FLOOD INSURANCE STUDY

GREENBRIER COUNTY, WEST VIRGINIA AND INCORPORATED AREAS

COMMUNITY NAME	COMMUNITY NUMBER
CORPORATION OF FALLING SPRINGS (TOWN OF RENICK)	540243
GREENBRIER COUNTY (UNINCORPORATED AREAS)	540040
*LEWISBURG, CITY OF	540281
*QUINWOOD, TOWN OF	540244
RAINELLE, TOWN OF	540228
RONCEVERTE, CITY OF	540043
RUPERT, TOWN OF	540044
WHITE SULPHUR SPRINGS, CITY OF	540045

*No Special Flood Hazard Areas Identified

EFFECTIVE DATE: OCTOBER 16, 2012

Federal Emergency Management Agency

FLOOD INSURANCE STUDY NUMBER
54025CV000A

NOTICE TO
FLOOD INSURANCE STUDY USERS

Communities participating in the National Flood Insurance Program have established repositories of flood hazard data for floodplain management and flood insurance purposes. This Flood Insurance Study (FIS) may not contain all data available within the repository. It is advisable to contact the community repository for any additional data.

Part or all of this FIS may be revised and republished at any time. In addition, part of this FIS may be revised by the Letter of Map Revision process, which does not involve republication or redistribution of the FIS. It is, therefore, the responsibility of the user to consult with community officials and to check the community repository to obtain the most current FIS components.

Selected Flood Insurance Rate Map panels for this community contain new flood zone designations. The flood hazard zones have been changed as follows:

Old Zones	New Zones
A1 through A30	AE
B	X
C	X

Initial Countywide FIS Effective Date: October 16, 2012

TABLE OF CONTENTS

TABLE OF CONTENTS - continued

FLOOD INSURANCE STUDY
GREENBRIER COUNTY, WEST VIRGINIA AND INCORPORATED AREAS

1.0 INTRODUCTION

1.1 Purpose of Study

This Flood Insurance Study (FIS) revises and supersedes the FIS reports and/or Flood Insurance Rate Maps (FIRMs), Flood Boundary Maps, and Floodway Maps in the geographic area of Greenbrier County, West Virginia, including the Cities of Lewisburg, Ronceverte, and White Sulphur Springs, the Towns of the Corporation of Falling Springs (Town of Renick), Quinwood, Rainelle, Rupert, and the unincorporated areas of Greenbrier County (hereinafter referred to collectively as Greenbrier County), and aids in the administration of the National Flood Insurance Act of 1968 and the Flood Disaster Protection Act of 1973. This study has developed flood risk data for various areas of the community that will be used to establish actuarial flood insurance rates. This information will also be used by Greenbrier County to update existing floodplain regulations as part of the Regular Phase of the National Flood Insurance Program (NFIP), and by local and regional planners to further promote sound land use and floodplain development. Minimum floodplain management requirements for participation in the NFIP are set forth in the Code of Federal Regulations at 44 CFR, 60.3.

Please note that the Town of Alderson is geographically located in both Monroe and Greenbrier Counties. Flood hazard information for the entire Town of Alderson is included in the Monroe County FIS report, and therefore not included in this countywide revision.

Please note that on the effective date of this study, the City of Lewisburg and the Town of Quinwood have no mapped Special Flood Hazard Areas (SFHA). This does not preclude future determinations of SFHAs that could be necessitated by changed conditions affecting the community (i.e. annexation of new lands) or the availability of new scientific or technical data about flood hazards.

In some states or communities, floodplain management criteria or regulations may exist that are more restrictive or comprehensive than the minimum Federal requirements. In such cases, the more restrictive criteria take precedence, and the State (or other jurisdictional agency) shall be able to explain them.

1.2 Authority and Acknowledgments

The sources of authority for this FIS are the National Flood Insurance Act of 1968 and the Flood Disaster Protection Act of 1973.

This countywide FIS has been prepared to include the Cities of Lewisburg, Ronceverte, and White Sulphur Springs, the Towns of the Corporation of Falling Springs (Town of Renick), Quinwood, Rainelle, Rupert, and the unincorporated areas of Greenbrier County.

Information on the authority and acknowledgments for each jurisdiction included in this countywide FIS, as compiled from their previously printed FIS reports, is shown below.

Greenbrier County (Unincorporated Areas):	The hydrologic and hydraulic analyses were prepared by Dodson-Lindblom Associates, Inc., for the Federal Emergency Management Agency (FEMA), under Contract No. EMW-84-C-1605. That work was completed in November 1985. In this revision, the hydrologic and hydraulic analyses for the Greenbrier River were prepared by the U.S. Geological Survey (USGS) for FEMA, under Inter-Agency Agreement No. EMW-88-E-2764. The work for this revised study was completed in October 1989.
Rainelle, Town of	The hydrologic and hydraulic analyses were prepared by Dodson-Lindblom Associates in preparation of the Flood Insurance Study for Greenbrier County, West Virginia, for the Federal Emergency Management Agency (FEMA). Dewberry and Davis modified the data for Sewell and Little Sewell Creeks; this work was completed in March 1986.
Ronceverte, City of:	The hydrologic and hydraulic analyses were prepared by the Huntington District of the U.S. Army Corps of Engineers (USACE) during the preparation of the Limited Map Maintenance Program for Alderson and Ronceverte, West Virginia.
White Sulphur Springs, City of:	The hydrologic and hydraulic analyses for the February 1977 FIS were prepared by the Soil Conservation Service (SCS), U.S. Department of Agriculture, for the Federal Emergency Management Agency (FEMA), under Inter-Agency Agreement No. IAA-H-9-76, Project Order No. 5. That work was completed in August 1977. For the April 15, 1992 FIS revision, the

hydrologic analyses for Howard Creek, Dry Creek, and Wades Creek were performed by the SCS. The hydraulic analyses for Wades Creek and Dry Creek were revised by the SCS, and the hydraulic analyses for Howard Creek were revised by Dobson-Lindblom Associates, Inc. Additional work on the hydraulic analyses for all three streams was performed by the Dewberry & Davis LLC. The work for the April 15, 1992 revision was completed in July 1991.

For the January 2, 2004 FIS revision, the hydrologic and hydraulic analyses for Howard Creek and Dry Creek were prepared by the West Virginia Natural Resource Conservation Service (NRCS, formerly SCS) for the city of White Sulphur Springs. This work was completed in November 1999.

There are no previous FIS reports for the City of Lewisburg, and the Towns of the Corporation of Falling Springs (Town of Renick), Quinwood, and Rupert; therefore the previous authority and acknowledgement information for these communities is not included in this FIS report.

Base map information shown on the FIRM (Exhibit 2) includes digital data obtained from the Greenbrier County GIS Department and the West Virginia Statewide Addressing and Mapping Board (WV SAMB). Corporate boundaries were provided by Greenbrier County GIS Department and road names were obtained from WV SAMB data set. The 2-foot pixel resolution natural color digital ortho-images were obtained from the WV SAMB. Adjustments were made to specific base map features to align them with the WV SAMB digital orthophotos.

The projection used in the preparation of this map was Universal Transverse Mercator (UTM) zone 17. The horizontal datum was the North American Datum of 1983 (NAD 83), GRS80 spheroid. Differences in datum, spheroid, projection or UTM zones used in the production of FIRMs for adjacent jurisdictions may result in slight positional differences in map features across jurisdiction boundaries. These differences do not affect the accuracy of this FIRM.

For this countywide FIS, no revised hydrologic and hydraulic analyses were prepared; however this revision reflects more up-to-date stream channel configurations and floodplain delineations than those shown in the previous FIRM for Greenbrier County. The redelineation of detailed flooding sources were conducted by Marshall Miller and Associates (MM&A) under Contract No. EMP-2002-GR-3653, with Region 1 Planning and

Development Council operating as the Cooperating Technical Partner. The Digital Food Insurance Rate Map (DFIMR) database and the mapping for streams studied by approximate methods were prepared for FEMA by AMEC, Earth & Environmental, Inc. under Contract No. HSFE03-07-D-0030, Task Order HSFE03-08-J-0009.

1.3 Coordination

An initial Consultation and Coordination Officer's (CCO) meeting is held typically with representatives of Federal Emergency Management Agency (FEMA), the community, and the study contractor to explain the nature and purpose of a FIS and to identify the streams to be studied by detailed methods. A final CCO meeting is held typically with representatives of FEMA, the community, and the study contractor to review the results of the study.

Greenbrier County (Unincorporated Areas):	For the September 1991 FIS report, an initial CCO meeting was held on April 16, 1984, to determine the streams to be studied by detailed methods. This meeting was attended by representatives from FEMA, the county, the Greenbrier County Commissioner, the Greenbrier County Disaster Services Director, and Dodson-Lindblom Associates, Inc. (the study contractor). Coordination with community officials, residents, newspapers, the Soil Conservation Service (SCS), the U.S. Geological Survey (USGS), the U.S. Army Corps of Engineers (USACE), the West Virginia Department of Natural Resources, The West Virginia Department of Highways, and PENTREE, Inc., provided pertinent information used in this study. On December 9, 1986, a final CCO meeting was held with representatives from FEMA, the county, and the study contractor to review the results of the study.
Rainelle, Town of	For the November 1987 FIS report, a final CCO meeting was held on December 9, 1986, with representatives from FEMA and the Town of Rainelle.
Ronceverte, City of:	For the May 1990 FIS report, the city of Ronceverte was notified on July 29, 1988, by the Federal Emergency Management Agency (FEMA) of the initiation of a Flood Insurance Study for the community. On May 11, 1989, a final CCO meeting was held with

representatives of FEMA and the city to review the results of the study.

White Sulphur Springs, City of: In the original 1978 FIS report, a search for basic data was made at all levels of government. The White Sulphur Springs city engineer provided a city map, dated September 12, 1975 from which the preliminary maps were made. The State of West Virginia, Department of Highways, provided a contour map which served as part of the hydraulic analysis, and was used to prepare the maps included with the original report. Rainfall information was obtained from the U.S. Department of Commerce, National Climatic Center. Most of this information is contained in the monthly publication entitled "Climatological Data for West Virginia." The USGS operates and maintains a continuous runoff recording gage on Howard Creek at Caldwell. This gage information was obtained from the USGS. Survey bench marks elevations were also obtained from the USGS. Much of the basic data used in preparing the 1978 FIS was developed by the SCS for use in planning a watershed protection and flood prevention project for the entire Howard Creek Watershed under authority of Public Law 83-566. Use of basic data developed for the flood prevention project was coordinated with those sponsors for use in the FIS for the city of White Sulphur Springs. Several CCO meetings were held with representatives of the City of White Sulphur Springs, FEMA, the SCS, and interested citizens during the course of the 1978 FIS. The first meeting was held on November 3, 1975, to determine study areas and to discuss the NFIP. Information obtained at this meeting was used to estimate the time and cost of conducting the study. The second CCO meeting was held on June 7, 1976, to formally initiate the study, discuss survey permission, and to reaffirm study areas. At this meeting, it was agreed that a portion of Wades Creek and Dry Creek, which is within the future annexation boundary of the City of White Sulphur Springs, would be included in the detailed study area. The final

CCO meeting was held on July 27, 1977, in White Sulphur Springs City Building. Presentations of the FIS were made by FEMA and the SCS. The preparations for, and the conduct of, the meeting were in conformance with NFIP guidelines. Local citizens asked several questions about the report. These questions were answered to the satisfaction of all concerned by the study contractor, the SCS. All problems discussed were resolved at the meeting.

For the 2004 FIS revision for the City of White Sulphur Springs, an initial CCO meeting was held on November 16, 1999, and a final CCO meeting was held on December 12, 2002. Both of these meetings were attended by representatives of the City of White Sulphur Springs, NRCS, and FEMA.

The dates of the initial and final CCO meetings held for the incorporated communities within the boundaries of Greenbrier County are shown in the following tabulation:

TABLE 1 – INITIAL AND FINAL CCO MEETINGS

Community Name	Initial CCO Date	Final CCO Date
Greenbrier County, (Unincorporated Areas)	April 16, 1984	December 9, 1986
Rainelle, Town of	*	December 9, 1986
Ronceverte, City of	July 29, 1988	May 11, 1989
White Sulphur Springs, City of	November 3, 1975	
	June 7, 1976	July 27, 1977
	November 16, 1999	December 12, 2002

For this countywide study, Greenbrier County and the Cities of Lewisburg, Ronceverte, and White Sulphur Springs, and the Towns of the Corporation of Falling Springs (Town of Renick), Quinwood, Rainelle, and Rupert were notified by phone in July 2008 that the FIS would be updated and converted to countywide format.

For this countywide study, a final CCO meeting was held on November 15, 2011, and was attended by representatives of Greenbrier County, the State, FEMA and the study contractor.

2.0 AREA STUDIED

2.1 Scope of Study

This Flood Insurance Study report covers the geographic area of Greenbrier County, West Virginia, including the incorporated communities listed in Section 1.1. The areas studied by detailed methods were selected with priority given to all known flood hazards and areas of projected development or proposed construction though Greenbrier County.

All or portions of the flooding sources listed in Table 2, "Flooding Sources Studied by Detailed Methods," were studied by detailed methods. Limits of detailed study are indicated on the Flood Profiles (Exhibit 1) and on the Flood Insurance Rate Map (FIRM). For purposes of this study, the detailed analysis for Sewell and Little Sewell Creeks were treated as one stream and will be referenced as Sewell Creek/Little Sewell Creek (Reference 16).

TABLE 2 – FLOODING SOURCES STUDIED BY DETAILED METHODS

Dry Creek	Meadow River
Greenbrier River	Sewell Creek/Little Sewell Creek
Howard Creek	Wades Creek

The areas studied by detailed methods were selected with priority given to all known flood hazard areas and areas of projected development and proposed construction at the time of the original study.

All or portions of the following streams listed in Table 3, "Flooding Sources Studied by Approximate Methods," were studied by approximate methods.

TABLE 3 – FLOODING SOURCES STUDIED BY APPROXIMATE METHODS

Anthony Creek	Little Laurel Creek
Bear Run	Little Roaring Creek
Beaver Creek	Little Sewell Creek
Becky Run	Long Branch
Beech Run	Maple Branch
Big Clear Creek	McMillion Creek
Big Rocky Run	Meadow Creek
Boggs Creek	Meadow River
Boggs Run	Methodist Branch
Brown Creek	Middle Branch
Bruffman Branch	Mill Branch
Buffalo Creek	Mill Creek
Burdette Creek	Morris Fork
Burns Run	Muddy Creek
Callahan Branch	North Fork Anthony Creek
Coats Run	North Fork Cherry River
Cold Knob Fork	Old Field Branch

TABLE 3 – FLOODING SOURCES STUDIED BY APPROXIMATE METHODS
(continued)

Culbearson Creek	Otter Creek
Dry Creek	Peaser Branch
Eagle Branch	Piney Creek
Elijah Branch	Renick Creek
Fleming Run	Roaring Creek
Flynn Creek	Robbins Run
Greenbrier River	Sam Creek
Harts Run	Second Creek
Hinton Branch	Sewell Creek
Hogcamp Run	Sinking Creek
Hominy Creek	Smoot Branch
Howard Creek	Snake Run
Hughart Creek	South Fork Big Clear Creek
Hunters Run	South Fork Cherry River
Indian Creek	Spring Creek
Job Knob Branch	Spruce Run
Kitchen Creek	Stony Run
Kuhn Branch	Sulphur Lick Run
Lake Sherwood	Summit Lake
Laurel Creek	Toms Creek
Laurel Run	Tuckahoe Run
Linn Branch	Wades Creek
Little Cedar Creek	Walton Run
Little Clear Creek	Wolfpen Creek
Little Creek	

Approximate methods of analysis were used to study those areas having low development potential and minimal flood hazards as identified at the initiation of the study.

This countywide FIS incorporates the determinations of Letters of Map Revisions (LOMRs) issued by FEMA. These LOMRs are presented in Table 4, "Letters of Map Revision (LOMRs)."

TABLE 4 – LETTERS OF MAP REVISION (LOMRs)

LOMC	Case Number	Effective Date	Project Identifier
LOMR	07-03-0022P	07/30/2007	Greenbrier Sporting Club – Howard Creek
LOMR	07-03-1035P	08/30/2007	Greenbrier Sporting Club - Howard Creek

2.2 Community Description

Greenbrier County is located in the western portion of West Virginia. It is bordered by the unincorporated areas of Pocahontas County to the northeast; the unincorporated areas of Webster County to the north; the unincorporated areas of Nicholas County to the northwest; the unincorporated areas of Fayette County to the west; the unincorporated areas of Summers County to the southwest; the unincorporated areas of Monroe County to the south; and the unincorporated areas of Bath County and Alleghany County, Virginia, to the east.

Greenbrier County is the second largest county in West Virginia, with 1,021 square miles and was created in March of 1778 from portions of Montgomery and Botetourt counties (Virginia) and was named for its primary river. The population for Greenbrier County as determined by the 2000 Census was 34,453 and the 2010 Census population was 35,480, an increase of 3.0% (Reference 38).

Greenbrier County is heavily forested and mountainous with most communities located in the stream valley bottoms. Agriculture, tourism, lumber, coal, and stone extracting and processing are the principal industries. Most residences and businesses are located in the larger communities although significant development of residences has proceeded in some unincorporated areas of the floodplains.

Stream beds in this area are on resistant rock and are very steep; stream slopes above the City of White Sulphur Springs are in excess of 50 feet per mile and 16 feet per mile below the city. Stream slopes are approximately 2 feet per mile on Sewell Creek/Little Sewell Creek.

Greenbrier County has been referred to as the Land of Karst. The eastern portion of the county has one of the world's densest karst stratas (Reference 46). Carbonate rocks have a surface outcrop area of about 1,000 square miles which represents about 4% of the state. However the number and length of caves is much higher than this number would suggest, and the area is a prolific source of underground aquifers (Reference 47). Approximately 15% of its terrain is dominated by karst as shown in the West Virginia State Geologic Map (Reference 48).

The climate of Greenbrier County is classified as continental. Such a climate is characteristic of a land mass the size of North America and is marked by large annual, daily, and day-to-day ranges of temperature. Summers are moderately warm and humid while winters are reasonably cold and cloudy. Weather changes occur every few days from the passing of cold or warm fronts and their associated centers of high and low pressure.

Winters are cold and snowy at the higher elevations in Greenbrier County. They are also cold in the valleys, but intermittent thaws preclude a long-lasting snow cover. Summers are fairly warm on mountain slopes and very warm with occasional very hot days in the valleys. Rainfall is evenly distributed during the year, but it is appreciably heavier on the windward, west-facing slopes than in the valleys. Normal annual precipitation is adequate for all crops, although summer temperatures and the length of the growing season, particularly at the higher elevations, may be inadequate.

The divide of the Allegheny Mountains, the main topographic barrier of the Eastern Allegheny Plateau and Mountains resource area, runs through the county, directly west of center, and forms a “rain shadow” that shelters the eastern portion of the county from the prevailing storm systems that move from northwest to southeast. For this reason, climate data recorded in the western part of the county will show lower average temperatures and higher average precipitation than the data recorded at Lewisburg in the eastern part of the county.

In winter, the average temperature is 33.1 degrees F and the average daily minimum temperature is 23.0 degrees. The lowest temperature on record, which occurred on December 23, 1989, is -22 degrees. In summer, the average temperature is 69.7 degrees and the average daily maximum temperature is 81.7 degrees. The highest recorded temperature, which occurred on July 17, 1988, is 98 degrees.

The total annual precipitation is about 40.60 inches. Of this, 18.4 inches, or 45 percent, usually falls in May through September. The growing season for most crops falls within this period. The heaviest 1-day rainfall during the period of record was 4.06 inches on July 19, 1954. Thunderstorms occur on about 47 days each year, and most occur in July.

The average seasonal snowfall is about 28.5 inches. The greatest snow depth at any one time during the period of record was 33 inches recorded on January 12, 1996. On the average, 19 days of the year have at least 1 inch of snow on the ground. The heaviest 24-hour snowfall on record was 20 inches recorded on April 3, 1901, and again on March 14, 1993 (Reference 45).

The Corporation of Falling Springs (Town of Renick) is a town in Greenbrier County. The population as determined by the 2010 Census was 211 (Reference 38).

The City of Lewisburg, nestled in the heart of the Greenbrier Valley, is the county seat. (Reference 41) The population for the City of Lewisburg as determined by the 2010 Census was 3,830 (Reference 38).

The Town of Quinwood was laid out in 1921, but not incorporated until 1947. It was named for Quin Morton and Walter Wood, then prominent coal operators (Reference 40). The population for the Town of Quinwood as determined by the 2010 Census was 290 (Reference 38).

The Town of Rainelle is located in the western part of Greenbrier County in southeastern West Virginia. The town is completely surrounded by unincorporated areas of Greenbrier County. The population for the Town of Rainelle as determined by the 2010 Census was 1,505 (Reference 38).

The City of Ronceverte is located in the southern portion of Greenbrier County, in southeastern West Virginia. It is bordered on all sides by the unincorporated areas of Greenbrier County. The city had a population of 2,312 in 1980 (Reference 26). The population for the City of Ronceverte as determined by the 2010 Census was 1,765 (Reference 38).

The Town of Rupert is one of the older settlements in Greenbrier County. It was founded by and named for Dr. Cyrus A. Rupert, and was incorporated on December 31, 1945 (Reference 40). The population for the Town of Rupert as determined by the 2010 Census was 942 (Reference 38).

The City of White Sulphur Springs is located in the southeastern part of West Virginia in Greenbrier County. The city is surrounded by the unincorporated areas of Greenbrier County.

According to the 2010 U.S. Census, the population of the city was 2,444 (Reference 38). The business district is located along U.S. Route 60, adjacent to Howard Creek. The largest residential area is located along the Howard Creek floodplain from Maple Avenue downstream to the Greenbrier Hotel property. This area contains about 190 family residences. Another major residential area is located on the Dry Creek floodplain, upstream from U.S. Route 60.

The Howard Creek drainage area upstream from White Sulphur Springs is similar to the rugged topography of the Southern Appalachian Ridges and Valleys. The drainage area is characterized by steep mountains rising to heights of over 1,200 feet above the narrow floodplains. Elevations range from 1,840 to 3,300 feet. Streams flowing through the floodplains are relatively steep, averaging between 100 and 150 feet per mile of stream length.

The major geologic structure of the area is the Browns Mountain Anticline. This structure forms the valley floor of Howard Creek. Bedrock along the anticline consists of sedimentary rocks - primarily sandstone, shale and limestone. The harder sandstone and limestone formations are responsible for the steep, rugged topography of the area.

The major surface soil association is the Weckert-Berks-Ernest association. These soils are normally shallow to moderately deep, droughty, infertile, and have slow infiltration fates when thoroughly wet. These soils are susceptible to severe erosion and high rates of runoff if not protected by adequate vegetative cover.

The moderate climate and abundance of rainfall produces good vegetative cover throughout the watershed. Vegetation is typical of the northern temperature zone, consisting mainly of northern hardwoods, including oak, hickory, and tulip poplar. Some Virginia and white pine occur in mixed stands. About 86 percent of the drainage areas contributing to flooding of the city is forested. About 7 percent is in grasses used for pastures and hay land. The remaining area has been developed for homes and businesses but, even in the developed areas, trees, shrubs, and grasses are abundant.

The combination of mountain terrain, shallow soils, narrow valleys, steep stream gradients, and urbanized floodplains creates conditions conductive to high damage-producing floods, despite good vegetative cover.

2.3 Principal Flood Problems

Hurricane generated rainfall and rapid spring snowmelt have been the principal causes of flooding. The flood of November 4-5, 1985, replaced the 1977 flood as the most devastating in the State. The remnants of Hurricane Juan, an intense, slow-moving, upper level, low-pressure trough moving eastward over the Ohio Valley, a high-pressure ridge over the eastern seaboard, and a low-level jet stream carrying large quantities of moisture from the Gulf of Mexico combined to form a storm that devastated sections of West Virginia. Forty-seven lives were lost, thousands were left homeless, and about 500 bridges were destroyed. Rainfall estimates for the 2-day storm were as much as 20 inches along the Eastern Divide between the Ohio River and Potomac River drainages in eastern West Virginia and western Virginia (Reference 43).

A strong storm system on the 19th of January, 1996, produced high winds, damaging thunderstorm winds and heavy rainfall. Snow melt in combination with the heavy rain resulted in flash flooding and then river flooding on most rivers. Record flooding occurred on portions of the Greenbrier River. Heavy rainfall and significant snow melt resulted in flash flooding which heavily damaged the public facilities at the Blue Bend Recreation Area near White Sulphur Springs, damaged several mobile homes near Rupert, washed out route 92 in three locations in Greenbrier County. Thunderstorm winds downed several trees in Renick. Heavy rain and snow melt resulted in major to record flooding on portions of the Greenbrier River. The Greenbrier River crested 6.5 feet above flood stage at Renick at 1800 EST on the 19th. The Greenbrier River at Alderson crested at a record 24.53 feet at 0500 EST on the 20th. This crest was 10.53 feet above flood stage and .58 feet above the previous record flood of 11/05/85. The City Hall at Ronceverte was flooded by nearly 7 feet of water from the Greenbrier River. The building sustained substantial damage. A temporary City Hall was established in the old junior high gymnasium building. Flash flooding and flooding damaged 40 businesses and 152 houses in Ronceverte. Around 150 people were evacuated and sought shelter in Greenbrier County. In Greenbrier County, 832 structures, 1 school and 4 churches were damaged or destroyed in the flash flooding and flooding (Reference 39).

Moderate to heavy rainfall late occurred on November 18 and through November 19, 2003. Significant flash flooding occurred along many streams and creeks throughout the county. The flooding damaged or destroyed hundreds of homes (Reference 39).

Flash flooding occurred on January 25, 2010, which was the highest level of flooding on the Greenbrier River in the past 15 years. Abundant rain advanced north into the region in advance of an area of low pressure to the west while a frontal boundary remained draped over the region. An average of 2 to 5 inches of rain fell from this system onto an already saturated ground from recent snow melt and rainfall. The heavy rain contributed to widespread flash flooding, mudslides, areal flooding, and river flooding (Reference 39).

The only major flood problem within the Town of Rainelle is the flooding along Sewell Creek/Little Sewell Creek.

There are four U.S. Geological Survey (USGS) gages located on the main stem of the Greenbrier River: at Durbin, No. 03180500 (Pocahontas County); at Buckeye, No. 03182500 (Pocahontas County); at Alderson, No. 03183500 (Monroe County); and at Hilldale, No. 03184000 (Summers County). The flood of record in the City of Ronceverte is that of November 1985, with a peak discharge of 80,000 cubic feet per second (cfs) along the Greenbrier River

In the City of White Sulphur Springs, floodwaters originating in the headwaters of Dry Creek, Wades Creek, and Howard Creek reach the City of White Sulphur Springs at about the same time. Floodwaters from the three streams spread out over the floodplain, inundating the major residential and commercial districts. Floods normally occur annually as a result of rainfall on frozen or saturated ground in late winter or early spring or as a result of heavy rainfall from thunderstorms or hurricanes during the summer. Historical records indicate that major floods occurred in 1919, 1934, 1967, 1972 and 1973 (U.S. Department of the Interior, Water Resources Data). Data for Howard Creek at Caldwell, WV, USGS gage No. 03182950, is only available from 1972 to 1978 (Reference 42).

Date of Flood	Recorded Flow	Estimated Frequency
1913	-	100 year
1934	-	-
1967	10,500	11 year
1972	14,000	23 year
1973	4,170	2 year

Significant flooding occurred on June 22 and 23, 1972. Floodwaters inundated a large portion of the business district along Main Street (U.S. Route 60), disrupting normal business operations and traffic patterns. Several business establishments were damaged by high-velocity floodwaters, including the newly constructed White Sulphur Springs National Bank. Floodwaters inundated the lumber yard of the White Sulphur Springs Lumber Mill on Dry Creek. More than 50 homes were damaged.

Damage to utilities consisted of washed-out sewer lines, inundation of the sewer plant, floodwater backing up in sewer lines, and disruption of electrical and telephone service. An 8-inch sewer line, crossing both Dry Creek and Howard Creek near the Jericho Draft Bridge, was broken by high-velocity floodwaters.

The 1972 flood caused considerable damage to the city's transportation system. Several hundred feet of U.S. Route 60 were inundated by floodwaters from Howard Creek and Wades Creek. The U.S. Route 60 bridge over Howard Creek at the Greenbrier Golf Course was damaged, blocking traffic between the City of White Sulphur Springs and Lewisburg. About 500 feet of U.S. Route 60 were partially washed out near the White Sulphur Springs Coal House along Wades Creek.
Sediment deposited in stream channels during the 1972 flood was especially damaging. In many areas, channel capacity was significantly reduced, causing higher estimated flood stages than under normal channel conditions. After the floodwaters receded, stream channels were left partially filled with sediment, reducing the capacity for future water flow. Local government officials, fearing that additional flooding might be caused by this condition, removed sediment deposits from Howard Creek throughout the city.

The 1972 flood, caused by Hurricane Agnes, was estimated to have a 4-percent chance of occurrence. In other words, a flood of this magnitude could be expected to occur once every 25 years. The 1-percent annual chance frequency flood, thus, would be considerably higher than the 1972 flood.

Two bridges and a large sewer line crossing the city caused higher flood stages than would normally occur. The Garden Street bridge over Howard Creek represents a restriction to the flood flows that cause an increase in the flood stages. Approximately 1,200 feet downstream from the Garden Street bridge, a 10-inch sewer line crosses Howard Creek. The line has been encased in concrete to protect it against washing out during floods. The concrete casing projects about 4 feet above the normal channel bottom, causing a small dam effect in the stream. The concrete bridge at White Sulphur Springs Bank building and the adjoining rock wall cause an increase in flood stages on Dry Creek. The bridge has a concrete arch opening about 6 feet high. A portion of the flow capacity of the arch opening is restricted by the rock retaining wall.

Prior to the installation of the dam and channel, it is estimated that the 0.2-percent annual chance frequency flood would be about 2.4 feet higher than the 1-percent annual chance flood, and 7.2 feet higher than the 1972 flood caused by Hurricane Agnes.

2.4 Flood Protection Measures

There are two low dams across Howard Creek on the Greenbrier Golf Course for prevention of erosion. These dams do not significantly affect flood levels.

The Meadow River has been channelized below its confluence with Sewell Creek/Little Sewell Creek for approximately 7,900 feet. Approximately 5,500 feet of Sewell Creek/Little Sewell Creek has been channelized beginning at the confluence with the Meadow River. Stream slopes are very flat, being approximately 2 feet per mile on the Meadow River and approximately 4 feet per mile on Sewell Creek/Little Sewell Creek. The design and construction of the channel project were performed by the U.S. Army Corps of Engineers (USACE), Huntington District. The maintenance for the channelization of Sewell Creek/Little Sewell Creek is performed by the Town of Rainelle.

There are no proposed flood protection projects for the Town of Rainelle at the time of this study.

No flood control measures have been taken to alleviate flooding within the City of Ronceverte.

A dam has been constructed on Dry Creek in Greenbrier County. This dam lowers flood discharges for both Dry and Howard Creeks in the City of White Sulphur Springs.

The sewer line casing discussed in Section 2.3 of this report will not provide any flood protection for the community. Flood storage originally created by the casing has been filled with sediment, eliminating any flood control aspects of this structure.

3.0 ENGINEERING METHODS

For the flooding sources studied in detail in the county, standard hydrologic and hydraulic study methods were used to determine the flood hazard data required for this study. Flood events of a magnitude which are expected to be equaled or exceeded once on the average during any 10-, 50-, 100-, or 500-year period (recurrence interval) have been selected as having special significance for floodplain management and for flood insurance rates. These events, commonly termed the 10-, 2-, 1-, and 0.2-percent annual chance floods, have a 10-, 2-, 1-, and 0.2-percent chance, respectively, of being equaled or exceeded during any year. Although the recurrence interval represents the long term average period between floods of a specific magnitude, rare floods could occur at short intervals or even within the same year. The risk of experiencing a rare flood increases when periods greater than 1 year are considered. For example, the risk of having a flood which equals or exceeds the 1-percent annual chance flood in any 50-year period is approximately 40 percent (4 in 10), and, for any 90-year period, the risk increases to approximately 60 percent (6 in 10). The analyses reported herein reflect flooding potentials based on conditions existing in the community at the time of completion of this study. Maps and flood elevations will be amended periodically to reflect future changes.

3.1 Hydrologic Analyses

Hydrologic analyses were carried out to establish the peak discharge-frequency relationships for each flooding source studied in detail affecting the county.

Pre-countywide Analyses

For Howard Creek, Wades Creek, and Dry Creek, in the unincorporated areas of Greenbrier County, flood routings were performed using SCS Technical Release 20 to develop values for the 10-, 2-, 1-, and 0.2-percent annual chance peak discharges (Reference 1). The following methods were used in developing the flood routings: rainfall data, obtained from the U.S. Weather Bureau Technical Paper No. 40; and isohyetal map of Tropical Storm Agnes, which occurred in 1972, was produced using available rainfall gages; and storm runoff, determined by estimating direct runoff from storm rainfall using the method described in the SCS National Engineering Handbook (References 2 and 3).

Discharges for the Meadow River and Sewell Creek/Little Sewell Creek, in the unincorporated areas of Greenbrier County, were determined using the USGS Open-File Report 80-1218 (Reference 4).

Natural discharge-frequency curves for the Greenbrier River were developed on a regional basis in accordance with the method outlined in Statistical Methods in Hydrology, by Leo R. Beard, and USGS Bulletin 17B (References 5 and 6). The flood flow-frequency analysis used the computer program, "Flood Flow Frequency Analysis, Preliminary, October 1976." All gauging stations used in this analysis are located along the Greenbrier River, with periods of record ranging from 28 to 91 years, and drainage areas ranging from 80.6 square miles to 1,625 square miles. A variable value of 60 years was adopted as being representative and was used in computing the expected frequency for each evaluation center.

For the flooding sources studied in detail in the City of White Sulphur Springs FIS, storm runoff was determined by estimating direct runoff from storm rainfall using the method described in the SCS National Engineering Handbook. The estimated rainfall-runoff relationship for Howard Creek was compared to gauged watersheds for verification. The gage at Buckeye, West Virginia, on the Greenbrier River has a length of record of about 48 years, while the Howard Creek gage at Caldwell, West Virginia, has a length of record of about 12 years (Reference 34).

Time of concentration of subareas was based on channel hydraulics. Channel cross sections were surveyed and bank-full flow velocities were computed.

Flood routings for all streams were performed using a computer with procedures outlined in the SCS Technical Release No. 20 to develop values for the 10-, 2-, and 1-percent annual chance peak discharges (Reference 1). The 0.2-percent annual chance peak discharges from Wades Creek were also performed using a computer with procedures outlined in the SCS Technical Release No. 20.

For the January 2, 2004 revision, the NRCS has revised the effective TR-20 hydrologic analysis from the previous study to reflect changes to Dry Creek and Howard Creek since it was developed. These changes reflect reduced flood discharges caused by a dam that has been built on Dry Creek.

Sewell Creek/Little Sewell Creek is ungaged. In order to develop discharges, the U. S. Geological Survey (USGS) Open-File Report 80-1218 Technique for Estimating Magnitude and Frequency of Floods in West Virginia was used to develop envelopes of discharges and their mean values (Reference 4). These values compared favorably to a 1-percent annual chance discharge curve developed for gage data from detailed studied streams within the area.

A summary of the drainage area-peak discharge relationships for the streams studied by detailed methods is shown in Table 5, "Summary of Discharges."

TABLE 5 - SUMMARY OF DISCHARGES

FLOODING SOURCE AND LOCATION	DRAINAGE AREA (sq. miles)	PEAK DISCHARGES (cubic feet per second) 10-Percent-Annual-Chance	2-Percent-Annual-Chance	1-Percent-Annual-Chance	0.2-Percent-Annual-Chance
DRY CREEK					
At Main Street	22.90	2,342	3,984	4,747	7,054
At upstream corporate limits of City of White Sulphur Springs	21.80	3,200	5,460	6,540	9,600
GREENBRIER RIVER					
Upstream of confluence of Howard Creek	1032.00	*	*	71,700	*
At River Mile 44.15	1143.00	51,000	67,000	75,000	90,000
Upstream of confluence of Second Creek	1148.00	*	*	75,000	*
At River Mile 28.5	1357.00	54,600	69,700	75,600	88,200
At USGS gage at City of Alderson	1364.00	*	*	79,500	*
HOWARD CREEK					
At Monroe Draft Road	83.61	10,500	17,500	21,500	31,500
At Harts Run Road	69.80	8,000	14,300	18,290	27,500

*Data not computed

TABLE 5 - SUMMARY OF DISCHARGES
(continued)

FLOODING SOURCE AND LOCATION	DRAINAGE AREA (sq. miles)	PEAK DISCHARGES (cubic feet per second) 10-Percent-Annual-Chance	2-Percent-Annual-Chance	1-Percent-Annual-Chance	0.2-Percent-Annual-Chance
HOWARD CREEK (continued)					
At U.S. Route 60	65.70	7,732	13,109	15,860	26,500
At Big Draft Road	59.80	6,807	11,750	14,264	24,900
At Garden Street	36.90	4,938	9,100	11,201	15,600
Approximately 2,670 feet upstream of Garden Street	29.50	3,681	6,981	8,662	13,700
At upstream corporate limits of City of White Sulphur Springs	27.68	3,800	7,100	9,100	14,000
MEADOW RIVER					
At railroad crossing	202.18	12,050	17,350	19,875	26,350
Above confluence with Sewell Creek/ Little Sewell Creek	163.97	10,250	14,875	17,100	22,795
SEWELL CREEK/ LITTLE SEWELL CREEK					
At confluence of Meadow River	38.21	3,325	5,125	6,000	8,350
At downstream corporate limits of Town of Rainelle	37.94	3,300	5,100	5,950	8,325
Approximately 750 feet upstream from Seventh Street bridge	16.61	1,750	2,775	3,300	4,700
At upstream corporate limits of Town of Rainelle	15.36	1,650	2,625	3,125	4,450
WADES CREEK					
At Allegany Avenue	7.40	2,000	3,500	4,200	6,100
At upstream corporate limits of City of White Sulphur Springs	6.94	1,920	3,300	3,980	5,800

In the 2004 FIS for White Sulphur Springs, for the areas studied by approximate methods, peak discharges were determined by use of the tabular method of flood routings (24-hour Type 2 storm distribution) (References 29 and 30). Parameters used in this method were developed by comparing these areas to similar areas in the detailed study.

Countywide Analyses

No new hydrologic analyses were conducted for detailed studied streams. For all streams studied by approximate methods, regression equations from the USGS report titled: "Estimation of Flood-Frequency Discharges for Rural, Unregulated Streams in West Virginia" (Reference 44) were used to estimate the 1-percent annual chance flood discharge. Equations were developed utilizing peak flow data from 290 gaging stations within West Virginia and surrounding states. West Virginia was divided into three regions, and Greenbrier County lies in the Central Mountains Region. Discharge in the Central Mountains Region was computed based on one parameter: $\log_{10}$-transformed drainage area.

3.2 Hydraulic Analyses

Analyses of the hydraulic characteristics of flooding from the sources studied were carried out to provide estimates of the elevations of floods of the selected recurrence intervals. Users should be aware that flood elevations shown on the Flood Insurance Rate Map (FIRM) represent rounded whole-foot elevations and may not exactly reflect the elevations shown on the Flood Profiles or in the Floodway Data table in the FIS report. Flood elevations shown on the FIRM are primarily intended for flood insurance rating purposes. For construction and/or floodplain management purposes, users are cautioned to use the flood elevation data presented in this FIS report in conjunction with the data shown on the FIRM.

Flood profiles were drawn showing computed water-surface elevations to an accuracy of 0.5 foot for floods of the selected recurrence intervals. Locations of the selected cross sections used in the hydraulic analyses are shown on the Flood Profiles (Exhibit 1). For stream segments for which a floodway was computed (Section 4.2), selected cross section locations are also shown on the FIRM (Exhibit 2).

Unless specified otherwise, the hydraulic analyses for this study are based on the effects of unobstructed flow. The flood elevations shown on the profiles are thus considered valid only if hydraulic structures remain unobstructed, operate properly, and do not fail. All elevations shown on the Flood Profiles and DFIRM (Exhibits 1 and 2) are referenced to the North American Vertical Datum of 1988 (NAV 88).

For each community within Greenbrier County that has a previously printed FIS report, the hydraulic analyses described in those reports have been compiled and are summarized below.

Pre-countywide Analyses

In the September 1991 FIS, cross-section data for the backwater analyses for Howard Creek, Wades Creek, and Dry Creek, in the unincorporated areas of Greenbrier County, were developed from field surveys, and topographic maps at a scale of 1:4,800 with a contour interval of 4 feet, topographic maps at a scale of 1:2,400 with a contour interval of 2 feet, and topographic maps at a scale of 1:24,000 with a contour interval of 20 and 40 feet (References 7, 8, and 9). Additional cross sections were obtained from the SCS. Cross sections at bridges on Howard Creek were either field surveyed or modeled using data obtained from the SCS. Cross sections at all other bridges and at the two dams on Howard Creek were field surveyed.

Cross-section data for the Meadow River and Sewell Creek/Little Sewell Creek were developed by field surveys and topographic maps at a scale of 1:4,800 and a contour interval of 4 feet (Reference 7). Cross sections for the railroad bridge downstream on the Meadow River were obtained from the CSX, Inc. (Reference 10). In the September 1991 FIS revision, cross sections for the backwater analyses for the Greenbrier River were field surveyed and located at close intervals above and below bridges in order to compute the significant backwater effects of these structures.

Water-surface elevations of floods of the selected recurrence intervals were computed using the USACE HEC-2 step-backwater computer program (Reference 11). Flood profiles were drawn showing computed water-surface elevations for floods on the selected recurrence intervals. Starting water-surface elevations for Howard Creek were taken from the 10-percent annual chance flood elevation of the Greenbrier River. Since the Greenbrier River is a much larger stream than Howard Creek, it was assumed that the lower flood elevation of the Greenbrier River could be used since its peak discharge would occur long after the peak discharge on Howard Creek. Starting water-surface elevations for the Meadow River, Sewell Creek/Little Sewell Creek and the Greenbrier River were determined using the slope/area method. Water-surface elevations of floods of the selected recurrence intervals for Dry Creek were computed using the SCS WSP-2 computer program (Reference 33) reflecting the construction of a flood control structure, Tuckahoe Dam, in the Dry Creek watershed. Water-surface elevations of floods of the selected recurrence intervals for Wades Creek were computed using the SCS WSP-2 computer program, as described in SCS Technical Release No. 61 (Reference 33). Starting water-surface elevations were calculated using the slope/area method.

Countywide Analyses

Channel roughness factors (Manning's "n") used in the hydraulic computations for the Greenbrier River were based on field inspection and calibration with the November 1985 flood. For the remaining streams, roughness factors used in hydraulic computations were assigned based on field inspections in winter and summer during which numerous photographic transparencies were taken. Channel and overbank "n" values were based on all available mapping, photographs, Chow's Open-Channel Hydraulics, and Barnes' Roughness Characteristics of Natural Channels (References 7, 8, 13, and 14). Table 6 – "Manning's "n" Values," shows the channel and overbank "n" values for the streams studied by detailed methods.

TABLE 6 – MANNING'S "n" VALUES

Stream	Channel "n"	Overbank "n"
Dry Creek	0.045	0.055 - 0.080
Greenbrier River	0.035 - 0.060	0.035 - 0.060
Howard Creek	0.025 - 0.065	0.020 - 0.075
Meadow River	0.035 - 0.040	0.040 - 0.070
Sewell Creek/Little Sewell Creek	0.035 - 0.042	0.050 - 0.080
Wades Creek	0.040 – 0.050	0.055 - 0.075

No new hydraulic analyses were conducted for detailed studied streams. For all streams studied by approximate methods, water surface profiles were computed using HEC-RAS steady state simulation. HEC-RAS applies a peak discharge at each cross section to determine a maximum water surface elevation. The elevations are calculated using the standard step method and the energy, continuity, and Manning equations. A subcritical flow regime was assumed for all reaches. Manning's "n" values were not selected based on land use data. Conservative representative values of 0.1 for overbank areas and 0.045 for channels were used for all newly developed Zone A models.

For the streams studied by approximate methods, GIS-based automated hydraulic methodologies were employed. These streams are supported by geo-referenced HEC-RAS models. While hydraulic structures were not incorporated into the models, cross sections were automatically generated and manually adjusted, where applicable, to capture areas of hydraulic contraction.

Specific watersheds in this countywide update were subject to karst conditions. Significant interaction between surface waters and groundwater that is characteristic of karst terrain cannot be adequately modeled without a complete understanding of the hydraulics of the watershed. The normal flow of waters over surface areas is depressed by loss of water through sink holes and sinking streams. This may result in an impact on the 1% annual chance flood profile, as lower volumes of water may occur on the surface (Reference 49). Water movement in karst terrain is especially unpredictable. Karst terrain can also have true underground streams with high rates of flow (Reference 50). It is not unusual for surface streams to disappear into rock openings and reappear at the surface, often as a spring, at locations beyond the watershed boundary defined by surface topography. Large amounts of rainfall could become "lost" to such underground drainages (Reference 51).

For this countywide study, approximate models were developed for streams located in karst areas for the segments with surface waters only, but were truncated once the stream went underground. Models were not developed for streams downstream of springs where the model flows were unable to be verified due to the uncertainty of the upstream hydrology.

This entire study was updated to the North American Vertical Datum of 1988 (NAVD 88).

All qualifying benchmarks within a given jurisdiction that are catalogued by the National Geodetic Survey (NGS) and entered into the National Spatial Reference System (NSRS) as First or Second Order Vertical and have a vertical stability classification of A, B or C are shown and labeled on the FIRM with their 6-character NSRS Permanent Identifier.

Benchmarks catalogued by the NGS and entered into the NSRS vary widely in vertical stability classification. NSRS vertical stability classifications are as follows:

- Stability A: Monuments of the most reliable nature, expected to hold position/elevation (e.g., mounted in bedrock)

- Stability B: Monuments which generally hold their position/elevation (e.g., concrete bridge abutment)

- Stability C: Monuments which may be affected by surface ground movements (e.g., concrete monument below frost line)

- Stability D: Mark of questionable or unknown vertical stability (e.g., concrete monument above frost line, or steel witness post)

In addition to NSRS benchmarks, the FIRM may also show vertical control monuments established by a local jurisdiction; these monuments will be shown on the FIRM with the appropriate designations. Local monuments will only be placed on the FIRM if the community has requested that they be included, and if the monuments meet the aforementioned NSRS inclusion criteria.

To obtain current elevation, description, and/or location information for benchmarks shown on the FIRM for this jurisdiction, please contact the Information Services Branch of the NGS at (301) 713-3242, or visit their Web site at www.ngs.noaa.gov.

It is important to note that temporary vertical monuments are often established during the preparation of a flood hazard analysis for the purpose of establishing local vertical control. Although these monuments are not shown on the FIRM, they may be found in the Technical Support Data Notebook associated with the FIS report and FIRM for this community. Interested individuals may contact FEMA to access these data.

3.3 Vertical Datum

All FIS reports and FIRMs are referenced to a specific vertical datum. The vertical datum provides a starting point against which flood, ground, and structure elevations can be referenced and compared. Until recently, the standard vertical datum used for newly created or revised FIS reports and FIRMs was the National Geodetic Vertical Datum of 1929 (NGVD 29). With the completion of the North American Vertical Datum of 1988 (NAVD 88), many FIS reports and FIRMs are now prepared using NAVD 88 as the referenced vertical datum.

All flood elevations shown in this FIS report and on the FIRM are now referenced to NAVD 88. Structure and ground elevations in the community must, therefore, be referenced to NAVD 88. The datum shift between NGVD 29 and NAVD 88 is specific to a particular county. In the case of Greenbrier County, the datum shift was -0.44 feet. The equation for Greenbrier County for the conversion of elevations from NGVD 29 to NAVD 88 is given by:

$$\text{NAVD88} = \text{NGVD } 29 - 0.44$$

It is important to note that adjacent communities may be referenced to NGVD 29. This may result in differences in base flood elevations across the corporate limits between the communities.

For more information on NAVD 88, see Converting the National Flood Insurance Program to the North American Vertical Datum of 1988, FEMA Publication FIA-20/June 1992, or contact the National Geodetic Survey at the following address:

NGS Information Services
NOAA, N/NGS12
National Geodetic Survey
SSMC-3, #9202
1315 East-West Highway
Silver Spring, Maryland 20910-3282
(301) 713-3242
http://www.ngs.noaa.gov

4.0 FLOODPLAIN MANAGEMENT APPLICATIONS

The NFIP encourages State and local governments to adopt sound floodplain management programs. To assist in this endeavor, each FIS report provides 1-percent annual chance floodplain data, which may include a combination of the following: 10-, 2-, 1-, and 0.2-percent annual chance flood elevations; delineations of the 1-percent and 0.2-percent annual chance floodplains; and a 1-percent annual chance floodway. This information is presented on the FIRM and in many components of the FIS report, including Flood Profiles, and Floodway Data tables. Users should reference the data presented in the FIS report as well as additional information that may be available at the local community map repository before making flood elevation and/or floodplain boundary determinations.

4.1 Floodplain Boundaries

To provide a national standard without regional discrimination, the 1-percent annual chance flood has been adopted by FEMA as the base flood for floodplain management purposes. The 0.2-percent annual chance flood is employed to indicate additional areas of flood risk in the county. For the streams studied in detail, the 1-percent annual chance and 0.2-percent annual chance boundaries have been determined at each cross section. The delineations are based on the best available topographic information.

Pre-countywide Analyses

For the streams studied in detail, the 1-percent and 0.2-percent annual chance floodplains have been delineated using the flood elevations determined at each cross section.

In the 1991 Greenbrier County (Unincorporated Areas) FIS, the boundaries between cross sections were interpolated using topographic maps at a scale of 1:4,800 with a contour interval of 4 feet, topographic maps at a scale of 1:1,200 with a contour interval of 2 feet, and topographic maps at a scale of 1:24,000 with contour intervals of 20 and 40 feet (References 7, 8, 9).

In the 1987 Town of Rainelle FIS, the boundaries between cross sections were interpolated using topographic maps at a scale of 1:24,000 with a contour interval of 20 feet and aerial photographs at a scale of 1:2,400 with a contour interval of 4 feet (References 7 and 9).

In the 1990 Town of Ronceverte FIS, the boundaries between cross sections were interpolated using topographic maps at a scale of 1:24,000 with a contour interval of 20 feet (Reference 9).

In the 2004 White Sulphur Springs FIS, the boundaries between the cross sections were interpolated using two sets of topographic maps, one at a scale of 1 "=100', with a contour interval of 2 feet, the other at a scale of 1:24,000, with a contour interval of 40 feet (References 9and 32).

For streams studied by approximate methods, the boundaries of the 1-percent annual chance floodplain were interpolated using topographic maps and the Flood Insurance Study for the unincorporated areas of Greenbrier County (Reference 9 and 15).

For the Town of Rainelle, the 1-percent annual chance floodplain boundaries were delineated using the Flood Hazard Boundary Map for the Town of Rainelle (Reference 37).

For White Sulphur Springs, the boundaries of the 1-percent annual chance floodplain were interpolated using topographic maps at a scale of 1:2,400, with a contour interval of 5 feet (Reference 35).

Countywide Analyses

Floodplains were spatially adjusted to fit the best available stream centerline data. Also, floodplain boundaries from the jurisdictions outlined in section 1.1 have been combined in this countywide revision.

Flooding sources previously studied by detailed methods were redelineated using effective base flood elevations and USGS 1/9 Arc Second (3 meter) DEM data for this revision.

For streams studied by approximate areas, the 1-percent annual chance floodplain boundaries were developed by AMEC utilizing automated hydrologic and hydraulic modeling and mapping technology. Approximate floodplain boundaries were mapped using USGS 1/9 Arc Second (3 meter) DEM.

The 1-percent and 0.2-percent annual chance floodplain boundaries are shown on the FIRM. On this map, the 1-percent annual chance floodplain boundary corresponds to the boundary of the areas of special flood hazards (Zones A and AE), and the 0.2-percent annual chance floodplain boundary corresponds to the boundary of areas of moderate flood hazards. In cases where the 1-percent and 0.2-percent annual chance floodplain boundaries are close together, only the 1-percent annual chance floodplain boundary has been shown. Small areas within the floodplain boundaries may lie above the flood elevations but cannot be shown due to limitations of the map scale and/or lack of detailed topographic data.

For the streams studied by approximate methods, only the 1-percent annual chance floodplain boundary is shown on the FIRM (Exhibit 2).

4.2 Floodways

Encroachment on floodplains, such as structures and fill, reduces flood-carrying capacity, increases flood heights and velocities, and increases flood hazards in areas beyond the encroachment itself. One aspect of floodplain management involves balancing the economic gain from floodplain development against the resulting increase in flood hazard. For purposes of the NFIP, a floodway is used as a tool to assist local communities in this aspect of floodplain management. Under this concept, the area of the 1-percent annual chance floodplain is divided into a floodway and a floodway fringe. The floodway is the channel of a stream, plus any adjacent floodplain areas, that must be kept free of encroachment so that the 1-percent annual chance flood can be carried without substantial increases in flood heights. Minimum federal standards limit such increases to 1.0 foot, provided that hazardous velocities are not produced. The floodways in this FIS are presented to local agencies as minimum standards that can be adopted directly or that can be used as a basis for additional floodway studies.

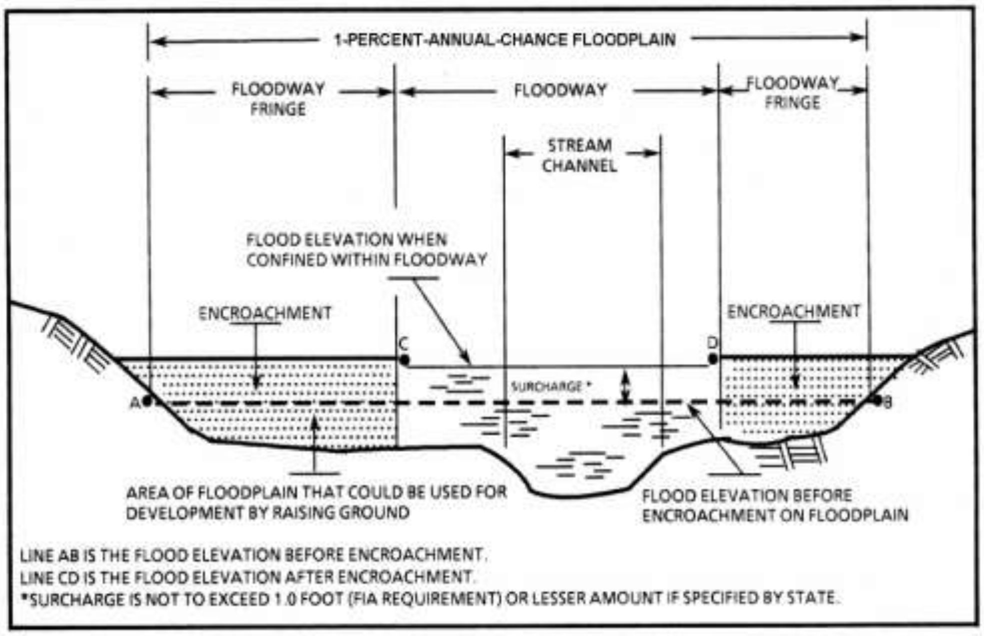
The floodways presented in this study were computed on the basis of equal conveyance reduction from each side of the flood plains. The results of these computations are tabulated at selected cross sections for each stream segment for which a floodway is computed (Table 7).

As shown on the FIRM (Exhibit 2), the floodway widths were determined at cross sections; between cross sections, the boundaries were interpolated. In cases where the boundaries of the flood-way and the 1-percent annual chance flood are either close together or collinear, only the floodway boundary has been shown. Portions of the floodway widths for Sewell/Little Sewell Creek and Howard Creek extend beyond the county boundary. Due to the scope of study of this revision, no floodway was calculated for the Greenbrier River.

Encroachment into areas subject to inundation by floodwaters having hazardous velocities aggravates the risk of flood damage, and heightens potential flood hazards by further increasing velocities. A listing of stream velocities at selected cross sections is provided in Table 7, "Floodway Data." To reduce the risk of property damage in areas where the stream velocities are high, the community may wish to restrict development in areas outside the floodway.

The area between the floodway and 1-percent annual chance floodplain boundaries is termed the floodway fringe. The floodway fringe encompasses the portion of the floodplain that could be completely obstructed without increasing the water-surface elevation of the 1-percent annual chance flood by more than 1.0 foot at any point. Typical relationships between the floodway and the floodway fringe and their significance to floodplain development are shown in Figure 1, "Floodway Schematic."

FIGURE 1: FLOODWAY SCHEMATIC



FLOODING SOURCE		FLOODWAY			BASE FLOOD WATER SURFACE ELEVATION (FEET NAVD)			
CROSS SECTION	DISTANCE[1]	WIDTH (FEET)	SECTION AREA (SQUARE FEET)	MEAN VELOCITY (FEET PER SECOND)	REGULATORY	WITHOUT FLOODWAY	WITH FLOODWAY	INCREASE
Dry Creek								
A	1,785	105	791	7.4	1,856.8	1,856.8	1,857.7	0.9
B	2,755	65	629	7.6	1,864.6	1,864.6	1,864.8	0.2
C	7,018	110	720	9.1	1,893.9	1,893.9	1,894.2	0.3
D	8,000	135	732	8.9	1,901.3	1,901.3	1,902.0	0.7
E	9,249	150	803	8.1	1,913.2	1,913.2	1,913.8	0.6
F	9,840	115	585	11.2	1,917.3	1,917.3	1,917.6	0.3
G	11,478	84	570	11.1	1,932.2	1,932.2	1,932.8	0.6
H	12,573	120	778	8.2	1,941.5	1,941.5	1,942.5	1.0

[1] Feet above confluence with Howard Creek

TABLE 7

FEDERAL EMERGENCY MANAGEMENT AGENCY

GREENBRIER COUNTY, WV AND INCORPORATED AREAS

FLOODWAY DATA

DRY CREEK

FLOODING SOURCE		FLOODWAY			BASE FLOOD WATER SURFACE ELEVATION (FEET NAVD)			
CROSS SECTION	DISTANCE[1]	WIDTH (FEET)	SECTION AREA (SQUARE FEET)	MEAN VELOCITY (FEET PER SECOND)	REGULATORY	WITHOUT FLOODWAY	WITH FLOODWAY	INCREASE
Howard Creek								
A	2,960	260	2,000	10.8	1,693.7	1,693.7	1,693.8	0.1
B	6,070	155	1,332	16.1	1,709.1	1,709.1	1,709.1	0.0
C	8,190	131	2,276	9.4	1,730.0	1,730.0	1,730.3	0.3
D	12,500	186	1,417	15.2	1,744.2	1,744.2	1,744.2	0.0
E	17,960	300	2,838	6.4	1,766.1	1,766.1	1,766.6	0.5
F	20,130	300	2,484	7.4	1,773.0	1,773.0	1,774.0	1.0
G	23,400	430	1,823	9.7	1,788.8	1,788.8	1,789.1	0.3
H	29,990	355	2,976	5.8	1,813.7	1,813.7	1,813.7	0.0
I	31,810	964	4,755	3.6	1,816.3	1,816.3	1,817.3	1.0
J	34,460	376	3,173	5.5	1,828.1	1,828.1	1,828.5	0.4
K	36,830	353	2,100	8.2	1,833.1	1,833.1	1,833.2	0.1
L	38,486	650	2,249	7.4	1,841.2	1,841.2	1,841.4	0.2
M	39,076	330	3,654	6.9	1,844.6	1,844.6	1,845.3	0.7
N	39,979	111	1,212	11.8	1,844.9	1,844.9	1,845.8	0.9
O	41,469	492	1,390	11.9	1,851.5	1,851.5	1,851.5	0.0
P	43,872	108	750	11.9	1,862.0	1,862.0	1,862.4	0.4
Q	45,906	285	2,115	4.9	1,872.9	1,872.9	1,873.9	1.0
R	46,386	367	2,726	3.7	1,873.9	1,873.9	1,874.8	0.9
S	47,750	494	1,795	6.8	1,877.2	1,877.2	1,877.9	0.7

[1] Feet above confluence with Greenbrier River

TABLE 7

FEDERAL EMERGENCY MANAGEMENT AGENCY

GREENBRIER COUNTY, WV AND INCORPORATED AREAS

FLOODWAY DATA

HOWARD CREEK

FLOODING SOURCE		FLOODWAY			BASE FLOOD WATER SURFACE ELEVATION (FEET NAVD)			
CROSS SECTION	DISTANCE[1]	WIDTH (FEET)	SECTION AREA (SQUARE FEET)	MEAN VELOCITY (FEET PER SECOND)	REGULATORY	WITHOUT FLOODWAY	WITH FLOODWAY	INCREASE
Meadow River								
A	30	289	4,299	4.0	2392.7	2392.7	2393.6	0.9
B	1,950	351	3,588	4.8	2393.4	2393.4	2394.3	0.9
C	5,440	195	2,816	6.1	2397.7	2397.7	2398.4	0.7
D	7,650	209	2,524	6.7	2399.6	2399.6	2400.4	0.8
E	9,710	361	4,810	3.5	2401.2	2401.2	2402.0	0.8
F	11,950	460	5,183	3.3	2401.9	2401.9	2402.8	0.9
G	14,170	390	4,228	4.0	2402.6	2402.6	2403.6	1.0
H	16,440	240	3,956	4.1	2403.9	2403.9	2404.6	0.7
I	18,740	293	4,641	3.5	2404.8	2404.8	2405.6	0.8
J	21,370	340	4,832	3.4	2405.6	2405.6	2406.4	0.8
K	23,830	533	7,359	2.2	2406.5	2406.5	2407.4	0.9
L	25,800	570	5,738	2.7	2406.7	2406.7	2407.6	0.9
M	28,060	470	6,225	2.5	2407.4	2407.4	2408.3	0.9
N	30,240	398	5,744	2.7	2408.0	2408.0	2408.9	0.9
O	31,650	305	2,920	5.4	2408.0	2408.0	2408.9	0.9
P	33,740	862	12,191	1.3	2408.7	2408.7	2409.7	1.0
Q	36,960	1,162	14,501	1.1	2408.8	2408.8	2409.8	1.0
R	39,330	1,529	18,058	0.9	2408.9	2408.9	2409.9	1.0

[1] Feet above confluence of Sewell Creek

TABLE 7

FEDERAL EMERGENCY MANAGEMENT AGENCY

GREENBRIER COUNTY, WV AND INCORPORATED AREAS

FLOODWAY DATA

MEADOW RIVER

FLOODING SOURCE		FLOODWAY			BASE FLOOD WATER SURFACE ELEVATION (FEET NAVD)			
CROSS SECTION	DISTANCE[1]	WIDTH (FEET)	SECTION AREA (SQUARE FEET)	MEAN VELOCITY (FEET PER SECOND)	REGULATORY	WITHOUT FLOODWAY	WITH FLOODWAY	INCREASE
Sewell Creek/ Little Sewell Creek								
A	2,830	199[2]	848	7.0	2,392.9	2,392.9	2,393.0	0.1
B	4,601	104	531	6.2	2,394.1	2,394.1	2,394.8	0.7
C	5,512	170	1722	1.9	2,395.8	2,395.8	2,396.7	0.9
D	5,945	248	1725	1.9	2,395.9	2,395.9	2,396.8	0.9
E	7,557	230	1884	1.8	2,396.1	2,396.1	2,397.0	0.9
F	9,940	115	829	3.8	2,398.6	2,398.6	2,399.6	1.0
G	11,379	78	747	7.0	2,401.4	2,401.4	2,402.1	0.7

[1] Feet above confluence with Meadow River
[2] This width extends beyond county boundary

TABLE 7

FEDERAL EMERGENCY MANAGEMENT AGENCY

GREENBRIER COUNTY, WV AND INCORPORATED AREAS

FLOODWAY DATA

SEWELL CREEK/LITTLE SEWELL CREEK

FLOODING SOURCE		FLOODWAY			BASE FLOOD WATER SURFACE ELEVATION (FEET NAVD)			
CROSS SECTION	DISTANCE[1]	WIDTH (FEET)	SECTION AREA (SQUARE FEET)	MEAN VELOCITY (FEET PER SECOND)	REGULATORY	WITHOUT FLOODWAY	WITH FLOODWAY	INCREASE
Wades Creek								
A	220	243	927	5.5	1855.0	1855.0	1855.6	0.6
B	1,250	106	489	8.8	1864.2	1864.2	1865.0	0.8
C	3,240	448	397	10.2	1882.7	1882.7	1883.7	1.0
D	4,522	142[2]	804	5.6	1901.6	1901.6	1902.6	1.0
E	6,205	85	440	7.5	1920.2	1920.2	1920.3	0.1
F	6,660	95	322	10.3	1926.1	1926.1	1926.1	0.0
G	7,657	120	445	7.4	1936.6	1936.6	1937.3	0.7
H	8,846	168	546	6.0	1952.4	1952.4	1953.0	0.6
I	10,166	66	289	11.2	1971.3	1971.3	1971.7	0.4

[1] Feet above confluence with Howard Creek
[2] Floodway is entirely within Greenbrier County

TABLE 7

FEDERAL EMERGENCY MANAGEMENT AGENCY

GREENBRIER COUNTY, WV AND INCORPORATED AREAS

FLOODWAY DATA

WADES CREEK

5.0 INSURANCE APPLICATIONS

For flood insurance rating purposes, flood insurance zone designations are assigned to a community based on the results of the engineering analyses. The zones are as follows:

Zone A

Zone A is the flood insurance rate zone that corresponds to the 1-percent annual chance floodplains that are determined in the FIS by approximate methods. Because detailed hydraulic analyses are not performed for such areas, no base flood elevations or depths are shown within this zone.

Zone AE

Zone AE is the flood insurance rate zone that corresponds to the 1-percent annual chance floodplains that are determined in the FIS by detailed methods. In most instances, whole-foot base flood elevations derived from the detailed hydraulic analyses are shown at selected intervals within this zone.

Zone X

Zone X is the flood insurance rate zone that corresponds to areas outside the 0.2-percent annual chance floodplain, areas within the 0.2-percent annual chance floodplain, and to areas of 1-percent annual chance flooding where average depths are less than 1 foot, areas of 1-percent annual chance flooding where the contributing drainage area is less than 1 square mile, and areas protected from the 1 -percent annual chance flood by levees. No base flood elevations or depths are shown within this zone.

6.0 FLOOD INSURANCE RATE MAP

The FIRM is designed for flood insurance and floodplain management applications.

For flood insurance applications, the map designates flood insurance rate zones as described in Section 5.0. In the 1-percent annual chance floodplains that were studied by detailed methods, shows selected whole-foot base flood elevations or average depths. Insurance agents use the zones and base flood elevations in conjunction with information on structures and their contents to assign premium rates for flood insurance policies.

For floodplain management applications, the map shows by tints, screens, and symbols, the 1-percent and 0.2-percent annual chance floodplains. Floodways and the locations of selected cross sections used in the hydraulic analyses and floodway computations are shown where applicable.

The current FIRM presents flooding information for the entire geographic area of Greenbrier County. Previously, separate Flood Hazard Boundary Maps and/or

FIRMs were prepared for each incorporated community with identified flood hazard areas and the unincorporated areas of the county. Historical map dates relating to pre-countywide maps prepared for each community are presented in Table 8, "Community Map History."

7.0 OTHER STUDIES

Flood Insurance Studies for the Towns of Alderson, Quinwood, Rainelle, Renick (also known as the Corporation of Falling Springs), and Rupert, the Cities of Ronceverte and White Sulphur Springs, the unincorporated areas of Greenbrier County, the unincorporated areas of Monroe County, and the unincorporated areas of Summers County have been published (References 15, 16, 17, 18, 19, 12, 20, 21, 22, and 23).

This study is authoritative for purposes of the Flood Insurance Program and the data presented here either supersede or are compatible with previous determinations.

8.0 LOCATION OF DATA

Information concerning the pertinent data used in preparation of this study can be obtained by contacting Federal Insurance and Mitigation Division, Federal Emergency Management Agency, One Independence Mall, Sixth Floor, 615 Chestnut Street, Philadelphia, Pennsylvania 19106-4404.

COMMUNITY NAME	INITIAL NFIP MAP DATE	FLOOD HAZARD BOUNDARY MAP REVISIONS DATE	INITIAL FIRM DATE	FIRM REVISIONS DATE
Corporation of Falling Springs (Town of Renick)	November 15, 1974	August 1, 1975	September 24, 1984	
Greenbrier County (Unincorporated Areas)	July 18, 1975	February 19, 1982	January 15, 1988	September 18, 1991
Quinwood, Town of	November 15, 1974	July 30, 1976	February 27, 1981	
Rainelle, Town of	February 11, 1977	None	November 19, 1987	
Ronceverte, City of	February 14, 1975	None	May 17, 1990	
Rupert, Town of	June 21, 1974	July 2, 1976	August 24, 1984	
White Sulphur Springs, City of	May 31, 1974	September 12, 1975	August 1, 1978	April 15, 1992 January 2, 2004

TABLE 8

FEDERAL EMERGENCY MANAGEMENT AGENCY

GREENBRIER COUNTY, WV
AND INCORPORATED AREAS

COMMUNITY MAP HISTORY

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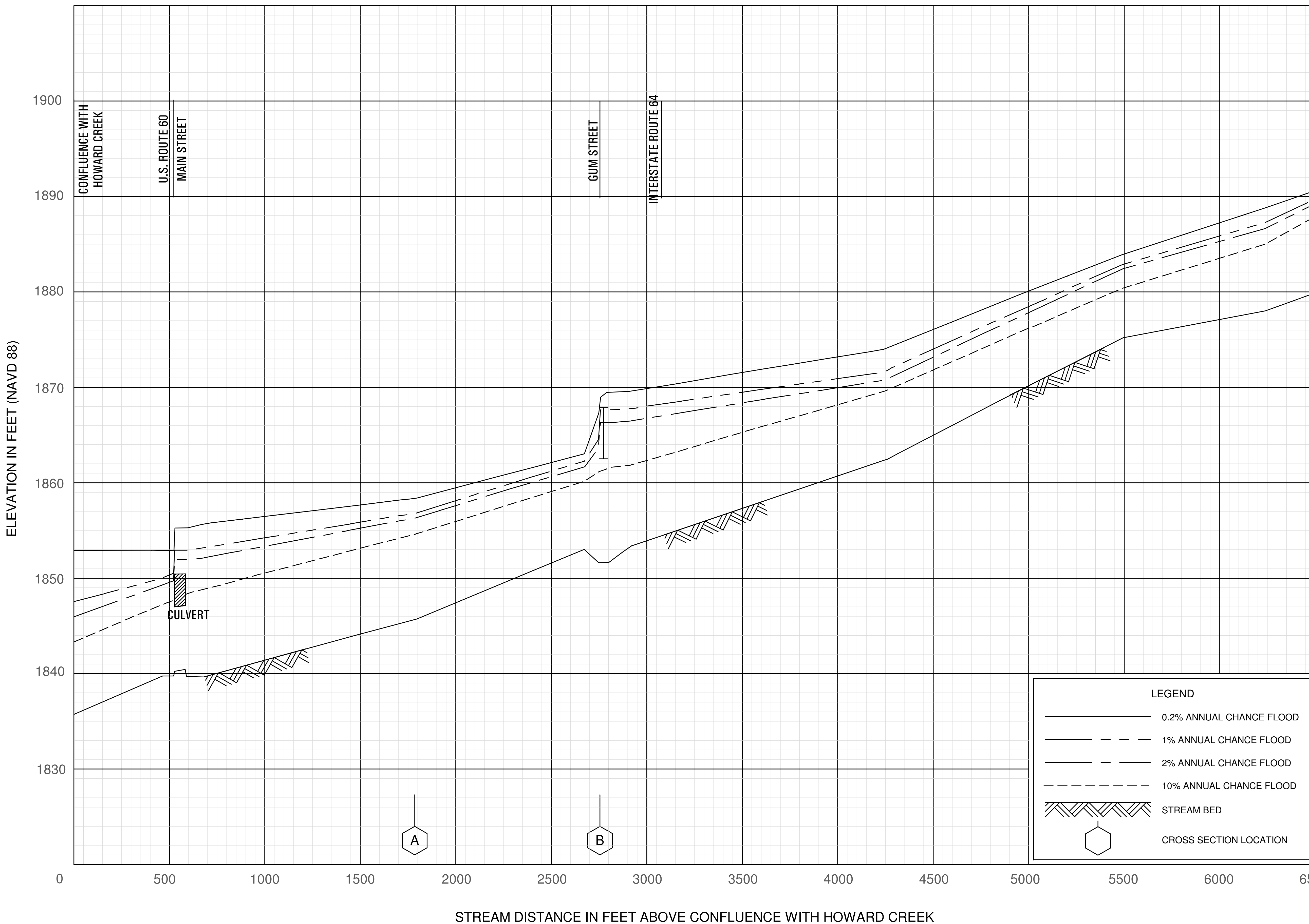

FLOOD PROFILES

DRY CREEK

FEDERAL EMERGENCY MANAGEMENT AGENCY

GREENBRIER COUNTY, WV AND INCORPORATED AREAS

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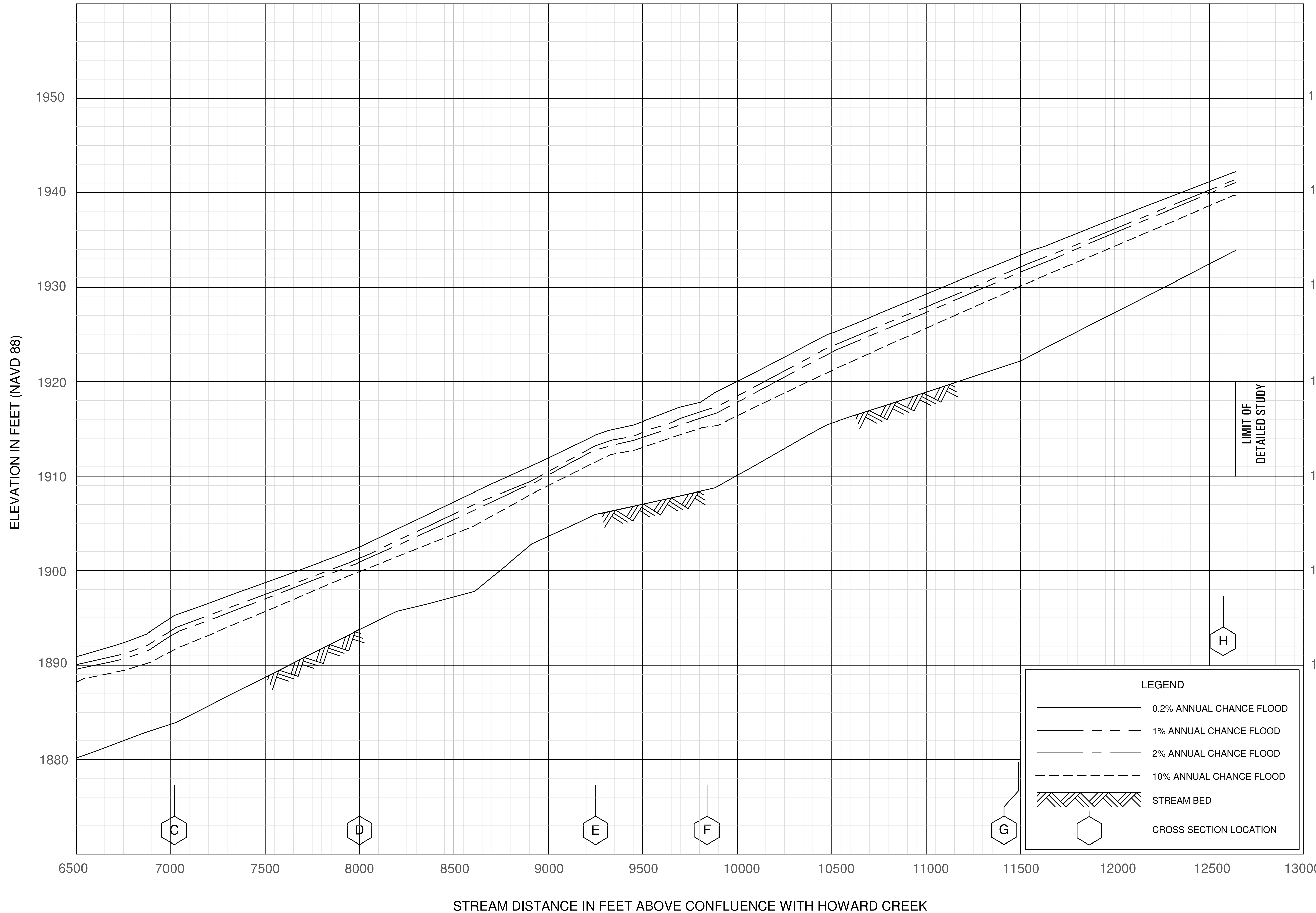
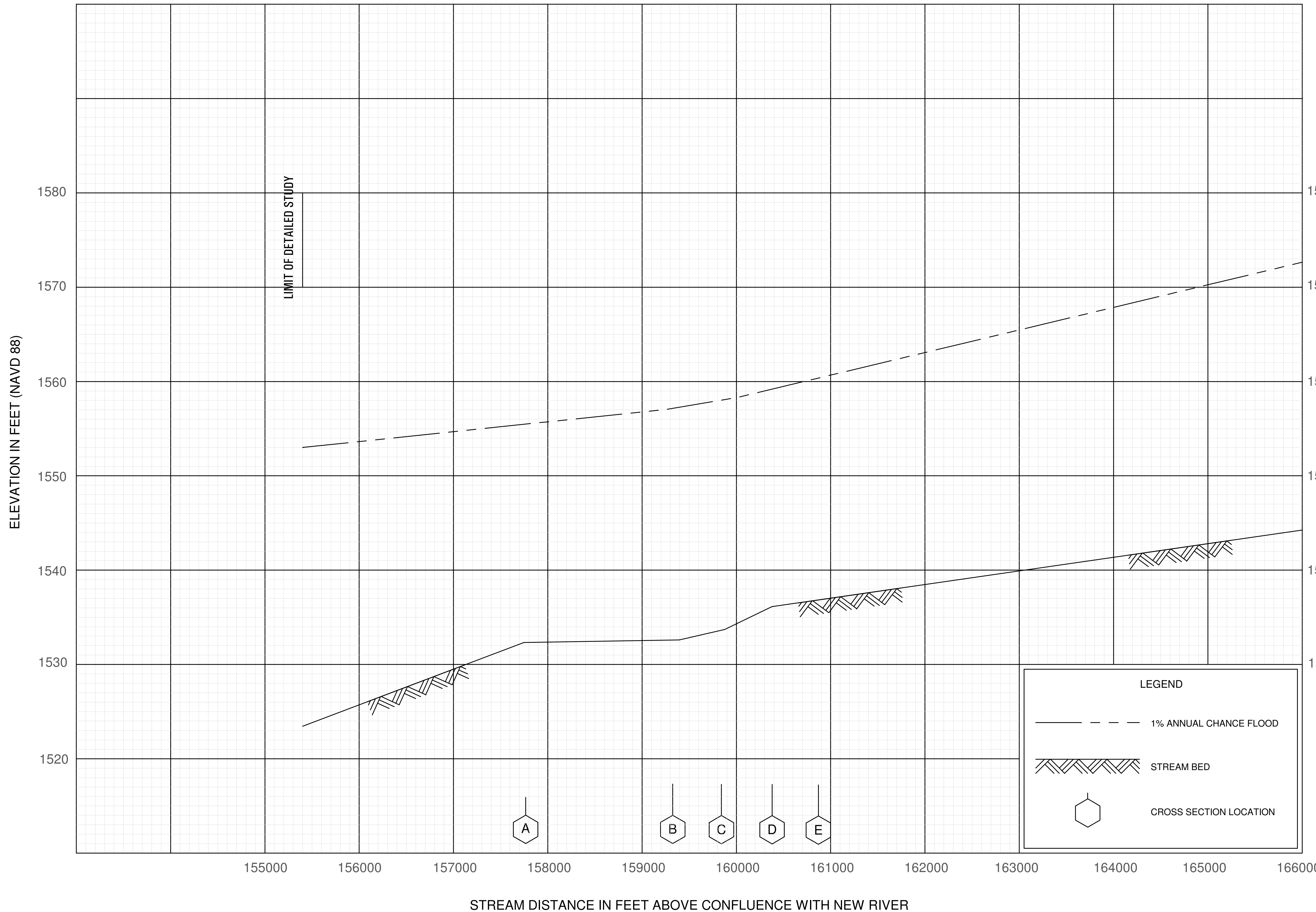


FLOOD PROFILES

DRY CREEK

FEDERAL EMERGENCY MANAGEMENT AGENCY

GREENBRIER COUNTY, WV
AND INCORPORATED AREAS



FLOOD PROFILES

GREENBRIER RIVER

FEDERAL EMERGENCY MANAGEMENT AGENCY

GREENBRIER COUNTY, WV
AND INCORPORATED AREAS

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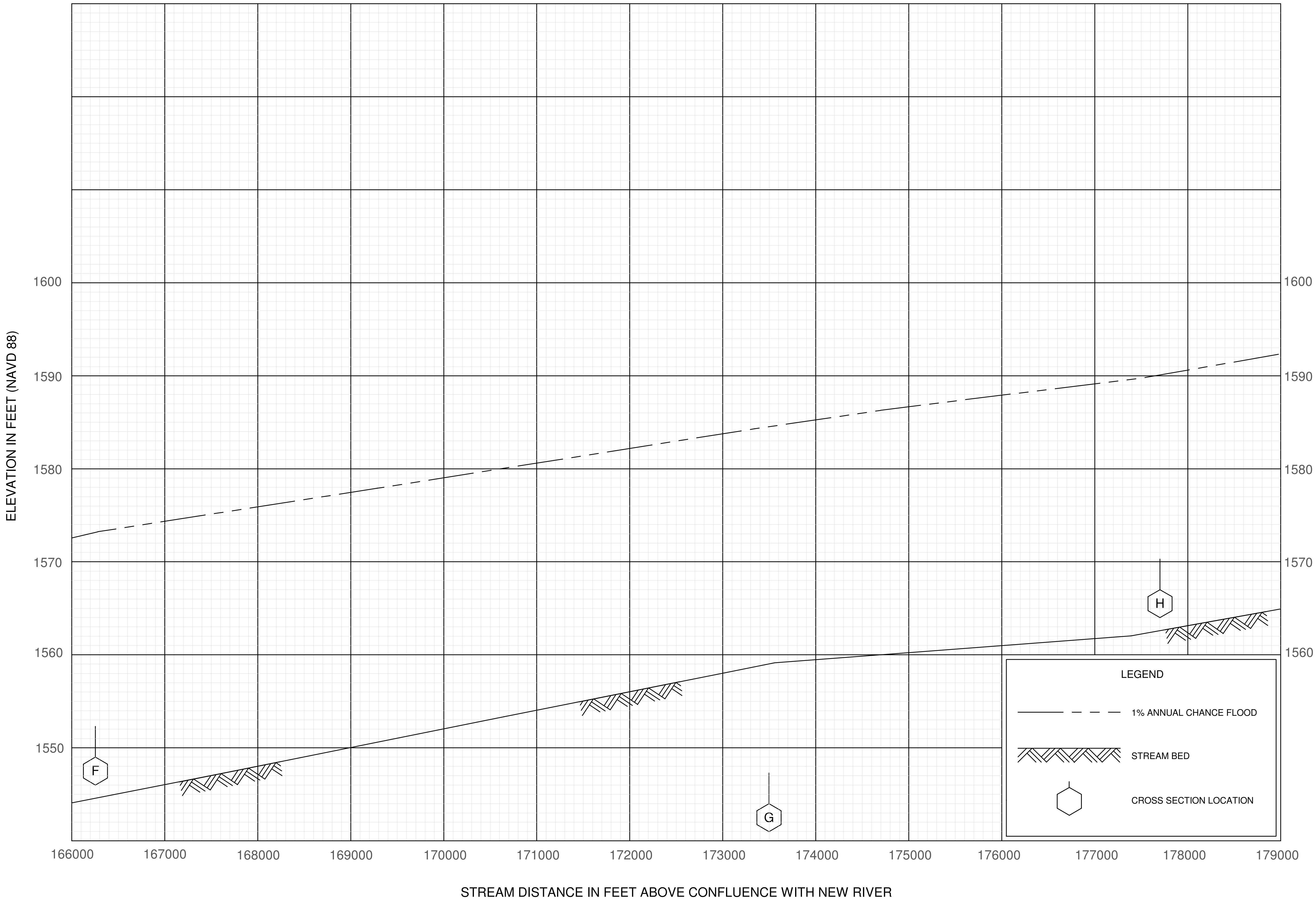

FLOOD PROFILES

GREENBRIER RIVER

FEDERAL EMERGENCY MANAGEMENT AGENCY

GREENBRIER COUNTY, WV

AND INCORPORATED AREAS

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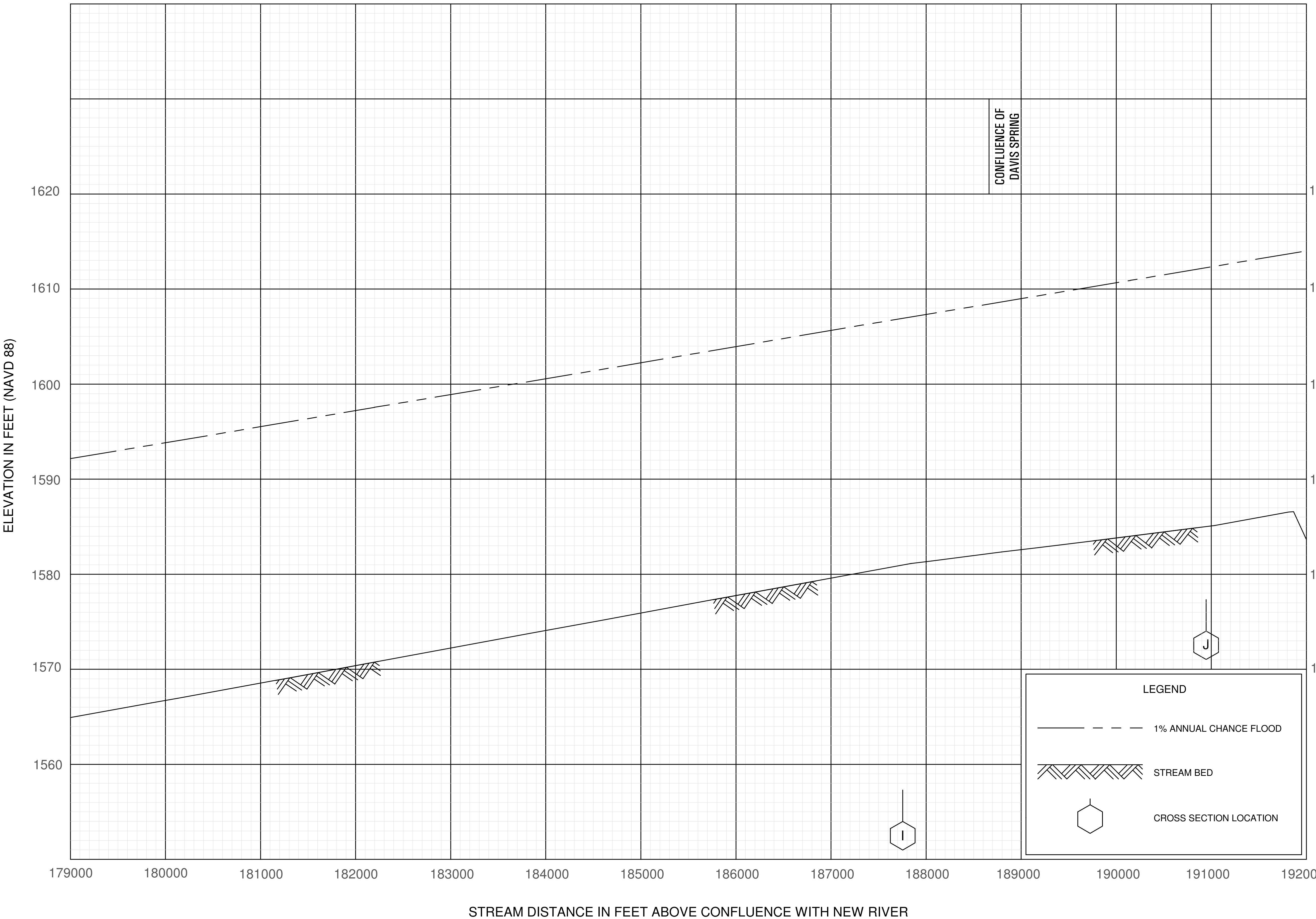


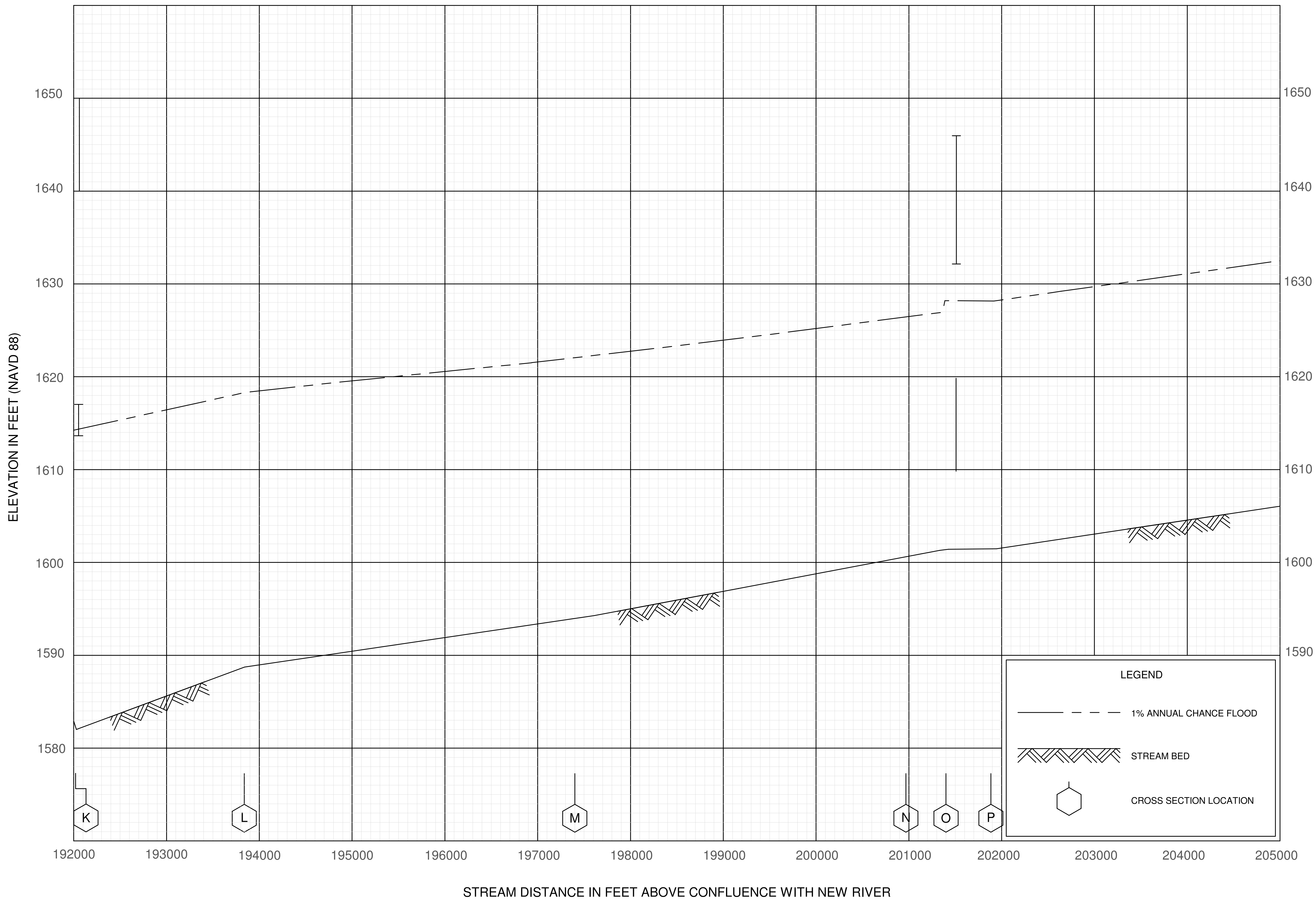
FLOOD PROFILES

GREENBRIER RIVER

FEDERAL EMERGENCY MANAGEMENT AGENCY

GREENBRIER COUNTY, WV

AND INCORPORATED AREAS



FLOOD PROFILES

GREENBRIER RIVER

FEDERAL EMERGENCY MANAGEMENT AGENCY

GREENBRIER COUNTY, WV
AND INCORPORATED AREAS

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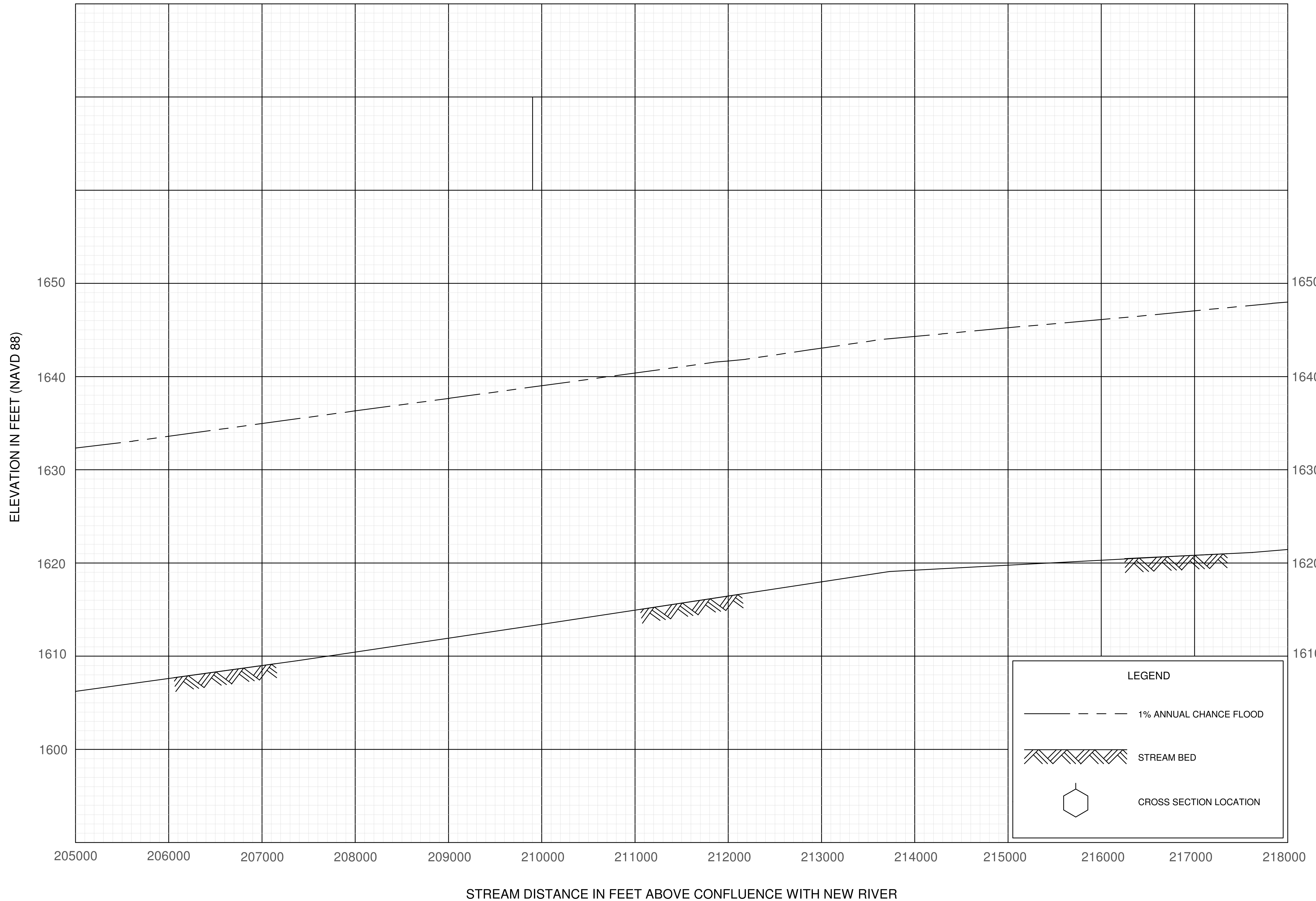

FLOOD PROFILES

GREENBRIER RIVER

FEDERAL EMERGENCY MANAGEMENT AGENCY

GREENBRIER COUNTY, WV

AND INCORPORATED AREAS

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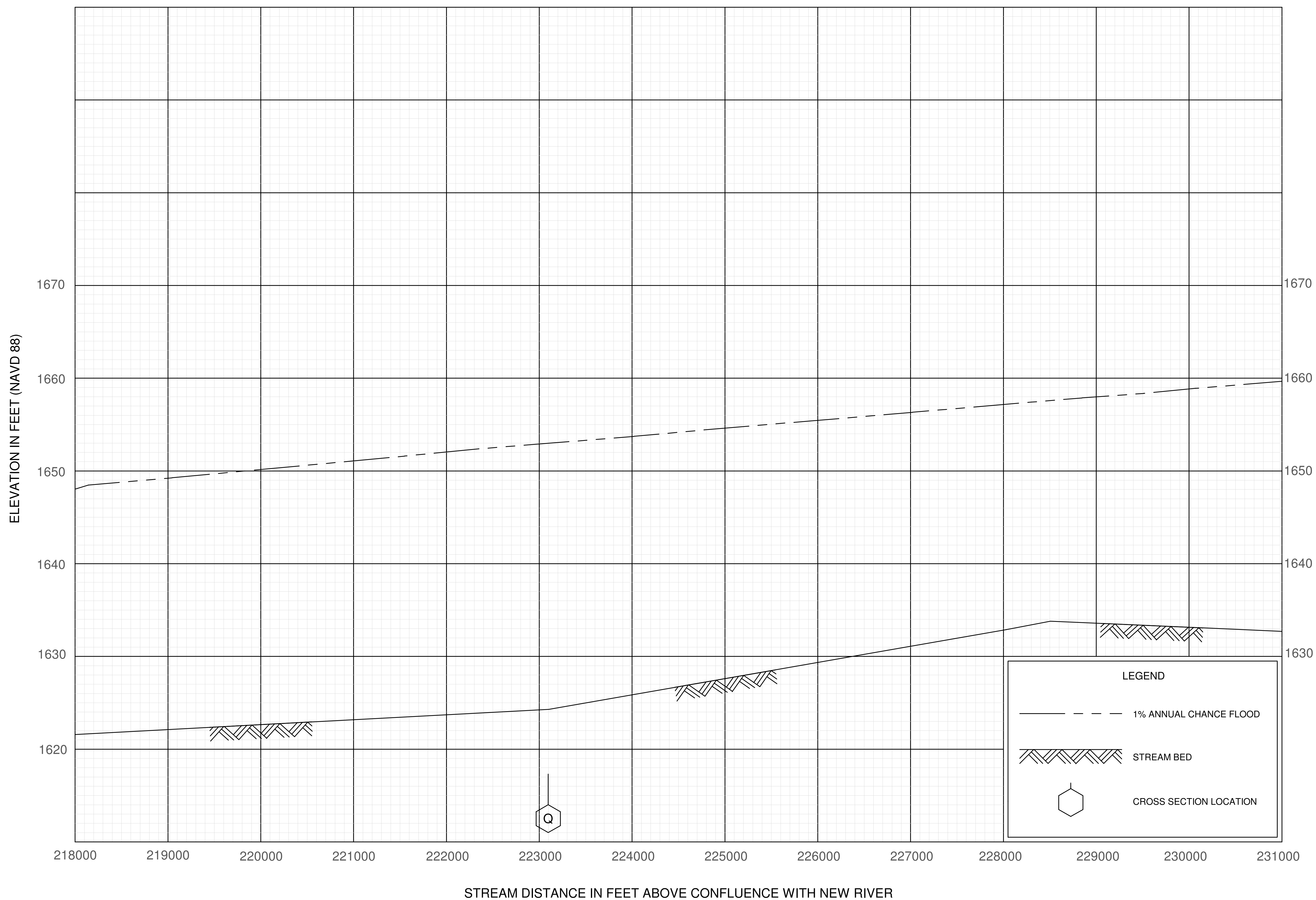

FLOOD PROFILES

GREENBRIER RIVER

FEDERAL EMERGENCY MANAGEMENT AGENCY

GREENBRIER COUNTY, WV

AND INCORPORATED AREAS

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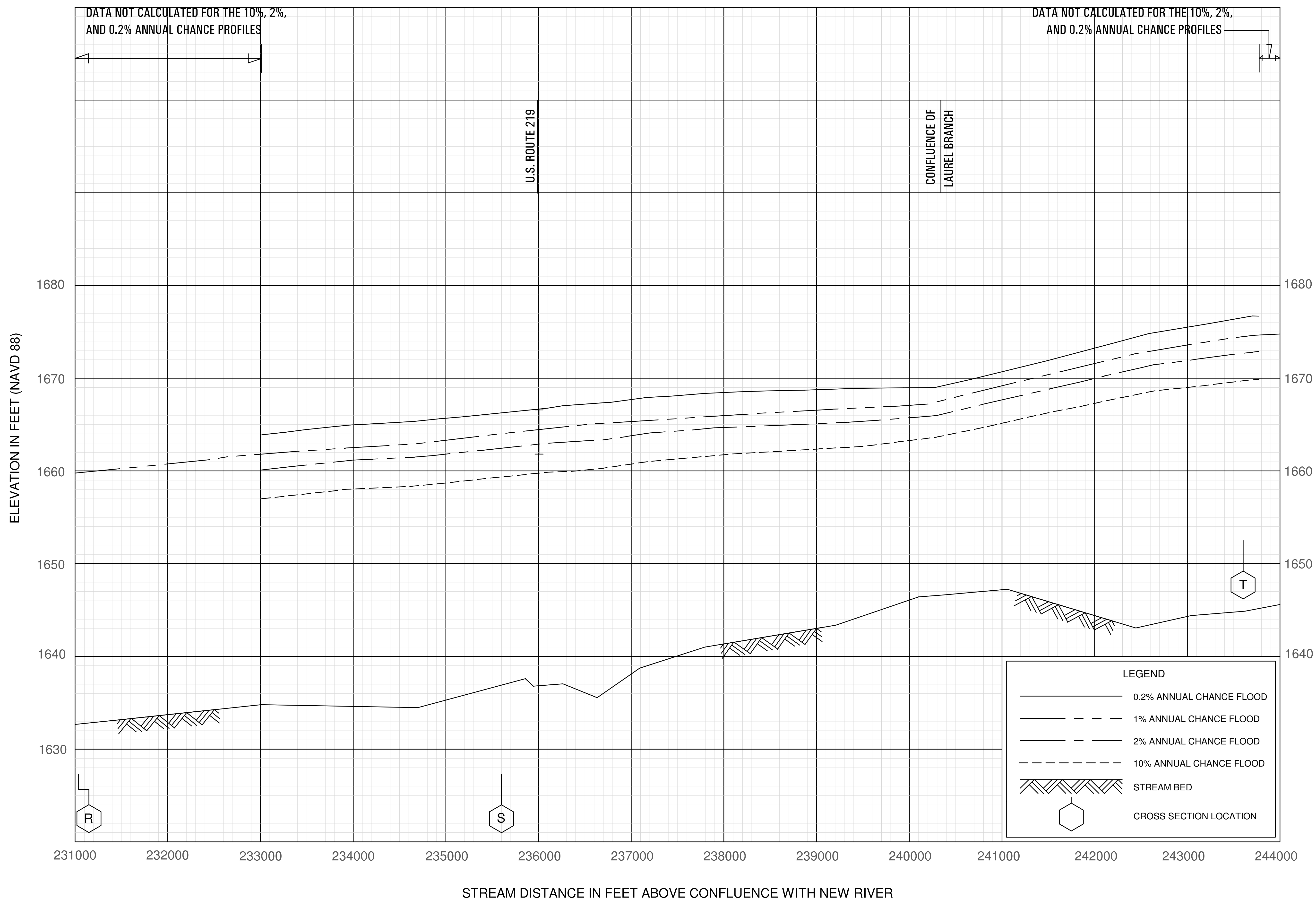


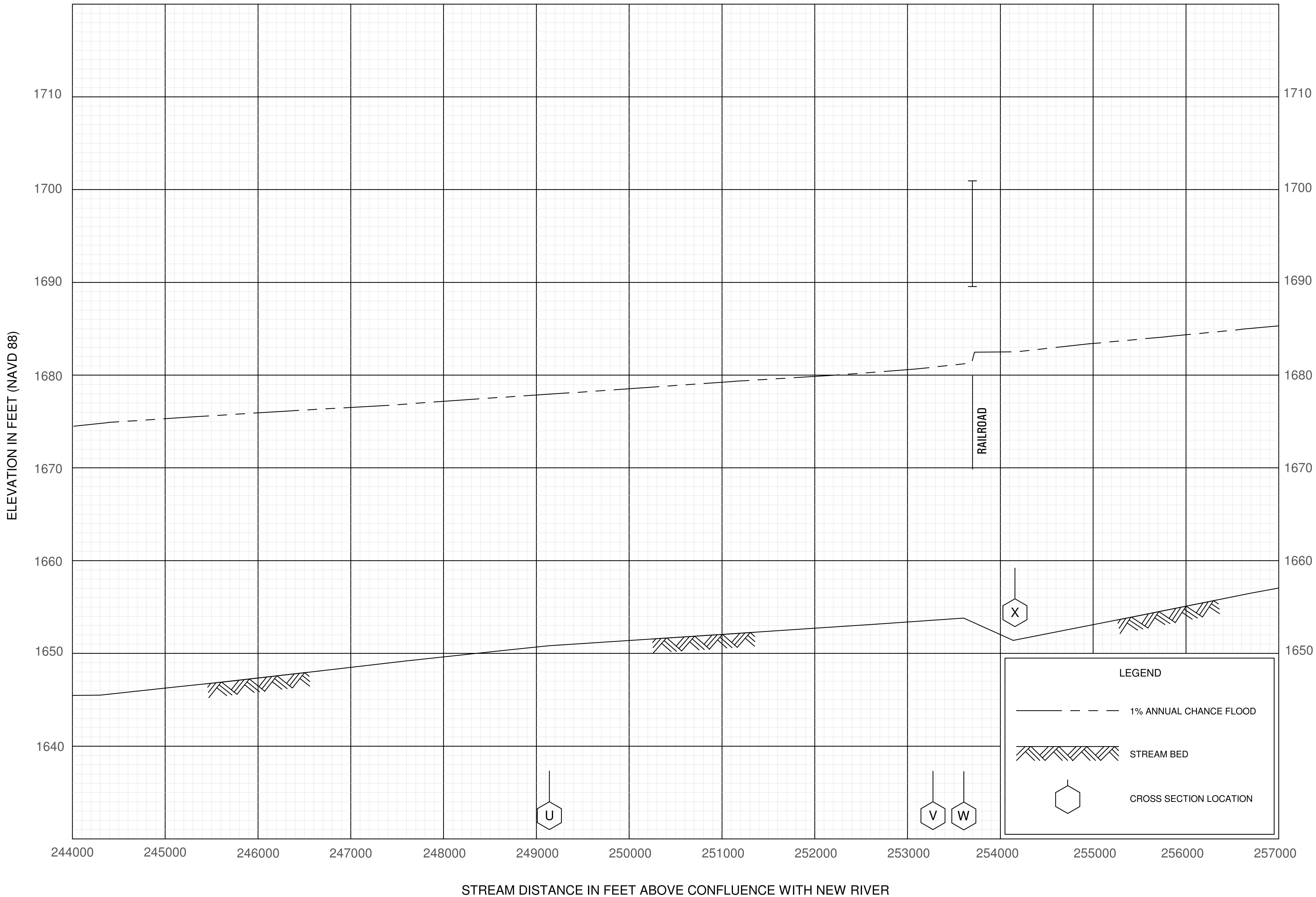
FLOOD PROFILES

GREENBRIER RIVER

FEDERAL EMERGENCY MANAGEMENT AGENCY

GREENBRIER COUNTY, WV

AND INCORPORATED AREAS



FLOOD PROFILES

GREENBRIER RIVER

FEDERAL EMERGENCY MANAGEMENT AGENCY

GREENBRIER COUNTY, WV

AND INCORPORATED AREAS

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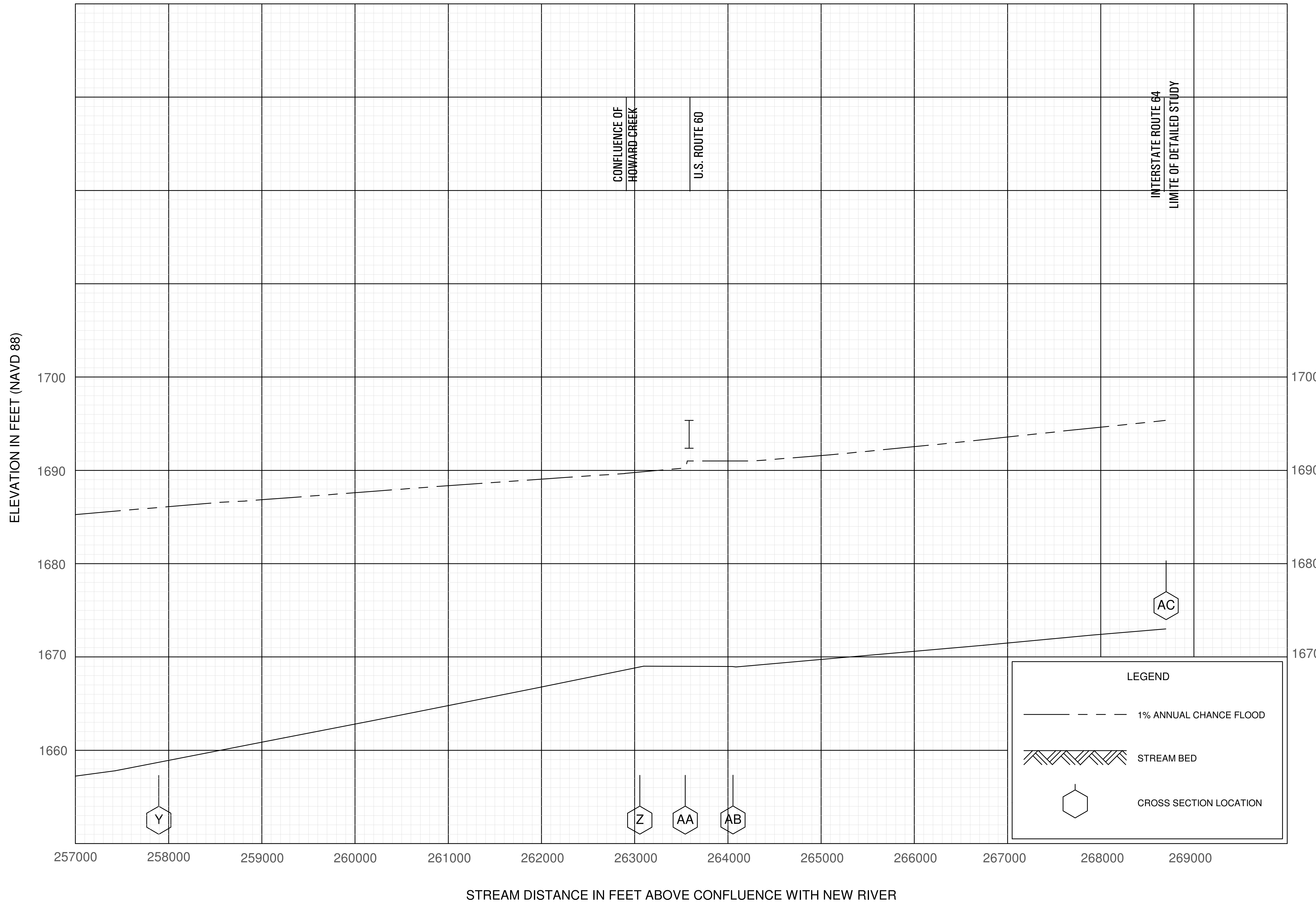


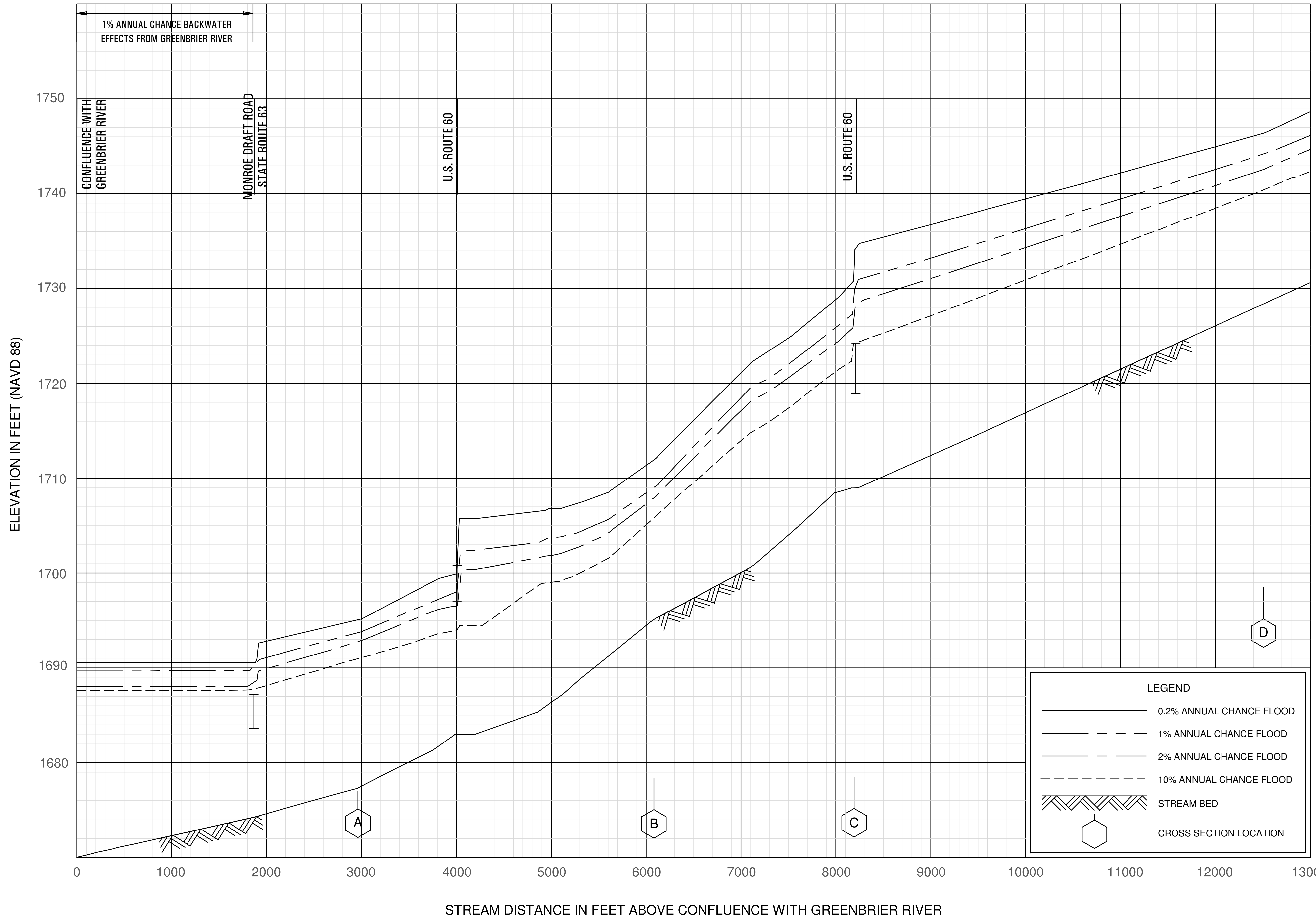
FLOOD PROFILES

GREENBRIER RIVER

FEDERAL EMERGENCY MANAGEMENT AGENCY

GREENBRIER COUNTY, WV

AND INCORPORATED AREAS



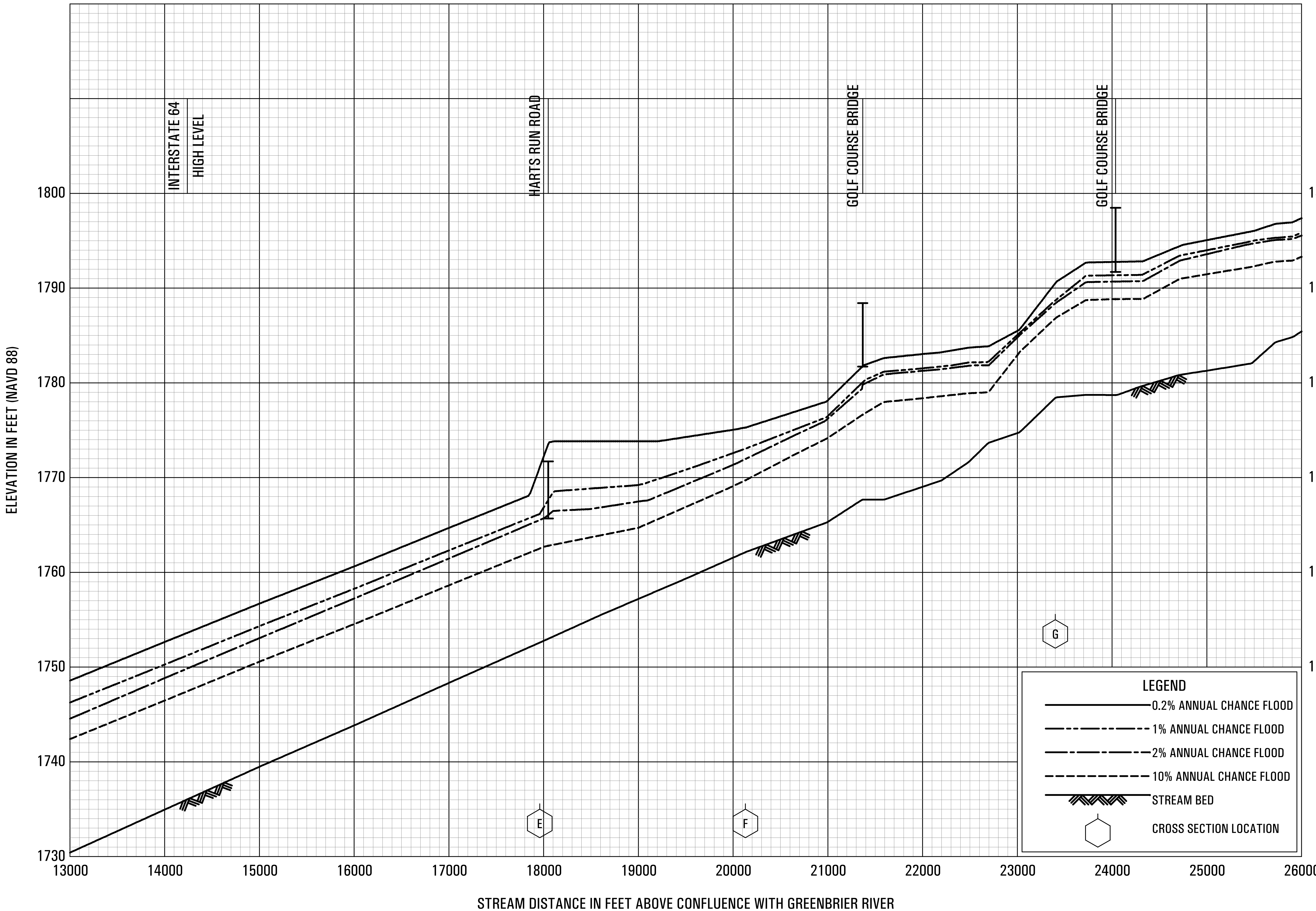
FLOOD PROFILES

HOWARD CREEK

FEDERAL EMERGENCY MANAGEMENT AGENCY

GREENBRIER COUNTY, WV

AND INCORPORATED AREAS



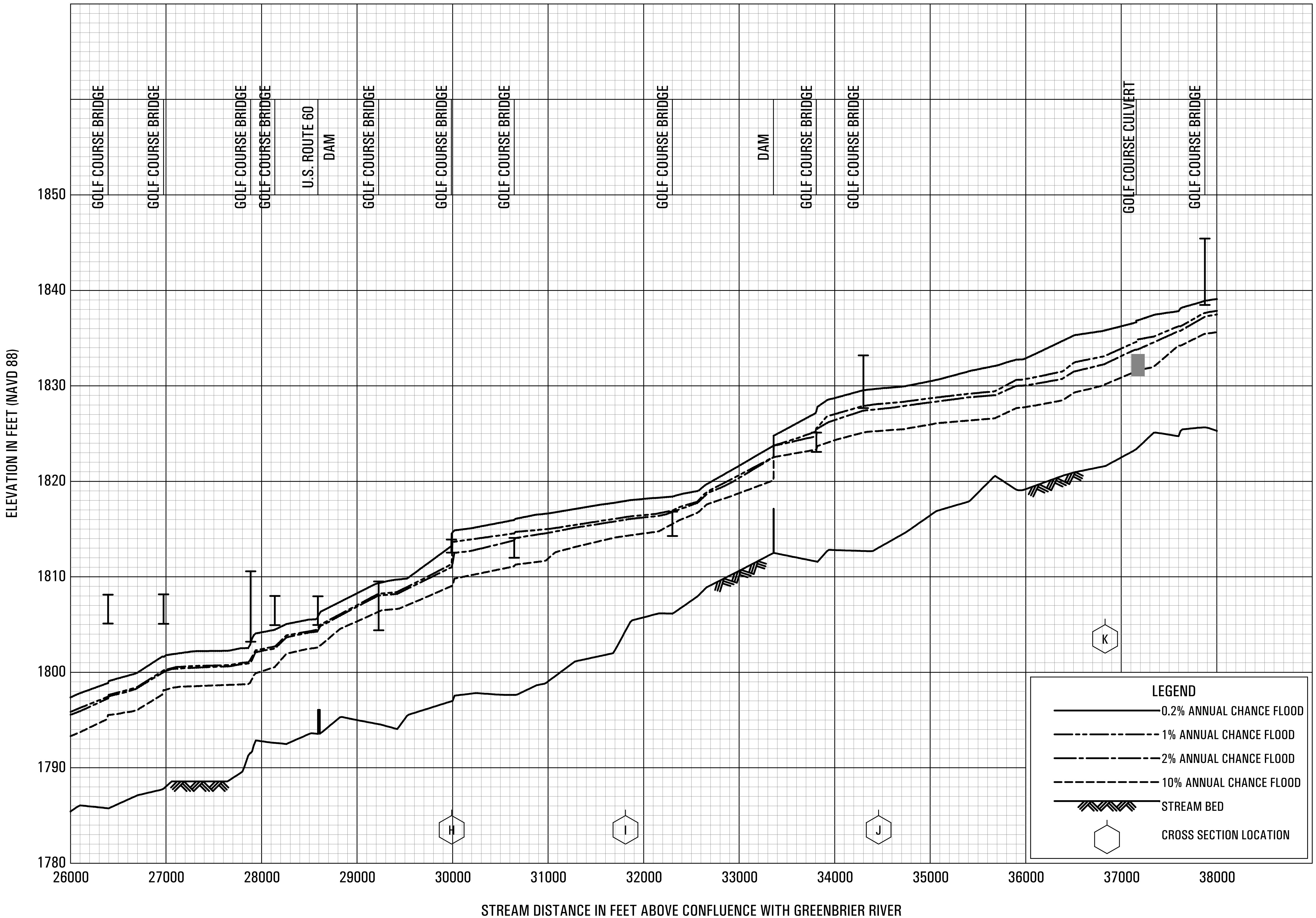
FLOOD PROFILES

HOWARD CREEK

FEDERAL EMERGENCY MANAGEMENT AGENCY

GREENBRIER COUNTY, WV

AND INCORPORATED AREAS



FLOOD PROFILES

HOWARD CREEK

FEDERAL EMERGENCY MANAGEMENT AGENCY

GREENBRIER COUNTY, WV

AND INCORPORATED AREAS

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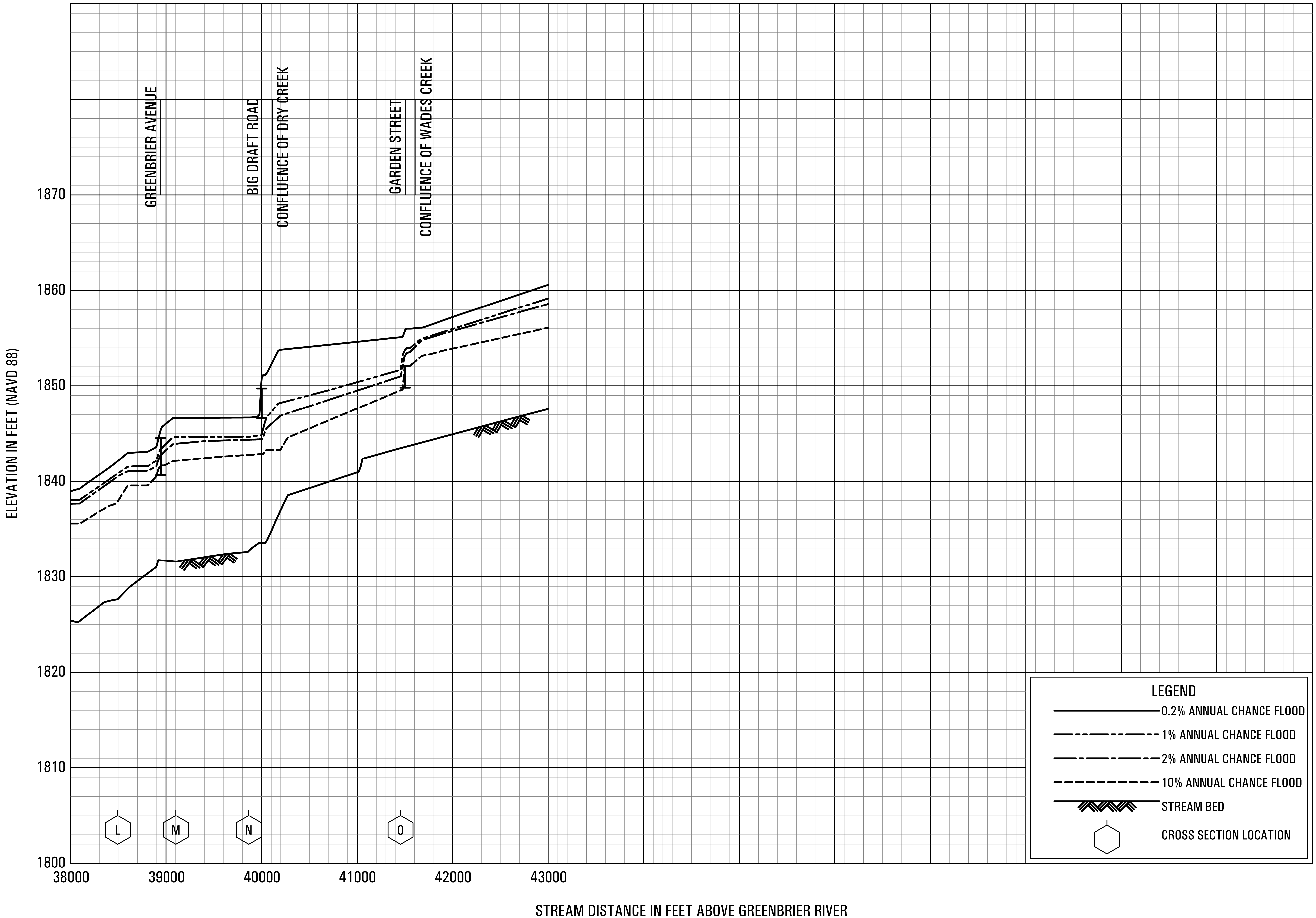


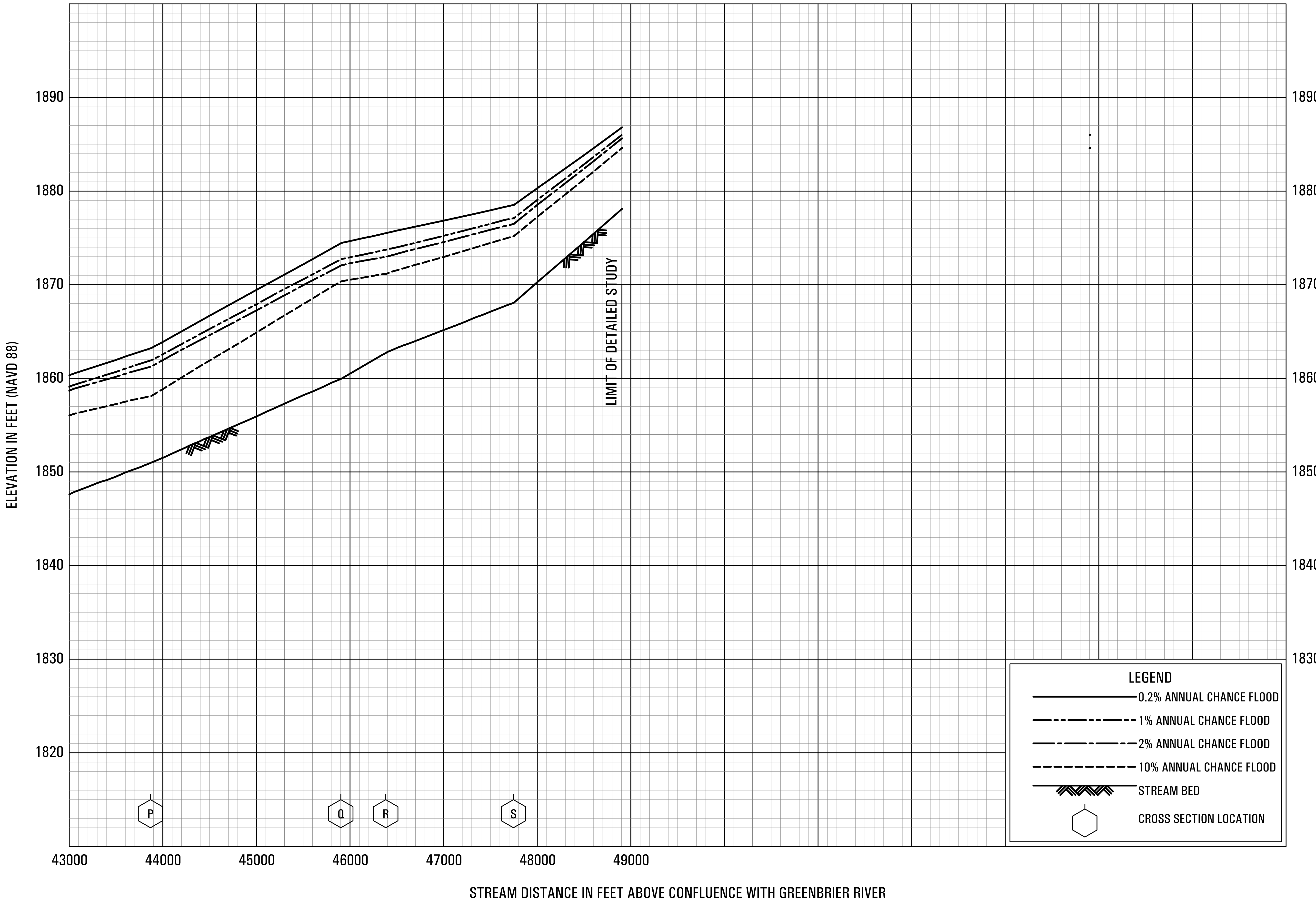
FLOOD PROFILES

HOWARD CREEK

FEDERAL EMERGENCY MANAGEMENT AGENCY

GREENBRIER COUNTY, WV

AND INCORPORATED AREAS



FLOOD PROFILES

HOWARD CREEK

FEDERAL EMERGENCY MANAGEMENT AGENCY

GREENBRIER COUNTY, WV
AND INCORPORATED AREAS

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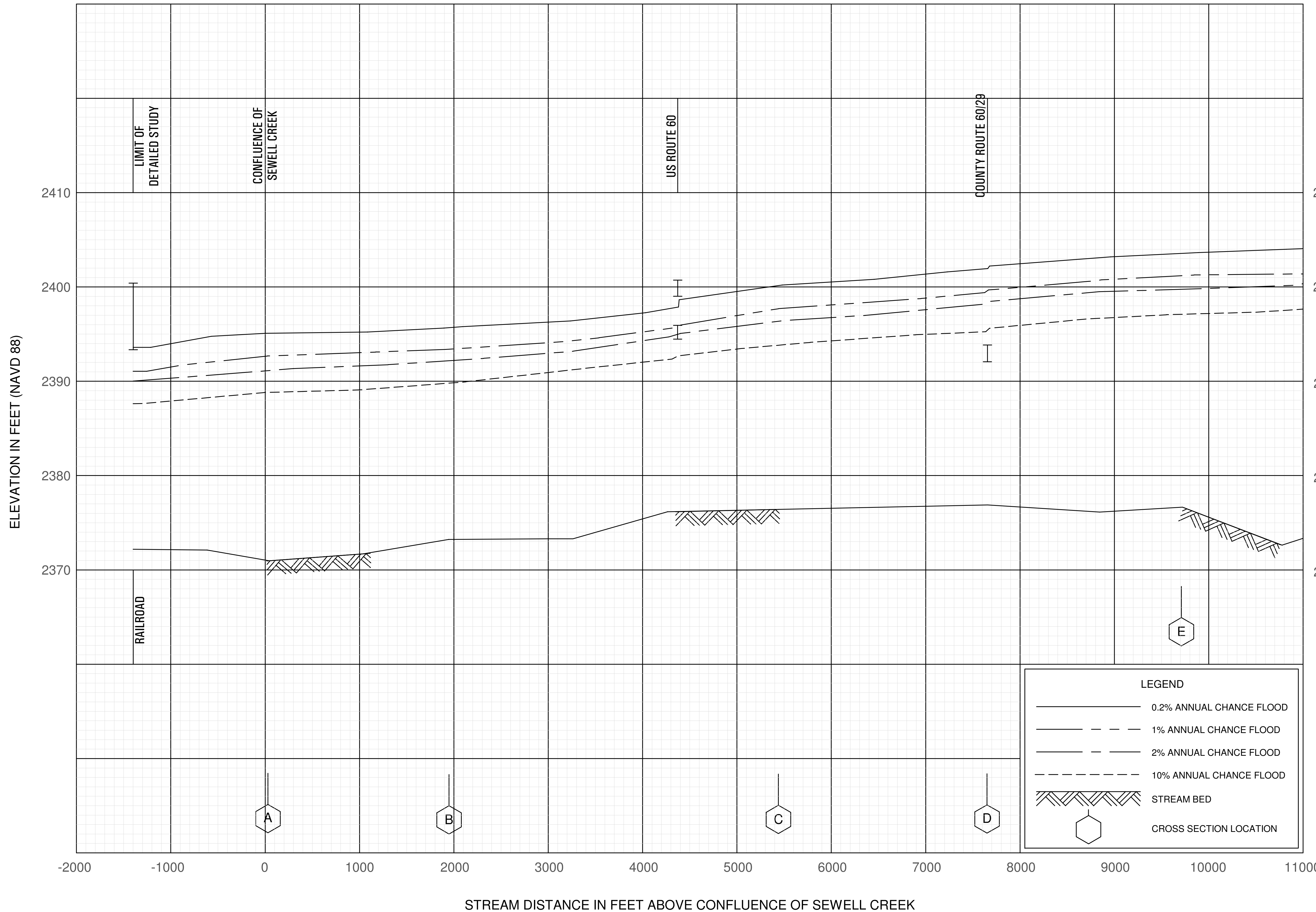


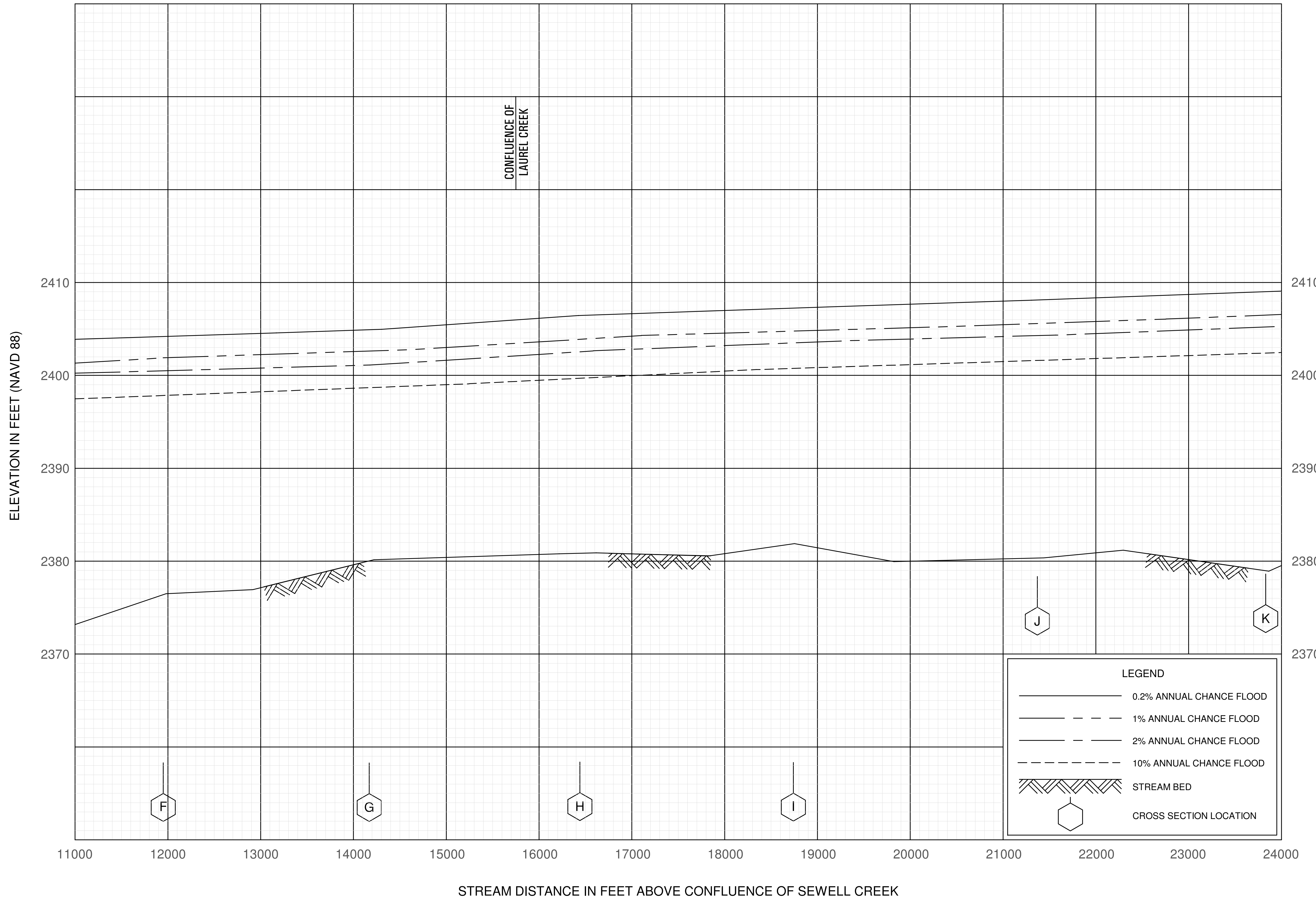
FLOOD PROFILES

MEADOW RIVER

FEDERAL EMERGENCY MANAGEMENT AGENCY

GREENBRIER COUNTY, WV

AND INCORPORATED AREAS



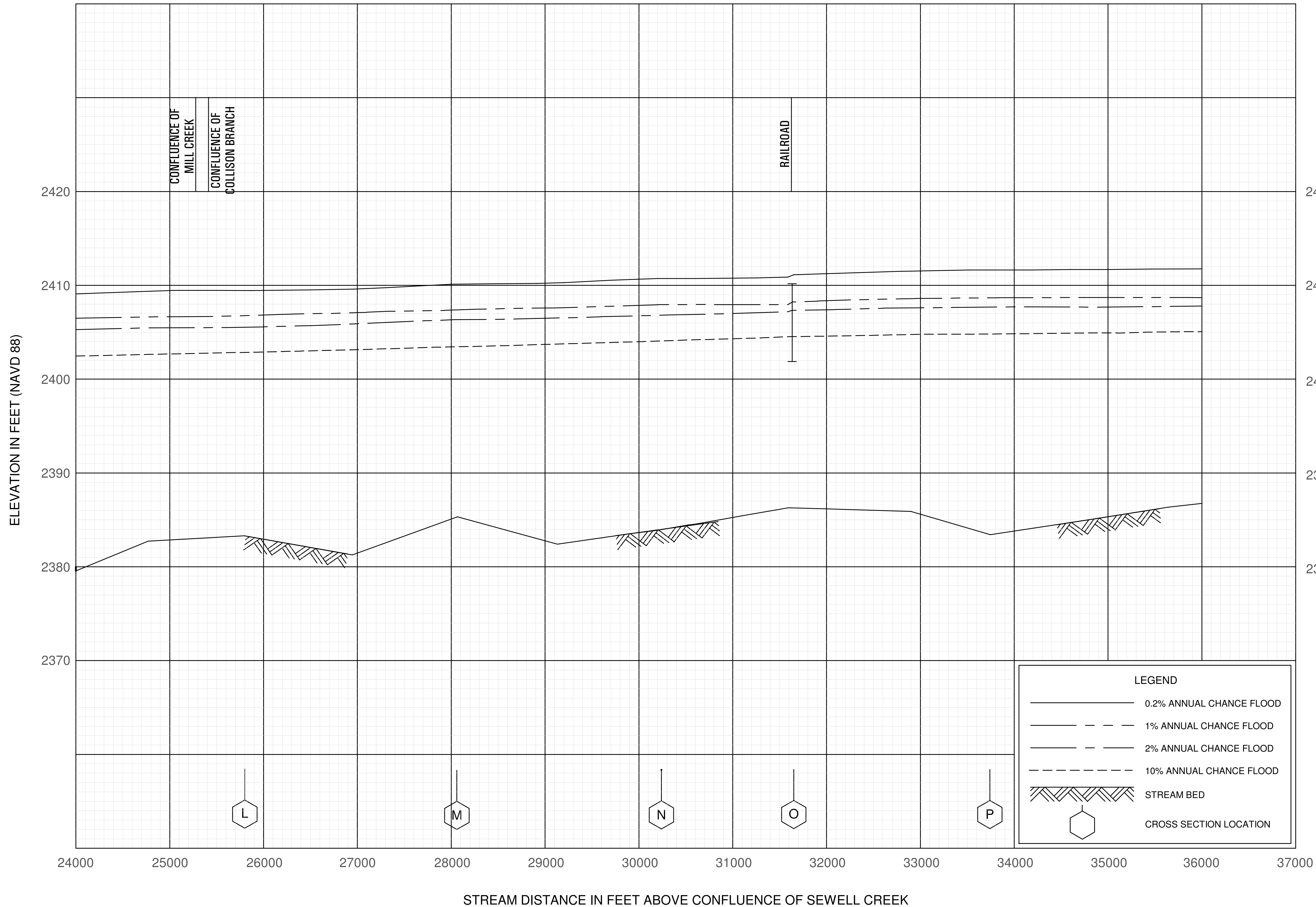
FLOOD PROFILES

MEADOW RIVER

FEDERAL EMERGENCY MANAGEMENT AGENCY

GREENBRIER COUNTY, WV

AND INCORPORATED AREAS



FLOOD PROFILES

MEADOW RIVER

FEDERAL EMERGENCY MANAGEMENT AGENCY

GREENBRIER COUNTY, WV

AND INCORPORATED AREAS

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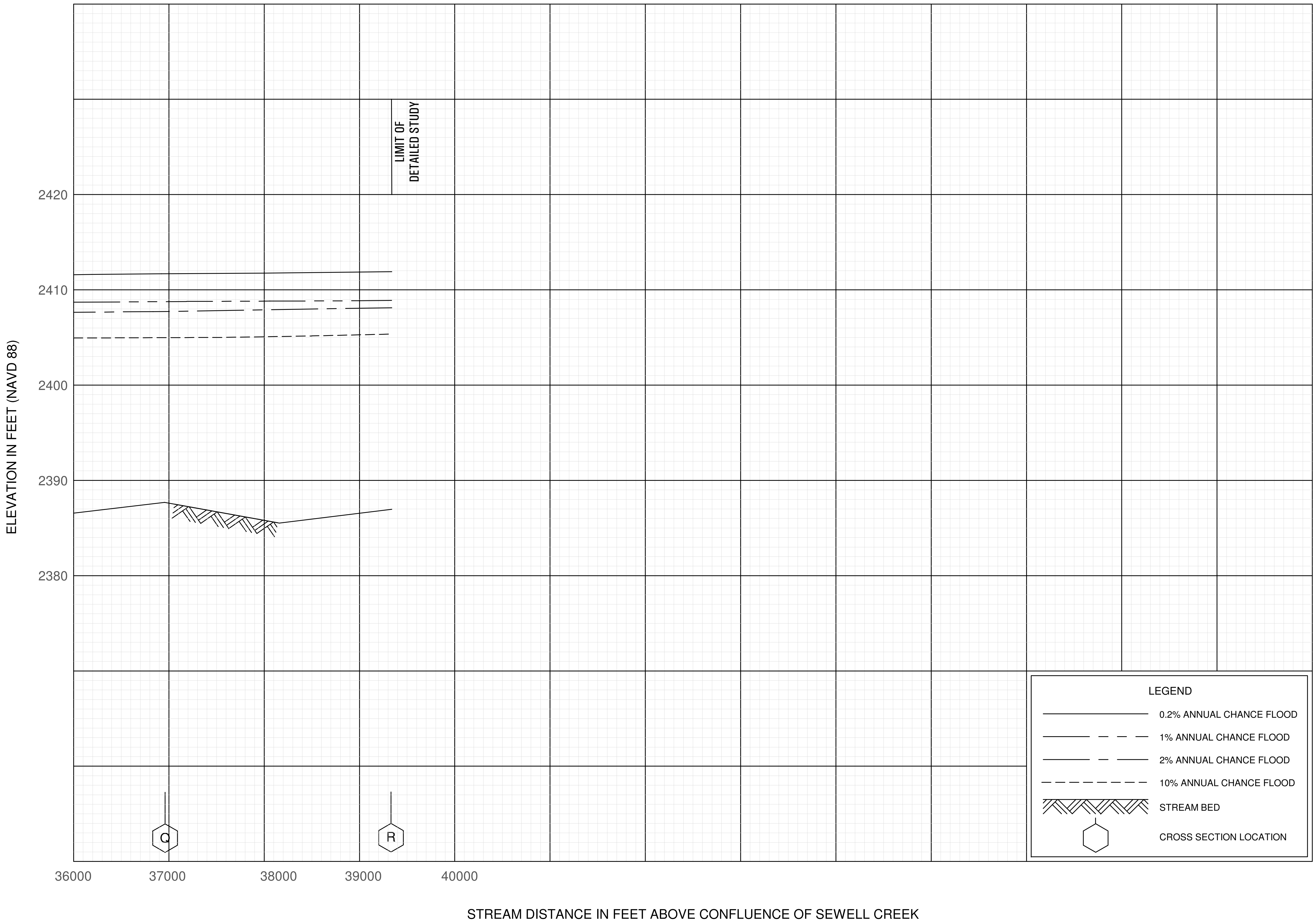
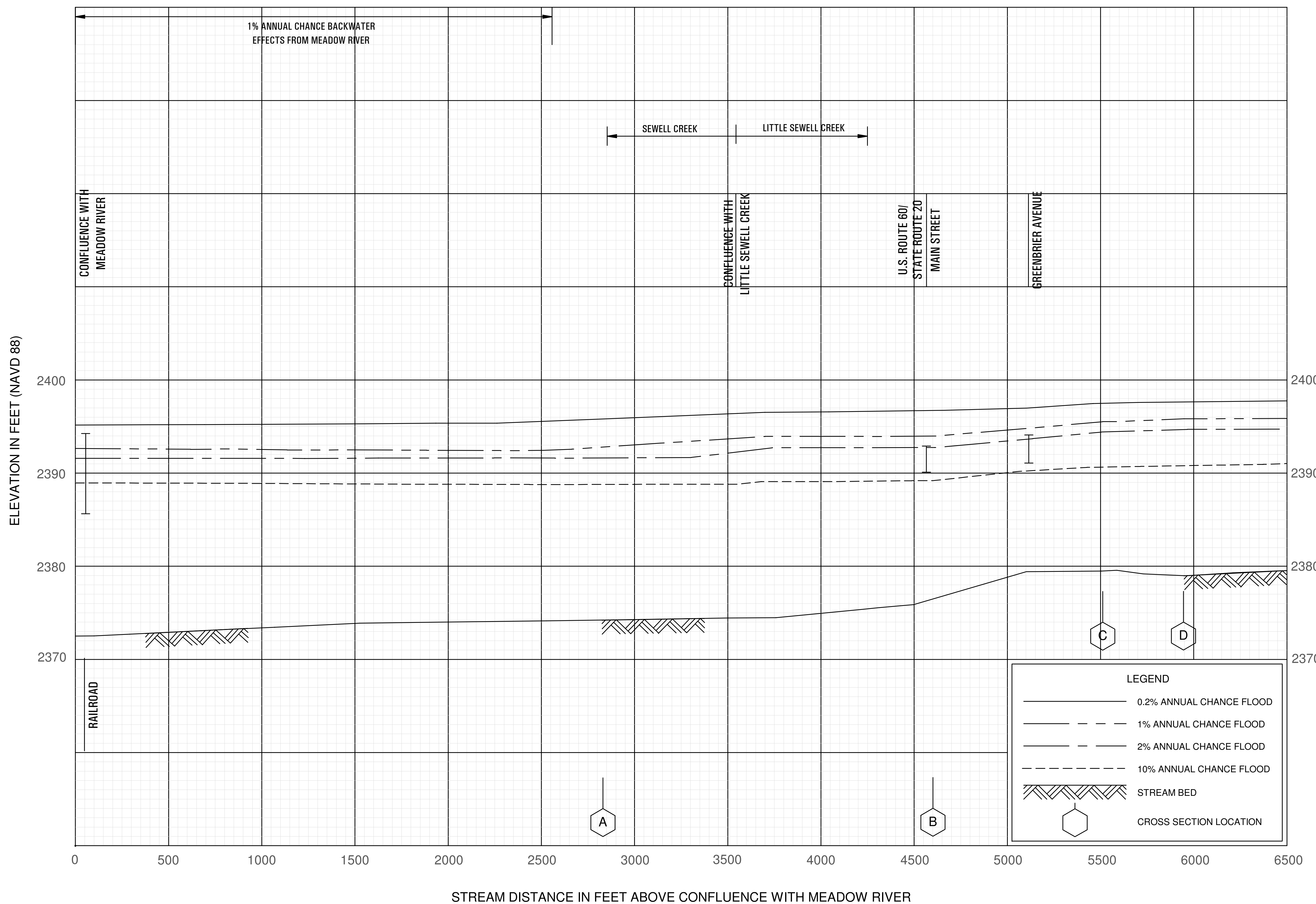


FLOOD PROFILES

MEADOW RIVER

FEDERAL EMERGENCY MANAGEMENT AGENCY

GREENBRIER COUNTY, WV
AND INCORPORATED AREAS

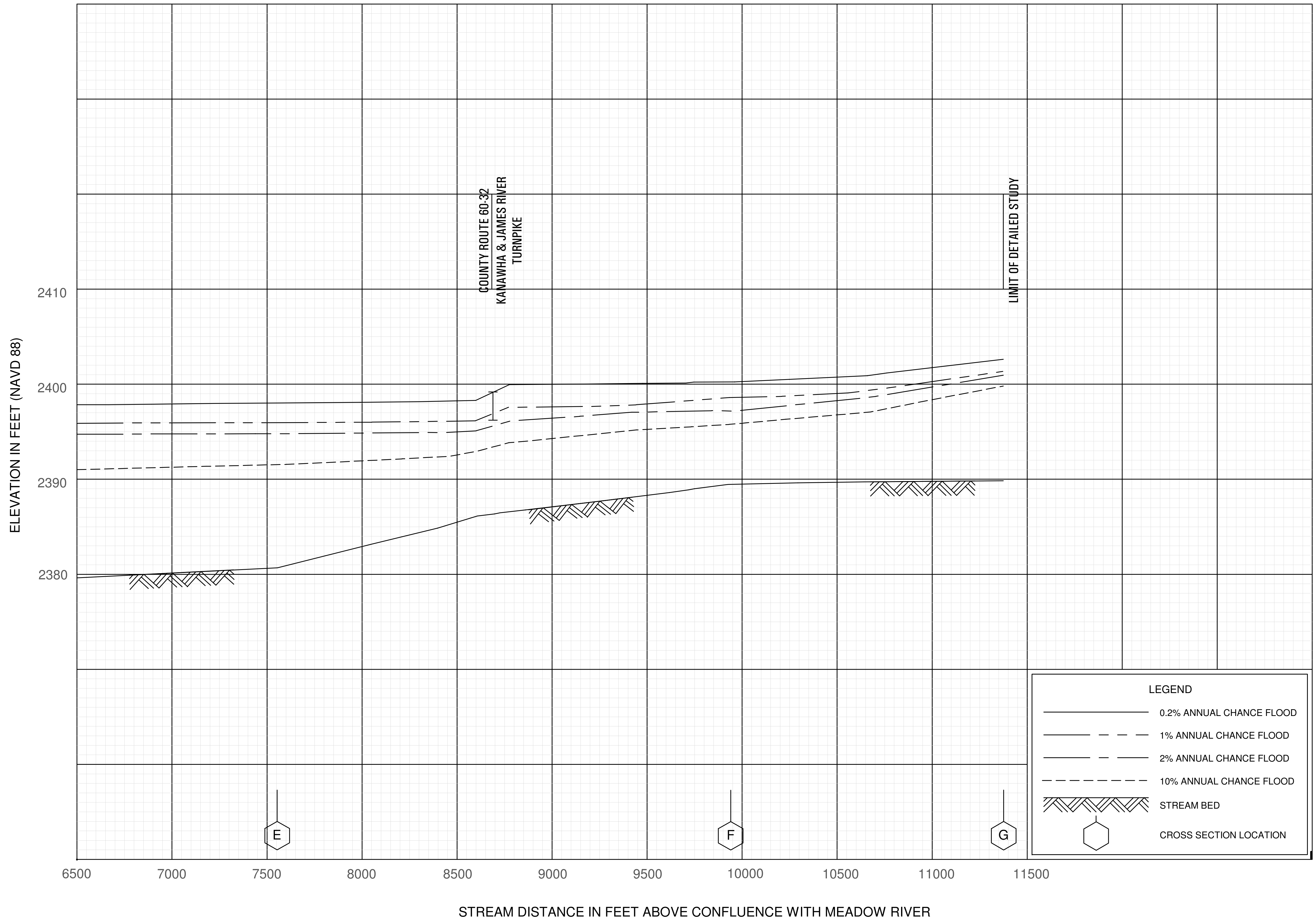


FLOOD PROFILES

SEWELL CREEK/LITTLE SEWELL CREEK

FEDERAL EMERGENCY MANAGEMENT AGENCY

GREENBRIER COUNTY, WV
AND INCORPORATED AREAS



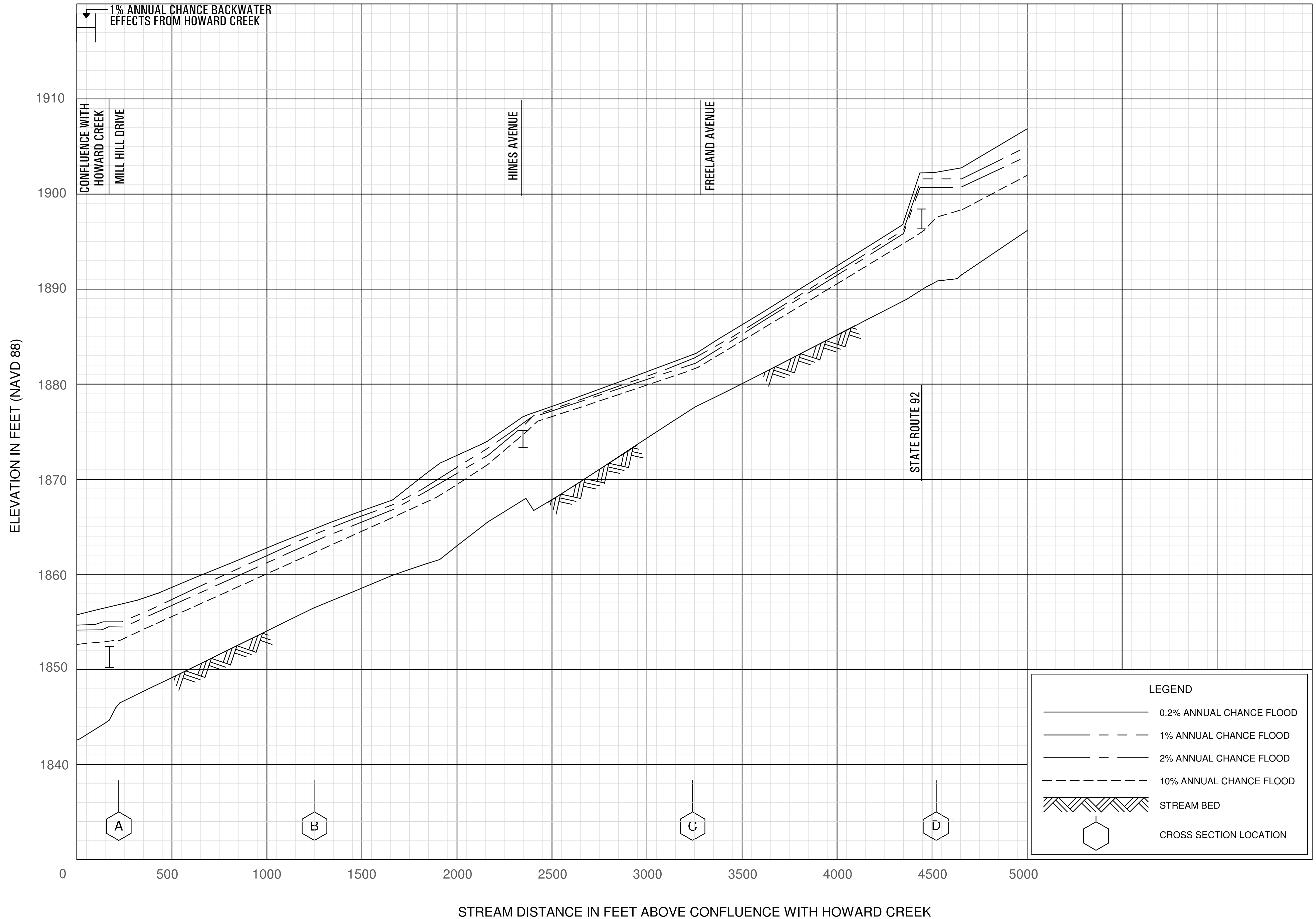
FLOOD PROFILES

LITTLE SEWELL CREEK

FEDERAL EMERGENCY MANAGEMENT AGENCY

GREENBRIER COUNTY, WV

AND INCORPORATED AREAS

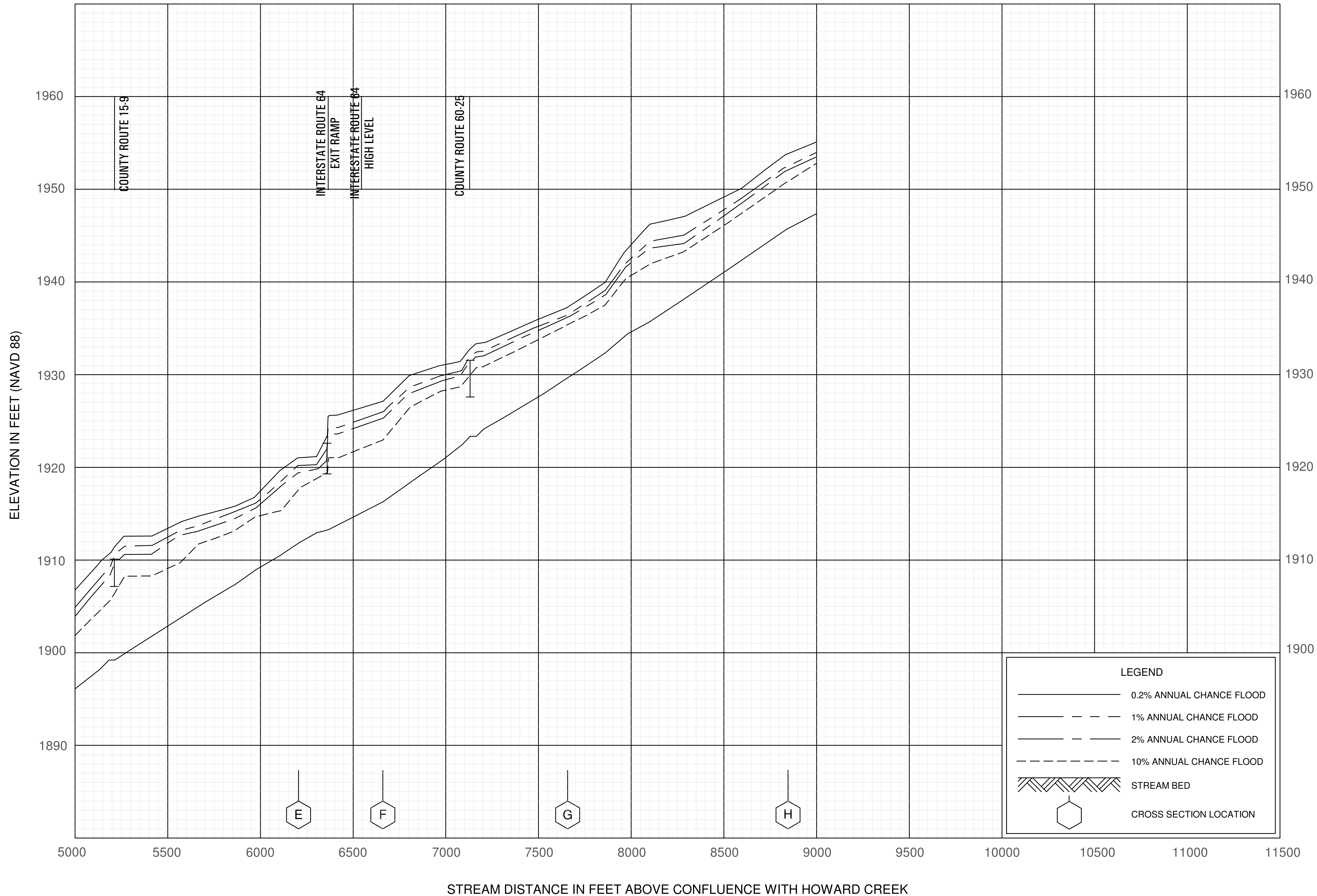


FLOOD PROFILES

WADES CREEK

FEDERAL EMERGENCY MANAGEMENT AGENCY

GREENBRIER COUNTY, WV
AND INCORPORATED AREAS



FLOOD PROFILES

WADES CREEK

FEDERAL EMERGENCY MANAGEMENT AGENCY

GREENBRIER COUNTY, WV
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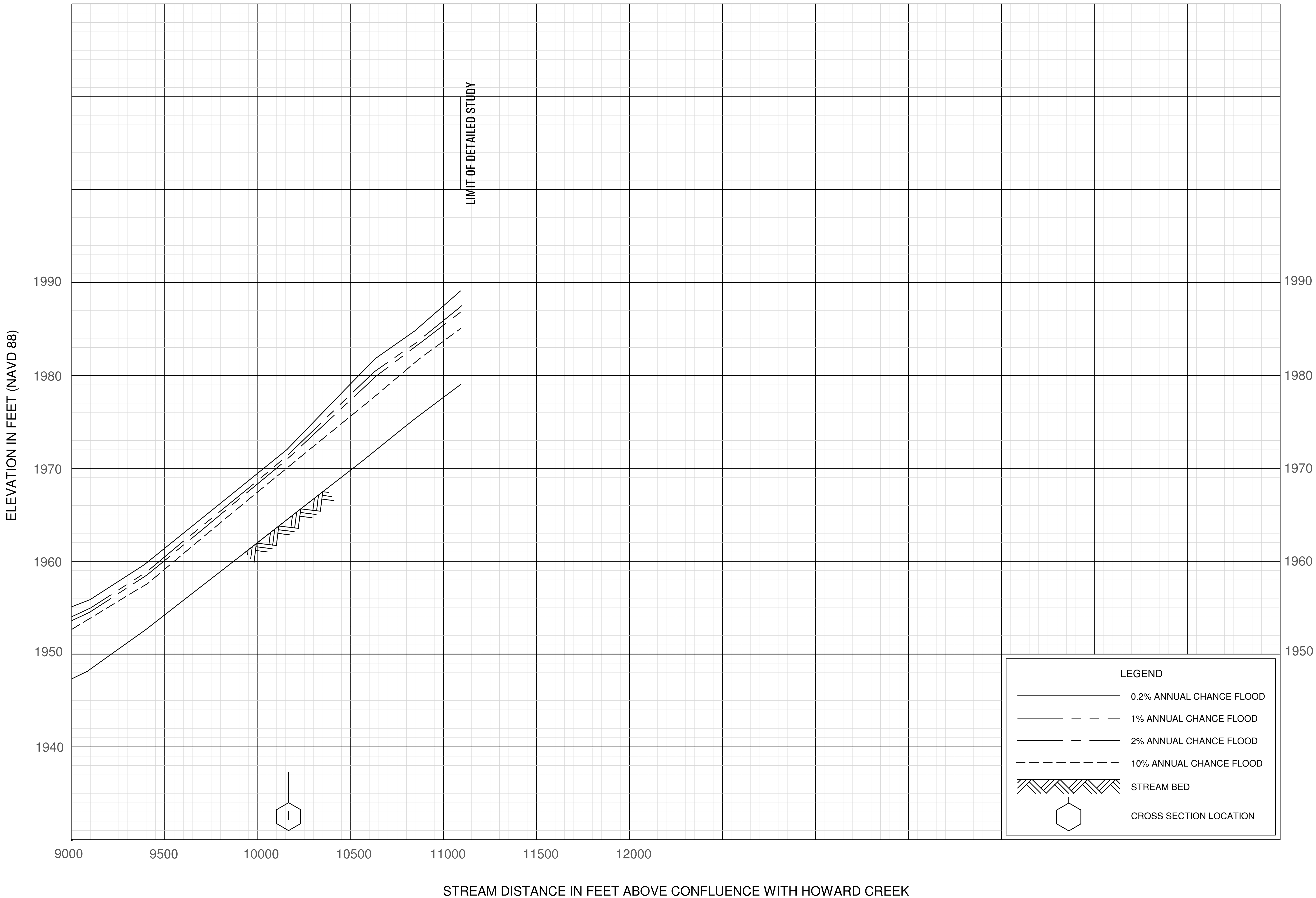

FLOOD PROFILES

WADES CREEK

FEDERAL EMERGENCY MANAGEMENT AGENCY

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