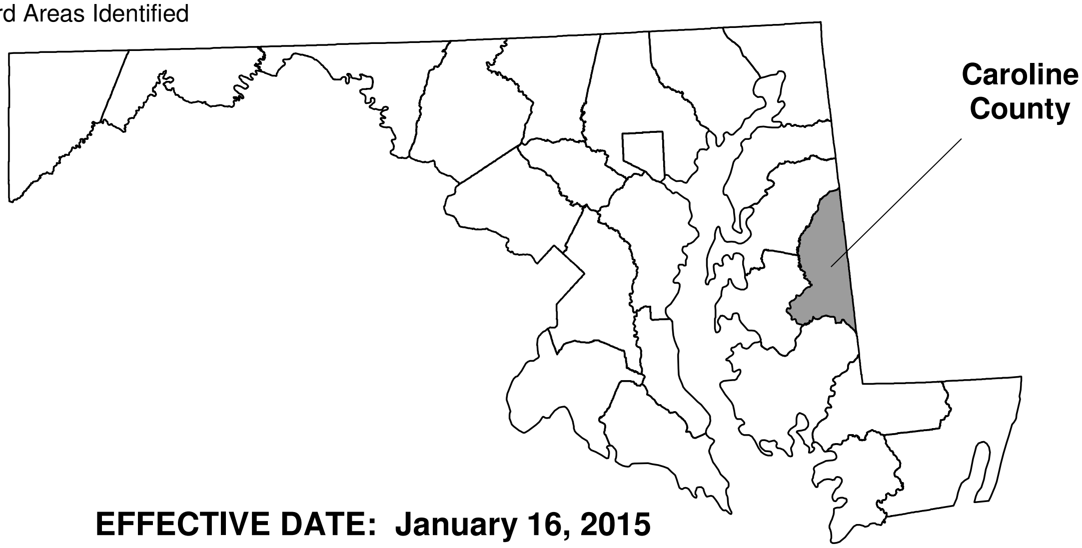
FLOOD INSURANCE STUDY

CAROLINE COUNTY, MARYLAND AND INCORPORATED AREAS

COMMUNITY NAME	COMMUNITY NUMBER	COMMUNITY NAME	COMMUNITY NUMBER
CAROLINE COUNTY (UNINCORPORATED AREAS)	240130	*HENDERSON, TOWN OF	240052
DENTON, TOWN OF	240104	HILLSBORO, TOWN OF	240111
FEDERALSBURG, TOWN OF	240013	*MARYDEL, TOWN OF	240115
GOLDSBORO, TOWN OF	240140	*PRESTON, TOWN OF	240163
GREENSBORO, TOWN OF	240014	*RIDGELY, TOWN OF	240144
		*TEMPLEVILLE, TOWN OF	240138

*No Special Flood Hazard Areas Identified



EFFECTIVE DATE: January 16, 2015

Federal Emergency Management Agency

FLOOD INSURANCE STUDY NUMBER
24011CV000A

NOTICE TO
FLOOD INSURANCE STUDY USERS

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

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

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

Old Zones	New Zones
A1 through A30	AE
V1 through V30	VE
B	X
C	X

Initial Countywide FIS Effective Date: January 16, 2015

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FLOOD INSURANCE STUDY
CAROLINE COUNTY, MARYLAND AND INCORPORATED AREAS

1.0 INTRODUCTION

1.1 Purpose of Study

This countywide Flood Insurance Study (FIS) investigates the existence and severity of flood hazards in, or revises and updates previous FIS's / Flood Insurance Rate Maps (FIRMs) in the geographic area of Caroline County, Maryland, including the Towns of Denton, Federalsburg, Goldsboro, Greensboro, Henderson, Hillsboro, Marydel, Preston, Ridgely, and Templeville, and the unincorporated areas of Caroline County (referred to collectively herein as Caroline County) and aids in the administration of the National Flood Insurance Act of 1968 and the Flood Disaster Protection Act of 1973. This FIS has developed flood-risk data for various areas of the community that will be used to establish actuarial flood insurance rates. This information will also be used by Caroline County to update existing floodplain regulations as part of the Regular Phase of the National Flood Insurance Program (NFIP), and will also be used by local and regional planners to further promote sound land use and floodplain development. Minimum floodplain management requirements for participation in the NFIP are set forth in the Code of Federal Regulations at 44 CFR, 60.3.

Please note that the Town of Federalsburg is geographically located in Caroline and Dorchester Counties. Flood hazard information for the entire Town of Federalsburg is included in its entirety in this FIS report.

Please note that the Town of Templeville is geographically located in Queen Anne's and Caroline Counties. The Town of Templeville is included in its entirety in this FIS report.

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

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

1.2 Authority and Acknowledgments

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

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

Caroline County, (Unincorporated Areas):	For the original April 1980 FIS report and the October 15, 1980 FIRM (hereinafter referred to as the 1980 FIS), the hydrologic and hydraulic analyses were prepared by Greenhorne and O'Mara, Inc., for the Federal Insurance Administration (FIA), under Contract No. H-3960. That work was completed in February 1978. For the September 7, 1998 revision, the hydrologic and hydraulic analyses for Miles Branch were prepared by GEO-Technical Services, Inc., for the Federal Emergency Management Agency (FEMA), under Contract No. EMW-93-C-4146. This work was completed in December 1995.
Denton, Town of:	The hydrologic and hydraulic analyses for the original study were prepared by Greenhorne & O'Mara, Inc., for the Federal Insurance Administration, under Contract No. H-3960. This work, which was completed in February 1978, covered all significant flooding sources affecting the Town of Denton, Maryland.
Federalsburg, Town of:	For the original September 1976 FIS report and March 15, 1977 FIRM (hereinafter referred to as the 1977 FIS), the hydrologic and hydraulic analyses were prepared by the U.S. Army Corps of Engineers (USACE) for the Federal Emergency Management Agency (FEMA) under Inter-Agency Agreement Nos. IAA-H-19-74, and IAA-H-16-75, Project Order Nos. 18 and 6, respectively. That work was completed in December 1975. For the September 7, 1998 revision, the hydrologic and hydraulic analyses for the Town of Federalsburg were prepared by

GEO-Technical Services, Inc. (GTS), for FEMA, under Contract No. EMW-93-C-4146-95-5. This work was completed in December 1995.

Greensboro, Town of: The hydrologic and hydraulic analyses for the original study were performed by Greenhorne & O'Mara, Inc., for the Federal Insurance Administration, under Contract No. H-3960. This work, which was completed in February 1978, covered all significant flooding sources in the Town of Greensboro, Maryland. The scope and methods of study were proposed to and agreed upon by the Federal Insurance Administration.

There are no previous FISs for the Towns of Goldsboro, Henderson, Hillsboro, Marydel, Preston, Ridgely, and Templeville; therefore the previous authority and acknowledgement information for these communities is not included in this FIS.

For this countywide FIS, revised hydrologic and hydraulic analyses were performed for the previously-studied reaches of Broadway Branch, Chapel Branch, Choptank River, Henderson Creek, Herring Run, Hunting Creek, Marshy Hope Creek, Miles Branch, Smithville Ditch, Tanyard Branch, Tidy Island Creek, and Watts Creek. New approximate floodplains were also mapped for Caroline County and its incorporated areas. This work was performed for FEMA by AMEC Environment & Infrastructure, Inc. under Contract No. HSFE03-07-D-0030, Task Order No. HSFE03-08-J-0014. The criteria for these floodplains can be found in Section 2.0 of this Flood Insurance Study.

The FEMA Region III office initiated a study to update the coastal storm surge elevations within the states of Virginia, Maryland, and Delaware, and the District of Columbia including the Atlantic Ocean, Chesapeake Bay including its tributaries, and the Delaware Bay. This effort is one of the most extensive coastal storm surge analyses to date, encompassing coastal floodplains in three states and including the largest estuary in the world. The study will replace outdated coastal storm surge stillwater elevations for all Flood Insurance Studies (FISs) in the study area, and serve as the basis for new coastal hazard analysis and ultimately updated Flood Insurance Rate Maps (FIRMs). Study efforts were initiated in 2008 and concluded in 2012.

This coastal study was conducted for FEMA under Project HSFE03-06-X-0023, “NFIP Coastal Storm Surge Model for Region III” and Project HSFE03-09-X-1108, “Phase II Coastal Storm Surge Model for FEMA

Region III." The US Army Corps of Engineers (USACE) and project partners assisted FEMA in the development and application of a state-of-the-art storm surge risk assessment capability for the FEMA Region III domain which includes the Delaware Bay, Chesapeake Bay, District of Columbia, Delaware-Maryland-Virginia Eastern Shore, Virginia. The work was performed by the Coastal Processes Branch (HF-C) of the Flood and Storm Protection Division (HF), U.S. Army Engineer Research and Development Center – Coastal & Hydraulics Laboratory (ERDC-CHL).

The end-to-end storm surge modeling system includes the Advanced Circulation Model for Oceanic, Coastal and Estuarine Waters (ADCIRC) for simulation of 2-dimensional hydrodynamics. ADCIRC was dynamically coupled to the unstructured numerical wave model Simulating WAves Nearshore (unSWAN) to calculate the contribution of waves to total storm surge. The resulting model system is typically referred to as SWAN+ADCIRC. A seamless modeling grid was developed to support the storm surge modeling efforts. The modeling system validation consisted of a comprehensive tidal calibration followed by a validation using carefully reconstructed wind and pressure fields from three major flood events for the Region III domain: Hurricane Isabel, Hurricane Ernesto, and extratropical storm Ida. Model skill was accessed by quantitative comparison of model output to wind, wave, water level and high water mark observations.

Base map information shown on this FIRM was provided in digital format. Streamline files and road centerlines were supplied by Caroline County. Political boundaries were obtained from the Maryland State Highway Administration and Caroline County. Adjustments were made to specific base map features to align them to aerial photography dated 2008 or later. 2003 and 2006 LiDAR data derived from the National Oceanic and Atmospheric Administration (NOAA) were utilized to delineate floodplain boundaries.

The coordinate system used for the production of this FIRM is Universal Transverse Mercator (UTM), Zone 18, 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.

The Digital Flood Insurance Rate Map (DFIRM) production for this study was performed by AMEC Environment & Infrastructure, Inc. for FEMA, under Contract No. HSFE03-07-D-0030, Task Order No. HSFE03-08-J-0014.

1.3 Coordination

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

For the 1980 FIS for Caroline County, Maryland (Unincorporated Areas), an initial CCO meeting was held on March 29, 1976, and was attended by representatives of Greenhorne & O'Mara, the county, and the FIA. Further coordination on this FIS included meetings with county officials, the U.S. Geological Survey (USGS), the Soil Conservation Service (SCS, now the National Resources Conservation Service, NRCS), the U.S, Army Corps of Engineers (USACE), Baltimore District, the U.S. Geodetic Survey, and the Maryland Water Resources Administration.

A final CCO meeting was held on April 30, 1979, and was attended by representatives of Greenhorne & O'Mara, the county, and the FIA.

For the September 7, 1998 revision, FEMA notified Caroline County by letter, dated December 31, 1996, that the FIS would be revised.

The coordination and the time and cost meetings for Denton, Maryland were held on March 30, 1976. The meeting, held in Denton, Maryland was attended by representatives from the Town of Denton, the FIA, and the study contractor. Further coordination for this study include separate meetings and conversations with the County officials, the U. S. Geological Survey (USGS), the U. S. Army Corps of Engineers (USACE), the Soil Conservation Service (SCS), and the State of Maryland Water Resources Administration.

On March 30, 1976, representatives from the study contractor and the FIA met with the city officials to discuss preliminary flood elevations, profiles and floodway delineations. On November 20, 1978, results of the study were reviewed at the final (CCO) meeting which was attended by representatives of the Town of Denton, the FIA, and the study contractor. The study was accepted at this meeting.

For the 1977 FIS prepared for the Town of Federalsburg, an initial CCO meeting was held on October 17, 1974, and a final CCO meeting was held on December 11, 1975. Both meetings were attended by representatives of the USACE, the Federal Insurance Administration, and the Town of Federalsburg.

For the September 7, 1998 revision, the Town of Federalsburg was notified by FEMA in a letter dated June 6, 1996, that its FIS would be revised using the analyses prepared by GTS.

The coordination and the time and cost meetings for Greensboro, Maryland, were held on March 30, 1976. The meeting, held in Denton, Maryland, was attended by representatives from the Town of Greensboro, the FIA, and the study contractor. Further coordination for this study included separate meetings and conversations with the Town officials, the U. S. Geological Survey (USGS), the U. S. Army Corps of Engineers (USACE), the Soil Conservation Service (SCS), the U. S. Geodetic Survey, and the State of Maryland Water Resources Administration. On March 29, 1976, representatives from the study contractor and the FIA met with the town officials to discuss preliminary flood elevations, profiles and floodway delineations.

On November 20, 1978, results of the study were reviewed at the final Consultation and Coordination Officer's (CCO) meeting which was attended by representatives of the Town of Greensboro, the FIA, and the study contractor.

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

TABLE 1 – INITIAL AND FINAL CCO MEETINGS

Community Name	Initial CCO Date	Final CCO Date
Caroline County (Unincorporated Areas)	March 29, 1976 December 31, 1996	April 30, 1979
Denton, Town of	March 30, 1976	November 20, 1978
Federalsburg, Town of	October 17, 1974 June 6, 1996	December 11, 1975
Greensboro, Town of	March 30, 1976	November 20, 1978

For this countywide study, Caroline County and the Towns of Denton, Federalsburg, Goldsboro, Greensboro, Henderson, Hillsboro, Marydel, Preston, Ridgely, and Templeville, were notified by phone in October 2009 that the FIS would be updated and converted to countywide format.

For this countywide study, a final CCO meeting was held on September 24, 2013 and was attended by representatives of FEMA, the Maryland State NFIP Office, Caroline County, the Towns of Denton, Federalsburg, Goldsboro, Greensboro, Henderson, Hillsboro, Marydel, Preston, Ridgely, and Templeville, and the study contractors. At this meeting the findings of the study and the potential impact of the study results on the community were discussed.

2.0 AREA STUDIED

2.1 Scope of Study

This FIS covers the geographic area of Caroline County, Maryland, including the Towns of Denton, Federalsburg, Goldsboro, Greensboro, Henderson, Hillsboro, Marydel, Preston, Ridgely, and Templeville.

All or portions of the flooding sources listed in Table 2 "Flooding Sources Studied by Detailed Methods" were studied by detailed methods. Limits of detailed study are indicated on the Flood Profiles (Exhibit 1) and on the FIRMs (Exhibit 2). The areas studied by detailed methods were selected with priority given to all known flood hazard areas and areas of projected development and proposed construction.

TABLE 2 – FLOODING SOURCES STUDIED BY DETAILED METHODS

Broadway Branch	Marshy Hope Creek
Chapel Branch	Miles Branch
Choptank River	Smithville Ditch
Henderson Creek	Tanyard Branch
Herring Run	Tidy Island Creek
Hunting Creek	Watts Creek

The Choptank River was studied by coastal analysis from the county boundary at the confluence of Hunting Creek to approximately 22.6 miles upstream near Town of Denton. Detailed riverine analysis of Choptank Creek continued 15.0 miles upstream and included detailed analysis in the Towns of Denton and Greensboro and continued upstream to just below the Town of Goldsboro.

The segment of Tuckahoe Creek that had been studied by detailed methods in the previous FIS has been superseded by the coastal detailed study. No profile has been generated in this FIS for Tuckahoe Creek.

Although the Town of Henderson was not previously mapped, the area of the town did have SFHAs in the effective unincorporated county map for the streams Henderson Creek and Henderson Creek South Branch. In coordination with local communities, SFHAs that drain less than 1-square mile while also producing floodplains too narrow to define at map-scale, were removed. For Henderson Creek, the limit of detailed study is located at the confluence of Henderson Creek South Branch and Henderson Creek, which is not within the town boundaries.

All or portions of several streams were studied by approximate methods and are listed in Table 3 "Flooding Sources Studied by Approximate Methods." 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 Caroline County.

TABLE 3 –FLOODING SOURCES STUDIED BY APPROXIMATE METHODS

Beetree Ditch	Tributary No. 1 to Forge Branch
Bell Creek	Tributary No. 1 to Fowling Creek
Chapel Branch	Tributary No. 1 to Harrington Beaverdam Ditch
Choptank River	Tributary No. 1 to Herring Run
Coolspring Branch	Tributary No. 1 to Houston Branch
Crowberry Creek	Tributary No. 1 to Hunting Creek
Deep Branch	Tributary No. 1 to Marshy Hope Creek
Faulkner Branch	Tributary No. 1 to Mason Branch
Forge Branch	Tributary No. 1 to Mill Creek
Fowling Creek	Tributary No. 1 to Piney Branch
Gravelly Branch	Tributary No. 1 to Robins Creek
Harrington Beaverdam Ditch	Tributary No. 1 to Smithville Ditch
Herring Run	Tributary No. 1 to Spring Branch
Herron Run	Tributary No. 1 to Tuckahoe Creek
Hog Creek	Tributary No. 1 to Tull Branch
Houston Branch	Tributary No. 1.1 to Mason Branch
Hunting Creek	Tributary No. 2 to Chapel Branch
Little Creek	Tributary No. 2 to Choptank River
Little Gravelly Branch	Tributary No. 2 to Faulkner Branch
Marsh Creek	Tributary No. 2 to Forge Branch
Marshy Hope Creek	Tributary No. 2 to Harrington Beaverdam Ditch
Mason Branch	Tributary No. 2 to Hunting Creek
Miles Branch	Tributary No. 2 to Mason Branch
Mill Creek	Tributary No. 2 to Tuckahoe Creek
Oldtown Branch	Tributary No. 2.1 to Forge Branch
Piney Branch	Tributary No. 2.1 to Tuckahoe Creek
Raccoon Branch	Tributary No. 3 to Choptank River
Robins Creek	Tributary No. 3 to Forge Branch
Sandtown Branch	Tributary No. 3 to Tuckahoe Creek
Skeleton Creek	Tributary No. 4 to Forge Branch
Smithville Ditch	Tributary No. 4 to Tuckahoe Creek
Spring Branch	Tributary No. 5 to Choptank River
Sullivan Branch	Tributary No. 6 to Choptank River
Tanyard Branch	Tubmill Branch
Tidy Island Creek	Tuckahoe Creek
Tommy Wright Branch	Tull Branch
Tributary No. 1 to Chapel Branch	Twiford Meadow Ditch
Tributary No. 1 to Choptank River	Wolfpit Branch
Tributary No. 1 to Faulkner Branch	

No previously-issued Letters of Map Revision (LOMRs) were recorded for this countywide study.

2.2 Community Description

Caroline County is one of three counties situated approximately midpoint on Maryland's eastern shore. Queen Anne’s and Talbot Counties border it on the north and west; Dorchester County borders it on the south; and the State of Delaware forms its eastern border, with Kent County to the northeast and Sussex County to the southeast.

The county encompasses an area of 326 square miles, 4 square miles of which are water. The Choptank River flows through Caroline County and drains into the Chesapeake Bay. Tuckahoe Creek and Hunting Creek, the main tributaries of the Choptank River, form part of the county's western and southern boundaries. A small area in the southeastern part of the county is drained by Marshy Hope Creek, one of the main tributaries of the Nanticoke River.

The population for Caroline County as determined by the 2000 Census was 29,772, and for the 2010 Census, the population was 33,066, a change of 11.1% (Reference 1).

The county is predominantly rural. There are some pockets of development near the Towns of Federalsburg, Denton, and Greensboro.

Caroline County lies in the Atlantic Coastal Plain province. The underlying rock or basement is in the form of hard crystalline rock or the Precambrian and Paleozoic eras. The basement complex slopes to the southeast, as do the overlying sediments. The sediments, consisting of sands, greensands, gravels, silts, clays, shales, and shell beds, range in age from the Early Cretaceous to the Recent period. The thickness of the sediments varies from 2,000 to 4,000 feet. The sands and gravels, which are porous and permeable, contain water and transmit it readily. The silts and clays also contain water but yield it slowly or not at all. The aquifers lying above a depth of 1,500 feet are mostly fresh, but locally may be slightly saline. The aquifers below a depth of 2,000 feet are primarily saline (Reference 2).

The soils of Caroline County are primarily loams, loamy sands, sandy loams, and clay loams. Approximately 95 percent of the county's land area is encompassed by the soils of the uplands and terraces. The soils of the river floodplains take in approximately 3 percent of the land area, and those of the swamps and marshes encompass approximately 2 percent. In the upland areas and terraces, the soils range from the excessively drained Galestown and Lakeland series to the poorly drained Pocomoke and Fallsington series. The soils in the floodplains consist primarily of the poorly and very poorly drained Bibb and Johnston Series. In the swamps and marshes very poorly drained silt, clay, and muck are found (Reference 3).

Of the 95 percent of the soils in the uplands, only approximately 17 percent do not need any special management practices. Soil drainage is the predominant management problem. Approximately 45 percent of the land consists of soils sufficiently wet so that artificial drainage is necessary before cultivation. Of that 45 percent, approximately one-fourth of the land requires only simple drainage to render the land fit for cultivation. The rest of the land requires intensive drainage measures (Reference 3).

Most of the county lies on a gently upward-sloping plain at an elevation of 40 to 60 feet. In the northern part of Caroline County, the elevation reaches 78 feet. However, the slope of the land seldom exceeds 5 percent and less than 2 percent of the total land area has slopes over 10 percent. The terrace plains on which Caroline County lies are dissected by numerous streams and rivers. In the headlands, the streams are generally straight. In the lower reaches, many streams exhibit meanders. The meanders are found in streams at or below an elevation of 20 feet. At tide level, these streams become meandering estuaries.

Numerous depressions or basins clot the landscape. These depressions, known as Maryland basins, are low, sandy rims with a central depression of oval shape. The size of these basins ranges from a few feet to several miles in the length of their major axis. These basins perform an important part in the water balance cycle of the county, providing areas for the storage and infiltration of rainfall, as well as for the evaporation and transpiration of soil moisture and groundwater. Often the water table in these basins is just a few inches below the center of the basin. Also found in the landscape are a few ponds and lakes. The ponds are historical remnants of the mill operation era, and were formed by the damming of creeks. Most of the ponds are no longer in existence, but some are still found on Broadway Branch near Goldsboro and on Hunting Creek near Linchester. These are Smithville Lake and Williston Lake, both of which are in Maryland basins, and Lake Chambers, near Federalsburg.

The overall drainage in the county tends to be slow, owing to the generally level or gently sloping relief of the land, numerous depressions, and also because the main rivers are tidal streams.

The Choptank River is tidal to Greensboro, Maryland. Tuckahoe Creek, a main tributary to the Choptank River, is tidal to Hillsboro, Maryland; Marshy Hope Creek is tidal to Federalsburg, Maryland.

The Choptank River is navigable from the Chesapeake Bay to Greensboro, Maryland. The controlling water depths in the Choptank River at mean low water (MLW) are 6.5 feet at the Pealiquor Shoals and approximately 3.5 feet in the channel from Denton to Greensboro (Reference 4). The USACE has dredged the Choptank River to provide an 8-foot-deep channel from Pealiquor Shoals to Greensboro (Reference 5).

Between Cambridge and Greensboro, six bridges span the Choptank River. These include a swing bridge on U.S. Route 50 at Cambridge, with an 18-foot vertical clearance above mean high water (MHW); a swing bridge on State Route 331 at Tanyard, with a 10-foot clearance; a bascule bridge on State Route 404 Business (Meeting House Road) at Denton, with a 4-foot clearance; a swing bridge for railroad trains at Denton, with a 6-foot clearance (proposed to be converted to a Greenway trail (Reference 6)); a bridge for State Route 404 Bypass around Denton; and a fixed bridge on State Route 314 at Greensboro, with a 10-foot clearance.

The Choptank River flood plain located in the city limits of Denton and Greensboro is too swampy for most types of development. Although there is some residential development in the flood plain, the majority has generally been above the higher flood levels. Anticipated development is expected to continue at a slow rate. It will probably not occur in the flood plain areas since suitable land for development is available elsewhere.

Tuckahoe Creek, from its confluence at the Choptank River to Stoney Point, has a 6-foot deep MLW channel. A fixed highway bridge on State Route 328 on Tuckahoe Creek has a 40-foot horizontal clearance and a vertical clearance of 17 feet MHW.

Caroline County is located in the middle latitudes. Here the general atmospheric flow pattern is west to east across the North American continent. During the cooler half of the year, a frequent succession of high and low pressure systems move along this flow-field, bringing alternate surges of cold, dry air from the north and warm humid air from the south. During the summer, this pattern tends to break down as warm moist air moves northward from the south and southwest and lingers over the area much of the time. A modifying effect on the temperature is exerted by the Chesapeake Bay, the Choptank River and the Atlantic Ocean (Reference 7). The mean annual temperature is 56 degrees Fahrenheit (°F), with a summer temperature of 74.9°F and a winter temperature of 36.7°F. The average duration of the freeze-free period lasts 187 days (Reference 8).

Precipitation in Caroline County is evenly distributed throughout the year. Heavy precipitation during the colder half of the year generally results from low-pressure systems moving north or northeast along the coast. In the summer, heavy rainfall is usually brought by thunderstorms. Tropical storms and hurricanes, although rare, may bring unusually heavy rainfall.

The mean annual precipitation is 43.2 inches. Snowfall averages 18.5 inches during the winter season (Reference 8).

The Town of Denton, located on the Maryland eastern shore in Caroline County, lies at the intersection of Maryland Route 404 and the Choptank River. The distance from the Chesapeake Bay to the town along the Choptank River is approximately 45 nautical miles. Along Routes U. S. 50 and Maryland 404, Denton lies about 30 miles due east from the Chesapeake Bay Bridge. The town is situated on the east bank of the Choptank River with the river forming a common boundary between the town and Caroline County.

Denton came into existence as the settlement of Eden-Town in 1773 (Reference 9). In 1796, approximately fifty acres in the Eden-Town locality was surveyed for the establishment of the Village of Denton and in 1802 it became the Town of Denton. In the early 1800s, trade and manufacturing facilities were established in the village. These facilities consisted of a market place and a factory for the making of plows. From these early beginnings, Denton continues to grow as a trade and government center (Reference 9). Denton envisions itself as an innovative, healthy, safe, well-balanced community that protects its historical integrity, preserves its unique natural resources, enhances its economical vitality and maintains its unique small town character. Denton's population will increase at an acceptable rate consistent with the ability of the Town and County to provide basic services and facilities. With the passage of Maryland House Bill 1141, guidance was provided to address municipal growth. Denton was recognized as a designated growth area. As a result of the overall situation assessment and in deference to the majority of Town residents' wishes, the maximum population for this plan will be constrained to no more than 10,000 residents. Due to the abundance of vacant infill area associated with the past decade of annexation activity and sizeable redevelopment area within Town, future residential growth will occur within the existing Town boundary. Planned growth area annexations shall be those which prioritize commercial/industrial land uses first followed by somewhat densely populated areas currently serviced by private wells and septic systems (Reference 6). According to the 2010 Census, the population in Denton was 4,418 people, which is a 49.3 percent increase over the 2000 Census population of 2,960 (Reference 1). Denton is presently the county seat of Caroline County.

Denton lies in the Atlantic Coastal Plain Province. The majority of the town lies above an elevation of 40 feet on a flat terrace plain. The 40 foot elevation contour parallels Fourth Street in the town's southwest section, curves out toward the intersection of Second and Randolph Streets in the west, and curves back east in the northern part of the town crossing Sixth

Street near High Street. The slopes above the 40 foot contour are generally flat, averaging 0 to 2 percent. West of the 40 foot contour, the land slopes steeply toward the Choptank River, and becomes a tidal marsh north and south of the Maryland 404 bridge. In the south, one encounters variable gradients of 15 to 30 percent toward Kerr Creek and the Choptank River.

At Denton, the Choptank River drains an area of approximately 200 square miles, most of which lies within Caroline County. The Choptank River is also influenced by tides from the Chesapeake Bay as far upstream as Greensboro, Maryland. At Denton, the tidal range for the Choptank River is approximately 2.2 feet for the mean tide and 2.5 feet for the spring tide.

The predominant soils in the town consist of the excessively drained Galestown Loamy Sands (Reference 3). Tidal marshes exist north of Unnamed Tributary No. 1 and west of First Street. In the vicinity of Unnamed Tributary No. 2 at Carter, Gateway and Edentown Streets, the soils are of the poorly drained Plummer Series. Further south and generally following Kerr Creek are alluvial deposits and other soils with poor to moderate drainage characteristics.

The Town of Federalsburg, Maryland, is located in the eastern part of the state, near the Delaware border and adjacent to the border between Caroline and Dorchester Counties. The 2010 Census population was 2,739, which was an increase of 4.5 percent over the 2000 Census population of 2,620 (Reference 1).

Topographic maps of the area in and about Federalsburg emphasize the overall flatness of the terrain and display features characteristic of the water management problems present in the area. Marshy Hope Creek flows through Federalsburg, with approximately 148 square miles of its 218 square mile watershed contributing at that point. The creek continues south to its junction with the Nanticoke River approximately five miles northeast of Vienna, Maryland.

The economy of the watershed is based on agricultural production. The watershed is in the major poultry producing area of the Delmarva Peninsula. The heavy concentration of the poultry industry on the peninsula has resulted in an expansion of the acreage of corn and soybeans grown and utilized locally.

Federalsburg is rapidly being discovered and there is a noticeable influx of people, expansion and development. New industry growth is fast becoming a reality. Federalsburg houses the largest industrial area in Caroline County, including three industrial parks: Federalsburg Industrial Park, Caroline Industrial Park and the Frank M. Adams Industrial Park.

All three parks offer city water, sewer, police protection, rail service and electric power to serve any need. The Frank M. Adams Industrial Park currently has room for expansion. The town has planned for controlled growth, and its citizens are dedicated to see Federalsburg prosper. Amidst this growth however, old-fashioned traditions and hospitality prevail. Federalsburg is known as the "heart" of the heart of the Eastern Shore (Reference 10).

The Town of Goldsboro is named after wealthy landowner, Dr. G.W. Goldsborough; its earliest industry was beaver pelt trading with Native Americans. This was a lucrative business since four major Indian paths on the Chesapeake Peninsula converged here. With Oak hickory and Oak gum forests, abundant grain fields, spawning fish, edible plants, freshwater streams and fur-bearing animals, Goldsboro grew into an important crossroads town. Today it remains one of the small charming villages that dot Caroline County's scenic landscape (Reference 11). The 2010 Census population was 246 (Reference 1).

Greensboro, located on the Maryland eastern shore in north-central Caroline County, lies at the intersection of Maryland Route 314 and the Choptank River. The distance along the Choptank River from the U. S. Route 50 bridge at Cambridge, Maryland to Greensboro, Maryland is approximately 37 nautical miles.

The Town of Greensborough (Greensboro) was established when the Maryland General Assembly authorized a purchase of about 100 acres of land at the Choptank Bridge. The land surveyed and purchased included the original village of Bridgetown (Reference 12).

According to the U.S. Bureau of the Census, the population of the Town of Greensboro was 1,931 in the 2010 Census, which was an increase of 18.3 percent over the 2000 Census of 1,632 (Reference 1).

Greensboro lies in the Atlantic Coastal Plain Province. The majority of the town lies above an elevation of 20 feet on a flat terrace plain. Two small areas of the town lie above the 40 foot elevation. Low elevations of two to three feet can be found in the swampy region in the southern sectors of the town near Sunset Avenue the overbank elevations are generally higher with a minimum elevation of six to seven feet. Near Park and Riverview Lane which separate the areas of higher 20 feet elevations in the west from the lower areas near the Choptank River the land slopes toward the Choptank River with gradients in the order of 5 to 10 percent.

Forge Branch, which is a tributary of Choptank River, has a drainage area of 9.8 square miles at Greensboro and a drainage area of 18.5 square miles at its confluence at the Choptank River. The drainage area of the Choptank

River at Greensboro is 135 square miles with most of the drainage area lying within Caroline County. The Choptank River is influenced by tides from the Chesapeake Bay.

The predominant soils in the town consist of excessively to well drained Sassafras loamy sands and Sassafras sandy loams (Reference 3) South of Sunset Avenue and generally east of Main Street one finds excessively drained soils of the Galestown Series. Opposite Tubmill Branch on the west bank of the Choptank River is an area of swamps. At the western border of the town and bordering Forge Branch, are the very poorly drained Johnston Series.

A small village midway between Goldsboro and Marydel in northern Caroline County, Henderson was originally known as Melville's Crossroads. The community developed around a stagecoach stop and a post office during the mid 19th century. With the advent of the railroad in 1868, the stagecoach service ended and the post office moved to the east side of town near the railroad where this quiet village was renamed Henderson. Caroline's relaxing rural byways wind through many hospitable hamlets like this one (Reference 11). The 2010 Census population was 146 (Reference 1).

The Town of Hillsboro, chronicled in Frederick Douglass' famous 1845 autobiography, evolved as a tobacco-trading center on Tuckahoe Creek. Hillsboro was the setting for several important events in Douglass' life including the permanent separation of his family among slaveholders. Hillsboro is also the home to the county's first fire company founded soon after a devastating fire destroyed East Main Street in 1896. Mostly residential, Hillsboro celebrates old-fashioned annual events including the community picnic, town-wide lawn sale and fireman's parade (Reference 11). The 2010 Census population was 161 (Reference 1).

The Town of Marydel, straddling the famous Mason-Dixon at the northern end of Caroline County, derives its name from its Maryland and Delaware roots. Visitors interested in history can view a crown stone of the Mason-Dixon Line, named after Charles Mason and Jeremiah Dixon who were hired to do the land survey. Although often referred to as the dividing line between the north and south, the Mason-Dixon Line resulted from a property dispute between the Penn and the Calvert families (Reference 11) The 2010 Census population was 141 (Reference 1).

The Town of Preston served as a focal point for the Underground Railroad during the 1840s and 1850s: at least three stations operated from here including one run by Harriet Tubman's parents. Preston was the county's first small town to completely pave its sidewalks with concrete, install a sewer system (circa 1914), and provide electric streetlights (before 1910).

Preston continues to have a lively business community with shopping, antiques, dining and ice cream. Just outside town, the Linchester Mill complex presents stories of the area's rich and diverse heritage. (Reference 11). The 2010 Census population was 719 (Reference 1).

The Town of Ridgely, once Reverend Greenbury Ridgely's grain field, is the site where this 'strawberry' town was established in May 1867. Caroline County's first railroad started here, which ultimately led to Ridgely's boom and its bust as more accessible transportation brought new competition for strawberries and grains. The present streetscape reflects that transient prosperity during the countywide canning boom (1895-1919). The former rail line is being transformed into a trail for hikers and bikers that like the outdoors and small town America. High adventure seekers can try hang gliding from the airport at Ridgely (Reference 11). The 2010 Census population was 1,639 (Reference 1).

Because of its many free black households and sympathetic Irish immigrants, the Town of Templeville was once known as a safe haven for Underground Railroad escapees. On July 3, 1863, native son Sergeant William Poor of Templeville fought alongside 300 Caroline soldiers in the Union Army's First Eastern Shore Regiment at Culp's Hill at the Battle of Gettysburg. The Confederate soldiers included William Hardcastle, a descendent of Thomas Hardcastle of "Castle Hall" near Goldsboro (Reference 11). The 2010 Census population was 138 (Reference 1).

2.3 Principal Flood Problems

Three major types of storms affecting Caroline County are large area extra-tropical storms, tropical storms, or hurricanes, and local thunderstorms.

Drainage characteristics in Caroline County are such that flood conditions are produced by high-intensity rainfall and by storm tides. The flat topography of the county, combined with its humid climate, high seasonal water tables, and generally poorly-drained soils, produce natural flood problems, such as the conveyance, control and disposal of surface water caused by abnormally high rainfall.

In the tidal reaches of the Choptank River and its tributaries, storm tides lead to flooding of the lowland areas adjacent to the river banks. Although it is an extremely rare event, the coincidence of large storm tides and high intensity rainfall may lead to severe flooding problems. There are records of floods dating back to 1876; and other major floods in Caroline County occurred in 1889, 1919, 1933, 1935, 1955, 1958, 1960, 1967, 1972, 1975, 1979, 1983, 1994, 1996, 1999, 2001, 2003, 2006, 2008, 2009 and 2011.

The principal source of flooding in the Town of Denton is the Choptank River. The flood elevations of the river are influenced by the magnitude of flood flows from the drainage basins in Caroline County, upstream from Denton and the tide levels in the Chesapeake Bay. High intensity rainfall over prolonged periods and storm tides on the Chesapeake both singly and in combination have led to flood elevations on the Choptank River which have inundated the low lying river banks in the Denton vicinity. In areas of flat topography and poorly drained soils, high intensity rainfall has lead to local flooding problems.

The principal flooding source in the Town of Federalsburg is Marshy Hope Creek. The drainage area characteristics of Marshy Hope Creek are such that flood conditions are produced by high intensity rainfall. Floodwater damages and problems related to agricultural water management occur in the same areas due to the flatness of the watershed and the extent of poorly drained soils. Floodwater problems include the conveyance, control, and disposal of surface water caused by abnormally high direct precipitation. Drainage problems occur where, under natural conditions, excess water keeps the soil too wet for sustained agricultural use. Land owners in the watershed have experienced complete crop losses in large areas during seasons with heavy rains, occurring approximately once every five years. Flooding occurs most often in the late summer and early autumn. Large portions of the business district of Federalsburg lie on the west bank of the floodplain subject to storm overflow.

The principal source of flooding around the Town of Greensboro is the Choptank River. The flood elevations on the river are influenced by the magnitude of flood flows from the drainage areas in Caroline County upstream from Greensboro and the tide levels in the Chesapeake Bay. High intensity rainfall over prolonged periods and storm tides on the Chesapeake both singly or in combination have led to flood elevations on the Choptank River which have inundated the low-lying riverbank areas in the Greensboro vicinity. The low-lying areas bordering Forge Branch may also experience flooding during high intensity rainstorms, especially during higher than normal flows on the Choptank River.

In 1919, Denton and Caroline County were subjected to an unusual increase in precipitation; within a three month period, rainfall exceeded the yearly average and caused widespread damage. In Greensboro, the rainfall caused widespread damage including the collapse of a bridge near Boyce Mill on the road from Greensboro to Delaware.

The hurricane that occurred in August 1933 generated wind speeds up to 50 miles per hour over the Chesapeake Bay area. The tidal surges generated by this hurricane were the highest recorded this century in the bay region. The surge heights above the tide generated by the hurricane varied from approximately 6.6 feet at the southern end of the bay at the Hampton Roads tidal gage to 5.8 feet at the Annapolis gage and to 7.2 feet at the Baltimore gage (References 13 and 14). Local residents recall floodwaters to a depth of 2 feet in the Town of Choptank because of this storm. In the Denton area, this storm uprooted trees, flooded cellars, paralyzed electric and telephone service, and inundated the Maryland Route 404 causeway by more than two feet of water. In Greensboro, the storm flooded the town pumping station depleting the supply of fresh water. Floodwaters also inundated the roads leading into town to a depth of two to three feet. In the downtown area of Greensboro water depths were as much as eight feet.

The September 1935 hurricane did not generate high tidal surges, but the 13 inches of rainfall which it deposited in the area over a 3-day period caused serious flood problems in many areas of Caroline County. The total rainfall for the month of September 1935, of 15.65 inches, is one of the highest recorded at Denton, and was not exceeded until 1967. Like the 1933 storm, the damage caused by the 1935 storm in Denton was limited to the flooding of cellars and the inundation of the Route 404 causeway. The stage generated by the 1935 storm at the Central Avenue bridge in Federalsburg is estimated by the USACE to have been 17.8 feet. During this storm the dam on Smithville Ditch broke. Total stormwater damage in Federalsburg was more than $200,000. This storm produced a flood stage of 17.4 feet above mean sea level (msl) and damages estimated to be half a million dollars. The USACE has established 10.0 feet msl as the elevation at which serious flood damages begin at Federalsburg. This 10.0 foot stage has been equaled or exceeded six times since 1876. In Greensboro, the floodwaters inundated the town pumping station, the Maryland Route 314 bridge, and numerous homes and businesses. The depth of water was 12 to 13 feet above the regular high-water marks.

Hurricanes Connie and Diane in August 1955 brought flooding to the Caroline County area. The rainfall over a 24-hour period varied from approximately 5 inches in the northwestern fringes of the county to about 8.6 inches at Blackwater, southwest of the county. The tidal surges generated in the Chesapeake Bay by Connie (August 11-13, 1955) were approximately 1 to 2 feet below the surges generated by the 1933 hurricane. Winds over the bay area varied from 35 to 45 mph. However, Diane and Connie caused little or no major flooding in Greensboro.

The 1958 storm climaxed a four month period of abnormally heavy rainfall and consequently led to flooding problems.

Hurricane Donna, of September 1960, generated 4 to 6 inches of rainfall in areas just northwest of Caroline County. The runoff generated by these rains was the second highest recorded at the Matthews gage on Beaverdam Creek and at the Greensboro gage on the Choptank River and the fourth highest recorded on Marshy Hope Creek at Adamsville.

In November of 1966, strong northwest winds and abnormally high spring tides led to the flooding of Maryland Route 404 at Denton.

A series of four high-intensity thunderstorms occurred in August 1967. In the August 3-5 storm, the area of heaviest rainfall was concentrated in northern Caroline County, just north of Denton. This area was subjected to rainfall of 10 or more inches. Most other areas in the county received from 6 to 10 inches of rainfall in the same 3-day period. The second storm, occurring on August 9-10, affected primarily the northern counties in Maryland. The third storm was concentrated over the Dorchester County area and Federalsburg. During the period of August 18-25, Caroline County received approximately 4 inches of rainfall. The fourth storm that month was concentrated in the area northeast of Baltimore. These four thunderstorms caused widespread damage in Caroline County. Severe damage done by these storms to highways and other public property was estimated at $125,000. The majority of the damage was to highway structures and embankments. Federalsburg, next to Marshy Hope Creek, had floodwater elevations at the Central Avenue bridge estimated by the USACE at 9.5 feet. The damage to private property in Federalsburg was estimated at $150,000. The 1967 storm broke most rainfall records in the county established by the hurricanes of August 1955. On August 4 the gage at Greensboro registered the highest runoff to date at that gage. In the Town of Greensboro Major Robert D. Miedl reported that the Choptank River had extended beyond the riverbanks flooding 15 buildings. The depth of water in some areas was measured at five feet.

Tropical Storm Agnes in 1972 deposited approximately 4 inches of rainfall in most areas of Caroline County. According to the Greensboro gage, the runoff generated by this storm has been exceeded by five other storms prior to this storm event and by seventeen other storms, subsequently. Nevertheless, the storm generated local flooding problems. The floodwater elevation in the low overbank area of the Choptank River east of the State Route 404 bridge at Denton was measured by the Maryland State Highway Administration at approximately 4 feet.

In July 1975, a week of heavy rains saturated the ground and generated high runoff. On Marshy Hope Creek, the gages at Adamsville and Faulkner Branch recorded the highest runoff to date. The Town of Federalsburg experienced flooding problems which were aggravated by the gradual breach of the dam at Smithville Lake. On the Choptank River, the flow at the Greensboro gage exceeded that generated by Tropical

Storm Agnes in 1972. The 1975 peak flow was exceeded in 1999 by Hurricane Floyd, and again in 2011 by Hurricane Irene.

On September 16, 1999, Hurricane Floyd battered the Maryland Eastern Shore and brought with it torrential rains and damaging winds. The hurricane caused widespread flash flooding as storm totals averaged around ten inches, most of which fell in a twelve hour period from the early morning through the afternoon on the 16th. The torrential downpours associated with Hurricane Floyd exceeded the 100-year-flood return period for most of the Eastern Shore. Hundreds of roads and bridges were closed. While the highest wind gusts in most areas were less than 60 mph, the combination of the heavy rain that loosened the ground and the persistence of the strong winds uprooted hundreds of trees across the Eastern Shore. Fifty-five roads were closed during the height of the storm including major roadways such as U.S. Route 50 and Maryland State Routes 213, 291, 300, 304 and 313. In Caroline County, towns near rivers (Denton, Federalsburg, Greensboro and Hillsboro) bore the brunt of the damage. Six roads and thirty bridges were in need of repairs. About 20 people were in shelters throughout the county. A dam break near Harmony closed Maryland State Route 16. Other dam failures or spillovers occurred on Lake Bonnie near Goldsboro, Crouse Mill in Tuckahoe State Park and Chambers Lake near Federalsburg. Three schools suffered water damage. Large pieces of roadways collapsed on Maryland State Route 480 and Second Street in Denton. Infrastructure damage alone was estimated as high as 2.5 million. A truck driver was injured when his vehicle overturned on a flooded Maryland State Route 312. Another effect of Floyd was a boom in the mosquito population throughout the Middle Atlantic States.

On June 17, 2001, showers and thunderstorms associated with the remnants of Tropical Storm Allison dropped heavy rain across Caroline County during the early morning. The heavy rain caused flash flooding of streams as well as damage to crops in the county. Forty-one roads had washouts and eleven roads were closed. Three roads remained closed into the start of the work week (the 18th) and one bridge needed to be inspected for possible damage. Five percent of the agricultural land within the county was damaged by the flooding. No serious injuries were reported. Storm totals included 7.50 inches in Denton, 5.80 inches in American Corner and 4.80 inches in Federalsburg.

On September 18, 2003, Tropical Storm Isabel caused a record breaking tide and storm surge up the Chesapeake Bay, heavy rain and strong power outage producing winds. Isabel made landfall as a hurricane near Drum Inlet, North Carolina around 10 p.m. EDT on the 18th and weakened as it tracked farther inland. At one time in its life cycle, it was a powerful Category 5 hurricane when it was north of the Leewood Islands. Isabel's track took it west of the bay and was able to funnel water into the bay. The surge was so strong that it negated the normal tide cycle in the bay. Evacuations occurred near the bay. Winds gusted up to 58 mph in the bay and caused numerous trees, tree limbs and power lines to be knocked down. This was one of the worst power outage events in history for Conectiv Energy. Overall about 148,000 of the 187,000 of Conectiv Energy's customers lost power. About three-quarters of the power was restored by the 20th and the rest by the 25th. Peak wind gusts included 58 mph in Cambridge (Dorchester County), 55 mph at the Baltimore-Washington International Airport and 44 mph in Tolchester Beach (Kent County). Storm totals included 3.40 inches in Federalsburg, and 3.13 inches in Denton.

On June 25, 2006, repeating thunderstorms with torrential downpours dropped up to around one foot of rain across southern parts of Caroline County. This caused extensive roadway, field and stream flooding. Hardest hit was Federalsburg where 11.5 inches of rain fell. An emergency was declared the morning of the 25th. About 40 people were evacuated along the Marshy Hope Creek where the worst flooding occurred. All were permitted to return except for people on the east side of Main Street. Flooding along the Marshy Hope Creek destroyed Railroad Avenue and badly damaged the tracks of the Maryland and Delaware Railroad Line. Over a dozen roads were closed in the county including the Central Avenue Bridge in Federalsburg. Three roads were still closed on the 29th. Railroad Avenue was repaired to the point that it was reopened on the 30th. The elementary school in Federalsburg suffered minor damage. Schools were closed throughout the week mainly because of closed roads. The heavy rain caused agricultural damage which ranged from fifteen to forty-five percent losses. The hardest hit crops were cucumbers. Damage also occurred to the wheat crop and early corn and soybean plants drowned. Chicken houses also were flooded. Flooding forced the postponement of the Greensboro Carnival. President George W. Bush declared Caroline County a disaster area.

On April 15, 2007 in Federalsburg, an intense nor'easter brought heavy rain and flooding to the Maryland Eastern Shore and strong winds to the region on the 16th. Rain began falling during the evening on the 14th, but fell at its heaviest from about Midnight EDT through about 3 p.m. EDT on the 15th. The rain ended before sunrise during the early morning of the 16th. Event precipitation totals averaged between 3 and 6 inches. The strongest winds occurred as the nor'easter pulled northeast of the region on the 16th from the early morning into the afternoon. Peak wind gusts averaged around 50 mph. Elsewhere similar flooding conditions occurred as mainly poor drainage, yard and field flooding was reported. The gusty northwest winds on Monday the 16th caused scattered power outages for both Delmarva Power and Choptank Electric Cooperative. Storm totals included 5.63 inches in American Corner and 3.80 inches in Federalsburg. Peak wind gusts included 54 mph in Salisbury (Dorchester County), 53 mph at the Baltimore-Washington International Airport, 48 mph in Easton (Talbot County), and 46 mph in Tolchester Beach (Kent County).

On September 6, 2008, Tropical Storm Hanna brought heavy rain, strong winds and some tidal flooding to the Eastern Shore during the day and into the evening. Rain moved into the region during the morning, fell heavy at times from the late morning into the afternoon and ended during the evening. The strongest winds occurred during the morning and afternoon with peak gusts as high as 56 mph. About 10,000 homes and businesses lost power on the Delmarva Peninsula. All power was restored by the 7th. Tidal flooding occurred during the early evening as the surge averaged two to three feet and affected mainly Talbot and Caroline Counties. In Caroline County, tidal flooding expanded into the Choptank River and flooded Crouse Park in Denton. Peak wind gusts included 37 mph in Ridgely (Caroline County). Precipitation totals included 1.99 inches in American Corner and 1.61 inches in Denton. The tide at Cambridge (Dorchester County) peaked at 4.36 feet above mean lower low water at 736 p.m. EDT on the 6th. Minor tidal flooding starts at 3.5 feet above mean lower low water and moderate tidal flooding starts at 4.5 feet above mean lower low water. The storm surge was estimated to reach 4 feet above normal in the Choptank River in Caroline County.

On August 22, 2009, torrential downpours from nearly stationary thunderstorms caused major damage to several roads and properties in Ridgely, Greensboro and Goldsboro in Caroline County. A rainfall measurement from Ridgely came in with a storm total of 9.55 inches of rain through 7 a.m. EDT on the 22nd. In Ridgely, seven roads including Maryland State Road 480 were closed due to flooding and three (Central Avenue, Holly Road and Peaviner Road) of them are expected to be closed for a while due to roadway damage. A restaurant on State Route 480 was damaged. A Maryland Avenue home suffered a partial wall collapse and major basement flooding. At least one water rescue was performed. Muscachie Farm was flooded. In Greensboro, the Choptank River flooded and closed Choptank River Road. Two roads were closed in Goldsboro and Maryland State Route 311 was damaged in Henderson.

On August 28, 2011, Hurricane Irene produced heavy flooding rain, tropical storm force wind gusts and caused one wind related death across the Eastern Shore. Preliminary damage estimates were around three million dollars and approximately 85,000 homes and businesses lost power. Power was not fully restored until September 1st. The combination of heavy rain and wind closed numerous roadways across the Eastern Shore and downed thousands of trees. Some schools were unable to open on Monday August 29th. There was a temporary ban on harvesting shellfish along Chesapeake Bay because of the excessive runoff. Some tomato, corn, watermelon and cantaloupe crops were destroyed. It was estimated that 30,000 chickens were also killed by the effects of Irene. Tropical storm force wind gusts overspread the Eastern Shore during the afternoon and early evening of the 27th and persisted into the afternoon of the 28th. Peak wind gusts averaged 50 to 60 mph. The strongest winds associated with Irene occurred at two distinct times. The first surge occurred during bands of heavier rain during the evening and late night of the 27th. The second peak occurred during the late morning and early afternoon of the 28th when skies were clearing and deeper mixing of the atmosphere brought stronger winds to the ground. The rain associated with Irene overspread the Eastern Shore between 7 a.m. EDT and Noon EDT on the 27th, fell at its heaviest from the late afternoon of the 27th into the early morning of the 28th and ended around Noon EDT on the 28th. Event precipitation totals averaged 6 to 12 inches and caused widespread field and roadway flooding. Because the flash flooding and flooding blended into one, all flooding related county entries were combined into one under flood events. On August 25, Maryland Governor Martin O'Malley declared a state of emergency in preparation for Irene. The Chesapeake Bay Bridge was closed to vehicular traffic. In Caroline County, about two dozen homes and businesses were damaged by flooding and wind. Flooding occurred along the Choptank River in Greensboro. Flooding also occurred along the Marshy Hope Creek in Federalsburg. Flooding rains forced the closure of sections of Maryland State Routes 313, 619, 314 and 480. In all the combination of wind and flooding rain closed twenty roadways in the county. Auction Road near Harmony was hardest hit and took weeks to re-open. Event rainfall totals included 11.68 inches in Denton, 10.50 inches in Hickman and 9.58 inches in Greensboro.

On October 29-30, 2012, Hurricane Sandy devastated portions of the Caribbean, Mid-Atlantic and Northeastern United States. Sandy is estimated in early calculations to have caused damage of at least $20 billion (2012 USD). Preliminary estimate of losses that included business interruption surpass $50 billion (2102 USD), behind only Hurricane Katrina (Reference 15).

Sandy developed from a tropical wave in the western Caribbean Sea on October 22, quickly strengthened and was upgraded to Tropical Storm Sandy six hours later. Sandy moved slowly northward toward the Greater Antilles and gradually intensified. On October 24, Sandy became a hurricane, made landfall near Kingston, Jamaica, a few hours later, re-emerged into the Caribbean Sea and strengthened into a Category 2 hurricane. On October 25, Sandy hit Cuba, then weakened to a to Category 1 hurricane. Early on October 26, Sandy moved through the Bahamas. On October 27, Sandy briefly weakened to a tropical storm and then restrengthened to a Category 1 hurricane. Early on October 29, Sandy curved north-northwest and then moved ashore near Atlantic City, New Jersey. In the United States, Hurricane Sandy affected at least 24 states, from Florida to Maine and west to Michigan and Wisconsin, with particularly severe damage in New Jersey and New York. Its storm surge hit New York City on October 29, flooding streets, tunnels and subway lines and cutting power in and around the city (Reference 16).

In Maryland, at least 100 feet of a fishing pier in Ocean City was destroyed. Governor Martin O'Malley said the pier is "half-gone." Due to high winds, the Chesapeake Bay Bridge and the Millard E. Tydings Memorial Bridge on I-95 were closed. During the storm, the Mayor of Salisbury instituted a Civil Emergency and a curfew.

In Caroline County, about 30 roads were closed, 2,000 residents were without power and residents of one village were under an advisory to boil water for health concerns, but overall, the county fared well during Hurricane Sandy. The Marshy Hope Creek in Federalsburg overflowed its banks during the storm. Federalsburg Recreation Park and Marina was closed and underwater. The G. Daniel Crouse Memorial Park in Denton was closed after the Choptank River overflowed its banks during the storm. Choptank Electric Cooperative said about 2,000 customers were without power as of noon, down from a peak of 2,684 customers at 10 a.m. the same day (Tuesday, October 30). Restoration crews hit the road at 6 a.m. Tuesday, and line crews, including 117 visiting crew members from contractors and co-ops in Tennessee, Alabama and Georgia, got to work soon after. There were a lot of trees down, poles down and wires down, and flooding keeping restoration crews out of some areas. At the peak of the storm, 13,160 Delmarva Power customers were without power between 11 p.m. and midnight Monday in the entire Centreville district, which includes Caroline, Queen Anne's, Talbot and Kent counties (Reference 17).

2.4 Flood Protection Measures

The Soil Conservation Service (SCS, now the Natural Resources Conservation Service, NRCS) proposed and initiated a number of watershed improvement plans in Caroline County. The projects included the Upper Choptank River Watershed Improvement Plan, the Goldsboro Watershed Improvement Plan, and the Forge Branch Watershed Plan. The funding for these projects was under the Maryland Public Law for small watershed programs, PL 83-566. The projects by SCS under the aforementioned law involved conservation land treatment and channel improvement. However, it should be noted that the prime function of these SCS projects was to alleviate local drainage problems. These projects had a negligible effect on the water-surface profiles on the Choptank River at Denton.

The Upper Choptank River Watershed Improvements Plan provided for conservation land treatment of 46,636 acres, and for 280 miles of channel work, to alleviate drainage problems. The Goldsboro Watershed Project provided for 1,960 acres of land treatment and 53.9 miles of channel improvements. The Forge Branch Watershed Project provided for development of farm drainage systems and channel improvements (References 18 and 19).

Watershed and flood protection programs that were funded under PL 83-566 of 1954 and were completed by the mid 1980's (Reference 20).

The SCS Work Plan for the Marshy Hope Creek Watershed provided for land treatment and for 458 miles of channel improvements. Included is the channelization of 9,000 feet of Marshy Hope Creek through Federalsburg, which was completed. As part of a general plan for channel improvement in the watershed, an economical, hydraulically effective flood prevention channel was constructed. At flood times, such as during record storm events, the flood prevention channel conveys, controls, and disposes of surface water that is potentially affected by the upstream channel improvements. In addition to providing flood protection, the trapezoidal earthen channel through Federalsburg is a major component of the improved water control system serving the 780 farms in the watershed. The SCS "Work Plan for the Marshy Hope Watershed," describes the basic effect of such works as an increase in net income from crop production" stemming from more efficient and expanded development of the watershed farm lands (References 21 and 22). This project, which was authorized by Congress in 1964, was completed in 1983 (Reference 20).

A Review Report covering the Nanticoke River and tributaries, and focusing on Marshy Hope Creek at Federalsburg, was prepared by USACE, Baltimore District, in February 1974, to determine the economic feasibility of flood control protection measures for the Town of Federalsburg. For the report, USACE took field studies using damage and real estate surveys; USACE assessed the extent and magnitude of damages with respect to flood levels and evaluated costs to land and property enhancement. The SCS supplied plans of the improved channel through Federalsburg, which were constructed as part of the drainage improvement in the basin. These plans included logs of subsurface exploration and as-built cross sections of the channel and the overbank (Reference 23).

In addition, the USACE completed (a) an analysis of the economic development of the area, (b) a study of the storm and flood history of the area, (c) hydraulic studies of Marshy Hope Creek in the Federalsburg vicinity under existing conditions, (d) hydraulic studies to determine the effects and feasibility of possible local protection or channel improvement projects, and (e) design and cost estimates of various improvement works and studies to determine the economic justification of such works. Solutions considered included reservoirs, diversions, channel improvements, levees, and various non-structural alternatives. Four levee plans were investigated with two levels of protection making a total of eight actual plans with associated interior drainage facilities. It was concluded that a flood control project along Marshy Hope Creek could not be constructed at a cost commensurate with the anticipated tangible benefits (Reference 23).

More recent flood protection measures have involved dealing with properties that have suffered repetitive losses under the NFIP program. The strategy is to eliminate or reduce the damage to property and the disruption of life caused by repeated flooding of the same properties. One solution is to buy up the properties and avoid repeated flooding of these structures. Depending on the severity of flooding at these locations, another possibility is to mitigate the structure so it is well above the base flood elevation (Reference 24).

Acquiring buildings and removing them from the floodplain is not only the most effective flood protection measure available, it is also a way to convert a problem area into a community asset and obtain environmental benefits. For example relocation, acquisition of buildings in a floodprone area ensures that the buildings will no longer be subject to damage. The major difference is that acquisition is undertaken by a government agency, so the cost is not borne by the property owner, and the land may be converted to a public use, such as a park (Reference 24).

Many roads in the county have flooding issues. Road closures impact evacuation routes and access to neighborhoods, and to critical and public facilities. Out of the 45 roads identified as having significant flooding issues, three roads were determined by the Caroline County Hazard Mitigation Planning Committee (HMPC) to be of high importance for mitigation: Seventh at Sunnyside Avenue in Federalsburg; River Road by the High School; and Old Denton Road at the bridge. Including these three road projects in the County's Capital Improvement Plan could provide funding to undertake this mitigation strategy and achieve flood protection of major evacuation routes (Reference 24).

There are presently no flood control structures or future plans for structures on the rivers studied in detail which would have an effect on the base flood water-surface elevations computed for this study.

3.0 ENGINEERING METHODS

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

3.1 Hydrologic Analyses

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

All streams studied by detailed methods received updated hydrologic and hydraulic data as part as this revision. Coastal areas along the Chesapeake Bay, and all tidal inlets, including tidal flooding on the Choptank River and Tuckahoe Creek were studied in the FEMA Region III Coastal Analysis and Mapping Study. The new hydrologic analysis calculated revised 10-, 2-, 1- and 0.2-percent annual chance flows. For this FIS update, flows were also established for streams studied using approximate methods.

In 1996, a set of regression equations for the state of Maryland were developed by Jonathan Dillow, a hydrologist for the USGS. Dillow defined regression equations for five physiographic regions: Appalachian Plateaus and Allegheny Ridges, Blue Ridge and Great Valley, Piedmont, Western Coastal Plain and Eastern Coastal Plain (References 25, 26 and 27). These equations were used by the Maryland State Highway Administration.

The Maryland Department of Environment contracted Dr. Glenn Moglen of the Department of Civil and Environmental Engineering at the University of Maryland to perform the updated hydrologic calculations for this FIS reports (Reference 25).

In 2006, Dr. Moglen developed a new set of regression equations for the State of Maryland based on the original Dillow regions. These equations were subsequently updated in 2010 using additional hydrologic data. The fixed region method used in the 2010 study is also based on the predefined physiographic regions of Dillow. Worcester County is located within the Eastern Coastal Plain. The 10-, 2-, 1-, and 0.2-percent annual chance flows used in this FIS update were calculated based on the 2010 equations.

The fixed region regression equations for the Eastern Coastal Plain Region are based on 28 stations in Maryland and Delaware with drainage area (DA) ranging from 0.91 to 113.7 square miles, percent A soils (S_A) ranging from 0.0 to 78.8 percent, and land slope (LSLOPE) ranging from 0.00250 to 0.0160 ft/ft.

Equations applicable to this report, along with their standard error of estimate in percent, and equivalent years of record are listed in Table 4, "Eastern Coastal Plain Fixed Regional Regression Equations" (Reference 27).

TABLE 4 – EASTERN COASTAL PLAIN
FIXED REGION REGRESSION EQUATIONS

Eastern Coastal Plain Fixed Region Regression Equation	Standard Error (percent)	Equivalent Years of Record
$Q_{10} = 924.3\ DA^{0.844} (S_A + 1)^{-0.196}\ LSLOPE^{0.445}$	36.7	9.7
$Q_{50} = 2941.5\ DA^{0.824} (S_A + 1)^{-0.222}\ LSLOPE^{0.531}$	41.6	15
$Q_{100} = 4432.9\ DA^{0.812} (S_A + 1)^{-0.230}\ LSLOPE^{0.557}$	44.2	17
$Q_{500} = 10{,}587\ DA^{0.783} (S_A + 1)^{-0.247}\ LSLOPE^{0.610}$	51.6	19

All calculations using the fixed region regression equations were initially performed with GISHydro2000. GISHydro is a computer program used to assemble and evaluate hydrologic models for watershed analysis. Originally developed in the mid-1980s, the program combines a database of terrain, land use, and soils data with specialized GIS tools for assembling data and extracting model parameters. The primary purpose of the GISHydro program is to assist engineers in performing watershed analyses in the State of Maryland. In the fall of 1997, a collaborative project between the Department of Civil and Environmental Engineering at the University of Maryland and the Maryland State Highway Administration updated and enhanced GISHydro into GISHydro2000.

AMEC used the drainage point locations developed by Moglen in GISHydro2000 to recompute the flows with the new 2010 equations using ArcGIS geoprocessing tools.

It should also be emphasized that these regression equations, although not developed by the USGS, provide better standard error performance than the current USGS regression equations for Maryland. These equations were endorsed for use in Maryland by the Maryland Hydrology Panel as documented in their report which can be obtained from the Maryland State Highway Administration (Reference 27).

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

TABLE 5 - SUMMARY OF DISCHARGES

		PEAK DISCHARGES (cubic feet per second)			
FLOODING SOURCE AND LOCATION	DRAINAGE AREA (sq. miles)	10% Annual-Chance	2% Annual-Chance	1% Annual-Chance	0.2% Annual-Chance
BROADWAY BRANCH					
Approximately 2,200 feet downstream of the confluence with Oldtown branch	11.07	547	1,020	1,289	2,127
Approximately 500 feet upstream of the confluence with Oldtown Branch	6.35	304	561	710	1,175
Approximately 700 feet downstream of Sandtown Road	5.76	274	505	639	1,058
Approximately 2,100 feet upstream of Sandtown Road	5.42	252	462	583	964
Approximately 2,700 feet upstream of Sandtown Road	4.99	229	420	530	876
Approximately 4,350 feet downstream of Henderson Road	4.49	205	376	474	785
Approximately 3,425 feet downstream of Henderson Road	4.05	183	334	422	698

TABLE 5 - SUMMARY OF DISCHARGES (continued)

FLOODING SOURCE AND LOCATION	DRAINAGE AREA (sq. miles)	PEAK DISCHARGES (cubic feet per second) 10% Annual-Chance	2% Annual-Chance	1% Annual-Chance	0.2% Annual-Chance
BROADWAY BRANCH (continued)					
Approximately 255 feet upstream of Henderson Road	3.87	175	320	404	668
CHAPEL BRANCH					
Approximately 4,580 feet upstream of Greensboro Road	14.86	688	1,284	1,620	2,657
Approximately 110 feet downstream of Garland Road	13.39	617	1,149	1,450	2,381
CHOPTANK RIVER					
Approximately 4,800 feet downstream of the confluence with Marsh Creek	511.89	13,714	23,962	29,018	43,086
Approximately 2,650 feet upstream of the confluence with Skeleton Creek	482.75	12,737	22,184	26,848	39,823
Approximately 6,350 feet upstream of the confluence with Tributary No. 3 Choptank	460.13	11,825	20,479	24,749	36,611
Approximately 5,340 feet downstream of the confluence with Crowberry Creek	438.24	11,178	19,329	23,355	34,544
Approximately 830 feet downstream of the confluence with Fowling Creek	261.28	7,105	12,402	15,074	22,615

TABLE 5 - SUMMARY OF DISCHARGES (continued)

FLOODING SOURCE AND LOCATION	DRAINAGE AREA (sq. miles)	PEAK DISCHARGES (cubic feet per second) 10% Annual-Chance	2% Annual-Chance	1% Annual-Chance	0.2% Annual-Chance
CHOPTANK RIVER (continued)					
Approximately 2,115 feet downstream of the confluence with Robins Creek	252.81	6,955	12,158	14,788	22,220
At the end of Pealiquor Landing Drive	229.41	6,400	11,204	13,641	20,548
Approximately 11,100 feet downstrea of Market Street	207.53	5,770	10,092	12,291	18,533
Approximately 3,600 feet upstream of Shore Highway	196.67	5,577	9,774	11,916	18,008
Approcimately 5,150 feet upstream of the confluence with Tributary No. 2 Choptank	177.11	5,086	8,924	10,890	16,499
Approximatey 360 feet downstream of the confluence with Forge Branch	163.00	5,017	8,675	10,545	15,844
Approximately 70 feet downstream of the confluence with Forge Branch	144.03	5,017	8,325	9,943	14,461
Approximately 230 feet downstream of the confluence with Gravelly Branch	137.08	5,017	8,325	9,943	14,344
Approximately 9,500 feet upstream of the confluence with Gravelly Branch	118.73	4,868	7,782	9,110	12,774
At upward most stream point	104.73	4,327	7,042	8,347	11,820

TABLE 5 - SUMMARY OF DISCHARGES (continued)

FLOODING SOURCE AND LOCATION	DRAINAGE AREA (sq. miles)	PEAK DISCHARGES (cubic feet per second) 10% Annual-Chance	2% Annual-Chance	1% Annual-Chance	0.2% Annual-Chance
HENDERSON CREEK					
Approximately 900 feet downstream of Wolf Road	1.57	94	180	233	404
Approximately 500 feet upstream of Wolf Road	1.43	82	158	203	351
HERRING RUN					
Approximately 50 feet upstream of Double Hills Road	6.52	437	853	1,097	1,880
Approximately 2,500 feet downstream of Legion Road	5.88	357	684	874	1,482
Approximately 1,350 feet downstream of Legion Road	5.32	321	613	784	1,330
Approximately 1,100 feet upstream of Legion Road	4.89	281	532	678	1,145
Approximately 275 feet upstream of Anderson Road	4.35	245	460	586	987
HUNTING CREEK					
Approximately 9,000 feet upstream Blades Road Bridge	24.03	1,129	2,159	2,736	4,515
Approximately 8,000 feet downstream of Back Landing Road	22.85	1,083	2,071	2,626	4,339
Approximately 730 feet downstream of Back Landing Road	20.57	977	1,868	2,369	3,918
Approximately 3,100 feet upstream of Back Landing Road	10.78	667	1,319	1,698	2,902

TABLE 5 - SUMMARY OF DISCHARGES (continued)

FLOODING SOURCE AND LOCATION	DRAINAGE AREA (sq. miles)	PEAK DISCHARGES (cubic feet per second) 10% Annual-Chance	2% Annual-Chance	1% Annual-Chance	0.2% Annual-Chance
HUNTING CREEK (continued)					
Approximately 5,730 feet upstream of Back Landing Road	9.75	638	1,270	1,638	2,816
Approximately 450 feet downstream of Preston Road	8.68	567	1,128	1,455	2,504
Approximately 1,850 feet upstream of Preston Road	6.97	450	892	1,151	1,984
MARSHY HOPE CREEK					
Approximately 4,600 feet downstream of Fredricksburg Hwy	160.51	4,754	8,386	10,256	15,614
Approximately 150 feet downstream of the confluence with Faulkner Branch	150.21	4,586	8,116	9,939	15,181
Approximately 300 feet upstream of the confluence with Faulkner Branch	139.63	4,374	7,777	9,542	14,634
Approximately 175 feet upstream of the confluence with Twiford Meadow Ditch	131.62	4,189	7,458	9,156	14,070
Approximately 375 feet upstream of the confluence with Sullivan Branch	123.01	3,946	7,034	8,643	13,305
Aproximately 275 feet upstream of the confluence with Houston Branch	111.20	3,711	6,653	8,193	12,679

TABLE 5 - SUMMARY OF DISCHARGES (continued)

FLOODING SOURCE AND LOCATION	DRAINAGE AREA (sq. miles)	PEAK DISCHARGES (cubic feet per second) 10% Annual-Chance	2% Annual-Chance	1% Annual-Chance	0.2% Annual-Chance
MARSHY HOPE CREEK (continued)					
Approximately 6,100 feet upstream of the confluence with Houston Branch	109.24	3,675	6,593	8,124	12,582
Approximately 5,300 feet downstream of Noble Road	107.90	3,444	6,115	7,511	11,561
Approximately 5,600 feet downstream of Noble Road	95.85	3,066	5,444	6,692	10,322
MILES BRANCH					
Approximately 800 feet downstream of Wright Road	1.33	92	180	233	409
At Wright Road	0.97	82	165	216	388
SMITHVILLE DITCH					
Approximately 700 feet upstream of Bloomery Road	11.82	708	1,364	1,740	2,926
Approximately 1,000 feet upstream of Bloomery Road	9.91	605	1,168	1,493	2,521
TANYARD BRANCH					
At downward most stream point	5.16	200	366	461	758
Approximately 1,150 feet downstream of Central Avenue	4.66	182	331	417	685
Approximately 2,000 feet downstream of Liberty Road	3.97	169	310	391	647

TABLE 5 - SUMMARY OF DISCHARGES (continued)

FLOODING SOURCE AND LOCATION	DRAINAGE AREA (sq. miles)	PEAK DISCHARGES (cubic feet per second) 10% Annual-Chance	2% Annual-Chance	1% Annual-Chance	0.2% Annual-Chance
TANYARD BRANCH (continued)					
Approximately 1,400 feet downstream of Liberty Road	3.34	156	287	365	610
Approximately 200 feet upstream of Federalsburg Hwy	3.00	140	258	328	548
Approximately 1,900 feet upstream of Federalsburg Hwy	2.74	126	232	295	493
Approximately 2,200 upstream of Federalsburg Hwy	2.44	110	201	255	425
TIDY ISLAND CREEK					
At downward most stream point	36.50	1,531	2,832	3,545	5,699
Approximately 450 feet downstream of the confluence with Coolspring Branch	33.49	1,433	2,658	3,332	5,373
Approximately 1,900 feet upstream of the confluence with Coolspring Branch	30.38	1,360	2,540	3,192	5,178
Approximately 2,300 feet upstream of the confluence with Coolspring Branch	29.66	1,345	2,518	3,167	5,147
WATTS CREEK					
Approximately 650 feet downstream of Shore Hwy	20.02	1,083	2,064	2,616	4,330
Approximately 650 feet upstream of Shore Hwy	13.37	749	1,434	1,824	3,048

TABLE 5 - SUMMARY OF DISCHARGES (continued)

FLOODING SOURCE AND LOCATION	DRAINAGE AREA (sq. miles)	PEAK DISCHARGES (cubic feet per second) 10% Annual-Chance	2% Annual-Chance	1% Annual-Chance	0.2% Annual-Chance
WATTS CREEK (continued)					
Approximately 4,500 feet upstream of Legion Road	12.1	655	1,240	1,574	2,617
Approximately 2,150 feet downstream of Hobbs Road	11.48	613	1,157	1,467	2,437

The stillwater elevations have been determined for the 10-, 2-, 1-, and 0.2-percent annual floods for the Choptank River and is summarized in Table 6, "Summary of Stillwater Elevations."

TABLE 6 - SUMMARY OF STILLWATER ELEVATIONS

FLOODING SOURCE AND LOCATION	ELEVATION (feet) NAVD88 10-Percent-Annual-Chance	2-Percent-Annual-Chance	1-Percent-Annual-Chance	0.2-Percent-Annual-Chance
CHOPTANK RIVER				
At confluence of Hunting Creek	4.0	4.8	5.2	6.2

*North American Vertical Datum of 1988

3.2 Hydraulic Analyses

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

During periods of peak flow, flood elevations in the vicinity of bridges and culverts are often increased by ice jams, debris blockage, and other obstructions to flow. The hydraulic analyses for this study, however, are based on the effects of unobstructed flow. The flood elevations shown on the profiles are valid only if hydraulic structures remain unobstructed, and dams and other flood control structures operate properly and do not fail.

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

This FIS is a restudy of all flood hazards identified on the effective FIRMs as listed in Table 9, "Community Map History."

Streams studied by detailed methods on the effective FIRM were to be restudied in detail while approximate effective streams were to be improved through enhanced approximate studies. For all of the studies, AMEC used the stream crossing inventory collected by the Maryland Department of the Environment (MDE) and the topographic data developed from LiDAR data for Caroline County to perform the hydraulic analyses. For detailed studies, AMEC also extracted channel data from the effective hydraulic models and incorporated it where appropriate. The hydraulic analyses were used to establish flood elevations and regulatory floodways for the subject flooding sources.

Detailed hydraulic models include water-surface profile development for the 10-percent (10-year), 2-percent (50-year), 1-percent (100-year) and 0.2-percent (500-year) annual chance floods and floodway. Enhanced approximate models include only the 1-percent annual chance flood and do not include flood profile or floodway development.

Water-surface elevations for floods of the selected recurrence intervals were computed through use of the USACE's HEC-RAS (Version 4.1) step-backwater computer program (Reference 28).

Starting water-surface elevations for Broadway Branch, Chapel Branch, Henderson Creek, Herring Run, Hunting Creek, Miles Branch, Smithville Ditch, Tanyard Branch and Watts Creek were computed by normal depth calculations. The starting surface-water elevations for three streams were computed by known water-surface elevations: Choptank River (1.51 feet); Marshy Hope Creek (9.72 feet); and Tidy Island Creek (37.37 feet).

The 2003 and 2006 LiDAR mass points provided by the National Oceanic and Atmospheric Administration (NOAA) were used to generate DEMs that served as the terrain basis for detailed and approximate study model data extractions. HEC-RAS (version 4.1) models were created using AMEC-developed automated tools.

The stream centerlines provided by the county were ortho-rectified and aligned with the contours where orthophotos were inconclusive. Cross-sections were placed within ArcGIS at hydraulically significant locations. Stream stationing for each designated reach begins at its outlet.

The DEMs were used to import the cross section data into HEC-RAS model. For streams studied in detail the channel data was extracted from effective HEC-2 hydraulic models and incorporated into the updated hydraulic models, where appropriate. Hydraulic structures were represented using MDE inventory information, aerial photography, and topography to obtain elevation data and structural geometry.

Stream crossings inventoried by MDE were incorporated in HEC-RAS models for detailed and enhanced approximate studies. Since the provided bridge data were not vertically referenced, structures were coded relative to road surface extracted from the terrain data. Inaccessible structures were modeled using data from effective HEC-2 models; otherwise, assumptions were made for structure geometry based on the available data and engineering judgment. The internal Manning's "n" values for stream crossings were adjusted based on the MDE inventory photos.

Channel and overbank roughness factors (Manning's "n" Values) were assigned to each cross section using HEC-RAS Reference Manual Table 3-1 (Reference 28). The aerial photographs and pictures taken by MDE during structure inventory were used to estimate the roughness coefficients. Table 7, "Manning's "n" Values," shows the channel and overbank "n" values for the streams studied by detailed methods.

TABLE 7 – MANNING'S "n" VALUES

Stream	Channel "n"	Overbank "n"
Broadway Branch	0.025-0.040	0.045-0.1
Chapel Branch	0.045-0.065	0.06-0.1
Choptank River	0.045-0.048	0.05-0.1
Henderson Creek	0.032-0.04	0.06-0.1
Herring Run	0.04-0.055	0.04-0.1
Hunting Creek	0.025-0.047	0.06-0.1
Marshy Hope Creek	0.04	0.05-0.1
Miles Branch	0.045	0.045-0.1
Smithville Ditch	0.045	0.1
Tanyard Branch	0.03-0.045	0.06-0.1

TABLE 7 – MANNING'S "n" VALUES (continued)

Stream	Channel "n"	Overbank "n"
Tidy Island Creek	0.04-0.045	0.1
Watts Creek	0.04-0.06	0.05-0.1

Floodways were developed for streams studied by detailed methods. Initially, Encroachment Method 4 was used to obtain equal conveyance reduction on each overbank, if possible. The results were imported into Method 1 and adjusted accordingly to maintain allowable surcharges throughout the study reach.

AMEC developed enhanced approximate floodplain models using their Automated Floodplain Generator (AFG) proprietary software along with ArcGIS v. 10.0. Stream crossing information was included in these approximate models. Despite enhancements to the typical approximate analysis, these models should not be utilized to support the mapping of Base Flood Elevations.

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

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

- Stability A: Monuments of the most reliable nature, expected to hold position/elevation (e.g., mounted in bedrock)
- Stability B: Monuments which generally hold their position/elevation (e.g., concrete bridge abutment)
- Stability C: Monuments which may be affected by surface ground movements (e.g., concrete monument below frost line)
- Stability D: Mark of questionable or unknown vertical stability (e.g., concrete monument above frost line, or steel witness post)

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

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

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

3.3 Coastal Analysis

The FEMA Region III office initiated a study to update the coastal storm surge elevations within the states of Virginia, Maryland, and Delaware, and the District of Columbia including the Atlantic Ocean, Chesapeake Bay including its tributaries, and the Delaware Bay. This effort is one of the most extensive coastal storm surge analyses to date, encompassing coastal floodplains in three states and including the largest estuary in the world. The study will replace outdated coastal storm surge stillwater elevations for all Flood Insurance Studies (FISs) in the study area, and serve as the basis for new coastal hazard analysis and ultimately updated Flood Insurance Rate Maps (FIRMs). Study efforts were initiated in 2008 and concluded in 2011.

This study was conducted for FEMA under Project HSFE03-06-X-0023, “NFIP Coastal Storm Surge Model for Region III” and Project HSFE03-09-X-1108, “Phase II Coastal Storm Surge Model for FEMA Region III.” The US Army Corps of Engineers (USACE) and project partners assisted FEMA in the development and application of a state-of-the-art storm surge risk assessment capability for the FEMA Region III domain which includes the Delaware Bay, Chesapeake Bay, District of Columbia, Delaware-Maryland-Virginia Eastern Shore, Virginia. The work was performed by the Coastal Processes Branch (HF-C) of the Flood and Storm Protection Division (HF), U.S. Army Engineer Research and Development Center – Coastal & Hydraulics Laboratory (ERDC-CHL).

The end-to-end storm surge modeling system includes the Advanced Circulation Model for Oceanic, Coastal and Estuarine Waters (ADCIRC) for simulation of 2-dimensional hydrodynamics. ADCIRC was dynamically coupled to the unstructured numerical wave model Simulating WAves Nearshore (unSWAN) to calculate the contribution of waves to total storm surge. The resulting model system is typically referred to as SWAN+ADCIRC. A seamless modeling grid was developed to support the storm surge modeling efforts. The modeling system validation consisted of a comprehensive tidal calibration followed by a validation using carefully reconstructed wind and pressure fields from three major flood events for the Region III domain: Hurricane Isabel, Hurricane Ernesto, and extratropical storm Ida. Model skill was accessed by quantitative comparison of model output to wind, wave, water level and high water mark observations.

3.4 Vertical Datum

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

All flood elevations shown in this FIS report and on the FIRM are now referenced to NAVD 88. In order to perform this conversion, effective NGVD 29 elevation values were adjusted downward by 0.79 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.

The BFEs shown on the FIRM represent whole-foot rounded values. For example, a BFE of 102.4 will appear as 102 on the FIRM and 102.6 will appear as 103. Therefore, users that wish to convert the elevations in this FIS to NGVD29 should apply the stated conversion factor to elevations shown on the Flood Profiles and supporting data tables in the FIS report, which are shown at a minimum to the nearest 0.1 foot.

NAVD88 + 0.79 = NGVD29

For additional information regarding conversion between the NGVD and NAVD, visit the National Geodetic Survey website (listed below) or contact the National Geodetic Survey at the following address:

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

4.0 FLOODPLAIN MANAGEMENT APPLICATIONS

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

4.1 Floodplain Boundaries

To provide a national standard without regional discrimination, the 1-percent annual chance flood has been adopted by FEMA as the base flood for floodplain management purposes. The 0.2-percent annual chance flood is employed to indicate additional areas of flood risk in the county. For the streams studied in detail, the 1-percent annual chance and 0.2-percent annual chance boundaries have been determined at each cross section. The delineations are based on the best available topographic information and stream channel configurations. Also, floodplain boundaries from the jurisdictions outlined in section 1.1 have been combined in this countywide revision.

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

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

Areas of coastline subject to significant wave attack are referred to as coastal high hazard zones. The USACE has established the 3-foot breaking wave as the criterion for identifying the limit of coastal high hazard zones (Reference 41). The 3-foot wave has been determined the minimum size wave capable of causing major damage to conventional wood frame of brick veneer structures. The one exception to the 3-foot wave criteria is where a primary frontal dune exists. The limit the coastal high hazard area then becomes the landward toe of the primary frontal dune or where a 3-foot or greater breaking wave exists, whichever is most landward. The coastal high hazard zone is depicted on the FIRMs as Zone VE, where the delineated flood hazard includes wave heights equal to or greater than three feet. Zone AE is depicted on the FIRMs where the delineated flood hazard includes wave heights less than three feet. A depiction of how the Zones VE and AE are mapped is shown in Figure 2.

Post-storm field visits and laboratory tests have confirmed that wave heights as small as 1.5 feet can cause significant damage to structures when constructed without consideration to the coastal hazards. Additional flood hazards associated with coastal waves include floating debris, high velocity flow, erosion, and scour which can cause damage to Zone AE-type construction in these coastal areas. To help community officials and property owners recognize this increased potential for damage due to wave action in the AE zone, FEMA issued guidance in December 2008 on identifying and mapping the 1.5-foot wave height line, referred to as the Limit of Moderate Wave Action (LiMWA). While FEMA does not impose floodplain management requirements based on the LiMWA, the LiMWA is provided to help communicate the higher risk that exists in that area. Consequently, it is important to be aware of the area between this inland limit and the Zone VE boundary as it still poses a high risk, though not as high of a risk as Zone VE (see Figure 2).

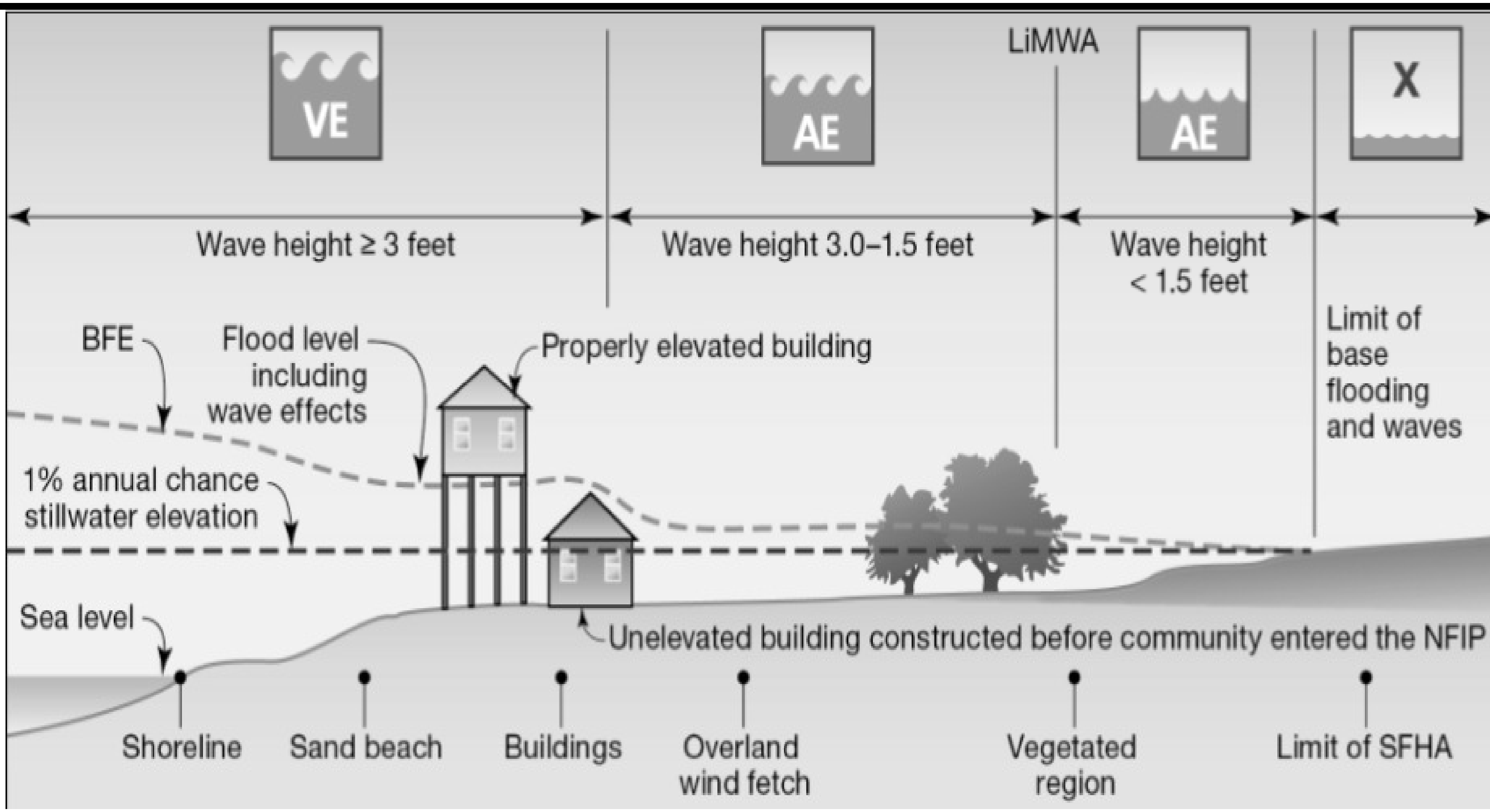

FIGURE 1	FEDERAL EMERGENCY MANAGEMENT AGENCY **CAROLINE COUNTY, MD AND INCORPORATED AREAS**	**TYPICAL TRANSECT SCHEMATIC**

4.2 Floodways

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

The floodways presented in this study were computed on the basis of equal conveyance reduction from each side of the flood plains. The results of these computations are tabulated at selected cross sections for each stream segment for which a floodway is computed (Table 8).

As shown on the FIRM (Exhibit 2), the floodway widths were determined at cross sections; between cross sections, the boundaries were interpolated. In cases where the boundaries of the flood-way and the 1-percent annual chance flood are either close together or collinear, only the floodway boundary has been shown.

Near the mouths of streams studied in detail, floodway computations are made without regard to flood elevations on the receiving water body. Therefore, "With Floodway" elevations presented in Table 8 for certain downstream cross sections of Broadway Branch, Chapel Branch, Henderson Creek, Miles Branch, and Smithville Ditch are lower than the regulatory flood elevations in that area, which must take into account the 1-percent annual chance flooding due to backwater from other sources.

The floodways in this report are recommended to local agencies as minimum standards that can be adopted or that can be used as a basis for additional studies.

The area between the floodway and 1-percent annual chance floodplain boundaries is termed the floodway fringe. The floodway fringe encompasses the portion of the floodplain that could be completely obstructed without increasing the water-surface elevation of the 1-percent annual chance flood by more than 1.0 foot at any point. A floodway was not determined for areas affected by tidal flooding, since a floodway in these areas is not appropriate. Typical relationships between the floodway and the floodway fringe and their significance to floodplain development are shown in Figure 2.

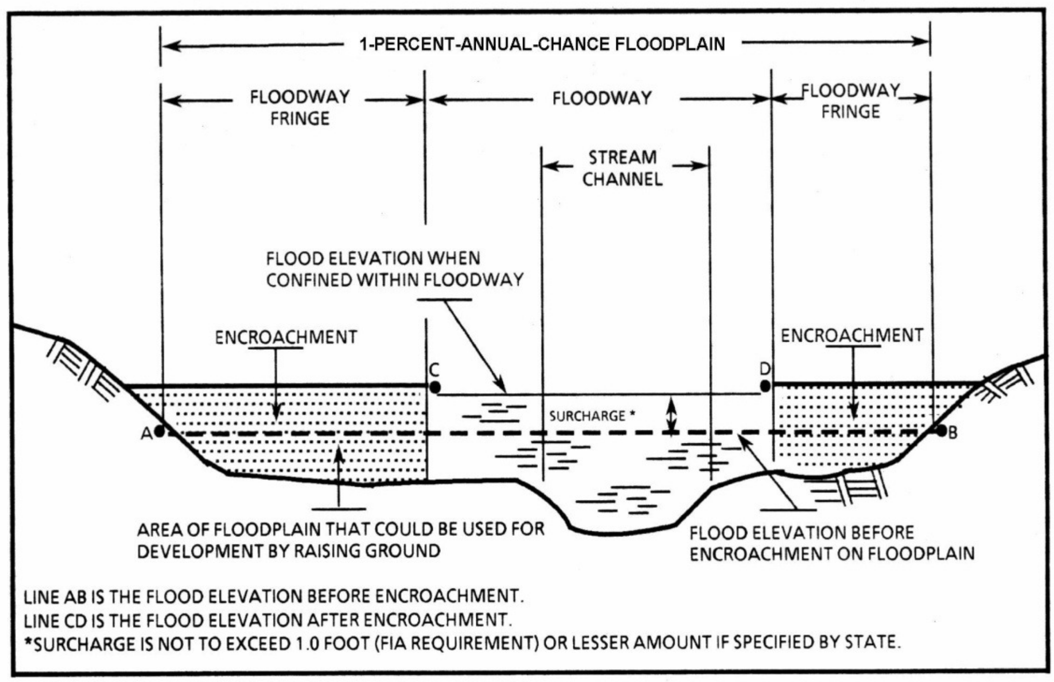

FIGURE 2: FLOODWAY SCHEMATIC

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
A	766	176	473	2.7	19.7	17.1[2]	17.4	0.3
B	1,193	289	767	1.7	19.7	17.9[2]	18.1	0.2
C	1,268	252	626	2.1	19.7	17.9[2]	18.2	0.3
D	1,341	400	1,867	0.7	26.1	26.1	26.4	0.3
E	1,672	383	3,749	0.3	26.1	26.1	26.4	0.3
F	2,738	399	3,022	0.2	26.1	26.1	26.4	0.3
G	3,588	209	1,233	0.6	26.1	26.1	26.4	0.3
H	5,239	218	527	1.3	26.5	26.5	26.9	0.4
I	6,539	153	339	2.1	30.2	30.2	30.6	0.4
J	8,294	279	437	1.5	34.8	34.8	35.0	0.2
K	8,429	198	556	1.1	35.8	35.8	36.2	0.4
L	8,628	60	239	2.7	35.8	35.8	36.2	0.4
M	9,743	44	183	3.5	37.3	37.3	37.8	0.5
N	10,649	85	281	2.1	38.5	38.5	39.0	0.5
O	10,720	68	210	2.8	39.4	39.4	39.9	0.5
P	10,909	50	200	2.9	39.6	39.6	40.1	0.5
Q	11,259	46	174	3.0	40.0	40.0	40.5	0.5
R	13,012	36	167	3.2	42.5	42.5	42.8	0.3
S	15,109	35	142	3.0	46.0	46.0	46.4	0.4
T	16,242	39	156	2.7	47.4	47.4	47.8	0.4
U	16,356	31	146	2.9	47.9	47.9	48.2	0.3

[1] Feet above confluence with Choptank River

[2] Elevations computed without consideration of backwater effects from Choptank River

TABLE 8

FEDERAL EMERGENCY MANAGEMENT AGENCY

CAROLINE COUNTY, MD

AND INCORPORATED AREAS

FLOODWAY DATA

BROADWAY BRANCH

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
V	16,890	44	227	1.9	48.4	48.4	48.7	0.3
W	16,984	33	193	2.2	48.9	48.9	49.5	0.6
X	17,683	30	132	3.2	49.7	49.7	50.3	0.6
Y	18,446	45	251	1.7	50.8	50.8	51.2	0.4
Z	18,594	40	320	1.3	52.7	52.7	53.1	0.4

[1] Feet above confluence with Choptank River

[2] Elevations computed without consideration of backwater effects from Choptank River

TABLE 8

FEDERAL EMERGENCY MANAGEMENT AGENCY

CAROLINE COUNTY, MD

AND INCORPORATED AREAS

FLOODWAY DATA

BROADWAY BRANCH

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
A	1,967	212	849	1.9	7.1	2.1[2]	2.1	0.0
B	4,550	329	856	1.9	7.1	3.1[2]	3.2	0.1
C	6,416	190	807	2.0	7.1	4.1[2]	4.3	0.2
D	7,990	227	1,106	1.5	7.1	5.2[2]	5.6	0.4
E	8,297	60	425	3.8	7.1	6.0[2]	6.2	0.2
F	8,508	179	1,042	1.6	7.1	6.2[2]	6.5	0.3
G	10,223	203	876	1.8	7.4	7.4	8.0	0.6
H	11,233	87	485	3.3	9.3	9.3	9.8	0.5
I	12,296	174	870	1.9	10.7	10.7	11.3	0.6
J	13,807	83	377	4.3	13.6	13.6	14.0	0.4
K	14,461	72	311	5.2	18.3	18.3	18.9	0.6
L	15,304	184	1,329	1.2	20.1	20.1	20.5	0.4
M	17,181	375	1,604	1.0	21.1	21.1	21.6	0.5
N	18,504	58	318	4.6	22.7	22.7	23.2	0.5
O	18,648	99	547	2.7	24.0	24.0	24.3	0.3
P	19,306	127	670	2.2	24.7	24.7	25.0	0.3

[1] Feet above confluence with Choptank River

[2] Elevations computed without consideration of backwater effects from Choptank River

TABLE 8

FEDERAL EMERGENCY MANAGEMENT AGENCY

CAROLINE COUNTY, MD

AND INCORPORATED AREAS

FLOODWAY DATA

CHAPEL BRANCH

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
A	1,280	630	8,906	1.4	5.9	5.9	6.6	0.7
B	2,870	1,117	11,857	1.0	6.0	6.0	6.7	0.7
C	5,074	1,243	12,070	1.0	6.1	6.1	6.8	0.7
D	7,190	1,037	11,715	1.0	6.3	6.3	7.0	0.7
E	8,190	831	8,050	1.5	6.3	6.3	7.0	0.7
F	8,970	615	6,974	1.8	6.4	6.4	7.1	0.7
G	9,231	580	5,980	2.1	6.4	6.4	7.1	0.7
H	10,946	952	14,136	0.9	6.6	6.6	7.3	0.7
I	11,377	621	9,425	1.3	6.6	6.6	7.3	0.7
J	13,018	742	8,849	1.4	6.8	6.8	7.5	0.7
K	14,290	830	9,637	1.3	6.9	6.9	7.6	0.7
L	16,061	851	10,836	1.1	7.0	7.0	7.7	0.7
M	17,144	1,297	13,264	0.9	7.0	7.0	7.7	0.7
N	21,456	875	8,358	1.3	7.3	7.3	8.0	0.7
O	23,236	912	8,828	1.2	7.5	7.5	8.2	0.7
P	25,319	686	7,297	1.5	7.7	7.7	8.4	0.7
Q	27,177	725	7,295	1.5	7.9	7.9	8.6	0.7
R	28,611	787	8,086	1.3	8.0	8.0	8.8	0.8
S	30,514	743	7,319	1.4	8.3	8.3	9.1	0.8
T	32,696	543	6,660	1.6	8.5	8.5	9.3	0.8
U	35,076	827	8,253	1.3	8.8	8.8	9.6	0.8

[1] Feet above Limit of Riverine Study*

* Limit of Riverine Study is approximately 13.5 miles above Dover Bridge Road

TABLE 8

FEDERAL EMERGENCY MANAGEMENT AGENCY

CAROLINE COUNTY, MD

AND INCORPORATED AREAS

FLOODWAY DATA

CHOPTANK RIVER

FLOODING SOURCE		FLOODWAY			BASE FLOOD WATER SURFACE ELEVATION (FEET NAVD)			
CROSS SECTION	DISTANCE[1]	WIDTH (FEET)	SECTION AREA (SQUARE FEET)	MEAN VELOCITY (FEET PER SECOND)	REGULATORY	WITHOUT FLOODWAY	WITH FLOODWAY	INCREASE
V	37,497	540	5,799	1.8	9.1	9.1	10.0	0.9
W	40,275	469	5,513	1.8	9.6	9.6	10.5	0.9
X	42,156	438	4,430	2.2	10.0	10.0	10.9	0.9
Y	44,176	371	4,924	2.0	10.4	10.4	11.3	0.9
Z	47,374	374	5,211	1.9	11.1	11.1	11.9	0.8
AA	49,416	364	4,822	2.1	11.4	11.4	12.3	0.9
AB	50,488	495	6,378	1.6	11.7	11.7	12.5	0.8
AC	52,352	519	6,427	1.5	11.8	11.8	12.7	0.9
AD	54,600	668	7,945	1.3	12.1	12.1	13.1	1.0
AE	55,990	717	6,089	1.6	12.4	12.4	13.3	0.9
AF	57,292	696	8,867	1.1	12.7	12.7	13.7	1.0
AG	58,887	617	6,664	1.5	13.0	13.0	13.9	0.9
AH	60,513	410	4,683	2.1	13.4	13.4	14.4	1.0
AI	61,963	508	5,845	1.7	14.0	14.0	15.0	1.0
AJ	64,079	390	4,821	2.1	14.7	14.7	15.7	1.0
AK	65,975	485	5,191	1.9	15.4	15.4	16.3	0.9
AL	67,671	543	5,533	1.6	15.9	15.9	16.9	1.0
AM	70,107	350	4,013	2.3	16.9	16.9	17.8	0.9
AN	72,243	610	6,614	1.4	17.6	17.6	18.5	0.9
AO	74,305	627	6,474	1.4	18.0	18.0	18.9	0.9
AP	76,170	577	5,592	1.6	18.5	18.5	19.5	1.0

[1] Feet above Limit of Riverine Study*

*Limit of Riverine Study is approximately 13.5 miles above Dover Bridge Road

TABLE 8

FEDERAL EMERGENCY MANAGEMENT AGENCY

CAROLINE COUNTY, MD

AND INCORPORATED AREAS

FLOODWAY DATA

CHOPTANK RIVER

FLOODING SOURCE		FLOODWAY			BASE FLOOD WATER SURFACE ELEVATION (FEET NAVD)			
CROSS SECTION	DISTANCE[1]	WIDTH (FEET)	SECTION AREA (SQUARE FEET)	MEAN VELOCITY (FEET PER SECOND)	REGULATORY	WITHOUT FLOODWAY	WITH FLOODWAY	INCREASE
AQ	79,927	447	4,209	2.0	20.0	20.0	20.9	0.9

[1] Feet above Limit of Riverine Study*

*Limit of Riverine Study is approximately 13.5 miles above Dover Bridge Road

TABLE 8

FEDERAL EMERGENCY MANAGEMENT AGENCY

CAROLINE COUNTY, MD

AND INCORPORATED AREAS

FLOODWAY DATA

CHOPTANK RIVER

FLOODING SOURCE		FLOODWAY			BASE FLOOD WATER SURFACE ELEVATION (FEET NAVD)			
CROSS SECTION	DISTANCE[1]	WIDTH (FEET)	SECTION AREA (SQUARE FEET)	MEAN VELOCITY (FEET PER SECOND)	REGULATORY	WITHOUT FLOODWAY	WITH FLOODWAY	INCREASE
A	695	70	122	1.9	37.4	35.1[2]	35.4	0.3
B	1,858	30	91	2.6	37.5	37.5	38.0	0.5
C	1,916	30	122	1.9	38.8	38.8	39.2	0.4
D	2,026	34	79	3.0	38.9	38.9	39.2	0.3
E	2,914	35	81	2.5	40.4	40.4	40.9	0.5
F	3,576	25	74	2.8	42.0	42.0	42.3	0.3
G	3,668	25	68	3.0	42.5	42.5	42.9	0.4
H	4,509	30	59	3.4	44.7	44.7	44.7	0.0
I	5,166	70	249	0.8	46.4	46.4	47.0	0.6

[1] Feet above confluence with Tidy Island Creek

[2] Elevations computed without consideration of backwater effects from Tidy Island Creek

TABLE 8

FEDERAL EMERGENCY MANAGEMENT AGENCY

CAROLINE COUNTY, MD

AND INCORPORATED AREAS

FLOODWAY DATA

HENDERSON 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
A	140	160	1,066	1.0	7.3	7.3	7.7	0.4
B	1,630	108	415	2.6	8.9	8.9	9.3	0.4
C	2,193	45	193	5.7	9.8	9.8	10.8	1.0
D	2,370	41	300	3.7	11.1	11.1	11.5	0.4
E	2,456	41	276	4.0	11.2	11.2	11.6	0.4
F	3,322	142	419	2.6	12.7	12.7	13.7	1.0
G	4,020	100	375	2.9	15.3	15.3	15.8	0.5
H	4,814	102	381	2.9	16.9	16.9	17.6	0.7
I	6,094	102	376	2.3	20.6	20.6	21.1	0.5
J	6,526	78	282	3.1	21.4	21.4	21.8	0.4
K	7,227	100	306	2.6	23.1	23.1	23.6	0.5
L	7,871	80	220	3.6	24.8	24.8	25.4	0.6
M	8,262	69	212	3.7	26.7	26.7	27.5	0.8
N	8,346	102	552	1.4	30.8	30.8	31.1	0.3
O	10,151	121	388	1.7	31.8	31.8	32.4	0.6
P	11,533	70	286	2.4	34.4	34.4	35.2	0.8
Q	11,856	110	250	2.3	34.7	34.7	35.6	0.9
R	11,939	100	461	1.3	36.9	36.9	37.5	0.6
S	12,054	100	476	1.2	36.9	36.9	37.5	0.6
T	12,207	131	619	0.9	37.0	37.0	37.6	0.6

[1] Feet above Limit of Riverine Study*

* Limit of Riverine Study is at Double Hills Road

TABLE 8

FEDERAL EMERGENCY MANAGEMENT AGENCY

CAROLINE COUNTY, MD

AND INCORPORATED AREAS

FLOODWAY DATA

HERRING 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
A	78	130	604	2.7	5.3	5.3	5.6	0.3
B	286	108	462	3.1	5.5	5.5	5.9	0.4
C	466	60	411	3.5	5.7	5.7	6.3	0.6
D	611	65	406	3.6	6.1	6.1	6.7	0.6
E	616	46	273	5.3	6.1	6.1	6.5	0.4
F	726	64	418	3.5	7.0	7.0	7.3	0.3
G	833	106	1,329	1.1	7.2	7.2	7.5	0.3
H	1,907	125	557	2.6	7.4	7.4	7.8	0.4
I	3,174	44	146	7.9	8.6	8.6	8.7	0.1
J	4,640	75	216	5.3	11.3	11.3	11.6	0.3

[1] Feet above Limit of Riverine Study*

*Limit of Riverine Study is approximately 9,300 feet above Back Landing Road

TABLE 8

FEDERAL EMERGENCY MANAGEMENT AGENCY

CAROLINE COUNTY, MD

AND INCORPORATED AREAS

FLOODWAY DATA

HUNTING 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
A	478	282	4,639	2.2	11.0	11.0	11.1	0.1
B	859	309	4,782	2.1	11.1	11.1	11.2	0.1
C	1,285	297	4,368	2.3	11.1	11.1	11.2	0.1
D	1,656	300	5,163	2.0	11.1	11.1	11.2	0.1
E	1,996	293	4,760	2.2	11.1	11.1	11.3	0.2
F	3,276	335	5,320	1.9	11.2	11.2	11.4	0.2
G	3,565	291	4,769	2.2	11.2	11.2	11.4	0.2
H	4,333	321	3,785	2.7	11.3	11.3	11.5	0.2
I	4,527	534	5,863	1.7	11.4	11.4	11.7	0.3
J	4,786	671	9,325	1.1	11.4	11.4	11.7	0.3
K	5,128	520	5,768	1.8	11.4	11.4	11.7	0.3
L	5,683	328	4,448	2.3	11.9	11.9	12.3	0.4
M	6,032	453	5,335	1.9	12.1	12.1	12.4	0.3
N	6,594	455	5,227	2.0	12.2	12.2	12.5	0.3
O	6,904	346	4,265	2.4	12.2	12.2	12.5	0.3
P	7,188	400	4,908	2.1	12.4	12.4	12.7	0.3
Q	7,401	428	5,157	2.0	12.4	12.4	12.8	0.4
R	7,853	418	5,301	1.9	12.5	12.5	12.8	0.3
S	8,200	400	4,816	2.1	12.5	12.5	12.9	0.4
T	8,902	433	4,819	2.1	12.6	12.6	13.0	0.4
U	9,423	463	5,101	1.9	12.7	12.7	13.1	0.4

[1] Feet above Limit of Study*

* Limit of Study is approximately 0.8 miles downstream of Federalsburg Highway

TABLE 8

FEDERAL EMERGENCY MANAGEMENT AGENCY

CAROLINE COUNTY, MD

AND INCORPORATED AREAS

FLOODWAY DATA

MARSHY HOPE 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
V	9,701	424	4,620	2.2	12.7	12.7	13.1	0.4
W	10,304	540	6,529	1.5	12.8	12.8	13.3	0.5
X	13,143	818	9,822	1.0	13.2	13.2	13.8	0.6
Y	15,763	646	6,685	1.4	13.6	13.6	14.2	0.6
Z	18,011	705	6,665	1.4	14.1	14.1	14.7	0.6
AA	21,479	922	7,827	1.2	14.6	14.6	15.3	0.7
AB	24,178	619	5,541	1.7	15.2	15.2	16.0	0.8
AC	26,772	885	7,773	1.1	16.0	16.0	16.8	0.8
AD	29,478	953	7,108	1.2	16.6	16.6	17.4	0.8
AE	32,778	768	5,733	1.4	17.5	17.5	18.4	0.9
AF	34,822	534	4,109	2.0	18.6	18.6	19.6	1.0
AG	36,750	748	5,850	1.4	19.7	19.7	20.6	0.9
AH	40,463	723	5,516	1.4	21.5	21.5	22.3	0.8

[1] Feet above Limit of Study*

* Limit of Study is approximately 0.8 miles downstream of Federalsburg Highway

TABLE 8

FEDERAL EMERGENCY MANAGEMENT AGENCY

CAROLINE COUNTY, MD

AND INCORPORATED AREAS

FLOODWAY DATA

MARSHY HOPE 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
A	293	73	72	3.3	11.2	3.6[2]	3.6	0.0
B	1,269	20	52	4.5	11.2	9.6[2]	10.0	0.4
C	1,743	25	56	4.2	13.1	13.1	13.4	0.3
D	2,339	42	87	2.7	16.0	16.0	16.4	0.4
E	2,664	93	435	0.5	20.7	20.7	21.3	0.6
F	3,529	34	87	2.7	21.2	21.2	22.0	0.8
G	4,354	25	60	3.9	24.0	24.0	24.6	0.6
H	5,257	18	63	3.7	28.1	28.1	28.5	0.4
I	6,557	20	70	3.3	31.0	31.0	31.5	0.5
J	7,237	44	92	2.5	32.7	32.7	33.2	0.5
K	8,129	30	73	3.2	35.9	35.9	36.2	0.3
L	8,863	70	174	1.2	36.4	36.4	36.9	0.5

[1] Feet above confluence of Marshy Hope Creek

[2] Elevations computed without consideration of backwater effects from Marshy Hope Creek

TABLE 8

FEDERAL EMERGENCY MANAGEMENT AGENCY

CAROLINE COUNTY, MD

AND INCORPORATED AREAS

FLOODWAY DATA

MILES BRANCH

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
A	726	45	278	6.3	21.6	19.3	20.2	0.9
B	1,734	134	822	2.1	21.6	20.9[2]	21.6	0.7
C	2,090	75	694	2.5	21.6	21.4	22.1	0.7
D	2,187	150	864	2.0	21.6	21.5	22.2	0.7
E	3,383	212	1,037	1.4	22.2	22.2	23.1	0.9
F	4,127	196	974	1.5	22.8	22.8	23.8	1.0
G	5,368	167	759	2.0	24.0	24.0	24.9	0.9
H	6,252	180	772	1.9	25.0	25.0	25.8	0.8
I	7,310	191	750	2.0	25.9	25.9	26.8	0.9
J	8,410	139	673	2.2	27.8	27.8	28.7	0.9

[1] Feet above confluence of Marshy Hope Creek

[2] Elevations computed without consideration of backwater effects from Marshy Hope Creek

TABLE 8

FEDERAL EMERGENCY MANAGEMENT AGENCY

CAROLINE COUNTY, MD

AND INCORPORATED AREAS

FLOODWAY DATA

SMITHVILLE DITCH

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
A	38	80	151	2.8	19.4	19.4	19.4	0.0
B	1,556	85	182	2.3	22.4	22.4	23.3	0.9
C	2,014	55	163	2.6	24.1	24.1	24.4	0.3
D	3,782	60	198	2.0	26.5	26.5	27.0	0.5
E	4,825	55	145	2.5	28.3	28.3	29.0	0.7
F	5,786	43	144	2.5	31.3	31.3	31.5	0.2
G	5,935	141	305	1.2	31.4	31.4	31.7	0.3
H	6,214	55	207	1.8	32.3	32.3	32.7	0.4
I	6,482	42	145	2.3	32.3	32.3	33.0	0.7
J	7,928	91	281	1.1	33.7	33.7	34.2	0.5
K	9,369	87	188	1.4	34.7	34.7	35.2	0.5

[1] Feet above Limit of Study*

*Limit of Study is approximately 1800 feet above Central Avenue

TABLE 8

FEDERAL EMERGENCY MANAGEMENT AGENCY

CAROLINE COUNTY, MD

AND INCORPORATED AREAS

FLOODWAY DATA

TANYARD 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
A	1,916	223	2,002	1.7	38.4	38.4	39.2	0.8
B	4,044	257	1,718	1.9	39.1	39.1	40.0	0.9
C	5,673	455	2,965	1.1	40.2	40.2	41.1	0.9
D	7,029	275	1,640	2.0	40.9	40.9	41.8	0.9
E	8,928	423	2,513	1.3	41.7	41.7	42.6	0.9
F	10,679	242	1,456	2.2	42.3	42.3	43.1	0.8

[1] Feet above county boundary

TABLE 8

FEDERAL EMERGENCY MANAGEMENT AGENCY

CAROLINE COUNTY, MD

AND INCORPORATED AREAS

FLOODWAY DATA

TIDY ISLAND 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
A	61	262	1,935	0.9	7.5	7.5	7.8	0.3
B	1,604	187	1,289	1.4	7.7	7.7	8.1	0.4
C	3,327	251	994	1.8	8.2	8.2	8.9	0.7
D	3,926	73	307	5.9	8.8	8.8	9.4	0.6
E	4,036	62	466	3.9	11.6	11.6	12.3	0.7
F	4,463	163	1,218	1.5	12.2	12.2	12.9	0.7
G	4,901	161	1,073	1.7	12.3	12.3	13.1	0.8
H	6,405	168	919	2.0	13.1	13.1	14.0	0.9
I	7,652	154	738	2.5	15.0	15.0	15.7	0.7
J	9,257	65	317	5.0	17.3	17.3	17.5	0.2
K	9,924	153	790	2.0	18.4	18.4	19.1	0.7
L	11,848	259	997	1.5	21.1	21.1	21.8	0.7
M	12,598	60	579	2.5	21.9	21.9	22.8	0.9
N	12,718	55	612	2.4	22.1	22.1	23.1	1.0
O	13,178	114	529	2.8	22.6	22.6	23.5	0.9

[1] Feet above Limit of Riverine Study*

* Limit of Riverine Study is at Double Hills Road

TABLE 8

FEDERAL EMERGENCY MANAGEMENT AGENCY

CAROLINE COUNTY, MD

AND INCORPORATED AREAS

FLOODWAY DATA

WATTS CREEK

5.0 INSURANCE APPLICATIONS

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

Zone A

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

Zone AE

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

Zone 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 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.

6.0 FLOOD INSURANCE RATE MAP

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

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

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

The countywide FIRM presents flooding information for the entire geographic area of Caroline County. Previously, separate Flood Hazard Boundary Maps and/or FIRMs were prepared for each incorporated community with identified flood hazard areas and the unincorporated areas of the county. Historical map dates relating to pre-countywide maps prepared for each community are presented in Table 9, "Community Map History."

7.0 OTHER STUDIES

Countywide studies have been completed for Dorchester and Talbot Counties, MD and Kent and Sussex Counties, Delaware (References 45-48).

Countywide studies are currently being prepared by FEMA for Queen Anne's County, Maryland (Reference 49).

Information pertaining to revised and unrevised flood hazards for each jurisdiction within Caroline County, Maryland has been compiled into this countywide FIS. Therefore, this FIS report supersedes all previous studies published on streams studied in this report and should be considered authoritative for the purposes of the NFIP.

COMMUNITY NAME	INITIAL NFIP MAP DATE	FLOOD HAZARD BOUNDARY MAP REVISIONS DATE	INITIAL FIRM DATE	FIRM REVISIONS DATE
Caroline County (Unincorporated Areas)	April 4, 1975	January 6, 1978	October 15, 1980	September 7, 1998
Denton, Town of	February 13, 1976	None	December 18, 1979	
Federalsburg , Town of	January 30, 1976	None	March 15, 1977	September 7, 1998
Goldsboro, Town of[1]	N/A	N/A	N/A	
Greensboro, Town of	June 28, 1974	January 30, 1976	November 1, 1979	
Henderson, Town of[1 2]	N/A	N/A	N/A	
Hillsboro, Town of	January 28, 1977	None	February 12, 1982	
Marydel, Town of[1 2]	N/A	N/A	N/A	
Preston, Town of[1 2]	N/A	N/A	N/A	
Ridgeley, Town of[1 2 3]	April 4, 1975	January 6, 1978	October 15, 1980	September 7, 1998
Templeville, Town of[1 2]	N/A	N/A	N/A	

[1]This community did not have a FIRM prior to the first countywide FIRM for Caroline County
[2]No Special Flood Hazard Areas Identified
[3]Dates for this community were taken from Caroline County (Unincorporated Areas)

TABLE 9

FEDERAL EMERGENCY MANAGEMENT AGENCY

CAROLINE COUNTY, MD
AND INCORPORATED AREAS

COMMUNITY MAP HISTORY

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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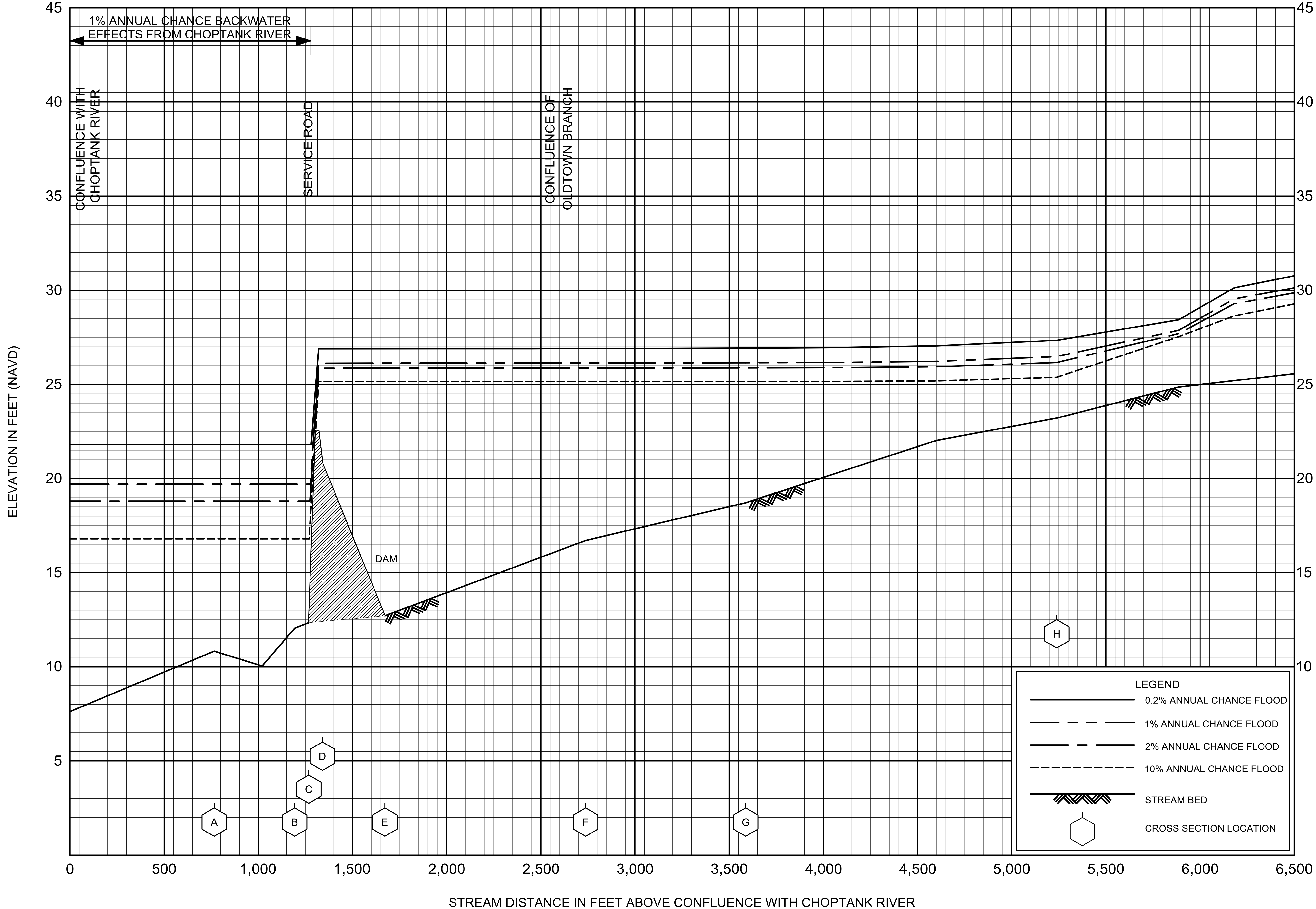


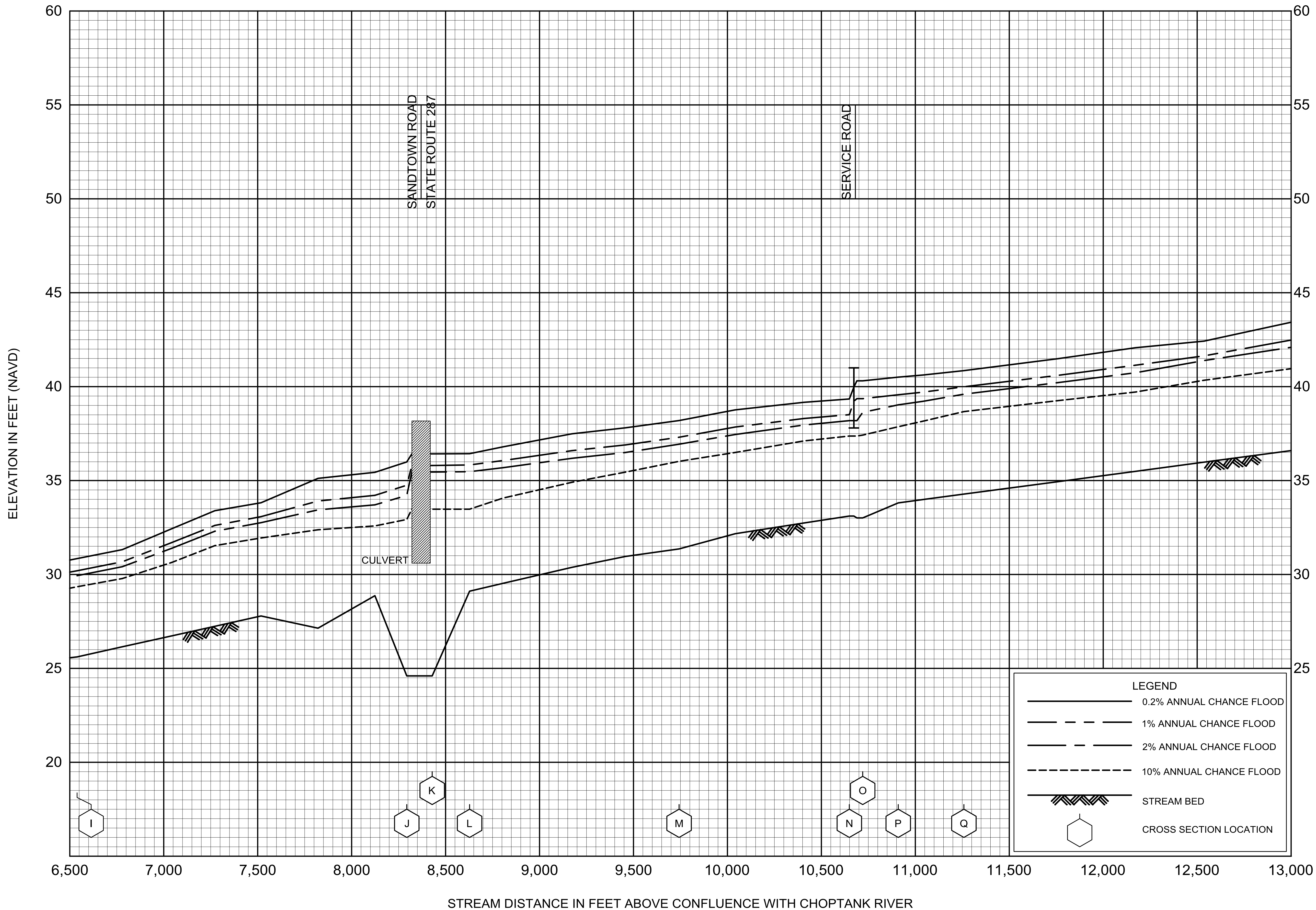
FLOOD PROFILES

BROADWAY BRANCH

FEDERAL EMERGENCY MANAGEMENT AGENCY

CAROLINE COUNTY, MD

AND INCORPORATED AREAS



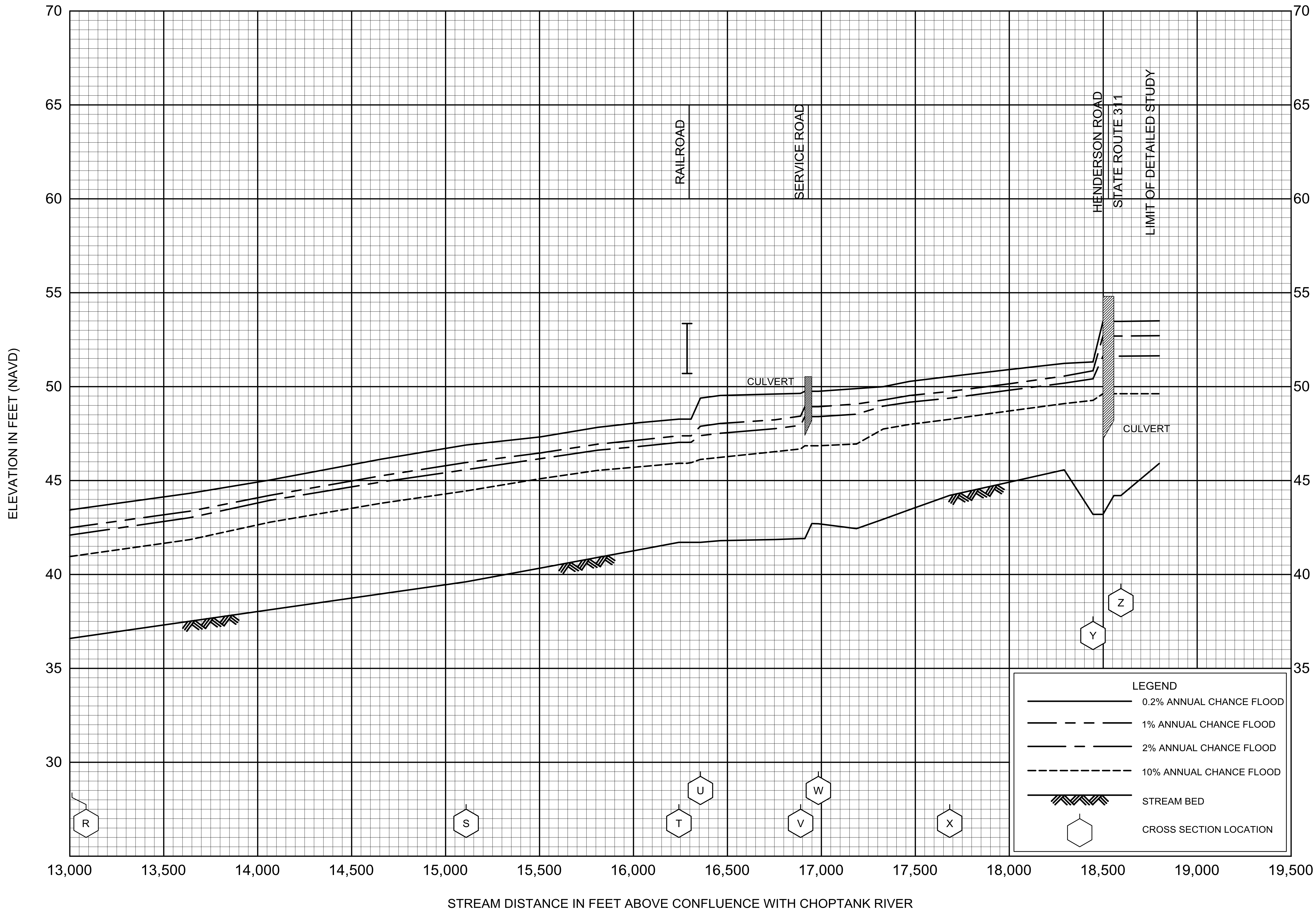
FLOOD PROFILES

BROADWAY BRANCH

FEDERAL EMERGENCY MANAGEMENT AGENCY

CAROLINE COUNTY, MD

AND INCORPORATED AREAS



FLOOD PROFILES

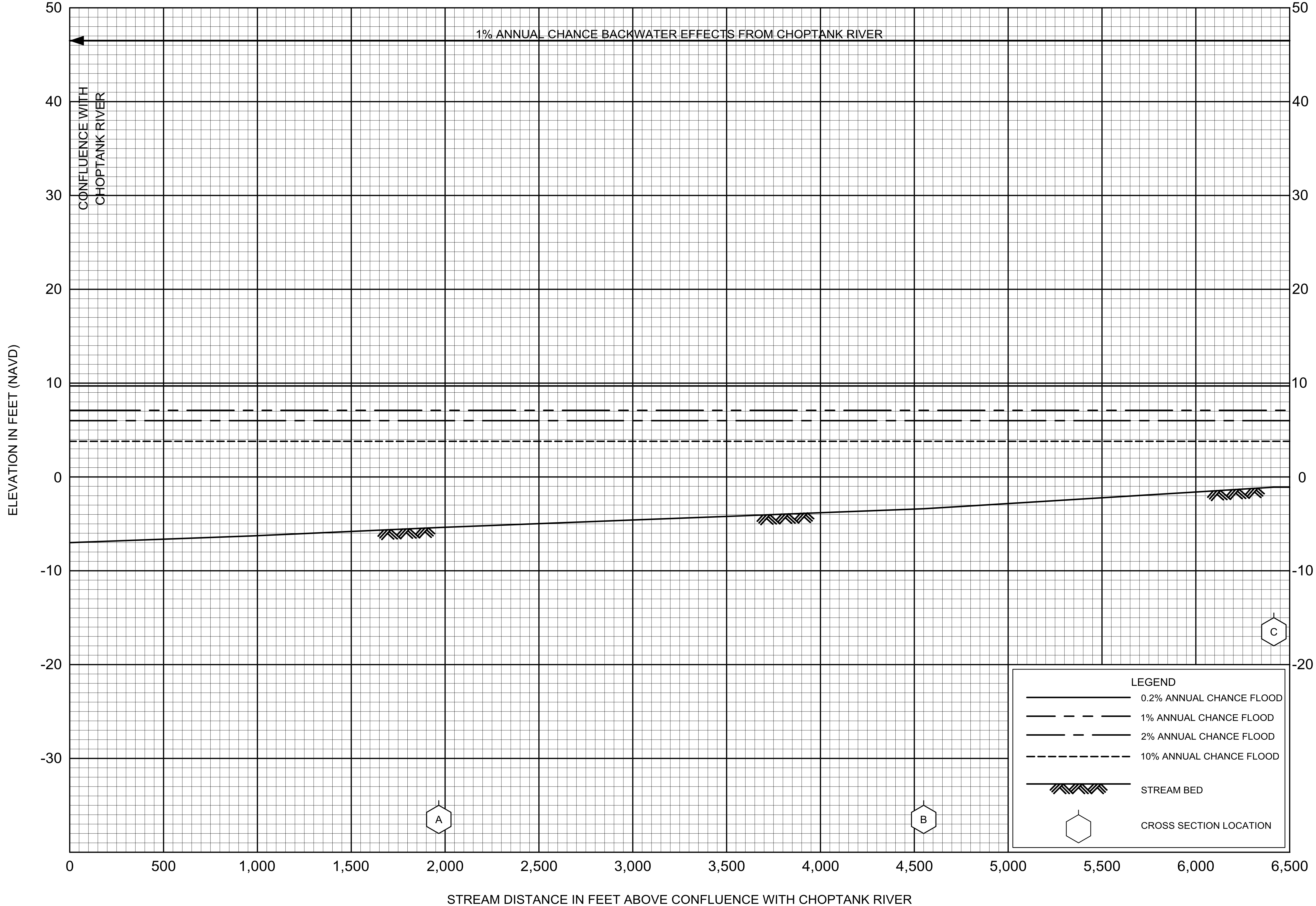
BROADWAY BRANCH

FEDERAL EMERGENCY MANAGEMENT AGENCY

CAROLINE COUNTY, MD

AND INCORPORATED AREAS

03P



FLOOD PROFILES

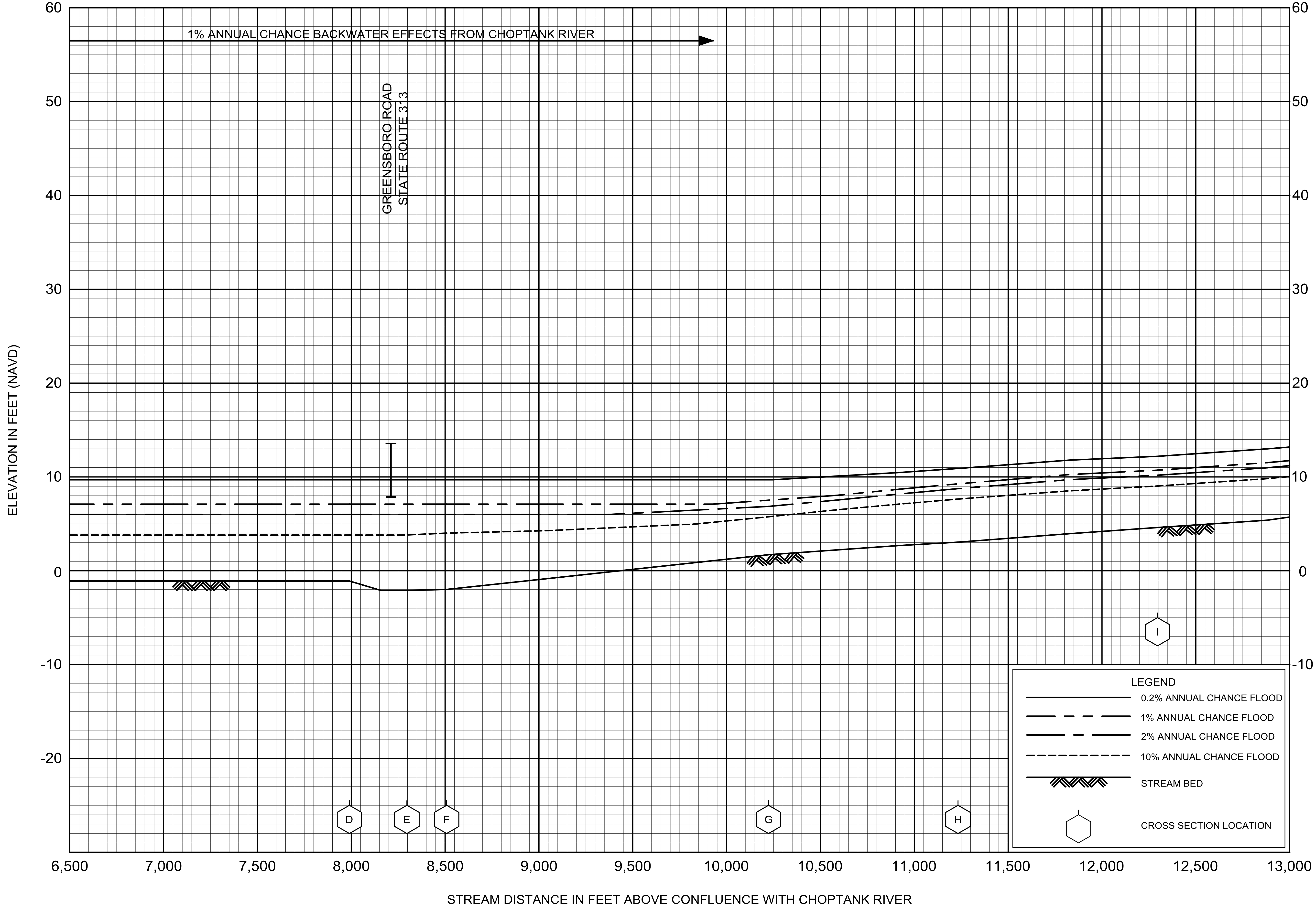
CHAPEL BRANCH

FEDERAL EMERGENCY MANAGEMENT AGENCY

CAROLINE COUNTY, MD

AND INCORPORATED AREAS

04P



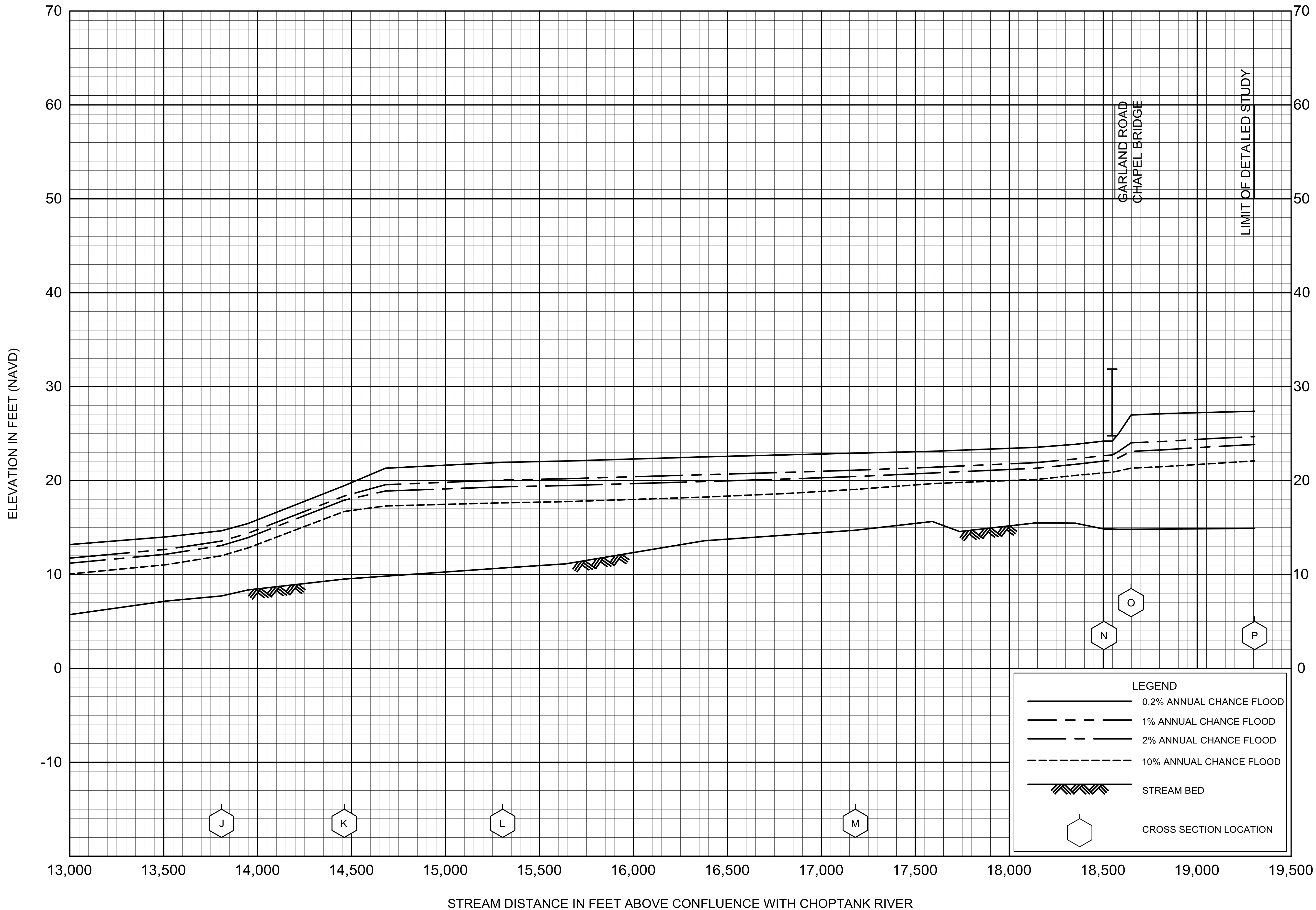
FLOOD PROFILES

CHAPEL BRANCH

FEDERAL EMERGENCY MANAGEMENT AGENCY

CAROLINE COUNTY, MD

AND INCORPORATED AREAS



FLOOD PROFILES

CHAPEL BRANCH

FEDERAL EMERGENCY MANAGEMENT AGENCY

CAROLINE COUNTY, MD

AND INCORPORATED AREAS

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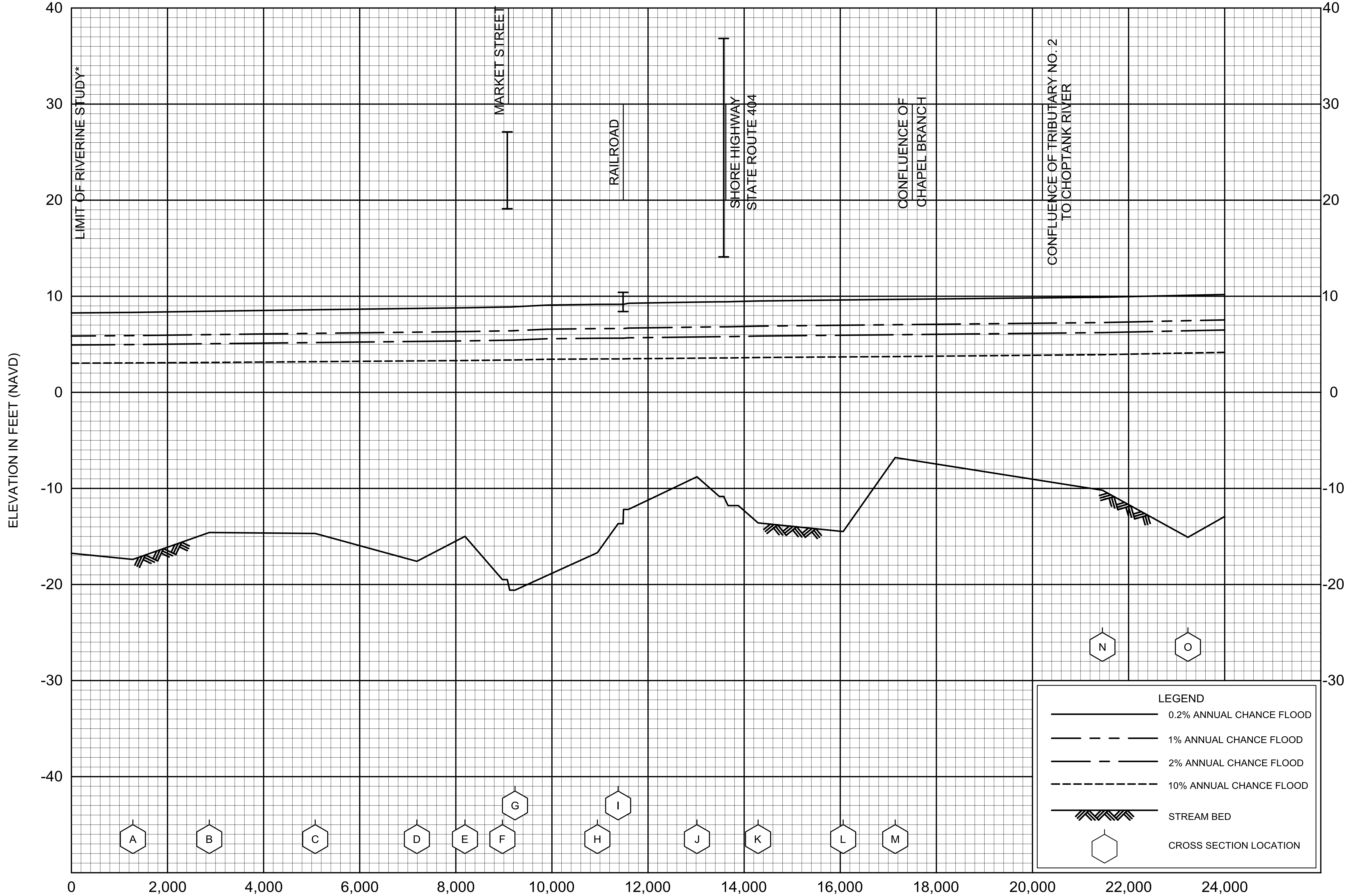


*LIMIT OF RIVERINE STUDY IS APPROXIMATELY
13.5 MILES ABOVE DOVER BRIDGE ROAD

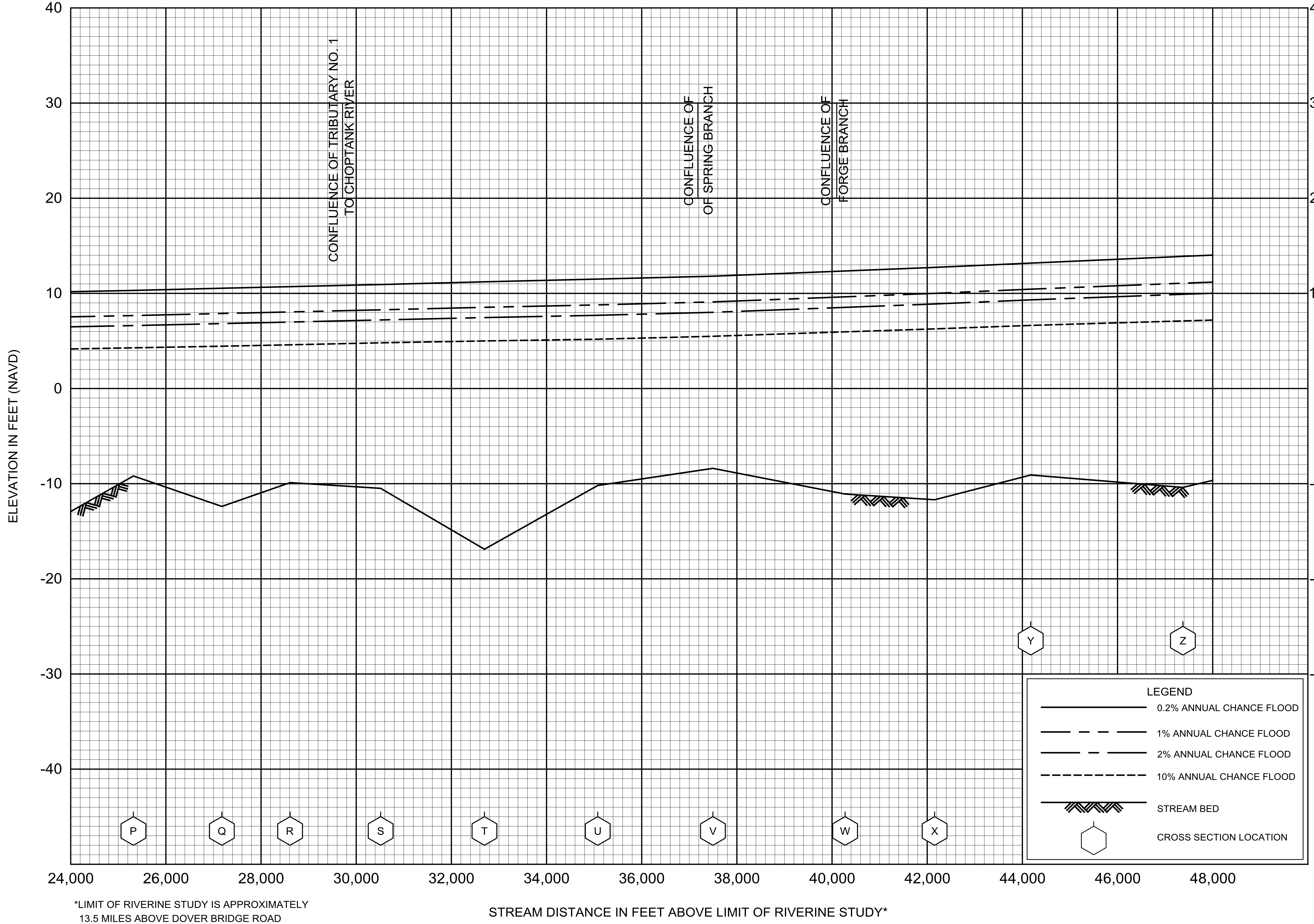
FLOOD PROFILES

CHOPTANK RIVER

FEDERAL EMERGENCY MANAGEMENT AGENCY

CAROLINE COUNTY, MD

AND INCORPORATED AREAS



*LIMIT OF RIVERINE STUDY IS APPROXIMATELY 13.5 MILES ABOVE DOVER BRIDGE ROAD

FLOOD PROFILES

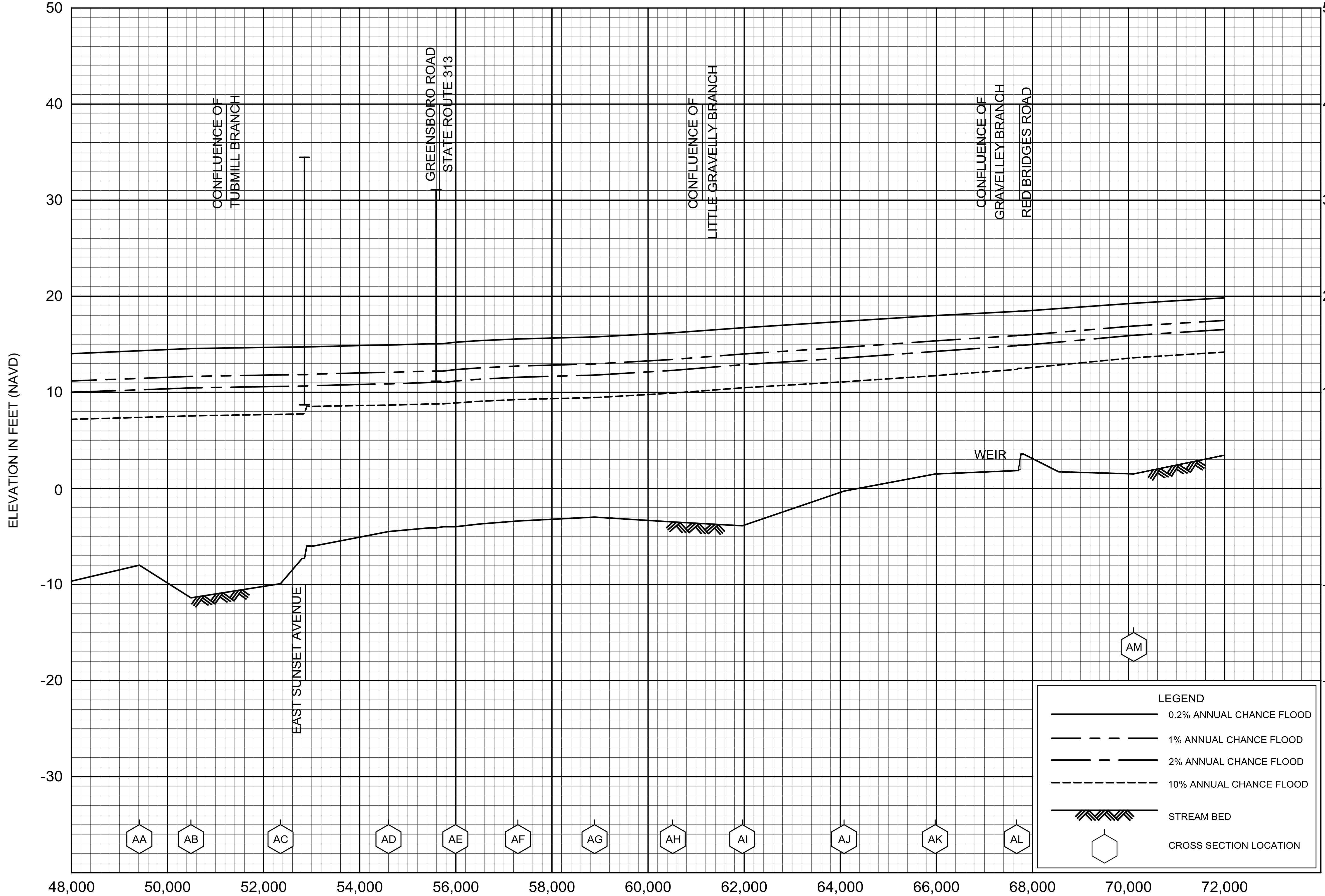
CHOPTANK RIVER

FEDERAL EMERGENCY MANAGEMENT AGENCY

CAROLINE COUNTY, MD

AND INCORPORATED AREAS

08P



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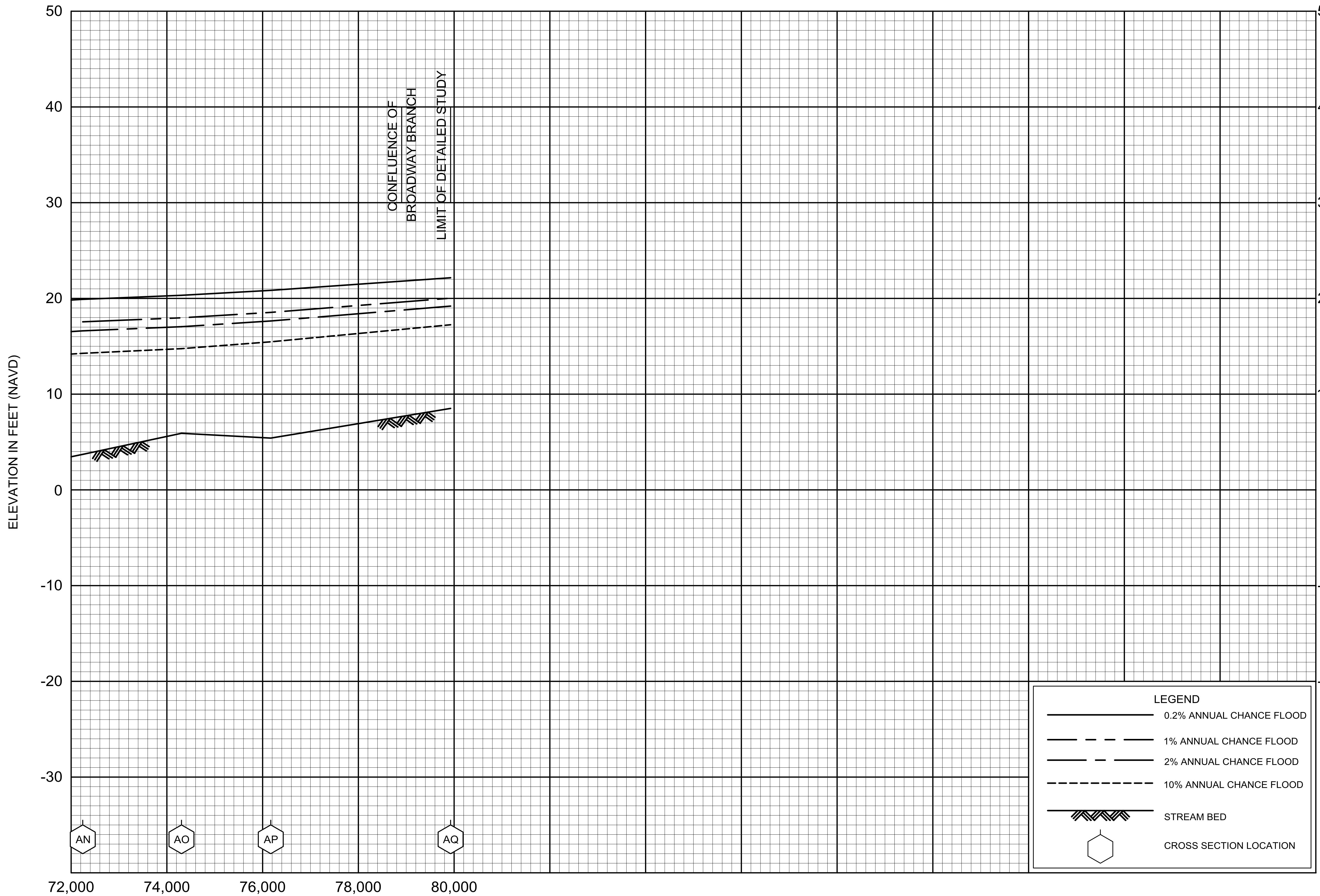
FLOOD PROFILES

CHOPTANK RIVER

FEDERAL EMERGENCY MANAGEMENT AGENCY

CAROLINE COUNTY, MD

AND INCORPORATED AREAS



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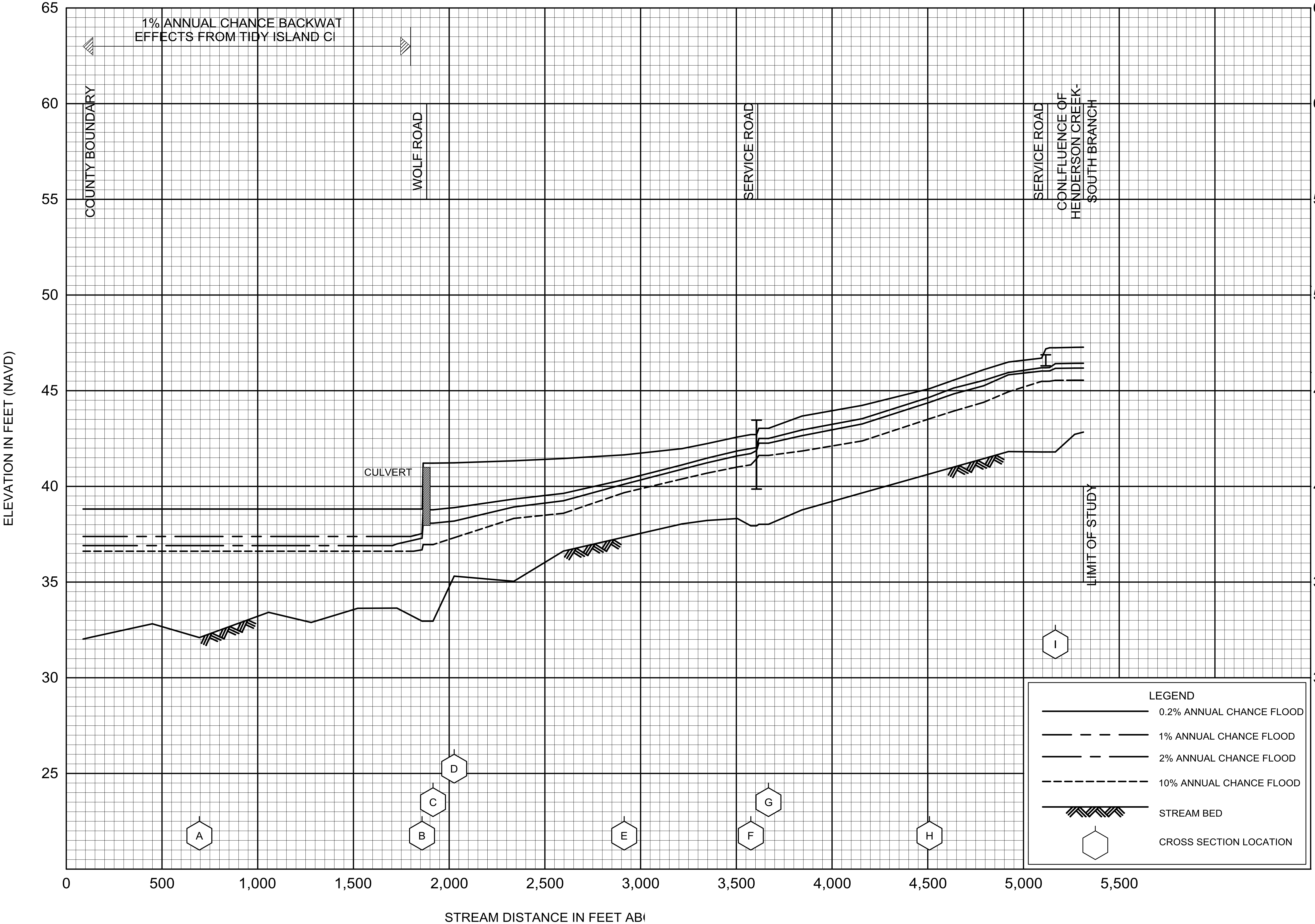
FLOOD PROFILES

CHOPTANK RIVER

FEDERAL EMERGENCY MANAGEMENT AGENCY

CAROLINE COUNTY, MD

AND INCORPORATED AREAS



FLOOD PROFILES

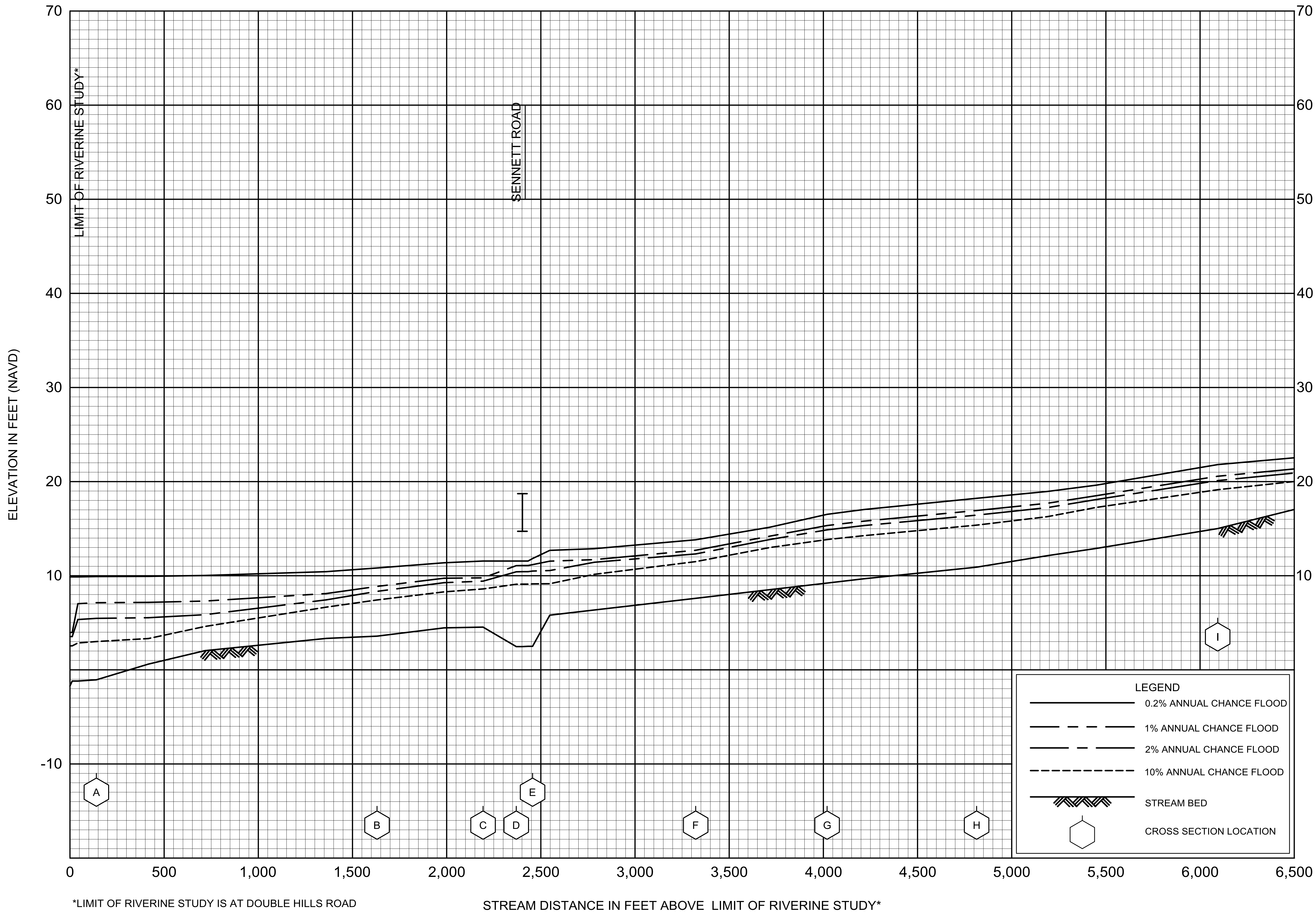
HENDERSON CREEK

FEDERAL EMERGENCY MANAGI

CAROLINE COUNTY, MD

AND INCORPORATED AREAS

11P



*LIMIT OF RIVERINE STUDY IS AT DOUBLE HILLS ROAD

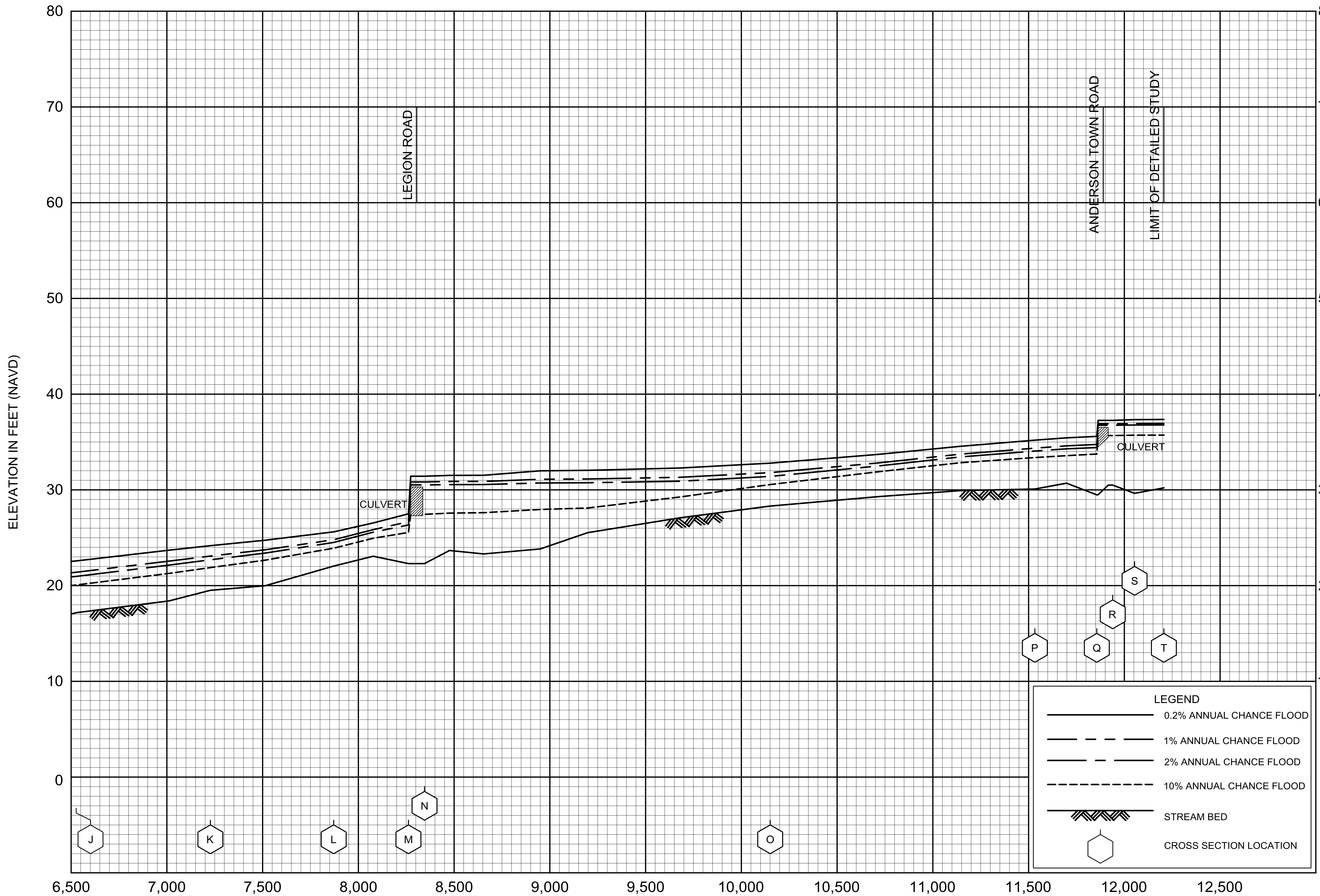
FLOOD PROFILES

HERRING RUN

FEDERAL EMERGENCY MANAGEMENT AGENCY

CAROLINE COUNTY, MD

AND INCORPORATED AREAS



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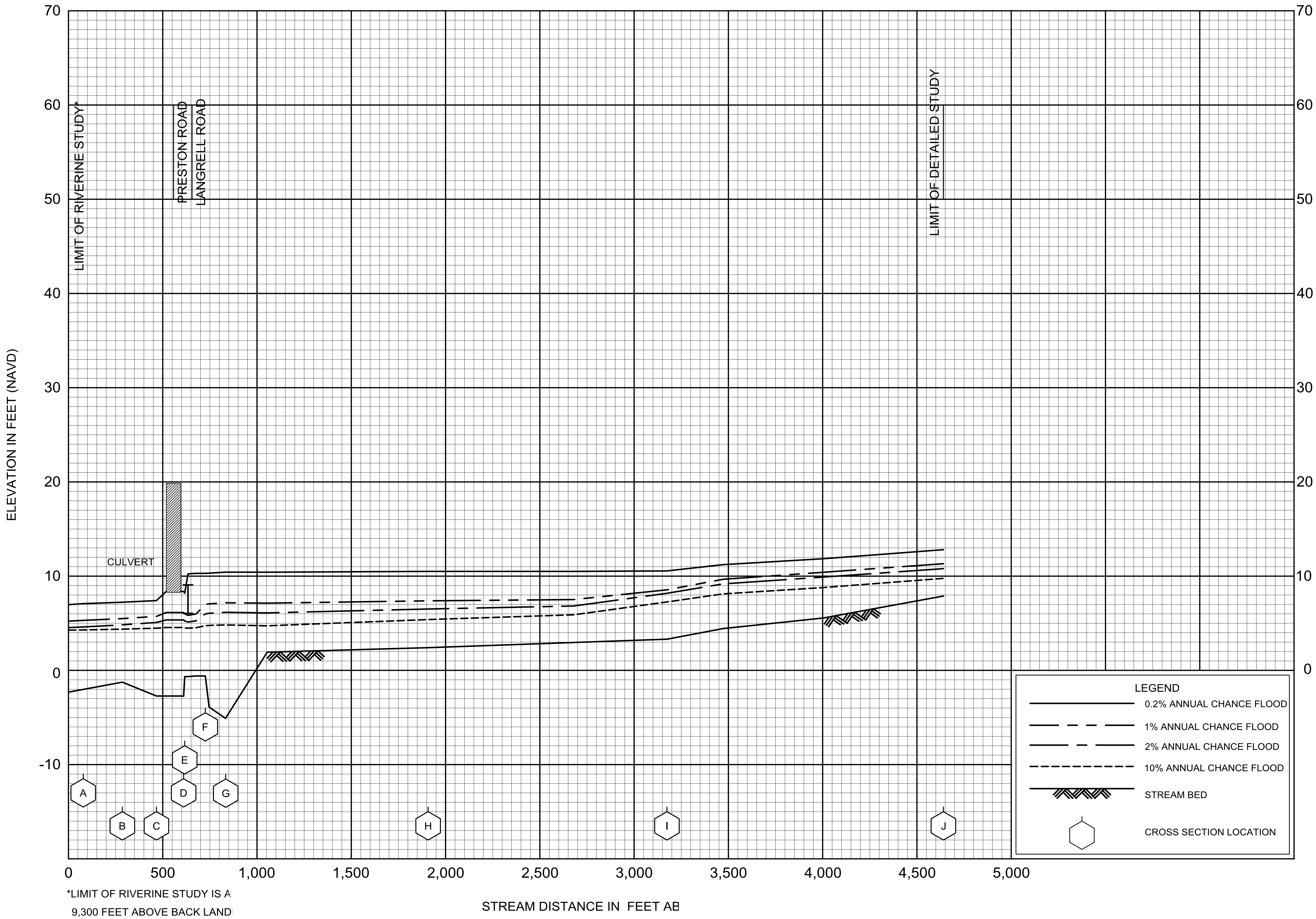
FLOOD PROFILES

HERRING RUN

FEDERAL EMERGENCY MANAGEMENT AGENCY

CAROLINE COUNTY, MD

AND INCORPORATED AREAS



FLOOD PROFILES

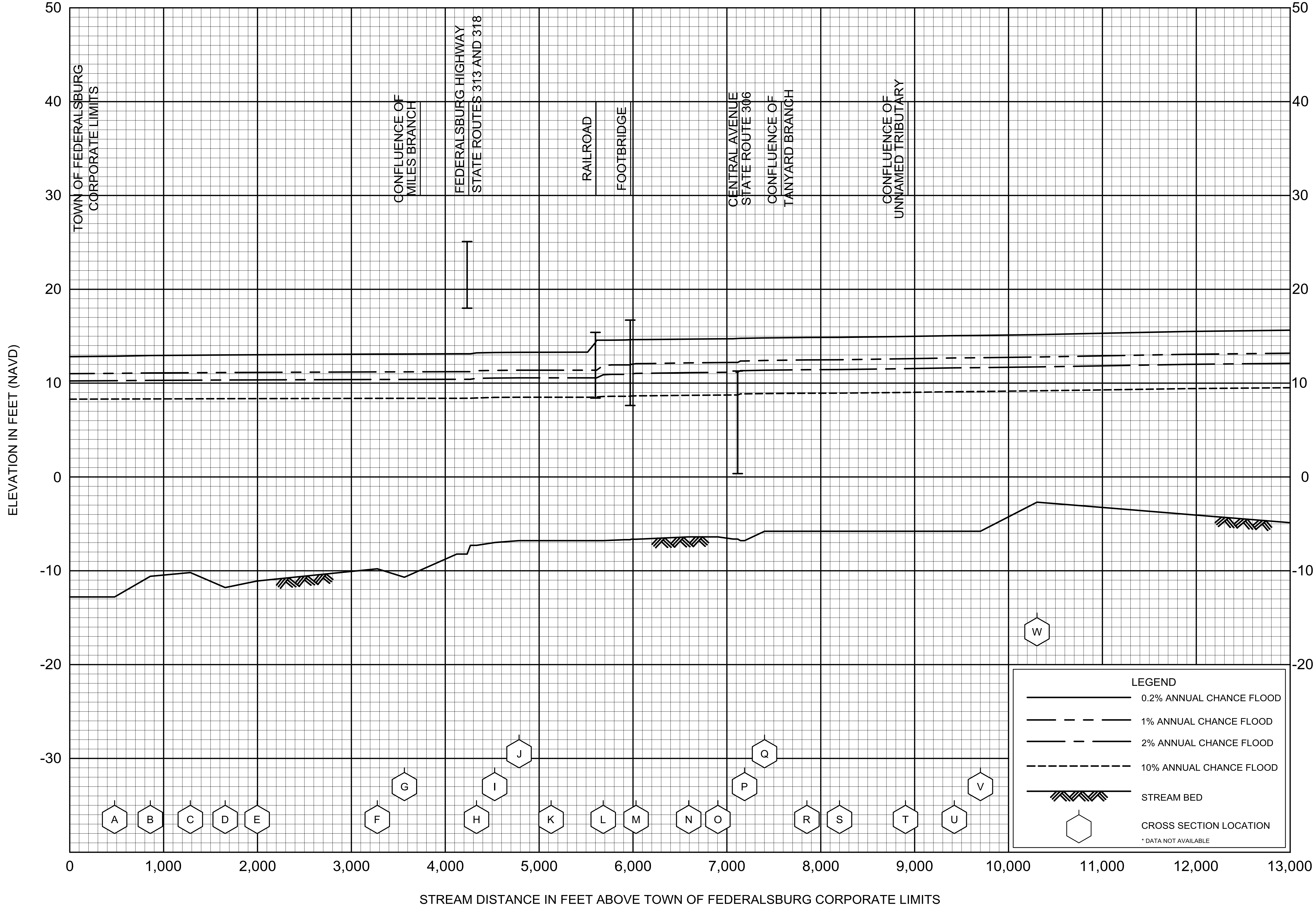
HUNTING CREEK

FEDERAL EMERGENCY MANAG

CAROLINE COUNTY, MD

AND INCORPORATED AREAS

14P



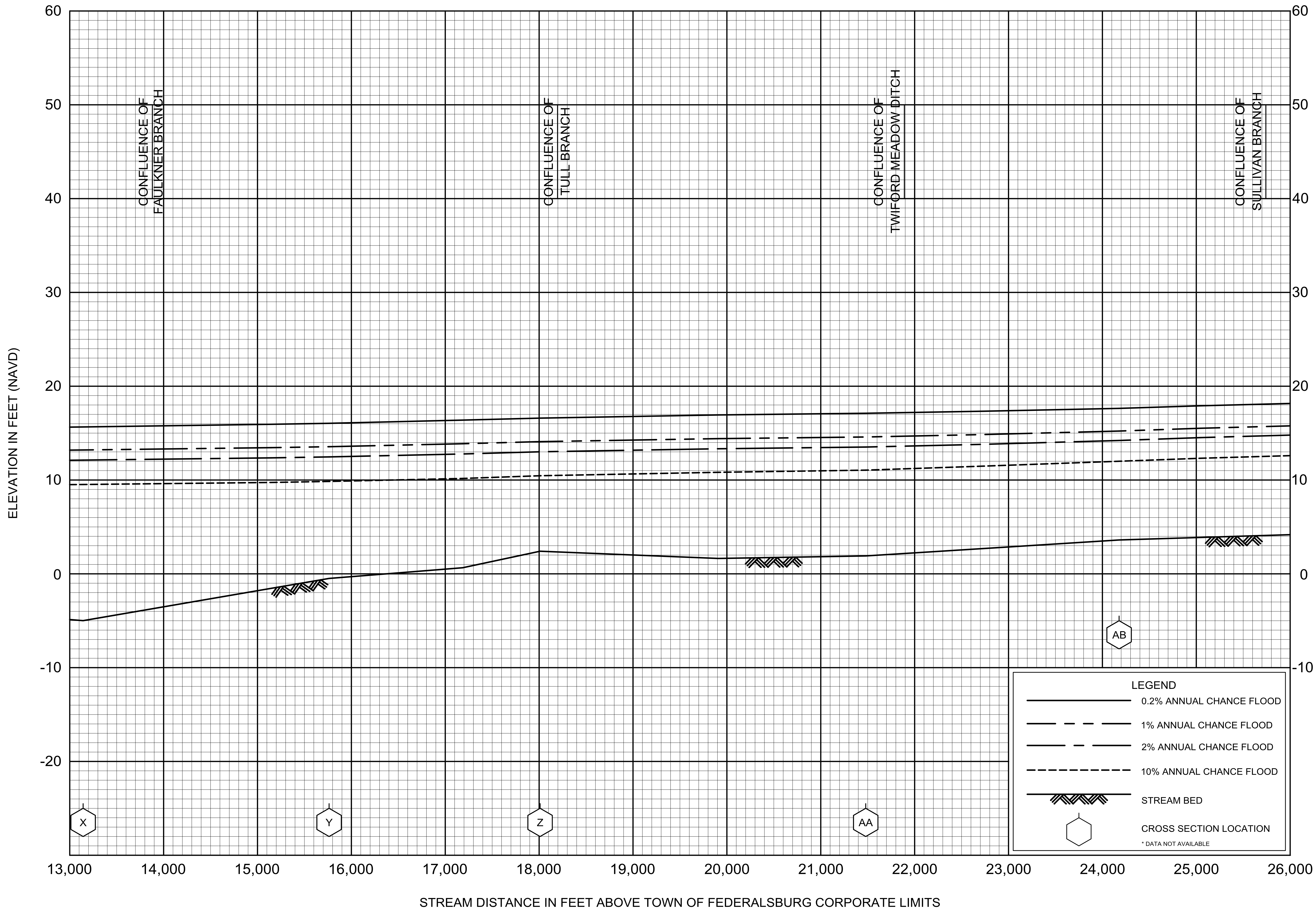
FLOOD PROFILES

MARSHY HOPE CREEK

FEDERAL EMERGENCY MANAGEMENT AGENCY

CAROLINE COUNTY, MD

AND INCORPORATED AREAS



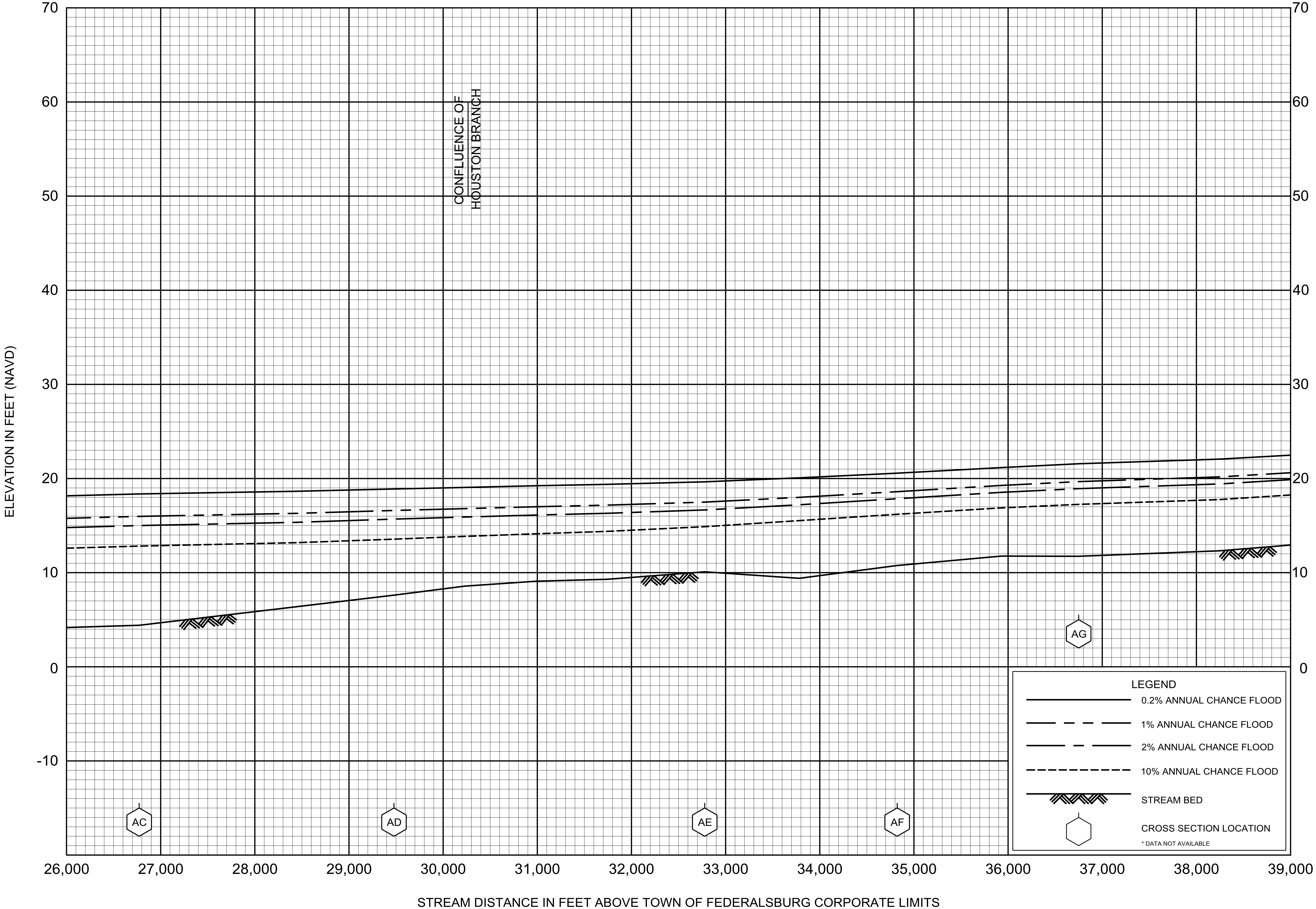
FLOOD PROFILES

MARSHY HOPE CREEK

FEDERAL EMERGENCY MANAGEMENT AGENCY

CAROLINE COUNTY, MD

AND INCORPORATED AREAS



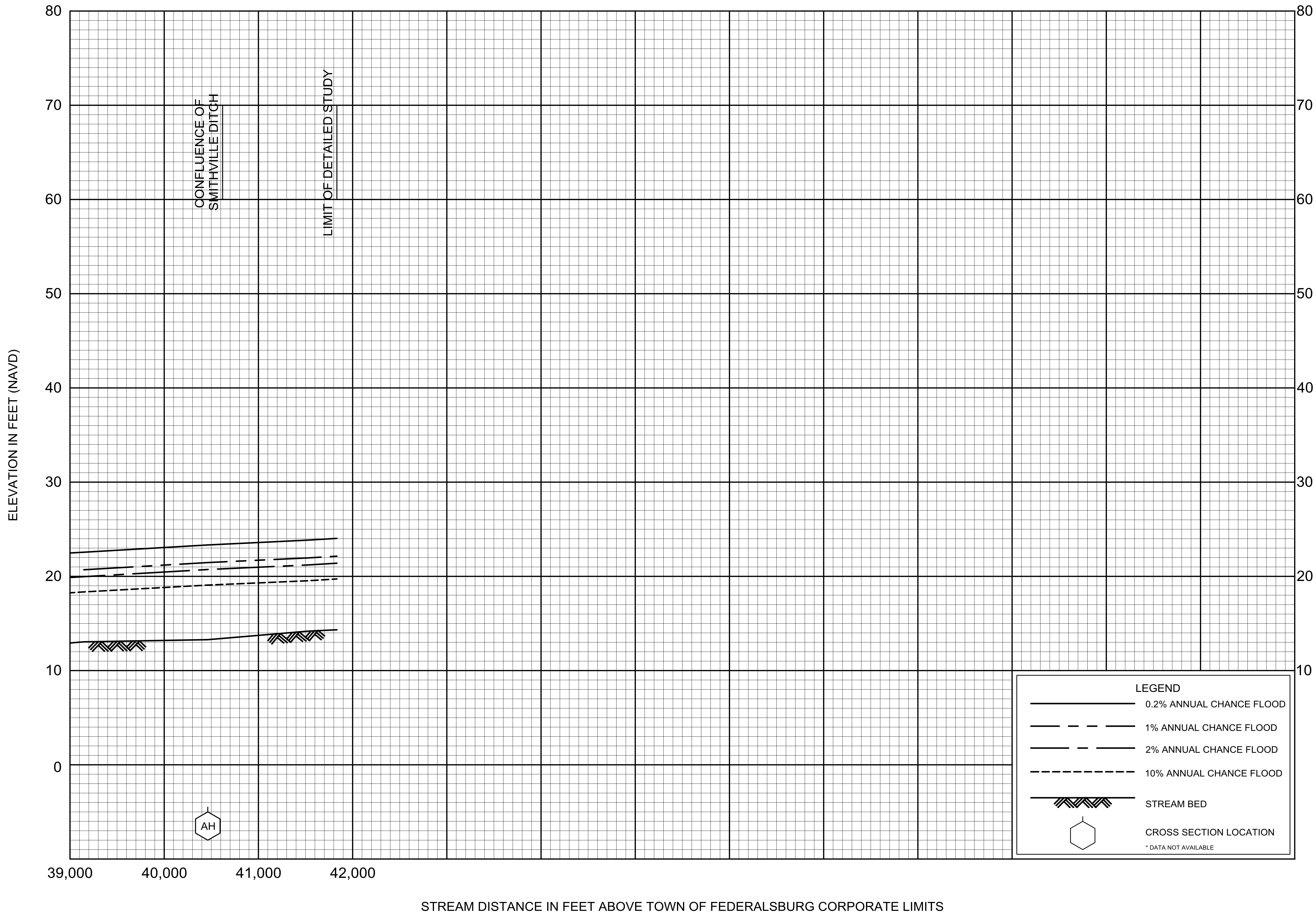
FLOOD PROFILES

MARSHY HOPE CREEK

FEDERAL EMERGENCY MANAGEMENT AGENCY

CAROLINE COUNTY, MD

AND INCORPORATED AREAS



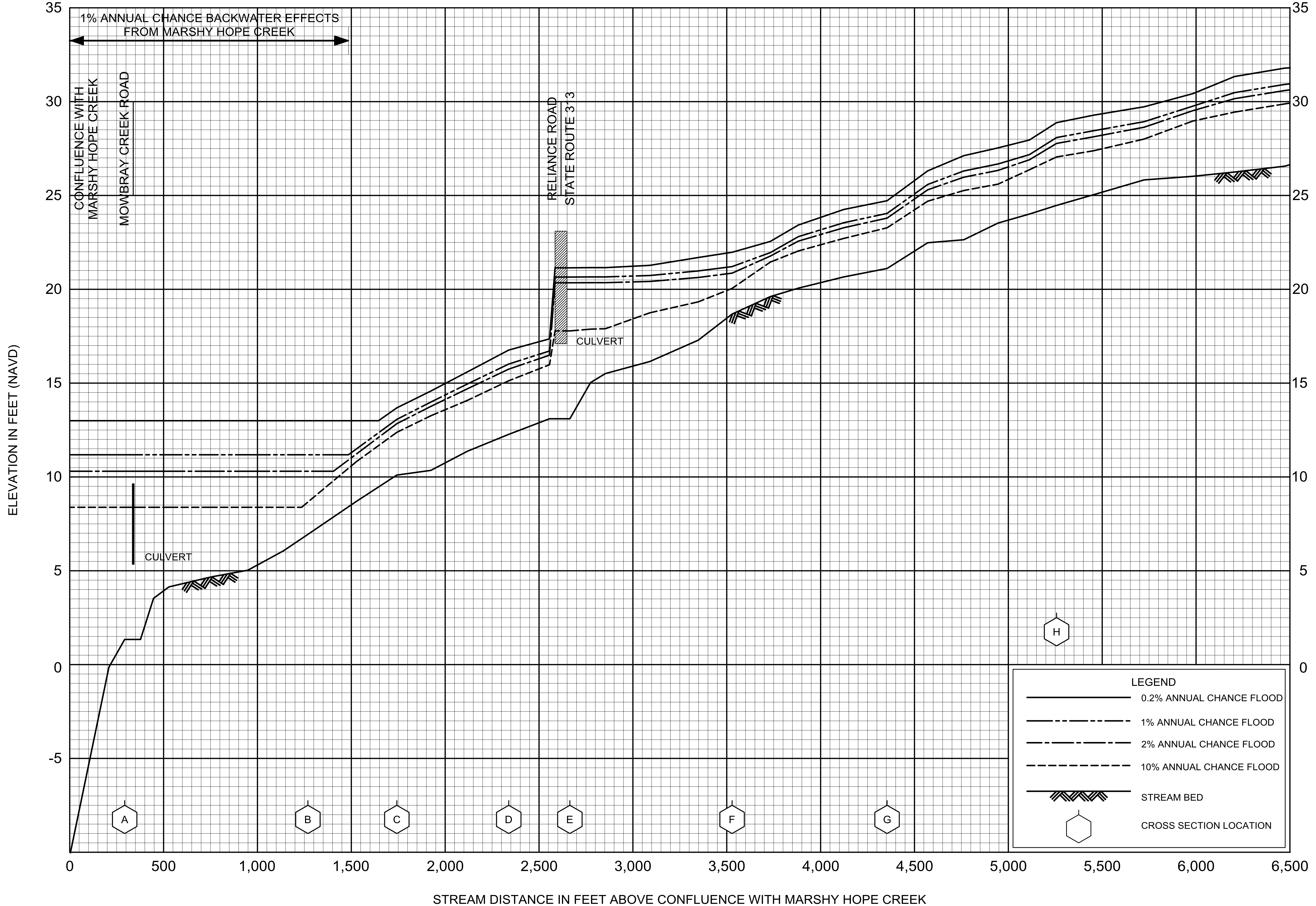
FLOOD PROFILES

MARSHY HOPE CREEK

FEDERAL EMERGENCY MANAGEMENT AGENCY

CAROLINE COUNTY, MD

AND INCORPORATED AREAS



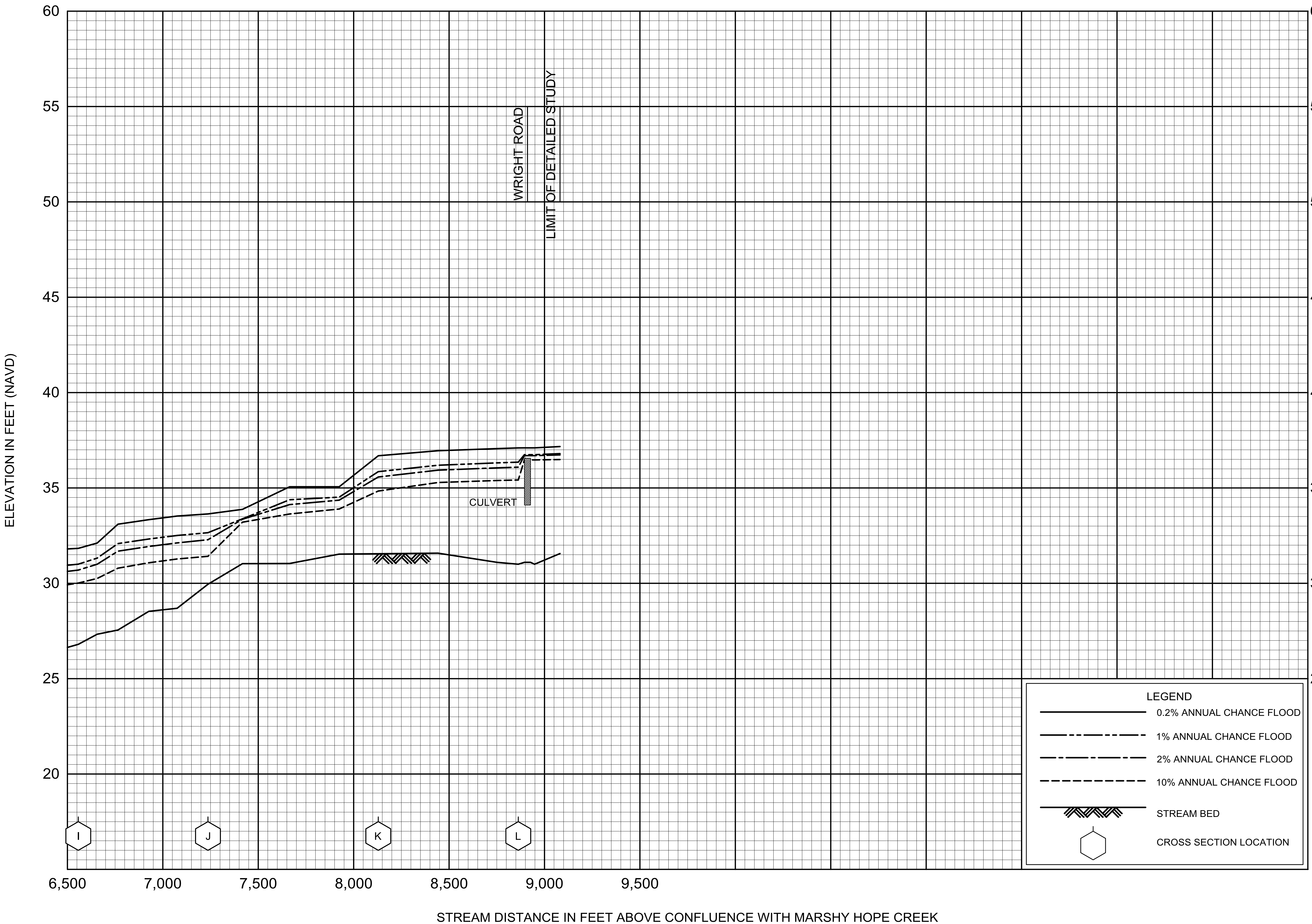
FLOOD PROFILES

MILES BRANCH

FEDERAL EMERGENCY MANAGEMENT AGENCY

CAROLINE COUNTY, MD

AND INCORPORATED AREAS



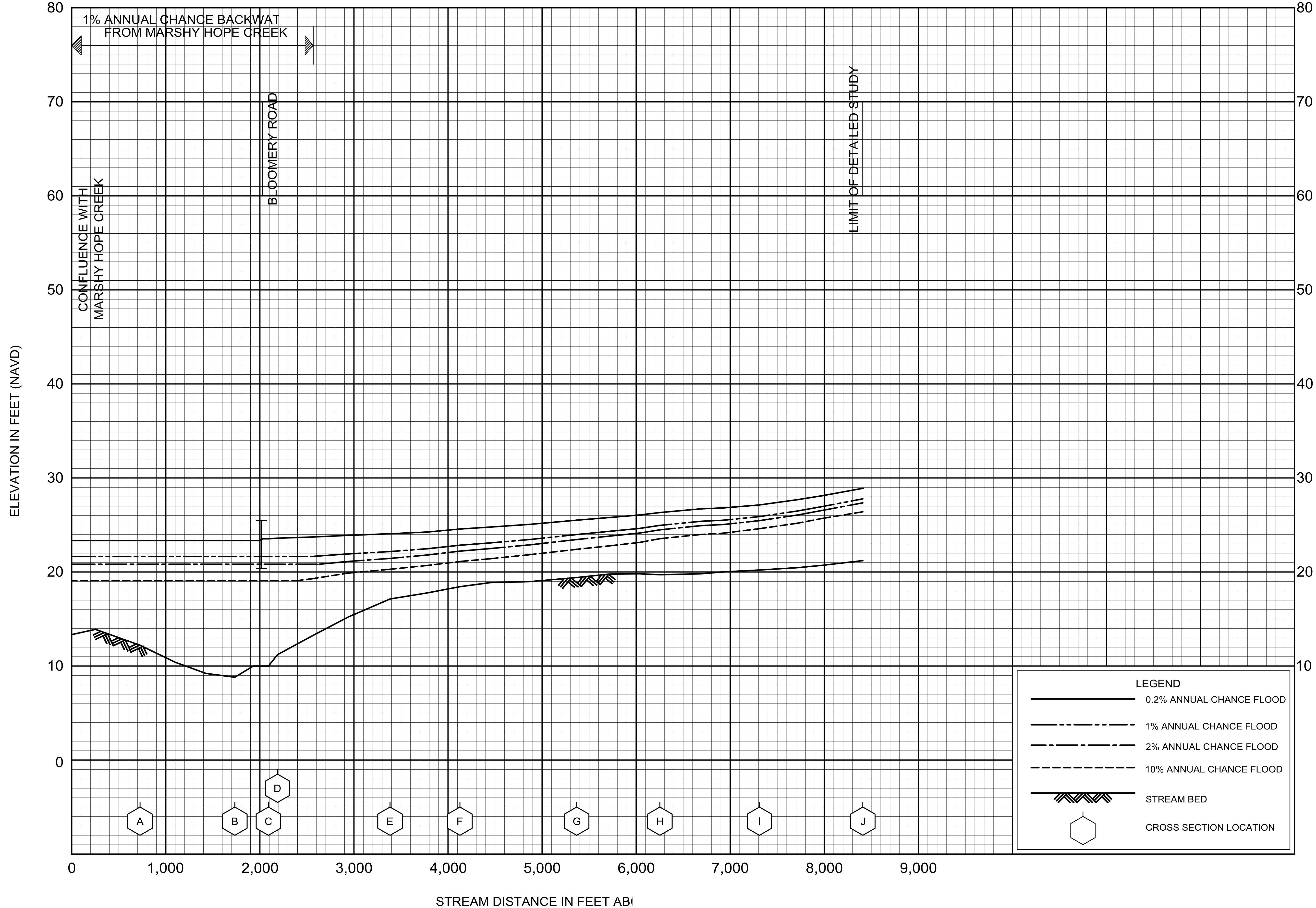
FLOOD PROFILES

MILES BRANCH

FEDERAL EMERGENCY MANAGEMENT AGENCY

CAROLINE COUNTY, MD

AND INCORPORATED AREAS



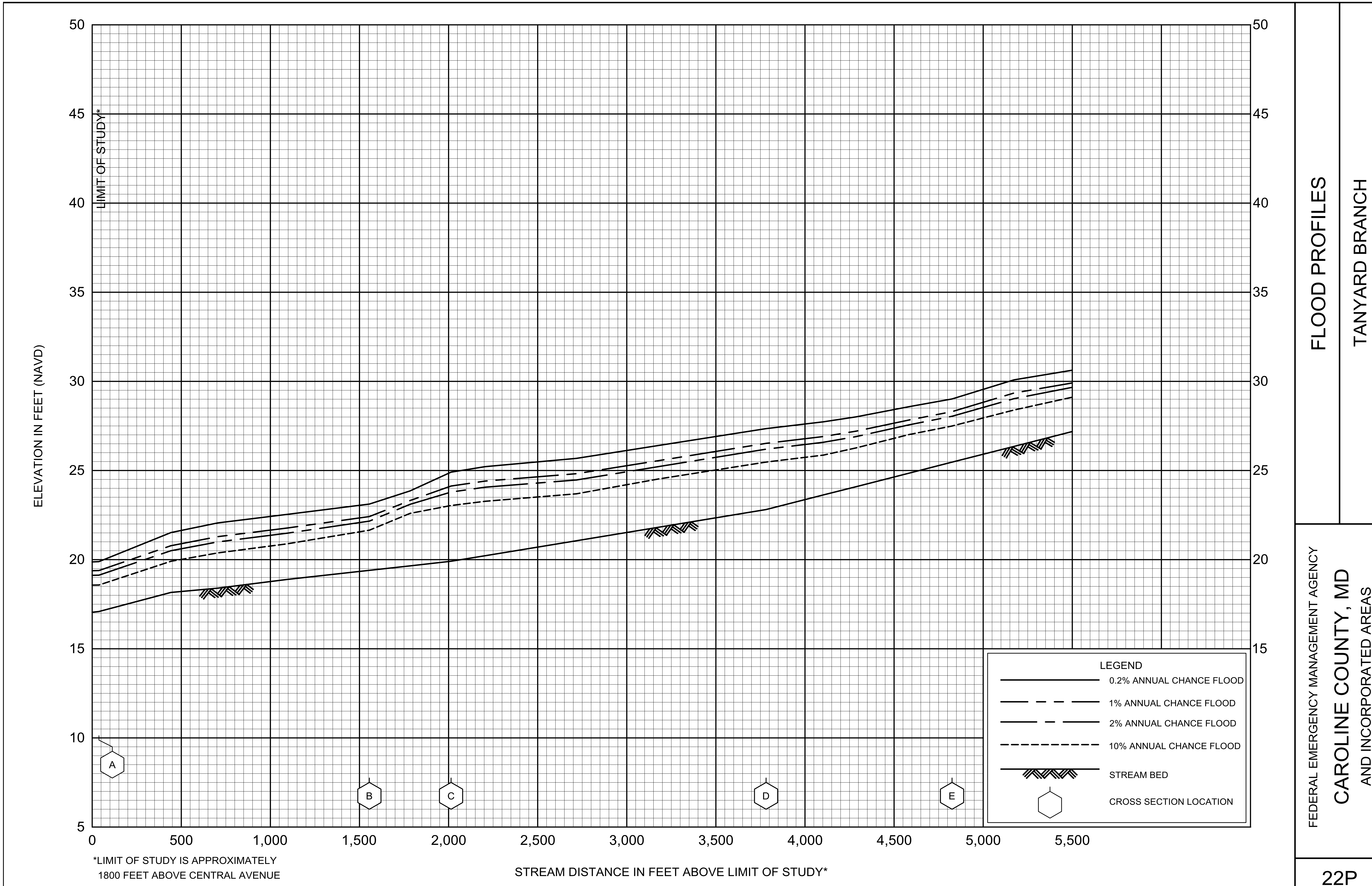
FLOOD PROFILES

SMITHVILLE DITCH

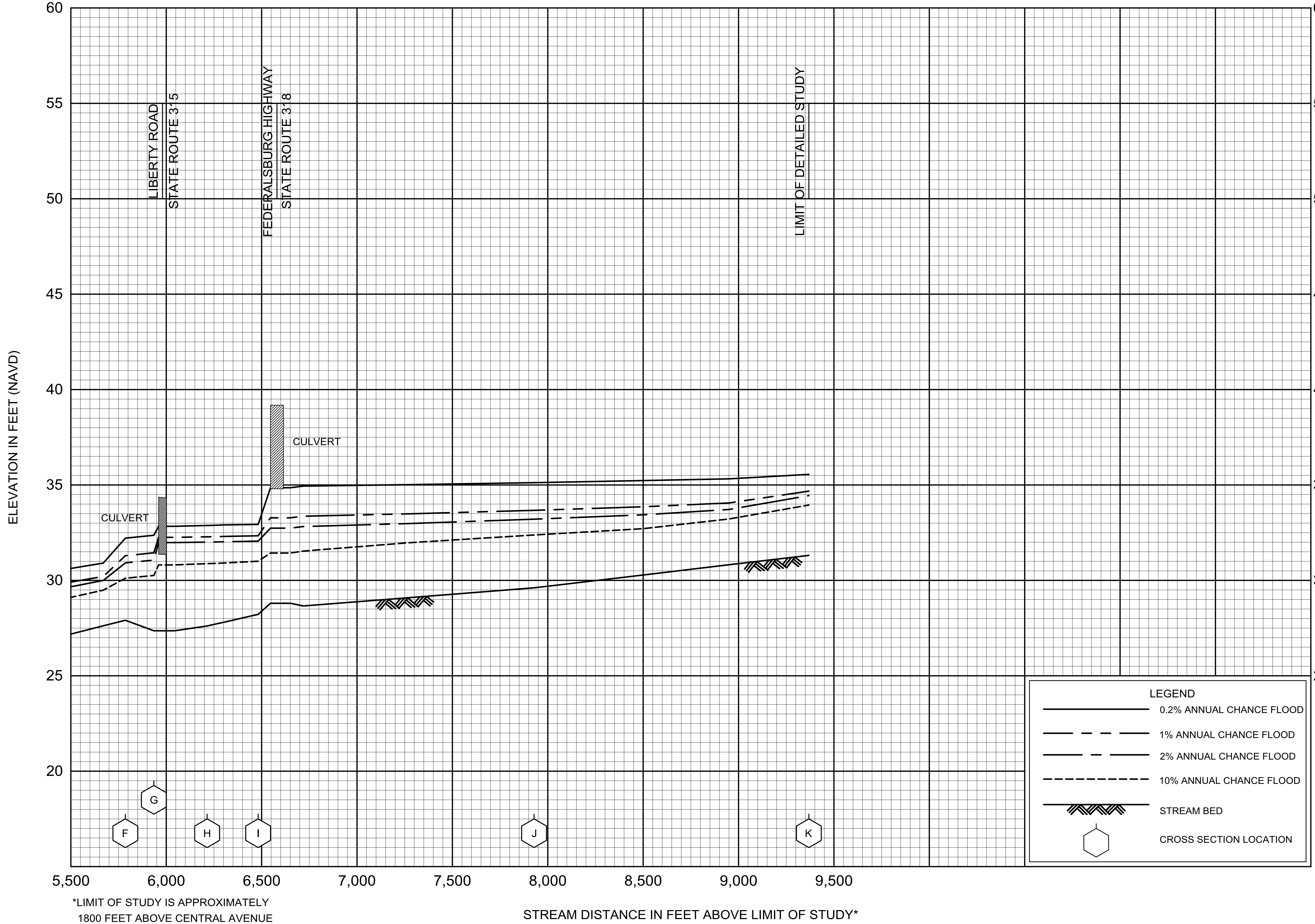
FEDERAL EMERGENCY MANAG

CAROLINE COUNTY, MD

AND INCORPORATED AREAS



LIMIT OF STUDY*
ELEVATION IN FEET (NAVD)
50
45
40
35
30
25
20
15
10
5
0
500
1,000
1,500
2,000
2,500
3,000
3,500
4,000
4,500
5,000
5,500
A
B
C
D
E
LEGEND
0.2% ANNUAL CHANCE FLOOD
1% ANNUAL CHANCE FLOOD
2% ANNUAL CHANCE FLOOD
10% ANNUAL CHANCE FLOOD
STREAM BED
CROSS SECTION LOCATION
*LIMIT OF STUDY IS APPROXIMATELY
1800 FEET ABOVE CENTRAL AVENUE
STREAM DISTANCE IN FEET ABOVE LIMIT OF STUDY*
FLOOD PROFILES
TANYARD BRANCH
FEDERAL EMERGENCY MANAGEMENT AGENCY
CAROLINE COUNTY, MD
AND INCORPORATED AREAS
22P



FLOOD PROFILES

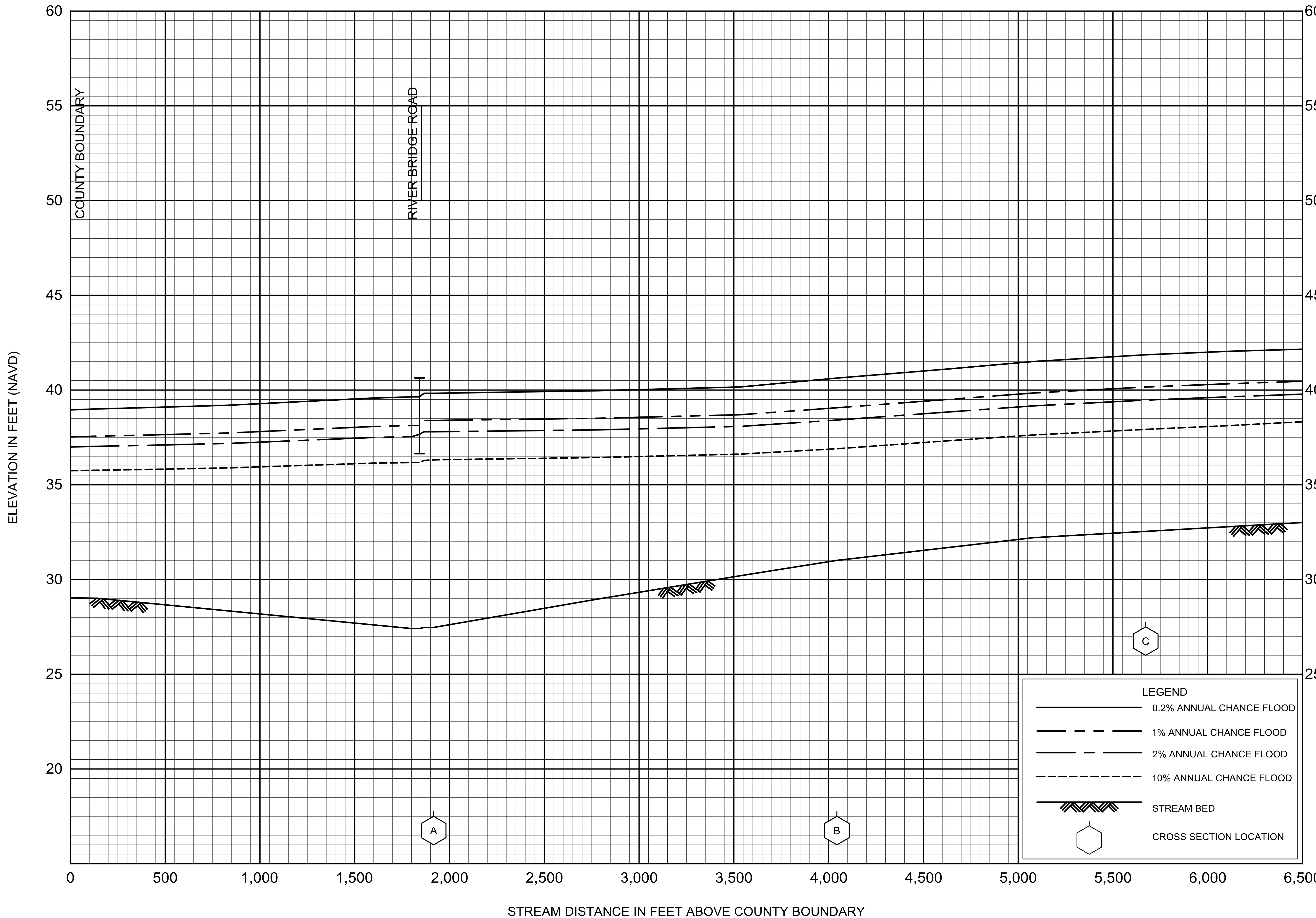
TANYARD BRANCH

FEDERAL EMERGENCY MANAGEMENT AGENCY

CAROLINE COUNTY, MD

AND INCORPORATED AREAS

23P



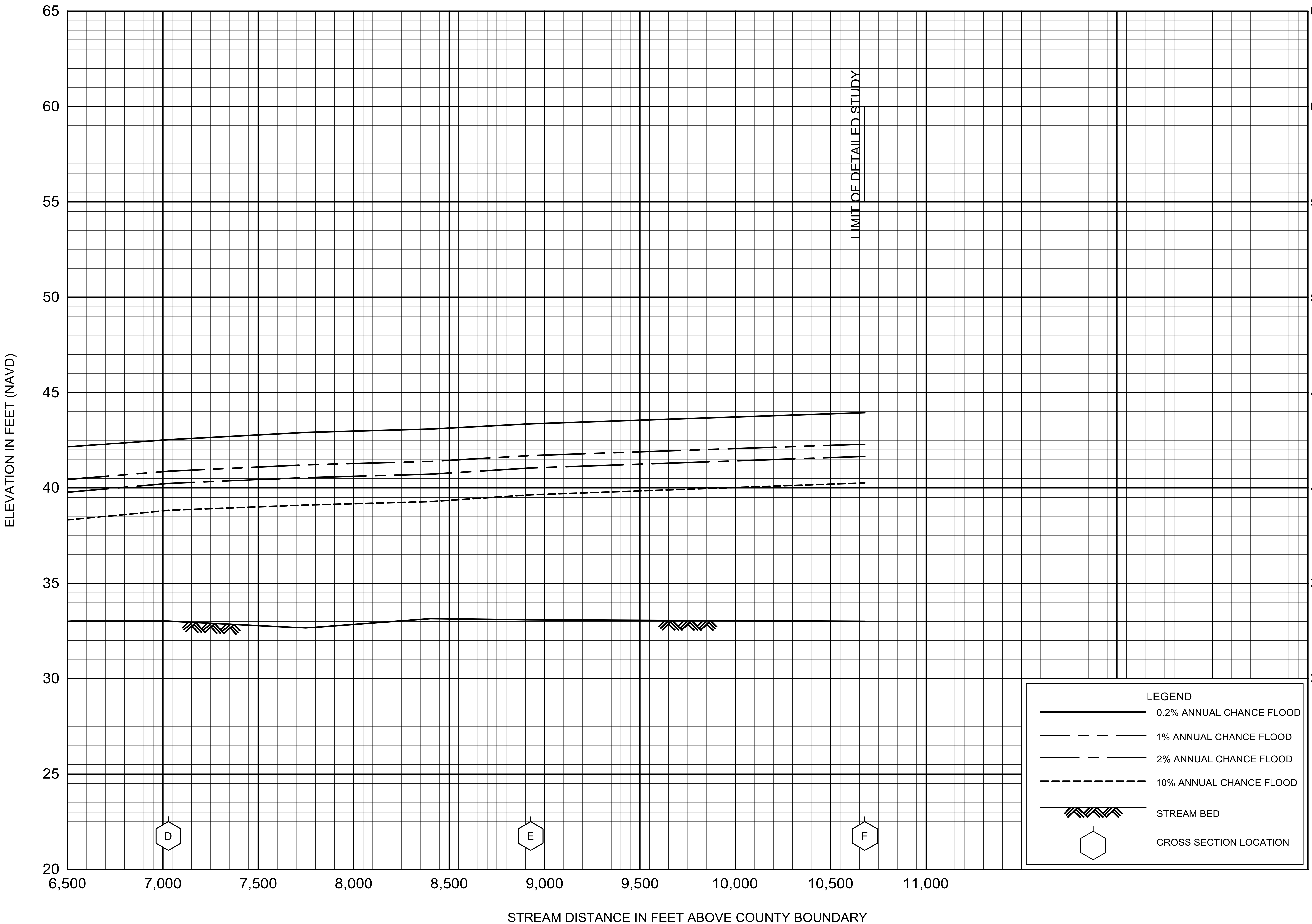
FLOOD PROFILES

TIDY ISLAND CREEK

FEDERAL EMERGENCY MANAGEMENT AGENCY

CAROLINE COUNTY, MD

AND INCORPORATED AREAS



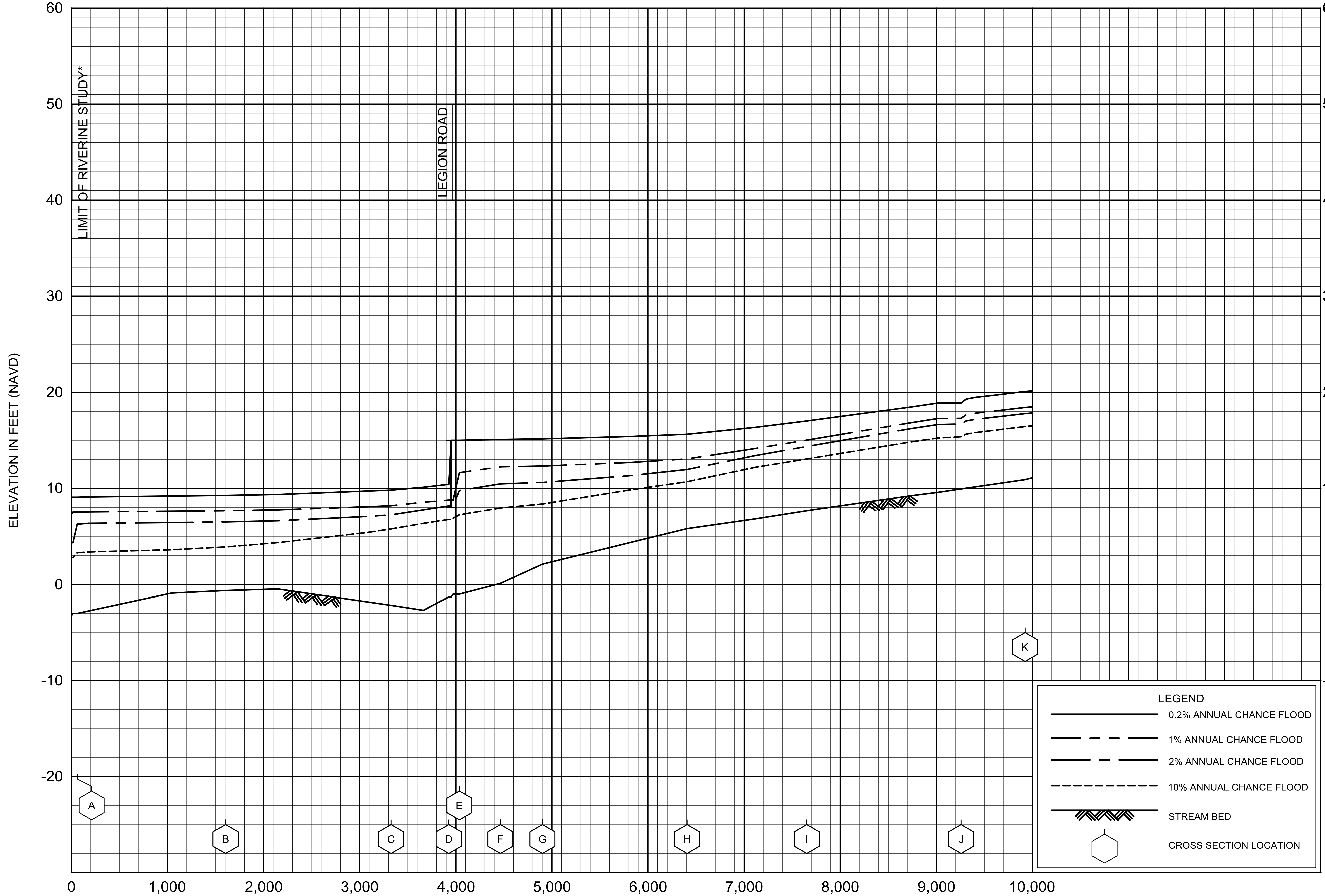
FLOOD PROFILES

TIDY ISLAND CREEK

FEDERAL EMERGENCY MANAGEMENT AGENCY

CAROLINE COUNTY, MD

AND INCORPORATED AREAS



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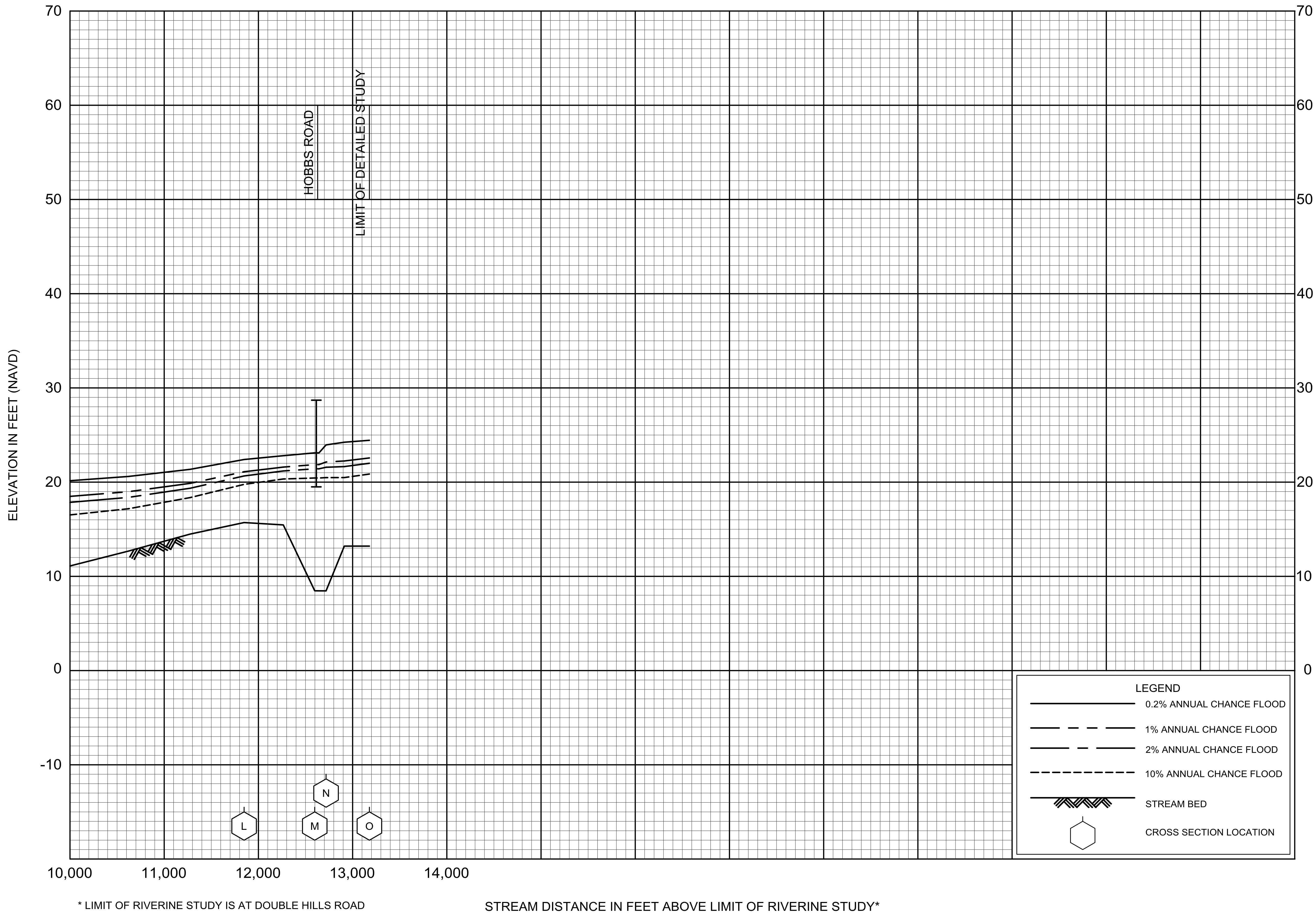
FLOOD PROFILES

WATTS CREEK

FEDERAL EMERGENCY MANAGEMENT AGENCY

CAROLINE COUNTY, MD

AND INCORPORATED AREAS



FLOOD PROFILES

WATTS CREEK

FEDERAL EMERGENCY MANAGEMENT AGENCY

CAROLINE COUNTY, MD

AND INCORPORATED AREAS