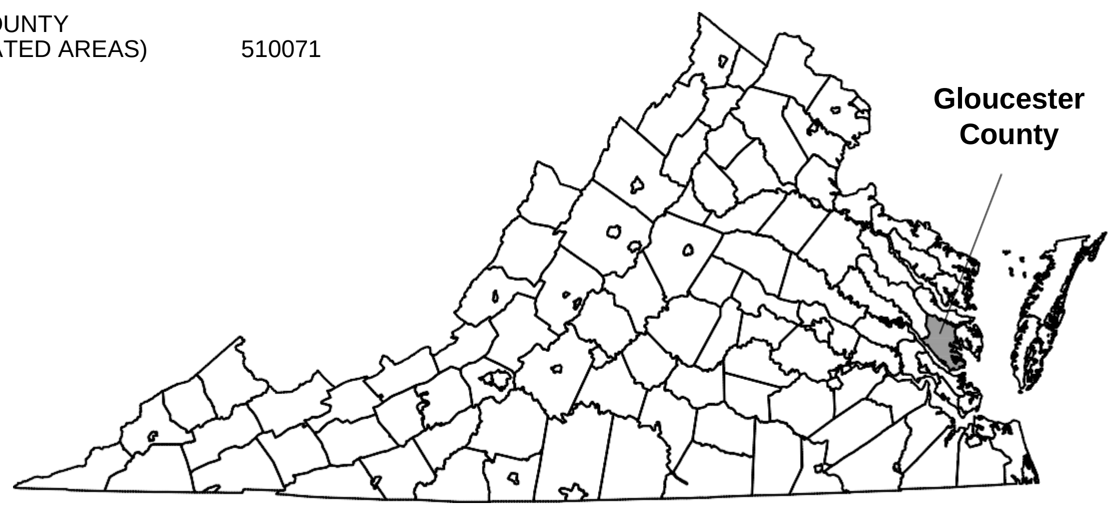
FLOOD INSURANCE STUDY

GLOUCESTER COUNTY, VIRGINIA (ALL JURISDICTIONS)

COMMUNITY NAME	**COMMUNITY NUMBER**
GLOUCESTER COUNTY (UNINCORPORATED AREAS)	510071



REVISED: NOVEMBER 19, 2014

Federal Emergency Management Agency

FLOOD INSURANCE STUDY NUMBER
51073CV000B

NOTICE TO
FLOOD INSURANCE STUDY USERS

Communities participating in the National Flood Insurance Program (NFIP) 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 (LOMR) 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.

Initial Countywide FIS Effective Date: September 17, 2010

Revised Countywide FIS Effective Date: November 19, 2014

TABLE OF CONTENTS

TABLE OF CONTENTS -- continued

FLOOD INSURANCE STUDY
GLOUCESTER COUNTY, VIRGINIA (ALL JURISDICTIONS)

1.0 INTRODUCTION

1.1 Purpose of Study

This countywide FIS investigates the existence and severity of flood hazards in, or revises and updates previous FISs / Flood Insurance Rate Maps (FIRMs) in the geographic area of Gloucester 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 Gloucester County to update existing floodplain regulations as part of the Regular Phase of the 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 (CFR) at 44 CFR, 60.3.

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.

The hydrologic and hydraulic analyses for the August 4, 1987 FIRM were prepared by the Norfolk District of the U.S. Army Corps of Engineers (USACE) for FEMA, under the Inter-Agency Agreement EMW-E-1153, Project Order No. 1, Amendment No. 15. This work was completed in October 1985.

For the September 17, 2010, countywide FIRM, no new hydrologic and hydraulic analyses were prepared, but the Digital Flood Insurance Rate Map (DFIRM) conversion was performed by AMEC, Earth & Environmental, Inc. for FEMA, under Contract No. HSFE03-07-D-0030, Task Order HSFE03-08-J-0007.

For the November 19, 2014, countywide revision, the coastal analysis and mapping for Gloucester County was conducted for FEMA by RAMPP under contract No. HSFEHQ-09-D-0369, Task Order HSFE03-10-J-0024. The coastal analysis involved transect layout, field reconnaissance, erosion analysis, and overland wave modeling including wave setup, wave height analysis and wave run-up. In addition, a storm surge study was conducted for FEMA by the USACE and its project partners under contract Nos. HSFE03-06-X-0023 and HSFE03-09-X-1108. 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).

Base map information shown on this FIRM was obtained in digital spatial format from the Commonwealth of Virginia and Gloucester County. Road centerline, county boundary, and streamline files were provided by the Gloucester County Department of Information Technology and Geographic Information Systems. 2006 digital orthophotographs were provided by the Virginia Geographic Information Network (VGIN). Adjustments were made to specific base map features to align them to 1" = 100' and 1" = 200' scale orthophotos.

The projection used in the preparation of this map is the North American Datum of 1983 (NAD 83) HARN Virginia State Plane south zone (FIPSZONE 4502). The horizontal datum is NAD 83 HARN, GRS80 spheroid. Differences in datum, spheroid, projection or State Plane zones used in the production of FIRMs for adjacent jurisdictions may result in slight positional differences in map features across jurisdiction boundaries. These differences do not affect the accuracy of this FIRM.

1.3 Coordination

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

For the 1987 FIS, an initial CCO meeting was held on April 14, 1983, with representatives of FEMA, Gloucester County, the Virginia State Water Control Board, and the study contractor (USACE).

On September 17, 1986, the results of the study were reviewed at a final CCO meeting attended by representatives of FEMA, Gloucester County, the Virginia State Water Control Board, and the study contractor (USACE).

For the 2010 countywide revision, Gloucester County was notified by letters sent in July 2008 that the FIS would be updated and converted to countywide format. A final CCO meeting was held on December 8, 2009 and was attended by representatives of FEMA, the Virginia State NFIP Office, Gloucester County, and the study contractor (AMEC).

For this revision, an initial CCO meeting was held on March 31, 2011, with representatives of FEMA, Gloucester County, and study contractor (RAMPP).

The results of the study were reviewed at the final CCO meeting held on May 20, 2013, and attended by representatives of FEMA, the study contractor, and Gloucester County. All problems raised at that meeting have been addressed in this study.

2.0 AREA STUDIED

2.1 Scope of Study

This FIS covers the geographic area of Gloucester County, Virginia.

For the August 4, 1987 study, the following riverine flooding sources were studied by detailed methods: Beaverdam Swamp, from its confluence with the Ware River to approximately 1.3 miles upstream of State Route 616; and Fox Mill Run, from its confluence with the Ware River to the downstream side of State Route 616.

For the August 4, 1987 study, the following riverine flooding sources were studied by approximate methods: portions of Beaverdam Swamp, Beech Swamp, Bland Creek, Burke Mill Stream, Burke Pond, Carvers Creek, Cow Creek, Cow Creek Pond, Crany Creek, Dragon Swamp, Ferry Creek, Fores Creek, Foxes Creek, portions of Fox Mill Run, Gallaman Swamp, Harper Creek, Haynes Pond, Poplar Spring Branch, the Poroptank River, Robins Pond, Pratts Swamp, Woods Mill Swamp and Zion Branch. Approximate analyses were used to study those areas having a low development potential or minimum flood hazards. The scope and methods of study were proposed to, and agreed upon by, FEMA and Gloucester County.

For the September 17, 2010 countywide study the 1-percent annual chance flood hazard for Beaverdam Reservoir was delineated based on data from the Beaverdam Reservoir Dam Break Inundation Zone Study completed in December, 2008 (Virginia Department of Game & Inland Fisheries, 2008). Using the analysis from this study a 1-percent annual chance flood hazard pool elevation was determined for the reservoir and, using this elevation, an approximate flood hazard was determined using the best available topographic data. No LOMRs were recorded for this countywide revision.

The November 19, 2014, countywide revision incorporates new detailed coastal flood hazard analyses for the Chesapeake Bay, Mobjack Bay, the North River, the Severn River, the Ware River and the York River.

2.2 Community Description

Gloucester County is located on the southeast end of Virginia's Middle Peninsula between the York and Rappahannock Rivers. It is bordered by the Piankatank River and Middlesex County to the north; Mobjack Bay, the Chesapeake Bay, and Mathews County to the east; the York River to the south; and King and Queen County to the west. The population of Gloucester County was 20,107 in 1980 (Census Bureau, 1982). The trend of increasing population which commenced after the 1940's has continued with the population as determined by the 2010 Census at 36,858 (Census Bureau, 2013). The county has 225 square miles of land area of which more than half is surrounded by water.

Land use within the floodplains of the county consists of scattered residential structures, summer cottages, small businesses, cropland, and forest. With the county's many miles of shoreline, there will be pressure for future development in these areas.

The county is situated in the Coastal Plain province and is underlain by sand, gravel, clay, and marl strata. Elevations within the county range from 0 to approximately 130 feet in the western portion of the county. In the southeastern portion, the terrain is generally flat with no unusual features. The eastern and southern sides of the county are also characterized by numerous inlets, bays, and creeks.

The area enjoys a temperate climate with moderate seasonal changes. The climate is characterized by moderately warm summers with temperatures averaging approximately 78 degrees Fahrenheit (°F) during July, the warmest month. The winters are cool with temperatures averaging approximately 38°F in January, the coolest month. The annual precipitation averages approximately 47.57 inches. There is some variation in the monthly averages; however, rainfall is distributed evenly throughout the year. Annual snowfall averages approximately 9.7 inches, generally occurring in light amounts and usually melting in a short period of time (Gloucester County, 2009).

2.3 Principal Flood Problems

The coastal areas of Gloucester County are vulnerable to tidal flooding from major storms such as hurricanes and nor'easters. Both types of storms produce winds that push large volumes of water against the shore.

With their high winds and heavy rainfall, hurricanes are the most severe storms that can hit the Gloucester County area. The term hurricane is applied to an intense cyclonic storm originating in tropical or subtropical latitudes in the Atlantic Ocean just north of the equator. A study of tracks of all tropical storms for which there is a record indicates that, on an average of once a year, a tropical storm of hurricane force passes within 250 miles of the area and poses a threat to Gloucester County. While hurricanes may affect the area from May through November, nearly 80 percent occur in the months of August, September, and October, with approximately 40 percent occurring in September. The most severe hurricane to strike the study area occurred in August 1933. Other notable hurricanes that caused significant flooding in Gloucester County occurred in September 1936, October 1954, August 1955, August 1995, September 1999 and September 2003.

Another type of storm that can cause severe damage to the county is the nor'easter. This is also a cyclonic type of storm and originates with little or no warning along the middle and northern Atlantic coast. These storms occur most frequently in the winter months but can occur at any time. Accompanying winds are not of hurricane force but are persistent, causing above-normal tides for long periods of time.

The amount and extent of damage caused by any tidal flood will depend on the topography of the area flooded, the rate of rise of floodwaters, the depth and duration of flooding, the exposure to wave action, and the extent to which structures have been placed in the floodplain. The depth of flooding during these storms depends on the velocity, direction, and duration of the wind; the size and depth of the body of water over which the wind is acting; and the astronomical tide. The duration of flooding depends on the duration of tide-producing forces. Floods caused by hurricanes are usually of much shorter duration than those caused by nor'easters. Flooding from hurricanes rarely lasts more than one tidal cycle, while flooding from nor'easters can last several days, during which the most severe flooding takes place at the time of the peak astronomical tide.

The timing or coincidence of the maximum storm surge with the normal high tide is an important factor in the consideration of flooding from tidal sources. Tidal waters in the study area normally fluctuate twice daily from 1.2 feet to -1.2 feet in the Chesapeake Bay (National Oceanic and Atmospheric Administration, 1984). The range of fluctuation is somewhat less in most of the connecting bays and inlets.

The area also contains numerous estuaries of the Chesapeake and Mobjack Bays that are subject to tidal flooding in their lower reaches. Flooding on the upper reaches of these streams may be caused by heavy rains occurring anytime throughout the year. Flooding may also occur as a result of intense rainfall produced by local summer thunderstorms or tropical disturbances, such as hurricanes, that move into the area from the Gulf or Atlantic coasts. Flood heights on these streams can rise from normal to extreme flood peaks in a relatively short period of time. The duration of flooding depends on the duration of runoff-producing rainfall. In some cases, floods may last for a couple of days, whereas floods occurring as a result of short duration summer thunderstorms usually rise to a maximum peak stage and subside to near normal levels in less than a day.

All development in the floodplain is subject to water damage. Some areas, depending on exposure, are subject to high velocity wave action that can cause structural damage and severe erosion along beaches. Waves are generated by the action of wind on the surface of the water. The entire eastern shoreline and portions of the southern shoreline of Gloucester County are vulnerable to wave damage due to the vast exposure afforded by the Chesapeake Bay and Mobjack Bay.

Gloucester County has experienced major storms since the early settlement of the area. Historical accounts of severe storms in the area date back several hundred years. The following paragraphs discuss some of the larger known floods that have occurred in recent history. This information is based on newspaper accounts, historical records, field investigations, and routine data collection programs normally conducted by the USACE.

The August 1933, hurricane was one of the most severe storms ever to occur in the Middle Atlantic Coast region. The storm passed inland near Cape Hatteras on August 22, and was accompanied by extreme winds and tides.

Norfolk reported the greatest 24-hour rainfall in its history, a fall of 6.64 inches. At Norfolk, gusts of wind reached measured velocities of 88 miles per hour (mph), although the maximum sustained velocity was only 56 mph. The highest tide of record at Hampton Roads was recorded on this date. In Gloucester County, widespread damage to homes, cropland, and livestock resulted from the tidal flooding that reached an elevation of approximately 8.8 feet at Gloucester Point. Due to the drainage characteristics of the area, the tidal waters and the coincident heavy rainfall were trapped, which added to the misfortune of the local inhabitants. Wells were fouled by the salt water, and the soil saturated by the salt intrusion required several years to return to its former productive state. Families were isolated, and all productive activities ceased for a 10-day period. The older inhabitants of the area do not have any recollection of a storm of equal magnitude as to the extent of flooding or damage suffered. In addition to damage from tidal flooding, much damage was caused to roofs, communication lines, and other structures by the high wind. Damage of this nature is characteristic of that caused by a severe hurricane (USACE, 1960).

The eye of the September 18, 1936, hurricane passed approximately 20 miles east of Cape Henry. High tides and gale force winds caused much damage throughout the lower Chesapeake Bay area as the storm moved off to the northeast. At Gloucester Point, the elevation of flooding reached 6.4 feet. Damage was severe, and by occurring during the depression period, became a doubled hardship on the populace (USACE, 1960).

On October 15, 1954, Hurricane Hazel passed approximately 60 miles inland through Virginia, causing high winds and moderately high tides. The center of the hurricane moved inland in the vicinity of the South Carolina-North Carolina border between 9 a.m. and 10 a.m., and rapid northward movement carried the center through Virginia between 2 p.m. and 6 p.m. Hurricane force winds with gusts of 80 to 100 mph were experienced near the path of the storm center and eastward to the coast. The tidal flooding during this hurricane caused considerable salt damage due to the dry antecedent soil conditions. There was also severe damage from the wind and salt spray (USACE, 1960).

On August 13, 1955, Hurricane Connie followed a path similar to the August 1933 hurricane and generated a fairly high storm surge. The surge occurred at the time of the astronomical low tide in this area, and the resultant tide was approximately 4.3 feet at Gloucester Point. The extremely heavy rainfall of approximately 9 inches in 24 hours with this hurricane added to the damage inflicted by the tidal flooding (USACE, 1960).

A tidal stage of major proportions occurred during the nor'easter of March 6-8, 1962, the “Ash Wednesday” storm. Disastrous flooding and high waves occurred all along the Atlantic Seaboard from New York to Florida. This storm was unusual even for a nor'easter since it was caused by a low pressure cell that moved from south to north and then reversed its course, moving again to the south and bringing with it huge volumes of water and high waves. In Gloucester County, this storm caused severe tidal flooding. Great destruction was caused by high waves and breakers superimposed on high tides. The waves and breakers undermined and collapsed buildings; eroded the beaches, roads, and sand dunes; interrupted communications and power lines; and damaged agricultural lands. Damaging high waters occurred on five successive high tides over a 2-day period and disrupted all normal activities for several days (USACE, 1962). The elevation of flooding reached 5.8 feet at Gloucester Point.

The "Superstorm of March '93" was also known as "The Storm of the Century" for the eastern United States, due to its large area of impact, all the way from Florida and Alabama through New England. The storm was blamed for some 200 deaths and cost a couple billion dollars to repair damages and remove snow. In Florida, it produced a storm surge of 9 to 12 feet that killed 11 people (more deaths than storm surges Hurricanes Hugo and Andrew combined) and it spawned 11 tornadoes. In a large swath from Alabama to New England, it dropped over a foot of snow. As the storm's center crossed Virginia, weather stations recorded their lowest pressure ever (Virginia Department of Energy Management, 2009).

A nor'easter battered eastern Virginia on Tuesday, January 27 and Wednesday, January 28, 1998. The slow movement of the storm combined with the highest astronomical tides of the month resulted in an extended period of gale to storm force onshore winds which drove tides to 6.44 feet above Mean Lower Low Water (MLLW) at Sewells Point in Norfolk. These tide levels resulted in moderate coastal flooding throughout the Hampton Roads area and the Virginia Eastern Shore. Locally moderate coastal flooding was also reported across the middle peninsula and northern neck areas. The rainfall combined with the gale and storm force winds resulted in scattered tree limbs downed across much of eastern Virginia. In addition, there were widely scattered power outages (National Climatic Data Center, 2008).

A nor'easter battered eastern Virginia from Tuesday, February 3, through Thursday, February 5, 1998. The slow movement of the storm resulted in an extended period of gale to storm force onshore winds which drove tides to 7.0 feet above MLLW at Sewells Point in Norfolk. In Gloucester County, the bay rose to 3 to 4 feet above normal, requiring one family to be rescued by rowboat. Otherwise, locally moderate flooding was reported across the middle peninsula and northern neck areas. The rainfall combined with the gale and storm force winds resulted in some trees downed across much of eastern Virginia. In addition, there were widely scattered power outages (National Climatic Data Center, 2008).

During the period of September 15-16, 1999, Hurricane Floyd was a Category 1 hurricane as it crossed the Wakefield Weather Forecast Office WFO) county warning area (CWA). Sustained tropical storm force winds with gusts to near hurricane force occurred over the northwest quadrant of the storm over interior portions of northeast North Carolina and along the coastal waters of the Wakefield marine area. The tidal departure at

Sewells Point in Norfolk was 3.9 feet above normal or 6.4 feet above MLLW. This resulted in moderate to locally severe coastal flooding approximately 2 hours before high tide on September 16th. The tide gage in downtown Norfolk recorded a tide of 7.1 feet above MLLW. Flooding was more widespread during Hurricane Floyd due to extremely heavy rainfall before and during the peak storm tide. Floyd will be remembered as an extremely wet hurricane for east-central Virginia. The presence of a stalled frontal boundary provided the focus for extremely heavy rains (National Climatic Data Center, 2008).

During the period of September 18–19, 2003, Hurricane Isabel was a Category 1 hurricane as it crossed the Wakefield WFO CWA. Sustained tropical storm force winds with frequent gusts to hurricane force occurred over Eastern Virginia, along and near the Chesapeake Bay and Atlantic Coastal Waters. The highest sustained wind speed recorded was 72 mph at Chesapeake Light (CHLV2). Other sustained wind speeds were 69 mph at Gloucester Point (VIMS). The highest gusts recorded were 107 mph at Gwynns Island (Mathews County), 100 mph at Reedville (Middlesex County), 93 mph at Chesapeake Light, 91 mph at Gloucester Point, and 83 mph at Norfolk Naval Air Station. The unusually large wind field uprooted many thousands of trees, downed many power lines, damaged hundreds of houses, and snapped thousands of telephone poles and cross arms. Hundreds of roads, including major highways, were blocked by fallen trees. Over 2 million customers of Dominion Virginia Power were without electricity. Isabel will be remembered for the greatest wind and storm surge in the region since Hazel in 1954, and the 1933 Chesapeake-Potomac Hurricane. Also, Isabel will be remembered for the most extensive power outages ever in Virginia and permanent change to the landscape from all the fallen trees and storm surge (National Climatic Data Center, 2008).

Coastal flooding associated with Tropical Storm Ernesto occurred on September 1, 2006 with tides of 4 to 5 feet above normal which combined with 6 to 8 foot waves, causing significant damage to homes, piers, bulkheads, boats, and marinas across portions of the Virginia Peninsula and Middle Peninsula near the Chesapeake Bay and adjacent tributaries (National Climatic Data Center, 2008).

An unnamed nor'easter of October 6-7, 2006 caused extensive damage in Gloucester County (Gloucester County, 2008).

From late Tuesday, November 21, into Thursday afternoon, November 23, 2006, an intense low pressure system off the North Carolina coast combined with an upper level cutoff low to provide very strong winds, heavy rains, and moderate coastal flooding across portions of eastern and southeast Virginia. Strong onshore winds caused moderate coastal flooding during times of high tide. Tidal departures were about 3 feet above normal during the event.

2.4 Flood Protection Measures

There are no existing flood control structures that would provide protection during major floods in the study area. There are a number of measures that have afforded some protection against flooding, including bulkheads and seawalls, jetties, sand dunes, and non-structural measures for floodplain management such as zoning codes. The "Uniform Statewide Building Code" that went into effect in September 1973 states, "where a structure is located in a 100-Year Flood Plain, the lowest floor of all future construction or substantial improvement to an existing structure..., must be built at or above that level, except for non-residential structures which may be floodproofed to that level" (Commonwealth of Virginia, 1973). These requirements will no doubt be beneficial in reducing future flood damage in the county.

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 riverine flooding source studied in detail affecting the county.

Information on the methods used to determine peak discharge-frequency relationships for the streams studied by detailed methods is shown below.

Pre-countywide Analyses

A discharge-frequency relationship was developed at a stream gage on Beaverdam Swamp above the study limits. This relationship was developed in accordance with the procedures outlined in U. S. Geological

Survey (USGS) Bulletin 17B and was based on 33 years of record (USGS, 1981). Flood discharge frequencies were also computed for the gage using regression equations developed from a regional analysis performed by the USGS (USGS, 1978). These regression equations were modified so that the computed discharges would agree with the gage-record discharges. These modified equations were used to compute discharges for the portions of Beaverdam Swamp and Fox Mill Run studied by detailed methods.

Based on the availability of previously published discharge information, a summary of the drainage area-peak discharge relationships for the streams studied by detailed methods is shown in Table 1, "Summary of Discharges".

TABLE 1 - SUMMARY OF DISCHARGES

FLOODING SOURCE AND LOCATION	DRAINAGE AREA (sq. miles)	PEAK DISCHARGES (cubic feet per second) 10-Percent Annual Chance	2-Percent Annual Chance	1-Percent Annual Chance	0.2-Percent Annual Chance
BEAVERDAM SWAMP					
At State Route 3/14	22.6	860	1,840	2,435	4,345
At State Route 616	21.1	835	1,790	2,370	4,240
Approximately 1.7 miles upstream of State Route 616	15.2	680	1,465	1,940	3,505
FOX MILL RUN					
At U. S. Route 17 Business	13.1	595	1,290	1,715	3,115
At U.S. Route 17	12.5	585	1,270	1,685	3,070
At State Route 616	8.8	460	1,010	1,340	2,475

September 17, 2010, Countywide Study

No new riverine hydrologic analysis was developed for this study.

November 19, 2014 Countywide Revision

No new riverine hydrologic analysis was developed for this revision.

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 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.

Pre-countywide Analyses

Cross sections for the backwater analyses of Beaverdam Swamp and Fox Mill Run were obtained from aerial photographs at a scale of 1:8,000 (Air Survey Corporation, 1983). The inundated portions of the sections were obtained from field measurement. All bridges, dams, and culverts were field surveyed to obtain elevation data and structural geometry.

Locations of selected cross sections used in the hydraulic analyses are shown on the Flood Profiles (Exhibit 1). For stream segments for which a floodway was computed (Section 4.2), selected cross-section locations are also shown on the FIRM (Exhibit 2).

Water-surface elevations of floods of the selected recurrence intervals were computed using the COE HEC-2 step-backwater computer program (USACE, 1982). Flood profiles were drawn showing computed water-surface elevations for floods of the selected recurrence intervals. Starting water-surface elevations for Beaverdam Swamp and Fox Mill Run were calculated using the slope/area method.

Roughness factors (Manning’s "n") used in the hydraulic computations were based on engineering judgment and field observations of the streams and floodplain areas. A channel "n" value of 0.035 and an overbank "n" value of 0.100 were used for Beaverdam Swamp and Fox Mill Run.

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

Approximate boundaries for the streams studied by approximate methods were determined by slope/area computations. Discharge/depth relations were then used to determine flood boundaries. The approximate boundaries were also based on previous studies, and familiarization and experience with similar streams.

September 17, 2010, Countywide Study

No new hydraulic analyses were performed for this revision. However, this entire study was updated from the National Geodetic Vertical Datum of 1929 (NGVD 29) to the North American Vertical Datum of 1988 (NAVD 88) using a conversion factor of -1.1 feet.

Detail-studied streams that were not re-studied as part of this map update may include a "profile base line" on the maps. This "profile base line" provides a link to the flood profiles included in the Flood Insurance Study report. The detail-studied stream centerline may have been digitized or redelineated as part of this revision. The "profile base lines" for these streams were based on the best available data at the time of their study and are depicted as they were on the previous FIRMs. In some cases where improved topographic data was used to redelineate floodplain boundaries, the "profile base line" may deviate significantly from the channel centerline or may be outside the SFHA.

November 19, 2014 Countywide Revision

No new riverine hydrologic analysis was developed for this revision.

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 (TSDN) associated with the FIS report and FIRM for this community. Interested individuals may contact FEMA to access these data.

3.3 Coastal Analyses

For the November 19, 2014, countywide revision, coastal analyses considering storm characteristics, and the shoreline and bathymetric characteristics of the flooding sources studied were carried out to provide estimates of the elevations of floods of the selected recurrence intervals. Coastal flood elevations are provided in Table 2, "Summary of Coastal Stillwater Elevations" in this report. If the elevation on the FIRM is higher than the elevation shown in this table, a wave height, wave runup, and/or wave setup component likely exists, in which case, the higher elevation should be used for construction and/or floodplain management purposes.

Development along the coast of Gloucester County is limited to interior areas, as well as Gloucester, Gloucester Point, sheltered rivers and bays, beginning at the Piankatank River, North River, Ware River Severn River, Southwest Branch, York River, Back Creek, Belleville Creek, Davis Creek, Wilsons Creek, Northwest Branch, Willetts Creek, Butler Creek, Heywood Creek, Thornton Creek, Northeast Branch, Timberneck Creek, Cedarbush

Creek, and Poropotank Creek. The entire shoreline along Mobjack Bay / Chesapeake Bay is undeveloped low sand spits and salt water marshland.

An analysis was performed to establish the frequency peak elevation relationships for coastal flooding in Gloucester County. The FEMA Region III office initiated a study in 2008 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. The study replaces outdated coastal storm surge stillwater elevations for all FISs in the study area, including Gloucester County, VA, and serves as the basis for updated FIRMs. Study efforts were initiated in 2008 and concluded in 2012.

The storm surge study was conducted for FEMA by the USACE and its project partners 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 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 (Luettich and Westernick, 2008). ADCIRC was dynamically coupled to the unstructured numerical wave model Simulating Waves Nearshore (unSWAN) to calculate the contribution of waves to total storm surge (USACE, 2012). The resulting model system is typically referred to as SWAN+ADCIRC (USACE, 2012). 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.

The tidal surge in the Atlantic Ocean and Chesapeake Bay affects approximately 300 miles of Gloucester County coastline. The eastern coastline, fronting along Chesapeake and Mobjack Bays, as well as portions of the Piankatank, North Ware, Severn, and York Rivers, are more prone to damaging wave action during high wind events due to the significant fetch over which winds can operate. The widths of several embayments narrow considerably. In these areas, the fetch over which winds can operate for wave generation is significantly less.

The storm-surge elevations for the 10-, 2-, 1-, and 0.2-percent annual chance floods were determined for Chesapeake Bay and are shown in Table 2, "Summary of Coastal Stillwater Elevations". The analyses reported herein reflect the stillwater elevations due to tidal and wind setup effects.

TABLE 2 - SUMMARY OF COASTAL STILLWATER ELEVATIONS

FLOODING SOURCE AND LOCATION	ELEVATION (feet NAVD 88) 10-PERCENT ANNUAL CHANCE	2-PERCENT ANNUAL CHANCE	1-PERCENT ANNUAL CHANCE	0.2-PERCENT ANNUAL CHANCE
CHESAPEAKE BAY/MOBJACK BAY				
At Tow Stake Point	4.6	5.5	6.0	7.6
At Bush Point	4.6	5.6	6.0	7.3
At confluence of Little Monday Creek	4.7	5.7	6.2	7.5
NORTH RIVER				
At confluence of Back Creek	4.7	5.8	6.5	9.0
At Lone Point	4.6	5.6	6.2	8.4
WARE RIVER				
At Deacons Neck Landing	4.8	6.0	6.6	9.5
At Ware Neck Point	4.6	5.6	6.0	7.8
SEVERN RIVER				
At Stump Point	4.7	5.8	6.3	7.9
At Turtle Neck Point	4.7	5.7	6.1	7.7
YORK RIVER				
At confluence of Poropotank River	5.3	6.4	6.8	8.8
At confluence of Jones Creek	5.1	6.1	6.6	8.1
At Blundering Point	4.9	6.0	6.5	7.9
At Coleman Memorial Bridge	4.8	6.0	6.5	7.8
At confluence of Perrin River	4.6	5.8	6.3	7.5

The methodology for analyzing the effects of wave heights associated with coastal storm surge flooding is described in a report prepared by the National Academy of Sciences (NAS) (NAS, 1977). This method is based on three major concepts. First, depth-limited waves in shallow water reach maximum breaking height that is equal to 0.78 times the stillwater depth. The wave crest is 70 percent of the total wave height above the stillwater level. The second major concept is that wave height may be diminished by dissipation of energy due to the presence of obstructions such as sand dunes, dikes, seawalls, buildings and vegetation. The amount of energy dissipation is a function of the physical characteristics of the obstruction and is determined by procedures prescribed in NAS Report. The third major concept is that wave height can be regenerated in open fetch areas due to the transfer of wind energy to the water. This added energy is related to fetch length and depth.

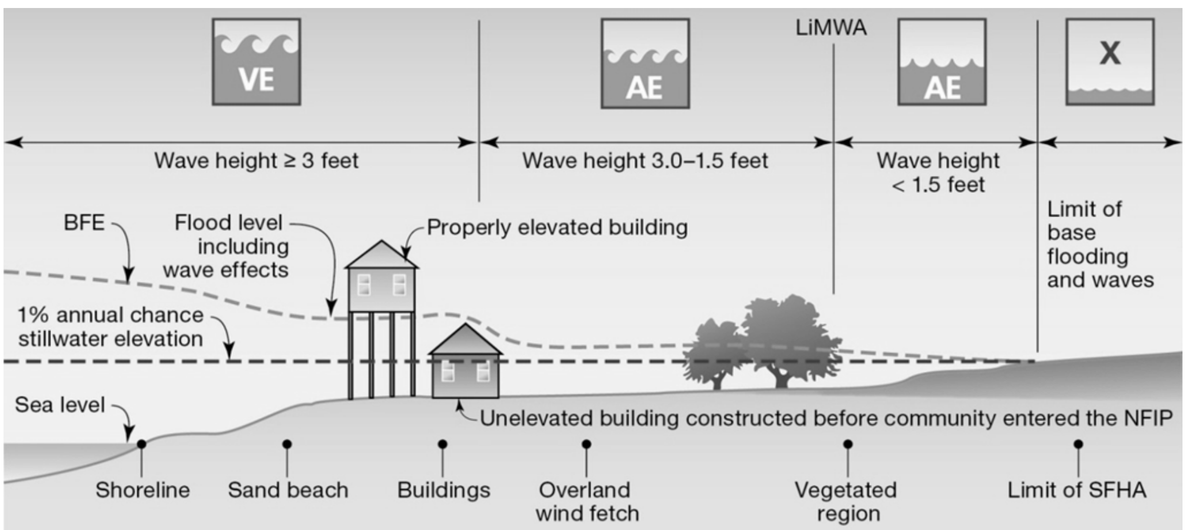
The coastal analysis involved transect layout, field reconnaissance, erosion analysis, and overland wave modeling, including wave setup, wave height analysis and wave runup.

Wave heights were computed across transects that were located along coastal and inland bay areas of Gloucester County, as illustrated on the

FIRMs. The transects were located with consideration given to existing transect locations and to the physical and cultural characteristics of the land so that they would closely represent conditions in the locality.

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 (USACE, 1975). 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 1, "Transect Schematic".

FIGURE 1 – TRANSECT SCHEMATIC



Each transect was taken perpendicular to the shoreline and extended inland to a point where coastal flooding ceased. Along each transect wave heights and elevations were computed considering the combined effects of changes in ground elevation, vegetation and physical features. The stillwater elevations for a 1% annual chance event were used as the starting elevations for these computations. Wave heights were calculated to the nearest 0.1 foot, and wave elevations were determined at whole-foot increments along the transects. The location of the 3-foot breaking wave for determining the terminus of the Zone VE (area with velocity wave action) was computed at each transect. Along the open coast the Zone VE designation applies to all areas seaward of the landward toe of the primary frontal dune system. The primary frontal due is defined as the point where the ground profile changes from relatively steep to relatively mild.

Dune erosion was taken into account along the Chesapeake Bay coastline. A review of the geology and shoreline type in Gloucester County was made to determine the applicability of standard erosion methods, and FEMA's standard erosion methodology for coastal areas having primary frontal dunes, referred to as the "540 rule," was used (FEMA, 2007a). This methodology first evaluates the dune's cross-sectional profile to determine whether the dune has a reservoir of material that is greater or less than 540 square feet. If the reservoir is greater than 540 square feet, the "retreat" erosion method is employed and approximately 540 square feet of the dune is eroded using a standardized eroded profile, as specified in FEMA guidelines. If the reservoir is less than 540 square feet, the "remove" erosion method is employed where the dune is removed for subsequent analysis, again using a standard eroded profile. The storm surge study provided the return period stillwater elevations required for erosion analyses. There were no areas within Gloucester County found to meet the aforementioned criteria.

Wave height calculations used in this study are higher than the wave height calculations from the methodologies described in the FEMA guidance for coastal mapping (FEMA, 2007a). Wave setup results in an increased water level at the shoreline due to the breaking of waves and transfer of momentum to the water column during hurricanes and severe storms. For the Gloucester County study, wave setup was determined directly from the coupled wave and storm surge model The total stillwater elevation (SWEL) with wave setup was then used for simulations of inland wave propagation conducted using FEMA's Wave Height Analysis for Flood Insurance Studies (WHAFIS) model Version 4.0 (FEMA, 2007c). WHAFIS is a one-dimensional model that was applied to each transect in the study area. The model uses the specified SWEL, the computed wave setup, and the starting wave conditions as input. Simulations of wave transformations were then conducted with WHAFIS taking into account the storm-induced erosion and overland features of each transect. Output from the model includes the combined SWEL and wave height along each cross-shore transect allowing for the establishment of BFEs and flood zones from the shoreline to points inland within the study area.

Wave runup is defined as the maximum vertical extent of wave uprush on a beach or structure. FEMA's 2007 Guidelines and Specifications require the 2% wave runup level be computed for the coastal feature being evaluated (cliff, coastal bluff, dune, or structure) (FEMA, 2007a). The 2% runup level is the highest 2% of wave runup affecting the shoreline during the 1-percent annual chance flood event. Each transect defined within the Region III study area was evaluated for the applicability of wave runup and, if necessary, the appropriate runup methodology was selected and applied to each transect. Runup elevations were then compared to WHAFIS results to determine the dominant process affecting BFEs and associated flood hazard levels. Based on wave runup rates, wave overtopping was computed following the FEMA 2007 Guidelines and Specifications.

Computed controlling wave heights at the shoreline range from 4.0 to 5.3 feet along Chesapeake and Mobjack Bays, from 4.7 to 5.6 feet along the Atlantic Ocean where the fetch is long to a range of 0.1 to 1.9 feet along Back Bay, where the fetch is short. The corresponding wave elevation at the shoreline varies from 9.8 to 11.0 feet NAVD 88 along Chesapeake Bay, 9.6 to 11.6 feet NAVD 88 along the Atlantic Ocean, and 2.5 feet to 7.2 feet NAVD 88 along Back Bay. The dune along the coast serves to reduce wave height transmitted inland, but the large areas of low-lying marshes which are inundated by the tidal surge allow regeneration of the waves as they proceed inland. In general, the relatively shallow depth of water in the marshes along with the energy dissipating effects of vegetation allows only minor regeneration of the waves.

Between transects, elevations were interpolated using topographic maps, land-use and land cover data, and engineering judgment to determine the aerial extent of flooding. The results of the calculations are accurate until local topography, vegetation, or cultural development within the community undergo major changes. A summary of the transect data for the coastal flooding sources in shown in Table 3, "Transect Data", which provides a listing of the transect locations, stillwater elevations, and initial crest elevations, and in Figure 2, "Transect Location Map".

TABLE 3 - TRANSECT DATA

Flood Source	Transect	Starting Wave Conditions for the 1% Annual Chance			Starting Stillwater Elevations (ft NAVD 88) Range of Stillwater Elevations (ft NAVD 88)				Zone Designation and BFE (ft NAVD 88)
		Coordinates	Significant Wave Height H_s (ft)	Peak Wave Period T_p (sec)	10% Annual Chance	2% Annual Chance	1% Annual Chance	0.2% Annual Chance	
NORTH RIVER	1	N 37.433203 W -76.452395	2.02	2.59	4.71	5.82	6.51	9.26	VE 9 AE 7
NORTH RIVER	2	N 37.422830 W -76.452356	2.46	3.04	4.70	5.79	6.48	9.05	VE 9 AE 7
NORTH RIVER	3	N 37.414257 W -76.442191	2.58	3.15	4.66	5.72	6.35	8.85	VE 9 AE 8
NORTH RIVER	4	N 37.411274 W -76.428272	4.76	3.13	4.63	5.67	6.30	8.63	VE 9 AE 6 - 8
NORTH RIVER	5	N 37.402945 W -76.415274	3.41	3.24	4.60	5.61	6.17	8.3	VE 9 AE 6 - 8
NORTH RIVER	6	N 37.386798 W -76.415885	4.23	3.85	4.59	5.59	6.12	8.14	VE 9 AE 6 - 7
MOBJACK BAY	7	N 37.368768 W -76.412404	5.17	4.73	4.59	5.57	6.02	7.86	VE 9 AE 6 -7
WARE RIVER	8	N 37.381140 W -76.431127	2.64	3.56	4.64	5.64	6.19	8.3	VE 9
WARE RIVER	9	N 37.381072 W -76.446399	3.02	3.73	4.69	5.74	6.29	8.42	VE 9 AE 7 - 8
WARE RIVER	10	N 37.378719 W -76.454327	2.42	3.19	4.72	5.79	6.36	8.64	VE 9 AE 8
WARE RIVER	11	N 37.381344 W -76.465079	3.14	3.35	4.75	5.83	6.38	8.68	VE 9
WARE RIVER	12	N 37.369842 W -76.469422	3.48	3.61	4.75	5.84	6.39	8.59	VE 9
WARE RIVER	13	N 37.359617 W -76.453258	2.95	3.24	4.72	5.78	6.31	8.33	VE 9
WARE RIVER	14	N 37.354406 W -76.434761	4.24	4.11	4.66	5.69	6.17	8.06	VE 9 AE 7 - 8

TABLE 3 - TRANSECT DATA -- continued

Flood Source	Transect	Starting Wave Conditions for the 1% Annual Chance			Starting Stillwater Elevations (ft NAVD88) Range of Stillwater Elevations (ft NAVD88)				Zone Designation and BFE (ft NAVD 88)
		Coordinates	Significant Wave Height H_s (ft)	Peak Wave Period T_p (sec)	10% Annual Chance	2% Annual Chance	1% Annual Chance	0.2% Annual Chance	
WARE RIVER	15	N 37.344106 W -76.421748	4.27	4.54	4.64	5.65	6.1	7.84	VE 9 AE 7 - 8
MOBJACK BAY	16	N 37.333272 W -76.399502	5.94	5.06	4.64	5.61	6.07	7.7	VE 9 AE 7 - 8
MOBJACK BAY	17	N 37.330463 W -76.415948	4.06	4.81	4.67	5.70	6.15	7.89	VE 9 AE 7 - 8
SEVERN RIVER	18	N 37.324575 W -76.428095	3.13	3.23	4.69	5.75	6.22	7.91	VE 9 AE 7 - 8
SEVERN RIVER	19	N 37.328279 W -76.451230	2.75	2.89	4.74	5.87	6.32	8.19	VE 9 AE 6 - 8
SEVERN RIVER	20	N 37.318601 W -76.447412	3.01	3.12	4.75	5.85	6.33	8.08	VE 9 AE 6 - 8
SEVERN RIVER	21	N 37.307628 W -76.417443	3.71	4.44	4.68	5.75	6.21	7.75	VE 9 AE 6 - 8
MOBJACK BAY	22	N 37.310495 W -76.392929	5.59	4.96	4.64	5.66	6.12	7.45	VE 9 AE 6 - 8
MOBJACK BAY	23	N 37.298715 W -76.395560	4.11	5.13	4.63	5.66	6.09	7.53	VE 9 AE 6 - 8
MOBJACK BAY	24	N 37.287828 W -76.382734	4.74	5.35	4.64	5.68	6.10	7.53	VE 9 AE 7 - 8
MOBJACK BAY	25	N 37.270386 W -76.388924	4.97	5.48	4.64	5.72	6.16	7.48	VE 8 - 9 AE 7 - 8
YORK RIVER	26	N 37.265539 W -76.396015	3.20	6.80	4.49	5.57	6.03	7.46	VE 8 - 9 AE 7 - 8
YORK RIVER	27	N 37.264743 W -76.407698	3.96	4.89	4.57	5.67	6.14	7.20	VE 9 AE 7 - 8

TABLE 3 - TRANSECT DATA -- continued

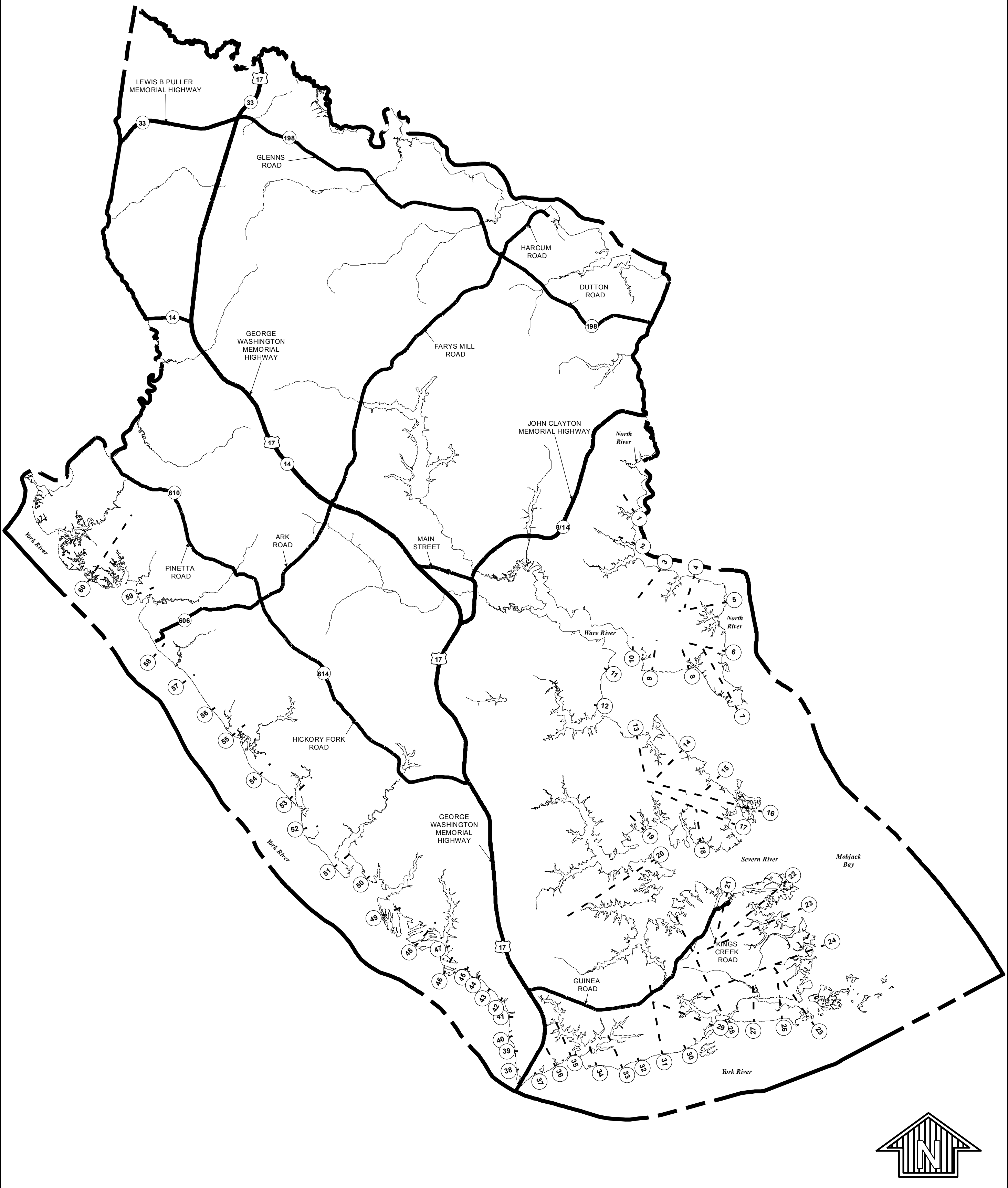
Flood Source	Transect	Starting Wave Conditions for the 1% Annual Chance			Starting Stillwater Elevations (ft NAVD88) Range of Stillwater Elevations (ft NAVD88)				Zone Designation and BFE (ft NAVD 88)
		Coordinates	Significant Wave Height H_s (ft)	Peak Wave Period T_p (sec)	10% Annual Chance	2% Annual Chance	1% Annual Chance	0.2% Annual Chance	
YORK RIVER	28	N 37.264565 W -76.418893	3.55	3.68	4.64	5.76	6.23	7.33	VE 9 AE 6 - 8
YORK RIVER	29	N 37.263832 W -76.424717	3.03	3.85	4.67	5.82	6.30	7.64	VE 9 AE 6 - 8
YORK RIVER	30	N 37.256339 W -76.435956	3.58	5.17	4.64	5.76	6.25	7.52	VE 9 AE 6 - 7
YORK RIVER	31	N 37.254710 W -76.445621	4.04	5.19	4.68	5.83	6.31	7.62	VE 10 AE 7 - 8
YORK RIVER	32	N 37.252748 W -76.455346	4.51	5.39	4.70	5.86	6.34	7.64	VE 10 AE 7
YORK RIVER	33	N 37.250527 W -76.462307	4.64	5.36	4.69	5.86	6.35	7.59	VE 10 AE 7
YORK RIVER	34	N 37.251420 W -76.472896	4.42	5.00	4.74	5.92	6.42	7.71	VE 10
YORK RIVER	35	N 37.254777 W -76.483420	2.88	4.22	4.78	5.97	6.47	7.77	VE 9 - 12
YORK RIVER	36	N 37.251333 W -76.489786	3.74	3.99	4.8	6.0	6.51	7.85	VE 10
YORK RIVER	37	N 37.248964 W -76.497952	3.75	4.62	4.82	6.03	6.54	7.88	VE 10
YORK RIVER	38	N 37.250473 W -76.505597	2.13	3.75	4.8	6.0	6.5	7.75	VE 13
YORK RIVER	39	N 37.256584 W -76.506168	2.05	2.51	4.81	6.01	6.51	7.82	VE 13
YORK RIVER	40	N 37.261221 W -76.508555	1.42	2.60	4.81	6.0	6.5	7.75	VE 10

TABLE 3 - TRANSECT DATA -- continued

Flood Source	Transect	Starting Wave Conditions for the 1% Annual Chance			Starting Stillwater Elevations (ft NAVD88) Range of Stillwater Elevations (ft NAVD88)				Zone Designation and BFE (ft NAVD 88)
		Coordinates	Significant Wave Height H_s (ft)	Peak Wave Period T_p (sec)	10% Annual Chance	2% Annual Chance	1% Annual Chance	0.2% Annual Chance	
YORK RIVER	41	N 37.267903 W -76.508274	1.41	2.16	4.81	5.98	6.48	7.71	VE 10
YORK RIVER	42	N 37.273394 W -7511685	1.35	2.16	4.81	5.96	6.45	7.7	VE 9 AE 7
YORK RIVER	43	N 37.277272 W -76.516133	1.87	2.49	4.82	5.95	6.3	7.7	VE 9 AE 7 - 8
YORK RIVER	44	N 37.280861 W -76.520798	1.89	2.30	4.84	5.98	6.46	7.75	VE 9 AE 7 - 8
YORK RIVER	45	N 37.283695 W -76.525326	2.07	2.54	4.83	5.97	6.45	7.77	VE 9 AE 8
YORK RIVER	46	N 37.282515 W -76.534771	2.40	2.81	4.86	6.01	6.48	7.78	VE 9 AE 7 - 8
YORK RIVER	47	N 37.291519 W -76.533386	1.93	2.26	4.85	5.94	6.42	7.71	VE 9
YORK RIVER	48	N 37.292026 W -76.546345	2.37	2.69	4.88	6.01	6.49	7.83	VE 9 AE 8
YORK RIVER	49	N 37.302155 W -76.559946	2.64	2.82	4.91	6.03	6.51	7.8	VE 9 AE 8 - 9
YORK RIVER	50	N 37.314408 W -76.565544	2.64	2.73	4.9	6.0	6.47	7.84	VE 9 AE 7
YORK RIVER	51	N 37.318533 W -76.579065	2.59	3.05	4.93	6.05	6.52	7.84	VE 9 AE 7 - 8
YORK RIVER	52	N 37.331253 W -76.591430	2.62	3.02	4.97	6.11	6.57	7.92	VE 16
YORK RIVER	53	N 37.341186 W -76.596612	2.44	2.64	4.99	6.09	6.55	8.01	VE 15

TABLE 3 - TRANSECT DATA -- continued

Flood Source	Transect	Starting Wave Conditions for the 1% Annual Chance			Starting Stillwater Elevations (ft NAVD88) Range of Stillwater Elevations (ft NAVD88)				Zone Designation and BFE (ft NAVD 88)
		Coordinates	Significant Wave Height H_s (ft)	Peak Wave Period T_p (sec)	10% Annual Chance	2% Annual Chance	1% Annual Chance	0.2% Annual Chance	
YORK RIVER	54	N 37.349471 W -76.609199	2.25	2.71	5.03	6.13	6.57	8.05	VE 9
YORK RIVER	55	N 37.362275 W -76.619837	3.04	3.12	5.04	6.13	6.56	8.13	VE 9 AE 7 - 8
YORK RIVER	56	N 37.370949 W -76.628236	2.92	3.18	5.08	6.17	6.57	8.12	VE 17
YORK RIVER	57	N 37.381591 W -76.637133	3.05	3.16	5.1	6.15	6.58	8.19	VE 18
YORK RIVER	58	N 37.390803 W -76.679726	2.68	2.99	5.12	6.21	6.61	8.24	VE 9
YORK RIVER	59	N 37.409604 W -76.658106	2.13	2.61	5.15	6.21	6.65	8.39	VE 12
YORK RIVER	60	N 37.414591 W -76.678020	2.67	2.93	5.20	6.28	6.70	8.48	VE 10 AE 7 - 9



FEDERAL EMERGENCY MANAGEMENT AGENCY

GLOUCESTER COUNTY, VA
(ALL JURISDICTIONS)

TRANSECT LOCATION MAP

FIGURE 2

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 NGVD 29. With the completion of 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 1.1 feet. 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.

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

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

4.0 FLOODPLAIN MANAGEMENT APPLICATIONS

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

4.1 Floodplain Boundaries

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

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

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

Pre-countywide Analysis

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

Between cross sections, the boundaries were interpolated using topographic maps at a scale of 1:4,800 with a contour interval of 2 feet (Air Survey Corporation, 1984).

For the streams studied by approximate methods, the boundaries of the 1-percent annual chance flood have been delineated using USGS topographic maps at a scale of 1:24,000 with contour intervals of 5 and 10 feet (USGS, various dates).

September 17, 2010 Countywide Study

For the September 17, 2010, countywide study, floodplains were spatially adjusted to fit the best available stream centerline and shoreline data.

This Countywide Revision

The 1-percent and 0.2-percent annual chance floodplain boundaries are shown on the FIRM (Exhibit 2). 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. Floodplain boundaries were delineated from 2011 LiDAR-based masspoints compiled to meet a 3.5-foot horizontal accuracy (USGS, 2011).

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 (USACE, 1975). 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.

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 for 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.

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 floodplains 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 floodplains.

Floodway widths were computed at cross sections. Between cross sections, the boundaries were interpolated. In cases where the boundaries of the floodway and the 1-percent annual chance flood are either close together or collinear, only the floodway boundary has been shown.

Encroachment into areas subject to inundation by floodwaters having hazardous velocities aggravates the risk of flood damage, and heightens potential flood hazards by further increasing velocities. A listing of stream velocities at selected cross sections is provided in Table 4, "Floodway Data". In order to reduce the risk of property damage in areas where the stream velocities are high, the community may wish to restrict development in areas outside the floodway.

The area between the floodway and 1-percent annual chance floodplain boundaries is termed the floodway fringe. The floodway fringe encompasses the portion of the floodplain that could be completely obstructed without increasing the water-surface elevation of the 1-percent annual chance flood by more than 1.0 foot at any point. Typical relationships between the floodway fringe and their significance to floodplain development are shown in Figure 3, "Floodway Schematic".

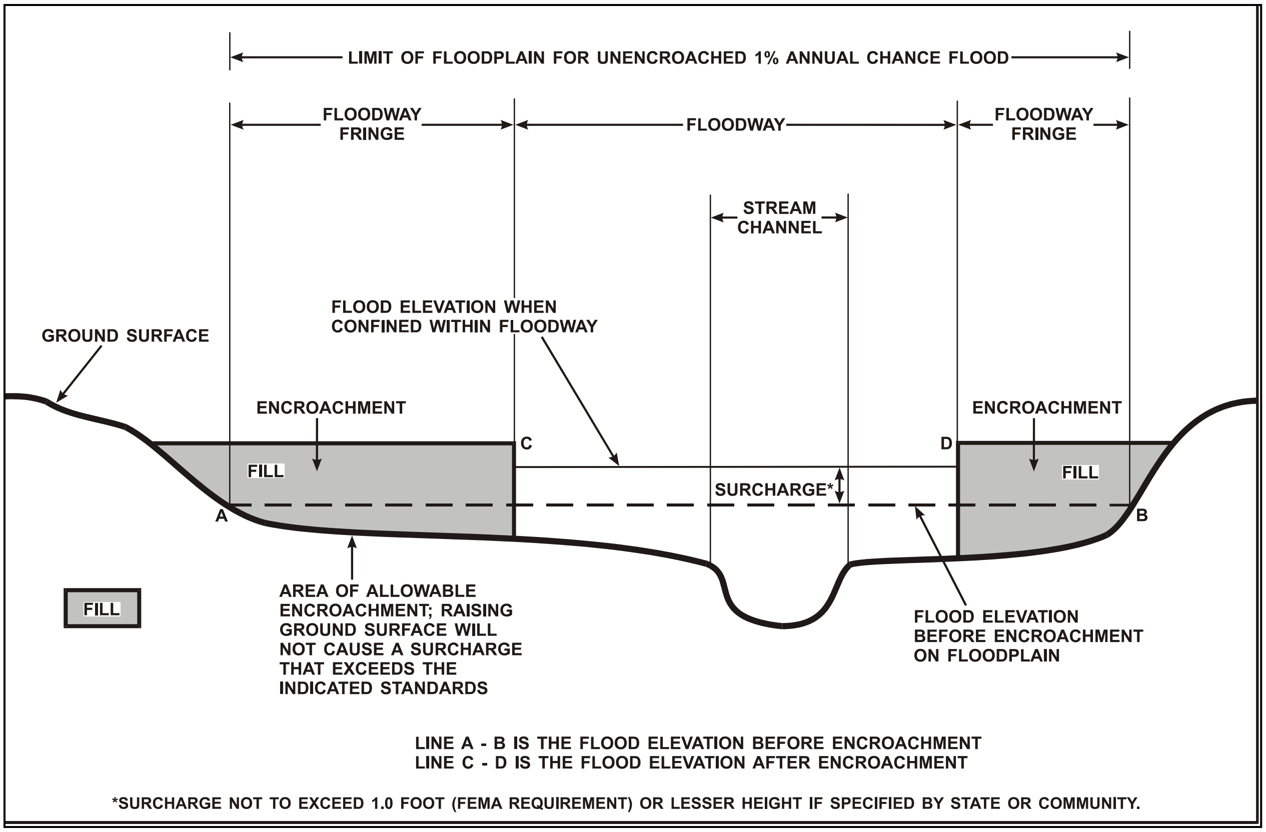


FIGURE 3 - FLOODWAY SCHEMATIC

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
Beaverdam Swamp								
A	17,500	670	6,535	0.4	9.5	9.5	10.3	0.8
B	18,980	355	2,330	1.0	9.6	9.6	10.4	0.8
C	23,490	330	1,675	1.4	11.7	11.7	12.3	0.6
D	24,530	230	1,300	1.8	12.5	12.5	13.1	0.6
E	26,780	670	2,860	0.8	13.4	13.4	14.1	0.7
F	29,400	510	1,475	1.4	14.7	14.7	15.5	0.8
Fox Mill Run								
A	14,190	270	1,295	1.3	6.8	6.8	7.5	0.7
B	15,320	180	1,200	1.4	8.4	8.4	9.2	0.8
C	16,960	250	1,055	1.6	9.2	9.2	9.9	0.7
D	18,910	230	1,385	1.2	14.4	14.4	14.4	0.0
E	21,330	325	990	1.6	15.3	15.3	15.7	0.4
F	23,950	285	870	1.7	18.6	18.6	19.4	0.8
G	26,700	190	540	2.5	22.1	22.1	22.8	0.7

[1] Feet above confluence with Ware River

TABLE 4

FEDERAL EMERGENCY MANAGEMENT AGENCY

GLOUCESTER COUNTY, VA
(ALL JURISDICTIONS)

FLOODWAY DATA

BEAVERDAM SWAMP – FOX MILL RUN

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

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

The current FIRM presents flooding information for the entire geographic area of Gloucester County. Historical data relating to the pre-countywide maps prepared for the each community are presented in Table 5, "Community Map History".

7.0 OTHER STUDIES

FISs for York, Mathews, and Middlesex Counties were prepared (FEMA, 2007b, 2009, and 2010). The results of those studies were in agreement with the results of the initial countywide Gloucester County FIS study of September 17, 2010.

FISs are currently being prepared for James City, King and Queen, Mathews, Middlesex, and York Counties (FEMA, unpublished)

Information pertaining to revised and unrevised hazards within Gloucester County has been compiled into this FIS. Therefore, this FIS supersedes all previously printed FIS reports, FHBMs, FBFMs and FIRMs for Gloucester County.

8.0 LOCATION OF DATA

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

COMMUNITY NAME	INITIAL IDENTIFICATION	FLOOD HAZARD BOUNDARY MAP REVISIONS DATE	FIRM EFFECTIVE DATE	FIRM REVISIONS DATE
Gloucester County (Unincorporated Areas)	March 25, 1974	May 26, 1978	August 4, 1987	August 3, 1992

TABLE 5

FEDERAL EMERGENCY MANAGEMENT AGENCY

GLOUCESTER COUNTY, VA
(ALL JURISDICTIONS)

COMMUNITY MAP HISTORY

9.0 BIBLIOGRAPHY AND REFERENCES

Air Survey Corporation of Reston, Virginia, Aerial Photographs, Scale 1:8,000: Gloucester County, Virginia, 1983.

Air Survey Corporation of Reston, Virginia, Topographic Maps compiled from aerial photographs, Scale 1:4,800, Contour Interval 2 Feet: Gloucester County, Virginia, 1984.

Commonwealth of Virginia, Virginia Uniform Statewide Building Code, Article 8, Part C, Section 872.6, September, 1973.

County of Gloucester, Department of Codes Compliance, Gloucester, Virginia. Storm related fee waiver: Codes Compliance, October 20, 2008. http://www.gloucesterva.info/board/ProposedOrdinances/2008/Decem ber2-PublicHearingExtendingWaiverofCertainPermitFees.pdf

Federal Emergency Management Agency. Atlantic Ocean and Gulf of Mexico Coastal Guidelines Update. Washington, District of Columbia, 2007.

Federal Emergency Management Agency, Flood Insurance Study, James City County, Virginia and Incorporated Areas, unpublished.

Federal Emergency Management Agency, Flood Insurance Study, King and Queen County, Virginia and Incorporated Areas, unpublished.

Federal Emergency Management Agency, Flood Insurance Study, Mathews County and Incorporated Areas, Virginia, November 16, 2007.

Federal Emergency Management Agency, Flood Insurance Study, Mathews County, Virginia and Incorporated Areas, unpublished.

Federal Emergency Management Agency, Flood Insurance Study, Middlesex County, Virginia and Incorporated Areas, May 3, 2010.

Federal Emergency Management Agency, Flood Insurance Study, Middlesex County, Virginia and Incorporated Areas, unpublished.

Federal Emergency Management Agency, Flood Insurance Study, York County, Virginia and Incorporated Areas, unpublished.

Federal Emergency Management Agency, Flood Insurance Study, York County and Incorporated Areas, Virginia, June 16, 2009.

Federal Emergency Management Agency. Wave Height Analysis for Flood Insurance Studies (WHAFIS), Version 4.0. Washington, District of Columbia, 2007.

Gloucester County, Gloucester, VA
http://www.gloucesterva.info/econ/countyprofile/2006countyprofile.pdf (last referenced on 01/08/09)

Luettich, R. A. and J.J Westernick. A (Parallel) Advanced Circulation Model for Oceanic, Coastal and Estuarine Waters (ADCIRC). Version 45.12. February 6, 2008. University of North Carolina at Chapel Hill, Institute of Marine Sciences. Morehead City, NC.

National Academy of Sciences, Methodology for Calculating Wave Action Effects Associated with Storm Surges, Washington, District of Columbia, 1977.

National Climatic Data Center, U.S. Department of Commerce, NOAA Satellite and Information Service, National Environmental Satellite, Data, and Information Service (NESDIS), NCDC Storm Event database (last accessed on July 15, 2008) http://www4.ncdc.noaa.gov/cgi-win/wwcgi.dll?wwevent~storms

U. S. Army Corps of Engineers, Galveston District, General Guidelines for Identifying Coastal High Hazard Zones, Galveston, Texas, 1975.

U. S. Army Corps of Engineers, Hydrologic Engineering Center, HEC-2 Water Surface Profiles, Users Manual, Davis, California, September, 1982.
U.S. Army Corps of Engineers. 2012. ERDC/CHL TR11-X. FEMA Region III Storm Surge Study Coastal Storm Surge Analysis: Modeling System Validation Submission No. 2.

U. S. Army Corps of Engineers, Norfolk District, Hurricane Survey, Garden Creek, Mathews County, Virginia, Norfolk, Virginia, December, 1960.

U. S. Army Corps of Engineers, Norfolk District, March 1962 Storm on the Coast of Virginia, Norfolk, Virginia, August 10, 1962.

U. S. Department of Commerce, Bureau of the Census, 1980 Census of Population, Characteristics of the Population, General Population Characteristics, Virginia, Washington, District of Columbia, August, 1982.

U.S. Department of Commerce, Census Bureau, State & County QuickFacts, http://quickfacts.census.gov/.

U. S. Department of Commerce, National Oceanic and Atmospheric Administration, Tide Tables 1985, High and Low Water Predictions, East Coast of North and South America including Greenland, Washington, District of Columbia, 1984.

U. S. Department of the Interior, Geological Survey, 7.5-Minute Series Topographic Maps, Scale 1:24,000, Contour Intervals 5 and 10 Feet: Shacklefords, Virginia, 1965, Photorevised 1979; Saluda, Virginia, 1965, Photorevised 1979; Wilton, Virginia, 1965, Photorevised 1973; Gressit, Virginia, 1965, Photorevised 1972 and 1973; Gloucester, Virginia, 1965, Photorevised 1973; Ware Neck, Virginia, 1965, Photorevised 1980; Williamsburg, Virginia, 1965, Photorevised 1979; Clay Bank, Virginia, 1965, Photorevised 1979; Achilles, Virginia, 1965, Photoinspected 1973; New Point Comfort, Virginia, 1964; Yorktown, Virginia, 1965, Photorevised 1980; Poquoson, Virginia, 1965, Photorevised 1979.

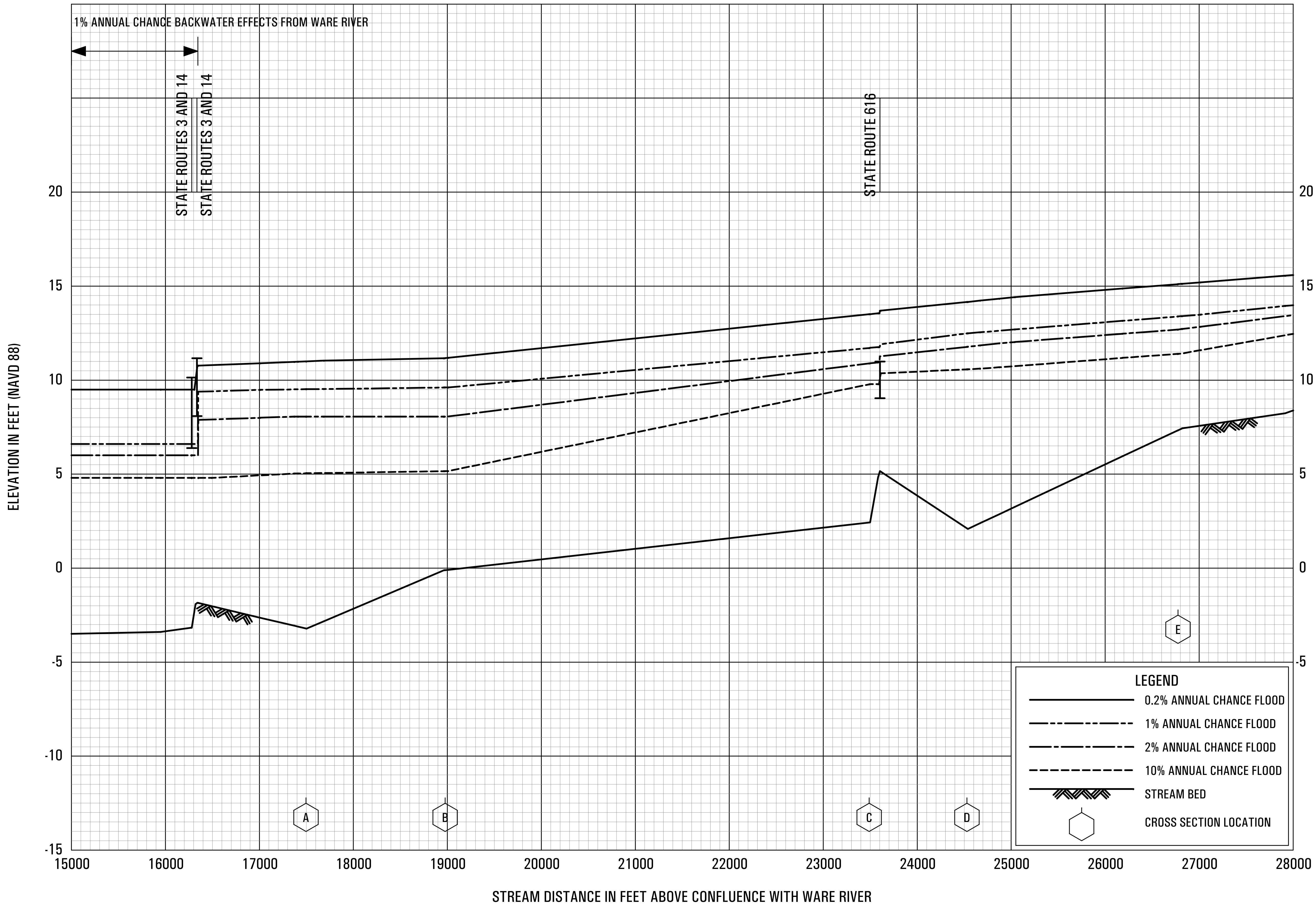
U. S. Department of the Interior, Geological Survey, Office of Water Data Collection, Interagency Advisory Committee on Water Data, "Guidelines for Determining Flood Flow Frequency," Bulletin 17B, Reston, Virginia, Revised September, 1981.

U. S. Department of the Interior, Geological Survey, Technique for Estimating Magnitude and Frequency of Floods in Virginia by Early M. Miller, Richmond, Virginia, January, 1978.

U.S. Geological Survey, Eleven County VA LiDAR Project, Rolla, Missouri, 2011.

Virginia Department of Game & Inland Fisheries, Beaverdam Swamp Reservoir Biologist Report, 2008, Gloucester County, Gloucester, VA http://www.dgif.virginia.gov/fishing/waterbodies/reports/2008%20Beaverdam%20Swamp%20Res%20Biologist%20Report.pdf

Virginia Department of Emergency Management, 2009, Virginia’s Weather History, http://www.vaemergency.com/newsroom/history/winter.cfm



FLOOD PROFILES

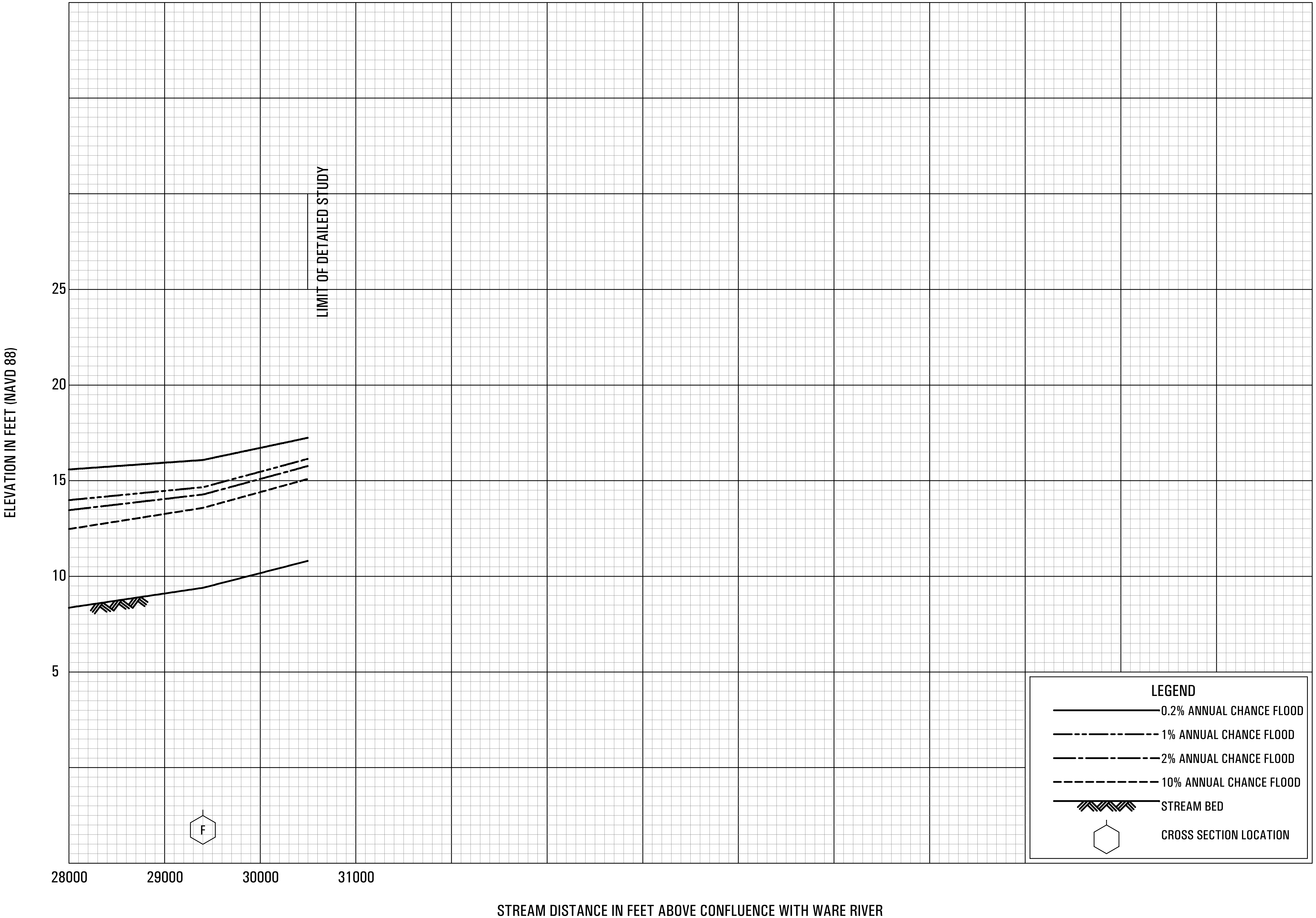
BEAVERDAM SWAMP

FEDERAL EMERGENCY MANAGEMENT AGENCY

GLOUCESTER COUNTY, VA

(ALL JURISDICTIONS)

01P



FLOOD PROFILES

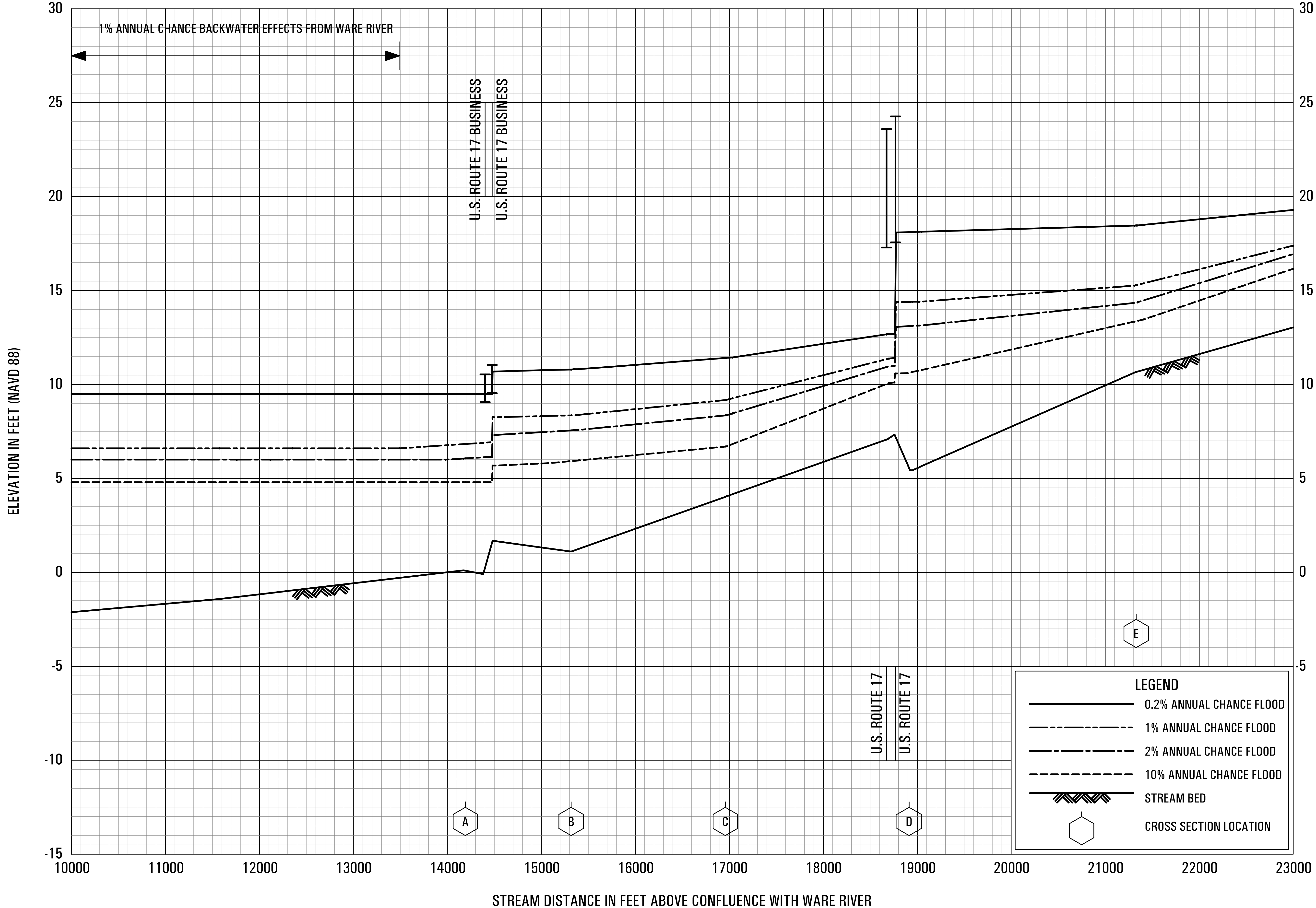
BEAVERDAM SWAMP

FEDERAL EMERGENCY MANAGEMENT AGENCY

GLOUCESTER COUNTY, VA

(ALL JURISDICTIONS)

02P



FLOOD PROFILES

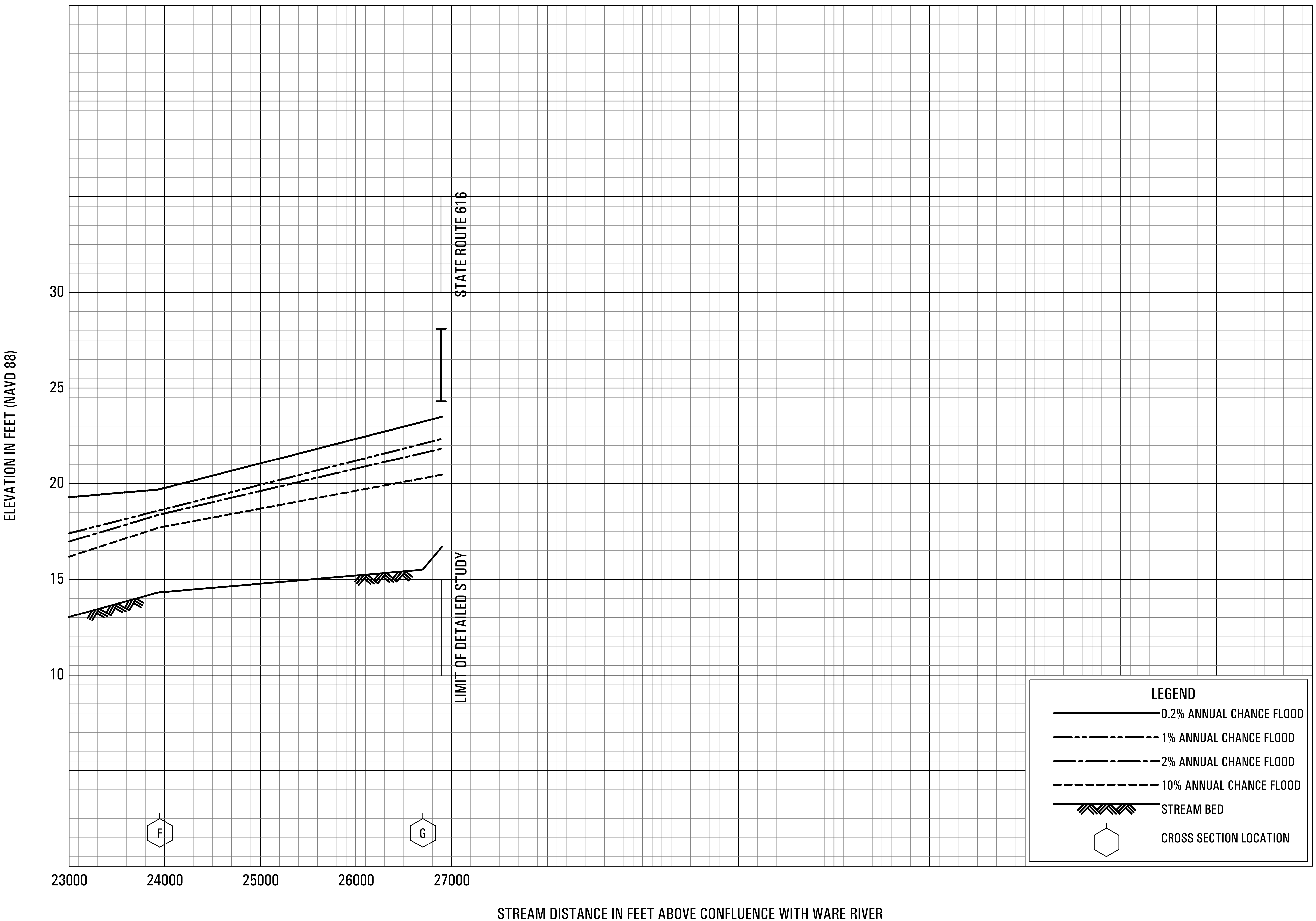
FOX MILL RUN

FEDERAL EMERGENCY MANAGEMENT AGENCY

GLOUCESTER COUNTY, VA

(ALL JURISDICTIONS)

03P



FLOOD PROFILES

FOX MILL RUN

FEDERAL EMERGENCY MANAGEMENT AGENCY

GLOUCESTER COUNTY, VA

(ALL JURISDICTIONS)