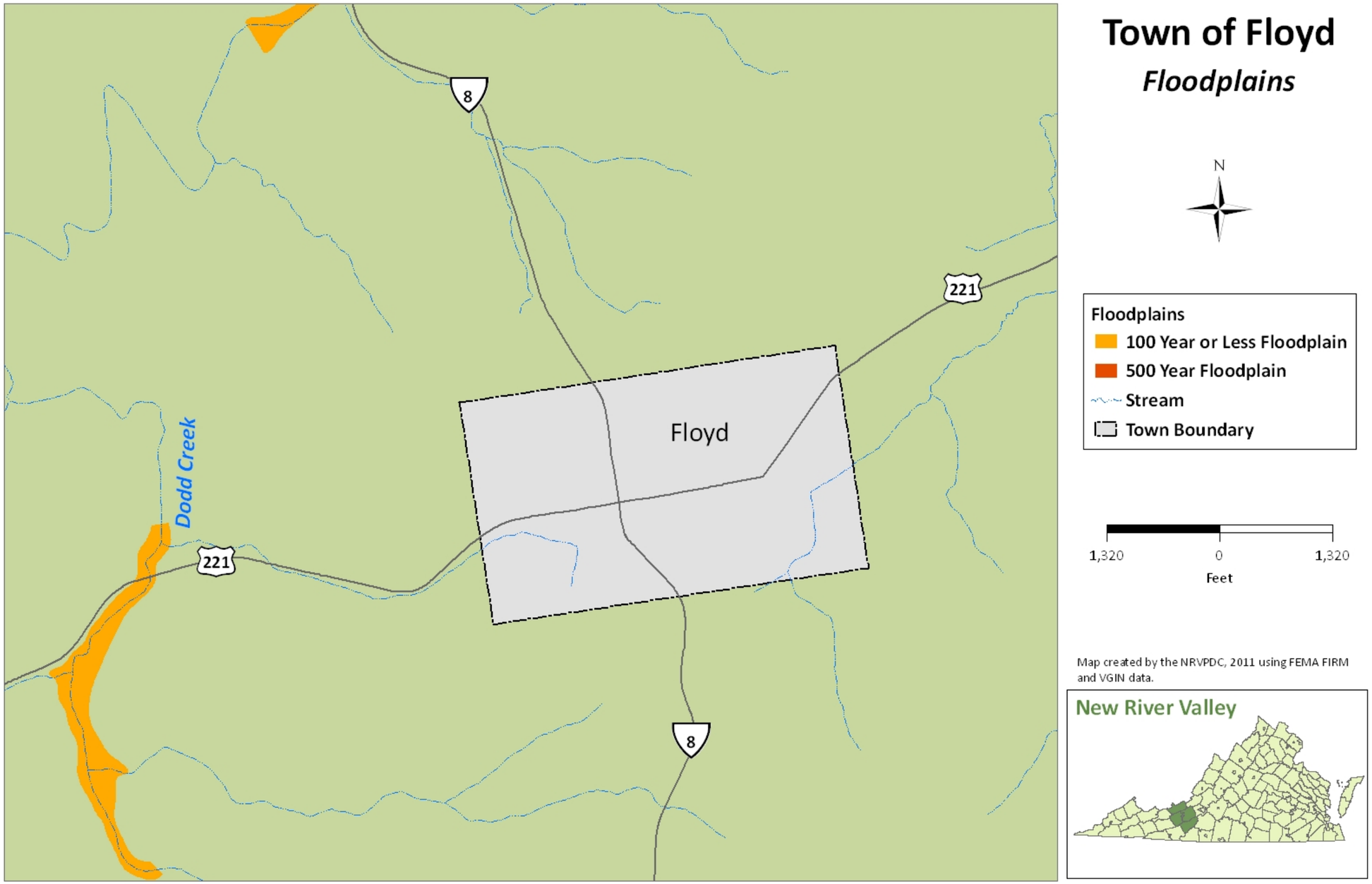
Graysontown reached 22,800 cubic feet per second (cfs). This flood has an approximate recurrence interval of 50 years. Map 14 illustrates the 100-year and 500-year floodplains in the county, while Map 15 illustrates the same for the Town of Floyd.

It is believed that the number of homes with significant flooding risk to primary living areas is limited in Floyd County. Only 12 properties in Floyd County participate in the National Flood Insurance Program and only one is a repetitive loss property. Floyd County is experiencing substantial housing and population growth, but it is not currently believed to be occurring in the flood hazard area.

Map 14. Floyd County Floodplains



Map 15. Town of Floyd Floodplains



4.5.2.11 Giles County

The unincorporated areas of Giles County can be affected by flooding from 19 different streams or stream segments. The Flood Insurance Study by FEMA breaks these into two groups. One group was studied in detail, the other in approximate methods. The following streams studied in detail were done so due to known history of flood hazard and the projected growth in area:

- New River (in or near towns)
- Doe Creek
- Greenbrier Branch
- Laurel Branch
- Little Stony Creek
- Piney Creek
- Sinking Creek
- Spruce Run
- Stony Creek
- Wolf Creek

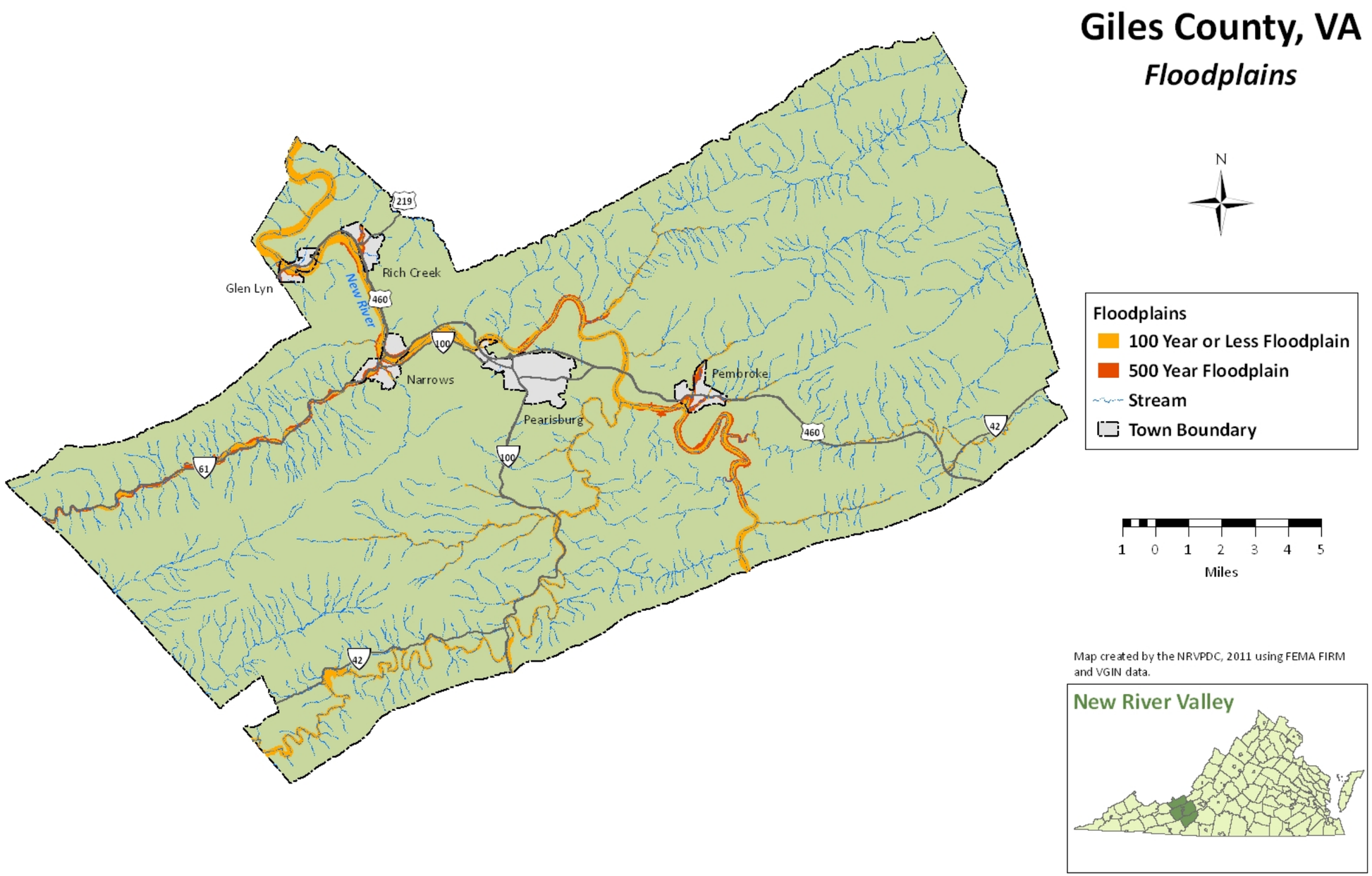
These were studied using approximate methods

- New River (remainder)
- Bluestone Lake
- Broad Hollow Creek
- Cecil Branch
- Dry Branch
- Little Sugar Run
- Sugar Run
- Tributary to Sugar Run
- Walbash Creek
- Walker Creek

Giles County is fairly rugged, with high mountains and narrow valleys with some rolling hills and small, flat plateaus. Many of the streams are characterized by large boulders and high-velocity flows during storms. This results in rapid and dangerous flash-flooding in several areas, threatening life and property with little time for warning and preparation (and thus the later identified needs of better warning mechanisms and swift-water rescue capabilities). Flowing through the middle of the county is the New River. Flowing northwest through Virginia and into West Virginia, the New River divides Giles County into almost two equal parts.

Low-lying areas of the county in the proximity of the above streams are the most subject to flooding (see maps below). Tropical storms and isolated storms are the main causes of flooding in the area. The largest flood recorded for the New River was in 1940 where the waters were almost to the 100-year flood elevation. A limited portion of the Celanese Acetate, LLC property, the largest employer in Giles County, is located along the New River, in the 100-year floodplain, so a 100-year storm or greater could have a dramatic indirect economic costs as well (in terms of work days lost). Doe Creek, Little Stony, and Sinking Creek all experienced their largest flood elevations in May 1973. Damages to property, road, bridges and utilities were reported to be between $600,000 and $800,000 ($1.5 million+ in 2003 dollars.) Detailed analysis on local flood-prone areas is provided next for Glen Lyn, Narrows, Pearisburg, Pembroke and Rich Creek.

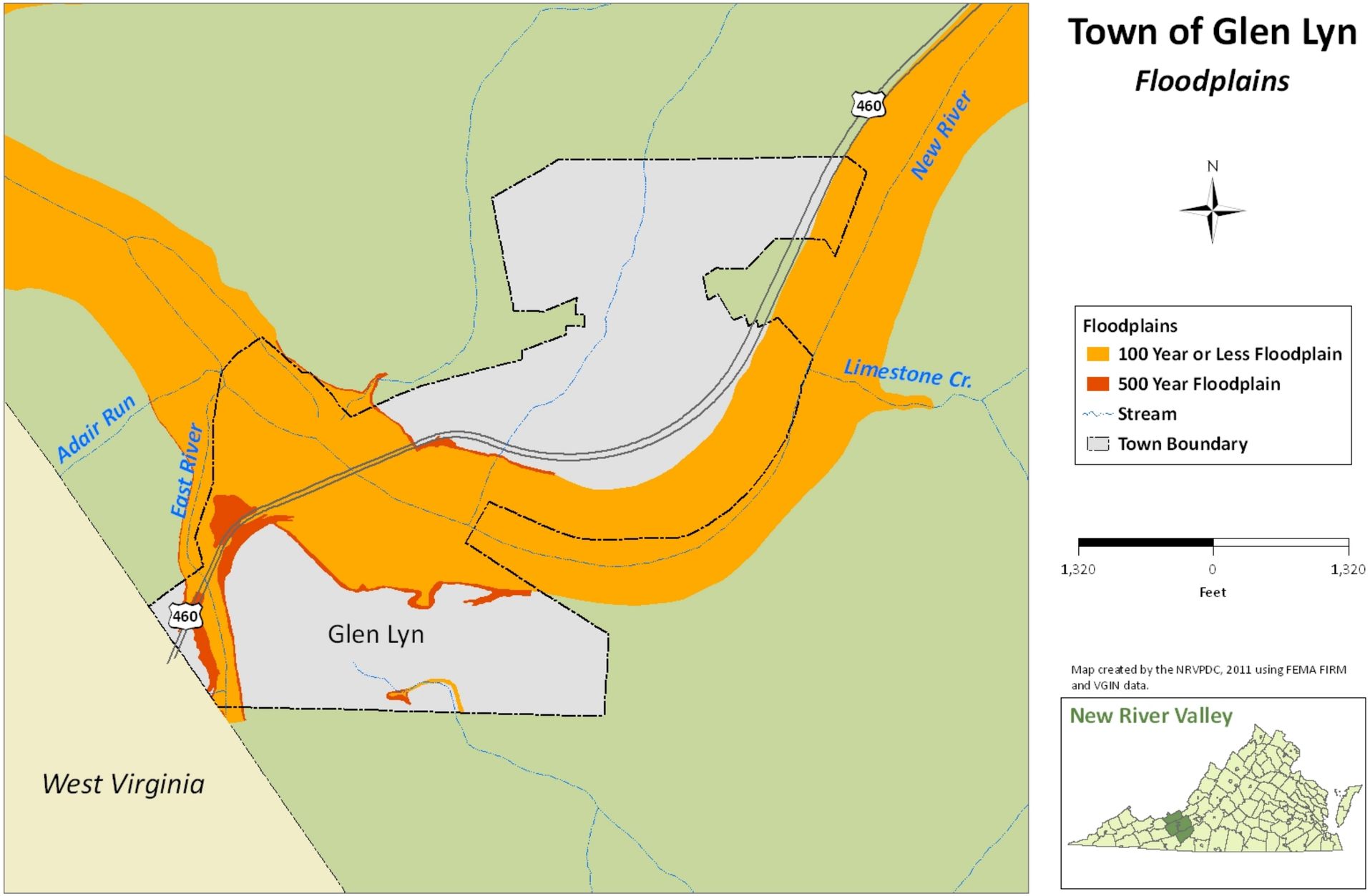
Map 16. Giles County Floodplains



4.5.2.12 Town of Glen Lyn

The Town of Glen Lyn lies alongside the New River as it flows north into West Virginia. Located within the floodplain and partially within the Town of Glen Lyn is the American Electric Power Plant. Otherwise, the majority of the Town is located on a hillside, and therefore only a few structures are at risk in the event of a flood. The largest recorded flood in the area was in 1940. The power plant became flooded, but only received minor damages. The 1940 event along with an event of 1916 and 1972 are the only recorded flood events for the Town of Glen Lyn. Glen Lyn participates in the National Flood Insurance Program, but there are currently no policies in effect.

Map 17. Town of Glen Lyn Floodplains

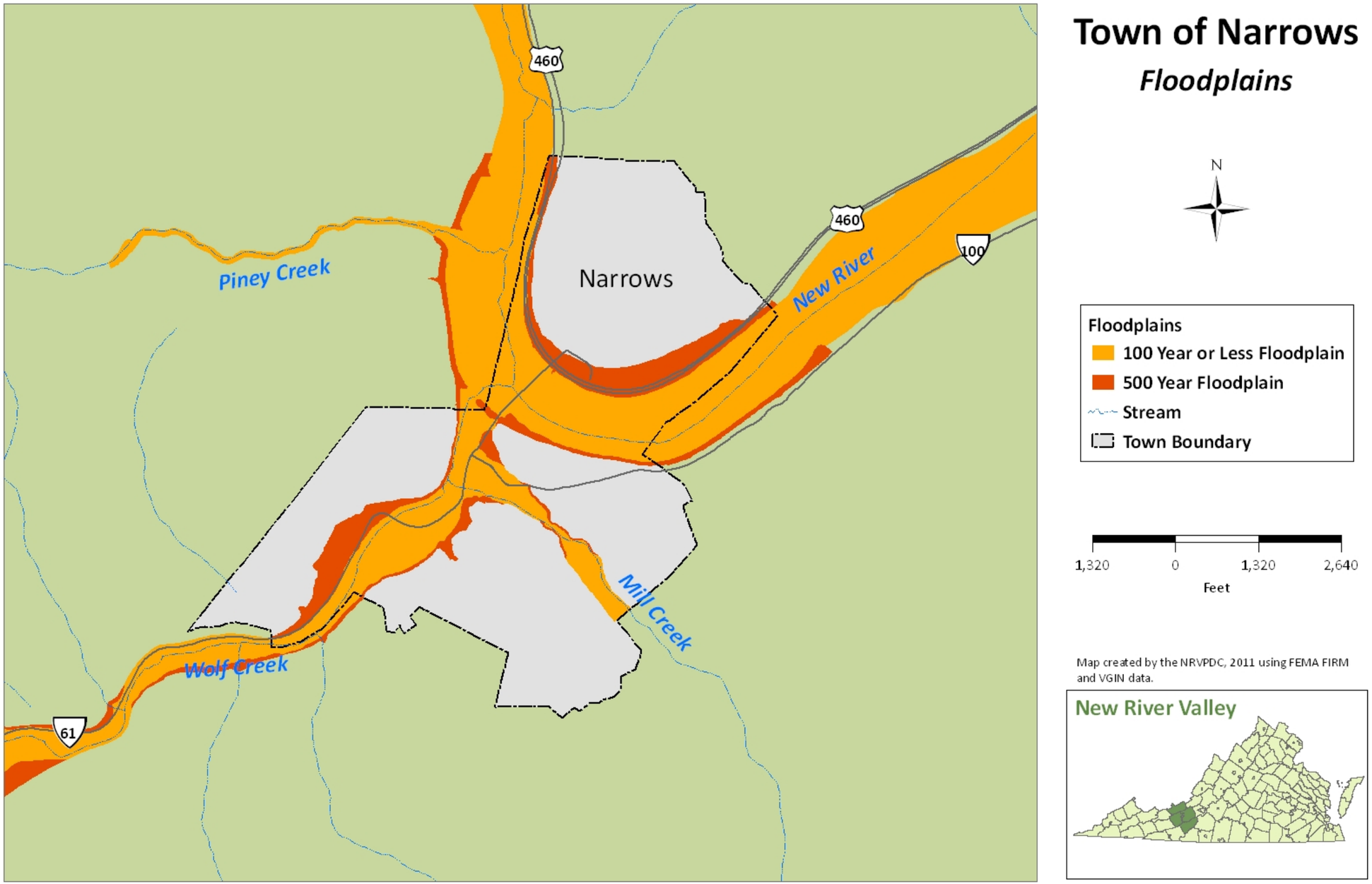


4.5.2.13 Town of Narrows

The Town of Narrows is located along a New River bend. The confluence of Wolf Creek and the New River occurs in the Town limits so flooding on the New has dramatic effects on the Town. Mill Creek, a tributary of Wolf, also contributes to flood problems. During the 1940 New River flood (estimated at 100-year flood), virtually the entire business section of the Town of Narrows was flooded. The local sewage treatment plant, still located in the New River floodplain, was damaged. Subsequent floods, including 1956 and 1972, caused significant property damage along Wolf Creek. Water entered homes and businesses peaking at a height of four feet in a local power substation.

The Town of Narrows is very vulnerable to flooding. There are no reported Repetitive Loss Properties in Narrows.

Map 18. Town of Narrows Floodplains



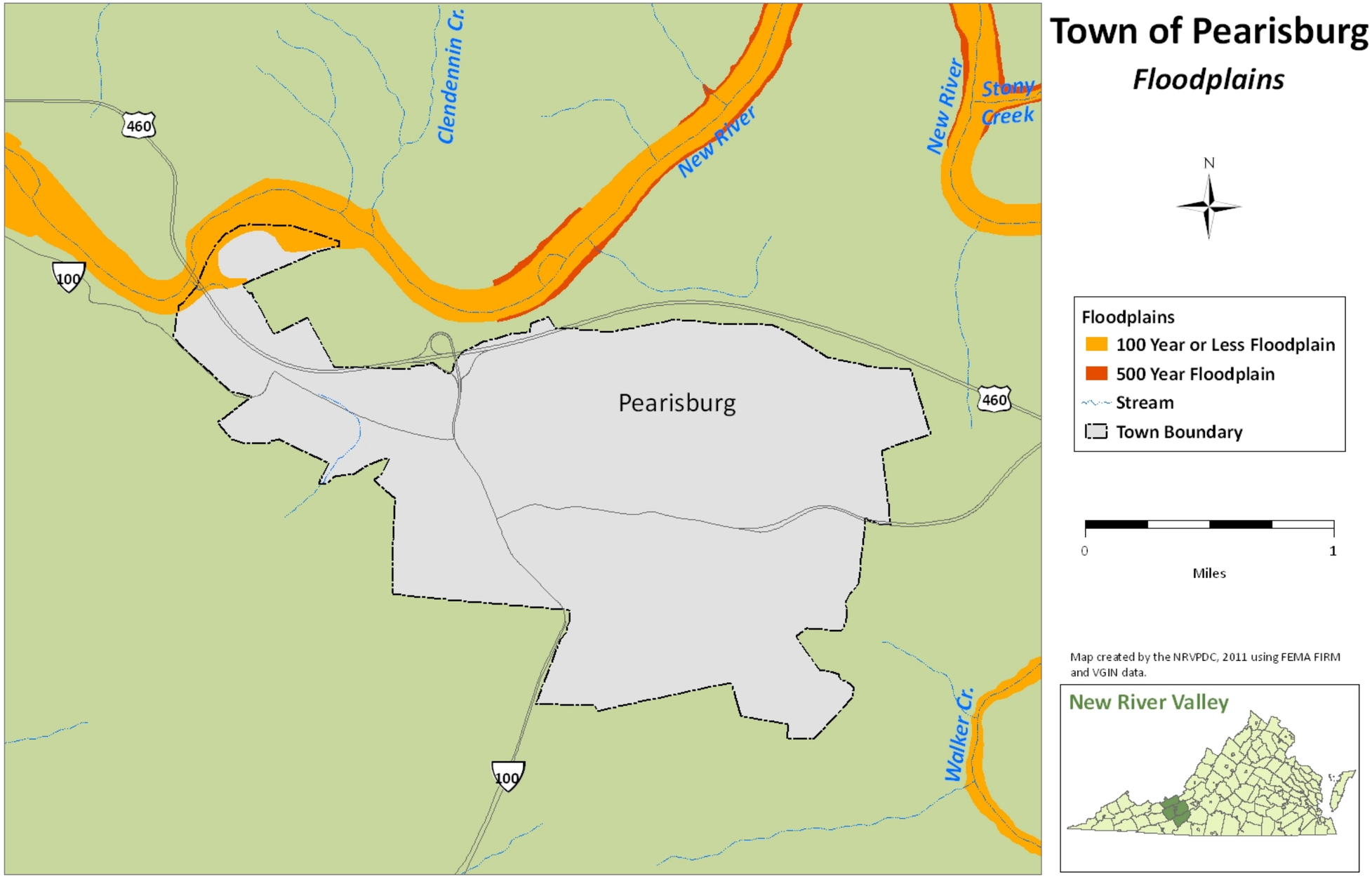
4.5.2.14 Town of Pearisburg

The Town of Pearisburg has experienced flood problems in the downtown area and on the east end. Most recently, the downtown experienced flooding in 1995, and the east end flooded in 2002. There has apparently been no federal flood insurance study in Pearisburg, though the Town conducted a study of downtown flooding issues in 1998.

Wenonah Street is affected by flooding in Pearisburg, as is the Bunker Hill area (Preliminary Engineering Report, 1998). Clifford and Chestnut streets experience minor stormwater flooding in backyards. Since no flood insurance studies or mapping have been done in the town, the risk factors are unknown.

Located inside the Town limits, the town's sewage treatment plant and a portion of the Hoechst-Celanese property (a major employer) are in the 100-year floodplain. The treatment plant facilities are elevated to a height of at least six inches above the base flood elevation. The treatment plant is valued at over $1 million. As of 2002, there were three flood insurance policies in Pearisburg area, covering $159,000 in structures. Pearisburg has one repetitive loss property.

Map 19. Town of Pearisburg Floodplains



4.5.2.15 Town of Pembroke

The Town of Pembroke is located in the center of Giles County. The town became incorporated in 1948 and had a population of 1,134 in 2000. Mays Hollow, Little Stony Creek, Doe Creek and the New River are all threats of flooding to the town and were the subjects of a flood insurance study in 1978.

Mays Hollow, Little Stony Creek and Doe Creek flow through the town while the New River flows along the town's southern border. The worst flooding on record of the New River was in August 1940. The flooding caused backwater effects that affected the lower lying areas and filled Little Stony and Doe Creek, causing damages to many residents.

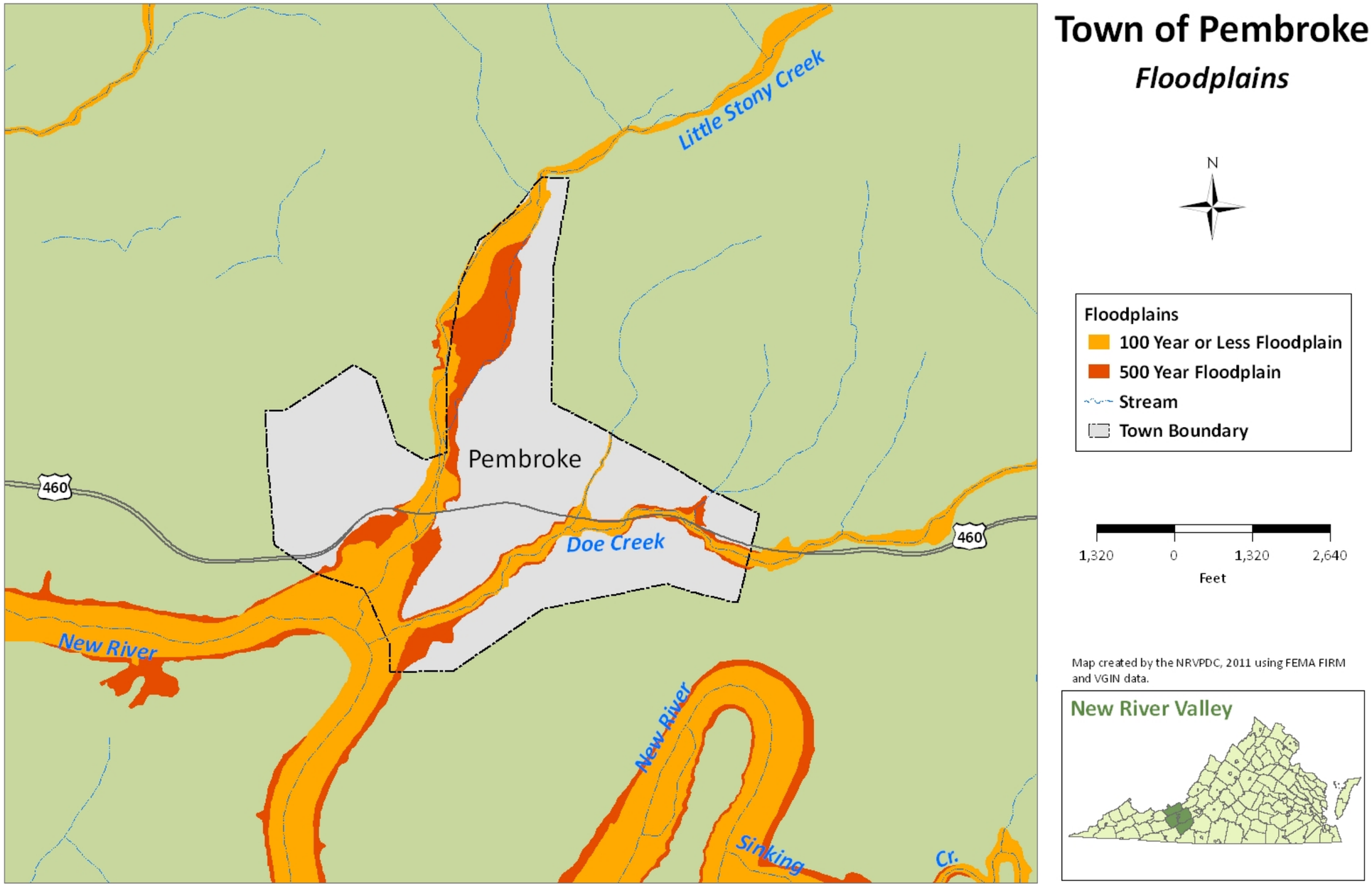
Localized thunderstorm events and tropical storm related precipitation are the primary cause of flooding in the area. A recent flood event occurred in July 2002, as already discussed, after a localized storm dropped 5.5+ inches of precipitation in less than four hours. This event caused flooding of Doe Creek, the temporary closing US Route 460, and substantial flood damage to residents and businesses.

Local residents point to the construction of US Route 460 and subsequent channelization of Doe Creek and Little Stony Creek as part of the problem. The small culverts are easily overwhelmed, and debris further exacerbates the problems.

The 2002 "Doe Creek" flood revealed part of Pembroke's vulnerability to flash-flooding. As Map 20 demonstrates, though, the Little Stony 100-year floodplain (flowing north to south) through the town is much larger than the Doe Creek 100-year floodplain (flowing east to west). If the 2002 event had been centered just slightly north and west, much more damage would have likely occurred, as there are many more structures close to the streambed along Little Stony.

Despite the high number of at-risk properties, there are only 23 flood insurance policies in the town, covering about $1.9 million in property.

Map 20. Town of Pembroke Floodplains



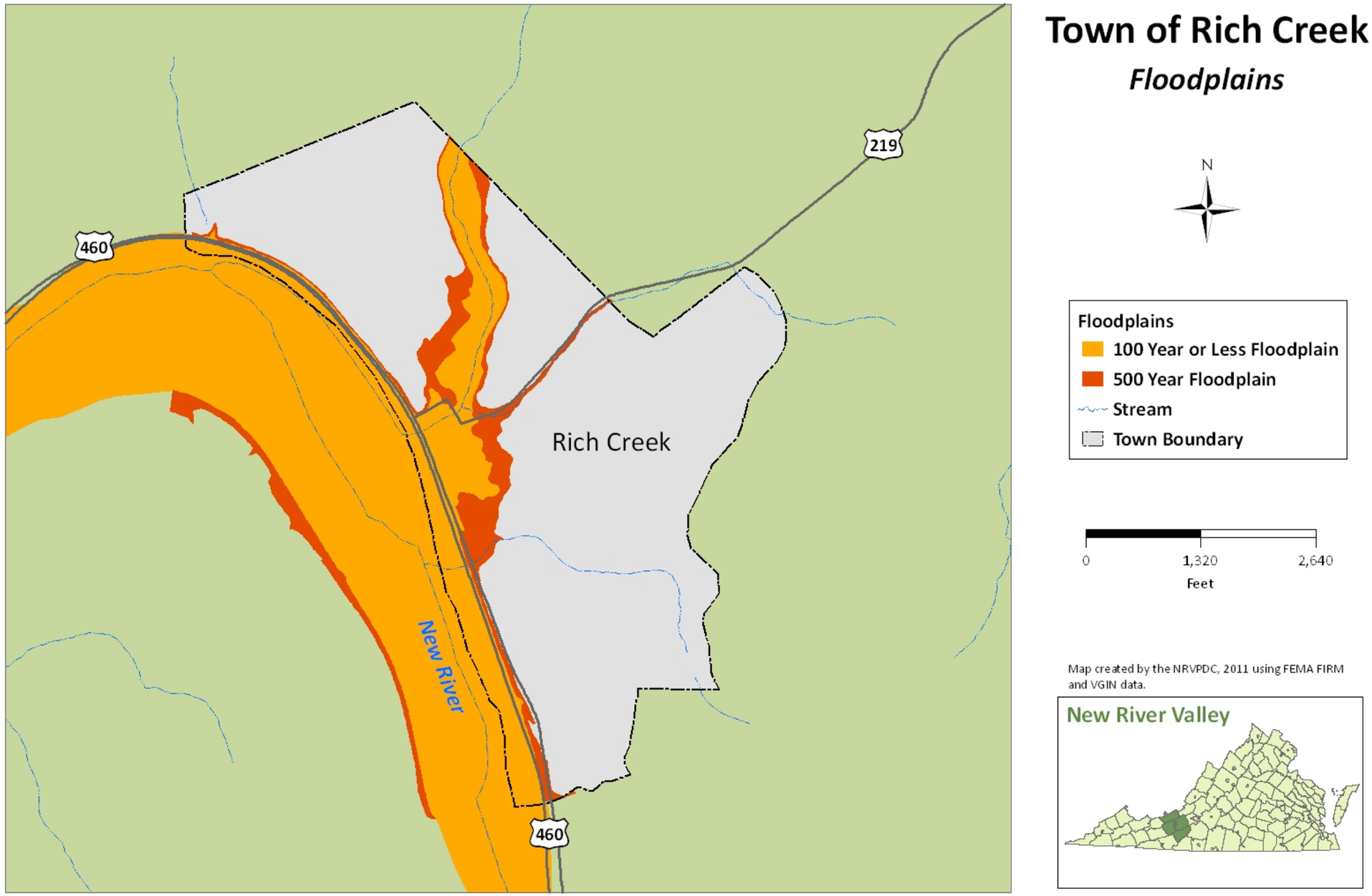
4.5.2.16 Town of Rich Creek

Incorporated in 1947, the Town of Rich Creek is located in Giles County only a few miles from West Virginia. The New River is the western boundary of the Town and is the primary source of periodical flooding. Another source of flooding is the Town's namesake, Rich Creek, a tributary to the New River.

Flooding in the Town of Rich Creek has been primarily due to heavy rains resulting from a tropical storm, or localized thunderstorm or frontal system. Flood events which resulted in property damage (including commercial) occurred in July 1916 and August 1940, but there is no data available on an estimation of damages. Both of these flood events were recorded as 100-year flood events.

Located on its namesake, much of Rich Creek is in the floodplain. No repetitive loss properties are known to be located in Rich Creek.

Map 21. Town of Rich Creek Floodplains



4.5.2.17 Montgomery County

Montgomery County is bordered on the north by Giles and Craig Counties, on the south by Floyd County, on the east by Roanoke County, and on the west by Pulaski County. Urbanized areas within the county experience fairly frequent flooding. These high risk areas will be discussed in more detail later.

The unincorporated areas of Montgomery County may be affected by flooding from many streams in the area. In the past, the most severe flooding of the major streams has been the result of heavy rains from tropical storms, while flooding of the smaller creeks has been primarily due to localized thunderstorms. Also, flooding is sometimes associated with heavy rains on top of snowmelt or a frozen ground.

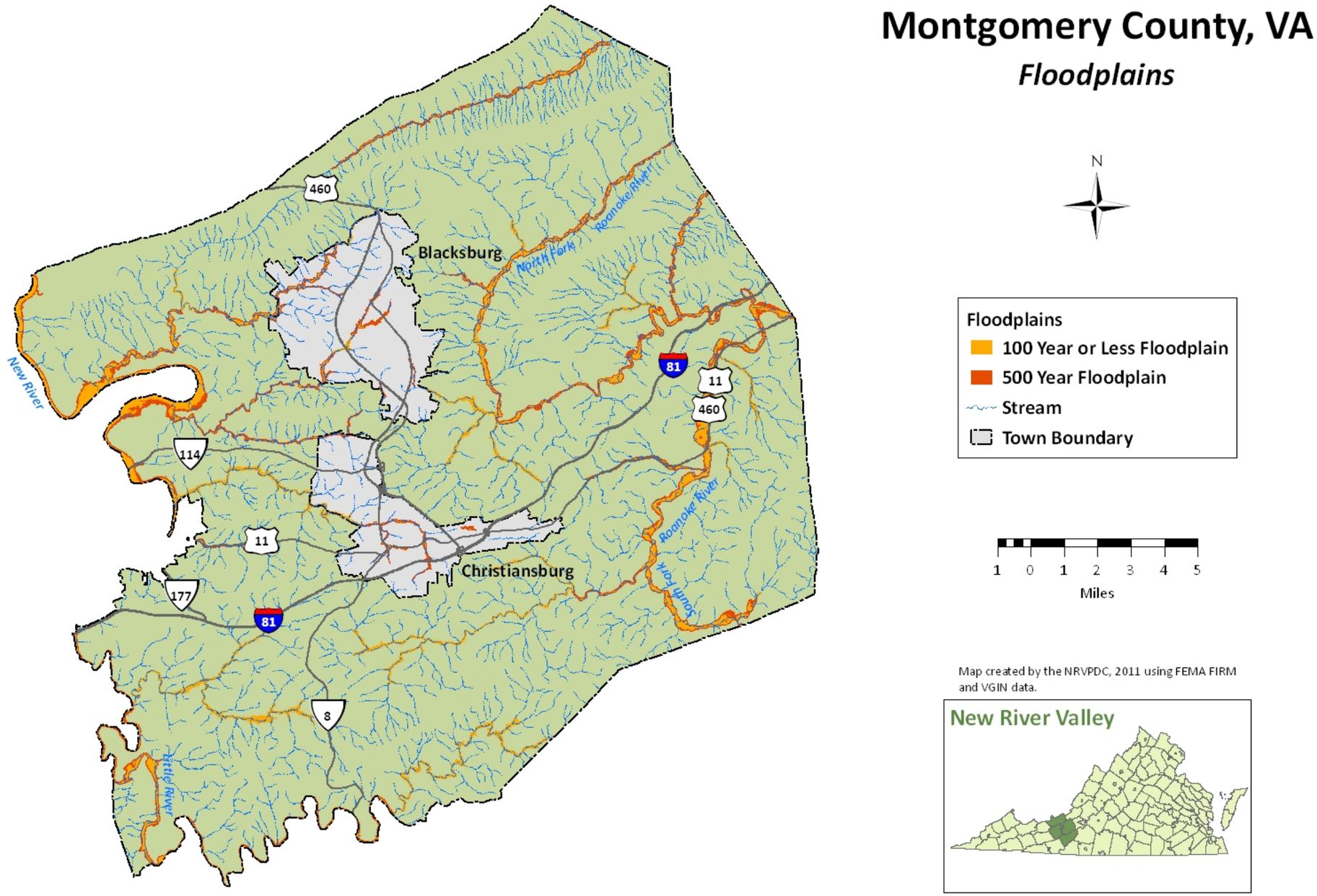
Flooding sources identified in the unincorporated areas of Montgomery County:

- Roanoke River
- North Fork Roanoke River
- South Fork Roanoke River
- Bottom Creek
- Bradshaw Creek
- Craig Creek
- Elliott Creek
- Goose Creek
- Indian Run
- Little River
- New River
- Plum Creek
- Slate Branch
- Spring Branch
- Stroubles Creek
- Toms Creek

The communities of Shawsville, Elliston, Lafayette, Allegheny Springs (Roanoke River basin) and Plum Creek, plus the towns of Blacksburg and Christiansburg are the primary areas affected. In June 1972, the elevations of the South Fork Roanoke and Roanoke River were at approximate 50-year frequency levels due to rainfall from tropical storm Agnes. This caused extensive damage to the adjacent communities in excess of one million dollars. This area also experienced flooding during the 1980s and 1990s and as recently as 2003. Many of these area are zoned for growth, including not only Blacksburg and Christiansburg but also much of Shawsville, Elliston and Plum Creek as evidenced by the new village designation in the future land use map.

As of September 2009, there were 182 NFIP in-force in the unincorporated areas of Montgomery County, covering $29,087,600 in structures. This areas includes eastern Montgomery and Plum Creek, but not the Towns of Blacksburg and Christiansburg, where policies in-force total $2,386,900 and $2,485,200, respectively (as of December 2002).

Map 22. Montgomery County Floodplains



4.5.2.18 Shawsville, Elliston, Lafayette and Alleghany Springs

Major flooding occurred in the Eastern Montgomery communities of Shawsville, Elliston, Lafayette and Alleghany Springs in 1940, 1972 and 1985. In June 1972, the elevations of the South Fork Roanoke and Roanoke River were at approximate 50-year frequency levels. This caused extensive damage to the above communities in excess of one million dollars. This area also experienced flooding in the early 1990's and as recently as the 2003 event referenced earlier.

In relatively mild downpours, communities in eastern Montgomery County experience flooded roads and hampered mobility. When serious rainfall occurs, as seen in the February 2003 event, substantial threats to life exist. Roads and bridges flood, as do homes, resulting in substantial damage.

4.5.2.19 Plum Creek

The Plum Creek section of Montgomery County is located largely along the Route 11 corridor between Christiansburg and Radford. While most flood hazard areas in unincorporated Montgomery County are zoned for agriculture, the Plum Creek area is largely zoned for growth.

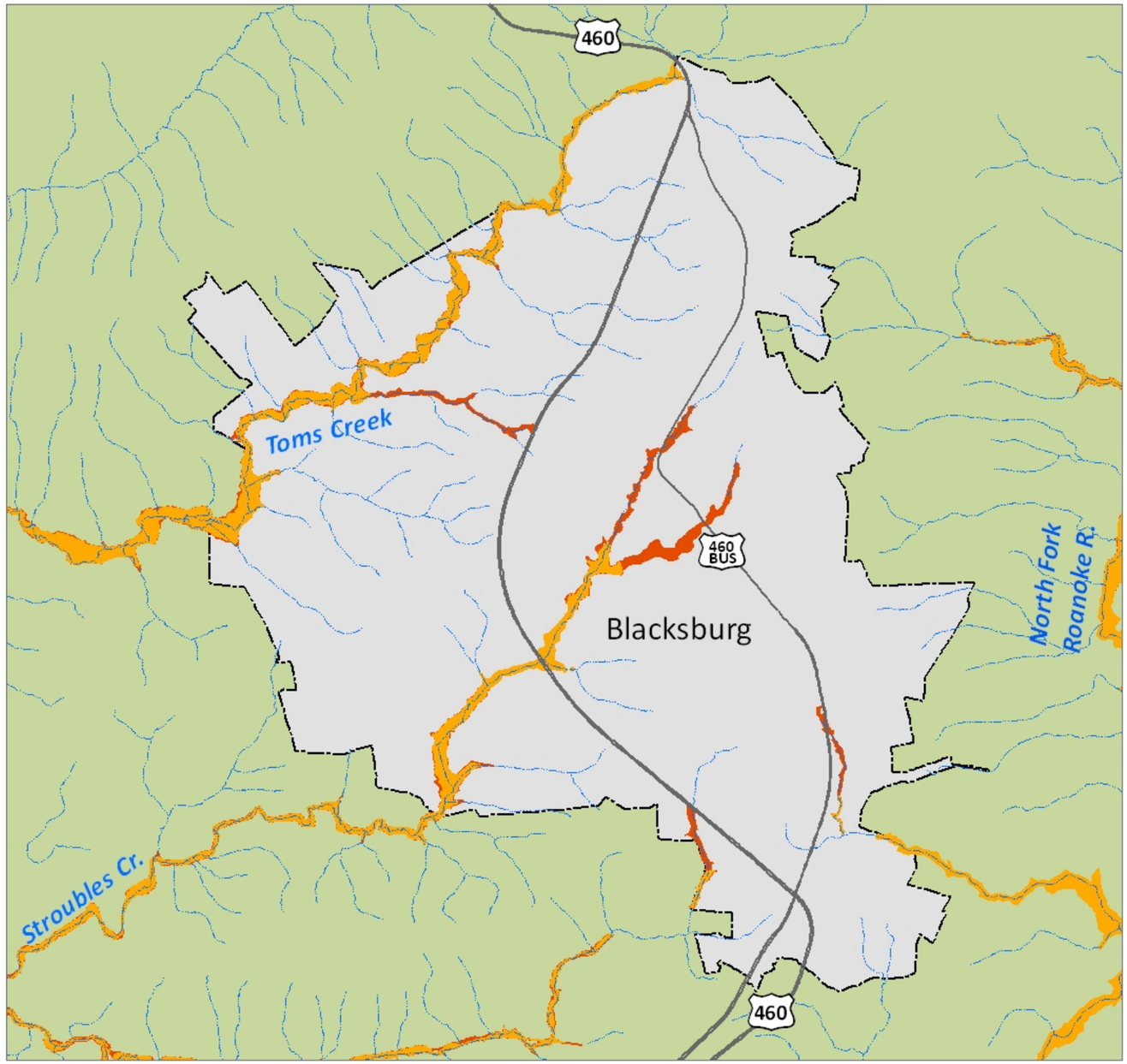
4.5.2.20 Town of Blacksburg

The Town of Blacksburg supports a population of 39,573 residents, the largest urban area in the New River Valley. The Town of Blacksburg was incorporated in 1871. Growth of the town has been as a result of the establishment and growth of Virginia Polytechnic Institute and State University (Virginia Tech) as a land grant college. The university began as an agriculture and mechanical college and has expanded to a leading university in such programs as engineering, architecture, business, and the arts. Currently home to approximately 25,000 students, the university is an enormous asset to the town.

Blacksburg is located atop the eastern continental divide where Toms and Stroubles Creeks flow into the New River. These two creeks along with Cedar Run, a tributary of the Roanoke River and Slate Branch are of the most concern for flood conditions. Flooding primarily occurs in the low-lying areas of the town and is the result of heavy rains of a localized storm, tropical storm, or combination rain and snowmelt in the area. Past history reports severe flooding include 1940, 1972, 1978, 1985, and 1991. The 1991 flood caused $4.5 million in damage on the Virginia Tech campus, including major damage to the Donaldson Brown Center (per Virginia Tech Environmental Health and Safety Services). Flood-protection methods for the residents and property of the town are controlled by the Town of Blacksburg in the form of zoning regulations, building codes and availability of FIRMs.

There are 13 flood insurance policies in force in Blacksburg, covering about $2.4 million in property. There are two repetitive loss properties in Blacksburg.

Map 23. Town of Blacksburg Floodplains



Town of Blacksburg

Floodplains

N

Floodplains
- 100 Year or Less Floodplain
- 500 Year Floodplain
- Stream
- Town Boundary

1 0 1
Miles

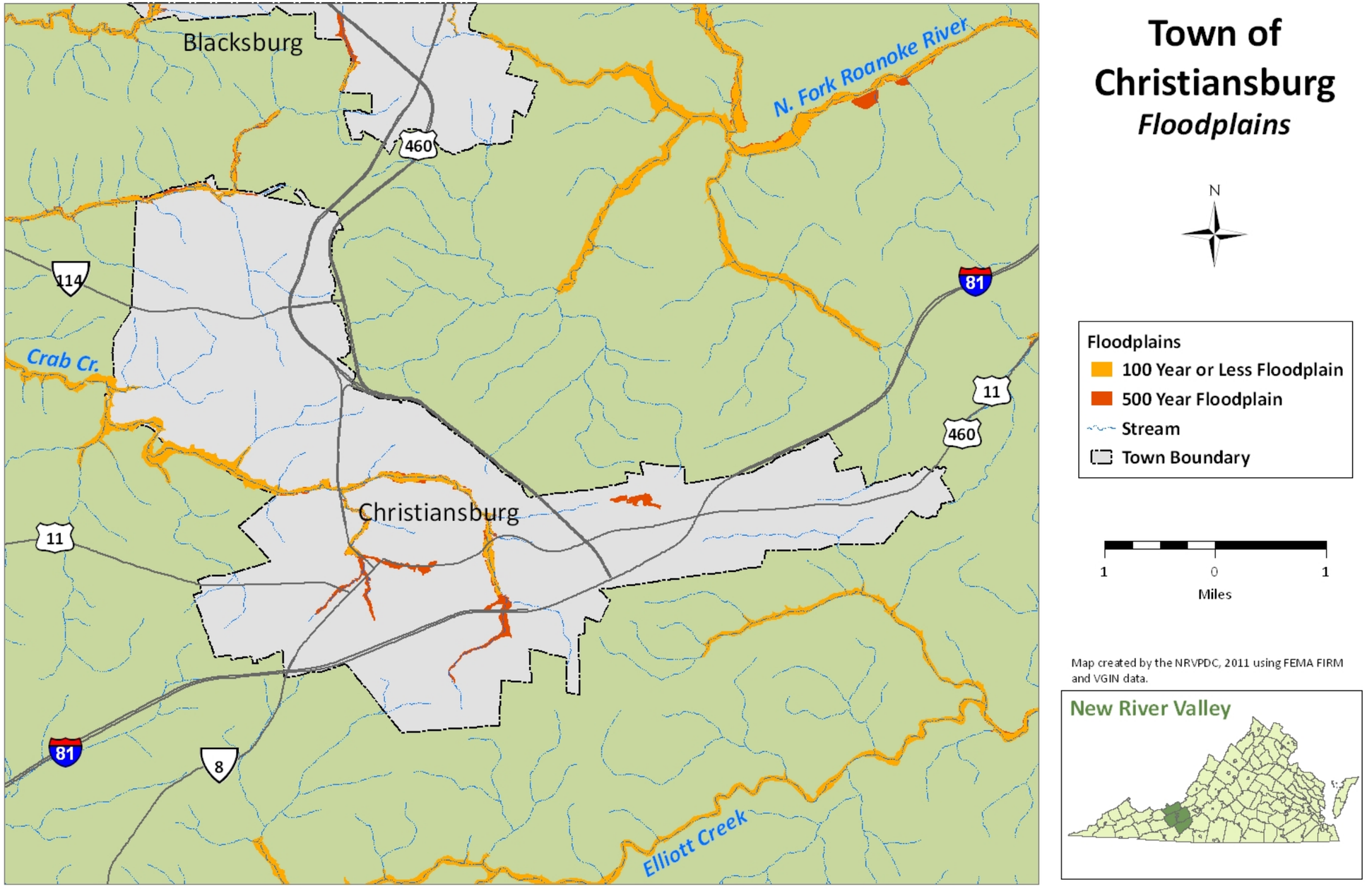
Map created by the NRVPDC, 2011 using FEMA FIRM and VGIN data.

4.5.2.21 Town of Christiansburg

The Town of Christiansburg is located in central Montgomery County and serves as the county seat and commercial center for the entire New River Valley. Christiansburg was incorporated in 1792 and boasts a population, in 2000, of 16,947 residents. The town, located in the Valley and Ridge Physiographic Province, is characterized by rolling hills cut by rugged valleys. The floodplains are narrow, as the streams have small drainage areas and steep slopes. Development primarily lies above flood elevations, but floodplain regulations mitigate flood damage to future development.

Low-lying areas of Christiansburg may be subject to periodic flooding from Crab Creek, Walnut Branch and other small tributaries. The most severe flooding occurred in 1940, 1972, and 1978 as a result of localized thunderstorms and major weather fronts. Due to these floods, the area experienced large economic losses, but no loss of life was reported.

Map 24. Town of Christiansburg Floodplains



4.5.2.22 Pulaski County

Pulaski County is bordered by the Counties of Bland, Floyd, Giles, Montgomery, Carroll and Wythe. There are two towns in the county, Dublin and Pulaski, which is the county seat. the New River bisects the county from southwest to northeast. American Electric Power has a hydroelectric reservoir on the New River (built in 1939) within the county as well. Significant tributaries of the New River in Pulaski County include Peak Creek, Little Walker Creek and Big Reed Island Creek. These plus Peak Creek's two tributaries, Tract Fork and Sproules Run, are the principal sources of flooding in the county.

The most significant flood history and risks exist in and around the Town of Pulaski. In the last 90 years, the town has experienced at least 11 100-year floods, plus a 500-year flood in 1929. Based on the frequency of 100+-year floods in the last century, there is a 10-13% chance every year that the town will experience this level of flooding, rather than the anticipated 0.2-1% chance anticipated.

Tropical storms, including Hurricanes Donna (1960), Camille (1969) and Agnes (1972) are one cause of flooding. Localized thunderstorms from May to September tend to cause localized flooding. Rainstorms of longer duration tend to occur in colder months; these can also be exacerbated by snow/ice melts, as in February 2003.

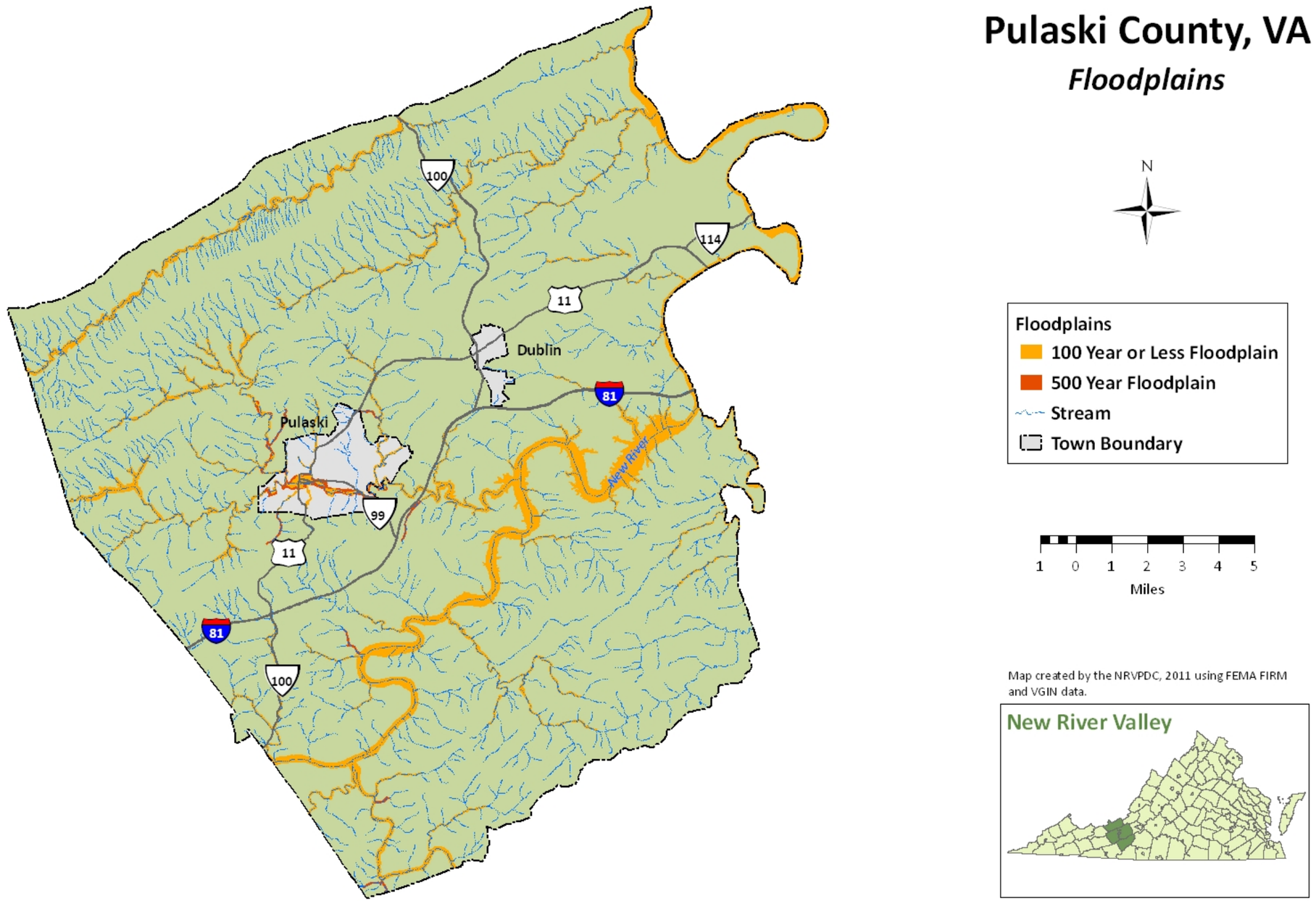
4.5.2.23 Big Reed Island Area

In the very southwest corner of Pulaski County, the Big Reed Island Creek flows from Floyd County to the New River at Allisonia. In the early 1990's, flooding destroyed two bridges in this area and damaged other structures.

4.5.2.24 Little Walker Creek Area

Located in the very northwest corner of Pulaski County, Little Walker Creek flows from Wythe County toward Giles County and the New River.

Map 25. Pulaski County Floodplains

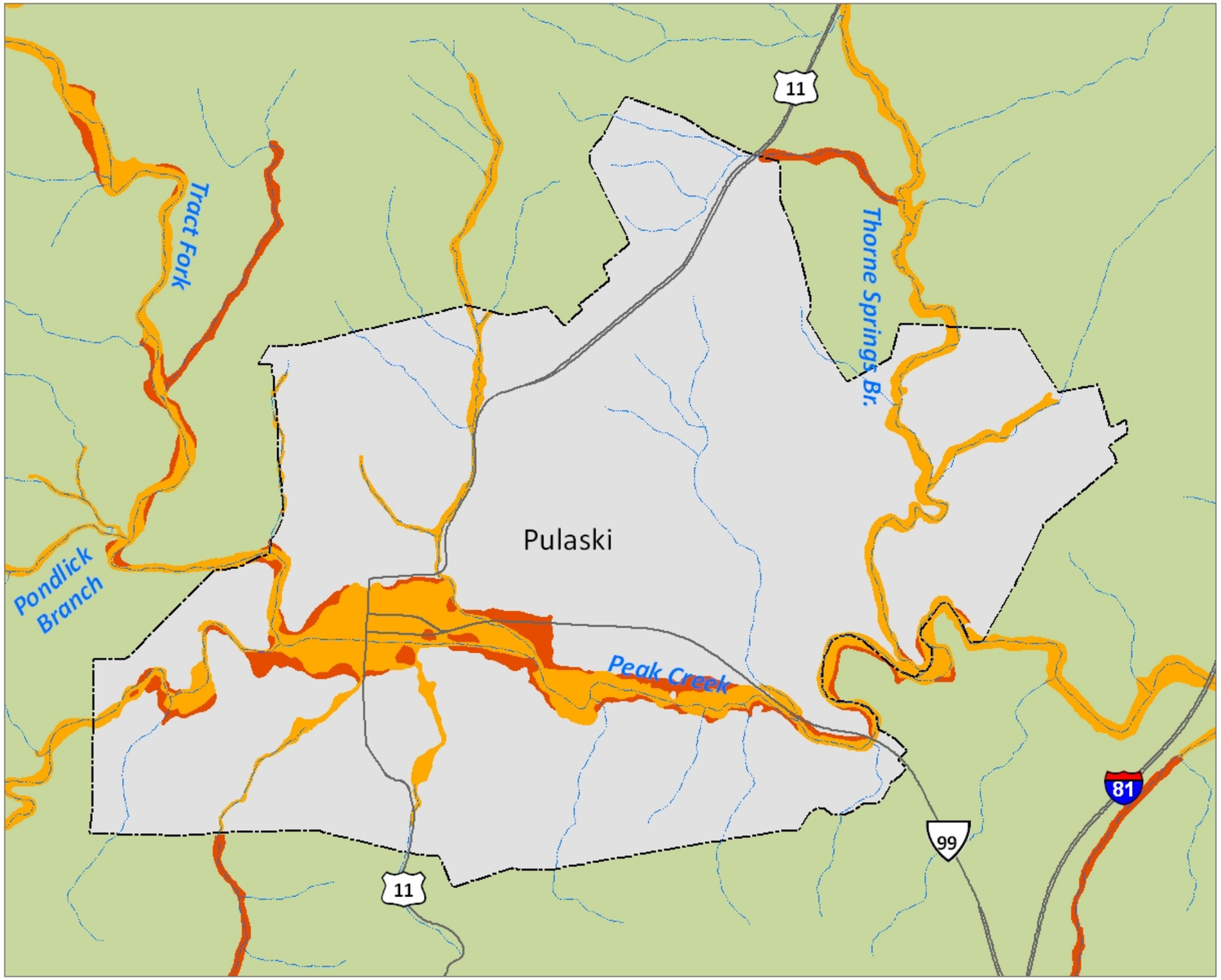


4.5.2.25 Town of Pulaski

The Town of Pulaski is subject to flooding from the main channel of Peak Creek. Peak Creek is a tributary to the New River with its confluence into Claytor Lake. Sproules Run and Tract Fork are also sources of flooding for the town, both are tributaries to Peak Creek. The Town's flooding is exacerbated by very steep terrain above the Town and the relatively flat terrain from the town to Claytor Lake (limiting more rapid drainage). Peak Creek has been channelized through the town, but the value of this is unclear. Analysis with the Virginia Department of Conservation (DCR) reveals that the flooding is also exacerbated by the channel obstructions, both man-made and natural. One man-made obstruction is the railroad trestle which acts as a dam and causes greater water depths and flooding during major storm events. Natural obstructions can include logjams.

The 100-year floodplain in the Town of Pulaski is fairly flat terrain and varies from 2,000 feet in width in the downtown area to 100 feet in the west end. Within the floodplain are roadways, educational and recreational facilities, business and commercial structures, scattered residences, and municipal facilities. Flood problems in the community can be separated into three distinct areas. These areas include the downtown area, the downstream, "Dora Highway" (east side) area, and the upstream, Kersey Bottom (west side) area. During the flood on May 28, 1973, 12 homes and two commercial establishments were inundated. Since that time, a few of those homes along Dora Highway have been bought out through FEMA and demolished. The last significant flood in the town occurred in March 2010. Flood waters rose into the downtown area, causing damage in several businesses and the sheriff's office.

Map 26. Town of Pulaski Floodplains



Town of Pulaski

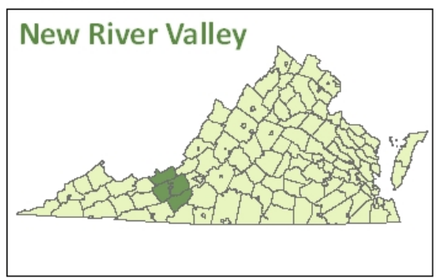
Floodplains

N

Floodplains
- 100 Year or Less Floodplain
- 500 Year Floodplain
- Stream
- Town Boundary

0 1
Miles

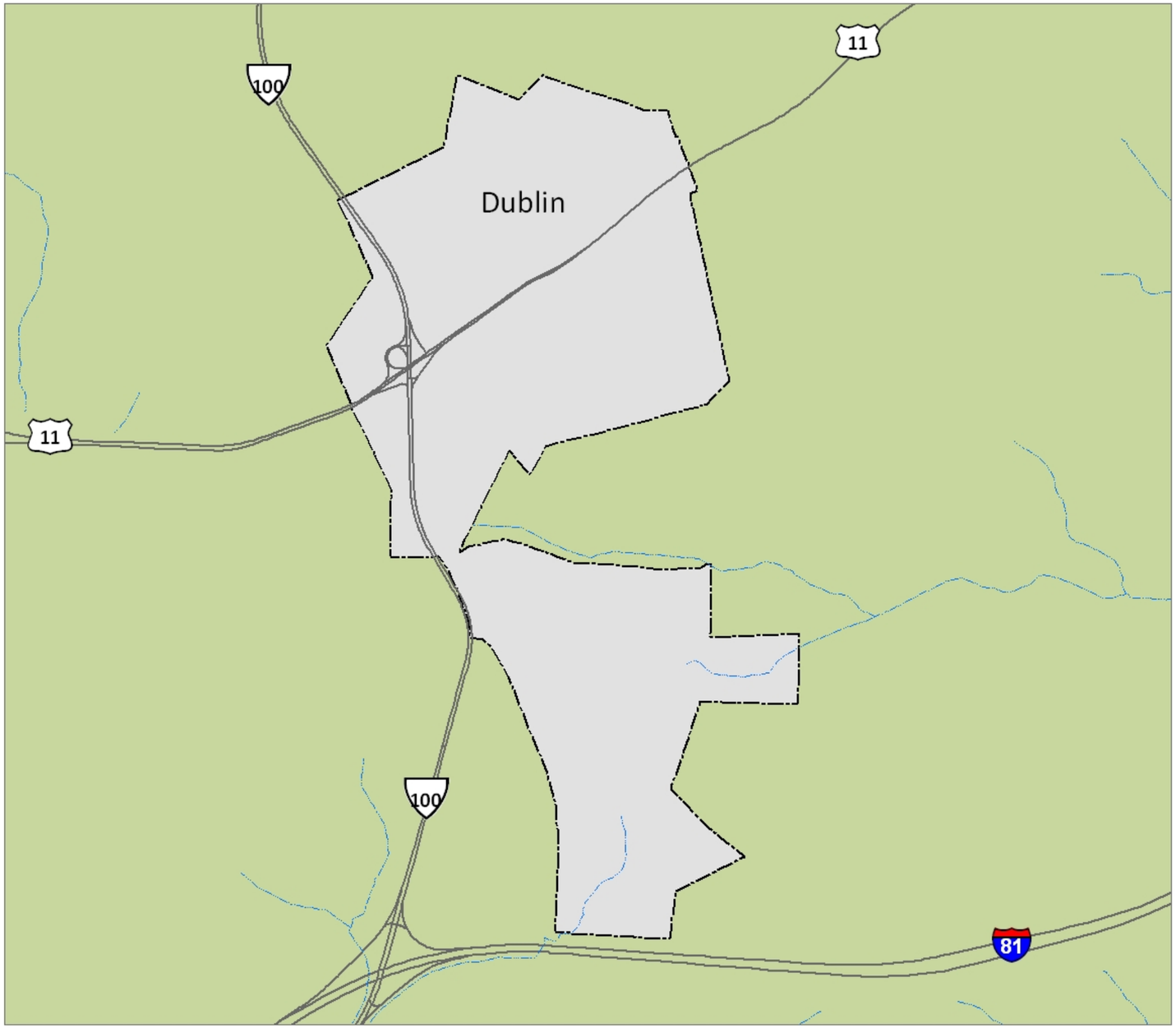
Map created by the NRVPDC, 2011 using FEMA FIRM and VGIN data.



4.5.2.26 Town of Dublin

There are also flooding problems reported in the downtown area of the Town of Dublin, according to the 1999 comprehensive plan, but Dublin did not participate in this planning process. There is no FIRM for Dublin, and they do not participate in the program. However, their comprehensive plan lists flood mitigation in high hazards areas as a top concern.

Map 27. Town of Dublin Floodplains



Town of Dublin

Floodplains

N

Floodplains
- 100 Year or Less Floodplain
- 500 Year Floodplain
- Stream
- Town Boundary

1,320 0 1,320 2,640
Feet

Map created by the NRVPDC, 2011 using FEMA FIRM and VGIN data.

New River Valley

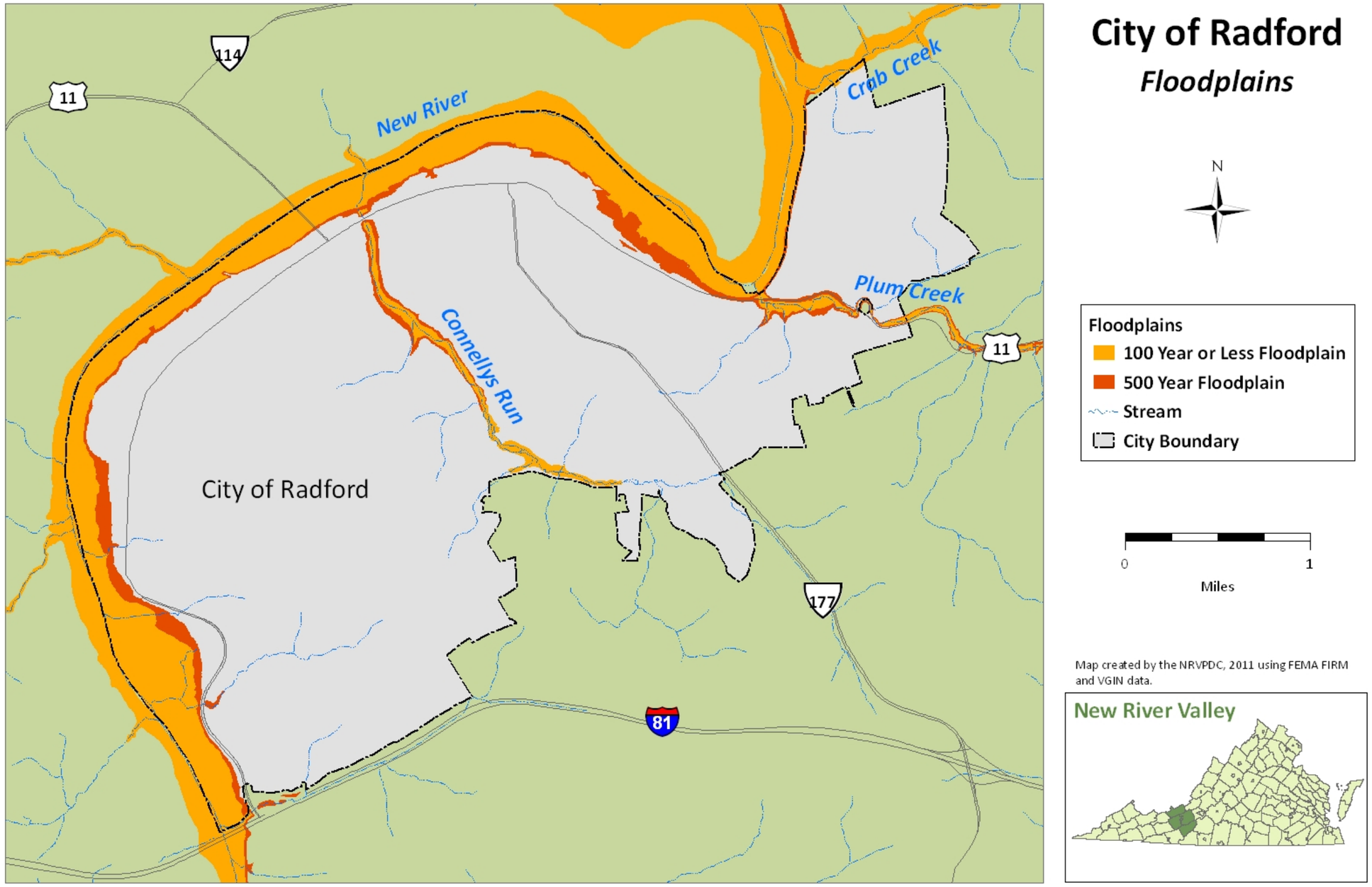
4.5.2.27 City of Radford

The City of Radford is located within southwestern Virginia and is bounded by Montgomery and Pulaski Counties. With a population of 15,859 in 2000, the area became an independent city in 1892. Located within the City of Radford is Radford University, a comprehensive institution with undergraduate and graduate programs. Radford University first began as an all-women's school in 1910 and then received affiliation from the General Assembly in 1964.

The New River creates Radford's western and northern corporate limits, fully eight miles of its border. The New River flows in a northern direction through the state of Virginia and is Radford's main cause of flooding. Major flooding of the New River has been recorded in 1914, 1940, and 1972 and is primarily the result of tropical storms. Connelly's Run is also a cause of concern for flooding in the area. Low-lying areas near this creek are likely to experience flooding due to a localized storm or frontal system. Located up stream in Pulaski County, Claytor Lake Dam controls most flood elevations. Radford's hydroelectric dam on Little River also has minimal effects on flood elevations.

Radford is essentially built upon the terraces of the New River. The first terrace, just a few feet above the river, is about one-quarter mile wide. Upon the next terrace, more than 50 feet above the first, are the main downtown businesses.

Map 28. City of Radford Floodplains



4.5.2.28 Drowning Risks

Even more important than the risk to structures are the risks to personal safety. Due to the rural, mountainous terrain of much of the New River Valley, many homes are precariously perched along streams. Often the only access is across private bridges. Likewise, many public roads and bridges are impacted by floodwaters. One of the greatest risks to personal safety from flooding comes as people try to drive onto flooded roadways or bridges. Nationally, nearly half of the flood or flash-flood related fatalities are auto-related. An auto will float in less than six inches of moving water and can be swept downstream into deeper waters. Victims of floods have often put themselves in perilous situations by ignoring warnings about travel or mistakenly thinking that a washed-out bridge is still open. This risk is largely preventable when people learn to respect the dangerous power of floodwaters.

4.5.2.29 Dam Inundation

There is, in reality, no way to predict the likelihood of dam failure, and the classification of "significant" and "high" hazards are, at least in part, rather random. The classification into a risk category also changes from one database to another over the period of a year or so. Generally speaking, the possibility of failure generally increases with age. Dams in the NRV are between 110 and 62 years of age. Considering that many dams were designed for an effective life of 50 years, this indicates that dam failure may eventually occur.

There is no history in the NRV of a dam failure among the registered and inspected dams. Thus, an assessment of damages is not probable. Preliminary research results on the areas affected by potential dam failures are still in a preliminary stage for the NRV. All dams in the region have a plan kept by DCR, but those plans are of varying quality and information. Only Claytor Lake has a downstream inundation map should the hydroelectric dam there fail, either partially or fully.

4.5.3 Past or Existing Mitigation

While the risk to lives and property from flooding is substantial in the New River Valley, the opportunities to mitigate those risks are also substantial. Some are as simple as recognizing and valuing the contribution of natural components (such as trees) and functions.

Most jurisdictions have already acted upon some of these opportunities. The level of flood mitigation across the New River Valley varies widely. All of the Counties, the City and most of the Towns participate in the NFIP. Participation requires the jurisdictions to regulate development in the floodway and the flood fringe through zoning or a separate ordinance. This means that in the designated floodway, no expansion of structures may occur. In a designated floodplain, substantial improvements (greater than 50% of current value) must be elevated or floodproofed. Also, floatable objects should be restrained in some manner to help avoid the obstruction of drainage structures. Local government participation means that citizens may then buy flood insurance. Based on preliminary assessment, it appears that from 10 to 50 percent of high-risk property is insured.

Jurisdictions such as the Towns of Blacksburg and Pulaski with major flood losses and large town staffs have been more active and pro-active in flood mitigation. Also some private citizens around the area are demonstrating basic mitigation techniques.

4.5.3.1 Town of Blacksburg

Blacksburg has more stringent stormwater management ordinances than Virginia requires. Blacksburg has initiated studies along Stroubles Creek and identified a series of stormwater detention ponds that would reduce flood elevations. Blacksburg has also digitized its floodplain maps and strictly prohibits any additional floodplain development. Blacksburg is also one of the first localities in the nation to implement a broad community communication network. This system can notify registered users of news through their home phone, cell phone, e-mail, pager, and/or fax.

4.5.3.2 Town of Pulaski

Pulaski initiated flood mitigation planning in 2001. It organized a committee composed of citizens, business owners and Town staff. Town staff digitized floodplain maps. Building upon prior Flood Insurance Studies, Corps of Engineer reports, and new analysis by DCR and the NRVPDC, a mitigation plan was drafted. So far, in accordance with that plan, the Town has

- Completed the removal of six houses from the floodplain using hazard mitigation grant funding,
- Established a flood mitigation section at the local library, and
- Created and mailed a flood mitigation newsletter to all residents in the floodplain.

The Town also wishes to apply to the Community Rating System to help reduce the cost of flood insurance and increase local participation.

4.5.3.3 Montgomery County

In the 1980s and 1990s, Montgomery County pursued federal assistance in the eastern portion of the county. The Corps of Engineers did analysis along Brake Branch, and the Natural Resource Conservation Service provided some streambank clearance assistance. In its current comprehensive planning process, Montgomery County staff and citizens are focusing intensely on environmental elements. The county zoning ordinance has been updated to require new construction to be at least one foot above base flood elevation. New structures must also have elevation certificates to show they meet this requirement. Staff also receive floodplain management training, including the Certified Floodplain Manager qualification. The county's FIRMs were updated in September 2009. In addition to local government action, citizens are increasing demonstrating mitigation propensities.

4.5.3.4 Giles County and the Town of Pembroke

Since the 2002 flooding in Pearisburg and Pembroke, Giles County has successfully sought streambank clearance assistance from the Natural Resource Conservation Service. Also since that flooding, the Town of Pembroke has increased its attention to drainage-system components and maintenance. The Town and County are seeking help from VDOT to assess culvert sizes and maintenance programs along primary and secondary roads in flood-prone areas. The Town also makes regular drainage system maintenance checks before and after flood events. Also, the Town of Pembroke hosted a special flood hazard and mitigation meeting as part of its comprehensive plan update in 2003. The Town is also including a sizable hazard mitigation section in the new comprehensive plan.

4.5.3.5 City of Radford

In part due to the City's enforcement of the floodplain zones, other entities in Radford are mitigating against flood damage. Hunter Ridge Apartments were built upon a mound, to ensure elevation out of the flood elevation levels. Radford University built a berm along the river to help protect the parking lot at the Dedmon Center.

4.5.3.6 Other Existing Mitigation Programs

The region also benefits from another federal program, the National Weather Service (NWS). With a local office in Blacksburg, the NWS distributes forecasts, statements, severe weather watches and warnings through local media outlets and the Emergency Alert System. The NWS also coordinates and monitors the Automated Flood Warning System (also Integrated Stream Flows (IFLOWs), a network of rain gauges in the eastern U.S. including the New River Valley. The system is automated and updated every 15 minutes and is available online at www.afws.net.

Additionally, the NWS and the National Oceanic and Atmospheric Administration (NOAA) operate NOAA Weather Radio, which makes statements and warnings ever-accessible. Moreover, new technology has enabled the "Specific Area Message Encoder" (SAME) program, which activates special radios in only the affected area when there is an imminent threat. These radios are available on the market for $30-40. Unfortunately, reception is spotty in the mountainous areas of the NRV. There are similar services available from private vendors for cell phones, fax machines, etc., including "Notify!" from the Weather Channel. In these and the new Town of Blacksburg service, people may choose which the types of events for which they wish to be notified.

4.5.4 Mitigation Opportunities

A complete listing of NRV hazard mitigation goals, objectives, and strategies can be found in Chapter 5: Mitigation Strategy. Below are the goals, objectives, and strategies identified by the flooding working group to specifically lessen the impacts of flooding in the region.

3. **Minimize flood-related deaths and losses of existing and future structures.**
    a. *Save lives at imminent risk.*
        i. Seek grant funding to develop early warning systems in high-risk areas utilizing new technology.
        ii. Develop regional capacity for swift-water rescue, including training and equipment purchase.
        iii. Encourage localities to participate in the Storm Ready Program offered by the National Weather Service.
        iv. Promote the NOAA, NWS campaign "Turn Around, Don't Drown" by utilizing signage and other awareness activities.
        v. Increase 2-way communication between NWS and emergency managers during flooding events, as well as communication with residents potentially affected by flooding.
        vi. Educate homeowners and residents in vulnerable areas about the dangers of floods.
        vii. Improve regional communication to improve flood response.
    b. *Reduce risks to critical facilities.*

i. Do not build new critical facilities in high hazard areas (may be a general policy decision or more strict zoning).
ii. Identify critical facilities in high-risk areas.
iii. Replace critical facilities currently located in high-risk areas.
iv. Identify measures to reduce risk of critical facilities in high hazard areas.

c. *Offer mitigation assistance to owners of flood-prone properties, especially repetitive loss properties.*
   i. Pursue mitigation grant opportunities to buy out, elevate or water-proof flood-prone properties through FEMA, VDEM, and Community Development Block Grant.
   ii. Study feasibility of mitigation in historic districts or with historic properties.

d. *Educate citizens about the inevitability of flooding, the dangers it poses to life and property, and the opportunities for mitigation.*
   i. Seek to update flood insurance studies and maps to understand risks more accurately.
   ii. Encourage the development of statewide databases and geographic information systems layers to assist local government planning efforts.
   iii. Encourage collection and development of better hazard history locally and incorporate into geographic information systems.
   iv. Incorporate hazard mitigation information in the future in the local comprehensive planning process.
   v. Utilize existing documents and programs from FEMA, the NFIP, VDEM, and the NWS to educate the public about hazards and mitigation opportunities.
   vi. Produce and distribute local newsletters and/or other mitigation documents to residents in high-hazard areas.
   vii. Coordinate with and support Community Emergency Response Team (CERT) information distribution activities in the community.
   viii. Provide community workshops.
   ix. Educate citizens about the availability and value of NFIP policies and encourage greater participation.
   x. Notify and educate property owners of structures in floodplain about the potential impacts.
   xi. Include a notice that property is in floodplain in deed or plat.

e. *Limit future development in floodplains.*
   i. Utilize zoning ordinances to further restrict undeveloped floodplains.
   ii. Encourage standards above NFIP standards when considering floodplain development.

f. *Develop adequate drainage structures and maintenance procedures to prohibit "back-up" flooding in high-hazard areas.*
   i. Seek grant and/or state funding for replacement of inappropriately sized culverts and drainage.
   ii. Pursue streambed clearance through citizen groups and/or the Natural Resources Conservation Service as needed to eliminate bottlenecks.

iii. Encourage bottomland farm fences to catch debris before reaching culverts.
iv. Schedule regular drainage system maintenance including before and after storms.
v. Work with VDOT to inventory culverts in the region.
vi. Ensure that future culverts are adequately sized for the estimated run-off from storms.
vii. Educate landowners about culvert maintenance to ensure culverts continue to efficiently handle stormwater.

g. *Develop stormwater facilities or upgrades as needed to limit flooding in high hazard areas.*
    i. Seek grant funding for regional stormwater detention facilities as needed. Reconsider design frequency of occurrence.
    ii. Seek channel improvements or upgrades as needed to reduce peak flood flows.
    iii. Pursue combinations of regional stormwater management strategies and onsite strategies.
    iv. Encourage alternative stormwater management options in both new and existing facilities.
    v. Inventory stormwater infrastructure to ensure adequate future maintenance.
    vi. Utilize floodplains as community assets such as parks or other open spaces.
    vii. Develop strategies for addressing impervious surfaces and their impact on stormwater.

h. *Pursue mitigation projects that achieve multiple community goals.*
    i. Pursue partnerships with land trusts to promote conservation easements on undeveloped floodplains and wetlands to aid flood mitigation.
    ii. Pursue the affordable housing alternatives for low-income families now living in floodplains.
    iii. Seek economic development opportunities, such as brownfields, which turn current “liabilities” into community assets.