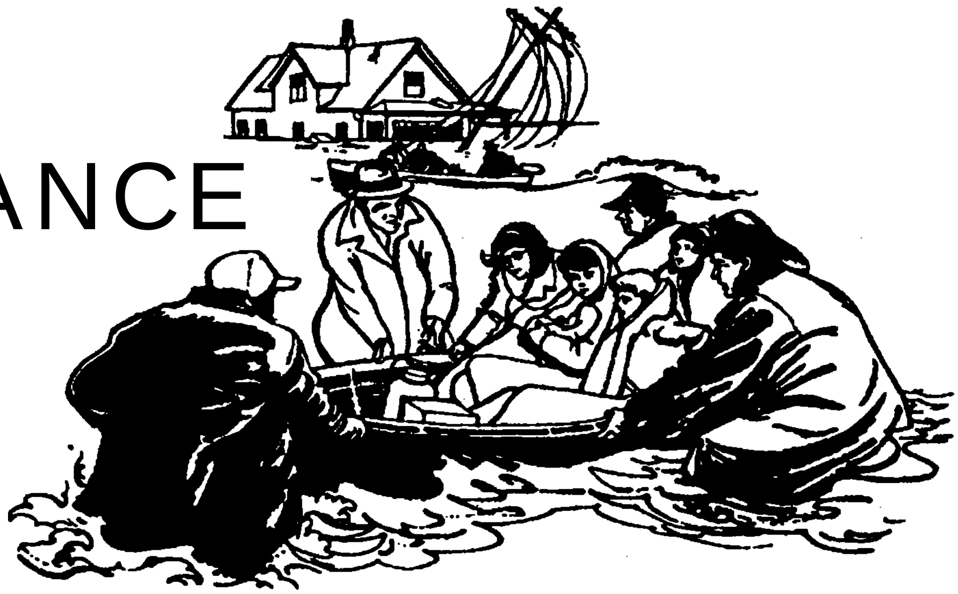
# FLOOD INSURANCE STUDY



**VOLUME 1 OF 2**

# FREDERICK COUNTY, MARYLAND AND INCORPORATED AREAS

| COMMUNITY NAME | COMMUNITY NUMBER |
|---|---|
| BRUNSWICK, CITY OF | 240028 |
| BURKITTSVILLE, VILLAGE OF | 240164 |
| EMMITSBURG, TOWN OF | 240029 |
| FREDERICK, CITY OF | 240030 |
| FREDERICK COUNTY (UNINCORPORATED AREAS) | 240027 |
| MIDDLETOWN, TOWN OF | 240162 |
| MOUNT AIRY, TOWN OF | 240200 |
| MYERSVILLE, TOWN OF | 240116 |
| NEW MARKET, TOWN OF | 240088 |
| ROSEMONT, VILLAGE OF | 240085 |
| THURMONT, TOWN OF | 240031 |
| WALKERSVILLE, TOWN OF | 240032 |
| WOODSBORO, TOWN OF | 240033 |


September 19, 2007

Federal Emergency Management Agency

FLOOD INSURANCE STUDY NUMBER
24021CV001A

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 information that was previously shown separately on the corresponding Flood Boundary and Floodway Map panels (e.g. floodways, cross-sections). In addition, former flood hazard zone designations have been changed as follows:

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

Initial Countywide FIS Effective Date: September 19, 2007

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FLOOD INSURANCE STUDY
FREDERICK, MARYLAND AND INCORPORATED AREAS

# 1.0 INTRODUCTION

## 1.1 Purpose of Study

This Flood Insurance Study (FIS) revises and updates information on the existence and severity of flood hazards in the geographic area of Frederick County, including the Cities of Brunswick and Frederick; the Towns of Emmitsburg, Middletown, Mount Airy, Myersville, New Market, Thurmont, Walkersville, and Woodsboro; the Villages of Burkittsville and Rosemont; and the unincorporated areas of Frederick County (referred to collectively herein as Frederick 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 and to assist the community in its efforts to promote sound floodplain management. Minimum floodplain management requirements for participation in the National Flood Insurance Program (NFIP) are set forth in the Code of Federal Regulations at 44 CFR, 60.3.

Please note that the Town of Mount Airy is geographically located in both Carroll and Frederick Counties and that the Town is non-floodprone.

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) will 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 FIS was prepared to include the unincorporated areas of, and incorporated communities within, Frederick County in a countywide format. 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.

| | |
|---|---|
| Emmitsburg, Town of: | The hydrologic and hydraulic analyses for this study were performed by Williams & Sheladia, Inc., for the Federal Insurance Administration (FIA), under Contract No. RFP-H-4518. This work, which was completed in April 1978, covered all significant flooding sources affecting the Town of Emmitsburg. |
| Frederick, City of: | For the original June 15, 1978 FIS, the hydrologic and hydraulic analyses were performed by Dalton, Dalton, Little, Newport for the FIA, under Contract No. H-3810. This work was completed in October, 1976. |

For the June 15, 1988 revision, the hydrologic and hydraulic analyses for a portion of Tributary No. 8 were prepared by Harris, Smariga & Associates, Inc. This work was completed in December 1986.

For the August 19, 1991 revision, the hydrologic and hydraulic analyses for Rock Creek were also prepared by Harris, Smariga & Associates, Inc. This work was completed in June 1990.

Frederick County (Unincorporated Areas): For the original December 1977 FIS, the hydrologic and hydraulic analyses were prepared for the Federal Emergency Management Agency (FEMA) by Dalton, Dalton, Little, and Newport under Contract Number H-3810. That work was completed in December 1976.

For the December 3, 1991 revision, the hydrologic and hydraulic analyses for an unnamed tributary to Hollow Creek were prepared by Vanmar Associates, Inc., of Mount Airy, Maryland. That work was completed in July 1990.

For the December 19, 1997 revision, the hydrologic and hydraulic analyses for Fishing Creek were taken from a floodplain management study prepared by the U.S. Department of Agriculture, the Natural Resources Conservation Service (NRCS), and the Maryland Department of Natural Resources, Water Resources Administration (Reference 1).

Thurmont, Town of: The hydrologic and hydraulic analyses for the March 1979 FIS were performed by Williams & Sheladia, Inc., for the FIA, under Contract No. H-H4518. This work, which was completed in April 1978, covered all significant flooding sources affecting the Town of Thurmont.

Walkersville, Town of: The hydrologic and hydraulic analyses for the March 1980 FIS were performed by Williams & Sheladia, Inc., for the FIA, under Contract No. H-H4518. This work, which was completed in April 1978, covered all significant flooding sources affecting the Town of Thurmont.

The authority and acknowledgments for the City of Brunswick, the Towns of Middletown, Mount Airy, Myersville, New Market and Woodsboro, and the Villages of Burkittsville and Rosemont are not available because FIS reports have never been published for these communities.

For this countywide FIS, revised hydrologic and hydraulic analyses were prepared for FEMA by AMEC Earth & Environmental, Inc. (AMEC) under Contract No. FS-2001-EMP-2001-RP-2411, and this work was completed in June 2005. The extents of these analyses are listed in Section 2.0 of this report.

Planimetric base map information was provided in digital format by the Frederick County Geographic Information Systems Department. These files were compiled at scales of 6000 and 12000. Additional information was derived from U.S.

Census Bureau TIGER Line Data and county supplied digital orthophotos. Users of this FIRM should be aware that minor adjustments may have been made to specific base map features.

The coordinate system used for the production of this FIRM is Universal Transverse Mercator (UTM), Zone 18 North, North American Datum of 1983 (NAD 83), GRS 80 spheroid. Corner coordinates shown on the FIRM are in latitude and longitude referenced to the UTM projection, NAD 83. Differences in the datum and spheroid used in the production of FIRMs for adjacent counties may result in slight positional differences in map features at the county boundaries. These differences do not affect the accuracy of information shown on the FIRM.

### 1.3 Coordination

Consultation Coordination Officer's (CCO) meetings may be held for each jurisdiction in this countywide FIS. An initial CCO meeting is held typically with representatives of 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.

The dates of the initial and final CCO meetings held for Frederick County and the incorporated communities within its boundaries are shown in Table 1, "Initial and Final CCO Meetings."

TABLE 1 - INITIAL AND FINAL CCO MEETINGS

| Community | Initial CCO Date | Final CCO Date |
|---|---|---|
| Town of Emmitsburg | April 21, 1977 | July 26,1978 |
| City of Frederick | September 30, 1975 | August 10, 1976 |
| Town of Thurmont | April 21, 1977 | October 12, 1978 |
| Town of Walkersville | April 1977 | January 30, 1979 |
| Frederick County, Unincorporated Areas | February 1975 | November 24, 1976 |

For this countywide FIS, the initial CCO meeting was held June 11, 2003. In attendance were representatives from FEMA, the State of Maryland, the City of Frederick, Frederick County, and AMEC. A final CCO meeting was held on August 30, 2005, and was attended by representatives from FEMA, the State of Maryland, the Cities of Brunswick and Frederick, the Towns of Emmitsburg, Middletown, Mount Airy, Myersville, Thurmont and Walkersville, the Village of Burkettsville, Frederick County, Fort Detrick, and AMEC.

## 2.0 AREA STUDIED

### 2.1 Scope of Study

This FIS covers the geographic area of Frederick County, Maryland.

For this revision, effective analyses for portions of Glade Creek and Little Tuscarora Creek were utilized to redelineate 1% (100-year) and 0.2% (500-year) annual chance floodplains according to more up-to-date topographic data. For a portion of Tuscarora Creek, water-surface elevations from the hydraulic analyses in support of a Letter of Map Revision (Case No. 03-03-121P) were used to redelineate 1% and 2% annual chance floodplain boundaries. In addition, the following streams were studied by approximate methods:

Beaver Branch, Bennett Creek, Bens Branch, Bolivar Branch (Tributary No. 13), Bolivar Branch (Tributary No. 14), Broad Run, Bussard Branch, Cabbage Run, Catoctin Creek, Cattail Branch, Deer Spring Branch, Doubs Branch (Tributary No. 26), Dry Run, Fahrney Branch, Friends Creek, Frostown Branch, Hazelnut Run, Harman Branch (Tributary No. 7), Hollow Creek, Hunting Creek, Israel Creek, Laurel Branch, Lewis Mill Branch, Linganore Creek, Little Bennett Creek, Little Catoctin Creek East, Little Catoctin Creek South, Little Catoctin Creek West, Little Hunting Creek, Little Owens Creek, Long Branch, Manor Run (Tributary No. 20), Middle Creek, Middle Catoctin Creek, Monocacy River, Muddy Creek, Muddy Run, North Branch, Owens Creek, Renn Branch (Tributary No. 115), Samuels Run, Spruce Run, Stony Branch, Toms Creek, Town Branch, Tributary No. 3 to Bennett Creek, Tributary No. 3 to Little Catoctin Creek South, Tributary No. 3 to Tuscarora Creek (II), Tributary No. 4 to Bennett Creek, Tributary No. 4 to Little Catoctin Creek South, Tributary No. 9 to Cone Branch, Tributary No. 9 to Middle Catoctin Creek, Tributary No. 10 to Middle Catoctin Creek, Tributary No. 62 to Beaver Branch, Tributary No. 63 to Beaver Branch, Tributary No. 69, Tributary No. 77 to Hunting Creek, Tributary No. 78 to Hunting Creek, Tributary No. 83 to Fishing Creek, Tributary No. 104 to Town Branch, Tributary No. 110 to Hazelnut Run, Turkey Creek, Tuscarora Creek, Tuscarora Creek (II), Unnamed Tributary No. 1 to Bens Branch, Unnamed Tributary to Tuscarora Creek (II), Unnamed Tributary to Urbana Branch, Urbana Branch.

Approximate analyses were used to study those areas having a low development potential or minimal flood hazards. The scope and methods of study were proposed to, and agreed upon by, FEMA and Frederick County.

All or portions of the flooding sources listed in Table 2, "Studied Stream Reaches," were studied by either detailed or limited detailed methods as part of this revision. Streams studied by limited detailed methods include only the 1% annual chance flood profile. Floodways have been developed for a portion of the limited detailed streams as designated in Table 2 below. Limits of detailed study are also indicated on the Flood Profiles (Exhibit 1) and on the FIRM.

TABLE 2 - STUDIED STREAM REACHES

| Stream | Study Area Description | Study Type |
|---|---|---|
| Ballenger Creek | From the confluence with Monocacy River to 0.2 mile downstream of Mount Phillip Road | Limited Detail (1% annual chance only) |
| Bush Creek | From the confluence with Monocacy River to a point 0.2 mile upstream of Green Valley Road | Limited Detail (1% annual chance only) |
| Butterfly Branch (Tributary No. 116) | From the confluence with Ballenger Creek to 0.3 mile upstream of Jefferson Pike | Limited Detail (1% annual chance only) |
| Carroll Creek | From the confluence with Monocacy River to the confluence of Silver Spring Branch (Tributary No. 95) | Detailed with Floodway |
| Carroll Creek | From the confluence of Silver Spring Branch (Tributary No. 95) to approximately 850 feet downstream of Edgewood Church Road | Limited Detail (1% annual chance only)* |
| Claggett Run (Tributary No. 129) | From the confluence with Rocky Fountain Run to 0.4 mile upstream of Fingerboard Road | Limited Detail (1% annual chance only) |
| Clifford Branch (Tributary No. 87) | From the confluence with Tuscarora Creek to 0.3 mile upstream of Hamburg Road | Limited Detail (1% annual chance only)* |
| Clifton Branch (Tributary No. 98) | From the confluence with Rock Creek to 0.5 mile upstream of Mt. Phillip Road | Detailed with Floodway |
| Detrick Branch (Tributary No. 9) | From the confluence with Monocacy River to 0.1 mile upstream of N. Market Street | Detailed with Floodway |
| Dublin Branch | From the confluence with Glade Creek to 1.4 miles upstream | Limited Detail (1% annual chance only)* |
| Edison Branch | From the confluence with Carroll Creek to downstream side of Christophers Crossing | Limited Detail (1% annual chance only)* |
| Glade Creek | From 0.2 mile downstream of DeVilbiss Bridge Road to 0.8 mile upstream of Glade Creek Road | Limited Detail (1% annual chance only) |
| Horsehead Run | From the confluence with Rocky Fountain Run to 1.2 miles upstream | Limited Detail (1% annual chance only) |

TABLE 2 - STUDIED STREAM REACHES - continued

| Stream | Study Area Description | Study Type |
|---|---|---|
| Israel Creek | From the confluence with Monocacy River to the downstream side of Water Street Road | Limited Detail (1% annual chance only) |
| King Branch (Tributary No. 118) | From the confluence with Ballenger Creek to downstream side of Arbor Drive | Limited Detail (1% annual chance only) |
| Linganore Creek | From the confluence with Monocacy River to downstream side of Gas House Pike | Limited Detail (1% annual chance only) |
| Little Tuscarora Creek | From the confluence with Tuscarora Creek to 0.1 mile upstream of Yellow Springs Road | Detailed with Floodway |
| Monocacy River | From the confluence with the Potomac River to 0.6 mile upstream of DeVilbiss Bridge Road Bridge | Limited Detail (1% annual chance only) |
| Park Branch (Tributary No. 8/99) | From the confluence with Monocacy River to downstream side of North East Street | Limited Detail (1% annual chance only)* |
| Pike Branch (Tributary No. 117) | From the confluence with Ballenger Creek to just upstream of Ballenger Creek Road | Limited Detail (1% annual chance only) |
| Rock Creek | From the confluence with Carroll Creek to downstream side of Baltimore National Parkway (US 40) | Detailed with Floodway |
| Rocky Fountain Run | From the confluence with Monocacy River to just downstream of New Design Road | Limited Detail (1% annual chance only) |
| Shookstown Creek (Tributary No. 96) | From the confluence with Carroll Creek to approximately 180 feet upstream of Bowers Road (2.0 miles) | Limited Detail (1% annual chance only)* |
| Shookstown Creek (Tributary No. 96) | From approximately 180 feet upstream of Bowers Road to a point 1.3 miles upstream | Limited Detail (1% annual chance only) |
| Silver Spring Branch (Tributary No. 95) | From the confluence with Carroll Creek to Kemp Lane | Detailed with Floodway |
| Silver Spring Branch (Tributary No. 95) | From Kemp Lane to approximately 400 feet downstream of Edgewood Church Road | Limited Detail (1% annual chance only)* |

TABLE 2 - STUDIED STREAM REACHES - continued

| Stream | Study Area Description | Study Type |
|---|---|---|
| Tributary No. 5 to Rock Creek | From the confluence with Rock Creek to 0.1 mile of upstream side of West Patrick Street | Detailed with Floodway |
| Tributary No. 6 to Carroll Creek | From the confluence with Carroll Creek to just downstream of Butterfly Lane (1.5 miles) | Limited Detail (1% annual chance only)* |
| Tributary No. 89 to Little Tuscarora Creek | From the confluence with Little Tuscarora Creek to downstream side of Springhill Drive | Detailed with Floodway |
| Tributary No. 122 to Horsehead Run | From the confluence with Horsehead Run to 1.1 miles upstream | Limited Detail (1% annual chance only) |
| Tributary No. 123 to Horsehead Run | From the confluence with Horsehead Run to 1.0 mile upstream | Limited Detail (1% annual chance only) |
| Tributary No. 124 to Horsehead Run | From the confluence with Horsehead Run to 0.1 mile upstream of Manor Woods Road | Limited Detail (1% annual chance only) |
| Tributary No. 125 to Horsehead Run | From the confluence with Horsehead Run to 0.4 mile upstream | Limited Detail (1% annual chance only) |
| Tributary No. 126 to Tributary No. 125 to Horsehead Run | From 0.4 mile upstream of outlet to Horsehead Run to downstream side of New Design Road | Limited Detail (1% annual chance only) |
| Tributary No. 127 to Rocky Fountain Run | From the confluence with Rocky Fountain Run to 1.1 miles upstream | Limited Detail (1% annual chance only) |
| Tributary No. 128 to Rocky Fountain Run | From the confluence with Rocky Fountain Run to just downstream of Baltimore and Ohio Railroad | Limited Detail (1% annual chance only) |
| Tributary to Glade Creek | From the confluence with Glade Creek to just downstream of DeVilbiss Bridge Road | Limited Detail (1% annual chance only) |
| Tributary to Tributary No. 89 to Little Tuscarora Creek | From the confluence with Tributary No. 89 to Little Tuscarora Creek to the upstream side of Christophers Crossing | Detailed with Floodway |
| Tuscarora Creek | From the RR Bridge downstream of Route 15 to the confluence of Clifford Branch (4.0 miles) | Limited Detail (1% annual chance only)* |

*Denotes Limited Detailed Stream for which a regulatory floodway was developed

Table 3, "Stream Name Changes," lists streams that have different names for this countywide FIS as compared to those used in previously published FIS Reports. Stream names as defined by Frederick County GIS data were utilized as primary identifiers. For consistency, the numbered tributary nomenclature used in previous FISs was maintained as a secondary identifier.

TABLE 3 - STREAM NAME CHANGES

| Community | Old Name | New Name |
|---|---|---|
| Unincorporated Areas | North Fork | Linganore Creek North Fork |
| City of Frederick and Unincorporated Areas | Tributary No. 5 | Tributary No. 5 to Rock Creek |
| City of Frederick and Unincorporated Areas | Tributary No. 6 | Tributary No. 6 to Carroll Creek |
| City of Frederick | Tributary No. 8 | Park Branch (Tributary No. 8/99) |
| City of Frederick and Unincorporated Areas | Tributary No. 9 | Detrick Branch (Tributary No. 9) |
| City of Frederick and Unincorporated Areas | Tributary No. 11 | Wormans Run (Tributary No. 11) |
| Unincorporated Areas | Tributary No. 10 | Two Mile Run (Tributary No. 10/93) |
| Town of Emmitsburg | Tributary No. 32 | Tributary No. 32 to Flat Run |
| Unincorporated Areas | Tributary No. 36 | Tributary No. 36 to Friends Creek |
| Unincorporated Areas | Tributary No. 38 | Tributary No. 38 to Tributary No. 36 to Friends Creek |
| Town of Emmitsburg and Unincorporated Areas | Tributary No. 40 | Tributary No. 40 to Flat Run |
| Unincorporated Areas | Tributary No. 41 | Tributary No. 41 to Flat Run |
| Unincorporated Areas | Tributary No. 74 | Muddy Run (Tributary No. 74) |
| Town of Thurmont, Unincorporated Areas | Tributary No. 76 | Tributary No. 76 to Hunting Creek |
| Unincorporated Areas | Tributary No. 87 | Clifford Branch (Tributary No. 87) |
| City of Frederick and Unincorporated Areas | Tributary No. 89 | Tributary No. 89 to Little Tuscarora Creek |

TABLE 3 - STREAM NAME CHANGES – continued

| Community | Old Name | New Name |
|---|---|---|
| Unincorporated Areas | Tributary to Tributary No. 89 | Tributary to Tributary No. 89 to Little Tuscarora Creek |
| City of Frederick and Unincorporated Areas | Tributary No. 93 | Two Mile Run (Tributary No. 10/93) |
| City of Frederick and Unincorporated Areas | Tributary No. 95-1 | Silver Spring Branch (Tributary No. 95) |
| Unincorporated Areas | Tributary No. 95-2 | Silver Spring Branch (Tributary No. 95) |
| Unincorporated Areas | Tributary No. 96-1 | Shookstown Creek (Tributary No. 96) |
| Unincorporated Areas | Tributary No. 96-3 | Shookstown Creek (Tributary No. 96) |
| City of Frederick and Unincorporated Areas | Tributary No. 98 | Clifton Branch (Tributary No. 98) |
| Unincorporated Areas | Tributary No. 99 | Park Branch (Tributary No. 8/99) |
| Unincorporated Areas | Tributary No. 101 | Tributary No. 101to Coppermine Branch (Tributary No. 102) |
| Unincorporated Areas | Tributary No. 102 | Coppermine Branch (Tributary No. 102) |
| Unincorporated Areas | Tributary No. 106 | Linganore Creek North Fork (Tributary No. 106) |
| Unincorporated Areas | Tributary No. 107 | Tributary No. 107 to Linganore Creek North Fork (Tributary No. 106) |
| Unincorporated Areas | Tributary No. 113 | Davis Branch (Tributary No. 113) |
| Unincorporated Areas | Tributary No. 116 | Butterfly Branch (Tributary No. 116) |
| Unincorporated Areas | Tributary No. 117 | Pike Branch (Tributary No. 117) |

TABLE 3 - STREAM NAME CHANGES - continued

| Community | Old Name | New Name |
|---|---|---|
| City of Frederick and Unincorporated Areas | Tributary No. 118 | King Branch (Tributary No. 118) |
| Unincorporated Areas | Tributary No. 122 | Tributary No. 122 to Horsehead Run |
| Unincorporated Areas | Tributary No. 123 | Tributary No. 123 to Horsehead Run |
| Unincorporated Areas | Tributary No. 124 | Tributary No. 124 to Horsehead Run |
| Unincorporated Areas | Tributary No. 125 | Tributary No. 125 to Horsehead Run |
| Unincorporated Areas | Tributary No. 126 | Tributary No. 126 to Tributary No. 125 to Horsehead Run |
| Unincorporated Areas | Tributary No. 127 | Tributary No. 127 to Rocky Fountain Run |
| Unincorporated Areas | Tributary No. 128 | Tributary No. 128 to Rocky Fountain Run |
| Unincorporated Areas | Tributary No. 129 | Claggett Run (Tributary No. 129) |
| Unincorporated Areas | Unnamed Tributary to Tributary No. 118 | Arundel Branch |

This FIS also incorporates the determinations of letters issued by FEMA resulting in map changes. These include Letters of Map Revision [LOMR], Letters of Map Revision - based on Fill [LOMR-F], and Letters of Map Amendment [LOMA], as shown in Table 4, "Letters of Map Change."

TABLE 4 - LETTERS OF MAP CHANGE

| Community | Flooding Source(s)/Project Identifier | Date Issued | Type |
|---|---|---|---|
| City of Frederick | Tuscarora Creek<br>Mill Island Parkway Bridge | June 23, 2003 | LOMR |
| Frederick County (Unincorporated Areas) | Arundel Branch<br>Kingsbrook Development | January 5, 1997 | LOMR |
| Frederick County (Unincorporated Areas) | Hunting Creek<br>Maple Run Golf Course | November 21, 1991 | LOMR |
| Frederick County (Unincorporated Areas) | Little Bennett Creek<br>Regnier Property | October 19, 1990 | LOMR |
| Frederick County (Unincorporated Areas) | Talbot Branch<br>Mathews Subdivision | December 6, 1989 | LOMR |

## 2.2 Community Description

Frederick County is located in both the Piedmont and Appalachian physiographic provinces in Maryland. The county is approximately 45 miles northwest of Washington, D.C. in what is considered the eastern limit of the Appalachian Mountain Range (Frederick County 1969).

The county is bordered by Loudoun County, Virginia to the southwest; Montgomery County, Maryland to the southeast; Washington County, Maryland to the west; Carroll County, Maryland to the northeast; the Townships of Cumberland, Freedom, and Liberty, Pennsylvania to the north; and the Borough of Carroll Valley, Pennsylvania to the north.

Topography in the county is extremely variable, ranging from an elevation as low as 200 feet above sea level in the extreme southeast corner at the banks of the Potomac River, to an elevation of nearly 2,000 feet above sea level in the mountains in the northwest portion of the county. Elevations are referenced to the North American Vertical Datum (NAVD) of 1988. Topographic characteristics range from low, wide, flat river valleys to high, steep mountain slopes in the northwest. The flattest areas are located in the Monocacy River Valley, which bisects the county in a north-south direction. This valley area is the most densely populated portion of the county, primarily due to the presence of the county seat, the City of Frederick, located in nearly the geographic center of the county (Frederick County 1969, 1974, and 1975). Drainage in the county is generally to the east and west into major streams, the Monocacy River and Catoctin Creek, which in turn flow south into the Potomac River located along the southern boundary.

Frederick County contains a total of 425,472 acres. Of this total, agricultural and rural uses comprise roughly 64.3 percent or approximately 273,389 acres. Woodlands comprise the next largest category at more than 65,528 acres - approximately 15.4 percent, followed by open space and parkland with 22,886 acres or 5.3 percent. The land uses on the remaining 15 percent of the land area break down as follows:

- Residential land uses: 43,723 acres or approximately 10.3 percent.
- Institutional/Public/Quasi-Public Uses: 10,725 acres or roughly 2.5 percent.
- Commercial/Industrial land uses: 9,221 acres or approximately 2.2 percent.

(Frederick County, 1998)

The flooding which has historically caused property damage in Frederick County has been predominately confined to areas along the banks of major streams, particularly the Monocacy and Potomac Rivers. The damage potential along the Potomac River is concentrated only in areas where towns, such as Brunswick and Point of Rocks, have developed at river crossings. Although the Monocacy River valley is flatter and wider than the Potomac River valley, major damage potential, other than to roads, has been confined to only a few locations where development has encroached the floodplain. Prior to the completion of the Carroll Creek Flood Control Project in 1997, the City of Frederick experienced significant flooding problems throughout the downtown area.

The climate of Frederick County varies between the mountainous regions in the west to the lower elevations in the east. The climate is characterized by moderate winters and warm to hot summers. The growing season generally lasts from 150 to 190 days, depending upon local geography; the upper elevations in the west have a shorter growing season. The average annual temperature ranges from 50 degrees Fahrenheit (ºF) in the mountains to 54ºF in the eastern part of the county.

Frederick County has grown in population from 51,920 in 1990 to 195,277 in 2000 (U.S. Census Bureau). Precipitation in Frederick County is rather evenly distributed throughout the year, though monthly averages suggest that August is the wettest month and February is the driest. Yearly precipitation totals typically range from 40 to 46 inches, with the mountainous northwest generally receiving slightly more precipitation than the eastern part of the county. The snowfall varies greatly between the upper and lower elevations in the county. The lower southeast part of the county averages 20 inches of snowfall, but the upper elevations in the west average over 40 inches of snowfall. Thunderstorms generally occur between May and August, and tropical storms or hurricanes usually hit the region between August and October (Frederick County 1969 and Commerce 1975).

## 2.3 Principal Flood Problems

Damage from major floods has occurred periodically in Frederick County along both the Potomac and Monocacy Rivers. The largest flood on record for the Potomac River occurred in 1936, with five other major floods, in decreasing order of severity, in 1943, 1889, 1972, 1937, 1996, and 1986 (Interior, multiple years). The largest flood on record for the Monocacy River occurred in 1972, with six other major floods, in decreasing order of severity, in 1975, 1889, 1933, 1996, 1937, and 1934 (Interior, multiple years and USCOE, 1971).

On the Potomac River within Frederick County, the most serious flood problem occurs at Point of Rocks, an unincorporated community (Reference 8). The 1972 flood, a result of Tropical Storm Agnes, caused extensive damage to this community and the immediate area, damaging over 200 homes and 6 businesses. Floods of greater intensity occurred in 1889, 1936, 1937, and 1943. At Point of Rocks, the 1972 flood is estimated to be of a 2% annual chance frequency, and the worst flood on record, in 1936, is estimated to be of a 1% annual chance frequency.

On the Monocacy River and its tributaries, the 1972 flood was the worst on record and caused damage to over 240 homes and 60 farms. Ten bridges were damaged at a repair cost of $7 million, and $20,000 of road damage was caused by erosion and siltation. The total estimated damage of the 1972 flood was $20 million. This flood on the Monocacy is estimated to have a recurrence frequency of 0.4% annual chance. In 1975, another flood of significance occurred on the Monocacy River. This flood was estimated to have been of a 1.3% annual chance recurrence frequency.

Prior to the construction of the flood control project referenced in Section 2.4, the City of Frederick often experienced severe flooding due to Carroll Creek. The most severe flood (in terms of damage to the city) occurred on October 7, 1976 as isolated storms dumped 7.2 inches of rain on the city in less than 16 hours. A large portion of the Historic Area of downtown Frederick was inundated and damage estimates ranged up to $25 million. The extremely saturated antecedent soil conditions were thought to contribute to the severity of the flooding.

## 2.4 Flood Protection Measures

In 1997, the $60 million Carroll Creek Flood Control project was completed. This project involved the installation of four conduits completely containing Carroll Creek for over a 1 mile stretch as it passes through the city. These conduits range in width from 18.5 to 19.5 feet and in height from 12.2 to 13.2 feet and extend from Baker Park in an easterly direction to Highland Street. Normal flows of Carroll Creek are conveyed in a channel that is perched between and/or above the box conduit system while two inlet weirs direct storm flows throughout the conduit system. A flood gate is located at the upstream end of the perched normal flow channel. City emergency procedures state that this gate is to be closed during heavy flow conditions.

Flood control levees were also constructed at the upstream and downstream ends of the conduit system to mitigate flooding. On the eastern end of the project, a flood control levee parallels Highland Street and also parallels Gas House Pike and Carroll Creek. This levee has yet to be completed and does not provide flood protection. On the western end of the project, flood control levees parallel both Carroll Parkway and North Bentz Street. In addition, there is approximately 600 feet of floodwall along the inlet weir. These levees and floodwalls serve to confine the flood flows to within the flood control system. Since its construction in 1997, the Carroll Creek Flood Control project has successfully protected the city from flooding.

With the exception of Carroll Creek, Frederick County has had little justification to provide flood protection through physical measures. Of the two major sources of flooding problems, the Potomac River and the Monocacy River, only the Monocacy River presents any possibility of justified flood protection works. The Potomac River Drainage Basin is beyond the jurisdiction of the county. Over 50 percent of the drainage area of the Monocacy River lies within Frederick County, therefore, flood control measures could be instituted if determined to be economically feasible. Considering the relatively limited damage sustained during past floods, it is considered unlikely that flood control measures of significance would be justified.

Several recreational lakes throughout the county provide a measure of flood attenuation for smaller floods. These small reservoirs are primarily water storage facilities and would have little, if any, measurable effect on floods of 2% annual chance recurrence frequency or greater.

The county does monitor the development within floodplains through the requirement of building permits. Through the process of review for issuance of building permits, control of development within the floodplain is possible. The Frederick County Zoning Ordinance allows no structures within the “annual floodplain” (Frederick County, 1972). The basis for establishing the annual floodplain boundary is currently based on soil types, and the county officials anticipate relying heavily on the floodplain delineation provided by this FIS. Past practice has also utilized the "historic floodplain," which is frequently determined by personal knowledge and known flood marks.

In addition, the county had adopted a Sediment Control Ordinance (Frederick County, 1971). In cooperation with the Natural Resources Conservation Service (formerly the Soil Conservation Service), the county reviews planned land development projects with the intent not only to control sediment, but also to manage the storm runoff. This policy requires the peak flow of storm runoff from newly developed land to be approximately the same as that which prevailed prior to development, calculated on the basis of a 50% annual chance frequency flood. The ordinance also requires that storage capacity be provided for the difference between the expected runoff from a 50% annual chance frequency flood prior to construction and the expected runoff from a 20% annual chance frequency flood after construction. Implementation of this policy will measurably reduce the peak discharge rate from a 10% annual chance frequency flood in the immediate downstream area of a developed drainage basin, but will have only minimal effect on the 1% annual chance frequency flood peak discharge.

Bridges destroyed during the 1972 flood in the Monocacy River basin were, in every instance, quite old and were not designed to pass flood discharges of large magnitude. All replacement bridges over the Monocacy River were designed with full recognition of the recorded high water marks of the 1972 flood, and the increase in the hydraulic efficiency will measurably reduce the backwater effects at the new road crossings. Because this is generally the location of homes that are close to the river, damage potential should be reduced.

## 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 FIS. Flood events of a magnitude which are expected to be equaled or exceeded once on the average during any 10-, 2-, 1-, or 0.2% annual chance 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% annual chance floods, have a 10-, 2-, 1-, and 0.2 % annual 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 chance of annual exceedence 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 county at the time of completion of this FIS. 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 the flooding sources studied in detail affecting the county.

**Pre-countywide Analyses**

Frederick County (Unincorporated Areas), the City of Frederick, and the Towns of Emmitsburg, Thurmont, and Walkersville have previously printed FIS reports. The hydrologic analyses described in those reports have been compiled and are summarized below.

Hydrologic analyses were carried out to establish the peak discharge frequency relationships for floods of the selected recurrence intervals for each flooding source studied in detail in the community.

Emmitsburg, Town of, March 1980, FIS

The hydrologic analyses and values match the Frederick County (Unincorporated Areas) FIS hydrologic values.

Frederick, City of, August 19, 1991, FIS

The peak discharge-frequency relationships at different locations were determined using Synder's synthetic flood frequency method (Snyder, 1958). The major portions of the watershed areas for the streams in the community are predominantly urban in character. Although there are two U.S. Geological Survey (USGS) gages in the vicinity, the discharge records of both these gages do not particularly reflect runoff characteristics of predominantly urban watersheds. The gage on the Monocacy River near Jug Bridge is located downstream of the community and receives the entire runoff discharge of the Carroll Creek system, which passes through the community. The watershed area at the gage, however, is very large (817 sq. miles) compared to the urban watershed area of the community and, therefore, does not accurately reflect the runoff characteristic of an urban area. It was, therefore, considered inappropriate to use the recorded discharges at either of the USGS gages in the vicinity to develop the peak discharge-frequency relationships at locations within the City of Frederick. Synthetic flood frequency relationships were developed using Snyder's method with the aid of the storm drainage maps of the City of Frederick and the Rainfall Frequency Atlas of the United States (Commerce, 1961).

Discharges for the various frequency floods obtained using Snyder's method under the existing condition of the watershed were compared with the discharges for similar frequency floods developed in the study prepared for the City of Frederick by Dewberry, Nealon and Davis (Dewberry, Nealon and Davis, 1975). The flood discharges determined for that study were based upon ultimate development of the watershed. Comparison of the discharges, considering the basis of calculation, indicated good agreement, therefore, the discharges computed in the report for the city were accepted and were the basis of the hydraulic determinations.

Although the Monocacy River near Frederick was designated by the community officials for approximate study, a detailed study was made both upstream and downstream to determine the 10%, 2%, 1%, and 0.2% annual chance profiles; these profiles were then used to establish the starting water-surface elevations for Carroll Creek and the other tributaries marked for detailed study. It was, therefore, necessary to make frequency analysis of the recorded peak annual discharges of the USGS gage on the Monocacy River near Jug Bridge.

For purposes of predicting 10%, 2%, 1%, and 0.2% annual chance flood magnitudes, using statistical analysis of recorded peak discharges, stream gaging stations were classified into three main groups as follows:

| | |
|---|---|
| Class I gages | Stations having 40 or more years of continuous records. |
| Class II gages | Stations having between 25 and 40 years of records. |
| Class III gages | Stations having less than 25 years of records. |

Continuous peak discharge records of the gage at Jug Bridge (#016430000) were obtained from the USGS. Computer printouts of frequency analyses of the gage using the log-Pearson Type III distribution were also obtained from the USGS (Water Resources Council, 1967 and 1976). This gage has 47 years of continuous records and is, therefore, designated as Class I. Based on the lengths of records, floods with the following frequencies can be reliably predicted from a standard frequency analysis:

| | |
|---|---|
| Class I gage | 1%-annual chance frequency |
| Class II gage | 2%-annual chance frequency |
| Class III gage | 4%-annual chance frequency |

A frequency analysis of recorded peak discharges at the Jug Bridge gage was made using the log-Pearson Type III distribution technique (recommended by Water Resources Council) (Water Resources Council, 1967 and 1976). Similar analyses made by the USGS used a computed skew coefficient which was found to be erratic due to the short period of record, and therefore, not considered sufficiently reliable. A new analysis was made using the map showing the isopleths of generalized skew coefficients of annual peak discharges prepared by the USGS (Water Resources Council, 1976 and Hardison, 1974). In this frequency analysis the plotted positions of existing data were based on the Gringorten formula (Ven, 1964 and Reich, 1973), since this method produced a better fit when used in the log-Pearson Type III distribution analyses. In accordance with the directive issued by the FIA no expected probability adjustment was made in the frequency analysis.

In order that the results of frequency analyses at the Jug Bridge gage could be projected to different locations on the Monocacy River, both upstream and downstream of the City of Frederick, curves of the drainage area-peak discharge relationship were prepared using records of the gages in Frederick and Carroll Counties which were judged to have sufficiently similar drainage basin characteristics. Mean values of peak discharges were calculated and plotted against drainage areas on log-log graph paper from which the equations of the best-fit curves were derived. Relationships were then developed between drainage area and discharge to allow projection of discharges for selected frequency floods to different locations of the gaged watersheds and also to ungaged watersheds having similar basin characteristics. These projection equations took the following general form:

$$\frac{Qs}{Qg} = \left(\frac{As}{Ag}\right)^{n_1} \frac{As^{(p \log As)}}{Ag^{(p \log Ag)}} \quad \text{for parabolic relationships}$$

$$\frac{Qs}{Qg} = \left(\frac{As}{Ag}\right)^{n_2} \quad \text{for straight line relationships}$$

where Qg and Ag are the discharge and drainage area at the gage, Qs and As the discharge and drainage area at the site in question, "p" is a coefficient, and "$n_1$" and "$n_2$" are exponents.

Based upon this relationship the various peak discharges on different locations of the Monocacy River were projected from the corresponding results of frequency analysis of the Jug Bridge gage.

The 0.2% annual chance peak flood discharges for all the creeks marked for detailed study in the community were obtained by plotting the 10-, 25-, 50-, and 1% annual chance peak flows on log-probability paper and extrapolating to the 0.2% annual chance flood frequency.

<u>Frederick County (Unincorporated Areas) December 1977, FIS</u>

In the determination of selected peak discharges at designated locations on streams, primary reliance was placed on statistical analyses of recorded peak discharges at established USGS gaging stations in the area (Interior, 1975). For purposes of predicting 10%, 2%, 1%, and 0.2% annual chance flood magnitudes, stream gaging stations were classified into three main groups as shown in the City of Frederick FIS description above.

Continuous peak discharge records of all the gages in Maryland were obtained from the USGS. Computer printouts of frequency analyses of these gages, using the log-Pearson Type III distribution, were also obtained from the USGS.

The 10 established USGS gages in the vicinity of the study area which were used to establish peak discharge-frequency relationships are as follows:

No. 01637500 on Catoctin Creek, near Middletown;
No. 01639000 on the Monocacy River, near Bridgeport;
No. 01638500 on the Potomac River, at Point of Rocks;
No. 01639500 on Big Pipe Creek, at Bruceville;
No. 01640500 on Owens Creek, at Lantz;
No. 01641000 on Hunting Creek, at Jim Town;
No. 01641500 on Fishing Creek, near Lewistown;
No. 01642500 on Linganore Creek, near Frederick;
No. 01643000 on the Monocacy River, at Jug Bridge, near Frederick;
No. 01643500 on Bennett Creek, at Park Mills.

Four of these gaging stations (Nos. 01638500, 01640500, 01642500, and 01643000) are Class I gages; the remaining stations are classified as Class II. Based on the lengths of records, floods with the following frequencies can be reliably predicted from a standard frequency analysis as shown in the City of Frederick FIS description above.

Frequency analyses of recorded peak discharges at all 10 gaging stations in the area were made by the Water Resources Council (Water Resources Council, 1967 and 1976). Similar analyses made by the USGS used computed skew coefficients that were found to be erratic due to the short period of record, except at gage No. 01638500, and, therefore, were not considered sufficiently reliable. New analyses were made using the map of isopleths of generalized skew coefficients of annual peak discharges, prepared by Clayton H. Hardison of the USGS, Reston, Virginia (Water Resources Council, 1976 and Hardison 1974). In this frequency analysis, the plotted positions of existing data were based on Gringorten formula, because this method produced a better fit when used in log-Pearson Type III distribution analysis (Ven, 1964 and Reich, 1973). In accordance with a directive issued by FEMA, no expected probability adjustment was made in the frequency analyses.

In order that the results of frequency analyses of the gages could be projected to different locations in the study area, curves of the drainage area-peak discharge relationship were prepared using records of those gages judged to have sufficiently similar drainage basin characteristics. Mean values of peak discharges were calculated and plotted against drainage areas on log-log graph paper from which the equations of the best-fit curves were derived. Relationships were then developed between drainage area and discharge to allow projection of discharges for selected frequency floods to different locations of the gaged watersheds, as well as ungaged watersheds having similar basin characteristics.

Based upon these relationships, the various peak discharges on ungaged streams with similar basin characteristics and at other locations on gaged streams were projected from the corresponding results of frequency analyses of the gages.

Where gage records are classified as Class II, the computed 1% annual chance peak discharge is not considered statistically reliable. Therefore, the 1% annual chance peak discharges for these watersheds were computed using the procedure described below. For predominantly natural watersheds with Class II gages, the 1% annual chance peak discharges were computed using the multiple regression equations for Maryland streams derived by Patrick N. Walker of the USGS (Interior, 1971). In recognition that these equations were developed using recorded discharges prior to 1968, the equations for peak flows were updated to include recorded discharges from 1968 through 1975, using a multiplication factor. A different multiplication factor was derived at each gage by comparing the 10-, 4-, and 2% annual chance peak flows obtained from frequency analyses at a Glass II gage with those computed using the regression equations, also at the corresponding gage. For ungaged watersheds or watersheds with Class II gages, the peak flows of different frequencies were calculated using updated multiple regression equations.

Special hydrologic computations were made for some streams having dams, or very high embankment crossings with small culvert openings, including Claggett Run (Tributary No. 129), Rocky Fountain Run, Tributary No. 124 to Horsehead Run, and Tributary No. 127 to Rocky Fountain Run. Such embankments produce significant storage effects upstream, thus moderating the peak discharges downstream. Also, because the HEC-2 computer program for backwater analysis does not have the capacity for storage computations, it is felt that coding such structures in the HEC-2 format and running through the HEC-2 program without the special storage calculations will result in unrealistically high water-surface elevations upstream of the structure.

Inflow hydrographs were constructed for the streams at these structures, and the hydrographs were routed through the storage reservoirs and outlet openings. The peak discharges at the downstream locations were adjusted to reflect the effects of storage.

The 0.2% annual chance peak flood discharges were obtained by plotting 10-, 25-, 50-, and 1% annual chance peak flows on log-probability paper and extrapolating to the 0.2% annual chance frequency.

The peak discharges for the Tropical Storm Agnes and Hurricane Eloise floods (1972 and 1975, respectively) were also projected at six locations from the recorded peak discharges of these floods at two gages, using the drainage area-peak discharge relationship for purposes of calibrating hydraulic computations with recorded high water marks.

Frederick County (Unincorporated Areas) December 3, 1991, FIS

NRCS TR-20 routing was used to determine the 1% annual chance peak discharge for Unnamed Tributary to Hollow Creek (Agriculture, 1983). The drainage area was divided into six subareas and Runoff Curve Number (RCN) values were assigned based on existing conditions, which were considered to be fully developed.

Frederick County (Unincorporated Areas) December 19, 1997, FIS

Storm runoff was calculated for Fishing Creek using the NRCS TR-20 computer program (Agriculture, 1983). In the Mountaindale area a portion of the discharge leaves the main channel and flows through the adjacent subwatershed. This diverted flow rejoins the main stem near Bethel Road. Time of Concentration (Tc) values were calculated using the Manning-Kinematic formulas described in NRCS Technical Note, Hydrology No. N4 (Agriculture, 1986). RCNs were calculated using a combination of data from an NRCS soil survey for Frederick County, USGS topographic maps, field observations, and local zoning maps (Agriculture, 1960, Interior, multiple years, and Frederick County Planning and Zoning Commission, 1984).

A summary of the drainage area-peak discharge relationships for the streams studied by detailed methods, except for Park Branch (Trib. 8/99) is shown in Table 5, "Summary of Discharges."

Thurmont, Town of, March 1979, FIS

There is a USGS stream gaging station about 2.3 miles downstream of the corporate limits of Thurmont on Hunting Creek. In order to obtain the floods of various selected frequencies for Hunting Creek, primary reliance was placed on the statistical analyses of this gaging station record. A log-Pearson Type III analysis of the annual peak flow data at the gage was performed following the Water Resources Council Guidelines (Water Resources Council, 1976). This included the use of an adjusted skew coefficient to account for the short length of the record at the gage. Fitting the Pearson Type III curve to the log transformed annual peak flow data yielded magnitudes of flows of 10-, 50-, and 1%annual chance recurrence intervals at the gaging station site.

In order to obtain the flows at various concentration points on Hunting Creek upstream of the gage site and within the corporate limits of Thurmont, the discharge-drainage area relationship within the region was examined. Drainage areas of 11 gaging stations (Interior, Various Volumes) in the vicinity of the study area (and within the Piedmont physiographic region of Maryland) and their corresponding 1% annual chance flows as computed by log-Pearson Type III analysis (Water Resources Council, 1976) were plotted on logarithmic graph (log-log paper). Several functions (one linear, one parabolic, one power, and three different hyperbolic functions) were then fitted to these points by the least square technique (University of California, 1975) and their corresponding indices of determination were calculated. It was found that the linear function on this log-log plot fitted the data best and the equation 0.68 of this curve of best fit was $Q = A^{0.68}$; where Q = computed discharge in cfs, and A = drainage area in square miles. The following relationship between the flows at the gaged site and ungaged site was then established utilizing this equation; and the relationship was used in obtaining flows of selected recurrence intervals at various points of known drainage areas on Hunting Creek:

$$Q_u = Q_g \times (A_u/A_g)^{0.68}$$

where $Q_u$, $Q_g$ = Flows of selected recurrence interval at ungaged site of interest and at the gage, respectively, and $A_u$, $A_g$ = Drainage areas at the ungaged site and at the gage.

Flows thus computed were then compared with the regional maximum and minimum values and were found to agree. Magnitudes of 0.2% annual chance flood at various points on the streams were determined by the straight line extrapolation of the 10-, 50-, and 1% annual chance flood magnitudes plotted on log-probability papers. Peak discharge-drainage area relationships for Hunting Creek and its tributary, Rouzer Creek, are shown in Table 5.

Walkersville, Town of, March 1980, FIS

Primary reliance in the determination of flood magnitude was on the regional flood characteristics as estimated from the statistical analyses of the gaging station data in the vicinity of the study area, since there are no gaging stations on the streams studied in detail in the community. A USGS study gives a series of regression equations relating the flows of selected recurrence intervals to various drainage basin characteristics for the computation of flows at ungaged areas of Maryland (State of Maryland, 1971). The USGS developed these regional regression equations by regressing flows of various recurrence intervals at gaging station sites in Maryland against the drainage areas, slopes, forest covers and several other physical characteristics of the corresponding basins. These equations, however, were developed in 1971 and used data through the year 1968 only. For the present study, these regional regression equations were initially used in determining flows of selected recurrence intervals at various concentration points on Glade Creek and its tributary, Dublin Branch. In consideration of the fact that several more years of data are now available and that two severe floods have occurred in the region since 1968, it was necessary to adjust the results obtained by these equations.

In order to do so, 10-, 2-, and 1% annual chance flows at 11 gaging stations in the general region of the study area were computed using these regression equations. These gaging stations were so chosen as to have the basin characteristics similar to the study area. Drainage areas and other physical characteristics for these gaging stations were obtained from another USGS report (Interior, 1970). At each gaging station, location flows of 10-, 2-, and 1% annual chance recurrence intervals computed by log-Pearson Type III analyses of annual peak flow records through 1976 were obtained from the USGS (Water Resources Council, 1976). Ratios of these flows at each of the 11 stations to the corresponding flows computed by the regression equations were then calculated. Computations showed four gage sites having ratios less than unity and these were excluded from further analysis. From the ratios (adjustment factors) at the remaining gage sites, applicable factors for 10-, 2-, and 1% annual chance flows at the concentration points under consideration were obtained by interpolation. These adjustment factors were then applied to the flow values obtained at those points on Glade Creek and Dublin Branch by the regression equations. Flows thus obtained were compared with discharges obtained from the drainage area-discharge curve for the Flat Run basin in the unincorporated areas of Frederick County as presented in the Flood Insurance Study for Frederick County (Housing and Urban Development, 1978). The discharge-drainage area relationship established by the present analyses was found to agree very closely with that relationship presented in the Frederick County study. However, in that study, the Glade Creek discharge obtained at the confluence with the Monocacy River was used through the upstream corporate limits of Walkersville. In this study, reduction of discharge due to the reduction in drainage area was taken into account. Table 5 summarizes the peak discharge drainage area relationships for the streams studied in Walkersville.

**Revised Analyses**

Information on the methods used to determine peak discharge-frequency relationships for the streams that have been restudied as part of this countywide FIS is shown below.

For this revision, two different types of hydrologic analyses were performed. The Carroll Creek watershed, which includes the historic City of Frederick and has a significant history of flooding, was studied using HEC-HMS rainfall runoff modeling (USACE, 2003). The latest Maryland regression equations, published in the Maryland Department of Transportation State Highway Administration Report (Maryland, 2004) (hereinafter referred to as regression equations) were utilized to determine flood discharges for the remaining streams studied by detailed or limited detailed methods as identified in Table 2.

**Carroll Creek Watershed**

Carroll Creek is roughly an 18 square mile watershed that covers the vast majority of the City of Frederick, Maryland. Carroll Creek itself runs directly through the historic downtown area of Frederick and had a history of significant flooding prior to 1997. In 1997, the aforementioned Carroll Creek Flood Control project was completed. This project has successfully mitigated flooding within the city since its construction. Tributaries to Carroll Creek include Clifton Branch (Tributary No. 98), Edison Branch, Rock Creek, Silver Spring Branch (Tributary No. 95), Shookstown Creek (Tributary No. 96), Tributary No. 5 to Rock Creek and Tributary No. 6 to Carroll Creek.

Hydrologic simulation modeling was used in the hydrologic analysis of the Carroll Creek Watershed to estimate peak flood flows and flood hydrographs. A hydrologic model is a mathematical representation of the physical response of a watershed to rainfall. Modeling is necessary to predict the response of a watershed under conditions different from those experienced historically. Different conditions include theoretical rainstorms, urban development, channel improvements, and detention ponds. Watershed models can be as simple as the rational method or as complex as intricate computer models. The essential features of a watershed model are that it represents the physical processes, it has sound theoretical basis, and can be verified by observed or measured data.

The hydrologic analysis reflected in the August 19, 1991 FIS for the Carroll Creek watershed was performed in 1978 by the Department of Housing and Urban Development using Snyder's synthetic flood frequency method. Because the peak discharges resulting from the aforementioned hydrologic analysis were felt to be significantly underestimated, the Water Resources Administration performed a hydrologic study in March of 1983. This rainfall-runoff analysis resulted in considerable increases in the discharge associated with the statistically defined 1% annual chance event. The results of this study were used to develop a hybrid HEC-2 hydraulic model to define a more accurate 1% annual chance floodplain. Although this newly developed floodplain was never incorporated into the FIS for the City of Frederick, its results have been widely utilized for regulatory permitting decisions and construction in the floodplain over the last 20 plus years. Since this hydrologic study was performed in 1983, significant development has occurred within the Carroll Creek Watershed.

Because the Carroll Creek watershed is the most developed and influential watershed within Frederick County, HEC-HMS rainfall-runoff hydrologic modeling was used to account for the rapidly changing conditions and to develop flood hydrographs to be routed through the HEC-RAS unsteady flow hydraulic model. The HEC-HMS hydrologic modeling software is the preferred software of the U.S. Army Corps of Engineers and now supersedes the HEC-1 flood hydrograph package. HEC-HMS simulates the precipitation-runoff processes of dendritic watersheds by producing a series of flood hydrographs for each basin, junction and reach within the model. These flood hydrographs are then linked to the HEC-RAS Unsteady Flow hydraulic model at their respective basin outlets along Carroll Creek. These flood hydrographs are then routed through the HEC-RAS model, enabling a timing element to be included in the analyses. Because Carroll Creek is a stream with unique hydraulic characteristics and a significant amount of attenuation, the aforementioned unsteady flow modeling approach was determined to be the most accurate method to depict current flood hazards. The HEC-RAS unsteady flow modeling approach is described in greater detail in the hydraulic analyses section of this report.

In order to develop a detailed and accurate hydrologic model, the Carroll Creek Watershed was divided into subbasins of approximately 0.5 square miles or less. Subbasins were delineated utilizing HEC GeoHMS and modified after field investigation and inspection of the City of Frederick's storm sewer drainage system.

The National Oceanic and Atmospheric Association's (NOAA) National Weather Service published updated precipitation frequency estimates for the Ohio River Basin and surrounding states, including Maryland on June 29, 2004 (NOAA, 2004). These estimates cover the full range for durations from 5 minutes to 60 days and for average recurrence intervals from 2 to 1000 years. These new, more detailed, estimates replace those contained in Technical Paper No. 40 titled "Rainfall frequency atlas of the United States for durations from 30 minutes to 24 hours and return periods from 1 to 100 years" (Weather Bureau). This new detailed rainfall data published by the NOAA was used in the HEC-HMS model and reflects significant increases in rainfall amounts for the City of Frederick, MD. Technical Paper No. 40 defined the 1% annual chance 24-hour rainfall depth for the City of Frederick as approximately 7 inches while the new NOAA rainfall depth for Frederick yields a 1% annual chance 24-hour rainfall of nearly 8 inches.

Curve Numbers for each subbasin within the Carroll Creek watershed were developed in accordance with the procedures outlined in the NRCS TR-55 manual (Agriculture, 1986). Curve numbers were calculated based on the hydrologic soil group, land use and soil moisture of a particular area. The most detailed and up-to-date land use and soil coverages were utilized in Curve Number development for the Carroll Creek watershed. Antecedent runoff condition II was assumed for all hydrologic computations. Each of the unique sub-areas within a subbasin was area weighted to form a composite curve number for input into the HEC-HMS model.

Times of concentration for each subbasin were generated using procedures from NRCS TR-55 and the Federal Highway Administration (FHWA) (Agriculture, 1986). The stream lengths, overland flow lengths, and their corresponding slopes used in the time of concentration calculations were determined from the City of Frederick 2-foot topographic data. Surface conditions and Manning's n values were estimated using the City's orthophotography. Channel shapes and conditions were determined from field survey data and inspection.

Additional hydrologic options within HEC-HMS, such as diversions, reservoirs, and sinks, were not utilized in the Carroll Creek model since the intent was to derive individual flood hydrographs to be routed through an unsteady flow HEC-RAS model for Carroll Creek. The flood hydrographs at each junction along the detailed modeled portion of Carroll Creek had to be extracted and linked to the HEC-RAS model. This process will be further detailed in the hydraulic analyses section.

Tributaries to Carroll Creek were modeled using the traditional HEC-RAS steady-state approach used in most FEMA studies. For these tributaries to Carroll Creek, peak discharges were extracted from the flood hydrographs produced in the HEC-HMS model and entered into the HEC-RAS steady state models at the subbasin outlets.

**Regression Equation Analyses**

Regression equation analyses were used to develop peak discharge-frequency relationships for each of the flooding sources designated for detailed or limited detailed restudy that are located outside of the Carroll Creek basin. These flooding sources are identified in Table 2 and are as follows; Horsehead Run, Tributary No. 122 to Horsehead Run, Tributary No. 123 to Horsehead Run, Tributary No. 124 to Horsehead Run, Tributary No. 125 to Horsehead Run, Tributary No. 126 to Tributary No. 125 to Horsehead Run, Tributary No. 127 to Rocky Fountain Run and Tributary No. 128 to Rocky Fountain Run are part of the Rocky Fountain Run subbasin near Buckeystown. Arundel Branch, Butterfly Branch (Tributary No. 116), King Branch (Tributary No. 118) and Pike Branch (Tributary No. 117) fall within Ballenger Creek subbasin south of the City of Frederick. Clifford Branch, Little Little Tuscarora Creek and Tributary No. 89 to Little Tuscarora Creek lie in the Tuscarora Creek subbasin in the northern extents of the City of Frederick. Dublin Branch and Tributary to Glade Creek constitute the Glade Creek subbasin northeast of Frederick near Walkersville. Rocky Fountain Run, Ballenger Creek, Tuscarora Creek, Glade Creek, Bush Creek, Linganore Creek, Israel Creek, Park Branch (Tributary No. 8/99) and Detrick Branch (Tributary No. 9) drain directly into the Monocacy River.

The latest Maryland regression equations were designated for use in developing flood discharges for the above mentioned flooding sources. These regression equations were developed for each physiographic province in Maryland. Frederick County falls in both the Blue Ridge and Piedmont provinces. The regression equations for the Blue Ridge province take into account the drainage area and limestone percentage for the drainage basin. Two sets of regression equations were developed for the Piedmont province based on the 'rural' and 'urban' basin classifications (classified based on percent impervious area). The equations for 'rural' basins take into account the drainage area and percent forested area whereas the 'urban' equations are comprised of drainage area and impervious area. For drainage basins located in both the blue ridge and piedmont regions, an area weighted approach was utilized to determine discharges.

Frederick County is located in the Blue Ridge and Piedmont physiographic provinces within the state of Maryland for the regression analysis. As a result, the following equations should be used for determining discharges:

**Piedmont Region:**

For the rural equations (less than 10 percent impervious area),

$Q_{10} = 992.6\ DA^{0.649}\ (FOR+1)^{-0.230}$

Standard Error: 24.3

$Q_{50} = 2146\ DA^{0.624}\ (FOR+1)^{-0.235}$

Standard Error: 27.5

$Q_{100} = 2897\ DA^{0.613}\ (FOR+1)^{-0.238}$

Standard Error: 30.6

$Q_{500} = 5519\ DA^{0.589}\ (FOR+1)^{-0.242}$

Standard Error: 39.7

For the **urban equations** (10 percent or greater impervious area)

$Q_{10} = 169.2\ DA^{0.622}\ (IA+1)^{0.435}$

Standard Error: 26.2

$Q_{50} = 562.4\ DA^{0.619}\ (IA+1)^{0.284}$

Standard Error: 27.7

$Q_{100} = 898.3\ DA^{0.619}\ (IA+1)^{0.222}$

Standard Error: 30.7

$Q_{500} = 2529\ DA^{0.623}\ (IA+1)^{0.079}$

Standard Error: 41.2

**Blue Ridge Region:**

$Q_{10} = 270.7\ DA^{0.787}\ (LIME+1)^{-0.332}$

Standard Error: 41.3

$Q_{50} = 612.7\ DA^{0.740}\ (LIME+1)^{-0.342}$

Standard Error: 41.7

$Q_{100} = 835.14\ DA^{0.722}\ (LIME+1)^{-0.347}$

Standard Error: 44.2

$Q_{500} = 1620.8\ DA^{0.685}\ (LIME+1)^{-0.358}$

Standard Error: 53.3

Where,

Q = Flow (cfs)
DA = Drainage Area (square miles)
FOR = Forested Area (%)
IA = Impervious Area (%)
LIME = Limestone (%)

Drainage subbasins were calculated using the ArcHydro extension of ArcMap 8.3.

A summary of the drainage area-peak discharge relationships for all 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 (cfs) % ANNUAL CHANCE 10% | 2% | 1% | 0.2% |
|---|---|---|---|---|---|
| ARUNDEL BRANCH | | | | | |
| Upstream of confluence with King Branch (Tributary No. 118) | 1.14 | * | * | 1147 | * |
| BALLENGER CREEK | | | | | |
| At confluence with Monocacy River | 20.51 | * | * | 7716 | * |
| Upstream of confluence of Pike Branch (Tributary No. 117) | 13.65 | * | * | 4130 | * |
| Upstream of confluence of Renn Branch (Tributary No. 115) | 6.1 | * | * | 3063 | * |
| BUSH CREEK | | | | | |
| Upstream of confluence with Monocacy River | 31.86 | * | * | 13034 | * |
| Upstream of confluence of Peter Pan Run | 24.67 | * | * | 8869 | * |
| 6.6 miles upstream of the confluence with Monocacy River | 18.95 | * | * | 9451 | * |
| Downstream of confluence of School Run | 17.01 | * | * | 9210 | * |
| Upstream of confluence of an unnamed tributary | 15.63 | * | * | 8840 | * |
| Upstream side of the intersection with Green Valley Road | 14.43 | * | * | 8340 | * |
| BUTTERFLY BRANCH (TRIBUTARY NO. 116) | | | | | |
| At confluence with Ballenger Creek | 1.17 | * | * | 1912 | * |
| CARROLL CREEK | | | | | |
| Upstream of confluence with Monocacy River | 17.46 | 4842 | 8346 | 9828 | 12310 |
| At the intersection with East Patrick Street | 16.13 | 5201 | 8373 | 9906 | 13044 |
| At the intersection with Bentz Street | 13.81 | 4663 | 7370 | 8853 | 11811 |
| Downstream of confluence of Tributary No. 6 to Carroll Creek | 13.39 | 5876 | 6825 | 8785 | 11705 |
| Downstream of confluence of Rock Creek | 11.93 | 4412 | 4617 | 8381 | 11119 |
| Upstream of confluence of Rock Creek | 7.46 | 2843 | 4588 | 5487 | 7420 |
| Upstream of Shookstown Branch (Tributary No. 96) | 4.44 | 2212 | 4207 | 4773 | 5259 |
| Upstream of Edison Branch | 2.47 | 1024 | 2010 | 2531 | 3285 |
| Upstream of Kemp Lane | 1.03 | * | * | 1155 | * |
| Approximately 1000 ft downstream of Edgewood Church Road | 0.73 | * | * | 813 | * |

TABLE 5- SUMMARY OF DISCHARGES – continued

| FLOODING SOURCE AND LOCATION | DRAINAGE AREA (sq. miles) | PEAK DISCHARGES (cfs) % ANNUAL CHANCE 10% | 2% | 1% | 0.2% |
|---|---|---|---|---|---|
| CLAGGETT RUN (TRIBUTARY NO. 129) | | | | | |
| At confluence with Rocky Fountain Run | 0.8 | * | * | 1496 | * |
| Above the intersection with Fingerboard Road | 0.5 | * | * | 1100 | * |
| CLIFFORD BRANCH (TRIBUTARY NO. 87) | | | | | |
| At confluence with Tuscarora Creek | 5.99 | * | * | 3163 | * |
| 0.48 miles upstream of confluence of Tuscarora Creek | 4.43 | * | * | 2619 | * |
| 0.60 miles upstream of intersection with Ford Road | 4.13 | * | * | 2507 | * |
| At the intersection with Hamburg Road | 3.66 | * | * | 2326 | * |
| CLIFTON BRANCH (TRIBUTARY NO. 98) | | | | | |
| Upstream of confluence with Rock Creek | 1.37 | 1136 | 1807 | 2017 | 2911 |
| 700 feet upstream of U.S. Route 40 | 0.73 | 691 | 1092 | 1175 | 1734 |
| COPPERMINE BRANCH (TRIBUTARY NO. 102) | | | | | |
| Upstream of confluence with Town Branch | 2.33 | 286 | 483 | 713 | 1300 |
| Upstream of confluence with Tributary No. 101 to Coppermine Branch (Tributary No. 102) | 2.00 | 250 | 420 | 623 | 1150 |
| DAVIS BRANCH (TRIBUTARY NO. 113) | | | | | |
| Upstream of confluence with Bush Creek | 0.97 | 139 | 233 | 354 | 720 |
| DETRICK BRANCH (TRIBUTARY NO. 9) | | | | | |
| Upstream of confluence with Monocacy River | 0.95 | 919 | 1678 | 2096 | 3343 |
| Upstream of Schifferstadt Blvd | 0.85 | 864 | 1564 | 1946 | 3079 |
| DUBLIN BRANCH | | | | | |
| At confluence with Glade Creek | 0.57 | * | * | 1970 | * |
| EDISON BRANCH | | | | | |
| At the confluence with Carroll Creek | 1.81 | * | * | 2540 | * |
| 800 feet upstream of Tuscanny Drive | 1.07 | * | * | 1454 | * |
| 700 feet downstream of Christophers Crossing | 0.52 | * | * | 928 | * |

TABLE 5- SUMMARY OF DISCHARGES - continued

| FLOODING SOURCE AND LOCATION | DRAINAGE AREA (sq. miles) | PEAK DISCHARGES (cfs) % ANNUAL CHANCE 10% | 2% | 1% | 0.2% |
|---|---|---|---|---|---|
| FISHING CREEK | | | | | |
| Approximately 0.25 mile downstream of Devilbiss Bridge Road | 18.23 | 2672 | * | 5132 | * |
| Approximately 0.4 mile downstream of Lenhart Road | 17.09 | 2714 | * | 5296 | * |
| Approximately 130 feet upstream of Utica Road | 15.50 | 2458 | * | 5195 | * |
| Approximately 0.23 mile upstream of Lewistown Road | 13.96 | 2519 | * | 5375 | * |
| Approximately 100 feet downstream of U.S. 15 | 12.50 | 2217 | * | 4310 | * |
| At Bethel Road | 10.58 | 2182 | * | 4252 | * |
| At Mountaindale Road | 9.46 | 1624 | * | 3888 | * |
| Approximately 0.9 mile upstream of Mountaindale Road | 7.47 | 1455 | * | 4020 | * |
| FISHING CREEK DIVERSION CHANNEL | | | | | |
| Throughout the entire divided flow | ** | 284 | * | 357 | * |
| FLAT RUN | | | | | |
| At confluence with Toms Creek | 41.40 | 4624 | 8733 | 11389 | 24500 |
| Above confluence of Tributary No. 32 to Flat Run | 12.00 | 1195 | 1993 | 2802 | 5350 |
| Below confluence of Tributary No. 40 to Flat Run | 10.30 | 1132 | 1928 | 2707 | 5030 |
| Above confluence of Tributary No. 40 to Flat Run | 9.70 | 1073 | 1828 | 2570 | 4500 |
| GLADE CREEK | | | | | |
| Upstream of Monocacy River | 8.12 | 1118 | 1178 | 2147 | 3119 |
| At the downstream corporate limits of the Town of Walkersville | 7.37 | 1030 | 1650 | 1950 | 2800 |
| Upstream of confluence with Dublin Branch | 6.83 | 978 | 1567 | 1850 | 2555 |
| 1200 feet downstream of Devilbiss Road | 2.79 | * | * | 2654 | * |
| Upstream of Glade Road | 1.10 | * | * | 1260 | * |
| HIGH RUN | | | | | |
| At confluence with Hunting Creek | 2.28 | 524 | 1083 | 1508 | 3300 |
| HORSEHEAD RUN | | | | | |
| At confluence with Rocky Fountain Run | 2.83 | * | * | 3206 | * |
| Upstream of confluence of Tributary No. 125 to Horsehead Run | 1.73 | * | * | 2573 | * |

TABLE 5- SUMMARY OF DISCHARGES – continued

| FLOODING SOURCE AND LOCATION | DRAINAGE AREA (sq. miles) | PEAK DISCHARGES (cfs) % ANNUAL CHANCE 10% | 2% | 1% | 0.2% |
|---|---|---|---|---|---|
| HUNTING CREEK | | | | | |
| Downstream of Moser Road | 12.37 | 1245 | 2220 | 2770 | 4200 |
| Upstream of confluence with Rouzer Creek | 10.27 | 1100 | 1960 | 2450 | 3750 |
| ISRAEL CREEK | | | | | |
| At confluence with Monocacy River | 33.45 | * | * | 11132 | * |
| 1.7 miles upstream of confluence with Monocacy River | 29.5 | * | * | 10300 | * |
| 2.2 miles upstream of confluence with Monocacy River | 29 | * | * | 10200 | * |
| KING BRANCH (TRIBUTARY NO. 118) | | | | | |
| At confluence with Ballenger Creek | 1.99 | * | * | 3384 | * |
| LINGANORE CREEK | | | | | |
| At confluence with Monocacy River | 88.89 | * | * | 20350 | * |
| Upstream of confluence of Tributary to Linganore Creek | 84.51 | * | * | 19728 | * |
| Upstream of Linganore Road Reservoir | 81.05 | * | * | 19230 | * |
| Upstream of confluence of Bens Branch | 60.92 | * | * | 16278 | * |
| LINGANORE CREEK NORTH FORK | | | | | |
| Downstream of confluence with Talbot Branch | 14.95 | 1406 | 2302 | 2768 | 4080 |
| Upstream of confluence with Talbot Branch | 9.87 | 964 | 1578 | 1897 | 2797 |
| LINGANORE CREEK NORTH FORK (TRIBUTARY NO. 106) | | | | | |
| Upstream of confluence with Linganore Creek North Fork | 3.07 | 382 | 661 | 960 | 1800 |
| Upstream of confluence with Tributary No. 107 to Linganore Creek North Fork (Tributary No. 106) | 0.91 | 138 | 233 | 354 | 640 |
| LITTLE TUSCARORA CREEK | | | | | |
| At confluence with Tuscarora Creek | 5.21 | 689 | 1399 | 1830 | 3255 |
| Upstream of confluence of Tributary No. 89 to Little Tuscarora Creek | 4.51 | 947 | 1993 | 2647 | 4860 |
| 0.2 miles downstream of Walter Martz Street | 3.97 | 869 | 1838 | 2446 | 4512 |
| 0.75 miles downstream of Yellow Springs Rd | 3.45 | 788 | 1679 | 2239 | 4153 |
| 0.20 miles downstream of Yellow Springs Rd | 3.26 | 765 | 1630 | 2180 | 4050 |
| Upstream of Yellow Springs Road | 3.1 | 734 | 1570 | 2100 | 3910 |

TABLE 5- SUMMARY OF DISCHARGES - continued

| FLOODING SOURCE AND LOCATION | DRAINAGE AREA (sq. miles) | PEAK DISCHARGES (cfs) % ANNUAL CHANCE 10% | 2% | 1% | 0.2% |
|---|---|---|---|---|---|
| MONOCACY RIVER | | | | | |
| At confluence with Potomac River | 990.78 | * | * | 69323 | * |
| Upstream of confluence of Furnace Branch | 964.98 | * | * | 68503 | * |
| Upstream of confluence of Hatchery Run | 959.37 | * | * | 68197 | * |
| Upstream of confluence of Locust Run | 956.53 | * | * | 68019 | * |
| Upstream of confluence of Bennett Creek | 890.43 | * | * | 64186 | * |
| Upstream of confluence of Rocky Fountain Run | 879.61 | * | * | 63474 | * |
| Upstream of confluence of Ballenger Creek | 855.44 | * | * | 62219 | * |
| Upstream of confluence of Bush Creek | 821.59 | * | * | 59933 | * |
| Upstream of confluence of Linganore Creek | 728.21 | * | * | 53357 | * |
| Upstream of confluence of Carroll Creek | 707.71 | * | * | 52037 | * |
| Upstream of confluence of Park Branch (Tributary No. 8/99) | 706.51 | * | * | 51949 | * |
| Upstream of confluence of Addison Run | 699.38 | * | * | 51426 | * |
| Upstream of confluence of Israel Creek | 665.74 | * | * | 49061 | * |
| Upstream of confluence of Tuscarora Creek | 647.77 | * | * | 50524 | * |
| Upstream of confluence of Glade Creek | 638.23 | * | * | 49877 | * |
| Upstream of confluence of Muddy Creek | 633.69 | * | * | 49672 | * |
| Upstream of confluence of Fishing Creek | 614.5 | * | * | 48973 | * |
| MUDDY RUN | | | | | |
| Downstream of Blue Mountain Road | 1.97 | 505 | 1073 | 1490 | 3260 |
| Upstream of confluence of Tributary No. 74 to Muddy Run | 0.62 | 188 | 388 | 564 | 1196 |
| PARK BRANCH (TRIBUTARY NO. 8/99) | | | | | |
| Upstream of the confluence with Monocacy River | 1.2 | * | * | 2270 | * |
| At the intersection with Schifferstadt Boulevard | 1 | * | * | 2080 | * |
| PIKE BRANCH (TRIBUTARY NO. 117) | | | | | |
| At confluence with Ballenger Creek | 1.41 | * | * | 2602 | * |
| ROCK CREEK | | | | | |
| Upstream of confluence with Carroll Creek | 4.45 | 2198 | 3910 | 4793 | 7014 |
| Upstream of confluence of Tributary No. 5 to Rock Creek | 3.75 | 1927 | 3366 | 4082 | 5982 |
| Upstream of confluence of Clifton Branch (Tributary No. 98) | 2.10 | 771 | 1540 | 1920 | 3025 |

TABLE 5- SUMMARY OF DISCHARGES - continued

| FLOODING SOURCE AND LOCATION | DRAINAGE AREA (sq. miles) | PEAK DISCHARGES (cfs) % ANNUAL CHANCE 10% | 2% | 1% | 0.2% |
|---|---|---|---|---|---|
| ROCKY FOUNTAIN RUN | | | | | |
| At confluence with Monocacy River | 5.94 | * | * | 4697 | * |
| At confluence of Horsehead Run | 1.31 | * | * | 3421 | * |
| ROUZER CREEK | | | | | |
| At confluence with Hunting Creek | 1.3 | 270 | 480 | 600 | 920 |
| SHOOKSTOWN CREEK (TRIBUTARY NO. 96) | | | | | |
| At confluence with Carroll Creek | 2.17 | * | * | 1878 | * |
| Upstream of Montevue Lane | 1.51 | * | * | 1422 | * |
| Upstream of Bowers Road | 0.60 | * | * | 680 | * |
| SILVER SPRING BRANCH (TRIBUTARY NO. 95) | | | | | |
| Upstream of confluence with Carroll Creek | 1.30 | 537 | 1107 | 1393 | 2171 |
| Upstream of confluence of an unnamed tributary | 0.68 | 290 | 653 | 845 | 1344 |
| Downstream of Edgewood Church Road | 0.36 | * | * | 666 | * |
| TRIBUTARY NO. 5 TO ROCK CREEK | | | | | |
| Upstream of confluence with Carroll Creek | 0.35 | 195 | 300 | 347 | 466 |
| TRIBUTARY NO. 6 TO CARROLL CREEK | | | | | |
| Upstream of confluence with Carroll Creek | 0.88 | * | * | 1383 | * |
| Downstream of U.S. Route 15 | 0.54 | * | * | 769 | * |
| TRIBUTARY NO. 36 TO FRIENDS CREEK | | | | | |
| At the downstream limit of detailed study | 2.17 | 572 | 1117 | 1584 | 3750 |
| Upstream of confluence of Tributary No. 38 to Tributary No. 36 to Friends Creek | 1.09 | 349 | 692 | 998 | 2250 |
| TRIBUTARY NO. 38 TO TRIBUTARY NO. 36 TO FRIENDS CREEK | | | | | |
| Upstream of confluence with Tributary No. 36 to Friends Creek | 0.41 | 172 | 347 | 514 | 1220 |
| TRIBUTARY NO. 40 TO FLAT RUN | | | | | |
| Above confluence with Flat Run | 0.6 | 125 | 215 | 329 | 720 |
| TRIBUTARY NO. 41 TO FLAT RUN | | | | | |
| Above confluence with Flat Run | 0.5 | 111 | 192 | 296 | 660 |

TABLE 5- SUMMARY OF DISCHARGES - continued

| FLOODING SOURCE AND LOCATION | DRAINAGE AREA (sq. miles) | PEAK DISCHARGES (cfs) % ANNUAL CHANCE 10% | 2% | 1% | 0.2% |
|---|---|---|---|---|---|
| TRIBUTARY NO. 74 TO MUDDY RUN | | | | | |
| Upstream of confluence with Muddy Run | 0.96 | 276 | 579 | 826 | 2100 |
| TRIBUTARY NO. 76 TO HUNTING CREEK | | | | | |
| Upstream of confluence with Hunting Creek | 1.10 | 168 | 288 | 433 | 1080 |
| At Survey Section C | 0.47 | 79 | 132 | 206 | 500 |
| TRIBUTARY NO. 89 TO LITTLE TUSCARORA CREEK | | | | | |
| At confluence with Little Tuscarora Creek | 0.91 | 433 | 829 | 1058 | 1775 |
| 0.6 miles upstream of confluence with Little Tuscarora Creek | 0.59 | 341 | 641 | 811 | 1341 |
| Upstream of the intersection with Spring Hill Road | 0.24 | 264 | 432 | 604 | 965 |
| TRIBUTARY NO. 101 TO COPPERMINE BRANCH (TRIBUTARY NO. 102) | | | | | |
| Upstream of confluence with Coppermine Branch (Tributary No. 102) | 0.25 | 53 | 92 | 145 | 270 |
| TRIBUTARY NO. 107 TO LINGANORE CREEK NORTH FORK (TRIBUTARY NO. 106) | | | | | |
| Upstream of confluence with Linganore Creek North Fork (Tributary No. 106) | 1.72 | 244 | 423 | 626 | 1180 |
| TRIBUTARY NO. 122 TO HORSEHEAD RUN | | | | | |
| At confluence with Horsehead Run | 0.81 | * | * | 1812 | * |
| TRIBUTARY NO. 123 TO HORSEHEAD RUN | | | | | |
| At confluence with Horsehead Run | 0.28 | * | * | 1315 | * |
| TRIBUTARY NO. 124 TO HORSEHEAD RUN | | | | | |
| At confluence with Horsehead Run | 0.43 | * | * | 978 | * |
| TRIBUTARY NO. 125 TO HORSEHEAD RUN | | | | | |
| At confluence with Rocky Fountain Run | 1.01 | * | * | 1838 | * |

TABLE 5- SUMMARY OF DISCHARGES - continued

| FLOODING SOURCE AND LOCATION | DRAINAGE AREA (sq. miles) | PEAK DISCHARGES (cfs) % ANNUAL CHANCE 10% | 2% | 1% | 0.2% |
|---|---|---|---|---|---|
| TRIBUTARY NO. 126 TO TRIBUTARY NO. 125 TO HORSEHEAD RUN | | | | | |
| At confluence with Tributary No. 125 to Horsehead Run | 0.4 | * | * | 1120 | * |
| TRIBUTARY NO. 127 TO ROCKY FOUNTAIN RUN | | | | | |
| At confluence with Rocky Fountain Run | 0.36 | * | * | 1305 | * |
| TRIBUTARY NO. 128 TO ROCKY FOUNTAIN RUN | | | | | |
| At confluence with Rocky Fountain Run | 0.43 | * | * | 1180 | * |
| TRIBUTARY TO GLADE CREEK | | | | | |
| At confluence with Glade Creek | 0.31 | * | * | 1407 | * |
| TRIBUTARY TO TRIBUTARY NO. 89 TO LITTLE TUSCARORA CREEK | | | | | |
| Upstream of the confluence with Tributary No. 89 to Little Tuscarora Creek | 0.17 | 100 | 246 | 345 | 714 |
| Downstream of the intersection with Christophers Street | 0.08 | 57 | 145 | 206 | 441 |
| TUSCARORA CREEK | | | | | |
| Upstream of confluence with Monocacy River | 27.16 | 3226 | 5192 | 6199 | 9007 |
| At U.S. Route 15 Bridge | 26.11 | 3128 | 5034 | 6010 | 8731 |
| Downstream of confluence of Little Tuscarora Creek | 24.43 | * | * | 5700 | * |
| Upstream of confluence of Little Tuscarora Creek | 18.87 | * | * | 4612 | * |
| At the intersection with Bloomfield Road | 9.01 | * | * | 4080 | * |
| 0.8 miles downstream of the confluence with Clifford Branch | 8.23 | * | * | 3855 | * |
| Upstream of the confluence with Clifford Branch | 1.9 | * | * | 1542 | * |
| TWO MILE RUN (TRIBUTARY NO. 10/93) | | | | | |
| Upstream of confluence with Monocacy River | 0.81 | 245 | 371 | 441 | 720 |

TABLE 5- SUMMARY OF DISCHARGES - continued

| FLOODING SOURCE AND LOCATION | DRAINAGE AREA (sq. miles) | PEAK DISCHARGES (cfs) % ANNUAL CHANCE 10% | 2% | 1% | 0.2% |
|---|---|---|---|---|---|
| UNNAMED TRIBUTARY TO HOLLOW CREEK | | | | | |
| Approximately 450 feet downstream of Beech Tree Lane | 0.52 | * | * | 1510 | * |
| WORMANS RUN (TRIBUTARY NO. 11) | | | | | |
| Upstream of confluence with Monocacy River | 0.35 | 137 | 214 | 252 | 420 |

* Data Not Computed
** Not Applicable

3.2 Hydraulic Analyses

Analyses of the hydraulic characteristics of flooding from the source 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 FIRM represent rounded whole-foot elevations and may not exactly reflect the elevations shown on the Flood Profiles or in the Floodway Data tables in the FIS report. For construction and/or floodplain management purposes, users are encouraged to use the flood elevation data presented in this FIS in conjunction with the data shown on the FIRM.

Cross sections were determined from topographic maps and field surveys. All bridges, dams, and culverts were field surveyed to obtain elevation data and structural geometry. All topographic mapping used to determine cross sections is referenced in Section 4.1.

Locations of 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.

The hydraulic analyses for this FIS were based on 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 qualifying bench marks within a given jurisdiction that are cataloged 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 or B are shown and labeled on the FIRM with their 6-character NSRS Permanent Identifier.

Bench marks cataloged 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 bench marks, 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 bench marks 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 this FIS and FIRM. Interested individuals may contact FEMA to access this data.

**Precountywide Analyses**

Frederick County (Unincorporated Areas), the City of Frederick, and the Towns of Emmitsburg, Thurmont, and Walkersville have previously printed FIS reports. The hydraulic analyses described in those reports have been compiled and are summarized below.

For all five studied communities, analyses of the hydraulic characteristics of the flooding sources studied in detail in the community were carried out to provide estimates of the elevations of floods of the selected recurrence intervals along each of these flooding sources.

<u>Emmitsburg, Town of, March 1980, FIS</u>

For the original study, water-surface profiles, including starting elevations and channel roughness factors, were taken from the previous study for Frederick County (HUD, 1978). For Flat Run and Flat Run (Tributary No. 40), water-surface elevations were computed through the use of the U. S. Army Corps of Engineers' HEC-2 standard step-backwater computer program (USACE, 1973, 1973, 1974).

The starting water-surface elevation for Tributary A was taken from the computed profiles for Flat Run. Flood profiles were drawn showing computed water-surface elevations to an accuracy of 0.5 foot for floods of the selected recurrence intervals.

Cross-section information for areas including the overbank portions of the stream and geometric details of roads and bridges were obtained from the previous study for Frederick County (HUD, 1978). 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 is computed (Section 4.2), selected cross-section locations are also shown on the revised FIRM.

Estimation of Manning's "n" values for the stream channel and overbank reaches were made from observation in the field. The roughness coefficients for Flat Run Tributary A within Emmitsburg ranged from 0.025 to 0.04 for channels and from 0.04 to 0.08 for overbank areas.

<u>Frederick, City of, August 19, 1991, FIS</u>

For the original study, water-surface elevations of floods of the selected recurrence intervals were computed through use of the USACE HEC-2 standard step backwater computer program for streams studied in detail (USACE, June 1973, October 1973, 1969, 1974).

An important element of the backwater profile computation is the determination of a water-surface elevation at the beginning cross section. To establish a beginning point water-surface elevation, a methodology developed by Dalton, Dalton, Little, and Newport (Sarkar, 1976) was used to overcome the lack of data necessary to utilize the options provided by the HEC-2 program and to obtain an accurate elevation without beginning the calculations at an excessive length downstream of the community boundary. Using this computer program the computation of water-surface profiles for the Monocacy River was commenced at a section downstream of Frederick and progressed upstream since the flow is subcritical. The water-surface profiles of the Monocacy River provided the starting water-surface elevations for all tributaries of the Monocacy studied in detail in the community. Similarly, the computed water-surface profiles for Carroll Creek and Rock Creek provided the starting water-surface elevations for tributaries, studied in detail, to these flooding sources.

Cross sectional information including the overbank portions, details of structures such as bridges and culverts, and the profiles of the top of the roadway were obtained through field surveying and field reconnaissance. Cross section data from a previous study on Carroll Creek, Rock Creek, Park Branch (Tributary No. 8/99), Tributary No. 5 to Rock Creek, and Tributary No. 6 to Carroll Creek, made by Dewberry, Nealon and Davis for the City of Frederick (Dewberry, Nealon and Davis, 1975), were utilized for the present study, after making spot verifications in the field to assess accuracy. Supplemental cross sections as well as additional sections and details of bridges and culverts were obtained through field surveying. Locations of selected cross sections, used in the hydraulic analyses, are shown on the FIRM.

Estimates of Manning's roughness values for the channel and the overbanks at each cross section were assigned from information collected in the field regarding vegetation and surface soils and irregularities. The initial estimates of roughness coefficients as well as other parameters, such as bridge loss coefficients, weir coefficients, etc. were slightly modified on the Monocacy River to make the computed water-surface profile pass through the stage-discharge relationships at the gage downstream of Frederick. Roughness values for the stream channel of the Monocacy River varied from 0.015 to 0.04 and for overbank areas from 0.03 to 0.08. For all streams studied in detail, roughness values varied from 0.016 to 0.040 in the channels and from 0.030 to 0.10 in the overbank areas.

Flood profiles were drawn showing computed water-surface elevations to an accuracy of 0.5 foot for floods of the selected recurrence intervals (Exhibit 1). Where the elevation difference between profiles was too small to plot the various floods only the 1% annual chance profile is shown.

<u>Frederick County (Unincorporated Areas) December 1977, FIS</u>

For the original study, cross section information, including the overbank portions, details of structures such as bridges and culverts, and the profiles of the top of the roadway, were obtained through field surveying and field reconnaissance. Several cross sections used in the hydraulic analyses are not shown, since they lie outside of the corporate limits. Cross section data from a previous study on the Monocacy River, made by the U.S. Army Corps of Engineers (USACE), were utilized for the present study to establish starting water-surface elevations or backwater elevations for tributary streams, after making spot verifications in the field to assess accuracy (USACE, 1971).

Water-surface elevations of floods of the selected recurrence intervals were computed using the USACE HEC-2 step-backwater computer program (USACE, June 1973, October 1973, 1969, 1974).

An important element of the backwater profile computation is the determination of the water-surface elevation at the initial cross section. To establish a beginning point water-surface elevation on several streams, a methodology developed by Dalton, Dalton, Little, and Newport was used to overcome the lack of data necessary to utilize the options provided by the HEC-2 program and obtain an accurate elevation without beginning calculations at an excessive length downstream of the county boundary (Sarkar, 1976). This method uses an iterative method of computation in which the initial estimate of energy slope and water-surface elevation at the beginning cross section are successively adjusted with respect to a downstream section through a systematic iterative procedure until the true energy gradient and water-surface elevation are arrived at for the beginning cross section within a specified limit of tolerance. In this method, one additional survey section at a suitable downstream location is required. Computation of water-surface profiles was commenced at the downstream end of detailed study and progressed upstream for subcritical flow and vice-versa for superficial flow.

Initial estimates of Manning's ("n") roughness values for the channel and the overbank areas at each cross section were assigned from information collected in the field regarding vegetation and surface soils and irregularities. The initial estimates of "n" values, as well as other parameters such as bridge loss coefficients and weir coefficients, were slightly modified to make the computed water-surface profile for the projected flood-of-record discharges match the high water marks at all available locations. Stream models calibrated in this manner were the Monocacy River, Glade Run, Park Branch (Tributary No. 8/99), Tuscarora Creek, Tributary No. 40 to Flat Run, and Tributary No. 76 to Hunting Creek. After this calibration process, Manning's "n" values ranged from 0.030 to 0.050 for the channel, and from 0.050 to 0.120 for the overbank areas. Profiles for the 10-, 2-, 1-, and 0.2% annual chance floods were then computed.

Frederick County (Unincorporated Areas) December 3. 1991, FIS

For this revision, the USACE HEC-2 hydraulic backwater model was used to analyze Unnamed Tributary to Hollow Creek (USACE, 1984). Only the 1% annual chance frequency flood was modeled.

Frederick County (Unincorporated Areas) December 19, 1997, FIS

For this revision, the USACE HEC-2 hydraulic backwater model was used to analyze Fishing Creek and the Fishing Creek Diversion Channel (USACE, 1984). Starting water-surface elevations were determined by the slope/area method. Cross sections were surveyed by the Maryland Water Resources Administration, or measured from topographic maps (Interior, 1985). Manning's "n" values were determined from field surveys, and ranged from 0.03 to 0.08 for the channel and from 0.03 to 0.18 for overbank areas.

The hydraulic analyses for this study are based on the effects of unobstructed flow. The flood elevations shown on the profiles are valid only if the hydraulic structures remain unobstructed and dams and other flood control structures operate properly and do not fail.

Locations of 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 revised FIRM.

Flood profiles were drawn showing computed water-surface elevations for floods of the selected recurrence intervals.

The hydraulic analyses for this study were based on 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.

For streams studied by approximate methods, the boundary of the 1% annual chance flood was taken from USGS flood-prone area maps, or by use of historical records (Interior, 1972 and 1973). Where such information was not available, a method of approximately determining the flood boundary developed by Dalton, Dalton, Little, and Newport was used.

Thurmont, Town of, March 1979, FIS

For the original study, water-surface profiles of floods of the selected recurrence intervals were computed through the use of the USACE HEC-2 standard step-backwater computation program for detailed streams (USACE, 1973 and 1974).

Cross-sectional information including the overbank portions of the stream and the road bridge geometric details were obtained through field surveying. Cross sections were located at close distances along the stream and close to any bridge or obstructing structures to give proper estimation of the backwater effects of such structures.

Water-surface elevations at the downstream corporate limit on Hunting Creek were established by backwater computation from the uniform depth at a cross section about 300 feet downstream of the corporate limits. Estimation of Manning's "n" values for the stream channel and overbank reaches were made from observation in the field. Such values for the channel and overbank in Thurmont ranged from 0.03 to 0.04 for channels and from 0.05 to 0.09 for overbanks.

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

Walkersville, Town of, March 1980, FIS

For the original study, water-surface elevations were computed through the use of the U. S. Army Corps of Engineers (USACE) HEC-2 standard step-backwater program (USACE, 1973 and 1974) for streams studied in detail. Cross-sectional information, including the overbank portions of the stream and the road and bridge geometric details, were obtained from surveying in the field.

Water-surface elevations at the downstream end of the study limits on Glade Creek were taken from the Frederick County Flood Insurance Study (HUD, 1978). Starting water-surface elevations for Dublin Branch were taken from the computed profiles for Glade Creek. Elevations of both Glade Creek and Dublin Branch are influenced by backwater from the Monocacy River.

Estimations of Manning's "n" values (channel roughness coefficients) for the stream channel and overbank reaches were made from observations in the field. Values for the two streams ranged from 0.03 to 0.035 for the channels and from 0.05 to 0.1 for their over-banks.

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 selected cross sections used in the hydraulic analyses are shown on the Flood Profiles (Exhibit 1). For stream segments for which a floodway is computed (Section 4.2), selected cross-section locations are also shown on the FIRM.

**Countywide Revision**

For this revision, water-surface elevations of floods for the selected recurrence intervals were computed using the USACE's HEC-RAS 3.1.2 computer program (USACE, 2004). With the exception of Carroll Creek, all streams were studied using the steady flow program (SNET) within HEC-RAS. The lower reach of Carroll Creek was modeled using the unsteady flow program (UNET) within HEC-RAS. This approach routes flow hydrographs developed in HEC-HMS through the

HEC-RAS model and enables the model to account for attenuation and a timing element.

The HEC-Geo-RAS 9.0 extension was used within ArcGIS 9.0 to assist in developing the HEC-RAS models. Normal depth was used for the initial water surface elevations in the hydraulic modeling for the majority of restudied streams, with the exception of Tuscarora Creek and those reaches upstream of another restudied stream. These upstream reaches included portions of Little Tuscarora Creek, Carroll Creek, Tributary 122 to Horsehead Run, Tributary 126 to Tributary No. 125 to Horsehead Run and Silver Spring Branch (Tributary 95). For those stream reaches with a downstream study, known water surface elevations (WSEL) from the downstream reaches were used as a downstream boundary condition. The upstream reach of Tuscarora Creek used the known WSEL from the hydraulic modeling from a previously approved LOMR (Case No. 03-03-121P) for its downstream boundary condition. Slopes for the normal depth calculation were estimated from the lower reaches of the studied streams from land and aerial survey data.

Stream centerline locations were digitized within ArcGIS using City of Frederick and Frederick County orthophotography, aerial and field survey data, and stream centerline planimetric files provided by Frederick County. Cross-sections were placed within ArcGIS using the GeoRAS extension at intervals less than 400 feet. Stream stationing for each designated reach begins at its outlet.

Stream channel topographic data was defined and extracted by creating three dimensional polylines within the channel that interpolate between field surveyed cross-sections that were taken between structures. Creating three dimensional polylines to represent the entire channel enables an accurate channel to be extracted from ArcGIS using the GeoRAS extension at all points within a given stream reach. Overbank geometric data was developed from aerial survey data. By using the GeoRAS extension, bank locations and flowpaths were also identified and imported into the HEC-RAS geometry file.

Hydraulic structures and channel cross-sections upstream and downstream of these structures were surveyed for all detailed studied streams. For limited detailed streams, crossings were either field surveyed, field measured, or available structural plans were obtained from the City of Frederick or Frederick County. Cross-sections were placed at necessary locations near structures within ArcGIS and were extracted into HEC-RAS using the GeoRAS extension and the aforementioned process to create channel geometry for the entire length of each flooding source. The field survey data was used to define the structure geometry within HEC-RAS.

Site visits were conducted in August and September 2003 to assess stream conditions, field survey locations and appropriate Manning's "n" values. Based upon the field review and comparison to values within 'Open-Channel Hydraulics' and 'Roughness Characteristics of Natural Channels' (Interior, 1967) the following values were selected for use in the modeling and placed in locations using the aerial photography.

TABLE 6 - MANNING'S "n" VALUES

| Stream | Channel "n" |
|---|---|
| Ballenger Creek | 0.043 |
| Bush Creek | 0.044 |
| Butterfly Branch (Tributary No. 116) | 0.043 |
| Carroll Creek | 0.04, 0.043, 0.019 |
| Claggett Run (Tributary No. 129) | 0.04 |
| Clifford Branch (Tributary No. 87) | 0.042 |
| Clifton Branch (Tributary No. 98) | 0.015, 0.043 |
| Detrick Branch (Tributary No. 9) | 0.043 |
| Dublin Branch | 0.04 |
| Edison Branch | 0.043 |
| Glade Creek | 0.042 |
| Horsehead Run | 0.042 |
| Israel Creek | 0.037 |
| King Branch (Tributary No. 118) | 0.043 |
| Linganore Creek | 0.038, 0.043 |
| Little Tuscarora Creek | 0.045 |
| Little Tuscarora Creek | 0.041 |
| Monocacy River | 0.045 |
| Park Branch (Tributary No. 8/99) | 0.042 |
| Pike Branch (Tributary No. 117) | 0.043 |
| Rock Creek | 0.045 |
| Rocky Fountain Run | 0.045 |
| Shookstown Creek (Tributary No. 96) | 0.043 |
| Silver Spring Branch (Tributary No. 95) | 0.045 |
| Tributary No. 5 to Rock Creek) | 0.02, 0.045 |
| Tributary No. 6 to Carroll Creek | 0.043, 0.02 |
| Tributary No. 89 to Little Tuscarora Creek | 0.042, 0.045 |
| Tributary No. 122 to Horsehead Run | 0.045 |
| Tributary No. 123 to Horsehead Run | 0.04 |
| Tributary No. 124 to Horsehead Run | 0.04 |
| Tributary No. 125 to Horsehead Run | 0.043 |
| Tributary No. 126 to Tributary No. 125 to Horsehead Run | 0.04 |
| Tributary No. 127 to Rocky Fountain Run | 0.043 |
| Tributary No. 128 to Rocky Fountain Run | 0.04 |
| Tributary to Glade Creek | 0.04 |
| Tributary to Tributary No. 89 to Little Tuscarora Creek | 0.04 |
| Tuscarora Creek | 0.041 |

Overbank values range from 0.03-0.1 for the above referenced flooding sources.

### 3.3 Vertical Datum

All FISs 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 in use for newly created or revised FISs and FIRMs was the National Geodetic Vertical Datum of 1929 (NGVD 29). With the finalization of the North American Vertical Datum of 1988 (NAVD 88), many FIS reports and FIRMs are being prepared using NAVD 88 as the referenced vertical datum.

All flood elevations shown in this FIS report and on the FIRM are referenced to NAVD 88. In order to perform this conversion, effective NGVD 29 elevation values were adjusted downward by 0.67 foot. Structure and ground elevations in the community must, therefore, be referenced to NAVD 88. 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. Elevations initially referenced to the City of Frederick local datum would have to be adjusted downward by 1.3 feet to convert to NAVD 88.

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:

Spatial Reference System Division
National Geodetic Survey, NOAA
Silver Spring Metro Center 3
1315 East-West Highway
Silver Spring, Maryland 20910
(301) 713-3191
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 provides 1% annual chance floodplain data, which may include a combination of the following: 10-, 2-, 1-, and 0.2% annual chance flood elevations; delineations of the 1- and 0.2% annual chance floodplains; and 1% annual chance floodway. This information is presented on the FIRM and in many components of the FIS, including Flood Profiles, Floodway Data tables, and Summary of Stillwater Elevation tables. Users should reference the data presented in the FIS 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- and 0.2% annual chance floodplain boundaries have been delineated using the flood elevations determined at each cross section. The delineations are based on the best available topographic information.

Topographic mapping for this countywide restudy was obtained from a number of sources. The following compilation of topographic datasets was utilized in the development of hydrologic and hydraulic restudies and flood hazard data in support of the Frederick Countywide Restudy.

City of Frederick 2-foot Aerial – The City of Frederick contracted the development of aerial topographic data in 2003 in support of 2-foot contour intervals. This dataset covers the entire City of Frederick and some surrounding areas. The aerial data was developed by Spectrum mapping (formerly 3Di). (Frederick, City, 2003)

Frederick County Department of Public Works (DPW) 5-foot Aerial – The Frederick County DPW contracted the development of 5-foot aerial topographic data in 1995. This data covers an area that runs from southwest of the City of Frederick to east of the City as shown on the attached map. Although Frederick County has confirmed the vertical datum to be NAVD 88, there is no metadata available for this dataset. (Frederick County, 1995)

Walkersville 5-foot Aerial - The Town of Walkersville contracted the development of aerial topographic data in 1998 in support of 5-foot contour intervals. This dataset covers the entire Town of Walkersville and some surrounding areas. (Walkersville, 1998)

Spectrum Mapping, LLC Datasets – After the aforementioned datasets were evaluated in detail, it was determined that two areas were deficient in topographic coverage that were to be studied by detailed/limited detailed methods; the Ballenger Creek Basin and a portion of Clifford Branch. As a result, Spectrum mapping was contracted by FEMA to perform aerial strip mapping of specified areas along Ballenger Creek, and to use previously captured data to develop contour data along Clifford Branch in 2004. This 4-foot contour data supplemented the aforementioned datasets. (Spectrum, 2004)

For the flooding sources previously studied by approximate methods that are not restudied and consequently listed in Section 2.1, the boundaries of the 1% annual chance floodplains were determined by digitizing and adjusting the effective approximate floodplain boundaries as previously designated on FHBMs, and/or FIRMs. These boundaries were adjusted according to more up-to-date stream centerline information as determined from aerial photography and planimetric data obtained from Frederick County. For those streams designated in Section 2.1 for refined approximate studies, new approximate floodplains were developed using a baseline HEC-RAS hydraulic model and automated mapping procedures. The new approximate floodplains were delineated based on the USGS 10 meter Digital Elevation Models (DEMs) where available.

The 1% and 0.2% annual chance floodplain boundaries are shown on the FIRM. On this map, the 1% annual chance floodplain boundary corresponds to the boundary of the areas of special flood hazards (Zones A and AE), and the 0.2% annual chance floodplain boundary corresponds to the boundary of areas of moderate flood hazards. In cases where the 1% and 0.2% annual chance floodplain boundaries are close together, only the 1% 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% annual chance floodplain boundary is shown on the FIRM.

## 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% 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% 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 FIS were computed for certain stream segments on the basis of equal conveyance reduction from each side of the floodplain.

Floodway widths were computed at cross sections. Between cross sections, the floodway boundaries were interpolated. The results of the floodway computations are tabulated for selected cross sections (Table 7). The computed floodways are shown on the FIRM . In cases where the floodway and 1% annual chance floodplain boundaries are either close together or collinear, only the floodway boundary is shown.

No floodways were computed for Arundel Branch, Ballenger Creek, Bush Creek, Butterfly Branch (Tributary No. 116), Claggett Run (Tributary No. 129), Fishing Creek, Horsehead Run, Israel Creek, King Branch (Tributary No. 118), Linganore Creek, Monocacy River, Pike Branch (Tributary No. 117), Rocky Fountain Run, Tributary No. 122 to Horsehead Run, Tributary No. 123 to Horsehead Run, Tributary No. 124 to Horsehead Run, Tributary No. 125 to Horsehead Run, Tributary No. 126 to Tributary No. 125 to Horsehead Run, Tributary No. 127 to Rocky Fountain Run, Tributary No. 128 to Rocky Fountain Run, and Tributary to Glade Creek.

Near the mouths of streams studied in detail, floodway computations are made without regard to flood elevations on the receiving water body. Therefore, "Without Floodway" elevations presented in Table 7 for certain downstream cross sections are lower than the regulatory flood elevations in that area, which must take into account the 1% annual chance flooding due to backwater from other sources.

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." In order 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% 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% 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 2.

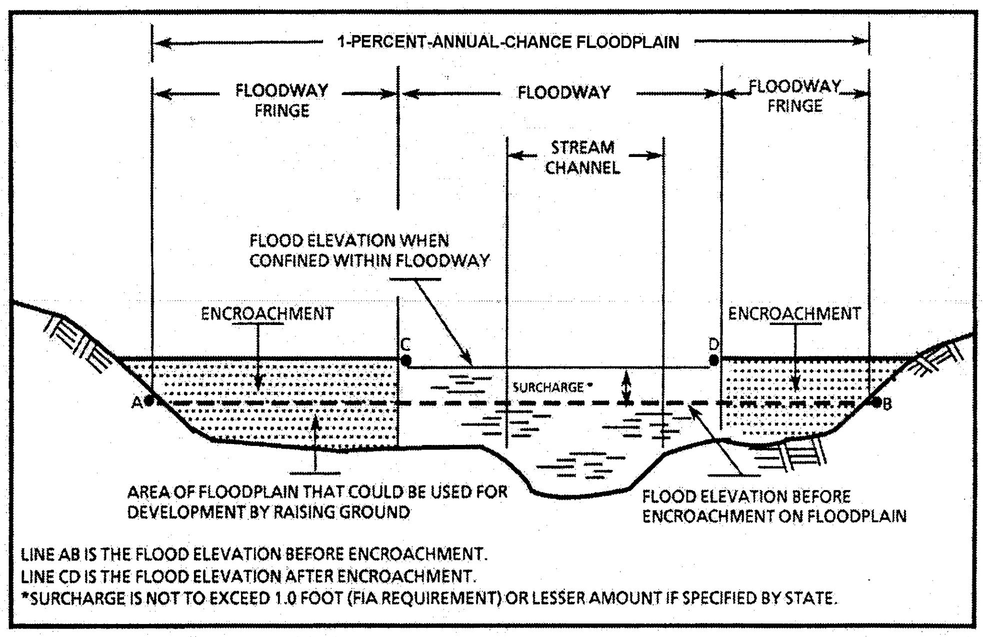


FIGURE 1: FLOODWAY SCHEMATIC

| 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 |
| Carroll Creek | | | | | | | | |
| 1.2 | 1,218 | 446 | 3728 | 2.8 | 266.3 | 257.8[2] | 258.8[2] | 1.0 |
| 3.5 | 3,489 | 765 | 5138 | 2.0 | 266.3 | 258.3[2] | 259.2[2] | 0.9 |
| 7.6 | 7,555 | 473 | 2241 | 4.8 | 266.9 | 266.9 | 267.2 | 0.3 |
| 16.2 | 16,196 | 420 | 2249 | 4.2 | 291.9 | 291.9 | 292.2 | 0.3 |
| 18.5 | 18,483 | 450 | 2416 | 3.7 | 297.5 | 297.5 | 297.9 | 0.4 |
| 20.6 | 20,593 | 1012 | 8876 | 0.6 | 310.5 | 310.5 | 311.5 | 1.0 |
| 23.9 | 23,886 | 273 | 1222 | 4.8 | 314.2 | 314.2 | 314.3 | 0.1 |
| 26.0 | 25,971 | 210 | 695 | 7.2 | 322.5 | 322.5 | 322.5 | 0.0 |
| 28.1 | 28,116 | 340 | 1375 | 1.9 | 329.9 | 329.9 | 330.2 | 0.3 |
| 29.9 | 29,890 | 135 | 390 | 6.4 | 340.0 | 340.0 | 340.0 | 0.0 |
| 30.7 | 30,659 | 330 | 796 | 3.2 | 346.6 | 346.6 | 347.3 | 0.7 |
| 32.9 | 32,914 | 64 | 155 | 7.4 | 373.8 | 373.8 | 374.1 | 0.3 |
| 34.1 | 34,095 | 182 | 267 | 4.3 | 394.0 | 394.0 | 394.7 | 0.7 |
| 35.5 | 35,519 | 123 | 158 | 5.2 | 424.2 | 424.2 | 424.9 | 0.7 |
| 37.4 | 37,443 | 59 | 120 | 6.8 | 476.8 | 476.8 | 477.2 | 0.4 |
| 40.4 | 40,444 | 97 | 181 | 4.5 | 570.6 | 570.6 | 571.3 | 0.7 |
| 43.0 | 42,980 | 43 | 109 | 7.5 | 701.5 | 701.5 | 701.5 | 0.0 |

[1] Feet above confluence with Monocacy River
[2] Elevation computed without consideration of backwater effects from Monocacy River

TABLE 7

FEDERAL EMERGENCY MANAGEMENT AGENCY

**FREDERICK COUNTY, MD AND INCORPORATED AREAS**

**FLOODWAY DATA**

**CARROLL CREEK**

| FLOODING SOURCE | | FLOODWAY | | | BASE FLOOD WATER SURFACE ELEVATION (FEET NAVD) | | | |
|---|---|---|---|---|---|---|---|---|
| CROSS SECTION | DISTANCE | WIDTH (FEET) | SECTION AREA (SQUARE FEET) | MEAN VELOCITY (FEET PER SECOND) | REGULATORY | WITHOUT FLOODWAY | WITH FLOODWAY | INCREASE |
| Clifford Branch (Tributary No. 87) | | | | | | | | |
| 1.0 | 1,040[1] | 189 | 788 | 4.0 | 374.7 | 374.7 | 375.5 | 0.8 |
| 3.5 | 3,527[1] | 168 | 517 | 5.1 | 395.8 | 395.8 | 396.6 | 0.8 |
| 5.9 | 5,896[1] | 295 | 674 | 3.9 | 421.7 | 421.7 | 422.6 | 0.9 |
| 9.9 | 9,900[1] | 309 | 548 | 4.6 | 502.8 | 502.8 | 503.2 | 0.4 |
| 12.8 | 12,813[1] | 130 | 374 | 6.2 | 581.8 | 581.8 | 581.8 | 0.0 |
| 13.8 | 13,845[1] | 175 | 402 | 5.8 | 612.2 | 612.2 | 612.2 | 0.0 |
| Clifton Branch (Tributary No. 98) | | | | | | | | |
| 2.4 | 2,364[2] | 77 | 139 | 8.5 | 366.7 | 366.7 | 366.7 | 0.0 |
| 3.3 | 3,329[2] | 142 | 356 | 3.3 | 376.7 | 376.7 | 377.2 | 0.5 |
| 3.9 | 3,940[2] | 132 | 274 | 4.3 | 382.1 | 382.1 | 382.5 | 0.4 |
| 4.2 | 4,206[2] | 101 | 225 | 5.2 | 385.3 | 385.3 | 385.9 | 0.6 |
| 6.7 | 6,715[2] | 30 | 118 | 10.0 | 432.7 | 432.7 | 432.8 | 0.1 |

[1] Feet above confluence with Tuscarora Creek
[2] Feet above confluence with Rock Creek

TABLE 7

FEDERAL EMERGENCY MANAGEMENT AGENCY

**FREDERICK COUNTY, MD AND INCORPORATED AREAS**

**FLOODWAY DATA**

**CLIFFORD BRANCH (TRIBUTARY NO. 87) – CLIFTON BRANCH (TRIBUTARY NO. 98)**

| FLOODING SOURCE | | FLOODWAY | | | BASE FLOOD WATER SURFACE ELEVATION (FEET NAVD) | | | |
|---|---|---|---|---|---|---|---|---|
| CROSS SECTION | DISTANCE | WIDTH (FEET) | SECTION AREA (SQUARE FEET) | MEAN VELOCITY (FEET PER SECOND) | REGULATORY | WITHOUT FLOODWAY | WITH FLOODWAY | INCREASE |
| Coppermine Branch (Tributary No. 102) | | | | | | | | |
| 1.7 | 1,740[1] | 51 | 179 | 4.0 | 467.8 | 467.8 | 468.5 | 0.7 |
| 1.9 | 1,860[1] | 47 | 188 | 3.8 | 468.3 | 468.3 | 469.3 | 1.0 |
| 2.2 | 2,230[1] | 160 | 533 | 1.2 | 468.7 | 468.7 | 469.7 | 1.0 |
| 3.4 | 3,350[1] | 39 | 86 | 7.2 | 470.9 | 470.9 | 471.2 | 0.3 |
| 3.5 | 3,465[1] | 64 | 195 | 3.2 | 472.4 | 472.4 | 473.4 | 1.0 |
| 3.7 | 3,710[1] | 24 | 79 | 7.9 | 473.6 | 473.6 | 473.9 | 0.3 |
| 3.8 | 3,825[1] | 37 | 138 | 4.5 | 475.1 | 475.1 | 475.6 | 0.5 |
| 4.1 | 4,130[1] | 70 | 244 | 2.6 | 475.6 | 475.6 | 476.6 | 1.0 |
| 5.4 | 5,400[1] | 70 | 146 | 4.3 | 479.7 | 479.7 | 480.4 | 0.7 |
| Davis Branch (Tributary No. 113) | | | | | | | | |
| 0.5 | 520[2] | 11 | 40 | 8.9 | 410.0 | 405.2[3] | 406.2[3] | 1.0 |
| 0.7 | 725[2] | 42 | 170 | 2.1 | 410.0 | 409.7[3] | 410.1[3] | 0.4 |
| 1.9 | 1,870[2] | 13 | 43 | 8.2 | 412.1 | 412.1 | 413.1 | 1.0 |

[1] Feet above confluence with Town Branch
[2] Feet above confluence with Bush Creek
[3] Elevation computed without consideration of backwater effects from Bush Creek

TABLE 7

FEDERAL EMERGENCY MANAGEMENT AGENCY

**FREDERICK COUNTY, MD AND INCORPORATED AREAS**

# FLOODWAY DATA

**COPPERMINE BRANCH (TRIBUTARY NO. 102) – DAVIS BRANCH (TRIBUTARY NO. 113)**

| FLOODING SOURCE | | FLOODWAY | | | BASE FLOOD WATER SURFACE ELEVATION (FEET NAVD) | | | |
|---|---|---|---|---|---|---|---|---|
| CROSS SECTION | DISTANCE | WIDTH (FEET) | SECTION AREA (SQUARE FEET) | MEAN VELOCITY (FEET PER SECOND) | REGULATORY | WITHOUT FLOODWAY | WITH FLOODWAY | INCREASE |
| Detrick Branch (Tributary No. 9) | | | | | | | | |
| 0.5 | 498[1] | 130 | 643 | 3.3 | 268.1 | 261.5[3] | 262.4[3] | 0.9 |
| 1.3 | 1,332[1] | 113 | 461 | 4.6 | 269.7 | 269.7 | 270.4 | 0.7 |
| 2.2 | 2,203[1] | 220 | 700 | 2.8 | 281.5 | 281.5 | 281.5 | 0.0 |
| 2.8 | 2,757[1] | 86 | 284 | 6.9 | 285.8 | 285.8 | 286.6 | 0.8 |
| Dublin Branch | | | | | | | | |
| 0.6 | 604[2] | 73 | 307 | 6.4 | 283.0 | 283.0 | 283.7 | 0.7 |
| 1.5 | 1,465[2] | 102 | 731 | 2.7 | 290.8 | 290.8 | 291.7 | 0.9 |
| 3.1 | 3,059[2] | 104 | 250 | 7.9 | 295.7 | 295.7 | 295.9 | 0.2 |
| 7.5 | 7,495[2] | 201 | 435 | 4.5 | 331.2 | 331.2 | 332.0 | 0.8 |

[1] Feet above confluence with Monocacy River
[2] Feet above confluence with Glade Creek
[3] Elevation computed without consideration of backwater effects from Monocacy River

TABLE 7

FEDERAL EMERGENCY MANAGEMENT AGENCY

**FREDERICK COUNTY, MD AND INCORPORATED AREAS**

**FLOODWAY DATA**

**DETRICK BRANCH (TRIBUTARY NO. 9) – DUBLIN BRANCH**

| FLOODING SOURCE | | FLOODWAY | | | BASE FLOOD WATER SURFACE ELEVATION (FEET NAVD) | | | |
|---|---|---|---|---|---|---|---|---|
| CROSS SECTION | DISTANCE | WIDTH (FEET) | SECTION AREA (SQUARE FEET) | MEAN VELOCITY (FEET PER SECOND) | REGULATORY | WITHOUT FLOODWAY | WITH FLOODWAY | INCREASE |
| Edison Branch | | | | | | | | |
| 0.9 | 900[1] | 106 | 426 | 9.2 | 329.4 | 329.4 | 330.0 | 0.6 |
| 1.3 | 1,346[1] | 81 | 503 | 9.7 | 332.1 | 332.1 | 332.5 | 0.4 |
| 2.4 | 2,400[1] | 37 | 311 | 14.1 | 339.0 | 339.0 | 339.4 | 0.4 |
| 4.2 | 4,200[1] | 91 | 396 | 7.6 | 352.6 | 352.6 | 353.5 | 0.9 |
| 6.0 | 6,000[1] | 80 | 442 | 5.8 | 366.8 | 366.8 | 367.4 | 0.6 |
| 7.7 | 7,654[1] | 34 | 104 | 11.4 | 375.2 | 375.2 | 375.3 | 0.1 |
| Flat Run | | | | | | | | |
| 0.2 | 240[2] | 313 | 2,519 | 4.5 | 373.5 | 373.5 | 374.5 | 1.0 |
| 1.4 | 1,380[2] | 721 | 4,083 | 2.8 | 375.4 | 375.4 | 376.4 | 1.0 |
| 3.7 | 3,660[2] | 134 | 602 | 4.7 | 379.2 | 379.2 | 380.2 | 1.0 |
| 5.3 | 5,320[2] | 224 | 1,014 | 2.8 | 383.0 | 383.0 | 383.8 | 0.8 |
| 5.5 | 5,465[2] | 259 | 1,335 | 2.1 | 385.4 | 385.4 | 385.5 | 0.1 |
| 7.5 | 7,465[2] | 90 | 550 | 5.1 | 386.8 | 386.8 | 387.3 | 0.5 |
| 7.6 | 7,595[2] | 89 | 528 | 5.3 | 387.4 | 387.4 | 387.7 | 0.3 |
| 9.3 | 9,275[2] | 49 | 351 | 8.0 | 390.4 | 390.4 | 391.4 | 1.0 |
| 9.6 | 9,565[2] | 329 | 1,006 | 2.7 | 392.0 | 392.0 | 392.9 | 0.9 |
| 9.8 | 9,750[2] | 305 | 1,321 | 2.1 | 394.5 | 394.5 | 394.8 | 0.3 |
| 11.9 | 11,925[2] | 84 | 323 | 8.0 | 400.7 | 400.7 | 400.7 | 0.0 |
| 13.9 | 13,925[2] | 98 | 643 | 4.0 | 411.9 | 411.9 | 412.6 | 0.7 |

[1] Feet above confluence with Carroll Creek
[2] Feet above confluence with Toms Creek

TABLE 7

FEDERAL EMERGENCY MANAGEMENT AGENCY

**FREDERICK COUNTY, MD AND INCORPORATED AREAS**

**FLOODWAY DATA**

**EDISON BRANCH – FLAT RUN**

| 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 |
| Hunting Creek | | | | | | | | |
| 0.0 | 0 | 71 | 390 | 7.1 | 433.8 | 433.8 | 434.3 | 0.5 |
| 0.1 | 130 | 164 | 646 | 4.3 | 434.1 | 434.1 | 435.0 | 0.9 |
| 0.4 | 396 | 61 | 230 | 12.0 | 438.4 | 438.4 | 438.4 | 0.0 |
| 1.0 | 1,045 | 64 | 298 | 9.3 | 442.6 | 442.6 | 443.2 | 0.6 |
| 1.3 | 1,330 | 90 | 308 | 9.0 | 452.5 | 452.5 | 453.4 | 0.9 |
| 1.7 | 1,740 | 358 | 603 | 4.6 | 455.7 | 455.7 | 456.2 | 0.5 |
| 2.2 | 2,180 | 112 | 304 | 8.1 | 469.7 | 469.7 | 470.3 | 0.6 |
| 2.5 | 2,450 | 219 | 631 | 3.9 | 475.4 | 475.4 | 476.3 | 0.9 |
| 2.8 | 2,780 | 287 | 416 | 5.9 | 477.0 | 477.0 | 477.7 | 0.7 |
| 2.8 | 2,820 | 287 | 416 | 5.9 | 479.7 | 479.7 | 480.4 | 0.7 |
| 2.9 | 2,930 | 259 | 398 | 6.2 | 481.7 | 481.7 | 482.4 | 0.7 |
| 3.5 | 3,530 | 43 | 200 | 12.3 | 490.8 | 490.8 | 490.8 | 0.0 |
| 3.8 | 3,835 | 50 | 209 | 11.7 | 495.9 | 495.9 | 495.9 | 0.0 |
| 4.5 | 4,535 | 45 | 228 | 10.8 | 506.3 | 506.3 | 506.7 | 0.4 |
| 4.9 | 4,930 | 94 | 326 | 7.5 | 515.8 | 515.8 | 516.3 | 0.5 |
| 5.2 | 5,230 | 38 | 191 | 12.3 | 518.9 | 518.9 | 519.9 | 1.0 |
| 5.5 | 5,530 | 37 | 190 | 12.9 | 527.3 | 527.3 | 527.3 | 0.0 |
| 6.6 | 6,630 | 36 | 188 | 13.0 | 543.8 | 543.8 | 543.8 | 0.0 |
| 7.1 | 7,095 | 87 | 422 | 5.8 | 556.3 | 556.3 | 556.7 | 0.4 |
| 7.4 | 7,370 | 70 | 233 | 10.5 | 562.7 | 562.7 | 562.7 | 0.0 |

[1] Feet above previous corporate limits for the City of Thurmont, dated March 1979

TABLE 7

FEDERAL EMERGENCY MANAGEMENT AGENCY

**FREDERICK COUNTY, MD AND INCORPORATED AREAS**

**FLOODWAY DATA**

**HUNTING CREEK**

| FLOODING SOURCE | | FLOODWAY | | | BASE FLOOD WATER SURFACE ELEVATION (FEET NAVD) | | | |
|---|---|---|---|---|---|---|---|---|
| CROSS SECTION | DISTANCE | WIDTH (FEET) | SECTION AREA (SQUARE FEET) | MEAN VELOCITY (FEET PER SECOND) | REGULATORY | WITHOUT FLOODWAY | WITH FLOODWAY | INCREASE |
| Linganore Creek North Fork | | | | | | | | |
| 9.1 | 9,115[1] | 57 | 321 | 8.6 | 408.2 | 408.2 | 408.3 | 0.1 |
| 11.0 | 11,000[1] | 233 | 1,001 | 1.9 | 416.3 | 416.3 | 416.8 | 0.5 |
| 11.7 | 11,650[1] | 133 | 466 | 4.1 | 418.1 | 418.1 | 418.8 | 0.7 |
| Linganore Creek North Fork (Tributary No. 106) | | | | | | | | |
| 0.2 | 230[2] | 550 | 2,268 | 0.4 | 418.6 | 418.6 | 419.6 | 1.0 |
| 0.8 | 770[2] | 150 | 260 | 3.7 | 419.2 | 419.2 | 419.8 | 0.6 |
| 1.9 | 1,900[2] | 74 | 204 | 4.7 | 424.6 | 424.6 | 425.1 | 0.5 |
| 2.5 | 2,490[2] | 76 | 22 | 4.3 | 429.4 | 429.4 | 429.4 | 0.0 |
| 2.7 | 2,700[2] | 60 | 288 | 3.3 | 430.9 | 430.9 | 431.4 | 0.5 |
| 3.1 | 3,100[2] | 116 | 425 | 2.3 | 431.1 | 431.1 | 432.1 | 1.0 |
| 4.6 | 4,554[2] | 67 | 155 | 2.3 | 435.9 | 435.9 | 436.2 | 0.3 |
| 4.8 | 4,786[2] | 27 | 47 | 7.5 | 436.7 | 436.7 | 436.7 | 0.0 |
| 5.5 | 5,500[2] | 24 | 52 | 6.8 | 443.8 | 443.8 | 443.8 | 0.0 |
| 5.7 | 5,708[2] | 24 | 97 | 3.7 | 448.8 | 448.8 | 449.0 | 0.2 |
| 6.2 | 6,226[2] | 24 | 45 | 7.8 | 451.2 | 451.2 | 451.2 | 0.0 |
| 7.8 | 7,780[2] | 15 | 57 | 6.2 | 469.5 | 469.5 | 470.5 | 1.0 |

[1] Feet above confluence with Linganore Creek
[2] Feet above confluence with Linganore Creek North Fork

TABLE 7

FEDERAL EMERGENCY MANAGEMENT AGENCY

**FREDERICK COUNTY, MD AND INCORPORATED AREAS**

# FLOODWAY DATA

**LINGANORE CREEK NORTH FORK – LINGANORE CREEK NORTH FORK (TRIBUTARY NO. 106)**

| FLOODING SOURCE | | FLOODWAY | | | BASE FLOOD WATER SURFACE ELEVATION (FEET NAVD) | | | |
|---|---|---|---|---|---|---|---|---|
| CROSS SECTION | DISTANCE | WIDTH (FEET) | SECTION AREA (SQUARE FEET) | MEAN VELOCITY (FEET PER SECOND) | REGULATORY | WITHOUT FLOODWAY | WITH FLOODWAY | INCREASE |
| Little Tuscarora Creek | | | | | | | | |
| 1.3 | 1,259[1] | 115 | 462 | 4.0 | 298.2 | 298.2 | 298.7 | 0.5 |
| 3.0 | 2,951[1] | 150 | 429 | 4.3 | 306.5 | 306.5 | 306.9 | 0.3 |
| 7.1 | 7,106[1] | 186 | 424 | 5.8 | 344.6 | 344.6 | 344.6 | 0.0 |
| 10.9 | 10,911[1] | 91 | 303 | 11.2 | 382.9 | 382.9 | 383.2 | 0.3 |
| 13.1 | 13,145[1] | 84 | 272 | 11.7 | 407.9 | 407.9 | 408.3 | 0.4 |
| 14.2 | 14,250[1] | 239 | 421 | 9.5 | 421.9 | 421.9 | 422.1 | 0.2 |
| 14.8 | 14,797[1] | 81 | 262 | 7.9 | 431.6 | 431.6 | 431.7 | 0.1 |
| 15.1 | 15,057[1] | 58 | 216 | 9.6 | 436.1 | 436.1 | 436.9 | 0.8 |
| 16.6 | 16,647[1] | 40 | 101 | 9.1 | 467.8 | 467.8 | 468.8 | 1.0 |
| 18.3 | 18,337[1] | 50 | 141 | 6.6 | 508.8 | 508.8 | 509.8 | 1.0 |
| Muddy Run | | | | | | | | |
| 3.6 | 3,600[2] | 100 | 308 | 4.8 | 439.5 | 439.5 | 440.5 | 1.0 |
| 3.7 | 3,690[2] | 289 | 840 | 1.8 | 441.7 | 441.7 | 442.7 | 1.0 |
| 4.6 | 4,550[2] | 100 | 236 | 6.3 | 455.3 | 455.3 | 455.3 | 0.0 |
| 4.7 | 4,675[2] | 60 | 194 | 7.7 | 457.1 | 457.1 | 457.4 | 0.3 |
| 5.4 | 5,400[2] | 61 | 232 | 6.4 | 468.4 | 468.4 | 469.3 | 0.9 |
| 7.8 | 7,805[2] | 41 | 84 | 6.7 | 554.6 | 554.6 | 555.1 | 0.5 |

[1] Feet above confluence with Tuscarora Creek
[2] Feet above confluence with Hunting Creek

TABLE 7

FEDERAL EMERGENCY MANAGEMENT AGENCY

**FREDERICK COUNTY, MD AND INCORPORATED AREAS**

**FLOODWAY DATA**

**LITTLE TUSCARORA CREEK – MUDDY RUN**

| FLOODING SOURCE | | FLOODWAY | | | BASE FLOOD WATER SURFACE ELEVATION (FEET NAVD) | | | |
|---|---|---|---|---|---|---|---|---|
| CROSS SECTION | DISTANCE | WIDTH (FEET) | SECTION AREA (SQUARE FEET) | MEAN VELOCITY (FEET PER SECOND) | REGULATORY | WITHOUT FLOODWAY | WITH FLOODWAY | INCREASE |
| Park Branch (Tributary No.8/99) | | | | | | | | |
| 2.1 | 2,083[1] | 82 | 535 | 4.2 | 266.8 | 261.7[3] | 262.4[3] | 0.7 |
| 4.1 | 4,146[1] | 103 | 642 | 3.2 | 266.8 | 266.4[3] | 266.8[3] | 0.4 |
| 6.1 | 6,147[1] | 123 | 558 | 3.7 | 274.6 | 274.6 | 275.5 | 0.9 |
| 7.6 | 7,617[1] | 80 | 331 | 6.3 | 281.5 | 281.5 | 282.0 | 0.5 |
| 8.1 | 8,147[1] | 64 | 397 | 5.2 | 285.8 | 285.8 | 286.1 | 0.3 |
| Rock Creek | | | | | | | | |
| 1.1 | 1,087[2] | 150 | 851 | 5.6 | 310.5 | 306.1[4] | 307.1[4] | 1.0 |
| 2.8 | 2,826[2] | 180 | 2,014 | 2.4 | 320.4 | 320.4 | 321.3 | 0.9 |
| 4.5 | 4,473[2] | 140 | 1,497 | 3.2 | 327.3 | 327.3 | 327.6 | 0.3 |
| 5.6 | 5,583[2] | 141 | 1,039 | 3.9 | 328.0 | 328.0 | 329.0 | 1.0 |
| 7.4 | 7,428[2] | 197 | 1,487 | 2.8 | 339.5 | 339.5 | 340.3 | 0.8 |
| 9.1 | 9,051[2] | 291 | 826 | 4.9 | 351.0 | 351.0 | 351.2 | 0.2 |
| 11.2 | 11,200[2] | 52 | 185 | 10.4 | 373.0 | 373.0 | 373.0 | 0.0 |
| 12.1 | 12,113[2] | 189 | 362 | 5.3 | 386.2 | 386.2 | 386.6 | 0.4 |
| 13.5 | 13,522[2] | 123 | 270 | 7.1 | 412.0 | 412.0 | 412.2 | 0.2 |
| 14.5 | 14,457[2] | 27 | 147 | 13.0 | 432.3 | 432.3 | 432.5 | 0.2 |

[1] Feet above confluence with Monocacy River
[2] Feet above confluence with Carroll Creek
[3] Elevation computed without consideration of backwater effects from Monocacy River
[4] Elevation computed without consideration of backwater effects from Carroll Creek

TABLE 7

FEDERAL EMERGENCY MANAGEMENT AGENCY

**FREDERICK COUNTY, MD AND INCORPORATED AREAS**

**FLOODWAY DATA**

**PARK BRANCH (TRIBUTARY NO. 8/99) – ROCK 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 |
| Rouzer Creek | | | | | | | | |
| 0.1 | 50 | 67 | 119 | 5.0 | 459.7 | 459.7 | 460.3 | 0.6 |
| 0.3 | 330 | 41 | 93 | 6.4 | 465.8 | 465.8 | 466.4 | 0.6 |
| 1.0 | 960 | 41 | 100 | 6.0 | 472.0 | 472.0 | 472.7 | 0.7 |
| 1.4 | 1,420 | 41 | 139 | 4.3 | 476.4 | 476.4 | 477.4 | 1.0 |
| 1.5 | 1,520 | 37 | 112 | 5.3 | 478.0 | 478.0 | 478.5 | 0.5 |
| 1.7 | 1,720 | 86 | 167 | 3.6 | 482.0 | 482.0 | 483.0 | 1.0 |
| 1.9 | 1,850 | 33 | 85 | 7.0 | 490.1 | 490.1 | 490.8 | 0.7 |
| 1.9 | 1,920 | 37 | 109 | 5.5 | 492.0 | 492.0 | 493.0 | 1.0 |
| 2.3 | 2,330 | 106 | 216 | 2.8 | 494.5 | 494.5 | 495.5 | 1.0 |
| 2.8 | 2,770 | 67 | 121 | 5.0 | 503.1 | 503.1 | 504.0 | 0.9 |
| 2.9 | 2,880 | 171 | 382 | 1.6 | 505.6 | 505.6 | 506.5 | 0.9 |
| 3.6 | 3,550 | 129 | 389 | 1.5 | 518.8 | 518.8 | 519.1 | 0.3 |
| 3.7 | 3,680 | 39 | 95 | 6.3 | 525.5 | 525.5 | 526.5 | 1.0 |
| 4.0 | 4,000 | 51 | 214 | 2.8 | 531.5 | 531.5 | 532.3 | 0.8 |
| 4.4 | 4,440 | 34 | 89 | 6.8 | 535.9 | 535.9 | 536.6 | 0.7 |
| 4.5 | 4,500 | 32 | 84 | 7.2 | 537.7 | 537.7 | 538.3 | 0.6 |

[1] Feet above confluence with Hunting Creek

TABLE 7

FEDERAL EMERGENCY MANAGEMENT AGENCY

**FREDERICK COUNTY, MD AND INCORPORATED AREAS**

## FLOODWAY DATA

**ROUZER 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 |
| Shookstown Creek (Tributary No. 96) | | | | | | | | |
| 0.7 | 705 | 55 | 211 | 8.9 | 315.0 | 315.0 | 315.0 | 0.0 |
| 3.8 | 3,782 | 98 | 226 | 6.3 | 337.3 | 337.3 | 337.8 | 0.5 |
| 7.1 | 7,081 | 177 | 320 | 4.5 | 360.7 | 360.7 | 361.5 | 0.8 |
| 10.0 | 9,964 | 154 | 255 | 5.6 | 396.8 | 396.8 | 397.5 | 0.7 |
| 11.3 | 11,297 | * | * | * | 435.6 | 435.6 | * | * |
| 13.1 | 13,138 | * | * | * | 498.7 | 498.7 | * | * |
| 14.7 | 14,664 | * | * | * | 561.1 | 561.1 | * | * |
| 15.9 | 15,927 | * | * | * | 624.9 | 624.9 | * | * |
| 17.4 | 17,364 | * | * | * | 774.4 | 774.4 | * | * |
| Silver Spring Branch (Tributary No. 95) | | | | | | | | |
| 1.2 | 1,200 | 75 | 233.6 | 6.0 | 354.5 | 354.5 | 355.5 | 1.0 |
| 2.7 | 2,700 | 30 | 90 | 9.4 | 372.7 | 372.7 | 373.7 | 1.0 |
| 3.9 | 3,868 | 84 | 157 | 5.4 | 395.8 | 395.8 | 395.8 | 0.0 |
| 6.0 | 6,038 | 46 | 117 | 7.3 | 466.2 | 466.2 | 466.7 | 0.5 |
| 8.2 | 8,209 | 8 | 48 | 13.9 | 540.5 | 540.5 | 540.6 | 0.1 |
| 11.4 | 11,371 | 26 | 80 | 8.3 | 715.9 | 715.9 | 716.4 | 0.5 |

[1] Feet above confluence with Carroll Creek
* Data not available

TABLE 7

FEDERAL EMERGENCY MANAGEMENT AGENCY

**FREDERICK COUNTY, MD AND INCORPORATED AREAS**

**FLOODWAY DATA**

**SHOOKSTOWN CREEK (TRIBUTARY NO. 96) – SILVER SPRING BRANCH (TRIBUTARY NO. 95)**

| FLOODING SOURCE | | FLOODWAY | | | BASE FLOOD WATER SURFACE ELEVATION (FEET NAVD) | | | |
|---|---|---|---|---|---|---|---|---|
| CROSS SECTION | DISTANCE | WIDTH (FEET) | SECTION AREA (SQUARE FEET) | MEAN VELOCITY (FEET PER SECOND) | REGULATORY | WITHOUT FLOODWAY | WITH FLOODWAY | INCREASE |
| Tributary No. 5 to Rock Creek | | | | | | | | |
| 1.2 | 1,185[1] | 20 | 48 | 7.2 | 355.7 | 355.7 | 355.7 | 0.0 |
| 1.6 | 1,560[1] | 49 | 141 | 0.9 | 374.4 | 374.4 | 374.9 | 0.5 |
| 2.1 | 2,088[1] | 195 | 1,676 | 0.2 | 395.0 | 395.0 | 395.2 | 0.2 |
| Tributary No. 6 to Carroll Creek | | | | | | | | |
| 0.2 | 219[2] | 53 | 210 | 6.6 | 293.5 | 289.3[3] | 289.7[3] | 0.4 |
| 1.3 | 1,311[2] | 43 | 226 | 4.3 | 299.0 | 299.0 | 299.9 | 0.9 |
| 1.9 | 1,943[2] | 59 | 155 | 6.3 | 300.9 | 300.9 | 301.3 | 0.4 |
| 2.4 | 2,419[2] | 19 | 81 | 12.0 | 308.1 | 308.1 | 308.1 | 0.0 |
| 2.8 | 2,842[2] | 52 | 279 | 3.5 | 313.4 | 313.4 | 314.1 | 0.7 |
| 3.4 | 3,362[2] | 33 | 172 | 5.6 | 316.3 | 316.3 | 317.2 | 0.9 |
| 4.1 | 4,145[2] | 44 | 108 | 9.0 | 326.1 | 326.1 | 326.2 | 0.1 |
| 5.3 | 5,297[2] | 36 | 172 | 4.5 | 341.8 | 343.4 | 343.9 | 0.5 |
| 7.9 | 7,937[2] | 29 | 92 | 8.3 | 409.7 | 409.7 | 410.2 | 0.5 |

[1] Feet above confluence with Rock Creek
[2] Feet above confluence with Carroll Creek
[3] Elevation computed without consideration of backwater effects from Carroll Creek

TABLE 7

FEDERAL EMERGENCY MANAGEMENT AGENCY

**FREDERICK COUNTY, MD AND INCORPORATED AREAS**

## FLOODWAY DATA

**TRIBUTARY NO. 5 TO ROCK CREEK – TRIBUTARY NO. 6 TO CARROLL 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 |
| Tributary No. 36 to Friends Creek | | | | | | | | |
| 1.2 | 1,200 | 35 | 189 | 8.4 | 1,004.6 | 1,004.6 | 1,005.6 | 1.0 |
| 2.6 | 2,600 | 33 | 169 | 9.4 | 1,020.0 | 1,020.0 | 1,020.8 | 0.8 |
| 3.9 | 3,880 | 80 | 276 | 5.7 | 1,033.0 | 1,033.0 | 1,034.0 | 1.0 |
| 4.0 | 4,010 | 395 | 2,164 | 0.7 | 1,037.2 | 1,037.2 | 1,037.2 | 0.0 |
| 6.2 | 6,150 | 35 | 139 | 11.4 | 1,097.4 | 1,097.4 | 1,097.4 | 0.0 |
| 6.3 | 6,260 | 47 | 310 | 5.1 | 1,102.2 | 1,102.2 | 1,102.3 | 0.1 |
| 6.5 | 6,520 | 35 | 138 | 11.5 | 1,104.6 | 1,104.6 | 1,104.6 | 0.0 |
| 7.5 | 7,520 | 22 | 91 | 11.0 | 1,139.6 | 1,139.6 | 1,139.8 | 0.2 |
| 7.6 | 7,640 | 53 | 267 | 3.7 | 1,145.5 | 1,145.5 | 1,146.1 | 0.6 |
| 8.0 | 7,970 | 36 | 117 | 8.5 | 1,152.8 | 1,152.8 | 1,153.7 | 0.9 |
| 8.1 | 8,070 | 78 | 176 | 5.7 | 1,156.4 | 1,156.4 | 1,156.4 | 0.0 |
| 8.6 | 8,575 | 24 | 175 | 5.7 | 1,175.8 | 1,175.8 | 1,175.8 | 0.0 |
| 9.1 | 9,075 | 70 | 175 | 5.7 | 1,195.1 | 1,195.1 | 1,195.1 | 0.0 |
| 9.6 | 9,600 | 66 | 174 | 5.7 | 1,215.5 | 1,215.5 | 1,215.5 | 0.0 |

[1] Feet above confluence with Friends Creek

TABLE 7

FEDERAL EMERGENCY MANAGEMENT AGENCY

**FREDERICK COUNTY, MD AND INCORPORATED AREAS**

# FLOODWAY DATA

**TRIBUTARY NO. 36 TO FRIENDS CREEK**

| FLOODING SOURCE | | FLOODWAY | | | BASE FLOOD WATER SURFACE ELEVATION (FEET NAVD) | | | |
|---|---|---|---|---|---|---|---|---|
| CROSS SECTION | DISTANCE | WIDTH (FEET) | SECTION AREA (SQUARE FEET) | MEAN VELOCITY (FEET PER SECOND) | REGULATORY | WITHOUT FLOODWAY | WITH FLOODWAY | INCREASE |
| Tributary No. 38 to Tributary No. 36 to Friends Creek | | | | | | | | |
| 0.7 | 710[1] | 81 | 103 | 5.0 | 1,124.1 | 1,124.1 | 1,124.1 | 0.0 |
| 0.8 | 800[1] | 118 | 431 | 1.2 | 1,129.4 | 1,129.4 | 1,129.4 | 0.0 |
| 1.1 | 1,070[1] | 56 | 78 | 6.6 | 1,136.7 | 1,136.7 | 1,137.6 | 0.9 |
| 1.2 | 1,230[1] | 53 | 84 | 6.1 | 1,148.6 | 1,148.6 | 1,148.7 | 0.1 |
| 1.3 | 1,290[1] | 28 | 64 | 8.0 | 1,149.8 | 1,149.8 | 1,150.6 | 0.8 |
| 1.5 | 1,500[1] | 26 | 74 | 7.0 | 1,155.4 | 1,155.4 | 1,156.4 | 1.0 |
| 2.6 | 2,600[1] | 27 | 73 | 7.0 | 1,214.1 | 1,214.1 | 1,215.1 | 1.0 |
| 2.7 | 2,740[1] | 29 | 75 | 6.9 | 1,223.1 | 1,223.1 | 1,224.0 | 0.9 |
| Tributary No. 40 to Flat Run | | | | | | | | |
| 0.9 | 900[2] | 17 | 40 | 8.2 | 398.5 | 398.5 | 399.0 | 0.5 |
| 1.7 | 1,715[2] | 21 | 65 | 5.1 | 408.3 | 408.3 | 409.3 | 1.0 |
| 1.8 | 1,810[2] | 83 | 348 | 1.0 | 411.5 | 411.5 | 411.5 | 0.0 |
| 3.9 | 3,900[2] | 30 | 49 | 6.7 | 428.8 | 428.8 | 429.1 | 0.3 |
| Tributary No. 41 to Flat Run | | | | | | | | |
| 0.6 | 565[2] | 22 | 63 | 4.7 | 393.9 | 393.9 | 394.9 | 1.0 |
| 1.7 | 1,725[2] | 18 | 43 | 7.0 | 413.4 | 413.4 | 413.6 | 0.2 |
| 2.9 | 2,885[2] | 15 | 22 | 5.9 | 432.0 | 432.0 | 432.0 | 0.0 |
| 3.0 | 2,990[2] | 29 | 81 | 1.6 | 436.9 | 436.9 | 436.9 | 0.0 |
| 3.6 | 3,565[2] | 13 | 19 | 7.0 | 444.8 | 444.8 | 444.8 | 0.0 |
| 4.7 | 4,715[2] | 12 | 19 | 7.1 | 466.7 | 466.7 | 466.7 | 0.0 |
| 5.3 | 5,290[2] | 14 | 23 | 5.9 | 476.9 | 476.9 | 477.4 | 0.5 |

[1] Feet above confluence with Tributary No. 36 to Friends Creek
[2] Feet above confluence with Flat Run

TABLE 7

FEDERAL EMERGENCY MANAGEMENT AGENCY

**FREDERICK COUNTY, MD AND INCORPORATED AREAS**

**FLOODWAY DATA**

**TRIBUTARY NO. 38 TO TRIBUTARY NO. 36 TO FRIENDS CREEK – TRIBUTARY NO. 40 TO FLAT RUN – TRIBUTARY NO. 41 TO FLAT RUN**

| FLOODING SOURCE | | FLOODWAY | | | BASE FLOOD WATER SURFACE ELEVATION (FEET NAVD) | | | |
|---|---|---|---|---|---|---|---|---|
| CROSS SECTION | DISTANCE | WIDTH (FEET) | SECTION AREA (SQUARE FEET) | MEAN VELOCITY (FEET PER SECOND) | REGULATORY | WITHOUT FLOODWAY | WITH FLOODWAY | INCREASE |
| Tributary No. 74 to Muddy Run | | | | | | | | |
| 0.4 | 400[1] | 40 | 100 | 8.3 | 480.8 | 480.8 | 480.8 | 0.0 |
| 1.4 | 1,380[1] | 40 | 100 | 8.3 | 508.8 | 508.8 | 508.8 | 0.0 |
| Tributary No. 76 to Hunting Creek | | | | | | | | |
| 0.2 | 225[2] | 295 | 500 | 5.8 | 361.9 | 361.9 | 362.9 | 1.0 |
| 1.1 | 1,125[2] | 76 | 171 | 2.5 | 370.6 | 370.6 | 371.6 | 1.0 |
| 2.7 | 2,690[2] | 50 | 83 | 5.2 | 386.2 | 386.2 | 386.5 | 0.3 |
| 3.3 | 3,310[2] | 50 | 107 | 4.1 | 392.5 | 392.5 | 392.9 | 0.4 |
| 3.5 | 3,450[2] | 50 | 142 | 3.1 | 396.6 | 396.6 | 396.6 | 0.0 |
| 4.6 | 4,580[2] | 50 | 85 | 5.1 | 409.6 | 409.6 | 409.6 | 0.0 |
| 6.6 | 6,605[2] | 38 | 53 | 3.9 | 433.7 | 433.7 | 434.2 | 0.5 |
| 6.7 | 6,700[2] | 45 | 102 | 2.0 | 434.5 | 434.5 | 435.0 | 0.5 |
| 8.2 | 8,150[2] | 29 | 35 | 5.9 | 454.3 | 454.3 | 454.8 | 0.5 |
| Tributary No. 89 to Little Tuscarora Creek | | | | | | | | |
| 1.3 | 1,278[3] | 69 | 183 | 5.8 | 319.6 | 319.6 | 320.2 | 0.6 |
| 2.9 | 2,943[3] | 52 | 164 | 6.5 | 337.4 | 337.4 | 337.4 | 0.0 |
| 4.2 | 4,200[3] | 57 | 111 | 7.3 | 349.8 | 349.8 | 350.0 | 0.2 |
| 5.1 | 5,051[3] | 42 | 89 | 6.8 | 359.4 | 359.4 | 359.7 | 0.3 |

[1] Feet above confluence with Muddy Run
[2] Feet above confluence with Hunting Creek
[3] Feet above confluence with Little Tuscarora Creek

TABLE 7

**FEDERAL EMERGENCY MANAGEMENT AGENCY**

**FREDERICK COUNTY, MD AND INCORPORATED AREAS**

**FLOODWAY DATA**

**TRIBUTARY NO. 74 TO MUDDY RUN – TRIBUTARY NO. 76 TO HUNTING CREEK – TRIBUTARY NO. 89 TO LITTLE TUSCARORA CREEK**

| FLOODING SOURCE | | FLOODWAY | | | BASE FLOOD WATER SURFACE ELEVATION (FEET NAVD) | | | |
|---|---|---|---|---|---|---|---|---|
| CROSS SECTION | DISTANCE | WIDTH (FEET) | SECTION AREA (SQUARE FEET) | MEAN VELOCITY (FEET PER SECOND) | REGULATORY | WITHOUT FLOODWAY | WITH FLOODWAY | INCREASE |
| Tributary No. 101 to Coppermine Branch (Tributary No. 102) | | | | | | | | |
| 0.1 | 130[1] | 5 | 16 | 9.0 | 468.8 | 468.8 | 469.3 | 0.5 |
| 1.7 | 1,680[1] | 11 | 25 | 5.7 | 495.2 | 495.2 | 495.6 | 0.4 |
| Tributary No. 107 to Linganore Creek North Fork (Tributary No. 106) | | | | | | | | |
| 0.4 | 375[2] | 35 | 170 | 3.7 | 437.5 | 437.5 | 438.5 | 1.0 |
| 0.5 | 475[2] | 35 | 168 | 3.7 | 437.9 | 437.9 | 438.8 | 0.9 |
| 0.6 | 625[2] | 30 | 151 | 4.2 | 441.3 | 441.3 | 441.3 | 0.0 |
| 1.1 | 1,125[2] | 30 | 87 | 7.2 | 442.0 | 442.0 | 443.0 | 1.0 |

[1] Feet above confluence with Coppermine Branch (Tributary No. 102)
[2] Feet above confluence with Linganore Creek North Fork (Tributary No. 106)

TABLE 7

**FEDERAL EMERGENCY MANAGEMENT AGENCY**

**FREDERICK COUNTY, MD AND INCORPORATED AREAS**

**FLOODWAY DATA**

**TRIBUTARY NO. 101 TO COPPERMINE BRANCH (TRIBUTARY NO. 102) – TRIBUTARY NO. 107 TO LINGANORE CREEK NORTH FORK (TRIBUTARY NO. 106)**

| FLOODING SOURCE | | FLOODWAY | | | BASE FLOOD WATER SURFACE ELEVATION (FEET NAVD) | | | |
|---|---|---|---|---|---|---|---|---|
| CROSS SECTION | DISTANCE | WIDTH (FEET) | SECTION AREA (SQUARE FEET) | MEAN VELOCITY (FEET PER SECOND) | REGULATORY | WITHOUT FLOODWAY | WITH FLOODWAY | INCREASE |
| Tributary to Tributary No. 89 to Little Tuscarora Creek | | | | | | | | |
| 1.2 | 1,200[1] | 30 | 60 | 5.8 | 374.8 | 374.8 | 375.1 | 0.3 |
| 2.1 | 2,062[1] | 20 | 74 | 2.8 | 401.7 | 401.7 | 402.5 | 0.8 |
| Tuscarora Creek | | | | | | | | |
| 0.5 | 500[2] | 200 | 900 | 6.9 | 274.2 | 260.1[3] | 261.1[3] | 1.0 |
| 5.6 | 5,620[2] | 271 | 798 | 7.8 | 274.2 | 271.6[3] | 272.1[3] | 0.5 |
| 7.0 | 7,032[2] | 463 | 1,983 | 2.9 | 275.1 | 275.1 | 275.1 | 0.0 |
| 8.8 | 8,760[2] | 378 | 2,499 | 2.3 | 280.2 | 280.2 | 280.8 | 0.6 |
| 14.1 | 14,079[2] | 106 | 589 | 6.8 | 288.0 | 288.0 | 288.7 | 0.7 |
| 18.0 | 18,008[2] | 107 | 670 | 6.1 | 301.6 | 301.6 | 302.5 | 0.9 |
| 22.2 | 22,197[2] | 292 | 906 | 4.5 | 322.0 | 322.0 | 322.1 | 0.1 |
| 27.3 | 27,299[2] | 259 | 1,376 | 2.8 | 353.4 | 353.4 | 353.9 | 0.5 |
| 29.1 | 29,050[2] | 231 | 1,483 | 2.6 | 362.8 | 362.8 | 362.8 | 0.0 |
| Twomile Run (Tributary No. 10/93) | | | | | | | | |
| 0.7 | 690[2] | 25 | 53 | 8.3 | 268.4 | 268.4 | 268.6 | 0.2 |
| Worman's Run (Tributary No. 11) | | | | | | | | |
| 0.6 | 550[2] | 18 | 30 | 8.4 | 268.4 | 268.4 | 268.5 | 0.1 |

[1] Feet above confluence with Little Tuscarora Creek (Tributary No. 89)
[2] Feet above confluence with Monocacy River
[3] Elevation computed without consideration of backwater effects from Monocacy River

TABLE 7

FEDERAL EMERGENCY MANAGEMENT AGENCY

**FREDERICK COUNTY, MD AND INCORPORATED AREAS**

## FLOODWAY DATA

**TRIBUTARY TO TRIBUTARY NO. 89 TO LITTLE TUSCARORA CREEK – TUSCARORA CREEK – TWOMILE RUN (TRIBUTARY NO. 10/93) – WORMAN'S RUN (TRIBUTARY NO. 11)**

## 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 AH

Zone AH is the flood insurance rate zone that corresponds to the areas of 1 percent annual chance shallow flooding (usually areas of ponding) where average depths are between 1 and 3 feet. Whole-foot base flood elevations derived from the detailed hydraulic analyses are shown at selected intervals within this zone.

Zone AO

Zone AO is the flood insurance rate zone that corresponds to the areas of 1 percent annual chance shallow flooding (usually sheet flow on sloping terrain) where average depths are between 1 and 3 feet. Average whole-depths derived from the detailed hydraulic analyses are shown within this zone.

Zone A99

Zone A99 is the flood insurance rate zone that corresponds to areas of the 1 percent annual chance floodplain that will be protected by a Federal flood protection system where construction has reached specified statutory milestones. No base flood elevations or depths are shown within this zone.

Zone V

Zone V is the flood insurance rate zone that corresponds to the 1 percent annual chance coastal floodplains that have additional hazards associated with storm waves. Because approximate hydraulic analyses are performed for such areas, no base flood elevations are shown within this zone.

Zone VE

Zone VE is the flood insurance rate zone that corresponds to the 1 percent annual chance coastal floodplains that have additional hazards associated with storm waves. 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.

Zone D

Zone D is the flood insurance rate zone that corresponds to unstudied areas where flood hazards are undetermined, but possible.

## 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% 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% and 0.2% 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 Frederick County. Previously, separate Flood Hazard Boundary Maps and/or FIRMs were prepared for each identified flood-prone incorporated community and the unincorporated areas of the county. This countywide FIRM also includes flood hazard information that was presented separately on Flood Boundary and Floodway Maps (FBFMs), where applicable. Historical data relating to the maps prepared for each community, up to and including this countywide FIS, are presented in Table 8, "Community Map History."

| COMMUNITY NAME | INITIAL IDENTIFICATION | FLOOD HAZARD BOUNDARY MAP REVISIONS DATE | FIRM EFFECTIVE DATE | FIRM REVISIONS DATE |
|---|---|---|---|---|
| Brunswick, City of | June 28, 1974 | December 28, 1975 | January 7, 1977 | None |
| Burkittsville, Village of | N/A | N/A | N/A | N/A |
| Emmitsburg, Town of | March 29, 1974 | January 16, 1976 | September 17, 1980 | None |
| Frederick, City of | October 18, 1974 | None | June 15, 1978 | June 15, 1988<br>August 19, 1991 |
| Frederick County (Unincorporated Areas) | July 19, 1974 | None | June 1, 1978 | August 8, 1980,<br>December 3, 1991,<br>December 19, 1997 |
| Middletown, Town of | January 14, 1977 | None | October 23, 1981 | None |
| Mount Airy, Town of | N/A | N/A | N/A | N/A |
| Myersville, Town of | December 6, 1974 | None | December 15, 1978 | None |
| New Market, Town of | N/A | N/A | N/A | N/A |

TABLE 8

FEDERAL EMERGENCY MANAGEMENT AGENCY

**FREDERICK COUNTY, MD**
**AND INCORPORATED AREAS**

COMMUNITY MAP HISTORY

| COMMUNITY NAME | INITIAL IDENTIFICATION | FLOOD HAZARD BOUNDARY MAP REVISIONS DATE | FIRM EFFECTIVE DATE | FIRM REVISIONS DATE |
|---|---|---|---|---|
| Rosemont, Village of | N/A | N/A | N/A | N/A |
| Thurmont, Town of | June 28, 1974 | January 16, 1976 | September 28, 1979 | None |
| Walkersville, Town of | June 28, 1974 | October 24, 1975 | September 30, 1980 | None |
| Woodsboro, Town of | January 21, 1977 | None | December 15, 1978 | None |

TABLE 8

FEDERAL EMERGENCY MANAGEMENT AGENCY

**FREDERICK COUNTY, MD**
**AND INCORPORATED AREAS**

COMMUNITY MAP HISTORY

## 7.0 OTHER STUDIES

Information pertaining to revised and unrevised flood hazards for each jurisdiction within Frederick County has been compiled into this FIS. Therefore, this FIS supersedes all previously printed FIS Reports, FHBMs, FBFMs, and FIRMs for all of the incorporated and unincorporated jurisdictions within Frederick County.

## 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.

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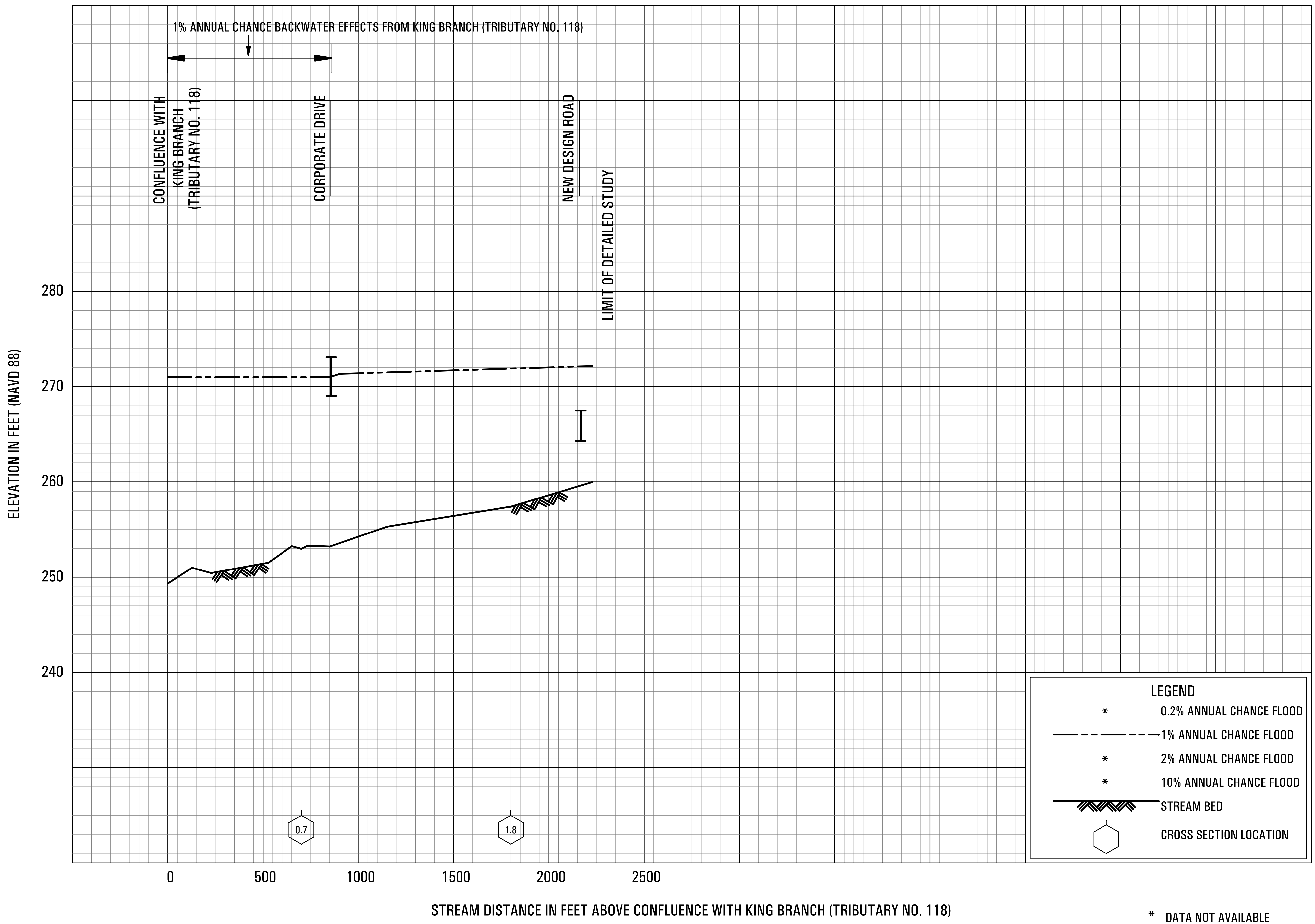


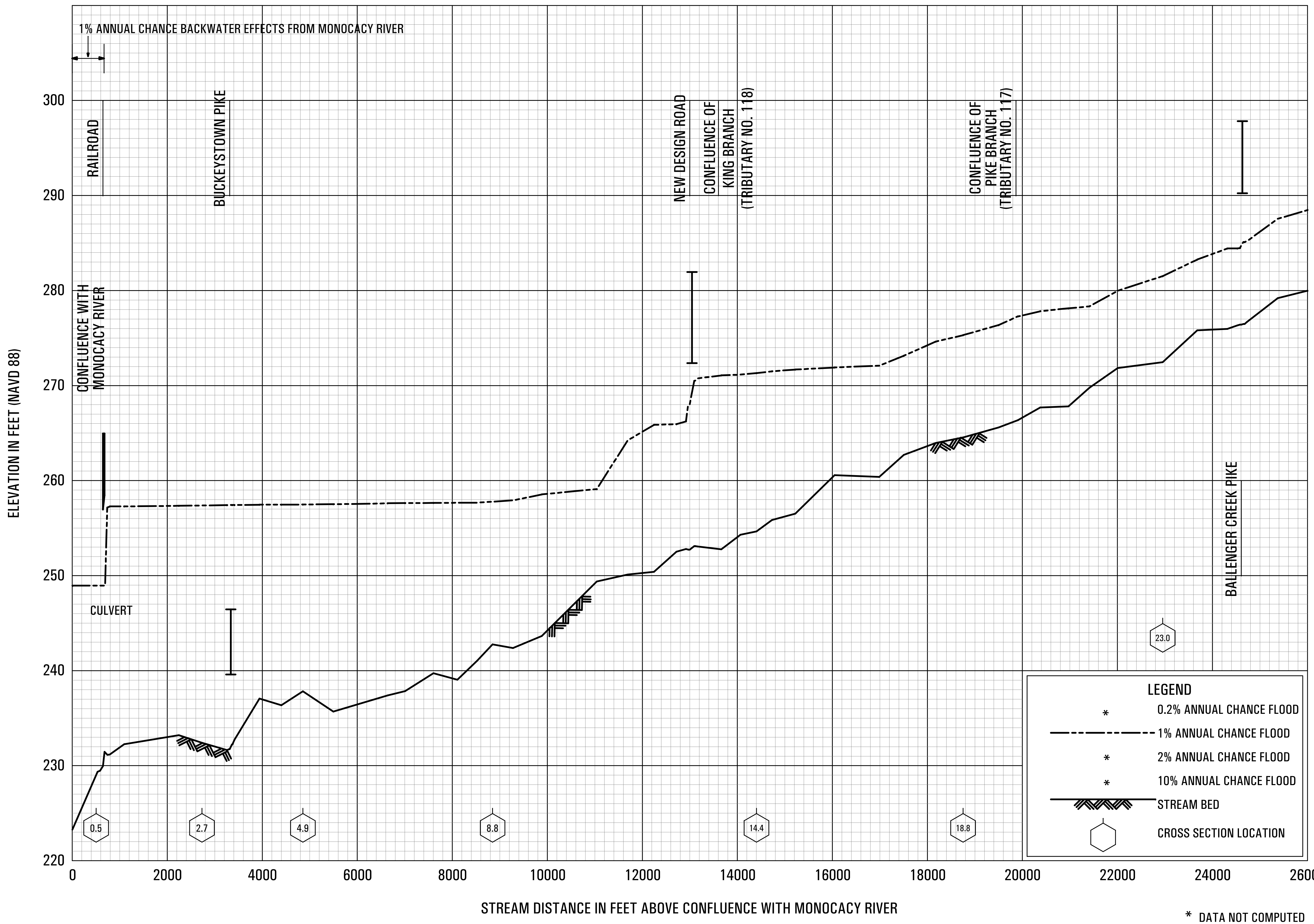

FLOOD PROFILES

ARUNDEL BRANCH

FEDERAL EMERGENCY MANAGEMENT AGENCY

FREDERICK COUNTY, MD

AND INCORPORATED AREAS




FLOOD PROFILES

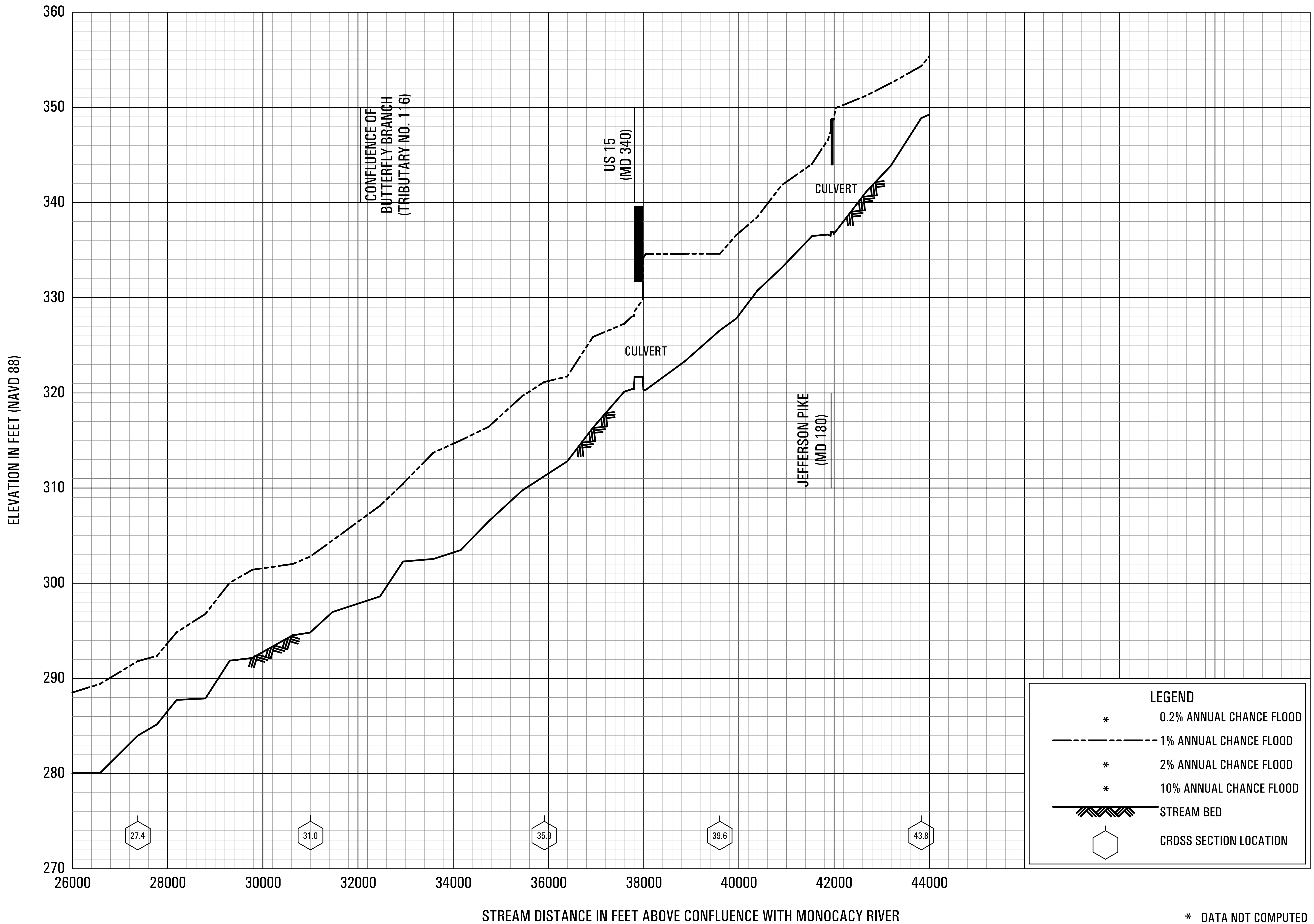
BALLENGER CREEK

FEDERAL EMERGENCY MANAGEMENT AGENCY

FREDERICK COUNTY, MD

AND INCORPORATED AREAS

02P




FLOOD PROFILES

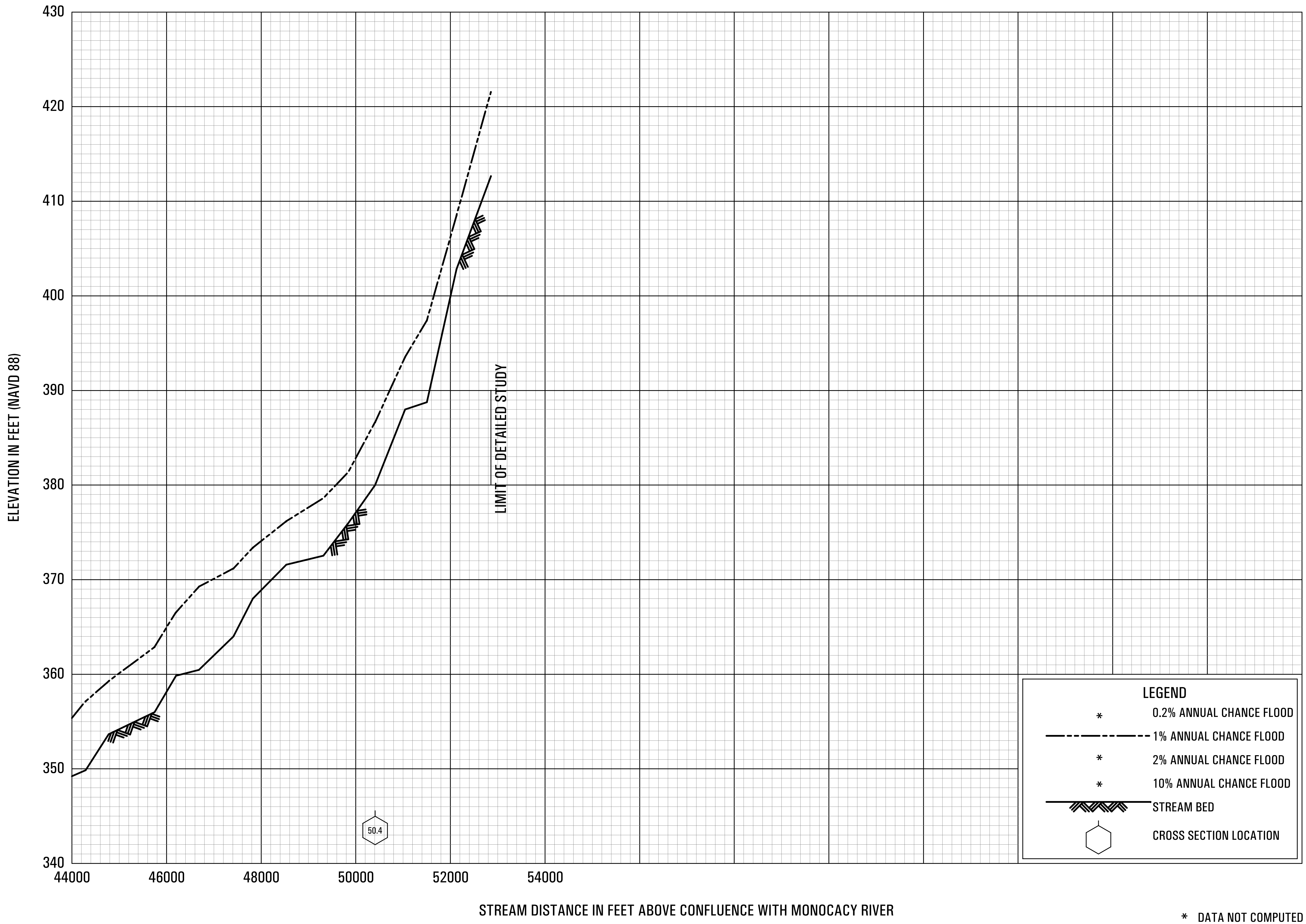
BALLENGER CREEK

FEDERAL EMERGENCY MANAGEMENT AGENCY

FREDERICK COUNTY, MD

AND INCORPORATED AREAS

03P




* DATA NOT COMPUTED

FLOOD PROFILES

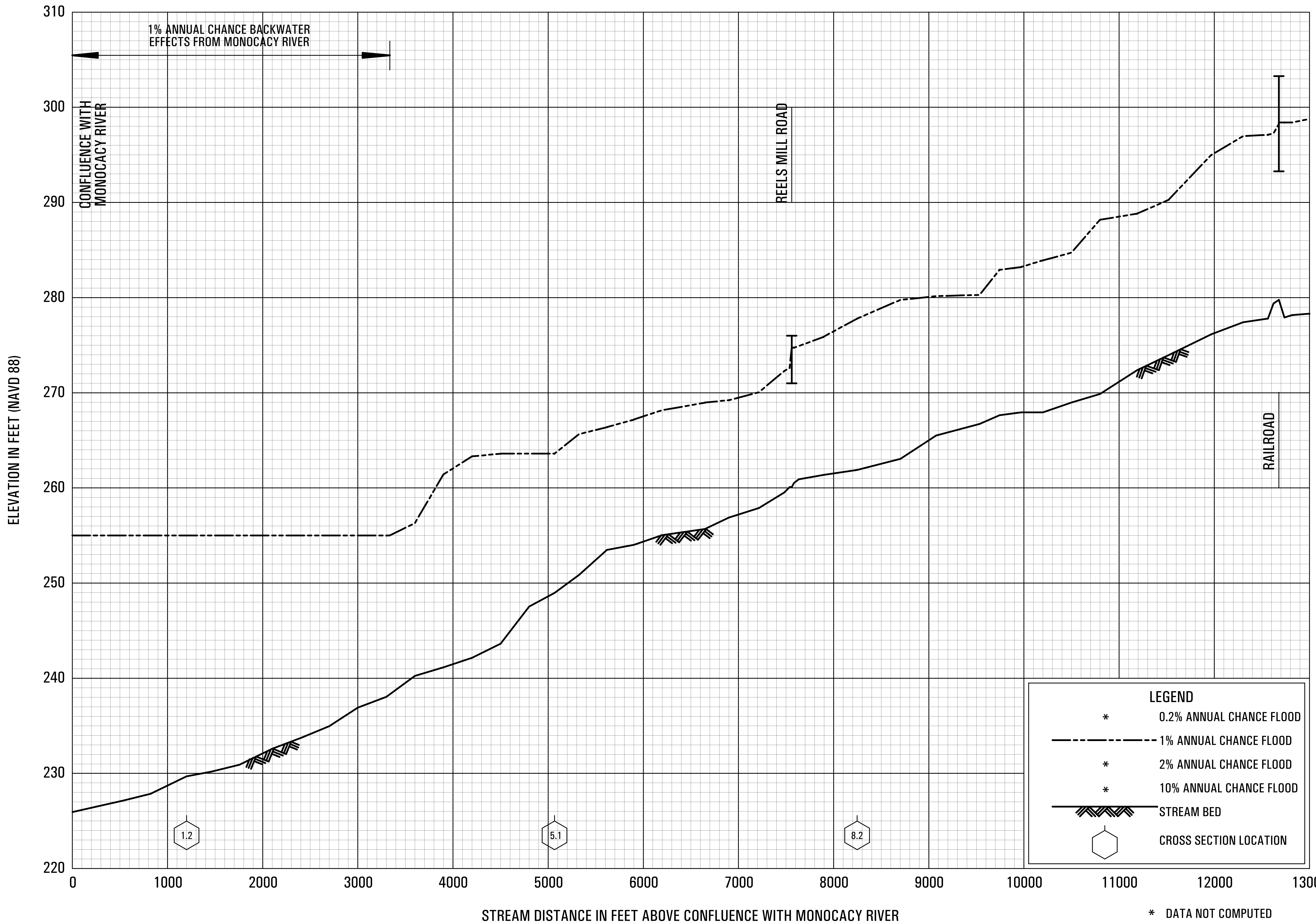
BALLENGER CREEK

FEDERAL EMERGENCY MANAGEMENT AGENCY

FREDERICK COUNTY, MD

AND INCORPORATED AREAS

04P



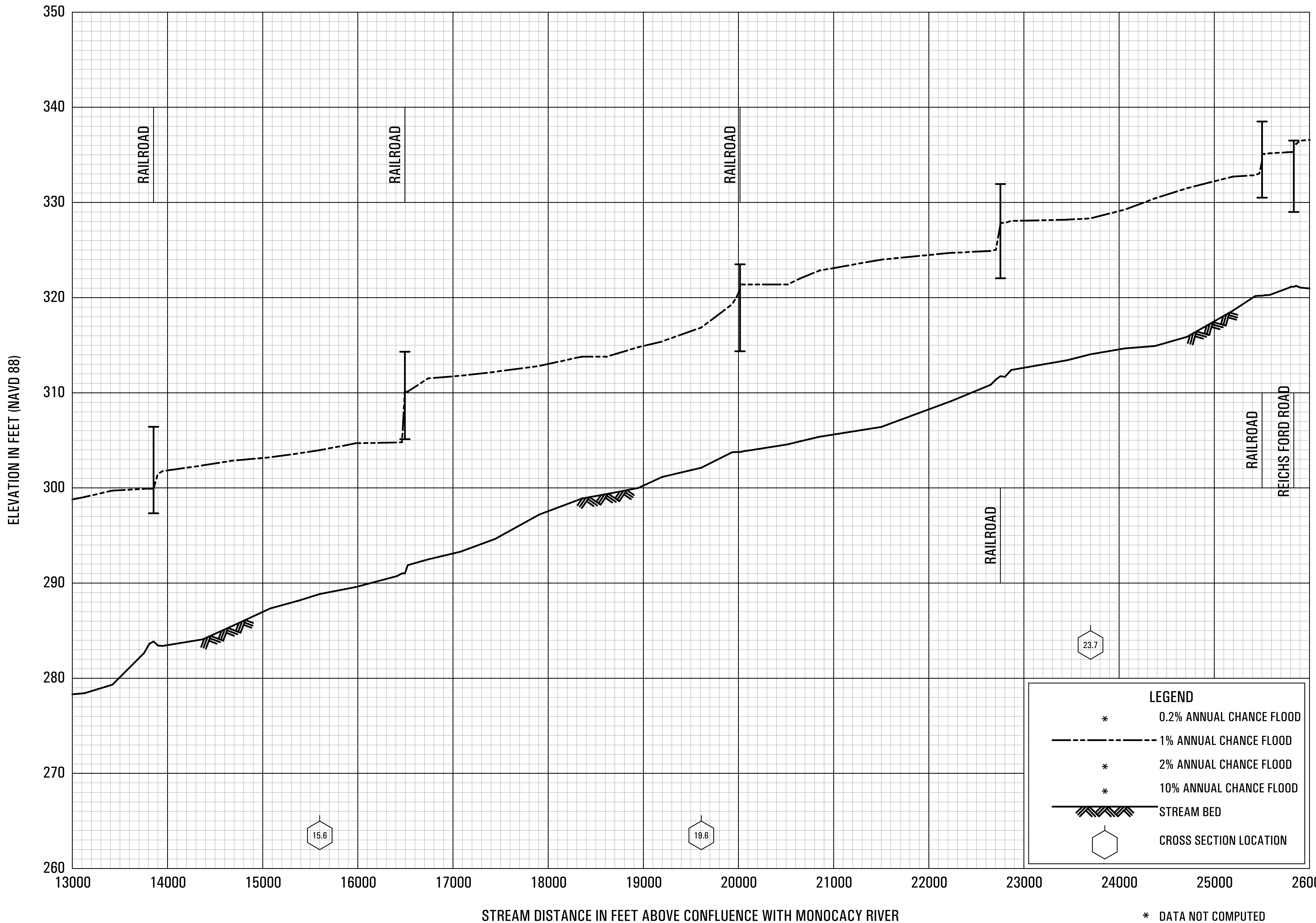

FLOOD PROFILES

BUSH CREEK

FEDERAL EMERGENCY MANAGEMENT AGENCY

FREDERICK COUNTY, MD

AND INCORPORATED AREAS




# FLOOD PROFILES

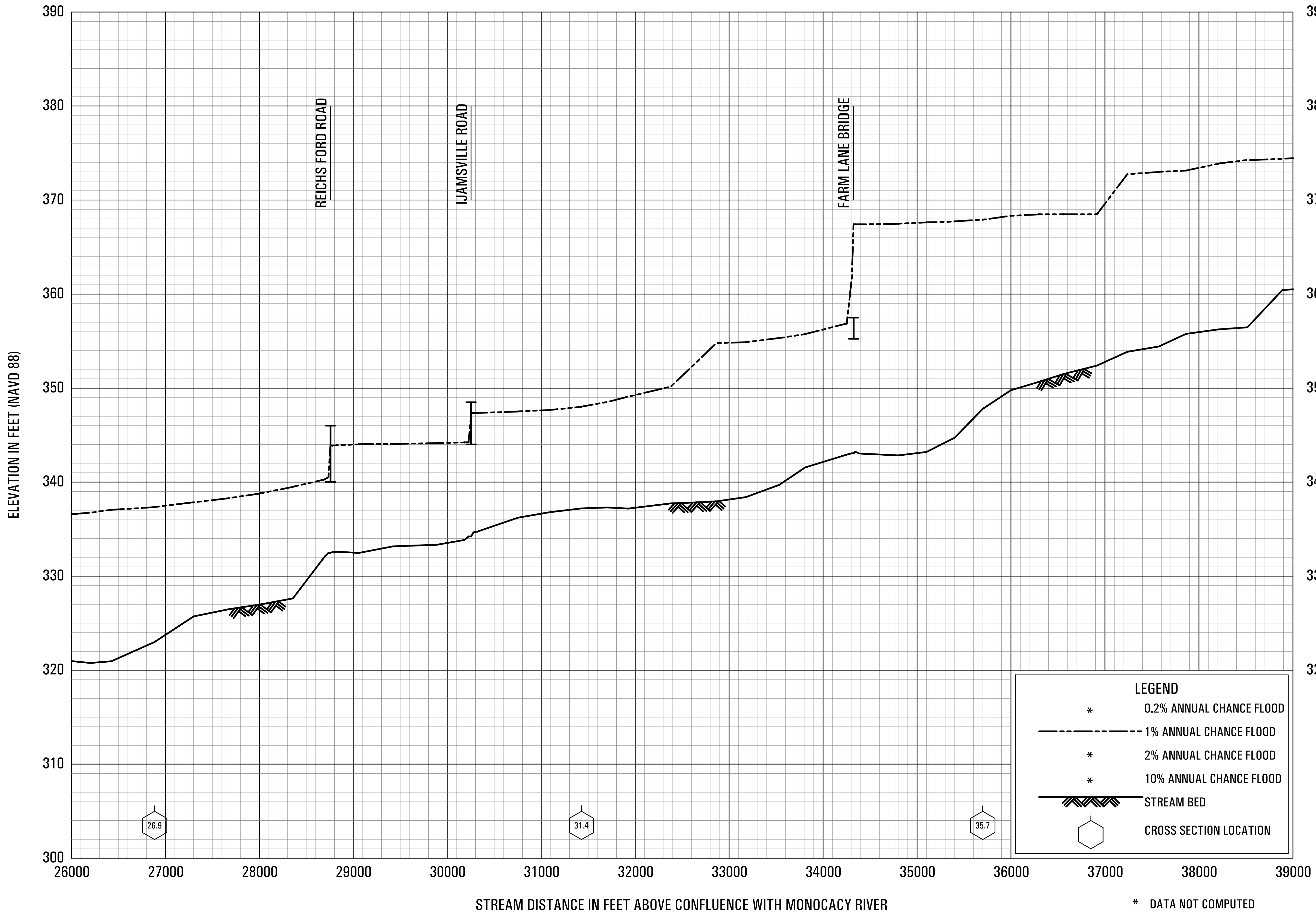
## BUSH CREEK

FEDERAL EMERGENCY MANAGEMENT AGENCY

## FREDERICK COUNTY, MD

AND INCORPORATED AREAS

06P




FLOOD PROFILES

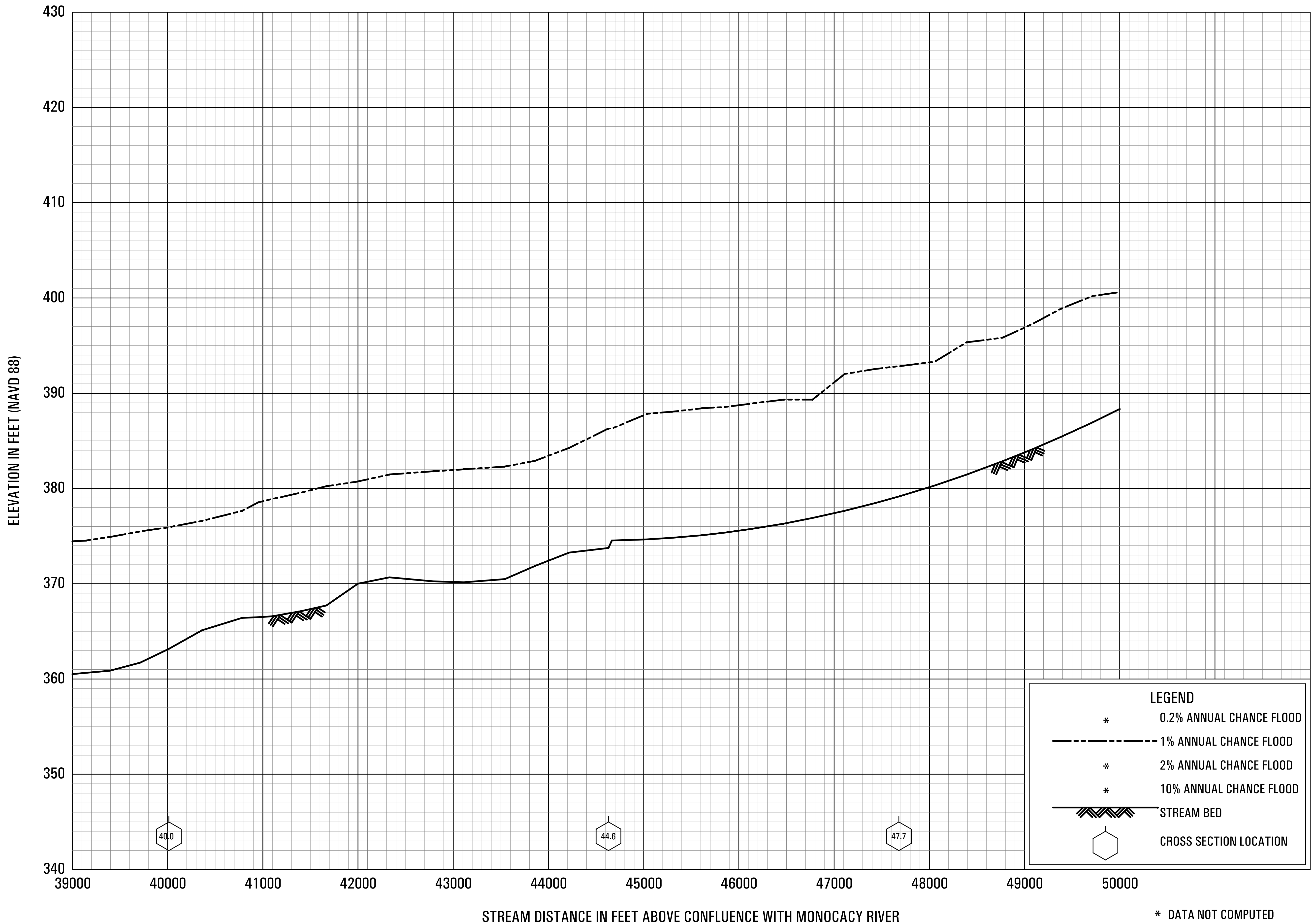
BUSH CREEK

FEDERAL EMERGENCY MANAGEMENT AGENCY

FREDERICK COUNTY, MD

AND INCORPORATED AREAS

07P




FLOOD PROFILES

BUSH CREEK

FEDERAL EMERGENCY MANAGEMENT AGENCY

FREDERICK COUNTY, MD

AND INCORPORATED AREAS

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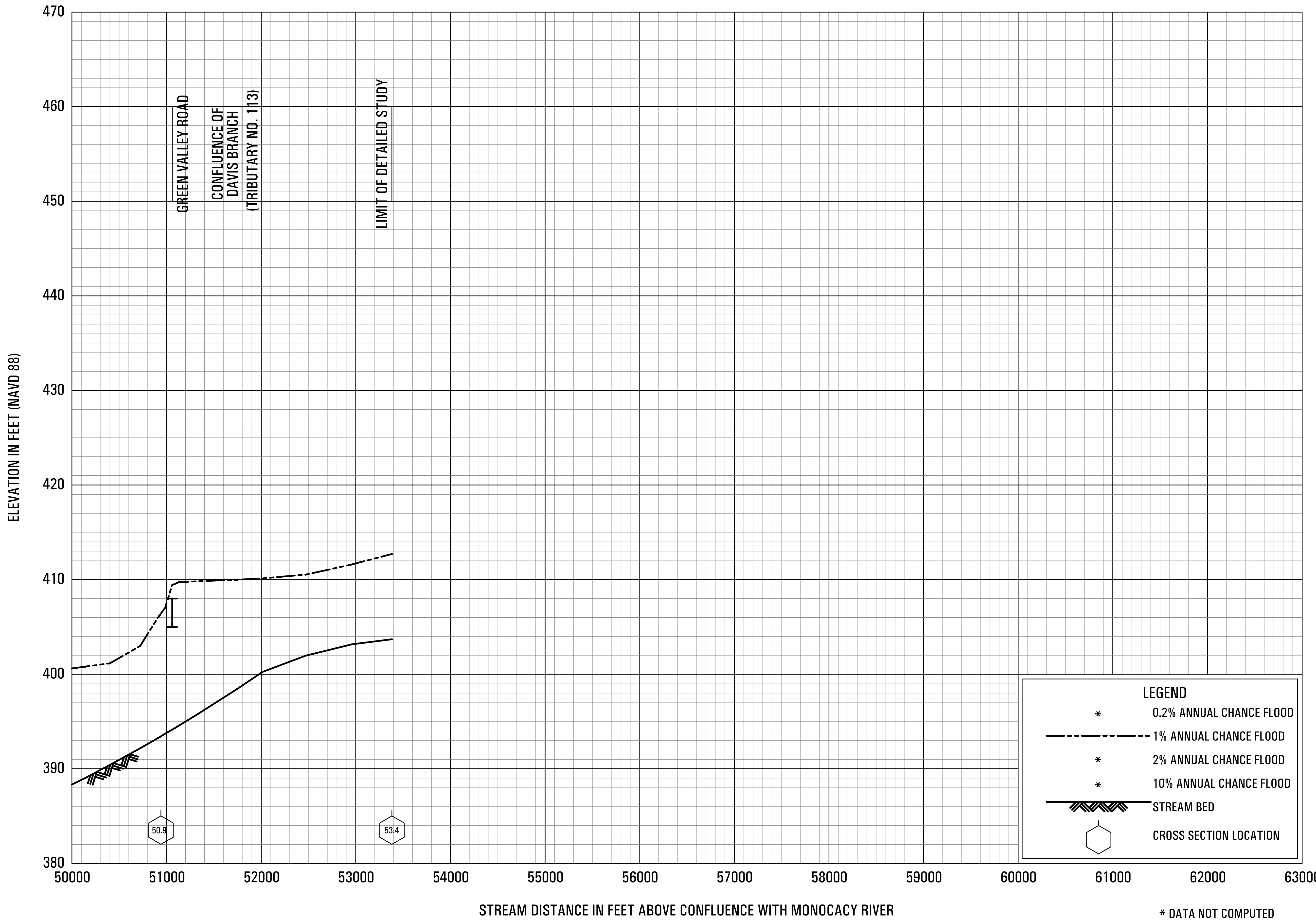


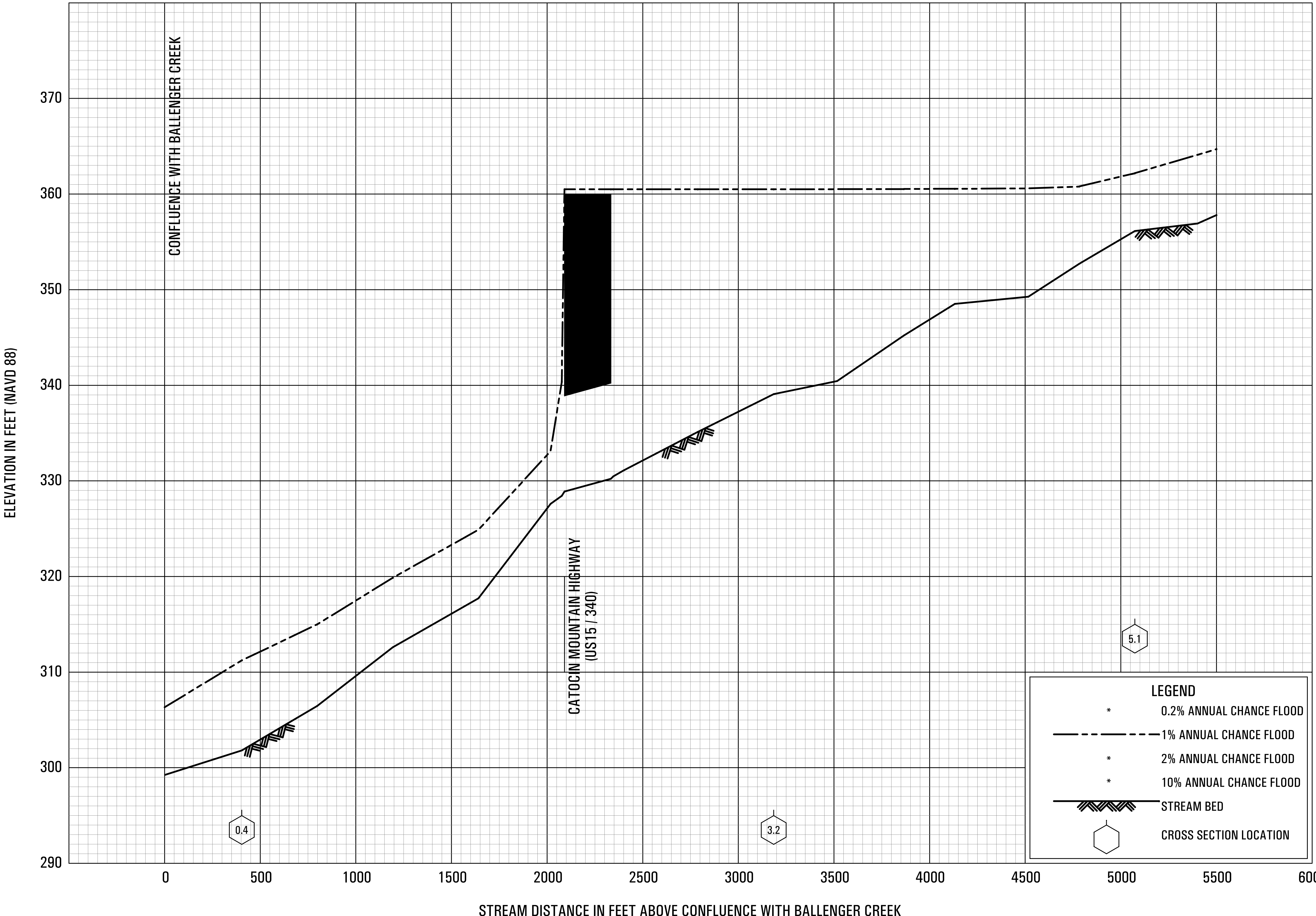

FLOOD PROFILES

BUSH CREEK

FEDERAL EMERGENCY MANAGEMENT AGENCY

FREDERICK COUNTY, MD

AND INCORPORATED AREAS



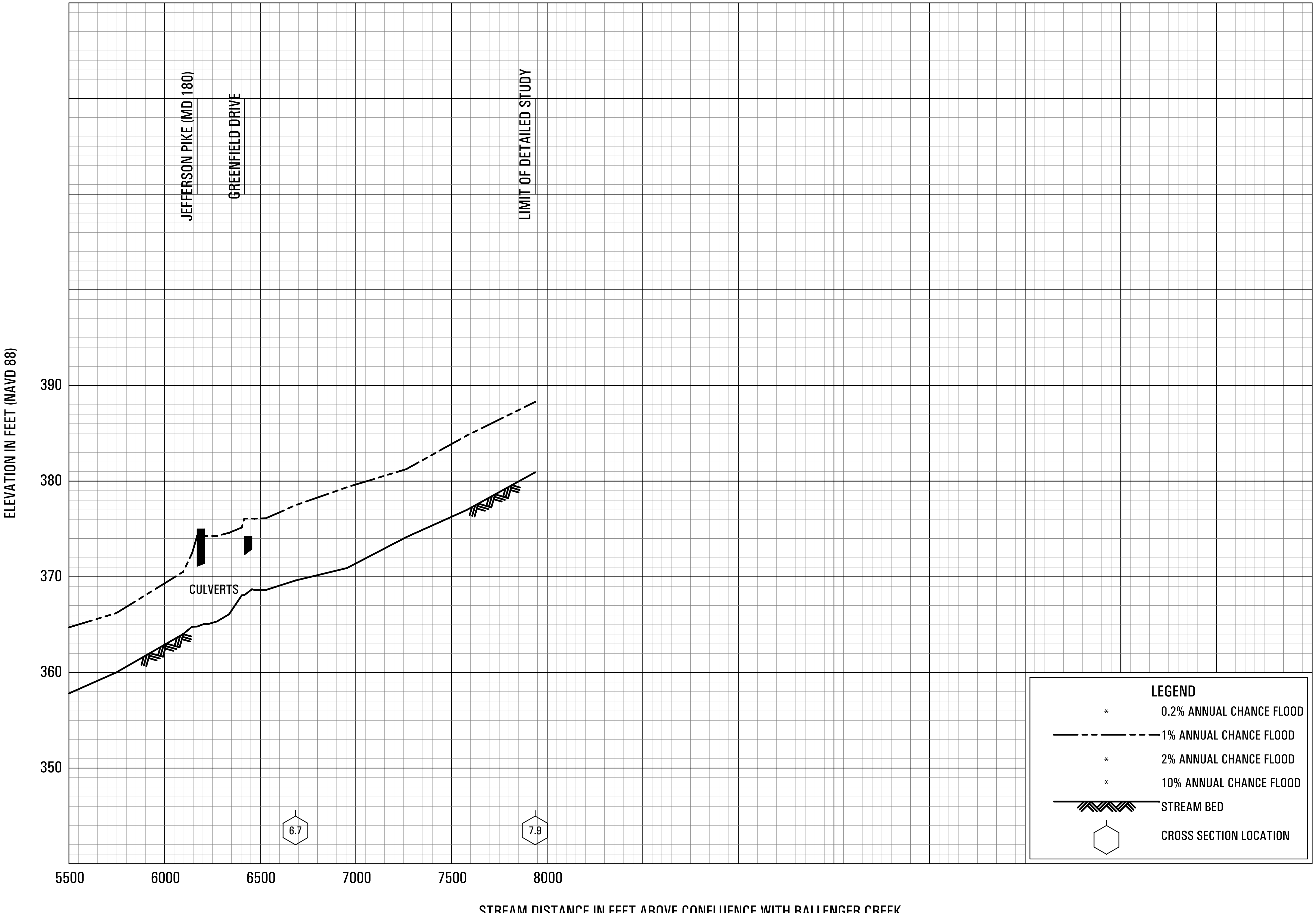

FLOOD PROFILES

BUTTERFLY BRANCH (TRIBUTARY NO. 116)

FEDERAL EMERGENCY MANAGEMENT AGENCY

FREDERICK COUNTY, MD

AND INCORPORATED AREAS



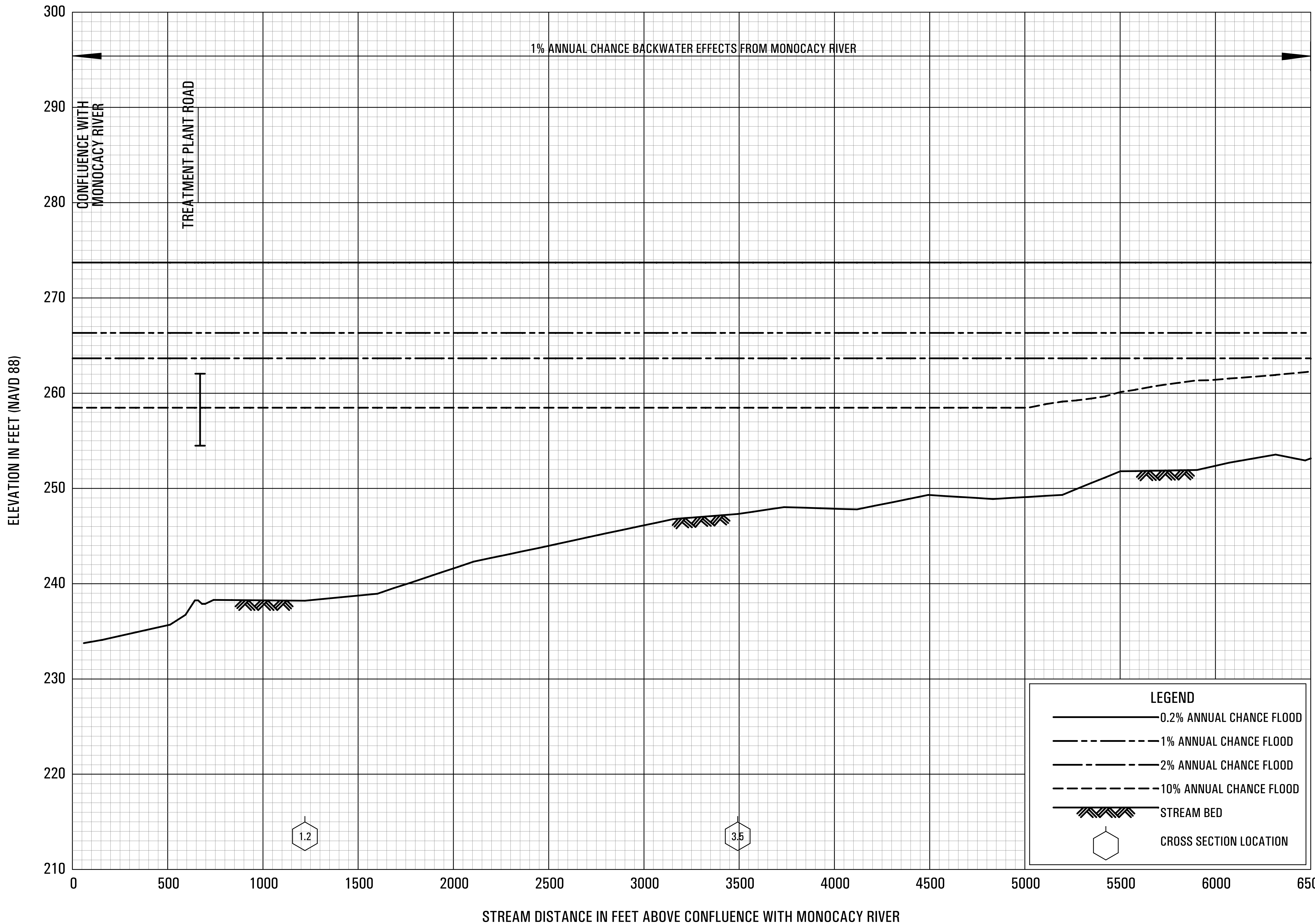

FLOOD PROFILES

BUTTERFLY BRANCH (TRIBUTARY NO. 116)

FEDERAL EMERGENCY MANAGEMENT AGENCY

FREDERICK COUNTY, MD

AND INCORPORATED AREAS




FLOOD PROFILES

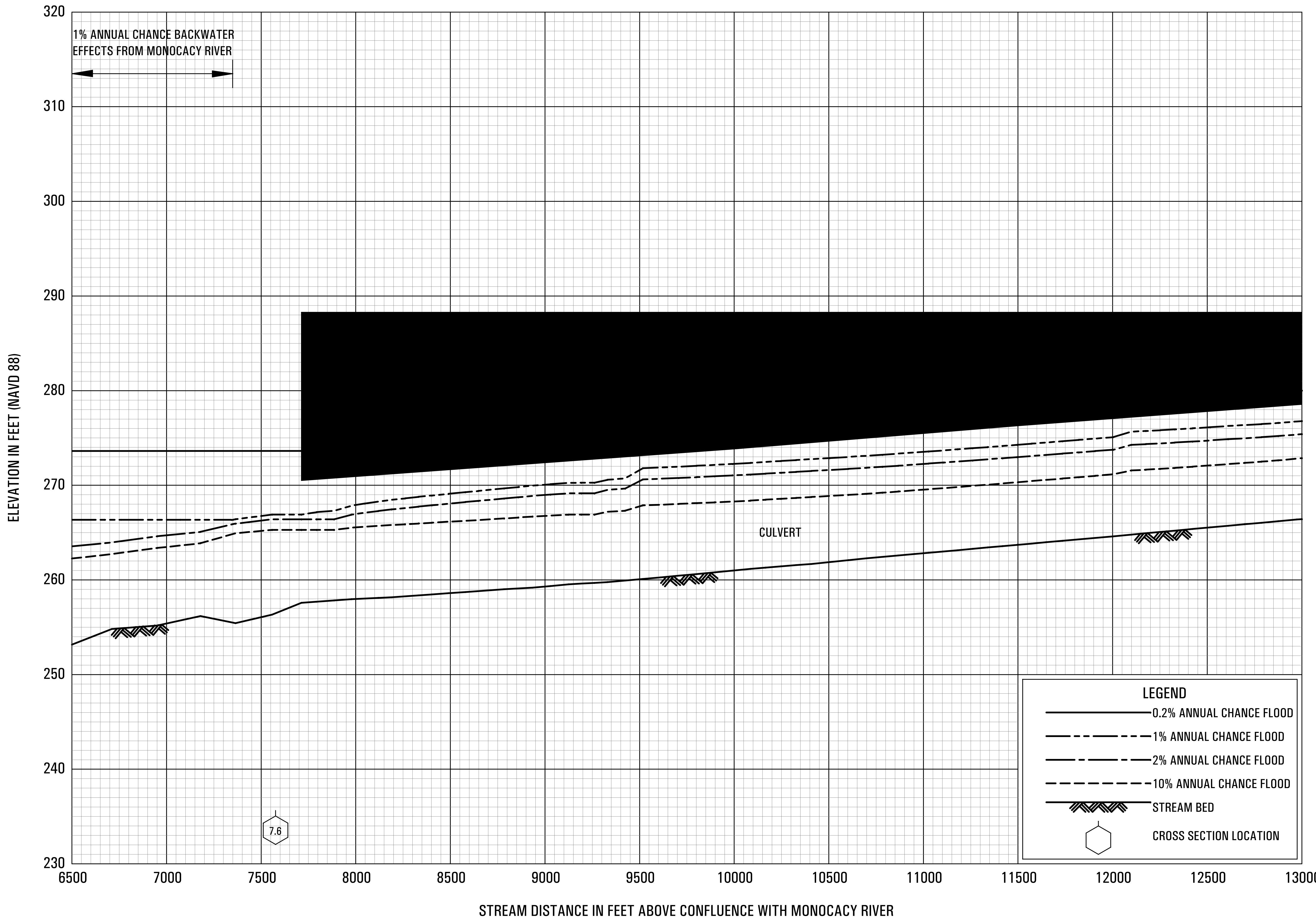
CARROLL CREEK

FEDERAL EMERGENCY MANAGEMENT AGENCY

FREDERICK COUNTY, MD

AND INCORPORATED AREAS

12P




FLOOD PROFILES

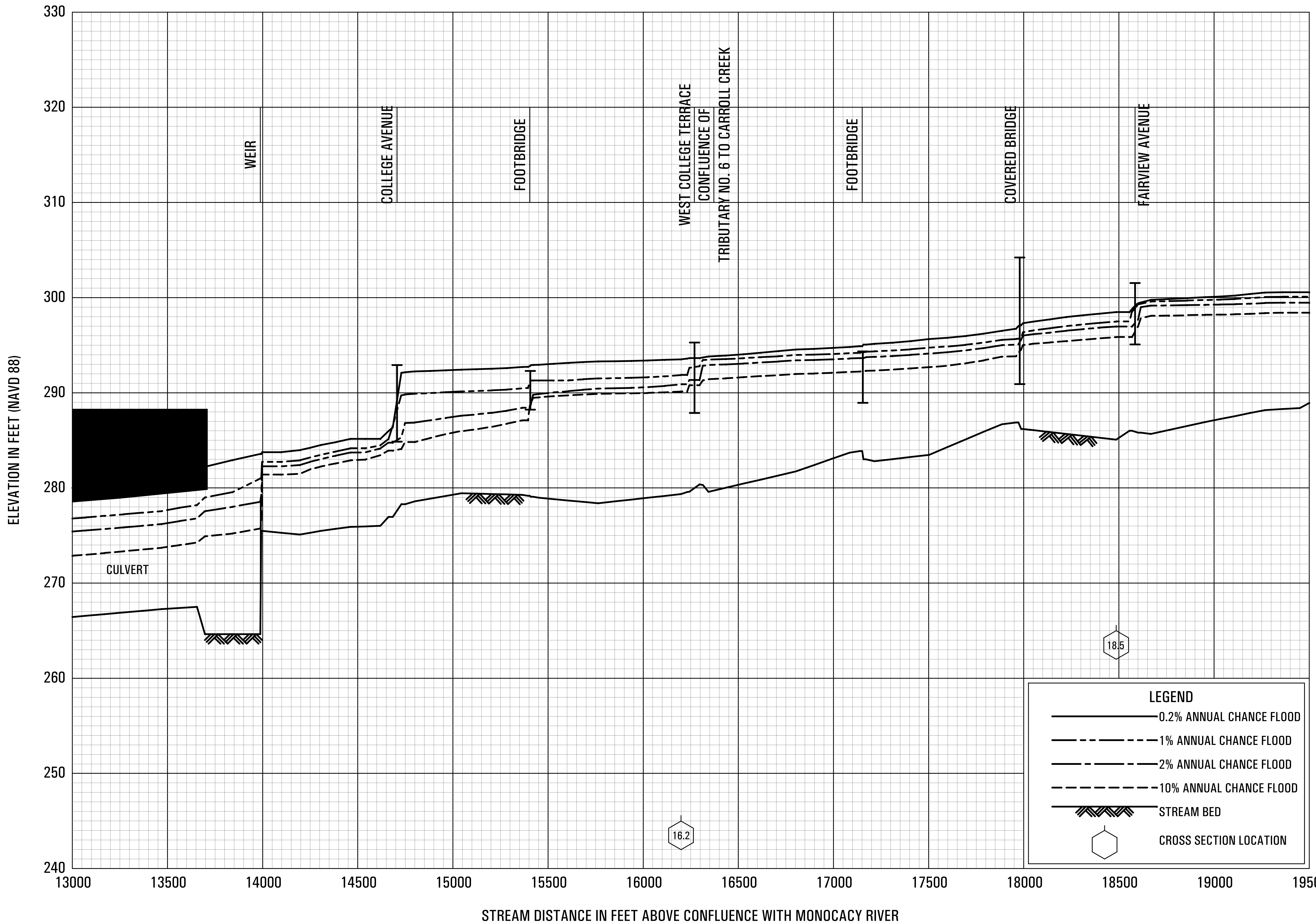
CARROLL CREEK

FEDERAL EMERGENCY MANAGEMENT AGENCY

FREDERICK COUNTY, MD

AND INCORPORATED AREAS

13P




FLOOD PROFILES

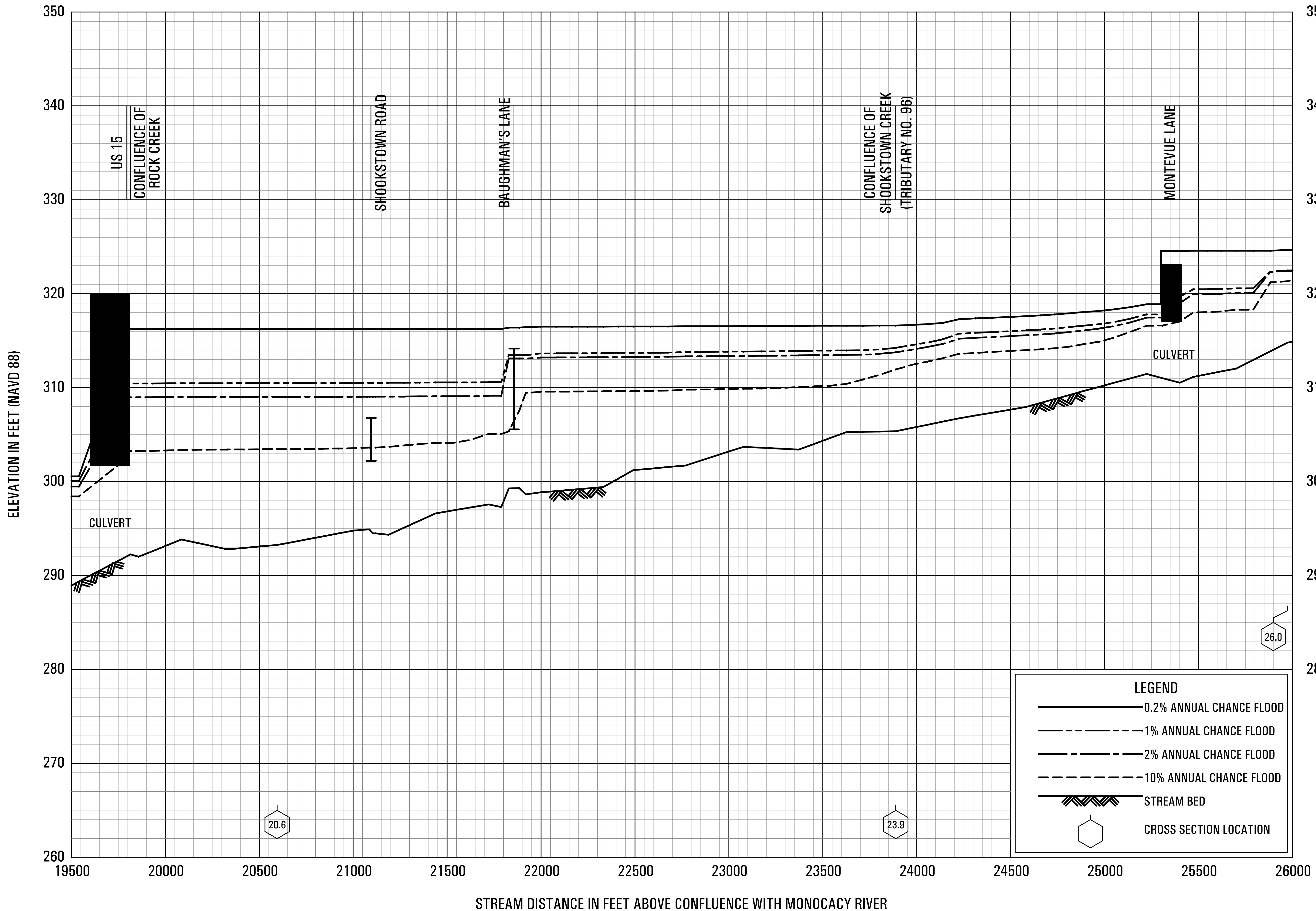
CARROLL CREEK

FEDERAL EMERGENCY MANAGEMENT AGENCY

FREDERICK COUNTY, MD

AND INCORPORATED AREAS

14P



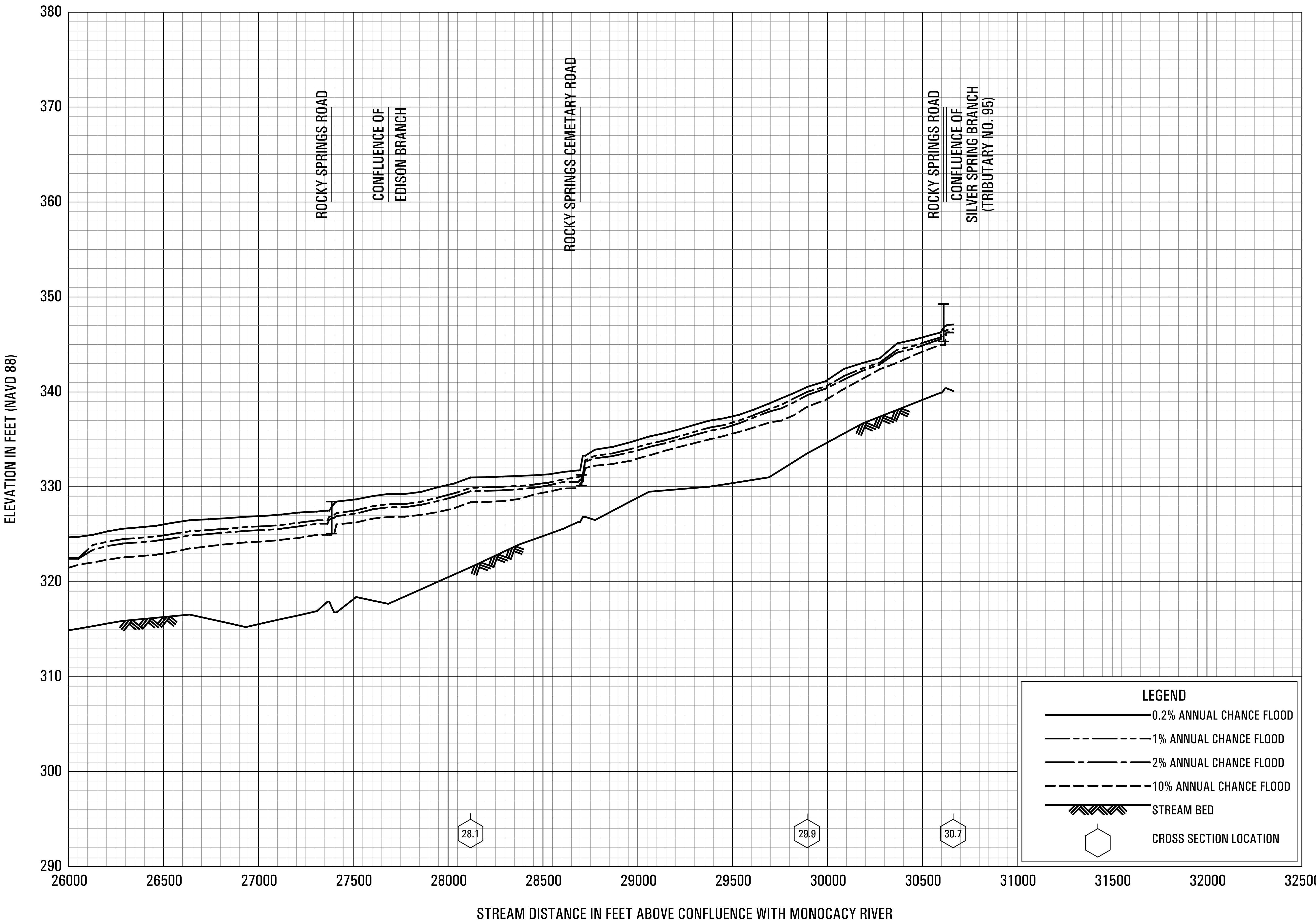

# FLOOD PROFILES

## CARROLL CREEK

FEDERAL EMERGENCY MANAGEMENT AGENCY

**FREDERICK COUNTY, MD**

AND INCORPORATED AREAS




FLOOD PROFILES

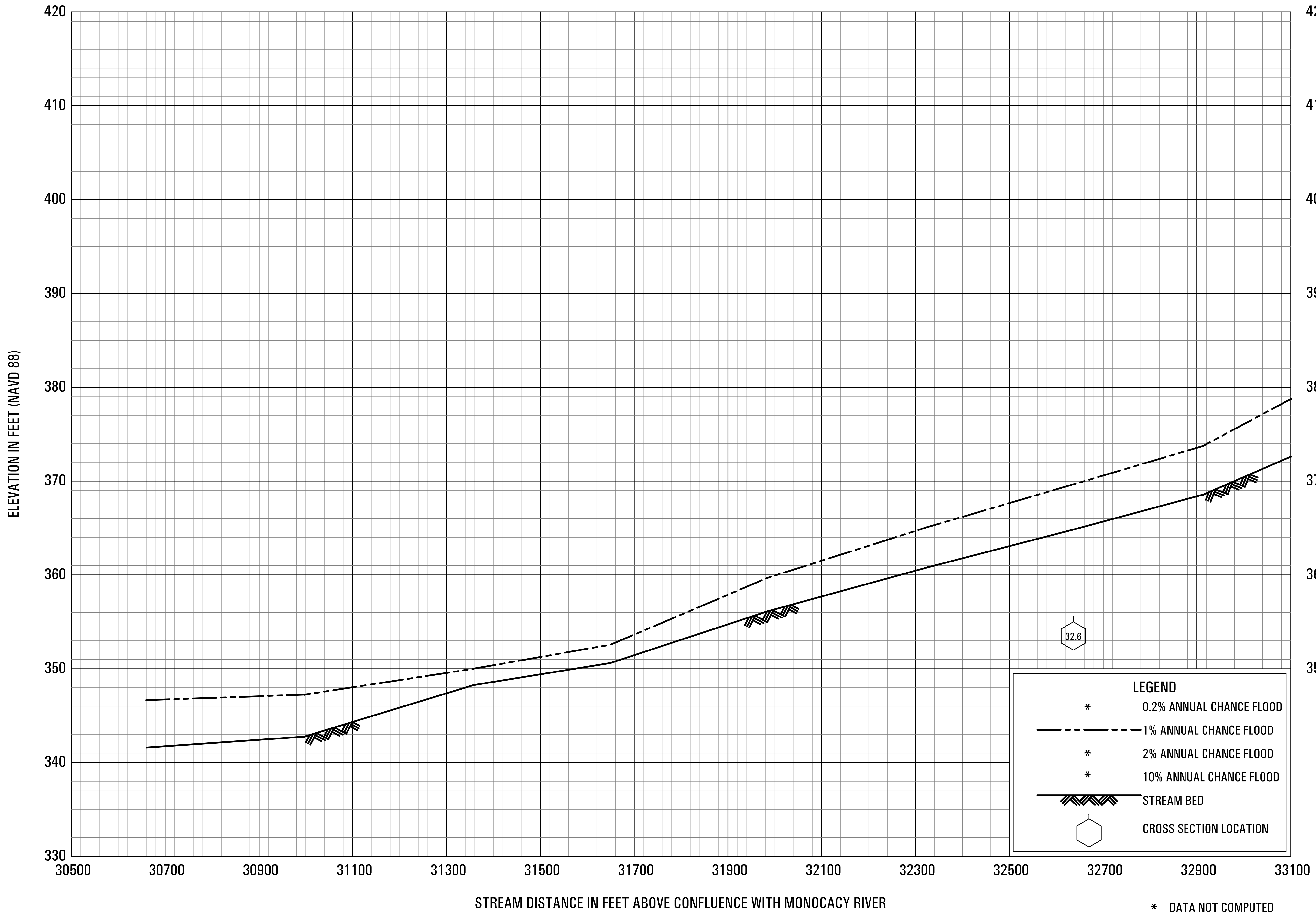
CARROLL CREEK

FEDERAL EMERGENCY MANAGEMENT AGENCY

FREDERICK COUNTY, MD

AND INCORPORATED AREAS

16P



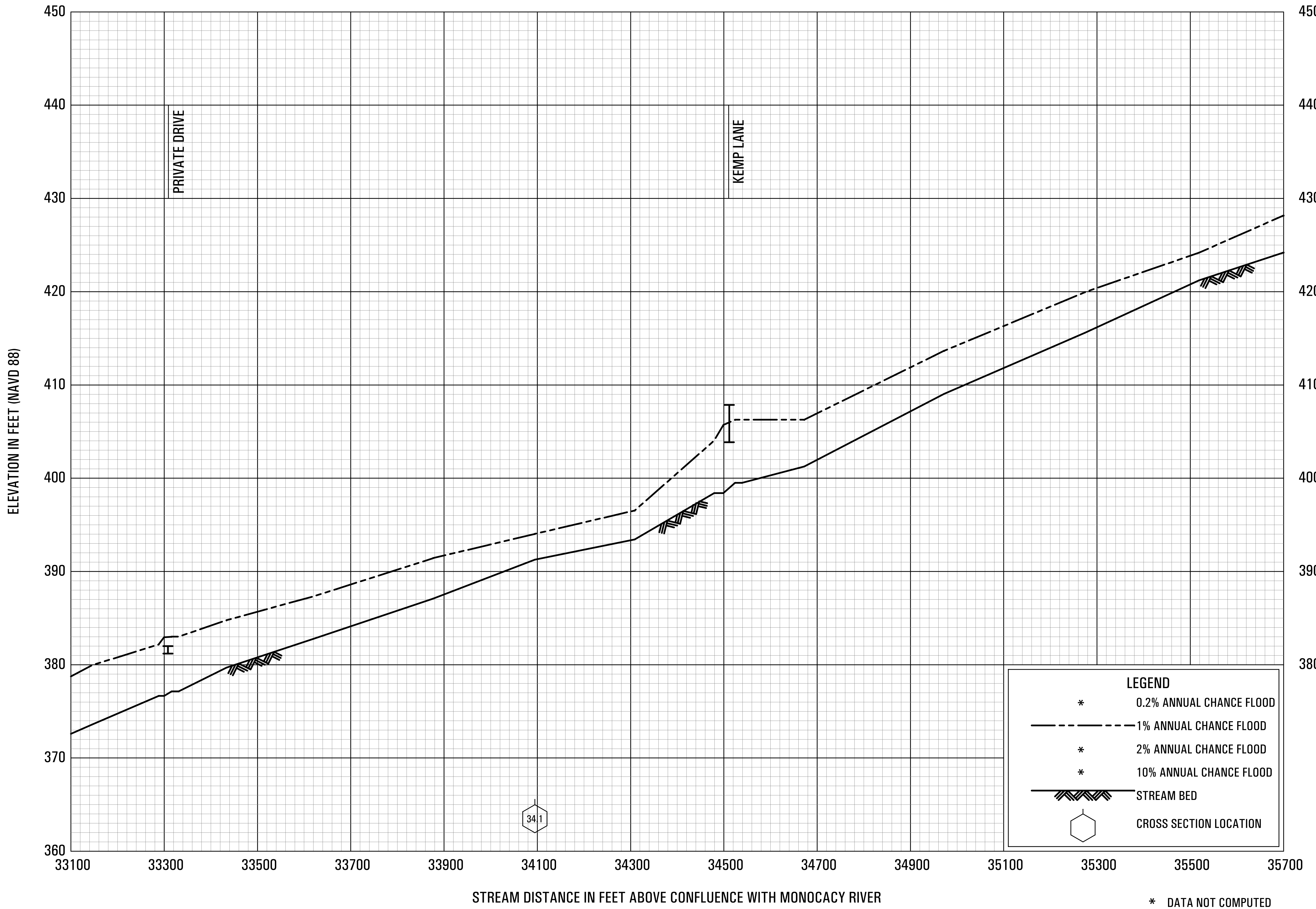

FLOOD PROFILES

CARROLL CREEK

FEDERAL EMERGENCY MANAGEMENT AGENCY

FREDERICK COUNTY, MD

AND INCORPORATED AREAS

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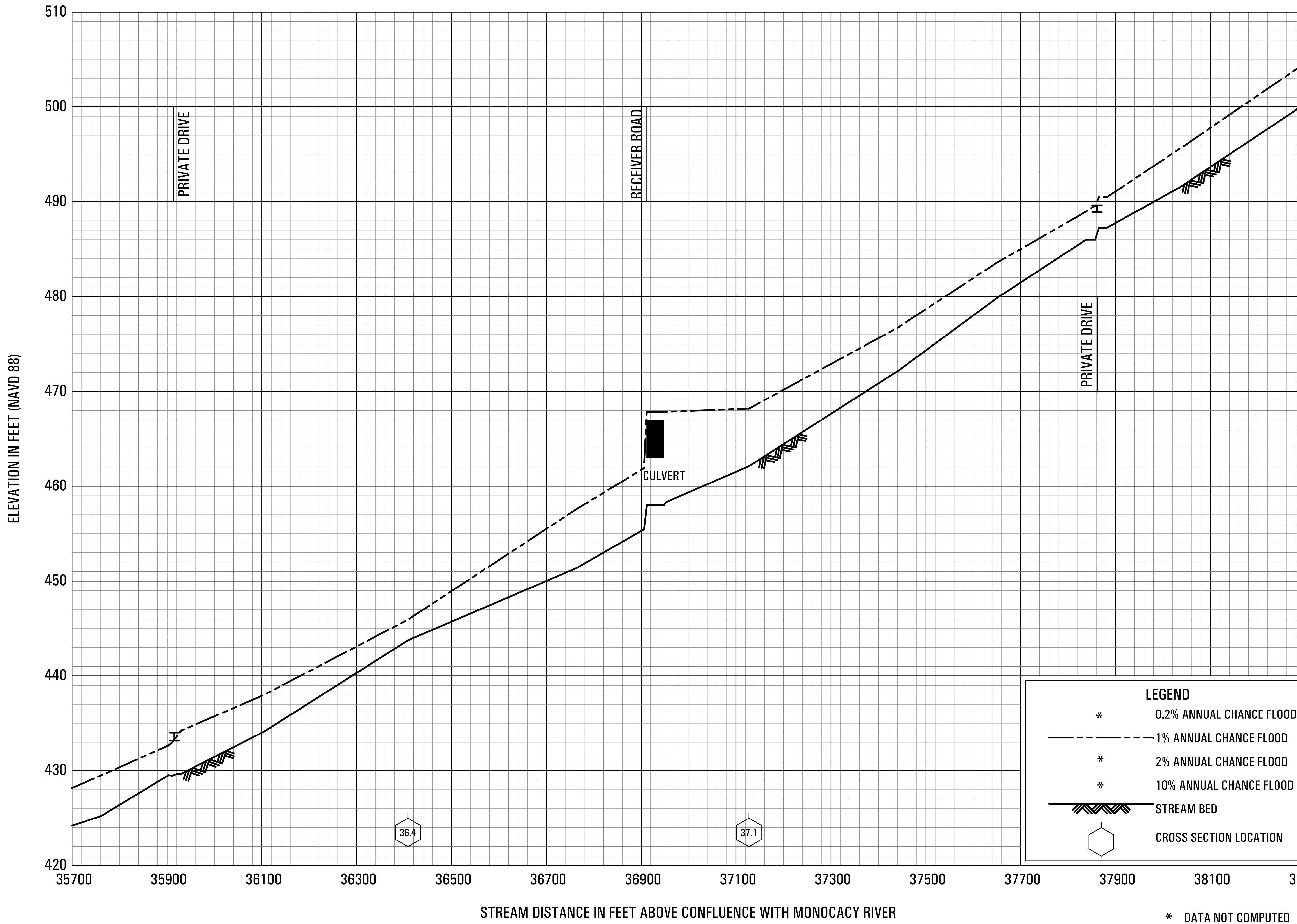
FLOOD PROFILES

CARROLL CREEK

FEDERAL EMERGENCY MANAGEMENT AGENCY

FREDERICK COUNTY, MD

AND INCORPORATED AREAS



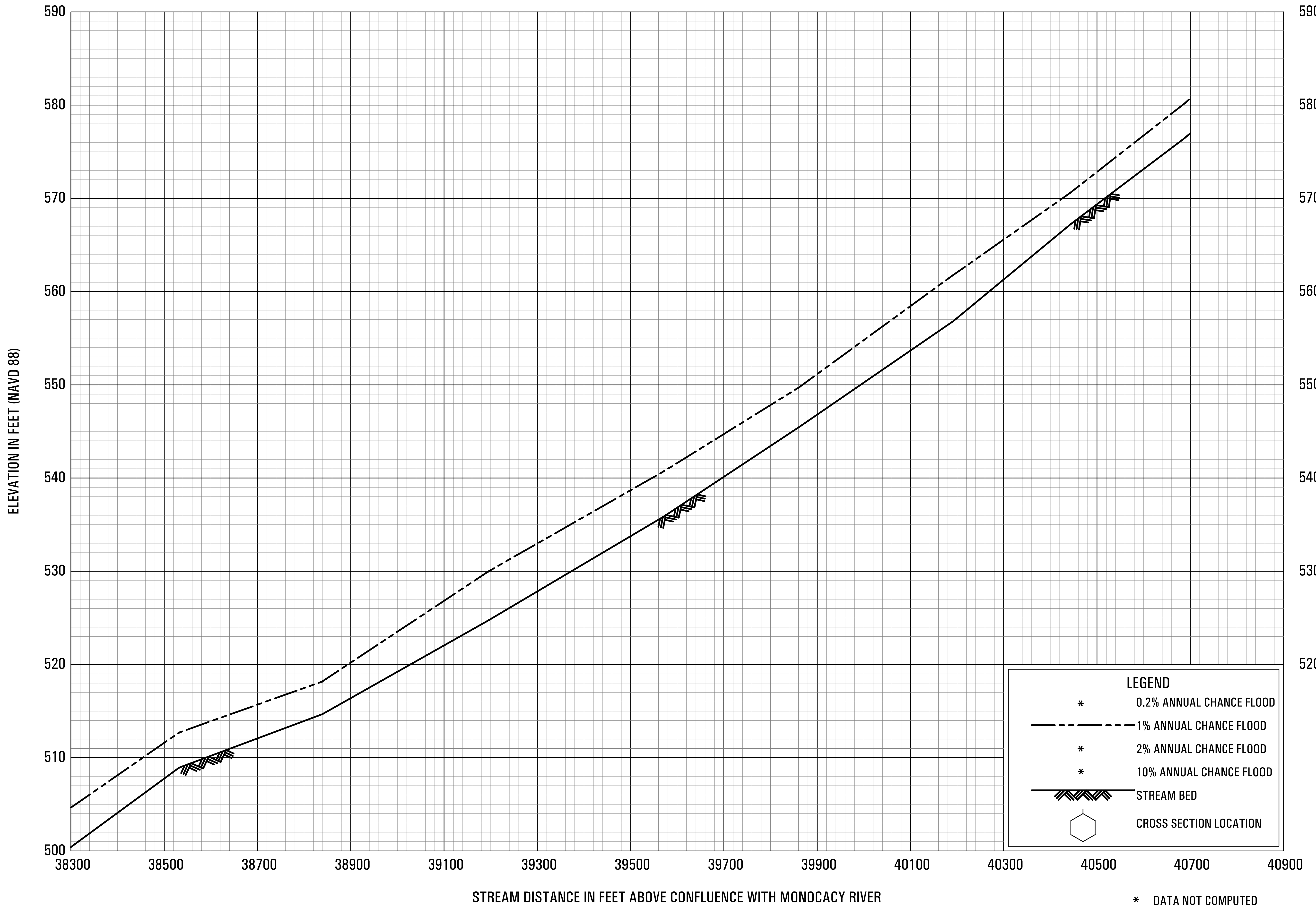

FLOOD PROFILES

CARROLL CREEK

FEDERAL EMERGENCY MANAGEMENT AGENCY

FREDERICK COUNTY, MD

AND INCORPORATED AREAS



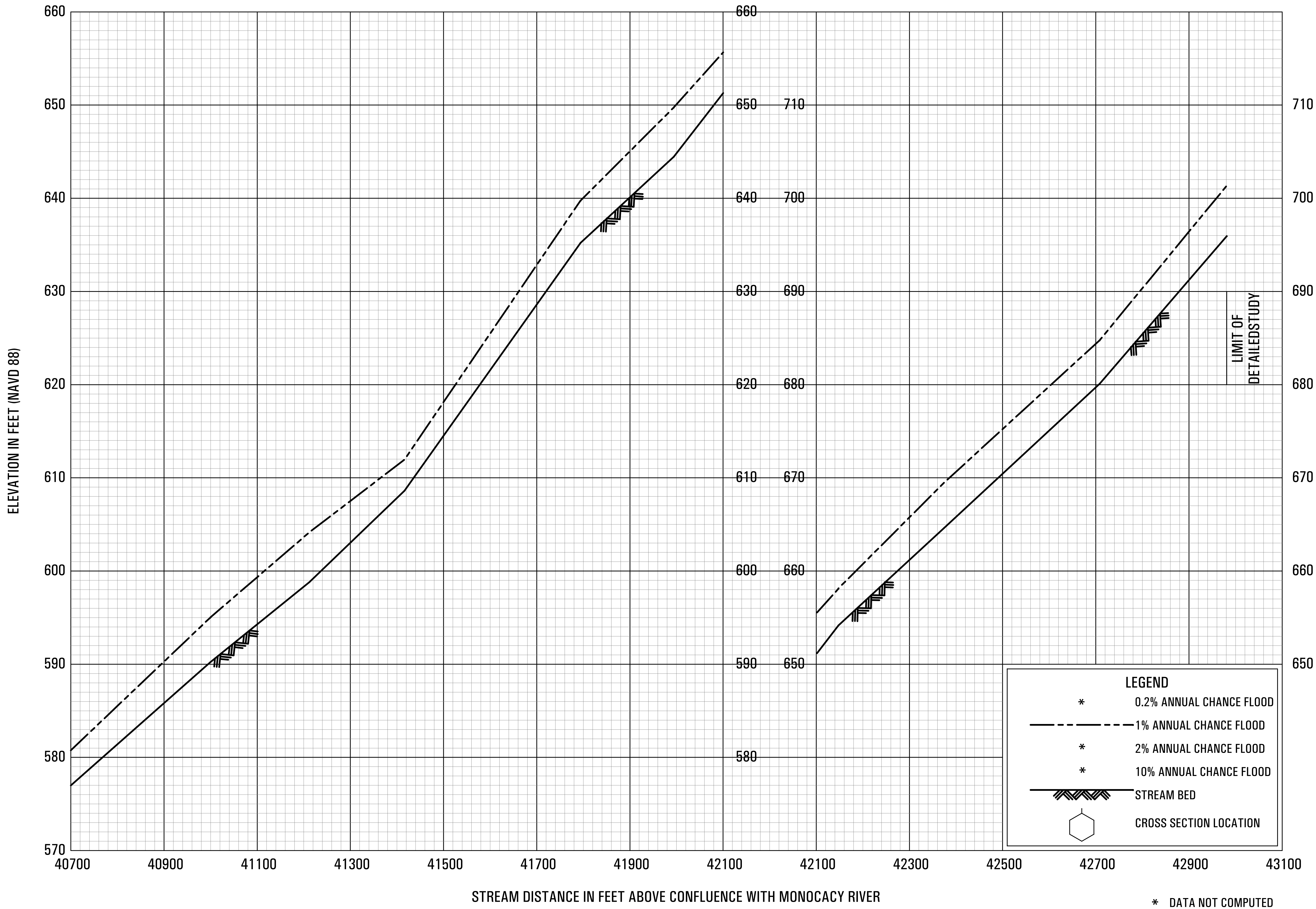

FLOOD PROFILES

CARROLL CREEK

FEDERAL EMERGENCY MANAGEMENT AGENCY

FREDERICK COUNTY, MD

AND INCORPORATED AREAS



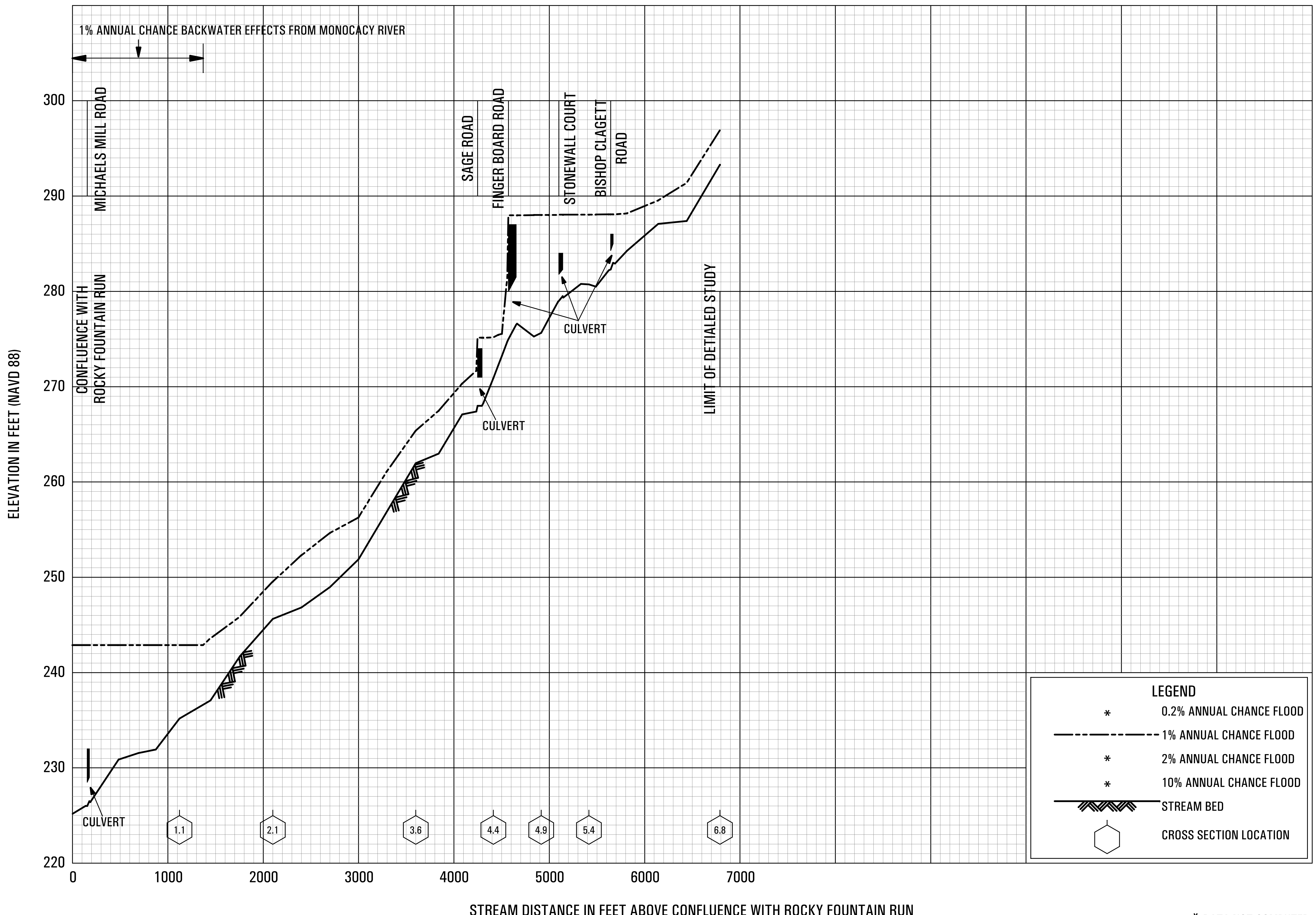

FLOOD PROFILES

CARROLL CREEK

FEDERAL EMERGENCY MANAGEMENT AGENCY

FREDERICK COUNTY, MD

AND INCORPORATED AREAS

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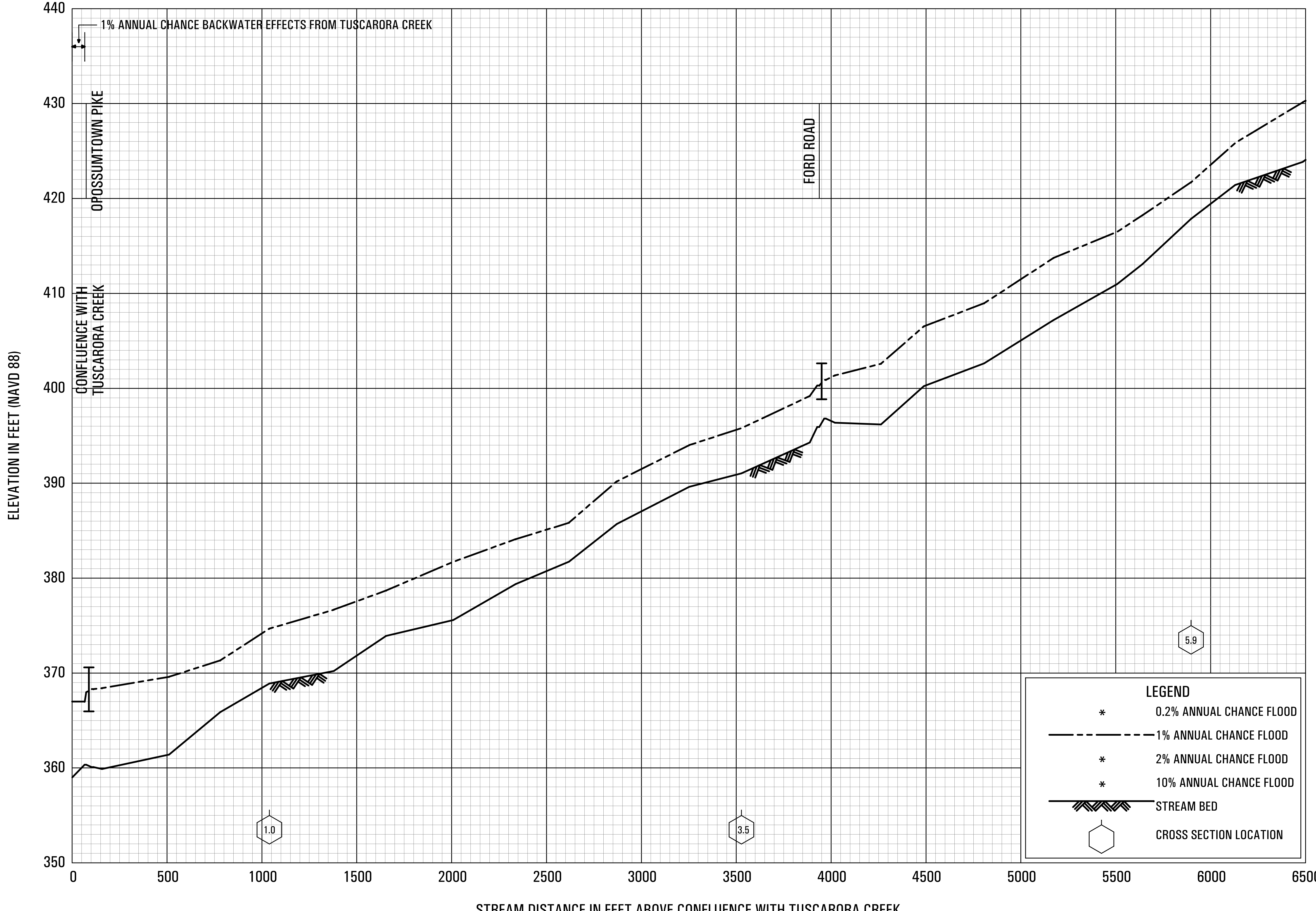
# FLOOD PROFILES

## CLAGGETT RUN (TRIBUTARY NO. 129)

FEDERAL EMERGENCY MANAGEMENT AGENCY

FREDERICK COUNTY, MD

AND INCORPORATED AREAS



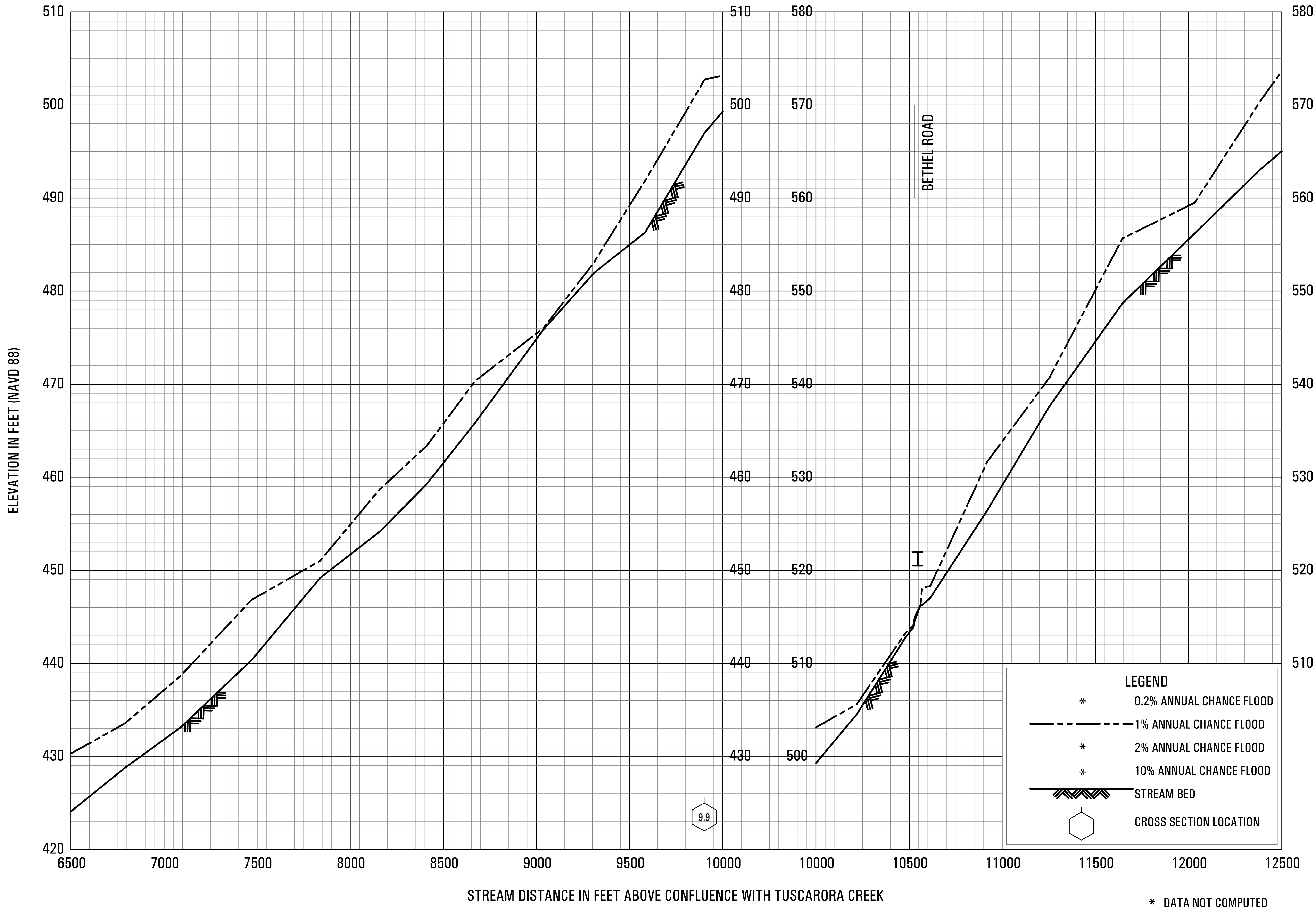

FLOOD PROFILES

CLIFFORD BRANCH (TRIBUTARY NO. 87)

FEDERAL EMERGENCY MANAGEMENT AGENCY

FREDERICK COUNTY, MD

AND INCORPORATED AREAS



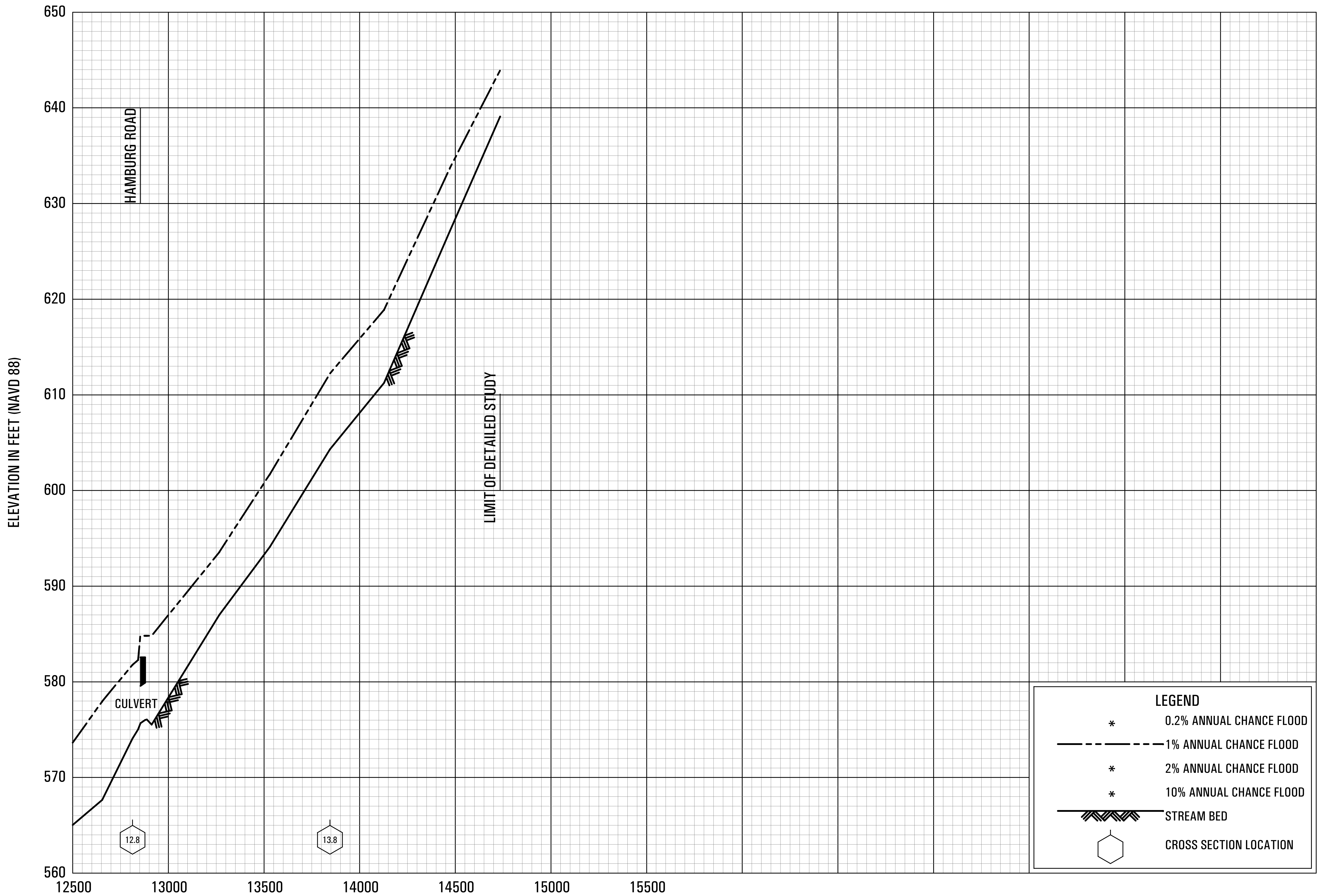

# FLOOD PROFILES

## CLIFFORD BRANCH (TRIBUTARY NO. 87)

FEDERAL EMERGENCY MANAGEMENT AGENCY

FREDERICK COUNTY, MD

AND INCORPORATED AREAS

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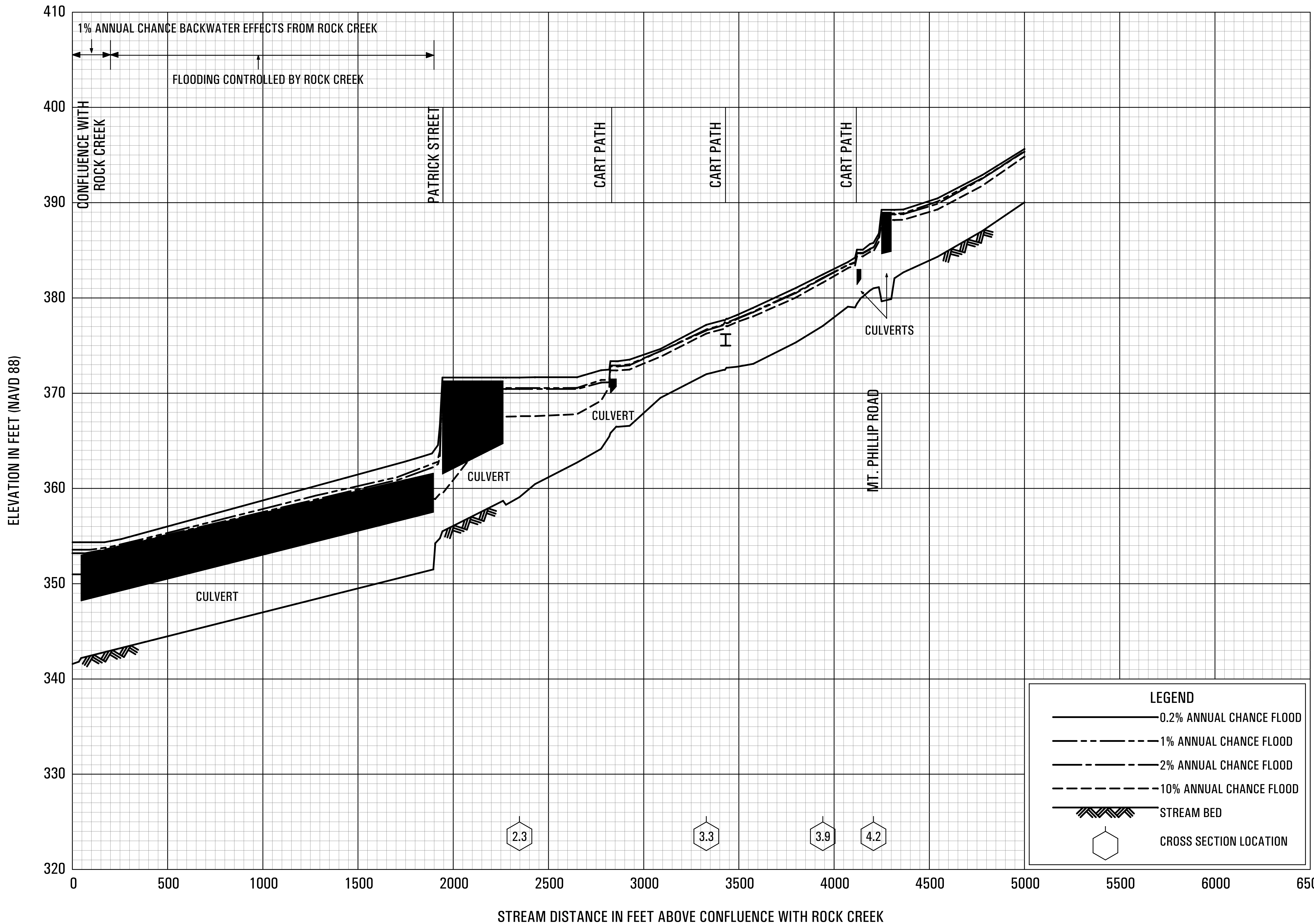
FLOOD PROFILES

CLIFFORD BRANCH (TRIBUTARY NO. 87)

FEDERAL EMERGENCY MANAGEMENT AGENCY

FREDERICK COUNTY, MD

AND INCORPORATED AREAS




FLOOD PROFILES

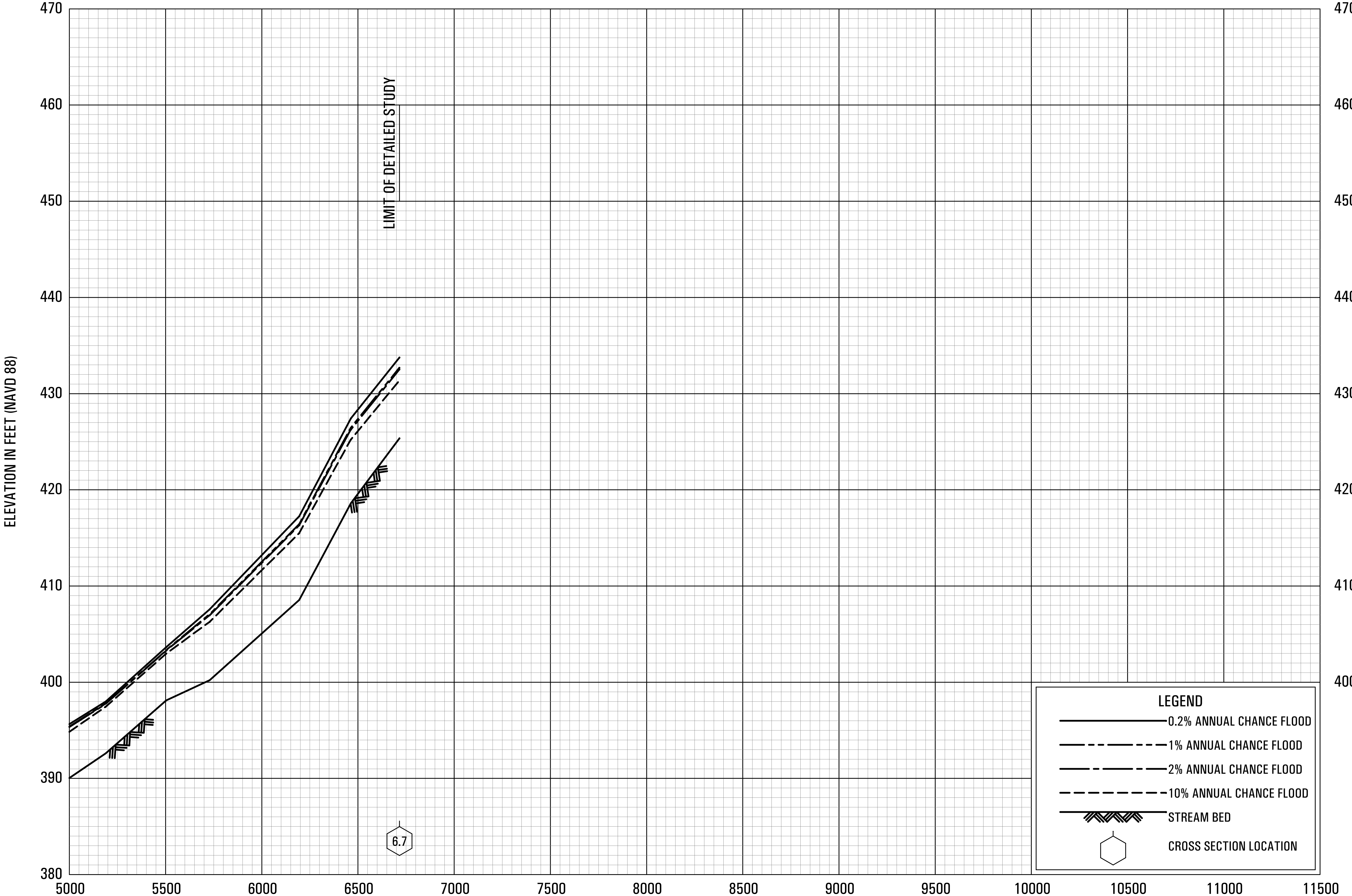
CLIFTON BRANCH (TRIBUTARY NO. 98)

FEDERAL EMERGENCY MANAGEMENT AGENCY

FREDERICK COUNTY, MD

AND INCORPORATED AREAS

26P




STREAM DISTANCE IN FEET ABOVE CONFLUENCE WITH ROCK CREEK

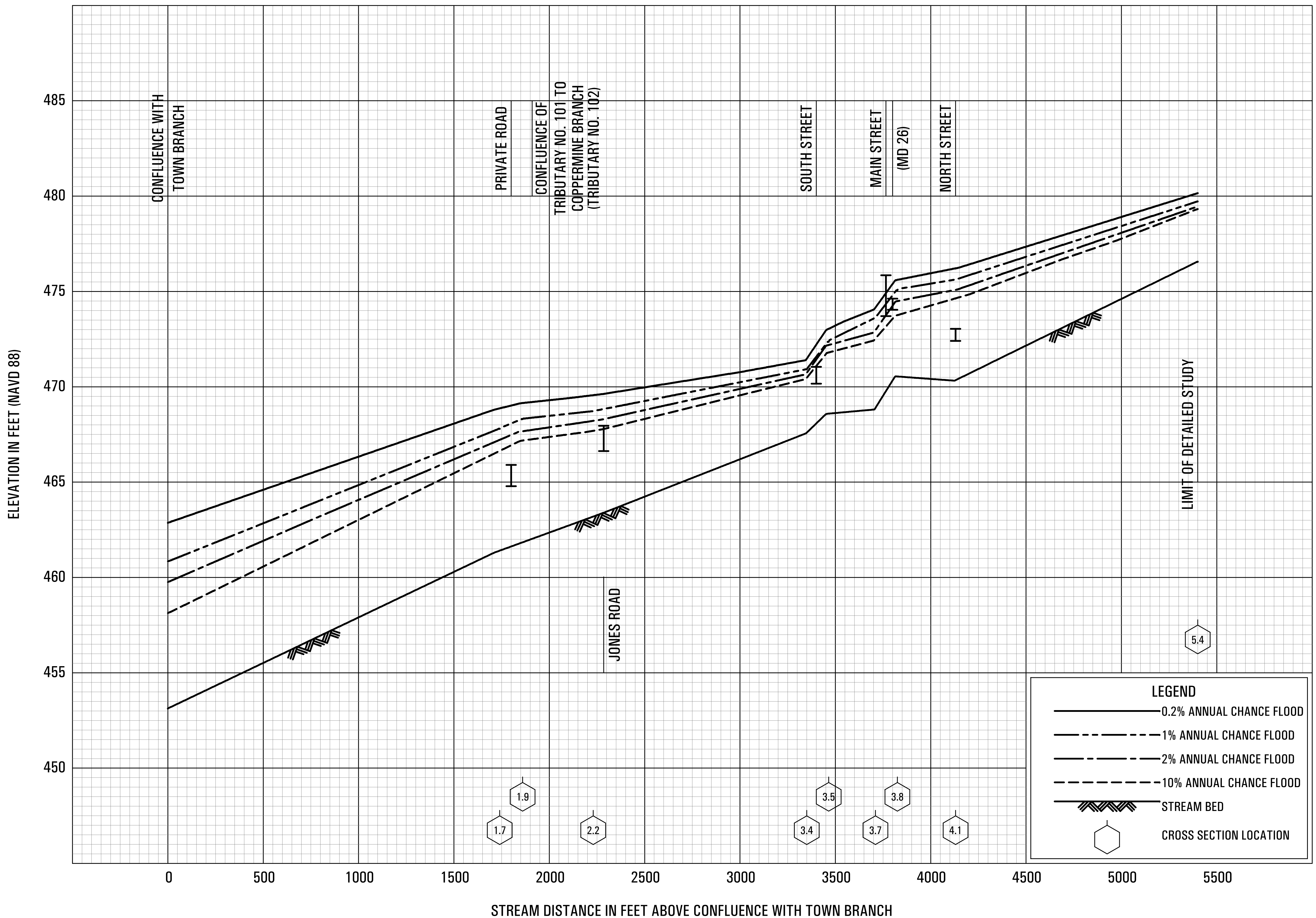
FLOOD PROFILES

CLIFTON BRANCH (TRIBUTARY NO. 98)

FEDERAL EMERGENCY MANAGEMENT AGENCY

FREDERICK COUNTY, MD

AND INCORPORATED AREAS



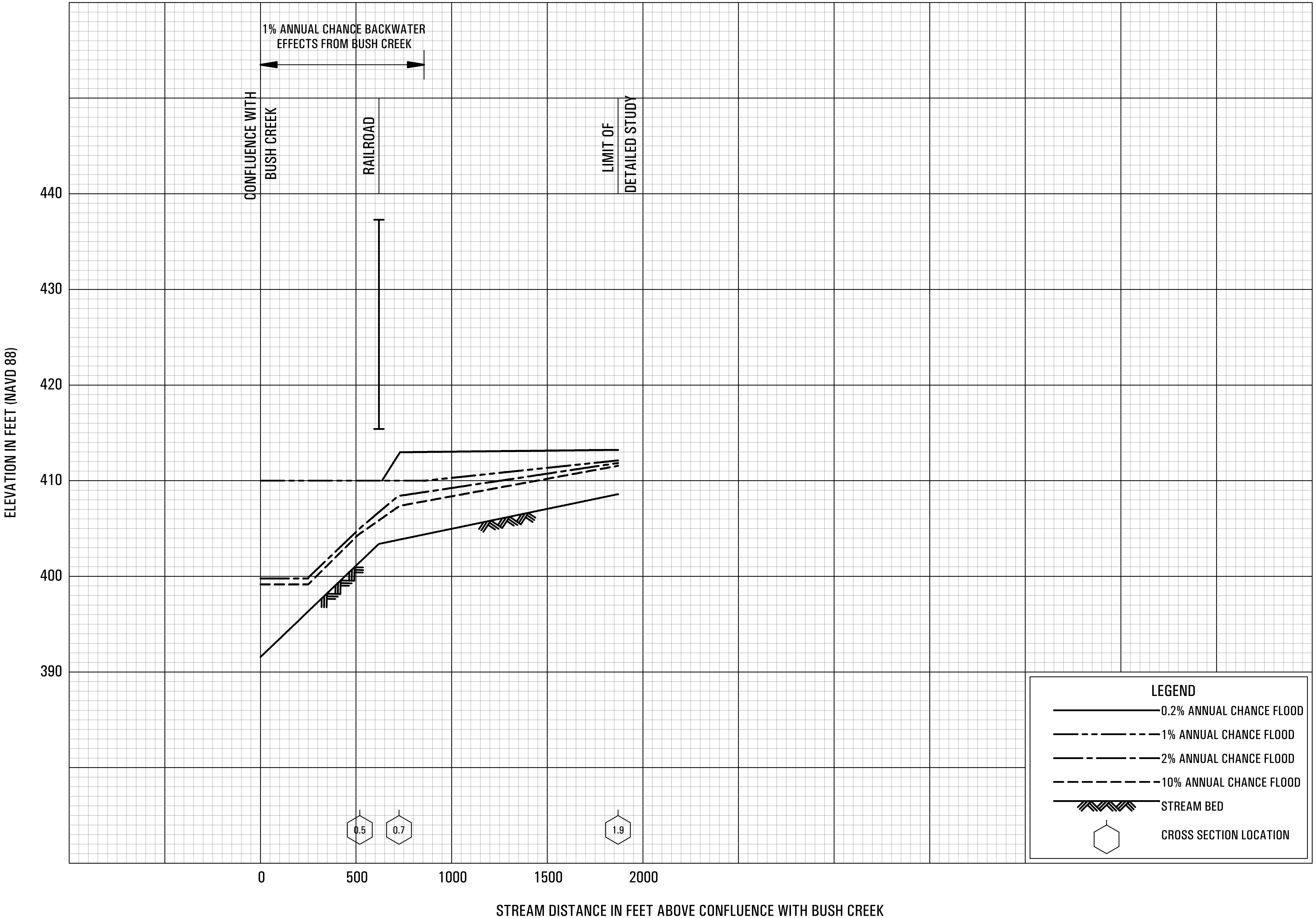

FLOOD PROFILES

COPPERMINE BRANCH (TRIBUTARY NO. 102)

FEDERAL EMERGENCY MANAGEMENT AGENCY

FREDERICK COUNTY, MD

AND INCORPORATED AREAS



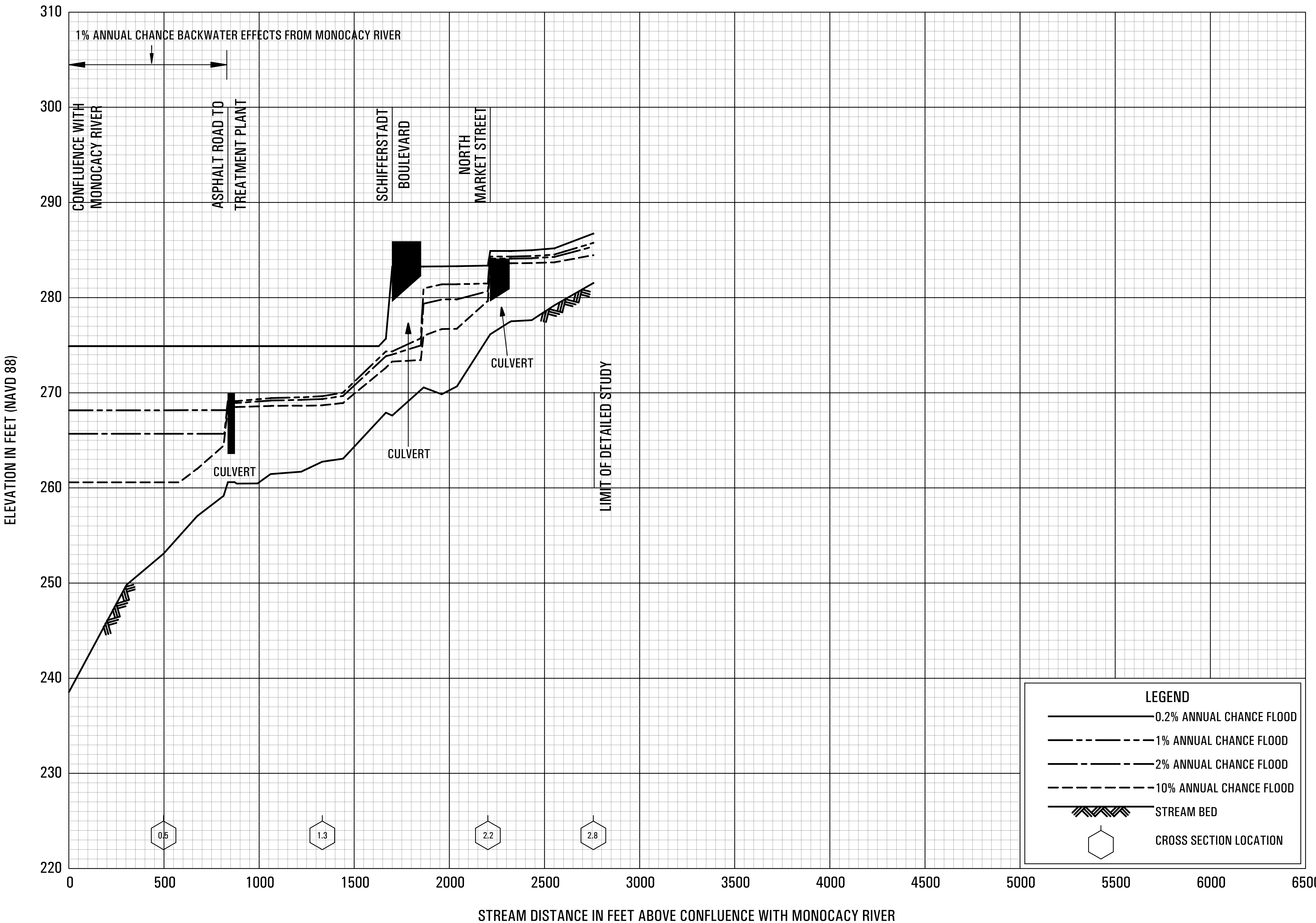

FLOOD PROFILES

DAVIS BRANCH (TRIBUTARY NO. 113)

FEDERAL EMERGENCY MANAGEMENT AGENCY

FREDERICK COUNTY, MD

AND INCORPORATED AREAS



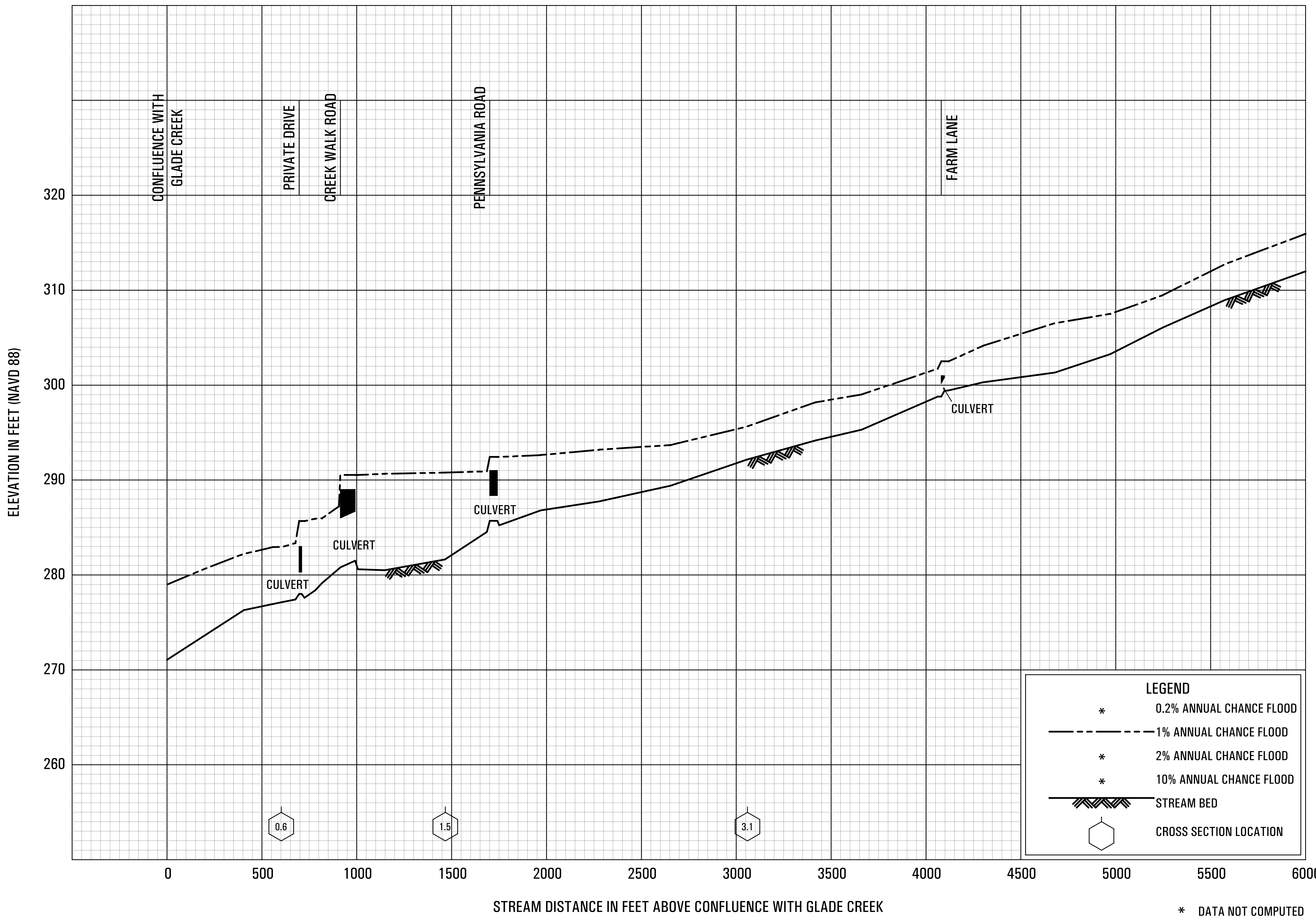

FLOOD PROFILES

DETRICK BRANCH (TRIBUTARY NO. 9)

FEDERAL EMERGENCY MANAGEMENT AGENCY

FREDERICK COUNTY, MD

AND INCORPORATED AREAS

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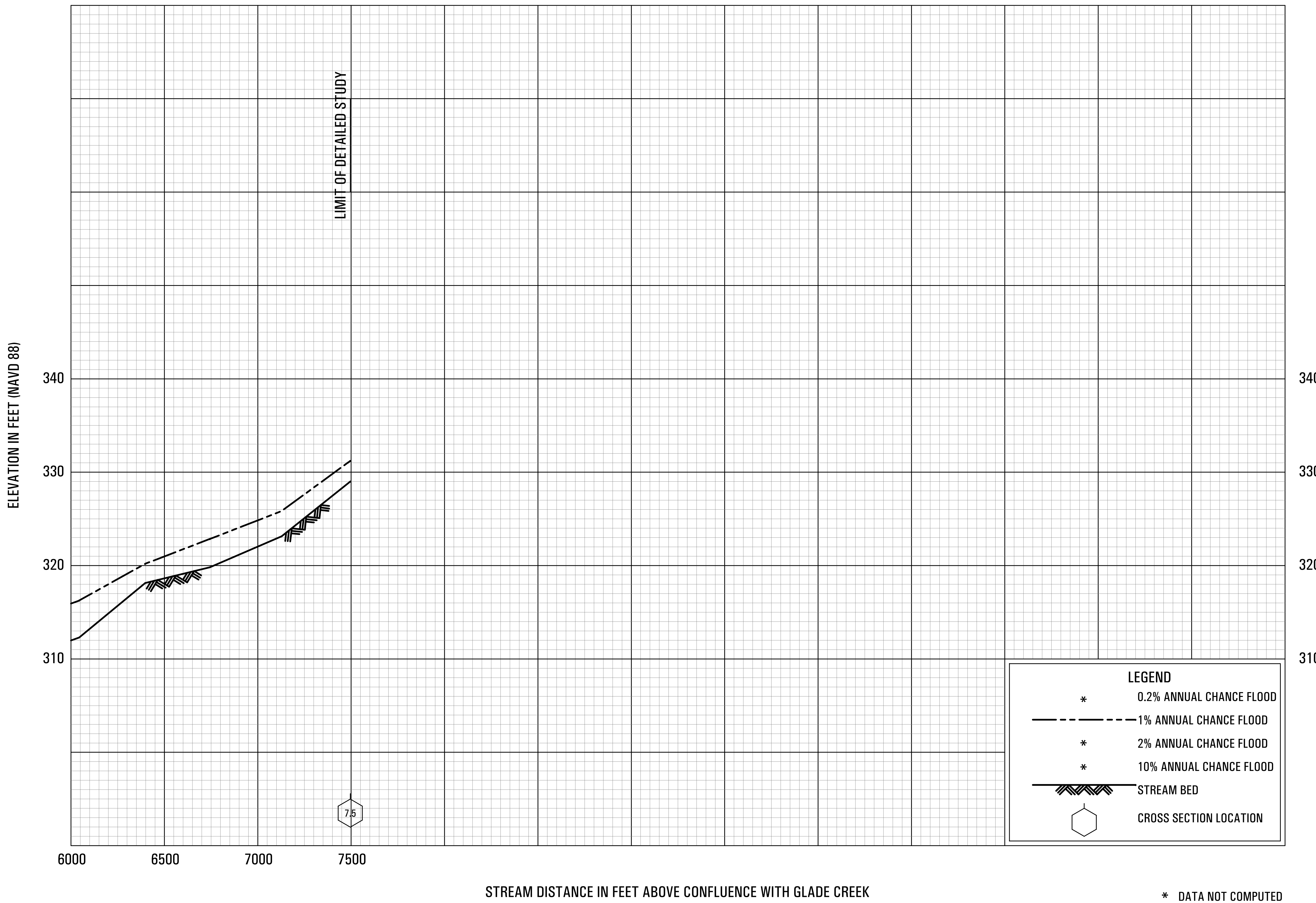
FLOOD PROFILES

DUBLIN BRANCH

FEDERAL EMERGENCY MANAGEMENT AGENCY

FREDERICK COUNTY, MD

AND INCORPORATED AREAS



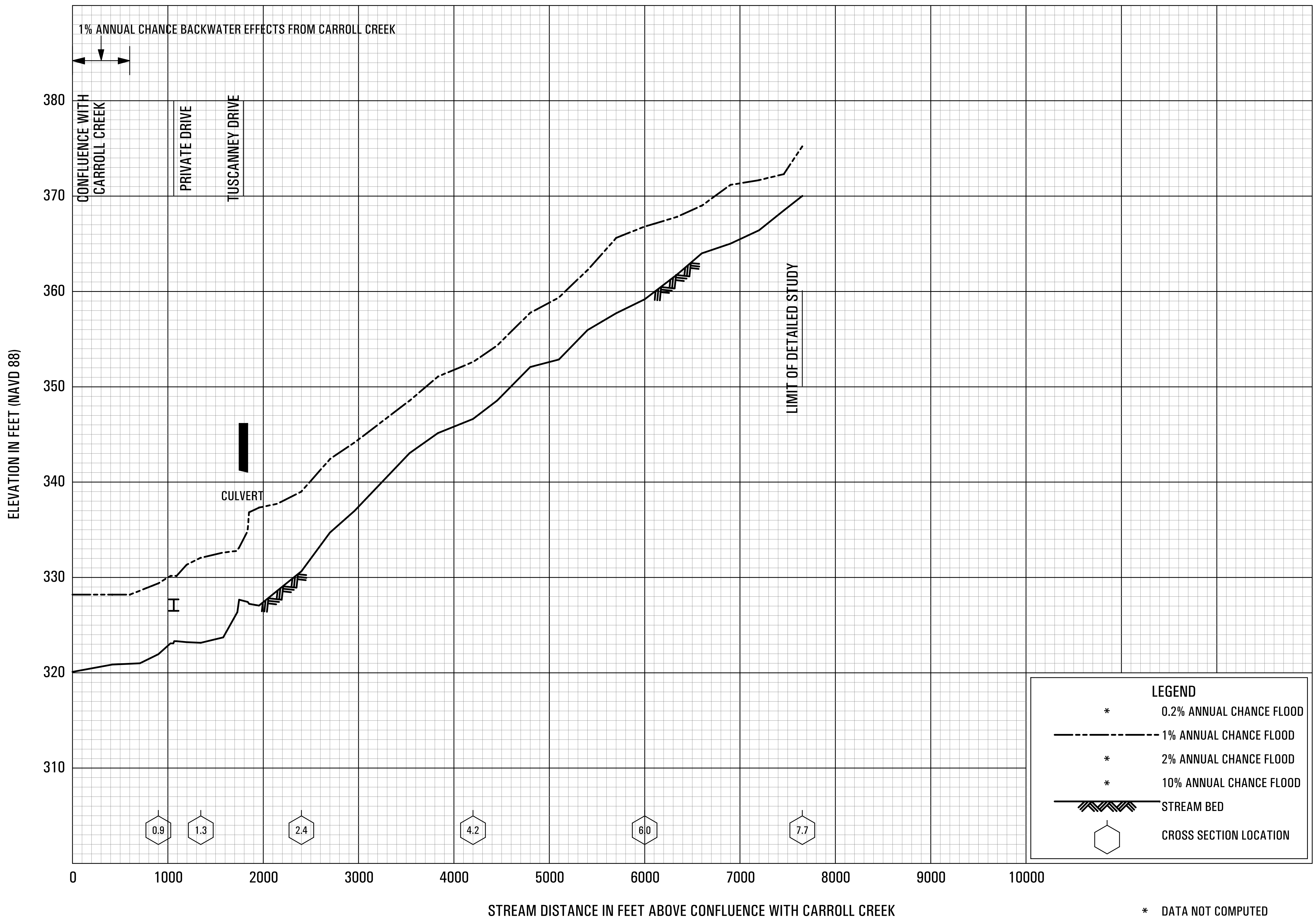

FLOOD PROFILES

DUBLIN BRANCH

FEDERAL EMERGENCY MANAGEMENT AGENCY

FREDERICK COUNTY, MD

AND INCORPORATED AREAS




FLOOD PROFILES

EDISON BRANCH

FEDERAL EMERGENCY MANAGEMENT AGENCY

FREDERICK COUNTY, MD

AND INCORPORATED AREAS