**2022-23 CTP Services and Projects performed by West Virginia University**
State: West Virginia
Total Costs: $280,000 ($180,000 Base CTP Funding, $100,00 Special Projects)
Performance Period: October 1, 2022, to September 30, 2023 (12 months)
Plan by Kurt Donaldson, Manager, WV GIS Technical Center, **West Virginia University**
2/14/2022

## EXECUTIVE SUMMARY

Global Outreach Services – CTP Base Funding. Cost $180,000

**Global Outreach Services for WV Flood Tool.**

- Statewide global outreach services that process and integrate new flood and reference GIS layers, tool enhancements, flood risk information, etc. for the WV Flood Tool (www.mapwv.gov/Flood). Services include computer programming, data development/geoprocessing, customized mapping, and technical support services (Task A). This project also supports two other activities in which a recent nationwide flood risk assessment determined that 46 percent of the roads in the State and 51 percent of the State's critical facilities — the highest state-level percentages in the Nation — would be closed by flooding based on current and future climate change models. The first subtask (Task B) integrates the WV Building Level Risk Assessment (BLRA) with FEMA's national inventory so standardized, consistent, and accessible building level information can be exchanged. Another subtask (Task C) enhances transportation flood inundation models on the RiskMAP View of the WV Flood Tool. See Table 1 for more detailed information.

Special Project 1. Cost $50,000.

**Map Riverine Flood Impacts of Vulnerably Disadvantaged Communities with Higher Stream Flow Change Forecast Models.**

- USACE forecast models predict higher stream flows in the future for central and southern West Virginia. In addition to forecasted higher stream flows, many of the disadvantaged communities in this region have a moderate to high Social Vulnerability Index. Small, incorporated communities in which large tracts of the community are in the Special Flood Hazard Area are especially vulnerable to climate change riverine flood impacts. Many of the vulnerable communities were established in the early-20th century along narrow river valleys and steep mountainsides during the boom of coal mining and timbering extraction industries. Specifically, this project will map the riverine flood impacts of vulnerably disadvantaged communities facing higher stream flow change forecast models. The targeted five disadvantaged communities (Clendenin, Rainelle, White Sulphur Springs, Camden-on-Gauley, and Richwood) incorporate the new 2016 flood studies recently published by FEMA. Both 2D and 3D maps will show changes in the floodplain forecast models and substantial damage impact on the built environment, including critical facilities, for the following scenarios: (1) Base Flood, (2) 500-YR Flood, and (3) Climate Change Flood Model. This activity will also incorporate the largest flood disaster mitigated reconstruction dataset in the State to date since the devastating April 1977 flood of the Tug Fork Basin in which the USACE Section 202 Mitigation Program was established in 1981. Primary objectives of this project are to communicate the flood risk facing these disadvantaged communities based on current and future climate changing models, and to evaluate how various flood protection measures (e.g., elevated structures from mitigated reconstruction) implemented recently in these communities will adapt to changing environmental factors due to the impacts of climate change. See Table 1 for a more detailed project description including a 3D Flood Visualization Movie example as a visual means to effectively communicate flood risk information.

Special Project 2. Cost $35,000.

**Update the WV Building Level Risk Assessment (BLRA) from New Flood Studies and Stakeholder Inputs.**

- The 2018 CDC Social Vulnerability Index for West Virginia shows seven counties with high vulnerability and 22 counties with moderate to high vulnerability. These social vulnerability factors may weaken a community's ability to prevent human suffering and financial loss in a disaster. The findings of the First Street Foundation's October 2021 risk assessment report states that West Virginia's built environment of critical facilities tops all other states for being vulnerable to flooding in current and future climate changing conditions. As for the built environment susceptible to riverine flooding, it is important to update the statewide building level risk assessment when new data sources become available (new flood studies, advisory flood height mapping, mitigated structures, elevation certificates - elevated building diagrams 5-8, LOMAS, etc.) so more accurate flood loss models and risk assessment products can be published in support of the State's flood reduction activities, especially those communities which are socially vulnerable in the Sate. Updates to critical facilities and other structures of significance shall be a priority in quantifying the degree of flood risk. Benefits to communities include the continued validation of primary floodplain structures, expansion on base level risk assessment information for further hazard reduction and planning efforts, and the use of risk assessment information for Community Rating System (CRS) insurance discounts. See Table 1 for more detailed information about this project.

Special Project 3. Cost $15,000.

**Map Landslide Incidents from the New FEMA LiDAR for 38 Counties.**

- Landslides are identified in the State Hazard Mitigation Plan as the #2 hazard in West Virginia. Climate change models for West Virginia that forecast heavy precipitation events for mountainous terrain with steep slopes will also result in a higher incidence of landslides. This activity will map landslides from the new FEMA-purchased LiDAR delivered in September 2021 that covers 38 counties. Landslide incidents and the type of landslide are used to generate the statewide landslide susceptibility map. The new LiDAR covers physiographic provinces in West Virginia that are most susceptible to landslide hazards. Mapped landslide incidents are published to the WV Flood Tool (RiskMAP View) and WV Landslide Tool. Landslide incidents can also be submitted to the USGS Landslide Inventory. See Table 1 for more detailed information.

Refer to **Table 1** below for more detailed project descriptions and additional resource links. All information from these projects will be published to the WV Flood Tool and will be accessible for hazard mitigation planning and risk reduction activities.

**EQUITY AND/OR CLIMATE CHANGE STATEMENT FOR WEST VIRGINIA**

- USACE Ohio River Basin Climate Change Models (Figure 1) forecast *substantial* stream flow increases for West Virginia. According to the report, watershed sub-basins located northeast, east, and south of the Ohio River are expected to experience greater precipitation and thus higher stream flows – up to 50% greater – during the period 2011-2099. See pages 15 and 16 of the report showing forecasted percent changes in Annual Mean Streamflow for three time periods: 2011-2040, 2041-2070, and 2071-2099. The potential impacts to infrastructure in these sub-basins where climate change models forecast higher stream flows is dramatic and potentially devastating.

- Over the past several years, the number of distressed counties in West Virginia has been steadily increasing. For FY 2022, West Virginia will have 17 distressed counties (most economically depressed counties) and 11 at-risk counties (counties at-risk of becoming economically distressed). With a few exceptions, the 17 distress counties are in the southern and central areas of the State. These 17 counties have an average poverty rate of 22.7%, well above the state average of 17.4% and the national average of 13.4%. ARC Report | Online Map

- The 2018 CDC Social Vulnerability Index for West Virginia shows 7 counties with high vulnerability and 22 counties with moderate to high vulnerability. These social vulnerability factors may weaken a community's ability to prevent human suffering and financial loss in a disaster. CDC Online Map.

- West Virginia has numerous small communities in which large tracts of the jurisdiction are in the Special Flood Hazard Area and thus especially vulnerable to climate change riverine flood impacts. Many of the vulnerable communities were established in the early-20th century along narrow river valleys and steep mountainsides during the boom of coal mining and timbering extraction industries.

- West Virginia ranked 1st highest in the nation for the prevalence of poor physical health, poor mental health, and activity limitations due to poor physical or mental health. Source: WV DHHR.

- In West Virginia, according to nonprofit First Street Foundation's October 2021 report titled "The 3rd National Risk Assessment: Infrastructure on the Brink," 46 percent of the roads in the state and 51 percent of the state's critical facilities — the highest state-level figures in the Nation — would be closed by flooding. Using modeling that incorporates climate change, First Street's risk assessment report quantifies the huge current and future number of critical facilities and road segments that would be shut down by an average flood.

**Figure 1.** Extract from Ohio River Basin Climate Change study in which West Virginia will experience greater precipitation and thus higher stream flows.

Generally, modeling results indicate a gradual increase in annual mean temperatures between 2011 and 2040 amounting to one-half degree per decade, with greater increases between 2041 and 2099 of one full degree per decade. Hydrologic flow changes show substantial variability across the ORB through the three time periods, with Hydrologic Unit Code (HUC)-4 sub-basins located northeast, east, and south of the Ohio River expected to experience greater precipitation and thus higher stream flows—up to 50% greater—during most of the three 30-year periods. Conversely, those HUC-4s located north and west of the Ohio River are expected to experience ever-decreasing precipitation (especially during the autumn season) resulting in decreased in-stream flows—up to 50% less—during the same periods.

The potential impacts to infrastructure, energy production, and both aquatic and terrestrial ecosystems over the three 30-year time periods range from minimal in some HUC-4 sub-basins to





Institute for Water Resources–Responses to Climate Change Program
Ohio River Basin Pilot Study

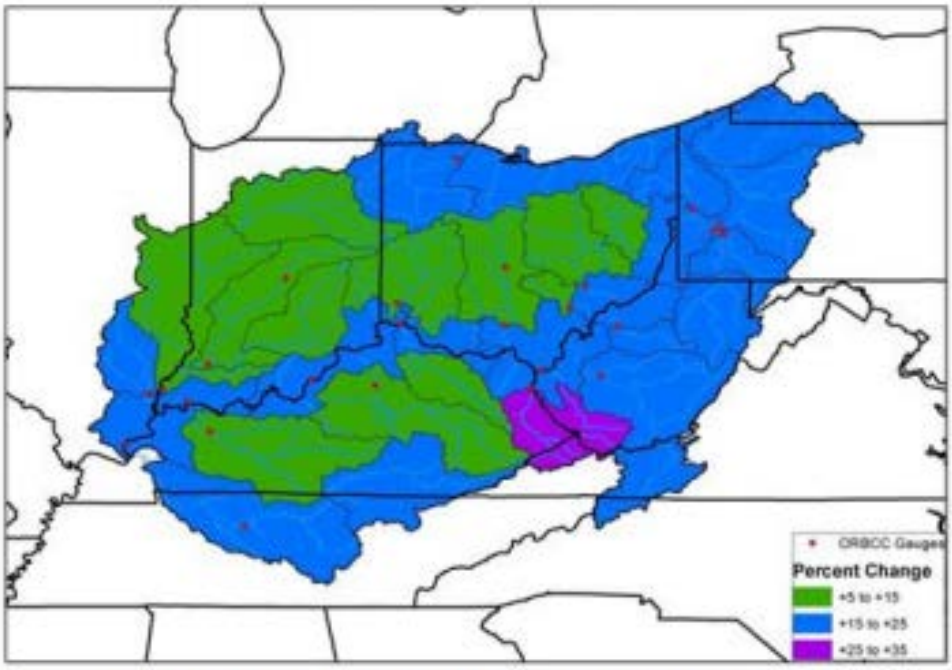



**Figure 7-4: Forecasted Annual Mean Percent Change in Streamflow (2071–2099)**

**Table 1.** 2022-23 CTP Work Tasks

| # | Task Description | 2022-23 |
|---|---|---|
| **CTP Base Funding Task A** | **[GLOBAL OUTREACH SERVICES FOR WV FLOOD TOOL]**<br><br>Statewide global outreach services that process and integrate new flood and reference GIS layers, tool enhancements, flood risk information, etc. for the WV Flood Tool (www.mapwv.gov/Flood). Services include computer programming, data development/geoprocessing, customized mapping, and technical support services. It supports new initiatives such as the WV Building Level Risk Assessment (BLRA) with FEMA's national inventory so standardized, consistent, and accessible building level information can be exchanged. Another task includes to enhance transportation flood inundation models for roads, railroads, and bridges to WV Flood Tool. This project supports disadvantaged, vulnerable communities subject to changing climate conditions in which models predict substantially higher stream flow conditions for watershed basins location south and east of the Ohio River. The WV Flood Tool and global outreach services support stakeholders in pre-disaster actions around adaptation, resilience, and mitigation. The global outreach supports FEMA's NFIP/CRS Program objectives to:<br><br>• Maintain consistent national standards while interjecting a tailored, local focus<br>• Use local data and integrate at state level to facilitate floodplain management<br>• Utilize local experience and knowledge<br>• Provide training and technical assistance<br>• Provide communities with state-based CRS credits<br>• Support Risk MAP Program Goals of Flood Hazard Data, Public Awareness and Outreach, Risk Planning, Enhanced Digital Platform, and Alignment and Synergies<br><br>*Through collaboration with Local, State, and Federal entities, the WV Flood Tool delivers quality data that increases public awareness and leads to actions that reduce risk to life and property*<br><br>To manage the wealth of available data and better communicate flood risk, the WV Flood Tool has maintained a public facing outreach tool for the public, communities, engineering/surveying companies, and others (Insurance companies, lending institutions, real estate companies) that has provided effective floodplain models, supporting datasets, water-surface elevations, floodplain boundaries, and additional enhanced flood risk information. During the past decade, the functionality and quality of data layers of the WV Flood Tool have progressed, resulting in an increased use of the application. Over time the WV Flood Tool has become more than just a flood determination tool, and today is routinely used by floodplain managers for building permit applications, floodplain regulations enforcement, pre- and post-disaster assessments, and for receiving flood insurance discount credits. For risk assessment and planning, the RiskMAP View includes structure-level risk assessments and mitigated properties to aid in flood reduction efforts. This initiative enables the website and the WV Flood Tool's global outreach program to adapt and remain relevant as both the datasets and technology continue to evolve.<br><br>Specific tasks under *global outreach services* in support of the WV Flood Tool include: | $180,000 |

**New Flood Map Products:**

- Incorporate new regulatory and non-regulatory flood hazard layers into the WV Flood Tool. Publish all the flood layers, query layers, geoprocessing layers, models, and attributes according to standardized procedures and cartographic design.

  - Effective and Preliminary National Flood Hazard Layers (e.g., Countywide RiskMAP Studies, 2016 Flood PRM Reaches in Southeastern WV)
    - Add effective or draft/preliminary NFHL, WSEL, and Flood Depth
    - Advisory Flood Heights and Base Flood Elevations
    - For Preliminary Flood Heights, in Flood Query Results Panel link Preliminary Flood Zones to FEMA's Map Changes Viewer
  - Flood Study Status Graphics
    - Active Flood Studies
    - Advisory Flood Heights
    - FEMA R3 Project Status Graphic
  - Floodplain Boundary, WSEL, Depth Layers
    - Floodplain Boundary: Advisory A Zones
    - WSEL: Advisory A Flood Heights (Advisory Base Flood Elevations)
    - Depth Grid: Model-Backed (HEC-RAS) Advisory A Depth Grids
  - Other Flood or Flood-Related Layers
    - Elevation Certificates
    - LOMAs, LOMRs (including Location-Verified LOMAs to correct parcel or structure)
    - Panel Index (GeoIndex)
    - Mitigated Buyout Properties
    - Flood Query Results Layers: Flood Zone Designation, Stream Name/Flood Source, Model Download
    - USGS High Water Marks and Stream Gages
    - H&H Hydrologic/Hydraulic Downloadable Models
    - Structure (bridges, culverts, etc.) Data Files (data files are needed)
    - Flood Manager List on WV Flood Tool

- Model-Backed Studies. The statewide Hazus depth grid created in 2010 is inaccurate and thus has a negative impact on building-level flood risk assessments and flood visualizations. Adding model-backed depth grids from flood studies improves the coverage and accuracy of the statewide depth grid, a flood risk assessment priority of attaining model-backed, gridded flood-risk depth grids for all 1-percent flood zones in West Virginia. In addition, model-backed Base Flood Height values provide important information for the Flood Query Results Panel and for processing LiDAR LOMAs using the Print Function of the WV Flood Tool. Lastly, depth grid errors associated with mapping issues identified from anomalous building level risk assessments are forwarded to Region 3 for CNMS problem area tracking.

- Follow WV GIS Technical Center's procedural guide for creating Flood Depth/Water Surface Elevation Grids and Redelineated AE Floodplains. The methodology creates a Water Surface TIN from the NHFL X-Sections, converts the WSEL TIN to a grid, and then subtracts the Ground Elevation Grid from the WSEL Grid to create the Water Depth Grid.

**Application Programming Development:**

- Execute software programming updates for desktop and mobile versions. Modify programming code of JavaScript application (www.mapwv.gov/flood) to enhance tool functions, messages, data layers, and cartography. Update flood risk information to the WV Property Search Tool, a companion product of the WV Flood Tool, to allow users to identify, for example, new structures built in flood zones. Make other tool enhancements based on requests from WV NFIP Coordinator.

  **Desktop Version:** https://www.mapwv.gov/flood
  **Mobile Version:** https://www.mapwv.gov/flood/mmap
  **Property Search and Report**: https://www.mapwv.gov/property

  - Enhance tool functions based on feedback or new opportunities. Program other application enhancements to include synchronizing with FEMA's National Flood Hazard Layer (NFHL) web services and FEMA Map Store products. Evaluate consuming NFHL web services with performance testing and other suitability measures. Program failover protocols for external web map services consumed by the Flood Tool. Enhance the WV Flood Tool to leverage the statewide building-level flood risk assessments generated from a Hazard Mitigation Grant.
  - In addition, the application programming development will include application updates to enhance tool functions, messages, data layers, and cartography.

**Update Flood Query Panel with New Flood Risk Data:**

- Develop and publish new risk assessment and mitigated layers to the WV Flood Tool, specifically
  - Mitigated Structures (wet floodproofing, dry floodproofing)
  - Elevation Certificates (focus on elevated Building Diagrams 5-8)
  - Dam Inundation Zones (for query purposes only)
  - 500-Year Depth Grids from new flood studies (both AE and A zones)

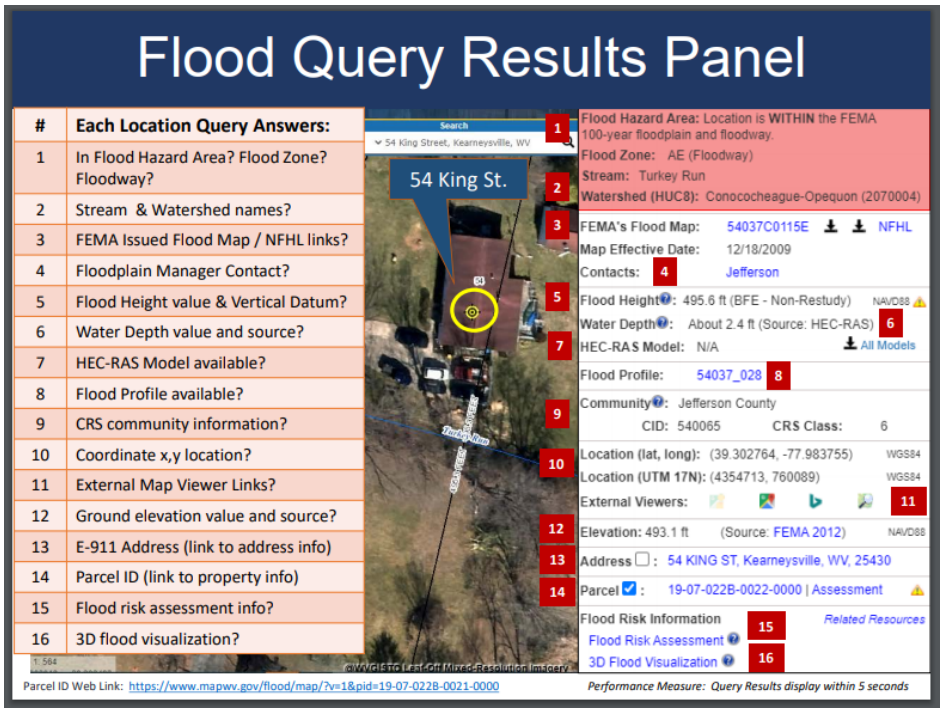
**Update Flood Query Panel with New Flood Risk Data:**

- Maintain and enhance Flood Query Results Panel with Dam Inundation Zones and 500-year flood depth values.

  - **Dam Inundation Zones:** The WV Flood Tool's query result panel for the RiskMAP View can be updated to alert a location that falls within a failed dam inundation zone. New flood inundations zones have been made available by the WV Conservation Agency and USACE for select dams. In addition, risk assessments can be done by performing an intersection between the built-up environment and flood inundation zones.
    - WV Dam Inundation Viewer of 168 High Risk Dams from the WV Conservation Agency
    - USACE Dam Inundation Viewer: https://nid.usace.army.mil/viewer/index.html
    - Summersville Dam Example: https://nid.sec.usace.army.mil/viewer/index.html?dsLibrary=NID-MD00069,NID-WV06702&x=-80.901&y=38.223&z=15

- **500-Year Flood Zone Depth Values:** FEMA's new RiskMAP studies are generating 500-year depth grids for riverine flooding. This information can be added to the RiskMAP View of the WV Flood Tool. The only way now to determine 500-year depths on the Flood Tool are by viewing the Flood Profiles of detailed studies.

  << Query Results Panel >>




**Reference Data:**

- Process and integrate new reference data to make the WV Flood Tool more accurate and current and for which communities can receive FEMA CRS credits. This task includes the publishing and caching of web map services that support the Flood Tool. The new FEMA-purchased LiDAR and derived elevation products are quite large in file size and require extensive computer processing and quality control checks before being published to the WV Flood Tool. Key reference data sets are ground elevation, parcels/assessment records, E-911 addresses, and aerial imagery.

  - HI-RESOLUTION TOGPOGRAPHIC DATA:
    - Update the WV Flood Tool with other reference layers (leaf-off aerial photography, E-911 site addresses, and property parcels/assessment records) that are essential in identifying flood risk structures with the WV Flood Tool.
    - *Accurate, high-resolution LiDAR-derived **elevation** products such as one-foot contours and one-meter DEMS that are incorporated into the WV Flood Tool are beneficial for floodplain determinations, LIDAR LOMAs, LAGs, water depth flood visualizations, flood risk studies, etc.*
  - PROPERTY PARCELS AND ASSESSMENT RECORDS: Update statewide parcel layer and assessment records to WV Flood Tool. *Accurate and current **parcels and assessment attributes** are essential to identifying flood risk structures in the WV Flood Tool*
    - Statewide Parcel Products (annual update) for Flood tool:
      - Master surface parcel file and standardized assessment attributes
      - Sketch diagrams for building identification of residential properties

- Parcel history (17 years) to search previous owners or deed book numbers. Important for improving positional accuracy of LOMAs and Buyout Properties.
  - Integrate surface parcel geometry for all 55 West Virginia counties
  - Join assessment records for commercial and residential properties for current tax year
  - Join parcels to more than 20,000 full-version tax maps
  - Coordinate parcel development with WV Property Tax Division and county assessors
  - Intersect parcels/assessment records with flood zones and classify according to risk (high, moderate, low)

- E-911 ADDRESSES: Update E-911 site and street addressing layers and address matching geocoding services for Flood Tool. *Accurate and current **E-911 site addresses** are essential to identifying flood risk structures in the WV Flood Tool.*

- AERIAL PHOTOGRAPHY: Add new 2022 leaf-off aerial photography for multiple counties to Flood Tool. Coordinate with county, state, and federal agencies through new West Virginia Orthoimagery Program. *Accurate and current **leaf-off aerial photography** is essential to identifying flood risk structures in the WV Flood Tool.*

- OTHER LAYERS: Update other reference layers (e.g., community boundaries, wetlands, public lands) that support FEMA CRS/NFIP programs and the WV Flood Tool. *Accurate and current **reference layers** are important to Communities for state-base CRS credits and for users referencing features of interest.*

- Resource Link: WV Flood Tool's Reference Layers

**Technical Services:**

Perform outreach and training services to include developing print and online educational materials, delivering presentations, administering email listserv, and participating in Flood Tool coordination meetings and data exchange with State NFIP, FEMA, USACE, NRCS, and other cooperators. Provide technical support to the Flood Hazard community like specifications (e.g., HEC-RAS downloadable model specifications) for contracts and other technical queries associated with flood and reference data. Enhance the WV Flood Tool to effectively increase flood risk communications for the public and communities. Educate and outreach to counties about submitting their locally produced address, parcel, imagery, and elevation data for inclusion in the Flood Tool.

- Technical Services include:
  - Promotional materials (flyers, videos, etc.)
  - Presentations (webinars, meetings, etc.)
  - Update content of Flood Tool launch page
  - Update listserv and contact list of community floodplain managers
  - Coordination meetings and project scoping for USACE WV Silver Jackets projects that support WV Flood Tool
  - Standardized Data Exchange
  - Instructional videos for Flood Tool and WV Building Level Risk Assessment (BLRA)
  - Updating WV Flood Tool and Flood Risk Assessment Glossary
  - Update various WV Flood Tool Resources web pages and links

| | | |
|---|---|---|
| | o Bundle FEMA and other agency risk assessment and mitigation resources for the WV floodplain management community (Permits, Elevation Certificates, Mitigation Resources, Model Floodplain Management Ordinance, etc.)<br>o 70% of WV floodplains are Approximate A Zones and not detailed studies. Identify future potential detailed studies where there are large numbers of floodplain structures in Approximate A Zone stream reaches with high flood depths (> 10 feet). See graphic.<br>o Technical support for local and state hazard mitigation plan updates. Accessed by an Index Guide spreadsheet named "RA_Info_Index.xlsx," risk assessment products include GIS layers, tables, subject reports, 3D Visualizations, and community profile risk matrices to supplement FEMA's Community Flood Risk Dashboards. | |
| **CTP Base Funding Task B** | **[WV BUILDING LEVEL RISK ASSESSMENT (BLRA) INTEGRATION WITH FEMA'S USA STRUCTURES PROGRAM]**<br><br>Over the past several years, the number of distressed counties in West Virginia has been steadily increasing. For FY 2022, West Virginia will have 17 distressed counties (most economically depressed counties) and 11 at-risk counties (counties at-risk of becoming economically distressed). Identifying and exchanging risk assessment/mitigation data at the building level is necessary to assist decision-makers supporting disadvantage communities in which devastating riverine flooding is projected to increase during this century.<br><br>Standardized structure-level information is required to support local and State hazard mitigation planning as well as other flood reduction efforts. This activity will tie in the WV Building Level Risk Assessment (BLRA) with FEMA's national inventory so standardized, consistent, and accessible building level information can be exchanged. Primary objectives of this activity include:<br><br>• Increase the 70% match rate to above 90% between the WV Flood Risk Building Inventory and FEMA's USA Structures. The WV Best Leaf-Off photography statewide coverage is the highest temporal and resolution imagery in the State. West Virginia ranks as the third most forested state in the nation and often has a dense forested canopy that makes identify structures remotely more difficult. Leaf-off imagery provides a reliable source for identifying building footprints.<br>• Collaborate on generating comprehensive building footprints with unique identifiers and complete building risk assessment attributes.<br>• Coordinate in exchanging accurate, property-level flood risk and mitigated information in an efficient manner with FEMA and other local, state, and federal partners.<br>• Collaborate specifically with Region 3 and FEMA Headquarters Geospatial Officer Chris Vaughan. | |

Comparison of current USA Structures to WV BLRA:

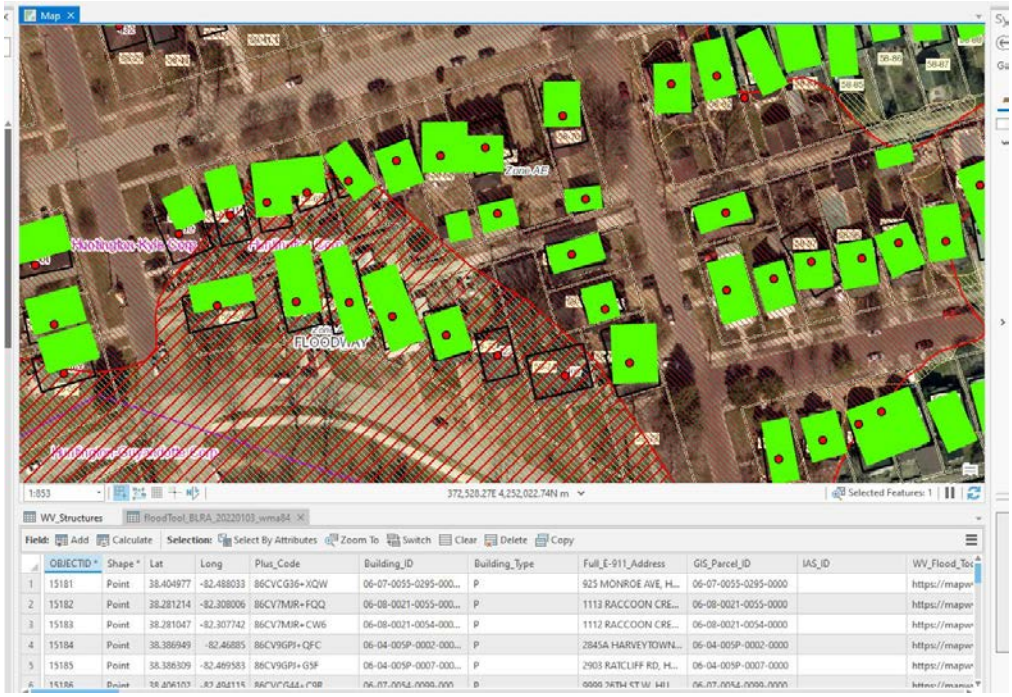
**< Current Match between USA Structures and WV BLRA >>**

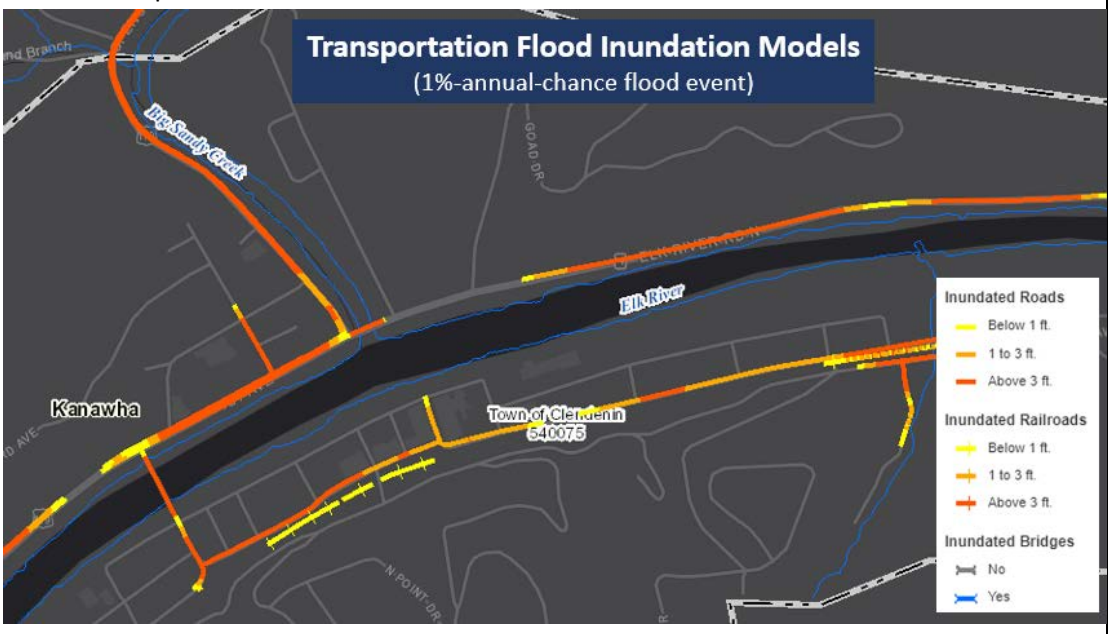
- 2021 USA Structures (for WV): 1,085,876 structure footprints
- WV BLRA: 98,467 points of primary structures located in the 1%-annual-chance floodplain
- 69,575 WV BLRA points intersect with USA Structures (70% match rate)

**<< Match between Microsoft Building Footprints and WV BLRA >>**

- 2018 Microsoft Footprints (for WV): 1,020,048 structure footprints
- WV BLRA: 98,467 points of primary structures located in the 1%-annual-chance floodplain
- 80,659 WV BLRA points intersect with USA Structures (82% match rate)
- BLRA Points that don't match lie outside of, or missing, Microsoft's building footprint outline.

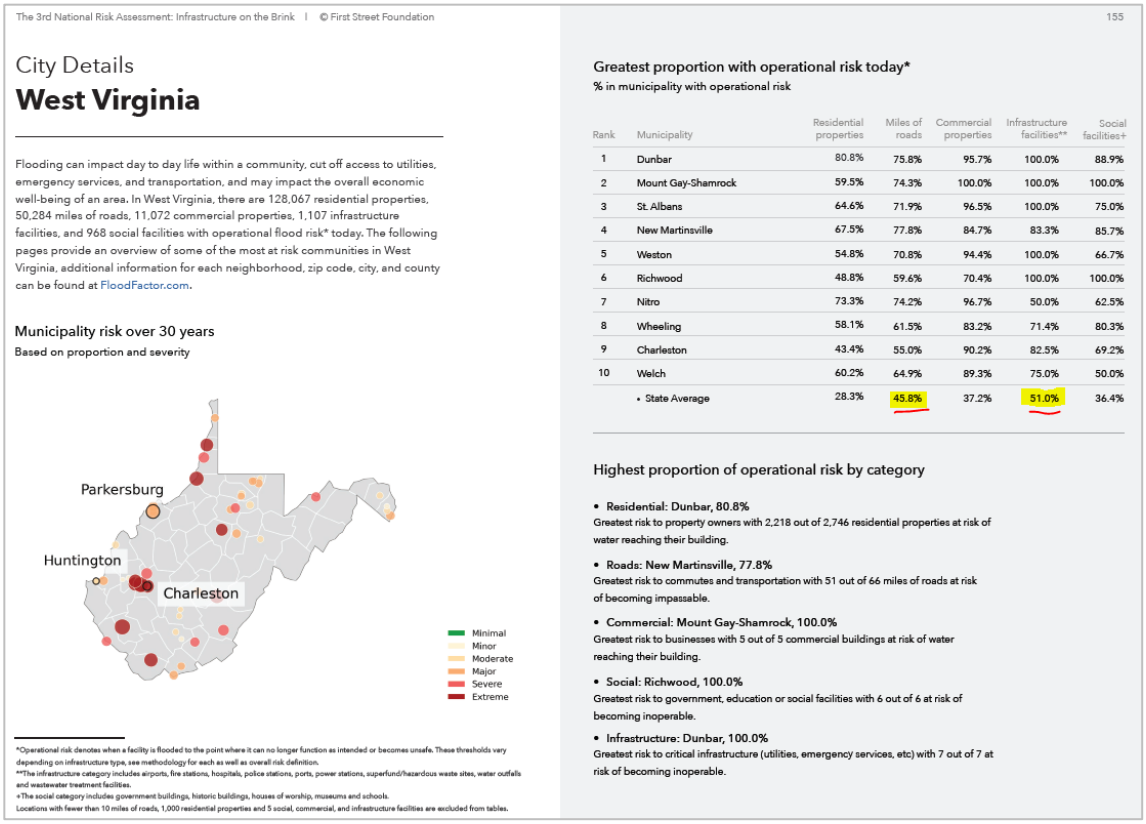
<< W BLRA Points (red) intersect with FEMA's USA Structures (green footprints). Black building outlines are Microsoft footprints. >>



| | |
|---|---|
| **CTP Base Funding Task C** | **[ENHANCE TRANSPORTATION FLOOD INUNDATION MODELS FOR ROADS, RAILROADS, AND BRIDGES TO WV FLOOD TOOL]**<br><br>In West Virginia, according to nonprofit First Street Foundation's October 2021 report titled "The 3rd National Risk Assessment: Infrastructure on the Brink," 46 percent of the roads in the state and 51 percent of the state's critical facilities — the highest state-level figures in the Nation — would be closed by flooding. Using modeling that incorporates climate change, First Street's risk assessment report quantifies the huge current and future number of critical facilities and road segments that would be shut down by an average flood. Because of the vulnerability to the State's transportation infrastructure, the WV GIS Technical Center will update and improve on its flood inundation models for roads, railroads, and bridges for a 1%-annual-chance (100 yr.) event.<br><br>Specifically, this activity will develop and publish transportation inundation models for a 1%-annual-chance flood event:<br><br>• Bridges Inundated: Use the FEMA-purchased LiDAR to identify each bridge deck elevation and then compare with available base flood elevations to determine if the bridge will be inundated by a 1%-annual-chance flood event. This activity will be conducted statewide for all major bridges from a WV DOT bridge source where base flood elevations exist.<br>• Roads and Railroads: Update existing road and railroad inundation models from new flood map restudies that produce new base flood elevations. Where no model-backed depth grids exist, substitute with the less accurate Hazus depth grid.<br>• Publish all transportation inundation models to the WV Flood Tool.<br>• Update community-level risk assessment transportation inundation reports. Communicate results of inundation models to stakeholders of hazard mitigation plan updates.<br><br><< WV Transportation Flood Inundation Model on RiskMAP View of WV Flood Tool >><br>  <br> |


<< Highest Road Flooding Risk in the Nation >>

According to the nonprofit First Street Foundation's October 2021 report titled "The 3rd National Risk Assessment: Infrastructure on the Brink," 46 percent of the roads in the state and 51 percent of the state's critical facilities — the highest state-level figures in the Nation — would be closed by flooding.



The 3rd National Risk Assessment: Infrastructure on the Brink | © First Street Foundation

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City Details

## West Virginia

Flooding can impact day to day life within a community, cut off access to utilities, emergency services, and transportation, and may impact the overall economic well-being of an area. In West Virginia, there are 128,067 residential properties, 50,284 miles of roads, 11,072 commercial properties, 1,107 infrastructure facilities, and 968 social facilities with operational flood risk* today. The following pages provide an overview of some of the most at risk communities in West Virginia, additional information for each neighborhood, zip code, city, and county can be found at FloodFactor.com.

Municipality risk over 30 years

Based on proportion and severity



*Operational risk denotes when a facility is flooded to the point where it can no longer function as intended or becomes unsafe. These thresholds vary depending on infrastructure type, see methodology for each as well as overall risk definition.
**The infrastructure category includes airports, fire stations, hospitals, police stations, ports, power stations, superfund/hazardous waste sites, water outfalls and wastewater treatment facilities.
+The social category includes government buildings, historic buildings, houses of worship, museums and schools.
Locations with fewer than 10 miles of roads, 1,000 residential properties and 5 social, commercial, and infrastructure facilities are excluded from tables.

Greatest proportion with operational risk today*

% in municipality with operational risk

| Rank | Municipality | Residential properties | Miles of roads | Commercial properties | Infrastructure facilities** | Social facilities+ |
|---|---|---|---|---|---|---|
| 1 | Dunbar | 80.8% | 75.8% | 95.7% | 100.0% | 88.9% |
| 2 | Mount Gay-Shamrock | 59.5% | 74.3% | 100.0% | 100.0% | 100.0% |
| 3 | St. Albans | 64.6% | 71.9% | 96.5% | 100.0% | 75.0% |
| 4 | New Martinsville | 67.5% | 77.8% | 84.7% | 83.3% | 85.7% |
| 5 | Weston | 54.8% | 70.8% | 94.4% | 100.0% | 66.7% |
| 6 | Richwood | 48.8% | 59.6% | 70.4% | 100.0% | 100.0% |
| 7 | Nitro | 73.3% | 74.2% | 96.7% | 50.0% | 62.5% |
| 8 | Wheeling | 58.1% | 61.5% | 83.2% | 71.4% | 80.3% |
| 9 | Charleston | 43.4% | 55.0% | 90.2% | 82.5% | 69.2% |
| 10 | Welch | 60.2% | 64.9% | 89.3% | 75.0% | 50.0% |
| | • State Average | 28.3% | 45.8% | 37.2% | 51.0% | 36.4% |

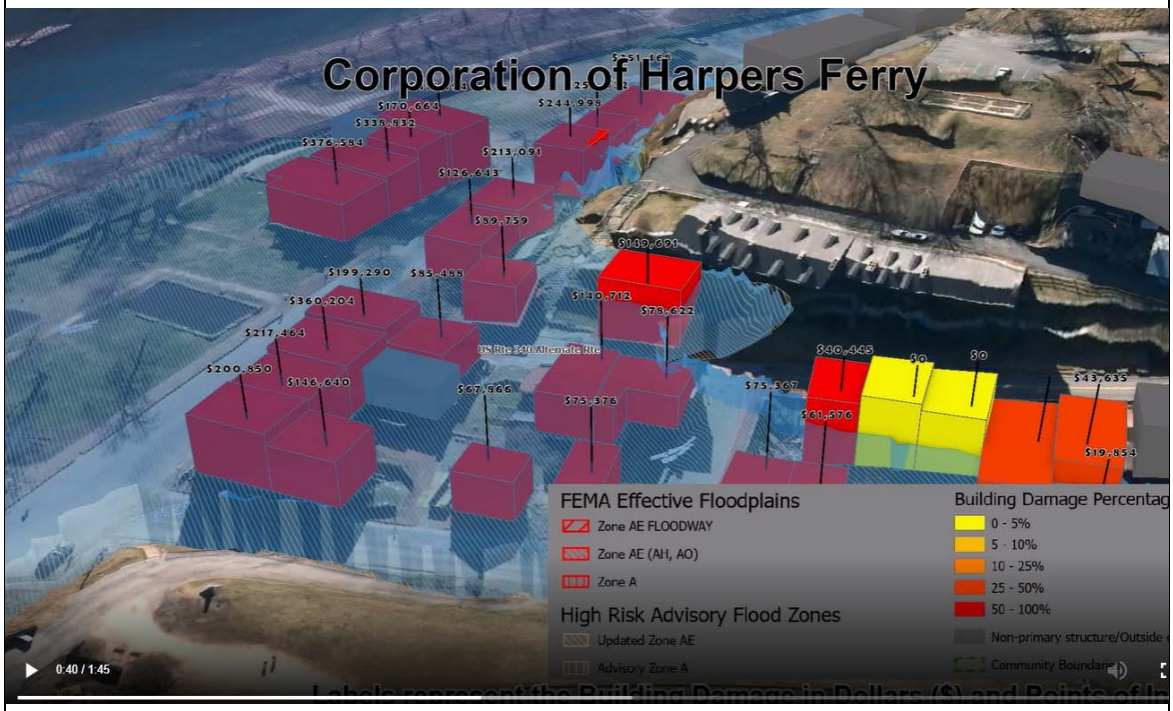
Highest proportion of operational risk by category

- **Residential: Dunbar, 80.8%**
  Greatest risk to property owners with 2,218 out of 2,746 residential properties at risk of water reaching their building.
- **Roads: New Martinsville, 77.8%**
  Greatest risk to commutes and transportation with 51 out of 66 miles of roads at risk of becoming impassable.
- **Commercial: Mount Gay-Shamrock, 100.0%**
  Greatest risk to businesses with 5 out of 5 commercial buildings at risk of water reaching their building.
- **Social: Richwood, 100.0%**
  Greatest risk to government, education or social facilities with 6 out of 6 at risk of becoming inoperable.
- **Infrastructure: Dunbar, 100.0%**
  Greatest risk to critical infrastructure (utilities, emergency services, etc) with 7 out of 7 at risk of becoming inoperable.

| | | |
|---|---|---|
| **Special Project 1** | **Map Riverine Flood Impacts of Vulnerably Disadvantaged Communities with Higher Stream Flow Change Forecast Models.**<br><br>USACE forecast models predict higher stream flows in the future for central and southern West Virginia. In addition to forecasted higher stream flows, many of the disadvantaged communities in this region have a moderate to high Social Vulnerability Index. Small, incorporated communities in which large tracts of the community are in the Special Flood Hazard Area are especially vulnerable to climate change riverine flood impacts. Many of the vulnerable communities were established in the early-20th century along narrow river valleys and steep mountainsides during the boom of coal mining and timbering extraction industries. Specifically, this project will map the riverine flood impacts of vulnerably disadvantaged communities facing higher stream flow change forecast models. The targeted five disadvantaged communities (Clendenin, Rainelle, White Sulphur Springs, Camden-on-Gauley, and Richwood) incorporate the new 2016 flood studies recently published by FEMA. Both 2D and 3D maps will show changes in the floodplain forecast models and substantial damage impact on the built environment, including critical facilities, for the following scenarios: (1) Base Flood, (2) 500-YR Flood, and (3) Climate Change Flood Model. This activity will also incorporate the largest flood disaster mitigated reconstruction dataset in the State to date since the devastating April 1977 flood of the Tug Fork Basin in which the USACE Section 202 Mitigation Program was established in 1981. Primary objectives of this project are to communicate the flood risk facing these disadvantaged communities based on current and future climate changing models, and to evaluate how various flood protection measures (e.g., elevated structures from mitigated reconstruction) implemented recently in these communities will adapt to changing environmental factors due to the impacts of climate change.<br><br>Climate Change Mapping:<br><br>• Forecast mapping models will be performed for five incorporated communities where new preliminary flood studies (PMRs - Physical Map Revisions) resulting from the June 2016 devastating flood have been completed by FEMA with the most current hydrology, high water marks, etc. The five communities of interest located in four counties are:<br>o Camden-on-Gauley (Webster County). *Chosen for high BFE increase and high substantial damage model flood estimates.*<br>o Rainelle and White Sulphur Springs (Greenbrier County). *High number of mitigation reconstruction projects.*<br>o Richwood (Nicholas County). *High number of structures in the floodway.*<br>o Clendenin (Kanawha County). *High number of mitigated reconstruction projects.*<br><br>• Incorporate Water Surface Elevation data at the following flood frequency and climate change scenarios:<br>o Base Flood: 1% Annual Chance (100-yr) WSEL<br>o 500-YR Flood: 0.2% Annual Chance (500-yr) WSEL<br>o Climate Change: 500-YR + 2 feet, or BFE + 3 feet (input from FEMA Region III). Water Surface Elevation (WSEL) and Depth Grids will be computed by redelineating the cross-sections. | |

- **Product Outputs**
  - Water Surface Elevation (WSEL) and Depth Grids for three flood scenarios: Base Flood, 500-YR Flood, and Climate Change Flood Model
  - Building flood loss damage loss estimates for all three scenarios
  - Maps will show changes in floodplain forecast models and impact on the built environment. Show degree of increased flood depths for built environment including critical facilities affected by climate change riverine models.
    - 2D/3D maps of different flood inundation scenarios
    - Build Environment statistics and visualization
  - Determine if recent mitigated reconstruction for towns like Rainelle and Clendenin will be affected by the climate change models. Generate 3D flood visualizations to communicate risk by showing:
    - Substantial damage by Base Flood, 500-YR Flood, and Climate Change Flood Model
    - 2016 Flood High Water Marks
    - Elevated Mitigated Structures
    - Critical Facilities
  - Compute Hazus substantial flood loss (damage dollar and percent) estimates to quantify degree of flooding using FEMA's Flood Assessment Structure Tool. Compare substantial damage estimates for Base Flood, 500-Year Flood, BFE+3 Climate Change Flood
  - Published Report of findings

- **3D Flood Risk Visualization Movies. Flood Risk Communications and Recommended Adaptive Measures.**
  - Develop 3D Flood Visualization with voice narration to explain risk assessment of flood model estimates. Discuss mitigated structures and recommend flood adaptive measures (e.g., build to higher flood protection standards, open space preservation) for climate change models showing areas of significant vulnerability.
  - Movie would show **substantial damage estimates** for different flood scenarios: Base Flood, 500-Year Flood, BFE+3 Climate Change Flood
  - Communicate the climate forecast models to communities for hazard mitigation and community resiliency planning
  - Communities targeted: Camden-on-Gauley, Clendenin, Rainelle, Richwood, and White Sulphur Springs
  - Mitigated Structures: Show pictures of mitigated structure in movie. If possible, include 3D view drone footage of communities with mitigated reconstruction.
  - Reference information could include June 2016 Flood high-water marks, critical facilities, mitigated structures, etc.
  - Include legend and title for viewers
  - See flood visualization movie of Harpers Ferry for basic concept

| | | |
|---|---|---|
| | << Harpers Ferry Flood Risk 3D Visualization Movie >><br>https://data.wvgis.wvu.edu/pub/RA/_resources/3Dflood/HarpersFerry_Jefferson_3D_Flood_2020_mp4.mp4<br>  <br> | |
| **Special Project 2** | **[UPDATE THE WV BUILDING LEVEL RISK ASSESSMENT (BLRA) FROM NEW FLOOD STUDIES AND STAKEHOLDER INPUTS]**<br><br>The 2018 CDC Social Vulnerability Index for West Virginia shows seven counties with high vulnerability and 22 counties with moderate to high vulnerability. These social vulnerability factors may weaken a community's ability to prevent human suffering and financial loss in a disaster. The findings of the First Street Foundation's October 2021 risk assessment report states that West Virginia's built environment of critical facilities tops all other states for being vulnerable to flooding in current and future climate changing conditions. As for the built environment susceptible to riverine flooding, it is important to update the statewide building level risk assessment when new data sources become available (new flood studies, advisory flood height mapping, mitigated structures, elevation certificates - elevated building diagrams 5-8, LOMAS, etc.) so more accurate flood loss models and risk assessment products can be published in support of the State's flood reduction activities, especially those communities which are socially vulnerable in the Sate. Updates to critical facilities and other structures of significance shall be a priority in quantifying the degree of flood risk. Benefits to communities include the continued validation of primary floodplain structures, expansion on base level risk assessment information for further hazard reduction and planning efforts, and the use of risk | $35,000 |

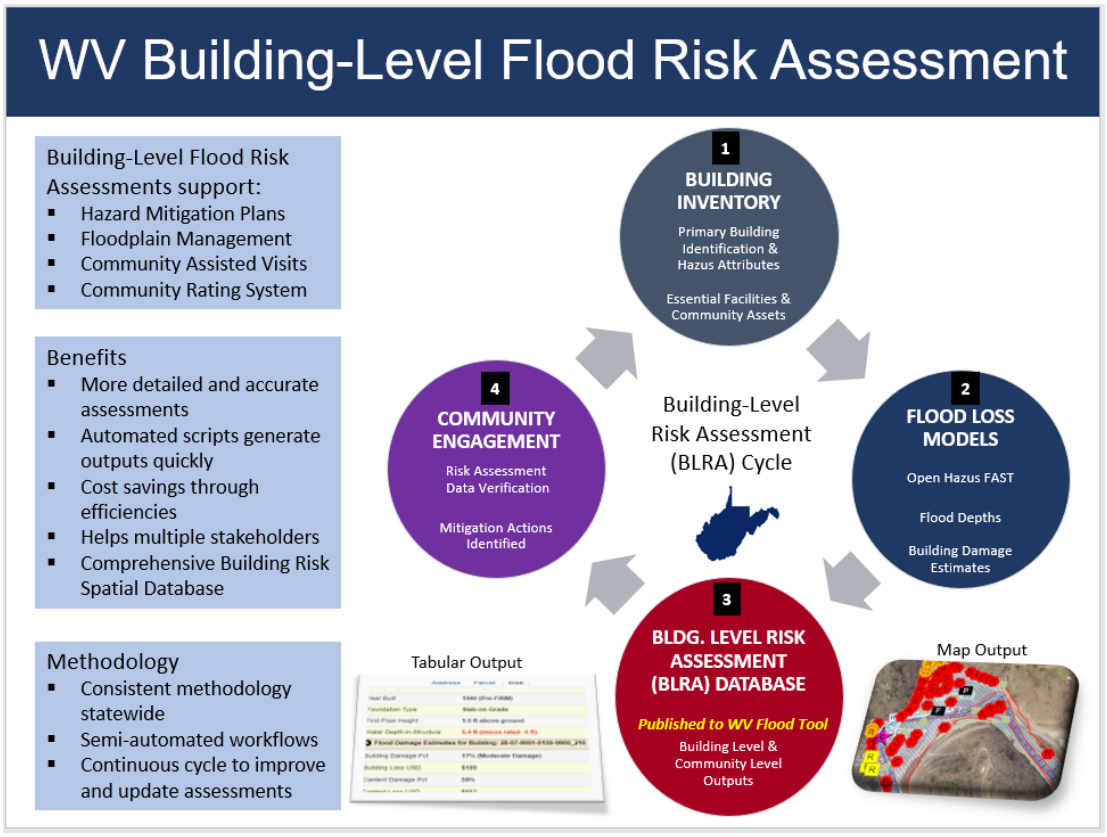
assessment information for Community Rating System (CRS) insurance discounts.

## Benefits to Communities

- Validation of primary structures in floodplain
- Expand on base level information for further hazard reduction and planning efforts
- Use risk assessment information for Community Rating System insurance discounts

*Methodology:* The statewide building-level risk assessment will be updated with building characteristics (building value, occupancy class, area, stories, etc.) from a new data pull of the statewide tax assessment database that occurs once per year. The Center will use change detection along with remote sensing (aerial imagery, building footprints) and tax assessment records (compare with previous year) methods to identify new or removed structures from the floodplain. With new input data, revise the flood loss estimates using FEMA's Flood Assessment Structure Tool (FAST). The Center will update and publish various risk assessment products for community engagement. Refer to the BLRA Cycle documents for more information.

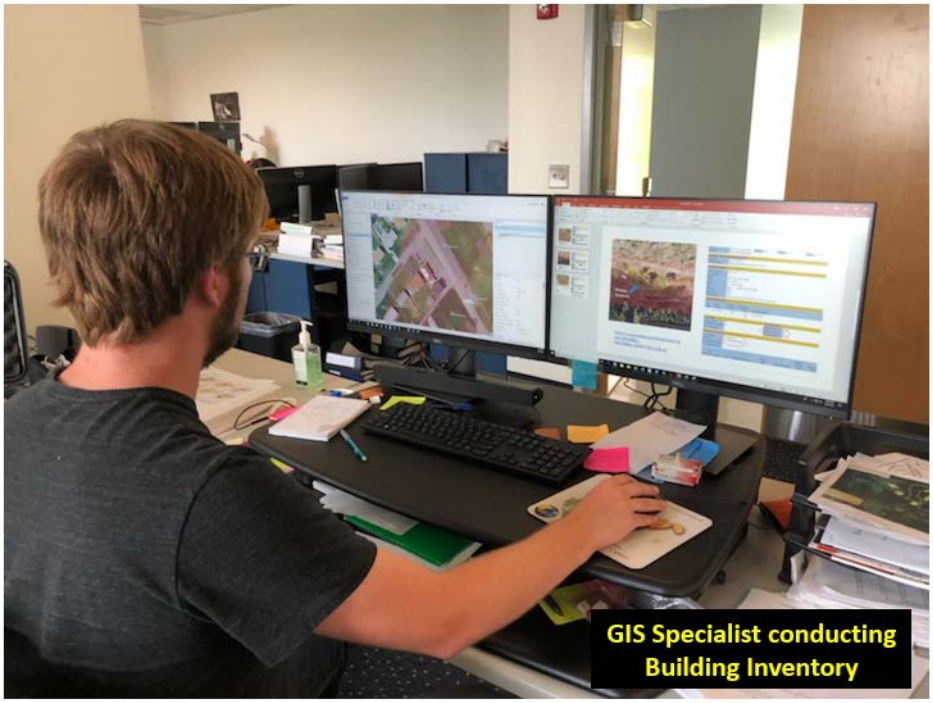
- BLRA Cycle Diagram of WV Building-Level Flood Risk Assessment procedures



The processing/validation procedures of the WV Building Level Risk Assessment (BLRA) are more accurate and comprehensive than a typical Hazus Level 2 analysis (it is a step up and should be called a Hazus Level 3). The enhanced processing and verification steps include:

- Visual aerial photography checks of every primary structure using the highest temporal and spatial resolution imagery.
- Building attribute checks by detailed tax assessment records. Customized online tax assessment web reports provide a per structure breakdown including multiple buildings (one-to-many relationship) in a single parcel. Building sketch diagrams are available for residential properties to distinguish characteristics of multiple building in a single parcel.
- Building land use codes from the tax assessment database are converted to Hazus specific/generalized occupancy classes including manufactured homes (RES2 occupancy class).
- The Building Year combined with the Initial FIRM Date determines the Pre/Post-FIRM status of each structure. (If the SFHA was not present when the structure was constructed, then a "Post-FIRM regulated to Pre-FIRM status" is tracked in the BLRA database).
- User-modified values for all Hazus input variables (Value, Occupancy Class, FFH, Area, Stories) can be entered to override building attributes compiled from tax assessment records.
- Each structure is assigned a unique Building Identifier (Parcel ID + Address) to relate structures to other risk assessment and mitigation databases. In the WV Flood Tool, the user can zoom to the structure by entering the building identifier in the Search function.

## Building Inventory

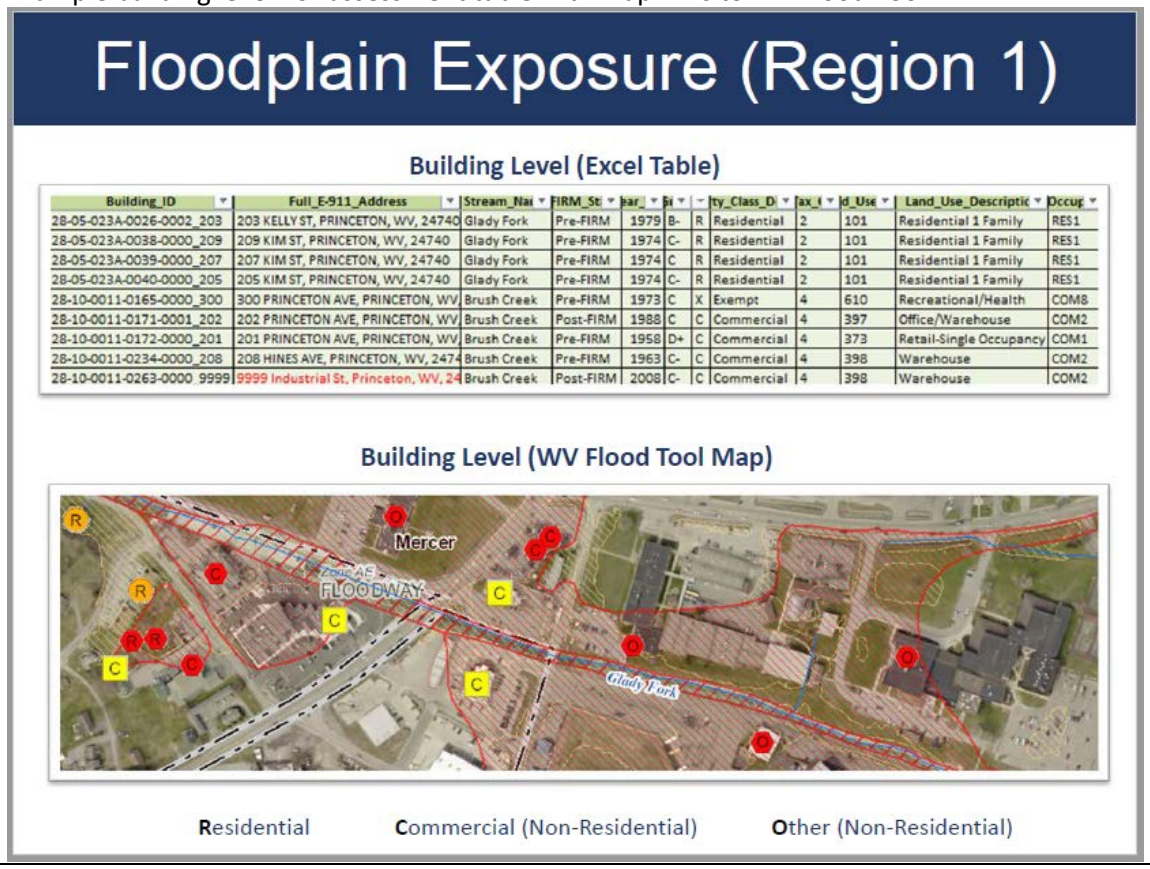


**WV Building Level Risk Assessment (BLRA) Data Sources:**

- Statewide BLRA Geodatabase (98,467 building points)
- BLRA County Files organized by WV Planning & Development Regions
- BLRA Data Extract Tables: High Building Value, High Damage Loss, High Minus Ratings
- BLRA Statewide Top Lists: Building Value, Flood Depth, Damage Loss $, Damage Loss %, Minus Rated, Mitigated Structures

*Refer to the Index Guide spreadsheet named "RA_Info_Index.xlsx" to access various risk assessment products (products, reports, tables, graphics) published in support of FEMA's Hazard Mitigation Plans and NFIP/CRS activities.*

Example building level risk assessment table with map links to WV Flood Tool




| Building_ID | Full_E-911_Address | Stream_Nai | FIRM_St | ear_ | Bi | | ty_Class_D | ax_I | d_Use | Land_Use_Descriptic | Occup |
|---|---|---|---|---|---|---|---|---|---|---|---|
| 28-05-023A-0026-0002_203 | 203 KELLY ST, PRINCETON, WV, 24740 | Glady Fork | Pre-FIRM | 1979 | B- | R | Residential | 2 | 101 | Residential 1 Family | RES1 |
| 28-05-023A-0038-0000_209 | 209 KIM ST, PRINCETON, WV, 24740 | Glady Fork | Pre-FIRM | 1974 | C- | R | Residential | 2 | 101 | Residential 1 Family | RES1 |
| 28-05-023A-0039-0000_207 | 207 KIM ST, PRINCETON, WV, 24740 | Glady Fork | Pre-FIRM | 1974 | C | R | Residential | 2 | 101 | Residential 1 Family | RES1 |
| 28-05-023A-0040-0000_205 | 205 KIM ST, PRINCETON, WV, 24740 | Glady Fork | Pre-FIRM | 1974 | C- | R | Residential | 2 | 101 | Residential 1 Family | RES1 |
| 28-10-0011-0165-0000_300 | 300 PRINCETON AVE, PRINCETON, WV | Brush Creek | Pre-FIRM | 1973 | C | X | Exempt | 4 | 610 | Recreational/Health | COM8 |
| 28-10-0011-0171-0001_202 | 202 PRINCETON AVE, PRINCETON, WV | Brush Creek | Post-FIRM | 1988 | C | C | Commercial | 4 | 397 | Office/Warehouse | COM2 |
| 28-10-0011-0172-0000_201 | 201 PRINCETON AVE, PRINCETON, WV | Brush Creek | Pre-FIRM | 1958 | D+ | C | Commercial | 4 | 373 | Retail-Single Occupancy | COM1 |
| 28-10-0011-0234-0000_208 | 208 HINES AVE, PRINCETON, WV, 2474 | Brush Creek | Pre-FIRM | 1963 | C- | C | Commercial | 4 | 398 | Warehouse | COM2 |
| 28-10-0011-0263-0000_9999 | 9999 Industrial St, Princeton, WV, 24 | Brush Creek | Post-FIRM | 2008 | C- | C | Commercial | 4 | 398 | Warehouse | COM2 |

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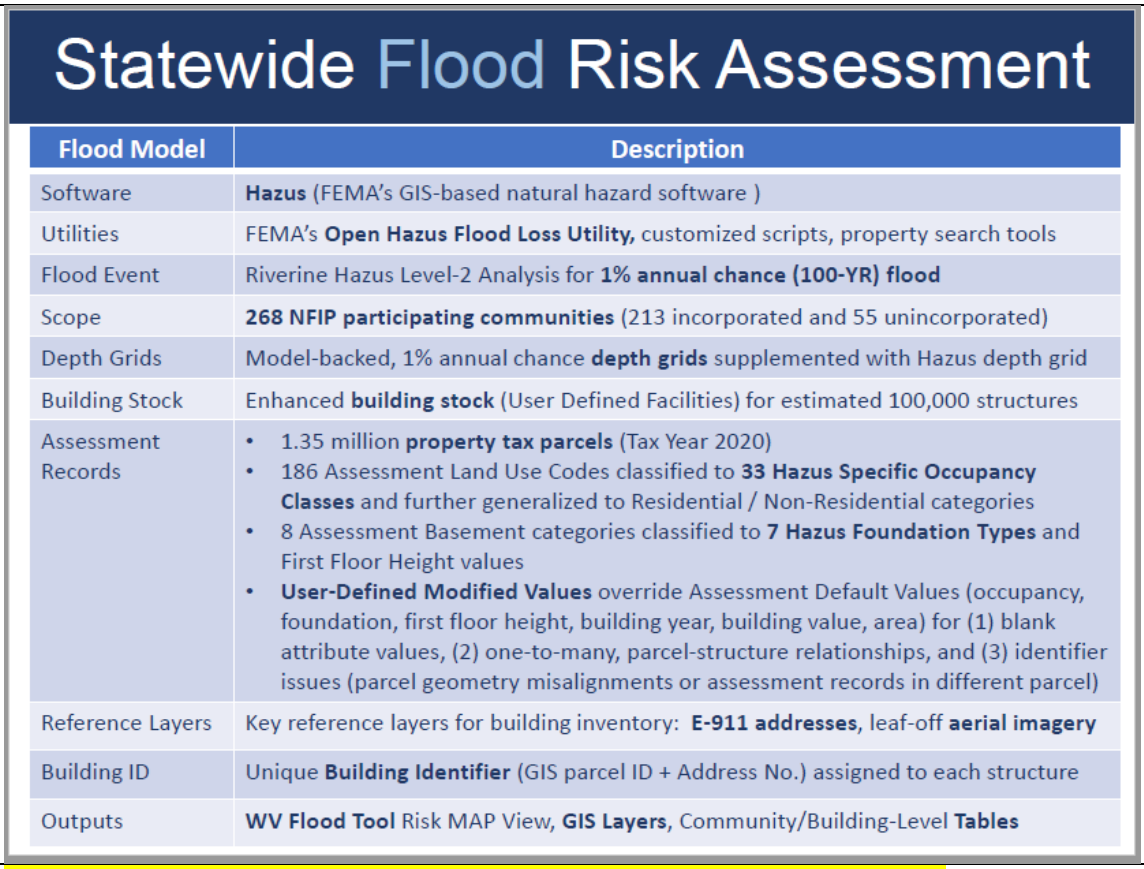


| Flood Model | Description |
|---|---|
| Software | **Hazus** (FEMA's GIS-based natural hazard software ) |
| Utilities | FEMA's **Open Hazus Flood Loss Utility,** customized scripts, property search tools |
| Flood Event | Riverine Hazus Level-2 Analysis for **1% annual chance (100-YR) flood** |
| Scope | **268 NFIP participating communities** (213 incorporated and 55 unincorporated) |
| Depth Grids | Model-backed, 1% annual chance **depth grids** supplemented with Hazus depth grid |
| Building Stock | Enhanced **building stock** (User Defined Facilities) for estimated 100,000 structures |
| Assessment Records | • 1.35 million **property tax parcels** (Tax Year 2020)<br>• 186 Assessment Land Use Codes classified to **33 Hazus Specific Occupancy Classes** and further generalized to Residential / Non-Residential categories<br>• 8 Assessment Basement categories classified to **7 Hazus Foundation Types** and First Floor Height values<br>• **User-Defined Modified Values** override Assessment Default Values (occupancy, foundation, first floor height, building year, building value, area) for (1) blank attribute values, (2) one-to-many, parcel-structure relationships, and (3) identifier issues (parcel geometry misalignments or assessment records in different parcel) |
| Reference Layers | Key reference layers for building inventory: **E-911 addresses**, leaf-off **aerial imagery** |
| Building ID | Unique **Building Identifier** (GIS parcel ID + Address No.) assigned to each structure |
| Outputs | **WV Flood Tool** Risk MAP View, **GIS Layers**, Community/Building-Level **Tables** |

</td><td></td></tr>
<tr><td>Special Project 3</td><td>[MAP LANDSLIDE INCIDENTS FROM THE NEW FEMA LIDAR FOR 38 COUNTIES].<br>Landslides are identified in the State Hazard Mitigation Plan as the #2 hazard in West Virginia. Climate change models for West Virginia that forecast heavy precipitation events for mountainous terrain with steep slopes will also result in a higher incidence of landslides. This activity will map landslides from the new FEMA-purchased LiDAR delivered in September 2021 that covers 38 counties. Landslide incidents and the type of landslide are used to generate the statewide landslide susceptibility map. The new LiDAR covers physiographic provinces in West Virginia that are most susceptible to landslide hazards. Mapped landslide incidents are published to the WV Flood Tool (RiskMAP View) and WV Landslide Tool. Landslide incidents can also be submitted to the USGS Landslide Inventory.<br><br>Resources:<br>Landslide Incidents | Landslide Susceptibility | Landslide Methodology Scholarly Paper (2020)</td><td>$15,000</td></tr>
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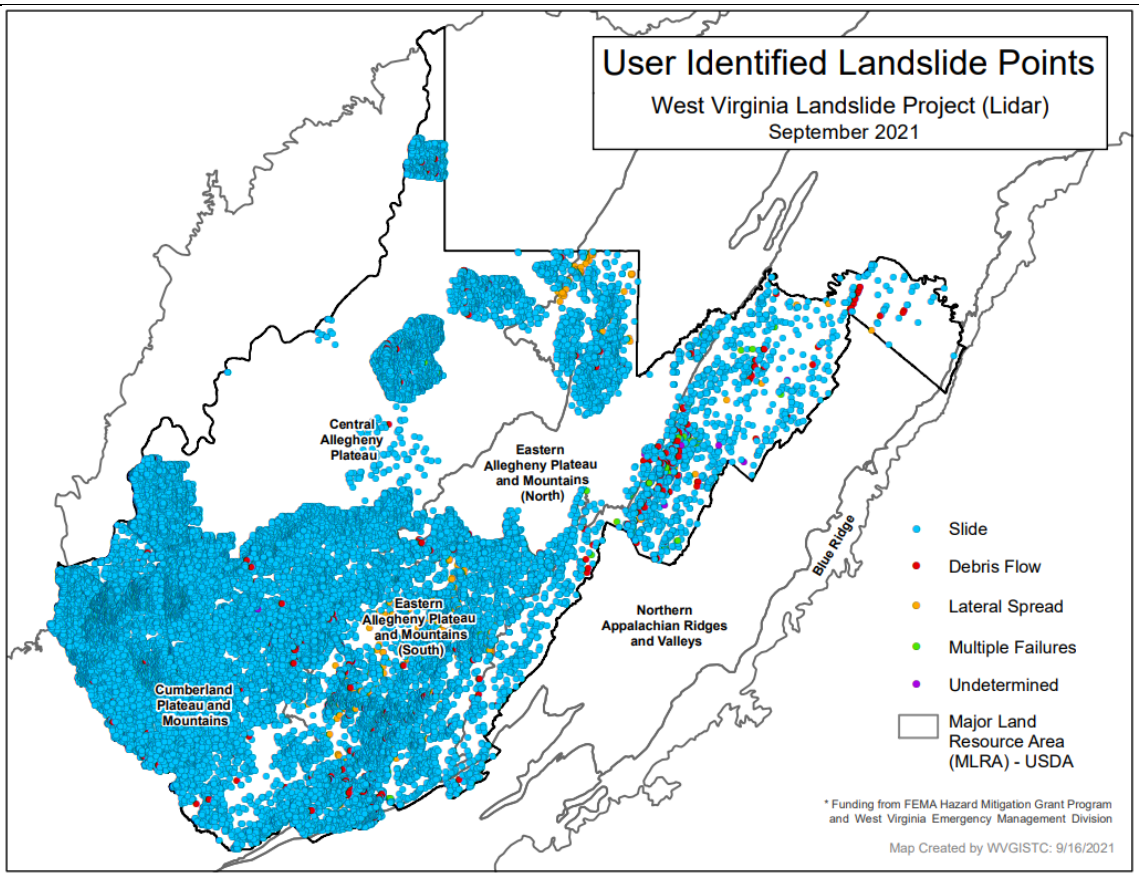
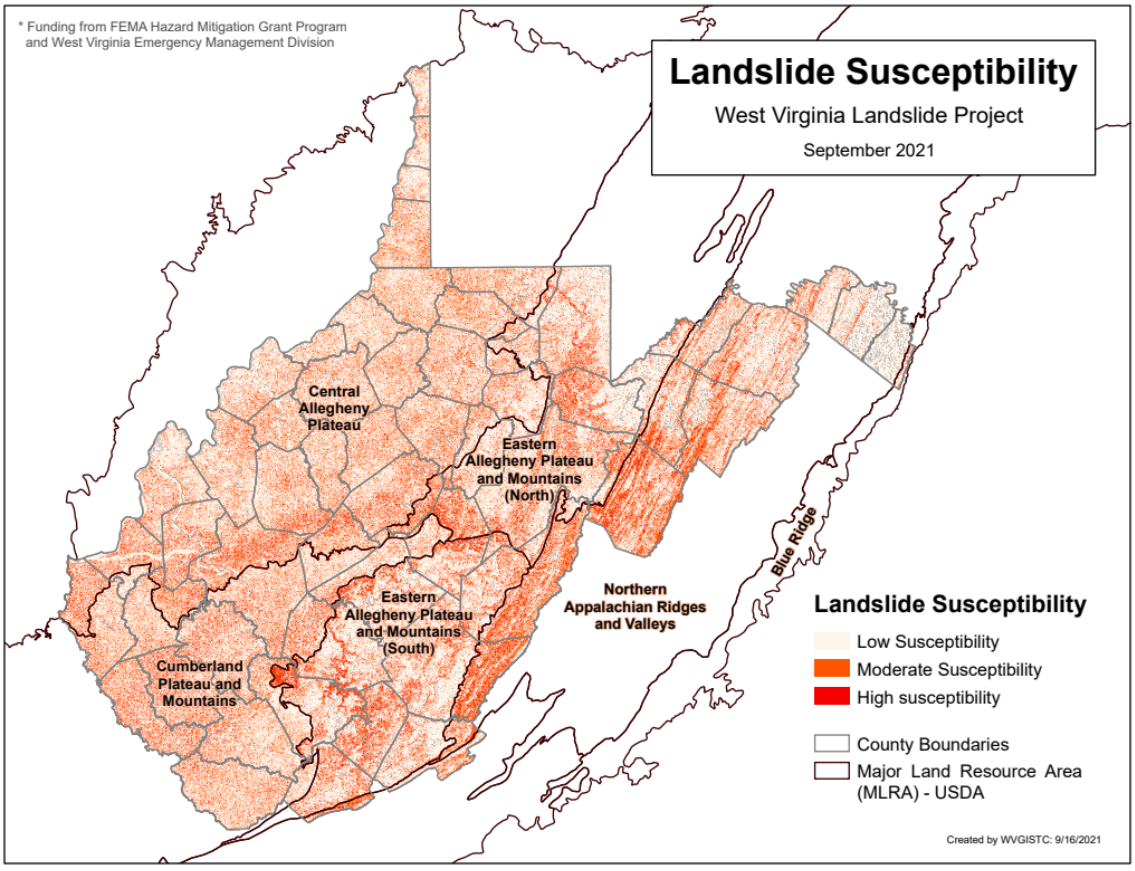
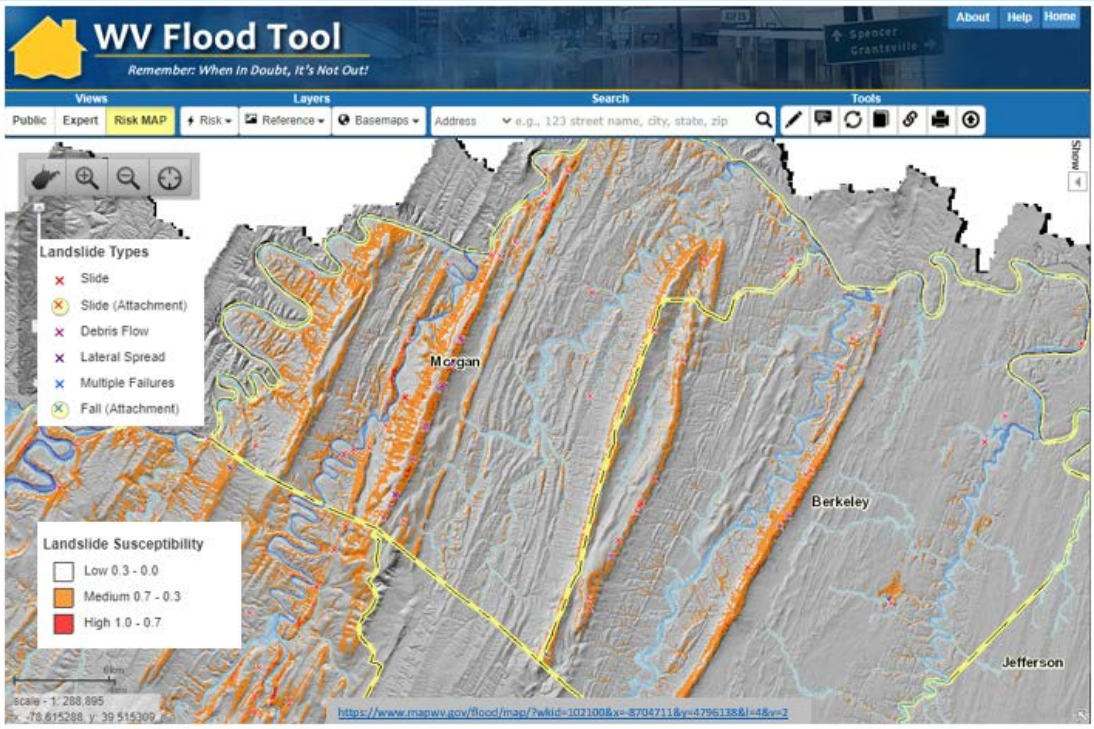
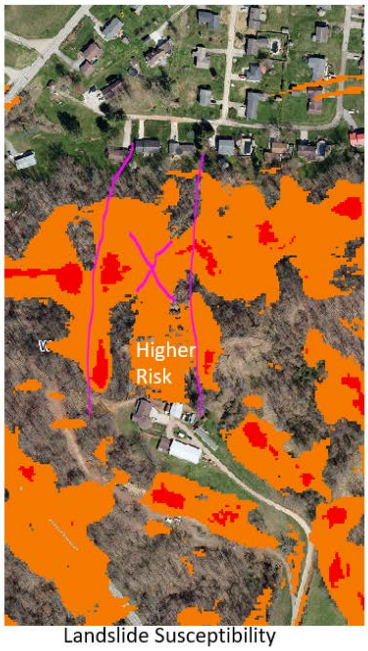

User Identified Landslide Points
West Virginia Landslide Project (Lidar)
September 2021
Central Allegheny Plateau
Eastern Allegheny Plateau and Mountains (North)
Eastern Allegheny Plateau and Mountains (South)
Cumberland Plateau and Mountains
Northern Appalachian Ridges and Valleys
Blue Ridge
Slide
Debris Flow
Lateral Spread
Multiple Failures
Undetermined
Major Land Resource Area (MLRA) - USDA
* Funding from FEMA Hazard Mitigation Grant Program and West Virginia Emergency Management Division
Map Created by WVGISTC: 9/16/2021


* Funding from FEMA Hazard Mitigation Grant Program and West Virginia Emergency Management Division
Landslide Susceptibility
West Virginia Landslide Project
September 2021
Central Allegheny Plateau
Eastern Allegheny Plateau and Mountains (North)
Eastern Allegheny Plateau and Mountains (South)
Cumberland Plateau and Mountains
Northern Appalachian Ridges and Valleys
Blue Ridge
Landslide Susceptibility
Low Susceptibility
Moderate Susceptibility
High susceptibility
County Boundaries
Major Land Resource Area (MLRA) - USDA
Created by WVGISTC: 9/16/2021

# Landslide Risk




# Landslide Susceptibility Maps




Landslide Susceptibility


Spring 2020 Aerial Imagery

April 2020
**Landslide**

Wood County

*Impacted home moved from foundation*


This Agreement supports the goals and objectives of the Cooperating Technical Partners (CTP) Program

- Enhanced Risk Assessment Data: Address gaps in flood hazard data to form a solid foundation for risk assessment, floodplain management, and actuarial soundness of the NFIP.
- Public Awareness/Outreach: Ensure that a measurable increase in the public's awareness and understanding of flood risk results in a measurable reduction of current and future vulnerability.
- Hazard Mitigation Planning: Lead and support states, and localities to effectively engage in risk-based mitigation planning resulting in sustainable actions that reduce or eliminate risks to life and property from natural hazards.
- Enhanced Digital Platform: Provide an enhanced digital platform that improves management of Risk MAP, stewardship of information produced by Risk MAP, and communication and sharing of risk data and related products to all levels of government and the public.
- Alignment and Synergies: Align risk analysis programs and develop synergies to enhance decision-making capabilities through effective risk communication and management.

| | | |
|---|---|---|
| | *Total Amount* | $280,000 |