FLOOD INSURANCE STUDY

WASHINGTON COUNTY, RHODE ISLAND
(ALL JURISDICTIONS)

VOLUME 1 OF 2

COMMUNITY NAME	COMMUNITY NUMBER
CHARLESTOWN, TOWN OF	445395
EXETER, TOWN OF	440032
HOPKINTON, TOWN OF	440028
NARRAGANSETT INDIAN TRIBE	445414
NARRAGANSETT, TOWN OF	445402
NEW SHOREHAM, TOWN OF	440036
NORTH KINGSTOWN, TOWN OF	445404
RICHMOND, TOWN OF	440031
SOUTH KINGSTOWN, TOWN OF	445407
WESTERLY, TOWN OF	445410

Revised:
October 16, 2013

Federal Emergency Management Agency

FLOOD INSURANCE STUDY NUMBER
44009CV001B

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.

The Federal Emergency Management Agency (FEMA) may revise and republish part or all of this FIS report at any time. In addition, FEMA may revise part of this FIS report by the Letter of Map Revision (LOMR) process, which does not involve republication or redistribution of the FIS report. Therefore, users should consult community officials and check the Community Map Repository to obtain the most current FIS components.

Initial Countywide FIS Effective Date: October 19, 2010

Revised Countywide FIS Date: October 16, 2013

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<u>EXHIBITS</u> - continued

FLOOD INSURANCE STUDY
WASHINGTON COUNTY, RHODE ISLAND (ALL JURISDICTIONS)

1.0 INTRODUCTION

1.1 Purpose of Study

This countywide Flood Insurance Study (FIS) investigates the existence and severity of flood hazards in, or revises and updates previous FISs/Flood Insurance Rate Maps (FIRMs) for the geographic area of Washington County, Rhode Island, including the Towns of Charlestown, Exeter, Hopkinton, Narragansett, New Shoreham, North Kingstown, Richmond, South Kingstown, Westerly, and lands designated for the Narragansett Indian Tribe (hereinafter referred to collectively as Washington County).

This FIS 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 county that will be used to establish actuarial flood insurance rates. This information will also be used by Washington 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.

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

1.2 Authority and Acknowledgments

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

The October 19, 2010 FIS (Reference 1) was prepared to include the incorporated communities within Washington County in a countywide format. Information on the authority and acknowledgments for each jurisdiction included in the 2010 countywide FIS, as compiled from their previously printed FIS reports, is shown below.

Charlestown, Town of:	the hydrologic and hydraulic analyses from the FIS report dated June 17, 1986, represent a revision of the original analyses by the U.S. Army Corps of Engineers (USACE) for the Federal Emergency Management Agency (FEMA). The original work was completed in 1972. The updated version was prepared by Stone & Webster Engineering Corporation for FEMA, under Contract No. EMW-C-0405. That work was completed in November 1983.

Exeter, Town of:	the hydrologic and hydraulic analyses from the FIS report dated September 1, 1981, were prepared by Harris-Toups Associates for FEMA under Contract No. H-4776. That work was completed in June 1980.
Hopkinton, Town of:	the hydrologic and hydraulic analyses from the FIS report dated September 16, 1980, were prepared by the U.S. Geological Survey (USGS) for the Federal Insurance Administration (FIA), under Inter-Agency Agreement No. IAA-H-9-77, Project Order No. 10, Amendment Nos. 1 and 2. That work was completed in June 1979.
Narragansett, Town of:	the hydrologic and hydraulic analyses from the FIS report dated May 1, 1984, represent a revision of the original analyses performed for FEMA. The updated version was prepared by PRC Harris, Inc., for FEMA, under Contract No. H-4776. That work was completed in July 1981. The wave height and wave runup analyses were also prepared by PRC Harris, Inc., for FEMA and were completed in March 1983.
New Shoreham, Town of:	the hydrologic and hydraulic analyses from the FIS report dated October 3, 1984, were performed by PRC Harris, Inc., for FEMA, under Contract No. H-4776. That work was completed in July 1981. The wave height and wave runup analyses were also performed by PRC Harris, Inc., under Modification M010 to Contract No. H-4776. That work was completed in April 1983.
North Kingstown, Town of:	the hydrologic and hydraulic analyses from the FIS report dated December 5, 1989, represent a revision of the original analyses by the USACE for FEMA under Inter-Agency Agreement No. IAA-H-8-71 P05. The first revision was prepared by Harris-Toups Associates under agreement with FEMA. That study was completed in May 1980. The wave height analyses for that study were prepared by Dewberry & Davis, under Contract No. EMW-C-0543. That work was completed in July 1981. In the second revision, approximate floodplain boundaries for a swamp area were redelineated. That work was carried out by Dewberry & Davis.

Richmond, Town of:	the hydrologic and hydraulic analyses from the FIS report dated May 1980 were performed by the USGS for the FIA under Inter-Agency Agreement No. IAA-H-9-77, Project Order No. 30. That work was completed in June 1979.
South Kingstown, Town of:	the hydrologic and hydraulic analyses from the FIS report dated January 3, 1986, represent a revision of the original analyses by the USACE. The original work was completed in 1971. The updated version was prepared by Stone & Webster Engineering Corporation for FEMA under Contract No. EMW-C-0405. The updated work was completed in December 1983.
Westerly, Town of:	the hydrologic and hydraulic analyses from the FIS report dated February 5, 1986, represent a revision of the original analyses performed by the USACE for FEMA under Inter-Agency Agreement No. IAA-H-8-71. The updated version was prepared by Stone & Webster Engineering Corporation for FEMA under Contract No. EMW-C-0405. That work was completed in October 1981.

The Authority and Acknowledgements for the Narragansett Indian Tribe lands were taken from the Town of Charlestown FIS report dated June 17, 1986 (Reference 2).

For the 2010 countywide study FIRM panels, planimetric base map information shown was provided in digital format by Rhode Island Geographic Information System (RI GIS). This information was derived from digital orthophotos produced at a scale of 1:5,000 with 2-foot Ground Sample Distance (GSD) from photography dated 2003 and 2004 (Reference 3).

The coordinate system used for the production of FIRM panels for the 2010 study was Rhode Island State Plane, North American Datum of 1983 (NAD 83), GRS80 spheroid. Corner coordinates shown on the FIRM are in latitude and longitude referenced to the Rhode Island State Plane FIPZONE 3800, NAD 83, GRS80. 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.

The coastal wave height analysis for this coastal study was prepared by the Strategic Alliance for Risk Reduction (STARR) for FEMA under Contract No. HSFEHQ-09-D-0370 and completed in July 2011. This new analysis resulted in revisions to the Special Flood Hazards Areas (SFHA) within the Towns of Charlestown, Narragansett, New Shoreham, North Kingstown, South Kingstown, and Westerly.

Base map information shown on the FIRM panels produced for this coastal study revision was derived from USGS High Resolution orthophotography dated spring of 2011, produced at six inch resolution cells. The horizontal datum used was North American Datum of 1983 (NAD 83) (Reference 4).

1.3 Coordination

Consultation Coordination Officer's (CCO) meetings may be held for each jurisdiction in this countywide FIS. An initial CCO meeting is held typically with representatives of FEMA, the community, and the study contractor to explain the nature and purpose of a FIS, and to identify the streams to be studied by detailed methods. An intermediate CCO meeting is held typically with representatives of FEMA, the community, and the study contractor to discuss interim concerns of the study. A final CCO meeting is held typically with representatives of FEMA, the community, and the study contractor to review the results of the study.

Prior to this countywide FIS, the dates of the initial, intermediate, and final CCO meetings held for the incorporated communities of Washington County are shown in Table 1, "Initial, Intermediate, and Final CCO Meetings."

TABLE 1 – INITIAL, INTERMEDIATE, AND FINAL CCO MEETINGS

Community	Initial CCO Date	Intermediate CCO Date	Final CCO Date
Town of Charlestown	September 5, 1979	December 2, 1983	February 11, 1985
Town of Exeter	April 19, 1978	June 1980	February 24, 1981
Town of Hopkinton	March 1976	*	April 28, 1980
Town of Narragansett	April 12, 1978	April 1, 1983	November 21, 1983
Town of New Shoreham	April 24, 1978	June 2, 1983	May 14, 1984
Town of North Kingstown	April 1978	May 1980	March 10, 1982
Town of Richmond	January 1976	*	December 13, 1979
Town of South Kingstown	September 5, 1979	December 2, 1983	December 4, 1984
Town of Westerly	September 7, 1979	November 25, 1981	February 26, 1985

*Data not available

In preparation of the 2010 countywide FIS, a Coastal Technical Coordination Meeting was held on April 6, 2009 to review the draft coastal redelineation. This meeting was attended by representatives of the communities, the study contractor, the Rhode Island Emergency Management Agency, and FEMA. The final CCO meeting was held on July 8, 2009. This meeting was attended by representatives of the Towns of Charlestown, Hopkinton, Narragansett, Richmond, South Kingstown, and Westerly, the study contractors, the Rhode Island Emergency Management Agency, and FEMA.

For this 2013 Coastal Study revision, letters were sent to all communities within the study area notifying them of the scope of the FIS, and soliciting pertinent information from them. Letters were mailed on May 26, 2010. The results of this coastal study were reviewed at the final CCO meetings held on May 2, 2012, and attended by representatives of the communities, FEMA Region 1, the Rhode Island Emergency Management Agency, and STARR. All questions raised at that meeting were addressed in this study.

2.0 AREA STUDIED

2.1 Scope of Study

This FIS covers the geographic area of Washington County, Rhode Island.

October 19, 2010 Countywide FIS:

All or portions of the flooding sources listed in Table 2, "Flooding Sources Studied by Detailed Methods," were studied by detailed methods. Limits of study were indicated on the Flood Profiles (Exhibit 1) and on the FIRM (Exhibit 2).

TABLE 2 - FLOODING SOURCES STUDIED BY DETAILED METHODS

Annaquatucket River	Pawcatuck River
Ashaway River	Pettaquamscutt River
Atlantic Ocean	Point Judith Pond
Block Island Sound	Potter Pond
Canonchet Brook	Queens Fort Brook
Canonchet Brook Tributary	Quidnessett Brook
Chipuxet River	Rhode Island Sound
Mastuxet Brook	Sand Hill Brook/Saw Mill Brook
Mattatuxet River	Saugatucket River
Mile Brook	Tomaquag Brook
Narragansett Bay	Wood River

The stream named Sand Hill Brook in the Town of North Kingstown FIS is referred to as Sand Hill Brook/Saw Mill Brook in this FIS. The 2010 countywide FIS also incorporated the determination of letters issued by FEMA resulting in map changes (Letters of Map Revision [LOMR]), as shown in Table 3, “Letters of Map Change.”

TABLE 3- LETTERS OF MAP CHANGE

Community	Flooding Source(s)/Project Identifier	Effective Date	Type	Case Number
North Kingstown, Town of	Unnamed Zone A- Interstate Diesel	September 16, 1992	LOMR	01-91-33
North Kingstown, Town of	Sand Hill Brook – Morgancrest Farm	November 20, 1996	LOMR	96-01-003P

TABLE 3- LETTERS OF MAP CHANGE - continued

Community	Flooding Source(s)/Project Identifier	Effective Date	Type	Case Number
Westerly, Town of	Winnapaug Pond/Atlantic Ocean - Misto Property	June 12, 2002	LOMR	20-01-688P
Westerly, Town of	Block Island Sound - Weekapaug Inn	May 25, 2006	LOMR	05-01-A502P

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.

All or portions of numerous flooding sources in the county were studied by approximate methods. Approximate analyses were used to study those areas having a low development potential or minimal flood hazards. The scope and methods of study were proposed to, and agreed upon by, FEMA and Washington County.

2013 Coastal Study Update

The coastal wave height analysis for this countywide coastal study was prepared by STARR. This new analysis resulted in revisions to the FIRM for the Towns of Charlestown, Narragansett, New Shoreham, North Kingstown, South Kingstown, and Westerly. Based on the new updated analysis, the results of LOMR cases 11-01-1012P and 12-01-0301P were superseded.

2.2 Community Description

Washington County is located in southwestern Rhode Island. The population of Washington County was 126,979 in 2010, 123,546 in 2000, and 110,006 in 1990 (Reference 5). It is bordered by Kent County to the north, Newport County to the east, the Atlantic Ocean to the south, Suffolk County, New York to the southwest, and New London County, Connecticut to the west.

Washington County is served by Interstate 95 and U.S. Route 1. State Route 138 connects Washington County with Newport County and the City of Newport.

The climate of Washington County is variable. The average annual precipitation is approximately 41 inches. Mean temperatures for January and July are approximately 30 degrees Fahrenheit (°F) and 71°F, respectively, with an average annual temperature of approximately 50°F (Reference 6).

The Town of Charlestown is located in the south-central portion of Washington County, approximately 24 miles east of New London, Connecticut, and 32 miles southwest of Providence, Rhode Island. It is bordered by the Town of South Kingstown to the east, Block Island Sound to the south, the Town of Westerly to the west, and the Towns of Hopkinton and Richmond to the north. The total area contained within the corporate limits of Charlestown is 41.3 square miles, of which 36.3 square miles is land.

Charlestown is a rural residential community that attracts both a permanent and seasonal population. There is very little industrial activity within the town, and the principal economic activity is farming. It is estimated that the population of Charlestown generally doubles during the summer months.

Many of the topographic features of the town result from glaciations. Glacial outwash formed a 1- to 2-mile wide strip of flat land which extends north from the coast. Glacial deposits known as the Charlestown recessional moraine (running the length of the town north of U.S. Route 1) sometimes reach over 100 feet in elevation. A series of large swamps, acts as a dam to hold back water. Inland, the topography reaches elevations of 150 feet (Reference 7).

The coastal area of Charlestown and the Town of South Kingstown is fronted by barrier beaches. In many areas, recreational use of the shoreline has kept the barrier beaches from fully recovering from past storms. Since the hurricanes of 1938 and 1954, development along the beaches in Charlestown has been light, except in the Quonochontaug area; development along the beaches is permitted and progressing in South Kingstown (Reference 8).

The Pawcatuck River drains the northern portion of Charlestown. Charlestown is situated in the south-central portion of the drainage basin, which has a total area of 303 square miles. In addition, the Pawcatuck River drains the northern and western portions of the Town of Westerly. Westerly is located at the downstream end of the drainage basin. The watershed is irregular in shape with the longest dimension being 22 miles. The maximum elevation of slightly more than 600 feet is in the northern portion of the basin; however, the average elevation is less than 200 feet. Low rounded hills rise above the very wide valleys where the major relief features are composed of glacial deposits. Much of the basin consists of wide, flat swampy valleys, making the average slope of the river quite low. Development in the basin is limited. Many large areas have been set aside by the State of Rhode Island as state forests and parks. A large part of Great Swamp in South Kingstown and Westerly is designated as a wildlife reservation. Approximately 5 miles of the river upstream of the confluence at Little Narragansett Bay are tidally influenced (Reference 9).

The Town of Exeter is located in northwest Washington County. Exeter is bordered by the Towns of West Greenwich and East Greenwich on the north; North Kingstown on the east; South Kingstown, Richmond, and Hopkinton on the south; and the State of Connecticut on the west.

The Town of Exeter has a total land area of 58.2 square miles. Wholesale and retail trade outlets make up a majority of the business in the town.

The topography of Exeter is variable, consisting of steep hills, lowlands and swamps. The relief of the town ranges from a high point of approximately 550 feet at Pine Hill to a low point of approximately 120 feet in the area of Locke Swamp.

Queens Fort Brook flows southwest from its headwaters, which are located in the northeastern portion of the town. At Slocumville Road, Queens Fort Brook turns west and continues for approximately 1.8 miles before it converges with the Queen River. The

Chipuxet River flows south for approximately 1.5 miles from Yawgoo Mill Pond, which is located near the eastern corporate limits, to the southern corporate limits.

The Town of Hopkinton is located in the western portion of Washington County. The Town of Hopkinton is situated approximately 30 miles southwest of the City of Providence and has a total land area of 43.9 square miles. Hopkinton is bordered on the west by the Towns of Voluntown and North Stonington, Connecticut; and by the Towns of Westerly, Richmond, and Exeter, Rhode Island, on the south, east, and north, respectively. Topographically, the area consists of rolling hills typically interspaced by broad, low-gradient stream valleys containing extensive wetlands. The majority of the road system has been built on high ground, away from the streams. Consequently, there has been very little development near the floodplains.

The Wood and Pawcatuck Rivers are the largest streams in the Towns of Hopkinton and Richmond. The Wood River originates at the outlet of Porter Pond in Sterling, Connecticut, and flows southeast to its confluence with the Flat River in Exeter, Rhode Island. From this point, it flows south through Hope Valley and Woodville until it joins the Pawcatuck River, south of Alton. The Wood River is the boundary between the Towns of Hopkinton and Richmond. It drains an area of 89 square miles. The Pawcatuck River originates at the outlet of Worden Pond in South Kingstown, Rhode Island, and flows southwest until it empties into the Atlantic Ocean at Westerly, Rhode Island. It flows through a part of Ashaway and forms Hopkinton's southern boundary. The drainage area above the Hopkinton, Rhode Island-North Stonington, Connecticut, corporate limits is 244 square miles.

Canonchet Brook, a tributary of the Wood River, flows southeast through the central part of the Town of Hopkinton and drains an area of 7.7 square miles. Tomaquag Brook, in the south-central part of the community, flows south to its confluence with the Pawcatuck River and drains an area of 8.7 square miles. The pattern of settlement in these basins is rural in character.

The Ashaway River and Mile Brook flow through the Village of Ashaway. The Ashaway River originates at the confluence of the Fall River and Parameter Brook, 1.5 miles north of Ashaway, and flows south to its confluence with the Pawcatuck River at Ashaway. The drainage area above the confluence is 29.8 square miles. Mile Brook rises about one-half mile east of Ashaway and flows southwest to the Pawcatuck River. It drains 1.26 square miles.

The Town of Narrangansett is located in the southeastern portion of Washington County, approximately 30 miles south of the City of Providence. It is bordered by the Town of South Kingstown to the west, the Town of North Kingstown to the north, Narragansett Bay and Rhode Island Sound to the east, and Block Island Sound to the south. Narragansett is situated within the Providence, Pawtucket, and Warwick Standard Metropolitan Statistical Area. It was established in 1670 and incorporated as a town in 1901 (Reference 6).

The town is primarily a rural residential, summer resort and fishing community. The shore resort area, which includes bay and ocean fronts, covers approximately 14 miles and includes several sheltered ponds and inlets.

The Town of Narragansett is situated in a coastal plain with terrain gently sloping to sea level. The maximum elevation is 100 feet in the northern portion of the town. The southern section of Narranganset is relatively flat with considerable areas of tidal marsh. The coastal topography ranges from steep rocky shorelines to gradually sloping sand beaches.

Floodplain areas of Narranganset which are developed include Bonnet Shores, Point Judith, some areas along Sand Hill Cove, areas along the Pettaquamscutt River, and several areas along the coastline.

The Town of New Shoreham encompasses the entire area of Block Island. The island is located south of Block Island Sound in the Atlantic Ocean at the mouth of Long Island Sound and 14 miles east of Montauk Point. From the shore of the island, Fishers Island, Watch Hill, Point Judith, Narragansett River, and Newport are visible.

Block Island is comprised of low erratic hills, rising to approximately 150 feet in elevation and interspersed with water table ponds and swamps. The soil is moderately permeable glacial till and does not support any freshwater streams. The coastline ranges in character from sandy beaches to 100-foot high bluffs. In general, most buildings are located on high ground above flood hazard areas, although a few scattered buildings on the Old Harbor area may be flood prone.

The Town of North Kingstown is located in southeastern Washington County. The town is bordered by the City of Warwick and the Town of East Greenwich on the north, Narragansett Bay on the east, the Towns of South Kingstown and Narragansett on the south, and by the Town of Exeter on the west. North Kingstown is located 20 miles south of Providence, the state capital. The incorporated area of the town is 58.3 square miles, of which 14.8 square miles are inland water.

The Mattatuxet River, located in the southern portion of the town, flows south through North Kingstown. The river originates at Silver Spring Lake and flows southeast before flowing into Carr Pond. After flowing out of Carr Pond, the Mattatuxet River flows south into the Pettaquamscutt River.

The Annaquatucket River flows southeast through the center of the town and into Belleville Pond. The river flows out of the pond and into Bissell Cove.

Sand Hill Brook/Saw Mill Brook, which is located in the northeast portion of the town, flows to the northeast. After passing under Potter Road, the brook turns to the north and flows into the Hunt River.

Quidnessett Brook is located in northeastern North Kingstown and flows southwest into Allen Harbor.

The Town of Richmond is located in central Washington County. Richmond is bordered by the Towns of Exeter to the north, Hopkinton to the west, Charlestown to the south, and South Kingstown to the east.

The Town of South Kingstown is located in the southeastern portion of Washington County, approximately 30 miles south of the City of Providence. It is bordered by Block Island Sound to the south, the Towns of Charlestown and Richmond to the west, the Towns of Exeter and North Kingstown to the north, and the Town of Narragansett to the east.

South Kingstown is a community of diversified small industry and attracts both a permanent and seasonal population. The area has experienced significant growth in its summer resort and tourist facilities as well as in year-round residential construction. The University of Rhode Island, considered one of the major facilities in America for oceanographic research, is located in South Kingstown.

The town encompasses an area of 62.3 square miles, of which 56.8 square miles are land (making South Kingstown geographically larger than any other Rhode Island city or town).

The 5.5 square miles of inland water in the town consist of numerous waterbodies, with many surrounded by swamps or having tributaries running through low, level, often swampy areas. The Saugatucket River watershed lies in the northeastern portion of South Kingstown and has a total area of 17.6 square miles above U.S. Route 1. Only a small portion of the watershed is outside the corporate limits. Urban areas are located in the lower reaches of the 5-mile stretch of the river running through the town. The remainder of the watershed is rural with some development taking place in the western portion of the watershed (Reference 10).

The Town of Westerly is located in the southwestern portion of Washington County. Westerly is approximately 18 miles east of New London, Connecticut, and 42 miles southwest of Providence, Rhode Island. It is bordered by the Town of Hopkinton to the north; the Town of Charlestown, Rhode Island to the east; Block Island Sound to the south; the Town of Stonington, Connecticut to the west; and the Town of North Stonington, Connecticut to the northwest.

2.3 Principal Flood Problems

Flooding in Charlestown is generally limited to the coastal lowlands along Block Island Sound. The most severe coastal flooding occurs during hurricanes, which are tropical in nature and are characterized by low barometric pressures, wind speeds greater than or equal to 75 miles per hour, torrential rain, tremendous waves, and tidal flooding. Severe coastal flooding resulted from the hurricanes of September 1938 and August 1954. Both of these storms had a severe effect on the entire coastline of the town. The 1938 and 1954 hurricanes were approximately a 1-percent-annual-chance and an approximately 1.2-percent-annual-chance storm (85 year recurrence interval), respectively.

The 1938 and 1954 hurricanes caused extensive damage to the barrier beaches along Charlestown's coastline. The 1938 hurricane destroyed or heavily damaged several homes between and behind the three small ponds at Quonochonaug. The 1954 hurricane caused less damage. The parking lot in front of Michel Pond is flooded during storms and requires frequent maintenance. East Beach was heavily built up with summer cottages before the 1938 hurricane, but these cottages were destroyed by that hurricane.

After the 1954 hurricane, the state condemned most of the barrier beaches and since then has managed it as a conservation area. As on East Beach, all cottages on Charlestown Beach were completely destroyed by the 1938 hurricane. Since the 1970s, the beach is only sparsely developed between the Charlestown Breachway and the Charlestown/South Kingstown corporate limits. Any development on the barrier is at a great risk to life and property (Reference 8).

The natural processes that tend to rebuild the barrier beaches have been hampered by increased use of the beaches for recreational purposes. This also causes some of the inland development to be open to wave attack from hurricanes (Reference 8). Although Charlestown residents would like beach areas protected and limits put on the number of new residents in the area, current trends of increased population and number of dwellings do not indicate that the coastline will be used less in the future (Reference 7).

Riverine flooding has not been as much of a problem in the town as tidal flooding. The vast amount of swampland within the Pawcatuck River basin has reduced flood peaks (Reference 9). USGS streamflow records collected in the vicinity indicate that annual peak flow can occur during any season of the year but occurs most frequently from December through April. Runoff from spring rains, sometimes accompanied by snowmelt, usually causes the highest peak flows to occur from March to April. High peaks also can occur during September and October due to runoff from tropical storms (Reference 11). The March 1968 flood produced a peak discharge of 1,700 cubic feet per second (cfs) on the Pawcatuck River at the Wood River Junction gage. This was estimated as an approximately 2.9-percent-annual-chance flood (35 year recurrence interval). In January 1978 and January 1979, floods produced peak discharges of 1,260 cfs and 1,210 cfs, respectively. These floods were approximately 6.7-percent-annual-chance estimated floods (15 year recurrence interval) (Reference 12).

There is no documentation of extensive flooding on Queens Fort Brook or on the Chipuxet River in the Town of Exeter. Flood prone areas on Queens Fort Brook are located upstream and downstream of the South County Trail Bridge, at the entrances of the Joseph H. Ladd School and at the confluence with the Queen River. Flooding on the Chipuxet River occurs upstream of Yawgoo Valley Road and in the vicinity of Wolf Rocks Trail Road. Flooding on Mail Road at Queen River occurs when rainfall amounts reach 4 inches and flooding on Summit Road at Roaring Brook occurs when rainfall amounts reach 2.5 inches. In both rainfall events the resultant flooding caused roads to be closed to traffic.

In the Town of Hopkinton, streamflow records collected in the vicinity by the USGS indicate annual peak flow can occur during any season of the year, but most frequently during the months December through April. The highest peak flows usually occur during March or April because of runoff from spring rains, at times augmented by snowmelt; or during September or October, due to runoff from tropical storms.

Based on historical information obtained for the USGS gaging stations on the Wood River at Hope Valley and on the Pawcatuck River at Westerly, the worst flood since 1886 was that of November 1927, which was caused by a tropical storm. No discharges were calculated for this flood, however, it is estimated to be at least a 0.5-percent-annual-chance flood. A flood which occurred in March 1968 was the second most severe. Peak discharges during this flood were 1,720 cfs, on the Wood River at the Hope Valley USGS gage, and 4,470 cfs, on the Pawcatuck River at the Westerly gage. This flood is estimated to be 2.5-percent-annual-chance flood (40 year recurrence interval). The percent-annual-chance for the two floods were obtained from flood-frequency distributions developed for these gaging stations.

The exposed location of the Town of Narragansett along Rhode Island Sound and Block Island Sound makes it vulnerable to periodic flooding and wave attack during hurricanes and coastal storms. In addition, Narragansett Bay creates a funneling effect during hurricanes, causing higher flood elevations in the northern portions of the town than along the southern coast. Several low-lying residential areas in the town are subject to inundation during severe hurricanes, such as the September 1938 hurricane (approximately 1-percent-annual-chance) and Hurricane Carol in 1954. These areas include Jerusalem, Galilee, Point Judith Pond, Sand Hill Cove, and Narragansett Pier. In addition, scattered areas subject to flooding are located along the east coast of the town and along the Pettaquamscutt River.

Damaging waves can occur in areas with sufficient fetch length and water depth. The entire open coastline of Narragansett, as well as some areas in Point Judith Pond, are subject to varying degrees of wave action.

The 1954 hurricane is described by the Providence Journal as follows (Reference 13):

> In the hurricane of 1954 the damage along the shore from Narragansett Pier to Matunuck was estimated by some responsible officials as the worst in the state. Hurricane Carol probed at the very vitals of the town's two fishing and recreation industries, smashing down fashionable beach clubs, public bathing pavilions and summer cottages with all-embracing fury. Galilee and Jerusalem isolated and ravaged and the coastline from Bonnet Shores to Point Judith in ruins in many places when the storm had passed.

The following excerpts from a report on the 1938 storm by the Providence Journal describe the destruction (Reference 14):

> Water completely inundated Narragansett Pier's Ocean Drive . . .
>
> Sand Hill Cove – Houses lined the beach 3 and 4 deep before the storm. After it passed there was only a huddle of broken homes and vast stretches of beach swept clean of all structures.
>
> Narragansett River – The mountainous seas crushed the exclusive Dunes Club on the beach at Narragansett. The hotel was battered and broken, the main clubhouse reduced to a shambles, the bathing pavilion smashed and the cabanas and guest houses carried away.
> Narragansett Pier at Ocean Drive – The seawall was reduced to small stones and the drive itself broken up and swept onto the lawns of the

> hotels that lined the waterfront. The beach-side of the main street was swept clean of its buildings.
>
> Narragansett Terrace – Almost barren of the scores of houses that stood on its shore . . . (was the) southeast corner of Narragansett Terrace in Riverside . . . the swirling waters left homes a half a mile away from their original site.

According to the Providence Journal in response to the hurricane of 1938 (Reference 14):

> No more eloquent testimony of the storm's power could be had than its destruction of the granite-block sea wall at Narragansett Pier. Not even that barrier could withstand the relentless fury of wind-driven water, and the storm roared on to undermine summer homes and dwellings, and to bring down Sherry's Pavilion – famous pier landmark and fling it, a twisted mass of wreckage, across the highway. Just a little further north, the Dunes Club was shaken in its foundations, its front torn out and its bath houses reduced to splinters.

High-water marks for the hurricanes of 1938 and 1954 in the area around Narragansett are shown in Table 4, "High-Water Mark Elevations" (References 13 through 19).

TABLE 4 – HIGH-WATER MARK ELEVATIONS

LOCATION	HURRICANE September 21, 1938 (feet NAVD 88*)	HURRICANE CAROL August 31, 1954 (feet NAVD 88*)
Narragansett Bay		
Newport		
Bailey Beach	12.6	**
Price Neck	14.1	10.1
Brenton Point	19.0, 17.7	**
Newport Harbor	10.5	**
USC&GS Tidal Gage	11.9	8.9
Middletown		
Coddington Cove	**	9.6
Portsmouth		
South End Providence Island	11.4	10.1
Melville	11.5	10.5
Homestead (Prudence Island)	13.3	11.1

* North American Vertical Datum of 1988 (NAVD 88)
**Data not available

TABLE 4 – HIGH-WATER MARK ELEVATIONS - continued

LOCATION	HURRICANE September 21, 1938 (feet NAVD 88*)	HURRICANE CAROL August 31, 1954 (feet NAVD 88*)
Narragansett Bay (continued)		
Bristol		
Bristol Point	**	10.1
Bristol Harbor	12.3, 13.1	11.6, 12.1
Warren		
Warren River Mouth	13.7	12.3
Barrington		
Rumstick Neck	14.2	**
Barrington Beach	14.6	14.1
Nayatt Point	14.5	14.2
Bullock Cove	14.3	13.6
East Providence		
Bullock Point	14.9	13.9
Crescent Park	15.2	**
Squantum Point	15.0	15.3
Providence		
Seekonk River	15.2	14.0
Point St. Bridge	15.7	14.4
USC&GS Tide Gage	14.9	13.9
Sakonnet River		
Little Compton		
Breakwater Point	12.9	9.8
Portsmouth		
Sandy Point	**	10.9
McCurry Point	**	10.4
Island Park	14.4	13.5
Railroad Bridge	14.7	**
Common Fence Point	13.3	11.1
Warren River		
Laurel Park	**	13.1
Kickamuit River	12.3	12.6
Fall River		
USC&GS Tide Gage	12.9	12.5

* North American Vertical Datum of 1988 (NAVD 88)
**Data not available

The Town of New Shoreham experiences coastal flooding caused by northeasters and hurricanes. Northeasters can occur at any time of the year but are more prevalent in the winter months, whereas hurricanes occur in the late summer and early fall months.

The following discussion on hurricanes and northeasters is useful for understanding their relationship to tidal elevations on Block Island. A hurricane develops as a tropical storm either near the Cape Verde Islands off the African coast or in the Caribbean Sea. Most hurricanes which reach Block Island approach from the south after recurving east of Florida and skirting the mid-Atlantic states. These hurricanes start their journey with a forward speed of 10 miles per hour and, after recurving toward Long Island, may increase their speed to 20 to 30 miles per hour and even up to 60 miles per hour as they approach the colder water temperatures found in the more northern latitudes.

The most destructive hurricane winds occur northeast of the eye where the spiral wind movement and forward motion of a storm combine. For this reason, the actual track of a hurricane is very important because of the effect its high wind velocity may have on the community. Tidal levels along the coastline are greatly influenced by the forces, duration, and direction of these winds as well as the distance or fetch across open water over which the winds act.

A northeaster travels in a southwest to northeast direction along the Atlantic coast, collecting moisture over the ocean and sending it inland via northeast winds. The northeaster differs from a hurricane in that it covers a larger area, the winds are not as intense, and it moves much more slowly. Where a hurricane may last for several hours, a northeaster may last for several days. For this reason, northeasters often last long enough to be accompanied by at least one high tide, resulting in the most severe flooding conditions. These high levels result from a drop in the barometric pressure and from strong winds which can blow out of the northeast across the considerable fetch of the Atlantic Ocean.

In a special report on the hurricane of 1938, which was approximately 1-percent-annual-chance flood, the Providence Journal provided the following account (Reference 14):

> Block Island suffered badly as far as its fishing fleet was concerned. The storm struck a stunning blow to the Island's fishermen. A goodly share of the fishing fleet was moored at the Island when the hurricane swept over it. At Old Harbor some of the boats piled up on the stone jetty and others, battered and broken, sunk at their moorings.

The following excerpts from witnesses on the island further describe the destruction:

> Mansion Beach – A wooden bench down on Mansion Beach washed up to East Mansion Road, and was found almost 1,000 feet further inland.
>
> Sachem Pond – Wave action caused a large breach (30 feet wide and 20 feet deep) in the dune between Rhode Island Sound and Sachem Pond.

> Ballard's Inn at Old Harbor – Four 10,000 gallon gas tanks (half full) were torn out of the sand where they were buried. Three of them were found later in different places. One was found near Mansion Beach, another by Indian Head Neck, and the third near Corn Neck Road, opposite Scotch Beach.
>
> Coast Guard Station on Corn Neck Road – Tides driven by wind caused great turbulence and crushed boats. Water was 2 feet deep in the station. Wind instruments broke at 120 miles per hour. Waves came across Corn Neck Road, knocking down sand dunes and going into Harbor Pond so that water rose over Ocean Avenue at the Power Plant site. Area at the Bridge Gage was covered with water, 2 feet deep.
>
> Old Harbor – Waves in Old Harbor were at such height that fishing boats carried over the red sandstone breakwater. Ballard's Inn washed into the harbor, only the frame remained. Docks were covered with water. The worst damage probably took place within one hour. Water had risen to just below Finn's (the Old Post Office) by the time it was over.
>
> Great Salt Pond – New Harbor – At Ryan's New Harbor Dock, water was 3 feet above the dock and went across Ocean Avenue. Water rose half way up the bank in front of the Narragansett Hotel.

Although Hurricane Carol in 1954 was not as severe as the hurricane of 1938, there were several cases of destructive flooding, as the local residents remember it:

> Water came into Mansion Pond from in between a mansion and the adjacent house located along Mansion Beach.
>
> At Great Salt Pond – New Harbor, a 30-foot yacht washed onto the Narragansett Hotel lawn, near the porch.

The Providence Journal, in reference to Hurricane Carol of 1954, gave the following account (Reference 13):

> Big winds failed to hurt Block Island seriously though the recorded wind velocity reached 135 miles an hour. Pavilion at State's new $100,000 beach development was slightly damaged.

An additional problem in New Shoreham caused by storms is erosion. As demonstrated by the steepness of the Mohegan Bluffs, erosion rates are high on the south shore where storm waves are greatest. They are less significant on the west and north shore where storm waves are damaging, but less severe. The entire coastline, including Great Salt Pond, is subject to some wave action during severe storms which may cause damage to structures. These effects are most significant where fetch lengths are longest and offshore water depth is greatest, such as the south and east shores.

Flooding within the Town of North Kingstown has been limited in the past. The most serious flooding problems have occurred where subdivisions have encroached upon floodplains and wetland areas (References 20 and 21).

Flood-prone areas on Sand Hill Brook/Saw Mill Brook are located between Briar Brook Drive and Spring Meadow Road in the vicinity of Potter Road, due to backwater from the Potter Road bridge, and the area approximately 1,000 feet downstream of Chadsely Lane. On the Annaquatucket River, flooding may occur from Boston Neck Road (State Route 1A) to Featherbed Road, from Tower Hill Road to the dam located at Belleville Pond and along the west side of the river upstream of Hatchery Road. Flooding may occur on Quidnessett Brook upstream of Quidnessett Road. There is no major flooding in residential areas along the Mattatuxet River.

Coastal flooding occurs in the vicinity of Bissell and Duck Coves east of Boston Neck Road (State Route 1A), Wickford Harbor, Wickford and Fishing Coves and an area north of the Naval Reservation near Tibbits Creek. Historic flood elevations are shown in Table 4, “High-Water Mark Elevations.”

In the Town of Richmond, stream-flow records collected in the vicinity of the study area by the USGS indicate annual peak flow can occur during any season of the year, especially between the months of December and April. The highest peaks often occur during March or April as a result of runoff from spring rains, at times augmented by snowmelt or during September or October from tropical storm runoff.

Flooding in South Kingstown is generally limited to the coastal lowlands along Block Island Sound, Point Judith Pond, and the Pettaquamscutt River.

Flooding in the Town of Westerly is associated with the coastal lowlands along Block Island Sound and the lower elevations along the Pawcatuck River. Further, flooding is associated with Quonochontaug Pond in Weekapaug/Haversham/ Shelter Harbor and with Chapman Pond/Aguntaug Swamp.

Six hurricanes have affected Rhode Island in the last two decades, causing minimal-to-moderate damage to the Rhode Island coastline. Three of these hurricanes caused mild-to-moderate damage to Washington County, RI. Hurricane Gloria in September 1985 caused moderate beach erosion along the Rhode Island beaches and wind gusts up to 92 miles per hour. Hurricane Gloria arrived at low tide and the storm surges were less than 5-feet above normal. Statewide, there were approximately 300,000 power outages due to the storm (References 22 and 23). Hurricane Bob made landfall in Newport County, Rhode Island in August 1991. With winds of 75 to 100 MPH, the storm severely affected coastal communities and extensive beach erosion occurred along the shore from Washington County, eastward. Hurricane Bob caused a storm surge of 5 to 8 feet along the Rhode Island shore. The hurricane damaged trees and utility poles leaving more than 60 percent of southeast Rhode Island residents without power (References 24, 25 and 26). In July 1996, the remnants of Hurricane Bertha formed waterspouts near Washington County, R.I. and caused structural roof damage to a few homes in Bristol County, RI. Wind damage across New England led to fallen trees and power lines (Reference 27).

High surf induced by Hurricane Earl in September 2010 resulted in minor coastal flooding in Newport, RI and left ocean debris behind. Washington and Newport counties were both under a tropical storm warning and Governor Donald Carcieri declared an emergency. Several school districts in Rhode Island released students from school early on September 3, as well as Bristol-Warren and Cumberland school Districts, which closed schools in anticipation of Hurricane Earl (References 28 and 29). In August 2011, Hurricane Irene produced significant amounts of rain, storm surge and coastal flooding, resulting in property damages within Washington County. Trees were downed in Charlestown and Narragansett, including on Boston Neck Road in Narragansett. The automated surface observing system at Westerly State Airport recorded sustained winds of 32 knots (37 MPH) and wind gusts to 46 knots (53 MPH) (References 28 and 29). In October 2012, Hurricane Sandy impacted the coastline of Newport County. The impacts of Hurricane Irene and Sandy have not been considered in the October 2013 coastal analysis study.

Between April 1 and April 12, 2010, 5 to 10 inches of rain fell across Washington County, resulting in rises on the Pawcatuck River at Westerly and Wood River Junction. The Pawcatuck River set a record of approximately 15.5 feet at Westerly and just over 11 feet at Wood River Junction (Reference 29).

From December 2010 through February 2011, the State of Rhode Island saw a series of six winter storms that led to record snowfalls across the state. These storms caused a number of problems statewide with transportation, power outages, and collapses. Snow accumulation from a winter storm on December 27, 2010 reached between 10 and 16 inches and left over 480,000 Rhode Island National Grid customers, majority of those in Newport and Washington counties, without power (Reference 30). Another 10 inches of snow accumulated on January 13, 2011 by a winter storm caused scattered power failures across the state, 126 customers in Washington County were without electricity. Washington County reported a few disabled vehicles and downed tree limbs. The storm winds ripped the wires off one house in the county. Water undermined a road in South Kingstown (Washington County) and resulted in the collapse of the road. One bridge in the county was also undermined and impassable (References 31, 32 and 33). Two more winter storms January 21, 2011 and January 26, 2011 accumulated another 12 to 18 inches of snow, causing numerous traffic accidents and closing schools. Early February two ice storms hit Rhode Island caused roof collapses and clogged storm drains (References 34 through 38).

2.4 Flood Protection Measures

Existing flood protection along the coast of Charlestown is limited to the natural protection offered by the barrier beaches, a few seawalls, and some scattered areas of dumped riprap. New houses built on the open coast are required to be elevated.

There are no flood control structures affecting riverine flows in the town. Most of the dams on the Pawcatuck River are old mill dams (mills destroyed). Neither these dams, nor the dams for the few mills still operating, are regulated. Inland flood protection is provided by the vast amount of swampland in the town.

Currently, there are no significant or extensive flood protection structures in the Town of Exeter. A dam is located on the Yawgoo Pond at its confluence with the Chipuxet River, but this structure does not provide flood protection in the Town of Exeter.

There are no flood control structures affecting streamflow in the Town of Hopkinton. The existing dams on the streams studied in detail are old mill dams (mills destroyed) and none are regulated. However, storm runoff intensity is greatly moderated by large areas of swamp, numerous ponds, and low-gradient streams and the surrounding countryside.

Currently, Hopkinton has a Flood Plain and Water Course Protection Zone which prohibits building below the 2-percent-annual-chance flood elevation.

In the Town of Narragansett, the Galilee area is protected from high waves by jetties which surround the "Harbor of Refuge," which includes the entrance to Point Judith Pond. The jetties do not provide protection from inundation caused by high storm tides. As a result of the devastation caused by the 1938 and 1954 hurricanes, an escape route above the flood level was constructed leading out of the Galilee area. The Escape Road services the Port of Galilee and the residential neighborhood known as Great Island. Other protective structures have been built by private owners to satisfy their individual requirements. These structures provide limited protection against damaging wave action.

In the Town of New Shoreham, flood protection measures have been built in several areas, primarily for protection against wave action. The Old Harbor is protected against large ocean waves by jetties; however, they do not significantly reduce wave heights during a 1-percent-annual-chance storm. Development has generally occurred in the upland portions of the island, affording the simplest method of flood protection. Any construction within 100 feet of a coastal feature is prohibited and the town's Flood Overlay District is intended to prohibit or restrict building in any area subject to flood hazards.

Currently, there are no significant flood protection structures in the Town of North Kingstown. Management measures provide some control of storm runoff in developed areas.

North Kingstown zoning laws and building code conform with FEMA requirements pertinent to protection of new construction in the event of a 1-percent-annual-chance flood.

There are no flood-control reservoirs which affect stream flow in the Town of Richmond. Currently, the Town of Richmond has no floodplain zoning law.

Existing flood protection along the coast of South Kingstown is limited to the natural protection offered by the barrier beaches themselves, a few seawalls, and some scattered areas of dumped riprap. New houses built on the open coast are required to be elevated.

There are no flood control structures affecting streamflow in South Kingstown. Of the two dams on the Saugatucket River, only the dam above State Route 108 has any means of controlling flow over the main spillway. A sluiceway to the east of the main river bank allows flows of a non-flood magnitude to circumvent the industrial park just south of State Route 108.

Existing flood protection along most of the coast of the Town of Westerly is limited to the natural protection offered by the barrier beaches themselves, a stretch of sand fill placed by the State of Rhode Island at Misquamicut Beach in 1959 and 1960, and a few seawalls.

Westerly has effective ordinances protecting its barrier beaches. Except for Atlantic Beach, the barrier beaches are zoned as flood prone residential areas, and development is stringently controlled. No building is permitted on dunes, and the owners of homes built behind dunes are required to protect them by building boardwalks to the beaches and by erecting snow fences (Reference 8).

The dam on the Pawcatuck River controlled by the Bradford Dyeing Association does provide some control of flood flows on the Pawcatuck River; however, there is little available data for this dam. Data for this dam were estimated for the purposes of this study.

There are no other flood control structures affecting streamflow in Westerly. Most of the dams on the Pawcatuck River are old mill dams that are not operating. Neither these dams, nor the dams for the few mills still operating, are regulated.

The State of Rhode Island's Coastal Resources Management Program (CRMP) has developed regulations for reconstruction after hurricanes and severe storms. Regulations provide guidance designed to minimize the impact of coastal hazards. Policies regulate where to build on a property, construction of shoreline protection facilities, and beneficial reuse of dredged materials help to mitigate some of the hazards associated with coastal areas. Erosion setbacks are very effective regulations that protect the property owner and the public resources. Much of the Rhode Island shoreline is eroding. Erosion rates are calculated by comparing the shoreline location from historic aerial photographs to the most recent shoreline position. Sections of the south shore barriers have erosion rates of more than three feet per year. In critical erosion areas on barriers, all residential construction with less than six units must be set back 30 times and commercial property 60 times the average annual erosion rate. The farther the structure is setback from the shore, the less the risk of erosive forces. These regulations were enacted about 30 years ago and policy should be reviewed for when the setback is gone and the structure is on the active beach.

3.0 <u>ENGINEERING METHODS</u>

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-, 50-, 100-, and 500-year 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 100-year flood (1-percent-chance of annual exceedence) in any 50-year period is approximately 40 percent (4 in 10), and, for any 90-year period, the risk increases to approximately 60 percent (6 in 10). The analyses reported herein reflect flooding potentials based on conditions existing in the county at the time of completion of this study. Maps and flood elevations will be amended periodically to reflect future changes. Riverine and coastal analyses are discussed separately in the following sections.

3.1 Riverine Hydrologic Analyses

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

In order to provide a national standard without regional discrimination, the 1-percent-annual-chance flood has been adopted by FEMA as the base flood for purposes of floodplain management. This flood has a 1-percent chance of being equaled or exceeded each year and is expected to be exceeded once on the average during any 100-year period. The risk of having a flood of this magnitude or greater increases when periods longer than 1 year are considered. For example, over a 30-year period, there is a 26 percent chance of experiencing a flood equal to or greater than the 1-percent-annual-chance flood. The 0.2-percent-annual-chance floodplain is also shown on the FIRM to indicate areas of moderate flood hazards.

Areas inundated by the 1-percent-annual-chance flood are shown as A and AE zones on the county's FIRM. It is in these areas that the FEMA requires local communities to exercise floodplain management measures as a condition for participation in the NFIP.

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

Discharges at various locations along the Pawcatuck River were estimated on the basis of peak flood discharge information from two gaging stations on the river. One gaging station is located at Wood River Junction in Hopkinton and has been in operation since October 1940. The other gaging station is located at Charlestown and has been in operation since November 1940. The most recent (1980) peak flood discharge-frequency distributions for the two gages were obtained from the USGS (Reference 12).

Peak discharges for the Pawcatuck River were estimated for locations between its mouth at Westerly and the Charlestown/South Kingstown corporate limits. Between the two gaging stations on the river, peak discharges were estimated on the basis of a drainage area proration of discharges from the flood-frequency distributions for both the gaging stations. The 10-percent-annual-chance flood at each gage was plotted against the drainage area for the corresponding gage on log-log graph paper. A line was then drawn between the two plotted points, and the slope, "n", of this line was calculated. This same procedure was also carried out for the 2-, 1-, and 0.2-percent-annual-chance floods to yield a total of four plotted lines, each having a unique slope. Slopes ranged from 1.05 for the 0.2-percent-annual-chance flood to 1.09 for the 10-percent-annual-chance flood. Each line used the following equation (Reference 39):

$$Q_1/Q_2 = (A_1/A_2)^n$$

Where Q_1 and A_1 are the discharge and drainage area, respectively, at the Wood River Junction gage, and Q_2 and A_2 are the discharge and drainage area at some other location. The exponent, "n", is the slope as defined above.

The series of A_2 values was determined by planimetering USGS topographic maps covering the drainage basins (Reference 40). These drainage areas were then used in the equation described above to determine the series of discharges at these selected locations.

In the Town of Exeter, the hydrology for both Queens Fort Brook and the Chipuxet River is based on flood-flow equations developed by the USGS in cooperation with the Rhode Island Department of Transportation. A report entitled "Flood Magnitude and Frequency of Small Rhode Island Streams" was used for streams which has drainage area less than one square mile (Reference 41). Multiple regression techniques were used to define the relation between flood peaks, based on records collected at a network of gaging stations maintained by the USGS and a set of watershed basin characteristics.

In the Town of Hopkinton, the USGS has maintained a gaging station on the Wood River at Hope Valley since March 1941. Peak discharges at this gage site for floods having recurrence intervals of 10-, 2-, 1-, and 0.2-percent-annual-chance were determined from a log-Pearson Type III distribution, using a weighted skew coefficient as recommended by the U.S. Water Resources Council (Reference 42).

Discharges at other sites on the Wood River, the Ashaway River, Mile and Tomaquag Brooks, and in the Canonchet Brook basin were estimated by interpolation on the basis of drainage area using the following relationship (Reference 39):

$$Q_1/Q_2 = (A_1/A_2)^{0.72}$$

Where Q_1 and A_1 are the discharge and drainage area at the Hope Valley gaging station, and Q_2 and A_2 are the discharge and drainage area at each of the other sites. The exponent, 0.72, is based on a study of the relationship of 50-, 2-, and 1-percent-annual-chance flood peaks and drainage areas at gaging stations in Rhode Island. Computation of discharges by this method rather than by use of any of the various available regional flood formulas was preferred for several reasons. With the exception of Johnson and Laraway (Reference 41), other formulas are based on streamflow data collected over a broad area (New England or northeastern United States) rather than locally. Also, the majority are based on data pertaining to large drainage basins and are not applicable to drainage areas of less than 10 square miles. Furthermore, the studies which produced formulas applicable to areas of less than 10 square miles do not include formulas for the 1- and/or 0.2-percent-annual-chance peaks. The Johnson and Laraway study provides formulas for computing 10- and 2-percent-annual-chance peaks for streams in Rhode Island and the formulas are applicable to drainage areas of less than 10 square miles. Discharges for these recurrence intervals at the Tomaquag and Canonchet Brook sites were computed by the Johnson-Laraway method and they compare favorably with those obtained by the above interpolation method.

Discharges for the Pawcatuck River were estimated on the basis of a drainage-area proration from flood-frequency distributions computed for the Pawcatuck River gaging stations at Wood River Junction, in operation since October 1940, and Westerly, in operation since November 1940. These distributions were developed in a manner similar to that previously mentioned for the Wood River gage.

In the Town of North Kingstown, the hydrology for the Mattatuxet River and Quidnessett Brook is based on flood flow equations developed by the USGS in cooperation with the State of Rhode Island Department of Transportation (Reference 41). For streams with a drainage area of less than 10 square miles, the USGS report "Flood Magnitude and Frequency of Small Rhode Island Streams" was utilized (Reference 41). Multiple regression techniques were used to define the relationship between flood peaks, based on records collected at a network of gaging stations maintained by the USGS, and a set of watershed basin characteristics.

Discharge-frequency relationships for the Annaquatucket River and Sand Hill Brook/Saw Mill Brook were determined from methodology developed by the SCS which analyzes anticipated rainfall and the resulting runoff (Reference 43). The Annaquatucket River and Sand Hill Brook/Saw Mill Brook watersheds were divided into areas of uniform characteristics. An analysis of slope, soil, vegetation, land use and stream channels of these areas was made to compute composite runoff curve numbers, times of concentration and travel times. Storage capacity and stage-discharge curves were computed for all significant reservoirs and natural valley storage areas. The 10-, 2-, 1-, and 0.2-percent-annual-chance synthetic storms were then flood routed through the upstream area of the watershed using the SCS "Computer Program for Project Formulation-Hydrology", TR-20 (Reference 44). The program computes surface runoff resulting from synthetic or natural rainstorms. It takes into account conditions concerning runoff and routes the flow through stream channels and reservoirs. The program combines the routed hydrograph with those from other tributaries and computes peak discharge, time of occurrence and the water-surface elevation at selected cross sections and reservoirs.

Rainfall data from various streams were obtained from U.S. Weather Bureau publications (References 20 and 45). A 48-hour distribution, which included the standard SCS 24-hour Type II rainfall distribution, was used for storms of all frequencies. The March 1968 flood was used to verify the watershed model by comparing the discharge per square mile of watershed with stream gage records of similar watersheds in southeast Massachusetts. The comparison matched for the stage-discharge relationship of flat gradient streams.

In the Town of South Kingstown, on many rivers throughout Rhode Island, and the United States in general, the USGS (and sometimes private organizations) maintains stream gaging stations for determining historic water levels at the site of the gage. These levels are then translated into flows through the use of the hydraulic characteristics of the river at the gage site. These historic flows can then be used to determine statistically, through a procedure known as "frequency analysis," the flood flow for the recurrence interval of interest. Often, the gage records of many streams and rivers in a particular hydrologic region are used to formulate a general equation which can be used for the region to determine flows in area streams on which no gage exists.

Since no gage exists on the Saugatucket River, peak discharges for the river were computed using an extension of a regional method of peak flow prediction applicable to New England (Reference 46). The regional method was formulated for use on ungaged rivers having drainage areas larger than those being studied in the Saugatucket River watershed. Thus, the regional method was extended to smaller basin sizes by estimating from published data the Mean Annual Flow (MAF) for gaged streams in the South Kingstown area for which the drainage area above the gage was less than 10 square miles. A regression line was drawn through the plot of the MAF values for 31 gages (each in operation for at least five years). The MAF for each of the two drainage areas of interest was taken from the regression line and used, along with the appropriate curves from Water-Supply Paper 1671, to determine the discharge for the recurrence intervals of interest.

In Potter Pond, the USACE determined in the original FIS for South Kingstown that the stillwater elevations were slightly lower than the elevations on the open coast (Reference 47). The original study was used as a guide by the study contractor in computing elevations for Potter Pond from the elevations for the outer coast presented in this study.

Stillwater elevations in Point Judith Pond were determined from elevations in the Galilee Harbor of Refuge using a stage correlation as described above. The elevations determined were carried throughout the length of Point Judith Pond (Reference 48).

Stillwater elevations for Rhode Island Sound were obtained from the FIS for the Town of Narragansett (Reference 49). For the Narragansett study, the 10-, 2-, 1-, and 0.2-percent-annual-chance outer coast surge hydrographs from Rhode Island Sound were routed up the mouth of the Pettaquamscutt River to the State Route 1A bridge in Narragansett using a one-dimensional computer model. Input to the model consisted of estuary geometry for a series of grids and the outer coast surge hydrographs. Using a rating curve for the State Route 1A bridge opening and a storage-elevation relationship for the portion of the river upstream of the bridge, volume of flow through the bridge was correlated to the stage-storage curve for the river basin to determine flood elevations for the upper portions of the river.

The most downstream section of the Pawcatuck River forms the border between Stonington, Connecticut, and Westerly, Rhode Island. The nontidal portion of this section of the river extends from a point downstream of the State Route 78 bridge to the confluence with the Shunock River. This section was studied in detail for the FIS for the Town of Stonington (Reference 50). In that study, the Westerly gaging station flow frequency distribution based on peak flood discharges prior to 1978 was used directly to determine the peak flood discharges for the 10-, 2-, 1-, and 0.2-percent-annual-chance floods. The direct application of flood frequency analyses for the Westerly gaging station to the nontidal portion of the Pawcatuck River downstream of the confluence of the Shunock River was found to be reasonable. Because the peak discharges presented in the Stonington study did not differ greatly from the discharges obtained from the 1980 frequency distribution, the discharges from the Stonington study were used for this FIS for Westerly.

For the stretch of the Pawcatuck River above the confluence with Ashaway River, the drainage area proration described above was performed for the FIS for the Town of

Hopkinton using frequency distributions based on peak flood discharges prior to 1979 for the two gages on the Pawcatuck River (Reference 11). The discharges obtained for the 2010 countywide study (based on 1980 frequency distributions) did not differ greatly from those presented in the Hopkinton study; therefore, the discharges from the Hopkinton study were used for this study.

No gage exists on Mastuxet Brook; therefore, peak flood discharges for the brook were computed using an extension of a regional method of peak flow prediction applicable to New England (Reference 46).

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

TABLE 5 – SUMMARY OF DISCHARGES

FLOODING SOURCE AND LOCATION	DRAINAGE AREA (sq. miles)	PEAK DISCHARGES (cfs) 10-PERCENT	2-PERCENT	1-PERCENT	0.2-PERCENT
ANNAQUATUCKET RIVER					
At Boston Neck Road	7.02	607	1,124	1,326	1,875
Approximately 800 feet downstream of Belleville Pond Dam	6.11	562	1,043	1,237	1,748
Approximately 50 feet upstream of railroad bridge	2.02	278	391	417	485
ASHAWAY RIVER					
At confluence with Pawcatuck River	29.8	700	1,000	1,150	1,550
CANONCHET BROOK					
At confluence with Wood River	7.73	260	380	440	590
Upstream of Alton Road	6.67	240	340	390	530
Upstream of State Route 3	5.46	210	300	340	460
CANONCHET BROOK TRIBUTARY					
Upstream of Canonchet Road (downstream culvert)	3.54	150	220	250	340
Upstream of Canonchet Road (upstream culvert)	0.45	30	50	60	80

TABLE 5 – SUMMARY OF DISCHARGES - continued

FLOODING SOURCE AND LOCATION	DRAINAGE AREA (sq. miles)	PEAK DISCHARGES (cfs) 10-PERCENT	2-PERCENT	1-PERCENT	0.2-PERCENT
CHIPUXET RIVER					
At Exeter/South Kingstown corporate limits	7.3	250	500	680	1,350
At confluence of Yawgoo Mill Pond	4.0	170	340	460	900
MASTUXET BROOK					
At State Route 1A	1.5	90	170	230	370
MATTATUXET RIVER					
At confluence with Pettaquamscutt River	5.02	150	300	405	820
Upstream of Carr Pond	3.22	110	220	299	602
Downstream of State Route 138 culvert	2.45	90	182	246	498
Approximately 800 feet downstream of U.S. Route 1 culvert	1.92	77	154	210	420
MILE BROOK					
At confluence with Pawcatuck River	1.26	70	100	120	160
PAWCATUCK RIVER					
Above USGS Gage No. 01118500 below Stillman Avenue	295.0	3,400	4,900	5,700	7,900
Above confluence with Shunock River	279.2	3,300	4,600	5,200	6,850
Upstream of the confluence of Ashaway River	244.0	2,700	3,750	4,300	5,650
Above the confluence of Tomaquag Brook	212.4	2,450	3,400	3,900	5,100
Above the confluence of Poquiant Brook	203.3	2,350	3,250	3,700	4,900
Above the confluence of the Wood River	115.4	1,250	1,800	2,050	2,700
Above the confluence of Meadow Brook	100.7	1,100	1,550	1,750	2,350

TABLE 5 – SUMMARY OF DISCHARGES - continued

FLOODING SOURCE AND LOCATION	DRAINAGE AREA (sq. miles)	PEAK DISCHARGES (cfs) 10-PERCENT	2-PERCENT	1-PERCENT	0.2-PERCENT
PAWCATUCK RIVER - continued					
At the USGS Gage No. 01117500 at Wood Junction	100.0	1,050	1,500	1,750	2,350
Above the confluence of White Brook	96.9	1,050	1,450	1,700	2,250
Above the confluence of Taney Brook	93.2	1,000	1,400	1,600	2,150
Above the confluence of the Beaver River	79.8	850	1,200	1,350	1,850
QUEENS FORT BROOK					
At confluence with Queen River	4.3	195	390	520	1,010
Approximately 600 feet upstream from Slocumville Road	3.4	135	270	360	700
QUIDNESSETT BROOK					
Above Naval Reservation	1.0	40	75	100	200
SAND HILL BROOK / SAW MILL BROOK					
Approximately 100 feet downstream of North Quidnessett Road	3.46	414	772	918	1,302
Approximately 100 feet downstream of Chadsely Lane	2.46	75	168	207	282
Approximately 100 feet downstream of Devil’s Foot Road	1.67	36	64	75	104
SAUGATUCKET RIVER					
Above U.S. Route 1	17.6	490	960	1,300	2,080
Above the confluence of Rocky Brook	10.9	350	670	910	1,460
TOMAQUAG BROOK					
At confluence with Pawcatuck River	8.70	290	410	480	650
Upstream of confluence of first tributary	6.84	240	350	400	540

TABLE 5 – SUMMARY OF DISCHARGES - continued

FLOODING SOURCE AND LOCATION	DRAINAGE AREA (sq. miles)	PEAK DISCHARGES (cfs) 10-PERCENT	2-PERCENT	1-PERCENT	0.2-PERCENT
TOMAQUAG BROOK - continued					
Upstream of Burdickville Road	5.89	215	310	360	490
WOOD RIVER					
Upstream of Alton	87.1	1,500	2,150	2,500	3,400
Upstream of confluence of Canonchet Brook	77.5	1,400	2,000	2,300	3,100
Hope Valley Gage No. 01118000	72.4	1,320	1,900	2,190	2,970
Upstream of confluence of Brushy Brook	61.2	1,150	1,700	1,950	2,650
Upstream of Barberville	55.1	1,100	1,550	1,800	2,450

3.2 Riverine Hydraulic Analyses

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

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

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

The hydraulic analyses for this FIS were based on unobstructed flow. The flood elevations shown on the profiles are thus considered valid only if hydraulic structures remain unobstructed, operate properly, and do not fail.

All elevations are referenced to the North American Vertical Datum of 1988 (NAVD 88).

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

Bench marks cataloged by the NGS and entered into the NSRS vary widely in vertical stability classification. NSRS vertical stability classifications are as follows:

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

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

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

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

Roughness factors (Manning's "n") used in the hydraulic computations were chosen by engineering judgment and were based on field observations of the streams and floodplain areas. Roughness factors for all streams studied by detailed methods are shown in Table 6, "Manning's "n" Values."

TABLE 6 - MANNING'S "n" VALUES

Stream	Channel “n”	Overbank “n”
Annaquatucket River	0.028 – 0.045	0.050 – 0.075
Ashaway River	0.035 – 0.060	0.040 – 0.120
Canonchet Brook	0.030 – 0.035	0.035 – 0.130
Canonchet Brook Tributary	0.030 – 0.035	0.035 – 0.130
Chipuxet River	0.040	0.080

TABLE 6 - MANNING'S "n" VALUES – continued

Stream	Channel "n"	Overbank "n"
Mastuxet Brook	0.040 – 0.070	0.040 – 0.070
Mattatuxet River	0.030 – 0.040	0.045 – 0.080
Mile Brook	0.035 – 0.050	0.040 – 0.100
Pawcatuck River (Charlestown)	0.020 – 0.050	0.070
Pawcatuck River (Hopkinton)	0.035 – 0.050	0.040 – 0.150
Pawcatuck River (Westerly)	0.025 – 0.050	0.035 – 0.150
Queens Fort Brook	0.040	0.080
Quidnessett Brook	0.025 – 0.040	0.060 – 0.080
Sand Hill Brook/Saw Mill Brook	0.015 – 0.045	0.030 – 0.085
Saugatucket River	0.013 – 0.080	0.020 – 0.150
Tomaquag Brook	0.035 – 0.040	0.045 – 0.150
Wood River	0.035 – 0.065	0.035 – 0.200

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

Cross-section data were obtained by ground survey and from topographic maps compiled from aerial photographs (Reference 51). Below-water sections were obtained by field measurement. All bridges and culverts were field surveyed to obtain elevation data and structural geometry.

Water-surface elevations of floods of the selected recurrence intervals were computed using the USACE HEC-2 step-backwater computer program (Reference 52). Flood profiles were drawn showing computed water-surface elevations for floods of the selected recurrence intervals. Starting water-surface elevations for the Pawcatuck River were obtained from the FIS for the Town of Westerly (Reference 53).

Hydraulic analyses, considering storm characteristics and the shoreline and bathymetric characteristics of the tidal flooding source studied, were carried out to provide estimates of the elevations of floods of the selected recurrence intervals along this shoreline.

In the Town of Exeter, water-surface elevations of selected recurrence intervals for Queens Fort Brook and the Chipuxet River were computed using the USACE HEC-2 step-backwater computer program (Reference 52). The cross sections for the backwater analyses of the streams studied by detailed methods were determined by field survey along the stream channel and were mapped at a scale of 1:4,800 with a contour interval of 5 feet. Cross sections were located at close intervals above and below bridges, dams, and culverts in order to compute the backwater effects of these structures. In addition, cross sections were taken between hydraulic controls wherever warranted by topographic changes.

The starting water-surface elevations for Queens Fort Brook were computed by using the slope/area method. The starting water-surface elevations for the Chipuxet River were computed at normal depth downstream of the Exeter-South Kingstown corporate limits.

Flood boundaries were delineated on maps at a scale of 1:4,800 with a contour interval of 5 feet prepared from strip aerial photographs taken in November 1979 (Reference 54).

In the Town of Hopkinton, starting water-surface elevations were calculated using the slope/area method or obtained from water-surface elevation versus discharge relationships developed for the dams that influence stage in the studied reaches. Flow over these dams was calculated through use of the formula:

$$Q = Cbh^{1.5}$$

where: Q = discharge,
C = discharge coefficient (dependent on dam geometry),
b = crest width, and
h = depth over crest of dam

Where appropriate, relationships were based on the assumption that waste gates would be closed and stop-logs would be in place.

Water-surface elevations for floods of the selected recurrence intervals were computed through use of the USGS E431 step-backwater computer program (Reference 55).

On the Tomaquag Brook profiles, the water-surface elevations reflecting backwater from the Pawcatuck River are based on elevations on the Pawcatuck River just upstream of State Route 3. Judging from the Pawcatuck River profiles and the slope of the riverbed, it was determined that the actual backwater elevations in the downstream reach of Tomaquag Brook would be less than 0.5 foot higher than at State Route 3.

In the Town of Narragansett, maps of the study area, at a scale of 1:1,200 with a contour interval of 2 feet, were used for the topographic data (Reference 56). The land-use and land cover data were obtained by field surveys and from aerial photographs (Reference 57). Depths below mean low water were determined from National Ocean Survey Nautical Charts (Reference 58). Information from the above sources was supplemented with USGS topographic maps (References 40 and 59).

For the portion of the Pettaquamscutt River below the State Route 1A bridge, a one-dimensional computer model was used to route the outer coast surge hydrograph to the bridge (Reference 60). Input consists of estuary geometry for a series of grids, and the outer coast storm surge hydrographs for the 10-, 2-, 1-, and 0.2-percent-annual-chance floods. The model solves the momentum and continuity equations in one-dimension and generates output consisting of a time series of elevations for each grid.

Since the computer model is not designed to calculate the hydraulics of bridge openings, a rating curve was developed to route the hydrographs through the State Route 1A bridge. A storage-elevation relationship was developed for the portion of the river above the bridge. Volume of flow through the bridge was calculated to the stage-storage curve for the river basin to determine flood elevations for the upper portions of the river.

In the Town of North Kingstown, water-surface elevations of floods of selected recurrence intervals for the Mattatuxet River and Quidnessett Brook were computed using the USACE HEC-2 step-backwater computer model (Reference 61). Water-surface elevations of floods of selected recurrence intervals for Sand Hill Brook/Saw Mill Brook and the Annaquatucket River were computed using the SCS WSP-2 water-surface profile computer program (Reference 62).

Cross sections of the backwater analyses of the streams studied by detailed methods were determined by field survey and mapped at a scale of 1:4,800 with a contour interval of 5 feet (Reference 54).

Starting water-surface elevations for the Mattatuxet River and Quidnessett Brook were obtained by normal depth calculations and for the Annaquatucket River and Sand Hill Brook/Saw Mill Brook from stage discharge curves developed in two SCS publications (References 20 and 21). The 2-percent-annual-chance flood elevations for the Annaquatucket River and Sand Hill Brook/Saw Mill Brook were not plotted on the profiles in the two SCS reports. However, by using back-up data supplied by the SCS, stage discharge curves were developed and the 2-percent-annual-chance elevations were calculated and plotted for this study.

There are several areas along the shoreline of North Kingstown which are affected by waves. These areas are designated as coastal high hazard zones. In the Town of North Kingstown, the area from the corporate limits north to Pine Point, around the vicinity of Wild Goose Point to the Wickford Harbor is considered a coastal high hazard area. Another hazard area extends from Sauga Point, around Quonset Point north to the mouth of the Potowomut River.

In the Town of Richmond, cross-section data for the Wood River were obtained by ground survey.

In the Town of South Kingstown, cross-section data for the above-water sections of the Saugatucket River were obtained by ground survey and topographic maps compiled from aerial photographs (Reference 51). Data for the below-water sections were obtained by field measurement. All bridges and culverts were field surveyed to obtain elevation data and structural geometry except for elevation data for the footbridges on the property of the Palisades Industrial Park, where the information was determined using a flood hazard analysis by the SCS (Reference 10).

In the Town of Westerly, for Mastuxet Brook and the upper section of the Pawcatuck River not subject to tidal fluctuations, cross-section data for the above-water sections were obtained by ground survey, digitized from aerial photography using photogrammetric techniques, or obtained from aerial mapping (References 11, 50, and 51).

Except for the reach of the Pawcatuck River between the North Stonington-Hopkinton corporate limits and the State Route 3 bridge, approximately 8,800 feet upstream, water-surface elevations of floods of the selected recurrence intervals were computed using the USACE HEC-2 step-backwater computer program (Reference 63). The analysis for the approximate 8,800-foot-long reach downstream of the State Route 3 bridge was taken from the FIS for the Town of Hopkinton using the USGS E431 step-backwater computer program (References 11 and 55). Flood profiles were drawn showing computed water-surface elevations for floods of the selected recurrence intervals.

The starting water-surface elevations for the Pawcatuck River were determined by two methods. The elevations were developed by trial and error utilizing the HEC-2 slope/area method. Then, elevations were developed by a trial and error hand calculation method, utilizing Manning's equation and solving for depth. It was found that the starting water-surface elevations determined with Manning's equation compared better with historical flood elevation data; therefore, the water-surface elevations for the Pawcatuck River were computed using Manning's equation (Reference 50). The starting water-surface elevation for Mastuxet Brook was taken to be mean spring high tide.

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Based on the results of the new coastal analysis, the backwater elevations are revised where necessary. The flooding sources of Mastuxet Brook, Mattatuxet River, Pawtucket River, Quindenessant Brook, and Saugatucket River were revised for backwater elevations.

3.3 Coastal Hydrologic Analyses

The stillwater elevation is the elevation of the water due to the effects of the astronomic tides and storm surge on the water surface. Hydrologic analyses carried out to establish the peak discharge-frequency relationships for Rhode Island Sound, Block Island Sound and Narragansett flooding sources affecting the communities of Charlestown, Narragansett, New Shoreham, North Kingstown, South Kingstown, and Westerly serve as a basis of coastal hydraulic analyses using detailed methods in accordance with Appendix D of the "Guidance for Coastal Flooding Analyses and Mapping," of the April 2003 FEMA "Guidelines and Specifications for Flood Hazard Mapping Partners" (Reference 64).

For this study, the 10-, 2-, 1-, and 0.2-percent-annual-chance floods for the nearest gages to Washington County on Long Island Sound and Narragansett Bay were obtained from the "Regional Frequency Analyses using L-Moments" memorandum developed by STARR (Reference 65) for areas subject to coastal flooding. Table 7 contains the stillwater elevations determined at the three nearest tide gage stations to Washington County. These values were linearly interpolated to all coastal transects throughout the county for use in coastal hydraulic analyses.

TABLE 7 - SUMMARY OF COASTAL STILLWATER ELEVATIONS

	Elevations (NAVD 88)*			
Flooding Source and Location	10-percent-annual-chance	2-percent-annual-chance	1-percent-annual-chance	0.2-percent-annual-chance
LONG ISLAND SOUND				
New London tide gage station 8461490 (41˚ 21.6’ N, 72˚ 5.4’ W)	4.8	7.4	9.4	17.7
NARRAGANSETT BAY				
Newport tide gage station 8452660 (41˚ 30.3’ N, 71˚ 19.6’ W)	5.3	8.3	10.5	19.9
Providence tide gage station 8454000 (41˚ 48.4’ N, 71˚ 24.0’ W)	7.0	10.9	13.8	26.0

*North American Vertical Datum of 1988 (NAVD 88)

Transects (profiles) were located for coastal hydrologic and hydraulic analyses perpendicular to the average shoreline along areas subject to coastal flooding and extending inland to a point where wave action ceased in accordance with the “Users Manual for Wave Height Analysis” (Reference 66). Transects were placed with consideration of topographic and structural changes of the land surface, as well as the cultural characteristics of the land so that they would closely represent local conditions.

Coastal transect topography data for the Towns of Charlestown, North Kingston, New Shoreham, and Westerly was obtained from Light Detection and Ranging (LiDAR) data collected in December 2006 by Terrapoint USA for Dewberry & Davis LLC (Reference 67). Data is accurate to 2 foot contours. Vertical accuracy is 0.33 ft at a 95-percent confidence interval.

For the Town of South Kingstown, 2-foot contours created from a Digital Terrain Model (DTM) developed using stereoscopic methods from April 2006 Aerial imagery collected by EarthData International, Inc. Masspoints and breaklines were developed from the imagery. The DTM was produced to be fully compliant with the American Society for Photogrammetry and Remote Sensing (ASPRS) accuracy standards for Class 1 mapping and 2-foot contour generation at a scale of 1:100. Contours were generated by the Town of South Kingstown (References 68 and 69).

For the Town of Narragansett, 2-foot contours were derived from planimetric data developed in 2009 by WSP Sells, Inc. (Reference 70).

Bathymetric data were obtained from the National Oceanographic and Atmospheric Administration (NOAA) National Ocean Service (NOS) Hydrographic Data Base (NOSHDB) and Hydrographic Survey Meta Data Base (HSMDB) (NOAA, May 27, 2010) (Reference 71). The sounding datum of mean low low water (MLLW) was converted to vertical datum NAVD88.

Transects were spaced close together in areas of complex topography and dense development. In areas having more uniform characteristics, transects 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.

3.4 Coastal Hydraulic Analyses

Wave height is the distance from the wave trough to the wave crest. The height of a wave is dependent upon wind speed and duration, water depth, and length of fetch. Offshore (deep water) and near shore (shallow water) heights and wave periods were calculated for restricted and unrestricted fetch settings following the methodology described in the February 2007 FEMA "Atlantic Ocean and Gulf of Mexico Coastal Guidelines Update" (Reference 72), for each coastal transect.

An extremal analysis of historical wind gage records was performed to determine the thresholds for peak wind speeds using three Peaks Over Threshold (POT) statistical methods. The wind speeds calculated from the extremal analysis for Quonset Airport were averaged, and the resulting value was used for Washington County wave height calculations at each coastal transect location. Wind speed data sets used in the extremal analyses were for the period September 1985 – May 2010 (Quonset State Airport).

Wave height and period values for the transects located along the Narragansett Bay were calculated using the Steady-State Spectral Wave Model (STWAVE). STWAVE is a phased-averaged spectral wave model that simulates depth-induced wave refraction and shoaling, depth- and steepness-induced wave breaking, diffraction, wind-wave growth, and wave-wave interaction and white capping that redistribute and dissipate energy in a growing wave field. The model accepts a spectral form of the wave as an input condition and provides wave height and period results over the gridded model domain.

Wave setup was assumed to be an important factor in determining total water level, since the coastline has historically experienced flooding damage above the predicted storm surge elevations. Wave setup is based upon wave breaking characteristics and profile slope. As stated in the "Atlantic Ocean and Gulf of Mexico Coastal Guidelines Update" (Reference 64), "Wave setup can be a significant contributor to the total water level landward of the +/- MSL shoreline and should be included in the determination of coastal BFEs." Wave setup values were calculated to the entire open coast shoreline in each community. Wave setup for each coastal transect was calculated by the Direct Integration Method (DIM) developed by Goda (2000) as described in the FEMA "Atlantic Ocean and Gulf of Mexico Coastal Guidelines Update" (Reference 64). For those coastal transects where a structure was located, the wave setup against the coastal structure was also calculated. For profiles with vertical structures or revetments, a failed structure analysis was performed and a new profile of the failed structure was generated and analyzed, in accordance with the USACE, Coastal Engineering Research Center report "Criteria for Evaluating Coastal Flood Protection Structures," (TR CERC-89-15) (Reference 73). The more conservative result of the two analyzed conditions was mapped.

Erosion analysis using FEMA's Coastal Hazard Analysis Modeling Program (CHAMP) Version 2.0 (Reference 74) was performed for profiles with erodible dunes and without coastal structures, such as vertical walls or revetments. The dune subject to erosion is a sandy feature with potentially light vegetation. Any thickly vegetated, rocky, silty, or clayey dune features or bluffs are assumed not subject to erosion. Predicted post-storm erosion profiles were used for analysis of wave heights associated with coastal storm surge flooding, where appropriate.

The methodology for analyzing the effects of wave heights is described in a report entitled "Methodology for Calculating Wave Action Effects Associated with Storm Surges," prepared by the National Academy of Sciences (Reference 75). 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 and seawalls, buildings, rising topography, and vegetation. The amount of energy dissipation is a function of the physical characteristics of the obstruction and is determined by procedures prescribed in the 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.

Along each transect, overland wave propagation was computed considering the combined effects of changes in ground elevation, vegetation, and physical features. Wave heights were calculated to the nearest 0.1 foot, and wave crest elevations were determined at whole-foot increments. The calculations were carried inland along the transect until the wave crest elevation was permanently less than 0.5 foot above the total water elevation or the coastal flooding met another flood source (i.e. riverine) with an equal water-surface elevation. The results of the calculations are accurate until local topography, vegetation, or cultural development of the area undergoes any major changes.

Areas of the 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 76). The 3-foot wave has been determined as the minimum size wave capable of causing major damage to conventional wood frame or brick veneer structures. This criterion has been adopted by FEMA for the determination of V-zones.

It has been shown in laboratory tests and observed in post storm damage assessments that wave heights as little as 1.5 feet can cause damage to and failure of typical Zone AE construction. Therefore, for NFIP advisory purposes only, a Limit of Moderate Wave Action (LiMWA) boundary has been added in coastal areas subject to moderate wave action. Please refer to your state or local building codes to determine if there are higher building standards in place. The LiMWA represents the approximate landward limit of the 1.5-foot breaking wave, and was delineated for all areas subject to significant wave attack in accordance with "Procedure Memorandum No. 50 – Policy and Procedures for Identifying and Mapping Areas Subject to Wave Heights Greater than 1.5 feet as an Informational Layer on Flood Insurance Rate Maps (FIRMs)" (Reference 77).

The effects of wave hazards in the Zone AE (or shoreline in areas where VE Zones are not identified) and the limit of the LiMWA boundary are similar to, but less severe than, those in Zone VE where 3-foot breaking waves are projected during a 1-percent-annual-chance flooding event.

In areas where wave runup elevations dominate over wave heights, such as areas with steeply sloped beaches, bluffs, and/or shore-parallel flood protection structures, there is no evidence to date of significant damage to residential structures by runup depths less than 3 feet. However, to simplify representation, the LiMWA was continued immediately landward of the VE/AE boundary in areas where wave runup elevations dominate. Similarly, in areas where the Zone VE designation is based on the presence of a primary frontal dune (PFD) or wave overtopping, the LiMWA was also delineated immediately landward of the Zone VE/AE boundary.

Wave runup is the uprush of water caused by the interaction of waves with the area of shoreline where the stillwater hits the land or other barrier intercepting the stillwater level. The wave runup elevation is the vertical height above the stillwater level ultimately attained by the extremity of the uprushing water. Wave runup at a shore barrier can provide flood hazards above and beyond those from stillwater inundation. Guidance in the February 2007 FEMA "Atlantic Ocean and Gulf of Mexico Coastal Guidelines Update" (Reference 64) suggests using the 2-percent wave runup value, the value exceeded by 2 percent of the runup events. The 2-percent wave runup value is particularly important for steep slopes and vertical structures. Wave runup was calculated for each coastal transect using methods from the Shore Protection Manual (SPM) (Reference 78) for vertical structures, Technical Advisory Committee for Water Retaining Structures (TAW) method for sloped structures with a slope steeper than 1:8, and mean runup height calculated by the FEMA Wave Runup Model RUNUP 2.0 multiplied by 2.2 was used to obtain the 2-percent runup height for non-vertical structures and profiles with a slope less than 1:8, as described in the February 2007 "Atlantic Ocean and Gulf of Mexico Coastal Guidelines Update" to Appendix D, "Guidance for Coastal Flooding Analysis and Mapping" (Reference 64).

When the runup is greater than or equal to 3 feet above the maximum ground elevation, the BFE was determined to be 3 feet above the ground crest elevation, in accordance with guidance in Appendix D. Computed runup was not adjusted if less than three feet above the ground crest.

When runup overtops a barrier such as a partially eroded bluff or a structure, the floodwater percolates into the bed and/or runs along the back slope until it reaches another flooding source or a ponding area. Standardized procedures for the treatment of shallow flooding and ponding were applied as described in Appendix D of the "Guidance for Coastal Flooding Analysis and Mapping" (Reference 79).

Where uncertified coastal structures such as vertical walls and revetments were present, additional analysis for wave setup and wave runup was performed on profiles assuming the structure will partially fail during the base flood. The post-failure slopes applied for this analysis were 1:3 for sloped revetments, and 1:1.5 for vertical walls, which are within the range suggested by the February 2007 "Atlantic Ocean and Gulf of Mexico Coastal Guidelines Update" to Appendix D (Reference 64).

In accordance with 44 CFR Section 59.1 of the NFIP the effect of the PFD on coastal high hazard area (V Zone) mapping was evaluated for the Towns of Charlestown, New Shoreham, North Kingstown, South Kingstown and Westerly. Identification of the PFD was based upon a FEMA approved numerical approach for analyzing the dune's dimensional characteristics. This approach utilized LiDAR data for the study areas (Reference 67) and assessed change in back slope to determine the landward toe of the PFD. In areas where the PFD defines the landward limit of the V Zone, the V Zone extends to the landward toe of the dune. The PFD defined the landward limit of the V Zone along portions of the shoreline only within the communities of Charlestown, New Shoreham, South Kingstown and Westerly.

Because wave height calculations are based on such parameters as the size and density of vegetation, natural barriers such as sand dunes, buildings, and other man-made structures, detailed information on the physical and cultural features of the study area were obtained from aerial photography. LiDAR data of the shorelines of the Towns of Charlestown, Narragansett, New Shoreham, North Kingstown, South Kingstown and Westerly, was used for the topographic data (Reference 67). Topographic data for the Town of South Kingstown was derived from a DTM (References 68 and 69); and planimetric data was used in the Town of Narragansett (Reference 70).The land-use and land cover data were obtained from USGS 2003 - 2004 High Resolution Orthoimagery for all the towns. Minor updates to the land-use data were made using USGS 2011 High Resolution Orthoimagery (Reference 4).

Figure 1 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 wave conditions in the community may not include all the situations illustrated in Figure 1.

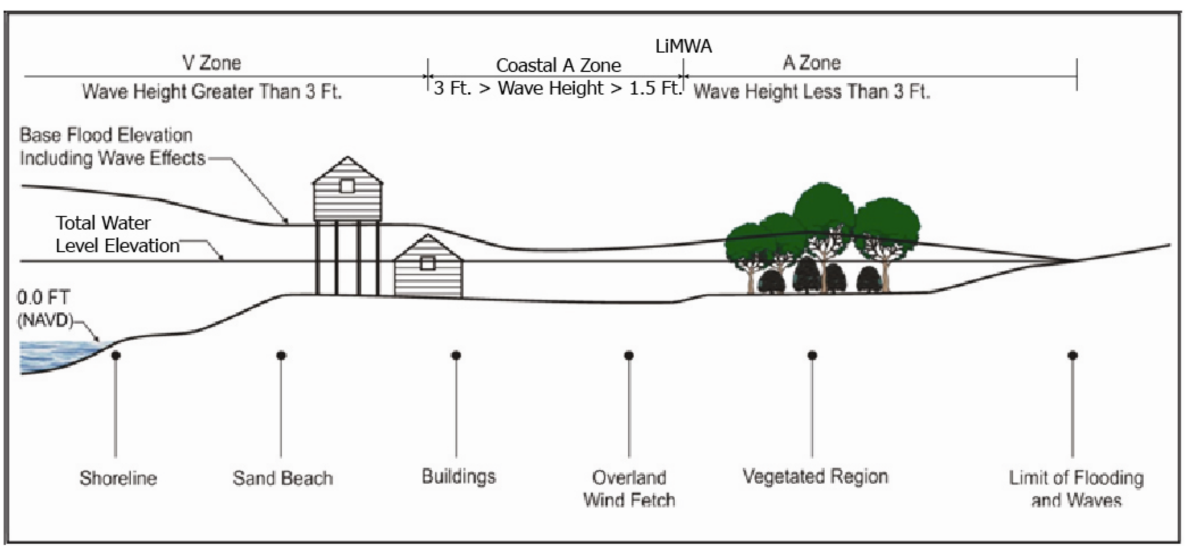

Figure 1 - TRANSECT SCHEMATIC

After analyzing wave heights along each transect, wave crest elevations were interpolated between transects. Various source data were used in the interpolation, including the topographic work maps, notes and photographs taken during field inspection, and engineering judgment. Controlling features affecting the wave crest elevations were identified and considered in relation to their positions at a particular transect and their variation between transects.

Along each transect, wave envelope elevations were computed considering the combined effects of changes in ground elevation, vegetation, and physical features. Between transects, elevations were interpolated using the topographic maps, land-use and land-cover data, and engineering judgment to determine the areal extent of flooding. It was determined that wave runup was not a significant flooding factor in the county. The results of the calculations are accurate until local topography, vegetation, or cultural development within the community undergo any major changes.

Table 8 provides a description of the transect locations, the 1-percent-annual-chance stillwater elevations, and the maximum 1-percent-annual-chance wave crest elevations. Figure 2, "Transect Location Map," illustrates the location of the transects for the county.

TABLE 8 - TRANSECT DESCRIPTIONS

Transect	Location	Elevation (Feet NAVD 88)		V Zone Mapping Method
		Stillwater 1-percent-annual-chance	Max. Wave Crest 1-percent-annual-chance [1]	
1	At the shoreline of Little Narragansett Bay, in the town of Westerly, at the end of Arraquat Rd, extended past Foster Cove Rd.	9.9	13	Overland Wave Propagation
2	At the shoreline of Block Island Sound, in the town of Westerly, Fort Rd, extended through Watch Hill Cove, Waters Edge Rd, Foster Cove, to about 140' South of Arraquat Rd	9.9	14	Overland Wave Propagation
3	At the shoreline of Block Island Sound, in the Town of Westerly, Lighthouse Rd, to about 575 South East of Fort Rd	9.9	16	Overland Wave Propagation
4	At the shoreline of Block Island Sound, in the Town of Westerly, through Mickill Pond, Niantic Ave, extended about 170' past Wauwinnet Ave	9.9	14	Primary Frontal Dune Analyses

[1] Because of map scale limitations, maximum wave elevations may not be shown on the FIRM.

TABLE 8 - TRANSECT DESCRIPTIONS - (continued)

Transect	Location	Elevation (Feet NAVD 88) Stillwater 1-percent-annual-chance	Elevation (Feet NAVD 88) Max. Wave Crest 1-percent-annual-chance [1]	V Zone Mapping Method
5	At the shoreline of Block Island Sound, in the Town of Westerly, Aloha Rd, extended to about 130' South East of Ocean View Hwy	9.9	14	Runup
6	At the shoreline of Block Island Sound, in the Town of Westerly, about 600' North East of Masschaug Rd, extended about 720' past Ocean View Hwy	9.9	14	Runup
7	At the shoreline of Block Island Sound, in the Town of Westerly, about 155' North East of Montego Rd, through Round Hill Rd, extended about 140' North West of Round Hill Rd	9.9	14	Runup
8	At the shoreline of Block Island Sound, in the Town of Westerly, Maplewood Ave, extended about 120' past Bayberry Dr	9.9	14	Runup
9	At the shoreline of Block Island Sound, in the Town of Westerly, Lawton Ave, extended to about 120' South East of 3rd St	10.0	15	Overland Wave Propagation
10	At the shoreline of Block Island Sound, in the Town of Westerly, about 220' East of and roughly parallel to Winnapaug Rd, extended to about 80' South of Shore Rd	10.0	15	Overland Wave Propagation
11	At the shoreline of Block Island Sound, in the Town of Westerly, through Atlantic Ave and Winnapaug Pond, roughly parralel to Via Roma, about 225' South of Shore Rd	10.0	15	Overland Wave Propagation
12	At the shoreline of Block Island Sound, in the Town of Westerly, through Atlantic Ave and Winnapaug Pond, through Shell Dr and the southern part of Brightman Way, roughly parralel to the northern part of Brightman Way, extened 500' south of Shore Dr	10.0	15	Overland Wave Propagation

[1] Because of map scale limitations, maximum wave elevations may not be shown on the FIRM.

TABLE 8 - TRANSECT DESCRIPTIONS - (continued)

Transect	Location	Elevation (Feet NAVD 88) Stillwater 1-percent-annual-chance	Elevation (Feet NAVD 88) Max. Wave Crest 1-percent-annual-chance [1]	V Zone Mapping Method
13	At the shoreline of Block Island Sound, in the Town of Westerly, through Atlantic Ave and Winnapaug Pond, through Utter St, Governor Ave, Cove Rd, extended about 250' past Cove Rd	10.0	15	Runup
14	At the shoreline of Block Island Sound, in the Town of Westerly, through Atlantic Ave and Winnapaug Pond, through Breach Dr, Cove Rd, and Francis Ave, just West of Weekapaug Rd, extended 80' north of Francis Ave	10.0	15	Overland Wave Propagation
15	At the shoreline of Block Island Sound, in the Town of Westerly, through Spray Rock Rd, Shawmut Ave, Taylor Ln, S Williams Ave, East of Meadow Ave, extended about 80' North of S Williams Ave	10.0	16	Runup
16	At the shoreline of Block Island Sound, in the Town of Westerly, through Quonochontaug Pond, through Rossini Rd, Wagner Rd, extended about 175' north of Bach Rd	10.1	15	Overland Wave Propagation
17	At the shoreline of Block Island Sound, in the Town of Charlestown, through W End Rd, W Beach Rd, through Quonochontaug Pond, through Shirley Dr, Lou Ave, Shady Harbor Dr, Cedar Knoll Dr, Hillcrest Dr, S Laurel Dr, to 120' south of Blueberry Hill Dr	10.1	15	Overland Wave Propagation
18	At the shoreline of Block Island Sound, in the Town of Charlestown, through Surfside Ave, Oceanfiew Ave, Neptune Ave, extended to 60' North West of Lucas Ave	10.1	15	Runup

[1] Because of map scale limitations, maximum wave elevations may not be shown on the FIRM.

TABLE 8 - TRANSECT DESCRIPTIONS - (continued)

Transect	Location	Elevation (Feet NAVD 88)		V Zone Mapping Method
		Stillwater 1-percent-annual-chance	Max. Wave Crest 1-percent-annual-chance [1]	
19	At the shoreline of Block Island Sound, in the Town of Charlestown, through Ninigret Pond, through Cove Dr, W Willow Ln, Foster Dr, Route 1, Extended about 900' through Deer Run	10.1	16	Primary Frontal Dune Analyses
20	At the shoreline of Block Island Sound, in the South West corner of South Kingstown, into Charlestown, through Green Hill Pond, Charlestown Beach Rd, Post Rd, Cross Mill Pond, extended 1,950' North West of Lakeside Dr and Center St intersection.	10.2	16	Primary Frontal Dune Analyses
21	At the shoreline of Block Island Sound, in the Town of South Kingstown, between Green Hill Beach Rd and Rosebriar Ave extended 320' through Browning St	10.3	15	Runup
22	At the shoreline of Block Island Sound, in the Town of South Kingstown, through the center of Trustom Pond, extended about 3,210' from 0' contour	10.3	16	Overland Wave Propagation
23	At the shoreline of Block Island Sound, in the Town of South Kingstown, through the center of Card Ponds, extended about 360' through Cards Pond Rd.	10.3	16	Overland Wave Propagation
24	At the shoreline of Block Island Sound, in the Town of South Kingstown, through Carpenters Beach Rd, extended about 500' through Cards Pond Rd	10.3	15	Runup
25	At the shoreline of Block Island Sound, in the Town of South Kingstown, roughly South of Blackberry Hill Dr, 880' from 0' contour	10.3	16	Runup
26	At the shoreline of Block Island Sound, in the Town of South Kingstown, extended about 500' through Matunuck Beach Rd, about 1,000' west of Prospect Rd	10.3	17	Overland Wave Propagation

[1] Because of map scale limitations, maximum wave elevations may not be shown on the FIRM.

TABLE 8 - TRANSECT DESCRIPTIONS - (continued)

Transect	Location	Elevation (Feet NAVD 88) Stillwater 1-percent-annual-chance	Elevation (Feet NAVD 88) Max. Wave Crest 1-percent-annual-chance [1]	V Zone Mapping Method
27	At the shoreline of Block Island Sound, in the Town of South Kingstown, at the intersection of Matunuck Beach Rd and Ocean Ave, through Penninsula Rd, extended about 2,190' through Prospect Rd and Potter's Pond	10.3	14	Runup
28	At the shoreline of Block Island Sound, in the Town of South Kingstown, through the eastern end of Ocean Ave, through Potter's Pond, extended about 4,390' through Sycamore Ln, through Potter's Pond again onto higher ground	10.3	22	Overland Wave Propagation
29	At the shoreline of Block Island Sound, in the Town of Narragansett, through Succotash Rd, Point Judith Pond, Basin Rd, Edith Rd, Island Rd, extended about 230' through Starfish Dr.	10.4	17	Runup
30	At the shoreline of Block Island Sound, in the Town of Narragansett, through Sand Hill Cove Rd, Gallilee Escape Route, Point Judith Pond, to about 60' south of the intersection of Conch Rd and Ram Head Rd.	10.4	15	Overland Wave Propagation
31	At the shoreline of Block Island Sound, in the Town of Narragansett, through Stanton Ave, the West end of Pine Ave, to about 65' south of the East end of Hemlock Ave	10.4	14	Runup
32	At the shoreline of Block Island Sound, in the Town of Narragansett, through Shore Rd, along Lane 5, to intersection of Lane 5 and Follett Rd	10.4	24	Runup
33	At the shoreline of Block Island Sound, in the Town of Narragansett, through the tip of Point Judith, about 60' past parking lot for Point Judith Lighthouse.	10.4	17	Overland Wave Propagation

[1] Because of map scale limitations, maximum wave elevations may not be shown on the FIRM.

TABLE 8 - TRANSECT DESCRIPTIONS - (continued)

Transect	Location	Elevation (Feet NAVD 88) Stillwater 1-percent-annual-chance	Max. Wave Crest 1-percent-annual-chance [1]	V Zone Mapping Method
34	At the shoreline of Rhode Island Sound, in the Town of Narraganset, extended about 490' past Southern end of Ocean Rd and driveway	10.4	15	Overland Wave Propagation
35	At the shoreline of Rhode Island Sound, in the Town of Narraganset, through Calef Ave about 140' South of Louise Ave, extended about 250' through Ocean Rd	10.4	17	Overland Wave Propagation
36	At the shoreline of Rhode Island Sound, in the Town of Narraganset, through Glenwood Ave, along High St, through Ocean Rd, through Schooner Cove Ln, ends about 85' East of Starbord Terrace	10.4	17	Overland Wave Propagation
37	At the shoreline of Rhode Island Sound, in the Town of Narraganset, through Ocean Rd, between Greenbrier Rd and Elizabeth Rd, about 545' past Sewell Rd	10.4	16	Overland Wave Propagation
38	At the shoreline of Rhode Island Sound, in the Town of Narraganset, Scarboro Beach, through Ocean Rd, Desano Dr, ending at Burnside Rd about 140' from Burnside Ave	10.4	15	Overland Wave Propagation
39	At the shoreline of Rhode Island Sound, in the Town of Narraganset, through Ocean Rd, roughly parallel to Baltimore Ave, about 316' South of Baltimore Ave and Ocean Rd intersection.	10.4	16	Overland Wave Propagation
40	At the shoreline of Rhode Island Sound, in the Town of Narraganset, roughly parallel to Newton Ave, about 980' West of interesection of Wildfield Farm Rd and Ocean Rd	10.4	16	Overland Wave Propagation
41	At the shoreline of Rhode Island Sound, in the Town of Narraganset, roughly from the intersection of Central St and Ocean Rd to the intersection of Watson Ave and Rodman St	10.4	19	Overland Wave Propagation

[1] Because of map scale limitations, maximum wave elevations may not be shown on the FIRM.

TABLE 8 - TRANSECT DESCRIPTIONS - (continued)

Transect	Location	Elevation (Feet NAVD 88) Stillwater 1-percent-annual-chance	Max. Wave Crest 1-percent-annual-chance [1]	V Zone Mapping Method
42	At the shoreline of Rhode Island Sound, in the Town of Narraganset, about 450' North East of intersection of Boston Neck Rd and Beach St, through Beach St, roughly to intersection of Wood Ave and Boston Neck Rd	10.5	16	Overland Wave Propagation
43	At the shoreline of Rhode Island Sound, in the Town of Narraganset, through Beach St, about 908' North West of North corner of Beach St parking lot	10.5	15	Overland Wave Propagation
44	At the shoreline of Rhode Island Sound, in the Town of Narraganset, through Southernmost mound structure, roughly parallel to Whale Rock Point, about 990' North West of Cormorant Rd	10.5	16	Overland Wave Propagation
45	At the shoreline of Narragansett Bay, in the Town of Narraganset, perpendicular to shore, extended to about 45' South East of the East end of Anawan Dr	10.5	14	Overland Wave Propagation
46	At the shoreline of Narragansett Bay, in the Town of Narraganset, through Arnold Rd extended to about 260' North West of Conanicut and Algonquin Rds	10.5	15	Runup
47	At the shoreline of Narragansett Bay, in the Town of Narraganset, through Dunes Rd, Bonnet Point Rd between Bayberry and Camden Rd extended about 50' past Withington Rd	10.5	16	Runup
48	At the shoreline of Narragansett Bay, in the Town of Narraganset, through Colonel John Gardner Rd Along Stratford Ave, through Bayberry Ln, Camden Rd, Wesquage Pond, extended about 660' past Bonnet Point Rd	10.5	20	Overland Wave Propagation

[1] Because of map scale limitations, maximum wave elevations may not be shown on the FIRM.

TABLE 8 - TRANSECT DESCRIPTIONS - (continued)

Transect	Location	Elevation (Feet NAVD 88) Stillwater 1-percent-annual-chance	Elevation (Feet NAVD 88) Max. Wave Crest 1-percent-annual-chance [1]	V Zone Mapping Method
49	At the shoreline of Narragansett Bay, in the Town of Narraganset, through Colonel John Gardner Rd, along King Phillip Rd extended to 50' West of Alan Ave	10.6	16	Overland Wave Propagation
50	At the shoreline of Narragansett Bay, in the Town of Narraganset, through intersection of Pier Rd and Aquarium Rd, extended roughly to the East end of Reactor Rd.	10.6	16	Overland Wave Propagation
51	At the shoreline of Narragansett Bay, in the Town of Narraganset, perpendicular to shore, extended roughly to the curve in Tarzwel Dr	10.6	16	Overland Wave Propagation
52	At the shoreline of Narragansett Bay, in the Town of North Kingstown, through Waterway Rd, Willet Rd, extended to about 30' East of Briggs Rd Roughly 415' south of Ferry Rd	10.6	16	Overland Wave Propagation
53	At the shoreline of Narragansett Bay, in the Town of North Kingstown, through Lloyd Rd, to about 630' South of Southern bend in Champlin Rd	10.7	22	Runup
54	At the shoreline of Narragansett Bay, in the Town of North Kingstown, through Plum Beach to about 135' East of Plum Beach Rd	10.8	17	Overland Wave Propagation
55	At the shoreline of Narragansett Bay, in the Town of North Kingstown, perpendicular to shore, roughly 500' North West of the East end of Plantation Ln, extended about 1,650' from the 0' contour.	10.9	15	Runup
56	At the shoreline of Narragansett Bay, in the Town of North Kingstown, through East end of Shady Cove Rd, through Terre Mar Dr about 220' from Rustic Way, about 50' past Terre Mar Dr.	11.0	16	Overland Wave Propagation

[1] Because of map scale limitations, maximum wave elevations may not be shown on the FIRM.

TABLE 8 - TRANSECT DESCRIPTIONS - (continued)

Transect	Location	Elevation (Feet NAVD 88)		V Zone Mapping Method
		Stillwater 1-percent-annual-chance	Max. Wave Crest 1-percent-annual-chance [1]	
57	At the shoreline of Narragansett Bay, in the Town of North Kingstown, roughly along Buena Vista Dr, about 170' West of Buena Vista and Winsor Ave intersection	11.1	19	Runup
58	At the shoreline of Narragansett Bay, in the Town of North Kingstown, from about 60' South of the East end of Beach Street, extended to Boston Neck Rd about 135' south of Beach St	11.2	22	Runup
59	At the shoreline of Narragansett Bay, in the Town of North Kingstown, about 75' South of and parallel with Poplar Ave, extended about 200' West of Steamboat Ave	11.3	19	Runup
60	At the shoreline of Narragansett Bay, in the Town of North Kingstown, parallel with Eldred Ln, through Pleasant and Fowler Streets, to about 1,300' west of Newtown Ave	11.3	17	Overland Wave Propagation
61	At the shoreline of Narragansett Bay, in the Town of North Kingstown, along 3rd St, about 340' North West of Sauga Ave	11.4	21	Runup
62	At the shoreline of Narragansett Bay, in the Town of North Kingstown, through McNaught St, Roger Williams Way, Dillabur Ave, extended about 740' through Conway Ave to about 410' South West of the South West end of Belver Ave	11.4	14	Runup
63	At the shoreline of Narragansett Bay, in the Town of North Kingstown, roughly perpendicular to shore, about 300' South of runway intersection at Quonset airport, through Airport St, Dillabur Ave, about 4,445' from 0' contour	11.5	15	Runup

[1] Because of map scale limitations, maximum wave elevations may not be shown on the FIRM.

TABLE 8 - TRANSECT DESCRIPTIONS - (continued)

Transect	Location	Elevation (Feet NAVD 88) Stillwater 1-percent-annual-chance	Elevation (Feet NAVD 88) Max. Wave Crest 1-percent-annual-chance [1]	V Zone Mapping Method
64	At the shoreline of Narragansett Bay, in the Town of North Kingstown, running roughly East West, about 1860' South of Pettee Ave and Naragansett St intersection, extended to about 415' East of Southern corner of Wilbert Way	11.9	15	Runup
65	At the shoreline of Narragansett Bay, in the Town of North Kingstown, extended to about 125' West of Narragansett St between Mt View Ave and Murray Ave	12.0	19	Overland Wave Propagation
66	At the shoreline of Narragansett Bay, in the Town of North Kingstown, roughly perpendicular to shore, extended about 1,200' from 0' contour, about 175' North of Scalabrini Rd	12.1	17	Overland Wave Propagation
67	At the shoreline of Rhode Island Sound, in the town of New Shoreham, roughly North South along East side of Sachem Pond, through Corn Neck Rd, about 2,220' from shore	8.0	12	Overland Wave Propagation
68	At the shoreline of Rhode Island Sound, in the town of New Shoreham, perpendicular to shoreline, extended roughly 980' East of Corn Neck Rd, between Mansion Rd and Andys Way	8.0	12	Runup
69	At the shoreline of Rhode Island Sound, in the town of New Shoreham, East side of Block Island, through corn Neck Rd, New Harbor, extended to about 230' East of Chamlin Rd	8.0	12	Overland Wave Propagation
70	At the shoreline of Rhode Island Sound, in the town of New Shoreham, East side of Block Island, through corn Neck Rd, Ocean Ave, extended to about 110' North East of Old Town Rd from about 354' East of intersection with Connecticut Ave	8.0	12	Runup

[1] Because of map scale limitations, maximum wave elevations may not be shown on the FIRM.

TABLE 8 - TRANSECT DESCRIPTIONS - (continued)

Transect	Location	Elevation (Feet NAVD 88) Stillwater 1-percent-annual-chance	Elevation (Feet NAVD 88) Max. Wave Crest 1-percent-annual-chance [1]	V Zone Mapping Method
71	At the shoreline of the Atlantic Ocean, in the town of New Shoreham, from about 310' South of East end of High St extended about 75' past Spring St	8.0	12	Overland Wave Propagation
72	At the shoreline of the Atlantic Ocean, in the town of New Shoreham, about 30' South of Spring St and Southeast Rd, extended about 170' past Spring St	8.0	13	Overland Wave Propagation
73	At the shoreline of the Atlantic Ocean, in the town of New Shoreham, roughly parallel to Lakeside Dr, about 760' East of Mohegan and Lakeside Dr, extended to about 375' South of Mohegan Tr	8.0	28	Runup
74	At the shoreline of Block Island Sound, in the town of New Shoreham, roughly perpendicular to shore, through Cooneymus Rd about 1,140' from shore.	7.9	12	Overland Wave Propagation
75	At the shoreline of Block Island Sound, in the town of New Shoreham, through Siahs Swamp and Graces Cove Rd, about 1,300' from shore	7.9	12	Overland Wave Propagation
76	At the shoreline of Block Island Sound, in the town of New Shoreham, through Champlin Rd, Cormorant Cove, New Harbor, extended to about 390' past Corn Neck Rd	7.9	13	Primary Frontal Dune Analyses

[1] Because of map scale limitations, maximum wave elevations may not be shown on the FIRM.

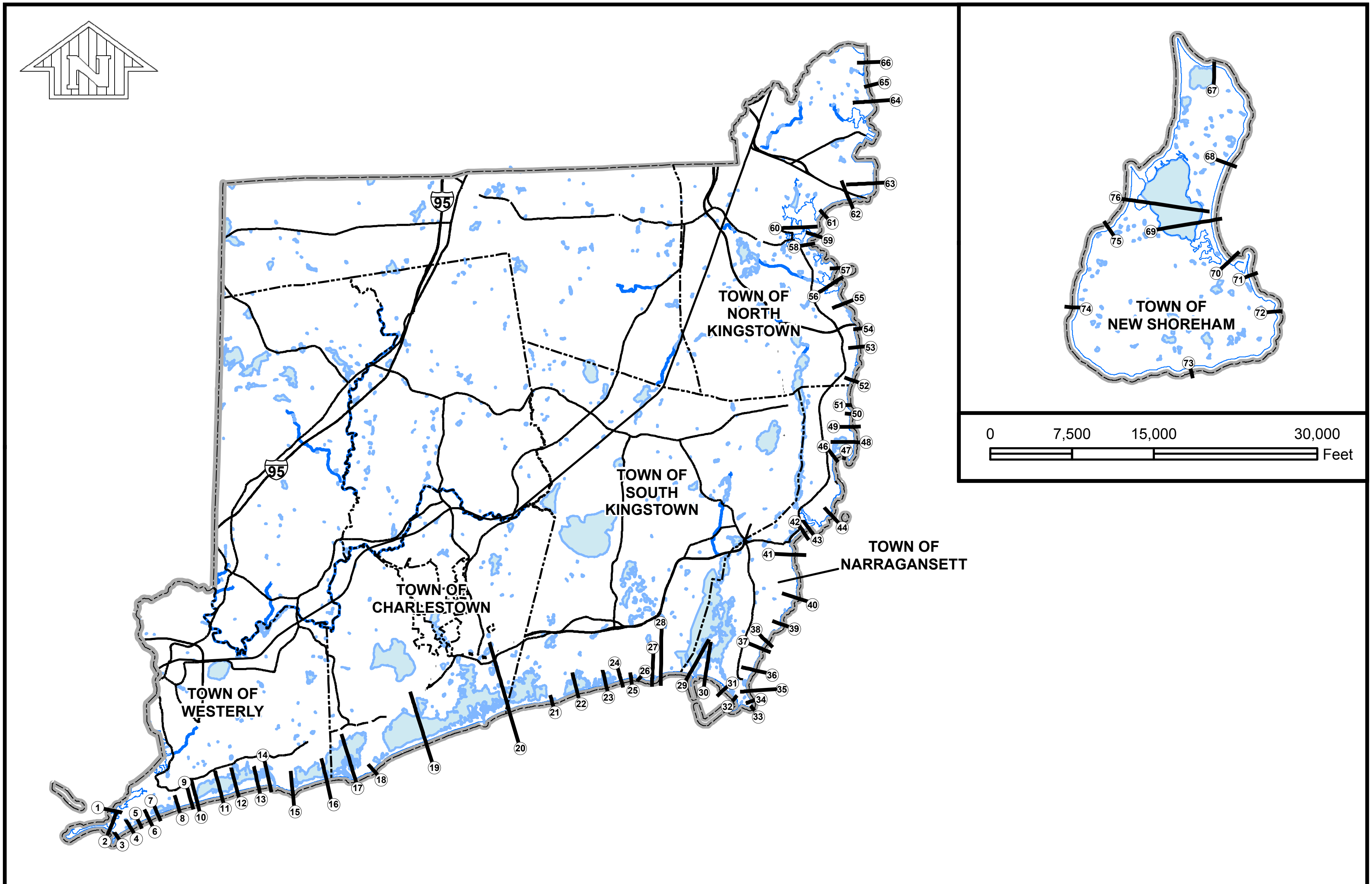

FIGURE 2

FEDERAL EMERGENCY MANAGEMENT AGENCY

WASHINGTON COUNTY, RI

(ALL JURISDICTIONS)

APPROXIMATE SCALE

0 11,250 22,500 45,000 67,500 90,000

Feet

TRANSECT LOCATION MAP

The results of the coastal analysis using detailed methods are summarized in Table 9, "Transect Data," which provides the flood hazard zone and base flood elevations for each coastal transect, along with the 10-, 2-, 1- and 0.2-percent-annual-chance flood stillwater elevations from the Rhode Island Sound, Block Island Sound and Narragansett flooding sources, including effects of wave setup where applicable. Historic flood damage information was also used in the determination of floodprone areas along the Washington shoreline.

TABLE 9 - TRANSECT DATA

Flooding Source and Transect Number	Stillwater Elevation				Total Water Level[1]		Base Flood Elevation (Feet NAVD 88)[2]
	10-percent-annual-chance	2-percent-annual-chance	1-percent-annual-chance	0.2-percent-annual-chance	1-percent-annual-chance	Zone	
LITTLE NARRAGANSETT BAY							
Entire shoreline within Westerly							
Transect 1	5.0	7.8	9.9	18.7	11.0	VE	13
						AE	12
BLOCK ISLAND SOUND							
Entire shoreline within Westerly							
Transect 2	5.0	7.8	9.9	18.7	11.8	VE	14
						AE	12
Transect 3	5.0	7.8	9.9	18.7	13.3	VE	16
						AE	14
Transect 4	5.0	7.8	9.9	18.7	12.0	VE	14
						AE	12
Transect 5	5.0	7.8	9.9	18.7	11.9	VE	14
						AE	12
Transect 6	5.0	7.8	9.9	18.7	12.0	VE	14
						AE	12
Transect 7	5.0	7.8	9.9	18.7	12.1	VE	14
						AE	12
Transect 8	5.0	7.8	9.9	18.8	11.4	VE	14
						AE	12
Transect 9	5.0	7.9	10.0	18.8	12.0	VE	15
						AE	12
Transect 10	5.0	7.9	10.0	18.8	12.1	VE	15
						AE	12

[1] Including stillwater elevation and effects of wave setup.

[2] Because of map scale limitations, base flood elevations shown on the FIRM represent average elevations for the zones depicted.

TABLE 9 - TRANSECT DATA – continued

Flooding Source and Transect Number	Stillwater Elevation				Total Water Level[1]		Base Flood Elevation
	10-percent-annual-chance	2-percent-annual-chance	1-percent-annual-chance	0.2-percent-annual-chance	1-percent-annual-chance	Zone	(Feet NAVD 88)[2]
BLOCK ISLAND SOUND - continued							
Entire shoreline within Westerly - continued							
Transect 11	5.1	7.9	10.0	18.8	12.7	VE	15
						AE	13
Transect 12	5.1	7.9	10.0	18.9	12.2	VE	15
						AE	13
Transect 13	5.1	7.9	10.0	18.9	12.9	VE	15
						AE	13
Transect 14	5.1	7.9	10.0	18.9	12.0	VE	15
						AE	12
Transect 15	5.1	7.9	10.0	18.9	13.4	VE	16
						AE	14
Transect 16	5.1	7.9	10.1	19.0	12.1	VE	15
						AE	13
Entire shoreline within Charlestown							
Transect 17	5.1	8.0	10.1	19.0	12.1	VE	15
						AE	12
Transect 18	5.1	8.0	10.1	19.1	12.7	VE	15
						AE	13
Transect 19	5.1	8.0	10.1	19.1	12.3	VE	16
						AE	12
Entire shoreline within South Kingstown							
Transect 20	5.2	8.1	10.2	19.3	12.5	VE	16
						AE	12
Transect 21	5.2	8.1	10.3	19.3	12.4	VE	15
						AE	12
Transect 22	5.2	8.1	10.3	19.4	12.7	VE	16
						AE	14
Transect 23	5.2	8.1	10.3	19.4	12.6	VE	16
						AE	13

[1] Including stillwater elevation and effects of wave setup.
[2] Because of map scale limitations, base flood elevations shown on the FIRM represent average elevations for the zones depicted.

TABLE 9 - TRANSECT DATA – continued

Flooding Source and Transect Number	Stillwater Elevation				Total Water Level[1]	Zone	Base Flood Elevation (Feet NAVD 88)[2]
	10-percent-annual-chance	2-percent-annual-chance	1-percent-annual-chance	0.2-percent-annual-chance	1-percent-annual-chance		
BLOCK ISLAND SOUND - continued							
Entire shoreline within South Kingstown - continued							
Transect 24	5.2	8.1	10.3	19.4	12.6	VE	15
						AE	13
Transect 25	5.2	8.1	10.3	19.5	12.6	VE	16
						AE	
Transect 26	5.2	8.1	10.3	19.5	13.5	VE	17
						AE	
Transect 27	5.2	8.1	10.3	19.5	12.3	VE	14
						AE	12
Transect 28	5.2	8.2	10.3	19.5	14.0	VE	22
						AE	14
Entire shoreline within Narragansett							
Transect 29	5.2	8.2	10.4	19.5	12.7	VE	17
						AE	13
Transect 30	5.3	8.2	10.4	19.6	12.8	VE	15
						AE	13
Transect 31	5.3	8.2	10.4	19.6	12.0	VE	14
						AE	12
Transect 32	5.3	8.2	10.4	19.6	13.9	VE	24
						AE	
Transect 33	5.3	8.2	10.4	19.6	13.3	VE	17
						AE	
RHODE ISLAND SOUND							
Entire shoreline within Narragansett							
Transect 34	5.3	8.2	10.4	19.6	13.3	VE	15
						AE	14
Transect 35	5.3	8.2	10.4	19.6	13.7	VE	17
						AE	14

[1] Including stillwater elevation and effects of wave setup.
[2] Because of map scale limitations, base flood elevations shown on the FIRM represent average elevations for the zones depicted.

TABLE 9 - TRANSECT DATA – continued

Flooding Source and Transect Number	Stillwater Elevation				Total Water Level[1]		Base Flood Elevation (Feet NAVD 88)[2]
	10-percent-annual-chance	2-percent-annual-chance	1-percent-annual-chance	0.2-percent-annual-chance	1-percent-annual-chance	Zone	
RHODE ISLAND SOUND - continued							
Entire shoreline within Narragansett - continued							
Transect 36	5.3	8.2	10.4	19.6	13.5	VE	17
						AE	13
Transect 37	5.3	8.2	10.4	19.6	12.8	VE	16
						AE	14
Transect 38	5.3	8.2	10.4	19.7	13.0	VE	15
						AE	14
Transect 39	5.3	8.2	10.4	19.7	13.5	VE	16
						AE	
Transect 40	5.3	8.2	10.4	19.7	13.9	VE	16
						AE	
Transect 41	5.3	8.2	10.4	19.7	14.1	VE	19
						AE	14
Transect 42	5.3	8.3	10.5	19.8	13.3	VE	16
						AE	13
Transect 43	5.3	8.3	10.5	19.8	12.7	VE	15
						AE	14
Transect 44	5.3	8.3	10.5	19.9	14.1	VE	16
						AE	14
NARRAGANSETT BAY							
Entire shoreline within Narragansett							
Transect 45	5.3	8.3	10.5	19.9	12.2	VE	14
						AE	
Transect 46	5.3	8.3	10.5	20.0	12.4	VE	15
						AE	13
Transect 47	5.3	8.3	10.5	20.0	12.2	VE	16
						AE	12
Transect 48	5.3	8.3	10.5	20.0	14.1	VE	20
						AE	
Transect 49	5.3	8.3	10.6	20.0	11.9	VE	16
						AE	12

[1] Including stillwater elevation and effects of wave setup.
[2] Because of map scale limitations, base flood elevations shown on the FIRM represent average elevations for the zones depicted.

TABLE 9 - TRANSECT DATA – continued

Flooding Source and Transect Number	Stillwater Elevation				Total Water Level[1]		Base Flood Elevation
	10-percent-annual-chance	2-percent-annual-chance	1-percent-annual-chance	0.2-percent-annual-chance	1-percent-annual-chance	Zone	(Feet NAVD 88)[2]
NARRAGANSETT BAY - continued							
Entire shoreline within Narragansett - continued							
Transect 50	5.3	8.3	10.6	20.0	12.8	VE	16
						AE	
Transect 51	5.4	8.3	10.6	20.0	11.8	VE	16
						AE	
Entire shoreline within North Kingstown							
Transect 52	5.4	8.4	10.6	20.1	12.6	VE	16
						AE	
Transect 53	5.4	8.5	10.7	20.4	13.3	VE	22
						AE	
Transect 54	5.5	8.5	10.8	20.5	12.5	VE	17
						AE	
Transect 55	5.5	8.6	10.9	20.8	12.1	VE	15
						AE	13
Transect 56	5.6	8.7	11.0	20.9	12.7	VE	16
						AE	13
Transect 57	5.6	8.8	11.1	21.1	12.3	VE	19
						AE	13
Transect 58	5.7	8.9	11.2	21.3	12.4	VE	22
						AE	12
Transect 59	5.7	8.9	11.3	21.4	13.7	VE	19
						AE	14
Transect 60	5.7	8.9	11.3	21.4	13.3	VE	17
						AE	13
Transect 61	5.8	9.0	11.4	21.6	12.9	VE	21
						AE	14
Transect 62	5.8	9.0	11.4	21.7	12.3	VE	14
						AE	12

[1] Including stillwater elevation and effects of wave setup.
[2] Because of map scale limitations, base flood elevations shown on the FIRM represent average elevations for the zones depicted.

TABLE 9 - TRANSECT DATA – continued

Flooding Source and Transect Number	Stillwater Elevation				Total Water Level[1]	Zone	Base Flood Elevation (Feet NAVD 88)[2]
	10-percent-annual-chance	2-percent-annual-chance	1-percent-annual-chance	0.2-percent-annual-chance	1-percent-annual-chance		
NARRAGANSETT BAY - continued							
Entire shoreline within North Kingstown - continued							
Transect 63	5.8	9.1	11.5	21.8	12.2	VE	15
						AE	12
Transect 64	6.0	9.4	11.9	22.5	12.3	VE	15
						AE	13
Transect 65	6.1	9.4	12.0	22.7	13.8	VE	19
						AE	14
Transect 66	6.1	9.5	12.1	22.9	13.3	VE	17
						AE	14
Entire shoreline within New Shoreham							
Transect 67	5.1	7.1	8.0	10.5	9.7	VE	12
						AE	
Transect 68	5.1	7.1	8.0	10.5	9.9	VE	12
						AE	12
Transect 69	5.1	7.1	8.0	10.5	9.9	VE	12
						AE	11
Transect 70	5.1	7.1	8.0	10.5	9.8	VE	12
						AE	10
ATLANTIC OCEAN							
Entire shoreline within New Shoreham							
Transect 71	5.1	7.1	8.0	10.5	9.9	VE	12
						AE	12
Transect 72	5.1	7.1	8.0	10.5	10.8	VE	13
						AE	
Transect 73	5.1	7.1	8.0	10.5	10.8	VE	28
						AE	

[1] Including stillwater elevation and effects of wave setup.
[2] Because of map scale limitations, base flood elevations shown on the FIRM represent average elevations for the zones depicted.

TABLE 9 - TRANSECT DATA – continued

Flooding Source and Transect Number	Stillwater Elevation				Total Water Level[1]		Base Flood Elevation
	10-percent-annual-chance	2-percent-annual-chance	1-percent-annual-chance	0.2-percent-annual-chance	1-percent-annual-chance	Zone	(Feet NAVD 88)[2]
BLOCK ISLAND SOUND							
Entire shoreline within New Shoreham							
Transect 74	5.1	6.9	7.9	10.2	10.1	VE	12
						AE	12
Transect 75	5.1	6.9	7.9	10.2	10.2	VE	12
						AE	
Transect 76	5.1	6.9	7.9	10.2	9.8	VE	13
						AE	10

[1] Including stillwater elevation and effects of wave setup.
[2] Because of map scale limitations, base flood elevations shown on the FIRM represent average elevations for the zones depicted.

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

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

All flood elevations shown in this FIS report and on the FIRM are referenced to NAVD 88. Structure and ground elevations in the community must, therefore, be referenced to NAVD 88. It is important to note that adjacent communities in other counties may be referenced to NGVD 29. This may result in differences in base flood elevations across the corporate limits between the communities.

Prior versions of the FIS reports and FIRMs were referenced to NGVD 29. When a datum conversion is effected for an FIS report and FIRM, the Flood Profiles, 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 FIRMs for Washington 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 to the NAVD 88 values. The conversion factor to NGVD is +0.9 foot.

The BFEs shown on the FIRM represent whole-foot rounded values. For example, a BFE of 102.4 will appear as 102 on the FIRM and 102.6 will appear as 103. Therefore, users that wish to convert the elevations in this FIS to NGVD 29 should apply the stated conversion factors to elevations shown on the Flood Profiles and supporting data tables in the FIS report, which are shown at a minimum to the nearest 0.1 foot.

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 Spatial Reference System Division, National Geodetic Survey, NOAA, Silver Spring Metro Center, 1315 East-West Highway, Silver Spring, Maryland 20910 (Internet address http://www.ngs.noaa.gov).

4.0 FLOODPLAIN MANAGEMENT APPLICATIONS

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

4.1 Floodplain Boundaries

To provide a national standard without regional discrimination, the 1-percent-annual-chance flood has been adopted by FEMA as the base flood for floodplain management purposes. The 0.2-percent-annual-chance flood is employed to indicate additional areas of flood risk in the county. For the streams studied in detail, the 1- and 0.2-percent-annual-chance floodplain boundaries have been delineated using the flood elevations determined at each cross section. Between cross sections, the boundaries were interpolated using topographic maps (Reference 51). In the Town of Exeter, the boundaries were interpolated using topographic maps at a scale of 1:4,800 with a contour interval of 5 feet (Reference 54). In the Town of Hopkinton, the boundaries were interpolated using topographic maps at a scale of 1:24,000 with a contour interval of 10 feet (Reference 40). In the Town of Narragansett, the boundaries were delineated using topographic maps at a scale of 1:1,200 with a contour interval of 2 feet (Reference 56).

For tidal areas without wave action, the 1- and 0.2-percent-annual-chance boundaries were delineated using the topographic maps referenced above (Reference 51). 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 the topographic maps referenced above. The 1-percent-annual-chance floodplain was divided into whole-foot elevation zones based on the average wave envelope elevation in that zone. Where the map scale did not permit these zones to be delineated at one-foot intervals, larger increments were used.

For the flooding sources studied by approximate methods, the boundaries of the 1-percent-annual-chance floodplains were delineated using the previously printed FIRMs for all of the incorporated jurisdictions within Washington County.

For coastal flooding sources studied by detailed methods in this county-wide FIS, the 1- and 0.2-percent-annual-chance flood boundaries were delineated using 2-foot contour topographic maps. For Charlestown, North Kingstown, New Shoreham, and Westerley 2-foot contours were developed from LiDAR data collected in 2006 (Reference 67). For South Kingtown, 2-foot contours were developed from a DTM based on April 2006 aerial imagery (Reference 68 and 69); and for Narragansett, 2-foot contours were developed from 2009 planimetric data (Reference 70).

The 1- 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 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- and 0.2-percent-annual-chance floodplain boundaries are close together, only the 1-percent-annual-chance floodplain boundary has been shown. Small areas within the floodplain boundaries may lie above the flood elevations but cannot be shown due to limitations of the map scale and/or lack of detailed topographic data.

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

4.2 Floodways

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

The floodways presented in this FIS were computed for the 2010 countywide study for certain stream segments on the basis of equal conveyance reduction from each side of the floodplain.

Floodway widths were computed at cross sections. Between cross sections, the floodway boundaries were interpolated. The results of the floodway computations are tabulated for selected cross sections (Table 10). The computed floodways are shown on the FIRM (Exhibit 2). In cases where the floodway and 1-percent-annual-chance floodplain boundaries are either close together or collinear, only the floodway boundary is shown.

The 2013 coastal study impacted the limit of backwater effects on some of the Floodway Data Tables and Flood Profiles by revising the annual 10-, 2-, 1-, and 0.2-percent-annual-chance flood elevations at the confluence of rivers and Narragansett Bay. Affected Floodway Data Tables and Flood Profiles were updated for Mastuxet Brook, Mattatuxet River, Pawtucket River (profile only), Quindenessant Brook, and Saugatucket River.

Portions of the floodway for the Pawcatuck River extend beyond the county boundary.

Near the mouths of streams studied in detail, floodway computations are made without regard to flood elevations on the receiving water body. Therefore, "Without Floodway" elevations presented in Table 10 for certain downstream cross sections of the Ashaway River, Mastuxet Brook, Mattatuxet River, Mile Brook, Quidnessett Brook, Saugatuck River, and Tomaquag Brook are lower than the regulatory flood elevations in that area, which must take into account the 1-percent-annual-chance flooding due to backwater from other sources.

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 10, "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 and the floodway fringe and their significance to floodplain development are shown in Figure 3.

FLOODING SOURCE		FLOODWAY			BASE FLOOD WATER-SURFACE ELEVATION (FEET NAVD 88)			
CROSS SECTION	DISTANCE	WIDTH (FEET)	SECTION AREA (SQUARE FEET)	MEAN VELOCITY (FEET PER SECOND)	REGULATORY	WITHOUT FLOODWAY	WITH FLOODWAY	INCREASE
Annaquatucket River								
A	595[1]	245	1,856	0.7	21.1	21.1	21.6	0.5
B	1,355[1]	249	1,058	1.3	21.2	21.2	21.7	0.5
C	1,945[1]	167	514	2.6	22.2	22.2	22.7	0.5
D	2,935[1]	152	553	2.4	29.8	29.8	30.8	1.0
E	4,635[1]	99	489	2.7	30.8	30.8	31.8	1.0
F	5,705[1]	117	513	2.5	31.5	31.5	32.5	1.0
G	6,510[1]	106	483	2.6	33.2	33.2	34.2	1.0
H	8,942[1]	129	737	1.7	41.9	41.9	42.9	1.0
I	9,302[1]	99	419	3.0	42.3	42.3	43.3	1.0
J	16,630[1]	49	93	5.5	62.0	62.0	63.0	1.0
K	17,195[1]	72	338	1.3	72.9	72.9	73.4	0.5
L	18,195[1]	142	578	0.7	74.9	74.9	75.9	1.0
M	18,417[1]	65	303	1.3	78.2	78.2	79.2	1.0
Ashaway River								
A	200[2]	45	201	5.7	26.5	22.3[3]	23.3[3]	1.0
B	1,200[2]	40	209	5.5	26.5	25.3[3]	25.8[3]	0.5
C	2,900[2]	40	221	5.2	29.0	29.0	29.9	0.9
D	3,800[2]	60	474	2.4	30.7	30.7	31.6	0.9
E	3,840[2]	60	393	2.9	32.5	32.5	32.6	0.1
F	4,050[2]	40	251	4.6	32.5	32.5	32.7	0.2
G	4,700[2]	40	179	6.4	33.9	33.9	34.7	0.8
H	4,750[2]	40	366	3.1	40.0	40.0	40.7	0.7
I	5,900[2]	40	348	3.3	40.3	40.3	41.1	0.9

[1]Feet above Boston Neck Road
[2]Feet above confluence with Pawcatuck River
[3]Elevation computed without consideration of backwater effects from Pawcatuck River

TABLE 10

FEDERAL EMERGENCY MANAGEMENT AGENCY

WASHINGTON COUNTY, RI (ALL JURISDICTIONS)

FLOODWAY DATA

ANNAQUATUCKET RIVER – ASHAWAY RIVER

FLOODING SOURCE		FLOODWAY			BASE FLOOD WATER-SURFACE ELEVATION (FEET NAVD 88)			
CROSS SECTION	DISTANCE[1]	WIDTH (FEET)	SECTION AREA (SQUARE FEET)	MEAN VELOCITY (FEET PER SECOND)	REGULATORY	WITHOUT FLOODWAY	WITH FLOODWAY	INCREASE
Canonchet Brook								
A	300	20	131	3.4	60.0	60.0	60.8	0.8
B	335	30	159	2.8	60.1	60.1	60.9	0.8
C	800	50	327	1.4	60.5	60.5	61.2	0.7
D	835	50	349	1.3	60.5	60.5	61.3	0.8
E	2,400	60	146	3.0	61.8	61.8	62.6	0.8
F	3,100	60	252	1.8	63.4	63.4	64.3	0.9
G	4,100	60	247	1.8	64.3	64.3	65.2	0.9
H	5,400	40	122	3.6	66.4	66.4	67.0	0.6
I	5,800	40	153	2.9	67.3	67.3	68.1	0.8
J	6,800	40	265	1.5	67.8	67.8	68.7	0.9
K	6,840	50	244	1.6	70.3	70.3	70.3	0.0
L	8,300	50	86	4.5	70.7	70.7	70.8	0.1
M	8,330	70	67	5.8	74.6	74.6	75.6	1.0
N	9,700	70	314	1.2	75.0	75.0	76.0	1.0
O	11,400	70	172	2.3	76.4	76.4	77.3	0.9
P	11,600	30	111	3.5	78.9	78.9	78.9	0.0
Q	12,500	30	145	2.3	79.0	79.0	79.3	0.3
R	12,550	30	121	2.8	79.4	79.4	79.4	0.0

[1]Feet above confluence with Wood River

TABLE 10

FEDERAL EMERGENCY MANAGEMENT AGENCY

WASHINGTON COUNTY, RI (ALL JURISDICTIONS)

FLOODWAY DATA

CANONCHET BROOK

FLOODING SOURCE		FLOODWAY			BASE FLOOD WATER-SURFACE ELEVATION (FEET NAVD 88)			
CROSS SECTION	DISTANCE[1]	WIDTH (FEET)	SECTION AREA (SQUARE FEET)	MEAN VELOCITY (FEET PER SECOND)	REGULATORY	WITHOUT FLOODWAY	WITH FLOODWAY	INCREASE
Canonchet Brook Tributary								
A	1,450	30	70	3.6	81.4	81.4	81.7	0.3
B	1,490	20	57	4.4	83.2	83.2	83.2	0.0
C	2,830	15	65	3.8	85.3	85.3	86.2	0.9
D	2,870	15	71	3.5	86.3	86.3	87.0	0.7
E	2,970	15	74	3.4	86.9	86.9	87.5	0.6
F	3,100	15	73	3.4	87.0	87.0	87.7	0.7
G	3,130	15	68	3.7	87.2	87.2	87.8	0.6
H	3,250	30	153	1.6	93.8	93.8	93.8	0.0
I	3,850	15	39	6.4	93.8	93.8	94.7	0.9
J	3,950	15	36	7.0	95.7	95.7	96.5	0.8
K	3,970	15	73	3.4	102.5	102.5	103.0	0.5
L	4,050	40	184	1.4	107.1	107.1	107.4	0.3
M	4,550	15	53	1.1	107.1	107.1	107.6	0.5
N	4,800	15	13	4.6	107.9	107.9	108.0	0.1
O	4,850	15	40	1.5	109.8	109.8	110.4	0.6
P	4,890	15	46	1.3	110.3	110.3	110.8	0.5
Q	5,750	15	11	5.6	115.5	115.5	115.5	0.0

[1]Feet above confluence with Canonchet Brook

TABLE 10

FEDERAL EMERGENCY MANAGEMENT AGENCY

WASHINGTON COUNTY, RI (ALL JURISDICTIONS)

FLOODWAY DATA

CANONCHET BROOK TRIBUTARY

FLOODING SOURCE		FLOODWAY			BASE FLOOD WATER-SURFACE ELEVATION (FEET NAVD 88)			
CROSS SECTION	DISTANCE	WIDTH (FEET)	SECTION AREA (SQUARE FEET)	MEAN VELOCITY (FEET PER SECOND)	REGULATORY	WITHOUT FLOODWAY	WITH FLOODWAY	INCREASE
Chipuxet River								
A	0[1]	200	599	1.1	99.1	99.1	99.9	0.8
B	1,090[1]	200	572	1.2	99.7	99.7	100.4	0.7
C	1,220[1]	200	642	1.1	101.9	101.9	102.1	0.2
D	2,615[1]	155	594	1.1	102.2	102.2	102.8	0.6
E	4,315[1]	77	141	4.8	104.3	104.3	104.6	0.3
F	5,590[1]	299	442	1.5	108.5	108.5	108.6	0.1
G	6,120[1]	75	241	1.9	109.0	109.0	109.1	0.1
H	6,360[1]	80	382	1.2	110.5	110.5	110.7	0.2
I	7,140[1]	193	466	1.0	110.6	110.6	111.0	0.4
J	7,780[1]	196	264	1.7	110.8	110.8	111.6	0.8
Mastuxet Brook								
A	150[2]	53	44	5.2	9.9	5.2[3]	5.2[3]	0.0
B	300[2]	88	590	0.4	11.9	11.9	11.9	0.0
C	1,250[2]	45	104	2.2	11.9	11.9	11.9	0.0
D	2,700[2]	28	42	5.5	33.0	33.0	33.3	0.3
E	2,819[2]	20	59	4.0	34.5	34.5	34.6	0.1
F	5,459[2]	80	144	1.6	39.9	39.9	40.9	1.0

[1]Feet above limit of detailed study; limit of detailed study is approximately 1,160 feet downstream of Wolf Rocks Road
[2]Feet above confluence with Mastuxet Cove
[3]Elevation computed without consideration of backwater effects from Little Narragansett Bay

TABLE 10

FEDERAL EMERGENCY MANAGEMENT AGENCY

WASHINGTON COUNTY, RI (ALL JURISDICTIONS)

FLOODWAY DATA

CHIPUXET RIVER – MASTUXET BROOK

FLOODING SOURCE		FLOODWAY			BASE FLOOD WATER-SURFACE ELEVATION (FEET NAVD 88)			
CROSS SECTION	DISTANCE	WIDTH (FEET)	SECTION AREA (SQUARE FEET)	MEAN VELOCITY (FEET PER SECOND)	REGULATORY	WITHOUT FLOODWAY	WITH FLOODWAY	INCREASE
Mattatuxet River								
A	0[1]	55	91	4.5	10.5	1.4[3]	1.4[3]	0.0
B	1,230[1]	21	89	4.6	10.5	3.9[3]	4.5[3]	0.6
C	1,500[1]	65	390	1.0	13.6	13.6	13.6	0.0
D	2,640[1]	225	1,012	0.4	13.6	13.6	13.6	0.0
E	4,050[1]	1,500	21,387	0.0	13.6	13.6	13.6	0.0
F	5,265[1]	103	373	0.8	13.6	13.6	13.6	0.0
G	7,555[1]	48	273	1.1	13.7	13.7	13.9	0.2
H	8,235[1]	55	248	1.2	13.7	13.7	13.9	0.2
I	9,116[1]	44	90	2.7	14.8	14.8	14.8	0.0
J	10,600[1]	17	97	2.5	16.6	16.6	16.8	0.2
K	11,100[1]	129	753	0.3	22.1	22.1	22.1	0.0
L	11,910[1]	18	71	2.9	22.1	22.1	22.1	0.0
M	12,638[1]	27	80	2.6	22.4	22.4	22.9	0.5
Mile Brook								
A	40[2]	15	19	6.5	26.9	23.1[4]	23.1[4]	0.0
B	1,200[2]	15	51	2.4	28.9	28.9	29.8	0.9
C	1,550[2]	15	31	3.9	30.2	30.2	30.7	0.5
D	1,650[2]	20	38	3.2	32.2	32.2	32.3	0.1
E	3,000[2]	20	50	2.4	36.0	36.0	37.0	1.0
F	3,250[2]	20	26	4.6	38.1	38.1	38.1	0.0

[1]Feet above confluence with Pettaquamscutt River
[2]Feet above confluence with Pawcatuck River
[3]Elevation computed without consideration of backwater effects from Narragansett Bay
[4]Elevation computed without consideration of backwater effects from Pawcatuck River

TABLE 10

FEDERAL EMERGENCY MANAGEMENT AGENCY

WASHINGTON COUNTY, RI (ALL JURISDICTIONS)

FLOODWAY DATA

MATTATUXET RIVER – MILE BROOK

FLOODING SOURCE		FLOODWAY			BASE FLOOD WATER-SURFACE ELEVATION (FEET NAVD 88)			
CROSS SECTION	DISTANCE[1]	WIDTH (FEET)	SECTION AREA (SQUARE FEET)	MEAN VELOCITY (FEET PER SECOND)	REGULATORY	WITHOUT FLOODWAY	WITH FLOODWAY	INCREASE
Pawcatuck River								
A	31,500	120/65[2]	801	7.1	11.4	11.4	11.4	0.0
B	32,840	120/60[2]	862	6.6	13.5	13.5	13.6	0.1
C	34,250	159/74[2]	1,113	5.1	14.9	14.9	15.5	0.6
D	35,670	120/60[2]	892	6.4	16.0	16.0	16.9	0.9
E	37,060	495/445[2]	2,363	2.4	18.2	18.2	18.9	0.7
F	37,675	201/136[2]	2,054	2.8	22.2	22.2	22.3	0.1
G	40,492	109/59[2]	1,090	4.8	23.0	23.0	23.2	0.2
H	45,166	146/70[2]	1,475	3.5	25.0	25.0	25.2	0.2
I	51,116	111/60[2]	1,210	4.3	26.5	26.5	27.0	0.5
J	52,728	110/60[2]	1,383	3.8	26.6	26.6	27.6	1.0
K	53,400	105	1,190	3.6	26.6	26.6	27.6	1.0
L	54,100	245	2,540	1.7	26.9	26.9	27.9	1.0
M	54,350	100	1,300	3.3	31.3	31.3	31.3	0.0
N	54,450	150	1,880	2.3	32.0	32.0	32.0	0.0
O	55,300	150	2,040	2.1	32.1	32.1	32.1	0.0
P	56,800	150	2,090	2.0	32.2	32.2	32.2	0.0
Q	58,000	150	2,000	2.1	32.3	32.3	32.4	0.1
R	59,000	150	2,210	2.0	32.4	32.4	32.5	0.1
S	60,400	150	1,870	2.3	32.5	32.5	32.6	0.1
T	61,400	150	1,910	2.3	32.6	32.6	32.8	0.2
U	61,700	65	620	6.9	32.6	32.6	32.8	0.2
V	61,820	90	1,260	3.4	33.4	33.4	33.4	0.0
W	68,400	229	2,338	1.8	34.1	34.1	34.3	0.2
X	78,300	95	1,102	3.9	34.9	34.9	35.4	0.5
Y	88,800	190	2,135	1.8	36.0	36.0	36.8	0.8
Z	88,905	170	1,742	2.2	37.1	37.1	37.3	0.2

[1]Feet above confluence with Little Narragansett Bay
[2]Width/width within county boundary

TABLE 10

FEDERAL EMERGENCY MANAGEMENT AGENCY

WASHINGTON COUNTY, RI (ALL JURISDICTIONS)

FLOODWAY DATA

PAWCATUCK RIVER

FLOODING SOURCE		FLOODWAY			BASE FLOOD WATER-SURFACE ELEVATION (FEET NAVD 88)			
CROSS SECTION	DISTANCE[1]	WIDTH (FEET)	SECTION AREA (SQUARE FEET)	MEAN VELOCITY (FEET PER SECOND)	REGULATORY	WITHOUT FLOODWAY	WITH FLOODWAY	INCREASE
Pawcatuck River (continued)								
AA	91,550	144	1,380	2.8	37.7	37.7	37.9	0.2
AB	97,500	446	2,281	1.7	38.4	38.4	38.9	0.5
AC	102,300	120	1,032	3.6	39.1	39.1	40.0	0.9
AD	103,983	105	1,240	3.0	39.5	39.5	40.5	1.0
AE	106,501	125	1,107	3.4	40.5	40.5	41.3	0.8
AF	106,831	130	1,223	3.0	41.3	41.3	41.8	0.5
AG	111,231	96	971	3.8	42.4	42.4	42.9	0.5
AH	113,271	68	697	2.9	43.0	43.0	43.5	0.5
AI	119,564	90	707	2.9	44.1	44.1	45.0	0.9
AJ	124,421	103	698	2.5	45.3	45.3	46.2	0.9
AK	129,115	68	463	3.8	46.8	46.8	47.8	1.0
AL	131,795	51	390	4.5	48.8	48.8	49.3	0.5
AM	131,853	56	456	3.8	50.3	50.3	50.3	0.0
AN	132,063	75	618	2.8	51.2	51.2	51.2	0.0
AO	136,703	58	509	3.4	51.7	51.7	52.3	0.6
AP	141,063	49	163	10.3	54.9	54.9	54.9	0.0
AQ	141,210	44	156	10.8	56.8	56.8	56.8	0.0
AR	147,785	93	509	3.2	60.4	60.4	61.0	0.6
AS	149,626	134	1,206	1.3	61.3	61.3	61.7	0.4
AT	149,866	45	153	10.6	64.1	64.1	64.1	0.0
AU	149,971	122	794	2.0	71.9	71.9	71.9	0.0
AV	151,704	102	398	4.1	72.6	72.6	72.6	0.0
AW	152,144	66	343	4.7	73.0	73.0	73.0	0.0
AX	152,342	149	1,001	1.6	84.3	84.3	84.6	0.3
AY	154,142	61	615	2.2	84.4	84.4	84.7	0.3
AZ	155,723	60	469	2.9	84.5	84.5	85.0	0.5

[1]Feet above confluence with Little Narragansett Bay

TABLE 10

FEDERAL EMERGENCY MANAGEMENT AGENCY

WASHINGTON COUNTY, RI (ALL JURISDICTIONS)

FLOODWAY DATA

PAWCATUCK RIVER

FLOODING SOURCE		FLOODWAY			BASE FLOOD WATER-SURFACE ELEVATION (FEET NAVD 88)			
CROSS SECTION	DISTANCE	WIDTH (FEET)	SECTION AREA (SQUARE FEET)	MEAN VELOCITY (FEET PER SECOND)	REGULATORY	WITHOUT FLOODWAY	WITH FLOODWAY	INCREASE
Pawcatuck River (continued)								
BA	156,405[1]	43	245	5.6	85.2	85.2	85.6	0.4
BB	156,708[1]	97	617	2.2	87.9	87.9	88.7	0.8
BC	158,168[1]	127	1,129	1.2	88.4	88.4	89.1	0.7
BD	160,383[1]	100	625	2.2	88.8	88.8	89.4	0.6
BE	161,833[1]	38	288	4.8	89.1	89.1	89.8	0.7
Queens Fort Brook								
A	125[2]	132	374	1.4	128.7	128.7	129.3	0.6
B	1,950[2]	36	113	4.6	131.7	131.7	132.2	0.5
C	3,180[2]	33	122	4.3	137.2	137.2	137.9	0.7
D	4,200[2]	30	128	4.1	141.1	141.1	141.8	0.7
E	5,190[2]	74	213	2.4	143.5	143.5	143.9	0.4
F	5,295[2]	79	503	1.0	146.8	146.8	146.8	0.0
G	6,040[2]	28	116	4.5	147.0	147.0	147.0	0.0
H	6,170[2]	34	218	2.4	149.4	149.4	149.4	0.0
I	6,450[2]	100	803	0.6	151.6	151.6	151.6	0.0
J	7,420[2]	154	1,166	0.3	151.6	151.6	151.7	0.1
K	8,300[2]	144	315	1.1	151.6	151.6	151.7	0.1
L	8,400[2]	165	556	0.6	152.6	152.6	152.6	0.0
M	8,925[2]	106	1,349	0.3	152.6	152.6	152.6	0.0
N	9,270[2]	142	777	0.5	152.6	152.6	152.6	0.0
O	9,500[2]	157	570	0.6	152.6	152.6	152.7	0.1
P	9,625[2]	245	856	0.4	156.9	156.9	157.0	0.1
Q	10,175[2]	13	37	9.7	158.1	158.1	158.3	0.2

[1]Feet above confluence with Little Narragansett Bay
[2]Feet above confluence with Queen River

TABLE 10

FEDERAL EMERGENCY MANAGEMENT AGENCY

WASHINGTON COUNTY, RI (ALL JURISDICTIONS)

FLOODWAY DATA

PAWCATUCK RIVER – QUEENS FORT BROOK

FLOODING SOURCE		FLOODWAY			BASE FLOOD WATER-SURFACE ELEVATION (FEET NAVD 88)			
CROSS SECTION	DISTANCE	WIDTH (FEET)	SECTION AREA (SQUARE FEET)	MEAN VELOCITY (FEET PER SECOND)	REGULATORY	WITHOUT FLOODWAY	WITH FLOODWAY	INCREASE
Quidnessett Brook								
A	50[1]	32	28	3.6	11.9	1.4[3]	1.4[3]	0.0
B	785[1]	139	114	0.9	11.9	3.3[3]	3.3[3]	0.0
C	1,770[1]	119	74	1.3	11.9	4.5[3]	4.5[3]	0.0
D	2,775[1]	84	52	1.9	11.9	8.0[3]	8.0[3]	0.0
E	3,200[1]	12	26	3.9	11.9	9.9[3]	10.1[3]	0.2
F	3,740[1]	11	24	4.2	13.0	13.0	13.3	0.3
G	4,000[1]	110	573	0.2	18.6	18.6	18.6	0.0
H	4,840[1]	24	61	1.6	18.6	18.6	18.6	0.0
Sand Hill Brook/Saw Mill Brook								
A	650[2]	109	726	1.3	15.2	15.2	16.2	1.0
B	1,709[2]	41	297	2.8	23.5	23.5	24.0	0.5
C	2,382[2]	82	626	1.7	23.6	23.6	24.6	1.0
D	2,569[2]	74	553	1.4	23.7	23.7	24.7	1.0
E	3,350[2]	200	1,613	0.5	23.7	23.7	24.7	1.0
F	3,635[2]	199	1,452	0.3	23.7	23.7	24.7	1.0
G	5,370[2]	56	270	1.0	24.3	24.3	25.3	1.0
H	6,895[2]	24	73	2.8	25.9	25.9	26.4	0.5
I	7,394[2]	259	1,728	0.4	32.4	32.4	33.3	0.9
J	7,618[2]	278	2,123	0.3	35.7	35.7	35.7	0.0
K	9,915[2]	65	426	0.5	35.7	35.7	36.7	1.0
L	10,995[2]	208	960	0.2	35.7	35.7	36.2	0.5
M	11,181[2]	166	1,146	0.1	37.8	37.8	38.3	0.5
N	11,940[2]	29	174	0.8	39.7	39.7	40.2	0.5
O	13,390[2]	17	48	1.6	39.8	39.8	40.7	0.9

[1]Feet above Bike Path at Allens Harbor
[2]Feet above confluence with Hunt River
[3]Elevation computed without consideration of backwater effects from Narragansett Bay

TABLE 10

FEDERAL EMERGENCY MANAGEMENT AGENCY

WASHINGTON COUNTY, RI (ALL JURISDICTIONS)

FLOODWAY DATA

QUIDNESSETT BROOK – SAND HILL BROOK/SAW MILL BROOK

FLOODING SOURCE		FLOODWAY			BASE FLOOD WATER-SURFACE ELEVATION (FEET NAVD 88)			
CROSS SECTION	DISTANCE	WIDTH (FEET)	SECTION AREA (SQUARE FEET)	MEAN VELOCITY (FEET PER SECOND)	REGULATORY	WITHOUT FLOODWAY	WITH FLOODWAY	INCREASE
Saugatucket River								
A	65[1]	94	279	4.7	10.4	2.0[3]	2.0[3]	0.0
B	1,365[1]	43	220	5.9	10.4	5.4[3]	5.4[3]	0.0
C	1,652[1]	97	750	1.7	14.3	14.3	14.3	0.0
D	2,452[1]	128	990	1.3	14.4	14.4	14.4	0.0
E	2,764[1]	73	483	2.7	14.4	14.4	14.4	0.0
F	4,364[1]	70	418	3.1	15.0	15.0	15.1	0.1
G	5,829[1]	43	306	4.2	15.9	15.9	16.2	0.3
H	6,409[1]	36	240	5.4	16.4	16.4	16.7	0.3
I	7,024[1]	26	182	7.1	17.1	17.1	17.7	0.6
J	7,249[1]	30	241	3.8	18.8	18.8	19.1	0.3
K	7,607[1]	35	331	2.7	21.6	21.6	21.9	0.3
L	7,869[1]	33	309	2.9	22.1	22.1	22.3	0.2
M	8,449[1]	236	2,513	0.4	30.6	30.6	30.6	0.0
N	13,314[1]	50	319	2.9	34.4	34.4	34.4	0.0
Tomaquag Brook								
A	100[2]	60	142	3.4	35.4	27.4[4]	28.4[4]	1.0
B	1,400[2]	65	236	2.0	35.4	31.5[4]	30.6[4]	0.9
C	2,300[2]	65	212	2.3	35.4	32.6[4]	33.4[4]	0.8
D	3,400[2]	120	216	1.8	35.4	35.3[4]	35.7[4]	0.4
E	4,300[2]	80	248	1.6	36.9	36.9	37.3	0.4
F	4,340[2]	80	214	1.9	37.7	37.7	38.2	0.5
G	4,520[2]	80	341	1.2	38.0	38.0	38.4	0.4
H	5,800[2]	130	339	1.2	38.6	38.6	39.1	0.5
I	7,000[2]	150	300	1.3	39.7	39.7	40.1	0.4
J	7,900[2]	80	139	2.6	41.3	41.3	41.7	0.4
K	7,950[2]	40	147	2.4	41.9	41.9	42.2	0.3

[1]Feet above Silver Lake Avenue
[2]Feet above confluence with Pawcatuck River
[3]Elevation computed without consideration of backwater effects from Atlantic Ocean
[4]Elevation computed without consideration of backwater effects from Pawcatuck River

TABLE 10

FEDERAL EMERGENCY MANAGEMENT AGENCY

WASHINGTON COUNTY, RI (ALL JURISDICTIONS)

FLOODWAY DATA

SAUGATUCKET RIVER – TOMAQUAG BROOK

FLOODING SOURCE		FLOODWAY			BASE FLOOD WATER-SURFACE ELEVATION (FEET NAVD 88)			
CROSS SECTION	DISTANCE[1]	WIDTH (FEET)	SECTION AREA (SQUARE FEET)	MEAN VELOCITY (FEET PER SECOND)	REGULATORY	WITHOUT FLOODWAY	WITH FLOODWAY	INCREASE
Wood River								
A	13,100	250	1,120	2.2	52.6	52.6	53.2	0.6
B	15,200	250	1,100	2.3	53.4	53.4	54.0	0.6
C	16,200	140	972	2.6	53.8	53.8	54.4	0.6
D	16,330	140	1,120	2.2	53.9	53.9	54.9	1.0
E	16,400	85	850	2.9	59.3	59.3	59.7	0.4
F	17,500	80	1,280	2.0	59.3	59.3	60.0	0.7
G	17,550	80	862	2.9	59.4	59.4	60.0	0.6
H	19,300	230	1,640	1.4	59.5	59.5	60.4	0.9
I	21,000	230	1,070	2.1	59.9	59.9	60.9	1.0
J	23,400	230	1,390	1.6	61.5	61.5	62.5	1.0
K	24,200	230	1,400	1.6	61.9	61.9	62.9	1.0
L	25,800	230	1,350	1.7	62.8	62.8	63.8	1.0
M	27,300	150	964	2.4	63.5	63.5	64.5	1.0
N	29,200	150	896	2.6	65.2	65.2	66.0	0.8
O	30,300	150	988	2.3	66.0	66.0	66.9	0.9
P	31,500	80	723	3.2	66.6	66.6	67.4	0.8
Q	32,300	80	680	3.4	67.0	67.0	67.8	0.8
R	32,440	70	633	3.6	67.1	67.1	67.9	0.8
S	33,500	70	601	3.8	68.1	68.1	68.8	0.7
T	33,870	70	610	3.8	68.4	68.4	69.2	0.8
U	34,500	100	794	2.9	68.8	68.8	69.6	0.8
V	34,700	120	821	2.8	69.0	69.0	69.9	0.9
W	36,100	105	750	3.1	70.0	70.0	71.0	1.0
X	36,800	105	804	2.9	70.6	70.6	71.6	1.0
Y	36,880	105	513	4.5	70.7	70.7	71.7	1.0
Z	36,950	100	979	2.4	79.1	79.1	79.7	0.6

[1]Feet above confluence with Pawcatuck River

TABLE 10

FEDERAL EMERGENCY MANAGEMENT AGENCY

WASHINGTON COUNTY, RI (ALL JURISDICTIONS)

FLOODWAY DATA

WOOD RIVER

FLOODING SOURCE		FLOODWAY			BASE FLOOD WATER-SURFACE ELEVATION (FEET NAVD 88)			
CROSS SECTION	DISTANCE[1]	WIDTH (FEET)	SECTION AREA (SQUARE FEET)	MEAN VELOCITY (FEET PER SECOND)	REGULATORY	WITHOUT FLOODWAY	WITH FLOODWAY	INCREASE
Wood River (continued)								
AA	38,200	140	869	2.2	79.4	79.4	80.1	0.7
AB	39,900	140	739	2.6	79.9	79.9	80.6	0.7
AC	41,000	140	742	2.6	80.3	80.3	81.2	0.9
AD	42,400	100	555	3.5	81.2	81.2	82.1	0.9
AE	43,300	70	547	3.6	81.9	81.9	82.8	0.9
AF	43,400	70	528	3.7	82.2	82.2	82.9	0.7
AG	44,100	160	321	6.1	85.3	85.3	85.7	0.4
AH	44,200	165	470	4.1	86.8	86.8	86.9	0.1
AI	44,300	180	736	2.6	98.7	98.7	98.8	0.1
AJ	45,600	100	1,040	1.9	99.0	99.0	99.4	0.4
AK	47,400	100	838	2.3	99.1	99.1	99.8	0.7
AL	48,200	100	823	2.4	99.3	99.3	100.0	0.7
AM	48,270	120	992	2.0	100.0	100.0	101.0	1.0
AN	49,000	120	931	2.1	100.2	100.2	101.2	1.0
AO	50,600	120	773	2.5	100.9	100.9	101.9	1.0
AP	51,500	120	883	2.2	101.4	101.4	102.3	0.9
AQ	52,600	110	731	2.7	101.7	101.7	102.5	0.8
AR	53,800	110	541	3.6	102.4	102.4	103.1	0.7
AS	55,000	110	797	2.4	103.3	103.3	104.1	0.8
AT	56,000	110	710	2.8	103.5	103.5	104.5	1.0
AU	56,800	110	671	2.9	103.9	103.9	104.8	0.9
AV	58,200	80	418	4.7	105.6	105.6	106.1	0.5
AW	58,800	80	357	5.5	108.2	108.2	108.4	0.2
AX	58,870	90	592	3.3	109.5	109.5	110.4	0.9
AY	59,100	90	346	5.2	113.6	113.6	113.9	0.3
AZ	59,400	90	722	2.5	114.3	114.3	114.5	0.2

[1]Feet above confluence with Pawcatuck River

TABLE 10

FEDERAL EMERGENCY MANAGEMENT AGENCY

WASHINGTON COUNTY, RI (ALL JURISDICTIONS)

FLOODWAY DATA

WOOD RIVER

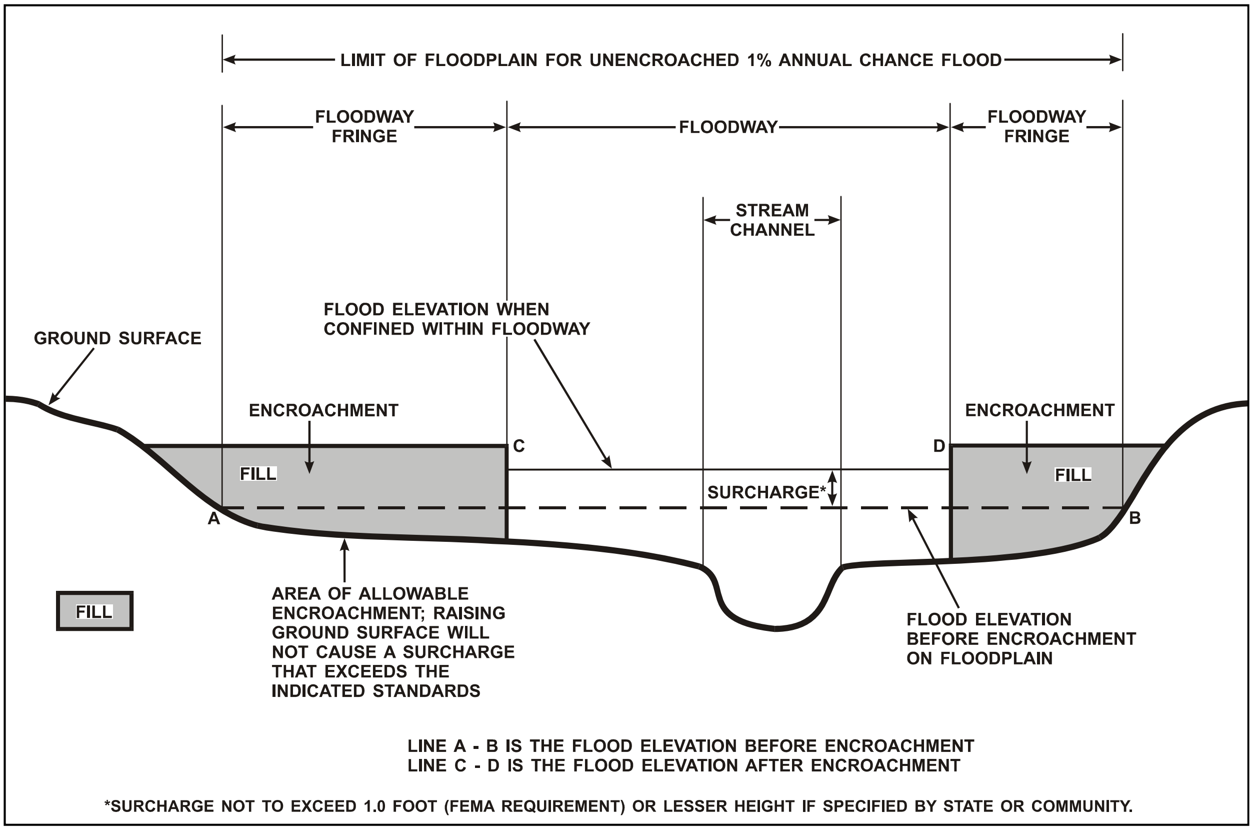

Figure 3 - FLOODWAY SCHEMATIC

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 (500-year) 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- 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 Washington County. Previously, separate Flood Hazard Boundary Maps and/or FIRMs were prepared for each identified flood-prone incorporated community of the county. This countywide FIRM also includes flood hazard information that was presented separately on Flood Boundary and Floodway Maps (FBFMs), where applicable. Historical data relating to the maps prepared for each community, up to and including the 2010 countywide FIS, are presented in Table 11, "Community Map History."

COMMUNITY NAME	INITIAL IDENTIFICATION	FLOOD HAZARD BOUNDARY MAP REVISION DATE(S)	FLOOD INSURANCE RATE MAP EFFECTIVE DATE	FLOOD INSURANCE RATE MAP REVISION DATE(S)
Charlestown, Town of	July 13, 1972	None	July 13, 1972	July 1, 1974 August 20, 1976 October 1, 1983 June 17, 1986 June 16, 1992 September 30, 1995
Exeter, Town of	March 14, 1975	None	March 1, 1982	None
Hopkinton, Town of	May 31, 1974	April 8, 1977	March 16, 1981	None
Narragansett Indian Tribe[1]	July 13, 1972	None	July 13, 1972	None
Narragansett, Town of	December 7, 1971	None	December 7, 1971	July 1, 1974 December 3, 1976 November 1, 1984 June 16, 1992 September 30, 1995
New Shoreham, Town of	January 3, 1975	October 1, 1983	April 3, 1985	June 16, 1992 September 30, 1995
North Kingstown, Town of	July 14, 1972	None	July 14, 1972	July 1, 1974 January 9, 1976 February 16, 1983 October 1, 1983 December 5, 1989 June 16, 1992

[1] Initial Identification and FIRM Effective Date for this community taken from the Town of Charlestown

TABLE 11

FEDERAL EMERGENCY MANAGEMENT AGENCY

WASHINGTON COUNTY, RI (ALL JURISDICTIONS)

COMMUNITY MAP HISTORY

COMMUNITY NAME	INITIAL IDENTIFICATION	FLOOD HAZARD BOUNDARY MAP REVISION DATE(S)	FLOOD INSURANCE RATE MAP EFFECTIVE DATE	FLOOD INSURANCE RATE MAP REVISION DATE(S)
Richmond, Town of	May 31, 1974	December 10, 1976	November 5, 1980	None
South Kingstown, Town of	July 13, 1972	None	July 13, 1972	July 1, 1974 November 12, 1976 February 4, 1977 October 1, 1983 January 3, 1986 June 16, 1992 September 30, 1995
Westerly, Town of	July 28, 1972	None	July 28, 1972	July 1, 1974 December 26, 1975 October 1, 1983 February 5, 1986 August 3, 1992 May 17, 1993

TABLE 11

FEDERAL EMERGENCY MANAGEMENT AGENCY

WASHINGTON COUNTY, RI (ALL JURISDICTIONS)

COMMUNITY MAP HISTORY

7.0 OTHER STUDIES

This FIS report either supersedes or is compatible with all previous studies published on streams studied in this report and should be considered authoritative for the purposes of the NFIP.

FISs have been prepared for the Towns of Portsmouth (Reference 80) and Jamestown (Reference 81), Newport County, Rhode Island, the Town of East Greenwich (Reference 82), Kent County, Rhode Island and the Towns of Stonington (Reference 83), North Stonington (Reference 84), and Voluntown (Reference 85), New London County, Connecticut. A FIRM has been prepared for the Town of West Greenwich (Reference 86), Kent County, Rhode Island. More recently, FISs were prepared for all jurisdictions in Kent County (Reference 87) and Newport County (Reference 88), Rhode Island.

Information pertaining to revised and unrevised flood hazards for each jurisdiction within Washington County has been compiled into this FIS. Therefore, this FIS supersedes all previously printed FIS Reports, FHBMs, FBFMs, and FIRMs for all of the incorporated jurisdictions within Washington County. This FIS also supersedes the 2010 countywide FIS.

For coastal flooding in the Towns of Charlestown, Narragansett, New Shoreham, North Kingstown, South Kingstown, and Westerly, this FIS supersedes the previously printed FISs and the 2010 countywide FIS.

8.0 LOCATION OF DATA

Information concerning the pertinent data used in preparation of this FIS can be obtained by contacting Federal Insurance and Mitigation Division, FEMA Region I, 99 High Street, 6th Floor, Boston, Massachusetts 02110.

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