**TECHNICAL SUPPORT DATA NOTEBOOK**

**HARDY COUNTY, WEST VIRGINIA**

**AND INCORPORATED AREAS**

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# General Documentation

General information relating to the processing of the study for Hardy County, West Virginia has been compiled and included in the following sections of this report.

## Introduction

Wood E&IS, formerly Amec Foster Wheeler, Inc., under the Architectural/Engineering Services to support Riverine Flood Hazard Analyses and Mapping Services contract for the West Virginia Department of Homeland Security and Emergency Management (WVDHSEM) was tasked to perform disaster recovery floodplain mapping throughout Hardy County to better define flood risk in both previously mapped and unmapped areas. This disaster recovery mapping effort included the development of new or revised approximate floodplain boundaries for approximately 325 miles of reach length. This refined and expanded flood hazard data would be made available to stakeholders through West Virginia’s Flood Hazard Determination Tool Website.

The information developed by Wood would also be utilized to develop enhanced flood risk communication products, such as flood depth grids which would also be made available through the WV website. This enhanced information would support both residents and public officials in better managing flood risk. Additionally, Wood will format the vector advisory approximate floodplain to be compatible with the Guidelines and Specifications for Flood Hazard Mapping Partners which will allow for a seamless incorporation into future DFRIM releases.

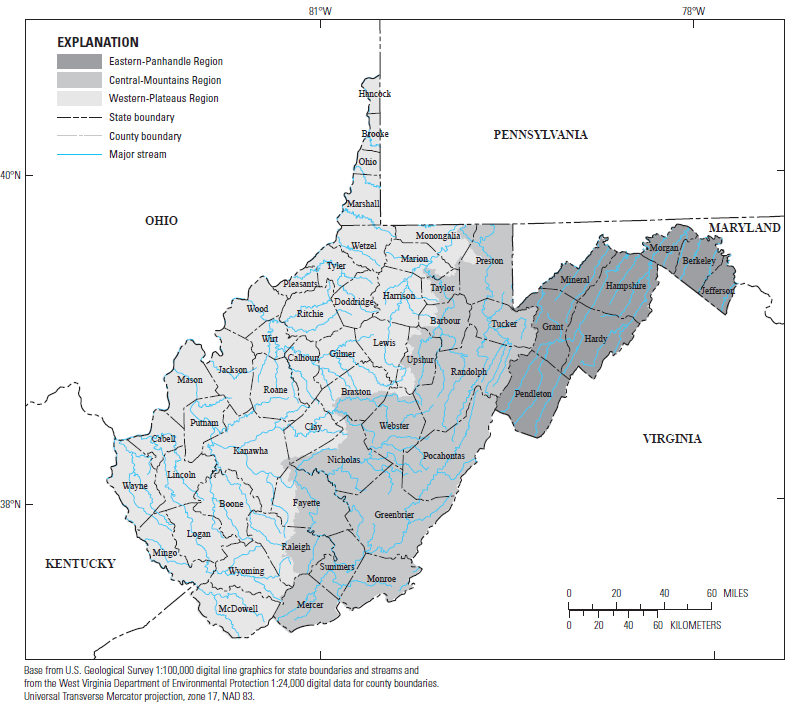
# Engineering Analysis

## Hydrology

Discharges were computed based on the United States Geological Survey’s (USGS) *Scientific Investigations Report 2010-5033 “Estimation of Flood-Frequency Discharges for Rural, Unregulated Streams in West Virginia”*, published in 2010.

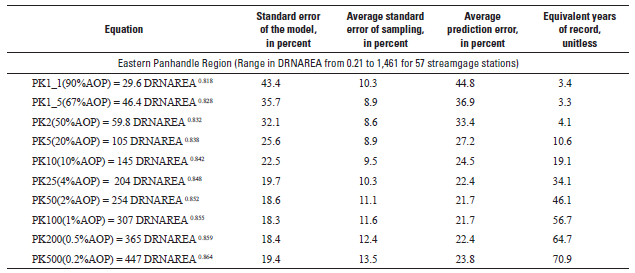
According to the report, Hardy County is located in the Eastern-Panhandle Region, as shown in Figure 1 below.

**Figure 1. West Virginia Hydrologic Regions**



The regression equations are summarized in Table 2.1.1.

**Table 2.1.1. Regression Equations (Eastern-Panhandle Region)**



The regression equation variable **DRNAREA** represents drainage area, measured in square miles.

Streamlines were digitized based on recent orthophotography as well as the best available topographic data referenced in Section 2.2.2.1. For hydrologic processing, reconditioned USGS ~30m (1 arcsecond) Digital Elevation Model (DEM) data (ortho-rectified streams supplemented with NHD data were burnt in, sinks were filled, then flow direction and accumulation grids were calculated) was utilized. Point feature data were developed at 300 feet interval (a user-specified value) along all stream centerlines designated for approximate analysis. Discharges were computed according to the regression equation for the 1% annual chance (Q100) storm event at every point, based on the drainage area computed from the reconditioned 30m DEM. Then discharges for points where gage weighting is regarded necessary per the 2010 Scientific Investigations Report were gage-weighted. The points were then filtered based on a threshold of 10% discharge change (also a user-specified value), to create the final point layer describing flow change locations throughout the County. Filtering was initiated at the downstream most point.

## Hydraulic Analyses

### Purpose of Study

FEMA tasked Wood with performing disaster recovery floodplain mapping throughout Hardy County to better define flood risk in both previously mapped and unmapped areas. Wood used approximate methods to restudy all reaches draining at least two square miles and not previously studied using detailed methods. In total, approximately 325 miles of reach length were studied and Table 2.2.1 identifies studied streams.

**Table 2.2.1 Approximate Study Stream Reaches (Hardy County)**

|  |  |  |  |  |  |
| --- | --- | --- | --- | --- | --- |
| **Flooding Source** | **Model Name** | **Reach Length (mi)** | **Flooding Source** | **Model Name** | **Reach Length (mi)** |
| Adams Run | Adams\_Run | 1.57 | Parker Hollow Run | Parker\_Hollow\_Run | 2.34 |
| Anderson Run | Anderson\_Run | 2.09 | Potlick Run | Potlick\_Run | 2.54 |
| Anderson Run Tributary 1 | Anderson\_Run\_T1 | 0.52 | Rodabaugh Run | Rodabaugh\_Run | 0.48 |
| Baker Run | Baker\_Run | 3.95 | Rohrbaugh Run | Rohrbaugh\_Run | 2.93 |
| Bears Hell Run | Bears\_Hell\_Run | 3.18 | Rohrbaugh Run Tributary 1 | Rohrbaugh\_Run\_T1 | 0.74 |
| Brake Run | Brake\_Run | 2.52 | Sauerkraut Run | Sauerkraut\_Run | 2.84 |
| Cacapon River | Cacapon\_River | 10.91 | Sawmill Run | Sawmill\_Run\_2 | 2.22 |
| Cacapon River Tributary 1 | Cacapon\_River\_T1 | 0.48 | Shooks Run | Shooks\_Run | 2.86 |
| Camp Branch | Camp\_Branch\_1 | 3.73 | Shooks Run Tributary 1 | Shooks\_Run\_T1 | 0.30 |
| Camp Branch (I) | Camp\_Branch\_2 | 2.06 | Sine Run | Sine\_Run | 1.11 |
| Camp Branch Tributary 1 | Camp\_Branch\_1\_T1 | 1.68 | Skaggs Run | Skaggs\_Run | 4.96 |
| Capon Run | Capon\_Run | 3.22 | Slate Rock Run | Slate\_Rock\_Run | 1.81 |
| Capon Run Tributary 1 | Capon\_Run\_T1 | 0.93 | South Branch Potomac River (Upper Reach) | South\_Branch\_Potomac\_River\_1 | 8.68 |
| Cove Run | Cove\_Run | 1.13 | South Branch Potomac River Tributary 3 | South\_Branch\_Potomac\_River\_1\_T1 | 1.07 |
| Crab Run | Crab\_Run | 1.46 | South Branch Potomac River Tributary 2 | South\_Branch\_Potomac\_River\_1\_T2 | 1.35 |
| Cullers Run | Cullers\_Run | 5.77 | South Branch Potomac River (Lower Reach) | South\_Branch\_Potomac\_River\_2 | 8.79 |
| Cullers Run Tributary 1 | Cullers\_Run\_T1 | 0.73 | South Branch Potomac River Tributary 1 | South\_Branch\_Potomac\_River\_2\_T1 | 4.36 |
| Dumpling Run | Dumpling\_Run | 5.65 | South Branch Potomac River Tributary 1a | South\_Branch\_Potomac\_River\_2\_T1\_1 | 2.57 |
| Dumpling Spring Run | Dumpling\_Spring\_Run | 1.87 | South Branch River Tributary 1 | Sawmill\_Run\_1 | 2.76 |
| Durgan Creek | Durgan\_Creek | 2.92 | South Fork South Branch Potomac River | South\_Fork\_South\_Branch\_Potomac\_River | 21.14 |
| Fort Run | Fort\_Run | 7.24 | Sperry Run | Sperry\_Run | 5.05 |
| Fravel Run | Fravel\_Run | 2.09 | Sperry Run Tributary 1 | Sperry\_Run\_T1 | 0.52 |
| Halfmoon Run | Halfmoon\_Run | 1.98 | Sperry Run Tributary 2 | Sperry\_Run\_T2 | 0.91 |
| Horn Camp Run | Horn\_Camp\_Run | 0.20 | Sperry Run Tributary 3 | Sperry\_Run\_T3 | 0.32 |
| Howards Lick Run | Howards\_Lick\_Run | 4.18 | Stony Run | Stony\_Run | 2.63 |
| Howards Lick Run Tributary 1 | Howards\_Lick\_Run\_T1 | 0.47 | Stony Run (I) | Stony\_Run\_3 | 4.23 |
| Hutton Run Tributary 1 | Hutton\_Run\_2 | 2.35 | Stony Run Tributary 1 | Stony\_Run\_T1 | 5.90 |
| Jenkins Run | Jenkins\_Run | 2.30 | Stony Run Tributary 1a | Stony\_Run\_T1\_1 | 1.43 |
| Kettle Creek | Kettle\_Creek | 0.25 | Stump Run | Stump\_Run | 2.43 |
| Long Lick Run | Long\_Lick\_Run | 2.17 | Three Strings Run | Three\_Strings\_Run | 1.20 |
| Long Lick Run Tributary 1 | Long\_Lick\_Run\_T1 | 1.62 | Trout Pond Run | Trout\_Pond\_Run | 2.10 |
| Lost River | Lost\_River | 31.72 | Trout Run | Trout\_Run | 16.92 |
| Lost River Tributary 1 | Lost\_River\_T1 | 3.21 | Trout Run Tributary 1 | Trout\_Run\_T1 | 7.97 |
| Lost River Tributary 2 | Lost\_River\_T2 | 0.78 | Trout Run Tributary 1a | Trout\_Run\_T1\_1 | 0.67 |
| Lost River Tributary 3 | Lost\_River\_T3 | 0.90 | Turnmill Run | Turnmill\_Run | 2.53 |
| Lost River Tributary 4 | Lost\_River\_T4 | 1.19 | Upper Cove Run | Upper\_Cove\_Run | 5.28 |
| Lower Cove Run | Lower\_Cove\_Run | 4.68 | Waites Run | Waites\_Run | 9.16 |
| Mill Gap Run | Mill\_Gap\_Run | 1.21 | Walnut Bottom Run | Walnut\_Bottom\_Run | 4.71 |
| Mitchell Run | Mitchell\_Run | 2.69 | Walnut Bottom Run Tributary 1 | Walnut\_Bottom\_Run\_T1 | 2.32 |
| Moores Run | Moores\_Run | 5.91 | Waterlick Run | Waterlick\_Run | 3.66 |
| Mudlick Run | Mudlick\_Run | 4.92 | Whetzel Hollow | Whetzel\_Hollow | 8.42 |
| Mudlick Run Tributary 1 | Mudlick\_Run\_T1 | 3.28 | Whetzel Hollow Tributary 1 | Whetzel\_Hollow\_T1 | 1.68 |
| Mudlick Run Tributary 2 | Mudlick\_Run\_T2 | 1.00 | Whetzel Hollow Tributary 2 | Whetzel\_Hollow\_T2 | 2.38 |
| North River | North\_River | 11.63 | Whitehead Run | Whitehead\_Run | 0.92 |
| North River Tributary 1 | North\_River\_T1 | 1.84 |  |  |  |

### Data Development

#### Topographic Data Source Description

Wood created a 4-foot resolution DEM by mosaicking bare earth LiDAR DEM tiles from FEMA Region 3 FY16 LiDAR project (USGS Contract G16PC00020). The LiDAR data was collected between 11/04/2016 and 04/27/2017 The mosaic was re-projected into the West Virginia State Plane North (NAD83) projected coordinate system, with both vertical and horizontal units in feet.

### Approximate Model Development

HEC-RAS (version 5.0.7) models were created using Wood-developed automated tools. For each stream, a geodatabase containing the stream centerline, bank stations, flow path locations and cross sections is created and the data is imported into a HEC–RAS model. There is a single model for each defined reach. The information below details the sources and procedure Wood used in the development of steady state hydraulic models for approximate studies in Hardy County, West Virginia.

#### Stream Layout and Cross-section Locations

Stream centerline locations were digitized within ArcGIS using recent orthophotography in conjunction with the 4-foot DEM. Streams were ortho-rectified at a reasonable scale (approximately 1:2000 and closer). Where a stream centerline could not be verified using the orthophoto, the terrain data was referenced for orientation.

#### Cross-section Geometry

Cross-sections were placed automatically at a user-defined interval and then modified based on the terrain and orthophotos. Stream stationing for each designated reach begins at its outlet. The coefficients of contraction and expansion were set to 0.1 and 0.3, respectively, for all cross sections. Where appropriate, ineffective flow stations were utilized to eliminate cross sections areas with no conveyance. Flowpaths were developed by buffering the stream centerline at a user-specified distance for the entire County. For the scope of this approximate analysis, this parameter was not adjusted following initial model development. Bank points were manually adjusted using terrain and orthophotos. Detailed channel survey data was not available for incorporation into these models and was not part of the scope for this effort.

#### Flow Data

Discharge computations were described in section 2.1 and incorporated into the hydraulic models accordingly.

#### Boundary Conditions

Normal depth was set as the boundary condition in the RAS analysis for the majority of analyzed streams. A known water-surface elevation was used as the boundary condition in the event that a reach designated for approximate analysis extended, in the upstream direction, a stream studied in detail.

#### Stream Crossings

No stream crossings were incorporated into the HEC-RAS models for these approximate analyses. Cross sections were adjusted to avoid stream crossing embankments where applicable. Some impoundments may have been approximately represented the model by placing a cross section on top of the embankment – engineering judgment was used to determine when this was appropriate.

#### Manning’s “n” Values

Manning’s “n” values were selected according to land use data. Overbanks values ranged between 0.016 and 0.12 in the overbanks. A typical value of 0.045 was used for channels.

#### Programs Used

Wood’s proprietary software, Automated Floodplain Generator (AFG), was used to create features that serve as the foundation for hydraulic models. ArcGIS version 10.2 was used throughout. The USACE’s Hydrologic Engineering Center’s HEC-RAS, version 5.0.7, was used for hydraulic analyses.

# Mapping Information

## Vertical Datum

The vertical datum for this project is NAVD 88. All flood elevation and depth values of the deliverable are in feet.

## Metadata File

Metadata files have been created for and submitted with the final deliverable dataset.

## Topographic Data

The same DEM used for hydraulic modeling as described in Section 2.2.2.1 is also used for floodplain mapping and depth and water surface grids creation.

# Miscellaneous Reference Materials

In addition to the standard FEMA deliverables consisting of revised 1% annual chance floodplain boundaries, HEC-RAS hydraulic models, and supporting GIS data, Wood also delivered enhanced flood risk communication data to be hosted on the West Virginia Flood Hazard Determination Tool website.

http://www.mapwv.gov/flood/

This information included both flood depth and flood elevation grid data. These grid data, with a cell size of 4 feet were produced for all flooding sources listed in Table 2.2.1.