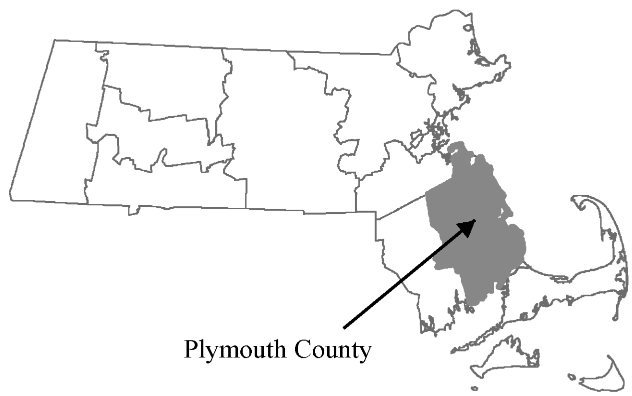
FLOOD INSURANCE STUDY

PLYMOUTH COUNTY, MASSACHUSETTS (ALL JURISDICTIONS)

Volume 1 of 4



COMMUNITY NAME	COMMUNITY NUMBER
ABINGTON, TOWN OF	250259
BRIDGEWATER, TOWN OF	250260
BROCKTON, CITY OF	250261
CARVER, TOWN OF	250262
DUXBURY, TOWN OF	250263
EAST BRIDGEWATER, TOWN OF	250264
HALIFAX, TOWN OF	250265
HANOVER, TOWN OF	250266
HANSON, TOWN OF	250267
HINGHAM, TOWN OF	250268
HULL, TOWN OF	250269
KINGSTON, TOWN OF	250270
LAKEVILLE, TOWN OF	250271
MARION, TOWN OF	255213
MARSHFIELD, TOWN OF	250273
MATTAPOISETT, TOWN OF	255214
MIDDLEBOROUGH, TOWN OF	250275
NORWELL, TOWN OF	250276
PEMBROKE, TOWN OF	250277
PLYMOUTH, TOWN OF	250278
PLYMPTON, TOWN OF	250279
ROCHESTER, TOWN OF	250280
ROCKLAND, TOWN OF	250281
SCITUATE, TOWN OF	250282
WAREHAM, TOWN OF	255223
WEST BRIDGEWATER, TOWN OF	250284
WHITMAN, TOWN OF	250285

REVISED
NOVEMBER 4, 2016

Federal Emergency Management Agency

FLOOD INSURANCE STUDY NUMBER
25023CV001C

NOTICE TO
FLOOD INSURANCE STUDY USERS

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

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

Initial Countywide FIS Effective Date: July 17, 2012

Revised Countywide FIS Effective Date: July 16, 2015

Revised Countywide FIS Effective Date: November 4, 2016

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FLOOD INSURANCE STUDY
PLYMOUTH COUNTY, MASSACHUSETTS (ALL JURISDICTIONS)

1.0 INTRODUCTION

1.1 Purpose of Study

This Flood Insurance Study (FIS) revises and updates information on the existence and severity of flood hazards in the geographic area of Plymouth County, including the City of Brockton and the Towns of Abington, Bridgewater, Carver, Duxbury, East Bridgewater, Halifax, Hanover, Hanson, Hingham, Hull, Kingston, Lakeville, Marion, Marshfield, Mattapoisett, Middleborough, Norwell, Pembroke, Plymouth, Plympton, Rochester, Rockland, Scituate, Wareham, West Bridgewater, and Whitman (referred to collectively herein as Plymouth County), and aids in the administration of the National Flood Insurance Act of 1968 and the Flood Disaster Protection Act of 1973. This study has developed flood-risk data for various areas of the community that will be used to establish actuarial flood insurance rates and to assist the community in its efforts to promote sound floodplain management. Minimum floodplain management requirements for participation in the National Flood Insurance Program (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.

For the July 17, 2012 FIS (Reference 1) was prepared to include the unincorporated areas of, and incorporated communities within, Plymouth 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, is shown below:

Abington, Town of:	The hydrologic and hydraulic analyses for the original study were prepared by Camp, Dresser, & McKee, Inc., (CDM) for the Federal Emergency Management Agency (FEMA), under Contract No. H-3861. This work was completed in September 1977. In the June 2, 1993 study, the hydrologic and hydraulic analyses for the Stream River were prepared by Green International Affiliates, Inc., for FEMA, under contract No. EMW-89-C-2820, GIA Project No. 8903. This work was completed in December 1990.

Bridgewater, Town of:	For the original November 17, 1981 FIS and May 17, 1982 FIRM, the hydrologic and hydraulic analyses were prepared by Sverdrup & Parcel and Associates, Inc., for FEMA, under Contract No. H-403F. That work, which was completed in March 1978, covered all significant flooding sources in the Town of Bridgewater. For the September 8, 1999 FIS, the hydraulic analyses for a portion of the Taunton River, the Town River, and the Matfield River and the hydrologic and hydraulic analyses for Sawmill Brook and Tributary A to Sawmill Brook were prepared by Green International Affiliates, Inc. for FEMA under Contract No. EMW-93-C-4144 (Task #17). This work was completed in November 1996.
Brockton, City of:	The hydrologic and hydraulic analyses for the September 1978 study were performed by CDM for the Federal Insurance Administration (FIA) under Contract No. H- 3861. This work, which was completed in August 1977, covered all significant flooding sources in the City of Brockton. All field survey data for this study were collected and compiled by Harry R. Feldman, Inc., under subcontract to CDM.
Carver, Town of:	The hydrologic and hydraulic analyses for the January 19, 1982 study were prepared by PJR Consulting Engineers for FEMA, under Contract No. H-4795. This work was completed in July 1980.
Duxbury, Town of:	The original hydrologic and hydraulic analyses were prepared by the U.S. Army Corps of Engineers (USACE) for FEMA, under Inter-Agency Agreement No. IAA-H-02-73 and IAA-H-19-74, Project Order Nos. 13 and 15, respectively. For the May 15, 1986 FIS, the hydrologic and hydraulic analyses were updated by PRC Harris for FEMA, under contract No. M010. That work was completed in May 1983. For the May 17, 2005 study, the hydrologic and hydraulic analyses for Massachusetts Bay, Duxbury Bay, and Kingston Bay were prepared by ENSR for FEMA, under Contract No. EMW-95-C4783. This work was completed in July 2001.

East Bridgewater, Town of:	The hydrologic and hydraulic analyses for the January 2, 1981 study were prepared by Sverdrup and Parcel and Associates, Inc., for the FIA under contract No. H-4037. This work, which was completed in November 1977, covered all significant flooding sources in the Town of East Bridgewater.
Halifax, Town of:	The hydrologic and hydraulic analyses for the January 5, 1982 study were performed by PJR Consulting Engineers for FEMA, under Contract NO. H-4795. This work was completed in March 1980.
Hanover, Town of:	The hydrologic and hydraulic analyses for the June 15, 1982 study were performed by PJR Consulting Engineers for FEMA, under Contract No. H-4795. This work was completed in July 1980.
Hanson, Town of:	The hydrologic and hydraulic analyses for the December 18, 1986 study were prepared by CDM, for FEMA, under Contract No. EMW-94-C-1601. This work was completed in June 1985. The original hydrologic and hydraulic analyses were performed by PJR Consulting Engineers for FEMA. The original work was completed in December 1979.
Hingham, Town of:	The hydrologic and hydraulic analyses for the June 3, 1986 study were prepared by PRC Harris for FEMA, under Contract No. H-4776. This work was completed in July 1983.
Hull, Town of:	The hydrologic and hydraulic analyses for the November 2, 1982 study were performed by Harris-Toups Associates for FEMA, under Contract No. H-4776. This work was completed in April 1980.
Kingston, Town of:	The hydrologic and hydraulic analyses in the February 5, 1985 study were performed by PRC Harris for FEMA, under Contract No. H-4776 (completed in June 1980) and under Contract Modification No. M010. This work was completed in May 1983.

Lakeville, Town of:	The hydrologic and hydraulic analyses for the May 15, 1984 study represent a revision of the original analyses prepared by Sverdrup and Parcel and Associates, Inc. for FEMA, under Contract No. H-4037. The hydrologic and hydraulic analyses in the 1984 updated version were prepared by Dewberry & Davis. This work was completed in August 1982.
Marion, Town of:	The hydrologic and hydraulic analyses for the February 17, 1988 study represent a revision of the original analyses prepared by the New England Division of the USACE for FEMA. The work for the original study was completed in May 1979. The hydrologic and hydraulic analyses in the 1988 updated version were also prepared by the New England Division of the USACE, under Inter-Agency Agreement No. EMW-E-0941. This work was completed October 1985.
Marshfield, Town of:	For the original July 3, 1986 FIS (hereinafter referred to as the 1986 FIS), the hydrologic and hydraulic analyses were prepared by PRC Harris for FEMA, under Contract No. H-4776. That work was completed in June 1983. For the June 16, 2006 revision, the hydrologic and hydraulic analyses for the entire shoreline of Massachusetts Bay and Duxbury Bay were prepared by ENSR for FEMA, under Contract No. EMW-95- C4783. This work was completed in July 2001.
Mattapoisett, Town of:	The hydrologic and hydraulic analyses for the July 2, 1987 study represent a revision of the original analyses prepared by the New England Division of the USACE for FEMA. The work for the original study was completed in May 1979. The hydrologic and hydraulic analyses in the July 1987 updated version were also prepared by the New England Division of the USACE, under Inter-Agency Agreement No. EMW-E-0941. This work was completed October 1985.

Middleborough, Town of:	The hydrologic and hydraulic analyses in the February 1, 1983 study represent a revision of the original analyses by Sverdrup and Parcel and Associates for FEMA, under Contract No. H-4306. The updated February 1983 version was prepared by Dewberry and Davis under agreement with FEMA. The February 1983 study was completed in August 1982. The hydrologic and hydraulic analyses in the updated study were computed by Dewberry and Davis.
Norwell, Town of:	The hydrologic and hydraulic analyses for the January 19, 1982 study were prepared by PJR Consulting Engineers for FEMA, under Contract No. H-4795. This work was completed in July 1980.
Pembroke, Town of:	The hydrologic and hydraulic analyses for the February 1982 study were performed by CDM, for the FIA, under Contract No. H- 3861. This work, which was completed in January 1978, covered all significant flooding sources affecting the Town of Pembroke.
Plymouth, Town of:	The hydrologic and hydraulic analyses for the July 17, 1986 study were prepared by PRC Harris, Inc., for FEMA, under Contract No. H-4776. This work was completed in June 1983. For the December 19, 2006 study, the hydrologic and hydraulic analyses for the entire shorelines of Cape Cod Bay, Kingston Bay, Massachusetts Bay, Plymouth Bay, and Plymouth Harbor were prepared by ENSR International for FEMA, under Contract No. EMB-96-CO0404. This work was completed in March 2002.
Plympton, Town of:	The hydrologic and hydraulic analyses for the January 5, 1982 study were performed by PJR Consulting Engineers for FEMA, under Contract No. H-4795. This work was completed in March 1980.
Rochester, Town of:	The hydrologic and hydraulic analyses for the January 5, 1982 study were prepared by PJR Consulting Engineers for FEMA, under Contract No. H-4795. This work was completed in May 1980.

Rockland, Town of:	The hydrologic and hydraulic analyses for the January 19, 1982 study were prepared by PJR Consulting Engineers for FEMA, under Contract No. H-4795. This work was completed in March 1980.
Scituate, Town of:	For the original FIS, the analyses were performed by the New England Division of the USACE, for FEMA. The original work was completed in August 1975. For the September 29, 1986 FIS and July 2, 1992 FIRM, the hydrologic and hydraulic analyses were prepared by PRC Engineering for FEMA, under Contract No. H-4776. That work was completed in August 1983. For the October 16, 2003 revision, the hydrologic and hydraulic analyses for Massachusetts Bay were prepared by ENSR for FEMA, under Contract No. EMW-95-C- 4783, and by Chas. H. Sells, Inc., under contract with ENSR, CHS Project No. 95-534. This work was completed in February 1999.
West Bridgewater, Town of:	The hydrologic and hydraulic analyses for the December 15, 1981 study were performed by Sverdrup & Parcel and Associates, Inc., for FEMA, under Contract No. H-4037. This study was completed in March 1979.
Wareham, Town of:	The hydrologic and hydraulic analyses for the August 4, 1987 study represent a revision of the original analyses prepared by the New England Division of the USACE for FEMA. The work for the original study was completed in May 1979. The hydrologic and hydraulic analyses in the August 14, 1987 version were also prepared by the New England Division of the USACE, under Inter-Agency Agreement No. FMW-E-0941. This work was completed October 1985.
Whitman, Town of:	The hydrologic and hydraulic analyses for the January 2, 1981 study were prepared by PJR Consulting Engineers for the FIA, under Contract No. H-4795. This work was completed in January 1980.

For the July 17, 2012 countywide FIS, coastal hydrologic and hydraulic analyses for the Towns of Hingham, Hull, Marion, Mattapoisett, and Wareham were 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. That study was completed March 28, 2008.

Base map information shown on the July 17, 2012 FIRM was derived from digital orthophotography. Base map files were provided in digital form by Massachusetts Geographic Information System (MassGIS). Ortho imagery was produced at a scale of 1:5,000. Aerial photography is dated April 2005. The projection used in the preparation of this map was Massachusetts State Plane mainland zone (FIPSZONE2001). The horizontal datum was NAD83, GRS1980 spheroid (Reference 2).

For the July 16, 2015 Narragansett Watershed revision of the countywide FIS, hydrologic and hydraulic analyses for the Towns of Bridgewater, Middleborough, Halifax, and Lakeville were prepared by USGS for FEMA under Contract No. HSFE01-11-X-0083. The study was completed March 24, 2014.

Base map information shown on the July 16, 2015 FIRM was derived from digital orthophotography. Base map files were provided in digital form by the USGS. Ortho imagery was produced at a scale of 1:2,400. Aerial photography is dated April 2013 or March and April 2009. The projection used in the preparation of this map was Massachusetts State Plane Mainland Zone (FIPSZONE2001). The horizontal datum was NAD83, GRS1980 spheroid (Reference 3).

The coastal wave height analysis for this November 4, 2016 coastal revision was prepared by the Strategic Alliance for Risk Reduction (STARR) for FEMA under Contract No. HSFEHQ-09-D-0370, Task Order 4. This new analysis resulted in revisions to the Special Flood Hazards Areas (SFHAs) within the Towns of Duxbury, Kingston, Marshfield, Norwell, Plymouth and Scituate. This study was completed May 1, 2013. The communities of Scituate, Marshfield, and Duxbury submitted material during the Appeal Period that is incorporated into the final mapping.

Base map information shown on the FIRM panels produced for this November 4, 2016 revision was derived digital orthophotography provided by MassGIS. This information was created from 30-cm pixel resolution photography dated April 2008. The horizontal datum used was North American Datum of 1983 (NAD 83) (Reference 4).

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 Plymouth 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 Abington	August 26, 1975	*	September 20, 1976
	*	*	November 7, 1991
Town of Bridgewater	May 1976	*	December 2, 1980
	January 23, 1997[1]	*	August 3, 1998
City of Brockton	August 26, 1975	April 19, 1977	April 2, 1978
Town of Carver	March 1978	*	August 11, 1981
Town of Duxbury	May 3, 1978	*	August 6, 1984
	September 29, 1994	*	August 31, 2004
Town of East Bridgewater	May 1976	November 21, 1977	February 25, 1980
Town of Halifax	March 1978	*	October 21, 1980
Town of Hanover	*	*	May 18, 1981
Town of Hanson	April 1984	*	February 4, 1986
Town of Hingham	March 22, 1978	March 12, 1980	November 20, 1984
Town of Hull	March 29, 1978	*	April 28, 1982
Town of Kingston	March 1978	July 15, 1983	September 25, 1984
Town of Marion	August 18, 1983	*	September 30, 1986
Town of Marshfield	May 2, 1978	June 23, 1983	June 17, 1985
	September 29, 1994	*	*
Town of Mattapoisett	August 18, 1983	*	August 19, 1986
Town of Middleborough	May 1976	January 12, 1978	August 11, 1981
Town of Norwell	March 1978	*	August 12, 1981
Town of Pembroke	September 22, 1975	July 12, 1977	June 26, 1978
Town of Plymouth	March 27, 1978	*	December 12, 1984
Town of Plympton	March 1978	*	January 20, 1981
Town of Rochester	March 1978	*	March 16, 1981
Town of Rockland	March 1978	January 22, 1980	January 8, 1981
Town of Scituate	April 17, 1978	*	June 15, 1985
	October 4, 1994	March 10, 1998	October 4, 2000
Town of West Bridgewater	May 1976	February 28, 1979	May 12, 1980
Town of Wareham	August 18, 1983	*	October 7, 1986
Town of Whitman	March 1978	*	July 24, 1980

*Data not available

For the July 17, 2012 countywide study, the initial CCO meeting was held on March 8, 2005, and was attended by representatives of FEMA, Southeastern Regional Planning and Economic Development District Office (SRPEDD), the communities, and ENSR.

The results of the study were reviewed at the final CCO meeting held on June 24 through 26, 2008, and attended by representatives of FEMA, Regional Management Center for Region 1 (RMC1), Massachusetts Department of Conservation and Recreation (MADCR), Coldwell Banker Residential Brokerage (CBRB), SRPEDD, and representatives from the City of Brockton and the Towns of Duxbury, Halifax, Hingham, Rockland, Plymouth, Scituate, and Wareham. All problems raised at that meeting have been addressed.

For the July 16, 2015 Narragansett Watershed revision, the Discovery meeting for Plymouth County was held on December 6, 2011 at the City Hall in Taunton. Two Work Map meetings were held on September 16, 2013 that communities in Plymouth County could attend: one at the public library in the City of Attleboro, and the second at the public library in the Town of Lakeville. The initial CCO meeting was held on September 16, 2013, and was attended by representatives of FEMA Region I, STARR, USGS, MADCR, and the communities. The results of the study were reviewed at the final CCO meeting held on June 24, 2014, which was attended by representatives of the same organizations. All problems raised at that meeting have been addressed.

For this November 4, 2016 coastal study revision, Discovery Meetings were held on March 31, 2011 at the Marshfield Town Hall and the Plymouth Main Library. Work Map Meetings were held with the communities on March 13, 2013, to discuss the initial results of the new coastal flood hazard analysis. The results of this coastal study were reviewed at the final CCO meeting held on June 6, 2013, and attended by representatives of FEMA Region I, STARR, MADCR, and the communities. All problems raised at that meeting were addressed in this study.

2.0 AREA STUDIED

2.1 Scope of Study

The July 17, 2012 FIS report covers the geographic area of Plymouth County, Massachusetts, including the incorporated communities listed in Section 1.1. 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 17, 2012 Countywide Analysis

All or portions of the flooding sources listed in Table 2, “Flooding Sources Studied by Detailed Methods,” were studied by detailed methods in the precountywide FISs. Limits of detailed study are indicated on the Flood Profiles (Exhibit 1) and on the FIRM. The areas studied by detailed methods were selected with priority given to all known flood hazards and areas of projected development or proposed construction.

TABLE 2 – FLOODING SOURCES STUDIED BY DETAILED METHODS

Flooding Source Name	Description of Study Reaches
Accord Brook	From 2,100 feet downstream of Prospect Street in Hingham to approximately 125 feet upstream of Main Street in Hingham.
Assawompset Pond	The entire shoreline within Plymouth County
Beaver Brook	From Elm Street in East Bridgewater to 3,255 feet upstream of Summer Street in East Bridgewater
Beaver Dam Brook	From its confluence with Bartlett Pond to approximately 2,700 feet upstream of State Route 3A in Plymouth
Billington Sea	The entire shoreline within the Town of Plymouth
Black Betty Brook	From its confluence with West Meadow Brook to approximately 900 feet upstream of Samuel Avenue
Black Brook	From 500 feet downstream of Central Street in East Bridgewater to approximately 1,200 feet upstream of Central Street in East Bridgewater
Black Pond Brook	From its confluence with Second Herring Brook to approximately 4,270 feet upstream of Central Street in Norwell
Bluefish River	At areas affected by coastal flooding from Massachusetts Bays in Duxbury
Bound Brook	From Mordecai Lincoln Road in Scituate to the corporate limits of Scituate-Cohasset, approximately 1,725 feet upstream of State Route 3A
Bourne Wharf	Tidal flooding including its wave action within the Town of Marshfield
Branch of Eel River	From its confluence with Eel River to approximately 115 feet upstream of Old Sandwich Road in Plymouth
Branch of Musquashcut Brook	Tidal flooding including its wave action within the Town of Scituate

TABLE 2 – FLOODING SOURCES STUDIED BY DETAILED METHODS - continued

Flooding Source Name	Description of Study Reaches
Cape Cod Bay	The entire shoreline within Plymouth County
Crane Brook	From the confluence with Weweantic River to 15,540 feet upstream of Cranberry Road in Carver
Crooked Meadow River	From Free Street in Hingham to Cushing Pond Dam in Hingham
Drinkwater River	From its confluence with Indian Head River to its confluence of Longwater Brook in Hanover
Drinkwater River Tributary	Between its confluences with the Drinkwater River in Hanover
Duck Hill River	At the wetlands area in Duxbury
Duxbury Bay	At areas affected by coastal flooding from Massachusetts Bays
	From the Marshfield-Duxbury corporate limit to Goose Point
Duxbury Marsh	For its entire length within the Town of Marshfield
Eel River (Town of Hingham)	From its confluence with Plymouth River to approximately 650 feet upstream of Brewster Road in Hingham
Eel River (Town of Plymouth)	From 360 feet upstream of Old Sandwich Road to approximately 60 feet upstream of the Dam at Russell Mill Pond
First Herring Brook	From the Driftway in Scituate to the corporate limits of Scituate-Norwell
French Stream	From its confluence with Drinkwater River to approximately 2,760 feet upstream of North Avenue in Rockland
Furnace Pond	The entire shoreline within the town of Pembroke
Great Quittacas Pond	The entire shoreline within the Town of Lakeville

TABLE 2 – FLOODING SOURCES STUDIED BY DETAILED METHODS - continued

Flooding Source Name	Description of Study Reaches
Green Harbor River	Tidal flooding including its wave action within the Town of Marshfield
Gulf	Tidal flooding including its wave action within the Town of Scituate
Halls Brook	From 200 feet downstream of Maple Street in Kingston to approximately 645 feet upstream of Winter Street in Kingston
Hannah Eames Brook	From Damons Point Road in Marshfield to approximately 1,030 feet upstream of New Main Street in Marshfield
Herring Brook	From the confluence with North River to the confluence with Furnace Pond
Herring River	Tidal flooding including its wave action within the Town of Scituate
Hockomock River	From the confluence with Town River to approximately 900 feet upstream of the abandoned railroad in West Bridgewater
Hull Bay	Along the entire coastline within the Town of Hull
Indian Brook	From 50 feet downstream of Seaview Drive in Plymouth to State Route 3A in Plymouth
Indian Head Brook	From the confluence with Indian Head River to approximately 45 feet upstream of Liberty Street in Hanson
Indian Head River	From the Confluence with North River in Pembroke to the confluence of Drinkwater River at Factory Dam in Hanson
Jones River	From a Dam 110 feet downstream of Elm Street in Kingston to the Silver Lake Dam in Kingston
Jones River Brook	From the confluence of Jones River to the corporate limits of Kingston-Plympton, 2,160 feet upstream of West Street in Kingston

TABLE 2 – FLOODING SOURCES STUDIED BY DETAILED METHODS - continued

Flooding Source Name	Description of Study Reaches
Kings Pond	The entire shoreline
Kingston Bay	From the coastal flooding areas in Duxbury to the entire shoreline of Plymouth
Little Wood Island River	From the wetlands area in Duxbury to the Town of Marshfield. Tidal flooding including its wave action within the Town of Marshfield.
Long Pond	The entire shoreline within the Town of Lakeville
Long Pond River	The entire length within the Town of Lakeville
Longwater Brook	From the confluence of Drinkwater River to an Unnamed Dam approximately 5,200 feet upstream
Massachusetts Bay	The entire shoreline from the Town of Hull to the Town of Plymouth
Matfield River	From the confluence with Taunton River to 275 feet upstream of Bridge Street in Bridgewater
Mattapoisett River	From 100 feet downstream of Wolf Island Road in Rochester to approximately 6,062 feet upstream of Snipatiuit Road in Rochester
Meadow Brook	From Central Street in East Bridgewater to approximately 2,300 feet upstream of Auburn Street in Whitman
Meadow Brook Tributary	From the confluence with Meadow Brook to 4,124 feet upstream of Auburn Street in Whitman
Mile Brook	From confluence of Halls Brook to approximately 100 upstream of the Dam, 350 feet downstream of the Kingston-Duxburry corporate limits
Musquashcut Brook	Tidal flooding including its wave action within the Town of Scituate
Musquashcut Pond	Tidal flooding including its wave action within the Town of Scituate

TABLE 2 – FLOODING SOURCES STUDIED BY DETAILED METHODS - continued

Flooding Source Name	Description of Study Reaches
Nemasket River[1]	From the confluence with Taunton River to the Assawompset Pond Dam in Middleborough
Northern Branch of Ben Mann Brook	From Hingham Street to approximately 950 feet upstream
Nunkets Pond	For the entire shoreline
Oldham Pond	For the entire shoreline
Palmer Mill Brook	From the confluence with Winnetuxet River to approximately 1,660 feet upstream of Hayward Street in Halifax
Pine Point	Tidal flooding including its wave action within the Town of Marshfield
Pine Point River	At the wetlands area in the Town of Duxbury
Plymouth Bay	The entire coastline in Plymouth County
Plymouth Harbor	The entire coastline in Plymouth County
Plymouth River	From Cushing Pond Dam in Hingham to approximately 2,068 feet upstream of Old Ward Street in Hingham
Pocksha Pond	The entire shoreline within Plymouth County
Poor Meadow Brook	From approximately 8,700 feet downstream of Main Street in Hanson to approximately 4,675 feet upstream of West Washington Street in Hanson
Rocky Meadow Brook	From its confluence with Weweantic River to approximately 2,868 feet upstream of France Street in Carver
Salisbury Brook	From its confluence with Salisbury Plain River to Elmwood Avenue in Brockton

[1]Flooding source re-studied during July 16, 2015 revision (see Table 3)

TABLE 2 – FLOODING SOURCES STUDIED BY DETAILED METHODS - continued

Flooding Source Name	Description of Study Reaches
Salisbury Plain River	From the corporate limits of East Bridgewater-West Bridgewater, approximately 720 feet downstream of Belmont Street in West Bridgewater to its confluence with Salisbury Brook
Satucket River (Lower Reach)	From 700 feet downstream of Plymouth Street in East Bridgewater to 1,000 feet upstream of Plymouth Street in East Bridgewater
Satucket River (Upper Reach)	From its confluence with Black Brook to 80 feet upstream of Pond Street in East Bridgewater
Satuit Brook	From 500 feet upstream of Front Street in Scituate to approximately 100 feet upstream of an abandoned railroad in Scituate
Sawmill Brook	From its confluence with Taunton River to approximately 4,826 feet upstream of Bedford Street in Bridgewater
Second Herring River	From its confluence with North River to its confluence with Black Pond Brook
Shinglemill Brook	From Webster Street (Route 123) to Whiting Street
Shumatuscacant River	From its confluence with Shumatuscacant Tributary to approximately 2,300 feet upstream of Summit Road in Abington
North Tributary to Shumatuscacant River	From its confluence with Shumatuscacant River to approximately 1,600 feet upstream of Wales Street
Shumatuscacant Tributary	From its confluence with Shumatuscacant River to 2,300 feet upstream of Summit Road in Abington
Smelt Brook	From State Route 3A in Kingston to 60 feet upstream of Cranberry Road in Kingston
Snows Brook	From its confluence with Taunton River in to 50 feet upstream of Forest Street in Bridgewater
South Brook	From its confluence with Town River to 25 feet upstream of Bedford Street in Bridgewater

TABLE 2 – FLOODING SOURCES STUDIED BY DETAILED METHODS - continued

Flooding Source Name	Description of Study Reaches
South Meadow Brook	From its confluence with Weweantic River to approximately 1,145 feet upstream of Pond Street in Carver
South River	Tidal flooding including its wave action within the Towns of Marshfield and Scituate
Straits Pond	The entire shoreline within Plymouth County
Stream Channel to Unnamed Tributary to Third Herring Brook	From its confluence with Unnamed Tributary to Third Herring Brook to the confluence of Tributaries 1 & 2 to Stream Channel to Unnamed Tributary to Third Herring Brook (approximately 950 feet upstream) in the Town of Hanover
Stream River	From the corporate limits of Whitman-Abington, approximately 1,900 feet downstream of Walnut Street in Abington to approximately 100 feet upstream of Ashland Street in Abington
Taunton River[1]	From the corporate limits of Bristol and Plymouth County, approximately 8,320 feet downstream of State Route 23 in Middleborough, to the confluence of Town and Matfield Rivers in Bridgewater
Tidal Flooding	The entire coastline of Plymouth County
Town Brook (Town of Hingham)	From Hingham Harbor to approximately 1,100 feet upstream of South Street in Hingham
Town Brook (Town of Plymouth)	From its confluence with Plymouth Harbor to approximately 6,850 feet upstream of the Billington Sea
Town River	From its confluence with Taunton River to its confluence with Lake Nippenicket Tributary
Tributary 1 to Stream Channel to Unnamed Tributary to Third Herring Brook	From its confluence with Stream Channel to Unnamed Tributary to Third Herring Brook to a point approximately 300 feet upstream in the Town of Hanover

[1]Flooding source re-studied during July 16, 2015 revision (see Table 3)

TABLE 2 – FLOODING SOURCES STUDIED BY DETAILED METHODS - continued

Flooding Source Name	Description of Study Reaches
Tributary 1 to Unnamed Tributary to Iron Mine Brook	From its confluence with Unnamed Tributary to Iron Mine Brook to Ponding Area 1 (approximately 1,280 feet upstream) in the Town of Hanover
Tributary 2 to Stream Channel to Unnamed Tributary to Third Herring Brook	From its confluence with Stream Channel to Unnamed Tributary to Third Herring Brook to a point approximately 370 feet upstream in the Town of Hanover
Tributary 2 to Unnamed Tributary to Iron Mine Brook	From its confluence with Unnamed Tributary to Iron Mine Brook to Ponding Area 2 (approximately 1,760 feet upstream) in the Town of Hanover
Tributary A	From its confluence with French Stream to Levin Road in Rockland
Tributary A to Sawmill Brook	From its confluence with Sawmill Brook to approximately 80 feet upstream of Colonial Drive in Bridgewater
Tributary to Meadow Brook	From its confluence with Meadow Brook to 1,340 feet upstream to the corporate limits of East Bridgewater-Whitman
Trout Brook	From its confluence with Salisbury Brook to approximately 415 feet upstream of Ames Street in Brockton
Turkey Hill Run	From its confluence with Weir River to approximately 160 feet upstream of East Street in Hingham
Unnamed Tributary 2 to Shinglemill Brook	From its confluence with Shinglemill Brook to approximately 1,300 feet upstream
Unnamed Tributary 3 to Shinglemill Brook	From its confluence with Shinglemill Brook to approximately 1,600 feet upstream
Weir River	From Foundry Pond Dam to Free Street in Hingham
West Meadow Brook	From its confluence with Town River upstream to the Mill Pond dam and from approximately 125 feet downstream of Spring Street to the West Bridgewater-Brockton corporate limit

TABLE 2 – FLOODING SOURCES STUDIED BY DETAILED METHODS - continued

Flooding Source Name	Description of Study Reaches
Weweantic River	From the corporate limits of Wareham-Carver, 5,700 feet downstream of Tremont Street in Carver, to the confluence of Rocky Meadow Brook and South Meadow Brook
Willow Brook	From its confluence with Town River in West Bridgewater to approximately 950 feet upstream of Main Street in West Bridgewater
Winnetuxet River	From its confluence with Taunton River to approximately 4,900 feet upstream of Main Street in Plympton

Detailed study streams that were not re-studied as part of any 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.

July 16, 2015 Narragansett Watershed Study

The riverine flooding analysis for the July 16, 2015 Narragansett Watershed study was prepared by USGS. This new analysis updated the hydrologic and hydraulic engineering data for the Nemasket and Taunton Rivers and Assawompset and Long Ponds in Plymouth County, as described in Table 3. The analysis resulted in revisions to the FIRM for the Towns of Bridgewater, East Bridgewater, Halifax, Lakeville, Middleborough, and Rochester. No LOMCs were incorporated into this revision.

November 4, 2016 Coastal Study Update

The coastal wave height analysis for this countywide coastal study was prepared by STARR. This new analysis resulted in revisions to the FIRM for the Towns of Duxbury, Kingston, Marshfield, Norwell, Plymouth and Scituate. Additional material submitted by the Towns of Duxbury, Marshfield and Scituate during the appeal period was incorporated into the mapping.

For flooding sources studied by detailed methods for July 17, 2012 countywide study, the July 16, 2015 revision, and this coastal revision, see Table 3, “Scope of Revision.”

TABLE 3 – SCOPE OF REVISION

Flooding Source	Limits of Revised or New Detailed Study
HINGHAM BAY[1]	The entire shoreline within the Towns of Hingham and Hull
MASSACHUSETTS BAY[1]	The entire shoreline within the Town of Hull
BUZZARDS BAY[1]	The entire shoreline within the Towns of Marion, Mattapoisett, and Wareham
TAUNTON RIVER[2]	From the Cherry Street Bridge between Halifax and Bridgewater to the Plymouth/Bristol County boundary
NEMASKET RIVER[2]	From the outlet of Assawompset Pond on the border of Lakeville and Middleborough to the confluence with the Taunton River in Middleborough
ASSAWOMPSET POND[2]	The shoreline in Lakeville and Middleborough
LONG POND[2]	The shoreline in Lakeville
CAPE COD BAY[3]	The entire shoreline within the Towns of Duxbury, Marshfield and Plymouth
DUXBURY BAY[3]	The entire shoreline within the Towns of Duxbury and Plymouth
KINGSTON BAY[3]	The entire shoreline within the Towns of Duxbury, Kingston and Plymouth
MASSACHUSETTS BAY[3]	The entire shoreline within the Towns of Marshfield and Scituate
PLYMOUTH BAY[3]	The entire shoreline within the Town of Plymouth

[1]July 17, 2012 Countywide study
[2]July 16, 2015 Narragansett Watershed study
[3] November 4, 2016 coastal study including additional material submitted by the Towns of Duxbury, Marshfield and Scituate

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 Plymouth County. For the countywide revisions, no new approximate studies were executed. All or portions of the flooding sources listed in Table 4, “Flooding Sources Studied by Approximate Methods,” were studied by approximate methods in the pre-countywide FISs.

TABLE 4 – FLOODING SOURCES STUDIED BY APPROXIMATE METHODS

Flooding Source Name	Community (s)
Accord Pond	Hingham
Agawam River	Plymouth
Annasnappet Brook	Plympton
Annasnappet Brook Reservoir	Plympton
Bares Brook, portions of	Marshfield
Barrows Brook	Plympton
Bartlett Brook	Middleborough
Bassett Brook	Kingston
Bay State Company Bog Reservoir	Plympton
Bear Swamp	Hingham
Beaver Brook	Abington, Bridgewater, Brockton, and East Bridgewater
Beaver Dam Brook	Plymouth, Middleborough
Beaver Dam Pond	Plymouth
Beech Hill Swamp, portions of	Hanover
Ben Mann Brook	Rockland
Besse Bog Reservoir	Plympton
Black Brook	Middleborough, Rochester, and East Bridgewater
Blackmere Reservoir	Wareham
Blood Pond	Bridgewater
Bound Brook Pond	Norwell, Hingham
Bouve Pond	Hingham
Branch Brook	Rochester
Branch of Eel River	Plymouth
Brewer Pond	Hingham
Carry Brook	Brockton
Cedar Swamp River	Lakeville
Clear Pond	Carver
Colchester Brook	Plympton
Cooks Pond	Plymouth
Coweeset River	Brockton
Cranberry Bogs	Plymouth
Cranberry Brook	Lakeville
Cross Street Bog Reservoir	Rochester
Crossman Pond	Kingston
Cushing Brook, portions of	Hanover, Rockland
Cushing Pond	Hingham
Daley Brook	Brockton
Doggett Brook	Rochester
Double Brook	Middleborough
Duck Hill	Duxbury
East Rocky Gutter Brook	Middleborough
Edson Brook	Brockton
Eel River	Plymouth, Hingham
Ellis Pond	Brockton

TABLE 4 – FLOODING SOURCES STUDIED BY APPROXIMATE METHODS
- continued

Flooding Source Name	Community (s)
Elm Street Brook	Bridgewater
Fall Brook	Middleborough
Fawn Pond	Plymouth
Federal Pond	Carver
Fivemile Ponds	Plymouth
Forbes Swamp	Rochester
Forge Pond	Plymouth
French Stream	Abington, Rockland
Fresh Pond	Plymouth
Frogfoot Brook Reservoir	Plymouth
Fulling Mill Brook	Hingham
Fulling Mill Pond	Hingham
Furnace Brook	Marshfield, Kingston
Glen Charlie Pond	Wareham
Goose Pond	Kingston
Great Cedar Swamp	Middleborough
Great Herring Pond	Plymouth
Great Quittacas Pond	Rochester, Middleborough
Great Sandy Bottom Pond	Pembroke
Great South Pond	Plymouth
Halfway Pond	Plymouth
Hathaway Brook	Lakeville
Hell Swamp, portions of	Hanover
Hockomock River, portions of	West Bridgewater
Holloway Brook	Lakeville
Hoop Pole Swamp	Norwell
Island Creek Pond	Duxbury
Jacobs Pond	Norwell
Jones River Brook	Plympton
Keene Pond	Duxbury
Lake Nippenicket (area around the lake)	Bridgewater
Little Cedar Swamp	Middleborough
Little Clear Pond	Plymouth
Little Herring Pond	Plymouth
Little Pond	Plymouth
Little Pudding Brook	Pembroke
Long Island Pond	Plymouth
Long Pond	Rochester, Plymouth
Longwater Brook, portions of	Hanover
Lorings Bog	Duxbury
Lovett Brook	Brockton
Lower Chandler Pond	Duxbury
Mann Brook, portions of	Hanover
Matfield River	East Bridgewater
Mattapoisett River	Mattapoisett
Meadow Brook	Abington

TABLE 4 – FLOODING SOURCES STUDIED BY APPROXIMATE METHODS
- continued

Flooding Source Name	Community (s)
Meadow Brook	Abington
Meadow Brook Tributary, remaining portions	East Bridgewater, Whitman
Meeting Home Swamp	Middleborough
Mile Brook	Duxbury, Kingston
Mill Pond	Duxbury, Norwell, Hanover, Lakeville
Molly’s Brook	Hanover
Morey Hole	Plymouth
Muddy Pond	Kingston
Muddy Pond Brook	Carver
North Hill Marsh	Duxbury
North River, portions of	Hanover
North Tributary Shumatuscacant River	Abington
Oakman Pond	Marshfield
Old Pond Swamp	Norwell
Old Swamp River	Hingham
Palmer Mill Brook, remaining portions	Halifax
Parsons	Marshfield
Peterson Pond	Norwell
Peterson Swamp	Halifax
Philips Brook	Duxbury
Pine Brook	Kingston
Pine Island Swamp, portions of	Hanover
Pine Lake	Duxbury
Plymouth River, remaining portions	Hingham
Poguoy Brook	Middleborough
Poksha Pond	Middleborough
Poor Meadow Brook	East Bridgewater
Pratt Pond	Kingston
Prospect Pond Reservoir	Plympton
Pudding Brook	Pembroke
Puddingshear Brook	Middleborough
Purchade Brook	Middleborough
Reed Bog Reservoir	Duxbury
Robbins Pond	East Bridgewater
Robinson Creek	Pembroke
Rocky Meadow Brook	Middleborough
Rocky Pond	Kingston
Rocky Run Pond	Pembroke
Round Pond	Duxbury
Russell Mill Pond	Plymouth
Russell Pond	Kingston
Salisbury Plain River, portions of	West Bridgewater
Sand Pond	Wareham
Satucket River, remaining portions	East Bridgewater
Satuit Brook	Scituate

TABLE 4 – FLOODING SOURCES STUDIED BY APPROXIMATE METHODS - continued

Flooding Source Name	Community (s)
Savery Pond	Plymouth
Sawmill Brook, remaining portions	Bridgewater
Scokes Pond	Plymouth
Second Herring Brook, remaining portions	Norwell
Shallow Pond	Plymouth
Shinglemill Brook, portions of	Hanover
Shorts Brook	Middleborough
Shumatuscacant River	Hanson, Whitman
Shumatuscacant Tributary, remaining portions	Whitman
Sippican River	Rochester
Snipatuit Brook	Rochester
Snipatuit Pond	Rochester
Snows Brook, remaining portions	Bridgewater
South Brook, remaining portions	Bridgewater
South Meadow Brook, remaining portions	Carver
South Meadow Pond	Carver
South River Reservoir	Duxbury
South Swamp	Scituate
Spooner Pond	Plymouth
Spring Brook	Bridgewater
Stetson Brook	Halifax
Stony Brook	Middleborough
Stump Brook	Halifax
Swamp Brook	Pembroke
Third Herring Brook	Norwell
Thirty Acre Pond	Brockton
Tispaquin Pond	Middleborough
Titicut Swamps	Bridgewater
Torrey Brook, portions of	Hanover
Torrey Pond	Norwell
Tower Brook	Hingham
Towsers Swamp	Rochester
Trackle Pond	Kingston
Tremont Pond	Wareham
Triangle Pond	Plymouth
Tributary A	Bridgewater
Tributary A to Meadow Brook	Whitman
Tributary A to Sawmill Brook	Bridgewater
Tributary B	Rockland
Triphammer Pond	Hingham
Tubbs Meadow Brook	Pembroke
Turkey Hill Run, remaining portions	Hingham
Turkey Swamp	Halifax
Turner Pond	Norwell

TABLE 4 – FLOODING SOURCES STUDIED BY APPROXIMATE METHODS
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Flooding Source Name	Community (s)
Upper Chandler Pond	Duxbury
Valley Swamp	Norwell
Wampum Swamp, portions of	Hanover
Wankinco River	Plymouth
Warner Pond	Plymouth
West Branch Sippican River	Rochester
West Meadow Brook	Brockton, West Bridgewater
West Rocky Gutter Brook	Middleborough
Weweantic River	Wareham, Middleborough
White Island Pond	Plymouth
White Oak Island Brook	Middleborough
Wildcat Brook	Norwell
Wildcat Creek	Norwell
Winkinco River	Carver
Winnetuxet River	Carver

The July 17, 2012 FIS also incorporates the determinations of letters issued by FEMA resulting in map changes (Letters of Map Revision [LOMR], Letters of Map Revision - based on Fill [LOMR-F], and Letters of Map Amendment [LOMA]), as shown in Table 5, "Letters of Map Change."

TABLE 5 – LETTERS OF MAP CHANGE

Community	Case Number	Flooding Source	Letter Date
Bridgewater, Town of	199102216FIA	Town River	10/23/1984
	05-01-0410P[1]	Kingston Bay	11/07/2005
East Bridgewater, Town of	95-01-061P[1]	Unnamed Tributary to Matfield River	08/19/1996
Hanover, Town of	01-01-023P[1]	Areas 1-9 Ponding	03/13/2002
	04-01-063P[1]	Unnamed Tributaries to Third Herring Brook, Iron Mine Brook, and Silver Brook	09/07/2005
	07-01-0795P[1]	Shinglemill Brook, Unnamed Tributary to Shinglemill Brook	12/26/2007
Rockland, Town of	08-01-0140P[1]	Hingham Street Basins and Northern Branch of Ben Mann Brook	06/16/2008
Scituate, Town of	06-01-B143P[1]	Massachusetts Bay	08/23/2006

[1]Incorporated during July 17, 2012 study

November 4, 2016 Coastal Study Update

The coastal wave height analysis for this countywide coastal study was prepared by STARR. This new analysis resulted in revisions to the FIRM for the Towns of Duxbury, Kingston, Marshfield, Norwell, Plymouth and Scituate. Additional material submitted by the Towns of Duxbury, Marshfield and Scituate during the appeal period was incorporated into the mapping.

2.2 Community Description

Plymouth County is located on the eastern coast of Massachusetts and consists of 25 towns and one city. The Towns of Duxbury, Hingham, Hull, Kingston, Marion, Mattapoisett, Plymouth, and Scituate fall along the coast of Plymouth County. The northern part of the county is made up of the City of Brockton and the Towns of Abington, Hanover, Marshfield, Norwell, Rockland, and Whitman. The Towns of Bridgewater, Carver, East Bridgewater, Halifax, Hanson, Lakeville, Middleborough, Pembroke, Plympton, and West Bridgewater are located in the middle portion of the county. The Towns of Wareham and Rochester are located in the southern portion of the county.

Plymouth County is bordered by Norfolk County to the northwest, Barnstable County to the southeast, and Bristol County to the west. Plymouth County's east coast is the Massachusetts Bay and it shares a northern water boundary with Suffolk County.

According to the U.S. Census, the population of Plymouth County was 494,919 in 2010, 472,822 in 2000 and 435,276 in 1990. The land area of Plymouth County consists of 659.08 square miles (Reference 5).

2.3 Principal Flood Problems

The coastal New England communities in Plymouth County are primarily subject to coastal flooding caused by northeasters and hurricanes. Northeasters can occur at any time of the year but are more prevalent in the winter months, whereas hurricanes mostly occur in the late summer and early fall months. The region north of Cape Cod generally experiences damage only from northeasters. A northeaster travels southwest to northeast along the Atlantic coast, collecting moisture over the ocean and sending it inland via northeast winds. Northeasters differ from hurricanes in that they cover a larger area, have less intense winds, and move more slowly. Where a hurricane may last for several hours, a northeaster may last for several days. For this reason, northeasters often last long enough to be accompanied by at least one high tide, which results in the most severe flooding conditions. In addition to flooding, damaging waves may occur from tidal surge in coastal areas. These high levels result from a drop in the barometric pressure and from strong winds that can blow out of the northeast across the considerable fetch of the Atlantic Ocean.

The flooding in Plymouth County causes considerable damage to residential and commercial structures; roads and bridges suffer structural damage as normally placid waterways surge beyond their banks. Some communities experience only minor flooding during periods of high rainfall as a result of high water in the lakes and swamps.

The flood problems for the communities within Plymouth County have been compiled and are described below. Very recent flood events or land development that has occurred since the date of each community's pre-countywide FIS, may not be reflected here:

The Shumatuscacant River, though relatively small, has in the past overtopped its banks. This overtopping was primarily due to inadequate culverts, which could not pass the storm runoff. Landfilling in some areas has contributed to this problem. In 1955, the Town of Abington experienced flooding problems due to two successive tropical hurricanes. Inadequate culverts at Adams, Central, and Center Streets caused localized flooding along the Shumatuscacant River. In March 1968, a relatively heavy rainstorm, preceded by another storm one week earlier, again caused high flows; but, due to the construction of three new bridges at Adams, Central, and Center Streets, the Shumatuscacant River did not cause any significant flooding problems.

The Town of Bridgewater has experienced considerable flood damage in the past, most notably from the storms of August 1955 and March 1968. During the 1955 flood, numerous roads were overtopped, including South Street over a small tributary to the Taunton River and Bedford Street near a pond. Hayward Street over the Town River, Water Street over South Brook, and Cross Street over Snows Brook were washed out. In addition, High Street along the Town River and Auburn and Summer Streets along the Taunton River were overtopped by the flood waters, and many low-lying areas of the town were inundated.

According to precipitation records, the August 1955 flood had a 1-percent-annual-chance of recurrence, and the March 1968 flood was equivalent to a 90-year event. No discharges or dollar estimates are available for these floods.

The 2010 flood was caused by 17 to 23 inches of rain from three primary storms over about a five-week period. It resulted in several bridges being overtopped. The recurrence interval for the 2010 flood was generally from a 50- to 100-year event, and greater than 100-year in some locations. The USGS streamgage on the Taunton River near Bridgewater (01108000), operated from 1929 to 1976, 1985 to 1988, and 1996 to present, experienced about a 100-year event on April 1, 2010 from the February to March 2010 storm events.

The City of Brockton has been besieged numerous times in the past with flooding problems. Major floods occurred in February 1886, March 1936, July 1938, August 1955, March 1968, and March 1969. The flood caused by Hurricane Diane in August 1955 was the greatest experienced to date. This storm caused considerable damage to residential and commercial structures along Salisbury Brook and Salisbury Plain River. Many bridges suffered serious structural damage as this normally placid waterway surged beyond its banks, raising havoc with anything in its path. Numerous bridge openings, even those in excellent shape, were too small to pass the required flow. Every river crossing having utility pipes slung under the bridge deck created obstructions by catching debris carried by the flood swollen streams. Eventually, these bridge openings clogged up and, as a result, water backup on the upstream side of the bridges caused adjacent areas to be inundated. Similar results occurred in both the 1968 and 1969 floods. Inadequate bridge openings, poorly located pipe crossings, and river channels clogged with debris all contributed to widespread damage along the river banks. Locations particularly hard hit were the Pleasant and Spring Street and Belmont Avenue areas. In every instance of major flooding noted above, these areas suffered the most damage.

Various other locations throughout the City of Brockton, notably Lovett, Doley, Dorchester, West Meadow, Edson, and Beaver Brooks and the Coweeset River, had experienced some flooding at the time the 1978 FIS became effective because of numerous subdivisions and developments being constructed in areas which either bordered on or were formerly swamplands. In the past, these waterways were relatively unimportant with a large area of overbank storage which could absorb flood flows. This storage area has since been filled in, thereby increasing the flood flows and flood stage of the watercourses. In many locations where roadways have been constructed over the brooks, the culvert is not capable of passing the 1-percent-annual-chance flow. As a result, water builds up on the upstream side of the culvert during significant storms, flooding the surrounding lowlands.

The Town of Carver has sustained little structural damage during floods because of sparse development along the streams. There is a relatively large area of swamps and bogs which are well regulated with many drop structures used in cranberry cultivation flow control. There has been major damage to the cranberry crops, but not to any of the control structures.

The Town of Duxbury, because of its coastal New England location, is highly susceptible to northeasters. In addition to flooding, damaging waves may occur from tidal surge in coastal areas. The entire coastline of the Duxbury Beach peninsula and much of the coastline along Duxbury and Kingston Bays has been determined to be subject to wave action.

The Town of Duxbury has experienced several floods in the past. The storm of February 1978, which has been designated a 1-percent-annual-chance event, generated elevations ranging from 10 to 12 feet in protected areas in the Town of Duxbury (Reference 6). Additional flooding was experienced at the immediate open coastline due to wave action. The storm of February 1978 was driven by northeast winds of over 30 mph and left 27 inches of snow. Bay Avenue, Plymouth, Cable Hill, and Landing Road suffered severe inundation by storm surge. People were evacuated from the Gurnet Road section and Landing Road. Other flooded areas included parts of Washington Street, Powder Point Avenue, King Caesar Road, Marginal Road, Bradford Road, Ocean Road, and Pine Street. Houses experienced damage and a section of roadway had to be rebuilt. On Kentucky Avenue, cars were completely submerged with only antennae showing. The force of the storm caused extensive damage, washing several houses out to sea. Part of the Marshall Street Bridge collapsed and many homes suffered water damage. At Duxbury Beach, the storm left blowouts 50 to 60 feet wide and 7 to 8 feet deep. The Powder Point Bridge leading to the beach was inundated (Reference 7).

The large number of rivers and streams in the Town of East Bridgewater has subjected the town to a moderate amount of past flooding. Flooding from the severe storm of August 1955 overtopped many bridges, damaged several, and completely washed out the Belmont Street Bridge which spans a tributary to Beaver Brook. The Bedford Street Bridge over the Matfield River and the South Street Bridge were covered by 2 to 3 feet of water. Along Meadow Brook, Harvard Street was overtopped and Forge Pond rose to a dangerously high level. Beaver Brook covered West Union and Spring Streets, and inundated much of the Elmwood area. Many low-lying areas, such as Pine Swamp, also experienced localized problems. Spring thaws often produce significant flooding on Spring Street, Willow Street, Harvard Street, Hobarth Street, and Pond Street. Flooding has also occurred at locations around Robbins Pond.

The Towns of Halifax, Hanover, and Hanson have sustained little damage during past floods. The relatively flat terrain and extensive bogs, swamps, and ponds have tended to reduce flood flows. The minor flooding which does occur in these areas during periods of high rainfall is a result of high water in the lakes and swamps. While it is an inconvenience to those affected, this type of flooding does not cause extensive damage.

The Town of Hingham is highly susceptible to northeasters. Areas which have flooded in the Town of Hingham include the neighborhood north of the Weir River and Rockland Street, the area west of Broad Cove, the coastline between the Weymouth Back River and Hingham Harbor, Free Street, and many areas near structures on the Weir, Crooked Meadow, and Plymouth Rivers. In addition to flooding, damaging waves may result in areas with sufficient fetch length and water depth. It has been determined that three such areas exist in the Town of Hingham. One is the coastline extending from the outlet of the Weymouth Back River along the northern and northeastern coastlines of Hingham Harbor. The second is the eastern coastline of Worlds End and Planters Hill, while the third is the northern coastline of Bumkin Island. Although many other locations may be protected from wave attack, they are still vulnerable to inundation by storm surge. Some areas where this type of flooding has occurred are Rockland Street at the Hingham-Hull town boundary and at the intersection of Kilby and Rockland Streets.

Riverine flooding is also a major concern in the Town of Hingham. Due to Hurricane Diane in 1955, several roads crossing over the Weir, Crooked Meadow, and Plymouth Rivers were overtopped by 3 to 5 feet of floodwaters. These included Cushing Road, Leavitt Street, Union Street, Free Street, Main Street, and Ward Street. Additional flooding and undermining problems have occurred at various locations along Town Brook, which has many culverts.

Much of the Town of Hull is flat and low. Because of its exposed location, the Town of Hull is subject to frequent coastal flooding, primarily northeasters. The storm of February 1978 generated elevations ranging from 10 to 11 feet in protected areas, and 13 to 14 feet in more exposed locations (Reference 6 and 8). An additional 10-15 feet of flooding was experienced at the immediate open-coast shoreline due to wave action. The seven-mile stretch of coast from Nantasket Beach to the Coast Guard Station at Point Allerton was under 6-10 feet of water. The Pemberton section was cut off from the rest of the town. Crescent Beach was heavily damaged when the ocean flowed over the beach into Straits Pond. Driven by northeast winds of over 30 miles per hour for 24 hours, the storm surge, combined with a high moon-tide, knocked out power and damaged or destroyed hundreds of homes and produced the worst flooding ever recorded in the Town of Hull (References 9, 10, 11, 12, and 13). The Nantasket Beach and Pemberton sections have been inundated and have had seawalls destroyed repeatedly during storms such as those that occurred in February 1978, March 1962, and August 1955 (References 9, 10, 11, 12, 13, 14, 15, 16 and 17).

The Town of Kingston is also highly susceptible to northeasters. Although the coastline is protected from severely damaging waves, such as those that occurred on the Hull, Scituate, and Marshfield coasts, the buildup of storm waters in Cape Cod Bay by northeasters causes high flood levels around the bay. Low lying areas such as the Rocky Nook area and Howlands Lane experience inundation during such storms. The northeaster of February 1978 caused flood levels in the Town of Kingston that ranged from 10.6 feet in exposed locations to 8.6 feet in more protected estuaries. The storm had a 1-percent-annual-chance of recurrence (Reference 6). Flooding resulting from rainstorms occurs near the central business district along Summer Street. Other flooding in the Town of Kingston is of a local nature and is generally not severely damaging.

The Town of Lakeville has experienced very little damage as the result of past storm due to the large amount of water storage available in the town. Assawompset Pond, s, Great Quittacas Pond, Little Quittacas Pond, Pocksha Pond and many small ponds and reservoirs account for this storage. Buena Vista Shores, along Long Pond, is a problem area where flooding has reached first flood levels. Huckleberry Shores, Nelson Shore, Churchill Shores and most other developments along the heavily populated shores of Long Pond have been subject to recurring flood problems, though not as severe as those at Buena Vista Shores. In addition, flooding affects Staples Shore, Pine Bluffs, and Indian shore along Assawompsett Pond.

Flooding in the Town of Marion generally occurs along the Buzzards Bay coastline, usually as a result of the high tides and wave action associated with hurricanes and major storms. The storm of September 21, 1938 had estimated tide elevations of 13.9 feet at Aucoot Cove and 14.3 feet at the Weweantic River (Reference 18). The hurricane of August 31, 1954 had estimated tide elevations of 13.4 feet at Aucoot Cove and 13.7 feet at the Weweantic River (Reference 18). These values represent estimated tidal elevations on the open coastline; individual tidal high-water marks in inlets or bays may have been higher or lower depending on the hydraulics at each location. The recurrence interval for the 1938 storm was 85 years and for the 1954 storm was 70 years. These values were developed by comparing estimated tide elevations at Aucoot Cove and the Weweantic River with a frequency curve developed for the same area; the curve was developed by correlating historical data of the Town of Marion with tide records at New Bedford, Massachusetts. The hurricane of 1954 caused extensive damage along the coast. No estimates of damage are available for this storm.

The Town of Marshfield is subject to coastal flooding caused by northeasters and hurricanes. The Town of Marshfield experienced severe flooding during the blizzard of February 1978. This storm generated storm surge elevations ranging from 9 to 10 feet in protected areas and from 10 to 11 feet in more exposed locations (References 6 and 8). Additional flooding was experienced at the immediate open coastline due to wave action. The February 1978 storm struck at noon on Friday driven by northeast winds over 30 mph and continued well into Tuesday night leaving behind 20 inches of snow. A power failure occurred at 3:00 p.m. Monday, which was not corrected for two days. This shut down pumping stations, leaving half the residents without drinking water. There was heavy damage to oceanfront properties from Humarock to Green Harbor. Sections of pavement were washed away from the roads in Fieldston and along the south end of the Brant Rock Esplanage. The Sea Street and Julian Street bridges were closed due to the dangerously high water of the South River. In addition, water in the South River rose very close to the surface of the Willow Street Bridge and inundated Chandler Drive with 2 feet of water. Along the North River, houses on Damons Point Circle were subject to water damage, and the roadway to Trouant's Island was submerged. The State Route 3A Bridge over the North River was also submerged at one time. At Brant Rock Center, the water depth reached approximately 3.5 feet, leading to the evacuation of hundreds of people as well as damage to many buildings and house trailers. In the Rexhame area, at the old mouth of the North River, several breaks occurred in the sand dunes allowing seawater to flow through to the South River. Heavy damage was caused by waves overlapping the Rexhame/Fieldston seawall, with not only houses experiencing damage, but roads being eroded or covered with rocks and debris. Many homes were damaged in the Bay Avenue area of Green Harbor and along Ocean Street in Fieldston (References 19, 20, and 21). The Brant Rock section has been repeatedly flooded during storms such as February 1978, February 1972, March 1962, and December 1959 (References 19, 20, 21, and 22). The low area along Bass Creek north of Ocean Street was flooded during the February 1978 storm by wave overwash from the shoreline between Sunrise Beach and Old Rexhame Dunes, causing the flooding in this area to rise to an elevation of approximately 6.5 feet (Reference 23). In addition to coastal and estuarine flooding, some inland areas have experienced periodic flooding from storm runoff; specific areas include the Green Harbor River upstream of the tidegate, Oakman Pond, Mounce Pond, and downstream of Chandlers Pond.

Flooding in the Town of Mattapoisett generally occurs along the Buzzards Bay coastline, usually as a result of the high tides and wave action associated with hurricanes and major storms. The storm of September 21, 1938 had estimated tide elevations of 13.0 feet at Nasketucket Bay, 13.7 feet at Mattapoisett Harbor, and 13.9 feet at Aucoot Cove (Reference 18). The hurricane of August 31, 1954 had estimated tide elevations of 12.4 feet at Nasketucket Bay, 13.1 feet at Mattapoisett Harbor, and 13.4 feet at Aucoot Harbor (Reference 18). These values represent estimated tidal elevations on the open coastline; individual tidal high-water marks in inlets or bays may have been higher or lower depending on the hydraulics at each location. The recurrence interval for the 1938 storm was 85 years and for the 1954 storm was 70 years. These values were developed by comparing estimated tide elevations at Aucoot Cove with a frequency curve developed for the same area; the curve was developed by correlating historical data of the Town of Mattapoisett with tide records at New Bedford, Massachusetts. The hurricane of 1954 caused extensive damage along the coast. No estimates of damage are available for this storm.

The Town of Middleborough experienced extensive damage during the flood of March 1968. The majority of the damage occurred along the Nemasket and Taunton Rivers. Along the Taunton River, the Vernon Street Bridge experienced minor damage and the Summer Street Bridge was inundated. A major washout occurred at the Auburn Street Bridge. Along the Nemasket River, Plymouth Street was overtopped and experienced minor damage. Along Precinct Street, a small tributary to the Nemasket River washed out the roadway. Just downstream of this point, along Summer Street, there was minor damage to the road from the same tributary. Purchade Brook caused a stone culvert to cave in at Cross Street. Roads in low-lying areas were also inundated.

The Town of Pembroke has been more fortunate than most Massachusetts communities regarding flooding problems. Two consecutive hurricanes, Connie and Diane in August 1955, produced the greatest known potential flooding situation. Intense rainfall, along with saturated soils, combined to produce extensive flooding throughout most of New England. The Town of Pembroke, however, remained relatively flood-free. Shallow localized flooding did occur at a few street intersections, as well as around the shoreline of a few ponds. The extensive network of cranberry bogs, swamps, and ponds effectively retained or reduced any possible flood flows. During periods of high seasonal rainfall, the water table in many portions of the town is so high that it causes localized flooding of basements in many areas. This condition is to be expected in any area which has as much swampy land as the Town of Pembroke does. This type of flooding, while causing an inconvenience to those affected, does not cause extensive damage. The North River, being completely tidal in the Town of Pembroke, has risen to flood stages in the past. This has been mainly the result of severe northeast storms with reduced barometric pressures, which can last for as long as 2 to 3 days. These intense barometric depressions can drive the tidal levels of the North River up to record flood levels. Fortunately, there has been very little damage from these storms in the Town of Pembroke. Marshes have been inundated, but, for the most part, the effect of these occurrences has been slight.

The coastline of the Town of Plymouth is subject to flooding from storm surge caused by northeasters. Although some of the coastline is protected from damaging waves, the buildup of storm waters in Cape Cod Bay by northeasters causes high flood levels around the bay. Tidal flooding north of Cape Cod is primarily caused by northeasters. The blizzard of February 1978 was a severe example of a northeaster, causing heavy damage along the entire Massachusetts coast. It had winds gusting to 70 mph, sustained wind speeds of 40 mph, and a duration lasting over several high tides. This storm, which was approximately a 1-percent-annual-chance event, generated flood elevations in Plymouth ranging from 12.7 to 21.9 feet in exposed coastal locations (Reference 8).

Historically, the Town of Rockland has sustained some damage during flood situations. However, the relatively flat terrain and small drainage areas have tended to reduce flood flows and damage from flood events.

The Town of Scituate is subject to coastal flooding caused by northeasters and hurricanes. The Town of Scituate experienced the worst flooding in its history during the blizzard of 1978. This storm was a classic northeaster, stalling with its center near Nantucket for approximately 48 hours. Northeast winds hit the Scituate coastline for this entire period and coincided with several high spring tides. Peak wind velocities of 79 mph were recorded at Logan Airport in Boston and 92 mph at Chatham on Cape Cod (Reference 8). The storm had a probability of near 1-percent-annual-chance. Heavy damage to much of the coastline was experienced in the town. More than 200 houses and many roadways and seawalls were damaged or destroyed in the Minot Beach, Cedar Point, Peggoty Beach, Mann Hill Beach, Sand Hill, Lighthouse Point, Scituate Harbor, Humarock, and Egypt Beach sections of the town.

The Scituate coastline experienced less severe damages during the storms of October 1991, February 1972, and December 1959. Although the storm of 1991 had a less than 1-percent-annual-chance, the storm caused significant flooding and damage along the Scituate coastline. The storm of 1959 damaged or destroyed 230 dwellings, destroyed seawalls, and damaged some shore roads. In addition to coastal flooding, several low-lying areas along streams and marshes in the town have flooded periodically.

In the Town of West Bridgewater, the major flood problems caused by past storms appear to have been in the vicinity of the Town River. During the storm of 1968, which was recorded as having a 75-year frequency, Scotland Road over the Town River was overtopped by six inches of water, as was South Main Street. Forest Street was overtopped by 1.0 foot of water. The discharges of the streams during this storm have not been estimated.

Flooding in the Town of Wareham generally occurs along the Buzzards Bay coastline, usually as a result of the high tides and wave action associated with hurricanes and major storms. The hurricanes of September 21, 1938 and August 31, 1954 had estimated stillwater tide elevations of 14.3 and 13.7 feet, respectively, along the Wareham coastline (Reference 18). These values represent estimated tidal elevations on the open coastline; individual tidal high-water marks in inlets or bays may have been higher or lower depending on the hydraulics at each location. The recurrence intervals of the 1938 and 1954 hurricanes were 85 and 70 years, respectively. These values were developed by comparing estimated tide elevations at the Town of Wareham with a frequency curve developed for the same area; this curve was developed by correlating historical data of the Town of Wareham with tide records at New Bedford.

There has been no history of major flooding in the Towns of Norwell, Plympton, Rochester, and Wareham. There has been minimal damage caused by flooding, as the low-lying areas and floodplains are mostly undeveloped.

Flooding within the Town of Norwell can be intensified by the presence of ice jams.

In the Town of Plympton, there is a relatively large area of swamps and bogs which tend to reduce flood flows and the damage resulting from flood events.

In the Town of Whitman, the relatively flat terrain, coupled with the small drainage areas, has tended to reduce any flood flows. The minor flooding that does occur in the Town of Whitman during periods of high rainfall is a result of the high water table found in the swamps and bogs. This type of flooding does not cause extensive damage.

Numerous major flooding events have occurred in Massachusetts over the last 50 years. Many of these have caused minimal-to-moderate damage to Plymouth County. Hurricane Gloria in September 1985 arrived at low tide and resulted in storm surges less than 5 feet above normal, minimizing damage to the coastline. Hurricane Bob in August 1991 passed over Plymouth County primarily affecting Southeastern Massachusetts, Cape Cod and the Islands. An unnamed coastal storm in October 1991 joined up with the remains of Hurricane Grace and produced the third highest tide recording at the Boston gage. This storm was labeled as the Perfect Storm by the National Weather Service. Winds measured over 80 mph and waves were over 30 feet in some parts of the Massachusetts coastline, causing flooding and wind damage to several counties, including Plymouth (References 24 and 25).

A coastal storm in December 1992 caused more than $12.6 million in damages to the Massachusetts public infrastructure such as; roads, bridges, public facilities, and public utilities. Plymouth County also saw flooding from severe storms in October 1996, June 1998, March 2001, April 2004 and May 2006. The June 1998 storm was slow moving and produced rainfall of 6 to 12 inches over much of eastern Massachusetts (Reference 25).

A series of widespread, large, low-pressure systems in southern New England in late February through late March 2010 resulted in record, or near record, rainfall and runoff. The total rainfall in this region during this period ranged from about 17 to 23 inches, which, coupled with seasonal low evaporation, resulted in record or near record peak flows at 13 of 37 streamgages in central and eastern Massachusetts, and in many cases was unprecedented in the past 100 years of weather history. The highest record peaks generally occurred in Narragansett Bay Watershed in southeastern Massachusetts in late March or early April; at most other streamgages, the peak was in mid-March. A presidential disaster was declared in multiple counties in eastern Massachusetts, including Plymouth County (Reference 26). In the Town of Middleborough, Plymouth Street was overtopped by Nemasket River; Summer Street was washed out by Beaver Dam Brook; Vernon Street was overtopped by Poquoy Brook and Taunton River; Wood Street was overtopped by Fall Brook; Walnut Street was overtopped by an unnamed stream; Bartlett

Brook along Thompson Street overtopped its banks and flooded low-lying farmland; Woloski Park was inundated; Pratt Farm Dam was breached; and Fuller/Plympton Street Dam was overtopped by Raven Brook.

In August 2011, Hurricane Irene, weakened to a tropical storm, flooded numerous roads, downed large trees and caused power outages throughout Plymouth County. Boston's (Suffolk County) strongest wind gusts were 63 mph at 11:10 am (Reference 27). Sustained wind speeds of 33 mph and gusts to 54 mph were recorded at Plymouth Municipal Airport before the Automated Surface Observing System (ASOS) failed at 10:32 EST (Reference 28).

On October 29 and October 30, 2012, Hurricane Sandy, a hybrid storm with both tropical and extra-tropical characteristics, brought high winds and coastal flooding to southern New England, including Plymouth County. Sandy reached hurricane status over the southwest Caribbean and headed north through the Bahamas where it interacted with a vigorous weather system loving west to east across the United States, making landfall near Atlantic City, NJ on October 29, 2012 as a category 1 hurricane based on the Saffir-Simpson Hurricane Wind Scale. Sustained wind speeds of 39 mph were reported by the Automated Surface Observing System at Plymouth Municipal Airport and Sandy produced wind gusts of 70 to 80 mph and moderate coastal flooding occurred within Plymouth County. In Wareham, wind gusts of 90 mph and concentrated damage occurred where a microburst was reported. Hardest hit locations in Wareham were Swifts Beach, Pinehurst, and Onset Bay Marina. Seas built to between 20 and 25 feet just off the east coast with a storm surge generally about 2.5 feet to 4.5 feet, peaking in between high tide cycles. Several coastal locations were flooded due to water coming over seawalls and numerous roads were closed countywide due to flooding and down trees (Reference 28).

On February 9, 2013, a low pressure system originating from the Great Lakes region combined with a low pressure system moving northeast from the Gulf Coast over New England producing up to 2 feet of snow, gale force winds, and moderate coastal flooding within Plymouth County. The arrival of the storm, named The Blizzard of 2013, coincided with an astronomical high tide producing 30 foot waves offshore, but due to the shift of winds from the northeast to the north at high tide, the storm surge dropped from 3 to 4 feet at low tide to 1.5 to 2.5 feet for most east coast locations. In Plymouth, Warren Avenue was flooded, a house on Taylor Avenue was destroyed, and the Pilgrim Sands Motel basement was flooded with 2 feet of water. In Scituate, coastal flood water depths reached up to 16.6 feet during the storm. Flood waters reached depths of 4 feet on numerous roads and the Scituate light house was damaged. Throughout the coastal areas of Plymouth County, significant beach erosion occurred, damaging dunes, sand fencing and stairs (Reference 28).

2.4 Flood Protection Measures

Flood protection measures for Plymouth County have been compiled from the pre-countywide FISs and are summarized below. Flood protection measures that have been implemented since the date of each community's pre-countywide FIS may not be reflected here.

Development in the floodplain is restricted by the zoning bylaws in the Town of Abington. Also, the 1955 flood illustrated all too graphically the need for culverts or bridges of adequate size to pass flood flows. In 1956, three new bridges were constructed at Adams, Central, and Center Streets to replace the culverts damaged in 1955. These bridges were designed to safely pass the "rare" flood that, in 1955, was considered to be the flood flow expected to occur once every 500 to 1,000 years. These bridges have decreased the potential for major flooding. The bridge at Center Street serves as the outlet for Island Grove Pond. At the upstream face of the bridge, an overflow weir was constructed and provided with stop planks as part of the outlet facilities. This weir has the capability of being adjusted to different weir elevations and, therefore, can be considered to have some flood protection capabilities.

Flood protection measures in the City of Brockton have not been implemented on any large scale. In 1975 a study was conducted by Fenton G. Keyes Associates for the USACE (References 29 and 30). This study investigated flood problems along Salisbury Brook and Salisbury Plain River, as they flow through the City of Brockton. Results of this study indicated that the primary causes of flooding in Brockton along the entire length of Salisbury Brook were inadequate culvert capacities and numerous utility pipes which are suspended under street bridges (Reference 29). The USACE determined that there was insufficient economic justification to permit federal participation in the construction of flood control improvement. Any major work on flood control would have to be supported entirely by local funds. One avenue of approach which could be easily supported by the city is channel cleanup. By removing much of the debris accumulated in the channels and bridge openings, flood hazards could be reduced. Wetlands zoning ordinances passed by the city will help in preventing extensive development in the floodplain.

The Town of Duxbury has a floodplain zoning plan to limit future development within floodplain areas. This not only protects against flood damages to new structures, but also assures that the natural flood storage areas in the town will be protected (Reference 31). Most of the Town of Duxbury is naturally protected from severe wave action by the Duxbury Beach peninsula; however, blowouts occurred through the dunes in the 1978 blizzard. The dunes have since been rebuilt and fenced off for protection from people and cars which may cause erosion. The only structural flood protection measures are discontinuous seawalls designed primarily to dissipate wave energy, not for total flood protection.

There are no structural flood protection measures existing in the Town of Halifax, nor are there current zoning regulations restricting development within any identified riverine floodplain. The most effective flood protection measures in the Town of Halifax are provided by the natural system of swamps which tend to attenuate flood flows by creating storage areas and by the generally flat terrain which reduces flood velocities.

The most effective flood protection measure in the Town of Hanover is provided by the natural system of swamps and ponds which tend to control flood flows by creating storage areas and by the moderate terrain which reduce flood velocities. There are three dams located on the Indian Head River in the Town of Hanover, but they do not provide flood protection.

The tidegate at Broad Cove protects the area between Broad Cove Road and Thaxter Street in the Town of Hingham from tidal inundation during the 1-percent-annual-chance storm. The Town of Hingham maintains a flood plain district to prohibit future development within flood plain areas. The district is based on a flood plain map prepared by historic observations. This not only protects against flood damage to new structures, but also assures that the natural flood storage areas in the town will be protected. Dams are located at Foundry and Cushing Ponds, but they do not provide flood control. A 2-foot high seawall protects part of the western shore of Hingham Harbor from storm surge and wave attack. Following Hurricane Diane in 1955, the Weir, Crooked Meadow, and Plymouth Rivers have been excavated from Leavitt Street to Main Street, and the culverts at Leavitt Street, Union Street, and Free Street have been replaced.

The Town of Hull employs numerous structural flood protection measures, primarily to dissipate wave energy and not for total flood protection. The February 1978 storm, which did considerable damage to existing seawalls and breakwaters, showed that structural flood controls are not completely reliable against storm damage. After this storm, several seawalls were replaced or improved, and some erosion control measures were taken. In Green Hill, the seawall, which flanks the hill, was repaired and riprap was placed to stabilize the bluff. The Crescent Beach breakwater was replaced after experiencing heavy damage in 1978, with waves washing over the beach into Straits Pond. The seawall at Gunrock was replaced with design improvements. Much of Nantasket Beach was fronted with sand dunes and small seawalls which were broken, overtopped, and washed away during the February 1978 storm. Most of the beachfront homes in this section experienced damage. At Point Allerton, the seawall was repaired. Along the causeway connecting Allerton and Pemberton, the seawall is being improved, and on Pemberton's inner and outer coast, the seawalls are being repaired. Bluff stabilization is underway at Green Hill and Strawberry Hill. A large seawall in the Kenberma section protects many houses which are below 10 feet in elevation. Many other locations in Bull have small seawalls or riprap.

While the Town of Kingston does not employ structural flood control measures, the land area has many natural flood protection features. The inland waterways have extensive flood storage in the form of cranberry bogs, ponds, and wetlands. The coastal zone is sheltered from ocean waves by the Duxbury/Plymouth Peninsula. The Town of Kingston also maintains a Conservancy District along its watercourses which serves to protect natural flood storage and the floodway, which carries most of the high velocity floodwaters.

In the Town of Lakeville, between Little Quittacas Pond and Great Quittacas Pond, there is a gatehouse used to control water levels for both flood control and water supply purposes. New Bedford Waterworks utilizes Little Quittacas Pond as its water supply. There is also a gatehouse between Assawompset Pond and Great Quittacas Pond because Assawompset Pond is also utilized for water supply. However, no flood protection works have been constructed which would significantly affect the flood conditions in the town.

The Town of Marshfield has a floodplain zoning ordinance to regulate future development within floodplain areas. This not only protects against flood damages to new structures, but also assures that the natural flood storage areas in the town will be protected (Reference 32). The Massachusetts Department of Natural Resources has restricted all the tidal marsh areas in the Town of Marshfield under the authority of Chapter 130, Section 105, of the General Laws of the Commonwealth of Massachusetts. The restricted areas include the tidal marshes along the North River, the South River, the Green Harbor River downstream of the cranberry bogs, and the Duxbury Marsh south of Careswell Street. Structural flood protection measures include seawalls and tidegates. The seawalls that have been constructed are used primarily to dissipate wave energy, not for total flood protection. The tidegates that were installed are used as a means of reducing flooding in low-lying areas. The seawalls are located from Rexhame Road to Shephard Avenue, from Samoset Avenue to Thomas Street, from Bradford Street to just south of Wave Street, and from just south of Beach Street to the Marshfield/Dewbury corporate limits. The shorelines between these sections of seawall are protected by riprap bluffs, sand dunes, jetties, and short sections of private seawalls. The tidegates are located at Dike Road near the mouth of the Green Harbor River and reduce the tidal flooding in the area between Ocean Street and Dike Road.

The Town of Mattapoisett joined the NFIP on May 8, 1974 and incorporated floodplain management regulations into its zoning laws to help future flood damages and related hazards. Due to changing conditions and restudies in the area, the ordinance was amended in April and June 1980. The Zoning Laws apply to all areas within the Town of Mattapoisett’s jurisdiction that are shown on the Flood Plain Zoning Map as being located within a "Special Hazard Zone." Under the existing Zoning Code, all new construction in the areas designated as a coastal high hazard area shall be located landward of the reach of the mean high tide. There is limited permitted use in the Special Hazards area for agriculture; commercial/industrial loading and parking areas; municipal uses that are directly related to, dependent upon, or essential to the area, such as beaches, golf courses, fish hatcheries, swimming areas, water works or pumping stations; residential uses such as lawns and gardens and structures not designed for human habitation; and residential dwellings in accordance with Building and Flood Proofing regulation. The Building Code further defines minimum requirements for structures within the Special Hazard areas: flood-proofing to 14 feet above mean sea level; new construction or significant alteration done under a special building flood-proofing permit; building elevations for new construction or substantial improvement to residential structures having the lowest floor elevation at or above the 1-percent-annual-chance flood level; and structures adequately anchored to prevent flotation, collapse, or lateral movement as well as being constructed of material, and in such a manner, as to prevent flood damage (Reference 33). There are no flood control structures present and none planned for the Town of Mattapoisett.

Geographically, the Town of Pembroke has a very efficient natural flood protection system. An extensive system of lakes, ponds, swamps, and cranberry bogs absorbs much of the potential flood waters. The 1955 hurricanes produced probably the greatest potential for flooding in Massachusetts in recorded meteorological history; however, the effects in the Town of Pembroke were very slight. The natural hydraulic network in the Town of Pembroke was instrumental in absorbing and retarding most peak flows produced by the heavy rains. In March 1968, heavy rains produced major flooding in adjacent communities but, again, virtually all of the Town of Pembroke was free of significant flooding. Once again, the hydraulic network helped in reducing peak flows. Minor flooding did occur in isolated localities and, because of an abnormally high water table, some flooding did occur in a few low-lying homes and basements, especially around the ponds. In the past few years, the town has enacted strict zoning ordinances, which have restricted development throughout much of the lower areas. These ordinances have so far proven to be very effective in limiting development in flood-prone areas. A continued effort will be required from all concerned to keep these ordinances in effect in the future. Pressure from developers will increase dramatically in the next few years, to try to force the community in to opening up more areas for development. Failure to adhere to current floodplain ordinances will increase the potential for serious flooding.

The land area in the Town of Plymouth has many natural flood protection features. The inland waterways have extensive flood storage in the form of cranberry bogs, ponds, and wetlands. The Town of Plymouth also maintains a conservancy district along its watercourses that serves to protect natural flood storage and the floodplains. The breakwater on Long Beach protects much of Plymouth Harbor from severe wave attack, as do several smaller retaining walls and a breakwater area in the immediate area of Plymouth Harbor. Breakwaters and retaining walls are also located along the shorelines of Kingston Bay and Plymouth Bay, providing protection from wave activity. Several dams are located on streams throughout the Town of Plymouth; none are used for flood control.

The Town of Scituate has floodplain zoning ordinances to regulate development in the flood-prone areas. Structural flood protection measures include numerous seawalls and revetments designed to protect against wave damage. As witnessed by the 1978 storm, such structures do not always provide the protection that is expected of them. Seawalls that were damaged or destroyed during the 1978 storm have either been repaired or rebuilt, most at their prior elevation. The walls along Scituate Harbor are built at higher elevations designed to withstand the 1- and 0.2-percent-annual-chance floods. Tack Factory Pond Dam and Old Oaken Bucket Pond Dam on First Herring Brook, Hunters Pond Dam on Bound Brook, and several smaller dams are located in the town. None of these dams are used as flood control structures.

Although there are no actual flood protection measures located in the Towns of Carver, Hanson, Norwell, Plympton, Rochester, Rockland, or Whitman, the natural system of lakes, ponds, swamps, and cranberry bogs is an effective flood protection measure. The flat terrain and creation of storage areas by the bogs retard flood flows.

There are no flood protection works existing or planned which would significantly affect flood conditions in the Towns of East Bridgewater, Middleborough, Marion, Wareham, and West Bridgewater.

As a non-structural flood protection measure, the Rockland Conservation Commission operates a permit system to control development along watercourses and water bodies.

The Towns of Marion and Plympton have also incorporated a set of floodplain management regulations into its zoning laws to help minimize future flood damages and related hazards.

3.0 ENGINEERING METHODS

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-, 50-, 100-, or 500-year period (recurrence interval) have been selected as having special significance for floodplain management and for flood insurance rates. These events, commonly termed the 10-, 50-, 100-, and 500-year floods, have a 10-, 2-, 1-, and 0.2-percent chance, respectively, of being equaled or exceeded during any year. Although the recurrence interval represents the long-term, average period between floods of a specific magnitude, rare floods could occur at short intervals or even within the same year. The risk of experiencing a rare flood increases when periods greater than 1 year are considered. For example, the risk of having a flood 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 county at the time of completion of this study. Maps and flood elevations will be amended periodically to reflect future changes.

3.1 Hydrologic Analyses

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

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

Precountywide Analyses

In the Town of Abington, the Shumatuscacant River is ungaged and no record of past floodflows or stages was available. Various methods were evaluated to best obtain the peak floodflows that could be expected. A method developed by the USGS Water Resources Division appeared to be most suitable for ungaged streams in Massachusetts (Reference 34). This method was developed after many years of monitoring an extensive number of gaged streams throughout Massachusetts. By multiple-regression techniques, a relationship was developed between the actual flood peaks experienced at the recording stations and their drainage basin characteristics. The results of this study indicate that flood peaks for any particular stream, whether it be gaged or ungaged, may be estimated from knowledge of the drainage basin area, main channel slope, and the mean annual precipitation of the basin. The peak flows for approximate study areas were also determined by this method. The 0.2-percent-annual-chance floodflows for all portions of the Shumatuscacant River and its eastern unnamed tributary, herein called the "Northern Tributary," were determined by straight line extrapolation from a logarithmic-probability plot of the 10-, 2-, and 1-percent-annual-chance flows. The total drainage area for the Shumatuscacant River varies from 0.00 to 3.45 square miles at the corporate limits, a relatively small watershed. For this reason, it was not feasible to develop one set of discharge-frequency relationships. Therefore, peak discharges were derived for six respective segments of the river and for the one segment of the "North Tributary" Shumatuscacant River for the 10-, 2-, 1-, and 0.2-percent-annual-chance floodflows.

For the Stream River, the discharge-frequency analysis was conducted using regional equations developed by S. William Wandle, Jr. (Reference 35). The 0.2-percent-annual-chance peak discharge was estimated graphically from the calculated values of the more frequent events.

In the Towns of Bridgewater, East Bridgewater, West Bridgewater and Middleborough, initial estimates of peak runoff for 10-, 2-, 1-, and 0.2-percent-annual-chance storms, obtained by using the Johnson-Tasker Multiple Regression Formulae, were judged to be high (Reference 36, 37, and 38). These formulae employ three parameters: a watershed area taken from standard USGS quadrangle maps, an annual precipitation value, and a value for the slope of the river. After close scrutiny, it was found that vast amounts of storage within the region's drainage area rendered the results to be inaccurate. An alternate method for finding run-off values by relating peak discharges areas was employed. It has been found that for sites on the same stream, the discharge ratios are directly proportional to the drainage area ratios raised to some power less than one. This may be expressed as:

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

Where Q_1 and A_1 are the discharge and drainage, respectively, at the ungaged site; Q_2 and A_2 are the discharge and drainage at the gaged site; and x is an exponent less than one. The value of x can be estimated from the slope of a graph showing the relation between mean annual flood and drainage area for the region. Records from the State Farm gaging station (01108000) on the Taunton River (located 1.0 mile upstream of Sawmill Brook) in Bridgewater were used to obtain values for Q_2 and A_2. Values for A_1 were taken from USGS topographic maps (Reference 39), and a value for x, which was 0.7, was obtained from the USGS office in Boston (Reference 40).

Peak discharges for the Town and Matfield Rivers were taken from the 1982 FIS for the Town of Bridgewater (Reference 41). For Sawmill Brook and Tributary A to Sawmill Brook, peak discharges were determined using the USGS Regional Regression Equations for Massachusetts (Reference 42).

There are no gaging stations on any of the watercourses studied in detail in the City of Brockton. Various hydrologic analyses were employed to determine peak flows for the selected recurrence intervals for Salisbury and Trout Brooks and the Salisbury Plain River. Peak flows for Salisbury Brook were determined by first calculating the peak flows of Lovett Brook and the peak inflow into Brockton Reservoir, upstream of the study area. These flows were determined by utilizing the Soil Conservation Service (USDA NRCS) method of peak runoff based on rainfall intensity and soil classification type (Reference 43). Flow into Brockton Reservoir was then routed through the reservoir to determine inflow to Waldo Lake. This flow was then routed through Waldo Lake to determine peak outflow from Waldo Lake. This adjusted flow was then routed through the remaining ponds in D.W. Field Park (Reference 44) to arrive at a peak flow out of Cross Pond, which feeds Salisbury Brook. Peak flows were determined for Lovett Brook by using the same USDA NRCS method of peak runoff determination routed down through the brook to Cross Pond. The respective peak flows were then added, taking into consideration that the peak flow from the series of ponds would be substantially reduced because of the impoundment of the flood waters supplied by Brockton Reservoir and Waldo Lake. These two water bodies provided sufficient storage to retard and diminish the peak flow out of Cross Pond. Once a peak flow was determined at the outlet of Cross Pond, a peak flow was determined at selected locations along Salisbury Brook using the USDA NRCS method of drainage area relationships (Reference 43). Peak flows for Trout Brook were determined by the USDA NRCS method of peak runoff determination. After routing these flows through the reach, peak flows were determined downstream of the confluence of Trout and Salisbury Brooks by adding graphically the peak flows from each brook. These flows were then used to establish peak flows downstream, again using the USDA NRCS method.

In the Town of Carver, a log-Pearson Type III analysis on all of the gages nearest to the study area was used to develop discharges for all detailed study streams; the results of the analysis were plotted as envelopes of curves of drainage area versus cfsm rates (cubic feet per second per square mile). Since the characteristics of the study area are different than those of the gaged streams, a final curve on the low side of the plotted data was selected for use. The curve was based on subjective judgment.

The peak discharges for the Winnetuxet River, Palmer Mill Brook, Indian Head Brook, Drinkwater River upstream of the tributary entering from Hell Swamp, and Longwater Brook from its confluence with the Drinkwater River to the upstream corporate limits were computed from regional regression equations developed by USGS for ungaged drainage basins in Massachusetts (Reference 45). Peak discharges for Poor Meadow Brook were computed from the revised version of the USGS regression equations (Reference 35). These equations relate peak flow to drainage area and slope. Peak discharges for the Taunton River were obtained from the September 8, 1999 FIS for the Town of Bridgewater (Reference 46).

A standard log-Pearson Type III analysis was used to determine peak flows on the Indian Head River for the selected recurrence intervals (Reference 47). Data used in this analysis was obtained at the USGS gage 01105730, located on the Indian Head River in the Town of Hanove (Reference 48)r. The analysis was based on a 12-year period of record. The discharges determined by this method for the Indian Head River were in close agreement with those used in the February 1982 FIS for the Town of Pembroke (References 47, 49, and 50). Because of the close agreement, the previously established discharges were used for the Indian Head River. On the Drinkwater River, from Factory Pond upstream to the tributary entering the river from Hell Swamp, the discharges were computed based on averaging results obtained by two methods. The first method was the log-Pearson Type III analysis of the Indian Head River gage (Reference 47). The second method used the regional regression equations developed by the USGS for ungaged drainage basins in Massachusetts (Reference 45). This combination of methods was also used to compute peak flows on French Stream and Drinkwater River Tributary. Peak discharges at other locations along the Indian Head River were transposed upstream and downstream of the gage based on drainage area.

Peak discharges for the 10-, 2-, 1-, and 0.2-percent-annual-chance floods in the Town of Hingham and along Smelt Brook were computed by the USGS regional formula for estimating flood magnitude and frequency (Reference 45). This formula is based on an analysis of all gaging stations in eastern Massachusetts; the following equation is used:

$$Q_n = C_1 A^{C2} S^{C3}$$

where Q_n is the peak discharge for recurrence interval n in cubic feet per second, A is the drainage area, S is the stream slope and C_1, C_2, and C_3 are coefficients specific to recurrence interval n.

The 10-, 2-, 1-, and 0.2-percent-annual-chance discharges for Jones River Brook, Halls Brook, Mile Brook, and the Jones River were determined using the HEC-1 flood hydrograph computer model (References 51 and 52). The model was calibrated to the March 1968 flood, which was slightly greater than a 10-percent-annual-chance storm measured at USGS gage 01105870, downstream of Elm Street on the Jones River. Unit hydrograph coefficients developed in the calibration run were used to synthesize hydrographs for the 10-, 2-, 1-, and 0.2- percent-annual-chance floods. Synthetic rainfall hyetographs were developed from Technical Paper No. 40 (Reference 53). Sub-basin hydrographs were routed through the numerous storage areas along the streams and were combined to develop the composite basin models.

The hydrologic data for Hannah Eames Brook and the streams studied by approximate methods in the Town of Marshfield were taken from the October 1, 1983 FIS for the Town of Marshfield (Reference 22). There are no continuous streamgages in any of the studied watersheds in this study. This analysis consisted of determining the mean annual flood and related floods using the Rational Method and assuming hydrograph distributions in specific areas. Information on rainfall was obtained from Weather Bureau Technical Paper No. 40 (Reference 53).

The hydrologic analyses for Second Herring Brook and Black Pond Brook consisted of the use of two methodologies. A standard log-Pearson Type III analysis was utilized to determine peak flows for the selected recurrence intervals at the USGS gage (01105870) located on the Jones River in the Town of Kingston. The analysis was based on 12 years of record. A discharge-drainage area proration method was used to transpose the results of the gage analysis to the detailed study streams in the Town of Norwell. The second method was the use of regional regression equations developed by the USGS for ungaged drainage basins in Massachusetts. These equations relate drainage area and slope to peak flow (Reference 45). The final results were an average of results obtained from these two methods.

Flows to Herring Brook were determined by utilizing a procedure developed by the USDA NRCS (Reference 43). Utilizing information concerning basin characteristics, a hydrograph was developed for Herring Brook, excluding any flow from Furnace Pond. These flows were then routed downstream to the confluence with the North River. Peak floodflows into Oldham and Furnace Ponds were based on previous calculations performed by the study contractor in 1964 (Reference 54). Inflows with a 10-, 2-, 1-, and 0.2-percent-annual-chance were developed and were then routed through the ponds, using standard routing procedures. Methods and computed outflows were thoroughly investigated for reasonableness and were found to reflect current hydrologic judgment. The 0.2-percent-annual-chance outflow was determined by extrapolating from the data.

For the July 17, 1986 Town of Plymouth FIS, for Town Brook, discharge-frequency relationships were determined using the USACE HEC-1 flood hydrograph computer model (References 51 and 52). The model was calibrated to the March 1968 flood at the USGS streamgage 01105870 downstream of Elm Street on the Jones River in the Town of Kingston. The gage was chosen because of the watershed similarities between the Jones River and the Town Brook and also because it is the closest gage to Town Brook. Peak discharges for the 10- and 1-percent-annual-chance floods on remaining riverine streams were determined using the USDA NRCS Tabular Method to develop composite hydrographs at selected points (Reference 55). Each watershed was divided into sub-areas, and drainage area, time of concentration (T_c), and travel time (T_t) were computed. A runoff curve number (RCN) was assigned to each sub-area based on soil and land-use characteristics. The 24-hour rainfall for the 10- and 1-percent-annual-chance floods was determined using National Weather Service Technical Paper 40 (Reference 53). Based on the RCN and the 24-hour rainfall, the runoff in inches was determined from tables prepared by the USDA NRCS (Reference 56). Hydrographs of flow in cubic feet per second per square mile (cfsm) for each point were taken from tables prepared by the USDA NRCS, based on T_c and T_t. The discharges in cfsm were then multiplied by drainage area and runoff in inches to obtain peak discharges in cubic feet per second. Peak discharges for the 2- and 0.2-percent- annual-chance floods were determined by extending the frequency curve of the 10- and 1-percent-annual-chance floods according to a log-Pearson Type III distribution.

A rating curve for the outlet of Snipatuit Pond was determined. Rainfall runoff for the 10, 2-, and 1-percent-annual-chance floods was added to a base water surface elevation on Snipatuit Pond, and the corresponding outlet flood magnitudes were determined from the rating curve. The 0.2-percent-annual-chance flood was determined from extreme probability paper. Regional discharge frequency equations developed by S. William Wandle were used for the remainder of the watershed, not including the 7.6-square-mile drainage area for Snipatuit Pond (Reference 45). The 1-percent-annual-chance flood magnitude from Snipatuit Pond (65 cubic feet per second) was added to each frequency of the regional equation. Although the peak from the pond and remaining watershed may not coincide, for the purposes of this study, they were assumed to be concurrent.

The peak discharges of French Stream were obtained by averaging the results of two methods of flood flow frequency determination. First, a standard log-Pearson Type III analysis was performed using 12 years of data from the USGS gage located on Indian Head River in Hanover, Massachusetts (01105730) (References45, 47, amd 48 39 and 40). French Stream is a tributary of the Indian Head River. A drainage area discharge relationship was used to transpose the results of the Indian Head River analyses to French Stream. The equation used for transposing the gage based data was as follows:

$$Q/Q_g = (A/A_g)^{0.75}$$

where Q is the discharge at the desired location on French Stream, Q_g is the discharge at the Indian Head River gage, A is the drainage area of French Stream at the desired location, and A_g is the drainage area at the Indian Head River gage (Reference 57). The second method used to obtain flood flows for French Stream was the regional regression equations developed by the USGS for ungaged watersheds in Massachusetts. The final discharges for use on French Stream were obtained by averaging the discharges developed by both methods.

The flood discharges of Tributary A were computed using the Rational Method in conjunction with a routing of the flood flows through the Summer Street culvert (Reference 58). The Rational Method was chosen because of the small drainage area and the high degree of urbanization in the Tributary A watershed. The peak discharges for Tributary A are less at the confluence with French Stream than downstream of Levin Road because the culvert at Summer Street through which the flood water is routed causes water storage to occur upstream of the culvert. This storage results in a reduced peak discharge downstream of Summer Street to the confluence with French Stream.

For the 1992 FIS, the hydrologic analysis for the Town of Scituate involved the study of two types of flooding sources: inland flooding of those areas affected by riverine flooding and coastal flooding affected by coastal storm surge and wave action. Combinations of both flooding types were considered for some areas. Due to the absence of streamflow records, peak discharges for the 10-, 50-, 100-, and 0.2-percent-annual-chance floods for the riverine streams studied by detailed methods were computed using the Rational Method and assuming hydrograph distributions.

<u>Countywide Analyses</u>

For the July 17, 2012 countywide revision, no new hydrologic analyses were conducted.

For the July 16, 2015 Narragansett Watershed analysis, hydrologic analyses were conducted for the Taunton and Nemasket Rivers.

Taunton River

Discharges for given annual exceedance probabilities (AEPs) at the Taunton River near Bridgewater USGS streamgage (01108000) are weighted values calculated with the USGS Weighted Independent Estimator (WIE) program (Reference 59). The program combines at-site log-Pearson Type III flow-frequency estimates with regional regression estimates. At-site estimates of the 10-, 2-, 1-, and 0.2-percent AEPs at the Taunton River gage were taken from Zarriello and others (Reference 60). These at-site estimates were based on 65 years of continuous record and 20 additional years of estimated peaks. The estimates calculated using regional regression equations are based on the basin characteristics drainage area (mi^2), stream density (mi/mi^2), and open water and wetland storage (percent) at the streamgage.

The Taunton River streamgage is just upstream of the Titicut Street Bridge. Theoretical AEP flows were transferred 8 miles upstream and 16 miles downstream from the gage using a weighted hybrid method (Reference 61) that combines regression equation estimates at the new location with the weighted estimate determined at the gaged site.

A section of splitflow occurs around two railroad bridges starting upstream of County Street/Route 140 above the Mill River in Taunton and downstream of the Honorable Gordon Owen Parkway which is downstream of Route 24. A flow optimization routine in HEC-RAS resulted in from 3,100 to 3,500 cfs going through the main channel under the railroad bridges at all of the theoretical flows modeled. Since the total flows vary from 4,230 at the 10% AEP to 6,890 cfs at the 0.2% AEP in this section of the river, the remainder of the flow that flowed outside the banks was from 700 to 3,650 cfs (16% to 53%) of the total.

The hydraulic model for the Taunton River was calibrated for the March and April 2010 event using the flood flow calculated at the streamgage for that event and high-water marks (HWMs) documented throughout the reach (Reference 26).

Nemasket River

Discharges for given AEPs on the Nemasket River were calculated using regional regression equations (Reference 60). The regional regression equations are based on the basin characteristics drainage area (mi^2), stream density (mi/mi^2), and open water and wetland storage (percent) at the streamgage.

The regional regression equations were used to estimate discharges for the 10-, 2-, 1-, and 0.2-percent AEPs for those sites from the outlet of Long Pond into Assawompset Pond to Assawompset Pond Dam (outlet of Assawompset Pond) into the Nemasket River and downstream to the MBTA Commuter Railroad Bridge (about 0.6 miles upstream of the confluence with the Taunton River).

Peak discharge-drainage area relationships for Plymouth County are shown in Table 6, “Summary of Discharges.”

TABLE 6 – 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
ACCORD BROOK					
At a point approximately 2,100 feet downstream of Prospect Street in Hingham	3.1	125	210	256	393
BEAVER BROOK					
At Elm Street in East Bridgewater	2.3	319	436	498	614
At Summer Street in East Bridgewater	1.3	313	428	487	600
BEAVER DAM BROOK					
At White Horse Beach	4.6	738	1136	1343	1932
Upstream of State Route 3A in Plymouth	2.3	603	899	1049	1469
BLACK BETTY BROOK					
At the confluence with West Meadow Brook	0.8	64	88	101	124
At the West Bridgewater/ Brockton town line	0.3	32	44	50	62
BLACK BROOK					
At Central Street in East Bridgewater	1.4	90	123	140	173
BLACK POND BROOK					
At the confluence with Second Herring Brook	2.9	125	210	260	395

TABLE 6 – 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
BOUND BROOK					
At Mordecai Lincoln Road in Scituate	7.2	370	635	950	1400
At the culvert at State Route 3A in Scituate	6.6	300	550	800	1200
CRANE BROOK					
At the confluence with the Weweantic River	12.3	295	430	505	650
At Cranberry Road in Carver	6.8	190	280	325	410
CROOKED MEADOW RIVER					
At the confluence of Fulling Mill Brook	4.3	177	297	362	556
DRINKWATER RIVER					
At Factory Pond	22.6	850	1,260	1,470	2,030
At confluence with Drinkwater River Tributary	18	770	1,035	1,155	1,470
Upstream of French Stream	11.2	480	740	870	1,240
Upstream tributary from Hell Swamp	3.4	160	270	330	520
DRINKWATER RIVER TRIBUTARY					
Upstream confluence with the Drinkwater River	4.5	80	225	315	560

TABLE 6 – 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
EEL RIVER (Town of Hingham)					
At its confluence with the Plymouth River	0.6	53	91	112	177
EEL RIVER (Town of Plymouth)					
At Sandwich Road in Plymouth	3.7	222	377	463	724
At Russell Millpond outlet	3	194	330	405	633
EEL RIVER BRANCH					
At Clifford Road in Plymouth	5.4	509	863	1060	1656
Approximately 1 mile upstream of Clifford Road	2.7	305	517	635	992
FIRST HERRING BROOK					
At the culvert at New Driftway	3	405	520	610	835
At Grove Street in Scituate	1.1	145	197	240	385
FRENCH STREAM					
At confluence with the Drinkwater River	8.6	390	590	700	1,000
Upstream of Rockland corporate limits	8.4	340	530	620	890
Upstream of Beech Hill Swamp Tributary	5.9	290	440	520	750
Upstream of Tributary B	4.9	240	360	430	620

TABLE 6 – 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
FRENCH STREAM					
Upstream of Studleys Pond Dam	4.1	200	310	360	520
1,650 feet upstream of North Avenue in Rockland	2	110	180	220	340
HALLS BROOK					
At confluence with Jones River	4.7	175	212	263	396
Approximately 400 feet upstream of Blackwater Pond	2.5	147	187	220	345
Approximately 2,500 feet downstream of Brookdale Road in Kingston	1.5	93	133	168	233
HANNAH EAMES BROOK					
At Damons Point Road in Marshfield	1.5	200	250	270	520
At New Main Street in Marshfield	0.7	150	195	210	260
HERRING BROOK					
At Mountain Avenue in Pembroke	1.6	92	162	217	374
At Barker Street in Pembroke	2	118	208	278	480

TABLE 6 – 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
HINGHAM STREET BASINS					
At Hingham Street	0.10	*	*	10	*
HOCKOMOCK RIVER					
At West Bridgewater/Bridgewater town line	22.6	648	887	1,014	1,249
At Maple Street in West Bridgewater	22.4	644	882	1,008	1,242
At Dirt Road in West Bridgewater	20.5	605	828	946	1,166
At West Center Street in West Bridgewater	20.3	601	823	941	1,159
At Manley Street in West Bridgewater	19.3	580	794	907	1,118
At West Street in West Bridgewater	18.4	562	769	879	1,083
INDIAN BROOK					
At State Route 3A in Plymouth	3.6	311	518	632	972
Downstream of Island Pond	0.8	154	261	320	499
INDIAN HEAD BROOK					
At its confluence with the Indian Head River	4.7	155	260	315	485
Downstream of Wamptatuck Pond	2.6	85	140	170	255

*Data not available

TABLE 6 – 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
INDIAN HEAD RIVER					
At USGS gaging station in Pembroke	30.3	1200	1,700	1,820	2,480
Upstream of Indian Head Brook	23	950	1,380	1,580	2,130
JONES RIVER					
At confluence with Kingston Bay	15.6[1]	640	830	960	1,220
Approximately 690 feet downstream of Wapping Road in Kingston	14	620	810	940	1,200
Approximately 4,040 feet upstream of Wapping Road in Kingston	12.8	530	680	820	1,060
Approximately 50 feet downstream of footbridge in Kingston	11.8	460	610	740	940
Approximately 1,350 feet downstream of Grove Street in Kingston	1.3	75	100	116	140
JONES RIVER BROOK					
At confluence with Jones River	4.9	180	250	300	380
LONGWATER BROOK					
At confluence with the Drinkwater River	2.9	130	220	270	410

[1]Does not include 4.1-square-mile area diverted from Silver Lake for water supply

TABLE 6 – 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
MATFIELD RIVER					
At High Street in Bridgewater	79.8	1,564	2,141	2,447	3,015
MATTAPOISETT RIVER					
At the downstream Rochester corporate limits	14.9	275	410	485	705
1,600 feet upstream of Rounseville Road in Rochester	12.1	100	120	135	170
3,000 feet downstream of the outlet of Snipatuit Pond	7.6	45	55	65	80
MEADOW BROOK					
At North Central Street in East Bridgewater	7.6	308	421	482	593
At Water Street in East Bridgewater	6.9	297	407	465	573
At Highland Street in East Bridgewater	4	197	270	308	380
At downstream Whitman corporate limits	3.7	150	235	270	480
MEADOW BROOK TRIBUTARY					
At confluence with Meadow Brook	1	50	85	105	160
MILE BROOK					
At confluence with Halls Brook	0.6	65	85	98	120

TABLE 6 – 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
NEMASKET RIVER					
At MBTA Commuter Railroad Bridge	70.1	694	1,063	1,256	1,628
At Murdock Street	69.9	684	1,048	1,239	1,605
At Plymouth Street	67.7	659	1,009	1,193	1,544
At Nemasket Street	66	631	966	1,142	1,476
At Wareham Street	62.1	579	886	1,048	1,353
At Bridge Street	60.3	555	848	1,003	1,293
At Vaughan Street	49.7	434	662	784	1,006
At Assawompset Pond Dam	49.2	427	652	772	990
At culvert at Route 105 and outlet of Long Pond into Assawompset Pond	23.4	224	348	414	533
NORTHERN BRANCH OF BEN MANN BROOK					
At Hingham Street	0.20	*	*	110	*
PALMER MILL BROOK					
At confluence with Winnetuxet River	8.6	250	415	505	765
Upstream of confluence with Colchester Brook	5.1	165	270	330	500
PLYMOUTH RIVER					
At the confluence of the Eel River	3.3	150	252	307	474

*Data not available

TABLE 6 – 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
PLYMOUTH RIVER - continued					
At the confluence of Penniman Hill Tributary	1.4	81	137	168	262
POOR MEADOW BROOK					
At the downstream Hanson corporate limits	14.2	420	650	780	1,080
Upstream of its confluence with the Shumatuscacant River	2.2	120	200	240	330
ROCKY MEADOW BROOK					
At the confluence with the Weweantic River	5.9	170	255	290	370
SALISBURY BROOK					
At Cross Pond	5.9	325	520	610	860
At Newbury Street in Brockton	7.1	370	590	690	980
At confluence with Trout Brook	7.7	390	630	740	1,040
SALISBURY PLAIN RIVER					
At Grove Street in Brockton	14.2	1,180	1,730	1,950	2,410
At Meadow Lane in Brockton	16.4	1,310	1,870	2,160	2,660
At Belmont Street in West Bridgewater	19.8	591	809	924	1,139

TABLE 6 – 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
SALISBURY PLAIN RIVER - continued					
At the Conrail bridge in West Bridgewater	19.3	580	794	907	1,118
SATUCKET RIVER (Lower Reach)					
At Plymouth Street in East Bridgewater	22.5	924	1,264	1,445	1,780
SATUCKET RIVER (Upper Reach)					
At confluence of Black Brook	18.1	806	1,103	1,260	1,553
At Pond Street in East Bridgewater	1.7	107	147	168	207
SATUIT BROOK					
At Stockbridge Road in Scituate	930	410	480	620	780
At the culvert at the railroad bed in Scituate	185	112	130	170	213
SAWMILL BROOK					
At confluence with Taunton River	3.7	172	277	332	496
At Bedford Street	2.3	125	202	243	366
SECOND HERRING BROOK					
At the confluence with North River	3.6	180	305	370	570

TABLE 6 – 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
SHINGLEMILL BROOK					
At the confluence with Unnamed Tributary 5 to Shinglemill Brook	0.60	*	*	532	*
SHUMATUSCACANT RIVER					
Upstream of Tributary to Shumatuscacant River	6.6	301	502	611	935
Upstream of Hobart Pond	6.1	240	410	500	770
From Abington-Whitman corporate limits to Center Street in Abington	3.45	145	230	265	370
From Center Street to Ralph G. Hamlin, Jr. Boulevard in Abington	2.5	115	175	205	280
From Ralph G. Hamlin, Jr. Boulevard in Abington to the confluence of the North Tributary Shumatuscacant River	2.2	110	170	195	255
From confluence of the North Tributary Shumatuscacant River to Lincoln Street in Abington	1.65	90	135	150	200
From Lincoln Street to Wyman Road in Abington	0.72	45	65	70	90
From Wyman Road to study limits, approximately 2300 ft upstream from Summit Road in Abington	0.44	25	35	40	50

*Data not available

TABLE 6 – 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
SHUMATUSCACANT RIVER – NORTH TRIBUTARY					
From confluence with Shumatuscacant River to approximately 1,700 feet upstream of Wales Street	0.44	25	30	35	45
SHUMATUSCACANT TRIBUTARY					
At confluence with Shumatuscacant River	1.2	65	110	140	220
SMELT BROOK					
At confluence with Jones River	1.3	89	153	188	294
SNOWS BROOK					
At South Street in Bridgewater	3.49	175	240	274	338
At Cross Street in Bridgewater	2.16	125	172	196	242
At Forest Street in Bridgewater	1.14	79	108	123	152
SOUTH BROOK					
At Hayward Street in Bridgewater	3.13	161	221	252	311
At Plymouth Street in Bridgewater	3.10	161	221	252	311
At Water Street (Downstream Crossing in Bridgewater)	3.09	161	221	252	311

TABLE 6 – 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
SOUTH BROOK - continued					
At Conrail Street in Bridgewater	2.08	122	167	190	235
At Constant Street in Bridgewater	1.65	104	142	162	200
At Bedford Street (State Route 18) in Bridgewater	1.04	75	103	118	145
SOUTH MEADOW BROOK					
At the confluence with the Weweantic River	13.8	320	470	550	710
At Main Street in Carver	6.3	175	265	360	390
STREAM RIVER					
At confluence with the Shumatuscacant River	1.54	90	155	190	275
TAUNTON RIVER					
Plain Street above Threemile River, Taunton	363	4,890	7,260	8,420	11,100
County Street/Route 140 above Mill River, Taunton	317	4,230	5,940	6,770	8,690
Route 24 above Forge River, Raynham/Taunton	302	4,080	5,630	6,380	8,120
South Street, Taunton	293	3,970	5,430	6,120	7,750
US Route 44, Taunton	283	3,860	5,210	5,850	7,370
Green Street/Plymouth Street, Bridgewater	271	3,740	4,990	5,570	6,970

TABLE 6 – 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
TAUNTON RIVER - continued					
Titicut Street (Taunton River near Bridgewater streamgage 01108000)	262	3,660	4,830	5,380	6,690
Auburn Street, Bridgewater	183	2,820	4,140	4,780	6,260
Cherry Street, Bridgewater	129	2,280	3,590	4,230	5,720
TOWN BROOK					
At Sandwich Street in Plymouth	3.9	132	174	202	255
At State Route 3	3	101	120	136	162
At a point approximately 40 feet upstream of the long culvert to Hingham Harbor	0.7	107	186	229	368
At the confluence of Baker Hill Tributary	0.3	11	24	31	58
TOWN RIVER					
At Hayward Street in Bridgewater	59.9	1,278	1,754	2,005	2,470
At Broad Street in Bridgewater	55	1,206	1,651	1,887	2,325
At Oak Street in Bridgewater	54.9	1,206	1,651	1,887	2,325
At High Street in Bridgewater	54.7	1,202	1,645	1,880	2,317
At the West Bridgewater corporate limit	54.2	1,196	1,637	1,870	2,305

TABLE 6 – 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
TOWN RIVER - continued					
At Main Street in West Bridgewater	50.7	1,142	1,563	1,786	2,201
At South Street in West Bridgewater	50.1	1,131	1,548	1,770	2,180
At Forest Street in West Bridgewater	42.5	1,010	1,382	1,579	1,946
At the old cart path in West Bridgewater	40.4	974	1,333	1,523	1,877
At Scotland Street in West Bridgewater	39.3	956	1,308	1,495	1,842
At State Route 24 in West Bridgewater	39.1	952	1,313	1,490	1,835
TRIBUTARY A					
At confluence of French Stream	0.7	100	120	130	150
550 feet downstream of Levin Road in Rockland	0.5	240	310	350	415
TRIBUTARY A TO SAWMILL BROOK					
Above confluence with Sawmill Brook	0.8	63	104	126	192
TRIBUTARY TO MEADOW BROOK					
At East Bridgewater-Whitman corporate limits	0.20	24	35	46	57
TROUT BROOK					
At Ames Street in Brockton	3.7	508	690	790	880

TABLE 6 – 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
TROUT BROOK - continued					
At Ashland Street in Brockton	4.9	640	870	990	1,110
At confluence with Salisbury Brook	6.5	790	1,100	1,210	1,370
TURKEY HILL BROOK					
At its confluence with the Weir River	1.4	89	152	187	292
UNNAMED TRIBUTARY 2 TO SHINGLEMILL BROOK					
At confluence with Unnamed Tributary 5 to Shinglemill Brook	0.04	*	*	57	*
UNNAMED TRIBUTARY 3 TO SHINGLEMILL BROOK					
At confluence with Shinglemill Brook	0.25	*	*	319	*
UNNAMED TRIBUTARY TO IRON MINE BROOK					
At Hanover Street	0.36	*	*	61	*
UNNAMED TRIBUTARY TO SILVER BROOK					
At Silver Street	0.03	*	*	22	*

*Data not available

TABLE 6 – 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
UNNAMED TRIBUTARY TO THIRD HERRING BROOK					
At Washington Street	0.27	*	*	104	*
WEIR RIVER					
At Foundry Pond outlet in Hingham	13.9	417	688	836	1267
At the confluence of Accord Brook	7.5	266	442	538	821
At the confluence of Tower Brook	6	266	377	459	702
WEST MEADOW BROOK					
At South Elm Street in West Bridgewater	6.2	265	363	414	511
At West Center Street in West Bridgewater	5.7	247	338	386	476
At Crescent Street in West Bridgewater	5.4	243	333	381	469
At dirt road in West Bridgewater	2.1	233	319	364	449
At the corporate limit	0.8	69	88	101	124
WEWEANTIC RIVER					
At the downstream Carver corporate limits	44.6	650	1,005	1,160	1,500
Upstream of the confluence of Crane Brook	32.3	515	770	890	1,120

*Data not available

TABLE 6 – 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
WEWEANTIC RIVER - continued					
At the confluence of South Meadow Brook and Rocky Meadow Brook	19.7	405	600	700	890
WILLOW BROOK					
At East Center Street in West Bridgewater	1.5	97	132	151	186
At the railroad bridge in West Bridgewater	1.3	86	118	134	166
WINNETUXET RIVER					
At confluence with Taunton River	36.5	865	1,415	1,710	2,565
Downstream of River Street bridge in Halifax	30.8	810	1,325	1,605	2,420
Downstream of confluence with Palmer Mill Brook	23.8	730	1,210	1,465	2,220
Upstream of confluence with Palmer Mill Brook	15.2	485	810	980	1,490
At downstream Plympton corporate limits	15.1	485	810	980	1,490
6,000 feet downstream of Winnetuxet Road bridge in Plympton	10.9	350	580	705	1,075

3.2 Hydraulic Analyses

Analyses of the hydraulic characteristics of flooding from the sources studied were carried out to provide estimates of the elevations of floods of the selected recurrence intervals. Users should be aware that flood elevations shown on the FIRM represent rounded whole-foot elevations and may not exactly reflect the elevations shown on the Flood Profiles or in the Floodway Data 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. 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 this 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 each community within Plymouth County that has a previously printed FIS report, the hydraulic analyses described in those reports have been compiled and are summarized below. Note that, for Nemasket River and Taunton River, all precountywide analyses have been superseded by updated analyses in countywide studies described after the precountywide analyses below.

<u>Precountywide Analyses</u>

Cross sections for the backwater analysis of the Shumatuscacant River, the Stream River, Salisbury and Trout Brooks, and the Salisbury Plain River were field-surveyed. The cross sections were placed at specific intervals along the river channels so that data collected would enable hydraulic properties to be accurately modeled by the computer.

Water-surface elevations of floods of the selected recurrence intervals were computed using the USACE HEC-2 step-backwater computer program (Reference 62 and 63). In the areas where cranberry cultivation presented complications, rating curves were developed at critical points along the stream (Reference 64).

For the Shumatuscacant River, the lack of any known high-water marks to be used for a starting water-surface elevation for the first cross section made it necessary to go through a hydraulic analysis to determine a starting elevation for the 10-, 2-, 1-, and 0.2-percent-annual-chance flood flows. The results of this investigation were then used in the HEC-2 computer program as the starting water-surface elevation of the most downstream cross section. Flood profiles were drawn showing computed water-surface elevations for floods of the selected recurrence intervals (References 62 and 63).

Starting water-surface elevations for South Meadow Brook and Crane Brook were obtained from flood profiles of the Weweantic River. Starting water-surface elevations for the Taunton River were taken from the FIS for the Town of Middleborough (Reference 65). Starting water-surface elevations for the Town River were taken from the Taunton River profile. Starting water-surface elevations for the Taunton River and Sawmill Brook were obtained from the profile of the Taunton River published in the 1982 FIS. The starting water-surface elevations for the Town and Matfield Rivers were obtained from the hydraulic model for the revised portion of the Taunton River. The starting water-surface elevation for Tributary A to Sawmill Brook was obtained from the hydraulic model for Sawmill Brook computed for the revised 1999 Bridgewater FIS. The starting water-surface elevations for Tributary to Meadow Brook were based on coincident flow. Starting water-surface elevations for the Mattapoisett River, Tributary A, Weweantic River, Crane Brook, Stream River, and all other brooks, streams, and rivers were determined using the slope/area method.

Starting water-surface elevations for French Stream were taken from the FIS for the Town of Hanover (Reference 66).

Starting water-surface elevations for the Winnetuxet River were obtained from the Taunton River water-surface profiles. Coincident flow was chosen for these two streams because the topographic and soil characteristics of this particular drainage area indicate the occurrence of coincident peak flows for the Taunton and Winnetuxet Rivers. Starting water-surface elevations for Palmer Mill Brook were obtained from the Winnetuxet River flood profiles.

Water-surface elevations taken from the FIS for the Town of Pembroke were used for the Indian Head River up to the Pembroke-Hanover corporate limits, where the end elevations were used to start new computations (Reference 50). Starting water-surface elevations for the Drinkwater River were developed using the generalized weir flow equation for Factory Pond (Reference 67). The starting water-surface elevations for Longwater Brook and French Stream were obtained from the Drinkwater River. Water-surface elevations for the North River were obtained from the tidal elevations computed for Massachusetts Bay (Reference 68). Starting water-surface elevations for Indian Head Brook were determined assuming coincident peak flows at its confluence with the Indian Head River. Starting water-surface elevations for Poor Meadow Brook were estimated by the slope/area method based on a 0.0006 energy grade line slope at the downstream corporate limits. Starting water-surface elevations for the Shumatuscacant River and Shumatuscacant Tributary were determined by the slope/area method. Starting water-surface elevations for Meadow Brook were taken from the FIS for the Town of East Bridgewater (Reference 69). Known water-surface elevations from Meadow Brook were used as starting elevations on Meadow Brook Tributary.

The starting water-surface elevations for the Salisbury Plain River were determined by solution of Manning's equation together with interpolated cross sections (slope-area method). A relationship was established such that, for any given flow, a starting water-surface elevation could be calculated. The starting water-surface elevations for Trout Brook were determined from the computed profile elevation of Salisbury Plain River at the confluence of Salisbury and Trout Brooks.

Approximate methods were used to study portions of Lovett, Daley, Dorchester, West Meadow, Edson, and Beaver Brooks; Thirty Acre, Ellis Brett, and Cross Ponds; the

Coweeset River; Robinson Creek; Pudding, Little Pudding, Tubbs Meadow, and Swamp Brooks; Rocky Run, Little Sandy Bottom, and Great Sandy Bottom Ponds; and a portion of Silver Lake. Utilizing historical information, field information, and basic hydraulic calculations (Reference 34), an area with 1-percent-annual-chance floods was delineated.

In the Town of Hingham, overbank extensions of field-surveyed cross sections and additional sections needed for hydraulic continuity were taken from topographic maps at a scale of 1:4,800 with a contour interval of 5 feet (Reference 70). All bridges and culverts were field-surveyed to obtain elevation data and structural geometry. For Town Brook, survey data were obtained from the Hingham Highway Department and a study on Town Brook (Reference 71). Because the survey was old, elevations were spot-checked in the field, and some additional sections were surveyed.

Water-surface elevations of floods of the selected recurrence intervals in the Town of Hingham were computed using the USACE HEC-2 step-backwater computer program (Reference 72). Flood profiles were drawn showing computed water-surface elevations for floods of the selected recurrence intervals. The computer model for each stream was calibrated to account for historic records, which were obtained from interviews with local residents and the Hingham Flood Plain Map (Reference 73). Present culvert conditions were used, and recent modifications were taken into consideration in the use of historic high-water marks.

Starting water-surface elevations for the Weir River, the Crooked Meadow River, and the Plymouth River were taken from standard hydraulic analyses on Foundry Pond Dam. Starting water-surface elevations for the Eel River were determined assuming coincident peak flows with the Plymouth River. For Accord Brook and Town Brook, starting water-surface elevations were determined using normal depth calculations. Starting water-surface elevations for Turkey Hill Run were taken as the mean high tide at its outlet on Straits Pond. Hydraulic analyses, considering storm characteristics and the shoreline and bathymetric characteristics of the tidal flooding sources studied, were carried out to provide estimates of the elevations of floods of the selected recurrence intervals along each of the shorelines.

The starting water-surface elevations for Jones River Brook, Smelt Brook, Halls Brook, Mile Brook, and Jones River were determined using the slope/area methods.

Cross-section data for the detailed study areas in the Towns of Norwell, Plympton, and Rochester were obtained by field survey and photogrammetric maps (References 74, 75, 76, and 77).

Water-surface elevations for the North River were computed by routing the tidal elevations through various structures and naturally constricted points. Starting water-surface elevations for Second Herring Brook were obtained by using a mean high tide elevation. Starting water-surface elevations for Black Pond Brook were determined using coincident peak flow at its confluence with Second Herring Brook. Starting water-surface elevations for the North River were obtained from tidal elevations developed for Massachusetts Bay (Reference 68).

Water-surface elevations of floods of the selected recurrence intervals were computed using the USACE HEC-2 step-backwater computer program (References 63 and 77). Cross sections for the backwater analysis of Herring Brook and North River were field-surveyed.

Cross sections were placed at specific intervals along the river channels such that data collected would enable hydraulic properties to be accurately modeled by the computer. Sections were interpolated between certain surveyed sections, as deemed necessary. These interpolated sections were prepared from survey data, with the aid of topographic mapping at a scale of 1:24,000, with a contour interval of 10 feet (Reference 78).

No profiles are shown for North River, Robinson Brook, or the downstream reach of Herring Brook because flood elevations are controlled by tidal flooding.

Cross sections for the flooding sources studied by detailed methods in the Town of Plymouth were obtained from field surveys. For the July 17, 1986 FIS, overbank extensions of field-surveyed cross sections and additional sections needed for hydraulic continuity were taken from topographic maps at a scale of 1:4,800 with a contour interval of 5 feet (Reference 79). Cross sections were located at close intervals upstream and downstream of bridges and culverts in order to compute the significant backwater effects in urbanized areas.

Water-surface elevations of floods of the selected recurrence intervals in the Town of Plymouth were computed using the USACE HEC-2 step-backwater computer program (References 80 and 81). Flood profiles were drawn showing computed water-surface elevations for floods of the selected recurrence intervals. Starting water-surface elevations for Beaver Dam Brook, Branch of Eel River, Eel River, Indian Brook, and Town Brook were determined using normal depth calculations.

Starting water-surface elevations for the Winnetuxet River were taken from the FIS for the Town of Halifax (Reference 82).

Water-surface elevations at road crossings in the Town of Scituate were calculated using the Francis Formula, with the adopted "C" values for roads and weirs being 3.09 and 3.33, respectively. Starting water-surface elevations were determined using normal depth calculations.

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

Roughness factors (Manning's "n" values) used in the hydraulic computations were determined from field observations, guided by U.S. Geological Water Supply Publications (References 83 and 84). Table 7, "Manning'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
Accord Brook	0.010-0.050	0.050-0.100
Beaver Brook	0.030-0.050	0.016-0.080
Beaver Dam Brook	0.025-0.070	0.090-0.100
Black Betty Brook	0.030-0.060	0.050-0.100
Black Brook	0.013-0.050	0.016-0.080
Black Pond Brook	0.04	0.060-0.110

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

Flooding Source	Channel "n"	Overbanks
Bound Brook	0.030-0.065	0.050-0.095
Branch of Eel River	0.015-0.060	0.090-0.100
Crane Brook	0.04	0.080-0.120
Crooked Meadow River	0.014-0.050	0.080-0.120
Drinkwater River	0.035	0.060-0.090
Drinkwater River Tributary	0.035	0.08
Eel River (Plymouth)	0.024-0.060	0.09
Eel River (Hingham)	0.015-0.050	0.090-0.120
First Herring Brook	0.023-0.060	0.090-0.100
French Stream (Hanover)	0.035	0.08
French Stream (Rockland)	0.030-0.045	0.050-0.100
Halls Brook	0.015-0.040	0.080-0.100
Herring Brook	0.025-0.030	0.075-0.080
Hockomock River	0.030-0.060	0.050-0.100
Indian Brook	0.020-0.065	0.020-0.100
Indian Head Brook	0.035-0.040	0.070-0.090
Indian Head River (Hanson)	0.35	0.060-0.100
Indian Head River (Hanover)	0.035	0.060-0.100
Jones River	0.015-0.040	0.080-0.110
Jones River Brook	0.030-0.040	0.100-0.110
Longwater Brook	0.035	0.08
Matfield River	0.035	0.100-0.120
Mattapoisett River	0.035-0.040	0.060-0.090
Meadow Brook (East Bridgewater)	0.023-0.030	0.016-0.030
Matfield River	0.035	0.100-0.120
Mattapoisett River	0.035-0.040	0.060-0.090
Meadow Brook (East Bridgewater)	0.023-0.030	0.016-0.030
Meadow Brook (Whitman)	0.035	0.060-0.080
Meadow Brook Tributary	0.040-0.045	0.060-0.100
Mile Brook	0.015-0.040	0.080-0.100
Nemasket River[1]	0.025-0.065	0.06-0.13
North River	0.025-0.030	0.075-0.080
Palmer Mill Brook	0.045	0.08
Plymouth River	0.014-0.050	0.080-0.120
Poor Meadow Brook	0.035-0.045	0.065-0.105
Rocky Meadow Brook	0.030-0.035	0.060-0.090
Salisbury Brook	0.025-0.040	0.060-0.080
Salisbury Plain River (Brockton)	0.025-0.040	0.060-0.080
Salisbury Plain River (West Bridgewater)	0.030-0.060	0.050-0.100

[1]July 16, 2015 Narragansett Watershed study

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

Flooding Source	Channel "n"	Overbanks
Satucket River	0.031-0.050	0.016-0.080
Satuit Brook	0.013-0.060	0.1
Sawmill Brook	0.04	0.100-.0120
Shumatuscacant River	0.035-0.040	0.080-0.100
Shumatuscacant River – North Tributary	0.012-0.040	0.080-0.100
Shumatuscacant Tributary	0.030-0.045	0.090-0.100
Smelt Brook	0.015-0.040	0.070-0.100
Snows Brook	0.013-0.060	0.016-0.070
South Brook	0.013-0.060	0.016-0.090
South Meadow Brook	0.033-0.037	0.060-0.080
Stream River	0.013-0.060	0.060-0.180
Taunton River [1]	0.035-0.060	0.080-0.10
Town Brook (Plymouth)	0.012-0.060	0.060-0.110
Town Brook (Hingham)	0.017-0.050	0.070-0.100
Town River	0.03-0.06	0.050-0.100
Tributary 1 to Stream Channel to Unnamed Tributary to Third Herring Brook	*	*
Tributary 1 to Tributary to Iron Mine Brook	*	*
Tributary 2 to Stream Channel to Unnamed Tributary to Third Herring Brook	*	*
Tributary 2 to Tributary to Iron Mine Brook	*	*
Tributary A	0.035-0.040	0.08
Tributary A to Sawmill Brook	0.04	0.12
Tributary to Meadow Brook	0.05	0.08
Trout Brook	0.025-0.040	0.060-0.080
Turkey Hill Brook	0.015-0.070	0.090-0.110
Weir River	0.014-0.050	0.080-0.120
West Meadow Brook	0.030-0.060	0.050-0.100
Weweantic River	0.025-0.037	0.060-0.090
Willow Brook	0.030-0.060	0.050-0.100
Winnetuxet River (Halifax)	0.035-0.045	0.050-0.100
Winnetuxet River (Plympton)	0.030-0.050	0.080-0.100

[1]July 16, 2015 Narragansett Watershed study
*Data not available

Countywide Analyses

For the July 17, 2012 countywide study, no new hydraulic analyses were conducted.

For the July 16, 2015 Narragansett Watershed analysis, hydraulic analyses were conducted for the Taunton and Nemasket Rivers.

Taunton River

Cross-section data and structure elevations for 24.5 miles of the Taunton River from the Cherry Street Bridge between the Towns of Halifax and Bridgewater to the Plain Street Bridge just upstream of the confluence with the Threemile River in Taunton were obtained from field surveys in May and October of 2012 and from cross sections obtained from prior FIS models (References 85 and 86).

Field data collected by USGS staff for the Taunton River model include elevation data collected with a total station theodolite and underwater depths collected with an Acoustic Doppler Current Profiler (ADCP), referenced to the elevation of the water surface at the time of the survey. Underwater and channel bank field survey data were merged with LiDAR data for the elevations of the overbanks. LiDAR data collected and processed by Photo Science Inc., under contract with the USGS. LiDAR was collected in the winter and spring of 2011 and processed and published in 2012. It was collected to a vertical accuracy of 30 cm with a 95% confidence interval.

Underwater points for cross sections in the Towns of Bridgewater and Middleborough were obtained from survey data collected by Sverdrup & Parcel and Associates, Inc. in 1977-78. These models were adapted for use in the subsequent county wide FISs for Plymouth and Bristol Counties (References 83 and 84).and then adapted for use here.

The computer programs HEC-RAS 4.1.0 and and HEC-GeoRAS 10.0 for ArcGIS 10.1 (References 87 and 88) were used to model stream profiles with 10-, 2-, 1-, and 0.2-percent annual exceedance probabilities for the Taunton River. The starting water-surface elevations for the 10-, 2-, 1-, and 0.2-percent annual exceedance probability flow profiles downstream from the Plain Street Bridge in Taunton were estimated from normal depth slope calculations. Normal depth slope was set at 0.00033 based on the slope at the lower end of the surveyed reach of the Taunton River, resulting in starting water surfaces greater than 4 feet NAVD88 for all modeled profiles in the vicinity of the Plain Street bridge. Although the Taunton River becomes tidal at the downstream end, the Mean High Water from the Tidal Flood Profile is between 3 and 4 feet NAVD88 in this location (US Army Corps of Engineers, September 1988) and thus the riverine flooding was expected to control the downstream water-surface elevations as opposed to tidal flooding.

Although mean high tides are not expected to control riverine floods with from 10- to 0.2-percent AEPs, tidal floods with from 10- to 0.2-percent AEPs will exceed riverine floods with from 10- to 0.2-percent AEPs at the downstream end of the Taunton River (up through the town of Taunton). Flood profiles and flood mapping are drawn to selected AEPs without regard to whether the flood is tidal or riverine. For the 10% AEP, the tidal flood exceeds the riverine flood up to the County Street or Route 140 bridge in Taunton. For the 1- and 0.2-percent AEP, the tidal flood exceeds the riverine flood up to the Taunton/Raynham town line.

All of the warnings in the models have been reviewed and found acceptable.

100- and 500-year flood boundaries were drafted with a Geographic Information System (GIS) using LiDAR data. LiDAR data were verified and adjusted based on digital orthophoto quads and field surveys. All LiDAR mapping data and surveyed cross sections are referenced to the North America Vertical Datum of 1988 (NAVD88) and the horizontal North American Datum of 1983 (NAD83).

Nemasket River, Assawompset Pond, and Long Pond

Cross-section data and structure elevations for 12 miles of the Nemasket River from the outlet of Assawompset Pond to the confluence with the Taunton River, and for the reach connecting Long Pond and Assawompset Pond, were obtained from field surveys in November and December of 2012, April 2013, and from prior FIS publications.

Field data collected by USGS staff for the Nemasket River model include elevation data and underwater depths (referenced to the elevation of the water surface at the time of the survey) collected with a total station theodolite. Underwater and channel bank field survey data were merged with LiDAR data describing the elevations of the overbanks. LiDAR data were collected and processed by Photo Science Inc., under contract with the USGS. LiDAR was collected in the winter and spring of 2011 and processed and published in 2012. It was collected to a vertical accuracy of 30 cm with a 95% confidence interval. Underwater invert elevations for selected cross sections were obtained from profile plots published in the FIS for Plymouth County (Reference 85) and adapted for use here.

The computer programs HEC-RAS 4.1.0 and HEC-GeoRAS 10.0 for ArcGIS 10.1 (References 87 and 88) were used to model stream profiles with 10-, 2-, 1-, and 0.2-percent AEPs for the Nemasket River. HEC-RAS 4.1.0 was used to model the 1-percent AEP water-surface elevation for Long Pond.

The starting water-surface elevations for the 10-, 2-, 1-, and 0.2-percent AEP flow profiles near the confluence with the Taunton River were estimated from normal depth slope calculations. Normal depth slope was set at 0.00015 based on the slope at the lower end of the surveyed reach of the Nemasket River. The 1-percent AEP water-surface elevation for Assawompset Pond, at the head of the Nemasket River, was set equal to the 1-percent water-surface elevation at the upstream boundary of the Nemasket River model. Outflow from the Assawompset Pond Dam is entirely controlled by tailwater (backwater from the Nemasket River) rendering any kind of routing analysis useless. The 1-percent AEP water-surface elevation for Long Pond was computed using hydraulic modeling of the 10-, 2-, 1-, and 0.2-percent AEP water-surface elevations for Assawompset Pond, in addition to high-water data collected at the two ponds in an effort to verify the close hydraulic connection between the water bodies.

All of the warnings in the models have been reviewed and found acceptable.

3.3 Coastal Hydrologic Analyses

In New England, the flooding of low-lying areas is caused primarily by storm surges generated by extratropical coastal storms called northeasters. 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, Plymouth 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.

Revised coastal analyses were performed for the open water flooding sources in the communities of Hingham, Hull, Marion, Mattapoisett, and Wareham (July 17, 2012 countywide FIS) and in the communities of Duxbury, Kingston, Marshfield, Norwell, Plymouth and Scituate (November 4, 2016 coastal study update). A description of these revised analyses is presented in the July 17, 2012 countywide analysis and the November 4, 2016 coastal study update sections below.

Coastal Stillwater elevations presented in the pre-countywide FISs that have not been superseded by the July 17, 2012 or November 4, 2016 coastal study updates have been compiled and are summarized below.

Pre-countywide Analyses

For the North River, the Eel River, and the Pine Point, Bourne Wharf, and Little Wood Island Rivers, a one-dimensional computer model was used to route the surge hydrographs through tidal portions of estuarine streams for the stillwater elevations for the Little Wood Island River, and Pine Point River (References 68, 89, 90 and 91). Input to the model consisted of stream depth, stream width, freshwater flows, and stream branching information for a series of grids. The model was calibrated to the February 1978 storm, and hydrographs for the 10-, 2-, 1-, and 0.2-percent-annual-chance floods storms were routed up the river to define the tidal elevation-frequency relationship for each stream reach.

Stillwater elevations for Kings Pond in the Town of Plymouth were found by combining the rainfall hydrograph with the storage rating curve for the pond. Stillwater elevations for Billington Sea were determined using the elevations at the nearest cross section in the Town Brook computer model (Reference 92). Wave setup in Plymouth and Duxbury was calculated using the procedures detailed in the FEMA guidelines for V Zone mapping (Reference 93).

The pre-countywide 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 8, "Summary of Pre-countywide Stillwater Elevations."

TABLE 8 – SUMMARY OF PRECOUNTYWIDE STILLWATER ELEVATIONS

FLOODING SOURCE AND LOCATION	ELEVATION (feet NAVD 88) 10-PERCENT	2-PERCENT	1-PERCENT	0.2-PERCENT
AREA 1				
Within the Town of Hanover	*	*	77.4	*
AREA 2				
Within the Town of Hanover	*	*	79.8	*
AREA 3				
Within the Town of Hanover	*	*	82.2	*
AREA 4				
Within the Town of Hanover	*	*	82.5	*
AREA 5				
Within the Town of Hanover	*	*	77.7	*
AREA 6				
Within the Town of Hanover	*	*	78.1	*
AREA 7				
Within the Town of Hanover	*	*	78.5	*
AREA 8				
Within the Town of Hanover	*	*	78.2	*
AREA 9				
Within the Town of Hanover	*	*	78.4	*
BILLINGTON SEA				
For entire shoreline within Town of Plymouth	81.5	81.1	82.2	82.7
BUTTERMILK BAY				
Red Brook Road in the Town of Plymouth	8.8	12.4	13.9	17.1
BUZZARDS BAY				
At Weweantic River	7.5	11.7	13.7	19.1
At Jacobs Neck	7.6	11.8	13.8	19.1

*Data not available

TABLE 8 – SUMMARY OF PRECOUNTYWIDE STILLWATER ELEVATIONS – continued

FLOODING SOURCE AND LOCATION	ELEVATION (feet NAVD 88) 10-PERCENT	2-PERCENT	1-PERCENT	0.2-PERCENT
EEL RIVER				
At State Route 3A in Town of Plymouth	8.8	9.9	10.2	11.3
FURNACE POND				
Along the entire shoreline within the Town of Pembroke	57.3	57.8	58.0	58.5
GREAT QUITACAS POND AND POCKSHA POND				
Within the Town of Lakeville	53.6	54.0	54.5	55.2
HINGHAM STREET BASINS				
Within the Town of Rockland	*	*	140.1	*
KINGS POND				
For entire shoreline within the Town of Plymouth	118.3	120.9	122.0	124.3
NORTH RIVER				
In the Town of Hanover	7.4	8.0	8.3	9.2
OLDHAM POND				
In the Town of Pembroke	58.3	58.8	59.0	59.5
PINE POINT, BOURNE WHARF, LITTLE WOOD ISLAND RIVERS				
Entire shoreline within Town of Marshfield	7.1	8	8.3	9.2
PONDING AREA 1				
Within the Town of Hanover	*	*	80.2	*
PONDING AREA 2				
Within the Town of Hanover	*	*	81.2	*
PONDING AREA 3				
Within the Town of Hanover	*	*	84.2	*
PONDING AREA 4				
Within the Town of Hanover	*	*	86.2	*

*Data not available

TABLE 8 – SUMMARY OF PRECOUNTYWIDE STILLWATER ELEVATIONS – continued

FLOODING SOURCE AND LOCATION	ELEVATION (feet NAVD 88)			
	10-PERCENT	2-PERCENT	1-PERCENT	0.2-PERCENT
PONDING AREA 5				
Within the Town of Hanover	*	*	84.2	*
PONDING AREA 6				
Within the Town of Hanover	*	*	81.2	*
PONDING AREA 7				
Within the Town of Hanover	*	*	77.2	*
PONDING AREA 8				
Within the Town of Hanover	*	*	64.2	*
PONDING AREA 9				
Within the Town of Hanover	*	*	66.2	*
PONDING AREA 10				
Within the Town of Hanover	*	*	74.2	*
PONDING AREA 11				
Within the Town of Hanover	*	*	77.2	*
PONDING AREA 12				
Within the Town of Hanover	*	*	77.2	*
PONDING AREA 13				
Within the Town of Hanover	*	*	85.2	*
PONDING AREA 14				
Within the Town of Hanover	*	*	80.2	*

*Data not available

July 17, 2012 Countywide Analysis

As part of the July 17, 2012 countywide update, revised coastal analyses were performed for the open water flooding sources in the communities of Hingham, Hull, Marion, Mattapoisett, and Wareham. Provided below is a summary of the analyses performed. All revised coastal analyses were performed in accordance with Appendix D "Guidance for Coastal Flooding Analyses and Mapping," (Reference 94) of the Guidelines and Specifications, as well as, the "Atlantic Ocean and Gulf of Mexico Coastal Guidelines Update," (Reference 95).

For the revised communities, published values in the Tidal Flood Survey (Reference 96) were used to estimate the stillwater elevations for the 10-, 2-, and 1-percent-annual-chance floods for Hingham Bay, Hull Bay, Weir River, Straits Pond, Massachusetts Bay, and Buzzards Bay. The 0.02-percent-annual-chance stillwater elevations for the revised flooding sources were extrapolated based on the more the frequent stillwater elevations in the Tidal Flood Survey. Stillwater elevations for the July 17, 2012 revised flooding sources are presented in Table 9.

TABLE 9 – SUMMARY OF STILLWATER ELEVATIONS – JULY 17, 2012

FLOODING SOURCE AND LOCATION	ELEVATION (feet NAVD 88[1])			
	10-PERCENT	2-PERCENT	1-PERCENT	0.2-PERCENT*
BROAD COVE				
For entire shoreline within Town of Hingham	8.4	9.3	9.7	10.6
BUZZARDS BAY				
Antassawamock	7.1	10.7	12.5	16.2
Aucoot Cove	7.6	11.4	13.2	17.1
Butler's Point	7.6	11.5	13.3	17.3
Crescent Beach	7.4	11.1	12.9	16.7
Cromeset Neck	7.8	11.7	13.6	17.6
Holly Woods	7.5	11.3	13.2	17.1
Jacobs Neck	7.8	11.8	13.7	17.7
Mattapoisett Harbor	7.3	11.1	12.8	16.7
Weweantic River	7.8	11.8	13.7	17.7
Wings Cove	7.6	11.6	13.5	17.6

[1]North American Vertical Datum of 1988
*extrapolated from USACE data

TABLE 9 – SUMMARY OF STILLWATER ELEVATIONS – JULY 17, 2012 – continued

FLOODING SOURCE AND LOCATION	ELEVATION (feet NAVD 88[1]) 10-PERCENT	2-PERCENT	1-PERCENT	0.2-PERCENT*
HINGHAM BAY				
At Bumpkin Island	8.4	9.3	9.7	10.6
From Hewitts Cove to Crow Point	8.4	9.3	9.7	10.6
HINGHAM HARBOR				
At Bottom, Sailor, Ragged, and Langlee Islands	8.4	9.3	9.7	10.6
From Crow Point to Planters Hill	8.4	9.3	9.7	10.6
HULL BAY				
Windmill Point to Hog Island Causeway, and South Shore of Peddocks Island	8.4	9.3	9.7	10.6
Hog Island Causeway to Packard Avenue in Kenberma	8.4	9.3	9.7	10.6
Packard Avenue in Kenberma to opposite of World's End	8.4	9.3	9.7	10.6
MASSACHUSETTS BAY				
Outer Coast from Hingham border to Windmill Point	8.4	9.3	9.7	10.6
North Shore of Peddocks Island	8.4	9.3	9.7	10.6
STRAITS POND				
Along the entire shoreline in Hull	8.4	9.3	9.7	10.6

[1]North American Vertical Datum of 1988
*extrapolated from USACE data

TABLE 9 – SUMMARY OF STILLWATER ELEVATIONS – JULY 17, 2012 – continued

FLOODING SOURCE AND LOCATION	ELEVATION (feet NAVD 88[1]) 10-PERCENT	2-PERCENT	1-PERCENT	0.2-PERCENT*
WEIR RIVER				
World's End to Washington Boulevard	8.4	9.3	9.7	10.6
Washington Boulevard to Nantasket Avenue	8.4	9.3	9.7	10.6
From confluence with Hingham Bay to George Washington Boulevard	8.4	9.3	9.7	10.6
From George Washington Boulevard to Foundry Pond	8.4	9.3	9.7	10.6
WEYMOUTH BACK RIVER				
From Hewitts Cove to Stodders Neck	8.4	9.3	9.7	10.6
From Stodders Neck to Fort Hill Street	8.4	9.3	9.7	10.6

[1]North American Vertical Datum of 1988
*extrapolated from USACE data

The elevations presented in the Tidal Flood Survey are referenced to the National Tidal Datum Epoch (NTDE) of 1960-1978. The current tidal datum is based on the NTDE of 1983-2001. The NTDE is a specific 19 year period that includes the longest periodic tidal variations caused by the astronomic tide-producing forces. The value averages out long term seasonal meteorological, hydrologic, and oceanographic fluctuations and provides a nationally consistent tidal datum network (bench marks) by accounting for seasonal and apparent environmental trends in sea level rise that affect the accuracy of tidal datums. For use in this coastal analysis revision, the stillwater elevations presented in the Tidal Flood Survey were converted to the current tidal datum. Datum conversion factors of +0.13 feet for Hingham and Hull and +0.15 for Marion, Mattapoisett, and Wareham were applied to the data in the Tidal Flood Survey.

July 16, 2015 Narragansett Watershed Study

For the July 16, 2015 partial countywide riverine analysis, stillwater elevations for Assawompset Pond and Long Pond were calculated.

November 4, 2016 Coastal Study Update

For the November 4, 2016 Coastal Study Update, the 10-, 2-, 1-, and 0.2-percent-annual-chance Stillwater elevations for the Towns of Duxbury, Kingston, Marshfield, Scituate, and Plymouth were taken from the July 17, 2012 Plymouth County FIS (Reference 1).

Stillwater elevations for all revised flooding sources are presented in Table 10.

TABLE 10 – SUMMARY OF REVISED STILLWATER ELEVATIONS

FLOODING SOURCE AND LOCATION	ELEVATION (feet NAVD 88[1])			
	10-PERCENT	2-PERCENT	1-PERCENT	0.2-PERCENT
ASSAWOMPSET POND[2]				
Along the entire shoreline	54.9	56.1	56.8	57.8
CAPE COD BAY[3]				
For entire open coastline within Town of Plymouth	8.3	9.1	9.5	10.3*
KINGSTON BAY[3]				
For entire shoreline within Town of Plymouth	8.3	9.1	9.5	10.3*
For entire shoreline within Town of Kingston	8.6	9.5	9.8	10.7*
LONG POND[2]				
Along the entire shoreline	55.6	56.9	57.2	57.8
MASSACHUSETTS BAY[3]				
Entire open coast coastline within the Town of Duxbury	8.3	9.1	9.5	10.3*

[1]North American Vertical Datum of 1988
[2]July 16, 2015 Narraganset Watershed Study
[3] November 4, 2016 Coastal Study Update
* Extrapolated from the 10-, 2-, and 1-percent stillwater elevations

TABLE 10 – SUMMARY OF REVISED STILLWATER ELEVATIONS - continued

FLOODING SOURCE AND LOCATION	ELEVATION (feet NAVD 88[1]) 10-PERCENT	2-PERCENT	1-PERCENT	0.2-PERCENT
MASSACHUSETTS BAY[3] - continued				
At Duxbury Marsh within the Town of Duxbury	8.3	9.1	9.5	10.3*
At Duxbury Bay within the Town of Duxbury	8.3	9.1	9.5	10.3*
At Kingston Bay within the Town of Duxbury	8.3	9.1	9.5	10.3*
Entire open coast coastline within the Town of Scituate	8.3	9.1	9.5	10.3*
Entire open coast coastline within the Town of Marshfield	8.3	9.1	9.5	10.3*
Duxbury Marsh within the Town of Marshfield	8.3	9.1	9.5	10.3*
Entire open coast coastline in the Town of Plymouth	8.3	9.1	9.5	10.3*
PLYMOUTH BAY[3]				
Entire open coast coastline in the Town of Plymouth	8.3	9.1	9.5	10.3*
PLYMOUTH HARBOR[3]				
Entire shoreline within harbor	8.3	9.1	9.5	10.3*

[1]North American Vertical Datum of 1988
[3] November 4, 2016 Coastal Study Update
* Extrapolated from the 10-, 2-, and 1-percent stillwater elevations

3.4 Coastal Hydraulic Analyses

July 17, 2012 Countywide Analysis

Wave setup along the open coast areas of Hingham, Hull, Marion, Mattapoisett, and Wareham was calculated using the procedures detailed in the “Atlantic Ocean and Gulf of Mexico Coastal Guidelines Update” (Reference 95). Specifically, the Direct Integration Method (DIM) was applied. Because much of the Plymouth County coastline has experienced historical flooding and damage above predicted surge and runup elevations, setup was assumed to be an important component of the analyses and was applied to the entire open coast shoreline in the revised communities, except for areas inundated by wave runup.

For the revised coastal portions of Plymouth County offshore wave characteristics representing a 1-percent-annual-chance storm were determined using data from the Wave Information Study (WIS). A Peaks-Over-Threshold statistical analysis (Reference 97) was applied on 20 years (1980-1999) of wave characteristic data from WIS Station No. 53. Mean wave characteristics were determined as specified in the FEMA guidance for V Zone mapping.

Wave heights and wave runup in Hingham, Hull, Marion, Mattapoisett, and Wareham were computed along transects that were located perpendicular to the average shoreline. The transects were located with consideration given to the physical and cultural characteristics of the land so that they would closely represent conditions in their locality. Transects were spaced close together in areas of complex topography and dense development. In areas having more uniform characteristics, the transects were spaced at larger intervals. It was also necessary to locate transects in areas where unique flooding existed and in areas where computer wave heights varied significantly between adjacent transects.

Transect Descriptions for the July 17, 2012 coastal analyses are shown in Table 11 below and have been re-numbered to conform to countywide standards.

TABLE 11 – TRANSECT DESCRIPTIONS – JULY 17, 2012

TRANSECT	LOCATION	ELEVATION (feet NAVD 88[2]) 1-PERCENT-ANNUAL-CHANCE STILLWATER	MAXIMUM 1-PERCENT-ANNUAL-CHANCE WAVE CREST[1]
1	The transect is located at along the east side of Stoddards Neck at a point approximately 1,400 feet north of U.S. Route 3A, extending west towards Davids Island.	9.7	13.76
2	The transect is located along the Back River shoreline at a point approximately 1,200 feet northwest of the west end of Shipyard Drive, extending south towards U.S. Route 3A.	9.7	15.01
3	The transect is located along the Hingham Bay shoreline at the north end of Wompatuck Road, extending southeast towards Foley Beach Road.	9.7	15.01
4	The transect is located along the Hingham Bay shoreline at a point approximately 150 feet in the vicinity of Howard Road, extending southwest towards Shute Avenue.	9.7	16.25
5	The transect is located along the Hingham Bay shoreline, extending southeast along Cushing Avenue towards Downer Avenue.	9.7	16.16
6	The transect is located along the Hingham Harbor shoreline at a point approximately 50 feet northeast of the intersection of Cushing Avenue and Downer Avenue, extending northwest towards Mann Street.	9.7	14.66

[1]Because of map scale limitations, the maximum wave elevation may not be shown on the FIRM.
[2]North American Vertical Datum of 1988

TABLE 11 – TRANSECT DESCRIPTIONS – JULY 17, 2012 – continued

TRANSECT	LOCATION	ELEVATION (feet NAVD 88[2]) 1-PERCENT-ANNUAL-CHANCE STILLWATER	MAXIMUM 1-PERCENT-ANNUAL-CHANCE WAVE CREST[1]
7	The transect is located along the Hingham Harbor shoreline at a point approximately 350 feet north of the intersection of Governor Long Road and Otis Street, extending southwest towards Broad Cove Road.	9.7	15.29
8	The transect is located along the Hingham Harbor shoreline at a point approximately 1000 feet southeast of the vicinity of Cole Road and Otis Street, extending southwest towards Lincoln Street.	9.7	14.28
9	The transect is located along the northern shoreline of Langlee Island, extending south towards the intersection of Otis Street and Summer Street on the mainland of Hingham.	9.7	16.84
10	The transect is located along the Hingham Harbor shoreline at a point approximately 300 feet northeast of the Summer Street Rotary, extending south towards Home Meadows.	9.7	15.22
11	The transect is located along the Hingham Harbor shoreline at a point approximately 1,300 feet northwest of the intersection of Seal Cove Road and Martins Lane, extending east towards Martins Lane.	9.7	15.01

[1]Because of map scale limitations, the maximum wave elevation may not be shown on the FIRM.
[2]North American Vertical Datum of 1988

TABLE 11 – TRANSECT DESCRIPTIONS – JULY 17, 2012 – continued

TRANSECT	LOCATION	ELEVATION (feet NAVD 88[2]) 1-PERCENT-ANNUAL-CHANCE STILLWATER	MAXIMUM 1-PERCENT-ANNUAL-CHANCE WAVE CREST[1]
12	The transect is located along the west side of Planters Hill at a point approximately 3,200 feet northwest of Martins Lane, extending southeast towards the Weir River.	9.7	16.5
13	The transect is located along the Hull Bay shoreline extending south along Beech Avenue towards World's End.	9.7	15.49/15.01*
14	The transect is located on southwest side of Spinnaker Island at a point approximately 400 feet south of the intersection of Spinnaker Island Causeway and Marina Drive, extending to the northeast.	9.7	15.55
15	The transect is located along the Hull Bay shoreline extending northeast along Western Avenue towards Main Street.	9.7	16.39
16	The transect is located at the north end of Peddocks Island, extending southwest towards island's center.	9.7	16.22
17	The transect is located along the Massachusetts Bay shoreline, extending south along Town Street.	9.7	16.95/15.97*
18	The transect is located along the Massachusetts Bay shoreline at a point approximately 900 feet northwest of the intersection of Christine Road and Harbor View Road, extending south towards Spring Street.	9.7	16.39

*Wave propagation from Hingham Bay
[1]Because of map scale limitations, the maximum wave elevation may not be shown on the FIRM.
[2]North American Vertical Datum of 1988

TABLE 11 – TRANSECT DESCRIPTIONS – JULY 17, 2012 – continued

TRANSECT	LOCATION	ELEVATION (feet NAVD 88[2]) 1-PERCENT-ANNUAL-CHANCE STILLWATER	MAXIMUM 1-PERCENT-ANNUAL-CHANCE WAVE CREST[1]
19	The transect is located along the Massachusetts Bay shoreline at a point approximately 150 feet west of the intersection of Nantasket Avenue and Fitzpatrick Way, extending southeast toward Allerton Harbor.	9.7	16.87/14.67*
20	The transect is located along the Massachusetts Bay shoreline extending north along Meridian Avenue towards Winthrop Avenue.	9.7	17.57
21	The transect is located along the Massachusetts Bay shoreline at a point approximately 800 feet south of Point Allerton, extending west towards Fitzpatrick Way.	9.7	23.28
22	The transect is located at along the Massachusetts Bay shoreline extending west along K Street towards Hull Bay.	9.7	21.91/16.8*
23	The transect is located along the Massachusetts Bay shoreline extending southwest along Warren Street towards Hull Bay.	9.7	21.61/ 14.8*
24	The transect is located along the Massachusetts Bay shoreline at a point approximately 800 feet south of the intersection of Bay Street and Nantasket Avenue, extending southwest towards Sagamore Hill.	9.7	22.06

*Wave propagation from Hingham Bay
[1]Because of map scale limitations, the maximum wave elevation may not be shown on the FIRM.
[2]North American Vertical Datum of 1988

TABLE 11 – TRANSECT DESCRIPTIONS – JULY 17, 2012 – continued

TRANSECT	LOCATION	ELEVATION (feet NAVD 88[2]) 1-PERCENT-ANNUAL-CHANCE STILLWATER	MAXIMUM 1-PERCENT-ANNUAL-CHANCE WAVE CREST[1]
25	The transect is located along the Massachusetts Bay shoreline at a point approximately 150 feet north of the intersection of Meade Avenue and Burr Road, extending southwest towards Atlantic Avenue.	9.7	23.43
26	The transect is located along the Massachusetts Bay shoreline at a point approximately 250 feet east of the intersection of Stoney Beach Road and Atlantic Avenue, extending southeast towards Straits Pond.	9.7	22.37
27	The transect is located along the Massachusetts Bay shoreline at a point approximately 650 feet northwest of Bath Avenue, extending south towards Straits Pond.	9.7	26.01
28	The transect is located along the Massachusetts Bay shoreline at a point approximately 450 feet northeast of the intersection of Reef Point and Summit Avenue, extending south toward Atlantic Avenue.	9.7	23.73
146	This transect represents the Buttermilk Bay shoreline in Wareham from the mouth of Red Brook to the U.S. Route 6 bridge over Cohasset Narrows. The shoreline in this area contains stable bluffs fronted by sandy beaches with pocket salt marshes.	13.7	18.71

[1]Because of map scale limitations, the maximum wave elevation may not be shown on the FIRM.
[2]North American Vertical Datum of 1988

TABLE 11 – TRANSECT DESCRIPTIONS – JULY 17, 2012 – continued

TRANSECT	LOCATION	ELEVATION (feet NAVD 88[2]) 1-PERCENT-ANNUAL-CHANCE STILLWATER	MAXIMUM 1-PERCENT-ANNUAL-CHANCE WAVE CREST[1]
147	This transect represents the Buzzards Bay shoreline from the U.S. Route 6 bridge crossing Cohasset Narrows to a point approximately 250 feet southeast of Shanley Way. This area is characterized by low bluffs, generally 10 to 20 feet high.	13.7	21.89
148	This transect represents the Buzzards Bay shoreline from a point approximately 250 feet southeast of Shanley Way to a point approximately 500 feet southeast of Long Neck Cemetery Road. This transect includes the shoreline of Butler Cove.	13.7	21.04
149	This transect represents the Buzzards Bay shoreline from a point approximately 500 feet southeast of Long Neck Cemetery Road to a point approximately 475 feet east of the intersection of Fisherman Cove Road and Robinwood Road.	13.7	18.97
150	This transect represents Jacobs Neck from a point along the Buzzards Bay shoreline approximately 475 feet east of the intersection of Fisherman Cove Road and Robinwood Road to the west side of Pleasant Harbor.	13.7	20.44

[1]Because of map scale limitations, the maximum wave elevation may not be shown on the FIRM.
[2]North American Vertical Datum of 1988

TABLE 11 – TRANSECT DESCRIPTIONS – JULY 17, 2012 – continued

		ELEVATION (feet NAVD 88[2])	
TRANSECT	LOCATION	1-PERCENT-ANNUAL-CHANCE STILLWATER	MAXIMUM 1-PERCENT-ANNUAL-CHANCE WAVE CREST[1]
151	This transect represents Onset Island. The shoreline of this island contains beach with residential coastal protection structures. The structures are mixed construction and generally in poor condition. Dense residential development is present in the area.	13.7	17.7
152	This transect represents the northern Onset Bay shoreline from Pleasant Harbor to Greene Street. This transect will also represent the southern shoreline of Onset Bay from Off Burgess Point Road to Burgess Point.	13.7	17.34
153	This transect represents the northern Onset Bay shoreline from Greene Street to the Onset Avenue Bridge over the East River. This transect will also represent the southern shoreline of Onset Bay from Over Jordan Road to Off Burgess Point Road.	13.7	18.11
154	This transect represents the Onset Bay shoreline from the Onset Avenue Bridge over the East River to Shell Point. The shoreline in this area is characterized by coastal bluffs, generally 20 to 30 feet high, fronted by a wide, sandy beach.	13.7	19.08
155	This transect represents Hogs Neck. The shoreline in this area is comprised of rocky shoreline and bluffs. The upland area is forest with sparse residential development.	13.7	21.64

[1]Because of map scale limitations, the maximum wave elevation may not be shown on the FIRM.
[2]North American Vertical Datum of 1988

TABLE 11 – TRANSECT DESCRIPTIONS – JULY 17, 2012 – continued

TRANSECT	LOCATION	ELEVATION (feet NAVD 88[2]) 1-PERCENT-ANNUAL-CHANCE STILLWATER	MAXIMUM 1-PERCENT-ANNUAL-CHANCE WAVE CREST[1]
156	This transect represents the Buzzards Bay shoreline from Hogs Neck to Stony Point Dike. The shoreline in this area contains sandy beach with eroding, vegetated dunes. Upland cover is forest with sparse residential development.	13.7	20.24
157	This transect represents the Buzzards Bay shoreline from Stony Point Dike to Little Harbor Beach. The shoreline in this area contains coastal bluffs, generally 40 to 50 feet high, with a sandy beach offshore of the bluffs. The upland cover is forest.	13.7	22.3
158	This transect represents the Buzzards Bay shoreline from Little Harbor Beach to Warrens Point. This transect also represents the Little Harbor shoreline. The outer shoreline in this area contains sandy beach with eroding dunes. Extensive salt marsh is visible.	13.7	21.51
159	This transect represents the Buzzards Bay shoreline from Warrens Point to a point approximately 4,100 feet west. The shoreline in this area is characterized by coastal bluffs, generally 20 to 30 feet high, with a cobble beach offshore of the bluffs.	13.7	22.3

[1]Because of map scale limitations, the maximum wave elevation may not be shown on the FIRM.
[2]North American Vertical Datum of 1988

TABLE 11 – TRANSECT DESCRIPTIONS – JULY 17, 2012 – continued

TRANSECT	LOCATION	ELEVATION (feet NAVD 88[2]) 1-PERCENT-ANNUAL-CHANCE STILLWATER	MAXIMUM 1-PERCENT-ANNUAL-CHANCE WAVE CREST[1]
160	This transect represents the Buzzards Bay shoreline from a point approximately 4,100 feet west of Warrens Point to a point along Wareham River approximately 425 feet east of Edgewater Road. The shoreline in this area is comprised of sandy beach.	13.7	22.21
161	This transect represents the eastern Wareham River shoreline from Edgewater Road to the U.S. Route 6 bridge over the Wareham River. This area contains sandy beach with pocket salt marshes. Dense residential development is present in the upland.	13.7	19.13
162	This transect represents the western Wareham River shoreline from the U.S. Route 6 bridge over the Wareham River to Swifts Beach. This transect also represents the shoreline of Broad Marsh River. The shoreline in this area is comprised of sandy beach.	13.7	24.93
163	This transect represents the Buzzards Bay shoreline at Swifts Beach. The shoreline in this area is characterized by sandy beach with eroding dunes. Dense residential development is present in the upland area.	13.7	21.96

[1]Because of map scale limitations, the maximum wave elevation may not be shown on the FIRM.
[2]North American Vertical Datum of 1988

TABLE 11 – TRANSECT DESCRIPTIONS – JULY 17, 2012 – continued

		ELEVATION (feet NAVD 88[2])	
TRANSECT	LOCATION	1-PERCENT-ANNUAL-CHANCE STILLWATER	MAXIMUM 1-PERCENT-ANNUAL-CHANCE WAVE CREST[1]
164	This transect represents the Buzzards Bay shoreline from Swifts Beach along Marks Cove to Marks Cove Road. The shoreline in this area contains marsh with forest and sparse residential development in the upland.	13.7	21.37
165	This transect represents the Buzzards Bay shoreline from Marks Cove Road to Cromeset Point. The shoreline in this area is comprised of sandy beach with eroding dunes and residential development upland. The upland cover is generally forest.	13.7	21.37
166	This transect represents the Buzzards Bay shoreline from Cromeset Point to a point along the Weweantic River approximately 650 feet west of the intersection of Cromeset Road and Progress Avenue. The shoreline in this area is characterized by cobble beach.	13.7	21.37
167	This transect represents the Buzzards Bay shoreline from a point approximately 650 feet west of the intersection of Cromeset Road and Progress Avenue to the U.S. Route 6 bridge over the Weweantic River. The shoreline in this area contains marsh.	13.7	20.57

[1]Because of map scale limitations, the maximum wave elevation may not be shown on the FIRM.
[2]North American Vertical Datum of 1988

TABLE 11 – TRANSECT DESCRIPTIONS – JULY 17, 2012 – continued

TRANSECT	LOCATION	ELEVATION (feet NAVD 88[2]) 1-PERCENT-ANNUAL-CHANCE STILLWATER	MAXIMUM 1-PERCENT-ANNUAL-CHANCE WAVE CREST[1]
168	The transect is located at a point approximately 725 feet southeast of the intersection of Bass Point Road and Delano Road extending to the west towards Delano Road.	13.6	20.98
169	The transect is located along the Buzzards Bay shoreline at a point approximately 1,325 feet northeast of Great Hill Point, extending to the northwest towards South Great Hill Drive.	13.5	21.34
170	The transect is located along the Buzzards Bay shoreline at a point approximately 725 feet southeast of the intersection of Register Road and Holly Road, extending to the west towards Point Road.	13.5	20.79
171	The transect is located along the Buzzards Bay shoreline at a point approximately 920 feet east of the intersection of Piney Point Road and Landing Road, extending to the southwest towards Bay Road.	13.5	20.91
172	This transect is located approximately midway along Sedge Cove, extending to the northwest towards Point Road.	13.3	21.06
173	This transect is located along the southern shoreline of Butler Point, extending to the northeast across Point Road.	13.3	22.1

[1]Because of map scale limitations, the maximum wave elevation may not be shown on the FIRM.
[2]North American Vertical Datum of 1988

TABLE 11 – TRANSECT DESCRIPTIONS – JULY 17, 2012 – continued

TRANSECT	LOCATION	ELEVATION (feet NAVD 88[2]) 1-PERCENT-ANNUAL-CHANCE STILLWATER	MAXIMUM 1-PERCENT-ANNUAL-CHANCE WAVE CREST[1]
174	This transect is located along the Sippican Harbor shoreline at the Cliffs, extending to the northeast across Sippican Neck.	13.3	23.41
175	This transect is located approximately midway along the causeway, extending to the north across Planting Island Cove towards Sippican Lane.	13.3	21.53
176	This transect is located along the Sippican Harbor shoreline at a point approximately 330 feet southwest of the intersection of Planting Island Road and West Avenue, extending to the north towards East Avenue.	13.3	22.67
177	This transect is located at Allens Point, extending to the north towards Allens Point Road.	13.3	21.82
178	This transect is located at the southern shoreline of Ram Island extending across Sippican Harbor to Black Point and north along Hermitage Road.	13.3	21.09
179	This transect is located along Sippican Harbor shoreline at a point approximately 450 feet south of the intersection of Pie Alley and Lewis Street, extending to the northwest towards Holmes Street.	13.3	21.09

[1]Because of map scale limitations, the maximum wave elevation may not be shown on the FIRM.
[2]North American Vertical Datum of 1988

TABLE 11 – TRANSECT DESCRIPTIONS – JULY 17, 2012 – continued

		ELEVATION (feet NAVD 88[2])	
TRANSECT	LOCATION	1-PERCENT-ANNUAL-CHANCE STILLWATER	MAXIMUM 1-PERCENT-ANNUAL-CHANCE WAVE CREST[1]
180	This transect is located along the Sippican Harbor shoreline at a point approximately 140 feet south of the intersection of Holly Lane and Quelle Lane, extending to the northwest towards Converse Road.	13.3	20.72
181	The transect is located at Converse Point, extending to the northwest along Moorings Road.	13.2	21.3
182	The transect is located along the Aucoot Cove shoreline at a point approximately 1,800 feet west of Converse Road, extending to the northwest towards Olde Knoll Road.	13.2	21.07
183	The transect is located at a point approximately 1,900 feet north of Joes Point, extending northwest towards Aucoot Road.	13.2	21.05
184	The transect is located along the Hiller's Cove shoreline extending to the northwest along Center Drive.	13.2	20.7
185	The transect is located along the Hiller's Cove shoreline at a point approximately 1,800 feet east of the intersection of Aucoot Road and Hollywood Road, extending to the northwest towards Mill Street.	13.2	20.67
186	The transect is located along the Buzzards Bay shoreline, extending to the west along Fairfield Avenue towards Old Tree Farm Road.	13.2	21.79

[1]Because of map scale limitations, the maximum wave elevation may not be shown on the FIRM.
[2]North American Vertical Datum of 1988

TABLE 11 – TRANSECT DESCRIPTIONS – JULY 17, 2012 – continued

		ELEVATION (feet NAVD 88[2])	
TRANSECT	LOCATION	1-PERCENT-ANNUAL-CHANCE STILLWATER	MAXIMUM 1-PERCENT-ANNUAL-CHANCE WAVE CREST[1]
187	This transect is located at Peases Point, extending to the northwest along Point Road.	13.2	20.77
188	This transect is located along the Buzzards Bay shoreline at a point approximately 350 feet northeast of the intersection of Beach Road and Bay Road, extending to the northwest towards Bowman Road.	13.2	20.81
189	The transect is located at Point Connett, extending to the northwest towards Beach Road.	13.2	20.95
190	The transect is located along the Buzzards Bay shoreline approximately 875 feet west from the intersection of Ridge Avenue and Cove Road, extending to the northwest across Pine Island Pond towards Angelica Avenue.	12.9	20.03
191	The transect is located along the Buzzards Bay shoreline at Beach Street, extending to the north towards Cedarcrest Avenue.	12.9	20.96
192	The transect is located along the Buzzards Bay shoreline at a point approximately 225 feet west of Prospect Drive, extending to the north towards Angelica Avenue.	12.9	20.79
193	The transect is located approximately 1,250 feet east of Ned's Point, extending to the north towards Pine Island Road.	12.9	20.67

[1]Because of map scale limitations, the maximum wave elevation may not be shown on the FIRM.
[2]North American Vertical Datum of 1988

TABLE 11 – TRANSECT DESCRIPTIONS – JULY 17, 2012 – continued

TRANSECT	LOCATION	ELEVATION (feet NAVD 88[2]) 1-PERCENT-ANNUAL-CHANCE STILLWATER	ELEVATION (feet NAVD 88[2]) MAXIMUM 1-PERCENT-ANNUAL-CHANCE WAVE CREST[1]
194	The transect is located along the Mattapoisett Harbor shoreline at a point approximately 350 feet southeast of the intersection of Water Street and North Street, extending to the north towards County Road.	12.8	20.96
195	The transect is located at the southeastern end of Reservation Road, extending to the northwest towards Fairhaven Road.	12.8	20.39
196	The transect is located at a point approximately 250 feet north of Shore Avenue, extending to the west towards Ocean Drive.	12.5	20.17
197	The transect is located along the Buzzards Bay shoreline at a point approximately 210 feet east of the Seaconet Road, extending to the north towards Camanset Road.	12.5	20.1
198	The transect is located along the Brant Island Cove shoreline at a point approximately 1,850 feet east of the intersection of Meadowbrook Lane and Jowick Street, extending to the north towards Anchorage Way.	12.5	20.1
199	The transect is located along the Nasketucket Bay shoreline between Pinehurst Avenue and Kerwin Avenue, extending to the north and towards Highland Avenue.	12.5	20.45

[1]Because of map scale limitations, the maximum wave elevation may not be shown on the FIRM.
[2]North American Vertical Datum of 1988

TABLE 11 – TRANSECT DESCRIPTIONS – JULY 17, 2012 – continued

		ELEVATION (feet NAVD 88[2])	
TRANSECT	LOCATION	1-PERCENT-ANNUAL-CHANCE STILLWATER	MAXIMUM 1-PERCENT-ANNUAL-CHANCE WAVE CREST[1]
200	The transect is located along the Nasketucket Bay shoreline at a point approximately 650 feet west of Black Duck Way, extending to the northeast towards Brant Beach Avenue.	12.5	18.98

[1]Because of map scale limitations, the maximum wave elevation may not be shown on the FIRM.
[2]North American Vertical Datum of 1988

Table 12, "Transect Data – July 17, 2012," lists the flood hazard zone and base flood elevations for each revised transect in the Towns of Hull, Hingham, Marion, Mattapoisett, and Wareham along the 1-percent-annual-chance stillwater elevation for the respective flooding source.

For the revised open water flooding sources, coastal transect data was extracted from topographic data collected by Sanborn Map Company, Inc. This data was collected within the restudy area by Light Detection and Ranging (LiDAR) technology. Additionally, portions of twenty-eight (28) coastal transects were land surveyed by Green International Affiliates, Inc. (GIA) to supplement LiDAR data collected by Sanborn Map Company Inc. for the restudy area (References 98 and 99). As appropriate, coastal protection structure details and 0.0 feet NAVD 88 elevation were included and noted in the transect land surveys performed by GIA. Bathymetric data from NOAA Nautical Charts were used to extend the transects offshore (Reference 100). Coastal processes that may affect the transect profile, such as dune erosion and seawall scour and failure, were estimated following the FEMA Guidelines.

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

Wave height and runup calculations used in the revised coastal analysis follow the methodologies described in the FEMA guidance for V Zone mapping (Reference 94). WHAFIS 3.0 was used to predict wave heights.

The FEMA Guidelines allow for the following methods to be used to determine wave runup: RUNUP 2.0; "Technical Advisory Committee for Water Retaining Structures" (TAW); Automated Coastal Engineering System (ACES); and the Shore Protection Manual (Reference 101). Each of the aforementioned methods has an appropriate set of nearshore conditions for which it should be applied. For example the methods described in the Shore Protection Manual are to be used to determine runup on vertical structures. These methods were applied for each of the restudied coastal transects, as appropriate.

These methodologies were used to compute wave envelope elevations associated with the 1-percent-annual-chance storm surge in Hingham, Hull, Marion, Mattapoisett, and Wareham. Accurate topographic, land-use, and land cover data are required for the coastal analyses. LiDAR data which meets the accuracy standards for flood hazard mapping were used for the topographic data (References 98 and 99). Depths below mean low water were determined from Bathymetic data from NOAA (Reference 100). The land-use and land cover data were obtained by field surveys and aerial photographs (Reference 102).

Areas of shallow flooding, designated AO zones, are shown along portions of the shoreline. These areas are the result of wave runup overtopping and ponding behind seawalls and berms with average depths of 1 to 2 feet.

TABLE 12 – TRANSECT DATA – JULY 17, 2012

	STILLWATER ELEVATIONS (feet NAVD 88[1])					
FLOODING SOURCE	10-PERCENT-ANNUAL CHANCE	2-PERCENT-ANNUAL-CHANCE	1-PERCENT-ANNUAL-CHANCE	0.2-PERCENT-ANNUAL-CHANCE	ZONE	BASE FLOOD ELEVATION (feet NAVD 88[1])
BUZZARDS BAY						
Transect 146	7.8	11.8	13.7	17.7	VE	21
Transect 147	7.8	11.8	13.7	17.7	VE	17
					AE	17
Transect 148	7.8	11.8	13.7	17.7	VE	18-21
					AE	14-15
Transect 149	7.8	11.8	13.7	17.7	VE	20
					AO	
					AE	15
Transect 150	7.8	11.8	13.7	17.7	VE	18-20
					AE	14-16
Transect 151	7.8	11.8	13.7	17.7	VE	17-18
					AE	16

[1]North American Vertical Datum of 1988

TABLE 12 – TRANSECT DATA – JULY 17, 2012 – continued

FLOODING SOURCE	STILLWATER ELEVATIONS (feet NAVD 88[1]) 10-PERCENT-ANNUAL CHANCE	2-PERCENT-ANNUAL-CHANCE	1-PERCENT-ANNUAL-CHANCE	0.2-PERCENT-ANNUAL-CHANCE	ZONE	BASE FLOOD ELEVATION (feet NAVD 88[1])
BUZZARDS BAY – continued						
Transect 152	7.8	11.8	13.7	17.7	VE	20
Transect 153	7.8	11.8	13.7	17.7	VE	19
Transect 154	7.8	11.8	13.7	17.7	VE	22
Transect 155	7.8	11.8	13.7	17.7	VE	23
Transect 156	7.8	11.8	13.7	17.7	VE	18-20
					AE	16
Transect 157	7.8	11.8	13.7	17.7	VE	30
Transect 158	7.8	11.8	13.7	17.7	VE	19-22
					AE	15
Transect 159	7.8	11.8	13.7	17.7	VE	22
Transect 160	7.8	11.8	13.7	17.7	VE	18-22
					AE	16
Transect 161	7.8	11.8	13.7	17.7	VE	17-19
					AE	15
Transect 162	7.8	11.8	13.7	17.7	VE	16-25
					AE	14-15
Transect 163	7.8	11.8	13.7	17.7	VE	18-22
					AE	15-16

[1]North American Vertical Datum of 1988

TABLE 12 – TRANSECT DATA – JULY 17, 2012 – continued

FLOODING SOURCE	STILLWATER ELEVATIONS (feet NAVD 88[1]) 10-PERCENT-ANNUAL CHANCE	2-PERCENT-ANNUAL-CHANCE	1-PERCENT-ANNUAL-CHANCE	0.2-PERCENT-ANNUAL-CHANCE	ZONE	BASE FLOOD ELEVATION (feet NAVD 88[1])
BUZZARDS BAY – continued						
Transect 164	7.8	11.8	13.7	17.7	VE	17-21
					AE	14-16
Transect 165	7.8	11.8	13.7	17.7	VE	20-21
					AE	15
Transect 166	7.8	11.8	13.7	17.7	VE	19-21
					AE	15-16
Transect 167	7.8	11.8	13.7	17.7	VE	18-21
Transect 168	7.8	11.7	13.6	17.6	VE	19-21
					AE	18
Transect 169	7.6	11.6	13.5	17.6	VE	15-21
Transect 170	7.6	11.6	13.5	17.6	VE	18-21
Transect 171	7.6	11.6	13.5	17.6	VE	17-21
					AE	15
Transect 172	7.6	11.6	13.5	17.6	VE	17-21
					AE	15
					AO	
Transect 173	7.6	11.5	13.3	17.3	VE	16-21
Transect 174	7.6	11.5	13.3	17.3	VE	32
					AO	
Transect 175	7.6	11.5	13.3	17.3	VE	16-22

[1]North American Vertical Datum of 1988

TABLE 12 – TRANSECT DATA – JULY 17, 2012 – continued

FLOODING SOURCE	STILLWATER ELEVATIONS (feet NAVD 88[1]) 10-PERCENT-ANNUAL CHANCE	2-PERCENT-ANNUAL-CHANCE	1-PERCENT-ANNUAL-CHANCE	0.2-PERCENT-ANNUAL-CHANCE	ZONE	BASE FLOOD ELEVATION (feet NAVD 88[1])
BUZZARDS BAY – continued						
Transect 176	7.6	11.5	13.3	17.3	VE	17-23
					AE	16
Transect 177	7.6	11.5	13.3	17.3	VE	16-22
Transect 178-179	7.6	11.5	13.3	17.3	VE	17-21
					AE	15-16
Transect 179	7.6	11.5	13.3	17.3	VE	17-21
					AE	15-16
Transect 180-181	7.6	11.5	13.3	17.3	VE	17-21
					AE	15
Transect 181	7.6	11.7	13.2	17.1	VE	17-21
					AE	15
Transect 182	7.6	11.7	13.2	17.1	VE	17-21
					AE	15
Transect 183	7.6	11.4	13.21	17.1	VE	18
					AE	16
Transect 184-185	7.6	11.4	13.21	17.1	VE	17-21
					AE	15-16
Transect 185	7.6	11.4	13.21	17.1	VE	17-21
					AE	15-16
Transect 186	7.6	11.4	13.21	17.1	VE	22
					AE	22

[1]North American Vertical Datum of 1988

TABLE 12 – TRANSECT DATA – JULY 17, 2012 – continued

FLOODING SOURCE	STILLWATER ELEVATIONS (feet NAVD 88[1]) 10-PERCENT-ANNUAL CHANCE	2-PERCENT-ANNUAL-CHANCE	1-PERCENT-ANNUAL-CHANCE	0.2-PERCENT-ANNUAL-CHANCE	ZONE	BASE FLOOD ELEVATION (feet NAVD 88[1])
BUZZARDS BAY – continued						
Transect 187-189	7.5	11.3	13.2	17.1	VE	17-21
					AE	15
Transect 188	7.5	11.3	13.2	17.1	VE	17-21
					AE	15
Transect 189	7.5	11.3	13.2	17.1	VE	17-21
					AE	15
Transect 190	7.4	11.1	12.9	16.7	VE	17-20
					AE	15-16
Transect 191	7.4	11.1	12.9	16.7	VE	15-16
					AE	17-21
Transect 192	7.4	11.1	12.9	16.7	VE	17-21
					AE	14-15
Transect 193	7.4	11.1	12.9	16.7	VE	16-21
					AE	15-16
Transect 194	7.3	11.1	12.8	16.7	VE	16-21
					AE	16
Transect 195	7.3	11.1	12.8	16.7	VE	17-20
					AE	15-16
Transect 196	7.1	10.7	12.5	16.2	VE	17-20
					AE	15

[1]North American Vertical Datum of 1988

TABLE 12 – TRANSECT DATA – JULY 17, 2012 – continued

	STILLWATER ELEVATIONS (feet NAVD 88[1])					
FLOODING SOURCE	10-PERCENT-ANNUAL CHANCE	2-PERCENT-ANNUAL-CHANCE	1-PERCENT-ANNUAL-CHANCE	0.2-PERCENT-ANNUAL-CHANCE	ZONE	BASE FLOOD ELEVATION (feet NAVD 88[1])
BUZZARDS BAY – continued						
Transect 197	7.1	10.7	12.5	16.2	VE	15-20
					AE	14
Transect 198	7.1	10.7	12.5	16.2	VE	16-20
					AE	14-15
Transect 199	7.1	10.7	12.5	16.2	VE	17-20
Transect 200	7.1	10.7	12.5	16.2	VE	19
					AE	14
HINGHAM BAY						
Transect 3	8.4	9.3	9.7	10.6	VE	14
Transect 4	8.4	9.3	9.7	10.6	VE	30
Transect 5	8.4	9.3	9.7	10.6	VE	13-16
HINGHAM HARBOR						
Transect 6	8.4	9.3	9.7	10.6	VE	15
Transect 7	8.4	9.3	9.7	10.6	VE	22
					AE	10
Transect 8	8.4	9.3	9.7	10.6	VE	14
					AE	10
Transect 9	8.4	9.3	9.7	10.6	VE	23

[1]North American Vertical Datum of 1988

TABLE 12 – TRANSECT DATA – JULY 17, 2012 – continued

FLOODING SOURCE	STILLWATER ELEVATIONS (feet NAVD 88[1]) 10-PERCENT-ANNUAL CHANCE	2-PERCENT-ANNUAL-CHANCE	1-PERCENT-ANNUAL-CHANCE	0.2-PERCENT-ANNUAL-CHANCE	ZONE	BASE FLOOD ELEVATION (feet NAVD 88[1])
HINGHAM HARBOR – continued						
Transect 10	8.4	9.3	9.7	10.6	VE	14
					AE	11
Transect 11	8.4	9.3	9.7	10.6	VE	13
HULL BAY						
Transect 13	8.4	9.3	9.7	10.6	VE	15-24
					AE	10
Transect 14	8.4	9.3	9.7	10.6	VE	24
Transect 15					VE	33
Transect 16	8.4	9.3	9.7	10.6	VE	18
MASSACHUSETTS BAY						
Transect 17	8.4	9.3	9.7	10.6	VE	16-18
					AO	
					AE	11-13
Transect 18	8.4	9.3	9.7	10.6	VE	20
Transect 19	8.4	9.3	9.7	10.6	AE	13
					VE	15
Transect 20	8.4	9.3	9.7	10.6	VE	21
Transect 21	8.4	9.3	9.7	10.6	VE	32

[1]North American Vertical Datum of 1988

TABLE 12 – TRANSECT DATA – JULY 17, 2012 – continued

FLOODING SOURCE	STILLWATER ELEVATIONS (feet NAVD 88[1]) 10-PERCENT-ANNUAL CHANCE	2-PERCENT-ANNUAL-CHANCE	1-PERCENT-ANNUAL-CHANCE	0.2-PERCENT-ANNUAL-CHANCE	ZONE	BASE FLOOD ELEVATION (feet NAVD 88[1])
MASSACHUSETTS BAY – continued						
Transect 22	8.4	9.3	9.7	10.6	VE	17-23
					AO	
					AE	10-14
Transect 23	8.4	9.3	9.7	10.6	VE	15-22
					AE	10-15
Transect 24	8.4	9.3	9.7	10.6	VE	20-22
					AO	
Transect 25	8.4	9.3	9.7	10.6	VE	36
Transect 26	8.4	9.3	9.7	10.6	VE	20-22
					AE	10-17
Transect 27	8.4	9.3	9.7	10.6	VE	21-26
					AE	10-15
Transect 28	8.4	9.3	9.7	10.6	VE	25
WEIR RIVER						
Transect 12	8.4	9.3	9.7	10.6	VE	22
					AE	10
WEYMOUTH BACK RIVER						
Transect 1	8.4	9.3	9.7	10.6	VE	16
					AE	10
Transect 2	8.4	9.3	9.7	10.6	VE	14

[1]North American Vertical Datum of 1988

November 4, 2016 Coastal Study Update

The energy-based significant wave height (Hmo) and peak wave period (Tp) are used as inputs to wave setup and wave runup calculations and were calculated using the Steady-State Spectral Wave Model (STWAVE) . STWAVE is a phased-averaged spectral wave model that simulates depth-induced wave refraction and shoaling, depth-and steepness-induced wave breaking, diffraction, wind-wave growth, and wave-wave interaction and white capping that redistribute and dissipate energy in a growing wave field. The model accepts a spectral form of the wave as an input condition and provides Hmo and Tp results over the gridded model domain.

Offshore (deepwater) wave heights, wave setup, and wave runup for each transect were calculated using Mathcad sheets developed by STARR to apply methodologies from the USACE's Coastal Engineering Manual (Reference 103) and FEMA Guidelines and Specifications (Reference 95). Methodologies for each type of calculation are discussed in more detail below. Results from the Mathcad calculations performed for each transect were compiled in a summary spreadsheet.

Overland wave heights were calculated for restricted and unrestricted fetch settings using the Wave Height Analysis for Flood Insurance Studies (WHAFIS), Version 4.0 (Reference 104), within the Coastal Hazard Analysis for Mapping Program (CHAMP) (Reference 105), following the methodology described in the FEMA Guidelines and Specifications for each coastal transect.

The general working procedure included eight steps: 1) laying out transects; 2) determining off-shore significant wave heights and corresponding wave periods from STWAVE outputs; 3) performing the off-shore engineering analysis; 4) preparing WHAFIS input data and populating the CHAMP database; 5) performing erosion analysis for erodible transects without a coastal structure; 6) performing WHAFIS modeling runs on eroded transects and transects with both intact and failed structures, as applicable; 7) performing wave runup analysis on intact and failed structures; and 8) identifying primary frontal dunes.

Coastal engineering analysis was performed for each coastal transect using wave condition extracted from the STWAVE model and SWEL data to generate wave setup and wave runup values for open coast transects and transects with vertical structures or revetments, and to generate input used in developing CHAMP and WHAFIS input data. Mathcad sheets were developed and applied by STARR for the calculations to help ensure consistency and accuracy. The input data and results of the analysis were compiled for each transect in a summary spreadsheet. The Mathcad sheets and summary spreadsheet are included in the digital data files compiled for the coastal submittal.

CHAMP is a Microsoft (MS) Windows-interfaced Visual Basic language program that allows the user to enter data, perform coastal engineering analyses, view and tabulate results, and chart summary information for each representative transect along a coastline within a user-friendly graphical interface. With CHAMP, the user can import digital elevation data, perform storm-induced erosion treatments, wave height and wave runup analyses, plot summary graphics of the results, and create summary tables and reports in a single environment. CHAMP version 2.0 (Reference 105) was used to perform erosion analysis, run WHAFIS, and apply RUNUP 2.0 to transects without coastal structures. Application of CHAMP followed the instructions in the FEMA Guidelines and

Specifications (Reference 95) and the Coastal Hazard Analysis Modeling Program user's guide found in the software documentation (Reference 106).

Wave setup can be a significant contributor to the total water level at the shoreline and was included in the determination of coastal base flood elevations. Wave setup is defined as the increase in total stillwater elevation against a barrier caused by the attenuation of waves in shallow water. Wave setup is based upon wave breaking characteristics and profile slope. Wave setup values were calculated for each coastal transect using the Direct Integration Method (DIM), developed by Goda (Reference 97), as described in the FEMA Guidelines and Specifications, Equation D.2.6-1. For those coastal transects where a structure was located, documentation was gathered on the structure, and the wave setup against the coastal structure was also calculated.

The fundamental analysis of overland wave effects for an FIS is provided by FEMA's Wave Height Analysis For Flood Insurance Studies computer program, WHAFIS 4.0, a computer program that uses representative transects to compute wave crest elevations in a given study area. Topographic, vegetative, and cultural features are identified along each specified transect landward of the shoreline. WHAFIS uses this and other input information to calculate wave heights, wave crest elevations, flood insurance risk zone designations, and flood zone boundaries along the transects.

The original basis for the WHAFIS model was the 1977 National Academy of Sciences (NAS) report "Methodology for Calculating Wave Action Effects Associated with Storm Surges" (Reference 107). The NAS methodology accounted for varying fetch lengths, barriers to wave transmission, and the regeneration of waves over flooded land areas. Since the incorporation of the NAS methodology into the initial version of WHAFIS, periodic upgrades have been made to WHAFIS to incorporate improved or additional wave considerations.

WHAFIS 4.0 was applied using CHAMP to calculate overland wave height propagation and establish base flood elevations. 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.

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 FEMA Guidelines and Specifications (Reference 95) 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 described in the FEMA Guidelines and Specifications (Reference 95). Runup estimates were developed for vertical walls using the guidance in Figure D.2.8-3 of the FEMA Guidelines and Specifications (Reference 95), taken from the Shore Protection Manual (Reference 101). Technical Advisory Committee for Water Retaining Structures (TAW) method was applied for sloped structures with a slope steeper than 1:8. For slopes milder than 1:8, the FEMA Wave Runup Model RUNUP 2.0 was used. Both the SPM and RUNUP 2.0 provide mean wave runup. The mean wave runup was multiplied by 2.2 to obtain the 2percent runup height. Wave runup elevation was added to the stillwater elevation and does not include wave setup.

The LiMWA is determined and defined as the location of the 1.5-foot wave. Typical constructions in areas of wave heights less than 3-feet high have experienced damage, suggesting that construction requirements within some areas of the AE zone should be more like those requirements for the VE zone. Testing and investigations have confirmed that a wave height greater than 1.5 feet can cause structure failure. The LiMWA was determined 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 108). The effects of wave hazards in the Zone AE areas (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.

The effects of wave hazards in the Zone AE areas (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.

Primary frontal dunes (PFDs) were identified in the communities of Plymouth, Duxbury, Marshfield and Scituate. However, they did not define the landward extent of the velocity zones for the Town of Duxbury. Provided below is a summary of the analyses performed. All revised coastal analyses were performed in accordance with the FEMA Guidelines and Specifications (Reference 95).

In accordance with 44 CFR Section 59.1 of the National Flood Insurance Program (NFIP), the effect of the PFD on coastal high hazard area (V Zone) mapping was evaluated for the Towns of Plymouth, Duxbury, Scituate and Marshfield. Identification of the PFD was based upon a FEMA-approved numerical approach for analyzing the dune's dimensional characteristics. Using this methodology, the landward toe of the PFD is delineated based on knowledge of local geological processes and remote sensing/GIS technologies utilizing LiDAR data. The PFD defined the landward limit of the V Zone along portions of the shoreline only within the Towns of Plymouth, Marshfield and Scituate.

The communities of Scituate, Marshfield, and Duxbury submitted material during the Appeal Period that was incorporated into the final mapping.

Transects in Scituate affected by this submittal were 32 and 35. The overland wave propagation analysis utilized high water marks collected from the blizzard of February 1978 as an indicator of the reduction of wave setup and resultant total water level on each of the transects.

Transects in Marshfield affected by this submittal were 55 through 60. The overland wave propagation analysis utilized high water marks collected from the blizzard of February 1978 as an indicator of the reduction of wave setup and resultant total water level on each of the transects.

The transect in Duxbury affected by this submittal was 71. The overland wave propagation analysis utilized high water marks collected from the blizzard of February 1978 as an indicator of the reduction of wave setup and resultant total water level on each of the transects.

The transect schematic Figure 1 represents a sample transect that illustrates the relationship between the stillwater elevation, the wave crest elevation, the ground elevation profile, and the location of the A/V zone boundary.

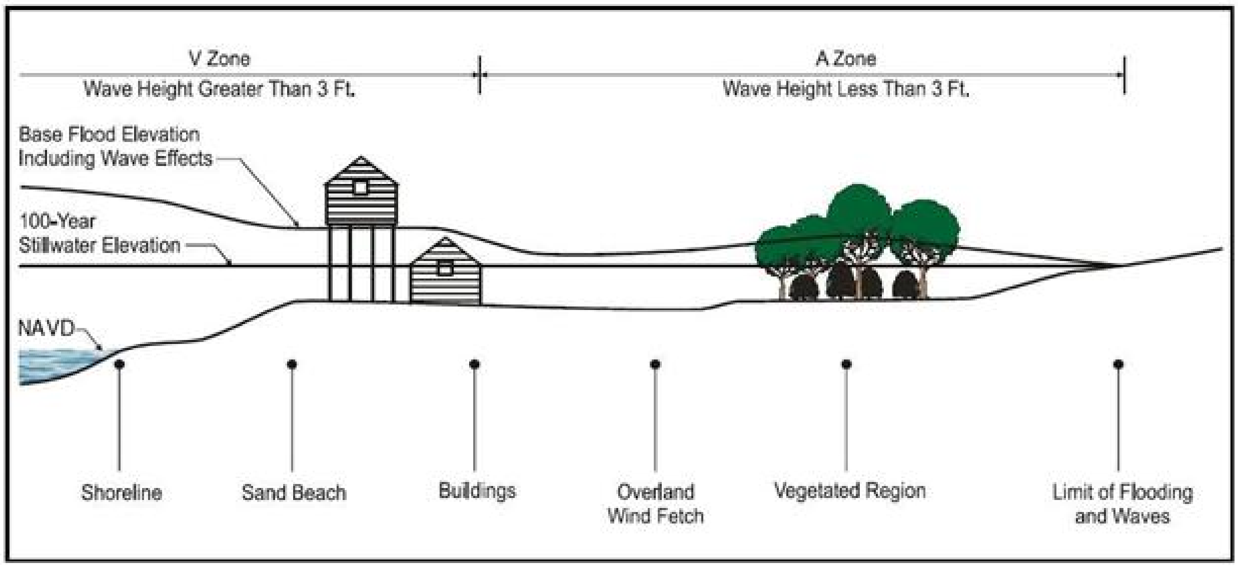

FIGURE 1 - TRANSECT SCHEMATIC

Transects (profiles) were located for coastal hydrologic and hydraulic analyses perpendicular to the average shoreline along areas subject to coastal flooding; transects extend off-shore to areas representative of deep water conditions and extend inland to a point where wave action ceases, in accordance with the User's Manual for Wave Height Analysis (Reference 109). 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. 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.

Coastal transect topography data was obtained from Light Detection and Ranging (LiDAR) data collected in January 2010 by Photo Science (Reference 110). Data is accurate to 2-foot contours. Bathymetric data was obtained from the NOAA National Ocean Service (NOS) Hydrographic Data Base (NOSHDB) and Hydrographic Survey Meta Data Base (HSMDB) (NOAA, May 27, 2010) (Reference 100). The sounding datum of mean low low water (MLLW) was converted to vertical datum NAVD 88.

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.

Table 13 provides a description of the revised transect locations, the 1-percent-annual-chance stillwater elevations, and the maximum 1-percent-annual-chance wave crest elevations. Figure 2, "Transect Location Map," illustrates the location of the transects for the county.

TABLE 13 – REVISED TRANSECT DESCRIPTIONS

		ELEVATION (feet NAVD 88[2])	
TRANSECT	LOCATION	1-PERCENT-ANNUAL-CHANCE STILLWATER	MAXIMUM 1-PERCENT ANNUAL CHANCE WAVE CREST[1]
29	The transect is located at the shoreline of Cohasset Harbor, in the Town of Scituate, from the Plymouth/Norfolk County Boundary to the end of Glades Road	9.5	18.8
30	The transect is located at the shoreline of Massachusetts Bay, in the Town of Scituate, from the end of Glades Road to approximately 2600 feet northeast of the Glades Road/Tilden Avenue intersection	9.5	16.21
31	The transect is located at the shoreline of Massachusetts Bay, in the Town of Scituate, from approximately 2600 feet northeast of the Glades Road/Tilden Avenue intersection to approximately 750 feet northeast of the Glades Road/Tilden Avenue intersection	9.5	23.4
32	The transect is located at the shoreline of Massachusetts Bay, in the Town of Scituate, from approximately 750 feet northeast of the Glades Road/Tilden Avenue intersection to approximately 200 feet northeast of the Glades Road/Bailey's Causeway intersection	9.5	23.8

[1]Because of map scale limitations, the maximum wave elevation may not be shown on the FIRM.
[2]North American Vertical Datum of 1988

TABLE 13 – REVISED TRANSECT DESCRIPTIONS – continued

TRANSECT	LOCATION	ELEVATION (feet NAVD 88[2]) 1-PERCENT-ANNUAL-CHANCE STILLWATER	MAXIMUM 1-PERCENT ANNUAL CHANCE WAVE CREST[1]
33	The transect is located at the shoreline of Massachusetts Bay, in the Town of Scituate, from approximately 200 feet northeast of the Glades Road/Bailey's Causeway intersection to the Glades Road/Grasshopper Lane intersection	9.5	23.1
34	The transect is located at the shoreline of Massachusetts Bay, in the Town of Scituate, from the Glades Road/Grasshopper Lane intersection to the Glades Road/Gannett Road intersection	9.5	22.8
35	The transect is located at the shoreline of Massachusetts Bay, in the Town of Scituate, from the Glades Road/Gannett Road intersection to the Surfside Road/Seagate Circle intersection	9.5	22.9
36	The transect is located at the shoreline of Massachusetts Bay, in the Town of Scituate, from the Surfside Road/Seagate Circle intersection to the Stanton Lane/Mann Hill Road (Extended) intersection	9.5	20.9
37	The transect is located at the shoreline of Massachusetts Bay, in the Town of Scituate, from the Stanton Lane/Mann Hill Road (Extended) intersection to Priscilla Avenue	9.5	20.2
38	The transect is located at the shoreline of Massachusetts Bay, in the Town of Scituate, from Priscilla Avenue to approximately 200 feet northwest of the Seaside Road/Bradford Avenue intersection	9.5	20.9

[1]Because of map scale limitations, the maximum wave elevation may not be shown on the FIRM.
[2]North American Vertical Datum of 1988

TABLE 13 – REVISED TRANSECT DESCRIPTIONS – continued

TRANSECT	LOCATION	ELEVATION (feet NAVD 88[2]) 1-PERCENT-ANNUAL-CHANCE STILLWATER	MAXIMUM 1-PERCENT ANNUAL CHANCE WAVE CREST[1]
39	The transect is located at the shoreline of Massachusetts Bay, in the Town of Scituate, from approximately 200 feet northwest of the Seaside Road/Bradford Avenue intersection to the Oceanside Drive/1st Avenue intersection	9.5	22.9
40	The transect is located at the shoreline of Massachusetts Bay, in the Town of Scituate, from the Oceanside Drive/1st Avenue intersection to approximately 600 feet south of the Oceanside Drive/11th Avenue intersection	9.5	23.4
41	The transect is located at the shoreline of Massachusetts Bay, in the Town of Scituate, from approximately 600 feet south of the Oceanside Drive/11th Avenue intersection to approximately 280 feet northeast of the Lighthouse Road/Rebecca Road intersection	9.5	22.4
42	The transect is located at the shoreline of Massachusetts Bay, in the Town of Scituate, from approximately 280 feet northeast of the Lighthouse Road/Rebecca Road intersection to the jetty located approximately 275 feet southeast of the Rebecca Road/Bates Road intersection	9.5	21.7

[1]Because of map scale limitations, the maximum wave elevation may not be shown on the FIRM.
[2]North American Vertical Datum of 1988

TABLE 13 – REVISED TRANSECT DESCRIPTIONS – continued

TRANSECT	LOCATION	ELEVATION (feet NAVD 88[2]) 1-PERCENT-ANNUAL-CHANCE STILLWATER	MAXIMUM 1-PERCENT ANNUAL CHANCE WAVE CREST[1]
43	The transect is located at the shoreline of Scituate Harbor, in the Town of Scituate, from the jetty located approximately 275 feet southeast of the Rebecca Road/Bates Road intersection to the jetty located approximately 550 feet north of the Edward Foster Road/Circuit Avenue Circle intersection	9.5	19.4
44	The transect is located at the shoreline of Massachusetts Bay, in the Town of Scituate, from the jetty located approximately 550 feet north of the Edward Foster Road/Circuit Avenue Circle intersection to approximately 500 feet east of the Edward Foster Road/Roberts Drive intersection	9.5	22.1
45	The transect is located at the shoreline of Massachusetts Bay, in the Town of Scituate, from approximately 500 feet east of the Edward Foster Road/Roberts Drive intersection to approximately 380 feet south of the Edward Foster Road/Roberts Drive intersection	9.5	24.4
46	The transect is located at the shoreline of Massachusetts Bay, in the Town of Scituate, from approximately 380 feet south of the Edward Foster Road/Roberts Drive intersection to approximately 1000 feet southeast of the Edward Foster Road/Crescent Avenue intersection	9.5	22.8

[1]Because of map scale limitations, the maximum wave elevation may not be shown on the FIRM.
[2]North American Vertical Datum of 1988

TABLE 13 – REVISED TRANSECT DESCRIPTIONS – continued

		ELEVATION (feet NAVD 88[2])	
TRANSECT	LOCATION	1-PERCENT-ANNUAL-CHANCE STILLWATER	MAXIMUM 1-PERCENT ANNUAL CHANCE WAVE CREST[1]
47	The transect is located at the shoreline of Massachusetts Bay, in the Town of Scituate, from approximately 1000 feet southeast of the Edward Foster Road/Crescent Avenue intersection to approximately 150 feet southeast of the Beach Road/Peggotty Beach Road intersection	9.5	23.4
48	The transect is located at the shoreline of Massachusetts Bay, in the Town of Scituate, from approximately 150 feet southeast of the Beach Road/Peggotty Beach Road intersection to the Town Way Ext/Town Way intersection	9.5	21.2
49	The transect is located at the shoreline of Massachusetts Bay, in the Town of Scituate, from the Town Way Ext/Town Way intersection to approximately 1000 feet southeast of the Gilson Road/Bassin Lane intersection	9.5	23.9
50	The transect is located at the shoreline of Massachusetts Bay, in the Town of Scituate, from approximately 1000 feet southeast of the Gilson Road/Bassin Lane intersection to the Collier Road/Michael Avenue intersection	9.5	23.4
51	The transect is located at the shoreline of Massachusetts Bay, in the Town of Scituate, from the Collier Road/Michael Avenue intersection to the North River	9.5	22.2

[1]Because of map scale limitations, the maximum wave elevation may not be shown on the FIRM.
[2]North American Vertical Datum of 1988

TABLE 13 – REVISED TRANSECT DESCRIPTIONS – continued

TRANSECT	LOCATION	ELEVATION (feet NAVD 88[2]) 1-PERCENT-ANNUAL-CHANCE STILLWATER	MAXIMUM 1-PERCENT ANNUAL CHANCE WAVE CREST[1]
52	The transect is located at the shoreline of Massachusetts Bay, in the Town of Marshfield, from the North River to approximately 850 feet north of the Cliff Road N/Shore Road intersection	9.5	19.4
53	The transect is located at the shoreline of Massachusetts Bay, in the Town of Scituate, from approximately 850 feet north of the Cliff Road N/Shore Road intersection to River Road	9.5	23.3
54	The transect is located at the shoreline of Massachusetts Bay, in the Town of Scituate, from River Road to approximately 450 feet north east of the Central Avenue/Atlantic Drive intersection	9.5	23.1
55	The transect is located at the shoreline of Massachusetts Bay, in the Town of Scituate, from approximately 450 feet north east of the Central Avenue/Atlantic Drive intersection to Newell Street	9.5	20.7
56	The transect is located at the shoreline of Massachusetts Bay, in the Town of Scituate, from Newell Street to Milton Street	9.5	20.7
57	The transect is located at the shoreline of Massachusetts Bay, in the Town of Scituate, from Milton Street to the Ocean Front Street/Old Mouth Road intersection	9.5	22.2

[1]Because of map scale limitations, the maximum wave elevation may not be shown on the FIRM.
[2]North American Vertical Datum of 1988

TABLE 13 – REVISED TRANSECT DESCRIPTIONS – continued

TRANSECT	LOCATION	ELEVATION (feet NAVD 88[2]) 1-PERCENT-ANNUAL-CHANCE STILLWATER	MAXIMUM 1-PERCENT ANNUAL CHANCE WAVE CREST[1]
58	The transect is located at the shoreline of Massachusetts Bay, in the Town of Marshfield, from the Ocean Front Street/Old Mouth Road intersection to Jackson Street	9.5	20.7
59	The transect is located at the shoreline of Massachusetts Bay, in the Town of Marshfield, from Jackson Street to Porter Street	9.5	22.0
60	The transect is located at the shoreline of Massachusetts Bay, in the Town of Marshfield, from Porter Street to Rexhame Road	9.5	20.8
61	The transect is located at the shoreline of Massachusetts Bay, in the Town of Marshfield, from Rexhame Road to approximately 250 feet southeast of the Foster Avenue/Brook Street intersection	9.5	20.9
62	The transect is located at the shoreline of Massachusetts Bay, in the Town of Marshfield, from approximately 250 feet southeast of the Foster Avenue/Brook Street intersection to approximately 230 feet south east of the Ocean Street/Shawmut Avenue intersection	9.5	22.4
63	The transect is located at the shoreline of Massachusetts Bay, in the Town of Marshfield, from approximately 230 feet south east of the Ocean Street/Shawmut Avenue intersection to South Street	9.5	22.9

[1]Because of map scale limitations, the maximum wave elevation may not be shown on the FIRM.
[2]North American Vertical Datum of 1988

TABLE 13 – REVISED TRANSECT DESCRIPTIONS – continued

TRANSECT	LOCATION	ELEVATION (feet NAVD 88[2]) 1-PERCENT-ANNUAL-CHANCE STILLWATER	MAXIMUM 1-PERCENT ANNUAL CHANCE WAVE CREST[1]
64	The transect is located at the shoreline of Massachusetts Bay, in the Town of Marshfield, from South Street to Jersey Street	9.5	21.8
65	The transect is located at the shoreline of Massachusetts Bay, in the Town of Marshfield, from Jersey Street to Wave Street	9.5	23.6
66	The transect is located at the shoreline of Massachusetts Bay, in the Town of Marshfield, from Wave Street to the A street/Water Street intersection	9.5	23.5
67	The transect is located at the shoreline of Massachusetts Bay, in the Town of Marshfield, at the mouth of the Green Harbor River, from the A Street/Water Street intersection to approximately 400 feet southeast of the Bay Avenue/Beach Street intersection	9.5	20.9
68	The transect is located at the shoreline of Massachusetts Bay, in the Town of Marshfield, from approximately 400 feet southeast of the Bay Avenue/Beach Street intersection to the Bay Avenue/Plymouth Avenue intersection in the Town of Duxbury	9.5	22.9
69	The transect is located at the shoreline of Duxbury Bay, in the Town of Marshfield, from Canal Street to Seaflower Lane	9.5	9.9

[1]Because of map scale limitations, the maximum wave elevation may not be shown on the FIRM.
[2]North American Vertical Datum of 1988

TABLE 13 – REVISED TRANSECT DESCRIPTIONS – continued

TRANSECT	LOCATION	ELEVATION (feet NAVD 88[2]) 1-PERCENT-ANNUAL-CHANCE STILLWATER	MAXIMUM 1-PERCENT ANNUAL CHANCE WAVE CREST[1]
70	The transect is located at the shoreline of Duxbury Bay, in the Town of Marshfield, from Seaflower Lane to approximately 900 feet north of the Abrams Hill Road/River Lane intersection	9.5	10.0
71	The transect is located at the shoreline of Massachusetts Bay, in the Town of Duxbury, from the Bay Avenue/Plymouth Avenue intersection to approximately 300 feet south of the Ocean Road S/ E Pine Road intersection	9.5	22.5
72	The transect is located at the shoreline of Duxbury Bay, in the Town of Duxbury from approximately 900 feet north of the Abrams Hill Road/River Lane intersection to Bay Pond Road	9.5	10.0
73	The transect is located at the shoreline of Massachusetts Bay, in the Town of Duxbury, from approximately 300 feet south of the Ocean Road S/ E Pine Road intersection to the Powder Point Bridge	9.5	21.3
74	The transect is located at the shoreline of Massachusetts Bay, in the Town of Duxbury, from the Powder Point Bridge to approximately 6500 feet southeast of the Powder Point Bridge	9.5	21.3
75	The transect is located at the shoreline of Massachusetts Bay, in the Town of Duxbury, from approximately 6500 feet southeast of the Powder Point Bridge to the boundary of the Town of Plymouth	9.5	21.2

[1]Because of map scale limitations, the maximum wave elevation may not be shown on the FIRM.
[2]North American Vertical Datum of 1988

TABLE 13 – REVISED TRANSECT DESCRIPTIONS – continued

TRANSECT	LOCATION	ELEVATION (feet NAVD 88[2]) 1-PERCENT-ANNUAL-CHANCE STILLWATER	MAXIMUM 1-PERCENT ANNUAL CHANCE WAVE CREST[1]
76	The transect is located at the shoreline of Massachusetts Bay, in the Town of Plymouth, from the Town boundary to Mandeville Avenue	9.5	22.5
77	The transect is located at the shoreline of Massachusetts Bay, in the Town of Plymouth, from Mandeville Avenue to Herbert Street	9.5	22.9
78	The transect is located at the shoreline of Massachusetts Bay, in the Town of Plymouth, from Herbert Street to approximately 450 feet southwest of 8th Street	9.5	20.1
79	The transect is located at the shoreline of Massachusetts Bay, in the Town of Plymouth, from approximately 450 feet southwest of 8th Street to approximately 450 feet southwest of the First Avenue/Fort Standish Avenue	9.5	20.4
80	The transect is located at the shoreline of Massachusetts Bay, in the Town of Plymouth, from approximately 450 feet southwest of the First Avenue/Fort Standish Avenue to the mouth of Kingston Bay	9.5	21.2
81	The transect is located at the shoreline of Duxbury Bay, in the Town of Duxbury from the Powder Point Bridge to the Upland Road/King Caesar Road intersection	9.5	12.3

[1]Because of map scale limitations, the maximum wave elevation may not be shown on the FIRM.
[2]North American Vertical Datum of 1988

TABLE 13 – REVISED TRANSECT DESCRIPTIONS – continued

TRANSECT	LOCATION	ELEVATION (feet NAVD 88[2]) 1-PERCENT-ANNUAL-CHANCE STILLWATER	MAXIMUM 1-PERCENT ANNUAL CHANCE WAVE CREST[1]
82	The transect is located at the shoreline of Duxbury Bay, in the Town of Duxbury, from the Upland Road/King Caesar Road intersection to Weston Road	9.5	12.1
83	The transect is located at the shoreline of Duxbury Bay, in the Town of Duxbury, from Weston Road to the mouth of Bluefish Lake	9.5	11.0
84	The transect is located at the shoreline of Duxbury Bay, in the Town of Duxbury, from the mouth of Bluefish Lake to Mattakeesett Court	9.5	11.1
85	The transect is located at the shoreline of Duxbury Bay, in the Town of Duxbury, from Mattakeesett Court to Winsor Street	9.5	11.0
86	The transect is located at the shoreline of Duxbury Bay, in the Town of Duxbury, from Winsor Street to Freeman Place	9.5	11.2
87	The transect is located at the shoreline of Duxbury Bay, in the Town of Duxbury, from Freeman Place to Linden Lane	9.5	11.4
88	The transect is located at the shoreline of Duxbury Bay, in the Town of Duxbury, from Linden Lane to Friendship Lane	9.5	11.8
89	The transect is located at the shoreline of Duxbury Bay, in the Town of Duxbury, from Friendship Lane to approximately 300 feet south of Ship Yard Lane	9.5	12.3

[1]Because of map scale limitations, the maximum wave elevation may not be shown on the FIRM.
[2]North American Vertical Datum of 1988

TABLE 13 – REVISED TRANSECT DESCRIPTIONS – continued

TRANSECT	LOCATION	ELEVATION (feet NAVD 88[2]) 1-PERCENT-ANNUAL-CHANCE STILLWATER	MAXIMUM 1-PERCENT ANNUAL CHANCE WAVE CREST[1]
90	The transect is located at the shoreline of Duxbury Bay, in the Town of Duxbury, from approximately 300 feet south of Ship Yard Lane to Wadsworth Lane	9.5	12.0
91	The transect is located at the shoreline of Duxbury Bay, in the Town of Duxbury, from Wadsworth Lane to Hornbeam Road	9.5	12.3
92	The transect is located at the shoreline of Duxbury Bay, in the Town of Duxbury, from Hornbeam Road to approximately 1500 feet northeast of the Marshall Street/Eagles Nest Way Intersection	9.5	12.2
93	The transect is located at the shoreline of Duxbury Bay, in the Town of Duxbury, from approximately 1500 feet northeast of the Marshall Street/Eagles Nest Way Intersection to the Marshall Street/Ocean Avenue intersection	9.5	14.0
94	The transect is located at the shoreline of Duxbury Bay, in the Town of Duxbury, from the Marshall Street/Ocean Avenue intersection to Bradford Road	9.5	12.6
95	The transect is located at the shoreline of Duxbury Bay, in the Town of Duxbury, from Bradford Road to Samoset Road	9.5	16.0
96	The transect is located at the shoreline of Duxbury Bay, in the Town of Duxbury, from Samoset Road to Priscilla Lane	9.5	16.4

[1]Because of map scale limitations, the maximum wave elevation may not be shown on the FIRM.
[2]North American Vertical Datum of 1988

TABLE 13 – REVISED TRANSECT DESCRIPTIONS – continued

TRANSECT	LOCATION	ELEVATION (feet NAVD 88[2]) 1-PERCENT-ANNUAL-CHANCE STILLWATER	MAXIMUM 1-PERCENT ANNUAL CHANCE WAVE CREST[1]
97	The transect is located at the shoreline of Duxbury Bay, in the Town of Duxbury, from Priscilla Lane to Patton Lane	9.5	16.6
98	The transect is located at the shoreline of Kingston Bay, in the Town of Duxbury, from Patton Lane to approximately 550 feet west of the Crescent Street/Howlands Landing intersection	9.5	13.9
99	The transect is located at the shoreline of Kingston Bay, in the Town of Duxbury, from approximately 550 feet west of the Crescent Street/Howlands Landing intersection to Pill Hill Lane	9.5	13.7
100	The transect is located at the shoreline of Kingston Bay, in the Town of Duxbury, from Pill Hill Lane to Beechwood Lane	9.5	13.7
101	The transect is located at the shoreline of Kingston Bay, in the Town of Duxbury, from Beechwood Lane to Grandview Avenue	9.5	13.7
102	The transect is located at the shoreline of Kingston Bay, in the Town of Duxbury, from Grandview Avenue to the Town of Kingston boundary	9.5	12.9
103	The transect is located at the shoreline of Kingston Bay, in the Town of Kingston, from the Town of Kingston boundary to Cedar Lane	9.8	11.8

[1]Because of map scale limitations, the maximum wave elevation may not be shown on the FIRM.
[2]North American Vertical Datum of 1988

TABLE 13 – REVISED TRANSECT DESCRIPTIONS – continued

TRANSECT	LOCATION	ELEVATION (feet NAVD 88[2]) 1-PERCENT-ANNUAL-CHANCE STILLWATER	MAXIMUM 1-PERCENT ANNUAL CHANCE WAVE CREST[1]
104	The transect is located at the shoreline of Kingston Bay, in the Town of Kingston, from Cedar Lane to Leigh Road	9.8	13.2
105	The transect is located at the shoreline of Kingston Bay, in the Town of Kingston, from Leigh Road to West Avenue	9.8	13.1
106	The transect is located at the shoreline of Kingston Bay, in the Town of Kingston, from West Avenue to Lantern Lane	9.8	16.8
107	The transect is located at the shoreline of Kingston Bay, in the Town of Kingston, from Lantern Lane to Gray Beach Road	9.8	16.4
108	The transect is located at the shoreline of Kingston Bay, in the Town of Kingston, from Gray Beach Road to Off Boundary Street	9.8	16.4
109	The transect is located at the shoreline of Kingston Bay, in the Town of Kingston, from Off Boundary Street to approximately 1100 feet east of the Boundary Street/Off Boundary Street intersection	9.8	16.4
110	The transect is located at the shoreline of Kingston Bay, in the Town of Plymouth, from approximately 1100 feet east of the Boundary Street/Off Boundary Street intersection to approximately 800 feet northwest of the Hedge Road/Sandi Drive intersection	9.5	17.6

[1]Because of map scale limitations, the maximum wave elevation may not be shown on the FIRM.
[2]North American Vertical Datum of 1988

TABLE 13 – REVISED TRANSECT DESCRIPTIONS – continued

TRANSECT	LOCATION	ELEVATION (feet NAVD 88[2]) 1-PERCENT-ANNUAL-CHANCE STILLWATER	MAXIMUM 1-PERCENT ANNUAL CHANCE WAVE CREST[1]
111	The transect is located at the shoreline of Kingston Bay, in the Town of Plymouth, from approximately 800 feet northwest of the Hedge Road/Sandi Drive intersection to approximately 700 feet northeast of the Hedge Road/Sandi Drive intersection	9.5	16.8
112	The transect is located at the shoreline of Plymouth Harbor, in the Town of Plymouth, from approximately 700 feet northeast of the Hedge Road/Sandi Drive intersection to Knapp Terrace	9.5	16.5
113	The transect is located at the shoreline of Plymouth Bay, in the Town of Plymouth, from Knapp Terrace to Lothrop Street	9.5	20.2
114	The transect is located at the shoreline of Plymouth Bay, in the Town of Plymouth, from Lothrop Street to the Water Street/Union Street intersection	9.5	19.0
115	The transect is located at the shoreline of Plymouth Bay, in the Town of Plymouth, from the Water Street/Union Street intersection to Ruffini Terrace	9.5	19.3
116	The transect is located at the shoreline of Plymouth Bay, in the Town of Plymouth, from Ruffini Terrace to Manters Point Road	9.5	21.5

[1]Because of map scale limitations, the maximum wave elevation may not be shown on the FIRM.
[2]North American Vertical Datum of 1988

TABLE 13 – REVISED TRANSECT DESCRIPTIONS – continued

TRANSECT	LOCATION	ELEVATION (feet NAVD 88[2]) 1-PERCENT-ANNUAL-CHANCE STILLWATER	MAXIMUM 1-PERCENT ANNUAL CHANCE WAVE CREST[1]
117	The transect is located at the shoreline of Plymouth Bay, in the Town of Plymouth, from Manters Point Road to approximately 250 feet east of the State Highway 3A/Ryder Way intersection	9.5	20.3
118	The transect is located at the shoreline of Plymouth Bay, in the Town of Plymouth, from approximately 250 feet east of the State Highway 3A/Ryder Way intersection to Bay Colony Drive	9.5	22.9
119	The transect is located at the shoreline of Plymouth Bay, in the Town of Plymouth, from Bay Colony Drive to Clay Hill Drive	9.5	23.2
120	The transect is located at the shoreline of Plymouth Bay, in the Town of Plymouth, from Clay Hill Drive to approximately 830 feet north east of the Bay Shore Drive/Gate Road intersection	9.5	23.2
121	The transect is located at the shoreline of Cape Cod Bay, in the Town of Plymouth, from approximately 830 feet north east of the Bay Shore Drive/Gate Road intersection to approximately 3000 feet northwest of the Rocky Hill Road/Power Hill Road intersection	9.5	20.8
122	The transect is located at the shoreline of Cape Cod Bay, in the Town of Plymouth, from approximately 3000 feet northwest of the Rocky Hill Road/Power Hill Road intersection to approximately 1500 feet northwest of the Rocky Hill Road/Power Hill Road intersection	9.5	22.8

[1]Because of map scale limitations, the maximum wave elevation may not be shown on the FIRM.
[2]North American Vertical Datum of 1988

TABLE 13 – REVISED TRANSECT DESCRIPTIONS – continued

TRANSECT	LOCATION	ELEVATION (feet NAVD 88[2]) 1-PERCENT-ANNUAL-CHANCE STILLWATER	MAXIMUM 1-PERCENT ANNUAL CHANCE WAVE CREST[1]
123	The transect is located at the shoreline of Cape Cod Bay, in the Town of Plymouth, from approximately 1500 feet northwest of the Rocky Hill Road/Power Hill Road intersection to Warrendale Road	9.5	21.9
124	The transect is located at the shoreline of Cape Cod Bay, in the Town of Plymouth, from Warrendale Road to Cochituate Road	9.5	19.9
125	The transect is located at the shoreline of Cape Cod Bay, in the Town of Plymouth, from Cochituate Road to White Horse Road	9.5	21.5
126	The transect is located at the shoreline of Cape Cod Bay, in the Town of Plymouth, from White Horse Road to William Avenue	9.5	21.4
127	The transect is located at the shoreline of Cape Cod Bay, in the Town of Plymouth, from William Avenue to Short Street	9.5	20.2
128	The transect is located at the shoreline of Cape Cod Bay, in the Town of Plymouth, from Short Street to Hilltop Avenue	9.5	21.5
129	The transect is located at the shoreline of Cape Cod Bay, in the Town of Plymouth, from Hilltop Avenue to Boat House Lane	9.5	20.4

[1]Because of map scale limitations, the maximum wave elevation may not be shown on the FIRM.
[2]North American Vertical Datum of 1988

TABLE 13 – REVISED TRANSECT DESCRIPTIONS – continued

TRANSECT	LOCATION	ELEVATION (feet NAVD 88[2]) 1-PERCENT-ANNUAL-CHANCE STILLWATER	MAXIMUM 1-PERCENT ANNUAL CHANCE WAVE CREST[1]
130	The transect is located at the shoreline of Cape Cod Bay, in the Town of Plymouth, from Boat House Lane to approximately 630 feet north of the Manomet Point Road/Bancrofts landing intersection	9.5	24.1
131	The transect is located at the shoreline of Cape Cod Bay, in the Town of Plymouth, from approximately 630 feet north of the Manomet Point Road/Bancrofts landing intersection to approximately 1150 feet southeast of the Manomet Point Road/Montrose Avenue intersection	9.5	25.0
132	The transect is located at the shoreline of Cape Cod Bay, in the Town of Plymouth, from approximately 1150 feet southeast of the Manomet Point Road/Montrose Avenue intersection to Strand Avenue	9.5	20.3
133	The transect is located at the shoreline of Cape Cod Bay, in the Town of Plymouth, from Strand Avenue to Old Beach Road	9.5	20.2
134	The transect is located at the shoreline of Cape Cod Bay, in the Town of Plymouth, from Old Beach Road to Bass Road	9.5	21.5
135	The transect is located at the shoreline of Cape Cod Bay, in the Town of Plymouth, from Bass Road to approximately 300 feet south east of Perch Road	9.5	23.3

[1]Because of map scale limitations, the maximum wave elevation may not be shown on the FIRM.
[2]North American Vertical Datum of 1988

TABLE 13 – REVISED TRANSECT DESCRIPTIONS – continued

TRANSECT	LOCATION	ELEVATION (feet NAVD 88[2]) 1-PERCENT-ANNUAL-CHANCE STILLWATER	MAXIMUM 1-PERCENT ANNUAL CHANCE WAVE CREST[1]
136	The transect is located at the shoreline of Cape Cod Bay, in the Town of Plymouth, from approximately 300 feet south east of Perch Road to Pond View Circle	9.5	22.6
137	The transect is located at the shoreline of Cape Cod Bay, in the Town of Plymouth, from Pond View Circle to Cranberry Lane	9.5	19.6
138	The transect is located at the shoreline of Cape Cod Bay, in the Town of Plymouth, from Cranberry Lane to approximately 550 feet southeast of Pilgrim way	9.5	21.2
139	The transect is located at the shoreline of Cape Cod Bay, in the Town of Plymouth, from approximately 550 feet southeast of Pilgrim way to Black Pond Lane	9.5	20.0
140	The transect is located at the shoreline of Cape Cod Bay, in the Town of Plymouth, from Black Pond Lane to Harlow's Landing	9.5	21.5
141	The transect is located at the shoreline of Cape Cod Bay, in the Town of Plymouth, from Harlow's Landing to approximately 2400 feet south of Harlow's Landing	9.5	19.8

[1]Because of map scale limitations, the maximum wave elevation may not be shown on the FIRM.
[2]North American Vertical Datum of 1988

TABLE 13 – REVISED TRANSECT DESCRIPTIONS – continued

TRANSECT	LOCATION	ELEVATION (feet NAVD 88[2]) 1-PERCENT-ANNUAL-CHANCE STILLWATER	MAXIMUM 1-PERCENT ANNUAL CHANCE WAVE CREST[1]
142	The transect is located at the shoreline of Cape Cod Bay, in the Town of Plymouth, from approximately 2400 feet south of Harlow's Landing to approximately 1350 feet south of Salt Marsh Lane	9.5	19.9
143	The transect is located at the shoreline of Cape Cod Bay, in the Town of Plymouth, from approximately 1,350 feet south of Salt Marsh Lane to the State Road 3A/Admiral Halsey Road intersection	9.5	20.5
144	The transect is located at the shoreline of Cape Cod Bay, in the Town of Plymouth, from the State Road 3A/Admiral Halsey Road intersection to Nonantum Road	9.5	20.5
145	The transect is located at the shoreline of Cape Cod Bay, in the Town of Plymouth, from Nonantum Road to Plymouth/Barnstable County Boundary	9.5	21.8

[1]Because of map scale limitations, the maximum wave elevation may not be shown on the FIRM.
[2]North American Vertical Datum of 1988

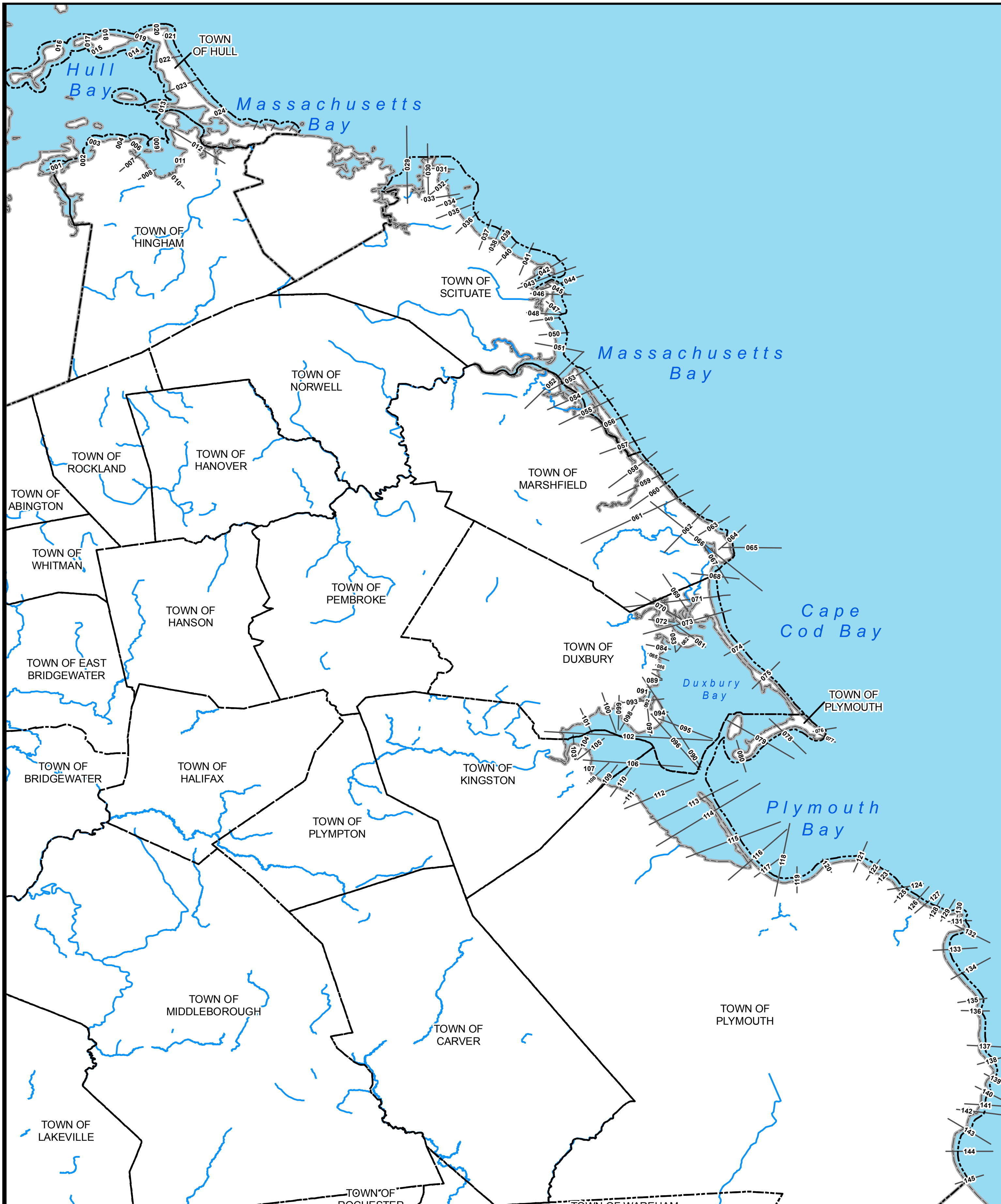

FIGURE 2

FEDERAL EMERGENCY MANAGEMENT AGENCY

PLYMOUTH, MA

(ALL JURISDICTIONS)

APPROXIMATE SCALE

0 14,000 28,000 42,000 56,000 Feet

TRANSECT LOCATION MAP

The results of the coastal analysis using detailed methods are summarized in Table 14, "Revised 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 different flooding sources, including effects of wave setup where applicable.

TABLE 14 – REVISED TRANSECT DATA

	STILLWATER ELEVATIONS (FEET NAVD88[3])				TOTAL WATER LEVEL[1]		
TRANSECT	10-PERCENT-ANNUAL CHANCE	2-PERCENT-ANNUAL-CHANCE	1-PERCENT-ANNUAL-CHANCE	0.2-PERCENT-ANNUAL-CHANCE	1-PERCENT-ANNUAL-CHANCE	ZONE	BASE FLOOD ELEVATION (FEET NAVD 88[2,3])
29	8.3	9.1	9.5	10.3	12.3	AE	13-14
						VE	14
30	8.3	9.1	9.5	10.3	14.7	AE	14-15
						VE	15
31	8.3	9.1	9.5	10.3	15.3	AE	14
						VE	20
32	8.3	9.1	9.5	10.3	15.6	AE	13-15
						VE	20
33	8.3	9.1	9.5	10.3	14.9	AE	14-15
						VE	19
34	8.3	9.1	9.5	10.3	14.9	VE	21
35	8.3	9.1	9.5	10.3	15.0	AE	11-16
						AO	3
						VE	16
36	8.3	9.1	9.5	10.3	13.7	AE	14
						VE	16

[1]Including stillwater elevation and effects of wave setup.
[2]Due to map scale limitations, base flood elevations shown on the FIRM represent average elevations for the zones depicted.
[3]North American Vertical Datum of 1988

TABLE 14 – REVISED TRANSECT DATA - continued

TRANSECT	STILLWATER ELEVATIONS (FEET NAVD88[3]) 10-PERCENT-ANNUAL CHANCE	2-PERCENT-ANNUAL-CHANCE	1-PERCENT-ANNUAL-CHANCE	0.2-PERCENT-ANNUAL-CHANCE	TOTAL WATER LEVEL[1] 1-PERCENT-ANNUAL-CHANCE	ZONE	BASE FLOOD ELEVATION (FEET NAVD 88[2,3])
37	8.3	9.1	9.5	10.3	13.2	AE	14
						VE	16
38	8.3	9.1	9.5	10.3	13.7	AE	15
						VE	16-17
39	8.3	9.1	9.5	10.3	15	VE	18
40	8.3	9.1	9.5	10.3	15.3	AE	15
						VE	18
41	8.3	9.1	9.5	10.3	14.6	AE	16
						VE	19
42	8.3	9.1	9.5	10.3	11.4	AE	15-16
						VE	16
43	8.3	9.1	9.5	10.3	13.5	AE	14
						VE	18
44	8.3	9.1	9.5	10.3	14.9	AE	15-16
						VE	19
45	8.3	9.1	9.5	10.3	15.1	VE	21
46	8.3	9.1	9.5	10.3	14.9	AE	15-16
						VE	18
47	8.3	9.1	9.5	10.3	15.7	AE	15
						VE	21

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

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

[3]North American Vertical Datum of 1988

TABLE 14 – REVISED TRANSECT DATA - continued

TRANSECT	STILLWATER ELEVATIONS (FEET NAVD88[3]) 10-PERCENT-ANNUAL CHANCE	2-PERCENT-ANNUAL-CHANCE	1-PERCENT-ANNUAL-CHANCE	0.2-PERCENT-ANNUAL-CHANCE	TOTAL WATER LEVEL[1] 1-PERCENT-ANNUAL-CHANCE	ZONE	BASE FLOOD ELEVATION (FEET NAVD 88[2,3])
48	8.3	9.1	9.5	10.3	13.9	AE	14
						VE	17
49	8.3	9.1	9.5	10.3	15.8	AE	14
						VE	19
50	8.3	9.1	9.5	10.3	15.3	AE	14
						VE	22
51	8.3	9.1	9.5	10.3	14.9	AE	16
						VE	17
52	8.3	9.1	9.5	10.3	12.7	AE	13-15
						VE	17
53	8.3	9.1	9.5	10.3	15.3	AE	14-15
						VE	23
54	8.3	9.1	9.5	10.3	15.1	AE	13-15
						VE	16-18
55	8.3	9.1	9.5	10.3	13.6	AE	10-14
						VE	13-15
56	8.3	9.1	9.5	10.3	13.7	AE	10-13
						VE	16
57	8.3	9.1	9.5	10.3	14.5	AE	10-14
						VE	17

[1]Including stillwater elevation and effects of wave setup.
[2]Due to map scale limitations, base flood elevations shown on the FIRM represent average elevations for the zones depicted.
[3]North American Vertical Datum of 1988

TABLE 14 – REVISED TRANSECT DATA - continued

	STILLWATER ELEVATIONS (FEET NAVD88[3])				TOTAL WATER LEVEL[1]		
TRANSECT	10-PERCENT-ANNUAL CHANCE	2-PERCENT-ANNUAL-CHANCE	1-PERCENT-ANNUAL-CHANCE	0.2-PERCENT-ANNUAL-CHANCE	1-PERCENT-ANNUAL-CHANCE	ZONE	BASE FLOOD ELEVATION (FEET NAVD 88[2,3])
58	8.3	9.1	9.5	10.3	13.6	AE	9*-15
						VE	17
59	8.3	9.1	9.5	10.3	14.4	AE	9*-15
						VE	18
60	8.3	9.1	9.5	10.3	13.6	AE	9*
						VE	17
61	8.3	9.1	9.5	10.6	13.6	AE	14-15
						AO	3
						VE	17
62	8.3	9.1	9.5	10.6	15.1	AE	15
						VE	18
63	8.3	9.1	9.5	10.6	14.8	VE	19
64	8.3	9.1	9.5	10.6	14.7	AE	16
						VE	18
65	8.3	9.1	9.5	10.6	15.3	AE	16
						VE	20
66	8.3	9.1	9.5	10.6	15.3	AE	16
						VE	22
67	8.3	9.1	9.5	10.6	13.6	AE	16
						VE	16

*Based on additional material submitted by community
[1]Including stillwater elevation and effects of wave setup.
[2]Due to map scale limitations, base flood elevations shown on the FIRM represent average elevations for the zones depicted.
[3]North American Vertical Datum of 1988

TABLE 14 – REVISED TRANSECT DATA - continued

TRANSECT	STILLWATER ELEVATIONS (FEET NAVD88[3]) 10-PERCENT-ANNUAL CHANCE	2-PERCENT-ANNUAL-CHANCE	1-PERCENT-ANNUAL-CHANCE	0.2-PERCENT-ANNUAL-CHANCE	TOTAL WATER LEVEL[1] 1-PERCENT-ANNUAL-CHANCE	ZONE	BASE FLOOD ELEVATION (FEET NAVD 88[2,3])
68	8.3	9.1	9.5	10.6	15.3	AE	16
						VE	17
69	8.3	9.1	9.5	10.3	9.5	AE	10
						VE	10-13
70	8.3	9.1	9.5	10.3	9.6	AE	10
						VE	11-13
71	8.3	9.1	9.5	10.3	14.7	AO	3
						VE	10-17
72	8.3	9.1	9.5	10.3	9.6	VE	10-13
73	8.3	9.1	9.5	10.3	13.9	AE	10-16
						VE	12-16
74	8.3	9.1	9.5	10.3	13.8	AE	16
						VE	16
75	8.3	9.1	9.5	10.3	13.8	AE	15-16
						VE	16-17
76	8.3	9.1	9.5	10.3	14.9	AE	15
						VE	17
77	8.3	9.1	9.5	10.3	15.3	VE	18
78	8.3	9.1	9.5	10.3	13.1	AE	14
						VE	15

[1]Including stillwater elevation and effects of wave setup.
[2]Due to map scale limitations, base flood elevations shown on the FIRM represent average elevations for the zones depicted.
[3]North American Vertical Datum of 1988

TABLE 14 – REVISED TRANSECT DATA - continued

TRANSECT	STILLWATER ELEVATIONS (FEET NAVD88[3]) 10-PERCENT-ANNUAL CHANCE	2-PERCENT-ANNUAL-CHANCE	1-PERCENT-ANNUAL-CHANCE	0.2-PERCENT-ANNUAL-CHANCE	TOTAL WATER LEVEL[1] 1-PERCENT-ANNUAL-CHANCE	ZONE	BASE FLOOD ELEVATION (FEET NAVD 88[2,3])
79	8.3	9.1	9.5	10.3	13.3	AE	14
						VE	15
80	8.3	9.1	9.5	10.3	13.8	AE	16
						VE	16
81	8.3	9.1	9.5	10.3	10.5	VE	13-15
82	8.3	9.1	9.5	10.3	10.9	VE	12
83	8.3	9.1	9.5	10.3	9.6	AE	10
						VE	12
84	8.3	9.1	9.5	10.3	9.6	AE	10-11
						VE	12
85	8.3	9.1	9.5	10.3	9.6	AE	10
						VE	12
86	8.3	9.1	9.5	10.3	9.6	AE	10
						VE	12
87	8.3	9.1	9.5	10.3	10.3	VE	12
88	8.3	9.1	9.5	10.3	9.8	AE	10
						VE	12
89	8.3	9.1	9.5	10.3	10.1	VE	15

[1]Including stillwater elevation and effects of wave setup.
[2]Due to map scale limitations, base flood elevations shown on the FIRM represent average elevations for the zones depicted.
[3]North American Vertical Datum of 1988

TABLE 14 – REVISED TRANSECT DATA - continued

TRANSECT	STILLWATER ELEVATIONS (FEET NAVD88[3]) 10-PERCENT-ANNUAL CHANCE	2-PERCENT-ANNUAL-CHANCE	1-PERCENT-ANNUAL-CHANCE	0.2-PERCENT-ANNUAL-CHANCE	TOTAL WATER LEVEL[1] 1-PERCENT-ANNUAL-CHANCE	ZONE	BASE FLOOD ELEVATION (FEET NAVD 88[2,3])
90	8.3	9.1	9.5	10.3	9.8	VE	12-17
91	8.3	9.1	9.5	10.3	9.9	VE	12
92	8.3	9.1	9.5	10.3	9.8	AE	11
						VE	12
93	8.3	9.1	9.5	10.3	11.5	AE	11-13
						VE	12-14
94	8.3	9.1	9.5	10.3	10.1	AE	11
						VE	12-14
95	8.3	9.1	9.5	10.3	10.6	VE	13-17
96	8.3	9.1	9.5	10.3	11.0	AE	11
						VE	13-17
97	8.3	9.1	9.5	10.3	11.3	AE	11
						VE	12-13
98	8.3	9.1	9.5	10.3	10.2	VE	15
99	8.3	9.1	9.5	10.3	10.0	AE	11
						VE	12-15
100	8.3	9.1	9.5	10.3	10.0	AE	11
						VE	12-15

[1]Including stillwater elevation and effects of wave setup.
[2]Due to map scale limitations, base flood elevations shown on the FIRM represent average elevations for the zones depicted.
[3]North American Vertical Datum of 1988

TABLE 14 – REVISED TRANSECT DATA - continued

TRANSECT	STILLWATER ELEVATIONS (FEET NAVD88[3]) 10-PERCENT-ANNUAL CHANCE	2-PERCENT-ANNUAL-CHANCE	1-PERCENT-ANNUAL-CHANCE	0.2-PERCENT-ANNUAL-CHANCE	TOTAL WATER LEVEL[1] 1-PERCENT-ANNUAL-CHANCE	ZONE	BASE FLOOD ELEVATION (FEET NAVD 88[2,3])
101	8.3	9.1	9.5	10.3	10.1	AE	11
						VE	12
102	8.3	9.1	9.5	10.3	9.8	AE	10
						VE	12-17
103	8.3	9.1	9.8	10.7	11.2	AE	11
						VE	12
104	8.6	9.5	9.8	10.7	10.9	VE	12
105	8.6	9.5	9.8	10.7	10.6	VE	13-15
106	8.6	9.5	9.8	10.7	11.3	VE	13-17
107	8.6	9.5	9.8	10.7	11.0	AE	11
						VE	13
108	8.6	9.5	9.8	10.7	11.3	VE	13
109	8.6	9.5	9.8	10.7	11.0	VE	15
110	8.3	9.1	9.5	10.3	11.5	VE	14
111	8.3	9.1	9.5	10.3	11.5	AE	11
						VE	15
112	8.3	9.1	9.5	10.3	11.2	VE	15-17
113	8.3	9.1	9.5	10.3	13.2	AE	13-14
						VE	15

[1]Including stillwater elevation and effects of wave setup.
[2]Due to map scale limitations, base flood elevations shown on the FIRM represent average elevations for the zones depicted.
[3]North American Vertical Datum of 1988

TABLE 14 – REVISED TRANSECT DATA - continued

TRANSECT	STILLWATER ELEVATIONS (FEET NAVD88[3]) 10-PERCENT-ANNUAL CHANCE	2-PERCENT-ANNUAL-CHANCE	1-PERCENT-ANNUAL-CHANCE	0.2-PERCENT-ANNUAL-CHANCE	TOTAL WATER LEVEL[1] 1-PERCENT-ANNUAL-CHANCE	ZONE	BASE FLOOD ELEVATION (FEET NAVD 88[2,3])
114	8.3	9.1	9.5	10.3	12.4	AE	13
						VE	15
115	8.3	9.1	9.5	10.3	12.6	AE	14
						VE	15
116	8.3	9.1	9.5	10.3	13.6	AE	15-16
						VE	16
117	8.3	9.1	9.5	10.3	13.3	AE	15
						VE	15
118	8.3	9.1	9.5	10.3	14.5	AE	10-15
						VE	17
119	8.3	9.1	9.5	10.3	14.8	VE	18
120	8.3	9.1	9.5	10.3	15.2	VE	23
121	8.3	9.1	9.5	10.3	13.7	VE	16
122	8.3	9.1	9.5	10.3	14.6	VE	17
123	8.3	9.1	9.5	10.3	14.4	VE	16
124	8.3	9.1	9.5	10.3	13.0	VE	15
125	8.3	9.1	9.5	10.3	13.8	VE	16
126	8.3	9.1	9.5	10.3	13.8	AE	14
						VE	16

[1]Including stillwater elevation and effects of wave setup.
[2]Due to map scale limitations, base flood elevations shown on the FIRM represent average elevations for the zones depicted.
[3]North American Vertical Datum of 1988

TABLE 14 – REVISED TRANSECT DATA - continued

TRANSECT	STILLWATER ELEVATIONS (FEET NAVD88[3]) 10-PERCENT-ANNUAL CHANCE	2-PERCENT-ANNUAL-CHANCE	1-PERCENT-ANNUAL-CHANCE	0.2-PERCENT-ANNUAL-CHANCE	TOTAL WATER LEVEL[1] 1-PERCENT-ANNUAL-CHANCE	ZONE	BASE FLOOD ELEVATION (FEET NAVD 88[2,3])
127	8.3	9.1	9.5	10.3	13.2	AE	14-15
						VE	15
128	8.3	9.1	9.5	10.3	13.9	AE	14
						VE	16
129	8.3	9.1	9.5	10.3	13.4	AE	13
						VE	15
130	8.3	9.1	9.5	10.3	13.8	VE	17
131	8.3	9.1	9.5	10.3	14.7	VE	17
132	8.3	9.1	9.5	10.3	13.3	VE	15
133	8.3	9.1	9.5	10.3	12.9	VE	15
134	8.3	9.1	9.5	10.3	13.8	VE	16
135	8.3	9.1	9.5	10.3	14.9	VE	18
136	8.3	9.1	9.5	10.3	14.4	VE	17
137	8.3	9.1	9.5	10.3	12.8	AE	14
						VE	15
138	8.3	9.1	9.5	10.3	13.7	VE	16
139	8.3	9.1	9.5	10.3	13.1	AE	14
						VE	15

[1]Including stillwater elevation and effects of wave setup.
[2]Due to map scale limitations, base flood elevations shown on the FIRM represent average elevations for the zones depicted.
[3]North American Vertical Datum of 1988

TABLE 14 – REVISED TRANSECT DATA - continued

TRANSECT	STILLWATER ELEVATIONS (FEET NAVD88[3]) 10-PERCENT-ANNUAL CHANCE	2-PERCENT-ANNUAL-CHANCE	1-PERCENT-ANNUAL-CHANCE	0.2-PERCENT-ANNUAL-CHANCE	TOTAL WATER LEVEL[1] 1-PERCENT-ANNUAL-CHANCE	ZONE	BASE FLOOD ELEVATION (FEET NAVD 88[2,3])
140	8.3	9.1	9.5	10.3	13.5	AE	14-15
						VE	16
141	8.3	9.1	9.5	10.3	13.0	AE	13-15
						VE	15
142	8.3	9.1	9.5	10.3	13.1	AE	14-15
						VE	15
143	8.3	9.1	9.5	10.3	13.2	VE	16
144	8.3	9.1	9.5	10.3	13.4	VE	16
145	8.3	9.1	9.5	10.3	14.0	VE	16

[1]Including stillwater elevation and effects of wave setup.
[2]Due to map scale limitations, base flood elevations shown on the FIRM represent average elevations for the zones depicted.
[3]North American Vertical Datum of 1988

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 (NGVD29). With the completion of the North American Vertical Datum of 1988 (NAVD88), many FIS reports and FIRMs are now prepared using NAVD88 as the referenced vertical datum.

All flood elevations shown in this FIS report and on the FIRM are referenced to the NAVD88. These flood elevations must be compared to structure and ground elevations referenced to the same vertical datum. Ground, structure, and flood elevations may be compared and/or referenced to NGVD29 by applying a standard conversion factor. **The conversion factor from NGVD29 to NAVD88 is -0.8, and from NAVD88 to NGVD29 is +0.8.**

For information regarding conversion between the NGVD29 and NAVD88, 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

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

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

Stability A: Monuments of the most reliable nature, expected to hold position/elevation well (e.g., mounted in bedrock)

Stability B: Monuments which generally hold their position/elevation well (e.g., concrete bridge abutment)

Stability C: Monuments which may be affected by surface ground movements (e.g., concrete monument below frost line)

Stability D: Mark of questionable or unknown vertical stability (e.g., concrete monument above frost line, or steel witness post)

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

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.

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 NGVD29 should apply the stated conversion factor 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.

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.