FLOOD INSURANCE STUDY

FEDERAL EMERGENCY MANAGEMENT AGENCY

VOLUME 1 OF 4

WASHINGTON COUNTY, RHODE ISLAND

(ALL JURISDICTIONS)

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

FEMA

REVISED:

APRIL 3, 2020

FLOOD INSURANCE STUDY NUMBER
44009CV001C

Version Number 2.3.3.2

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

SECTION 1.0 – INTRODUCTION

1.1 The National Flood Insurance Program

The National Flood Insurance Program (NFIP) is a voluntary Federal program that enables property owners in participating communities to purchase insurance protection against losses from flooding. This insurance is designed to provide an alternative to disaster assistance to meet the escalating costs of repairing damage to buildings and their contents caused by floods.

For decades, the national response to flood disasters was generally limited to constructing flood-control works such as dams, levees, sea-walls, and the like, and providing disaster relief to flood victims. This approach did not reduce losses nor did it discourage unwise development. In some instances, it may have actually encouraged additional development. To compound the problem, the public generally could not buy flood coverage from insurance companies, and building techniques to reduce flood damage were often overlooked.

In the face of mounting flood losses and escalating costs of disaster relief to the general taxpayers, the U.S. Congress created the NFIP. The intent was to reduce future flood damage through community floodplain management ordinances, and provide protection for property owners against potential losses through an insurance mechanism that requires a premium to be paid for the protection.

The U.S. Congress established the NFIP on August 1, 1968, with the passage of the National Flood Insurance Act of 1968. The NFIP was broadened and modified with the passage of the Flood Disaster Protection Act of 1973 and other legislative measures. It was further modified by the National Flood Insurance Reform Act of 1994 and the Flood Insurance Reform Act of 2004. The NFIP is administered by the Federal Emergency Management Agency (FEMA), which is a component of the Department of Homeland Security (DHS).

Participation in the NFIP is based on an agreement between local communities and the Federal Government. If a community adopts and enforces floodplain management regulations to reduce future flood risks to new construction and substantially improved structures in Special Flood Hazard Areas (SFHAs), the Federal Government will make flood insurance available within the community as a financial protection against flood losses. The community's floodplain management regulations must meet or exceed criteria established in accordance with Title 44 Code of Federal Regulations (CFR) Part 60.3, *Criteria for Land Management and Use*.

SFHAs are delineated on the community's Flood Insurance Rate Maps (FIRMs). Under the NFIP, buildings that were built before the flood hazard was identified on the community's FIRMs are generally referred to as "Pre-FIRM" buildings. When the NFIP was created, the U.S. Congress recognized that insurance for Pre-FIRM buildings would be prohibitively expensive if the premiums were not subsidized by the Federal Government. Congress also recognized that most of these floodprone buildings were built by individuals who did not have sufficient knowledge of the flood hazard to make informed decisions. The NFIP requires that full actuarial rates reflecting the complete flood risk be charged on all buildings constructed or substantially improved on or after the effective date of the initial FIRM for the community or after December 31, 1974, whichever is later. These buildings are generally referred to as "Post-FIRM" buildings.

1.2 Purpose of this Flood Insurance Study Report

This Flood Insurance Study (FIS) Report revises and updates information on the existence and severity of flood hazards for the study area. The studies described in this report developed flood hazard data that will be used to establish actuarial flood insurance rates and to assist communities in efforts to implement sound floodplain management.

In some states or communities, floodplain management criteria or regulations may exist that are more restrictive than the minimum Federal requirements. Contact your State NFIP Coordinator to ensure that any higher State standards are included in the community's regulations.

1.3 Jurisdictions Included in the Flood Insurance Study Project

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

The jurisdictions that are included in this project area, along with the Community Identification Number (CID) for each community and the 8-digit Hydrologic Unit Codes (HUC-8) sub-basins affecting each, are shown in Table 1. The Flood Insurance Rate Map (FIRM) panel numbers that affect each community are listed. If the flood hazard data for the community is not included in this FIS Report, the location of that data is identified.

Table 1: Listing of NFIP Jurisdictions

Community	CID	HUC-8 Sub-Basin(s)	Located on FIRM Panel(s) (*all preceded by 44009C*)	If Not Included, Location of Flood Hazard Data
Charlestown, Town of	445395	01090005	0158J, 0159J, 0161J, 0162J, 0163J, 0164J, 0166J, 0167J, 0168K, 0169K, 0178J, 0186J, 0188J, 0276K, 0277K, 0278J, 0279J, 0281K, 0282J, 0283J, 0301J	
Exeter, Town of	440032	01090004, 01090005, 01100001	0035J, 0045J, 0055J, 0060J, 0062J, 0065J, 0070J, 0080J, 0085J, 0090J, 0091J, 0092J, 0093J, 0094J	
Hopkinton, Town of	440028	01090005	0045J, 0062J, 0064J, 0065J, 0068J, 0135J, 0141J, 0142J, 0143J, 0144J, 0151J, 0152J, 0153J, 0154J, 0161J, 0163J	
Narragansett Indian Tribe	445414	01090005	0162J, 0166J, 0167J, 0168K, 0169K	
Narragansett, Town of	445402	01090004, 01090005	0114K, 0118J, 0192J, 0194J, 0202K, 0203K, 0204K, 0206J, 0208J, 0211J, 0212J, 0213J, 0214J, 0307J, 0326J	
New Shoreham, Town of	440036	01090005	0352J, 0353J, 0354J, 0356J, 0358J, 0361J, 0362J, 0363J, 0364J, 0366J, 0368J	

Community	CID	HUC-8 Sub-Basin(s)	Located on FIRM Panel(s) (*all preceded by 44009C*)	If Not Included, Location of Flood Hazard Data
North Kingstown, Town of	445404	01090004, 01090005	0013H, 0014J, 0018J, 0019J, 0085J, 0092J, 0094J, 0101H, 0102J, 0103H, 0104J, 0106J, 0107J, 0108J, 0109J, 0111J, 0112J, 0113J, 0114K, 0116J, 0118J, 0185J, 0201J, 0202K	
Richmond, Town of	440031	01090005	0060J, 0062J, 0064J, 0068J, 0070J, 0080J, 0090J, 0151J, 0152J, 0153J, 0154J, 0158J, 0159J, 0160J, 0161J, 0162J, 0166J, 0178J, 0180J	
South Kingstown, Town of	445407	01090004, 01090005	0090J, 0093J, 0094J, 0114K, 0178J, 0179J, 0180J, 0184K, 0185J, 0186J, 0187J, 0188J, 0189J, 0191J, 0192J, 0193J, 0194J, 0201J, 0202K, 0203K, 0204K, 0211J, 0282J, 0301J, 0302J, 0306J	
Westerly, Town of	445410	01090005	0137J, 0139K, 0141J, 0142J, 0143J, 0144J, 0161J, 0163J, 0234J, 0242J, 0252K, 0253J, 0254J, 0256J, 0257J, 0258J, 0259J, 0261J, 0262J, 0276K, 0278J	

1.4 Considerations for using this Flood Insurance Study Report

The NFIP encourages State and local governments to implement sound floodplain management programs. To assist in this endeavor, each FIS Report provides floodplain data, which may include a combination of the following: 10-, 4-, 2-, 1-, and 0.2-percent annual chance flood elevations (the 1% annual chance flood elevation is also referred to as the Base Flood Elevation (BFE)); delineations of the 1% annual chance and 0.2% annual chance floodplains; and 1% annual chance floodway. This information is presented on the FIRM and/or in many components of the FIS Report, including Flood Profiles, Floodway Data tables, Summary of Non-Coastal Stillwater Elevations tables, and Coastal Transect Parameters tables (not all components may be provided for a specific FIS).

This section presents important considerations for using the information contained in this FIS Report and the FIRM, including changes in format and content. Figures 1, 2, and 3 present information that applies to using the FIRM with the FIS Report.

- Part or all of this FIS Report may be revised and republished at any time. In addition, part of this FIS Report may be revised by a Letter of Map Revision (LOMR), which does not involve republication or redistribution of the FIS Report. Refer to Section 6.5 of this FIS Report for information about the process to revise the FIS Report and/or FIRM.

  It is, therefore, the responsibility of the user to consult with community officials by contacting the community repository to obtain the most current FIS Report components. Communities participating in the NFIP have established repositories of flood hazard data for floodplain management and flood insurance purposes. Community map repository addresses are provided in Table 30, “Map Repositories,” within this FIS Report.

- New FIS Reports are frequently developed for multiple communities, such as entire counties. A countywide FIS Report incorporates previous FIS Reports for individual communities and the unincorporated area of the county (if not jurisdictional) into a single document and supersedes those documents for the purposes of the NFIP.

  The initial Countywide FIS Report for Washington County became effective on October 19, 2010. Refer to Table 27 for information about subsequent revisions to the FIRMs.

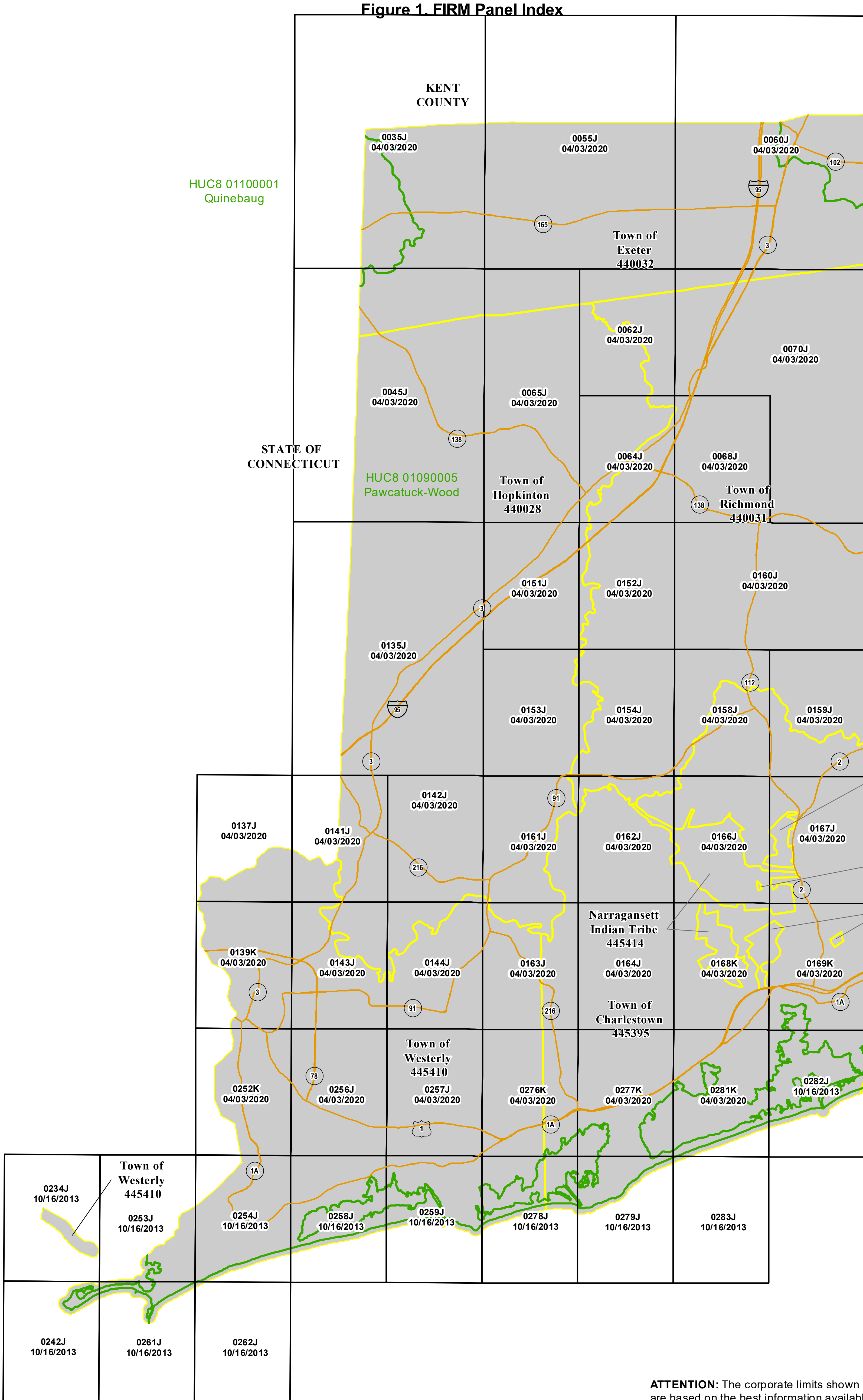
- FEMA does not impose floodplain management requirements or special insurance ratings based on Limit of Moderate Wave Action (LiMWA) delineations at this time. The LiMWA represents the approximate landward limit of the 1.5-foot breaking wave. If the LiMWA is shown on the FIRM, it is being provided by FEMA as information only. For communities that do adopt Zone VE building standards in the area defined by the LiMWA, additional Community Rating System (CRS) credits are available. Refer to Section 2.5.4 for additional information about the LiMWA.

  The CRS is a voluntary incentive program that recognizes and encourages community floodplain management activities that exceed the minimum NFIP requirements. Visit the FEMA Web site at www.fema.gov/national-flood-insurance-program-community-rating-system or contact your appropriate FEMA Regional Office for more information about this program.

- FEMA has developed a *Guide to Flood Maps* (FEMA 258) and online tutorials to assist users in accessing the information contained on the FIRM. These include how to read panels and step-by-step instructions to obtain specific information. To obtain this guide and other assistance in using the FIRM, visit the FEMA Web site at www.fema.gov/online-tutorials.

The FIRM Index in Figure 1 shows the overall FIRM panel layout within Washington County, and also displays the panel number and effective date for each FIRM panel in the county. Other information shown on the FIRM Index includes community boundaries, flooding sources, watershed boundaries, and United States Geological Survey (USGS) Hydrologic Unit Code – 8 (HUC-8) codes.

Figure 1. FIRM Panel Index



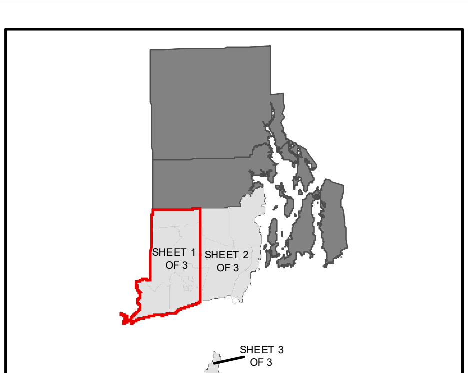
ATTENTION: The corporate limits shown on this FIRM Index are based on the best information available at the time of publication. As such, they may be more current than those shown on FIRM panels issued before April 3, 2020.

1 inch = 9,333 feet 1:112,000

Map Projection:
Rhode Island State Plane (FIPSZONE 3800); North American Datum 1983; Western Hemisphere

THE INFORMATION DEPICTED ON THIS MAP AND SUPPORTING DOCUMENTATION ARE ALSO AVAILABLE IN DIGITAL FORMAT AT
HTTPS://MSC.FEMA.GOV

SEE FLOOD INSURANCE STUDY FOR ADDITIONAL INFORMATION



NATIONAL FLOOD INSURANCE PROGRAM
FLOOD INSURANCE RATE MAP INDEX
(SHEET 1 OF 3)

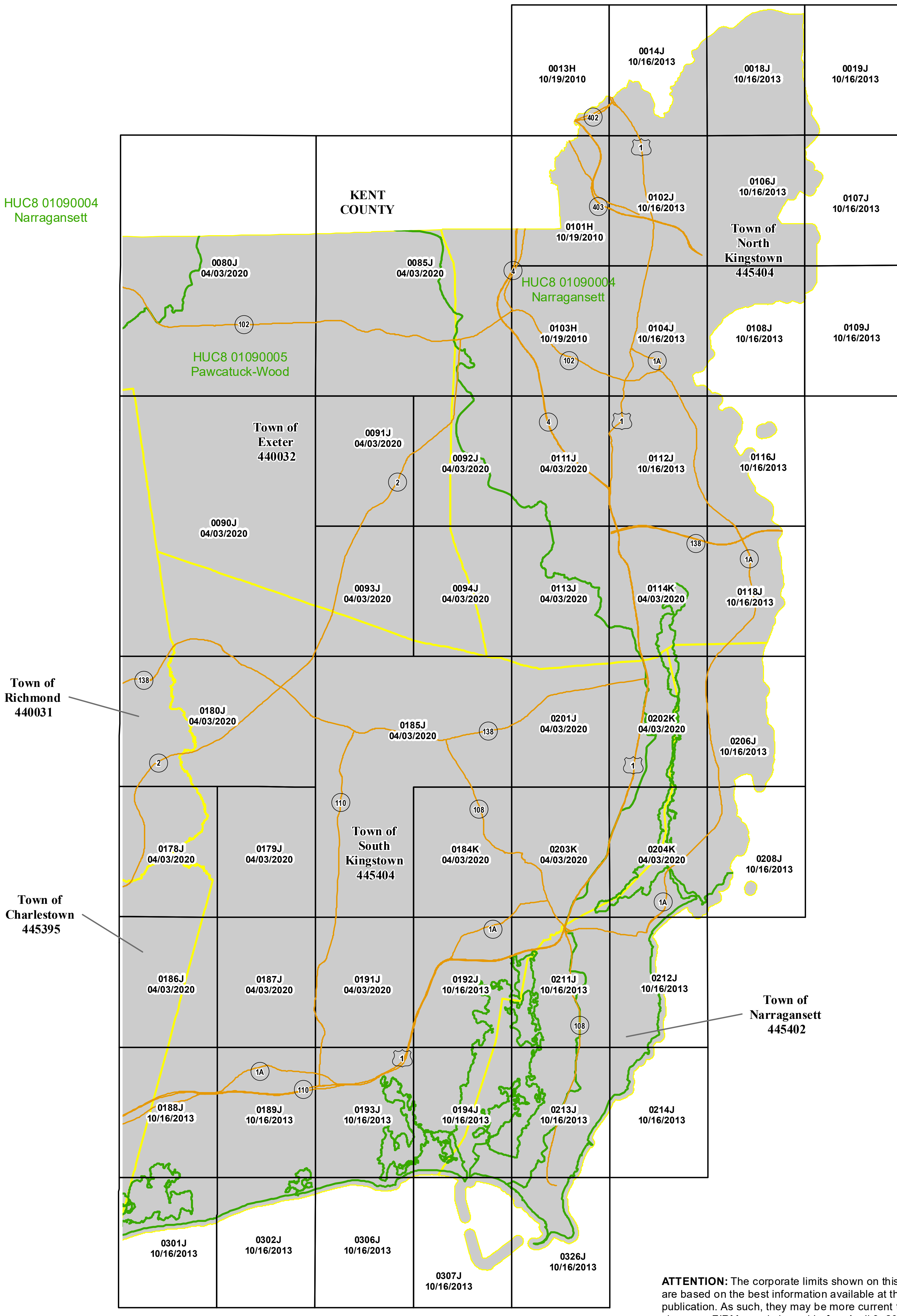
WASHINGTON COUNTY, RI (ALL JURISDICTIONS)

PANELS PRINTED:
0035, 0045, 0055, 0060, 0062, 0064, 0065, 0068, 0070, 0135, 0137, 0139, 0141, 0142, 0143, 0144, 0151, 0152, 0153, 0154, 0158, 0159, 0160, 0161, 0162, 0163, 0164, 0166, 0167, 0168, 0169, 0234, 0242, 0252, 0253, 0254, 0256, 0257, 0258, 0259, 0261, 0262, 0276, 0277, 0278, 0279, 0281, 0282, 0283

FEMA

MAP INDEX
44009CIND1C
MAP REVISED
April 3, 2020

Figure 1. FIRM Panel Index



ATTENTION: The corporate limits shown on this FIRM Index are based on the best information available at the time of publication. As such, they may be more current than those shown on FIRM panels issued before April 3, 2020.

1 inch = 8,750 feet | 1:105,000

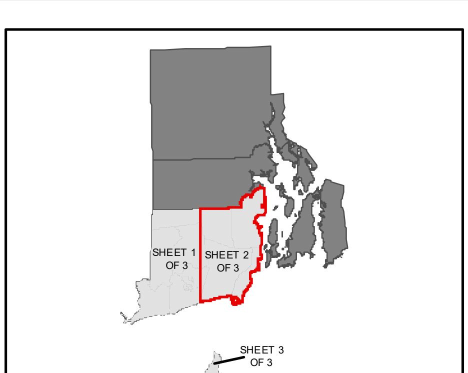
0 2,500 5,000 10,000 Feet

0 500 1,000 2,000 3,000 Meters

Map Projection:
Rhode Island State Plane (FIPSZONE 3800); North American Datum 1983; Western Hemisphere

THE INFORMATION DEPICTED ON THIS MAP AND SUPPORTING DOCUMENTATION ARE ALSO AVAILABLE IN DIGITAL FORMAT AT
HTTPS://MSC.FEMA.GOV

SEE FLOOD INSURANCE STUDY FOR ADDITIONAL INFORMATION



NATIONAL FLOOD INSURANCE PROGRAM
FLOOD INSURANCE RATE MAP INDEX
(SHEET 2 OF 3)

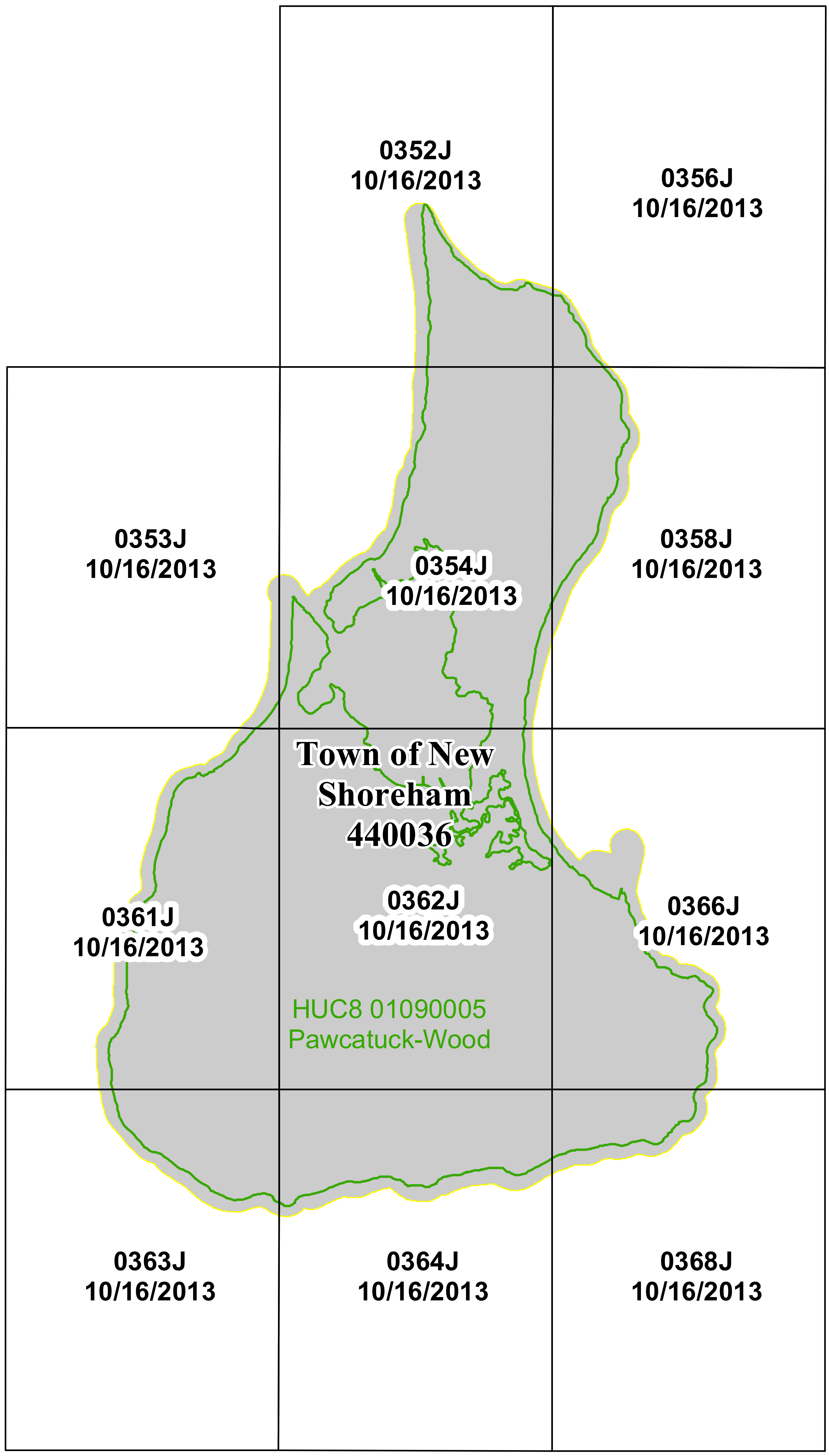
WASHINGTON COUNTY, RI (ALL JURISDICTIONS)

PANELS PRINTED:
0013, 0014, 0018, 0019, 0080, 0085, 0090, 0091, 0092, 0093, 0094, 0101, 0102, 0103, 0104, 0106, 0107, 0108, 0109, 0111, 0112, 0113, 0114, 0116, 0118, 0178, 0179, 0180, 0184, 0185, 0186, 0187, 0188, 0189, 0191, 0192, 0193, 0194, 0201, 0202, 0203, 0204, 0206, 0208, 0211, 0212, 0213, 0214, 0301, 0302, 0306, 0307, 0326

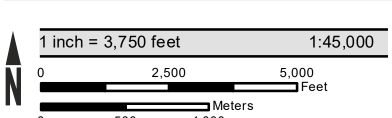
FEMA

MAP INDEX
44009CIND2C
MAP REVISED
April 3, 2020

Figure 1. FIRM Panel Index



ATTENTION: The corporate limits shown on this FIRM Index are based on the best information available at the time of publication. As such, they may be more current than those shown on FIRM panels issued before April 3, 2020.

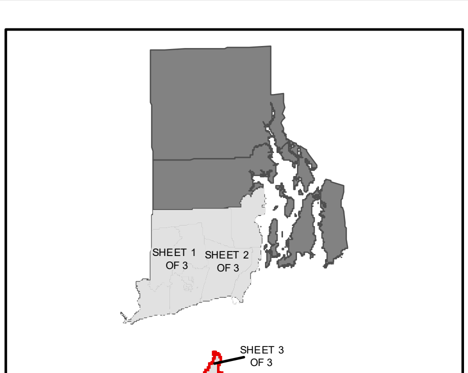


Map Projection:
Rhode Island State Plane (FIPSZONE 3800); North American Datum 1983; Western Hemisphere

THE INFORMATION DEPICTED ON THIS MAP AND SUPPORTING DOCUMENTATION ARE ALSO AVAILABLE IN DIGITAL FORMAT AT

HTTPS://MSC.FEMA.GOV

SEE FLOOD INSURANCE STUDY FOR ADDITIONAL INFORMATION



NATIONAL FLOOD INSURANCE PROGRAM
FLOOD INSURANCE RATE MAP INDEX
(SHEET 3 OF 3)

WASHINGTON COUNTY, RI (ALL JURISDICTIONS)

PANELS PRINTED:

0352, 0353, 0354, 0356, 0358, 0361, 0362, 0363, 0364, 0366, 0368

FEMA

MAP INDEX
44009CIND3C
MAP REVISED
April 3, 2020

Each FIRM panel may contain specific notes to the user that provide additional information regarding the flood hazard data shown on that map. However, the FIRM panel does not contain enough space to show all the notes that may be relevant in helping to better understand the information on the panel. Figure 2 contains the full list of these notes.

Figure 2: FIRM Notes to Users

NOTES TO USERS

For information and questions about this map, available products associated with this FIRM including historic versions of this FIRM, how to order products, or the National Flood Insurance Program in general, please call the FEMA Map Information eXchange at 1-877-FEMA-MAP (1-877-336-2627) or visit the FEMA Flood Map Service Center website at msc.fema.gov. Available products may include previously issued Letters of Map Change, a Flood Insurance Study Report, and/or digital versions of this map. Many of these products can be ordered or obtained directly from the website. Users may determine the current map date for each FIRM panel by visiting the FEMA Flood Map Service Center website or by calling the FEMA Map Information eXchange.

Communities annexing land on adjacent FIRM panels must obtain a current copy of the adjacent panel as well as the current FIRM Index. These may be ordered directly from the Flood Map Service Center at the number listed above.

For community and countywide map dates, refer to Table 27 in this FIS Report.

To determine if flood insurance is available in the community, contact your insurance agent or call the National Flood Insurance Program at 1-800-638-6620.

The map is for use in administering the NFIP. It may not identify all areas subject to flooding, particularly from local drainage sources of small size. Consult the community map repository to find updated or additional flood hazard information.

BASE FLOOD ELEVATIONS: For more detailed information in areas where Base Flood Elevations (BFEs) and/or floodways have been determined, consult the Flood Profiles and Floodway Data and/or Summary of Non-Coastal Stillwater Elevations tables within this FIS Report. Use the flood elevation data within the FIS Report in conjunction with the FIRM for construction and/or floodplain management.

Coastal Base Flood Elevations shown on the map apply only landward of 0.0' North American Vertical Datum of 1988 (NAVD88). Coastal flood elevations are also provided in the Coastal Transect Parameters table in the FIS Report for this jurisdiction. Elevations shown in the Coastal Transect Parameters table should be used for construction and/or floodplain management purposes when they are higher than the elevations shown on the FIRM.

FLOODWAY INFORMATION: Boundaries of the floodways were computed at cross sections and interpolated between cross sections. The floodways were based on hydraulic considerations with regard to requirements of the National Flood Insurance Program. Floodway widths and other pertinent floodway data are provided in the FIS Report for this jurisdiction.

Figure 2. FIRM Notes to Users

FLOOD CONTROL STRUCTURE INFORMATION: Certain areas not in Special Flood Hazard Areas may be protected by flood control structures. Refer to Section 4.3 "Non-Levee Flood Protection Measures" of this FIS Report for information on flood control structures for this jurisdiction.

PROJECTION INFORMATION: The projection used in the preparation of the map was Rhode Island State Plane (FIPSZONE 3800). The horizontal datum was NAD83, GRS1980 spheroid. Differences in datum, spheroid, projection or State Plane zones used in the production of FIRMs for adjacent jurisdictions may result in slight positional differences in map features across jurisdiction boundaries. These differences do not affect the accuracy of the FIRM.

ELEVATION DATUM: Flood elevations on the FIRM are referenced to the North American Vertical Datum of 1988. These flood elevations must be compared to structure and ground elevations referenced to the same vertical datum. For information regarding conversion between the National Geodetic Vertical Datum of 1929 and the North American Vertical Datum of 1988, visit the National Geodetic Survey website at www.ngs.noaa.gov/ or contact the National Geodetic Survey at the following address:

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

Local vertical monuments may have been used to create the map. To obtain current monument information, please contact the appropriate local community listed in Table 30 of this FIS Report.

BASE MAP INFORMATION: Base map information shown on the FIRM was provided by Rhode Island GIS at a scale of 1:5,000. The following panels used base map information provided by the U.S. Geological Survey at a scale of 1:300: 0014J, 0018J, 0019J, 0102J, 0104J, 0106J, 0107J, 0108J, 0109J, 0112J, 0114J, 0116J, 0118J, 0139J, 0168J, 0169J, 0184J, 0188J, 0189J, 0192J, 0193J, 0194J, 0202J, 0203J, 0204J, 0206J, 0208J, 0211J, 0212J, 0213J, 0214J, 0234J, 0242J, 0252J, 0253J, 0254J, 0258J, 0259J, 0261J, 0262J, 0276J, 0277J, 0278J, 0279J, 0281J, 0282J, 0283J, 0301J, 0302J, 0306J, 0307J, 0326J, 0352J, 0353J, 0354J, 0356J, 0358J, 0361J, 0362J, 0363J, 0364J, 0366J, and 0368J. The following panels used base map information provided by the U.S. Geological Survey and Rhode Island GIS at a resolution of 0.3 meter, dated 2015: 0035J, 0045J, 0055J, 0060J, 0062J, 0064J, 0065J, 0068J, 0070J, 0080J, 0085J, 0090J, 0091J, 0092J, 0093J, 0094J, 0111J, 0113J, 0114K, 0135J, 0137J, 0139K, 0141J, 0142J, 0143J, 0144J, 0151J, 0152J, 0153J, 0154J, 0158J, 0159J, 060J, 0161J, 0162J, 0163J, 0164J, 0166J, 0167J, 0168K, 0169K, 0178J, 0179J, 0180J, 0184K, 0185J, 0186J, 0187J, 0191J, 0201J, 0202K, 0203K, 0204K, 0252K, 0256J, 0257J, 0276K, 0277K, and 0281K. For information about base maps, refer to Section 6.2 “Base Map” in this FIS Report.

The map reflects more detailed and up-to-date stream channel configurations than those shown on the previous FIRM for this jurisdiction. The floodplains and floodways that were transferred from the previous FIRM may have been adjusted to conform to these new stream channel configurations. As a result, the Flood Profiles and Floodway Data tables may reflect stream channel distances that differ from what is shown on the map.

Figure 2. FIRM Notes to Users

Corporate limits shown on the map are based on the best data available at the time of publication. Because changes due to annexations or de-annexations may have occurred after the map was published, map users should contact appropriate community officials to verify current corporate limit locations.

NOTES FOR FIRM INDEX

REVISIONS TO INDEX: As new studies are performed and FIRM panels are updated within Washington County, Rhode Island, corresponding revisions to the FIRM Index will be incorporated within the FIS Report to reflect the effective dates of those panels. Please refer to Table 27 of this FIS Report to determine the most recent FIRM revision date for each community. The most recent FIRM panel effective date will correspond to the most recent index date.

ATTENTION: The corporate limits shown are based on the best information available at the time of publication of this FIRM index. As such, they may be more current than those shown on FIRM panels issued before April 3, 2020.

SPECIAL NOTES FOR SPECIFIC FIRM PANELS

This Notes to Users section was created specifically for Washington County, Rhode Island, effective April 3, 2020.

LIMIT OF MODERATE WAVE ACTION: Zone AE has been divided by a Limit of Moderate Wave Action (LiMWA). The LiMWA represents the approximate landward limit of the 1.5-foot breaking wave. The effects of wave hazards between Zone VE and the LiMWA (or between the shoreline and the LiMWA for areas where Zone VE is not identified) will be similar to, but less severe than, those in Zone VE.

FLOOD RISK REPORT: A Flood Risk Report (FRR) may be available for many of the flooding sources and communities referenced in this FIS Report. The FRR is provided to increase public awareness of flood risk by helping communities identify the areas within their jurisdictions that have the greatest risks. Although non-regulatory, the information provided within the FRR can assist communities in assessing and evaluating mitigation opportunities to reduce these risks. It can also be used by communities developing or updating flood risk mitigation plans. These plans allow communities to identify and evaluate opportunities to reduce potential loss of life and property. However, the FRR is not intended to be the final authoritative source of all flood risk data for a project area; rather, it should be used with other data sources to paint a comprehensive picture of flood risk.

Each FIRM panel contains an abbreviated legend for the features shown on the maps. However, the FIRM panel does not contain enough space to show the legend for all map features. Figure 3 shows the full legend of all map features. Note that not all of these features may appear on the FIRM panels in Washington County.

Figure 3: Map Legend for FIRM

SPECIAL FLOOD HAZARD AREAS: *The 1% annual chance flood, also known as the base flood or 100-year flood, has a 1% chance of happening or being exceeded each year. Special Flood Hazard Areas are subject to flooding by the 1% annual chance flood. The Base Flood Elevation is the water surface elevation of the 1% annual chance flood. The floodway is the channel of a stream plus any adjacent floodplain areas that must be kept free of encroachment so that the 1% annual chance flood can be carried without substantial increases in flood heights. See note for specific types. If the floodway is too narrow to be shown, a note is shown.*

	Special Flood Hazard Areas subject to inundation by the 1% annual chance flood (Zones A, AE, AH, AO, AR, A99, V and VE)
Zone A	The flood insurance rate zone that corresponds to the 1% annual chance floodplains. No base (1% annual chance) flood elevations (BFEs) or depths are shown within this zone.
Zone AE	The flood insurance rate zone that corresponds to the 1% annual chance floodplains. Base flood elevations derived from the hydraulic analyses are shown within this zone.
Zone AH	The flood insurance rate zone that corresponds to the areas of 1% annual chance shallow flooding (usually areas of ponding) where average depths are between 1 and 3 feet. Whole-foot BFEs derived from the hydraulic analyses are shown at selected intervals within this zone.
Zone AO	The flood insurance rate zone that corresponds to the areas of 1% annual chance shallow flooding (usually sheet flow on sloping terrain) where average depths are between 1 and 3 feet. Average whole-foot depths derived from the hydraulic analyses are shown within this zone.
Zone AR	The flood insurance rate zone that corresponds to areas that were formerly protected from the 1% annual chance flood by a flood control system that was subsequently decertified. Zone AR indicates that the former flood control system is being restored to provide protection from the 1% annual chance or greater flood.
Zone A99	The flood insurance rate zone that corresponds to areas of the 1% annual chance floodplain that will be protected by a Federal flood protection system where construction has reached specified statutory milestones. No base flood elevations or flood depths are shown within this zone.
Zone V	The flood insurance rate zone that corresponds to the 1% annual chance coastal floodplains that have additional hazards associated with storm waves. Base flood elevations are not shown within this zone.
Zone VE	Zone VE is the flood insurance rate zone that corresponds to the 1% annual chance coastal floodplains that have additional hazards associated with storm waves. Base flood elevations derived from the coastal analyses are shown within this zone as static whole-foot elevations that apply throughout the zone.

Figure 3: Map Legend for FIRM

	Regulatory Floodway determined in Zone AE.
OTHER AREAS OF FLOOD HAZARD	
	Shaded Zone X: Areas of 0.2% annual chance flood hazards and areas of 1% annual chance flood hazards with average depths of less than 1 foot or with drainage areas less than 1 square mile.
	Future Conditions 1% Annual Chance Flood Hazard – Zone X: The flood insurance rate zone that corresponds to the 1% annual chance floodplains that are determined based on future-conditions hydrology. No base flood elevations or flood depths are shown within this zone.
	Area with Reduced Flood Risk due to Levee: Areas where an accredited levee, dike, or other flood control structure has reduced the flood risk from the 1% annual chance flood.
OTHER AREAS	
	Zone D (Areas of Undetermined Flood Hazard): The flood insurance rate zone that corresponds to unstudied areas where flood hazards are undetermined, but possible.
NO SCREEN	Unshaded Zone X: Areas of minimal flood hazard.
FLOOD HAZARD AND OTHER BOUNDARY LINES	
(ortho) (vector)	Flood Zone Boundary (white line on ortho-photography-based mapping; gray line on vector-based mapping)
	Limit of Study
	Jurisdiction Boundary
	Limit of Moderate Wave Action (LiMWA): Indicates the inland limit of the area affected by waves greater than 1.5 feet
GENERAL STRUCTURES	
Aqueduct Channel Culvert Storm Sewer	Channel, Culvert, Aqueduct, or Storm Sewer
Dam Jetty Weir	Dam, Jetty, Weir
	Levee, Dike, or Floodwall
Bridge	Bridge

Figure 3: Map Legend for FIRM

COASTAL BARRIER RESOURCES SYSTEM (CBRS) AND OTHERWISE PROTECTED AREAS (OPA): *CBRS areas and OPAs are normally located within or adjacent to Special Flood Hazard Areas. See Notes to Users for important information.*

CBRS AREA 09/30/2009	Coastal Barrier Resources System Area: Labels are shown to clarify where this area shares a boundary with an incorporated area or overlaps with the floodway.
OTHERWISE PROTECTED AREA 09/30/2009	Otherwise Protected Area
REFERENCE MARKERS	
22.0	River mile Markers
CROSS SECTION & TRANSECT INFORMATION	
B 20.2	Lettered Cross Section with Regulatory Water Surface Elevation (BFE)
5280 21.1	Numbered Cross Section with Regulatory Water Surface Elevation (BFE)
17.5	Unlettered Cross Section with Regulatory Water Surface Elevation (BFE)
8	Coastal Transect
	Profile Baseline: Indicates the modeled flow path of a stream and is shown on FIRM panels for all valid studies with profiles or otherwise established base flood elevation.
	Coastal Transect Baseline: Used in the coastal flood hazard model to represent the 0.0-foot elevation contour and the starting point for the transect and the measuring point for the coastal mapping.
513	Base Flood Elevation Line
ZONE AE (EL 16)	Static Base Flood Elevation value (shown under zone label)
ZONE AO (DEPTH 2)	Zone designation with Depth
ZONE AO (DEPTH 2) (VEL 15 FPS)	Zone designation with Depth and Velocity

Figure 3: Map Legend for FIRM

BASE MAP FEATURES	
Missouri Creek	River, Stream or Other Hydrographic Feature
234	Interstate Highway
234	U.S. Highway
234	State Highway
234	County Highway
MAPLE LANE	Street, Road, Avenue Name, or Private Drive if shown on Flood Profile
RAILROAD	Railroad
	Horizontal Reference Grid Line
	Horizontal Reference Grid Ticks
+	Secondary Grid Crosshairs
Land Grant	Name of Land Grant
7	Section Number
R. 43 W. T. 22 N.	Range, Township Number
$^{42}76^{000m}E$	Horizontal Reference Grid Coordinates (UTM)
365000 FT	Horizontal Reference Grid Coordinates (State Plane)
80° 16’ 52.5”	Corner Coordinates (Latitude, Longitude)

SECTION 2.0 – FLOODPLAIN MANAGEMENT APPLICATIONS

2.1 Floodplain Boundaries

To provide a national standard without regional discrimination, the 1% annual chance (100-year) flood has been adopted by FEMA as the base flood for floodplain management purposes. The 0.2% annual chance (500-year) flood is employed to indicate additional areas of flood hazard in the community.

Each flooding source included in the project scope has been studied and mapped using professional engineering and mapping methodologies that were agreed upon by FEMA and Washington County as appropriate to the risk level. Flood risk is evaluated based on factors such as known flood hazards and projected impact on the built environment. Engineering analyses were performed for each studied flooding source to calculate its 1% annual chance flood elevations; elevations corresponding to other floods (e.g. 10-, 4-, 2-, 0.2-percent annual chance, etc.) may have also been computed for certain flooding sources. Engineering models and methods are described in detail in Section 5.0 of this FIS Report. The modeled elevations at cross sections were used to delineate the floodplain boundaries on the FIRM; between cross sections, the boundaries were interpolated using elevation data from various sources. More information on specific mapping methods is provided in Section 6.0 of this FIS Report.

Depending on the accuracy of available topographic data (Table 22), study methodologies employed (Section 5.0), and flood risk, certain flooding sources may be mapped to show both the 1% and 0.2% annual chance floodplain boundaries, regulatory water surface elevations (BFEs), and/or a regulatory floodway. Similarly, other flooding sources may be mapped to show only the 1% annual chance floodplain boundary on the FIRM, without published water surface elevations. In cases where the 1% and 0.2% annual chance floodplain boundaries are close together, only the 1% annual chance floodplain boundary is shown on the FIRM. Figure 3, "Map Legend for FIRM", describes the flood zones that are used on the FIRMs to account for the varying levels of flood risk that exist along flooding sources within the project area. Table 2 and Table 3 indicate the flood zone designations for each flooding source and each community within Washington County, Rhode Island, respectively.

Table 2, "Flooding Sources Included in this FIS Report," lists each flooding source, including its study limits, affected communities, mapped zone on the FIRM, and the completion date of its engineering analysis from which the flood elevations on the FIRM and in the FIS Report were derived. Descriptions and dates for the latest hydrologic and hydraulic analyses of the flooding sources are shown in Table 12. Floodplain boundaries for these flooding sources are shown on the FIRM (published separately) using the symbology described in Figure 3. On the map, the 1% annual chance floodplain corresponds to the SFHAs. The 0.2% annual chance floodplain shows areas that, although out of the regulatory floodplain, are still subject to flood hazards.

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. The procedures to remove these areas from the SFHA are described in Section 6.5 of this FIS Report.

Table 2: Flooding Sources Included in this FIS Report

Flooding Source	Community	Downstream Limit	Upstream Limit	HUC-8 Sub-Basin(s)	Length (mi) (streams or coastlines)	Area (mi^2) (estuaries or ponding)	Floodway (Y/N)	Zone shown on FIRM	Date of Analysis
Ashaway River	Hopkinton, Town of	Confluence with Pawcatuck River	Headwaters at confluence of Green Fall River and Parmenter Brook	01090005	3.20		Y	AE	02/01/2016
Atlantic Ocean	Multiple	Entire coastline	Entire coastline	N/A	252.1		N	AE	07/01/2012
Barberville Canal	Hopkinton, Town of	Confluence with Wood River	Divergence from Wood River	01090005	0.08		Y	AE	02/01/2016
Beaver River	Richmond, Town of	Confluence with Pawcatuck River	State Route 138	01090005	3.89		Y	AE	02/01/2016
Canonchet Brook	Hopkinton, Town of	Confluence with Wood River	Confluence with Canonchet Brook Tributary	01090005	2.62		Y	AE	06/01/1979
Canonchet Brook Tributary	Hopkinton, Town of	Confluence with Canonchet Brook	Approximately 875 feet upstream of Canonchet Road	01090005	1.20		Y	AE	06/01/1979
Chipuxet River	Exeter, Town of; North Kingstown, Town of; South Kingstown, Town of	Mouth at Worden Pond	Headwaters at outflow of The Reservoir	01090005	8.73		Y	AE	02/01/2016
Glen Rock Canal	South Kingstown, Town of	Confluence with Usquepaug River	Divergence from Queen River	01090005	0.11		Y	AE	02/01/2016
Green Fall River	Hopkinton, Town of	Confluence with Parmenter Brook and Ashaway River	County boundary	01090005	0.22		Y	AE	02/01/2016
Mastuxet Brook	Westerly, Town of	Mouth at Mastuxet Cove	Approximately 2,690 feet upstream of private drive	01090005	1.07		Y	AE	10/01/1981
Mattatuxet River	North Kingstown, Town of	Confluence with Pettaquamscutt River	Silver Spring Lake Dam	01090004	2.49		Y	AE	05/01/1980

Flooding Source	Community	Downstream Limit	Upstream Limit	HUC-8 Sub-Basin(s)	Length (mi) (streams or coastlines)	Area (mi^2) (estuaries or ponding)	Floodway (Y/N)	Zone shown on FIRM	Date of Analysis
Mile Brook	Hopkinton, Town of	Confluence with Pawcatuck River	Approximately 1,650 feet upstream of State Route 3	01090005	0.63		Y	AE	06/01/1979
Pawcatuck River	Charlestown, Town of; Hopkinton, Town of; Richmond, Town of; Westerly, Town of	Gayitt Point	Confluence with Usquepaug River	01090005	29.32		Y	AE	02/01/2016
Queen River	Exeter, Town of; South Kingstown, Town of	Glen Rock Dam	Edwards Pond	01090005	9.01		Y	AE	02/01/2016
Queens Fort Brook	Exeter, Town of	Confluence with Queen River	Approximately 610 feet upstream of Slocumville Road	01090005	1.87		Y	AE	06/01/1980
Quidnessett Brook	North Kingstown, Town of	Bike Path at Allens Harbor	Approximately 1,000 feet upstream of Fletcher Road	01090004	1.03		Y	AE	07/01/1981
Sand Hill Brook	North Kingstown, Town of	Approximately 650 feet above confluence with Hunt River	Approximately 1,530 feet upstream of Brookside Drive	01090004	2.55		Y	AE	07/01/1981
Saugatucket River	South Kingstown, Town of	Silver Lake Avenue	Saugatucket Road	01090005	2.65		Y	AE	12/01/1983
Tomaquag Brook	Hopkinton, Town of	Confluence with Pawcatuck River	Diamond Hill Road	01090005	1.74		Y	AE	06/01/1979
Usquepaug River	Richmond, Town of; South Kingstown, Town of	Confluence with Pawcatuck River	Divergence from Glen Rock Canal	01090005	5.88		Y	AE	02/01/2016
White Rock Canal	Westerly, Town of	Confluence with Pawcatuck River	Divergence from Pawcatuck River	01090005	0.25		Y	AE	02/01/2016
Wood River	Hopkinton, Town of; Richmond, Town of	Confluence with Pawcatuck River	Barberville Dam	01090005	11.96		Y	AE	02/01/2016
Woodville Canal	Hopkinton, Town of	Confluence with Wood River	Divergence from Wood River	01090005	0.26		Y	AE	02/01/2016

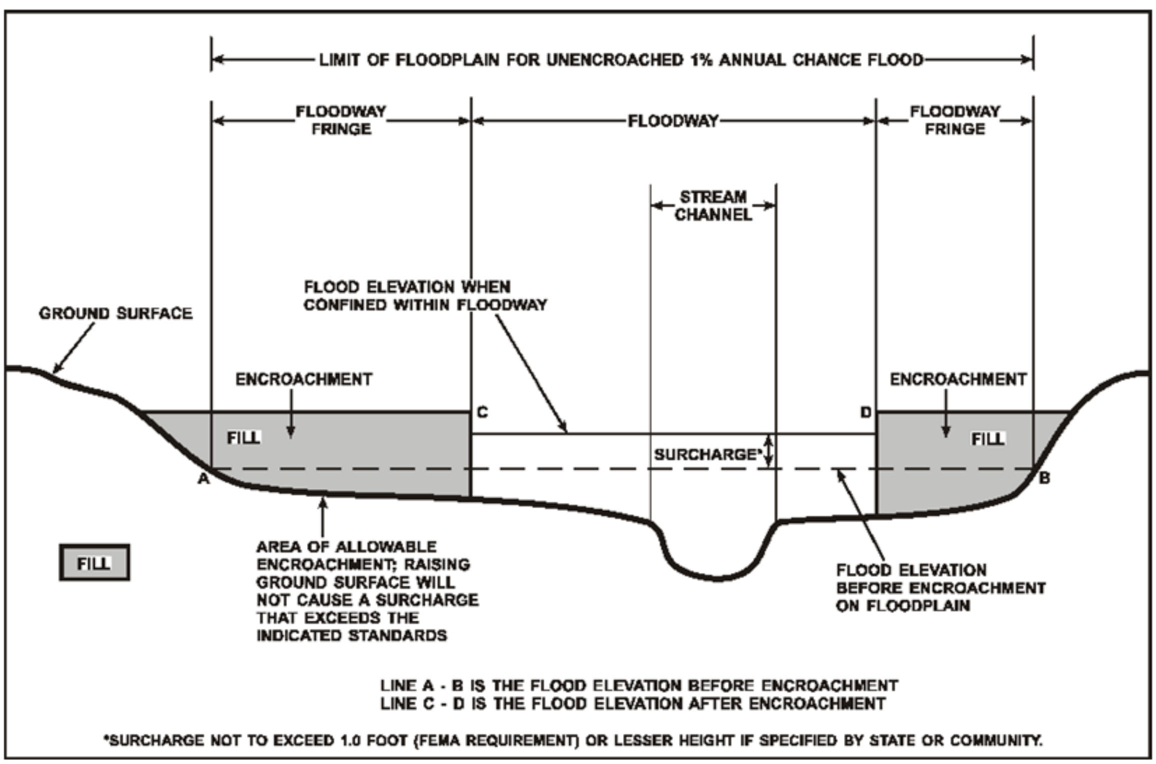
2.2 Floodways

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 balancing floodplain development against increasing flood hazard. With this approach, the area of the 1% annual chance floodplain on a river is divided into a floodway and a floodway fringe based on hydraulic modeling. The floodway is the channel of a stream, plus any adjacent floodplain areas, that must be kept free of encroachment in order to carry the 1% annual chance flood. The floodway fringe is the area between the floodway and the 1% annual chance floodplain boundaries where encroachment is permitted. The floodway must be wide enough so that the floodway fringe could be completely obstructed without increasing the water surface elevation of the 1% annual chance flood more than 1 foot at any point. Typical relationships between the floodway and the floodway fringe and their significance to floodplain development are shown in Figure 4.

To participate in the NFIP, Federal regulations require communities to limit increases caused by encroachment to 1.0 foot, provided that hazardous velocities are not produced. The floodways in this project are presented to local agencies as minimum standards that can be adopted directly or that can be used as a basis for additional floodway projects.

Figure 4: Floodway Schematic



Floodway widths presented in this FIS Report and on the FIRM were computed at cross sections. Between cross sections, the floodway boundaries were interpolated. For certain stream segments, floodways were adjusted so that the amount of floodwaters conveyed on each side of the floodplain would be reduced equally. The results of the floodway computations have been tabulated for selected cross sections and are shown in Table 23, “Floodway Data.”

All floodways that were developed for this Flood Risk Project are shown on the FIRM using the symbology described in Figure 3. In cases where the floodway and l% annual chance floodplain boundaries are either close together or collinear, only the floodway boundary has been shown on the FIRM. For information about the delineation of floodways on the FIRM, refer to Section 6.3.

2.3 Base Flood Elevations

The hydraulic characteristics of flooding sources were analyzed to provide estimates of the elevations of floods of the selected recurrence intervals. The Base Flood Elevation (BFE) is the elevation of the 1% annual chance flood. These BFEs are most commonly rounded to the whole foot, as shown on the FIRM, but in certain circumstances or locations they may be rounded to 0.1 foot. Cross section lines shown on the FIRM may also be labeled with the BFE rounded to 0.1 foot. Whole-foot BFEs derived from engineering analyses that apply to coastal areas, areas of ponding, or other static areas with little elevation change may also be shown at selected intervals on the FIRM.

Cross sections with BFEs shown on the FIRM correspond to the cross sections shown in the Floodway Data table and Flood Profiles in this FIS Report. BFEs are primarily intended for flood insurance rating purposes. For construction and/or floodplain management purposes, users are cautioned to use the flood elevation data presented in this FIS Report in conjunction with the data shown on the FIRM.

2.4 Non-Encroachment Zones

This section is not applicable to this Flood Risk Project.

2.5 Coastal Flood Hazard Areas

For most areas along rivers, streams, and small lakes, BFEs and floodplain boundaries are based on the amount of water expected to enter the area during a 1% annual chance flood and the geometry of the floodplain. Floods in these areas are typically caused by storm events. However, for areas on or near ocean coasts, large rivers, or large bodies of water, BFE and floodplain boundaries may need to be based on additional components, including storm surges and waves. Communities on or near ocean coasts face flood hazards caused by offshore seismic events as well as storm events.

Coastal flooding sources that are included in this Flood Risk Project are shown in Table 2.

2.5.1 Water Elevations and the Effects of Waves

Specific terminology is used in coastal analyses to indicate which components have been included in evaluating flood hazards.

The stillwater elevation (SWEL or still water level) is the surface of the water resulting from astronomical tides, storm surge, and freshwater inputs, but excluding wave setup contribution or the effects of waves.

- *Astronomical tides* are periodic rises and falls in large bodies of water caused by the rotation of the earth and by the gravitational forces exerted by the earth, moon and sun.
- *Storm surge* is the additional water depth that occurs during large storm events. These events can bring air pressure changes and strong winds that force water up against the shore.
- *Freshwater inputs* include rainfall that falls directly on the body of water, runoff from surfaces and overland flow, and inputs from rivers.

The 1% annual chance stillwater elevation is the stillwater elevation that has been calculated for a storm surge from a 1% annual chance storm. The 1% annual chance storm surge can be determined from analyses of tidal gage records, statistical study of regional historical storms, or other modeling approaches. Stillwater elevations for storms of other frequencies can be developed using similar approaches.

The total stillwater elevation (also referred to as the mean water level) is the stillwater elevation plus wave setup contribution but excluding the effects of waves.

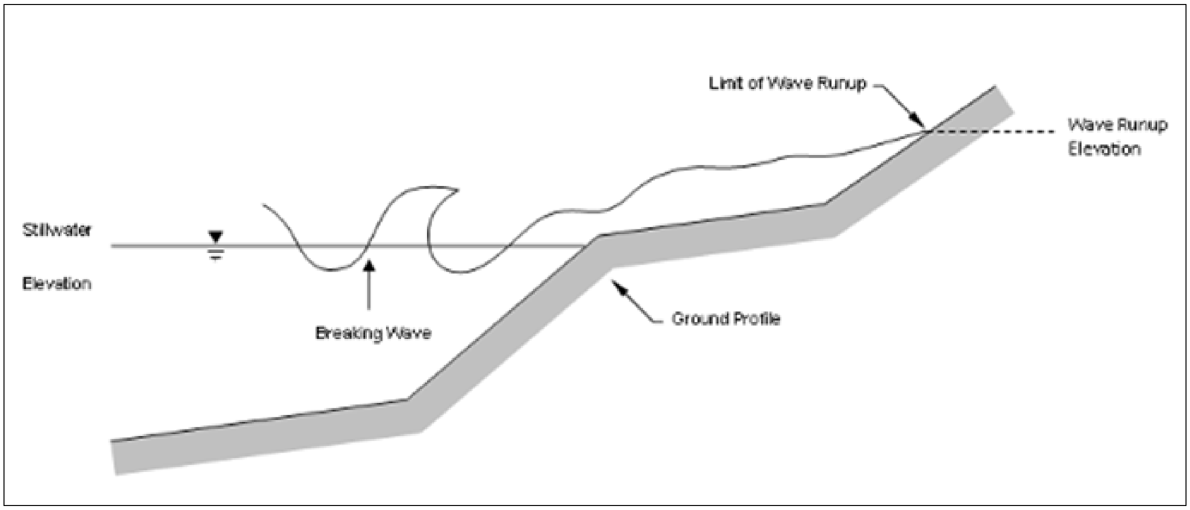
- *Wave setup* is the increase in stillwater elevation at the shoreline caused by the reduction of waves in shallow water. It occurs as breaking wave momentum is transferred to the water column.

Like the stillwater elevation, the total stillwater elevation is based on a storm of a particular frequency, such as the 1% annual chance storm. Wave setup is typically estimated using standard engineering practices or calculated using models, since tidal gages are often sited in areas sheltered from wave action and do not capture this information.

Coastal analyses may examine the effects of overland waves by analyzing storm-induced erosion, overland wave propagation, wave runup, and/or wave overtopping.

- *Storm-induced erosion* is the modification of existing topography by erosion caused by a specific storm event, as opposed to general erosion that occurs at a more constant rate.
- *Overland wave propagation* describes the combined effects of variation in ground elevation, vegetation, and physical features on wave characteristics as waves move onshore.
- *Wave runup* is the uprush of water from wave action on a shore barrier. It is a function of the roughness and geometry of the shoreline at the point where the stillwater elevation intersects the land.
- *Wave overtopping* refers to wave runup that occurs when waves pass over the crest of a barrier.

Figure 5: Wave Runup Transect Schematic



2.5.2 Floodplain Boundaries and BFEs for Coastal Areas

For coastal communities along the Atlantic and Pacific Oceans, the Gulf of Mexico, the Great Lakes, and the Caribbean Sea, flood hazards must take into account how storm surges, waves, and extreme tides interact with factors such as topography and vegetation. Storm surge and waves must also be considered in assessing flood risk for certain communities on rivers or large inland bodies of water.

Beyond areas that are affected by waves and tides, coastal communities can also have riverine floodplains with designated floodways, as described in previous sections.

Floodplain Boundaries

In many coastal areas, storm surge is the principle component of flooding. The extent of the 1% annual chance floodplain in these areas is derived from the total stillwater elevation (stillwater elevation including storm surge plus wave setup) for the 1% annual chance storm. The methods that were used for calculation of total stillwater elevations for coastal areas are described in Section 5.3 of this FIS Report. Location of total stillwater elevations for coastal areas are shown in Figure 8, “1% Annual Chance Total Stillwater Levels for Coastal Areas.”

In some areas, the 1% annual chance floodplain is determined based on the limit of wave runup or wave overtopping for the 1% annual chance storm surge. The methods that were used for calculation of wave hazards are described in Section 5.3 of this FIS Report.

Table 25 presents the types of coastal analyses that were used in mapping the 1% annual chance floodplain in coastal areas.

Coastal BFEs

Coastal BFEs are calculated as the total stillwater elevation (stillwater elevation including storm surge plus wave setup) for the 1% annual chance storm plus the additional flood hazard from overland wave effects (storm-induced erosion, overland wave propagation, wave runup and wave overtopping).

Where they apply, coastal BFEs are calculated along transects extending from offshore to the limit of coastal flooding onshore. Results of these analyses are accurate until local topography, vegetation, or development type and density within the community undergoes major changes.

Parameters that were included in calculating coastal BFEs for each transect included in this FIS Report are presented in Table 16, "Coastal Transect Parameters." The locations of transects are shown in Figure 9, "Transect Location Map." More detailed information about the methods used in coastal analyses and the results of intermediate steps in the coastal analyses are presented in Section 5.3 of this FIS Report. Additional information on specific mapping methods is provided in Section 6.4 of this FIS Report.

2.5.3 Coastal High Hazard Areas

Certain areas along the open coast and other areas may have higher risk of experiencing structural damage caused by wave action and/or high-velocity water during the 1% annual chance flood. These areas will be identified on the FIRM as Coastal High Hazard Areas.

- *Coastal High Hazard Area (CHHA)* is a SFHA extending from offshore to the inland limit of the primary frontal dune (PFD) or any other area subject to damages caused by wave action and/or high-velocity water during the 1% annual chance flood.
- *Primary Frontal Dune (PFD)* is a continuous or nearly continuous mound or ridge of sand with relatively steep slopes immediately landward and adjacent to the beach. The PFD is subject to erosion and overtopping from high tides and waves during major coastal storms.

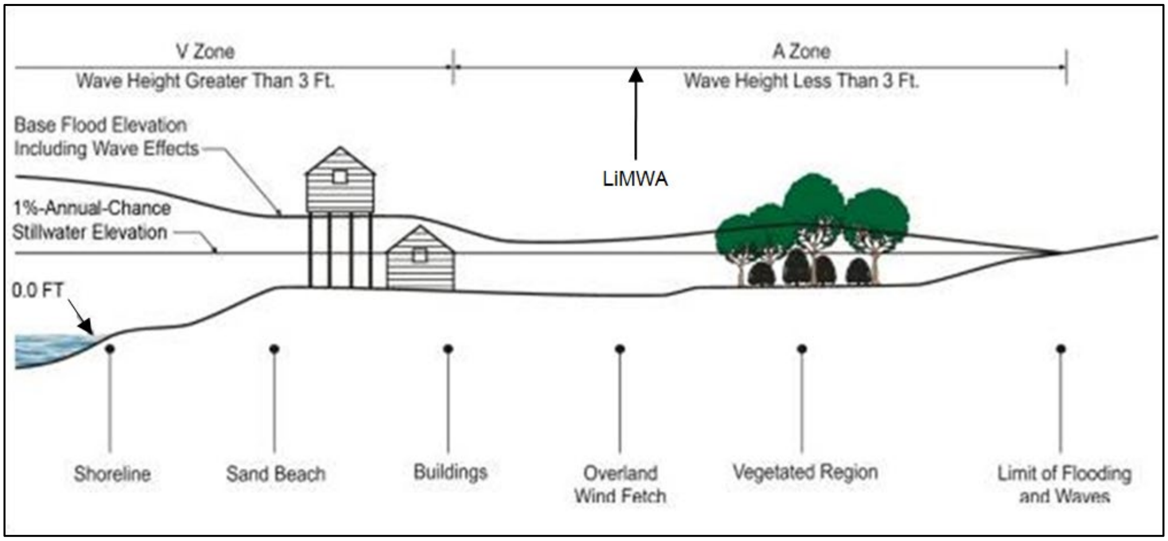
CHHAs are designated as "V" zones (for "velocity wave zones") and are subject to more stringent regulatory requirements and a different flood insurance rate structure. The areas of greatest risk are shown as VE on the FIRM. Zone VE is further subdivided into elevation zones and shown with BFEs on the FIRM.

The landward limit of the PFD occurs at a point where there is a distinct change from a relatively steep slope to a relatively mild slope; this point represents the landward extension of Zone VE. Areas of lower risk in the CHHA are designated with Zone V on the FIRM. More detailed information about the identification and designation of Zone VE is presented in Section 6.4 of this FIS Report.

Areas that are not within the CHHA but are SFHAs may still be impacted by coastal flooding and damaging waves; these areas are shown as "A" zones on the FIRM.

Figure 6, "Coastal Transect Schematic," illustrates the relationship between the base flood elevation, the 1% annual chance stillwater elevation, and the ground profile as well as the location of the Zone VE and Zone AE areas in an area without a PFD subject to overland wave propagation. This figure also illustrates energy dissipation and regeneration of a wave as it moves inland.

Figure 6: Coastal Transect Schematic



Methods used in coastal analyses in this Flood Risk Project are presented in Section 5.3 and mapping methods are provided in Section 6.4 of this FIS Report.

Coastal floodplains are shown on the FIRM using the symbology described in Figure 3, "Map Legend for FIRM." In many cases, the BFE on the FIRM is higher than the stillwater elevations shown in Table 16 due to the presence of wave effects. The higher elevation should be used for construction and/or floodplain management purposes.

2.5.4 Limit of Moderate Wave Action

Laboratory tests and field investigations have shown that wave heights as little as 1.5 feet can cause damage to and failure of typical Zone AE building construction. Wood-frame, light gage steel, or masonry walls on shallow footings or slabs are subject to damage when exposed to waves less than 3 feet in height. Other flood hazards associated with coastal waves (floating debris, high velocity flow, erosion, and scour) can also damage Zone AE construction.

Therefore, a LiMWA boundary may be shown on the FIRM as an informational layer to assist coastal communities in safe rebuilding practices. The LiMWA represents the approximate landward limit of the 1.5-foot breaking wave. The location of the LiMWA relative to Zone VE and Zone AE is shown in Figure 6.

The effects of wave hazards in Zone AE between Zone VE (or the shoreline where Zone VE is not identified) and the limit of the LiMWA boundary are similar to, but less severe than, those in Zone VE where 3-foot or greater breaking waves are projected to occur during the 1% annual chance flooding event. Communities are therefore encouraged to adopt and enforce more stringent floodplain management requirements than the minimum NFIP requirements in the LiMWA. The NFIP Community Rating System provides credits for these actions.

Where wave runup elevations dominate over wave heights, there is no evidence to date of significant damage to residential structures by runup depths less than 3 feet. Examples of these areas include areas with steeply sloped beaches, bluffs, or flood protection structures that lie parallel to the shore. In these areas, the FIRM shows the LiMWA immediately landward of the

VE/AE boundary. Similarly, in areas where the zone VE designation is based on the presence of a primary frontal dune or wave overtopping, the LiMWA is delineated immediately landward of the Zone VE/AE boundary.

SECTION 3.0 – INSURANCE APPLICATIONS

3.1 National Flood Insurance Program Insurance Zones

For flood insurance applications, the FIRM designates flood insurance rate zones as described in Figure 3, "Map Legend for FIRM." Flood insurance zone designations are assigned to flooding sources based on the results of the hydraulic or coastal analyses. Insurance agents use the zones shown on the FIRM and depths and base flood elevations in this FIS Report in conjunction with information on structures and their contents to assign premium rates for flood insurance policies.

The 1% annual chance floodplain boundary corresponds to the boundary of the areas of special flood hazards (e.g. Zones A, AE, V, VE, etc.), and the 0.2% annual chance floodplain boundary corresponds to the boundary of areas of additional flood hazards.

Table 3 lists the flood insurance zones in Washington County.

Table 3: Flood Zone Designations by Community

Community	Flood Zone(s)
Charlestown, Town of	A, AE, VE, X
Exeter, Town of	A, AE, X
Hopkinton, Town of	A, AE, X
Narragansett Indian Tribe	A, AE, X
Narragansett, Town of	AE, VE, X
New Shoreham, Town of	AE, VE, X
North Kingstown, Town of	A, AE, VE, X
Richmond, Town of	A, AE, X
South Kingstown, Town of	A, AE, VE, X
Westerly, Town of	A, AE, VE, X

SECTION 4.0 – AREA STUDIED

4.1 Basin Description

Table 4 contains a description of the characteristics of the HUC-8 sub-basins within which each community falls. The table includes the main flooding sources within each basin, a brief description of the basin, and its drainage area.

Table 4: Basin Characteristics

HUC-8 Sub-Basin Name	HUC-8 Sub-Basin Number	Primary Flooding Source	Description of Affected Area	Drainage Area (square miles)
Narragansett	01090004	Narragansett Bay	The Narragansett Watershed is the watershed drained by all coastal rivers emptying into Narragansett Bay, Rhode Island, except Blackstone River.	1,379
Pawcatuck-Wood	01090005	Pawcatuck River	The Pawcatuck River starts at Worden Pond, situated in the Great Swamp in South Kingstown, and follows a 33-mile-long course, meandering mostly through open and sparsely settled country having a multitude of lakes and swamps. The river flows in a generally southwesterly direction into Little Narragansett Bay at the Rhode Island-Connecticut state line. The lower part of the river forms the boundary between Stonington and North Stonington, Connecticut, and Westerly, Rhode Island.The Pawcatuck-Wood Watershed encompasses a 300-square-mile area of land in southern Rhode Island and southeastern Connecticut. Its seven major drainage basins include the Queen, Wood, Chickasheen, Chipuxet, Shunock, Green Fall, and Pawcatuck Rivers and their tributaries. It is one of the few remaining relatively pristine natural areas along the northeast corridor between New York and Boston.	369
Quinebaug	01100001	Quinebaug River	The Quinebaug River is a river in south-central Massachusetts and eastern Connecticut, with watershed extending into western Rhode Island. The river is about 69 miles in length. It originates from East Brimfield Lake and ponds northwest of Sturbridge, Massachusetts, flows generally southeast and south through Connecticut (Putnam, Danielson, Plainfield, Canterbury, and Jewett City), and joins Aspinook Pond which begins in Canterbury and ends in Jewett City. The river then continues to the Shetucket River northeast of Norwich. That river flows from there into the Thames River and drains into Long Island Sound. It is dammed in its upper reaches at East Brimfield Dam, Westville Dam, and West Thompson Dam - all for flood control - as well as numerous mill dams which powered mills along the river's course. Some of these still provide hydroelectric power today. The Quinebaug River watershed covers 850 square miles and extends into western Rhode Island. There are 29 named streams in the watershed including six major tributaries (the French, Moosup, and Five Mile Rivers and Wales, Mill and Cady Brooks). The watershed also contains 54 lakes and ponds, 31 of which have an area of 10 acres or more, for a total of about 3,000 acres; the largest is East Brimfield Reservoir in Brimfield and Sturbridge (420 acres).	739

4.2 Principal Flood Problems

Table 5 contains a description of the principal flood problems that have been noted for Washington County by flooding source.

Table 5: Principal Flood Problems

Flooding Source	Description of Flood Problems
Michel Pond	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.
Rhode Island Sound	The exposed location of the Town of Narragansett along Rhode Island Sound makes it vulnerable to periodic flooding and wave attack during hurricanes and coastal storms.
Narragansett Bay	Narragansett Bay creates a funneling effect during hurricanes, causing higher flood elevations in the northern portions of the town than along the southern coast.
Point Judith Pond	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. Damaging waves can occur in areas with sufficient fetch length and water depth. Some areas in Point Judith Pond, are subject to varying degrees of wave action. Flooding in South Kingstown is generally limited to the coastal lowlands along Block Island Sound, Point Judith Pond, and the Pettaquamscutt River.
Sand Hill Cove	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. The following excerpts from a report on the 1938 storm by the Providence Journal describe the destruction (Providence Journal 1938): 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.

Flooding Source	Description of Flood Problems
Pawcatuck River	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 (U.S. Army Corps 1979A). 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 (FIS, 1980). 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) (NOAA, A). Based on historical information obtained for the USGS gaging stations 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 was 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. Scattered areas subject to flooding are located along the east coast of the town and along the Pettaquamscutt River, are subject to inundation during severe hurricanes, such as the September 1938 hurricane (approximately 1-percent-annual-chance) and Hurricane Carol in 1954. 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.
Pettaquamscutt River	Flooding in South Kingstown is generally limited to the coastal lowlands along Block Island Sound, Point Judith Pond, and Pettaquamscutt River. Scattered areas subject to flooding are located along the east coast of Narragansett and along the Pettaquamscutt River, and are subject to inundation during severe hurricanes, such as the September 1938 hurricane (approximately 1-percent-annual-chance) and Hurricane Carol in 1954.
Queens Fort Brook	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.
Chipuxet River	There is no documentation of extensive flooding on Queens Fort Brook or on the Chipuxet River in the Town of Exeter. Flooding on the Chipuxet River occurs upstream of Yawgoo Valley Road and in the vicinity of Wolf Rocks Trail Road.
Queen River	Flooding on Mail Road at Queen River occurs when rainfall amounts reach 4 inches. Rainfall events the resultant flooding caused roads to be closed to traffic.

Flooding Source	Description of Flood Problems
Roaring Brook	Flooding on Summit Road at Roaring Brook occurs when rainfall amounts reach 2.5 inches. Rainfall events the resultant flooding caused roads to be closed to traffic.
Wood River	Based on data collected at the USGS gaging station on the Wood River at Hope Valley during the period of record (1941-2015), the greatest discharge recorded is 5,470 cfs on March 30, 2010. This flood is estimated to have an annual exceedance probability less than 0.2 percent (greater than a 500-year recurrence interval). The second large peak recorded at the gage is 2,390 cfs on June 6, 1982 (between the 2- and 4-percent annual exceedance probabilities). The annual exceedance probabilities were obtained from flood-frequency distributions developed for these gaging stations (USGS, 2012).
Narragansett River	The following excerpts from a report on the 1938 storm by the Providence Journal describe the destruction (Providence Journal 1938): 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.
Sand Hill Brook	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.
Saw Mill Brook	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.
Quidnessett Brook	Flooding may occur on Quidnessett Brook upstream of Quidnesset Road.
Annaquatucket River	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.
Quonochontaug Pond	Flooding is associated with Quonochontaug Pond in Weekapaug/Haversham/ Shelter Harbor and with Chapman Pond/Aguntaug Swamp.
Chapman Pond	Flooding is associated with Quonochontaug Pond in Weekapaug/Haversham/ Shelter Harbor and with Chapman Pond/Aguntaug Swamp.

Table 6 contains information about historic flood elevations in the communities within Washington County.

Table 6: Historic Flooding Elevations

Flooding Source	Location	Historic Peak (Feet NAVD88)	Event Date	Approximate Recurrence Interval (years)	Source of Data
Ashaway River	Laurel St, Brdg 50, upstream	37.22	Late March-Early April, 2010		USGS, 2011B
Ashaway River	Laurel St, Brdg 50, downstream	35.9	Late March-Early April, 2010		USGS, 2011B
Ashaway River	Rt 216 & Laurel St, downstream	39.43	Late March-Early April, 2010		USGS, 2011B
Ashaway River	Rt 216 & Laurel St, downstream	39.59	Late March-Early April, 2010		USGS, 2011B
Ashaway River	Rt 216 (Ash 19.1)	44.81	Late March-Early April, 2010		USGS, 2011B
Ashaway River	Wellstown Rd Brdg 49, downstream	49.79	Late March-Early April, 2010		USGS, 2011B
Ashaway River	Wellstown Rd Brdg 49, upstream	51.89	Late March-Early April, 2010		USGS, 2011B
Beaver River	Hillsdale Rd., downstream	224.11	Late March-Early April, 2010		USGS, 2011B
Beaver River	Hillsdale Rd., upstream	232.47	Late March-Early April, 2010		USGS, 2011B
Beaver River	01117468 Rt 138 (Usquepaugh Rd)	114.48	Late March-Early April, 2010		USGS, 2011B
Chipuxet River	Camp Rd. Brdg	135.93	Late March-Early April, 2010		USGS, 2011B
Chipuxet River	Indian Corner Rd. Brdg, downstream	126.04	Late March-Early April, 2010		USGS, 2011B
Chipuxet River	Indian Corner Rd. Brdg, upstream	124.88	Late March-Early April, 2010		USGS, 2011B
Chipuxet River	Yawgoo Valley Rd. Brdg, upstream	112.4	Late March-Early April, 2010		USGS, 2011B
Chipuxet River	Yawgoo Valley Rd. Brdg, downstream	109.9	Late March-Early April, 2010		USGS, 2011B
Chipuxet River	Wolf Rocks Rd. Brdg, upstream	102.12	Late March-Early April, 2010		USGS, 2011B
Chipuxet River	Wolf Rocks Rd. Brdg, downstream	102.06	Late March-Early April, 2010		USGS, 2011B

Flooding Source	Location	Historic Peak (Feet NAVD88)	Event Date	Approximate Recurrence Interval (years)	Source of Data
Chipuxet River	Hwy 138 Brdg, upstream	96.36	Late March-Early April, 2010		USGS, 2011B
Chipuxet River	Station 01117350 Rt 138	98.18	Late March-Early April, 2010		USGS, 2011B
Frenchtown Bk-Hunt R	Station 01116905 Hunt River	35.18	Late March-Early April, 2010		USGS, 2011B
Green Falls River	Rt 95 New London Tpk Brdg 48, upstream	57.67	Late March-Early April, 2010		USGS, 2011B
Green Falls River	Rt 95 New London Tpk Brdg 48, downstream	56.43	Late March-Early April, 2010		USGS, 2011B
Hunt River	Davisvill Rd Brdg, upstream	43.48	Late March-Early April, 2010		USGS, 2011B
Hunt River	Hwy 402 Brdg, upstream	37.05	Late March-Early April, 2010		USGS, 2011B
Hunt River	Hwy 402 Brdg, upstream	36.97	Late March-Early April, 2010		USGS, 2011B
Hunt River	Hwy 402 Brdg, downstream	36.32	Late March-Early April, 2010		USGS, 2011B
Hunt River	Hwy 1 Brdg, upstream	30.05	Late March-Early April, 2010		USGS, 2011B
Hunt River	Hwy 1 Brdg, downstream	28.59	Late March-Early April, 2010		USGS, 2011B
Hunt River	Hwy 1 Brdg, downstream	27.89	Late March-Early April, 2010		USGS, 2011B
Hunts R.-Scrabbletown Bk	Rt 2, Rt 4, Stony Ln. LE Brdg abutment	60.64	Late March-Early April, 2010		USGS, 2011B
Hunts R.-Scrabbletown Bk	Rt 2, Rt 4, Stony Ln., upstream	58.96	Late March-Early April, 2010		USGS, 2011B
Hunts R.-Scrabbletown Bk	Rt 2, Rt 4 , Stony Ln., upstream	59.03	Late March-Early April, 2010		USGS, 2011B
Hunts R.-Scrabbletown Bk	Rt 2, Rt 4 , Stony Ln., downstream	55.54	Late March-Early April, 2010		USGS, 2011B
Hunts R.-Scrabbletown Bk	Rt 2, Rt 4 , Stony Ln., downstream	55.68	Late March-Early April, 2010		USGS, 2011B

Flooding Source	Location	Historic Peak (Feet NAVD88)	Event Date	Approximate Recurrence Interval (years)	Source of Data
Hunts R.-Scrabbletown Bk	South Rd., Shady Hill Dr., upstream	243.86	Late March-Early April, 2010		USGS, 2011B
Hunts R.-Scrabbletown Bk	South Rd., Shady Hill Dr., downstream	237.56	Late March-Early April, 2010		USGS, 2011B
Hunt River	Rt 2 & South Rd., upstream	44.96	Late March-Early April, 2010		USGS, 2011B
Hunt River	Rt 2 & South Rd., downstream	44.4	Late March-Early April, 2010		USGS, 2011B
Pawcatuck River	Biscuit City Rd., upstream	93.11	Late March-Early April, 2010		USGS, 2011B
Pawcatuck River	Biscuit City Rd., upstream	93.38	Late March-Early April, 2010		USGS, 2011B
Pawcatuck River	Biscuit City Rd., downstream	92.78	Late March-Early April, 2010		USGS, 2011B
Pawcatuck River	Sherman Ave., upstream	89.92	Late March-Early April, 2010		USGS, 2011B
Pawcatuck River	Sherman Ave., upstream	89.92	Late March-Early April, 2010		USGS, 2011B
Pawcatuck River	Sherman Ave., downstream	89.87	Late March-Early April, 2010		USGS, 2011B
Pawcatuck River	Sherman Ave., upstream	90.09	Late March-Early April, 2010		USGS, 2011B
Pawcatuck River	Rt. 2 (01117430), upstream	92.27	Late March-Early April, 2010		USGS, 2011B
Pawcatuck River	Rt. 2 (01117430), upstream	92.29	Late March-Early April, 2010		USGS, 2011B
Pawcatuck River	Shannock Village Rd., upstream	83.95	Late March-Early April, 2010		USGS, 2011B
Pawcatuck River	Shannock Village Rd., downstream	75.41	Late March-Early April, 2010		USGS, 2011B
Pawcatuck River	Kings Factory Rd Brdg 542, downstream	50.65	Late March-Early April, 2010		USGS, 2011B
Pawcatuck River	Kings Factory Rd Brdg 542, upstream	52.62	Late March-Early April, 2010		USGS, 2011B
Pawcatuck River	Brudickville Rd Bdg 375 disc 01118010, downstream	47.11	Late March-Early April, 2010		USGS, 2011B

Flooding Source	Location	Historic Peak (Feet NAVD88)	Event Date	Approximate Recurrence Interval (years)	Source of Data
Pawcatuck River	Brudickville Rd Bdg 375 disc 01118010, upstream	48.4	Late March-Early April, 2010		USGS, 2011B
Pawcatuck River	Biscuit City Rd Brdg (on house, upstream)	0	Late March-Early April, 2010		USGS, 2011B
Pawcatuck River	Rt 91, downstream Brdg nr, upstream USGS gage	54.06	Late March-Early April, 2010		USGS, 2011B
Pawcatuck River	gage house 01117500 Wood R Junc	54.02	Late March-Early April, 2010		USGS, 2011B
Pawcatuck River	Rt. 1, downstream	6.59	Late March-Early April, 2010		USGS, 2011B
Pawcatuck River	Rt. 1, upstream	9.03	Late March-Early April, 2010		USGS, 2011B
Pawcatuck River	NAPA Auto Parts, upstream	14.76	Late March-Early April, 2010		USGS, 2011B
Pawcatuck River	NAPA Auto Parts, downstream	13.98	Late March-Early April, 2010		USGS, 2011B
Pawcatuck River	Rt. 78, downstream	16.58	Late March-Early April, 2010		USGS, 2011B
Pawcatuck River	Rt. 78, upstream	15.33	Late March-Early April, 2010		USGS, 2011B
Pawcatuck River	Bridge St., downstream	18.36	Late March-Early April, 2010		USGS, 2011B
Pawcatuck River	Bridge St., upstream	18.61	Late March-Early April, 2010		USGS, 2011B
Pawcatuck River	Boombridge Rd., upstream	29.54	Late March-Early April, 2010		USGS, 2011B
Pawcatuck River	Boombridge Rd., downstream	29.73	Late March-Early April, 2010		USGS, 2011B
Pawcatuck River	Potter Hill Rd., upstream	33.33	Late March-Early April, 2010		USGS, 2011B
Pawcatuck River	Potter Hill Rd., downstream	32.36	Late March-Early April, 2010		USGS, 2011B
Pawcatuck River	Rt. 3, downstream	34.15	Late March-Early April, 2010		USGS, 2011B
Pawcatuck River	Rt. 3, upstream	36.73	Late March-Early April, 2010		USGS, 2011B

Flooding Source	Location	Historic Peak (Feet NAVD88)	Event Date	Approximate Recurrence Interval (years)	Source of Data
Pawcatuck River	Rt 91&216 Brdg 194, upstream	41.6	Late March-Early April, 2010		USGS, 2011B
Pawcatuck River	Rt 91&216 Brdg 194, downstream	40.96	Late March-Early April, 2010		USGS, 2011B
Pawcatuck River	Old Shannok Rd Brdg 58 dam	71.54	Late March-Early April, 2010		USGS, 2011B
Pawcatuck River	Old Shannok Rd Brdg 58, upstream	65.75	Late March-Early April, 2010		USGS, 2011B
Pawcatuck River	Old Shannok Rd Brdg 58, downstream	64.94	Late March-Early April, 2010		USGS, 2011B
Pawcatuck River	Rt 112 & Butter Ln., upstream	60.25	Late March-Early April, 2010		USGS, 2011B
Pawcatuck River	Rt 112 & Butter Ln., upstream	60.2	Late March-Early April, 2010		USGS, 2011B
Pawcatuck River	Rt 112 & Butter Ln., downstream	55.42	Late March-Early April, 2010		USGS, 2011B
Queen River	Glen Rock Rd. at mill pond	113.8	Late March-Early April, 2010		USGS, 2011B
Queen River	Dugway Rd Brdg, downstream	119.98	Late March-Early April, 2010		USGS, 2011B
Queen River	DugwayRd Brdg, upstream	116.69	Late March-Early April, 2010		USGS, 2011B
Queen River	Mail Rd 01117370	125.62	Late March-Early April, 2010		USGS, 2011B
Queen River	West Allenton Rd Brdg, upstream	135.2	Late March-Early April, 2010		USGS, 2011B
Queen River	West Allenton Rd Brdg, downstream	134.71	Late March-Early April, 2010		USGS, 2011B
Queen River	William Reynolds Rd Brdg, upstream	147.84	Late March-Early April, 2010		USGS, 2011B
Queen River	William Reynolds Rd Brdg, downstream	145.89	Late March-Early April, 2010		USGS, 2011B
Queen River	disc 011173545 William Reynolds Rd.	156.43	Late March-Early April, 2010		USGS, 2011B
Queen River	disc 011173545 William Reynolds Rd.	156.5	Late March-Early April, 2010		USGS, 2011B

Flooding Source	Location	Historic Peak (Feet NAVD88)	Event Date	Approximate Recurrence Interval (years)	Source of Data
Queen River	disc 011173545 William Reynolds Rd.	156.54	Late March-Early April, 2010		USGS, 2011B
Queen River	Rt 102 (10 Rod Rd.) Staff gage	188.53	Late March-Early April, 2010		USGS, 2011B
Sandhill Brook	Chadsey Rd.	26.4	Late March-Early April, 2010		USGS, 2011B
Sandhill Brook	Potter Rd., upstream	22.45	Late March-Early April, 2010		USGS, 2011B
Sandhill Brook	Potter Rd., downstream	20.38	Late March-Early April, 2010		USGS, 2011B
Tomaquag River	Collins Rd Brdg, upstream	89.55	Late March-Early April, 2010		USGS, 2011B
Tomaquag River	Collins Rd Brdg, downstream	85.65	Late March-Early April, 2010		USGS, 2011B
Tomaquag River	Diamond Hill Rd culvert, downstream	43.85	Late March-Early April, 2010		USGS, 2011B
Tomaquag River	Diamond Hill Rd culvert, upstream	46.57	Late March-Early April, 2010		USGS, 2011B
Tomaquag River	Diamond Hill Rd culvert, upstream	46.73	Late March-Early April, 2010		USGS, 2011B
Tomaquag River	Rt 216-Chase Hill Rd, downstream	39.16	Late March-Early April, 2010		USGS, 2011B
Tomaquag River	Rt 216-Chase Hill Rd, upstream	39.21	Late March-Early April, 2010		USGS, 2011B
Usquepaug River	Station 01117420, upstream	101.97	Late March-Early April, 2010		USGS, 2011B
Usquepaug River	Station 01117420, downstream	101.08	Late March-Early April, 2010		USGS, 2011B
Usquepaug River	dsc. 01117410 Rt 138, upstream	108.63	Late March-Early April, 2010		USGS, 2011B
Usquepaug River	dsc. 01117410 Rt 138, downstream	107.88	Late March-Early April, 2010		USGS, 2011B
Usquepaug River	Old, upstreamquepaug Rd, upstream	111.82	Late March-Early April, 2010		USGS, 2011B
Usquepaug River	Old, upstreamquepaug Rd, downstream	107.55	Late March-Early April, 2010		USGS, 2011B

Flooding Source	Location	Historic Peak (Feet NAVD88)	Event Date	Approximate Recurrence Interval (years)	Source of Data
Wood River	94 Woodville Rd	58.55	Late March-Early April, 2010		USGS, 2011B

4.3 Non-Levee Flood Protection Measures

Table 7 contains information about non-levee flood protection measures within Washington County such as dams, jetties, and or dikes. Levees are addressed in Section 4.4 of this FIS Report.

Table 7: Non-Levee Flood Protection Measures

Flooding Source	Structure Name	Type of Measure	Location	Description of Measure
Pawcatuck River	Bradford Dyeing Association Dam	dam	Westerly	Provides some control of flood flows on the river; however, there is little available data for this dam.
Saugatucket River	-	dam, sluiceway	South Kingstown	Dam has some means of controlling flow over the main spillway. Sluiceway to the east of the main river bank allows flows of a non flood magnitude to circumvent the industrial park to the south.

4.4 Levees

This section is not applicable to this Flood Risk Project.

Table 8: Levees

[Not Applicable to this Flood Risk Project]

SECTION 5.0 – ENGINEERING METHODS

For the flooding sources in the community, standard hydrologic and hydraulic study methods were used to determine the flood hazard data required for this study. Flood events of a magnitude that are expected to be equaled or exceeded at least once on the average during any 10-, 25-, 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-, 25-, 50-, 100-, and 500-year floods, have a 10-, 4-, 2-, 1-, and 0.2% annual chance, respectively, of being equaled or exceeded during any year.

Although the recurrence interval represents the long-term, average period between floods of a specific magnitude, rare floods could occur at short intervals or even within the same year. The risk of experiencing a rare flood increases when periods greater than 1 year are considered. For example, the risk of having a flood that equals or exceeds the 100-year flood (1-percent chance of annual exceedance) during the term of a 30-year mortgage is approximately 26 percent (about 3 in 10); for any 90-year period, the risk increases to approximately 60 percent (6 in 10). The analyses reported herein reflect flooding potentials based on conditions existing in the community at the time of completion of this study. Maps and flood elevations will be amended periodically to reflect future changes.

5.1 Hydrologic Analyses

Hydrologic analyses were carried out to establish the peak elevation-frequency relationships for floods of the selected recurrence intervals for each flooding source studied. Hydrologic analyses are typically performed at the watershed level. Depending on factors such as watershed size and shape, land use and urbanization, and natural or man-made storage, various models or methodologies may be applied. A summary of the hydrologic methods applied to develop the discharges used in the hydraulic analyses for each stream is provided in Table 12. Greater detail (including assumptions, analysis, and results) is available in the archived project documentation.

A summary of the discharges is provided in Table 9. A summary of stillwater elevations developed for non-coastal flooding sources is provided in Table 10. (Coastal stillwater elevations are discussed in Section 5.3 and shown in Table 16.) Stream gage information is provided in Table 11.

Table 9: Summary of Discharges

Flooding Source	Location	Drainage Area (Square Miles)	Peak Discharge (cfs)				
			10% Annual Chance	4% Annual Chance	2% Annual Chance	1% Annual Chance	0.2% Annual Chance
Annaquatucket River	At Boston Neck Road	7.02	607	*	1,124	1,326	1,875
Annaquatucket River	Approximately 800 feet downstream of Belleville Pond Dam	6.11	562	*	1,043	1,237	1,748
Annaquatucket River	Approximately 50 feet upstream of railroad bridge	2.02	278	*	391	417	485
Ashaway River	Above confluence with Pawcatuck River	28.9	1,080	1,470	1,790	2,130	3,010
Ashaway River	Below headwaters at confluence of Green Fall River and Parmenter Brook	26.3	979	1,330	1,620	1,930	2,720
Beaver River	Above confluence with Pawcatuck River	12.4	442	610	750	905	1,300
Beaver River	Above unnamed tributary 260 feet above Shannock Hill Road	11.0	391	544	673	819	1,200
Beaver River	Above tributary below USGS gage 01117468	9.45	308	432	540	665	990
Beaver River	At USGS gage 01117468 at State Route 138	9.22	298	419	524	648	966
Canonchet Brook	At confluence with Wood River	7.73	260	*	380	440	590
Canonchet Brook	Upstream of Alton Road	6.67	240	*	340	390	530
Canonchet Brook	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
Canonchet Brook Tributary	Upstream of Canonchet Road (upstream culvert)	0.45	30	*	50	60	80
Chipuxet River	Above mouth at Worden Pond	16.0	387	526	637	762	1,050
Chipuxet River	At confluence with White Horn Brook	15.0	387	526	637	762	1,050
Chipuxet River	Above Great Swamp	11.0	283	399	499	613	899

Flooding Source	Location	Drainage Area (Square Miles)	Peak Discharge (cfs)				
			10% Annual Chance	4% Annual Chance	2% Annual Chance	1% Annual Chance	0.2% Annual Chance
Chipuxet River	At USGS gage 01117350	9.59	252	356	445	547	804
Chipuxet River	At outlet of Hundred Acre Pond	9.17	243	343	429	527	775
Chipuxet River	Above unnamed tributary 700 feet below Exeter/South Kingstown corporate limit	7.22	198	281	351	433	638
Chipuxet River	Above unnamed tributary below Yawgoo Mill Pond	3.97	119	170	213	264	391
Chipuxet River	Below Slocum Reservoir	2.48	117	163	202	244	346
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
Mattatuxet River	Upstream of Carr Pond	3.22	110	*	220	299	602
Mattatuxet River	Downstream of State Route 138 culvert	2.45	90	*	182	246	498
Mattatuxet River	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	At USGS gage 01118500	295	4,090	5,290	6,320	7,480	10,500
Pawcatuck River	Above confluence with Shunock River	275	3,880	5,000	6,000	7,100	9,980
Pawcatuck River	Above confluence with Ashaway River	242	3,500	4,520	5,430	6,440	9,060
Pawcatuck River	Above confluence with Tomaquag Brook	218	3,220	4,170	5,010	5,940	8,370
Pawcatuck River	Above confluence with Poquiant Brook	206	3,080	3,980	4,790	5,680	8,020
Pawcatuck River	Above confluence with Wood River	114	1,430	1,840	2,180	2,570	3,580
Pawcatuck River	Above Cedar Swamp	107	1,360	1,750	2,075	2,445	3,410
Pawcatuck River	Above confluence with Meadow Brook	100	1,290	1,660	1,970	2,320	3,240
Pawcatuck River	At USGS gage 01117500	99.3	1,280	1,650	1,960	2,310	3,220

Flooding Source	Location	Drainage Area (Square Miles)	Peak Discharge (cfs)				
			10% Annual Chance	4% Annual Chance	2% Annual Chance	1% Annual Chance	0.2% Annual Chance
Pawcatuck River	Above confluence with White Brook	95.9	1,240	1,600	1,910	2,250	3,140
Pawcatuck River	Above confluence with Taney Brook	92.7	1,210	1,560	1,860	2,190	3,060
Pawcatuck River	Above confluence with Beaver River	78.7	1,100	1,370	1,640	1,930	2,700
Queen River	Above Glen Rock Reservoir	28.0	805	1,160	1,480	1,830	2,750
Queen River	Above unnamed tributary 1,400 feet below Locke Brook	26.2	780	1,140	1,460	1,810	2,740
Queen River	Above confluence with Locke Brook	21.2	720	1,080	1,400	1,760	2,700
Queen River	At USGS gage 01117370 at Mail Road	19.6	698	1,060	1,380	1,740	2,690
Queen River	Above unnamed tributary above USGS gage 01117370	18.5	697	1,040	1,350	1,690	2,590
Queen River	Above confluence with Queens Fort Brook	13.9	637	912	1,150	1,400	2,080
Queen River	Above confluence with Fisherville Brook	4.74	410	577	717	860	1,260
Queens Fort Brook	At confluence with Queen River	4.3	195	*	390	520	1,010
Queens Fort Brook	Approximately 600 feet upstream of 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
Sand Hill Brook / Saw Mill Brook	Approximately 100 feet downstream of Chadsely Lane	2.46	75	*	168	207	282
Sand Hill Brook / Saw Mill Brook	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
Saugatucket River	Above confluence with Rocky Brook	10.9	350	*	670	910	1,460

Flooding Source	Location	Drainage Area (Square Miles)	Peak Discharge (cfs)				
			10% Annual Chance	4% Annual Chance	2% Annual Chance	1% Annual Chance	0.2% Annual Chance
Tomaquog Brook	At confluence with Pawcatuck River	8.70	290	*	410	480	650
Tomaquog Brook	Upstream of confluence with first tributary	6.84	240	*	350	400	540
Tomaquog Brook	Upstream of Burdickville Road	5.89	215	*	310	360	490
Usquepaug River	Above confluence with Pawcatuck River	36.6	897	1,240	1,550	1,900	2,790
Usquepaug River	At USGS gage 01117420 at State Route 2	36.1	892	1,240	1,550	1,900	2,790
Usquepaug River	At outlet of Glen Rock Reservoir	32.8	860	1,210	1,520	1,874	2,770
Wood River	Above confluence with Pawcatuck River	88.5	1,990	2,620	3,150	3,750	5,260
Wood River	Below confluence with Canonchet Brook	84.5	1,890	2,480	2,990	3,550	5,000
Wood River	Above confluence with Canonchet Brook	76.8	1,730	2,260	2,720	3,230	4,590
Wood River	Above confluence with Diamond Brook	75.2	1,700	2,220	2,670	3,170	4,510
Wood River	At USGS gage 01118000	73.5	1,670	2,170	2,610	3,110	4,430
Wood River	Above confluence with Brushy Brook	61.0	1,440	1,900	2,290	2,730	3,850
Wood River	Below confluence with Baker Brook	54.6	198	281	351	433	638

Figure 7: Frequency Discharge-Drainage Area Curves

[Not Applicable to this Flood Risk Project]

Table 10: Summary of Non-Coastal Stillwater Elevations

		Elevations (feet NAVD88)				
Flooding Source	Location	10% Annual Chance	4% Annual Chance	2% Annual Chance	1% Annual Chance	0.2% Annual Chance
Worden Pond	South Kingstown	90.2	90.9	91.5	92.3	93.9

Table 11: Stream Gage Information used to Determine Discharges

Flooding Source	Gage Identifier	Agency that Maintains Gage	Site Name	Drainage Area (Square Miles)	Period of Record	
					From	To
Pawcatuck River	01117500	USGS	Pawcatuck River at Wood River Junction, RI	100	12/07/1940	09/30/2010
Pawcatuck River	01117430	USGS	Pawcatuck River at Kenyon, RI	72.7	11/13/1957	09/30/2010
Wood River	01118000	USGS	Wood River at Hope Valley, RI	72.4	03/12/1941	09/30/2010
Pawcatuck River	01118500	USGS	Pawcatuck River at Westerly, RI	295	11/27/1940	09/30/2010

5.2 Hydraulic Analyses

Analyses of the hydraulic characteristics of flooding from the sources studied were carried out to provide estimates of the elevations of floods of the selected recurrence intervals. Base flood elevations on the FIRM represent the elevations shown on the Flood Profiles and in the Floodway Data tables in the FIS Report. Rounded whole-foot elevations may be shown on the FIRM in coastal areas, areas of ponding, and other areas with static base flood elevations. These whole-foot elevations may not exactly reflect the elevations derived from the hydraulic analyses. Flood elevations shown on the FIRM are primarily intended for flood insurance rating purposes. For construction and/or floodplain management purposes, users are cautioned to use the flood elevation data presented in this FIS Report in conjunction with the data shown on the FIRM. 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.

For streams for which hydraulic analyses were based on cross sections, locations of selected cross sections are shown on the Flood Profiles (Exhibit 1). For stream segments for which a floodway was computed (Section 6.3), selected cross sections are also listed on Table 23, "Floodway Data."

A summary of the methods used in hydraulic analyses performed for this project is provided in Table 12. Roughness coefficients are provided in Table 13. Roughness coefficients are values representing the frictional resistance water experiences when passing overland or through a channel. They are used in the calculations to determine water surface elevations. Greater detail (including assumptions, analysis, and results) is available in the archived project documentation.

Table 12: Summary of Hydrologic and Hydraulic Analyses

Flooding Source	Study Limits Downstream Limit	Study Limits Upstream Limit	Hydrologic Model or Method Used	Hydraulic Model or Method Used	Date Analyses Completed	Flood Zone on FIRM	Special Considerations
Annaquatucket River	Boston Neck Road (State Route 1A), North Kingstown, RI	Downstream of railroad tracks, North Kingstown, RI	Synthetic rainfall-runoff method, TR20 (U.S. Dept. Ag., 1972)	Step-backwater computer model WSP2 (U.S. Dept. Ag., 1976B)	May, 1980	AE w/floodway	
Ashaway River	Confluence with Pawcatuck River, Hopkinton, RI	Confluence of Green Falls River and Parmenter Brook, approximately 750 feet upstream of Interstate 95, Hopkinton, RI	USGS floodflow regression equations (USGS, 2012).	HEC-RAS River Analysis System Version 4.1 (U.S. Army Corps, 2010)	March, 2016	AE w/floodway	
Beaver River	Confluence with Pawcatuck River, Richmond, RI.	Upstream side of Kingstown Road (State Route 138), Richmond, RI.	LPIII analysis of gaging record (01117468) 41 years record, weighted with USGS floodflow regression equations (USGS, 2012). Discharges transferred by proration with drainage area.	HEC-RAS River Analysis System Version 4.1 (U.S. Army Corps, 2010)	March, 2016	AE w/floodway	
Canonchet Brook	Confluence with Wood River, Hopkinton, RI	Confluence with Canonchet Brook Tributary, approximately 100 feet upstream of Main Street (State Route 3), Hopkinton, RI	USGS floodflow regression equations (USGS, 1976B)	Step-backwater computer program, E431 (USGS, 1976B).	June, 1979	AE w/floodway	

Flooding Source	Study Limits Downstream Limit	Study Limits Upstream Limit	Hydrologic Model or Method Used	Hydraulic Model or Method Used	Date Analyses Completed	Flood Zone on FIRM	Special Considerations
Canonchet Brook Tributary	Confluence with Canonchet Brook approximately 100 feet north of Main Street (State Route 3), Hopkinton, RI	Approximately 800 feet upstream of Canonchet Road northernmost crossing, Hopkinton, RI	LPIII analysis of gaging record on Wood River (01118000) 40 years record. Discharges transferred by proration with drainage area: Q1/Q2=(A1/A2)0.72.	Step-backwater computer program, E431 (USGS, 1976B).	June, 1979	AE w/floodway	
Chipuxet River	Mouth at Worden Pond, South Kingstown, RI.	Outflow dam of The Reservoir, Exeter, RI.	LPIII analysis of gaging record (01117350) 42 years record each, weighted with USGS floodflow regression equations (USGS, 2012). Discharges transferred by proration with drainage area.	HEC-RAS River Analysis System Version 4.1 (U.S. Army Corps, 2010)	March, 2016	AE w/floodway	
Green Fall River	Confluence with Parmenter Brook, approximately 750 feet upstream of Interstate 95, Hopkinton, RI.	Rhode Island-Connecticut state boundary.	USGS floodflow regression equations (USGS, 2012).	HEC-RAS River Analysis System Version 4.1 (U.S. Army Corps, 2010)	March, 2016	AE w/floodway	
Mastuxet Brook	Confluence with Mastuxet Cove (Little Narragansett Bay/Pawcatuck River), Westerly, RI	Approximately 2700 feet upstream of an unnamed private road crossing, Westerly, RI	USGS regionalization technique described in USGS (1964).	No description provided	October, 1981	AE w/floodway	

Flooding Source	Study Limits Downstream Limit	Study Limits Upstream Limit	Hydrologic Model or Method Used	Hydraulic Model or Method Used	Date Analyses Completed	Flood Zone on FIRM	Special Considerations
Mattatuxet River	Confluence with Pettaquamscutt River, 1300 feet downstream of Gilbert Stuart Road, North Kingstown, RI.	Upstream of a dam approximately 500 feet upstream of U.S. Route 1.	USGS floodflow regression equations (USGS, 1976B)	HEC-2 Water Surface Profiles Program (U.S. Army Corps, 1977)	May, 1980	AE w/floodway	
Mile Brook	Confluence with Pawcatuck River, Hopkinton, RI.	Approximately 1600 feet upstream of Main Street (State Route 3), Hopkinton, RI.	LPIII analysis of gaging record on Wood River (01118000) 40 years record. Discharges transferred by proration with drainage area: Q1/Q2=(A1/A2)0.72.	Step-backwater computer program, E431 (USGS, 1976B).	June, 1979	AE w/floodway	
Pawcatuck River	1.4 miles downstream from U.S. Route 1 Bridge, Westerly, RI and Stonington, CT.	Approximately 100 feet upstream of Biscuit City Road in Richmond and Charlestown, RI	LPIII analysis of gaging record (01118500, 01117500) 75 years record each, weighted with USGS floodflow regression equations (USGS, 2012). Discharges transferred by proration with drainage area.	HEC-RAS River Analysis System Version 4.1 (U.S. Army Corps, 2010)	March, 2016	AE w/floodway	

Flooding Source	Study Limits Downstream Limit	Study Limits Upstream Limit	Hydrologic Model or Method Used	Hydraulic Model or Method Used	Date Analyses Completed	Flood Zone on FIRM	Special Considerations
Queen River	Glen Rock Reservoir, South Kingstown, RI.	Edwards Pond, 0.25 miles upstream of Ten Rod Road (State Route 102), Exeter, RI.	LPIII analysis of gaging record (01117370, 01117420--16 and 39 years record, respectively), weighted with USGS floodflow regression equations (USGS, 2012). Discharges transferred by proration with drainage area.	HEC-RAS River Analysis System Version 4.1 (U.S. Army Corps, 2010)	March, 2016	AE w/floodway	
Queens Fort Brook	Confluence with Queen River, Exeter, RI.	Approximately 600 feet upstream of Slocumville Road (South Road), Exeter, RI.	USGS floodflow regression equations (USGS, 1976B)	HEC-2 Water Surface Profiles Program (U.S. Army Corps, 1979H)	June, 1980	AE w/floodway	
Quidnessett Brook	Mouth at Narragansett Bay, North Kingstown, RI.	Approximately 950 feet upstream of Fletcher Road Dam, North Kingstown, RI	USGS floodflow regression equations (USGS, 1976B)	HEC-2 Water Surface Profiles Program (U.S. Army Corps, 1977)	May, 1980	AE w/floodway	
Sand Hill Brook	Approximately 100 feet downstream of North Quidnessett Road, North Kingstown, RI.	Downstream side of Devils Foot Road, North Kingstown, RI.	Synthetic rainfall-runoff method, TR20 (U.S. Dept. Ag., 1965)	Step-backwater computer model WSP2 (U.S. Dept. Ag., 1976B)	May, 1980	AE w/floodway	
Saugatucket River	Silver Lake Avenue, South Kingstown, RI.	Upstream side of Saugatuck Road, South Kingstown, RI.	USGS regionalization technique described in USGS (1964).	No description provided	December, 1983	AE w/floodway	

Flooding Source	Study Limits Downstream Limit	Study Limits Upstream Limit	Hydrologic Model or Method Used	Hydraulic Model or Method Used	Date Analyses Completed	Flood Zone on FIRM	Special Considerations
Tomaquag Brook	Confluence with Pawcatuck River, Hopkinton, RI	Diamond Hill Road, Hopkinton, RI	USGS floodflow regression equations (USGS, 1976B)	Step-backwater computer program, E431 (USGS, 1976B).	June, 1979	AE w/floodway	
Usquepaug River	Confluence with Pawcatuck River, Richmond and South Kingstown, RI.	Glen Rock Reservoir, South Kingstown, RI.	LPIII analysis of gaging record (01117370, 01117420--16 and 39 years record, respectively), weighted with USGS floodflow regression equations (USGS, 2012). Discharges transferred by proration with drainage area.	HEC-RAS River Analysis System Version 4.1 (U.S. Army Corps, 2010)	March, 2016	AE w/floodway	
Wood River	Confluence with Pawcatuck River, Hopkinton and Richmond, RI	Approximately 500 feet upstream of Barberville Dam	LPIII analysis of gaging record (01118000) 74 years record, weighted with USGS floodflow regression equations (USGS, 2012). Discharges transferred by proration with drainage area.	HEC-RAS River Analysis System Version 4.1 (U.S. Army Corps, 2010)	March, 2016	AE w/floodway	

Table 13: Roughness Coefficients

Flooding Source	Channel "n"	Overbank "n"
Annaquatucket River	0.028 – 0.045	0.050 – 0.075
Ashaway River	0.03 - 0.06	0.08 - 0.18
Beaver River	0.045 - 0.055	0.05 - 0.2
Canonchet Brook	0.030 – 0.035	0.035 – 0.130
Canonchet Brook Tributary	0.030 – 0.035	0.035 – 0.130
Chipuxet River	0.03 - 0.075	0.04 - 0.2
Green Fall River	0.035 - 0.046	0.06 - 0.15
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	0.025 - 0.055	0.04 - 0.18
Queen River	0.035 - 0.06	0.04 - 0.2
Queens Fort Brook	0.04	0.08
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
Usquepaug River	0.035 - 0.05	0.06 - 0.2
Wood River	0.035 - 0.055	0.035 - 0.2

5.3 Coastal Analyses

For the areas of Washington County that are impacted by coastal flooding processes, coastal flood hazard analyses were performed to provide estimates of coastal BFEs. Coastal BFEs reflect the increase in water levels during a flood event due to extreme tides and storm surge as well as overland wave effects.

The following subsections provide summaries of how each coastal process was considered for this FIS Report. Greater detail (including assumptions, analysis, and results) is available in the archived project documentation. Table 14 summarizes the methods and/or models used for the coastal analyses. Refer to Section 2.5.1 for descriptions of the terms used in this section.

Table 14: Summary of Coastal Analyses

Flooding Source	Study Limits From	Study Limits To	Hazard Evaluated	Model or Method Used	Date Analysis was Completed
Long Island Sound	Entire coastline	Entire coastline	Extremal Analysis	Peaks Over Threshold (POT)	August 2013
Long Island Sound	Entire coastline	Entire coastline	Stillwater Elevation	Tide Gage Analysis	August 2013
Long Island Sound	Entire coastline	Entire coastline	Wave Setup	Direct Integration Method (DIM)	August 2013
Long Island Sound	Unrestricted fetches in Washington County	Unrestricted fetches in Washington County	Waves	USACE Coastal Engineering Manual Empirical Wave Growth equations	August 2013
Long Island Sound	Entire coastline in Washington County	Entire coastline in Washington County	Waves	USACE Automated Coastal Engineering System	August 2013
Long Island Sound	Entire coastline	Entire coastline	Overland Wave Propagation	WHAFIS	August 2013
Long Island Sound	Vertical coastal protection structures	Vertical coastal protection structures	Wave runup	Shore Protection Manual (SPM)	August 2013
Long Island Sound	Coastal protection structures sloping from 1:1 to 1:8	Coastal protection structures sloping from 1:1 to 1:8	Wave runup	TAW	August 2013
Long Island Sound	Coastal protection structures sloping gentler than 1:8 and natural beaches	Coastal protection structures sloping gentler than 1:8 and natural beaches	Wave runup	RUNUP 2.0	August 2013
Long Island Sound	Entire coastline	Entire coastline	Coastal Erosion	Coastal Hazard Analysis and Modeling Program (CHAMP)	August 2013

5.3.1 Total Stillwater Elevations

The total stillwater elevations (stillwater including storm surge plus wave setup) for the 1% annual chance flood were determined for areas subject to coastal flooding. The models and methods that were used to determine storm surge and wave setup are listed in Table 14.

Figure 8: 1% Annual Chance Total Stillwater Elevations for Coastal Areas

[Not Applicable to this Flood Risk Project]

Tidal gages can be used instead of historic records of storms when the available tidal gage record for the area represents both the astronomical tide component and the storm surge component. Table 15 provides the gage name, managing agency, gage type, gage identifier, start date, end date, and statistical methodology applied to each gage used to determine the stillwater elevations. For areas between gages, peak stillwater elevations for selected recurrence intervals were estimated by linear interpolation between gages. A regionalized statistical approach was applied to the gage data so that return period statistics at gages with shorter periods of record could be identified.

Table 15: Tide Gage Analysis Specifics

Gage Name	Managing Agency of Tide Gage Record	Gage Type	Start Date	End Date	Statistical Methodology
New London tide gage station 8461490	NOAA	Tide	unknown	unknown	L-Moments with a Wakeby distribution
Newport tide gage station 8452660	NOAA	Tide	unknown	unknown	L-Moments with a Wakeby distribution
Providence tide gage station 8454000	NOAA	Tide	unknown	unknown	L-Moments with a Wakeby distribution
Quonset Airport KOQU	NOAA	ASOS (Wind)	09/01/1985	05/30/2010	Weibull distribution

Wave Setup Analysis

Wave setup was computed during transect-based analysis through the methods listed in Table 14.

5.3.2 Waves

Empirical wind wave growth equations were used to calculate the deepwater bulk wave parameters required for transect-based analysis in unrestricted and fetch-restricted settings. Table 15 provides the wind observation station name, managing agency, gage type, start date, end date, and statistical methodology applied to each gage used to determine the wind speeds for use in wind wave growth.

5.3.3 Coastal Erosion

A single storm episode can cause extensive erosion in coastal areas. Storm-induced erosion was evaluated to determine the modification to existing topography that is expected to be associated with flooding events. Erosion was evaluated using the methods listed in Table 14.

5.3.4 Wave Hazard Analyses

Overland wave hazards were evaluated to determine the combined effects of ground elevation, vegetation, and physical features on overland wave propagation and wave runup. These analyses were performed at representative transects along all shorelines for which waves were expected to be present during the floods of the selected recurrence intervals. The results of these analyses were used to determine elevations for the 1% annual chance flood.

Transect locations were chosen with consideration given to the physical land characteristics as well as development type and density so that they would closely represent conditions in their locality. Additional consideration was given to changes in the total stillwater elevation. Transects were spaced close together in areas of complex topography and dense development or where total stillwater elevations varied. In areas having more uniform characteristics, transects were spaced at larger intervals. Transects shown in Figure 9, "Transect Location Map," are also depicted on the FIRM. Table 16 provides the location, stillwater elevations, and starting wave conditions for each transect evaluated for overland wave hazards. In this table, "starting" indicates the parameter value at the beginning of the transect.

Wave Height Analysis

Wave height analyses were performed to determine wave heights and corresponding wave crest elevations for the areas inundated by coastal flooding and subject to overland wave propagation hazards. Refer to Figure 6 for a schematic of a coastal transect evaluated for overland wave propagation hazards.

Wave heights and wave crest elevations were modeled using the methods and models listed in Table 14, "Summary of Coastal Analyses".

Wave Runup Analysis

Wave runup analyses were performed to determine the height and extent of runup beyond the limit of stillwater inundation for the 1% annual chance flood. Wave runup elevations were modeled using the methods and models listed in Table 14.

Table 16: Coastal Transect Parameters

Flood Source	Coastal Transect	Starting Wave Conditions for the 1% Annual Chance		Starting Stillwater Elevations (ft NAVD88) Range of Stillwater Elevations (ft NAVD88)				
		Significant Wave Height H_s (ft)	Peak Wave Period T_p (sec)	10% Annual Chance	4% Annual Chance	2% Annual Chance	1% Annual Chance	0.2% Annual Chance
Little Narragansett Bay	1	3.14	3.42	5.0	*	7.8	9.9	18.7
Block Island Sound	2	13.24	7.26	5.0	*	7.8	9.9	18.7
Block Island Sound	3	13.24	7.26	5.0	*	7.8	9.9	18.7
Block Island Sound	4	13.24	7.26	5.0	*	7.8	9.9	18.7
Block Island Sound	5	13.24	7.26	5.0	*	7.8	9.9	18.7
Block Island Sound	6	13.24	7.26	5.0	*	7.8	9.9	18.7
Block Island Sound	7	13.24	7.26	5.0	*	7.8	9.9	18.7
Block Island Sound	8	13.24	7.26	5.0	*	7.8	9.9	18.8
Block Island Sound	9	13.24	7.26	5.0	*	7.9	10.0	18.8
Block Island Sound	10	13.24	7.26	5.0	*	7.9	10.0	18.8
Block Island Sound	11	13.24	7.26	5.1	*	7.9	10.0	18.8
Block Island Sound	12	13.24	7.26	5.1	*	7.9	10.0	18.9
Block Island Sound	13	13.24	7.26	5.1	*	7.9	10.0	18.9
Block Island Sound	14	13.24	7.26	5.1	*	7.9	10.0	18.9
Block Island Sound	15	13.24	7.26	5.1	*	7.9	10.0	18.9
Block Island Sound	16	13.24	7.26	5.1	*	7.9	10.1	19.0

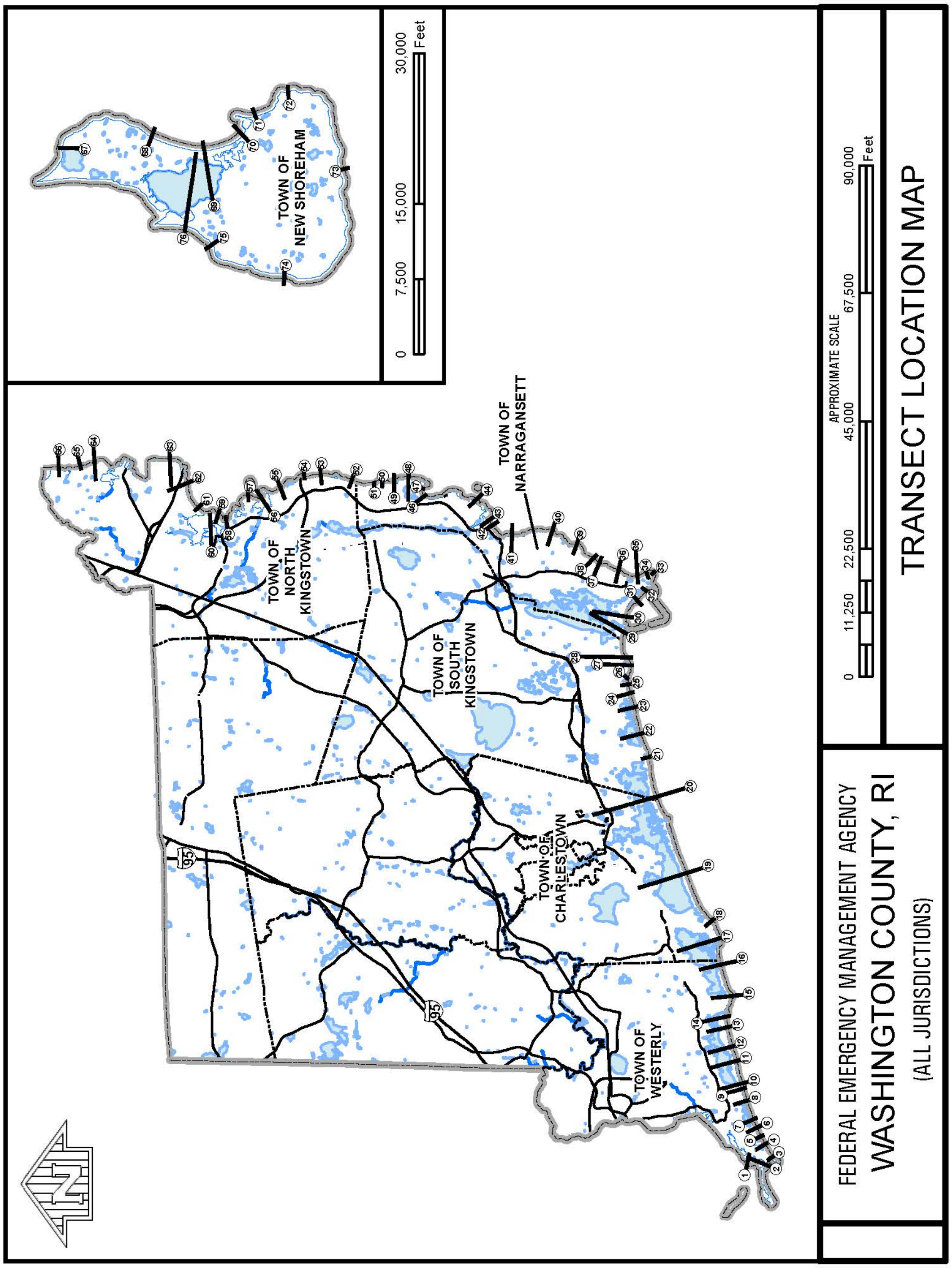
Flood Source	Coastal Transect	Starting Wave Conditions for the 1% Annual Chance		Starting Stillwater Elevations (ft NAVD88) Range of Stillwater Elevations (ft NAVD88)				
		Significant Wave Height H_s (ft)	Peak Wave Period T_p (sec)	10% Annual Chance	4% Annual Chance	2% Annual Chance	1% Annual Chance	0.2% Annual Chance
Block Island Sound	17	13.24	7.26	5.1	*	8.0	10.1	19.0
Block Island Sound	18	13.24	7.26	5.1	*	8.0	10.1	19.1
Block Island Sound	19	13.24	7.26	5.1	*	8.0	10.1	19.1
Block Island Sound	20	13.24	7.26	5.2	*	8.1	10.2	19.3
Block Island Sound	21	13.24	7.26	5.2	*	8.1	10.3	19.3
Block Island Sound	22	13.24	7.26	5.2	*	8.1	10.3	19.4
Block Island Sound	23	13.24	7.26	5.2	*	8.1	10.3	19.4
Block Island Sound	24	13.24	7.26	5.2	*	8.1	10.3	19.4
Block Island Sound	25	13.24	7.26	5.2	*	8.1	10.3	19.5
Block Island Sound	26	13.24	7.26	5.2	*	8.1	10.3	19.5
Block Island Sound	27	13.24	7.26	5.2	*	8.1	10.3	19.5
Block Island Sound	28	13.24	7.26	5.2	*	8.2	10.3	19.5
Block Island Sound	29	13.24	7.26	5.2	*	8.2	10.4	19.5
Block Island Sound	30	13.24	7.26	5.3	*	8.2	10.4	19.6
Block Island Sound	31	13.24	7.26	5.3	*	8.2	10.4	19.6
Block Island Sound	32	13.24	7.26	5.3	*	8.2	10.4	19.6
Block Island Sound	33	14.78	7.53	5.3	*	8.2	10.4	19.6
Rhode Island Sound	34	14.78	7.53	5.3	*	8.2	10.4	19.6

Flood Source	Coastal Transect	Starting Wave Conditions for the 1% Annual Chance		Starting Stillwater Elevations (ft NAVD88) Range of Stillwater Elevations (ft NAVD88)				
		Significant Wave Height H_s (ft)	Peak Wave Period T_p (sec)	10% Annual Chance	4% Annual Chance	2% Annual Chance	1% Annual Chance	0.2% Annual Chance
Rhode Island Sound	35	14.78	7.53	5.3	*	8.2	10.4	19.6
Rhode Island Sound	36	14.78	7.53	5.3	*	8.2	10.4	19.6
Rhode Island Sound	37	14.78	7.53	5.3	*	8.2	10.4	19.6
Rhode Island Sound	38	14.78	7.53	5.3	*	8.2	10.4	19.7
Rhode Island Sound	39	14.78	7.53	5.3	*	8.2	10.4	19.7
Rhode Island Sound	40	14.78	7.53	5.3	*	8.2	10.4	19.7
Rhode Island Sound	41	14.78	7.53	5.3	*	8.2	10.4	19.7
Rhode Island Sound	42	14.78	7.53	5.3	*	8.3	10.5	19.8
Rhode Island Sound	43	14.78	7.53	5.3	*	8.3	10.5	19.8
Rhode Island Sound	44	14.78	7.53	5.3	*	8.3	10.5	19.9
Narragansett Bay	45	8.53	3.30	5.3	*	8.3	10.5	19.9
Narragansett Bay	46	11.61	10.00	5.3	*	8.3	10.5	20.0
Narragansett Bay	47	8.83	10.00	5.3	*	8.3	10.5	20.0
Narragansett Bay	48	13.16	3.30	5.3	*	8.3	10.5	20.0
Narragansett Bay	49	5.68	10.00	5.3	*	8.3	10.6	20.0
Narragansett Bay	50	8.01	3.30	5.3	*	8.3	10.6	20.0
Narragansett Bay	51	4.30	10.00	5.4	*	8.3	10.6	20.0
Narragansett Bay	52	6.46	9.10	5.4	*	8.4	10.6	20.1

Flood Source	Coastal Transect	Starting Wave Conditions for the 1% Annual Chance		Starting Stillwater Elevations (ft NAVD88) Range of Stillwater Elevations (ft NAVD88)				
		Significant Wave Height H_s (ft)	Peak Wave Period T_p (sec)	10% Annual Chance	4% Annual Chance	2% Annual Chance	1% Annual Chance	0.2% Annual Chance
Narragansett Bay	53	6.56	9.10	5.4	*	8.5	10.7	20.4
Narragansett Bay	54	6.56	9.10	5.5	*	8.5	10.8	20.5
Narragansett Bay	55	6.56	9.10	5.5	*	8.6	10.9	20.8
Narragansett Bay	56	6.56	9.10	5.6	*	8.7	11.0	20.9
Narragansett Bay	57	6.56	9.10	5.6	*	8.8	11.1	21.1
Narragansett Bay	58	6.56	9.10	5.7	*	8.9	11.2	21.3
Narragansett Bay	59	6.56	9.10	5.7	*	8.9	11.3	21.4
Narragansett Bay	60	6.56	9.10	5.7	*	8.9	11.3	21.4
Narragansett Bay	61	6.56	9.10	5.8	*	9.0	11.4	21.6
Narragansett Bay	62	6.56	9.10	5.8	*	9.0	11.4	21.7
Narragansett Bay	63	4.53	3.30	5.8	*	9.1	11.5	21.8
Narragansett Bay	64	3.18	3.30	6.0	*	9.4	11.9	22.5
Narragansett Bay	65	4.43	5.60	6.1	*	9.4	12.0	22.7
Narragansett Bay	66	3.94	5.60	6.1	*	9.5	12.1	22.9
Narragansett Bay	67	12.97	7.21	5.1	*	7.1	8.0	10.5
Narragansett Bay	68	12.97	7.21	5.1	*	7.1	8.0	10.5
Narragansett Bay	69	12.97	7.21	5.1	*	7.1	8.0	10.5
Narragansett Bay	70	12.97	7.21	5.1	*	7.1	8.0	10.5

Flood Source	Coastal Transect	Starting Wave Conditions for the 1% Annual Chance		Starting Stillwater Elevations (ft NAVD88) Range of Stillwater Elevations (ft NAVD88)				
		Significant Wave Height H_s (ft)	Peak Wave Period T_p (sec)	10% Annual Chance	4% Annual Chance	2% Annual Chance	1% Annual Chance	0.2% Annual Chance
Atlantic Ocean	71	12.97	7.21	5.1	*	7.1	8.0	10.5
Atlantic Ocean	72	12.97	7.21	5.1	*	7.1	8.0	10.5
Atlantic Ocean	73	12.97	7.21	5.1	*	7.1	8.0	10.5
Block Island Sound	74	12.97	7.21	5.1	*	6.9	7.9	10.2
Block Island Sound	75	12.97	7.21	5.1	*	6.9	7.9	10.2
Block Island Sound	76	12.97	7.21	5.1	*	6.9	7.9	10.2

Figure 9: Transect Location Map



5.4 Alluvial Fan Analyses

This section is not applicable to this Flood Risk Project.

Table 17: Summary of Alluvial Fan Analyses

[Not Applicable to this Flood Risk Project]

Table 18: Results of Alluvial Fan Analyses

[Not Applicable to this Flood Risk Project]

SECTION 6.0 – MAPPING METHODS

6.1 Vertical and Horizontal Control

All FIS Reports and FIRMs are referenced to a specific vertical datum. The vertical datum provides a starting point against which flood, ground, and structure elevations can be referenced and compared. Until recently, the standard vertical datum used for newly created or revised FIS Reports and FIRMs was the National Geodetic Vertical Datum of 1929 (NGVD29). With the completion of the North American Vertical Datum of 1988 (NAVD88), many FIS Reports and FIRMs are now prepared using NAVD88 as the referenced vertical datum.

Flood elevations shown in this FIS Report and on the FIRMs are referenced to NAVD88. These flood elevations must be compared to structure and ground elevations referenced to the same vertical datum. For information regarding conversion between NGVD29 and NAVD88 or other datum conversion, visit the National Geodetic Survey website at www.ngs.noaa.gov, or contact the National Geodetic Survey (NGS) at the following address:

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

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 archived project documentation associated with the FIS Report and the FIRMs for this community. Interested individuals may contact FEMA to access these data.

To obtain current elevation, description, and/or location information for benchmarks in the area, please contact information services Branch of the NGS at (301) 713-3242, or visit their website at www.ngs.noaa.gov.

The datum conversion locations and values that were calculated for Washington County are provided in Table 19.

Table 19: Countywide Vertical Datum Conversion

Quadrangle Name	Quadrangle Corner	Latitude	Longitude	Conversion from NGVD29 to NAVD88 (feet)
All in Washington County	-	-	-	-0.9
Average Conversion from NGVD29 to NAVD88 = -0.9 feet				

Table 20: Stream-Based Vertical Datum Conversion

[Not Applicable to this Flood Risk Project]

6.2 Base Map

The FIRMs and FIS Report for this project have been produced in a digital format. The flood hazard information was converted to a Geographic Information System (GIS) format that meets FEMA's FIRM database specifications and geographic information standards. This information is provided in a digital format so that it can be incorporated into a local GIS and be accessed more easily by the community. The FIRM Database includes most of the tabular information contained in the FIS Report in such a way that the data can be associated with pertinent spatial features. For example, the information contained in the Floodway Data table and Flood Profiles can be linked to the cross sections that are shown on the FIRMs. Additional information about the FIRM Database and its contents can be found in FEMA's *Guidelines and Standards for Flood Risk Analysis and Mapping*, www.fema.gov/guidelines-and-standards-flood-risk-analysis-and-mapping.

Base map information shown on the FIRM was derived from the sources described in Table 21.

Table 21: Base Map Sources

Data Type	Data Provider	Data Date	Data Scale	Data Description
Digital Orthophoto	Rhode Island GIS	2003, 2004	1:5,000	Orthoimagery used for original countywide study
Digital Orthophoto	USGS	2011	1:300	Orthoimagery used for 2013 coastal update
Digital Orthophoto	USGS	2016	1:600	Orthoimagery used for 2020 riverine update
Political Boundaries	Rhode Island GIS, USGS	2005	1:24,000	Municipal and county boundaries
Surface Water Features	Rhode Island GIS, USGS	2005	1:24,000	Streams, rivers, and lakes
Transportation Features	Rhode Island GIS, US Census	2006	1:100,000	Roads and railroads
Coastal Barrier Resources System (CBRS)	U.S. Fish and Wildlife Service	1990	1:24,000	Coastal Barrier Resources System boundaries

6.3 Floodplain and Floodway Delineation

The FIRM shows tints, screens, and symbols to indicate floodplains and floodways as well as the locations of selected cross sections used in the hydraulic analyses and floodway computations.

For riverine flooding sources, the mapped floodplain boundaries shown on the FIRM have been delineated using the flood elevations determined at each cross section; between cross sections, the boundaries were interpolated using the topographic elevation data described in Table 22. For each coastal flooding source studied as part of this FIS Report, the mapped floodplain boundaries on the FIRM have been delineated using the flood and wave elevations determined at each transect; between transects, boundaries were delineated using land use and land cover data, the topographic elevation data described in Table 22, and knowledge of coastal flood processes. In ponding areas, flood elevations were determined at each junction of the model; between junctions, boundaries were interpolated using the topographic elevation data described in Table 22.

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

The floodway widths presented in this FIS Report and on the FIRM were computed for certain stream segments on the basis of equal conveyance reduction from each side of the floodplain. Floodway widths were computed at cross sections. Between cross sections, the floodway boundaries were interpolated. Table 2 indicates the flooding sources for which floodways have been determined. The results of the floodway computations for those flooding sources have been tabulated for selected cross sections and are shown in Table 23, "Floodway Data."

Certain flooding sources may have been studied that do not have published BFEs on the FIRMs, or for which there is a need to report the 1% annual chance flood elevations at selected cross sections because a published Flood Profile does not exist in this FIS Report. These streams may have also been studied using methods to determine non-encroachment zones rather than floodways. For these flooding sources, the 1% annual chance floodplain boundaries have been delineated using the flood elevations determined at each cross section; between cross sections, the boundaries were interpolated using the topographic elevation data described in Table 22. All topographic data used for modeling or mapping has been converted as necessary to NAVD88. The 1% annual chance elevations for selected cross sections along these flooding sources, along with their non-encroachment widths, if calculated, are shown in Table 24, "Flood Hazard and Non-Encroachment Data for Selected Streams."

Table 22: Summary of Topographic Elevation Data used in Mapping

		Source for Topographic Elevation Data					
Community	Flooding Source	Description	Scale	Contour Interval	$RMSE_z$	$Accuracy_z$	Citation
Charlestown, Town of; Exeter, Town of; Hopkinton, Town of; Narragansett, Town of; Narragansett Indian Tribe; North Kingstown, Town of; Richmond, Town of; South Kingstown, Town of; Westerly, Town of	Ashaway River, Beaver River, Chipuxet River, Green Fall River, Pawcatuck River, Queen River, Usquepaug River, Wood River, other flooding sources in Pawcatuck-Wood Watershed	2011 lidar data for Northeast	-	2 ft	10 cm		

BFEs shown at cross sections on the FIRM represent the 1% annual chance water surface elevations shown on the Flood Profiles and in the Floodway Data tables in the FIS Report. Rounded whole-foot elevations may be shown on the FIRM in coastal areas, areas of ponding, and other areas with static base flood elevations.