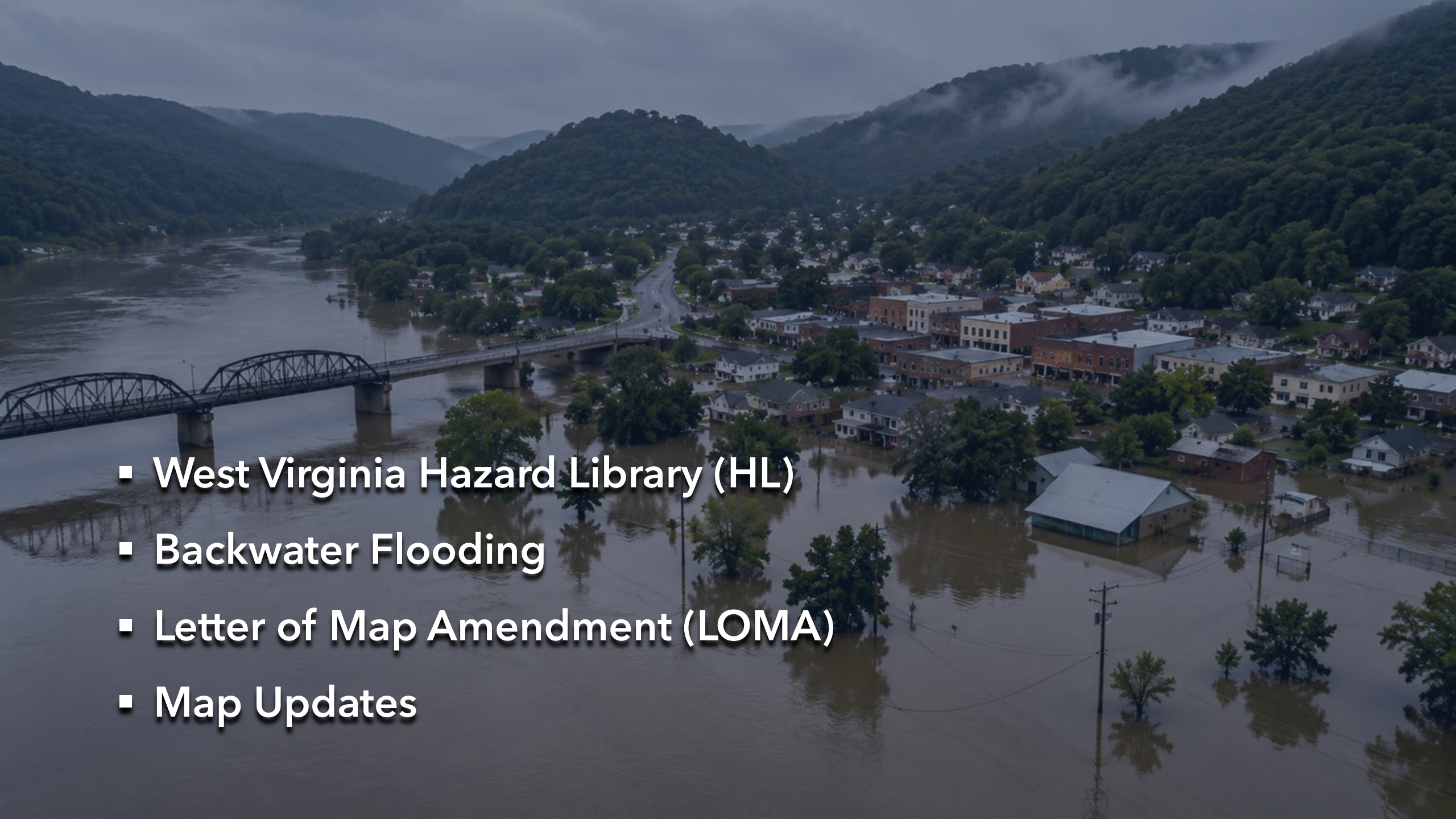
Flood Risk Tools and Resources: Review and Update

Behrang Bidadian
Kurt Donaldson

June 17, 2026

WV GIS Technical Center
West Virginia University



- West Virginia Hazard Library (HL)
- Backwater Flooding
- Letter of Map Amendment (LOMA)
- Map Updates

West Virginia Hazard Library (HL)

Image courtesy of Rorozoa on Freepik

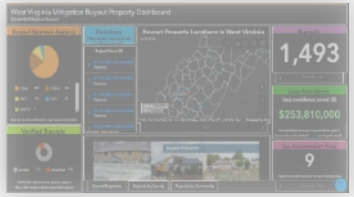
WV Hazard Library

A comprehensive source of data, documents, and media related to flood risk that we collect or generate.

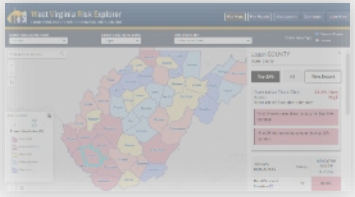
Flood Visualizations

WV Flood Tool

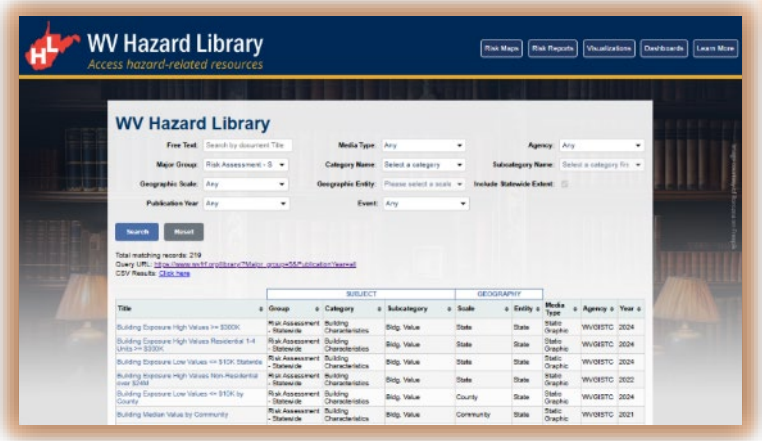
Flood Dashboards



WV Risk Explorer



Example Tools



Hazard Library

WV Flood Resiliency Framework (WVFRF)

Community Engagement Meeting

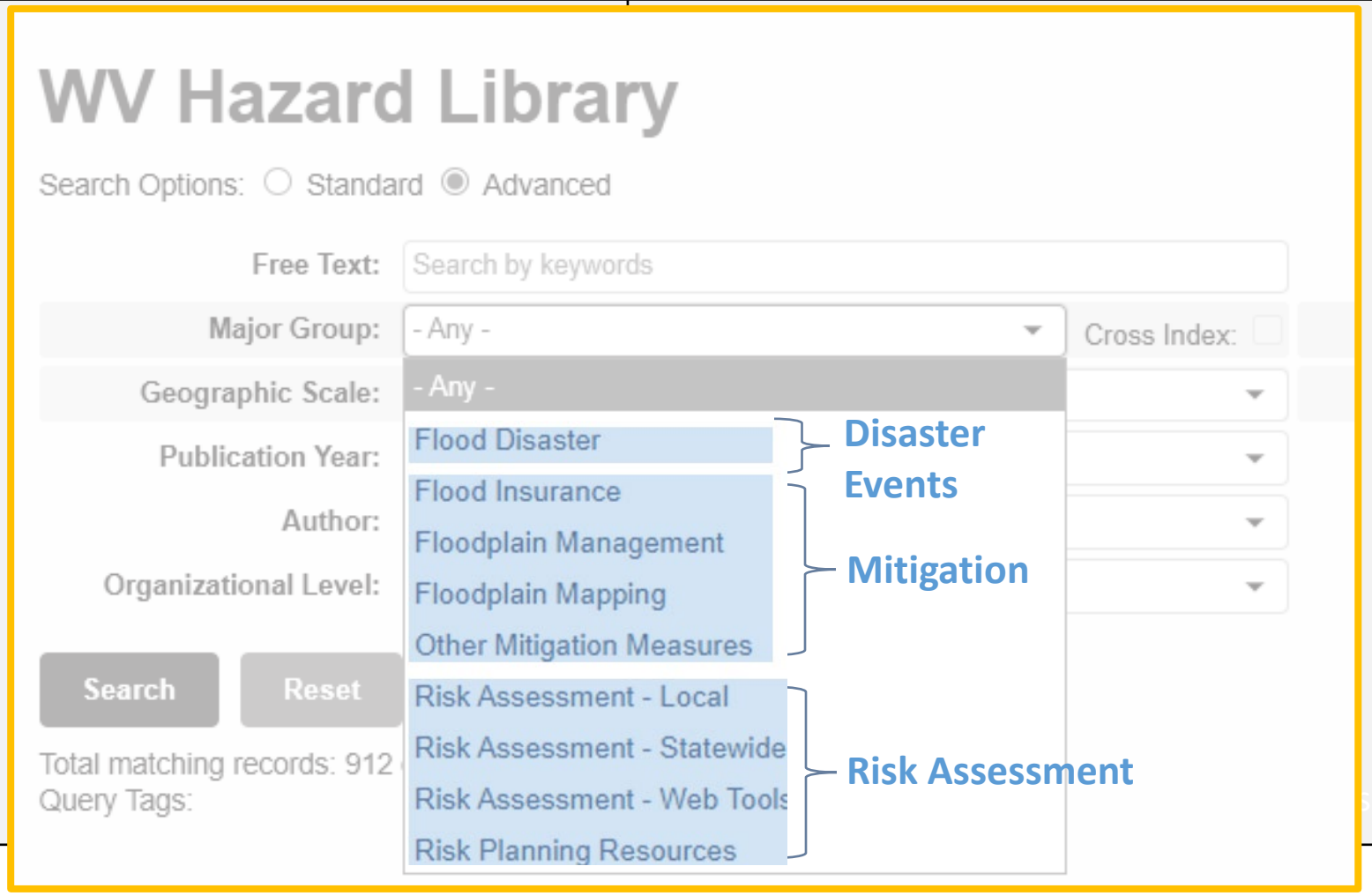
Flood Symposium **Stakeholders**

WV Hazard Library...

Content of Hazard Library

TOPICS	MEDIA TYPES	SEARCH TYPES

- **Flood Disaster Events**
  - Flood Event
  - Flood Research
- **Mitigation**
  - Flood Insurance
  - Floodplain Management
  - Floodplain Mapping
  - Other Mitigation Measures
- **Risk Assessment & Planning**
  - State Risk Assessments
  - Local Risk Assessments
  - Planning Resources
  - Web Tools



WV Hazard Library...

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• **Flood Disaster Events**
  ○ Flood Event
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• **Mitigation**
  ○ Flood Insurance
  ○ Floodplain Management
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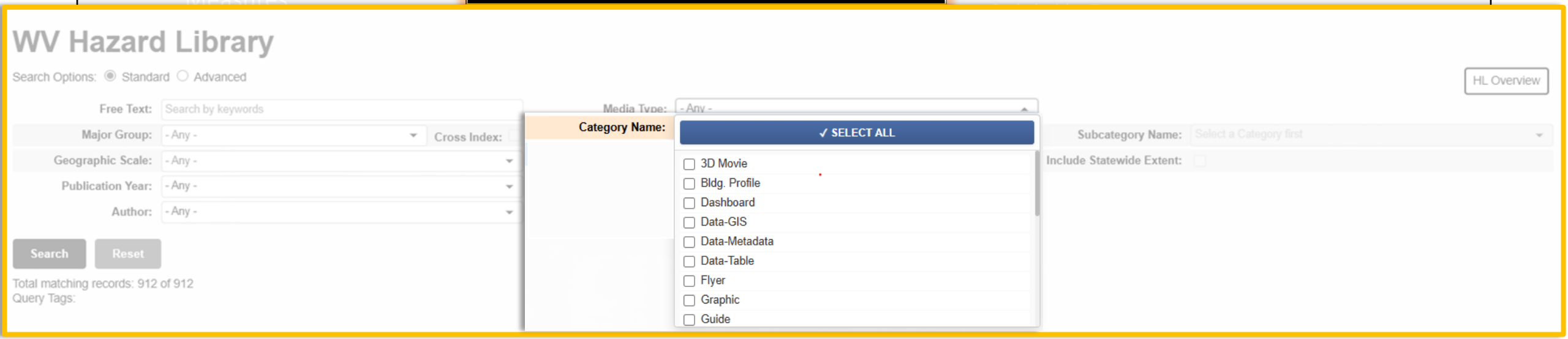
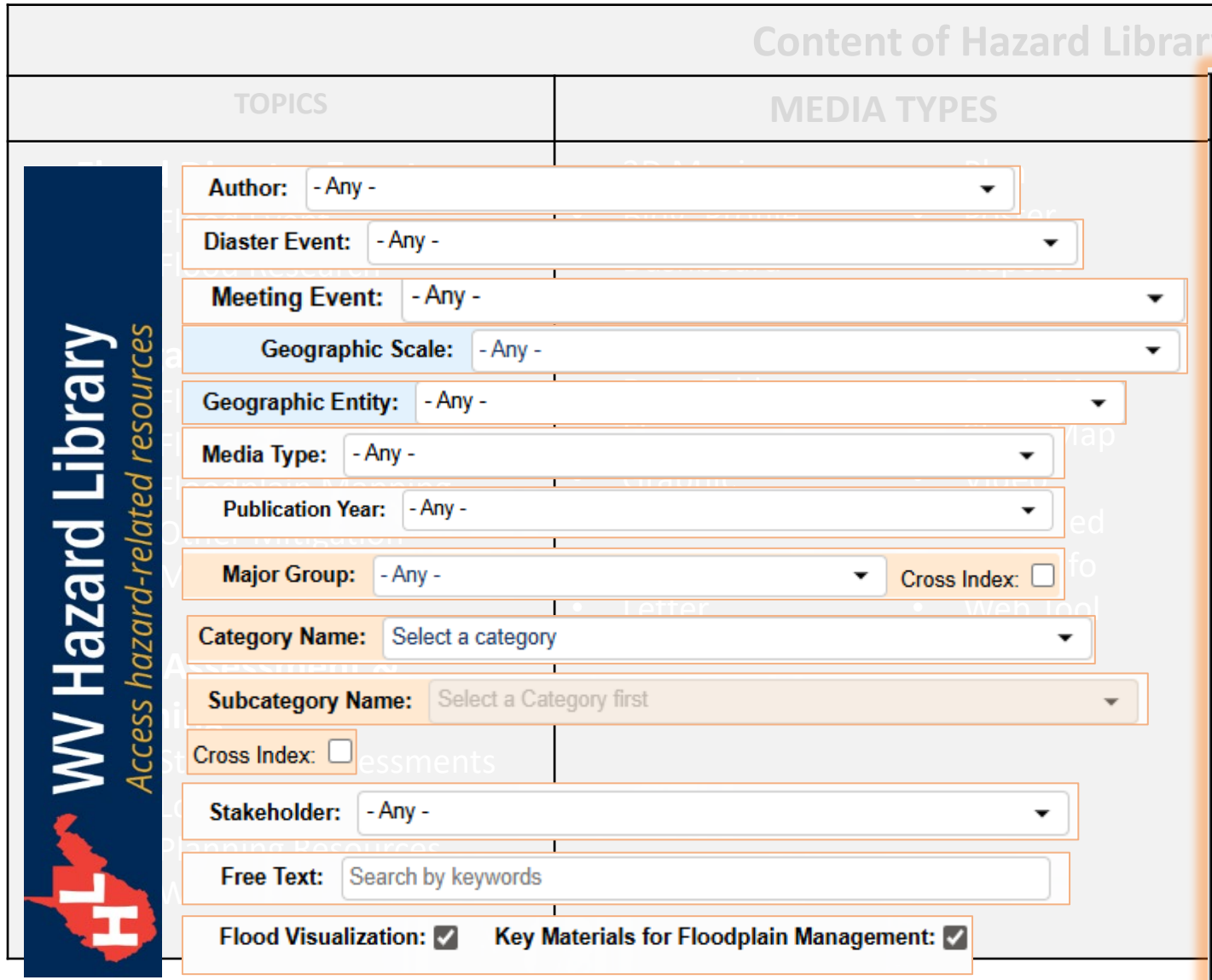
  ○ Other Mitigation Measures
	• 3D Movie
	• Bldg. Profile
	• Dashboard
	• Data-GIS
	• Data-Metadata
	• Data-Table
	• Flyer
	• Graphic
	• Guide
	• Journal Article
	• Letter
	• News Article
	• Picture
	• Plan
	• Poster
	• Report
	• Slides
	• Social Media
	• Static Map
	• Story Map
	• Video
	• Viewshed
	• Web Info
	• Web Tool
		• Agency
		• Downloadable Data
		• Event Disaster
		• Event Meeting
		• Geographic Scale
		  ○ Entity
		• Media Type
		• Publication Date
		• Subject
		  ○ Major Group
		  ○ Category
		  ○ Subcategory
		  ○ *cross-indexing*



WV Hazard Library...



SEARCH TYPES

- Agency
- Downloadable Data
- Event Disaster
- Event Meeting
- Geographic Scale
  - Entity
- Media Type
- Publication Date
- Subject
  - Major Group
  - Category
  - Subcategory
  - *cross-indexing*
- Stakeholder Type
- Title (free text search)
- Predefined Searches
  - Visualizations
  - Floodplain Management Key Materials

WV Hazard Library...

Key Materials for Floodplain Management

WV Hazard Library

Search Options: ○ Standard ◉ Advanced

HL Overview

Free Text:	Search by keywords	**Media Type:**	- Any -		
Major Group:	- Any - Cross Index: ☐	**Category Name:**	Select a Major Group first	**Subcategory Name:**	Select a Category first
Geographic Scale:	- Any -	**Geographic Entity:**	Select a Scale first	**Include Statewide Extent:**	☐
Publication Year:	- Any -	**Diaster Event:**	- Any -	**Meeting Event:**	- Any -
Author:	- Any -	**Project:**	- Any -	**Stakeholder:**	- Any -
Organizational Level:	- Any -	**Risk Findings:**	- Any -	**Flood Visualization:** ☐	**Key Materials for Floodplain Management:** ☑

Search Reset

Total matching records: 15 of 912

Query Tags:

Key Materials for Floodplain Management: Yes ×

CSV Results: Click here

Query URL: https://wvfrf.org/library/?includeKeyMaterials=true&sort...=Title&sorttype=asc&view=advanced

		SUBJECT						
Title	**More Info**	**Group**	**Category**	**Subcategory**	**Scale**	**Media Type**	**Author**	**Pub Year**
Building Permit Training Guides & Resources	ⓘ	Floodplain Management	Permits	Building Permit	State	Guide	WV EMD	None
Flood Elevations (BFE / AFH / Elevation Certificates)	ⓘ	Floodplain Management	Flood Elevation	BFE / AFH / Elevation Certificates	State	Guide	FEMA, Multiple Authors	None
Floodplain Management Training & Community Support Workshop (Based on FEMA Course: 273)	ⓘ	Floodplain Management	Requirements & Guidance	Supplemental Floodplain Mgmt. Resources	State	Slides	FEMA, WV EMD	2026
Past WVFMA Conference Presentations	ⓘ	Floodplain Management	Requirements & Guidance	WV Floodplain Managers Conference	State	Slides	WV FMA	None

WV Hazard Library...

Flood Visualization

WV Hazard Library

Search Options: ○ Standard ◉ Advanced

HL Overview

Free Text:	Search by keywords	**Media Type:**	- Any -		
Major Group:	- Any - Cross Index: ☐	**Category Name:**	Select a Major Group first	**Subcategory Name:**	Select a Category first
Geographic Scale:	- Any -	**Geographic Entity:**	Select a Scale first	**Include Statewide Extent:**	☐
Publication Year:	- Any -	**Diaster Event:**	- Any -	**Meeting Event:**	- Any -
Author:	- Any -	**Project:**	- Any -	**Stakeholder:**	- Any -
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Building Permit Training Guides & Resources	?	Floodplain Management	Permits	Building Permit	State	Guide	WV EMD	None
Flood Elevations (BFE / AFH / Elevation Certificates)	?	Floodplain Management	Flood Elevation	BFE / AFH / Elevation Certificates	State	Guide	FEMA, Multiple Authors	None
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WV Hazard Library...

WV Hazard Library

Search Options: ○ Standard ◉ Advanced

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Major Group: - Any - Cross Index: ☐

Geographic Scale: - Any -

Publication Year: - Any -

Author: - Any -

Organizational Level: - Any -

Media Type: - Any -

Category Name: Select a category

Geographic Entity: - Any -

Diaster Event: - Any -

Project: - Any -

Risk Findings: - Any -

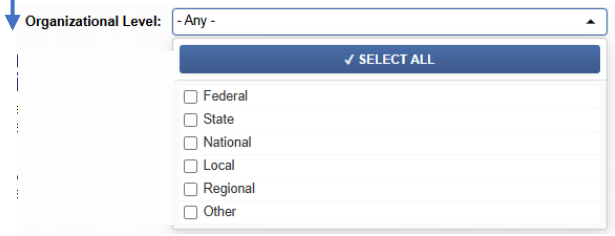
Subcategory Name: Select a Category first

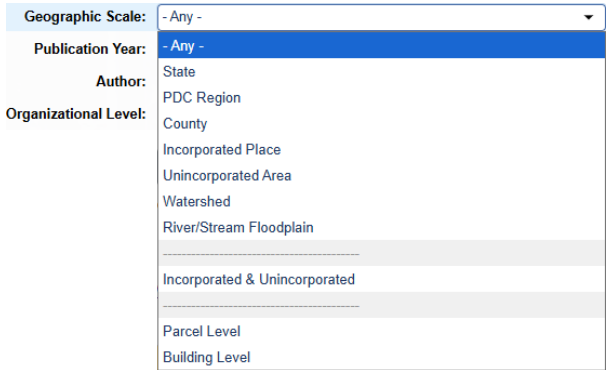
Include Statewide Extent: ☐

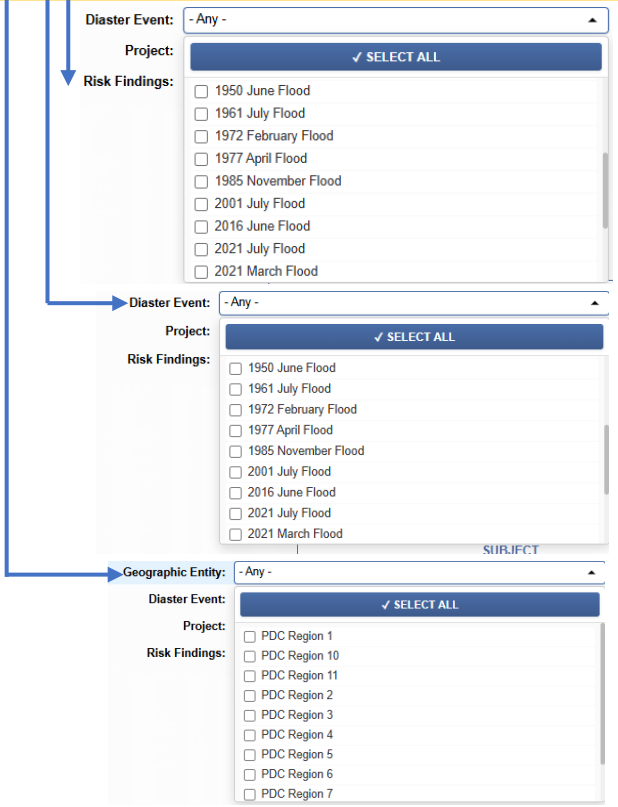
Meeting Event: - Any -

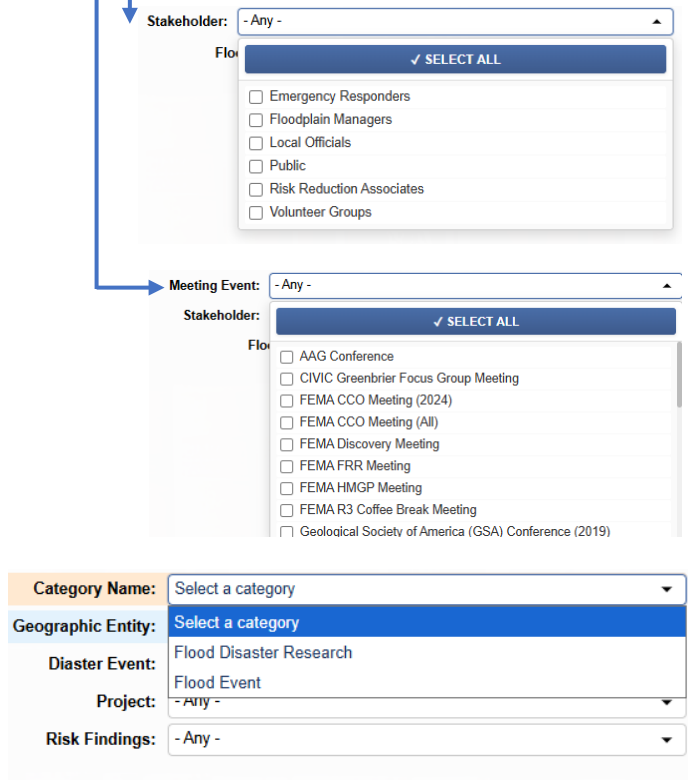
Stakeholder: - Any -

Flood Visualization: ☐ Key Materials for Floodplain Management: ☐







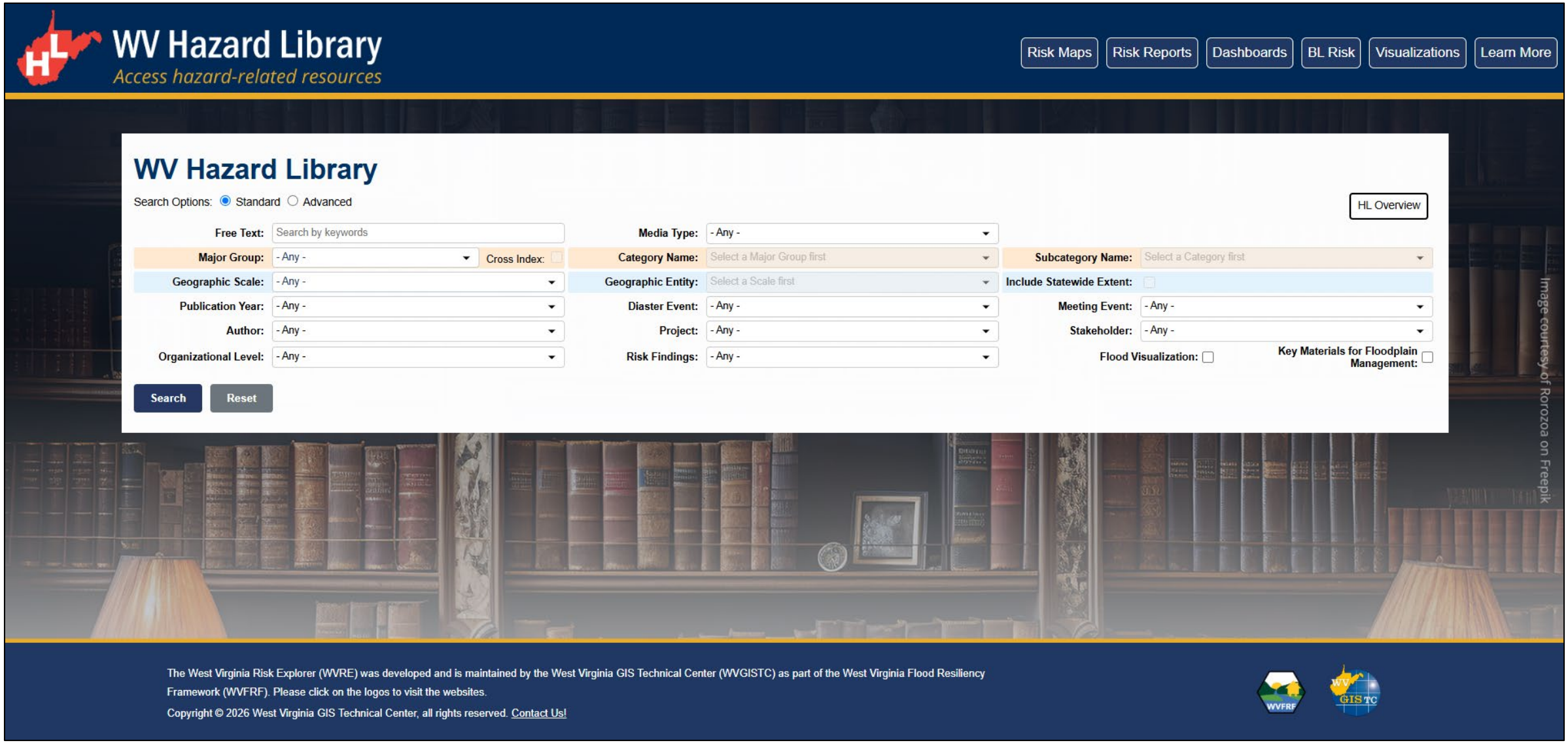


WV Hazard Library...

https://wvfrf.org/library

https://wvfrf.org/wvre

https://wvfrf.org



Backwater Flooding

Backwater Flooding Effect

River Confluences

High flows in a main river prevent tributaries from discharging efficiently.
Common in large river systems

Bridges and Culverts

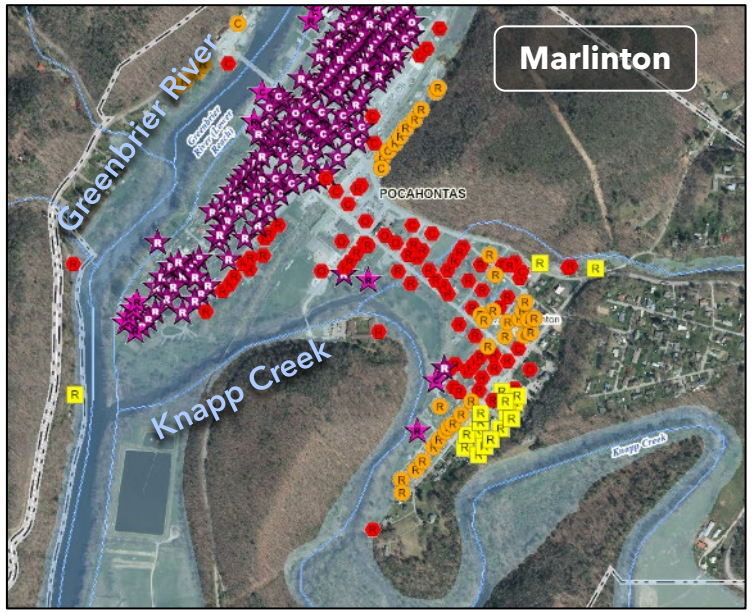
Undersized openings and bridge structural elements create hydraulic constrictions.
Water surface elevations increase upstream.

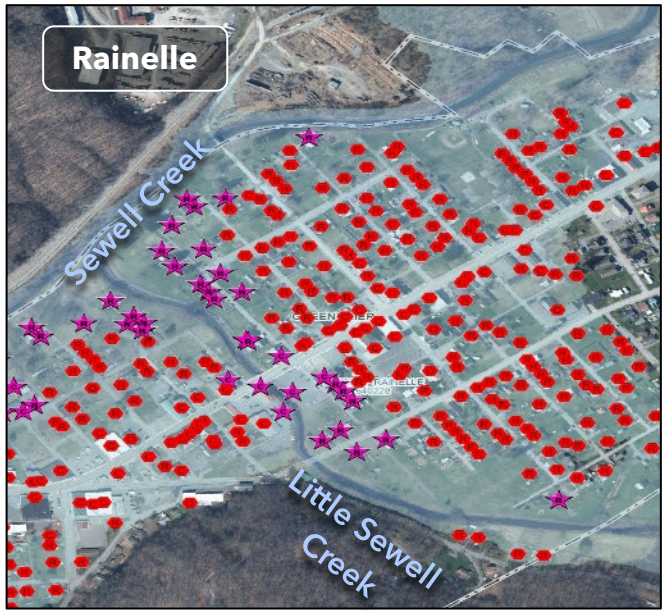
Sediments and Debris Accumulation

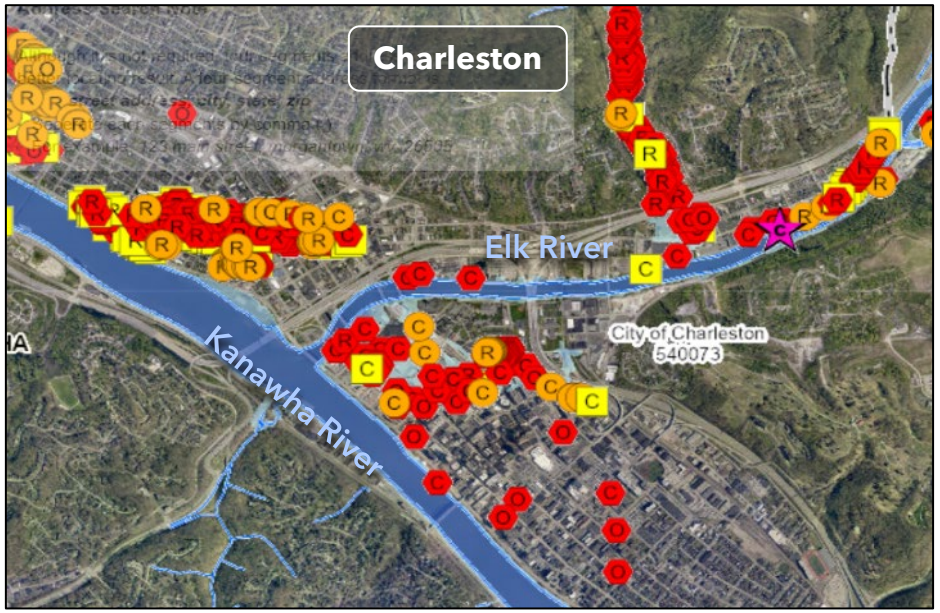
Temporary obstructions can create sudden backwater flooding effect.

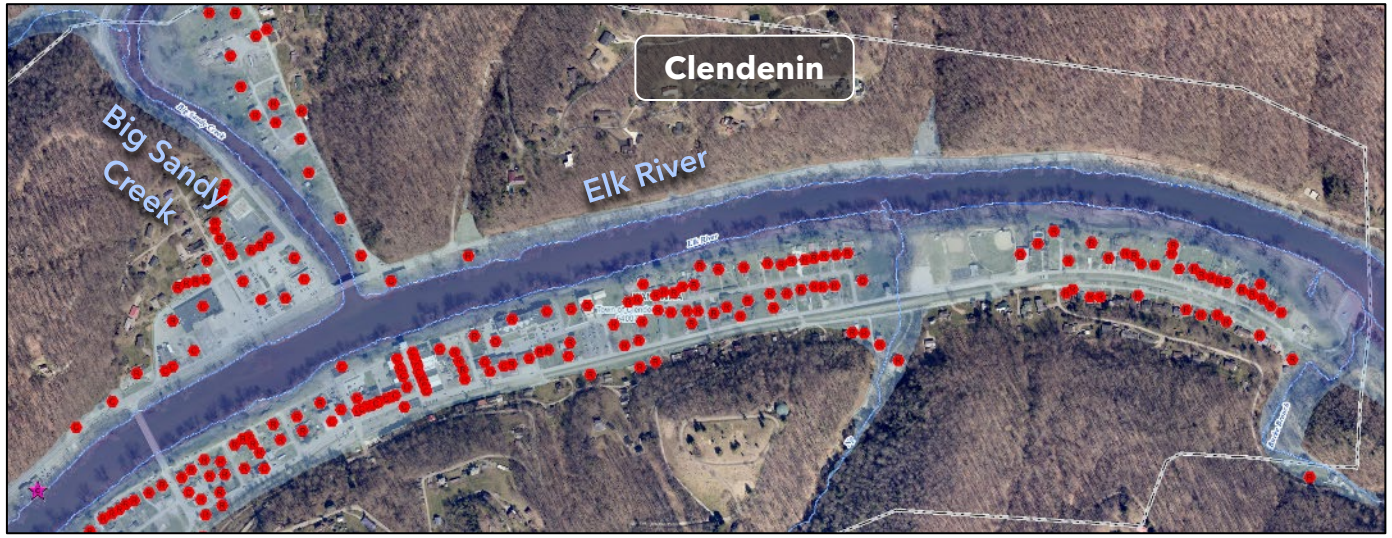
River Confluences

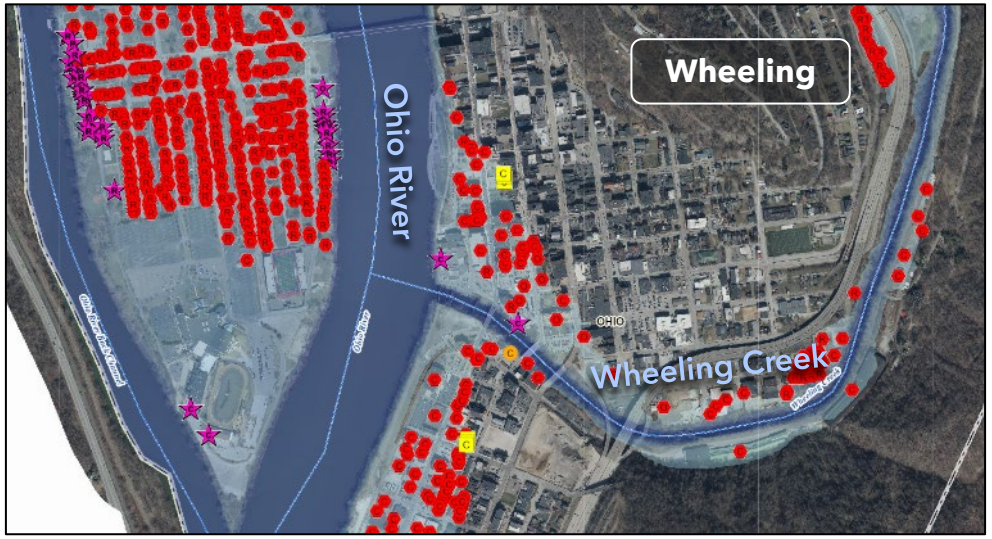
Most major cities in West Virginia were established at river confluences.







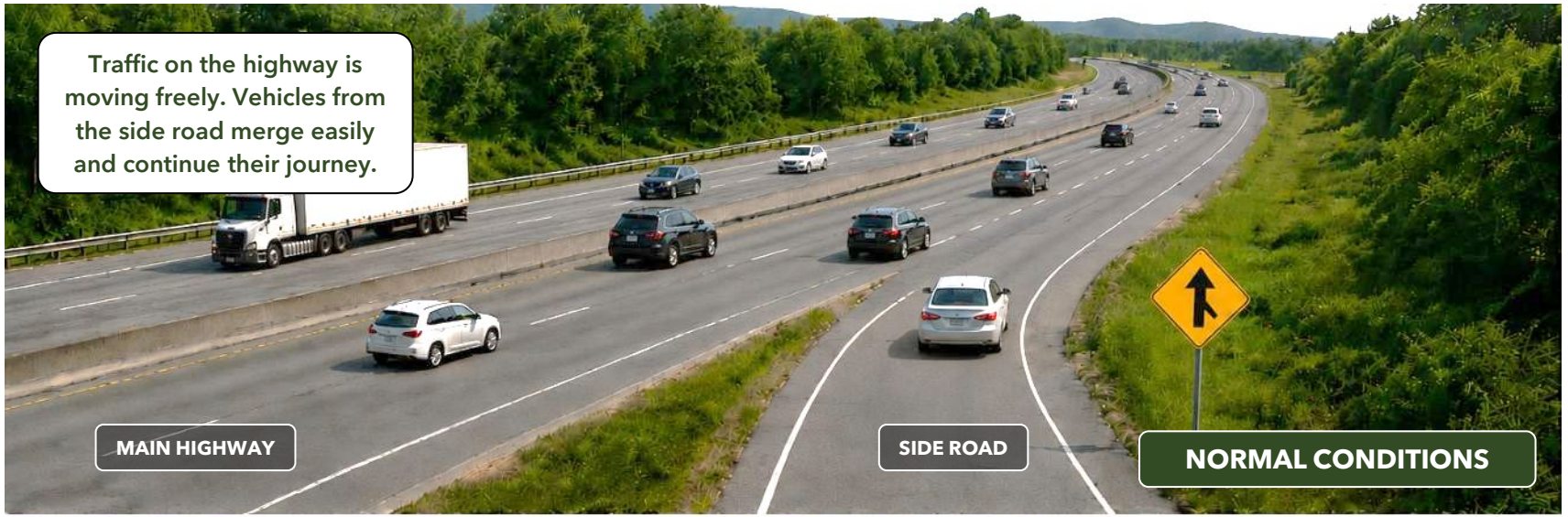


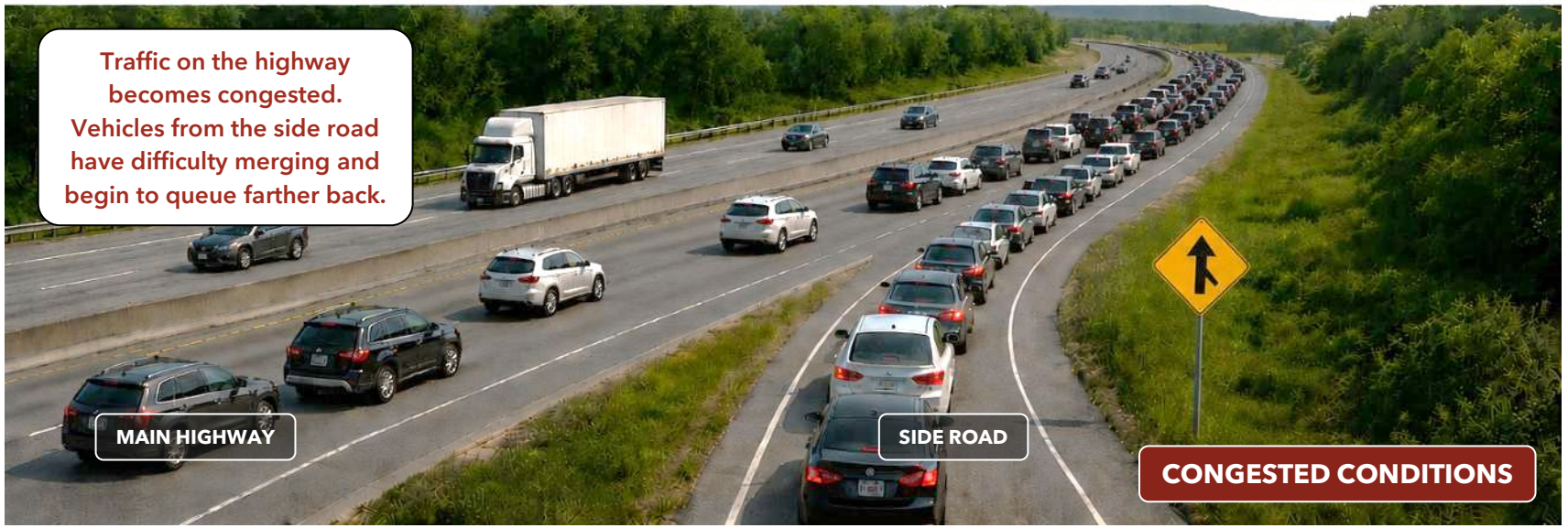


Why Does a Backup Occur?

A Traffic Analogy

When conditions worsen ahead, the backup propagates backward through the system.





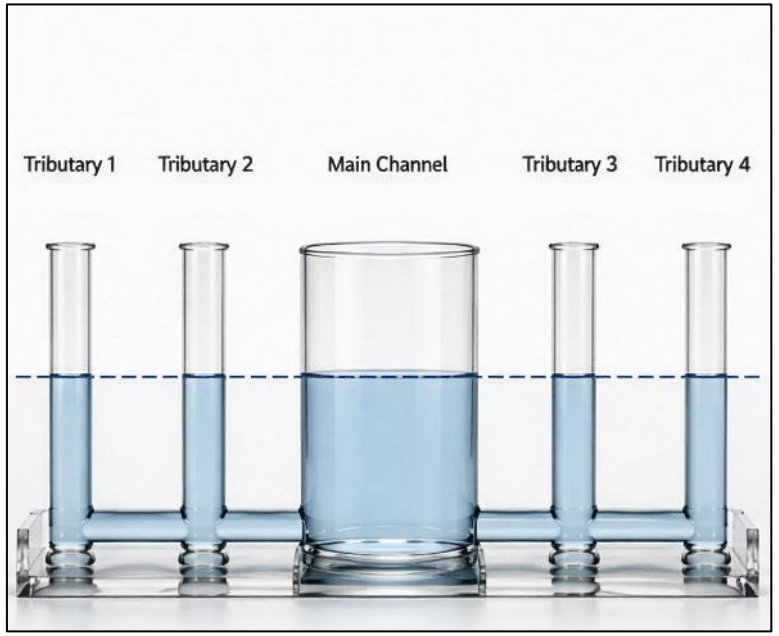
River Confluences...

Conceptual Analogy

Simplified conceptual representation; actual river systems involve flowing water and changing hydraulic conditions.

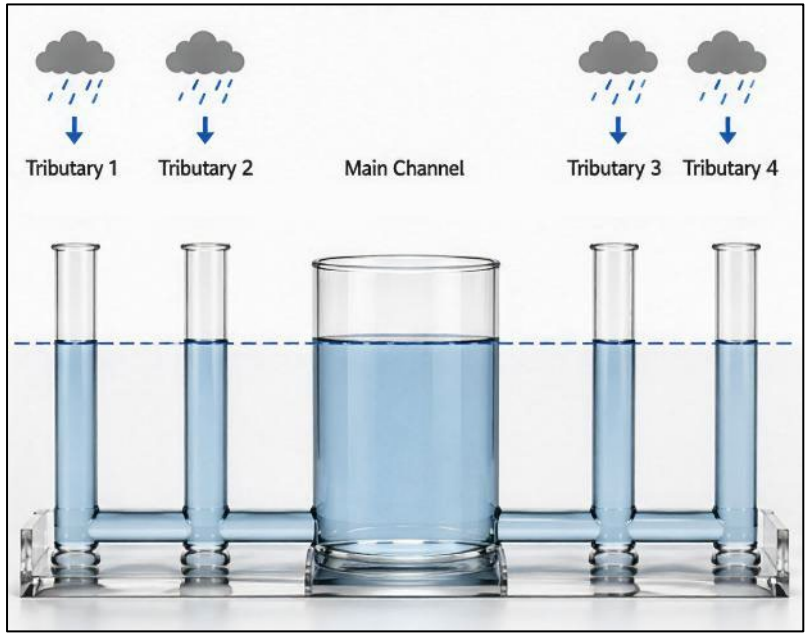
INITIAL CONDITION

Water levels are in balance.



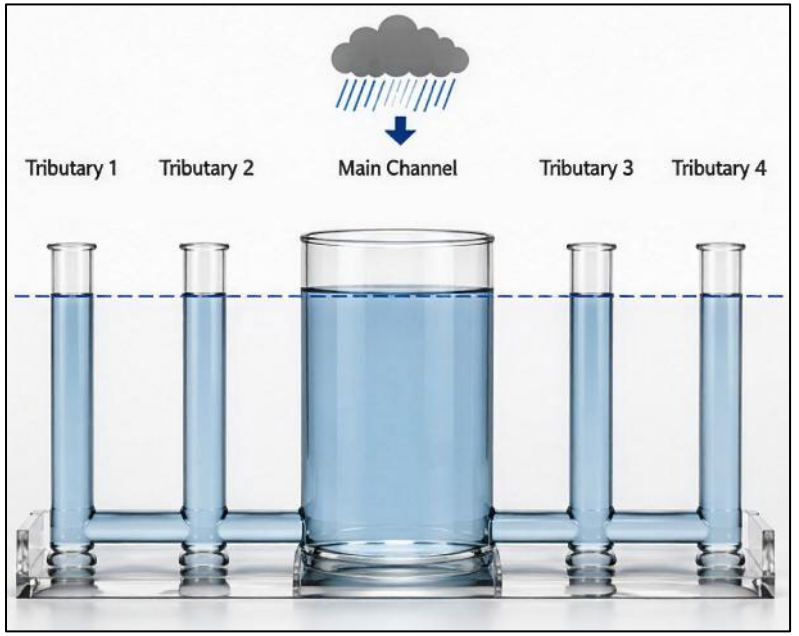
TRIBUTARY FLOW INCREASE

Water added to the tributaries.
Water levels rise throughout the system and stabilize at a higher elevation.



MAIN CHANNEL FLOW INCREASE

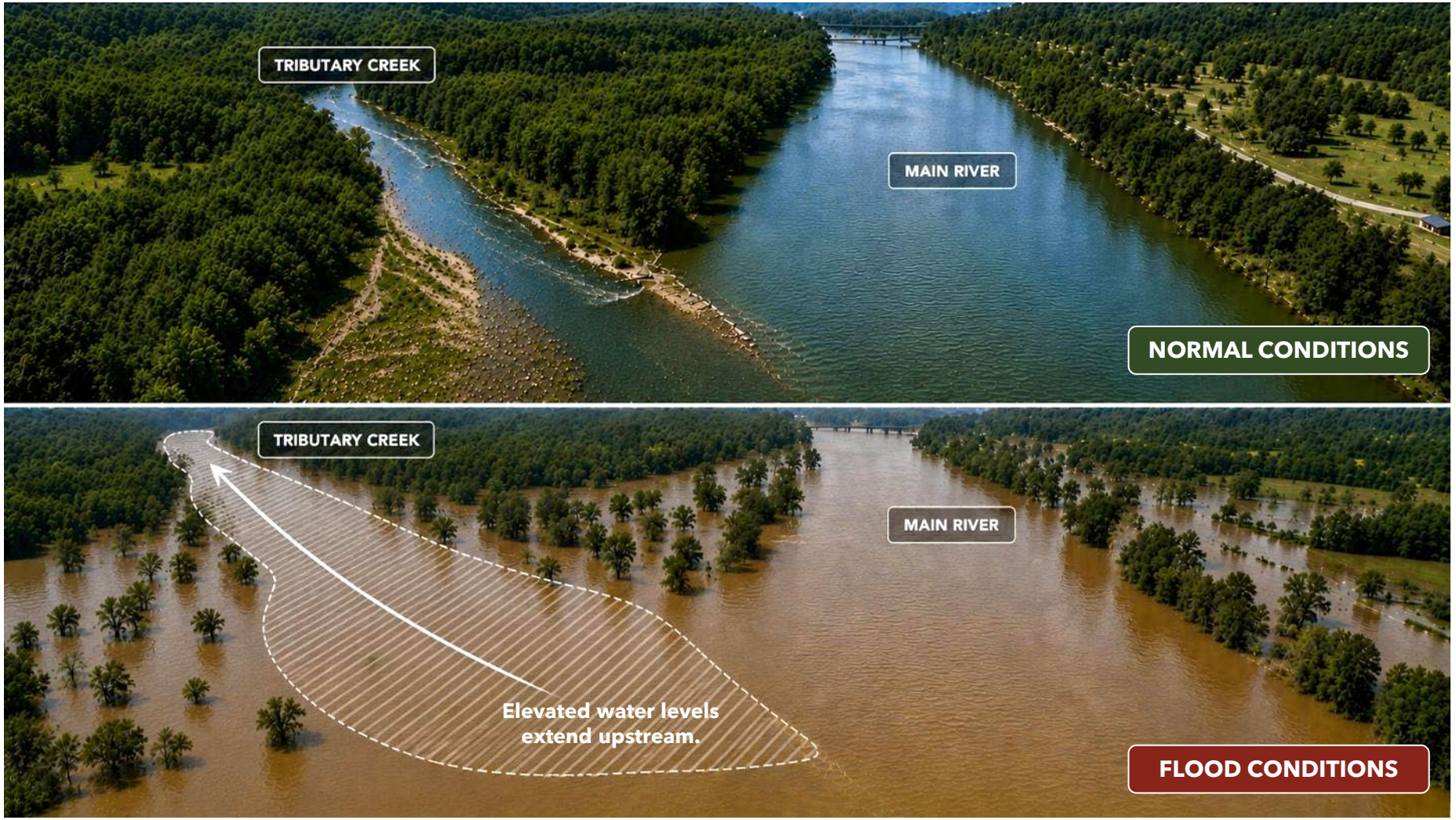
Much more water added to the main channel.
Water levels rise throughout the system and stabilize at a much higher elevation.



A large increase in the main channel raises water levels throughout the connected system. Tributaries experience higher water-surface elevations because the elevated downstream stage reduces their ability to drain efficiently.

River Confluences...

Backwater effect

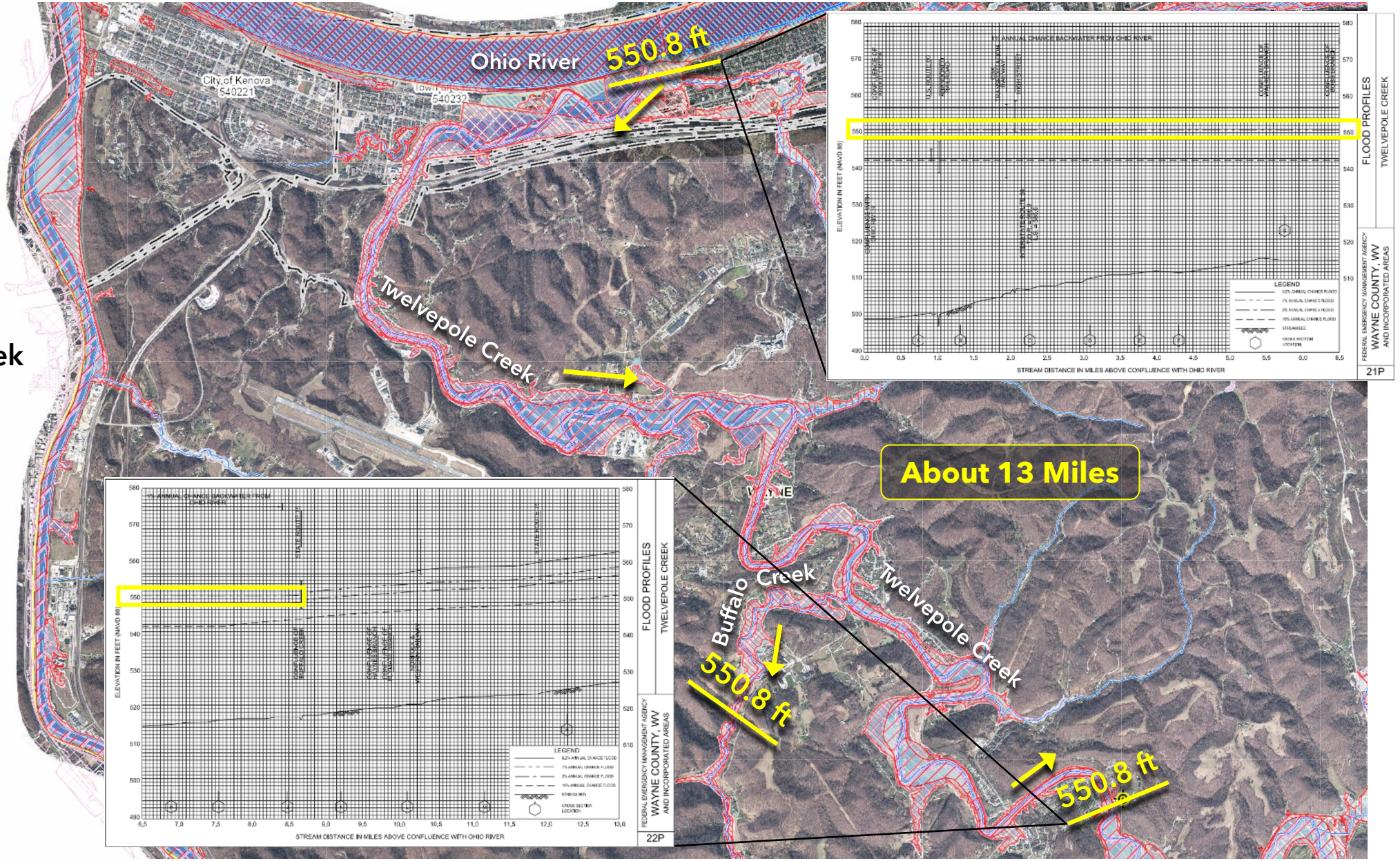


When flood levels rise in the main river, the tributary cannot drain efficiently. Water levels increase upstream in the tributary, creating a backwater effect.

River Confluences...

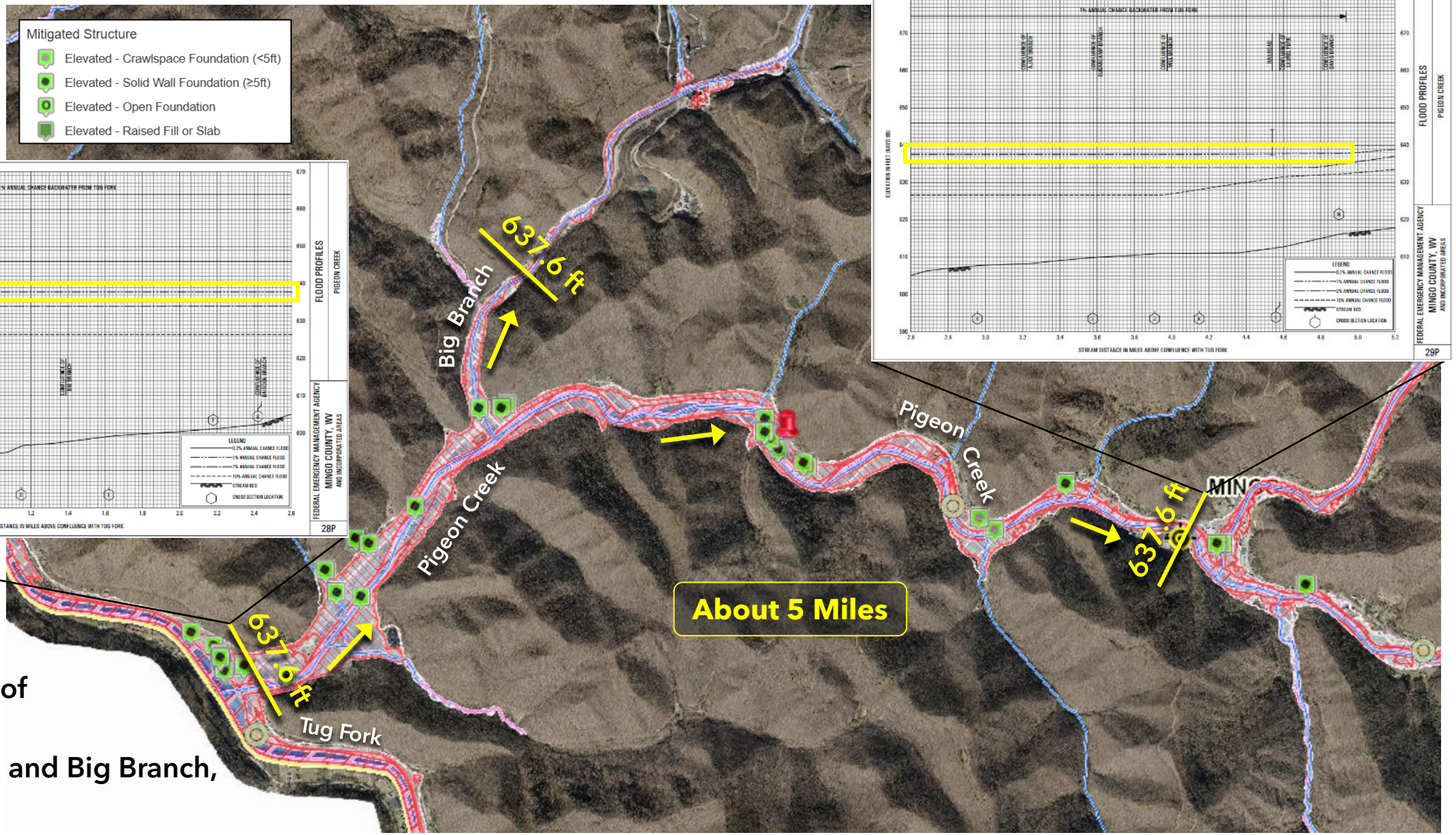
Example

Backwater effect of the Ohio River into the Twelvepole Creek and Buffalo Creek, Wayne County



River Confluences...

Example



Backwater effect of the Tug Fork into the Pigeon Creek and Big Branch, Mingo County

River Confluences...

Mitigation Approach

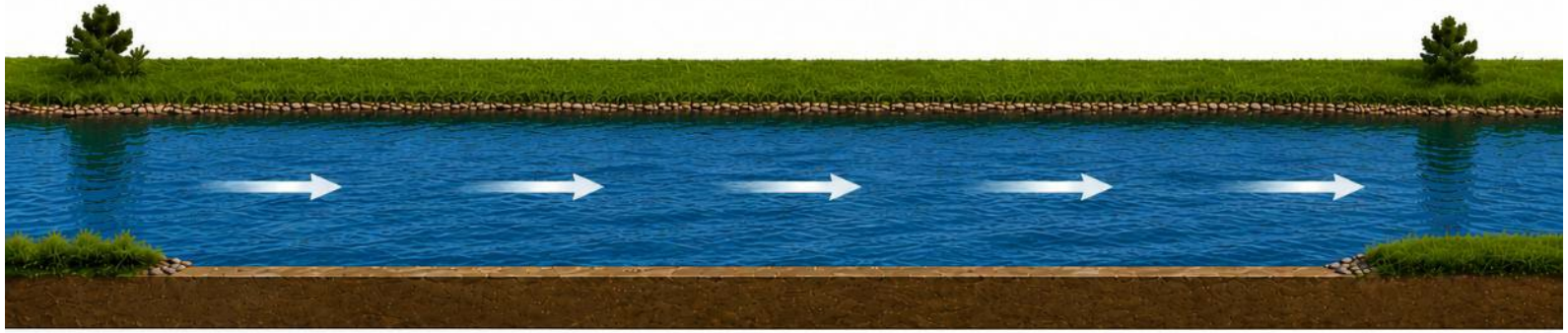
- Use floodplain mapping that accounts for confluence backwater effects.
- Elevate or relocate structures.
- Limit development in backwater-prone areas.
- Restore natural floodplain storage by open space preservation near the confluences.
- Protect tributary floodways from encroachment.

Bridges and Culverts

Hydraulic Constrictions

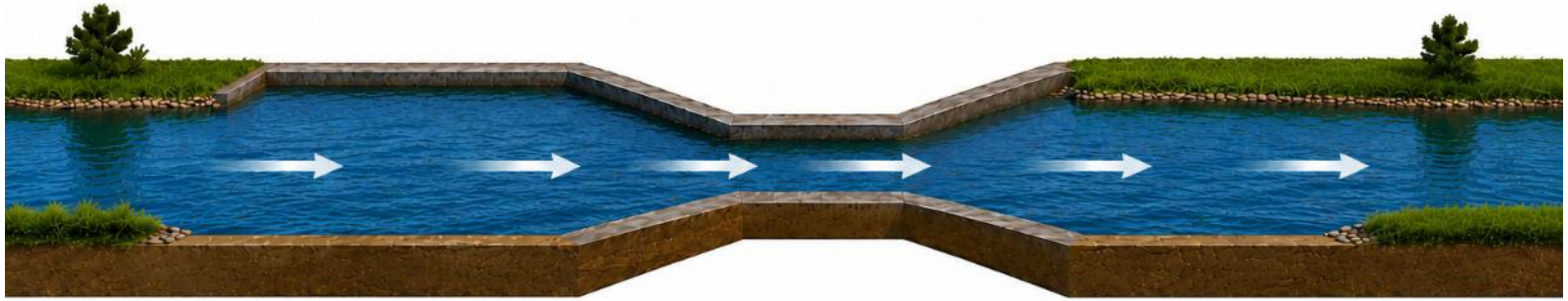
UNRESTRICTED CHANNEL

Flow passes through the channel without significant upstream ponding.



CONSTRICTED CHANNEL

The available flow area is reduced, but the opening may remain sufficient under normal conditions.



FLOOD CONDITIONS

During high flows, the constriction limits conveyance capacity, causing water levels to rise upstream and creating a backwater effect.

A hydraulic constriction reduces the available flow area. During flood conditions, water cannot pass through the opening as efficiently, causing water levels to rise upstream.

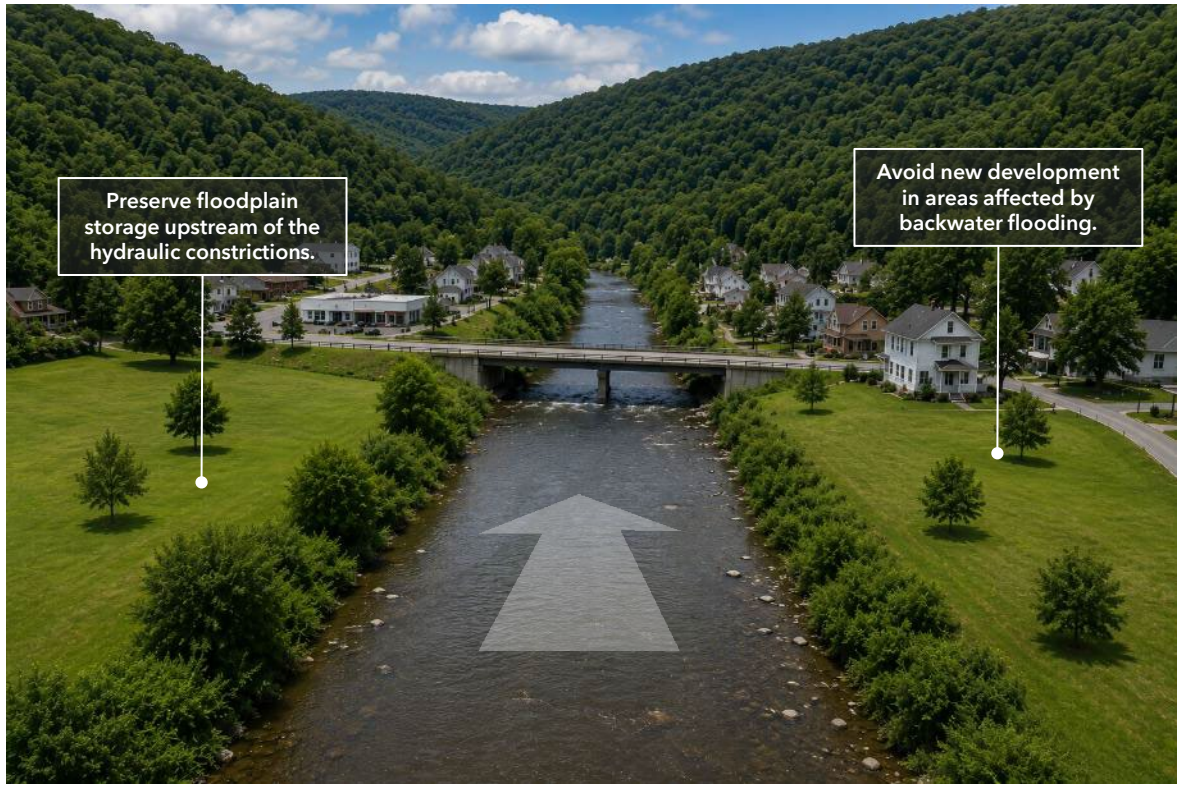
Bridges and Culverts...

Backwater effect

Bridges and Culverts...

Mitigation Approach

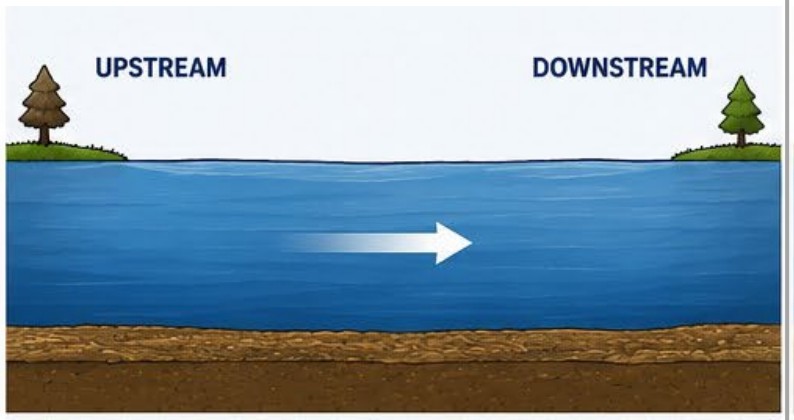
- Identify crossings that contribute to flooding.
- Incorporate crossing constraints into flood risk assessments.
- Limit new development in areas affected by crossing-related backwater flooding.
- Coordinate with transportation agencies on problem crossings.
- Preserve floodplain storage upstream of constricted crossings.

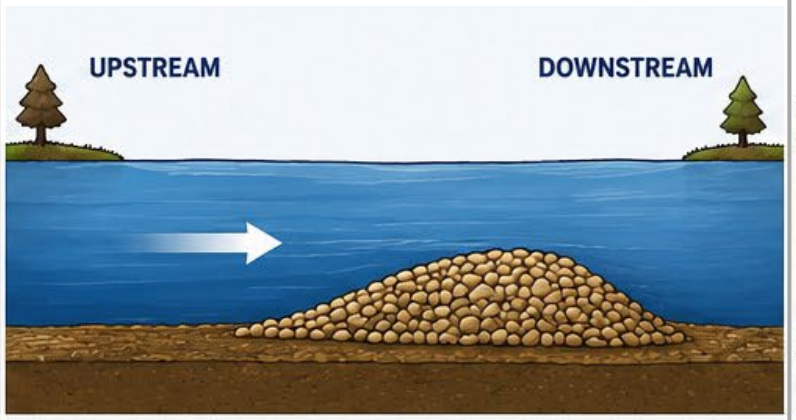


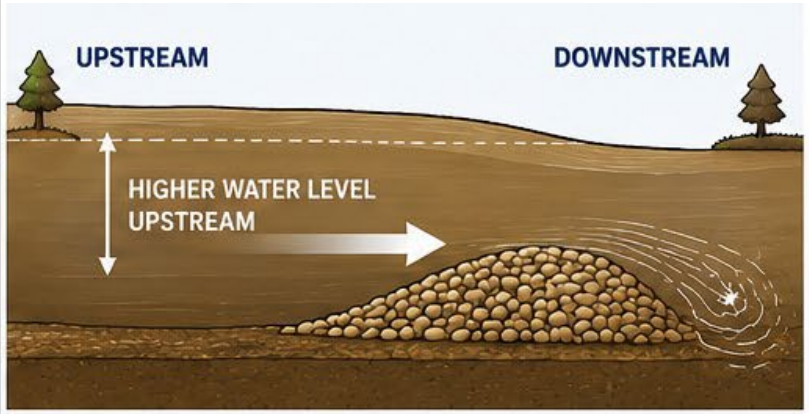
Sediments and Debris Accumulation

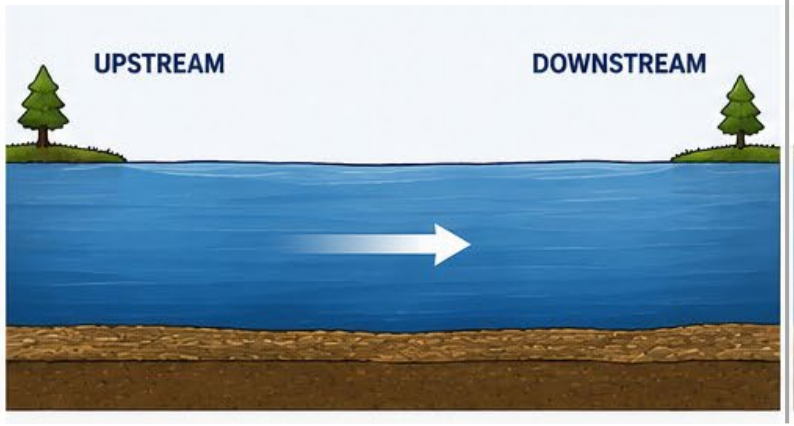
Flow Obstructions

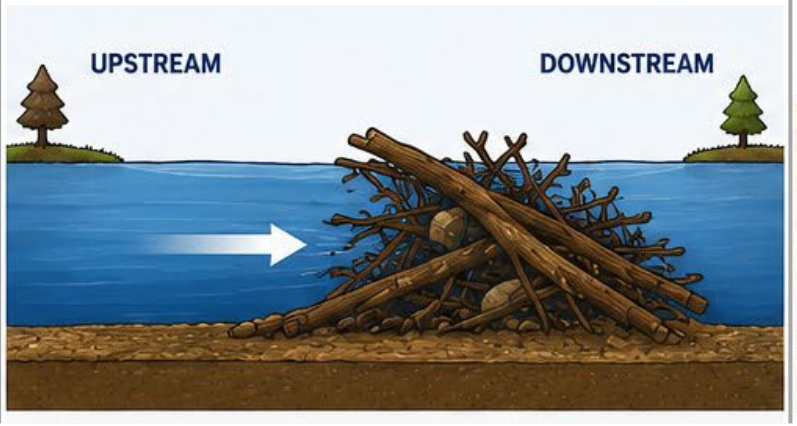
NORMAL CONDITIONS	PARTIAL OBSTRUCTION	FLOOD CONDITIONS
Unobstructed flow. Water surface is nearly uniform.	Sediments / debris accumulate in the channel, reducing the effective flow area.	Water backs up upstream, causing higher water levels. Flow accelerates through the remaining opening.

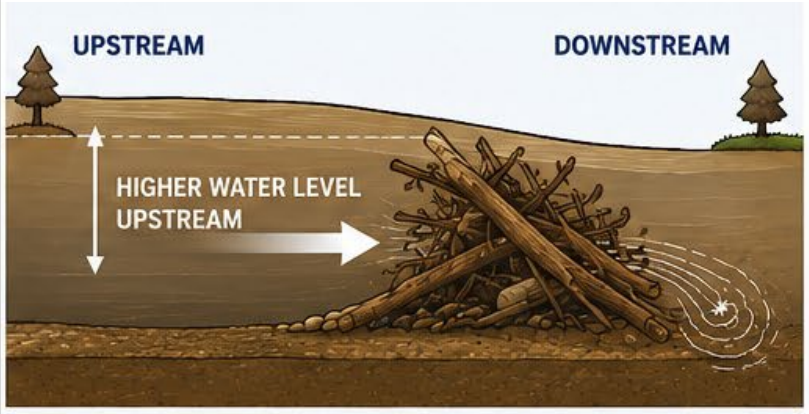












Sediments and Debris Accumulation...

Backwater effect / Higher Flood Heights

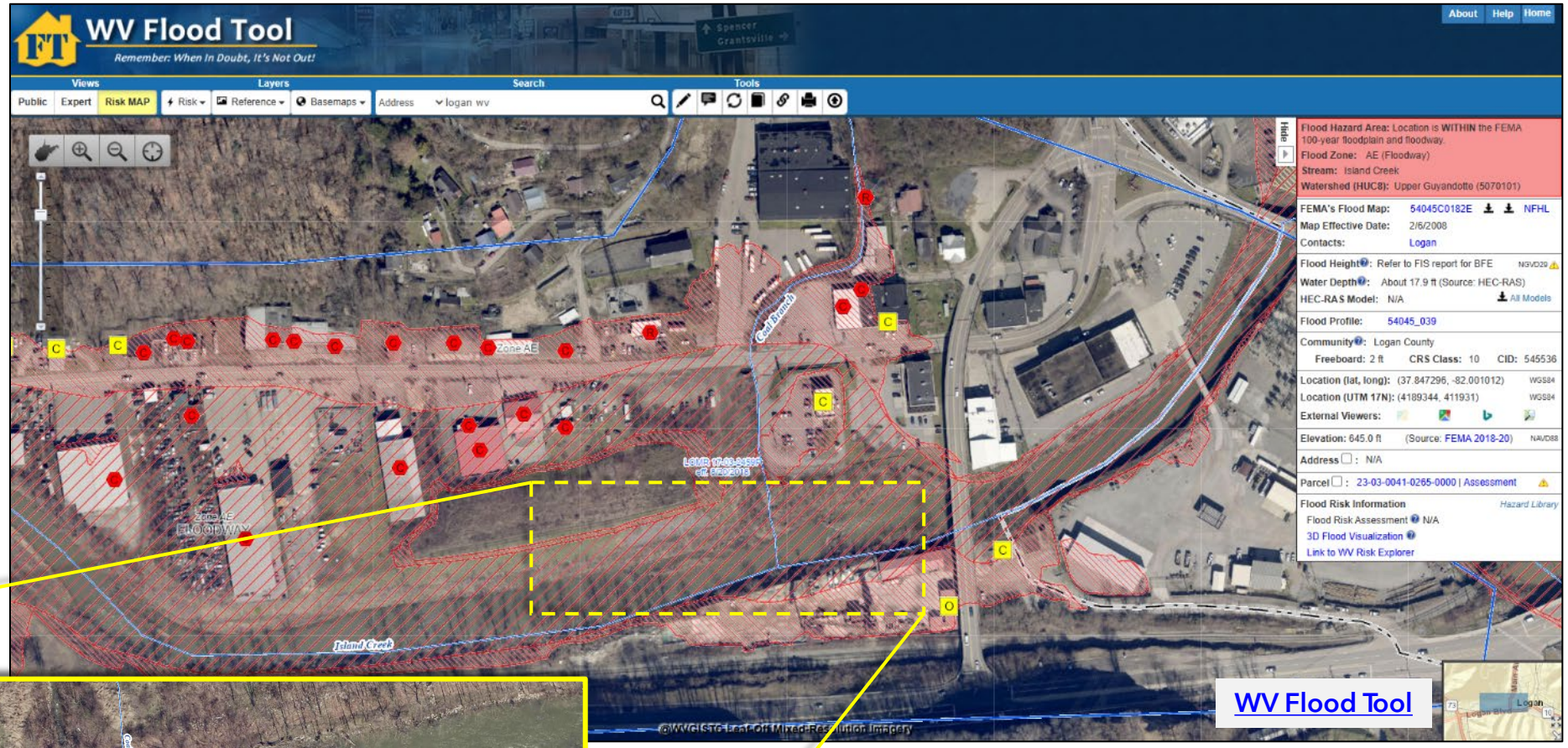
Sediment deposits and debris accumulations reduce the effective flow area of a channel. During flood conditions, water backs up upstream of the obstruction, increasing water levels and flood risk.

Sediments and Debris Accumulation…

Example

Accumulated sediments and woody debris in Island Creek, Logan County

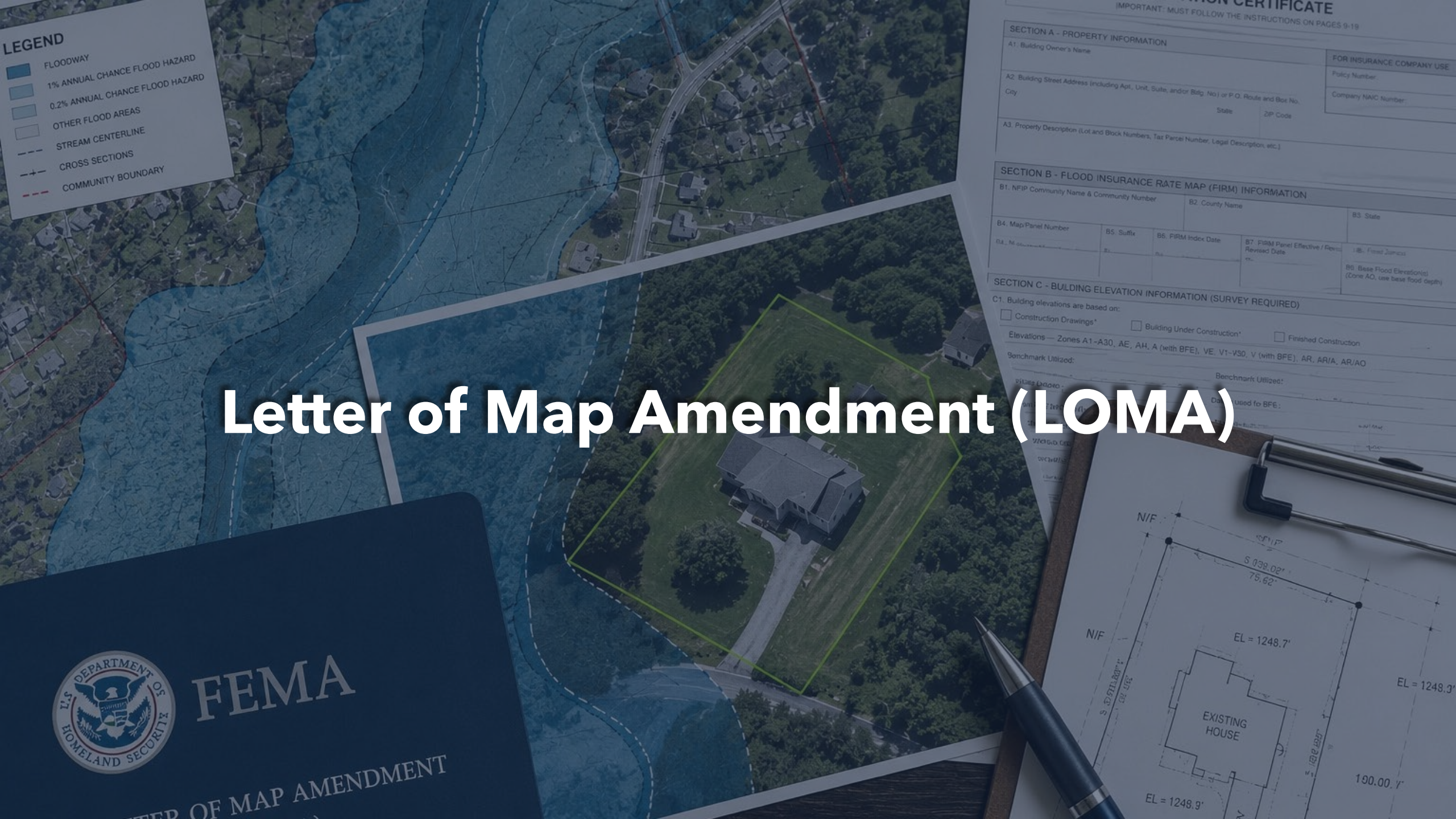
Channel obstructions may increase flood elevations.



Sediments and Debris Accumulation...

Mitigation Approach

- Inspect channels and stream crossings regularly.
- Identify locations prone to frequent sediment and debris accumulation.
- Limit new development in areas vulnerable to sediment accumulation.
- Remove excessive sediment and debris where appropriate.
- Stabilize streambanks and reduce upstream erosion sources.



Letter of Map Amendment (LOMA)

Types of LOMCs

- Letter of Map Amendment (LOMA)
- Letter of Map Revision (LOMR)
- Letter of Map Revision Based on Fill (LOMR-F)
- Conditional Letter of Map Revision (CLOMR)
- Conditional Letter of Map Revision Based on Fill (CLOMR-F)

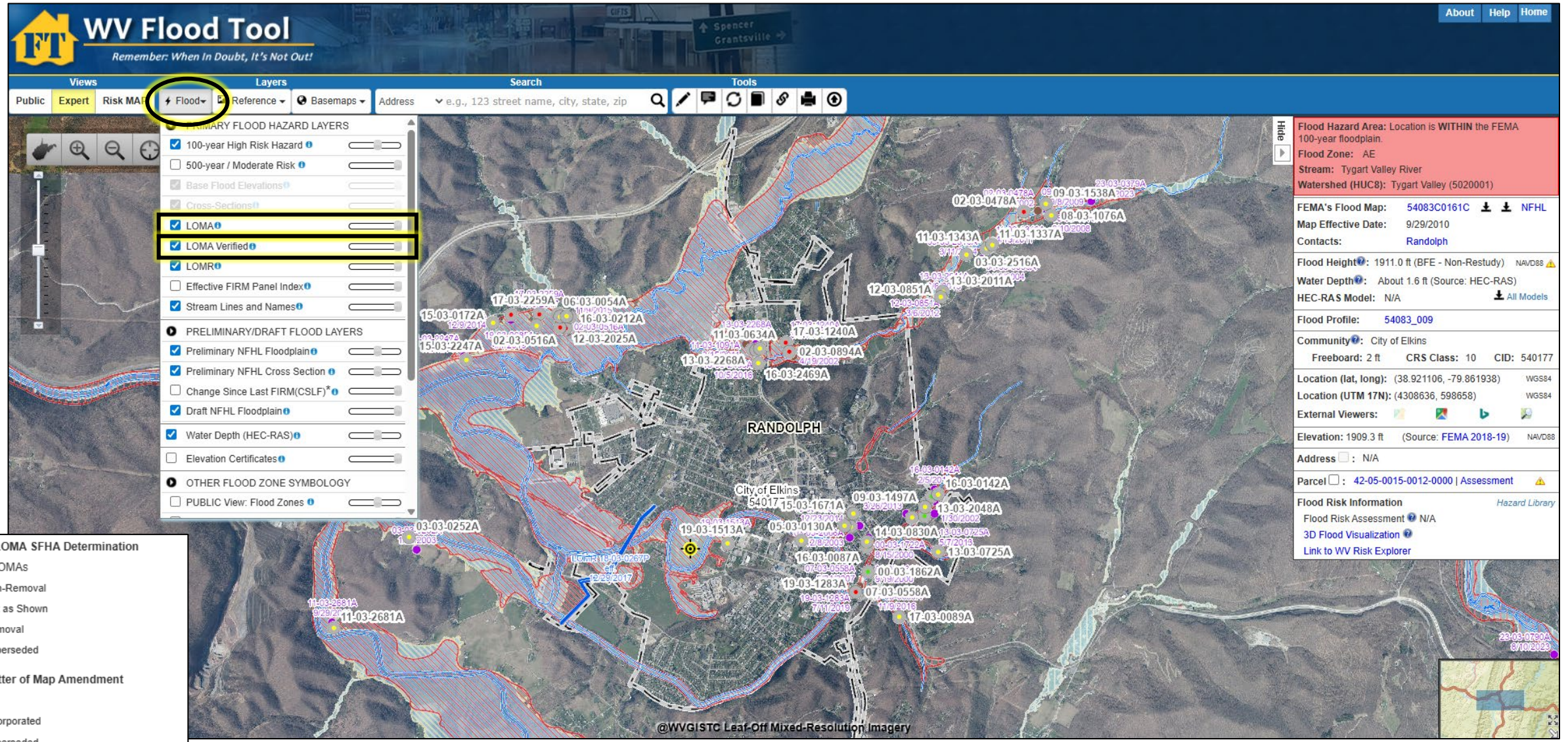
Letter of Map Amendment (LOMA)

- Official determination of a property's location and elevation, relative to the boundary of SFHA and the Base Flood Elevation (BFE)
- For an individual structure or property
- Letter amends the Flood Insurance Rate Map (FIRM) for the specific property; no new map is published

LAG > BFE

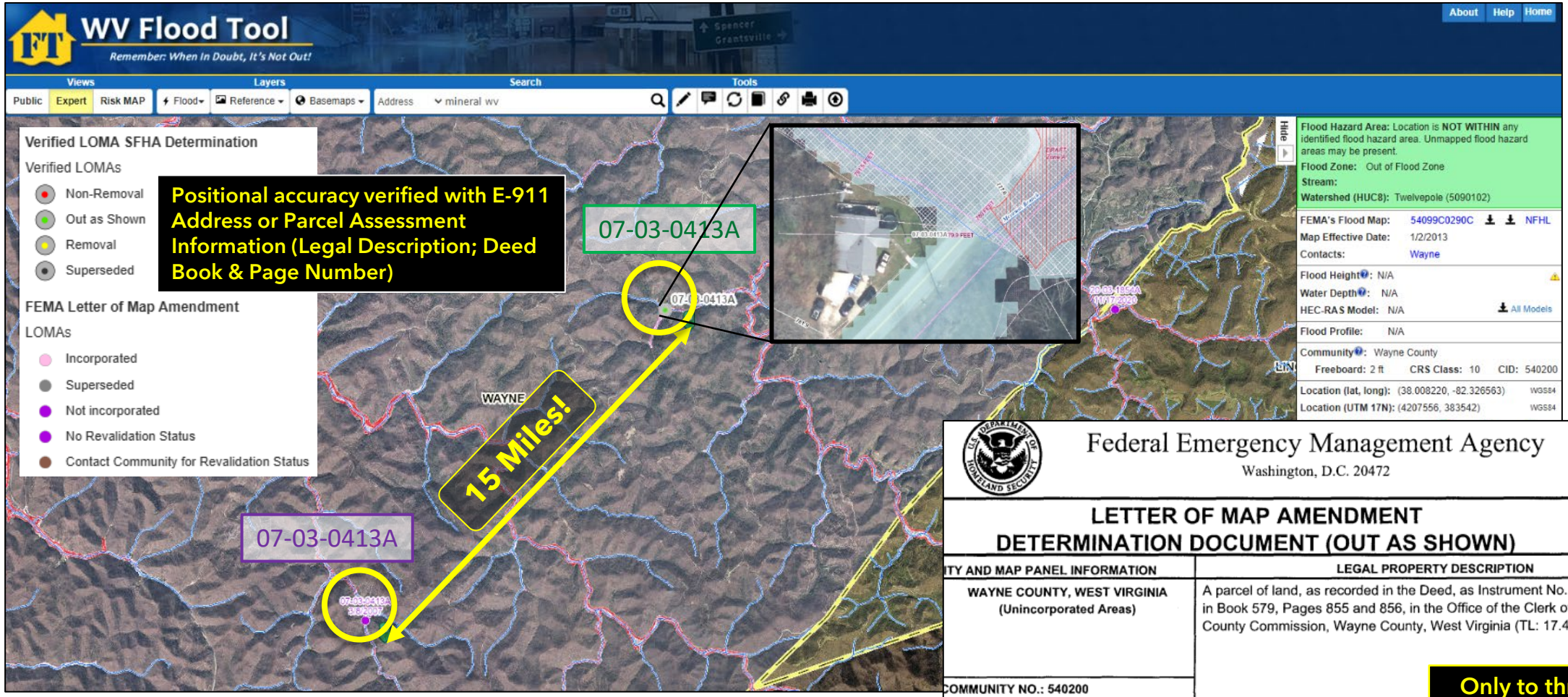
LAG: Lowest Adjacent Grade
(LLE: Lowest Lot Elevation)
BFE: Base Flood Elevation

Verified LOMAs on WV Flood Tool



Original LOMAs from FEMA (LOMA) and their copies with the locations verified (LOMA Verified)

Verified LOMAs on WV Flood Tool...



Federal Emergency Management Agency
Washington, D.C. 20472

LETTER OF MAP AMENDMENT
DETERMINATION DOCUMENT (OUT AS SHOWN)

ITY AND MAP PANEL INFORMATION	LEGAL PROPERTY DESCRIPTION
WAYNE COUNTY, WEST VIRGINIA (Unincorporated Areas)	A parcel of land, as recorded in the Deed, as Instrument No. 49389, in Book 579, Pages 855 and 856, in the Office of the Clerk of the County Commission, Wayne County, West Virginia (TL: 17.4)
COMMUNITY NO.: 540200	
NUMBER: 5402000075B	
DATE: 9/18/1987	
RCE: MCCOMAS BRANCH; MCCOMAS BRANCH	APPROXIMATE LATITUDE & LONGITUDE OF PROPERTY: 37.955, -82.388 SOURCE OF LAT & LONG: PRECISION MAPPING STREETS 7.0 DATUM: NAD 83
DETERMINATION	

Only to three decimal digits!

Verified LOMAs on WV Flood Tool...

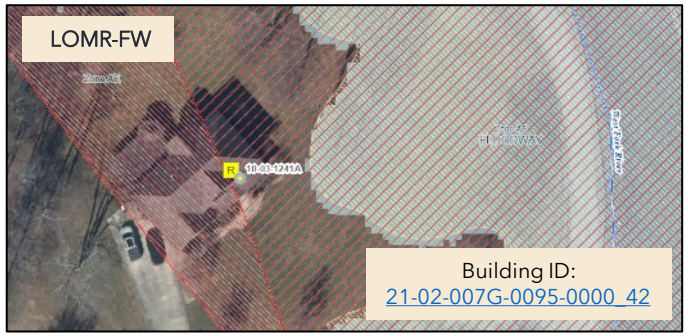
Verified LOMA SFHA Determination

Verified LOMAs
- Non-Removal
- Out as Shown
- Removal
- Superseded

FEMA Letter of Map Amendment

LOMAs
- Incorporated
- Superseded
- Not incorporated
- No Revalidation Status
- Contact Community for Revalidation Status

Total FEMA LOMAs (1997 to 2025)	4,432	100%
Project Category		
LOMA	4,115	92.8%
Fill (LOMR-F)	245	5.5%
Floodway (LOMR-FW)	72	1.6%
Outcome		
Mapped Out (Removal) *	3,305	74.6%
Mapped In (Non-Removal) **	531	12.0%
Outside SFHA (Out as Shown) ***	438	9.9%
Other ****	158	3.6%
Reval Status		
Superseded	59	

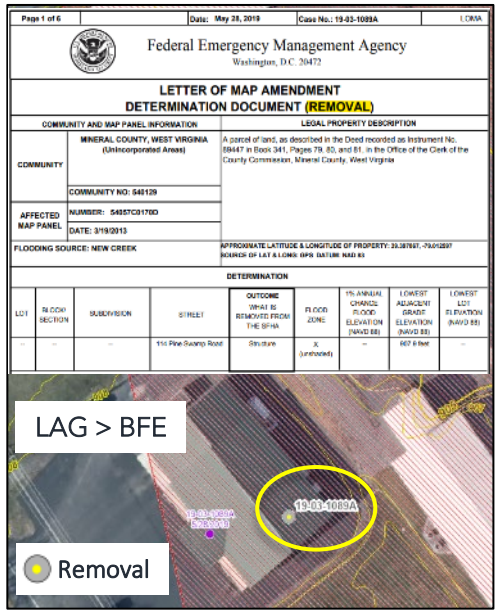


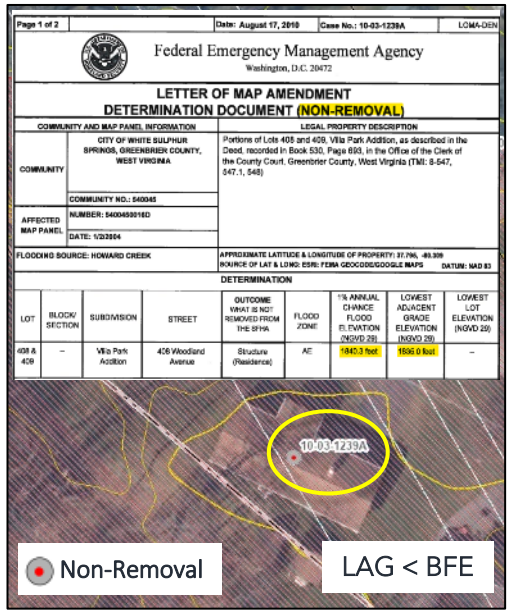
** Mapped Out includes:* 'Portion of property removed', 'Property removed', 'Structure removed-Property partially inundated'

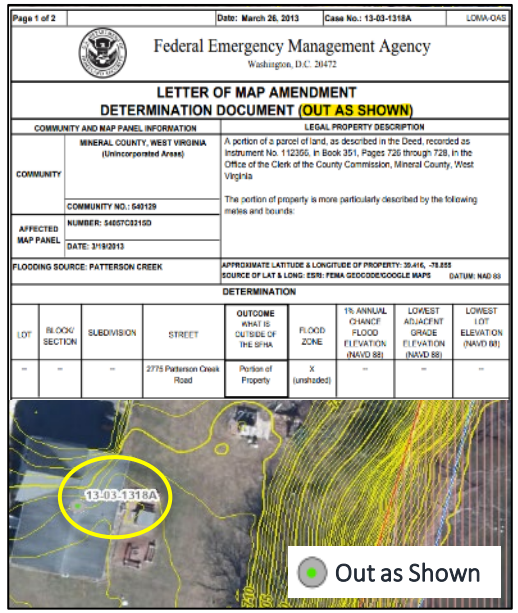
*** Mapped In includes:* 'Denied',' Portion of property denied', 'Portion of property denied and in floodway', 'Property denied', 'Structure denied', 'Structure denied and in floodway'

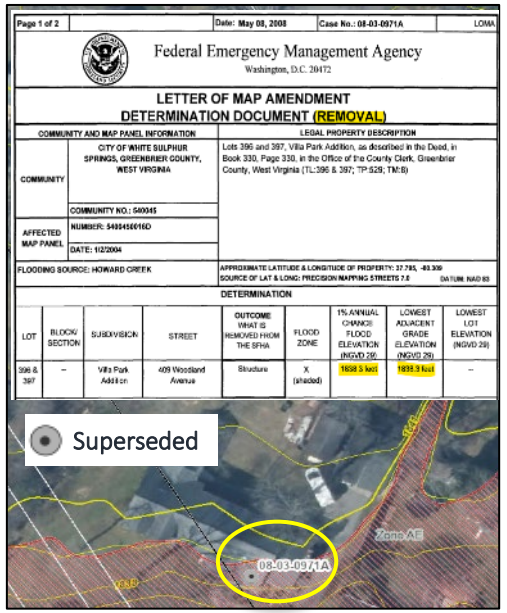
**** Outside SFHA includes:* 'Portion of property out as shown', 'Property out as shown', 'Structure out as shown-Property partially inundated'

***** Other includes:* Null values, 'Multiple', 'No outcome (Other response or violation)', UNKNOWN

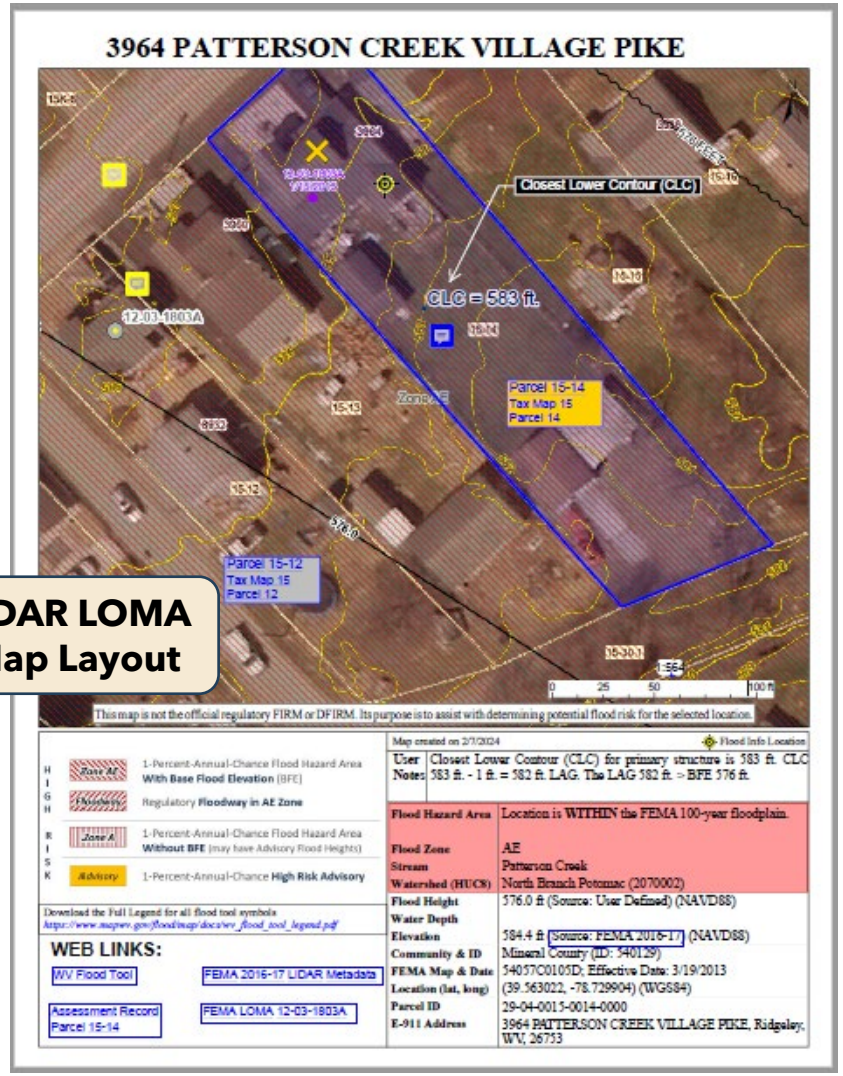




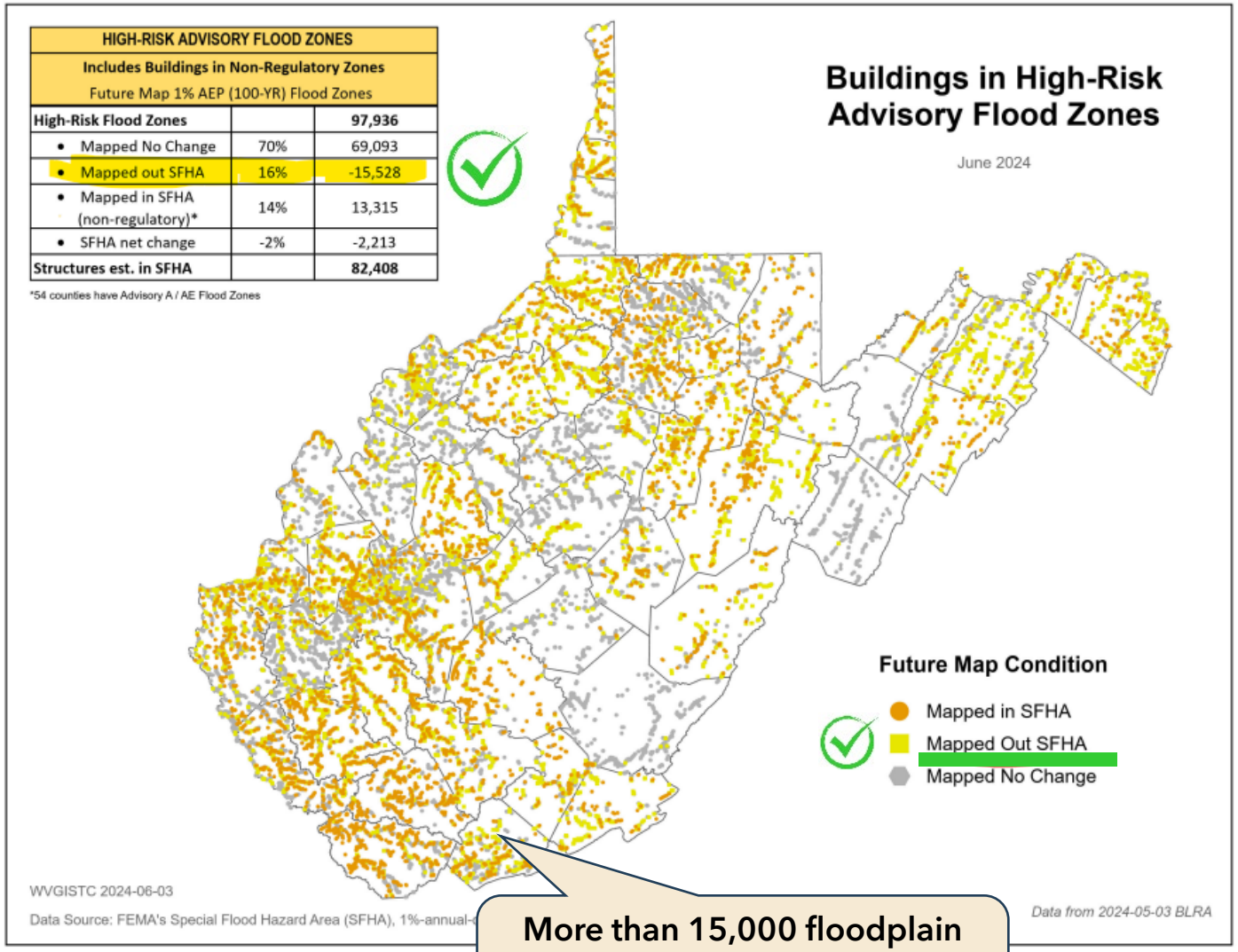




SFHA Buildings Changes: LOMAs for Mapped Out

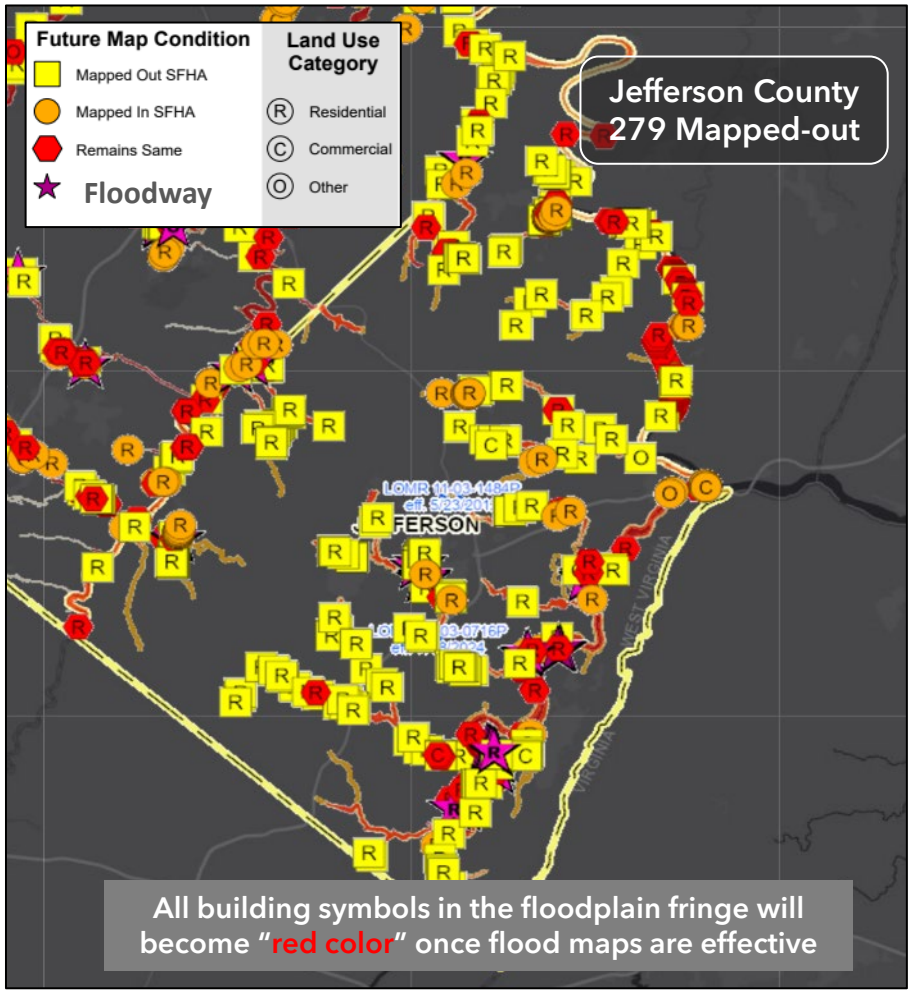


LiDAR LOMA Map Layout



More than 15,000 floodplain structures (yellow symbol) may be eligible for LiDAR LOMAs

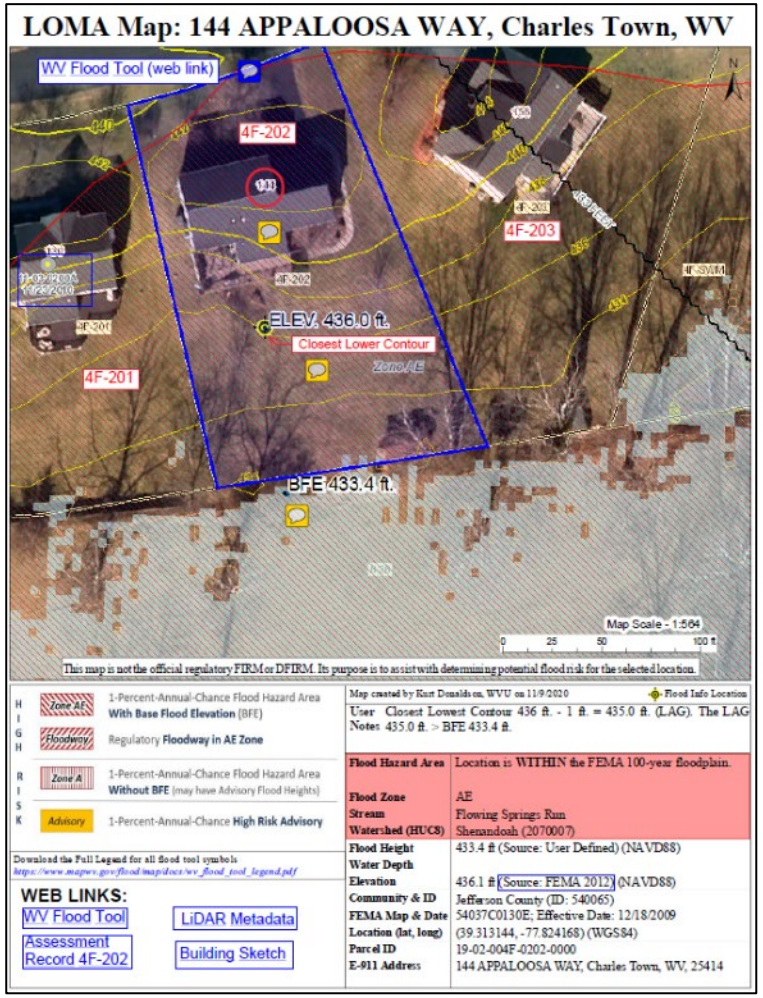
SFHA Buildings Changes: LOMAs for Mapped Out…



Mapped-out structures of the SFHA may qualify for LOMAs

WV Flood Tool LiDAR LOMA:

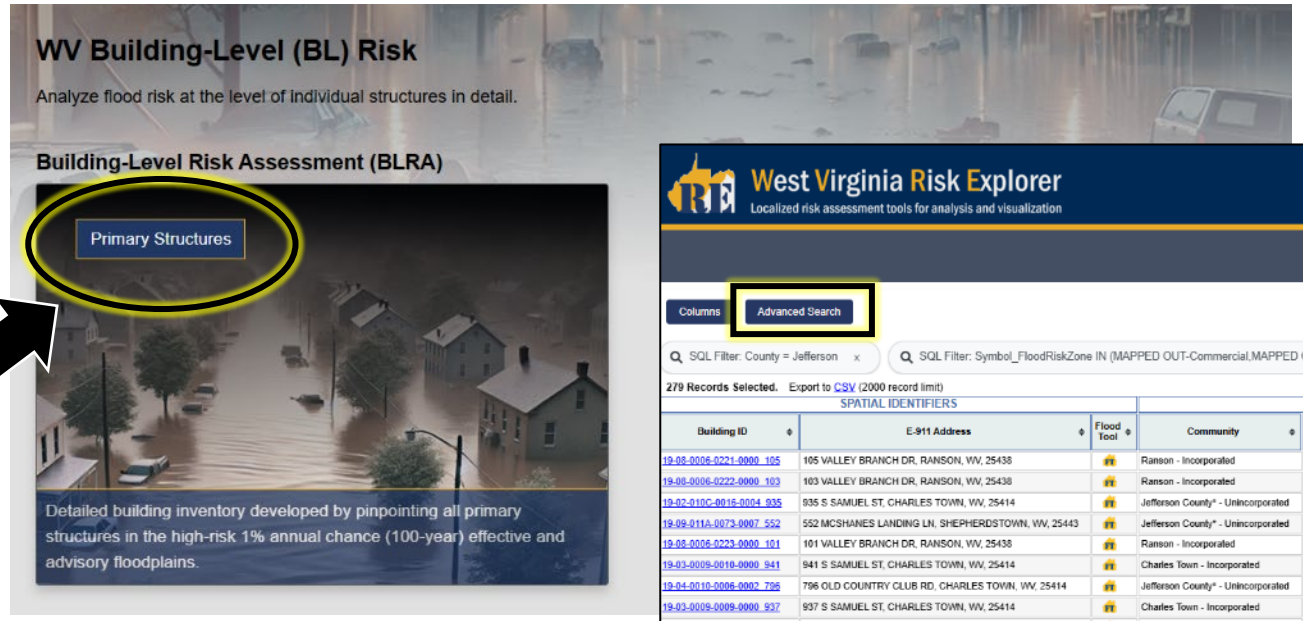
Instructions | Guide

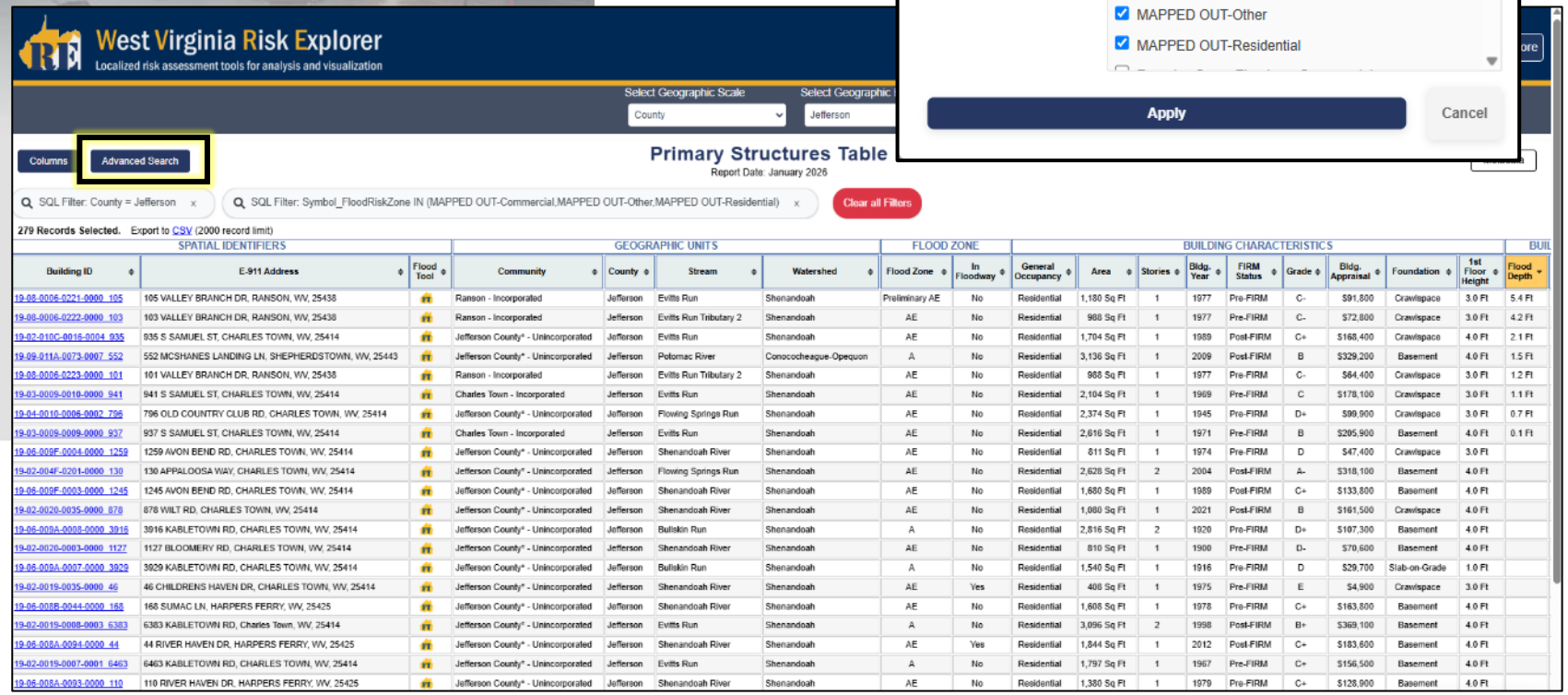


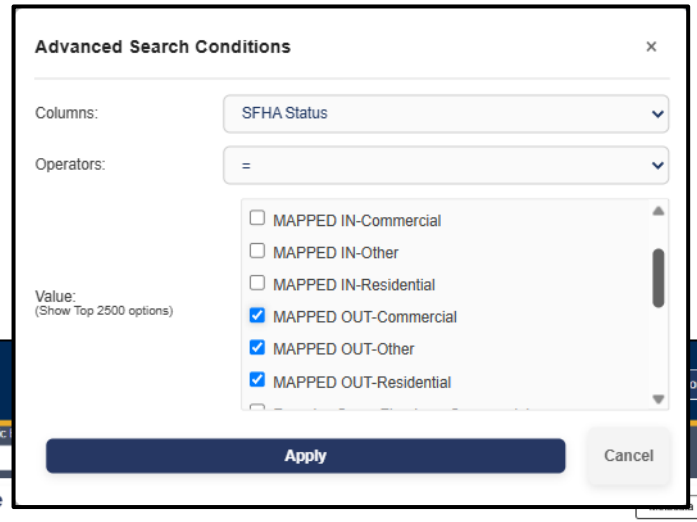
No need to wait until the maps become effective
May reduce flood insurance costs
Can be presented for selling properties

Mapped-out List from WV Risk Explorer (BL Tool)

https://wvfrf.org/wvre/buildings





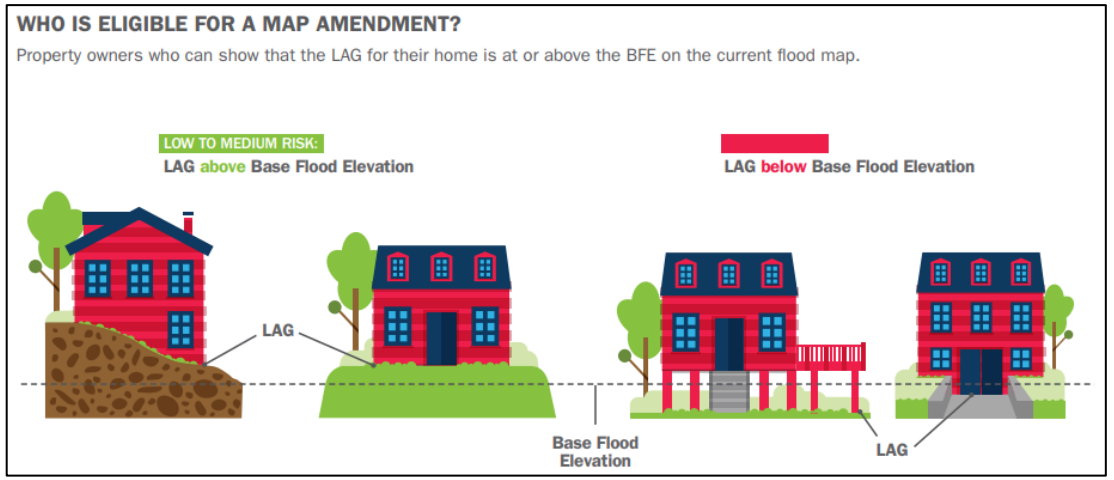


LiDAR for Map Amendments

LiDAR data can replace the requirement to submit elevation information certified by a licensed land surveyor or professional engineer, which can create a cost savings for property owners.

The WV Flood Tool (www.mapwv.gov/flood) can be used for the map requirement of LOMAs for properties located in A or AE Flood Zones.

High-Risk advisory flood zones identify potential structures that could be removed from the SFHA.



Source: How to Request a Map Amendment (2021)

LAG: Closest lower contour value minus half of the contour interval or 1 ft, whichever is greater

When LiDAR Cannot Be Used for LOMA

There are situations when LiDAR cannot be used in a LOMA request. These include applications involving the following:

- Buildings or lots elevated using **fill**
- Buildings or lots in the regulatory **floodway** or Zone AO
- Buildings **under construction**
- **Conditional** determinations
- Requests to **supersede** previously issued LOMAs based on certified elevation data
- If the entire lot is **to be reviewed**, an Elevation Form is required to complete the case with the Lowest Lot Elevation certified by a licensed land surveyor or registered professional engineer.

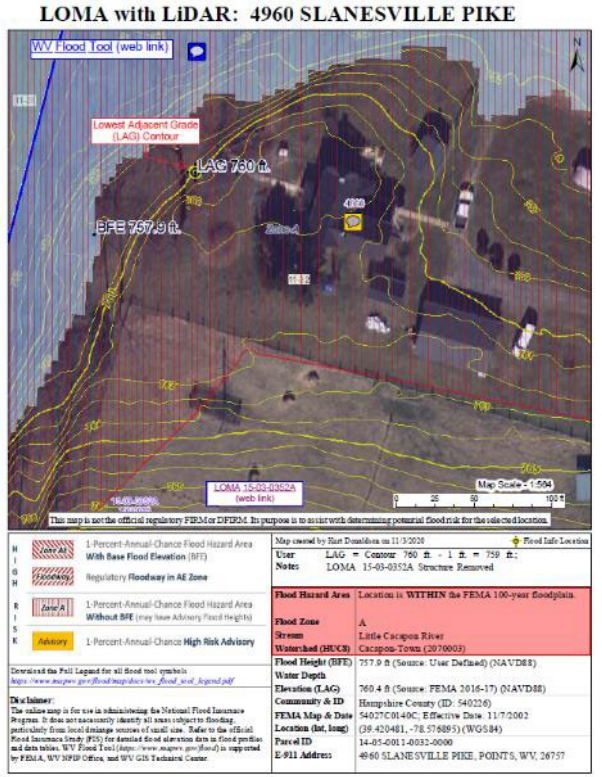
Example of LOMA Qualification

LiDAR LOMA Submission – 4 Steps

1) Determine LiDAR coverage. West Virginia has statewide Quality Level 2 (QL2) LiDAR coverage and derivative elevation products (statewide 1-meter DEM and 1- or 2-foot contours) published to the WV Flood Tool.

2) Print **LOMA Map** using WV Flood Tool

- Identify published building-level risk assessments for potential Mapped Out structures
- Determine LOMA Type: Existing Structure or Lot
- Determine BFE
- Determine LAG/LLE
- Add Annotation
- Print and Download LOMA Map
- Save to PDF File

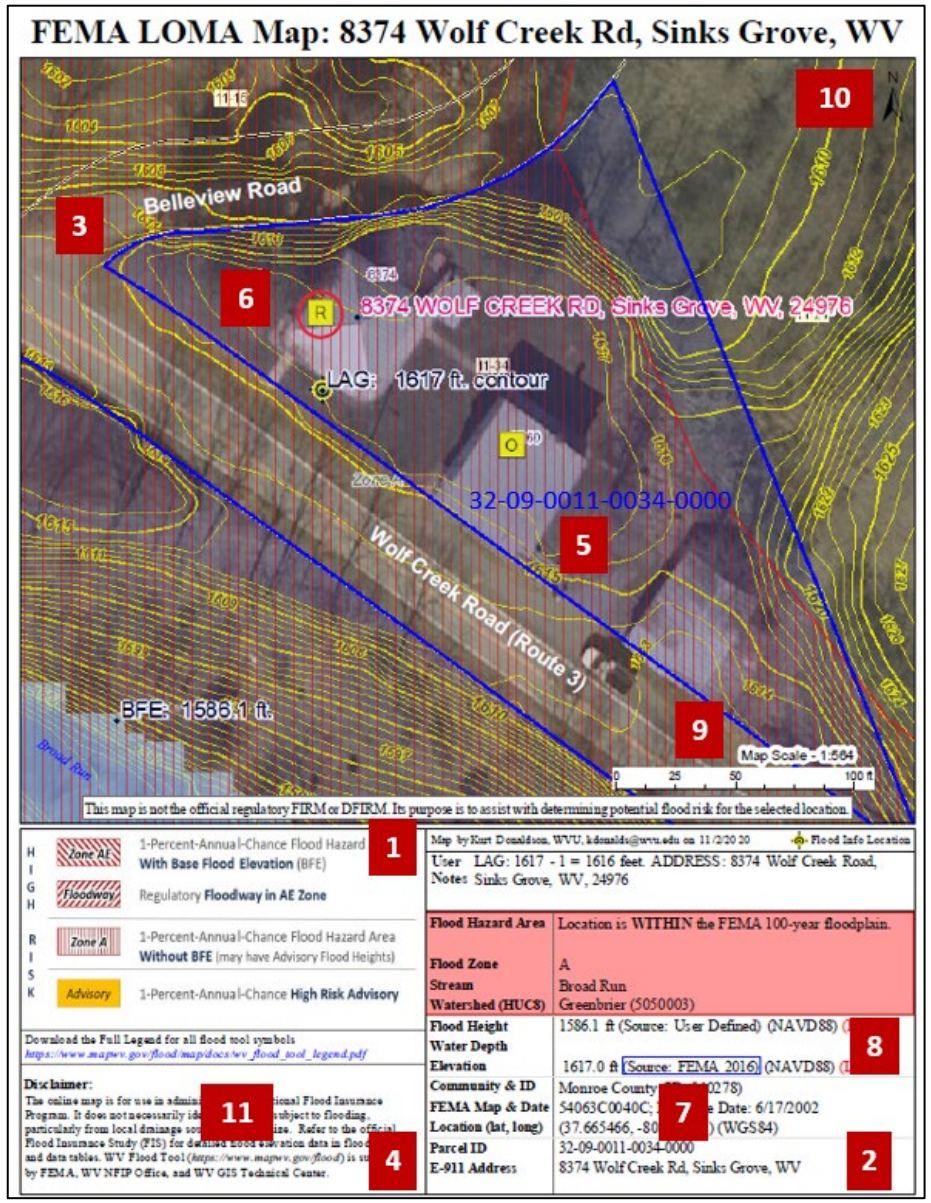


Click here for more detailed instructions

3) Further Edit/Annotate Print LOMA (optional)

4) Submit LiDAR LOMA Map Exhibit using FEMA's Online LOMC Portal (no fee charged)

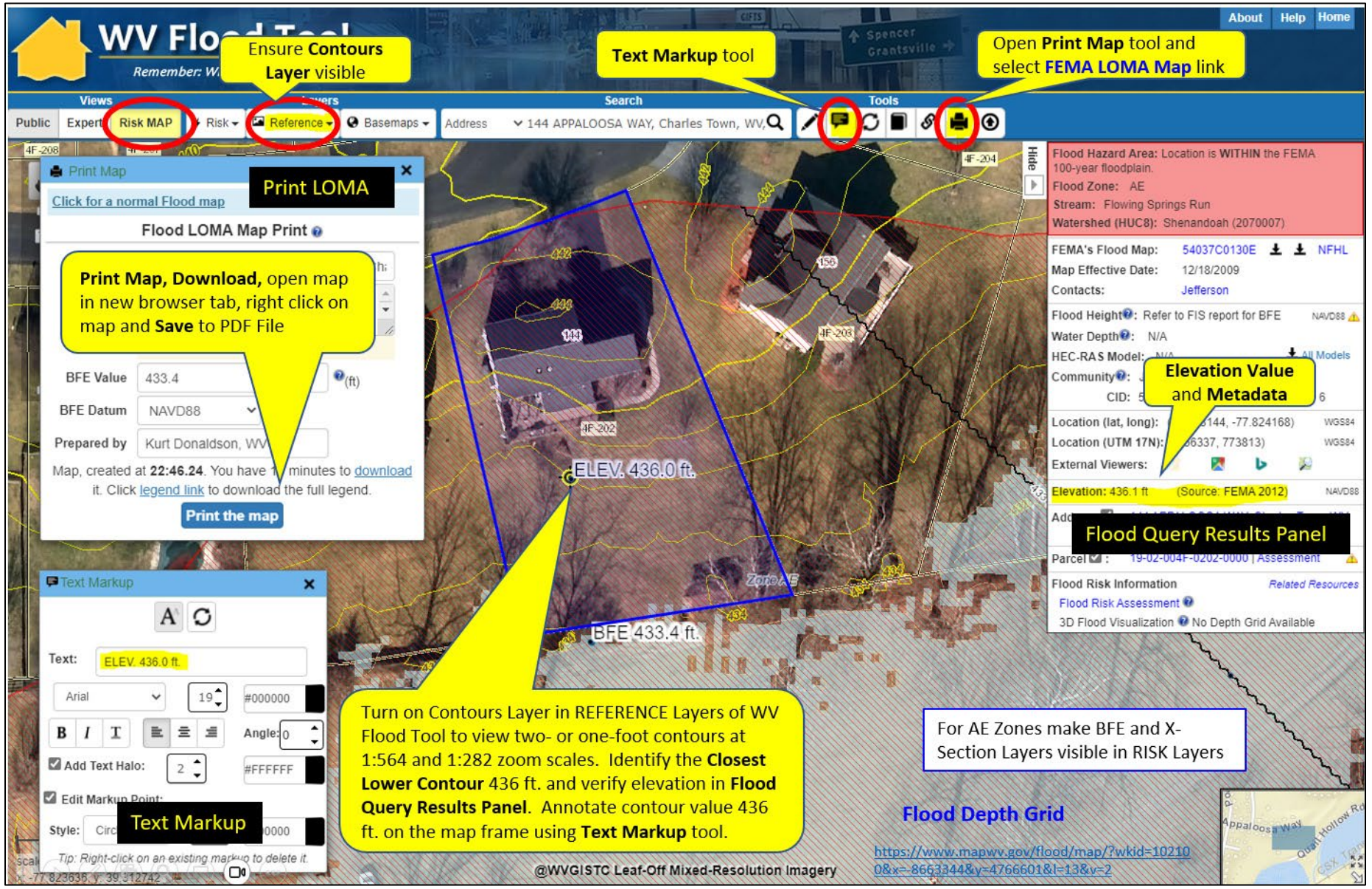
What needs to be submitted?



#	Map Elements Required
1	Name, organization, and contact information for the map creator
2	E-911 Address of property
3	Road or street intersection reference
4	Assessor's full Parcel ID Number (APN) for the building/lot
5	Clearly identified building and/or lot boundaries
6	Aerial imagery that shows building footprint
7	Date, Source, and Accuracy of the LiDAR collected
8	Vertical Datum of elevation data (e.g., NAVD 88, NGVD 29)
9	Scale Bar
10	North Arrow
11	WV Flood Tool Location web link

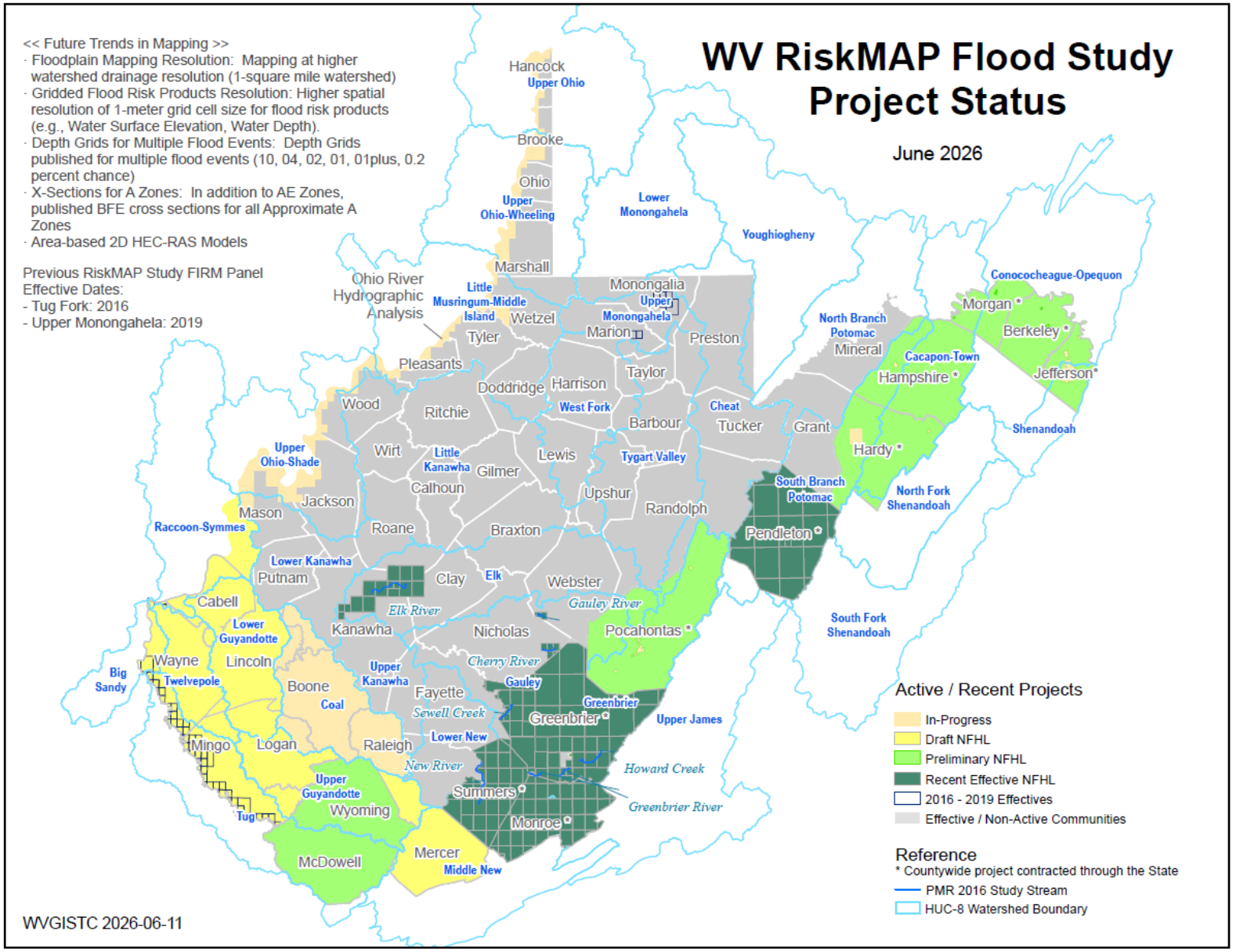
More than one map can be made to present all elements.

LOMA Map – Identify LAG



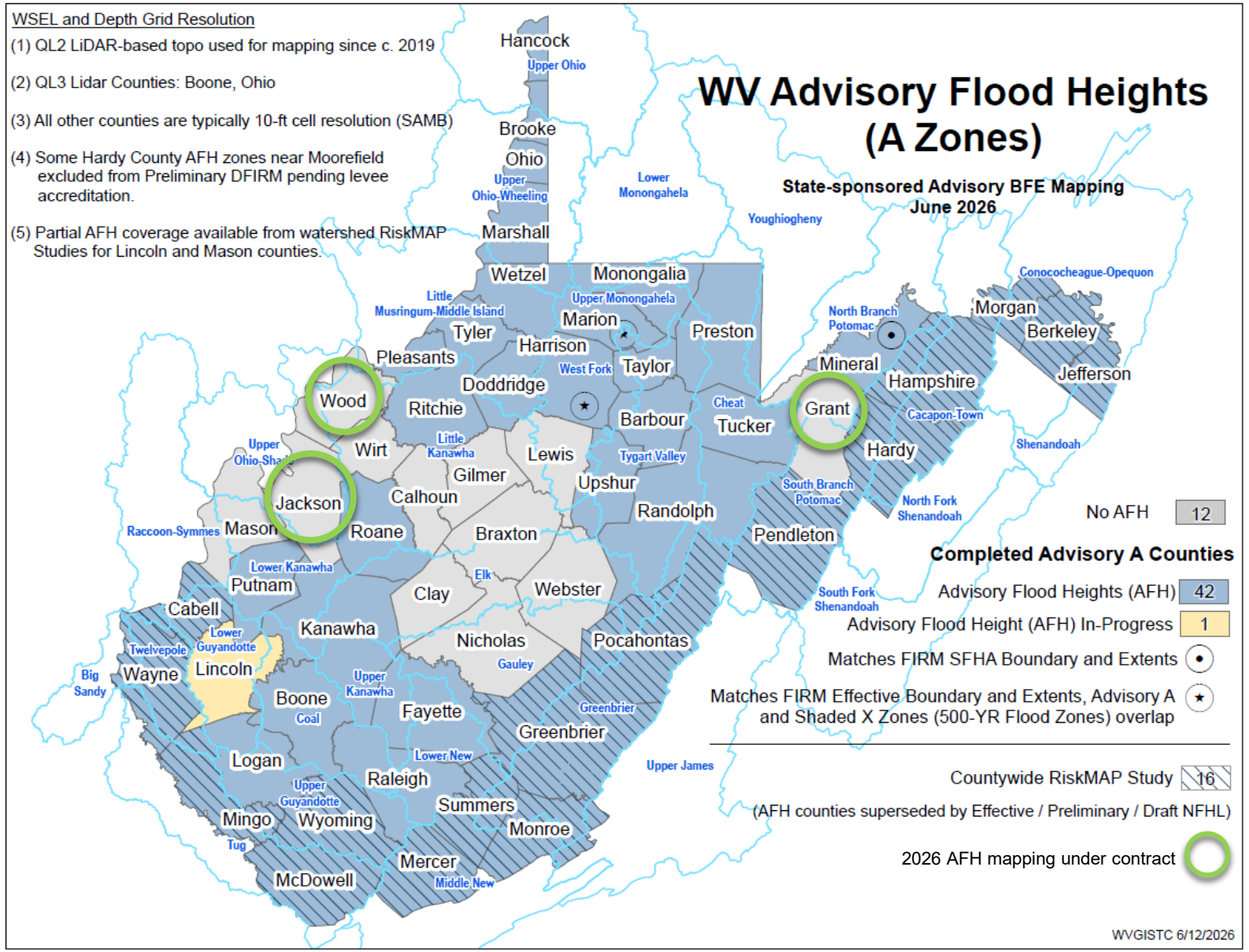
Map Updates

WV RiskMAP



https://data.wvgis.wvu.edu/pub/RA/HL/MIT/MAPPING/Status/WV_FloodStudies.pdf

Advisory Flood Heights



https://data.wvgis.wvu.edu/pub/RA/HL/MIT/FPM/4-Flood-Elev/AFH/Advisory_A_and_AFH_Status.pdf

Local Floodplain Information requested for WV Flood Tool

- **Significant Facilities in floodplain verified on Risk MAP View**

Police Station

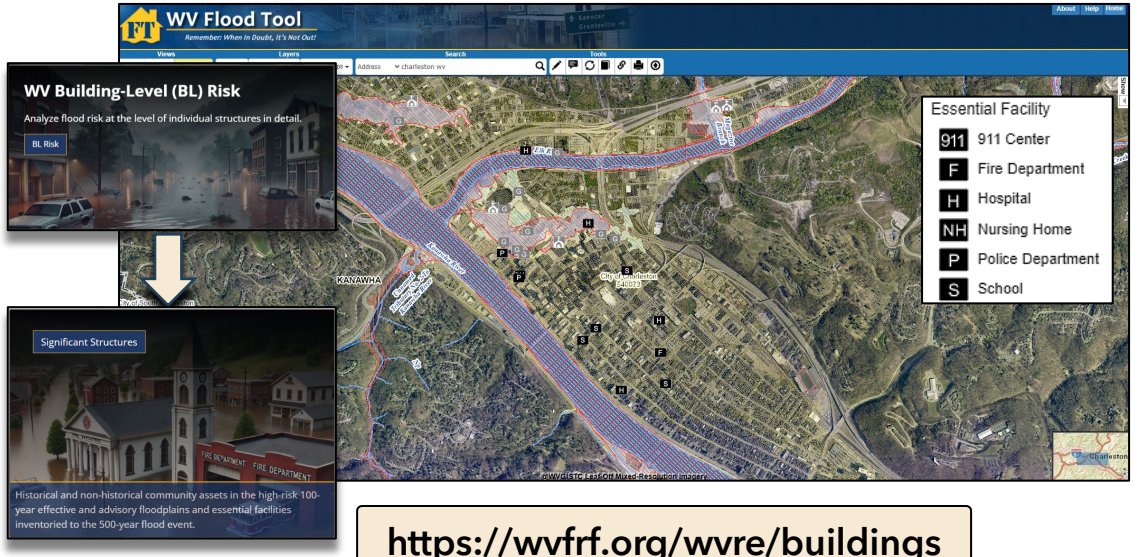
Fire Station


E-911 Dispatch


School


Hospital


Nursing Home



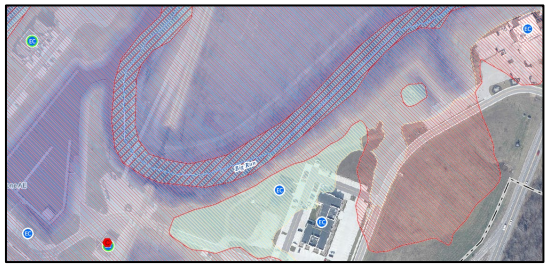
https://wvfrf.org/wvre/buildings

- **Elevation Certificates (finished construction only)**

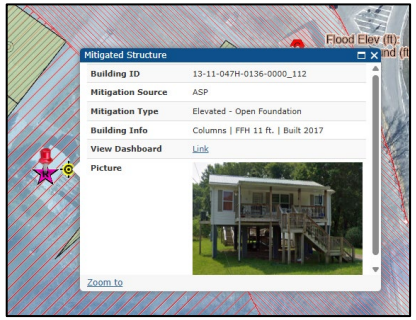
  Pictures

  Accurate Latitude/Longitude

  Location (lat, long): (39.384569, -81.479326)



- **Pictures of Elevated Buildings in SFHA where FFH > 5 feet**

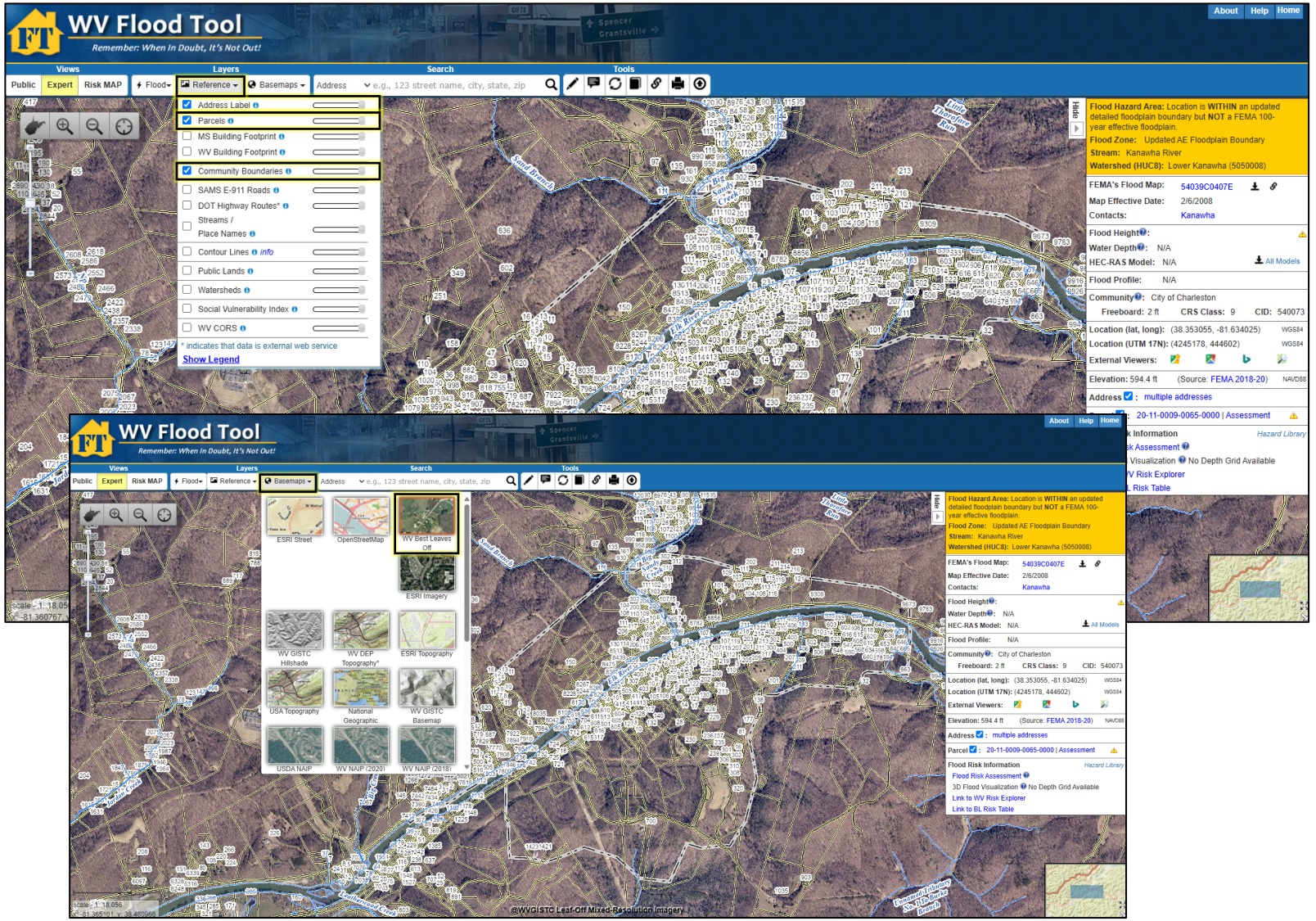


- **Pictures of High-Water Marks of past major floods**

County Reference Layers

Verify accurate and current on WV Flood Tool:

- Municipal Legal Boundaries
  (www.mapwv.gov/BAS)
- Leaf-Off Aerial Imagery
  (county imagery status)
- E-911 Site Addresses
  (www.mapwv.gov/address)
- Tax Parcels
  (www.mapwv.gov/Parcel)



Links to Tools / Data

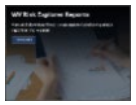
- WV Floodplain Managers Directory: https://www.mapwv.gov/flood/content/wvCountyFloodplainManagersList.htm

→ WV Flood Tool: https://www.mapwv.gov/flood/

→ West Virginia Flood Resiliency Framework (WVFRF): https://wvfrf.org/

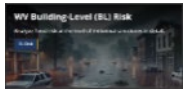
→ West Virginia Risk Explorer (WVRE) (Landing Page): https://www.wvfrf.org/wvre/

→ WV Risk Explorer Maps: https://wvfrf.org/wvre/map/?scaleid=3&gslid=&index=CUM_INDEX&type=pct

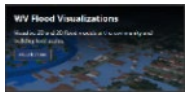


→ WV Risk Explorer Reports: https://wvfrf.org/wvre/report/?entityid=68&scaleid=1&type=all

→ WV Flood Dashboards: https://wvfrf.org/wvre/dashboard/home/



→ WV Building-Level (BL) Risk: https://wvfrf.org/wvre/buildings/



→ WV Flood Visualizations: https://wvfrf.org/wvre/visualization/home/

→ Access Data: https://wvfrf.org/wvre/data/home/

→ WV Hazard Library: https://wvfrf.org/library/

→ Landslide Tools: https://wvfrf.org/wvre/landslides/

→ Legal Boundaries: https://www.mapwv.gov/BAS

Future Direction

- Maintenance and Data Updates
- Training and Technical Support
- Sustainable Funding for Ongoing Operations of the Tools

Thank you!

Questions?

Email:
kurt.donaldson@mail.wvu.edu
behrang.bidadian@mail.wvu.edu

WV GIS Technical Center
West Virginia University

Supplemental

WV Hazard Library

Content of Hazard Library

TOPICS

- **Flood Disaster Events**
  - Flood Event
  - Flood Research
- **Mitigation**
  - Flood Insurance
  - Floodplain Management
  - Floodplain Mapping
  - Other Mitigation Measures
- **Risk Assessment & Planning**
  - State Risk Assessments
  - Local Risk Assessments
  - Planning Resources
  - Web Tools

MEDIA TYPES

- 3D Movie
- Bldg. Profile
- Dashboard
- Data-GIS
- Data-Metadata
- Data-Table
- Flyer
- Graphic
- Guide
- Journal Article
- Letter
- News Article
- Picture
- Plan
- Poster
- Report
- Slides
- Social Media
- Static Map
- Story Map
- Video
- Viewshed
- Web Info
- Web Tool

SEARCH TYPES

- Agency
- Downloadable Data
- Event Disaster
- Event Meeting
- Geographic Scale
  - Entity
- Media Type
- Publication Date
- Subject
  - Major Group
  - Category
  - Subcategory
  - *cross-indexing*
- Stakeholder Type
- Title (free text search)
- Predefined Searches
  - Visualizations
  - Floodplain Management Key Materials

Critical Infrastructure: Essential Facilities

- Essential Facilities provide emergency services during a flood.
- Communities need to establish emergency protocols to maintain critical services amidst a flood.

Police Station

Fire Station


E-911 Dispatch


School


Hospital


Nursing Home

- Schools with children in vulnerable age groups often also serve as shelters during floods.
- Nursing homes and hospitals with immobile patients are particularly more susceptible to flooding.

Clendenin Volunteer Fire Department
Kanawha County
Inundated, Jun. 2016
Building ID: 20-02-0007-0040-0000_109

Marlinton Volunteer Fire Department
Pocahontas County
Inundated, Nov. 1985
Building ID: 38-08-0001-0095-0000_709B

Nicholas County Nursing &
Rehabilitation Center
Richwood
Inundated, June. 2016 (Not active anymore)
Building ID: 34-06-0010-0072-0000_18

Spanishburg Elementary School
Mercer County
Inundated, Feb. 2025
Building ID: 28-11-0026-0075-0000_8544

Clendenin Elementary School
Kanawha County
Inundated, Jun. 2016
(Demolished)

Bridge Elementary School
Kanawha County
Inundated, Jun. 2016
Building ID: 20-15-0023-0077-0000_5120

Community Assets: Non-Historical

- Non-Historical community assets such as churches often serve as emergency shelters during floods.
- Flooding can disrupt critical community lifelines including safety, health, shelter, water, and energy.


Religious Organization


Educational Building


Emergency Medical Services


Government Building

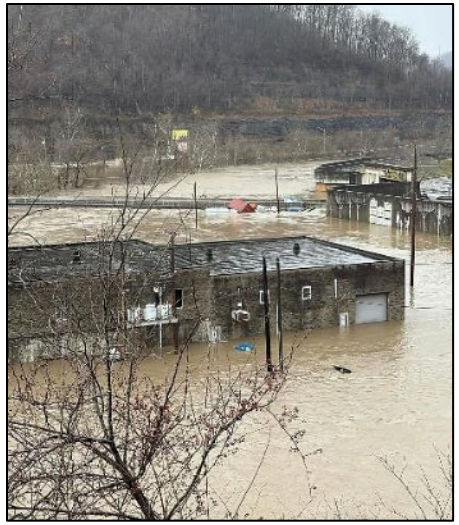

Utility


National Register Historical Structure


In Historic District Older than 1930


Other Assets


Jan-Care of Guardian Angel (EMS)
Welch, McDowell County
Inundated, Feb. 2025
Building ID: 27-15-0002-0247-0000_58


Williamson Water Plant (Veolia Water)
Williamson, Mingo County
Inundated, Feb. 2025
Building ID: 30-11-0007-0233-0000_317

Valley Grove Assembly of God
Valley Grove, Ohio County
Inundated, Jun. 2025
Building ID: 35-08-0VG9-0083-0000_8580

Borderland Baptist Church
Mingo County
Inundated, Feb. 2025
Building ID: 30-10-362K-0010-0000_46


Cornerstone Church
Matewan, Mingo County
Inundated, Feb. 2025
Building ID: 30-08-0009-0071-0000_1028