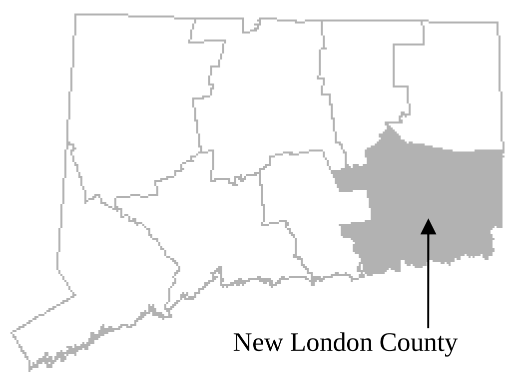
FLOOD INSURANCE STUDY

NEW LONDON COUNTY, CONNECTICUT (ALL JURISDICTIONS)

Volume 1 of 4



COMMUNITY NAME	COMMUNITY NUMBER
BOZRAH, TOWN OF	090094
COLCHESTER, TOWN OF	090095
EAST LYME, TOWN OF	090096
FRANKLIN, TOWN OF	090154
GRISWOLD, TOWN OF	090173
GROTON LONG POINT ASSOCIATION	090167
GROTON, CITY OF	090126
GROTON, TOWN OF	090097
JEWETT CITY, BOROUGH OF	090098
LEBANON, TOWN OF	090155
LEDYARD, TOWN OF	090157
LISBON, TOWN OF	090172
LYME, TOWN OF	090127
MONTVILLE, TOWN OF	090099
NEW LONDON, CITY OF	090100
NOANK FIRE DISTRICT	090129
NORTH STONINGTON, TOWN OF	090101
NORWICH, CITY OF	090102
OLD LYME, TOWN OF	090103
PRESTON, TOWN OF	090139
SALEM, TOWN OF	090156
SPRAGUE, TOWN OF	090105
STONINGTON, BOROUGH OF	090193
STONINGTON, TOWN OF	090106
VOLUNTOWN, TOWN OF	090143
WATERFORD, TOWN OF	090107

Revised:
August 5, 2013

Federal Emergency Management Agency

FLOOD INSURANCE STUDY NUMBER
09011CV001B

NOTICE TO
FLOOD INSURANCE STUDY USERS

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

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

Initial Countywide FIS Effective Date: July 18, 2011

Revised Countywide FIS Date: August 5, 2013

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EXHIBITS – continued

Exhibit 1 - Flood Profiles - continued

FLOOD INSURANCE STUDY
NEW LONDON COUNTY, CONNECTICUT (ALL JURISDICTIONS)

1.0 INTRODUCTION

1.1 Purpose of Study

This Flood Insurance Study (FIS) revises and supersedes the FIS reports and/or Flood Insurance Rate Maps (FIRMs) in the geographic area of New London County, including the Cities of Groton, New London and Norwich, the Towns of Bozrah, Colchester, East Lyme, Franklin, Griswold, Groton, Lebanon, Ledyard, Lisbon, Lyme, Montville, North Stonington, Old Lyme, Preston, Salem, Sprague, Stonington, Voluntown, and Waterford, the political subdivisions of Noank Fire District, and Groton Long Point Association, and the Boroughs of Jewett City and Stonington (referred to collectively herein as New London County), and aids in the administration of the National Flood Insurance Act of 1968 and the Flood Disaster Protection Act of 1973. The Pequot Indian Reservation is also labeled on the FIRMs. This study has developed flood-risk data for various areas of the county that will be used to establish actuarial flood insurance rates. This information will also be used by the communities of New London County to update existing floodplain regulations as part of the Regular Phase of the National Flood Insurance Program (NFIP), and by local and regional planners to further promote sound land use and floodplain development. Minimum floodplain management requirements for participation in NFIP are set forth in the Code of Federal Regulations at 44 CFR, 60.3.

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

1.2 Authority and Acknowledgments

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

The July 18, 2011 Countywide FIS was prepared to incorporate all the communities within New London County in a countywide format. Information on the authority and acknowledgements for each jurisdiction included in this countywide FIS, as compiled from their previously printed FIS reports and FIS Supplement-Wave Height Analysis Reports, is shown below:

Bozrah, Town of: In the original March 30, 1981 study, the hydrologic and hydraulic analyses were prepared by the U.S. Army Corps of Engineers (USACE) for the Federal Insurance Administration (FIA), under Inter-Agency Agreement No. IAA-H-9-79. That work was completed in March 1980.

In the 1995 revision, the hydrologic and hydraulic analyses for the Yantic River were prepared by Roald Haestad, Inc., for the Federal Emergency Management Agency (FEMA), under Contract No. EMW-90-C-3126. This work was completed in December 1992. Additional hydrologic and hydraulic analyses were prepared by Roald Haestad, Inc., during the preparation of the FIS for the City of Norwich. That work was completed in March 1992.

Colchester, Town of: In the original December 15, 1981 study and June 15, 1982 FIRM, the hydrologic and hydraulic analyses were prepared by the U.S. Geological Survey (USGS) for the FIA, under Inter-Agency Agreement No. IAA-H-14-78. That work was completed in March 1980.

In the July 15, 1992 revised study, hydrologic and hydraulic analyses for Meadow Brook and Day Meadow Brook were prepared by the USGS for the Federal Emergency Management Agency (FEMA) under Inter-Agency Agreement No. EMW-87-E-2764, Project Order No. 1. This study was completed in December 1990.

For the June 4, 1996 revision, the hydrologic and hydraulic analyses for Judd Brook were taken from the precountywide FIS for the Borough of Colchester.

East Lyme, Town of: For the December 15, 1980 study, the hydrologic and hydraulic analyses were prepared by James P. Purcell Associates, Inc., for the FIA, under Contract No. H-4561. That work was completed in March 1979.

The wave height analysis, dated December 15, 1983, was prepared by Dewberry & Davis for

East Lyme, Town of: - continued	the FEMA, under Contract No. EMW-C-0543. That work was completed in January 1982. For the June 16, 1992 revision, the hydrologic and hydraulic analyses were prepared by Green International Affiliates, Inc., for FEMA, under Contract No. EMW-93-C-4144 This work was completed in January 1994.
Franklin, Town of	The hydrologic and hydraulic analyses for the 1981 study were prepared by the USACE, New England Division for the FIA, under Inter-Agency Agreement NO. IAA-H-9-79. This work was completed in May 1980.
Griswold, Town of:	The hydrologic and hydraulic analyses for the 1983 study were completed by Dewberry & Davis, a technical evaluation contractor, for FEMA, under Contract No. EMW-C-0543. This work was completed in May 1983.
Groton, City of:	The wave height analysis for this study was prepared by Dewberry & Davis for FEMA, under Contract No. EMW-C-0543. This work was completed in March 1983.
Groton Long Point Association:	The wave height analysis for this study was prepared by Dewberry & Davis for FEMA. This work was completed in March 1982.
Groton, Town of:	The hydrologic and hydraulic analyses in the February 15, 1984 study represent a revision of the original analyses by the USACE for FEMA, under Inter-Agency Agreement No. lAA-H-2-73, project Order 1, and lAA-H-19-74, project Order 22. The updated riverine analysis was prepared by James P. Purcell Associates, Inc., under agreement with FEMA. The updated riverine analysis was completed in March 1979. The wave height analysis for this study was prepared by Dewberry & Davis for FEMA, under Contract No. EMW-C0543. This work was completed in March 1983.
Jewett City, Borough of:	The hydrologic and hydraulic analyses for the 1984 study were prepared by Dewberry & Davis, taken from the FIS for the Town of Griswold, Connecticut, for FEMA under

Jewett City, Borough of: - continued	Contract No. EMW-C-0968. This work was completed in May 1983.
Lebanon, Town of:	The hydrologic and hydraulic analyses for the 1988 study were prepared by the USGS for FEMA, under Inter-Agency Agreement No. EMW-85-E-1823, Project Order No. 20. This work was completed in December 1986.
Ledyard, Town of:	The hydrologic and hydraulic analyses for the 1980 study were prepared by Luchs and Beckerman for the FIA, under Contract No. H-4725. This study was completed in April 1979.
Lisbon, Town of:	The hydrologic and hydraulic analyses for the 1984 study were completed by Dewberry & Davis, a technical evaluation contractor, for FEMA, under Contract No. EMW-C-0543. This work was completed in April 1983.
Lyme, Town of:	The hydrologic and hydraulic analyses for the 1978 study were performed by the Soil Conservation Service (SCS NRSC), Storrs, Connecticut, for the FIA, under Inter-Agency Agreement No. IAA-H-9-76, Project Order No. 1. This work, which was completed in November 1976, covered all flooding sources affecting the Town of Lyme, with the exception of Uncas Pond and Norwich Pond, which were determined to be Zone A in December 1976, by Dames and Foore, under Contract to FIA.
Montville, Town of:	In the original January 1980 study, the hydrologic and hydraulic analyses were prepared by James P. Purcell Associates, Inc., for the FIA, under Contract No. H-4561. That work was completed in March 1979. In the December 5, 1995 revision, the hydrologic and hydraulic analyses for Latimer Brook were prepared by Green International Affiliates, Inc., for FEMA, under Contract No. EMW-93-C-4144. This work was completed in February 1994. The hydrologic and hydraulic analyses for Trading Cove Brook were obtained from the March 1994 study for the City of Norwich.

New London, City of	The wave height analysis for this study was prepared by Dewberry & Davis for FEMA, under Contract No. EMW-C-0543. This work was completed in March 1983.
Noank Fire District	The wave height analysis for this study was prepared by Dewberry & Davis for FEMA, under Contract No. EMW-C-0543. This work was completed in December 1982.
North Stonington, Town of:	The hydrologic and hydraulic analyses for the 1984 study were completed by Dewberry & Davis, a technical evaluation contractor, for FEMA under Contract No. EMW-H-4833. This work was completed in August 1983.
Norwich, City of:	The hydrologic and hydraulic analyses for the June 15, 1978 study were prepared by Anderson-Nichols and Company, Inc., for FEMA, under Contract No. H-3862. In the November 1, 1985 revision, the updated analyses for the Thames and Yantic Rivers were prepared by Dewberry & Davis under agreement with FEMA. That revised study was completed in July 1984. In the April 15, 1992 revision updated information for the Shetucket River was prepared by the USGS for FEMA under Inter-Agency Agreement No. EMM-86-E-2224, Project Order No. 1. That work was completed in December 1989. In the 1994 revision, the hydrologic and hydraulic analyses for the streams studied by detailed methods were prepared by Roald Haestad, Inc., for FEMA, under Inter-Agency Agreement No. EMW-90-C-3126. That work was completed in March 1992.
Old Lyme, Town of	The wave height analysis for this study was prepared by Dewberry & Davis for FEMA, under Contract No. EMW-C-0543. This work was completed in February 1983.
Preston, Town of:	The hydrologic and hydraulic analyses for the 1984 study were completed by Dewberry & Davis, a technical evaluation contractor, for FEMA, under Contract No. EMW-C-0543. This work was completed in April 1983.

Salem, Town of:	The hydrologic and hydraulic analyses for the 1981 study were prepared by the USACE for FEMA, under Inter-Agency Agreement No. IAA-H-9-79. This work was completed in January 1980.
Sprague, Town of:	The hydrologic and hydraulic analyses for the 1984 study were completed by Dewberry & Davis, a technical evaluation contractor, for FEMA, under Contract No. EMW-C-0543. This work was completed in July 1983.
Stonington, Borough of	The wave height analysis for this study was prepared by Dewberry & Davis for FEMA, under Contract NO. W-C-0543. This work was completed in November 1982.
Stonington, Town of	The wave height analysis for this study was prepared by Dewberry & Davis for FEMA, under Contract No. EMW-C-0543. This work was completed in January 1983.
Voluntown, Town of:	The hydrologic and hydraulic analyses for the 1984 study were prepared by the USGS for the FEMA, under Inter-Agency Agreement No. EMU-85-E-1823, Project Order No. 20. This work was completed in September 1985.
Waterford, Town of:	The hydrologic and hydraulic analyses for the February 4, 1981 study were prepared by James P. Purcell Associates, Inc., for FEMA, under Contract No. H-4561. The work for the original study was completed in March 1979. The hydrologic and hydraulic analyses, including wave height analysis, in the September 5, 1990 revision were prepared by the USACE, New England Division, for FEMA, under Inter-Agency Agreement No. EMW-E-0941, Project Order No. 1, Amendment No. 26. The work for this revision was completed in August 1987.

For the July 18, 2011 countywide FIS, redelineation of coastal flood hazard data was performed for open water flooding sources in the Town of East Lyme, City of Groton, Groton Long Point Association, Town of Groton, Noank Fire District, Town of Old Lyme, City of New London, Borough of Stonington, Town of Stonington and Town of Waterford. It was prepared by CDM for FEMA, under Contract No. EME-2003-CO-

0340, and by Ocean and Coastal Consultants, Inc. for CDM, under Contract No. 2809-999-003-CS.

Base map information shown on the original countywide FIRM was derived from digital orthophotography. Base map files were provided in digital form by the Connecticut Department of Environmental Protection. Ortho imagery was produced at a scale of 1:12,000. Aerial photography is dated 2000, 2004 and 2005. The projection used in the preparation of this map was Connecticut State Plane zone (FIPSZONE0600). The horizontal datum was NAD83, GRS1980 spheroid.

August 2013 Coastal Study Update

The coastal wave height analysis for this countywide coastal study was prepared by the Strategic Alliance for Risk Reduction (STARR) for FEMA under Contract No. HSFEHQ-09-D-0370 and completed in July 2011. This new analysis resulted in revisions to the FIRM for the Town of East Lyme, City of Groton, Groton Long Point Association, Town of Groton, Noank Fire District, Town of Old Lyme, City of New London, Borough of Stonington, Town of Stonington and Town of Waterford.

Base map information shown on FIRM panels produced for this revision was derived from digital orthophotography. Base map files were provided in digital form by the Connecticut Department of Environmental Protection. Ortho imagery was produced at a scale of 1:12,000. Aerial photography is dated 2000, 2004 and 2005. The projection used in the preparation of this map was Connecticut State Plane Feet zone (FIPSZONE0600). The horizontal datum was NAD83, GRS1980 spheroid.

1.3 Coordination

The purpose of an initial Consultation Coordination Officer's (CCO) meeting is to discuss the scope of the FIS. A final meeting is held to review the results of the study.

The dates of the initial, intermediate and final CCO meetings held for the incorporated communities within New London County are shown in Table 1, "CCO Meeting Dates for Precountywide FIS."

TABLE 1 – CCO MEETING DATES FOR PRECOUNTYWIDE FIS

Community Name	Initial CCO Date	Intermediate CCO Date	Final CCO Date
Town of Bozrah	August 3, 1992	*	*
Town of Colchester	July 18, 1988	*	*
Town of East Lyme	*	*	November 18,1994
Town of Franklin	November 1978	*	January 29, 1981
Town of Griswold	March 19, 1978	November 26, 1980	October 20, 1983
Town of Groton	June 8, 1977	January 11, 1979	April 19, 1983
Groton Long Point Association	*	*	September 30, 1981
City of Groton	*	*	April 20, 1983

*Data not available

TABLE 1 – CCO MEETING DATES FOR PRECOUNTYWIDE FIS - continued

Community Name	Initial CCO Date	Intermediate CCO Date	Final CCO Date
Borough of Jewett City	*	*	March 28, 1984
Town of Lebanon	February 5, 1985	December 1986	May 7, 1987
Town of Ledyard	March 22, 1978	*	May 1, 1980
Town of Lisbon	May 12, 1978	November 25, 1980	October 20, 1983
Town of Lyme	March 1975	November 1975	November 3, 1976
Town of Montville	July 15, 1993	*	November 18, 1994
City of New London	*	*	*
Noank Fire District	*	*	January 14, 1983
Town of North Stonington	April 13, 1978	March 5, 1980	April 26, 1984
City of Norwich	April 21, 1992	*	*
Town of Old Lyme	*	*	March 30, 1983
Town of Preston	April 14, 1978	November 25, 1980	October 19, 1983
Town of Salem	November 1978	*	March 24, 1981
Town of Sprague	April 13, 1978	December 9, 1980	October 20, 1983
Town of Stonington	*	*	February 25, 1983
Borough of Stonington	*	*	January 13, 1983
Town of Voluntown	February 5, 1985	December 1986	May 7, 1987
Town of Waterford	May 1, 1985	*	May 31, 1989

*Data not available

For the July 18, 2011 Countywide FIS, the initial CCO meetings were held on October 24 and 25 of 2006 and were attended by representatives of FEMA, USACE, Connecticut Department of Transportation (DOT), Southeastern Connecticut Council of Governments (SCCOG), Connecticut Department of Environmental Protection (DEP), University of Connecticut (UCONN), Natural Resources Conservation Service (NRCS), CDM, and New London County communities.

The results of the July 18, 2011 study were reviewed at the final CCO meeting held on Wednesday, July 15, 2009, and attended by representatives of Town of Montville, Town of Colchester, Town of Lebanon, Town of East Lyme, Town of Salem, Town of Preston, Groton Long Point Association, Town of Waterford, Town of Groton, City of Norwich, Town of North Stonington, Town of Griswold, City of New London, Town of Old Lyme, Town of Sprague, Town of Franklin and Town of Voluntown. All problems raised at that meeting have been addressed in the July 18, 2011 study.

For this 2013 coastal study revision, letters were sent to all communities within the county notifying them of the scope of the FIS, and soliciting pertinent information from them. Letters were mailed on April 28, 2010. The results of this countywide study were reviewed at the final CCO meetings held on January 17, 2012, and attended by representatives of the communities, the Connecticut Department of Energy and Environmental Protection (DEEP), FEMA Regional Service Center (RSC), FEMA, and STARR. All problems raised at that meeting were addressed in this study.

2.0 AREA STUDIED

2.1 Scope of Study

This FIS report covers the geographic area of New London, Connecticut. The areas studied by detailed methods were selected with priority given to all known flood hazards and areas of projected development or proposed construction.

July 18, 2011 Countywide FIS:

All or portions of the flooding sources listed in Table 2 were studied by detailed methods.

TABLE 2 – FLOODING SOURCES STUDIED BY DETAILED METHODS

Flooding Source Name	Description of Study Reaches
Amston Lake	For the entire shoreline within the Town of Lebanon
Beaver Brook (Town of Lyme)	From its confluence with Eight Mile River to approximately 6,075 feet upstream of Route 156
Beaver Brook (Town of Sprague)	From its confluence with the Shetucket River to the Sprague-Franklin corporate limits
Birch Plain Creek	From its confluence with Baker Cove to just upstream of the Town of Groton-City of Groton corporate limits
Blissville Brook	From its confluence with the Shetucket River to approximately 400 feet upstream of Ames Road
Bobbin Mill Brook	From its confluence with the Yantic River to just upstream of Scotland Road in the City of Norwich
Connecticut River	Storm tides from Long Island Sound that affect Connecticut River in the Town of Lyme
Day Meadow Brook	From River Road to a point approximately 3,800 feet upstream (near State Route 2)
Denison Brook	From State Route 138 to Fish Road
East Branch Eight Mile River	From approximately 900 feet downstream of Darling Road to the confluence of Harris Brook

TABLE 2 – FLOODING SOURCES STUDIED BY DETAILED METHODS – continued

Flooding Source Name	Description of Study Reaches
Eccleston Brook	From 4,800 feet upstream of State Route 215 to 6,150 feet upstream of State Route 215
Eight Mile River	From its confluence with the Connecticut River to just upstream of Route 156
Fishers Island Sound	*
Fishtown Brook	From Fishtown Road to U.S. Route 1
Flat Brook	From its confluence with Mill Cove to approximately 100 feet upstream of Baldwin Hill Road
Ford Brook	From its confluence with Trading Cove Brook to approximately 100 feet upstream of Newton Street
Fort Hill Brook	From Mumford Cove to Interstate 95
Fourmile River	From its confluence with Long Island Sound to Boston Post Road
Gardner Brook	From its confluence with the Yantic River to a point approximately 13,700 feet upstream
Glasgo Pond	Within the Town of Griswold
Goldmine Brook	From its confluence with Trading Cove Brook to approximately 100 feet upstream of Salem Turnpike
Great Meadow Brook	From its confluence with Pachaug River to approximately 4,850 feet upstream of Wyle School Road
Great Plain Brook	From its confluence with Trading Cove Brook to approximately 700 feet upstream of Norman Road

* Detailed study reaches for coastal areas are superseded by the August 2013 Coastal Study Update. See coastal sections for more information.

TABLE 2 – FLOODING SOURCES STUDIED BY DETAILED METHODS – continued

Flooding Source Name	Description of Study Reaches
Green Fall River	From 2,100 feet upstream of Wellstown Road in the Town of Hopkinton, Washington County, Rhode Island, to Clarks Falls Pond Dam
Harris Brook	From its confluence with East Branch Eight Mile River to approximately 4,500 feet upstream of dam
Hunter Brook	From the confluence with the Shetucket River to approximately 1,800 feet upstream of the second crossing of Hunters Road
Jeremy River	From 4,600 feet upstream of State Route 149 to Old Hartford Road
Joe Clark Brook	From its confluence with Poquetanuck Cove to a point approximately 7,600 feet upstream from the Preston-Ledyard corporate limits
Jordan Brook	From its confluence with Jordan Cove to approximately 1,600 feet upstream from Douglas Lane
Judd Brook	From Old Hebron Road to approximately 2,350 feet upstream of Norwich Avenue
Latimer Brook	From its confluence with Niantic River to approximately 400 feet upstream of Beckwith Road
Little River	From its confluence with the Shetucket River to approximately 2,750 feet upstream of State Route 138
Long Island Sound	*
Long Island Sound and Connecticut River	*
Long Island Sound and Thames River	*

* Detailed study reaches for coastal areas are superseded by the August 2013 Coastal Study Update. See coastal sections for more information.

TABLE 2 – FLOODING SOURCES STUDIED BY DETAILED METHODS – continued

Flooding Source Name	Description of Study Reaches
Meadow Brook	From its confluence with Jeremy River to a point approximately 3,250 feet upstream of State Route 16
Nevins Brook	From its confluence with Jordan Brook to approximately 4,950 feet upstream of Fog Plain Road
Niantic River	Within the Town of East Lyme
Norwichtown Brook	From its confluence with the Yantic River to approximately 550 feet upstream of Case Street
Oxoboxo Brook	From Horton Cove to Rockland Pond Dam
Pachaug Pond	Within the Town of Griswold
Pachaug River	From its confluence with Quinebaug River to its confluence with dam at Pachaug Pond
Pachaug River (Town of Voluntown)	From a point approximately 800 feet upstream of Carol Road to 5,000 feet upstream of Beach Pond Dam
Pattagansett River	From its confluence with Long Island Sound to Pattagansett Lake Dam
Pawcatuck River	From 31,000 feet upstream of the confluence with Little Narragansett Bay to the North Stonington, Connecticut-Hopkinton, Rhode Island boundary
Pine Swamp Brook	From its confluence with Thames River to approximately 1,300 feet upstream of Harvard Terrace
Poquetanuck Cove	From its confluence with the Thames River to the confluence of Joe Clark Brook
Quinebaug River	From its confluence with the Shetucket River to the Lisbon, New London County-Canterbury, Windham County boundary
Red Cedar Lake	For its entire length

TABLE 2 – FLOODING SOURCES STUDIED BY DETAILED METHODS – continued

Flooding Source Name	Description of Study Reaches
Shewville Brook	From 10,650 upstream of its confluence with Hewitt Brook to approximately 750 feet upstream of Shewville Road
Shetucket River	From 16,000 feet upstream of Route 2A to approximately 300 feetupstream of North Main Street in the Town of Sprague
Shunock River	From its confluence with the Pawcatuck River to approximately 5,200 feet upstream of Main Street
Spaulding Pond Brook	From its confluence with Shetucket River to approximately 150 feet upstream of dam
Susquetonscut Brook (Town of Franklin)	From 2,000 feet upstream of its confluence with the Yantic River to Champion Road
Susquetonscut Brook (Town of Lebanon)	From 15,000 feet upstream of its confluence with the Yantic River to Bender Road
Tenmile River	From its confluence with the Willimantic River upstream to Palmer Pond
Thames River and Shetucket River	From just downstream of the Town of Montville-City of Norwich corporate boundary to just upstream of its confluence with Yantic River
Trading Cove Brook	From its confluence with the Thames River to approximately 300 feet upstream of the confluence with Goldmine Brook
Tributary A	From its confluence with Birch Plain Creek approximately 2,070 feet upstream of Tower Road
Tributary B	From its confluence with the Yantic River to approximately 75 feet upstream of Mediterranean Lane
Tributary C	From its confluence with Shetucket River to approximately 60 feet upstream of the Main Street Culvert

TABLE 2 – FLOODING SOURCES STUDIED BY DETAILED METHODS – continued

Flooding Source Name	Description of Study Reaches
Tributary D	From its confluence with the Shetucket River to approximately 600 feet upstream of Saint Regis Avenue
Tributary E	Within the City of Norwich
Tributary F	From its confluence with Thames River to Albert Street
Whitford Brook (Town of Groton)	From its confluence with Mystic River to the Groton-Stonington corporate limits
Whitford Brook	From approximately 1,800 feet upstream of Lantern Hill Road to approximately 400 feet upstream of the second crossing of Lantern Hill Road
Williams Brook	From approximately 750 feet upstream of its confluence with Whitford Brook Swamp to approximately 4,950 feet upstream of Town Farm Drive
Williams Pond	For its entire length
Yantic River	From its confluence with Thames River to Sisson Road
Yantic River East Channel	From approximately 1,000 feet upstream of its confluence with the Thames River to approximately 3,700 feet upstream

Tributary E was studied in detail: however, no flooding is shown on the FIRM because the floodplains were less than 200 feet wide.

Approximate analyses were used to study those areas having a low development potential or minimal flood hazards. The scope and methods of study were proposed to, and agreed upon, by FEMA and the individual communities within New London County. For the July 18, 2011 countywide revision, no new approximate studies were executed. All or portions of the flooding sources listed in Table 3, “Flooding Sources Studied by Approximate Methods,” were studied by approximate methods in the precountywide FISs.

TABLE 3 – FLOODING SOURCES STUDIED BY APPROXIMATE METHODS

Flooding Source Name	Community
Adams Brook	Sprague
Amos Lake	Preston
Ashwillet Brook	North Stonington
Assekonk Brook	North Stonington
Avery Pond	Preston
Ayer Pond	Preston
Babcock Pond	Colchester
Bailey Pond	Voluntown
Baltic Reservoir	Sprague
Bartlett Brook	Lebanon
Bates Pond	Preston
Beaver Brook	East Lyme, Franklin
Beaver Dam Brook	East Lyme, Groton (Town)
Beebe Pond	Groton (Town)
Bentley Brook	Bozrah
Billings Avery Brook	Ledyard
Billing's Brook	Griswold
Bindloss Brook	Groton (Town)
Blissville Brook	Lisbon
Bog Meadow Reservoir	Norwich
Bogue Brook	Montville
Then Brandegee Lake	Waterford
Brewster Pond	Lebanon
Bride Brook	East Lyme
Broad Brook	Preston
Burton Brook	Griswold
Byron Brook	Norwich
Cabin Brook	Colchester
Cedar Swamp	Preston, Voluntown
Choate Brook	Preston
Church Brook	Waterford
Clayville Pond	Griswold
Cold Brook	Franklin
Cold Brook	Norwich
Cooks Pond	Preston
Cote Pond	Norwich
Cranberry Meadow Brook	East Lyme
Crooked Brook	Griswold
Crowley Brook	Preston
Dawley Pond	Voluntown
Deep Hollow Brook	Montville
Deep River	Lebanon
Deep River Reservoir	Colchester
Denison Brook	Voluntown
Dickinson Creek	Colchester

TABLE 3 – FLOODING SOURCES STUDIED BY APPROXIMATE METHODS - continued

Flooding Source Name	Community
Doaneville Pond	Griswold
Douglas Swamp	Voluntown
East Branch Eight Mile River	Lyme, Salem
Eccleston Brook (upper portions)	Groton (Town)
Elisha Brook	Norwich
Exeter Brook	Lebanon
Fairview Reservoir	Norwich
Falls Brook	Montville
Fenger Brook	Waterford
Fishtown Brook (upper portions)	Groton (Town)
Folwix Brook	Preston
Fort Hill Brook (upper portions)	Groton (Town)
Fox Brook	Montville
Gagers Pond	Franklin
Gardner Lake	Bozrah
Gay Pond	Preston
Glade Brook	North Stonington
Goldmine Brook	Norwich
Grassy Hill Brook	Lyme
Great Brook	Groton (Town)
Great Meadow Brook	Voluntown
Green Fall Pond	Voluntown
Green Fall River	Voluntown
Green Swamp Brook	Waterford
Haleys Brook	Ledyard, Groton (Town)
Hall Brook	Colchester, Lebanon
Hallville Pond	Preston
Hampstead Brook	Groton (Town)
Hanover Reservoir	Sprague
Harris Brook	Salem
Hatching House Brook	Groton (Town)
Havey Brook	Griswold
Hazard Pond	Voluntown
Hetchel Swamp Brook	North Stonington
Hewitt Brook	Preston
Hunts Brook	Montville, Waterford
Indiantown Brook	Ledyard, Preston
Jeremy River	Colchester
Jordan Brook	Lebanon
Judd Brook	Colchester
Kahn pond and adjacent pond areas	Franklin
Koistenen Brook	Voluntown
Lake of Isles Brook	North Stonington, Preston
Lakes Pond Brook	Waterford
Lantern Hill Brook	Ledyard
Lantern Hill Pond	North Stonington

TABLE 3 – FLOODING SOURCES STUDIED BY APPROXIMATE METHODS - continued

Flooding Source Name	Community
Latimer Brook	Montville, Salem
Ledyard Lake	Ledyard
Lee Brook	Ledyard
Lewis Pond	Preston
Lisbon Brook	Lisbon
Lowden Brook	Voluntown
Main Brook	North Stonington, Preston
McAlpine Brook	Montville
McCarthy Brook (NE of Baltic Road)	Franklin
Meadow Brook	Colchester
Mill Brook	Griswold
Miller Brook	North Stonington, Preston
Mineral Spring Brook	Bozrah
Mohegan Brook	Montville
Morgan Pond	Ledyard
Mount Misery Brook	Voluntown
Mountain Brook	Franklin
Myers Brook	Preston
Myron Kinney Brook	Voluntown
Nelkin Brook	Colchester
Norwich Pond	Lyme
Norwichtown Brook	Norwich
Oil Mill Brook	Waterford
Papermill Pond	Sprague
Pattagansett River	East Lyme
Pease Brook	Franklin, Lebanon
Pendleton Hill Brook	North Stonington
Phelps Brook	North Stonington
Pine Brook	Colchester
Poquetanuck Brook	Preston
Prentice Brook	North Stonington
Rattlesnake Brook	Griswold, Preston
Red Brook	East Lyme
Red Brook	Ledyard, Groton (Town)
Roaring Brook	Lyme
Rogers Lake	Lyme
Rosemond Lake	Ledyard
Round Brook	Bozrah
Salmon River	Colchester
Savin Lake	Lebanon
Sheep Barn Brook	Griswold
Sherman Brook	Lebanon
Shetucket River	Sprague
Shewville Brook	Preston
Spaulding Pond Brook	Norwich
Spinnging Mill Brook	Lebanon

TABLE 3 – FLOODING SOURCES STUDIED BY APPROXIMATE METHODS - continued

Flooding Source Name	Community
Stone Hill Reservoir	Griswold
Stony Brook	Montville, Waterford
Susquetonscut Brook	Franklin
Swamp area along Hartshorn Brook	Franklin
Swamp area along Norwich Lebanon Road southeast of Brush Hill Road	Franklin
Swamp area at the southern end of Bellows Brook	Franklin
Swamp area northeast of the intersection of Champion Road and State Route 87	Franklin
Swamp area northeast of the intersection of Kahn Road and Blue Hill Road	Franklin
Swamp area south of Turkey Hill	Franklin
Tadman Pond	Bozrah
Taftville Reservoir	Norwich
Tenmile River	Lebanon
The Fourmile River	East Lyme
Thompson Brook	Ledyard
Trading Cove Brook	Bozrah, Montville
Tributary A (upper portions)	Groton (Town)
Uncas Pond	Lyme
West Branch Brook	Ledyard
West Branch Red Brook	Groton (Town)
Whalebone Creek	Lyme
Whittle Brook	Montville
Wood River	Voluntown
Wyassup Brook	North Stonington
Yantic River	Lebanon
Yawkucs Brook	North Stonington

No new detailed-studies were performed for the July 18, 2011 countywide FIS.

Detail-studied streams that were not re-studied as part of this revision may include a profile baseline on the FIRM. The profile baselines for these streams were based on the best available data at the time of their study and are depicted as they were on the previous FIRMs. In some cases the transferred profile baseline may deviate significantly from the channel or may be outside of the floodplain.

As part of the July 18, 2011 countywide FIS, redelineation of coastal flood hazard data was performed for open water flooding sources in the communities of Town of East Lyme, City of Groton, Groton Long Point Association, Town of Groton, Noank Fire District, Town of Old Lyme, City of New London, Borough of Stonington, Town of Stonington and Town of Waterford. It was prepared by CDM for FEMA, under Contract No. EME-2003-CO-0340, and by Ocean and Coastal Consultants, Inc. for CDM, under Contract No. 2809-999-003-CS. This study was completed July 11, 2008. This study has been superseded by the August 2013 Coastal Study Update.

The July 18, 2011 FIS also incorporates the determinations of letters issued by FEMA resulting in map changes (Letter of Map Revision [LOMR], Letter of Map Revision - based on Fill [LOMR-F], and Letter of Map Amendment [LOMA]), as shown in Table 4, "Letters of Map Change."

TABLE 4 – LETTERS OF MAP CHANGE

Community	Case Number	Flooding Source	Letter Date
East Lyme, Town of	93-01-003P	Niantic Bay	02/261993
Groton, Town of	96-01-051P	Haleys Brook, West Branch Red Brook	01/20/1997
East Lyme, Town of	97-01-051P	Pattagansett River	02/21/1999
Norwich, City of	03-01-077P	Great Plain Brook	01/16/2004
New London, City of	05-01-0174P	Thames River	04/19/2005
Colchester, Town of	09-01-1230P	Unnamed Tributary To Sherman Brook	02/15/2010

August 2013 Coastal Study Update

The coastal wave height analysis for this countywide coastal study was prepared by STARR. This new analysis resulted in revisions to the FIRM for the Borough of Stonington, Groton Long Point Association, Noank Fire District, Cities of Groton and New London and Towns of East Lyme, Groton, Old Lyme, Stonington and Waterford.

2.2 Community Description

New London County is located in southeast Connecticut. In New London County, there are nineteen (19) towns, three (3) cities, and two (2) boroughs. The Towns of Colchester, Franklin, Griswold, Lebanon, Lisbon, Sprague, Voluntown, and the Borough of Jewett City are located in northern New London County. The Towns of Bozrah, Ledyard, Montville, North Stonington, Preston, Salem, and the City of Norwich are in the central portion of the county. The Towns of East Lyme, Lyme, Old Lyme, Stonington, Waterford, the Cities of Groton and New London, Groton Long Point Association, the Borough of Stonington, and the Noank Fire District are located in the southern portion of the county. The Pequot Indian Reservation is located in the Town of North Stonington.

New London County is bordered on the north by Windham County, Connecticut, and on the west by Middlesex County, Connecticut. It is bordered on the northwest by the Counties of Tolland and Hartford, Connecticut. New London County is bordered on the east by Washington County, Rhode Island. It is bordered on the south by Fishers Island Sound and Long Island Sound.

According to the 2010 US Census, the population of New London County was 274,055 (Reference 1). The total land area in New London County consists of 665.91 square miles (sq. mi.).

The terrain of New London County is mostly level, becoming more elevated only in its northern extreme. The topography then ranges from gently rolling terrain in the valleys to steep hilly terrain in several upland areas. The highest point in the county is Gates Hill in the Town of Lebanon at approximately 660 feet above sea level, and the lowest point is sea level (Reference 2).

The land area of the county consists primarily of soil developed on till and bedrock in the uplands. Glacial deposits, and the erosion of these deposits by running water from glacial melt, have created an irregular earth surface in some areas. The most common soils in New London County are loams formed on glacial till. The remainder of the soils are alluvial, formed on glacial outwash or floodplains. The bedrock in this area of Connecticut is predominantly unweathered gneiss and schist overlain by glacial till or outwash. The soils were formed from glacial till, outwash and wind-blown deposits. Glacial deposits over bedrock are primarily of two types: nonstratified material or till composed of clay, sand, gravel, and boulders, intermingled; and stratified material composed of sand and gravel. These soils are deep and well drained with moderate to moderately rapid permeability. The characteristics of these soils facilitate precipitation retention where the hills are slightly to moderately sloped. The result is numerous streams, valleys, hills, steep slopes, inland wetlands, lakes, ponds, and bedrock outcroppings (Reference 3).

Outside the residential, commercial, and industrial areas, the vegetation is composed primarily of trees and undergrowth in woodlands, grasses in the open fields and pastures, farm crops in the few fields devoted to agriculture, and various swamp plants in the inland wetlands. Woodlands predominate, especially on slopes and summits of the many hills. In the woodlands, hardwoods far outnumber the softwoods.

New London County is part of the Coastal Lowlands that cover the entire New England Coast. The Connecticut Coastal Lowlands form a narrow strip of land, 6 to 16 miles wide, that runs along the southern shore of New London County at Long Island Sound. The Coastal Lowlands are characterized by lower ridges and beaches and harbors along the coast (Reference 4).

The County of New London has many rivers and brooks, some of which flow to Long Island Sound. The Thames River, which flows south into Long Island Sound, is one of the principal rivers in Connecticut. Although the Thames River is only 15 miles long, the basin extends approximately 75 miles north, with the Shetucket and Quinnebaug Rivers being the main contributing sources of water. The drainage area of the Thames River basin is 1,478 square miles.

The climate of the county is relatively mild compared to the rest of New England, with relatively mild winters and warm summers. The mean annual temperature for the county is 50 degrees Fahrenheit (ºF). Generally, summer temperatures range from 70°F to 90 ºF; temperatures over 100 ºF do occur, but infrequently. Winter temperatures range between 10 ºF and 40 ºF. The prevailing winds are northwesterly in the winter and southwesterly in the summer. Hurricanes occur most frequently during the months of August, September, and October. The average annual precipitation is 46 inches.

2.3 Principal Flood Problems

Floods in the New London County have occurred in every season of the year. Floods in late summer and fall are usually the result of hurricanes or other storms moving northeast along the Atlantic coast. The most severe flooding occurs during hurricanes or coastal storms. These storms, with their intense winds and rainfall, can create abnormally high tidal surges, wave runup, and peak runoff. The low-lying tidal shoreline areas of New London County are subjected to periodic flooding by severe storms. The shoreline along Long Island Sound, with its high concentration of residential structures, is highly susceptible to heavy damage. When the hurricane's track is west of the coastal communities, the hurricane's counterclockwise winds tend to increase the adverse effect of the tidal surge.

Winter floods result from occasional thaws, particularly in years of heavy snowfall. Flooding has also occurred in early spring when the ground was frozen. Spring floods are common and are caused by rainfall in combination with snowmelt. When coastal storms occur in winter and spring, the flooding problem is compounded by ice jams and runoff from melting snow.

Historic flooding in eastern Connecticut extends back to the early 17th century. The two earliest hurricanes of record in New England, namely August 15, 1635, and August 3, 1638, created flood levels apparently higher than the recent floods of 1938 and 1954, and probably were the greatest experienced in New England during the past 300 years (Reference 5). Though no records exist for Connecticut, it is reasonable to assume that these hurricanes also caused extensive tidal flooding along the Connecticut coast. Records indicate that the coast of Connecticut has experienced hurricane tidal flooding on over 60 occasions since 1769. On nine of these occasions, severe tidal flooding occurred. The five greatest, as far as can be determined from existing records, were the hurricanes of 1938, 1893, 1954, 1815, and 1944 (in descending order of estimated magnitude). Historical information regarding flood problems due to hurricanes is included in the USACE study entitled, “Hurricane Survey, Connecticut Coastal and Tidal Areas” (Reference 6).

The hurricanes of 1938 and 1954 caused some of the worst flooding in New London County. The 1938 hurricane resulted in the greatest disaster in Connecticut's history up to that time, because of the combined effects of flooding, gale winds, and storm surge. The tide was high when the storm surge struck and resulted in a maximum tidal elevation of 8.8 feet. The recurrence interval of this flood height is approximately 2.2-percent-annual-chance. The hurricane of 1954 moved up the Atlantic coast and entered Connecticut in the New London area causing a maximum tidal elevation of 8.0 feet, with a recurrence interval of approximately 5-percent-annual-chance (Reference 7). Tidal surges during severe storms cause flooding along both the Niantic and the Thames Rivers, the larger rivers in the area, and along other smaller streams flowing into either these rivers or Long Island Sound. Where structures are located in the floodplains, damage occurs. In Waterford, hurricane tidal flood damages for the 1938 and 1954 hurricanes were scattered along the entire shoreline, with principal concentrations at the head of Niantic Bay and in the Ridgewood area on the west bank of Alewife Cove. Much of the loss in 1954 was from damage to boats (Reference 6).

Shoreline damages in the Town of East Lyme resulted in losses of $1,070,000 and $990,000 during the 1938 and 1954 hurricanes, respectively (Reference 6). In addition, the Town of Montville suffered losses of $900,000 and $700,000 during the 1938 and 1954 hurricanes, respectively due to shoreline damages. At the CCO meetings for the

March 1979 study for the Town of East Lyme, comments were made regarding repeated coastal and riverine flooding. Tidal flooding occurs along Shore Drive, Shore Road, and Atlantic Street, just off Niantic Bay. Also, tidal flooding was reported on both the east and west shores of Black Point. Flooding at Giants Neck Road because of Bride Brook overflowing its banks was reported.

The September 1938 storm was the maximum flood of record for the Town of Norwich. If this flood were to occur at the present time, it would have an estimated recurrence interval of approximately 0.3-percent-annual-chance flood. During the September 1938 flood, high water marks of 8 feet and 1 inch were recorded at the corner of Bath and Franklin Streets and marks of 5 feet and 5 inches were recorded above the railroad tracks to Laurel Hill at the Shetucket River.

The most notable flood along the Quinebaug River occurred in August, 1955, as the result of Hurricane Diane. The peak discharge caused by that storm was 40,700 cubic feet per second (cfs). Other notable floods were the two floods of March 1936, which were caused by extra-tropical storms. These had peak discharges of 22,800 cfs and 25,000 cfs. Also, a peak discharge of 2,240 cfs was recorded for the Pauchaug River in 1938 at a gage near the borough of Jewett City. Flooding also occurred in July and September of 1938 as the result of hurricanes.

Two severe floods in Preston occurred in March 1936 and were caused by extra-tropical storms. Serious flooding also occurred in July and September of 1938 as the result of hurricanes.

The flood of record for the Shetucket River, affecting the Towns of Preston, Sprague, Norwich, and Lisbon occurred in September 1938 as the result of a hurricane. This hurricane is often referred to as the "New England Hurricane." Severe flooding also occurred along the Shetucket and Quinebaug Rivers as the result of Hurricane Diane which occurred on August 19, 1955.

Major floods in the Town of Lebanon occurred in March 1936, September 1938, and August 1955. Of these, the flood of September 1938, caused by a hurricane, was the most severe. Streamflow records at USGS gaging station No. 01193500 on the Salmon River at East Hampton and No. 01127500 on the Yantic River at Yantic, which are in the vicinity of Lebanon, indicate that the September 1938 flood has a recurrence interval of approximately 1-percent-annual-chance. The small segment of the Yantic River within the Town of Franklin has been a source of frequent overbank flooding, due at least in part to a dike which was built to protect a sanitary sewer siphon. There are several houses in the floodplain in this area.

Hurricane Gloria hit the Town of Waterford on September 27, 1985. Total damages, estimated at $650,000, were a result of one or a combination of the following: previous shoreline instability, wind and wave action during the storm, and the degree of exposure at the shoreline. Rainfall was insignificant compared to other storm effects due to the location of the town east of the eye of the storm. Damages were generally classified as dock damage, structural damage (sea walls, retaining walls, and bulkhead damage), and beach erosion (approximately 4,000 linear feet) (Reference 8). In Waterford, further inland, riverine flooding, not directly related to tidal surges of the Niantic and the Thames Rivers, has occurred with resulting damage incurred.

In the Town of Colchester, major floods have occurred in March 1913, November 1927, March 1936, September 1938, August 1955, February 1973, January 1978, and January 1979. Streamflow records at the USGS gaging station on the Salmon River in the nearby Town of East Hampton indicate that the September 1938 and January 1979 floods had approximate recurrence intervals of 1-percent-annual-chance.

Major floods also occurred in Voluntown in March 1936 and in September 1938 (caused by a hurricane); the September 1938 flood was the most severe.

Areas adjacent to the Eight Mile River are subject to flooding caused by the overflow of the river or water from the tidally affected Connecticut River. The most severe flooding is the result of the rainfall from hurricanes. The flood events that had the most effect on the Town of Lyme occurred in 1936, 1938, 1944, 1950, 1954, and 1955.

The low elevation of Groton Long Point Association makes it very susceptible to tidal flooding. Residences are heavily concentrated along the coastline and they are subject to damage from tidal flooding with wave action. Many residential and commercial structures are located in low-lying areas further inland and, though not subject to damage from the surf, they are subject to tidal flooding. The southern portion of the point, in the Shore Avenue area, is exposed to the wave action from Fishers Island Sound and it is here that the most damage has occurred in the past. The shoreline structures along Mumford and Palmer Coves have also experienced wave action damage, but to a lesser degree.

A small dam failure occurred on March 6, 1963 on Spaulding Pond Brook. This failure occurred during a moderate storm on the Spaulding Pond Dam, 400 feet above the center of the City of Norwich. Thousands of gallons of water poured into the city, leaving 6 dead and property damage in the millions of dollars (Reference 9).

Flooding problems exist in the Horton Cove area in the community of Montville. Also, tidal flooding is a recurring problem in the industrial area at Montville Station, just south of the mouth of Horton Cove. In 1982, a major riverine flooding event occurred in Montville and East Lyme, which caused damage to bridges and structures along the Fourmile River, Latimer Brook, and the surrounding area. The event is the highest on record at the USGS gaging station on the Fourmile River in East Lyme. A regional storm drainage study confirmed reports that localized inland flooding occured in the Oxoboxo, Stony, and Trading Cove Brooks due to culverts with inadequate capacity being inundated (Reference 10).

Streamflow records collected in the vicinity of North Stonington by the USGS indicate that annual peak flow can occur during any season of the year; however, it occurs most frequently during the months of December through April. The highest peak flows usually occur during March or April because of runoff from spring rains, which are often increased by snowmelt; or during September or October, due to runoff from tropical storms. Flooding has not been a major problem on the Pawcatuck River. The vast amount of swampland within the basin has caused very slow flood formation with only minor peak floods (Reference 11). Based on historical information obtained from the USGS gaging station No. 01118500 on the Pawcatuck River at Westerly, the worst flood since gage operation began in 1886 was that of November 1927. This flood was caused by a tropical storm. No discharges were calculated for this flood; however, it is estimated to have been a 0.5-percent-annual-chance flood. The flood of March 1968 was the second most severe. Peak discharges for this flood were 4,470 cfs on the Pawcatuck River at the Westerly gage. This was estimated to be approximately 3.3-percent-annual-chance flood. More recent floods in January 1978 and January 1979 at the Westerly gage produced peak discharges of 4,110 cfs and 4,010 cfs, respectively. Both of these storms had an estimated recurrence interval of approximately 5-percent-annual-chance (Reference 12).

The USGS gaging station at North Lyme recorded high stages on September 21, 1938, October 16, 1955, and August 19, 1955. This gaging station is located downstream of Salem on the East Branch Eight Mile River. There has been significant flooding in the past at Salem Four Corners, where State Routes 82 and 85 intersect, particularly at the area on State Route 82 immediately west of the intersection. This route was described as having been overtopped by approximately one foot of water during a past flood.

Seven hurricanes have affected Connecticut in the last two decades, causing minimal damage to New London County. Hurricane Gloria in September 1985, Hurricane Bob in August 1991, Hurricane Grace in October 1991, Hurricane Bertha in July 1996, and Hurricane Tammy in October 2005. Hurricane Gloria made landfall in the Westport, CT area as a Category II hurricane. Relatively light rainfall minimized flooding and debris cleanup and power restoration were the major issues for this hurricane. Hurricane Bob travelled up the eastern seaboard and struck Newport, Rhode Island as a Category II hurricane and caused light to moderate tree damage in central Connecticut. Hurricane Grace resulted in 30-50 foot seas along the coastline from New Jersey to Maine but damage to Connecticut was minimal. Hurricane Bertha caused minimal damage to Connecticut resulting in downed power lines and damaged trees. The remnants of Hurricane Tammy combined with a low-pressure system caused heavy rainfall events from October 7-10th and October 14-15th, 2005. The combined rainfall across the state from both of these events totaled between 9 and 16 inches. Combined, the rainfall from these two events totaled 9 – 16 inches. The rainfall caused major flooding in Hartford County and Tolland County and moderate flooding across the entire state of Connecticut. A total of 14 dams completely failed or partially failed and another 30 dams were damaged across the state of Connecticut. Several dozen roads were washed out or undermined. Some residents of the two counties were evacuated. The remnants of hurricane Tammy caused $6.1 million in damages to municipal and non-profit properties, $6.9 million to businesses and an estimated $30 million of damages to private residences (References 13 & 14). In August 2011 Hurricane Irene and in October 2012 Hurricane Sandy impacted the coastline of New London County. The impacts of these hurricanes have not been considered in the August 2013 coastal analysis study.

A nor’easter in December 1992 killed 3 people and destroyed 26 homes in Connecticut. The storm caused $4.3 million in damages to over 6,000 homes. Tides in Long Island Sound stacked up due to the 55 MPH winds which resulted in the third highest tide of 9.2 feet NAVD 88 measured in Bridgeport, CT eroded shorelines and damaged homes (Reference 13).

In December 2003, a winter storm with heavy snowfall in Windham County, (20 inches), Hartford County (19 inches) and Fairfield, New London, and Tolland Counties (18 inches) resulted in a presidential disaster declaration for these counties (Reference 13).

In April of 2007 a nor'easter dropped greater than 7 inches of rain in Fairfield, Litchfield, Middlesex, New Haven and New London Counties. Rainfall in Fairfield County ranged from 3.57 inches to 7.81 inches. The Federal Emergency Management Agency (FEMA) reported that flood damages in Connecticut exceeded an estimated $6.4 million. Over 200 people in Connecticut were forced to evacuate their residences. Residential damages were as follows, Fairfield: 48 major damages & 1,600 total residential units impacted, Middlesex: 3 major damages & 11 total residential units impacted, New Haven: 32 major damages & 446 total residential units impacted. Business damages were as follows, Fairfield: 5 businesses with major damage of an estimated cost of $958,000, Middlesex: 7 businesses with major damage with an estimated cost of damage of $598,000, New Haven: 2 businesses with major damage with an estimated cost of damage of $550,000, New London: 1 business with major damage with an estimated cost of $2 million (Reference 13).

Torrential downpours from an unnamed tropical storm in October 2010 downed trees and utility wires, leaving over 17,000 Connecticut residents without power. The storm dumped 2 inches of rain an hour, flooded many roads, and damaged the Lonshore Marina in Fairfield County. Fairfield schools closed early and the National Weather Service issued flash flood warnings for Fairfield, New London, and Middlesex counties (Reference 15).

From December 2010 through January 2011, the State of Connecticut saw a series of winter storms that led to a record snowfall of 4' 11" statewide. These storms caused a number of problems statewide with transportation and ceiling collapses. These are summarized below:

A winter storm in December 2010 left an estimated 350 customers without power. New London County saw 1.41 inches of rain and 46 mph wind gusts (Reference 16).

In January 2011, a snow emergency was declared in preparation for the third snowstorm in three weeks to hit Connecticut. Parts of Fairfield County saw up to 22 inches of snow and schools were closed for two days. There was extensive damage to six classrooms and administrative offices of Ponus Ridge Middle School; the school remained closed until the sheetrock and fallen parts of the ceiling were removed. Many storm drains and grassy spaces in the County were blocked by ice, and water accumulated quickly on the streets. New London County spent $94,333 on snow-related expenses to transport the 17 inches of snow to vacant areas. Metro-North trains were suspended from Stamford to New Haven (References 17 through 20).

Ella, a two day winter storm that occurred in February 2011 brought approximately 10" of snow and 3/4" of ice to Connecticut. The Emergency Operations Center was opened by the governor. Ice and winds knocked down power lines around the region, with a reported 1,400 outages in Fairfield County alone The National Weather Service issued ice storm and freezing rain warnings for Fairfield County. Water from melting snow, ice and falling rain gathered in Fairfield's streets, leading to flooding on major roads.

Fairfield's schools closed again. Route 163, Route 62 closed due to flooding in New London County. Multiple buildings in Middletown and Middlesex Counties were evacuated after a building collapsed from built up snow (References 21 through 25).

2.4 Flood Protection Measures

Flood protection measures for New London County have been compiled and are summarized below:

Non-structural measures of flood protection are being utilized to aid in the prevention of future flood damage. These are in the form of land use regulations adopted from the code of Federal Regulations which control building construction within areas that have a high risk of flooding.

One significant development from the aftermath of the 1982 flooding was the development of a statewide flood warning system under the management of the Connecticut Department of Environmental Protection. While this will not prevent flooding from occuring in the future, its purpose is to provide advance warning and prevent the loss of lives and property.

There are no known flood protection measures existing at this time that affect flooding along any body of water in the Towns of Colchester, Lebanon, Ledyard, Lyme, North Stonington, Salem, Voluntown, and Waterford.

The only existing structural flood protection measure in the Town of Bozrah is the Gilman Dam, which is located on the Yantic River.

Consideration was given to protection of the flooded area in the vicinity of Oak Beach in the Town of Lyme. The considered plan located in Oak Brach consisted of sand fill and diking along the shore with necessary tieback dikes to high ground. However, no work to construct such protection has ever begun (Reference 6).

Following the record flood of September 1938 on the Shetucket River, the USACE constructed the Mansfield Hollow flood control dam. That project was completed in March 1952. The dam is located on the Natchaug River about five miles upstream from its confluence with the Shetucket River. Floods with the recurrence interval of the September 1938 flood on the Shetucket River at Willimantic, Connecticut modified by the Mansfield Hollow dam would have a peak discharge of about 25,700 cfs compared to an experienced flow of 52,200 cfs. Though the reservoir reduces the frequency and severity of floods, there still remains a flood hazard on the unprotected floodplains.

Flooding along the Quinebaug River, in the communities of Griswold, Lisbon, and Preston, is reduced by USACE dams which were built to form the following lakes: Hodges Village Lake, located at Oxford, Massachusetts; Buffumville Lake, at Oxford and Charlton, Massachusetts; Westville Lake, at Southbridge, Massachusetts; East Brimfield Lake, at Fiskdale, Massachusetts; West Thompson Lake, at North Grosvenordale, Connecticut; and Mansfield Hollow Lake, at Mansfield, Connecticut. West Thompson Lake, finished in October 1965, was the last of these projects to be completed. The storage provided by several ponds on the Pachaug River also diminishes the effects of storms in Griswold.

Dams located at Stony and Bogue Brooks reservoirs and at Oxoboxo Lake retain large amounts of storage water. Also, dams at several small reservoirs provide further moderate control of upland runoff. The topography of the study area enables quick discharge of runoff to the lower reaches of the numerous watershed areas with a minimal lag time (Reference 10). A preliminary study by the USACE for the Montville Station area on the Thames River indicated that tidal flooding damage could be reduced with dikes and walls. At this time, no work has commenced on flood protection measures for this community (Reference 6). Channel encroachment limit lines have not been proposed along the Thames River by the State of Connecticut since the Thames River is influenced by tidal surges from Long Island Sound.

The existing dams on the streams studied in detail in North Stonington are old mill dams, and none of these are regulated. However, storm runoff intensity is greatly moderated by large areas of swamp, numerous ponds, and low gradient streams in the surrounding countryside.

Between 1952 and 1965, the USACE constructed six flood control reservoirs in the Thames River Basin. These reservoirs control runoff from the upper watersheds of the Shetucket and Quinebaug Rivers above the City of Norwich. The city also has several small reservoirs that provide moderate control of upland runoff. Two such reservoirs were constructed by the SCS in 1963 and 1964 on Spaulding Pond Brook (References 9, 26, & 27). The Shetucket River Channel Improvement Project was completed in January 1959 by the USACE. In conjunction with regular navigational dredging on the Thames River, the rock excavation and the raising of the Laurel Avenue Bridge have significantly increased the flood-carrying capacity of the lower Shetucket River. State Channel Encroachment Lines have been adopted along the Yantic and Shetucket Rivers in Norwich to restrict building in potentially hazardous areas. The City Council has also adopted a map prepared by the Inland Wetlands Watercourses and Conservation Commission which regulates building in wetland areas. The City of Norwich has adopted floodplain regulations that require 100 percent compensatory storage be provided for all new encroachments in the floodplain.

Construction for the New London Hurricane Protection Barrier located along the New London waterfront at Shaw Cove on the Thames River was started in August 1978 and completed in May 1986. The project is operated and maintained by the city of New London and provides protection from high tides caused by coastal storms and hurricanes, and from interior flooding caused by Truman Brook in the industrial and commercial area in the vicinity of Shaw Cove and New London Harbor. This project is currently designated as a Provisional Accredited Levee (PAL) and labeled on the FIRM as PAL. This PAL designation is set to expire on December 22, 2011 (Reference 28).

There are two dams located on Harris Brook in Salem but neither structure provides flood protection.

Beech Pond does exert a dampening effect on flood peaks on the Pachaug River in Voluntown.

A hurricane survey prepared by the USACE indicates a preliminary study has been made for breakwater protection of the New London Harbor area in the Town of Groton. Construction of the breakwaters would be beneficial to the City of Groton and perhaps to the Town of Groton since tidal surges along the Thames River would be reduced, as well as damage. However, the construction of the breakwaters has not begun and is not under consideration at this time (Reference 7).

The Town of Waterford has incorporated into its zoning laws a set of floodplain management regulations to help minimize future flood damages and related hazards. The zoning regulations for the Town of Waterford require that the following conditions be met to obtain a Zoning Compliance Permit for new construction and substantial improvement within a Flood Hazard Area: a) all new construction and substantial improvements to residential structures have their lowest floor (including basement) elevated to or above the base flood level; b) all new construction and substantial improvements to nonresidential structures have their lowest floor (including basement) elevated or flood-proofed to or above the base flood level; and c) adequate drainage is provided so as to reduce exposure to flood damage. Further floodplain management measures regarding manufactured homes (mobile homes), water-supply and sewage-disposal systems, alterations of existing water courses and floodways are included in the zoning regulations (Reference 29).

3.0 <u>ENGINEERING METHODS</u>

For the flooding sources studied by detailed methods in the county, standard hydrologic and hydraulic study methods were used to determine the flood-hazard data required for this study. Flood events of a magnitude that is expected to be equaled or exceeded once on the average during any 10-, 2-, 1-, or 0.2-percent-annual-chance period (recurrence interval) have been selected as having special significance for floodplain management and for flood insurance rates. These events, commonly termed the 10-, 2-, 1-, and 0.2-percent-annual-chance floods, have a 10-, 2-, 1-, and 0.2-percent chance, respectively, of being equaled or exceeded during any year. Although the recurrence interval represents the long-term, <u>average</u> 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 1-percent-annual-chance flood in any 50-year period is approximately 40 percent (4 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.

3.1 Riverine Hydrologic Analyses

Hydrologic analyses were carried out to establish peak discharge-frequency relationships for each flooding source studied by detailed methods affecting the community.

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

Precountywide Analyses

Since no stream gage records were available for Beaver Brook (Town of Sprague), a regression analysis of stream gages in the region developed by L. Weiss and revised by P. Biscuti was used to determine discharges for this brook (References 30 and 31). The results of this analysis were extended using a log-Pearson Type III analysis.

The USDA NRSC computer program (Reference 32) for synthetic rainfall-runoff methods was used for Beaver Brook (Town of Lyme) and the Eight Mile River to obtain the 10-, 2-, 1-, and 0.2-percent-annual-chance peak discharge. The results were checked with the USGS stream gages 01194500 on the East Branch Eight Mile River and 1-1940 on Eight Mile River (period of record 1937-1966).

USGS flood flow formulas for Connecticut and for ungaged streams were used to determine discharge-frequency data for Birch Plain Creek, Fort Hill Brook, Tributary A, and Whitford Brook (Town of Groton) (Reference 30). Since there are no gaging stations on these streams, these formulas were empirically derived from stream gaging stations and precipitation gaging stations in Connecticut with 10 to 45 years of record. The formulas utilized drainage basin characteristics and precipitation data, and yielded the 1-percent-annual-chance peak discharge.

Since no stream gage records were available for Blissville Brook, a regression analysis of stream gages in the region developed by L. Weiss and revised by P. Biscuti was used to determine discharges for this brook (References 30 and 33). The results of this analysis were extended using a log-Pearson Type III analysis (Reference 34).

For Bobbin Mill Brook, Ford Brook, Great Plain Brook, Goldmine Brook, Hunter Brook, Norwichtown Brook, Spaulding Pond Brook, Trading Cove Brook, Tributary A, Tributary B, Tributary C, Tributary D, Tributary E, Tributary F, and the Yantic River East Channel, regional frequency-discharge formulas for Connecticut were used and weighted with gaged data on streams with similar basin characteristics (Reference 35). No flooding is shown for Tributary A and E in the City of Norwich because the floodplains were less than 200 feet wide.

For Denison Brook, Great Meadow Brook and the Pachaug River (Town of Voluntown), the 1-percent-annual-chance flood discharge for the streams studied by detailed methods was based on equations developed from Connecticut Water Resource Bulletin No. 36 (Reference 36). This regional method relates drainage area, channel slope, and 24-hour rainfall intensity values to the peak discharge by regression equations.

Discharges for Eccleston Brook and Fishtown Brook were determined in the original FIS for the Town of Groton (Reference 30). The discharges were determined using the USDA NRSC TR-20 computer program based on procedures described in the USDA NRSC National Engineering Handbook (References 37 and 38). Twenty-four hour rainfall was determined from Weather Bureau Technical Paper 29 (Reference 39). Infiltration effects were accounted for through hydrologic soil grouping based on soil maps and land use.

USGS flood flow formulas for ungaged streams were used to define discharge-frequency data for the Fourmile River, Pattagansett River and Latimer Brook in East Lyme (Reference 35). These formulas were empirically derived from stream-gaging and precipitation-gaging stations in Connecticut with 10 to 45 years of record. The formulas used drainage basin characteristics and precipitations data and yielded the 1-percent-annual-chance peak discharge. Values of the 10-, 2-, 1-, and 0.2-percent-annual-chance peak discharges were determined from a log-Pearson Type III distribution, which is obtained from the calculated 1-percent-annual-chance peak discharges and a standard deviation and skew coefficient or annual maximum flows. Flood flows for Latimer Brook in Montville were calculated in 1994 using revised USGS regional flood flow formulas (Reference 36). For the1995 restudied portion of Latimer Brook (approximately 2,800 feet upstream of Darrow Pond to the East Lyme-Montville corporate limits), these flood flows were verified using USGS regional flood flow formulas (Reference 36). The Town of East Lyme has one stream gaging station that has provided data since the early 1960s. Nevertheless, the data gives only the mean annual flood levels. No continuous recording data are available. The available information was used and calculations were made using the log-Pearson Type III distribution. The resulting discharge frequency data compared reasonably well with that obtained with the flood flow formulas for ungaged streams.

There are no discharge records for Gardner Brook; the peak discharge frequencies were determined by regional regression equations. Discharges were related to basin characteristics such as drainage area, stream length, streambed slope, and rainfall parameters as described in a statewide flood flow formula determination (Reference 40). The resulting flow values were also compared with statistically analyzed gaged stream records in the region and were found to be in general agreement.

Flood flow frequency analyses for the Jeremy River, Judd Brook, and Meadow Brook, followed the log-Pearson Type III method, as outlined in Water Resources Council Bulletin 17 (Reference 34). The 10-, 2-, 1-, and 0.2-percent-annual-chance peak discharges were related to basin characteristics such as drainage area, stream length, streambed slope, and rainfall parameters, as described in a statewide flood flow formula determination (Reference 41).

The 1-percent-annual-chance flood discharges for Day Meadow Brook and the restudied portion of Meadow Brook (approximately 2,140 feet downstream of Levy Road to a point approximately 3,250 feet upstream of State Route 16) were based on equations developed from a report on flood magnitude and frequency of Connecticut streams (Reference 42). This regional method related drainage area, area of stratified drift, and 24-hour rainfall intensity values to the peak discharge through regression equations.

The USGS maintains a gaging station on the East Branch Eight Mile River near North Lyme, which is located about two miles below Salem. The period of record for this gage extends from September 1937 to the present. Based on records of this gage, peak discharge frequencies were developed using a log-Pearson Type III statistical distribution in accordance with procedures outlined by the Water Resources Council (Reference 34). The 1-percent-annual-chance discharge was obtained from a statewide flood flow formula determination (Reference 30). Discharges for the 10-, 2-, and 0.2-percent-annual-chance floods were obtained from the Hartford office of the USGS.

Since stream gage records were not available for Joe Clark Brook, Flat Brook, Pine Swamp Brook, and Williams Brook, multiple regression analysis of stream gages in the region developed by L. Weiss and revised by P. Biscuti was used to determine discharges for these brooks (Reference 33).

Flow frequencies for Jordan and Nevins Brooks were based on USGS flood flow formulas for ungaged streams (Reference 30). These formulas were empirically derived from stream-gaging and precipitation gaging stations in Connecticut with 10 to 45 years of record. The formulas utilize drainage basin characteristics and precipitation data to yield the 1-percent-annual-chance peak discharge. The values of the 10-, 2-, 1-, and 0.2-percent-annual-chance peak discharges were determined from a log-Pearson Type III distribution, which was obtained from the calculated 1-percent-annual-chance peak discharge, the standard deviation and skew coefficient of annual maximum flow.

There are no discharge records for Harris Brook. Peak discharge frequencies for Harris Brook were determined by regional regression equations. Discharges were related to basin characteristics such as drainage area, stream length, streambed slope, and rainfall parameters as described in the statewide flood flow formula determination (Reference 30). The resulting flow values were also compared with statistically analyzed gaged stream records in the region and were found to be in general agreement.

Discharges for the Little River were determined using a regional regression analysis recently developed by L. Weiss based on records at 96 gaging stations in Connecticut (Reference 43). Discharges computed with regression equations at the USGS gaging station on the Little River at Hanover (No. 01123000 with 31 years of record) were first compared to discharges determined by a log-Pearson Type III analysis of the gage data. The percent difference between the discharges computed by the two methods for each frequency was then applied to discharges determined by the regression equations at other sites along the Little River. Discharges for the 0.2-percent-annual-chance flood were determined by graphical extrapolation.

For Oxoboxo Brook, USGS flood flow formulas for ungaged streams from the Town of Montville January 1980 FIS, and the City of Norwich study, were used to establish the peak discharge-frequency relationships (References 35 and 44). These formulas were empirically derived from stream-gaging and precipitation-gaging stations in Connecticut with 10 to 45 years of record. There are several gaging stations on streams in Montville, however, only water quality data, daily flows and groundwater runoff data are recorded. No flood peak elevations are obtained, and monitoring is not continuous. Also, less than 10 years of records are available (References 31 and 45). The flood flow formulas used drainage basin characteristics and precipitation data to yield the 1-percent-annual-chance peak discharge. Values of the 10-, 2-, 1-, and 0.2-percent-annual-chance peak discharges were determined from a log-Pearson Type III distribution, which was obtained from the calculated 1-percent-annual-chance peak discharge, the standard deviation of annual maximum flows, and a regional skew coefficient

The discharges for the Pachaug River in Griswold and Jewett City were determined using data from USGS gage No. 01126950 with 11 years of record (Reference 30). The statistical characteristics of these records were adjusted to conform to the regional patterns reflected by a log-Pearson Type III analysis of long-term gage records in the area (Reference 34).

USGS gaging stations on the Quinebaug River (No. 0112550 at Putnam with 33 years of record and No. 01127000 at Jewett City with 40 years of record) were used for defining the frequency/discharge relationships of this river in Griswold and Jewett City (Reference 46). The 10-, 2-, 1-, and 0.2-percent-annual-chance peak discharges were obtained from log-Pearson Type III analyses of annual peak flow data performed by the USGS and the USDA NRSC (Reference 34). Discharges were then adjusted for reductions due to the flood control reservoirs on the Quinebaug River by a factor obtained by the USACE (Reference 47).

USGS gaging stations on the Shetucket River near Willimantic, (No. 01122500 with 25 years of record) and on the Quinebaug River (No. 0 112550 at Putnam with 33 years of record and No. 01127000 at Jewett City with 40 years of record) were used for defining the frequency-discharge relationships of these streams (Reference 48). The 10-, 2-, 1-, and 0.2-percent-annual-chance peak discharges were obtained from log-Pearson Type III analyses of annual peak flow data performed by the USGS and the USDA NRSC (Reference 34). In Libson, Preston, and Sprague, discharges were then adjusted for reductions due to the flood control reservoirs on the Shetucket and Quinebaug Rivers by a factor obtained by the USACE (Reference 49). In Norwich, these values were cross verified with results of evaluations performed on the Shetucket River by the USACE in 1957, prior to construction of flood control reservoirs.

In North Stonington, discharges for the Shunock River were determined using a regional regression analysis recently developed by L. Weiss based on records at 96 gaging stations in Connecticut (Reference 43). Discharges were then adjusted for storage using a storage correction multiplier determined from the Federal Highway Administration publication, "Runoff Estimates for Small Rural Watersheds and Development of a Sound Design Method" (Reference 50).

Peak discharges for the Green Fall River were also based on the L. Weiss regional regression analysis (Reference 43). An additional procedure was also used to account for the storage behind the Clarks Falls Pond Dam and the Spalding Pond Dam. The time of peak discharge is delayed when water is retained in the ponds and in Bell Cedar Swamp; therefore, it does not coincide with the peak discharge on the other fork of the Green Fall River. This causes discharges on the Green Fall River downstream of the confluence of the two forks of the river to be lower than they would be under coincident peak conditions. In the hydrologic analysis, discharges were first computed with regression equations at the USGS gaging station on the Pendleton Hill Brook tributary to the Green Fall River near Clarks Falls (No. 01118300 with 24 years of record). These discharges were compared with discharges determined by a log-Pearson Type III analysis of the gage data. The percent difference between the discharges computed by the two methods for each frequency was then applied to discharges determined by the regression equations at other sites along the Green Fall River. Discharges for the 0.2-percent-chance-annual flood were determined by graphical extrapolation. Next, an analysis of the discharges determined at the confluence of the two forks of the Green Fall River was performed using a dimensionless curvilinear unit hydrograph from the USDA NRSC, "National Engineering Handbook" combining the peak of the flow over the Clarks Falls Pond Dam with the flow of the other fork of the Green Fall River at the determined lag time (Reference 51). The percent reduction in discharge due to storage in the ponds and swampland was then calculated for each flood frequency being studied. These percentages of reduction were then applied to the discharges calculated at other locations downstream on the Green Fall River. The discharges used for the fork of the Green Fall River flowing over the Clark Falls Pond Dam to the fork in the river were determined using the procedures used to calculate the 1-percent-annual-chance discharge in a report on the Clarks Falls Pond Dam (Reference 52).

Peak discharges for the Pawcatuck River were obtained from the FISs for the Towns of Westerly, Rhode Island, and Ledyard, Connecticut, respectively (References 53 and 54). For the Pawcatuck River in Westerly, frequency discharges were determined at two gaging stations and then computed at other locations based on a transfer equation of the form:

$$Q1/Q2 = [A1/A2]^{n}$$

where Q1 is the frequency discharge and A1 is the drainage area at the Wood River Junction gage; and Q2 is the frequency discharge and A2 is the drainage area at the desired location. The exponent n is a value representing the slope of a straight line fitted between plotted points of drainage area and frequency discharge on log-log paper using data from the two gages. To obtain frequency discharges for the Pawcatuck River in North Stonington, this same transfer equation was applied using the drainage area upstream of the confluence of the Shunock River.

For Susquetonscut Brook (Town of Franklin), a discharge frequency analysis was performed using data from the USGS gaging station located 0.5 miles upstream of its confluence with the Yantic River in Franklin. Peak discharge frequencies were developed using a standard log-Pearson Type III statistical distribution in accordance with procedures outlined by the Water Resources Council (Reference 34). The 1-percent-annual-chance flood discharge for Susquetonscut Brook, in Franklin is published in a report entitled "Floodflow Formulas for Urbanized and Nonurbanized Areas of Connecticut" (Reference 30). Discharges for the 10-, 2-, and 0.2-percent-annual-chance floods were obtained from the Hartford office of the USGS.

For Susquetonscut Brook (Town of Lebanon), the 1-percent annual-chance flood discharge for the Susquetonscut Brook was based on the American Society of Civil Engineers journal article “Flood Flows for Urbanized and Non-urbanized Areas of Connecticut” (Reference 38). This regional method relates drainage area, channel slope, and 24-hour rainfall intensity values to the peak discharge by regression equations.

For the Tenmile River, the 1-percent annual-chance flood discharge was based on the American Society of Civil Engineers journal article “Flood Flows for Urbanized and Non-urbanized Areas of Connecticut” (Reference 38). This regional method relates drainage area, channel slope, and 24-hour rainfall intensity values to the peak discharge by regression equations.

Peak discharges for Whitford Brook in North Stonington were obtained from the FISs for the Towns of Westerly, Rhode Island, and Ledyard, Connecticut, respectively

(References 53 and 54). In North Stonington, a regression analysis of stream gages in the region developed by L. Weiss and revised by P. Biscuti was used to determine discharges for this brook (References 30 and 33). For Whitford Brook in Ledyard, multiple regression analyses of stream gages in the region were applied. The regression analysis developed by L. Weiss was used (Reference 33). The 1-percent-annual-chance discharge were computed directly. Values of the 10-, 2-, and 0.2-percent-annual-chance peak discharges were obtained from a log-Pearson Type III distribution of annual peak flow data (Reference 34).

Peak discharges for the 10-, 2-, 1-, and 0.2-percent-annual-chance recurrence intervals for the Yantic River in Bozrah and Norwich were obtained from the 1992 FIS for the City of Norwich (Reference 55). In Franklin, discharge frequencies for the Yantic River were taken from the June 15, 1978 FIS for the downstream community of the City of Norwich (Reference 56). In Lebanon, 1-percent annual-chance flood discharge for the Yantic River was based on the American Society of Civil Engineers journal article "Flood Flows for Urbanized and Non-urbanized Areas of Connecticut" (Reference 38). This regional method relates drainage area, channel slope, and 24-hour rainfall intensity values to the peak discharge by regression equations. In Bozrah and Franklin, the Norwich flows were adjusted by multiplying the adopted discharges in Norwich by a factor equal to the ratio of the drainage areas to the 0.7 exponential power. In 1992, the USGS office in Hartford, Connecticut, performed a peak flow frequency analysis on the Yantic River gage. The peak discharges shown in the previously printed City of Norwich FIS, dated April 15, 1992, fall within the 90 percent confidence interval of the revised City of Norwich 1994 FIS analysis; therefore, the established discharges in the City of Norwich 1992 FIS were used. In the 1995 FIS revision for the Town of Bozrah, the 1-percent-annual-chance peak discharge for the Yantic River at Gilman Dam, which was computed using the ratio of the drainage areas, is approximately 1.2 percent higher than the value shown in the Town of Lebanon FIS. To maintain consistency with the upstream community, the 1-percent-annual-chance peak discharge was taken from the FIS for the Town of Lebanon (Reference 27).

In Norwich, the method used for approximate study was based on a regression analysis of Connecticut streams. Stages were then determined from a stage-drainage area curve. Existing dams and reservoirs with moderate flood control storage, located on the upper portions of the Shetucket and Quinebaug River watersheds, reduce the peak flows in the vicinity of Norwich. Similar structures on Spaulding Pond Brook (Reservoir sites 1 and 2), Hunter Brook (Taftville Reservoir), and Norwichtown Brook (Bog Meadow Reservoir) also reduce the peak discharges on these streams. This reduction in discharge was taken into account in the hydrologic analyses.

<u>July 18, 2011 Countywide Analysis</u>

For the July 18, 2011 countywide FIS, no new hydrologic analyses were conducted.

Peak discharge-drainage area relationships for New London County are shown in Table 5 Summary of Discharges.

TABLE 5 – SUMMARY OF DISCHARGES

FLOODING SOURCE AND LOCATION	DRAINAGE AREA (SQUARE MILES)	PEAK DISCHARGES (CUBIC FEET PER SECOND) 10-PERCENT ANNUAL CHANCE	2-PERCENT ANNUAL CHANCE	1-PERCENT ANNUAL CHANCE	0.2-PERCENT ANNUAL CHANCE
BEAVER BROOK (TOWN OF SPRAGUE)					
At confluence with Shetucket River	11	697	1,064	1,254	1,763
BIRCH PLAIN CREEK					
At the Contrail tracks	3.12	410	670	800	1,200
At Thomas Road	1.73	230	370	450	670
At Poquonnock Road	0.98	160	250	300	450
At Clarence B. Sharp Highway	0.62	150	240	290	430
BLISSVILLE BROOK					
At confluence with Shetucket River	4.09	245	387	461	674
Upstream of Graham Pond	3.4	215	340	400	590
BOBBIN MILL BROOK					
Junction at Yantic River	0.98	240	430	560	670
Junction at Tributary B	0.46	130	230	300	360
DAY MEADOW BROOK					
At River Road	0.49	*	*	200	*
DENISON BROOK					
At its confluence with the Pachaug River	4.21	*	*	375	*
EAST BRANCH EIGHT MILE RIVER					
At the downstream Salem corporate limits	19.6	1,160	1,920	2,300	3,350
Below Harris Brook	14.3	930	1,540	1,860	2,700

*No Data Available

TABLE 5 – SUMMARY OF DISCHARGES - continued

FLOODING SOURCE AND LOCATION	DRAINAGE AREA (SQUARE MILES)	PEAK DISCHARGES (CUBIC FEET PER SECOND) 10-PERCENT ANNUAL CHANCE	2-PERCENT ANNUAL CHANCE	1-PERCENT ANNUAL CHANCE	0.2-PERCENT ANNUAL CHANCE
ECCLESTON BROOK					
At State Route 215	2.70	510	840	1,000	1,550
At U.S. Route 1	0.80	185	305	365	550
EIGHT MILE RIVER	*	*	*	*	*
FISHTOWN BROOK					
At its confluence with Eccleston Brook	0.80	185	305	365	550
FLAT BROOK					
At mouth	1.45	195	315	380	575
FORD BROOK					
Junction at Trading Cove Brook	2.96	430	700	820	1,200
Junction at Gardner Brook	1.83	300	480	570	830
At New London Turnpike	0.34	85	140	160	240
FORT HILL BROOK					
At the Contrail Tracks	2.21	290	470	560	830
At U.S. Route 1	1.61	250	410	490	730
At Interstate 95	0.56	140	230	270	400
FOURMILE RIVER					
At Long Island Sound	6.57	450	740	910	1,400
At State Route 156	6.25	430	700	860	1,300
At Interstate Route 95	5.8	410	680	830	1,250
At State Route 51	5.26	400	660	800	1,200

*No Data Available

TABLE 5 – SUMMARY OF DISCHARGES - continued

FLOODING SOURCE AND LOCATION	DRAINAGE AREA (SQUARE MILES)	PEAK DISCHARGES (CUBIC FEET PER SECOND) 10-PERCENT ANNUAL CHANCE	2-PERCENT ANNUAL CHANCE	1-PERCENT ANNUAL CHANCE	0.2-PERCENT ANNUAL CHANCE
GARDNER BROOK					
At the confluence with Yantic River	13.5	725	1,250	1,500	2,200
Below Parson Brook	10.4	600	1,040	1,250	1,830
GOLDMINE BROOK					
Junction at Trading Cove Brook	2.58	340	550	650	1,000
GREAT MEADOW BROOK					
At its confluence with the Pachaug River	6.33	*	*	860	*
GREAT PLAIN BROOK					
Junction at Trading Cove Brook	0.6	290	525	695	830
At New London Turnpike	0.4	215	390	510	610
At cross section F	0.2	130	230	300	360
GREEN FALL RIVER					
At downstream North Stonington corporate limits	26.3	944	1,670	2,134	3,905
Upstream of confluence of Parmenter Brook	23.1	869	1,543	1,973	3,625
Upstream of confluence of Glade Brook	17.7	700	1,244	1,589	2,923
Upstream of fork with Green Fall River	9.7	593	1,100	1,335	2,076

*No Data Available

TABLE 5 – SUMMARY OF DISCHARGES - continued

FLOODING SOURCE AND LOCATION	DRAINAGE AREA (SQUARE MILES)	PEAK DISCHARGES (CUBIC FEET PER SECOND) 10-PERCENT ANNUAL CHANCE	2-PERCENT ANNUAL CHANCE	1-PERCENT ANNUAL CHANCE	0.2-PERCENT ANNUAL CHANCE
HARRIS BROOK					
At the confluence with East Branch Eight Mile River	7	500	800	1,000	1,400
Above Fraser Brook	3	275	440	550	770
HUNTER BROOK					
At cross section1	0.64	100	160	210	260
Junction at Shetucket River	1.13	150	250	320	390
JEREMY RIVER					
At confluence with Meadow Brook	23.9	1,450	2,450	3,000	4,150
JOE CLARK BROOK					
At confluence with Poquetanuck Cove	3.35	270	480	610	950
JORDAN BROOK					
At its confluence with Jordan Cove	6.39	760	1,200	1,500	2,200
Above its confluence with Nevins Brook	4.53	420	680	820	1,200
Approximately 900 feet downstream of Boston Post Road	3.85	370	600	730	1,100
At Interstate Route 95	2.66	300	500	600	900
Approximately 3,500 feet downstream of State Route 52	1.76	220	350	430	640
At State Route 52	0.72	160	270	330	480

TABLE 5 – SUMMARY OF DISCHARGES - continued

FLOODING SOURCE AND LOCATION	DRAINAGE AREA (SQUARE MILES)	PEAK DISCHARGES (CUBIC FEET PER SECOND) 10-PERCENT ANNUAL CHANCE	2-PERCENT ANNUAL CHANCE	1-PERCENT ANNUAL CHANCE	0.2-PERCENT ANNUAL CHANCE
JUDD BROOK					
At Hebron Avenue	3.93	300	500	600	900
Approximately 2,500 feet upstream of Hebron Avenue	2.6	200	350	400	600
Approximately 2,000 feet upstream of Sate Route 85	1.27	100	160	200	300
LATIMER BROOK					
At downstream Montville corporate limits	11.48	945	1,595	1,965	2,790
At State Route 85	6.8	735	1,295	1,600	2,350
At confluence with Niantic River	17.18	1,100	1,800	2,100	3,200
Above confluence with Cranberry Meadow Brook	11.74	945	1,595	1,965	2,780
At Grassy Hill Road	9.11	880	1,525	1,890	2,770
LITTLE RIVER					
Downstream of confluence of Negro Brook	43.2	2,390	3,920	4,770	6,990
MEADOW BROOK					
At Interchange 16 State Route 2	35.2	2,450	4,000	4,800	6,650
At confluence of Jeremy River	11.3	1,000	1,550	1,800	2,500
Upstream of Mill Hill Road	7.58	700	1,150	1,400	1,950

TABLE 5 – SUMMARY OF DISCHARGES - continued

FLOODING SOURCE AND LOCATION	DRAINAGE AREA (SQUARE MILES)	PEAK DISCHARGES (CUBIC FEET PER SECOND) 10-PERCENT ANNUAL CHANCE	2-PERCENT ANNUAL CHANCE	1-PERCENT ANNUAL CHANCE	0.2-PERCENT ANNUAL CHANCE
MEADOW BROOK – cont'd					
At Levy Road	6.39	*	*	750	*
NEVINS BROOK					
Above its confluence with Jordan Brook	1.86	220	360	440	660
At Fog Plain Road	1.23	180	280	350	510
At Interstate Route 95	0.29	90	150	180	270
NORWICHTOWN BROOK					
Junction at Yantic River	2.51	290	530	650	820
Junction at Tributary A	1.59	130	250	300	400
OXOBOXO BROOK					
At confluence with Horton Cove	11.92	860	1,400	1,700	2,600
At Connecticut Turnpike (State Route 52)	10.86	840	1,400	1,700	2,500
At outlet of Rockland Pond	9.33	780	1,300	1,600	2,300
PACHUAG RIVER					
At confluence of Quinebaug River	63.1	1,150	1,825	2,150	3,050
At Gage1269.5 (Griswold)	53	1,000	1,575	1,875	2,650
At Glasgo Dam between Pachaug and Glasgo Ponds	37.8	763	1,206	1,435	2,022

*No Data Available

TABLE 5 – SUMMARY OF DISCHARGES - continued

FLOODING SOURCE AND LOCATION	DRAINAGE AREA (SQUARE MILES)	PEAK DISCHARGES (CUBIC FEET PER SECOND) 10-PERCENT ANNUAL CHANCE	2-PERCENT ANNUAL CHANCE	1-PERCENT ANNUAL CHANCE	0.2-PERCENT ANNUAL CHANCE
PACHUAG RIVER (TOWN OF VOLUNTOWN)					
At downstream Griswold-Voluntown corporate limits	29.6	*	*	2,100	*
Upstream of confluence of Mount Misery Brook	15.2	*	*	1,300	*
Upstream of confluence of Great Meadow brook	7.11	*	*	400	*
PATTAGANSETT RIVER					
At Long Island Sound	8.91	610	1,000	1,200	1,800
At State Route 156	7.53	560	930	1,100	1,700
At confluence with Dodge Pond Branch	6.7	500	840	1,000	1,500
At Interstate Route 95	4.98	450	740	900	1,400
At Pattagansett Lake outfall	3.83	390	640	780	1,200
PAWCATUCK RIVER					
Upstream of confluence of Shunock	279.2	3,300	4,600	5,200	6,850
PINE SWAMP BROOK					
Above Mill Cove	2.13	210	375	475	790
QUINEBAUG RIVER					
Upstream of confluence of Broad Brook	717	9,514	17,125	21,565	38,055
Upstream of confluence of Pachaug River	651	8,500	15,500	18,038	36,077

*No Data Available

TABLE 5 – SUMMARY OF DISCHARGES - continued

FLOODING SOURCE AND LOCATION	DRAINAGE AREA (SQUARE MILES)	PEAK DISCHARGES (CUBIC FEET PER SECOND) 10-PERCENT ANNUAL CHANCE	2-PERCENT ANNUAL CHANCE	1-PERCENT ANNUAL CHANCE	0.2-PERCENT ANNUAL CHANCE
QUINEBAUG RIVER – cont'd					
At confluence with Shetucket River	744	9,799	17,639	22,212	39,197
SHETUCKET RIVER					
Upstream of confluence of Qunebaug River	516	13,200	25,200	32,400	57,600
Junction at Quinebaug River (Norwich)	516	13,200	25,200	32,400	57,600
Junction at Tributary D (Norwich, Preston)	1,269	22,100	36,300	45,100	76,600
Junction at Little River (Norwich, Sprague)	465	12,100	23,100	29,700	52,800
SHEWVILLE BROOK					
At Shewville Road	11.8	550	1,010	1,290	2,150
SHUNOCK RIVER					
At confluence with Pawtucket River	16	1,036	1,586	2,016	3,058
At State Route 184	13.8	944	1,456	1,853	2,819
At Rocky Hollow Road (North Stonington)	8	596	917	1,165	1,775
SPAULDING POND BROOK					
At Chestnut Avenue (Norwich)	0.98	140	230	300	370
At Mohegan Park Road No. 2 (Norwich)	0.5	85	140	180	220

TABLE 5 – SUMMARY OF DISCHARGES - continued

FLOODING SOURCE AND LOCATION	DRAINAGE AREA (SQUARE MILES)	PEAK DISCHARGES (CUBIC FEET PER SECOND) 10-PERCENT ANNUAL CHANCE	2-PERCENT ANNUAL CHANCE	1-PERCENT ANNUAL CHANCE	0.2-PERCENT ANNUAL CHANCE
SUSQUETONSCUT BROOK (TOWN OF FRANKLIN)					
At Franklin corporate limits	15.8	1,080	1,790	2,180	3,200
At Meeting House Hill Road (Franklin)	12.7	930	1,540	1,870	2,750
SUSQUETONSCUT BROOK (TOWN OF LEBANON)					
At Franklin-Lebanon corporate limits	10.9	*	*	2,470	*
Upstream from Route 207	5.65	*	*	1,900	*
Upstream from Chappel Road (Lebanon)	4.41	*	*	1,500	*
Upstream from confluence of Burgess Brook	2.53	*	*	822	*
TENMILE RIVER					
At its confluence with the Williamantic River	17	*	*	3,000	*
Upstream of confluence of Giffords Brook	6.09	*	*	1,500	*
THAMES RIVER	*	*	*	*	*
TRADING COVE BROOK					
At confluence with Trading Cove	13.4	1,240	2,100	2,380	400

*No Data Available

TABLE 5 – SUMMARY OF DISCHARGES - continued

FLOODING SOURCE AND LOCATION	DRAINAGE AREA (SQUARE MILES)	PEAK DISCHARGES (CUBIC FEET PER SECOND) 10-PERCENT ANNUAL CHANCE	2-PERCENT ANNUAL CHANCE	1-PERCENT ANNUAL CHANCE	0.2-PERCENT ANNUAL CHANCE
TRADING COVE BROOK - continued					
At Connecticut Turnpike (State Route 52)	8.57	900	1,540	1,740	2,980
TRIBUTARY A					
At its confluence with Birch Plain Creek	1.39	170	270	330	500
At. U.S. Route 1	0.90	150	250	300	440
Junction at Norwichtown Brook	0.72	160	270	350	420
TRIBUTARY B (Norwich)					
Junction at Yantic River	0.98	240	430	560	670
Junction at Bobbin Mill Brook	0.52	110	200	260	310
TRIBUTARY C (Norwich)					
Junction at Shetucket River	0.09	30	60	80	90
TRIBUTARY D					
At Saint Regis Avenue (Norwich)	0.22	70	130	175	200
Junction at Shetucket River	0.47	130	240	315	375
TRIBUTARY E					
Junction at Tributary D (Norwich)	0.09	35	60	80	90
TRIBUTARY F					
At Dunham Street (Norwich)	0.13	50	98	130	153

TABLE 5 – SUMMARY OF DISCHARGES - continued

FLOODING SOURCE AND LOCATION	DRAINAGE AREA (SQUARE MILES)	PEAK DISCHARGES (CUBIC FEET PER SECOND) 10-PERCENT ANNUAL CHANCE	2-PERCENT ANNUAL CHANCE	1-PERCENT ANNUAL CHANCE	0.2-PERCENT ANNUAL CHANCE
TRIBUTARY F - continued					
At Woodside Street (Norwich)	0.05	24	48	65	75
WHITFORD BROOK					
At its confluence with Mystic River	15.03	1,400	2,200	2,700	4,000
At the inlet to Hyde Pond	13.79	1,250	1,950	2,400	3,550
Downstream of Long Pond	4.6	620	800	900	1,110
Below Long Pond	4.56	620	800	884	1,100
Below Lee Brook	4.31	620	800	900	1,110
WILLIAMS BROOK	*	*	*	*	*
YANTIC RIVER					
Junction at Bobbin Mill Brook	95.65	5,650	10,360	11,530	23,655
At USGS gaging station (Norwich)	90	5,400	9,900	11,015	22,600
At Franklin-Norwich town line	89.3	5,400	9,900	11,015	22,600
At the Bozrah-Norwich corporate limits	88.3	5,400	9,900	11,015	22,600
Below Susquetonscut Brook	86.5	5,300	9,700	10,800	22,100
Above Susquetonscut Brook	70.7	4,560	8,360	9,300	19,000
At Fitchville Road	52.7	3,700	6,800	7,600	15,500

*No Data Available

TABLE 5 – SUMMARY OF DISCHARGES - continued

FLOODING SOURCE AND LOCATION	DRAINAGE AREA (SQUARE MILES)	PEAK DISCHARGES (CUBIC FEET PER SECOND) 10-PERCENT ANNUAL CHANCE	2-PERCENT ANNUAL CHANCE	1-PERCENT ANNUAL CHANCE	0.2-PERCENT ANNUAL CHANCE
YANTIC RIVER – continued					
Upstream of confluence with Pease Brook	39.4	3,030	5,550	6,180	12,680
At Gilman Dam	38.6	2,990	5,470	6,020	12,500
Upstream of confluence of Polly Brook	37	*	*	5,690	*
Upstream of confluence of Waterman Brook	36.4	*	*	5,460	*
Upstream of confluence of Gillette Brook	34.7	*	*	4,580	*
Upstream of confluence of Goshen Brook	33	*	*	4,100	*

*No Data Available

The stillwater elevations have been determined for the 10-, 2-, 1-, and 0.2-percent-annual-chance floods for the flooding sources studied by detailed methods and are summarized in Table 6, "Summary of Pond Stillwater Elevations."

TABLE 6 – SUMMARY OF POND STILLWATER ELEVATIONS

FLOODING SOURCE AND LOCATION	ELEVATION (feet NAVD[1]) 10-PERCENT ANNUAL CHANCE	2-PERCENT ANNUAL CHANCE	1-PERCENT[2] ANNUAL CHANCE	0.2-PERCENT ANNUAL CHANCE
AMSTON LAKE				
Entire shoreline within the community of Lebanon	*	*	526.1	*
GLASCO POND				
Entire shoreline within the community of Griswold	184.7	185.3	185.6	186.3

[1] North American Vertical Datum of 1988
*Data Not Available

TABLE 6 – SUMMARY OF POND STILLWATER ELEVATIONS - continued

FLOODING SOURCE AND LOCATION	ELEVATION (feet NAVD[1]) 10-PERCENT ANNUAL CHANCE	2-PERCENT ANNUAL CHANCE	1-PERCENT[2] ANNUAL CHANCE	0.2-PERCENT ANNUAL CHANCE
PACHAUG POND				
Entire shoreline within community of Griswold	158.1	158.6	158.8	159.3
RED CEDAR LAKE				
Entire shoreline within community of Lebanon	*	*	440.1	*
WILLIAMS POND				
Entire shoreline within the community of Lebanon	*	*	446.1	*

[1] North American Vertical Datum of 1988
*Data Not Available

3.2 Riverine Hydraulic Analyses

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

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

Cross section data for the below-water sections were obtained from field surveys and/or topographic maps compiled from aerial photographs. Cross sections were located at close intervals above and below bridges, culverts, and dams in order to compute the significant backwater effects of these structures. In addition, cross sections were taken between hydraulic controls whenever warranted by topographic changes.

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

The hydraulic analyses for the July 18, 2011 study were based on unobstructed flow. The flood elevations shown on the Flood Profiles (Exhibit 1) are thus considered valid only if hydraulic structures remain unobstructed, operate properly, and do not fail.

For flooding sources studied by approximate methods, only 1-percent-annual-chance flood elevations were computed.

For the communities of Stonington and Noank Fire District, no flood profiles existed in their precountywide FISs, thus no flood profiles exist for those reaches of streams in this countywide FIS. For the Pawcatuck River in the Town of Stonington, the Washington County, Rhode Island FIS was used to create Flood Profiles. For the Town of Groton, the Flood Hazard Boundary Map (FHBM) did not cover the entire town, thus some cross-sections and floodways that appear on the profiles do not appear on the countywide FIRM. Where available, cross-sections for these communities were taken off of their respective FHBMs and are shown on this countywide FIRM (Exhibit 2). In some cases cross-section data was missing from the precountywide FHBMs, and thus could not be reproduced for the July 18, 2011 countywide FIS.

For the Fourmile River in Old Lyme, cross-sections and Flood Profiles were created using data from the precountywide East Lyme FIS.

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

<u>Precountywide Analyses</u>

Water-surface elevations for Birch Plain Creek, Bobbin Mill Brook, Eccleston Brook, Fishtown Brook, Ford Brook, Fort Hill Brook, Great Plain Brook, Goldmine Brook, Hunter Brook, Norwichtown Brook, Oxoboxo Brook, Spaulding Pond Brook, Shetucket River, Thames River, Trading Cove Brook, Tributary A, Tributary B, Tributary C, Tributary D, Tributary E, Tributary F, Yantic River, and Yantic River East Channel, were computed using the USACE HEC-2 step-backwater computer program (Reference 57). Water-surface elevations for the revised portions of Norwichtown Brook were computed using the USDA NRSC WSP-2 computer program (Reference 58).

At various locations along the streams in Norwich, the analysis indicates that flow would be supercritical. Because of the inherent instability of supercritical flow, critical depth was assumed at those locations when establishing the profile elevations for the July 18, 2011 study. Water-surface elevations on the Thames River were started at a cross section located 0.68 river miles downstream of the corporate limits. Two backwater evaluations were performed and the elevations obtained from the higher of the two evaluations were used in the profiles. The first evaluation utilized the 10-, 2-, 1-, and 0.2-percent-annual-chance tidal elevations with smaller riverine flows used in the backwater. The riverine flows used were 10-, 2-, l-, and 0.2-percent-annual-chance flows, respectively. The second evaluation utilized the 10-, 2-, 1-, and 0.2-percent-annual-chance flows backwatered from a normal tidal elevation, specifically meaning the spring high tide. The tidal flow dominated throughout the studied reach of Thames. At approximate River Mile 1.06 on the Shetucket River, the riverine flow dominated and was used from this point on upstream. The starting water-surface elevations for all upstream tributaries were taken directly from the profiles of the downstream river at their confluence.

In the Norwich, March 15, 1994 revision, starting water-surface elevations for the Yantic River were computed using the discharge capacity rating curve for Mill Dam No. 2. Starting water-surface elevations for Trading Cove Brook were obtained from the HEC-2 data file prepared by Anderson-Nichols and Company, Inc. Starting water-surface elevations for the revised portion of Norwichtown Brook were computed based on historical flooding where the starting water-surface elevations for the 1-, and 0.2-percent-annual-chance floods were based on the 5-year discharge for the Yantic River. Starting water-surface elevations for Hunter Brook were computed assuming critical depth at the downstream end of the railroad culvert, located at the confluence with the Shetucket River. The HEC-2 Graphical Method for Solving Island Divided Flows was used to determine the peak discharge and natural flood elevations (without tidal effects) for the east and west channels of the Yantic River where it is separated by Holly Lock Island (Reference 57). Since the majority of the flow is carried in the west channel, it will be referred to as the Yantic River. The east channel will be referred to as the Yantic River East Channel.

Starting water-surface elevations for the Shetucket River outside of Norwich were taken from the FIS for the City of Norwich (Reference 55).

Starting water-surface elevations for Birch Plain Creek, Tributary A, Fort Hill Brook, Eccleston Brook, Fishtown Brook, and Whitford Brook (Town of Groton) were determined by combining the mean spring tide levels and the coastal storm surge levels for the various recurrence intervals. Approximate flood elevations for the upper portion of Tributary A were determined from normal depth calculations.

Because tidal influence predominates throughout the reaches of the Thames River, the starting water-surface levels for Oxoboxo Brook were estimated between the mean spring tide levels and the storm surge levels of the Thames River for the various return frequency floods. Starting water-surface elevations for Trading Cove Brook were obtained from the HEC-2 data file prepared by Anderson-Nichols and Company, Inc., prepared for the FIS for the City of Norwich (Reference 44).

Water-surface elevations for Beaver Brook (Town of Sprague), Blissville Brook, Green Fall River, Joe Clark Brook (Town of Preston), Little River, Pawcatuck River, Shunock River, and Whitford Brook (North Stonington) were computed using the USACE HEC-2 step-backwater computer program (Reference 57). Starting water-surface elevations for Beaver Brook (Town of Sprague), Blissville Brook, and the Little River were determined using the slope/area method. Starting water-surface elevations for Joe Clark Brook in Preston were taken from the FIS for the City of Norwich and the Town of Ledyard (References 54 and 55). Starting water-surface elevations for the Shunock and Green Fall Rivers were calculated using critical depth. For the Pawcatuck River and Whitford Brook, starting water-surface elevations were obtained by normal depth calculations

Starting water-surface elevations for Flat Brook, Pine Swamp Brook, Joe Clark Brook, Shewville Brook, Williams Brook, and Whitford Brook in Ledyard were obtained by normal depth calculations, critical depth was used on streams where structures were at the beginning of the run. Water-surface elevations for the streams studied in detail were computed using the USACE HEC-2 step-backwater computer model (Reference 57). This was supplemented by analysis using the SCS WSP-2 computer step-backwater model (Reference 59), for a complex condition on Pine Swamp Brook at Harvard Terrace. Profiles of tributaries were based on normal depth conditions at the downstream ends. Cross section data for these flood sources were obtained from field surveys. All bridges and culverts within detailed study areas were field surveyed to obtain elevation data and structural geometry.

For Denison Brook, Great Meadow Brook, Pachaug River (Town of Voluntown), the 1-percent-chance-annual flood elevations were determined using a USGS regional analysis that relates depth of flooding to basin drainage area. Approximately 100 gaging station records were used to develop a relationship between depth in the channel at each USGS gaging station versus the drainage area of each station (Reference 60). Changes in flood elevations caused by hydraulic structures such as dams, culverts, or bridges were computed using the appropriate survey technique (References 61 through 63). For the Pachaug River (Town of Voluntown), the discharge at the downstream corporate limits was used to check the corresponding flood elevation at Pachaug Pond Dam downstream of Voluntown in the Town of Griswold using USGS techniques for dam computations (Reference 61). Water-surface elevations of floods of the selected recurrence intervals were then used along with topographic maps at a scale of 1:24,000 with a contour interval of 10 feet to determine the extent of flooding (Reference 64). Flood profiles were drawn showing computed water-surface elevations for floods of the selected recurrence intervals.

Water-surface elevations for the East Branch Eight Mile River and Harris Brook in Salem were computed through the use of the USACE HEC-2 computer program (Reference 65). Starting water-surface elevations for the East Branch Eight Mile River were calculated using the slope/area method. Starting water-surface elevations for Harris Brook were taken from the last cross section on the East Branch Eight Mile River. Flood profiles were drawn showing computed water-surface elevations to an accuracy of 0.5 foot for floods of the selected intervals.

Water-surface profiles for the Eight Mile River and Beaver Brook (Town of Lyme) were developed using the SCS WSP2 computer step-backwater model (Reference 58). Profiles were determined for the 10-, 2-, 1-, and 0.2-percent-chance-annual floods using a starting elevation at the l0- percent-chance-annual floodtide. Analyses of levels of the Connecticut River and Long Island Sound were conducted by the USACE, New England Division. The elevations used for 10-, 2-, 1-, and 0.2-percent-chance-annual flood levels were obtained from the USACE publication, "Tidal Hydrology" (Reference 5). These elevations were extended into the Eight Mile River until they intersected the riverine stage for the appropriate frequency event. Flooding limits on stream studied by approximate methods were based on hydrologic considerations and visual inspection.

Water-surface elevations for Gardner Brook, Jordan Brook, and Nevins Brook, were computed using the USACE HEC-2 step-backwater computer program (Reference 57). Starting water-surface elevations for Gardner Brook were developed using normal depth calculations at the confluence with the Yantic River. Starting water surface elevations for Jordan Brook, and Nevins Brook were estimated between the mean spring tide and the coastal storm surge levels for the various return frequency floods.

Flood elevations for the Susquetonscut Brook in Franklin were determined using the HEC-2 step-backwater computer program (Reference 65). Starting water-surface elevations on Susquetonscut Brook were calculated using the slope/area method at the mouth (approximately 2,000 feet downstream from the corporate limits).

Water-surface elevations for the Fourmile River, Pattagansett River and Latimer Brook were computed using the USACE HEC-2 step-backwater computer program (Reference 57). Starting water-surface elevations were calculated between the mean spring tide levels and the coastal storm surge levels for the various return frequency floods. Comparisons of the profiles of the floods of the selected recurrence intervals were made with the estimated profiles and elevations of historic floods reasonable correlation was evident. The estimated profiles and elevations were obtained by field observations and interviews with town officials and local citizens. Starting water-surface elevations for Latimer Brook in Montville were obtained from the water-surface elevation at the downstream contiguous community of East Lyme.

In the December 15, 1981 FIS for Colchester, starting water-surface elevations for Meadow Brook were obtained from normal depth calculations, while the starting water-surface elevation for the Jeremy River was taken from the initially determined Meadow Brook profile at the point of confluence. In the July 15, 1992, FIS, starting water-surface elevations for the restudied portion of Meadow Brook (approximately 2,140 feet downstream of Levy Road to a point approximately 3,250 feet upstream of State Route 16) and for Day Meadow Brook were obtained by computing the critical depth at their downstream limits. Starting water-surface elevations for Judd Brook were obtained from normal depth calculations. Flood profiles were drawn showing computed water-surface elevations for floods of the selected recurrence intervals.

Except for in Griswold, water-surface elevations for the Quinebaug and Pachaug Rivers were computed through the use of the USACE HEC-2 step-backwater computer model (Reference 57). Starting water-surface elevations for the Quinebaug and Pachaug Rivers were determined using the slope/area method.

Water-surface elevations for the Quinebaug River and the Pachaug River in Griswold were computed using the USACE HEC-2 step-backwater computer model (Reference 66). Starting water-surface elevations for the Quinebaug River and the Pachaug River were determined using the slope/area method.

Water-surface elevations for the Yantic River in Bozrah and Norwich were computed using the USACE HEC-2 step-backwater computer program (Reference 57). In the Bozrah, March 30, 1981 study and in the November 2, 1995 revision, starting water-surface elevations for the Yantic River were obtained from the FIS for the City of Norwich (Reference 55).

Flood elevations for the Yantic River in Franklin were determined using the HEC-2 step-backwater computer program (Reference 65). Starting water-surface elevations for the Yantic River were taken from the FIS for the City of Norwich, Connecticut (Reference 56).

Streambed elevations for Susquetonscut Brook, Tenmile River, and Yantic River in Lebanon were plotted on the flood profiles and were determined both by field surveys at structures such as dams, culverts, and bridges, and from contours crossing the stream channel on the topographic maps at a scale of 1:24,000 with a contour interval of 10 feet (Reference 64). Streambed elevations for the Yantic River were taken directly from the channel encroachment line report (Reference 67). For Susquetonscut Brook and the Tenmile River, the 1-percent-chance-annual flood elevations were determined using a USGS regional analysis that relates depth of flooding to basin drainage area. Approximately 100 gaging station records were used to develop a relationship between depth in the channel at each USGS gaging station versus the drainage area of each station (Reference 68). Changes in flood elevations caused by hydraulic structures such as dams, culverts, or bridges were computed using the appropriate survey technique (References 58, 60, & 64). The 1-percent-annual-chance flood elevations for the Yantic River were determined as part of a recent report on the establishment of channel encroachment lines and floodplain delineation (Reference 67). Results from the Yantic River were reviewed and the published 1-percent-annual-chance flood elevations were incorporated directly in this report. Water-surface elevations of floods of the selected recurrence intervals were then used along with topographic maps at a scale of 1:24,000 with a contour interval of 10 feet and the channel encroachment line report to determine the extent of flooding (References 33 and 69).

July 18, 2011 Countywide Analyses

For the July 18, 2011 countywide revision, no new hydraulic analyses were conducted.

Roughness factors (Manning’s “n” values) used in the hydraulic computations were determined from field observations, guided by U.S. Geological Water Supply Publications. Table 7, “Mannning’s “n” values” shows the channel and overbank “n” values for the streams studied by detailed methods:

TABLE 7 – MANNING’S “n” VALUES

Flooding Source	Channel "n"	Overbanks “n”
Beaver Brook (Town of Lyme)	0.025-0.075	0.025-0.075
Beaver Brook (Town of Sprague)	0.035 - 0.045	0.040 - 0.090
Birch Plain Creek	0.018-0.030	0.020-0.070
Blissville Brook	0.025 - 0.055	0.050 - 0.070
Bobbin Mill Brook	0.040 - 0.060	0.060 - 0.120
Day Meadow Brook	0.04	0.070 - 0.080
Denison Brook	*	*
East Branch Eight Mile River	0.035	0.07

*Data Not Available

TABLE 7 – MANNING'S "n" VALUES - continued

Flooding Source	Channel "n"	Overbanks "n"
Eccleston Brook	0.015-0.070	0.020-0.100
Eight Mile River	0.025-0.075	0.025-0.075
Fishtown Brook	0.015-0.070	0.020-0.100
Flat Brook	0.015 - 0.050	0.050 - 0.080
Ford Brook	0.040 - 0.060	0.060 - 0.120
Fort Hill Brook	0.030-0.080	0.015-0.080
Fourmile River	0.020 - 0.080	0.030 - 0.070
Gardner Brook	0.030 - 0.040	0.070 - 0.085
Goldmine Brook	0.040 - 0.060	0.060 - 0.120
Great Meadow Brook	*	*
Great Plain Brook	0.040 - 0.060	0.060 - 0.120
Green Fall River	0.035 -0.070	0.030 - 0.050
Harris Brook	0.035	0.07
Hunter Brook	0.040 - 0.060	0.030 - 0.200
Jeremy River	0.030 - 0.040	0.045 - 0.080
Joe Clark Brook	0.030 - 0.035	0.050 - 0.060
Jordan Brook	0.015 - 0.080	0.030 - 0.080
Judd Brook	0.025 - 0.050	0.060 - 0.080
Latimer Brook (East Lyme)	0.030 - 0.100	0.010 - 0.100
Latimer Brook (Montville)	0.030 - 0.045	0.040 - 0.120
Little River	0.040 - 0.050	0.050 - 0.060
Meadow Brook	0.035 - 0.040	0.060 - 0.070
Nevins Brook	0.015 - 0.060	0.030 - 0.080
Norwichtown Brook	0.035 - 0.045	0.050 - 0.085
Oxoboxo Brook	0.009 - 0.060	0.030 - 0.080
Pachaug River	0.020 - 0.050	0.025 - 0.060
Pachaug River (Town of Voluntown	*	*
Pattagansett River	0.01	0.010 - 0.020
Pawcatuck River	0.025 - 0.050	0.035 - 0.150
Pine Swamp Brook	0.030 - 0.055	0.050 - 0.075
Quinebaug River (Jewett City, Griswold)	0.020 - 0.050	0.035 - 0.085
Quinebaug River (Lisbon)	0.030 - 0.050	0.040 - 0.080
Quinebaug River (Preston)	0.030 - 0.045	0.040 - 0.060
Shetucket River (Lisbon, Preston)	0.050 - 0.080	0.08
Shetucket River (Norwich)	0.040 - 0.060	0.060 - 0.120
Shetucket River (Sprague)	0.030 - 0.080	0.040 - 0.090
Shewville Brook	0.035 - 0.050	0.035 - 0.080
Shunock River (N. Stonington)	0.030 - 0.055	0.030 - 0.100
Spaulding Pond Brook	0.040 - 0.060	0.060 - 0.120
Susquetonscut Brook (Town of Franklin)	0.035 - 0.060	0.06 - 0.12

*Data Not Available

TABLE 7 – MANNING'S "n" VALUES - continued

Flooding Source	Channel "n"	Overbanks "n"
Susquetonscut Brook (Town of Lebanon)	*	*
Ten Mile River	*	*
Thames River	*	*
Trading Cove Brook	0.060 - 0.100	0.080 - 0.120
Tributary A	0.016-0.080	0.030-0.080
Tributary B	0.040 - 0.060	0.060 - 0.120
Tributary C	0.040 - 0.060	0.060 - 0.120
Tributary D	0.040 - 0.060	0.060 - 0.120
Tributary E	0.040 - 0.060	0.060 - 0.120
Tributary F	0.040 - 0.060	0.060 - 0.120
Whitford Brook (Groton)	0.015-0.050	0.030-0.090
Whitford Brook (N. Stonington)	0.020 - 0.050	0.040 - 0.065
Williams Brook	0.024 - 0.060	0.035 - 0.080
Yantic River (Bozrah)	0.025 - 0.070	0.050 - 0.100
Yantic River (Franklin)	0.035 - 0.060	0.06 - 0.12
Yantic River (Norwich)	0.040 - 0.050	0.025 - 0.100
Yantic River East Channel	0.040 - 0.060	0.060 - 0.120

*Data Not Available

August 2013 Coastal Study Update

Based on the results of the new coastal analysis, the backwater elevations are revised where necessary. The flooding sources of Anguilla Brook, Birch Plain Creek, Connecticut River, Copps Brook, Eccleston Brook, Fort Hill Brook, Jordan Brook, Latimer Brook, Mill Brook, Pattagansett River, Pawcatucket River, Stony Brook, Thames River, Tributary A, Whitford Brook (Town of Groton) were revised for backwater elevations.

3.3 Coastal Hydrologic Analyses

In New England, the flooding of low-lying areas is caused primarily by storm surges generated by extra-tropical coastal storms called northeasters or nor'easters. Hurricanes also occasionally produce significant storm surges in New England, but they do not occur nearly as frequently as northeasters. Hurricanes in New England typically have a more severe impact on the south facing coastlines. Due to its geographic location, New London County is susceptible to flooding from both hurricanes and northeasters.

A northeaster is typically a large counterclockwise wind circulation around a low pressure. The storm is often as much as 1,000 miles wide, and the storm speed is approximately 25 mph as it travels up the eastern coast of the United States. Sustained wind speeds of 10-40 mph are common, with short-term wind speeds of up to 70 mph. Such information is available on synoptic weather charts published by the National Weather Service (Reference 70).

The stillwater elevation is the elevation of the water due to the effects of the astronomic tides and storm surge on the water surface. Hydrologic analyses carried out to establish the peak discharge-frequency relationships for Long Island Sound flooding sources affecting the communities of Town of East Lyme, City of Groton, Groton Long Point Association, Town of Groton, Noank Fire District, Town of Old Lyme, City of New London, Borough of Stonington, Town of Stonington and Town of Waterford, serve as a basis of coastal hydraulic analyses using detailed methods in accordance with Appendix D of the "Guidance for Coastal Flooding Analyses and Mapping," of the April 2003 FEMA "Guidelines and Specifications for Flood Hazard Mapping Partners" (Reference 71).

For this effective study, the 10-, 2-, 1-, and 0.2-percent-annual-chance floods for the nearest gages to New London County on Long Island Sound were obtained from the "Regional Frequency Analyses using L-Moments" memorandum developed by STARR (Reference 72) for areas subject to coastal flooding. Table 8 contains the stillwater elevations determined at the nearest tide gage stations to New London County. These values were linearly interpolated to all coastal transects throughout the county for use in coastal hydraulic analyses.

TABLE 8 - SUMMARY OF COASTAL STILLWATER ELEVATIONS

	Elevations in feet (NAVD 88)			
Flooding Source and Location	**10-percent-annual-chance**	**2-percent-annual-chance**	**1-percent-annual-chance**	**0.2-percent-annual-chance**
LONG ISLAND SOUND				
New London tide gage station 8461490 (41˚ 21.6' N, 72˚ 5.4' W)	4.8	7.4	9.4	17.7
New Haven tide gage station 8465705 (41˚ 17' N, 72˚ 54.5' W)	6.9	8.3	8.9	10.1
Newport tide gage station 8452660 (41° 30.3' N, 71° 19.6' W)	5.3	8.3	10.58	19.9

Transects (profiles) were located for coastal hydrologic and hydraulic analyses perpendicular to the average shoreline along areas subject to coastal flooding and extending inland to a point where wave action ceased in accordance with the "Users Manual for Wave Height Analysis" (Reference 73). Transects were placed with consideration of topographic and structural changes of the land surface, as well as the cultural characteristics of the land so that they would closely represent local conditions. Coastal transect topography data was obtained from Light Detection and Ranging (LiDAR) data collected in December 2006 by Terrapoint USA for Dewberry & Davis LLC. Data is accurate to 2-ft contours (Reference 74). Vertical accuracy is 0.33 ft at a 95-percent confidence interval. Bathymetric data was obtained from the National Oceanographic and Atmospheric Administration (NOAA) National Ocean Service (NOS) Hydrographic Data Base (NOSHDB) and Hydrographic Survey Meta Data Base (HSMDB) (NOAA, May 27, 2010) (Reference 75). The sounding datum of mean low low water (MLLW) was converted to vertical datum NAVD88.

Transects were spaced close together in areas of complex topography and dense development. In areas having more uniform characteristics, transects were spaced at larger intervals. It was also necessary to locate transects in areas where unique flooding existed and in areas where computed wave heights varied significantly between adjacent transects.

3.4 Coastal Hydraulic Analyses

Wave height is the distance from the wave trough to the wave crest. The height of a wave is dependent upon wind speed and duration, water depth, and length of fetch. Offshore (deep water) and near shore (shallow water) heights and wave periods were calculated for restricted and unrestricted fetch settings following the methodology described in the February 2007 FEMA "Atlantic Ocean and Gulf of Mexico Coastal Guidelines Update" (Reference 76), for each coastal transect.

An extremal analysis of historical wind gage records was performed to determine the thresholds for peak wind speeds using three Peaks Over Threshold (POT) statistical methods. The wind speeds calculated from the extremal analysis for Groton Airport/New London, and the resulting value was used for New London County wave height calculations at each coastal transect location. Wind speed data sets used in the extremal analyses were for the period January 1943 – May 2010.

Wave setup was assumed to be an important factor in determining total water level, since the coastline has historically experienced flooding damage above the predicted storm surge elevations. Wave setup is based upon wave breaking characteristics and profile slope. As stated in the "Atlantic Ocean and Gulf of Mexico Coastal Guidelines Update" (Reference 76), "Wave setup can be a significant contributor to the total water level landward of the +/- MSL shoreline and should be included in the determination of coastal BFEs." Wave setup values were calculated to the entire open coast shoreline in each community. Wave setup for each coastal transect was calculated by the Direct Integration Method (DIM) developed by Goda (2000) as described in the FEMA "Atlantic Ocean and Gulf of Mexico Coastal Guidelines Update" (Reference 76). For those coastal transects where a structure was located, the wave setup against the coastal structure was also calculated. For profiles with vertical structures or revetments, a failed structure analysis was performed and a new profile of the failed structure was generated and analyzed, in accordance with the USACE, Coastal Engineering Research Center report "Criteria for Evaluating Coastal Flood Protection Structures," (TR CERC-89-15) (Reference 77). The more conservative result of the two analyzed conditions was mapped.

Erosion analysis using FEMA's Coastal Hazard Analysis Modeling Program (CHAMP) Version 2.0 (Reference 78) was performed for profiles with erodible dunes and without coastal structures, such as vertical walls or revetments. The dune subject to erosion is a sandy feature with potentially light vegetation. Any thickly vegetated, rocky, silty, or clayey dune features or bluffs are assumed not subject to erosion. Predicted post-storm erosion profiles were used for analysis of wave heights associated with coastal storm surge flooding, where appropriate.

The methodology for analyzing the effects of wave heights is described in a report entitled “Methodology for Calculating Wave Action Effects Associated with Storm Surges,” prepared by the National Academy of Sciences (Reference 79). This method is based on three major concepts. First, depth-limited waves in shallow water reach maximum breaking height that is equal to 0.78 times the stillwater depth. The wave crest is 70 percent of the total wave height above the stillwater level. The second major concept is that wave height may be diminished by dissipation of energy due to the presence of obstructions such as sand dunes, dikes and seawalls, buildings, rising topography, and vegetation. The amount of energy dissipation is a function of the physical characteristics of the obstruction and is determined by procedures prescribed in the NAS report. The third major concept is that wave height can be regenerated in open fetch areas due to the transfer of wind energy to the water. This added energy is related to fetch length and depth.

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

Areas of the coastline subject to significant wave attack are referred to as coastal high hazard zones. The USACE has established the 3-foot breaking wave as the criterion for identifying the limit of coastal high hazard zones (Reference 80). The 3-foot wave has been determined as the minimum size wave capable of causing major damage to conventional wood frame or brick veneer structures. This criterion has been adopted by FEMA for the determination of V-zones.

It has been shown in laboratory tests and observed in post storm damage assessments that wave heights as little as 1.5 feet can cause damage to and failure of typical Zone AE construction. Therefore, for advisory purposes only, a Limit of Moderate Wave Action (LiMWA) boundary has been added in coastal areas subject to moderate wave action. The LiMWA represents the approximate landward limit of the 1.5-foot breaking wave, and was delineated for all areas subject to significant wave attack in accordance with “Procedure Memorandum No. 50 – Policy and Procedures for Identifying and Mapping Areas Subject to Wave Heights Greater than 1.5 feet as an Informational Layer on Flood Insurance Rate Maps (FIRMS)” (Reference 81).

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

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

Wave runup is the uprush of water caused by the interaction of waves with the area of shoreline where the stillwater hits the land or other barrier intercepting the stillwater level. The wave runup elevation is the vertical height above the stillwater level ultimately attained by the extremity of the uprushing water. Wave runup at a shore barrier can provide flood hazards above and beyond those from stillwater inundation. Guidance in the February 2007 FEMA "Atlantic Ocean and Gulf of Mexico Coastal Guidelines Update" (Reference 76) suggests using the 2-percent wave runup value, the value exceeded by 2 percent of the runup events. The 2-percent wave runup value is particularly important for steep slopes and vertical structures. Wave runup was calculated for each coastal transect using methods from the Shore Protection Manual (SPM) (Reference 82) for vertical structures, Technical Advisory Committee for Water Retaining Structures (TAW) method for sloped structures with a slope steeper than 1:8, and mean runup height calculated by the FEMA Wave Runup Model RUNUP 2.0 multiplied by 2.2 was used to obtain the 2-percent runup height for non-vertical structures and profiles with a slope less than 1:8, as described in the February 2007 "Atlantic Ocean and Gulf of Mexico Coastal Guidelines Update" to Appendix D, "Guidance for Coastal Flooding Analysis and Mapping" (Reference 76).

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

When runup overtops a barrier such as a partially eroded bluff or a structure, the floodwater percolates into the bed and/or runs along the back slope until it reaches another flooding source or a ponding area. Standardized procedures for the treatment of shallow flooding and ponding were applied as described in Appendix D of the "Guidance for Coastal Flooding Analysis and Mapping" (Reference 71).

Where uncertified coastal structures such as vertical walls and revetments were present, additional analysis for wave setup and wave runup was performed on profiles assuming the structure will partially fail during the base flood. The post-failure slopes applied for this analysis were 1:3 for sloped revetments, and 1:1.5 for vertical walls, which are within the range suggested by the February 2007 "Atlantic Ocean and Gulf of Mexico Coastal Guidelines Update" to Appendix D (Reference 76).

In accordance with 44 CFR Section 59.1 of the NFIP the effect of the PFD on coastal high hazard area (V Zone) mapping was evaluated for the Borough of Stonington, Groton Long Point Association, Noank Fire District, Cities of Groton and New London and Towns of East Lyme, Groton, Old Lyme, Stonington and Waterford. Identification of the PFD was based upon a FEMA approved numerical approach for analyzing the dune's dimensional characteristics. This approach utilized LiDAR data for the study areas (Reference 83) and assessed change in back slope to determine the landward toe of the PFD. In areas where the PFD defines the landward limit of the V Zone, the V Zone extends to the landward toe of the dune. The PFD defined the landward limit of the V Zone along portions of the shoreline only within the City New London and the Towns of Old Lyme and Waterford.

Because wave height calculations are based on such parameters as the size and density of vegetation, natural barriers such as sand dunes, buildings, and other man-made structures, detailed information on the physical and cultural features of the study area were obtained from aerial photography. LiDAR data of the shorelines of Borough of Stonington, Groton Long Point Association, Noank Fire District, Cities of Groton and New London and Towns of East Lyme, Groton, Old Lyme, Stonington and Waterford, was used for the topographic data. The land-use and land cover data were obtained from USGS 2008 High Resolution Orthoimagery for the Bridgeport, Hartford, and New Haven, Connecticut Urban Areas (Reference 84).

Figure 1, "Transect Schematic," represents a sample transect which illustrates the relationship between the stillwater elevation, the wave crest elevation, the ground elevation profile, and the location of the A/V zone boundary. Actual wave conditions may not include all the situations illustrated in Figure 1.

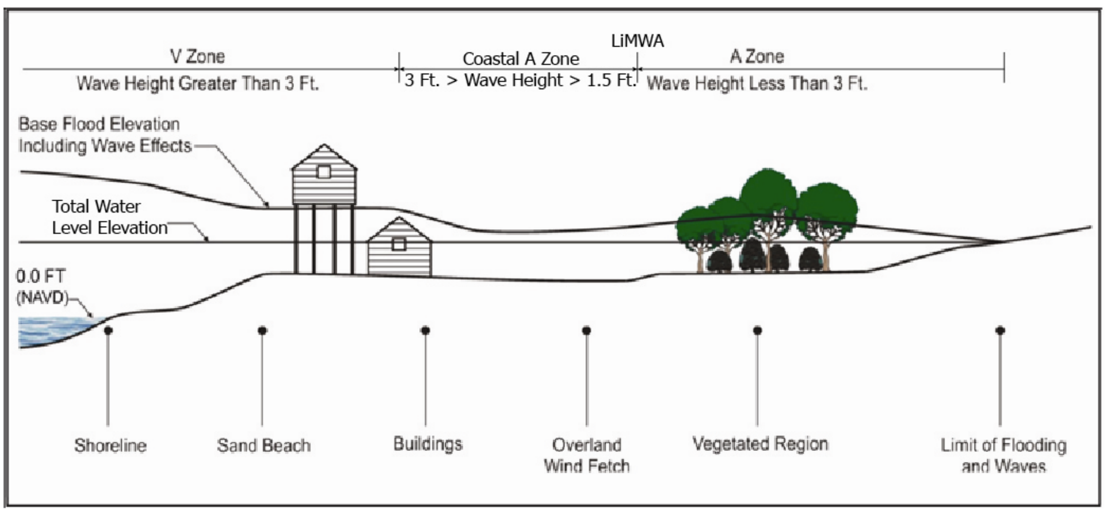

FIGURE 1 – TRANSECT SCHEMATIC

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

Along each transect, wave envelope elevations were computed considering the combined effects of changes in ground elevation, vegetation, and physical features. Between transects, elevations were interpolated using the previously cited topographic maps, land-use data, land-cover data, and engineering judgment to determine the areal extent of flooding. The results of the calculations are accurate until local topography, vegetation, or cultural development within the community undergoes any major changes.

Table 9 provides a description of the transect locations, the 1-percent-annual-chance coastal stillwater elevations, and the maximum 1-percent-annual-chance wave crest elevations. Figure 2, "Transect Location Map," illustrates the location of the transects for the county.

TABLE 9 - TRANSECT DESCRIPTIONS

Transect	Location	Elevation (Feet NAVD 88)		V Zone Mapping Method
		Stillwater 1-percent-annual-chance	Max. Wave Crest 1-percent-annual-chance[1]	
1	At the shoreline of Connecticut River, in the Town Of Old Lyme, Northern corporate limits to Raymond E. Baldwin Bridge	9.3	15	Runup
2	At the shoreline of Long Island Sound, in the Town Of Old Lyme, Raymond E. Baldwin Bridge to Noyes Road, Extended	9.3	14	Runup
3	At the shoreline of Long Island Sound, in the Town Of Old Lyme, Noyes Road, Extended to Osprey Road, Extended	9.3	15	Overland Wave Propagation
4	At the shoreline of Long Island Sound, in the Town Of Old Lyme, Osprey Road, Extended to Griswold Point, Extended	9.3	15	Overland Wave Propagation
5	At the shoreline of Long Island Sound, in the Town Of Old Lyme, Griswold Point, Extended to Springfield Road, Extended	9.3	15	Runup
6	At the shoreline of Long Island Sound, in the Town Of Old Lyme, Springfield Road, Extended to Glover Avenue, Extended	9.3	14	Runup
7	At the shoreline of Long Island Sound, in the Town Of Old Lyme, Glover Avenue, Extended to Prospect Street, Extended	9.3	15	Overland Wave Propagation
8	At the shoreline of Long Island Sound, in the Town Of Old Lyme, Prospect Street, Extended to Cutler Road, Extended	9.3	16	Overland Wave Propagation

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

TABLE 9 - TRANSECT DESCRIPTIONS - continued

Transect	Location	Elevation (Feet NAVD 88)		V Zone Mapping Method
		Stillwater 1-percent-annual-chance	Max. Wave Crest 1-percent-annual-chance [1]	
9	At the shoreline of Long Island Sound, in the Town Of Old Lyme, Cutler Road, Extended to Approximately 400 feet Northeast of Hatchett Point Road	9.3	18	Overland Wave Propagation
10	At the shoreline of Long Island Sound, in the Town Of Old Lyme, Approximately 400 feet Northeast of Hatchett Point Road to Hillcrest Road, Extended	9.3	14	Runup
11	At the shoreline of Long Island Sound, in the Town Of Old Lyme, Hillcrest Road, Extended to Eastern corporate limits	9.3	20	Wave Overtopping Splash Zone
12	At the shoreline of Long Island Sound, in the Town Of East Lyme, Western corporate limits to Approximately 300 feet Southwest of Hilltop Road	9.3	18	Overland Wave Propagation
13	At the shoreline of Long Island Sound, in the Town Of East Lyme, Approximately 300 feet Southwest of Hilltop Road to Lake Shore Drive	9.3	25	Wave Overtopping Splash Zone
14	At the shoreline of Long Island Sound, in the Town Of East Lyme, Lake Shore Drive, Extended to Pattagansett Road, Extended	9.3	16	Wave Overtopping Splash Zone
15	At the shoreline of Long Island Sound, in the Town Of East Lyme, Pattagansett Road, Extended to Great Wight Way, Extended	9.4	17	Overland Wave Propagation
16	At the shoreline of Long Island Sound, in the Town Of East Lyme, Great Wight Way, Extended to Approximately 400 feet East of West Lane, Extended	9.4	17	Wave Overtopping Splash Zone

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

TABLE 9 - TRANSECT DESCRIPTIONS - continued

Transect	Location	Elevation (Feet NAVD 88)		V Zone Mapping Method
		Stillwater 1-percent-annual-chance	Max. Wave Crest 1-percent-annual-chance [1]	
17	At the shoreline of Niantic Bay, in the Town Of East Lyme, Approximately 400 feet east of West Lane, Extended to Nehantic Drive, Extended	9.4	16	Wave Overtopping Splash Zone
18	At the shoreline of Niantic Bay, in the Town Of East Lyme, Nehantic Drive, Extended to Approximately 300 feet Northeast of Beach Avenue	9.4	14	Wave Overtopping Splash Zone
19	At the shoreline of Niantic Bay, in the Town Of East Lyme, Approximately 300 feet Northeast of Beach Avenue to Crescent Avenue, Extended	9.4	19	Runup
20	At the shoreline of Niantic Bay, in the Town Of East Lyme, Crescent Avenue, Extended to Haigh Avenue, Extended	9.4	15	Runup
21	At the shoreline of Niantic Bay, in the Town Of East Lyme, Haigh Avenue, Extended to Smith Avenue, Extended	9.4	17	Overland Wave Propagation
22	At the shoreline of Niantic Bay, in the Town Of East Lyme, Smith Avenue, Extended to Eastern corporate limits	9.4	18	Overland Wave Propagation
23	At the shoreline of Niantic Bay, in the Town Of Waterford, Western corporate limits to Approximately 2000 feet north of the Bay point	9.4	16	Overland Wave Propagation
24	At the shoreline of Long Island Sound, in the Town Of Waterford, Approximately 2000 feet north of the Bay point to Fox Island	9.4	16	Wave Overtopping Splash Zone
25	At the shoreline of Long Island Sound, in the Town Of Waterford, Fox Island to Gardiners Wood Road, Extended	9.4	15	Wave Overtopping Splash Zone

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

TABLE 9 - TRANSECT DESCRIPTIONS - continued

Transect	Location	Elevation (Feet NAVD 88)		V Zone Mapping Method
		Stillwater 1-percent-annual-chance	Max. Wave Crest 1-percent-annual-chance [1]	
26	At the shoreline of Long Island Sound, in the Town Of Waterford, Gardiners Wood Road, Extended to Anita Avenue, Extended	9.4	17	Overland Wave Propagation
27	At the shoreline of Long Island Sound, in the Town Of Waterford, Anita Avenue, Extended to Leonard Road, Extended	9.4	15	Runup
28	At the shoreline of Long Island Sound, in the Town Of Waterford, Leonard Road, Extended to Approximately 500 feet northwest of Magonk Point	9.4	15	Primary Frontal Dune
29	At the shoreline of Long Island Sound, in the Town Of Waterford, Approximately 500 feet northwest of Magonk Point to Magonk Point Road, Extended	9.4	14	Runup
30	At the shoreline of Long Island Sound, in the Town Of Waterford, Magonk Point Road, Extended to Westcot Road, Extended	9.4	16	Wave Overtopping Splash Zone
31	At the shoreline of Long Island Sound, in the Town Of Waterford, Westcot Road, Extended to Approximately 700 feet north of of Goshen Point	9.4	17	Runup
32	At the shoreline of Long Island Sound, in the Town Of Waterford, Approximately 700 feet north of of Goshen Point to Eastern corporate limits	9.4	16	Overland Wave Propagation
33	At the shoreline of Long Island Sound, in the City Of New London, Western corporate limits to Ocean Avenue, Extended	9.5	13	Runup

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

TABLE 9 - TRANSECT DESCRIPTIONS - continued

Transect	Location	Elevation (Feet NAVD 88)		V Zone Mapping Method
		Stillwater 1-percent-annual-chance	Max. Wave Crest 1-percent-annual-chance [1]	
34	At the shoreline of Long Island Sound, in the City Of New London, Ocean Avenue, Extended to Reyquinn Street, Extended	9.5	14	Wave Overtopping Splash Zone
35	At the shoreline of New London Harbor, in the City Of New London, Reyquinn Street, Extended to Chapel Drive, Extended	9.5	15	Wave Overtopping Splash Zone
36	At the shoreline of New London Harbor, in the City Of New London, Chapel Drive, Extended to Thames Street, Extended	9.5	13	Runup
37	At the shoreline of New London Harbor, in the City Of New London, Thames Street, Extended to Converse Place, Extended	9.5	13	Wave Overtopping Splash Zone
38	At the shoreline of New London Harbor, in the City Of New London, Converse Place, Extended to Walbach Street, Extended	9.5	15	Wave Overtopping Splash Zone
39	At the shoreline of New London Harbor, in the City Of New London, Walbach Street, Extended to Thames River - Gold Star Memorial Bridge	9.5	12	Runup
40	At the shoreline of Thames River, in the City Of New London, Gold Star Memorial Bridge to Northern corporate limits	9.5	15	Overland Wave Propagation
41	At the shoreline of Thames River, in the Town Of Groton, Southern corporate limits of Town of Waterford to Northern Corporate limits of Town of Groton	9.5	13	Overland Wave Propagation
42	At the shoreline of Thames River, in the Town Of Groton, Crystal Lake Road, Extended to Gold Star Memorial Bridge	9.6	13	Overland Wave Propagation

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

TABLE 9 - TRANSECT DESCRIPTIONS - continued

Transect	Location	Elevation (Feet NAVD 88)		V Zone Mapping Method
		Stillwater 1-percent-annual-chance	Max. Wave Crest 1-percent-annual-chance [1]	
43	At the shoreline of New London Harbor, in the City Of Groton, Gold Star Memorial Bridge to David Street, Extended	9.6	14	Wave Overtopping Splash Zone
44	At the shoreline of New London Harbor, in the City Of Groton, David Street, Extended to Bayview Avenue, Extended	9.6	17	Wave Overtopping Splash Zone
45	At the shoreline of New London Harbor, in the City Of Groton, Bayview Avenue, Extended to Rita Santacroce Drive, Extended	9.6	17	Overland Wave Propagation
46	At the shoreline of Long Island Sound, in the City Of Groton, Rita Santacroce Drive, Extended to 1st Street, Extended	9.6	18	Overland Wave Propagation
47	At the shoreline of Fishers Island Sound, in the City Of Groton, 1st Street, Extended to Pennsylvania Avenue, Extended	9.6	17	Overland Wave Propagation
48	At the shoreline of Fishers Island Sound, in the City Of Groton, Pennsylvania Avenue, Extended to GROTON-NEW LONDON AIRPORT	9.6	15	Overland Wave Propagation
49	At the shoreline of Fishers Island Sound, in the Town Of Groton, GROTON-NEW LONDON AIRPORT to Approxmiately 3000 feet west of Mumford Point	9.6	13	Runup
50	At the shoreline of Fishers Island Sound, in the Town Of Groton, Approxmiately 3000 feet west of Mumford Point to Mumford Cove	9.6	15	Runup
51	At the shoreline of Fishers Island Sound, in the Town Of Groton, Mumford Cove to Southern Coporate Limits	9.7	14	Runup

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

TABLE 9 - TRANSECT DESCRIPTIONS - continued

Transect	Location	Elevation (Feet NAVD 88) Stillwater 1-percent-annual-chance	Elevation (Feet NAVD 88) Max. Wave Crest 1-percent-annual-chance[1]	V Zone Mapping Method
52	At the shoreline of Fishers Island Sound, in the Groton long point association, Northern Coporate Limits to Island Circle	9.7	15	Runup
53	At the shoreline of Fishers Island Sound, in the Groton long point association, Island Circle to Approximately 1000 feet south of Beach Road	9.7	15	Wave Overtopping Splash Zone
54	At the shoreline of Fishers Island Sound, in the Groton long point association, Approximately 1000 feet south of Beach Road to Tautog Street, Extended	9.7	15	Wave Overtopping Splash Zone
55	At the shoreline of Fishers Island Sound, in the Groton long point association, Tautog Street, Extended to Shore Avenue, Extended	9.7	16	Wave Overtopping Splash Zone
56	At the shoreline of Fishers Island Sound, in the Groton long point association, Shore Avenue, Extended to Cross Street, Extended	9.7	13	Runup
57	At the shoreline of Fishers Island Sound, in the Noank Fire District, Cross Street, Extended to Palmer Cove	9.7	16	Wave Overtopping Splash Zone
58	At the shoreline of Fishers Island Sound, in the Noank Fire District, Palmer Cove to West Cove	9.7	18	Overland Wave Propagation
59	At the shoreline of Fishers Island Sound, in the Noank Fire District, West Cove to Approximately 300 feet South of Chesbro Avenue	9.7	15	Wave Overtopping Splash Zone
60	At the shoreline of Fishers Island Sound, in the Noank Fire District, Approximately 300 feet South of Chesbro Avenue to Main Street, Extended	9.7	14	Wave Overtopping Splash Zone

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

TABLE 9 - TRANSECT DESCRIPTIONS - continued

Transect	Location	Elevation (Feet NAVD 88) Stillwater 1-percent-annual-chance	Elevation (Feet NAVD 88) Max. Wave Crest 1-percent-annual-chance[1]	V Zone Mapping Method
61	At the shoreline of Fishers Island Sound, in the Noank Fire District, Main Street, Extended to Cedar Road, Extended	9.7	14	Wave Overtopping Splash Zone
62	At the shoreline of Fishers Island Sound, in the Town Of Groton, Cedar Road, Extended to Eastern corporate limits	9.8	14	Wave Overtopping Splash Zone
63	At the shoreline of Fishers Island Sound, in the Town Of Stonington, Western corporate limits to Nauyaug Point Road, Extended	9.8	15	Wave Overtopping Splash Zone
64	At the shoreline of Fishers Island Sound, in the Town Of Stonington, Nauyaug Point Road, Extended to Cat Brier Lane, Extended	9.8	14	Wave Overtopping Splash Zone
65	At the shoreline of Fishers Island Sound, in the Town Of Stonington, Western corporate limits to Approximately 200 feet east of Dubois Drive, Extended	9.8	17	Overland Wave Propagation
66	At the shoreline of Fishers Island Sound, in the Town Of Stonington, Jackson Avenue, Extended to Masons Island Road	9.8	14	Overland Wave Propagation
67	At the shoreline of Fishers Island Sound, in the Town Of Stonington, Approximately 200 feet east of Dubois Drive, Extended to Shore Way, Extended	9.8	15	Runup
68	At the shoreline of Fishers Island Sound, in the Town Of Stonington, Shore Way, Extended to Shore Road ,Extended	9.8	15	Wave Overtopping Splash Zone
69	At the shoreline of Fishers Island Sound, in the Town Of Stonington, Shore Road ,Extended to Old Stonington Road ,Extended	9.8	14	Runup

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

<u>TABLE 9 - TRANSECT DESCRIPTIONS</u> – continued

Transect	Location	Elevation (Feet NAVD 88) Stillwater 1-percent-annual-chance	Elevation (Feet NAVD 88) Max. Wave Crest 1-percent-annual-chance[1]	V Zone Mapping Method
70	At the shoreline of Fishers Island Sound, in the Town Of Stonington, Old Stonington Road ,Extended to Noyes Avenue, Extended	9.8	16	Runup
71	At the shoreline of Fishers Island Sound, in the Town Of Stonington, Noyes Avenue, Extended to Intersection of Boulder Avenue and Hopkins Street	9.8	14	Overland Wave Propagation
72	At the shoreline of Fishers Island Sound, in the Town Of Stonington, Intersection of Boulder Avenue and Hopkins Street to Approximately 200 feet west of Open Way, Extended	9.8	16	Runup
73	At the shoreline of Fishers Island Sound, in the Town Of Stonington, Approximately 200 feet west of Open Way, Extended to Approximately 400 feet west of Wamphassuc Road	9.8	13	Runup
74	At the shoreline of Fishers Island Sound, in the Town Of Stonington, Approximately 400 feet west of Wamphassuc Road to North Street, Extended	9.8	15	Wave Overtopping Splash Zone
75	At the shoreline of Fishers Island Sound, in the Town Of Stonington, North Street, Extended to Western Corporate Limits of Borough of Stonington	9.8	14	Runup
76	At the shoreline of Fishers Island Sound, in the Town Of Stonington, Western Corporate Limits of Borough of Stonington to Alpha Avenue, Extended	9.9	16	Runup

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

TABLE 9 - TRANSECT DESCRIPTIONS – continued

Transect	Location	Elevation (Feet NAVD 88) Stillwater 1-percent-annual-chance	Elevation (Feet NAVD 88) Max. Wave Crest 1-percent-annual-chance [1]	V Zone Mapping Method
77	At the shoreline of Fishers Island Sound, in the Borough Of Stonington, Alpha Avenue, Extended to Trumbull Street, Extended	9.9	18	Runup
78	At the shoreline of Fishers Island Sound, in the Borough Of Stonington, Trumbull Street, Extended to Ash Street, Extended	9.9	17	Runup
79	At the shoreline of Fishers Island Sound, in the Borough Of Stonington, Ash Street, Extended to Bradley Street, Extended	9.9	17	Runup
80	At the shoreline of Fishers Island Sound, in the Borough Of Stonington, Bradley Street, Extended to Woodland Avenue, Extended	9.9	14	Wave Overtopping Splash Zone
81	At the shoreline of Fishers Island Sound, in the Town Of Stonington, Woodland Avenue, Extended to Approximately 1600 feet west of Wequetequock Passage	9.9	15	Runup
82	At the shoreline of Fishers Island Sound, in the Town Of Stonington, Intersection of Stonington Road and Elm Street to Palmer Neck Road	9.9	13	Runup
83	At the shoreline of Fishers Island Sound, in the Town Of Stonington, Approximately 1600 feet west of Wequetequock Passage to Brucker Pentway, Extended	9.9	14	Overland Wave Propagation
84	At the shoreline of Fishers Island Sound, in the Town Of Stonington, Brucker Pentway, Extended to Eastern corporate limits	9.9	14	Overland Wave Propagation

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

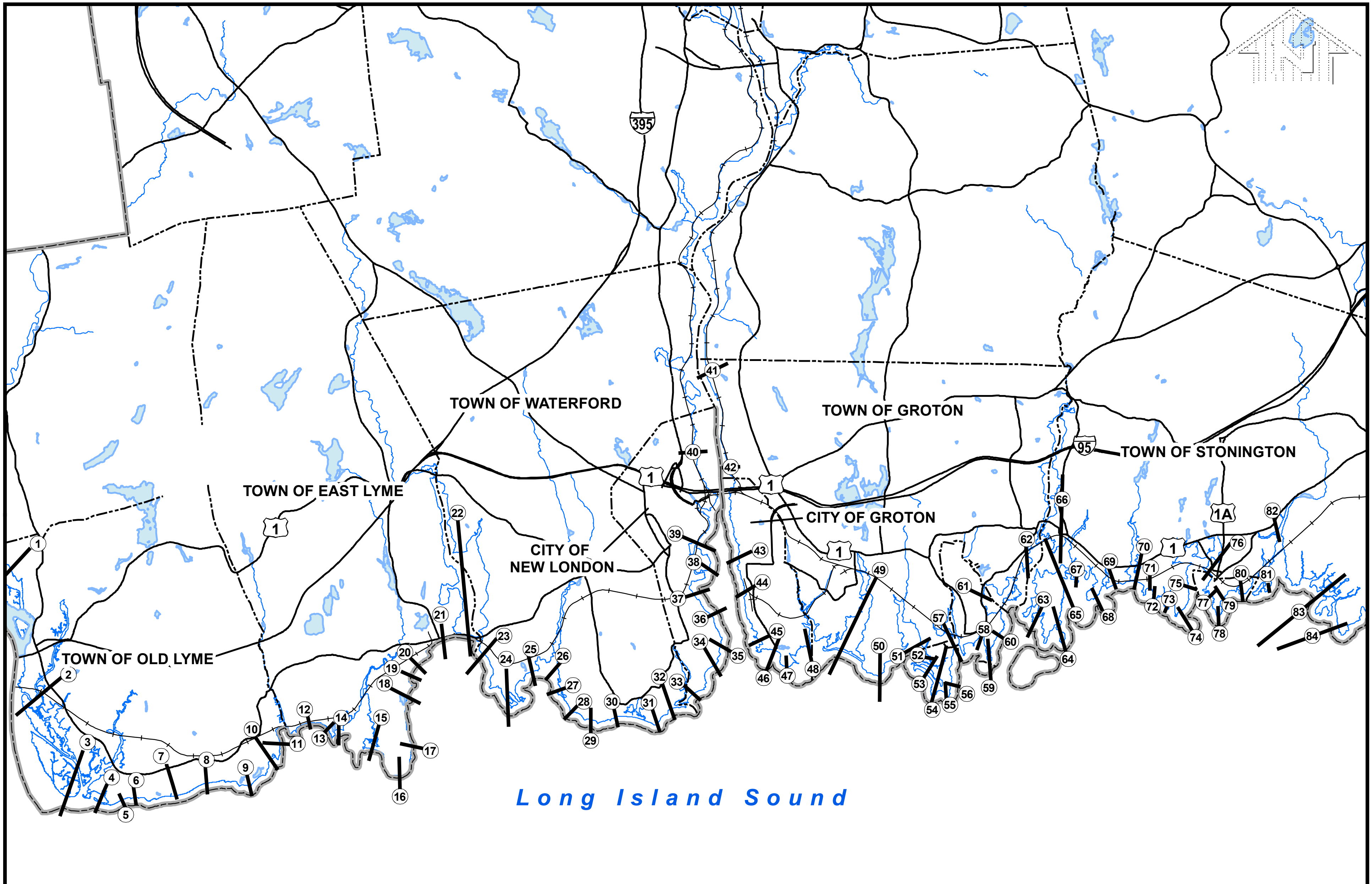

FIGURE 2

FEDERAL EMERGENCY MANAGEMENT AGENCY

NEW LONDON COUNTY, CT

(ALL JURISDICTIONS)

APPROXIMATE SCALE

0 16,000 32,000 48,000 64,000 Feet

TRANSECT LOCATION MAP

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

TABLE 10 - TRANSECT DATA

Flooding Source and Transect Number	**Stillwater Elevation**				**Total Water Level** [1]	**Zone**	**Base Flood Elevation (Feet NAVD 88)** [2]
	10-percent-annual-chance	**2-percent-annual-chance**	**1-percent-annual-chance**	**0.2-percent-annual-chance**	**1-percent-annual-chance**		
CONNECTICUT RIVER							
Transect 1	5.3	7.6	9.3	15.8	9.8	VE	13 - 15
						AE	*
LONG ISLAND SOUND							
Transect 2	5.3	7.6	9.3	15.9	10.0	VE	14
						AE	9 - 12
Transect 3	5.2	7.6	9.3	16.1	10.5	VE	14 - 16
						AE	11
Transect 4	5.2	7.6	9.3	16.2	10.7	VE	14 - 16
						AE	12
Transect 5	5.2	7.6	9.3	16.3	10.8	VE	15 - 16
						AE	13
Transect 6	5.2	7.6	9.3	16.3	10.7	VE	11 - 14
						AE	12
Transect 7	5.1	7.6	9.3	16.4	10.3	VE	13 - 15
						AE	12 - 13
Transect 8	5.1	7.6	9.3	16.5	10.4	VE	13
						AE	12
Transect 9	5.1	7.5	9.3	16.6	11.9	VE	15 - 17
						AE	12
Transect 10	5.1	7.5	9.3	16.7	10.6	VE	14
						AE	11
Transect 11	5.0	7.5	9.3	16.8	12.1	VE	19
						AE	11
Transect 12	5.0	7.5	9.3	16.9	11.7	VE	14
						AE	9
Transect 13	5.0	7.5	9.3	16.9	11.9	VE	26
						AE	*

[*] Data not available.

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

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

TABLE 10 - TRANSECT DATA - continued

Flooding Source and Transect Number	Stillwater Elevation				Total Water Level [1]	Zone	Base Flood Elevation (Feet NAVD 88) [2]
	10-percent-annual-chance	2-percent-annual-chance	1-percent-annual-chance	0.2-percent-annual-chance	1-percent-annual-chance		
LONG ISLAND SOUND - continued							
Transect 14	5.0	7.5	9.3	17.0	12.0	VE	14 - 16
						AE	*
Transect 15	5.0	7.5	9.4	17.0	11.7	VE	13
						AE	13
Transect 16	5.0	7.5	9.4	17.1	12.4	VE	14 - 17
						AE	13
Transect 24	4.8	7.4	9.4	17.5	12.2	VE	16
						AE	*
Transect 25	4.8	7.4	9.4	17.6	11.4	VE	12 - 15
						AE	11 - 12
Transect 26	4.8	7.4	9.4	17.6	10.8	VE	14
						AE	11
Transect 27	4.8	7.4	9.4	17.7	10.3	VE	13 - 15
						AE	12
Transect 28	4.8	7.4	9.4	17.7	11.1	VE	15
						AE	12
Transect 29	4.8	7.4	9.4	17.7	10.8	VE	12 - 14
						AE	12
Transect 30	4.8	7.4	9.4	17.8	11.7	VE	16
						AE	*
Transect 31	4.8	7.4	9.4	17.8	11.4	VE	14
						AE	12 - 13
Transect 32	4.8	7.4	9.4	17.8	11.3	VE	13
						AE	13
Transect 33	4.8	7.5	9.5	17.8	10.4	VE	11 - 13
						AE	10 - 12
Transect 34	4.8	7.5	9.5	17.9	11.0	VE	14
						AE	11
Transect 46	4.9	7.6	9.6	18.1	11.2	VE	15
						AE	13 - 14

[*] Data not available.

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

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

TABLE 10 - TRANSECT DATA - continued

Flooding Source and Transect Number	Stillwater Elevation				Total Water Level [1]	Zone	Base Flood Elevation (Feet NAVD 88) [2]
	10-percent-annual-chance	2-percent-annual-chance	1-percent-annual-chance	0.2-percent-annual-chance	1-percent-annual-chance		
NIANTIC BAY							
Transect 17	4.9	7.5	9.4	17.1	10.9	VE	13 - 16
						AE	12 - 13
Transect 18	4.9	7.5	9.4	17.2	13.0	VE	14
						AE	12 - 14
Transect 19	4.9	7.5	9.4	17.2	12.5	VE	19
						AE	*
Transect 20	4.9	7.5	9.4	17.3	10.7	VE	12 - 15
						AE	*
Transect 21	4.9	7.5	9.4	17.3	11.8	VE	14
						AE	*
Transect 22	4.9	7.5	9.4	17.4	11.8	VE	13 - 15
						AE	*
Transect 23	4.8	7.5	9.4	17.4	10.6	VE	13
						AE	12
NEW LONDON HARBOR							
Transect 35	4.8	7.5	9.5	17.9	11.0	VE	12 - 15
						AE	*
Transect 36	4.8	7.5	9.5	17.9	10.0	VE	11 - 13
						AE	11
Transect 37	4.8	7.5	9.5	17.9	10.5	VE	14
						AE	*
Transect 38	4.8	7.5	9.5	17.9	12.7	VE	15
						AE	13 - 15
Transect 39	4.8	7.5	9.5	17.9	10.9	VE	12
						AE	*
Transect 43	4.9	7.6	9.6	18.1	10.8	VE	14
						AE	11
Transect 44	4.9	7.6	9.6	18.1	11.1	VE	14
						AE	*
Transect 45	4.9	7.6	9.6	18.1	11.2	VE	14
						AE	11

[*] Data not available.

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

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

TABLE 10 - TRANSECT DATA - continued

Flooding Source and Transect Number	Stillwater Elevation				Total Water Level [1]	Zone	Base Flood Elevation (Feet NAVD 88) [2]
	10-percent-annual-chance	2-percent-annual-chance	1-percent-annual-chance	0.2-percent-annual-chance	1-percent-annual-chance		
THAMES RIVER							
Transect 40	4.8	7.5	9.5	18.0	10.6	VE	13
						AE	*
Transect 41	4.8	7.5	9.5	18.0	10.5	VE	13
						AE	12
Transect 42	4.8	7.5	9.6	18.0	10.9	VE	13
						AE	*
FISHERS ISLAND SOUND							
Transect 47	4.9	7.6	9.6	18.1	11.6	VE	14
						AE	*
Transect 48	4.9	7.6	9.6	18.1	10.3	VE	13 - 15
						AE	11
Transect 49	4.9	7.6	9.6	18.2	10.4	VE	13 - 14
						AE	11
Transect 50	4.9	7.6	9.6	18.2	10.5	VE	14
						AE	11
Transect 51	4.9	7.6	9.7	18.2	11.0	VE	14
						AE	11
Transect 52	4.9	7.6	9.7	18.2	10.5	VE	13 - 14
						AE	10 - 11
Transect 53	4.9	7.6	9.7	18.2	10.8	VE	14 - 15
						AE	11 - 12
Transect 54	4.9	7.6	9.7	18.2	12.4	VE	15 - 16
						AE	11 - 13
Transect 55	4.9	7.6	9.7	18.3	11.2	VE	13 - 17
						AE	12
Transect 56	4.9	7.6	9.7	18.3	10.5	VE	11 - 13
						AE	10
Transect 57	4.9	7.6	9.7	18.3	13.4	VE	12 - 16
						AE	12
Transect 58	4.9	7.7	9.7	18.3	11.0	VE	15
						AE	13

[*] Data not available.
[1] Including stillwater elevation and effects of wave setup.
[2] Because of map scale limitations, base flood elevations shown on the FIRM represent average elevations for the zones depicted.

TABLE 10 - TRANSECT DATA - continued

Flooding Source and Transect Number	Stillwater Elevation				Total Water Level [1]	Zone	Base Flood Elevation (Feet NAVD 88) [2]
	10-percent-annual-chance	2-percent-annual-chance	1-percent-annual-chance	0.2-percent-annual-chance	1-percent-annual-chance		
FISHERS ISLAND SOUND - continued							
Transect 59	4.9	7.7	9.7	18.3	12.5	VE	14
						AE	13 - 14
Transect 60	4.9	7.7	9.7	18.3	10.9	VE	14
						AE	13
Transect 61	4.9	7.7	9.7	18.4	11.0	VE	14
						AE	13
Transect 62	4.9	7.7	9.8	18.4	10.1	VE	13 - 14
						AE	10
Transect 63	4.9	7.7	9.8	18.4	11.1	VE	15
						AE	11
Transect 64	4.9	7.7	9.8	18.4	10.8	VE	14
						AE	12 - 13
Transect 65	5.0	7.7	9.8	18.5	11.3	VE	14
						AE	11 - 12
Transect 66	5.0	7.7	9.8	18.5	10.3	VE	14
						AE	11 - 13
Transect 67	5.0	7.7	9.8	18.5	10.9	VE	15
						AE	12
Transect 68	5.0	7.7	9.8	18.5	12.0	VE	15
						AE	12
Transect 69	5.0	7.7	9.8	18.5	10.5	VE	14
						AE	12
Transect 70	5.0	7.7	9.8	18.5	11.2	VE	14
						AE	10 - 13
Transect 71	5.0	7.8	9.8	18.5	10.7	VE	13
						AE	11 - 12
Transect 72	5.0	7.8	9.8	18.5	10.5	VE	14
						AE	12
Transect 73	5.0	7.8	9.8	18.5	10.8	VE	13 - 15
						AE	11
Transect 74	5.0	7.8	9.8	18.6	11.8	VE	15
						AE	*

* Data not available.

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

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

TABLE 10 - TRANSECT DATA – continued

Flooding Source and Transect Number	Stillwater Elevation				Total Water Level [1]	Zone	Base Flood Elevation (Feet NAVD 88) [2]
	10-percent-annual-chance	2-percent-annual-chance	1-percent-annual-chance	0.2-percent-annual-chance	1-percent-annual-chance		
FISHERS ISLAND SOUND - continued							
Transect 75	5.0	7.8	9.8	18.6	10.6	VE	12 - 14
						AE	11
Transect 76	5.0	7.8	9.9	18.6	10.4	VE	14
						AE	11 - 13
Transect 77	5.0	7.8	9.9	18.6	11.5	VE	15 - 16
						AE	12
Transect 78	5.0	7.8	9.9	18.6	11.0	VE	14 - 16
						AE	12
Transect 79	5.0	7.8	9.9	18.6	10.9	VE	16 - 17
						AE	12
Transect 80	5.0	7.8	9.9	18.6	11.2	VE	13
						AE	12 - 13
Transect 81	5.0	7.8	9.9	18.7	11.0	VE	15
						AE	*
Transect 82	5.0	7.8	9.9	18.7	10.2	VE	13
						AE	10
Transect 83	5.0	7.8	9.9	18.7	10.5	VE	13 - 14
						AE	*
Transect 84	5.0	7.8	9.9	18.7	11.0	VE	14
						AE	*

[*] Data not available.

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

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

3.5 Vertical Datum

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

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

Versions of the FIS report and FIRM prior to July 18, 2011 were referenced to NGVD 29. When a datum conversion is effected for an FIS report and FIRM, the Flood Profiles, base flood elevations (BFEs) and ERMs reflect the new datum values. To compare structure and ground elevations to 1-percent-annual-chance (100-year) flood elevations shown in the FIS and on the FIRM, the subject structure and ground elevations must be referenced to the new datum values.

As noted above, the elevations shown in the FIS report and on the FIRM for New London County are referenced to NAVD 88. Ground, structure, and flood elevations may be compared and/or referenced to NGVD 29 by applying a standard conversion factor. The conversion from NGVD 29 to NAVD 88 is -0.9 foot and from NAVD 88 to NGVD 29 is +0.9 foot. The conversion from NGVD 29 to NAVD 88 was performed using the USACE's CORPSCON Version 6.0.1 computer program to calculate vertical adjustment factors for the southwest corners of USGS Quadrangles within and around the county boundary.

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

For information regarding conversion between the NGVD and NAVD, 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

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

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

4.0 <u>FLOODPLAIN MANAGEMENT APPLICATIONS</u>

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

4.1 Floodplain Boundaries

In order to provide a national standard without regional discrimination, the 1-percent-annual-chance flood has been adopted by FEMA as the base flood for floodplain management purposes. The 0.2-percent-annual-chance flood is employed to indicate additional areas of flood risk in the community.

For unrevised streams in New London County, data was taken from previously printed FISs for each individual community and are compiled below.

For the streams studied in detail, the 1- and 0.2-percent-annual-chance floodplain boundaries have been delineated using the flood elevations determined at each cross section. The boundaries were interpolated between cross sections, using topographic maps at a scale of 1:2,400 with a contour interval of 5 feet (Reference 85), at a scale of 1:2,400 with a contour interval of 2 feet (Reference 86), at a scale of 1:24,000 with a contour interval of 10 feet (Reference 87), at a scale of 1:2,400, with a contour interval of 4 feet (Reference 88), at a scale of 1:2,400, with a contour interval of 10 feet (Reference 89), at a scale of 1:4,800 feet with a contour interval of 4 feet (Reference 90), at a scale of 1:4,800 with a contour interval of 5 feet (Reference 91), at a scale of 1:4,800 with a contour interval of 10 feet, and 1:9,600, with a contour interval of 10 feet.

For the flooding sources studied by approximate methods, the 1-percent-annual-chance flood boundary was delineated using the Flood Hazard Boundary Maps for the Town of Griswold (Reference 92), the Town of Lebanon (Reference 93), the Town of North Stonington (Reference 94), the Town of Preston (Reference 95), the Town of Voluntown (Reference 96), also using field inspection and USGS topographic maps, the Town of Bozrah (Reference 97), the Town of Franklin (Reference 98), the Town of Ledyard, the Town of Lisbon (References 89 and 99), the Town of Salem (References 100 and 101), for the Town of Sprague (References 102 and 103), also using field surveys, community and historic data, engineering judgment for the Town of East Lyme (Reference 104), the Town of Montville (Reference 105), also previously printed FIS, the Town of Colchester, and the Borough of Colchester (References 106 and 107), the City of Norwich (Reference 108), and the Town of Waterford (Reference 109).

The 1- and 0.2-percent-annual-chance floodplain boundaries are shown on the FIRM (Exhibit 2). On this map, the 1-percent-annual-chance floodplain boundary corresponds to the boundary of the areas of special flood hazards (Zones A and AE), and the 0.2-

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

For the flooding sources studied by approximate methods, only the 1-percent annual-chance floodplain boundary is shown on the FIRM (Exhibit 2). For coastal flooding sources studied by detailed methods in this county-wide FIS, the 1- and 0.2-percent-annual-chance flood boundaries were delineated using 2-foot-contour topographic maps developed from LiDAR data collected in 2004 (Reference 110) and 2006 (Reference 83).

In the Town of East Lyme, for the tidal areas, flood boundaries are indicated on the FIRM. On this map, special flood hazards inundated by the 1-percent-annual-chance flood that have additional hazards due to wave action have been designated as Zone VE

In the City of Groton and Groton Long Point Association, areas inundated by the 1-percent-annual-chance flood are shown as A and V Zones on the community's FIRM. It is in these areas that FEMA requires local communities to exercise floodplain management measures as a condition for participation in the National Flood Insurance Program.

In the Town of Groton, for the tidal areas with wave action, the flood boundaries were delineated using the elevations determined at each transect; between transects, the boundaries were interpolated using engineering judgment, land cover data, and topographic maps at a scale of 1:2,400 with a contour interval of 4 feet (References 111 and 112). The 1-percent-annual-chance floodplain was divided into whole-foot elevation zones based on the average wave crest elevation in that zone. Where the map scale did not permit these zones to be delineated at one foot intervals, larger increments were used.

For the upper portion of Tributary A in the Town of Groton, the boundary of the 1-percent-annual-chance flood was delineated using a topographic map at a scale of 1"=200' with a contour interval of 25 feet along with USGS topographic maps at a scale of 1:24,000 with a contour interval of 10 feet (References 113 and 114). For the remaining areas studied by approximate methods, the boundary of the 1-percent-annual-chance flood was delineated using USGS topographic maps at a scale of 1:24,000 enlarged to a scale of 1:12,000, with a contour interval of 10 feet (Reference 114). Locations of elevations between contour lines were determined by interpolation.

In the Town of Montville, the boundaries for Latimer Brook were interpolated between cross sections using a USGS quadrangle map enlarged.

In the Town of Norwich, Tributaries A and E were considered to be areas of minimal flooding because the 1-percent-annual-chance floodplain width was less than 200 feet; therefore, they are not included on the FIRM.

4.2 Floodways

Encroachment on floodplains, such as structures and fill, reduces flood-carrying capacity, increases flood heights and velocities, and increases flood hazards in areas beyond the encroachment itself. One aspect of floodplain management involves balancing the economic gain from floodplain development against the resulting increase in flood hazard. For purposes of the NFIP, a floodway is used as a tool to assist local communities in this aspect of floodplain management. Under this concept, the area of the 1-percent-annual-chance floodplain is divided into a floodway and a floodway fringe. The floodway is the channel of a stream, plus any adjacent floodplain areas, that must be kept free of encroachment so that the base flood can be carried without substantial increases in flood heights. Minimum Federal standards limit such increases to 1 foot, provided that hazardous velocities are not produced. The floodways in the July 2011 study are presented to local agencies as minimum standards that can be adopted directly or that can be used as a basis for additional floodway studies.

Encroachment into areas subject to inundation by floodwaters having hazardous velocities aggravates the risk of flood damage, and heightens potential flood hazards by further increasing velocities. A listing of stream velocities at selected cross sections is provided in Table 11, "Floodway Data." In order to reduce the risk of property damage in areas where the stream velocities are high, the community may wish to restrict development in areas outside the floodway.

The area between the floodway 1-percent-annual-chance floodplain boundaries is termed the floodway fringe. The floodway fringe encompasses the portion of the floodplain that could be completely obstructed without increasing the water-surface elevation of 1-percent-annual-chance flood by more than 1.0 foot at any point. Typical relationships between the floodway and the floodway fringe and their significance to floodplain development are shown in Figure 2.

Floodway widths were computed at cross sections. Between cross sections, the floodway boundaries were interpolated. The results of the floodway computations are tabulated for selected cross sections (Table 11). The computed floodway is shown on the FIRM (Exhibit 2). In cases where the floodway and 1-percent-annual-chance floodplain boundaries are either close together or collinear, only the floodway boundary is shown.

The floodways presented in the July 2011 study were computed on the basis of equal conveyance reduction from each side of the floodplains and using an optimization scheme to obtain a difference in energy grade line elevations between natural and encroached conditions. The results of these computations are tabulated at selected cross sections for each stream segment for which a floodway is computed (Table 11).
Floodways were computed separately for the Yantic River and the Yantic River East Channel by using the HEC-2 divided flow analyses, as mentioned in Section 3.0.

The 2013 coastal study impacted the limit of backwater effects on some of the Floodway Data Tables and Flood Profiles by revising the annual 10-, 2-, 1-, and 0.2-percent annual chance flood elevations at the confluence of several rivers and Long Island Sound. Affected Floodway Data Tables and Flood Profiles were updated for Anguilla Brook, Birch Plain Creek, Connecticut River, Copps Brook, Eccleston Brook, Fort Hill Brook, Jordan Brook, Latimer Brook, Mill Brook, Pattagansett River, Pawcatucket River, Stony Brook, Thames River, Tributary A, Whitford Brook (Town of Groton).

Near the mouths of streams studied in detail, floodway computations are made without regard to flood elevations on the receiving water body. Therefore, "Without Floodway" elevations presented in Table 11 for certain downstream cross sections of Pachaug River in Jewett City, Fourmile River, the Pattagansett River, and Latimer Brook in East Lyme, Birch Plain Creek, Tributary A, Fort Hill Brook, and Whitford Brook in Town of Groton, Blissville Brook in Lisbon, Oxoboxo Brook in Montville, Joe Clark Brook in Preston, Beaver Brook in Sprague, Shetucket River, the Yantic River East Channel, Tributary F, the Yantic River, and Hunter Brook in Norwich, and Jordan Brook in Waterford are lower than the regulatory flood elevations in that area, which must take into account the 1-percent-annual-chance flooding due to backwater from other sources.

A floodway generally is not appropriate in areas such as those that may be inundated by floodwaters from Long Island Sound. Thus, no floodway was prepared for the lower reaches of the Eight Mile River or Connecticut River, where flooding results from high levels of Long Island Sound rather than from high stream flow.

Because flooding on the Thames River and Poquetanuck Cove is tidally influenced, no floodway has been delineated for these two flooding sources.

Floodways were not determined for Day Meadow Brook and the portion of Meadow Brook upstream of Levy Road.

On the Eight Mile River upstream of the dam at Mt. Archer Road, the floodway has been deleted up to the farthest point of backwater from the dam. It is not appropriate to delineate a floodway within the confines of such an impoundment because the friction slope for the dam-created impoundment is equal to zero.

The area between the floodway and 1-percent-annual-chance floodplain boundaries is termed the floodway fringe. The floodway fringe encompasses the portion of the floodplain that could be completely obstructed without increasing the water-surface elevation (WSEL) of the base 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 3, “Floodway Schematic”.

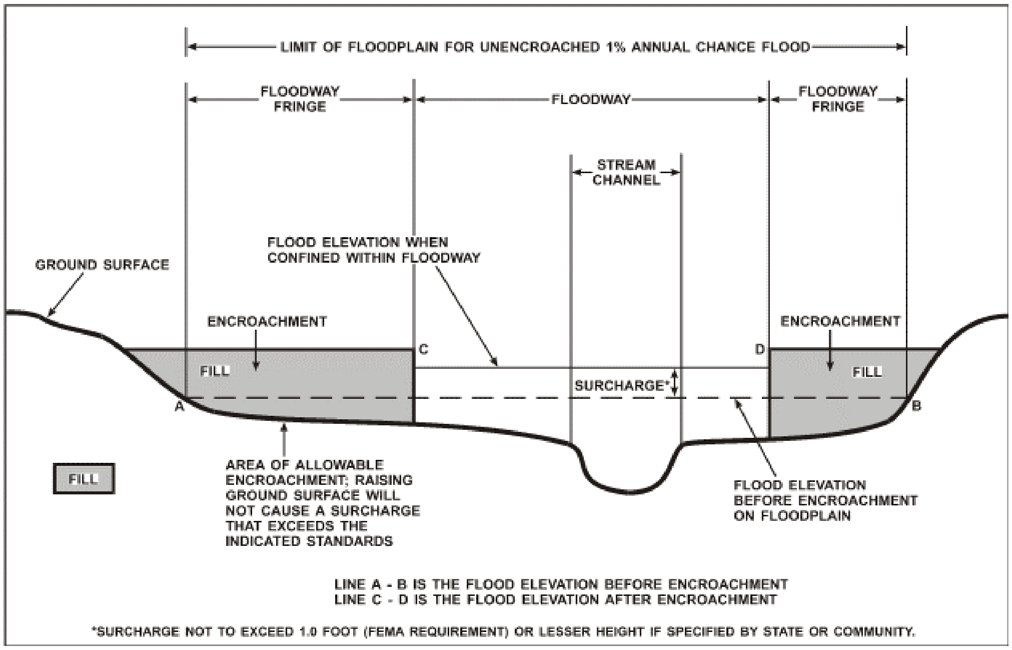

FIGURE 3 – FLOODWAY SCHEMATIC

Table 11, Floodway Data, has been compiled in Volume 2.