Hazard Mitigation
Loss Avoidance Study
Tazewell County, Virginia

Town of Bluefield Acquisition Demolitions
DR-VA-1386 - Severe Storms and Flooding July 8 - Aug. 7, 2001 - Declared July 12
DR-VA-1411 - Severe Storms and Tornado Apr. 28 - May 3, 2002 - Declared May 5
DR-VA-1406 - Storms and Flooding Mar 17 - Mar 20, 2002 - Declared Apr 2
Flood Mitigation Assistance (FMA) 2006

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Introduction

The Commonwealth of Virginia has a history and exposure to a wide array of natural hazards as demonstrated by 73 federal disaster declarations occurring since 1953 (Table 1).[1] As such, the Commonwealth has a long-established commitment to hazard mitigation in the encouragement, promotion, assistance with, and funding of the implementation of measures to reduce or eliminate long-term risk to people and property from natural hazards and their effects.

Table 1: Federally Declared Disaster Declarations in Virginia and Tazewell County

Incident Type	Virginia (#)	Tazewell (#)
Severe Storm	19	9
Flood	16	1
Hurricane	16	3
Fire	8	
Snowstorm	6	5
Biological	2	2
Drought	2	1
Earthquake	1	
Freezing	1	
Severe Ice Storm	1	
Terrorist	1	
Total	**73**	**21**

Since 1990, nearly $335 million of Hazard Mitigation Assistance (HMA) funding has been allocated[2] to Virginia communities and agencies funding more than 560 projects and mitigating nearly 1,300 properties.[3] Of those dollars $4.4M has been spent on various projects in Tazewell County, including at least $3.3M on property acquisitions in the Town of Bluefield (Table 3).

To document and evaluate the impact of this funding, and update the *Commonwealth of Virginia Hazard Mitigation Plan*, VDEM determined that it is appropriate to examine a selection of completed mitigation projects and estimate the real-world losses avoided through those projects.

[1] FEMA Open Data: https://www.fema.gov/openfema-data-page/disaster-declarations-summaries-v2
[2] Includes closed, obligated, and approved projects.
[3] FEMA Open Data: https://www.fema.gov/openfema-data-page/hazard-mitigation-assistance-projects-v2

Table 2: Hazard Mitigation Assistance (HMA) grants 1990 – 2022 Virginia

HMA Project Type - Virginia	$ Amount	# Projects
Acquisition /Relocation	$151,079	3
Acquisition/Demolition; Acquisition /Relocation; Elevation or Acquisition	$78,070,122	139
Advanced Assistance; 5% Initiative Projects	$842,082	5
ANS (Alert and Notification Systems); 5% Initiative Projects	$1,772,384	18
Code Enforcement - Post and Pre Disaster	$118,712	1
Dry Floodproofing of Non-residential Structures; Dry Floodproofing of Historic Residential Structures; Structural Retrofitting of Existing Buildings; Floodproofing	$622,036	5
Education and Outreach	$965,089	22
Elevation; Elevation or Acquisition	$68,158,953	88
Feasibility, Engineering and Design Studies	$461,076	6
Generators for Critical Facilities; Generator Quick Connect	$7,725,987	26
Infrastructure Protective Measure	$21,542,612	2
Infrastructure Protective Measure; Floodwater Storage and Diversion; Acquifer Storage and Recovery	$13,179,680	1
Infrastructure Retrofit	$2,510,440	1
Management Cost	$20,864,622	42
Minor Localized Flood Reduction Projects; Stormwater Management; Localized Flood Control Project; Drainage; Stormwater Management	$7,994,705	9
Miscellaneous	$1,680,426	18
Mitigation Reconstruction	$801,081	4
No Data	$335,335	10
Other Equipment Purchase and Installation	$1,833,474	15
Other Non Construction (Regular Project Only)	$905,366	9
Planning	$16,341,487	115
Shoreline Protection Measures; Floodplain and Stream Restoration	$3,676,770	2
Shoreline Protection Measures; Wetland Restoration/Creation; Living Shoreline; Soil Stabilization; Floodplain and Stream Restoration	$1,121,000	1
Soil Stabilization	$516,994	1
Technical Assistance	$152,106	3
Utility Protective Measures; Water and Sanitary Sewer Protective Measures	$734,432	7
Utility Protective Measures; Water and Sanitary Sewer Protective Measures; Infrastructure Protective Measure	$80,596,121	4

HMA Project Type - Virginia	$ Amount	# Projects
Utility Protective Measures; Water and Sanitary Sewer Protective Measures; Infrastructure Protective Measure; Localized Flood Control Project	$16,070	1
Wind Retrofit	$1,023,034	5
Grand Total	**$334,713,275**	**563**

Table 3: Hazard Mitigation Assistance (HMA) grants 1990 – 2022 Tazewell County

HMA Project Type – Tazewell County	$ Amount	# Projects
Acquisition of Private Real Property (Structures and Land) - Riverine	$1,709,468	6
Acquisition of Public Real Property (Structures and Land) - Riverine	$2,348,059	3
Multihazard Mitigation Plan	$392,368	6
Grand Total	**$4,449,895**	**15**

This report presents the study in the following sections: 1) Study Summary, 2) Project Summary, 3) Study Methodology, and 4) Loss Avoidance Calculations.

Study Summary

The study area (Figure 1 & Figure 2) is located in the Town of Bluefield, Tazewell County, which is part of the Cumberland Plateau Planning District Commission (CPPDC). The CPPDC has identified, through a Hazard Identification and Risk Assessment (HIRA) process, 14 natural hazards most likely to impact the district's communities.[4] Flooding was assessed as the highest risk to mitigate. The projects selected for the study include 12 property acquisitions on Beaver Pond Creek. This area has an extensive history of riverine flooding. It has also experienced post-mitigation flooding necessary for a study such as this one, to determine what losses would have occurred had those structures remained unmitigated when later flooding occurred.

Study Area – Tazwell County, Town of Bluefield
Hazard Type – Riverine Flooding
Project Type – Acquisition & Demolition
Total Project Cost – $3,270,282
Total Losses Avoided – $2,222,589
Return on Investment (ROI) | Benefit-Cost Ratio – 0.68

This LAS demonstrated losses avoided at 8 of the 12 properties returned far in advance of the project useful life of 100 years (Table 8). These projects exceeded the desired costs saved in an approximate 20-year period.

Four other properties did not demonstrate cost effectiveness. However, damage estimates were calculated for a single post-mitigation event. Considering the flood history and continued flooding to these properties, it is assumed the return on investment will be experienced over the course of the project useful life of 100 years. Overall, benefit cost analysis yields a BCR of 2.51 using a 7% discount rate, and a 5.53 BCR using a 3% discount rate.

[4] Cumberland Plateau Planning District Commission Hazard Mitigation Plan (FEMA Approved 2020)

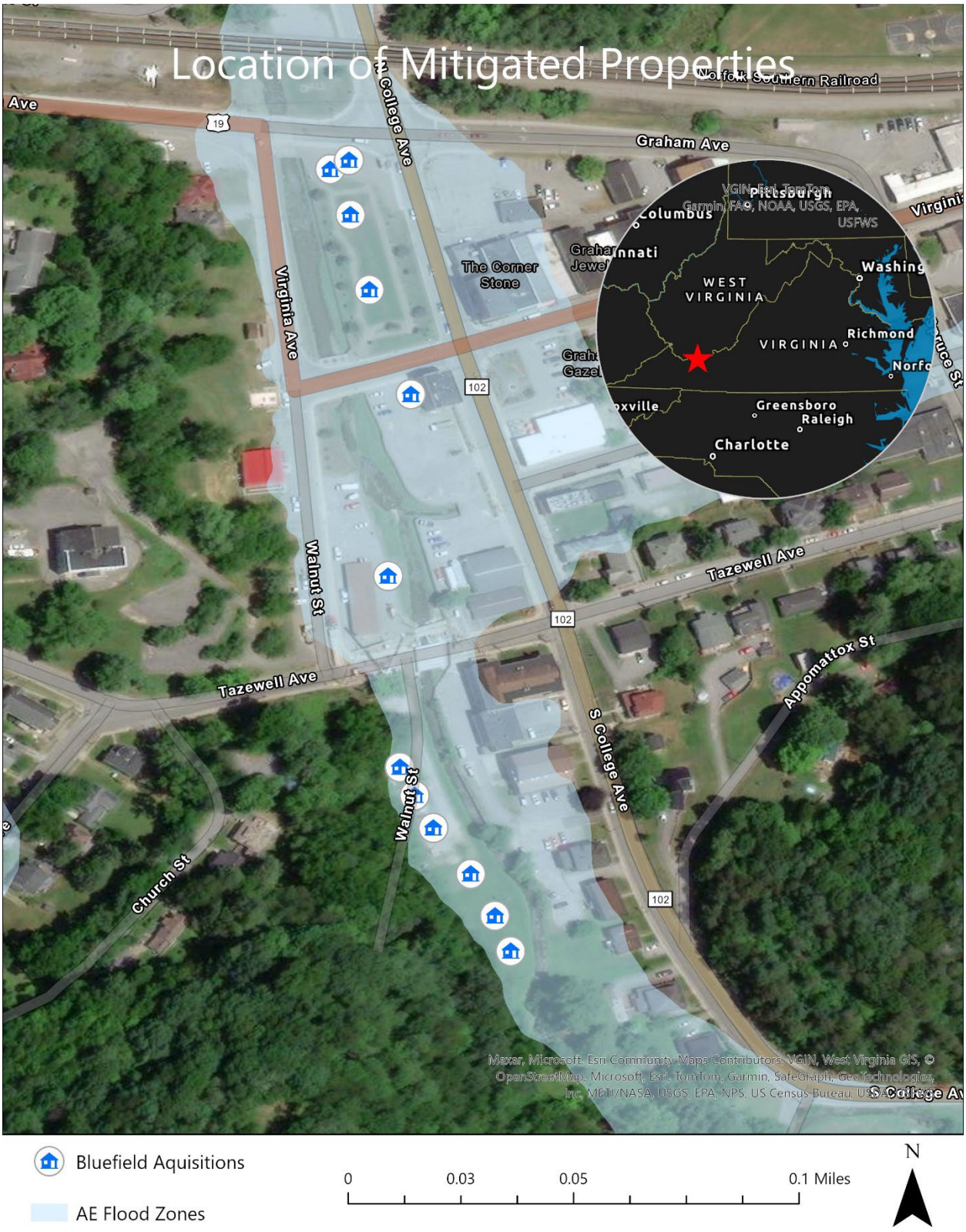

Figure 1: Location of mitigated properties

Figure 2: Study area with mitigated properties (2003) & resulting open green space (2023)

Project Summary

The project structures included in this LAS were all acquired and demolished, with the remaining land being converted to open greenspace in perpetuity. The 12 properties included in this study were acquired and demolished between 2002 and 2007. It was important that the study properties be in approximate relation to one another in terms of location, topography and flood history, and that the projects were completed early enough to allow time for post-mitigation flood events to occur.

Grant: Hazard Mitigation Assistance (HMA)

- **Subgrant(s):**
  - **Project Number:**
  - **Property ID Reference**
- DR-VA-1386 - Severe Storms and Flooding July 8 - Aug. 7, 2001 - Declared July 12
  - VA 1386-314-004, VA 1386-314-005, &VA 1386-314-006
  - 1-6, 9, & 10
- DR-VA-1411 - Severe Storms and Tornado Apr. 28 - May 3, 2002 - Declared May 5
  - VA 1406-314-008 & VA 1406-314-005
  - 7
- DR-VA-1406 - Storms and Flooding Mar 17 - Mar 20, 2002 - Declared Apr 2
  - VA 1411-314-001
  - 11 & 12
- Flood Mitigation Assistance (FMA) 2006
  - VA FMA-2006-314-013
  - 8

Applicant – Town of Bluefield (Subrecipient)
FEMA Approved Multi-Hazard Mitigation Plan – Cumberland Plateau Hazard Mitigation Plan (FEMA Approved 2020)
Flood Zone Designation – Zone AE
Flood Insurance Study – 51185CV001A & 51185CV002A[5]
Project Type – Acquisition & demolition of 12 properties (6 residential, 6 non-residential)
Project Useful Life – 100 Years[6]

[5] Flood Insurance Study Tazewell County, Virginia, and Incorporated Areas, 51185CV001A & 51185CV002A, February 18, 2011
[6] FEMA Benefit-Cost Analysis *BCA Reference Guide*, June 2009 at https://www.fema.gov/grants/guidance-tools/benefit-cost-analysis

Pre-Mitigation Problem Description[7]

The Town of Bluefield is located in northeastern Tazewell County adjacent to the Jefferson National Forest and West Virginia border. The town sits at the base of the Blue Ridge East River Mountain with a total area of 7.6 square miles. Elevations range from 2,400 to almost 4,000 feet above sea level. The watershed includes six sub-basins of the New River Basin including Mudfork, Wrights Valley Creek, Bluestone River, Beaver Pond Creek, Whitney Branch, and Brush Fork. The study area itself sits along Beaver Pond Creek near the confluence to the Bluestone River.

The mitigated properties are located in the 100-year floodplain and have experienced repetitive flooding. Major flooding issues occur primarily as flash flooding during intense periods of rain. Further exacerbating the flood problem is a complex system of concrete culverts and retaining walls restricting the natural conveyance of water flow in Beaver Pond Creek and the Whitney Branch forcing flood waters to flow overland to reach a natural channel. Beaver Pond Creek upstream residences and downstream businesses are subject not only to primary flash flooding, but also backwater flooding due to the culvert systems limited capacity to pass heavy flows.

Post-Mitigation Event

On May 29th, 2023, a wide swath of heavy rain impacted southwest and central Virginia. The rainfall began the previous evening, continuing into the following afternoon with 2-5" of rainfall over a 24-hour period (Figure 3). The Bluestone River reached a record level of 10.96 feet with an estimated 1,480 cubic square feet of discharge, a moderate to major flood stage (Figure 4).[8] Flash-flooding, most significantly impacted the eastern end of Tazewell County in the areas of Bluefield and Pocahontas. The local emergency operations center was activated, bridges and roadways were flooded, some local businesses closed, and at least 10-12 residents were reported evacuated.

[7] Cumberland Plateau Planning District Commission Hazard Mitigation Plan (FEMA Approved 2020); Flood Insurance Study Tazewell County, Virginia, and Incorporated Areas, 51185CV001A, February 18, 2011

[8] USGS gage at Bluestone River at Falls Mills, VA – 03177710. Bluestone River at Falls Mills, VA - USGS Water Data for the Nation

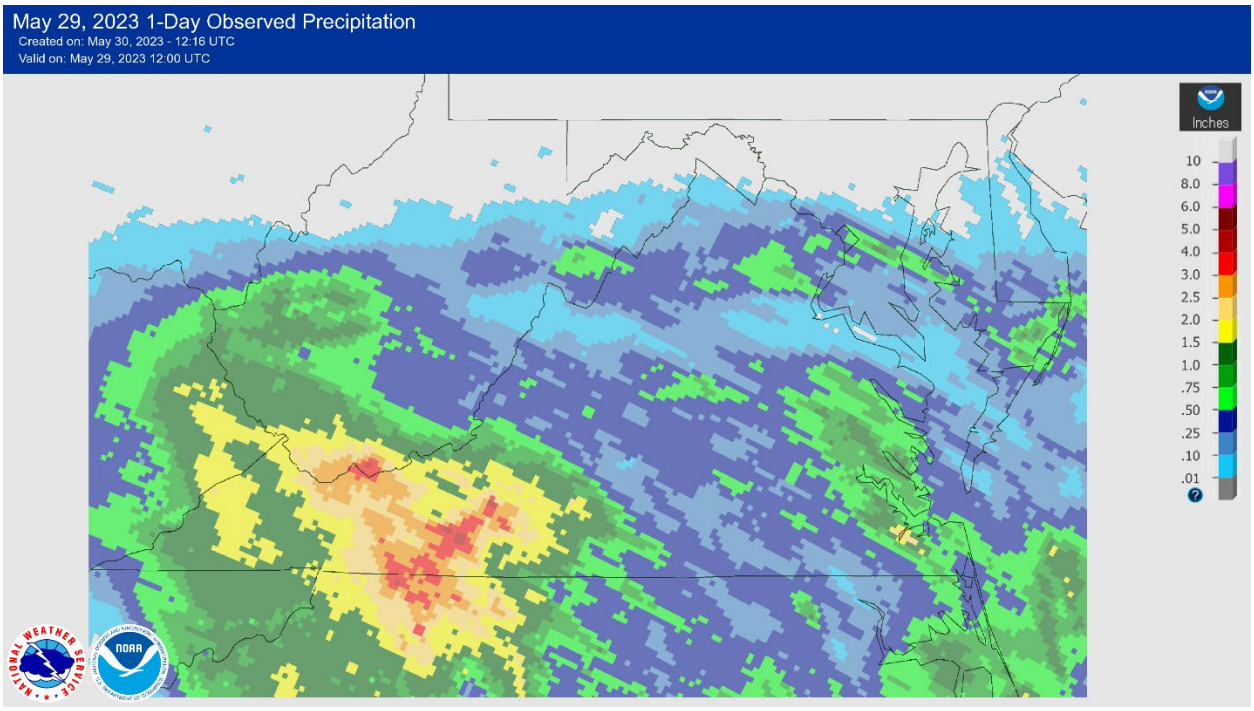

Figure 3: Observed precipitation

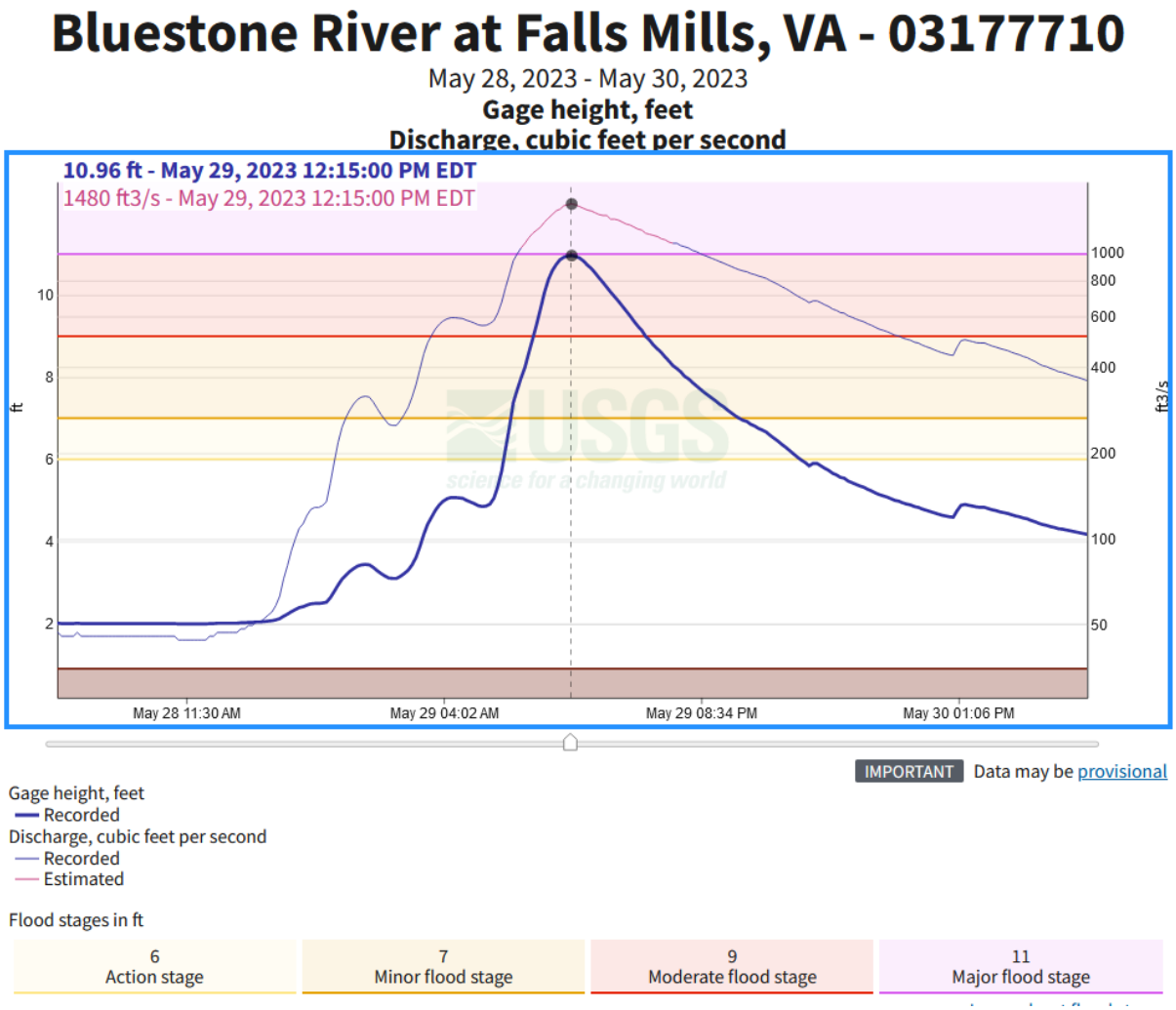

Figure 4: Falls Mill river gage

Figure 5: Flooding at Stockton Bridge

Figure 6: Receding flood waters at Stockton Bridge

Figure 7: Receding flood waters at intersection of S. College Ave. and Virginia Ave.

[9]

[9] Photo credit: WVVA 59 - https://www.youtube.com/watch?v=P5QHa-kTkug

Figure 8: Receding flood waters intersection of S. College Ave. and Virginia Ave.

[10]

[10] Photo credit: WVVA 59 - https://www.youtube.com/watch?v=P5QHa-kTkug

Study Methodology

A loss avoidance study (LAS) provides a justification for existing and future mitigation projects and activities. The ability to assess the economic performance of mitigation projects over time is important to encourage future funding and continued support of mitigation projects, activities, and programs. An LAS requires that the project(s) studied be completed prior to the event(s) analyzed, as losses avoided through the mitigation measure are determined by comparing the damage that would have been caused by the event had the projects not be implemented.

The following list provides examples of standard data inputs for conducting an LAS:

- Cost of the mitigation measure
- First floor elevations (pre-mitigation)
- First floor elevations (post-mitigation – Elevations only)
- Base Flood Elevations
- Building type
- Number of stories
- Foundation type
- Square footage of the structure
- Acreage of property parcel
- Building replacement value
- Number of residents, and number employed (for residential properties)
- Depth of flooding in project area (post-mitigation event)

Assumptions

- Building replacement value is based on default values ranging from $128 to $174 per square foot.[11]
- Contents replacement value is based on FEMA BCA 6.0 Toolkit defaults of 100% (Residential RES1), 14% (commercial COM1and government GOV1), and 83% (Commercial COM3).
- Depth damage function values are based on FEMA BCA 6.0 Toolkit to determine avoided building, contents, and displacement costs during the post-mitigation event.
- For residential properties an annual social benefit is calculated assuming on average a 2-person household with at least one person working. [12]

[11] Hazus Inventory Technical Manual Hazus 6.0, November 2022.
https://www.fema.gov/sites/default/files/documents/fema_hazus-6-inventory-technical-manual.pdf
[12] US Census Quick Facts Town of Bluefield, VA.
https://www.census.gov/quickfacts/bluefieldtownvirginia

- Flood depth at property locations were estimated based on river gauge data and the regulatory Flood Insurance Study (FIS) at the 10-year recurrence interval.[13]
- First floor elevations without data are assumed one-foot above grade (slab on grade).[14]

Loss Avoidance Calculations

To complete this study, the following calculations were performed to estimate losses avoided through mitigation from the May 29, 2023 post-mitigation storm event:

- Stream Discharge
- Flood Depth Elevations
- Ground Elevations
- Building depth-damage costs
- Building contents depth-damage costs
- Displacement costs
- Social benefits
- Expected annual ecosystems benefits
- Benefit cost ratio

Table 4: Example recurrence interval stream discharge and flood depth elevation

Recurrence Interval	Stream Flow (cfs)	Flood Elevation
10	1,424	2,322
50	1,975	2,324
100	2,212	2,325
500	2,762	2,327

[13] USGS gage at Bluestone River at Falls Mills, VA – 03177710; Flood Insurance Study Tazewell County, Virginia, and Incorporated Areas, 51185CV001A & 51185CV002A, February 18, 2011.
[14] Hazus Inventory Technical Manual Hazus 6.0, November 2022. https://www.fema.gov/sites/default/files/documents/fema_hazus-6-inventory-technical-manual.pdf

Table 5: Example depth damage curve - Building

Depth Damage Curve – Building (Example Only)		
Flood depth (ft)	**Percent (%)**	**Damage Value ($)**
-2	0.5	2,110.52
-1	0.5	2,110.52
0	1.0	4,221.04
1	12.5	52,763.04
2	20.4	86,109.28
3	25.9	109,325.01
4	31.7	133,807.06
5	33.5	141,404.94
6	37.5	158,289.12
7	39.4	166,309.10
8	42.2	178,128.02
9	45.1	190,369.04
10	46.6	196,700.61
11	46.6	196,700.61
12	46.6	196,700.61
13	46.6	196,700.61
14	46.6	196,700.61
15	46.6	196,700.61
16	46.6	196,700.61

Table 6: Example depth damage curve - Contents

Depth Damage Curve – Contents (Example Only)		
Flood depth (ft)	**Percent (%)**	**Damage Value ($)**
-2	0.0	-
-1	0.0	-
0	0.0	-
1	22.0	11,143.55
2	30.0	15,195.75
3	39.0	19,754.48
4	45.0	22,793.63
5	48.0	24,313.20
6	52.0	26,339.30
7	56.0	28,365.41
8	59.0	29,884.98
9	61.0	30,898.03
10	63.0	31,911.08
11	63.0	31,911.08
12	63.0	31,911.08
13	63.0	31,911.08
14	63.0	31,911.08
15	63.0	31,911.08
16	63.0	31,911.08

Table 7: Example depth damage curve - Displacement

Depth Damage Curve – Displacement (Example Only)		
Flood depth (ft)	**Days**	**Damage Value ($)**
-2	0	-
-1	0	-
0	0	-
1	45	12,748.37
2	90	25,496.75
3	135	38,245.13
4	180	63,741.89
5	255	79,677.36
6	270	95,612.84
7	315	111,548.31
8	360	101,987.03
9	405	114,735.41
10	450	127,483.79
11	450	127,483.79
12	450	127,483.79
13	450	127,483.79
14	450	127,483.79
15	450	127,483.79
16	450	127,483.79

Losses Avoided

Losses avoided and the benefit-cost ratio are reported below. Table 8 reports the property ID, total project cost, estimated depth of flooding[15] from the May 29, 2023 storm event, value of damage to the building and contents, displacement costs, expected annual social and ecosystems benefit, total damage losses avoided[16], and benefit cost ratio.

Table 8: Losses avoided

ID	Total Project Costs	Flood Depth	Building Damage Value	Contents Damage Value	Displacement Damage Value	Expected Annual Social Benefit	Expected Annual Ecosystems Benefit	Total Damage Losses Avoided	Benefit-Cost Ratio
1	$48,667	3.15	$59,760	$35,220	$26,730	$13,622	$2,126	$137,458	2.82
2	$48,667	2.50	$64,363	$35,311	$26,730	$13,622	$2,339	$142,365	2.93
3	$48,667	2.37	$68,572	$39,873	$17,820	$13,622	$1,170	$141,058	2.90
4	$48,667	3.07	$83,594	$49,267	$26,730	$13,622	$957	$174,170	3.58
5	$48,667	1.97	$124,222	$72,233	$17,820	$13,622	$744	$228,640	4.70
6	$48,667	2.23	$97,674	$56,795	$17,820	$13,622	$957	$186,868	3.84
7	$718,333	0.52	$99,205	$20,576	$29,890		$9,569	$159,240	0.22
8	$333,711	2.23	$129,602	$31,799	$54,345		$1,914	$217,660	0.65
9	$1,612,903	2.17	$293,930	$72,119	$93,252		$5,103	$464,404	0.29
10	$133,333	2.50	$74,450	$99,007	$20,362		$2,552	$196,371	1.47
11	$80,000	2.69	$34,578	$8,484	$7,250		$744	$51,055	0.64
12	$100,000	2.68	$49,643	$66,017	$6,789		$851	$123,300	1.23
	$3,270,282		**$1,179,593**	**$586,701**	**$345,537**			**$2,222,589**	**0.68**

While not all properties exhibited a cost-effective benefit cost ratio, eight of the 12 properties prove cost effective in under 20 years of the 100-year useful life following a single post-mitigation event.

[15] Flood depths are rounded to the nearest whole number.

[16] Calculation includes a single year for social and ecosystem benefit reflecting the benefit for this single event.