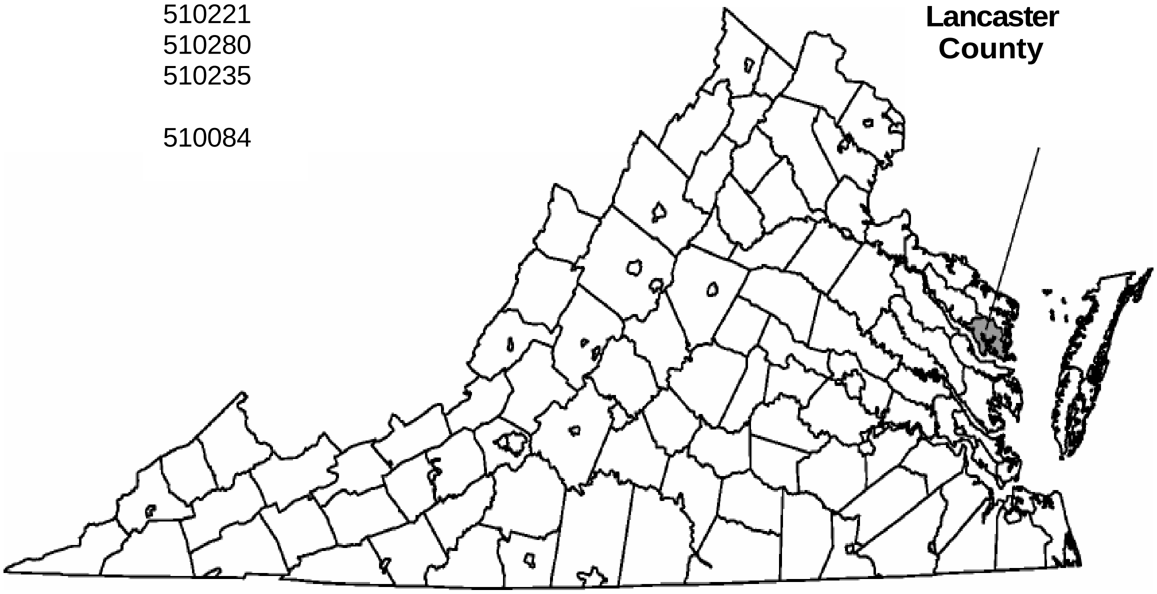
FLOOD
INSURANCE
STUDY

LANCASTER COUNTY,
VIRGINIA
AND INCORPORATED AREAS

COMMUNITY NAME	COMMUNITY NUMBER
IRVINGTON, TOWN OF	510221
KILMARNOCK, TOWN OF	510280
WHITE STONE, TOWN OF	510235
LANCASTER COUNTY (UNINCORPORATED AREAS)	510084



REVISED DATE:
OCTOBER 2, 2014

U.S. DEPARTMENT OF HOMELAND SECURITY

Federal Emergency Management Agency

FLOOD INSURANCE STUDY NUMBER
51103CV000B

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.

Initial countywide FIS Report Effective Date: September 17, 2010

Revised countywide FIS Report Dates: October 02, 2014-	to change Special Flood Hazard Areas, to update map format, to reflect updated topographic information, and to incorporate new detailed coastal flood hazard analyses.

TABLE OF CONTENTS

TABLE OF CONTENTS - continued

FLOOD INSURANCE STUDY
LANCASTER COUNTY, VIRGINIA AND INCORPORATED AREAS

1.0 INTRODUCTION

1.1 Purpose of Study

This countywide Flood Insurance Study (FIS) revises and updates previous FIS's / Flood Insurance Rate Maps (FIRMs) in the geographic area of Lancaster County, Virginia, including the Town of Irvington, the Town of Kilmarnock, the Town of White Stone and the unincorporated areas of Lancaster County (referred to collectively herein as Lancaster 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 Lancaster 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 Kilmarnock is geographically located in Lancaster and Northumberland Counties. The Town of Kilmarnock is included in its entirety in this FIS report.

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, Lancaster 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.

Irvington, Town of:	The hydrologic analysis for this study was prepared by the Norfolk District of the U. S. Army Corps of Engineers (COE) for the Federal Emergency Management Agency (FEMA), under Inter-Agency Agreement

	EMW-84-E1506, Project Order No. 1, Amendment No. 20. This work was completed in January 1986.
Lancaster County (Unincorporated Areas):	The hydrologic and hydraulic analyses for this study were prepared by the Norfolk District of the U. S. Army Corps of Engineers (COE) for the FEMA, under Inter-Agency Agreement EMW84-E-1506, Project Order No. 1, Amendment No. 22. This work was completed in August 1986.

No previous FIS reports were published for the Towns of Kilmarnock and White Stone.

For the September 17, 2010 countywide study, no revised hydrologic and hydraulic analyses were prepared.

For the September 17, 2010 countywide study, planimetric base map information is provided in digital format for all FIRM panels. These files were compiled at scales of 6000 and 12000 from aerial photography dated 2007. Additional information was derived from transportation, political and hydrographic line features provided by the Lancaster County GIS Services. Users of this FIRM should be aware that minor adjustments may have been made to specific base map features.

For the September 17, 2010 countywide study, the coordinate system used for the production of this FIRM is Universal Transverse Mercator (UTM), Zone 18 North, North American Datum of 1983 (NAD 83), GRS 80 spheroid. Corner coordinates shown on the FIRM are in latitude and longitude referenced to the UTM projection, NAD 83. Differences in the datum and spheroid used in the production of FIRMs for adjacent counties may result in slight positional differences in map features at the county boundaries. These differences do not affect the accuracy of information shown on the FIRM.

The Digital Flood Insurance Rate Map (DFIRM) conversion for for the September 17, 2010 countywide study was performed by AMEC, Earth & Environmental, Inc. for FEMA, under Contract No. HSFE03-07-D-0030, Task Order HSFE03-08-J-0007

For the October 02, 2014 countywide revision, a new coastal storm surge analysis was incorporated for the Chesapeake Bay and its tributaries. In addition the Stillwater elevations were updated. The Sun Engineering under RAMPP assisted FEMA in the development and application of a state-of-the-art storm surge risk assessment. The coastal analysis and mapping was conducted for FEMA 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 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).

For the October 02, 2014 countywide revision, the base map information was provided in digital format by the Virginia Geographic Information Network. This information was photogrammetrically compiled at a scale of 1:2400 from aerial photography dated 2009.

For the October 02, 2014 countywide revision, the coordinate system used is the North American Datum of 1983 (NAD83) HARN Virginia State Plane south zone (FIPSZONE 4502). The horizontal datum was NAD 83 HARN, GRS 80 spheroid. Differences in the datum and spheroid used in the production of FIRMs for adjacent counties may result in slight positional differences in map features at the county boundaries. These differences do not affect the accuracy of information shown on the FIRM.

1.3 Coordination

An initial 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.

On January 31, 1984, an initial Consultation and Coordination Officer's (CCO) meeting was held with representatives of FEMA, the county, the Virginia State Water Control Board, and the COE (the study contractor). At this meeting, the nature and purpose of the study and the scope and limits of work were explained, and flood information currently available concerning the county was obtained.

Contacts with various State and Federal agencies were made during the study in order to minimize possible hydrologic and hydraulic conflicts. A search for basic data was made at all levels of government.

For the Town of Irvington, an initial Consultation and Coordination Officer's (CCO) meeting was held on August 7, 1979, with representatives of FEMA, the town, the Virginia State Water Control Board, and the COE (the study contractor). At this meeting, the nature and purpose of the study and the scope and limits of work were explained, and flood information currently available concerning the community was obtained.

On March 26, 1987, the results of the study were reviewed at a final CCO meeting attended by representatives of FEMA, the county, the Virginia State Water Control Board, and the study contractor.

On September 18, 1986, the results of the study were reviewed at a final CCO meeting attended by representatives of FEMA, the town, the Virginia State Water Control Board, and the study contractor.

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

TABLE 1 – INITIAL AND FINAL CCO MEETINGS

Community Name	Initial CCO Date	Final CCO Date
Irvington, Town of	August 7, 1979	September 18, 1986
Lancaster County (Unincorporated Areas)	January 31, 1984	March 26, 1987

In October 2008, Lancaster County and the Towns of Irvington, Kilmarnock, and White Stone were notified by letters that the FIS would be updated and converted to countywide format. Also, a final meeting was held on December 7, 2009 and was attended by representatives of Lancaster County, the Towns of Irvington and Kilmarnock, the study contractor, and FEMA.

For the October 02, 2014 revision, an initial CCO meeting was held on March 30, 2011, with representatives of FEMA, the study contractor (RAMPP) and Lancaster County. Another meeting was held on January 28, 2013, regarding Flood Risk Review, with representatives of FEMA, the study contractor (RAMPP), Lancaster County GIS department, and Planning and Zoning department.

The result of this study were reviewed at the final CCO meeting held on May 22, 2013, and attended by representatives of FEMA, the study contractor, and Lancaster County. All problems raised at the meeting have been addressed in this study.

2.0 AREA STUDIED

2.1 Scope of Study

This FIS covers the geographic area of Lancaster County, Virginia, including the Towns of Irvington, Kilmarnock, and White Stone.

Tidal flooding including its wave action from the Chesapeake Bay and the

Rappahannock River, and their adjoining estuaries was studied by detailed methods. 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 through August 1991.

The following flooding sources were studied by approximate methods: Lancaster Creek, Chinns Pond, Balls Millpond, Balls Branch, Belwood Swamp, Callahan Swamp, Davis Millpond, Blakemore Millpond, Little Branch, the Western Branch Corrotoman River, Browns Creek, Camps Millpond, Camps Prong, Norris Prong, Duntons Millpond, McMahon Swamp, Norris Pond, and several unnamed tributaries. 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 Lancaster County.

For the Town of Irvington, tidal flooding from the Rappahannock River which affects Carter Creek and Eastern Branch was studied by detailed methods. 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 through January 1991.

For the October 02, 2014 revision, new detailed coastal flood hazard analyses for the Chesapeake Bay is incorporated.

No Letters of Map Revision (LOMRs) were recorded for this study.

2.2 Community Description

Lancaster County lies in the southeastern end of the Northern Neck, which is the ancient name for the narrow peninsula between the Rappahannock River and the Potomac River. It is bordered by the City of Richmond and the unincorporated areas of Northumberland County to the north, the Chesapeake Bay to the east, and the unincorporated areas of Middlesex County and the Rappahannock River to the south and west. The county has 136 square miles of land area, and the 1980 population was 10,129 (Reference 1). The population for Lancaster County as determined by the 2000 Census was 11,567 and the 2006 estimated population was 11,519 and the 2010 Census was 11,391, a decrease of 1.5% in 2010 from 2000 (Reference 21).

Lancaster County was formed in 1651 from Northumberland and York Counties and was named for the county of Lancaster in England.

Settlers began moving into the area around 1640 from settlements on the James and York Rivers and from Maryland. The county seat was originally at Millenbeck, the estate of William Ball, who settled here in 1651 on the west side of the Corrotoman River. Later the county seat was moved to its present location in the community of Lancaster (Reference

2).

Although the basic industries of manufacturing, agriculture, and fisheries declined slightly in the 1980's, dramatic increases were noted in retail trade, recreational activity, and professional service employment. Kilmarnock has become the hub of retail and service businesses in the Northern Neck. The influx of retirees and outflow of younger people began in the early 1990's and continues today. The Rappahannock Westminster-Canterbury retirement community, opened in 1985, is a multi-million dollar investment, providing services that continue to attract retirees to the county (Reference 23).

Abundant sights and attractions encourage tourism and recreation today. Historic buildings, restaurants, marinas, and resorts all entice tourists interested in the serene, natural beauty of the county as well as the recreational activities available (Reference 23).

While much of the future development will continue to be residential, as evidence by major residential developments approved at the Golden Eagle and Windmill Point, there is also evidence of significant commercial development. This is most evident in the Kilmarnock Technology Park where several local and new businesses are constructing new facilities. Also, the demand for mini-storage units has resulted in the construction and approval of new facilities of this type with several more in the planning stage (Reference 23).

As agriculture and aquaculture have declined as economic forces in the county, tourism and retirement or second home construction has been on the rise. Tourists and potential residents are attracted to areas with a rich historic background. The County can benefit from initiatives aimed at protecting and promoting its heritage (Reference 24).

Lancaster County enjoys a temperate climate with moderate seasonal changes characterized by warm summers and cool winters. Temperatures average approximately 78 degrees Fahrenheit (°F) during July, the warmest month, and 41°F in January, the coldest month. Annual precipitation over the area averages approximately 43 inches (Reference 2). There is some variation in the monthly averages; however, this rainfall is distributed uniformly throughout the year. Annual snowfall averages approximately 13.6 inches, generally occurring in light amounts and usually melting in a short period of time (Reference 25).
ancaster County is located in the Coastal Plain province and is underlain by sand, gravel, clay, marl, and shell. Elevations within the county range from sea level to approximately 115 feet.

The Town of Irvington lies near the mouth of Carters Creek where it flows into the Rappahannock River approximately 10 miles upstream from the Chesapeake Bay. It is bordered by the unincorporated areas of Lancaster County to the north and east, Carters Creek to the west, and Eastern

Branch to the south. The town has 1.5 square miles of land area with approximately 9 miles of shoreline. The 1980 population of the town was 567 (References 1 and 2). The population for the Town of Irvington as determined by the 2000 Census was 673 (Reference 22).Development in the floodplains of Irvington consists of scattered residences, businesses, and marinas. The town is primarily a waterfront community, with many private beaches and piers. A resort hotel and cottages accommodate tourists coming to the area for the excellent fishing and water sports.

Irvington is located in the southeastern end of Virginia's famous "Northern Neck" peninsula between the Rappahannock and Potomac Rivers. It is a low and level region with a wide tidal inlet. Land elevations in this area range between 0 to 30 feet.

The Town of Kilmarnock is located near the mouth of Rappahannock River and is located within the Northern Neck George Washington Birthplace American Viticultural Area winemaking appellation. The town has a total area of 2.9 square miles, of which, 2.9 square miles of it is land and 0.35 % is water. The population for the Town of Kilmarnock as determined by the 2000 Census was 1,244 (Reference 28).

The Town of White Stone was named “White Stone” as it refers to the accumulations of white stones in the area’s waterways. The town has a total area of 1.0 square miles, all of it land. The population for the Town of White Stone as determined by the 2000 Census was 358 (Reference 29).

2.3 Principal Flood Problems

The coastal areas of Lancaster County are vulnerable to tidal flooding from major storms such as hurricanes and northeasters. 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 study area. The term hurricane is applied to an intense cyclonic storm originating in tropical or subtropical latitudes in the Atlantic Ocean north of the equator. 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 county occurred in August 1933.

Another type of storm that could cause severe damage to the county is the northeaster. 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 northeasters. Flooding from hurricanes rarely lasts more than one tidal cycle, while flooding from northeasters 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 for the Chesapeake Bay normally fluctuate twice daily from an elevation of 1.1 feet to minus 1.1 feet. The mean range of tide in the Rappahannock River varies from approximately 1.2 feet at Windmill Point to 1.4 feet at Orchard Point to 1.6 feet at Morattico (Reference 3). The range of fluctuation may be somewhat less in the connecting bays and inlets. The mean range of tide in the Rappahannock River at Irvington is 1.4 feet. Prolonged easterly or southeasterly winds tend to raise the water level in the river, while prolonged northwest winds tend to depress the water level.

Irvington has experienced major storms since the early settlement of the area. Historical accounts of severe storms in the area date back several hundred years. Numerous storms of tropical origin have passed over and near the lower reaches of the Rappahannock River causing widespread damage. Although the hurricanes are very destructive, the winds are generally reduced below hurricane velocity as they pass through the area.

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 southeastern portion of the county, from the Corrotoman River to Indian Creek, is vulnerable to wave damage because of the vast exposure afforded by the Chesapeake Bay and the Rappahannock River.

Lancaster 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.

The August 1933 hurricane was one of the most severe storms ever to occur in the Middle Atlantic Coast region. This tropical hurricane passed inland near Cape Hatteras on August 22, passed slightly west of Norfolk, and continued in a northern direction accompanied by extreme wind and tide. The storm surge in the Chesapeake Bay and tidal estuaries was the highest of record and coincided with the astronomical tide. The tide at the mouth of the Rappahannock River reached 6.6 feet and 7.0 feet at Urbanna in Middlesex County (Reference 4).

Hurricane Hazel, the second most destructive of recent hurricanes to strike the area, entered the mainland south of Wilmington, North Carolina, during the morning of October 15, 1954. It moved rapidly northward, passing over Norfolk and Fredericksburg in the early afternoon. The winds were from the east and southeast until the eye passed. During this phase of the storm, damaging tides were along the western shore of the Chesapeake Bay and the right bank of the Rappahannock River. When the eye passed, the wind shifted to the southwest with higher wind velocities and damages to the left bank. The hurricane tide was not as high as the August 1933 storm tide although the tidal surge was superimposed on the normal high tide (Reference 4).

During 1955, two hurricanes affected the Lancaster County area. On August 12-13, 1955, Hurricane Connie followed a path similar to the August 1933 hurricane. The storm generated a fairly high storm surge, but it occurred at the time of the astronomical low tide in this area, causing only minor damage. On August 17-18, 1955, Hurricane Diane passed inland to the west of Lancaster County and did not produce a damaging tide (Reference 4).

A tidal stage of major proportions occurred during the northeaster 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 northeaster 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 Lancaster 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 (Reference 26).

In November 1985, high winds and tides combined to play havoc with the Rappahannock River shoreline in the worst storm in decades. The storm was a product of a low pressure system that swept up the Atlantic Seaboard. Northeast winds in excess of 65 miles per hour (mph) pushed tides 5 feet above normal and battered piers, bulkheads, boats, boathouses, and other waterfront structures along the Chesapeake Bay and Rappahannock County.

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 (Reference 27).

A Northeaster produced heavy rain and strong winds across central and eastern Virginia on Tuesday, January 27th and Wednesday, January 2 8th, 1998. Rainfall totals generally ranged from 2 to 4 inches. This rainfall caused street flooding and flooding of poor drainage areas throughout the region (Reference 22).

A Northeaster battered eastern Virginia from Tuesday, February 3rd through Thursday, February 5th, 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 Mean Lower Low Water (MLLW) at Sewells Point in Norfolk. These tide levels resulted in moderate to severe coastal flooding throughout the Hampton Roads area and the Virginia Eastern Shore (Reference 23).

During the period of September 15-16, 1999, Hurricane Floyd was a Category 1 hurricane as it crossed the Wakefield WFO (Weather Forecast Office) 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 Mean Lower Low Water (MLLW). This resulted in moderate to locally severe coastal flooding approximately 2 hours before high tide on the 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 (Reference 22).

During the period of September 18–19, 2003, Hurricane Isabel was a Category 1 hurricane as it crossed the Wakefield WFO county warning area. 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 (Reference 22).

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 (Reference 22).

Coastal flooding associated with Tropical Cyclone Sandy occurred on September 28 and 29, 2012, with 10.90 inches of rain reported in Lancaster (Reference 22).

2.4 Flood Protection Measures

There are no existing flood control structures that would provide protection during major floods in the county. There are a number of measures that have afforded some protection against flooding, including bulkheads, 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" (Reference 5). 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 Coastal Analyses

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 along each of the shorelines. 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

Town of Irvington

Irvington, because of its sheltered location, is not subject to significant wave action concurrent with the 100-year storm; therefore, a wave height analysis was not performed.

Lancaster County (Unincorporated Areas)

Special consideration was given to the vulnerability of Lancaster County to wave attack. The inclusion of wave heights, which is the distance from the trough to the crest of the wave, increases the water-surface elevation. The height of a wave is dependent upon wind speed and its duration, depth of water, and length of fetch. The wave crest elevation is the sum of the stillwater elevation and the portion of the wave height above the stillwater elevation. During severe storms such as the August 1933 hurricane, wave attack produced breaching and failure of bulkheads. The intruding waters caused damage to residences and commercial buildings.

These concepts and equations were used to compute wave heights and wave crest elevations associated with the 1-percent-annual-chance storm surge. Accurate topographic, land-use, and land-cover data are required for the wave height analysis. Maps of the shoreline areas from Norris Bridge (State Route 3) to Indian Creek at a scale of 1:4,800 with a contour interval of 2 feet were used for the topographic data (Reference 9). The land-use and land-cover data were obtained from notes and photographs taken during field inspections, engineering judgment, and aerial photographs (Reference 10). In other areas along the Rappahannock River subject to wave action (from Norris Bridge to Towles Point), maps a scale of 1:24,000 with contour intervals of 5 and 10 feet were used (Reference 11).

Tide records for Lancaster County are inadequate to establish a tide frequency relationship. The adopted tide frequency was obtained by a correlation of the tide frequency curve developed for the Norfolk Harbor gage (located approximately 10 miles inside the Chesapeake Bay) with available tide records and high-water marks at Gloucester Point, Virginia; Lewisetta, Virginia; and Solomon's Island, Maryland. There are historical accounts of tidal flooding for nearly 300 years, but a reasonably accurate indication of the heights reached in Norfolk Harbor is available only since 1908 and a complete record since 1928. The Gloucester Point gage was established in 1950, the Lewisetta gage in 1974, and the Solomon's Island gage in 1937.

The procedure used to develop the frequencies for Lancaster County is as follows:

a. A Norfolk Harbor statistical analysis was performed in accordance with the procedures outlined in Bulletin 1 7B (Reference 6). The Pearson Type III methodology without the logs was incorporated for the selected period of record from 1928 through 1978. The Pearson Type III distribution without the logs was selected as a result of the following:

    (1) A number of different distributions were fitted to tidal elevation data. The Pearson Type III distribution without the logs provided the best fit of the data points.

    (2) It was felt that a statistical analysis would produce a more reliable and reproducible result when compared to a graphical approach.

b. Consideration was given to separating hurricane and non-hurricane events. Although objective statistical approaches are available for incomplete samples (a hurricane related tide exists for less than 50 percent of the years on record), they do not always provide reasonable results. Therefore, all tropical and extratropical events were included together in the analysis of the annual maximum tides.

c. The analysis of the 51 years of systematic record indicated that the 1933 and 1936 floods could be high outliers. However, assuming that the true distribution is defined by the computed (non-adjusted) statistics, the value for the 1933 flood has an exceedence probability of 0.010. It was determined that, with 51 years of record, the probability of a flood this rare being exceeded is 40 percent. Since this risk is so high and it is known that several floods as large and possibly larger than the 1933 flood have historically occurred, the 1933 flood (and any smaller floods) was not considered to be a high outlier.

d. Historical accounts indicate that tides have occurred in Norfolk Harbor at approximately 8.0 feet in 1667 and 1785 and approximately 7.9 feet in 1846. There has been a gradual rise in sea level over the investigated period of record at Norfolk Harbor. There was some question as to the amount of adjustment that should be made to the historical floods. To avoid overestimating the impact of the rise in sea level, the historical floods were increased by only 0.50 foot (approximately the same adjustment for the 1924 to 1942 period). The analysis based on a historical period of 312 years resulted in a slight move to the left of the upper portion of the frequency curve when compared to the systematic record. Since the adjustment was not very large and there is some question as to the reliability of the historical data, the COE adopted the computed statistics based on the 51 years of systematic record.

e. The lower portion of the statistical curve was adjusted with a partial duration analysis using plotting positions in accordance with Weibull (Reference 6). It included all elevations above 4.26 feet.

f. Tidal elevations were correlated between the Gloucester Point, Lewisetta, and Solomon's Island gages, and Norfolk Harbor to determine estimated tidal heights for Lancaster County.

g. Tidal elevations were correlated between the Lewisetta and Gloucester Harbor gages, and Norfolk Harbor to determine estimated tidal heights for Irvington.

September 17, 2010 Countywide Analyses

No new coastal analyses were performed for September 17, 2010 Countywide Analyses. However, this entire study was updated to the North American Vertical Datum of 1988 (NAVD 88).

October 02, 2014 Countywide Revision

For the October 02, 2014 Revision, users of the FIRM should be aware that coastal flood elevations are provided in Table 2, “Summary of Coastal Stillwater Elevations” table 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 coastline of Lancaster County consists of mainly private residences and agricultural land. Extensive residential development exists along the Chesapeake Bay and its estuaries. Undeveloped area are located throughout Lancaster County, consisting of mainly of woodlands and marsh.

An analysis was performed to establish the frequency peak elevation relationships for coastal flooding in Gloucester County. The Federal Emergency Management Agency (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 Flood Insurance Studies (FISs) in the study area, including Gloucester County, VA, and serves as the basis for updated Flood Insurance Rate Maps (FIRMs). Study efforts were initiated in 2008 and concluded in 2012.

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 et. al, 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 Chesapeake Bay affects approximately 108 miles on Lancaster County coastline. The eastern coastline, fronting along Chesapeake as well as coastline of the Rappahannock River 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 stillwater elevations for the 10-, 2-, 1-, and 0.2- percent annual chance floods have been determined for the Chesapeake Bay and the Rappahannock

River and are shown in Table 2. The tidal frequency relationship represents the combined effect of both hurricanes and northeasters on tidal flooding and reflects the random probability of surges occurring coincident with the normal astronomical tide.

TABLE 2: SUMMARY OF STILLWATER ELEVATIONS

	ELEVATION (feet) NAVD88			
FLOODING SOURCE AND LOCATION	10-Percent-Annual-Chance	2-Percent-Annual-Chance	1-Percent-Annual-Chance	0.2-Percent-Annual-Chance
CHESAPEAKE BAY				
Entire shoreline within county	3.4	4.2	4.6	5.7-5.9
RAPPAHANNOCK RIVER				
Shoreline from confluence with Chesapeake Bay to Norris Bridge (State Route 3)	3.2-3.4	3.7-4.2	3.9-4.4	4.9-5.7
Shoreline from Norris Bridge (State Route 3) to county boundary	3.6-3.7	4.4-4.9	4.6-5.2	5.4-6.7
Shorelines of Carter Creek and Eastern Branch within Town of Irvington	3.0	3.7	3.9	5.3

The methodology for analyzing the effects of wave heights associated with coastal storm surge flooding is described in the National Academy of Sciences (NAS) report (Reference 8). This method is based on three major concepts. First, depth-limited waves in shallow water reach a maximum breaking height that is equal to 0.78 times the stillwater depth, and the wave crest is 70 percent of the total wave height above the stillwater level. The second major concept is that the wave height may be diminished by the 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 described in Reference 8. 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 and mapping for Lancaster County was conducted for FEMA by RAMPP (Sun Engineers) 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 runup

Wave heights were computed along transects (cross-section lines) that were located along the coastal areas, as illustrated in Figure 1, in accordance with the User's Manual for Wave Height Analysis (Reference 12). The transects were located with consideration given to the physical and cultural characteristics of the land so that they would closely represent conditions in their locality. Transects were spaced close together in areas of complex topography and dense development. In areas having more uniform characteristics, they were spaced at larger intervals. It was also necessary to locate transects in areas where unique flooding existed and in areas where computed wave heights varied significantly between adjacent transects. Table 3, "Transect Descriptions," provides a listing of the transect locations and stillwater elevations, as well as initial wave crest elevations.

Each transect was taken perpendicular to the shoreline and extended inland to a point where wave action ceased. Along each transect, wave heights and wave crest elevations were computed considering the combined effects of changes in ground elevation, vegetation, and physical features. The 1-percent-annual chance stillwater elevations were used as the starting elevations for these computations. Wave heights were calculated to the nearest 0.1 foot, and wave crest elevations were determined at whole-foot increments along the transect. The location of the 3-foot breaking wave for determining the terminus of the V zone (area with velocity wave action) was also computed at each transect. It was assumed that the beach area would erode during a major storm, thus reducing its effectiveness in decreasing wave heights.

Figure 2 is a profile for a typical transect illustrating the effects of energy dissipation and regeneration on a wave as it moves inland. This figure shows the wave crest elevations being decreased by obstructions, such as buildings, vegetation, and rising ground elevations, and being increased by open, unobstructed wind fetches. Actual conditions in Lancaster County may not include all the situations illustrated in Figure 2.

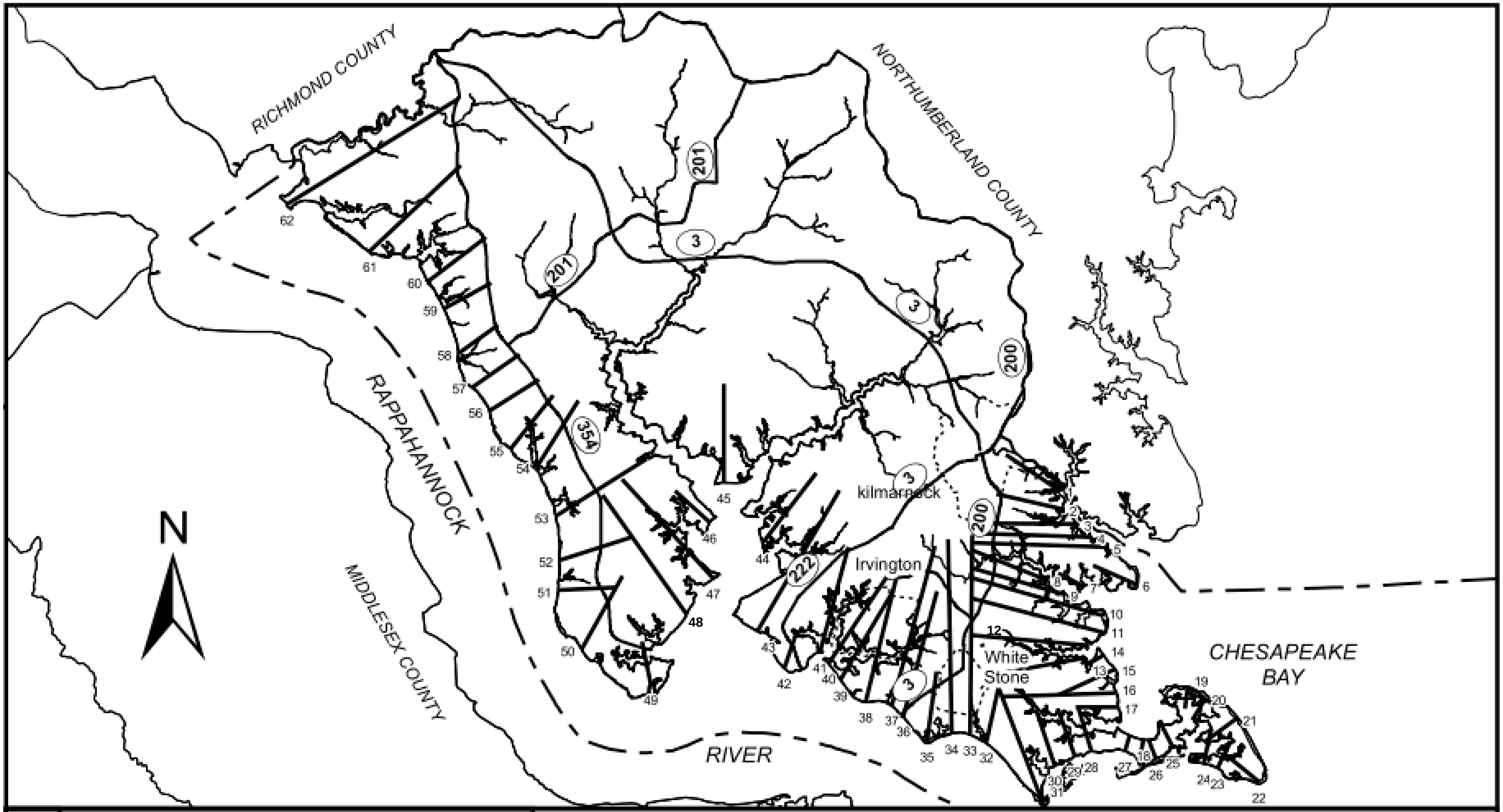


FIGURE 1

FEDERAL EMERGENCY MANAGEMENT AGENCY

LANCASTER COUNTY, VA AND INCORPORATED AREAS

APPROXIMATE SCALE

3 0 3 6 9 Miles

TRANSECT LOCATION MAP

TABLE 3 - TRANSECT DATA

		Starting Wave Conditions for the 1% Annual Chance			Starting Stillwater Elevations (ft **NAVD88**) Range of Stillwater Elevations (ft **NAVD88**)				
Flood Source	Transect	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	Zone Designation and BFE (ft NAVD 88)
Chesapeake Bay	1	N 37.699746 W -76.352113	1.0	2.4	3.4	4.3	4.6	5.9	AE 6
Chesapeake Bay	2	N 37.694373 W -76.351089	1.0	2.7	3.4	4.3	4.6	5.9	AE 7
Chesapeake Bay	3	N 37.690047 W -76.345904	1.3	3.2	3.4	4.2	4.6	5.8	VE 7
Rappahannock River	4	N 37.68618 W -76.340991	1.4	5.1	3.4	4.2	4.5	5.7	VE 7
Rappahannock River	5	N 37.683083 W -76.335317	1.7	5.8	3.3	4.1	4.4	5.7	VE 7
Rappahannock River	6	N 37.67211 W -76.325075	1.4	6.9	3.4	4.1	4.4	5.6	VE 7
Rappahannock River	7	N 37.671886 W -76.344222	1.6	6.6	3.4	4.2	4.5	5.9	VE 7
Rappahannock River	8	N 37.673986 W -76.357502	1.7	2.9	3.4	4.3	4.6	6.0	VE 12
Rappahannock River	9	N 37.669732 W -76.351405	2.1	3.1	3.4	4.2	4.6	6.0	VE 11
Rappahannock River	10	N 37.663343 W -76.337652	1.1	6.8	3.4	4.2	4.5	5.8	VE 7
Rappahannock River	11	N 37.65835 W -76.337061	1.6	7.0	3.4	4.2	4.5	5.9	VE 7
Rappahannock River	12	N 37.654778 W -76.343508	1.5	6.5	3.4	4.2	4.5	6.0	VE 11
Rappahannock River	13	N 37.651173 W -76.344195	1.7	4.2	3.5	4.2	4.5	6.1	VE 7
Rappahannock River	14	N 37.65171 W -76.337474	2.0	6.8	3.4	4.2	4.5	6.0	VE 7
Rappahannock River	15	N 37.647556 W -76.333555	2.0	6.7	3.5	4.2	4.5	5.9	VE 7
Rappahannock River	16	N 37.64075 W -76.333523	1.4	6.3	3.4	4.2	4.5	6.0	VE 7
Rappahannock River	17	N 37.636591 W -76.332753	1.6	5.8	3.4	4.2	4.4	5.9	VE 7
Rappahannock River	18	N 37.626893 W -76.323655	1.6	4.0	3.4	4.1	4.4	5.8	VE 7
Rappahannock River	19	N 37.641268 W -76.307167	1.6	6.6	3.3	4.0	4.2	5.5	VE 6
Rappahannock River	20	N 37.63861 W -76.300706	1.7	6.1	3.3	4.0	4.3	5.4	VE 7

TABLE 3 - TRANSECT DATA (continued)

		Starting Wave Conditions for the 1% Annual Chance			Starting Stillwater Elevations (ft **NAVD88**) Range of Stillwater Elevations (ft **NAVD88**)				
Flood Source	Transect	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	Zone Designation and BFE (ft NAVD 88)
Rappahannock River	21	N 37.632391 W -76.28959	1.2	6.8	3.3	4.0	4.2	5.3	VE 6
Rappahannock River	22	N 37.613965 W -76.281799	1.4	7.1	3.2	3.7	3.9	4.8	VE 6
Rappahannock River	23	N 37.618175 W -76.296786	0.9	6.7	3.2	3.8	4.0	4.9	VE 6
Rappahannock River	24	N 37.619632 W -76.301721	1.6	6.8	3.2	3.9	4.1	5.0	VE 6
Rappahannock River	25	N 37.62454 W -76.313017	1.3	5.8	3.3	3.9	4.1	5.2	VE 6
Rappahannock River	26	N 37.62126 W -76.319276	1.4	6.0	3.3	3.9	4.2	5.2	VE 6
Rappahannock River	27	N 37.623734 W -76.330526	0.9	5.6	3.3	3.9	4.2	5.2	VE 7
Rappahannock River	28	N 37.623923 W -76.34272	1.7	5.8	3.4	4.1	4.3	5.4	VE 7
Rappahannock River	29	N 37.622818 W -76.348884	1.5	5.5	3.4	4.2	4.4	5.6	VE 7
Chesapeake Bay	30	N 37.620083 W -76.356205	1.1	5.4	3.4	4.1	4.3	5.6	VE 7
Rappahannock River	31	N 37.608953 W -76.360759	1.7	4.9	3.4	4.0	4.3	5.3	VE 7
Rappahannock River	32	N 37.62735 W -76.380927	1.6	3.8	3.4	4.0	4.3	5.4	VE 6
Chesapeake Bay	33	N 37.629585 W -76.386888	2.4	3.3	3.4	4.1	4.4	5.4	VE 15
Chesapeake Bay	34	N 37.63002 W -76.393622	0.7	4.3	3.4	4.1	4.4	5.5	VE 7
Chesapeake Bay	35	N 37.628024 W -76.402727	3.4	3.9	3.4	4.1	4.4	5.5	VE 7
Chesapeake Bay	36	N 37.635421 W -76.411168	2.1	3.8	3.4	4.1	4.4	5.5	VE 16
Chesapeake Bay	37	N 37.638726 W -76.415244	1.1	4.1	3.5	4.2	4.4	5.6	VE 18
Chesapeake Bay	38	N 37.639759 W -76.424767	1.1	4.2	3.5	4.2	4.4	5.6	VE 7
Chesapeake Bay	39	N 37.6463 W -76.433864	1.6	3.3	3.5	4.2	4.4	5.6	VE 17
Chesapeake Bay	40	N 37.651251 W -76.43794	0.9	4.0	3.3	3.9	4.1	5.5	VE 14
Chesapeake Bay	41	N 37.654503 W -76.441082	1.8	3.0	3.3	3.9	4.2	5.5	VE 7

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	
Chesapeake Bay	42	N 37.650088 W -76.454312	1.4	4.6	3.5	4.2	4.4	5.6	VE 14
Chesapeake Bay	43	N 37.661018 W -76.463681	0.9	4.7	3.5	4.2	4.5	5.7	VE 7
Chesapeake Bay	44	N 37.6866 W -76.461143	0.7	3.7	3.6	4.2	4.5	5.7	AE 7
Chesapeake Bay	45	N 37.704311 W -76.474833	1.8	2.8	3.6	4.3	4.6	5.9	VE 7
Chesapeake Bay	46	N 37.692891 W -76.480269	2.1	3.4	3.6	4.3	4.6	5.9	VE 11
Chesapeake Bay	47	N 37.676592 W -76.479367	2.3	3.5	3.6	4.3	4.6	5.8	VE 17
Chesapeake Bay	48	N 37.666391 W -76.489554	1.7	4.1	3.6	4.4	4.7	6.0	VE 7
Chesapeake Bay	49	N 37.646167 W -76.503006	0.7	4.5	3.6	4.4	4.7	6.0	VE 7
Chesapeake Bay	50	N 37.656724 W -76.528136	0.7	3.7	3.7	4.4	4.7	6.0	VE 7
Chesapeake Bay	51	N 37.674057 W -76.536183	0.8	4.3	3.7	4.4	4.7	5.9	VE 15
Rappahannock River	52	N 37.682814 W -76.535409	1.1	3.5	3.7	4.4	4.7	5.9	VE 13
Rappahannock River	53	N 37.695592 W -76.536573	0.7	3.4	3.7	4.4	4.7	5.9	VE 17
Rappahannock River	54	N 37.710096 W -76.543064	1.1	4.0	3.7	4.5	4.8	6.0	VE 7
Rappahannock River	55	N 37.715384 W -76.552578	1.0	3.5	3.7	4.5	4.8	6.1	VE 7
Rappahannock River	56	N 37.726543 W -76.560018	0.6	4.6	3.7	4.6	4.9	6.1	VE 13
Rappahannock River	57	N 37.733633 W -76.56581	0.6	4.3	3.8	4.6	4.9	6.1	VE 7
Rappahannock River	58	N 37.743586 W -76.570856	1.0	3.3	3.8	4.5	4.8	6.0	VE 7
Rappahannock River	59	N 37.756564 W -76.575765	0.6	3.2	3.7	4.6	4.9	6.2	VE 9
Rappahannock River	60	N 37.764678 W -76.581282	0.4	3.8	3.7	4.6	4.9	6.2	VE 7
Rappahannock River	61	N 37.773769 W -76.602573	0.5	3.7	3.8	4.7	5.0	6.4	VE 7
Rappahannock River	62	N 37.787781 W -76.632539	1.1	3.8	3.8	4.8	5.1	6.5	VE 8

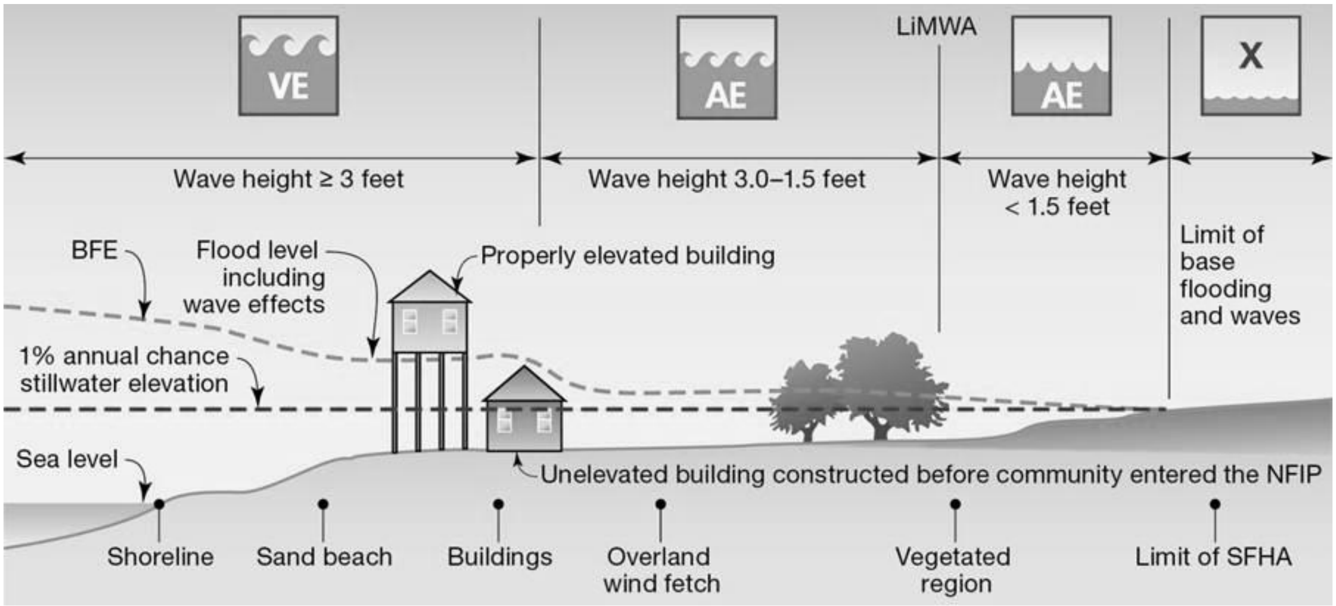


FIGURE 2 – TRANSECT SCHEMATIC

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. 2 Vertical Datum

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

All flood elevations shown in this FIS report and on the FIRM are now referenced to NAVD 88. Structure and ground elevations in the community must, therefore, be referenced to NAVD 88. 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.

Prior to the June 19, 2012, the FIS report and FIRM were referenced to NGVD 29. When a datum conversion is effected for an FIS report and FIRM, the Flood Profiles, base flood elevations (BFEs) and ERMs reflect the new datum values. To compare structure and ground elevations to 1-percent annual chance flood elevations shown in the FIS and on the FIRM, the subject structure and ground elevations must be referenced to the new datum values.

As noted above, the elevations shown in the FIS report and on the FIRM for Lancaster County are referenced to NAVD 88. Ground, structure, and flood elevations may be compared and/or referenced to NGVD 29 by applying a standard conversion factor. The conversion factor to NGVD 29 is:

NGVD 29 -0.9 = NAVD 88

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

NGS Information Services
NOAA, N/NGS12
National Geodetic Survey
SSMC-3, #9202
1315 East-West Highway

Silver Spring, Maryland 209 10-3282
(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.

Pre-countywide Analysis

Town of Irvington

The 1 percent annual chance and 0.2 percent annual chance tidal flooding boundaries have been delineated using topographic maps a scale of 1:24,000 with a contour interval of 10 feet (Reference 11).

Lancaster County (Unincorporated Areas)

For tidal areas without wave action, the 1 percent annual chance and 0.2 percent annual chance boundaries were delineated using topographic maps at a scale of 1:4,800 with a contour interval of 2 feet and at a scale of 1:24,000 with contour intervals of 5 and 10 feet (References 9 and 11). For the tidal areas with wave action, the flood boundaries were delineated using the elevations determined at each transect; between transects, the boundaries were interpolated using engineering judgment, land-cover data, and topographic maps. The 1 percent annual chance floodplain was divided into whole-foot elevation zones based on the average wave crest elevation in that zone. Where the map scale did not permit these zones to be delineated at one foot intervals, larger increments were used.

September 17, 2010 Countywide Analyses

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

The approximate and detailed floodplains have been digitally redelineated using previous effective base flood elevations and new, two-foot contour topographic data provided by Lancaster County.

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, 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 1).

October 02, 2014 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, 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 mass points complied to meet a 3.5 foot horizontal accuracy (Reference 30).

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 7). 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.

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.

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 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 are 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.

The floodway widths are determined at cross sections; between cross sections, the boundaries are 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 is shown.

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

No floodways have been computed in Lancaster County.

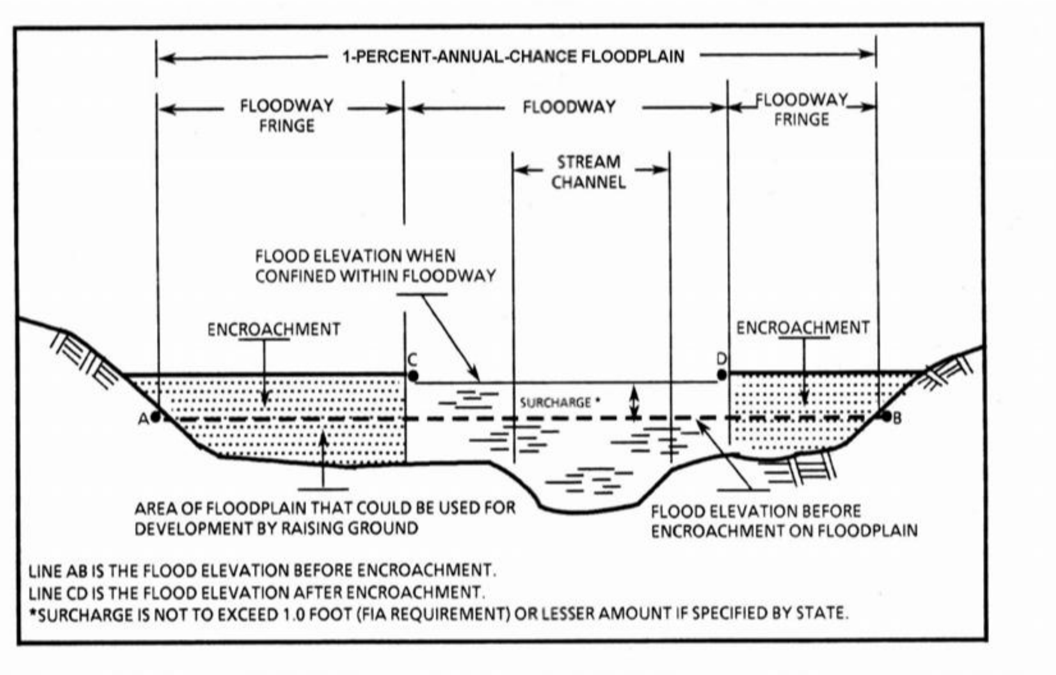


FIGURE 3: FLOODWAY SCHEMATIC

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 Lancaster County. Historical data relating to the maps prepared for each community, up to and including this countywide FIS, are presented in Table 4, "Community Map History."

7.0 OTHER STUDIES

A search was made for existing literature on the flood hazards in Lancaster County. In 1978, the Virginia Institute of Marine Science (VIMS), under contract to FEMA, prepared a storm surge model for predicting storm surges along the Chesapeake Bay, both eastern and western shores (References 14 and 15).

The countywide FIS reports for the adjacent Virginia counties of Essex, Middlesex, Northumberland, and Richmond are currently underway.

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

8.0 LOCATION OF DATA

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

COMMUNITY NAME	INITIAL IDENTIFICATION	FLOOD HAZARD BOUNDARY MAP REVISIONS DATE	FIRM EFFECTIVE DATE	FIRM REVISIONS DATE
Irvington, Town of	October 18, 1974	September 12, 1975	August 4, 1987	
Kilmarnock, Town of	September 17, 2010	None	September 17, 2010	
Lancaster County, Unincorporated Areas	January 24, 1975	None	March 4, 1988	August 3, 1992
White Stone, Town of	August 30, 1974	November 28, 1975	September 24, 1984	

TABLE 4

FEDERAL EMERGENCY MANAGEMENT AGENCY

LANCASTER COUNTY, VA
AND INCORPORATED AREAS

COMMUNITY MAP HISTORY

9.0 BIBLIOGRAPHY AND REFERENCES

1. U. S. Department of Commerce, Bureau of the Census, 1980 Census of Population, Characteristics of the Population, General Population Characteristics, Virginia, Washington, D. C., August 1982.
2. Commonwealth of Virginia, Division of State Planning and Community Affairs, Data Summary - Lancaster County, Richmond, Virginia, April 1972.
3. U. S. Department of Commerce, National Oceanic and Atmospheric Administration, National Ocean Service, Tide Tables 1986, High and Low Water Predictions, East Coast of North and South America Including Greenland, Washington, D. C., May1985.
4. U. S. Army Corps of Engineers, House Document 456, 88th Congress, 2nd Session, Tidewater Portions of the Patuxent, Potomac, and Rappahannock Rivers Including Adjacent Chesapeake Bay Shoreline-Interim Hurricane Survey, 1964.
5. Commonwealth of Virginia, Virginia Uniform Statewide Building Code, Article 8, Part C, Section 872.6, September 1973.
6. 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.
7. U. S. Army Corps of Engineers, Galveston District, General Guidelines for Identifying Coastal High Hazard Zones, Galveston, Texas, 1975.
8. National Academy of Sciences, Methodology for Calculating Wave Action Effects Associated with Storm Surges, Washington, D. C., 1977.
9. Air Survey Corporation of Virginia, of Reston, Virginia, Topographic Maps compiled from aerial photographs, Scale 1:4,800, Contour Interval 2 Feet: Lancaster County, Virginia, 1985.
10. Air Survey Corporation of Virginia, of Reston, Virginia, Aerial Photographs: Lancaster County, Virginia, 1985.
11. U. S. Department of the Interior, Geological Survey, 7.5-Minute Series, Scale 1:24,000, Contour Intervals 5 and 10 Feet: Morattico, Virginia, 1968, Photorevised 1979; Lively, Virginia, 1968; Lancaster, Virginia, 1968; Reedville, Virginia, 1968; Urbanna, Virginia, 1968; Irvington, Virginia, 1968, Photorevised 1979; Fleets Bay, Virginia, 1968; Wilton, Virginia, 1964, Photorevised 1973; Deltaville, Virginia, 1964.

12. Federal Emergency Management Agency, User's Manual for Wave Height Analysis, Washington, D. C., February 1981.

13. U. S. Department of Housing and Urban Development, Flood Hazard Boundary Map, Unincorporated Areas of Lancaster County, Virginia, January 24, 1975.

14. Virginia Institute of Marine Science, Volume I, Storm Surge Height-Frequency Analysis and Model Prediction for Chesapeake Bay, Gloucester Point, Virginia, June 1978.

15. Virginia Institute of Marine Science, Volume II, A Finite Element Storm Surge Analysis and its Application to a Bay-Ocean System, Gloucester Point, Virginia, September 1978.

16. Federal Emergency Management Agency, Flood Insurance Study, Unincorporated Areas of Middlesex County, Virginia (Unpublished).

17. Federal Emergency Management Agency, Flood Insurance Study, Unincorporated Areas of Northumberland County, Virginia (Unpublished).

18. Federal Emergency Management Agency, Flood Insurance Study, Unincorporated Areas of Lancaster County, Virginia (Unpublished).

19. Federal Emergency Management Agency, Flood Insurance Study, Town of Irvington, Lancaster County, Virginia (Unpublished).

20. Commonwealth of Virginia, Secretary of the Commonwealth, Report of the Commonwealth to the Governor and General Assembly of Virginia, Richmond, Virginia, 1983.

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

22. 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 August 12, 2008) http://www4.ncdc.noaa.gov/cgi-win/wwcgi.dll?wwevent~storms

23. Lancaster County, Virginia Comprehensive Plan, Chapter 1- Background, History, Recent Developments and Trends, 2007, Lancaster County, Virginia. http://www.lancova.com/compplan ch1 .pdf

24. Lancaster County, Virginia Comprehensive Plan, Chapter 6- Public Facilities, Infrastructure and Services, 2007, Lancaster County, Virginia. http://www.lancova.com/comp_plan_ch6.pdf

25. Virginia Economic Development Partnership, Community Profiles, Lancaster County, VA 2008, http://virginiascan.yesvirginia.org/Admin/CommunityProfiles/Profiles/CityCounty5 1103 .pdf

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

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

28. http://en.wikipedia.org/wiki/Kilmarnock,_Virginia

29. http://en.wikipedia.org/wiki/White_Stone,_Virginia

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

31. Federal Emergency Management Agency, Flood Insurance Study, Lancaster County and Incorporated Areas, Virginia, September 17, 2010.

32. USACE, 2012b. FEMA Region III Storm Surge Study, Coastal Storm Surge Analysis: Storm Surge Results, Intermediate Data Submittal No. 3 *in Draft Form*, July, 2012, USACE ERDC/CHL, Vicksburg, MS